Government of Odisha (GOO)
Chief Engineer, World Bank Projects, Odisha
Odisha State Roads Project

Consultancy Services for Road Sector Institutional Development Loan # 7577-IN

ROAD INFRASTRUCTURE SAFETY MANAGEMENT REVIEW

VOLUME I - REPORT

Intercontinental Consultants and Technocrats Pvt Ltd

In joint venture with
Grant Thornton Advisory Pvt. Ltd.

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Abbreviations

AE	Assistant Engineer
ARRB	Australian Road Research Board
BUA	Built up Area
CE	Chief Engineer
Ch.	Chainage
CMVR	Central Motor Vehicle Rules
CRF	Central Road Fund
CRRI	Central Road Research Institute
EE	Executive Engineer
EIC	Engineer-In-Chief
FPRA	Forum for Prevention of Road Accidents
GED	General Electric Department
GoI	Government of India
GoO	Government of Odisha
GRSP	Global Road Safety Partnership
GT-APL	Grant Thornton Advisory Pvt. Ltd.
HMV	Heavy Motor Vehicle
IAHE	Indian Academy of Highway Engineers
ICU	Intensive Care Unit
IDS	Institutional Development Strategy
IG	Inspector General
IRAP	International Road Assessment Programme
IRC	Indian Roads Congress
IRF	International Road Federation
ISAP	Institutional Strengthening Action Plan
JE	Junior Engineer
LASA	LEA Associates South Asia Pvt. Ltd.
LCV	Light Commercial Vehicle
MC	Municipal Corporation
MDR	Major District Road
MoRT&H	Ministry of Road Transport and Highways
MV	Motor Vehicle
MVI	Motor Vehicle Inspector
NCC	National Cadet Corporation
NCERT	National Council of Educational Research and Training
NCRB	National Crime Records Bureau
NGO	Non-Government Organisation

NH	National Highway
NHAI	National Highways Authority of India
NITHE	National Institute for Training of Highway Engineers
ODR	Other District Road
OHM	Object Hazard Marker
ORSS	Odisha Road Safety Society
OSRP	Odisha State Roads Project
OSRTC	Odisha State Road Transport Corporation
OWD	Odisha Works Department
PMU	Project Management Unit
PHD	Public Health Department
PWD	Public Works Department
R&B	Roads and Bridges
Rd	Road
RD	Rural Development
RDD	Rural Development Department
RRPM	Raised Reflective Pavement Marker
RSAP	Road Safety Action Plan
RSID	Road Sector Institutional Development
RTA	Regional Transport Authority
RTO	Regional Transport Officer
SCERT	State Council of Educational Research and Training
SCRB	State Crime Records Bureau
SE	Superintending Engineer
SH	State Highway
SMEC	Snowy Mountain Engineering Corporation
SRSC	State Road Safety Council
STA	State Transport Authority
TMC	Traffic Management Centre
ToR	Terms of Reference
VR	Village Road
VRU	Vulnerable Road User
WB	World Bank

Executive Summary

I. Introduction

During late 1990s, GOO has commissioned Snowy Mountains Engineering Corporation (SMEC) to review the prevalent institutional and financial structures and processes associated with the OWD and develop an Institutional Development Strategy (IDS) which is focused on the OWD and its linkages with other road sector agencies. Following the recommendations of IDS, during mid-2000s, GOO has initiated the new OSRP, with the support of World Bank, and developed an Institutional Strengthening Action Plan (ISAP) for phased implementation.

Following the recommendations of ISAP, the OWD called for consultancy services for Odisha Road Sector Institutional Development Study (RSID), in which '**Road Safety Engineering and Planning**' is initiated among various other tasks.

II. Objectives and approach to Study

The following are the major objectives to achieve under the task 'Road Safety Engineering and Planning'.

- Develop a road safety action plan for the State including engineering and institutional improvements, which if implemented can reduce the rate of accidents in Odisha
- Assist the capacity building of OWD design units in road safety engineering

The terms of reference for the task 'road safety engineering and planning' require the consultants to:

1. **Execute a road infrastructure safety management review of relevant OWD engineering functions and of a limited sample survey of road network;**
2. **Conduct a preliminary assessment of the current road safety responsibility framework in the state;**
3. Provide technical capacity building in road safety design to OWD units;
4. Facilitate a high level workshop to explore GOO's concerns, aims and priorities to improve road safety management; and
5. Facilitate GOO planning for more strategic externally-assisted multi-sectoral measures to improve overall road safety management strategy, capacity and outcomes in Odisha.

This report aims to satisfy the tasks outlined in points 1 and 2 above.

III. Methodology adopted for the Study

To prepare the road safety action plan, it is required to collect, compile and analyses the crash data of the state and also to have a safety assessment of the road network. The terms of reference identified potential sources of data as police crash database, hospital and medical data, insurance data and special sample surveys of road network sections covering at least selected stretch of 2000 km of roads in rolling/ plain/ mountainous terrains besides major urban roads.

The consultants has collected crash data from the State Crime Records Bureau(SCRB) and other sources and conducted road safety assessment on 2000 km in selected districts. The districts were road safety assessment were conducted are shown below.

- Balasore
- Keonjhar

- Cuttack
- Ganjam
- Jajpur
- Khurdha
- Sambalpur
- Sundargarh

The above districts were selected based on the following criteria:

1. Select the districts where average number of fatalities in NHs are greater than 80
2. Select the districts, where average number of fatalities in SHs are greater than 50

The average number of fatalities on different road categories (NH, SH and other roads) during the period 2009-11, is shown in **Figure I**. This figure was used to select the districts for road safety assessment.

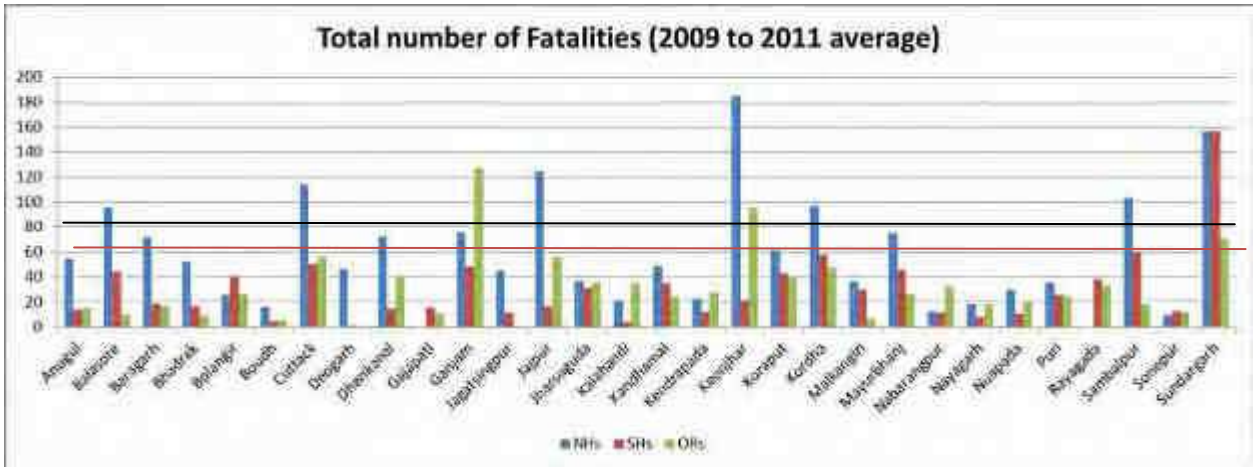

Figure I: Average number of Fatalities (2009-11) - Odisha

Following discussions with OWD, it was decided not to consider the roads managed by NHAI, since it is recognized that the same will be taken up for improvements by NHAI irrespective of OWD's interventions. Hence, it was decided to focus more on SHs and MDRs and some selected NHs managed by Ministry through the OWD in these selected districts.

The road safety assessment was carried out by 4 teams, each led by experienced road safety experts, during the months of November and December 2012. The category of roads and the corresponding length assessed on the selected districts is shown below.

- National Highways – 396.50 Km
- State Highways - 984.50 Km
- Major District Roads - 391.7 Km
- Other District Roads - 205.50 Km
- Rural Roads - 31 Km

A total length of 2009 km was assessed to determine the general hazards affecting road safety on the state road network.

IV. Crash Data Analysis

The crash data available with the SCRB does not help to conduct a thorough accident analysis, since it is not in desirable format to conduct an appropriate accident investigation and prevention analysis. However, it has enough data to determine the broad issues affecting road safety in the State. However, it is essential to point out that Odisha requires an efficient and scientific road crash database management

system to implement accident prevention and investigation techniques based on data gathered in scientific manner.

An attempt has been made in this report to find a correlation between the nature of accidents happening on various categories of roads and road type, road user and the locations. The key findings of crash data analysis is given below.

Crash data analysis – Key findings
• Though National Highways and State Highways constitute only 11 percent of the state road network, which carried low to high volume of traffic (excluding Panchayat roads), approximate 75 percent of crashes occur on these roads; • Around 40 percent of road crashes occur in open rural areas, while the remaining 50 percent occur around populated areas like 'inside a village' or other built-up areas, where the traffic mix with the vulnerable road users and 10 percent near narrow bridges/ culverts; • Around 28 percent of fatalities occur among the truck drivers and passengers, 26 percent among vulnerable road users (pedestrians, cyclists and motorized two wheelers) and 18 percent of fatalities among users of passenger cars; • Among the nature of accidents, 19 percent of fatalities are due to head-on collisions, 17 percent due to 'Overturning', 15 percent due to right turn and rear end collisions, and 30 percent due to 'Others'. The collision types in 'Others' category might include run-off accidents, hit pedestrian and hit road side objects like large trees and street lighting and electric poles; and • Crash data indicates sharp horizontal curves and junction (major and minor) locations might be the major hazardous locations in the State.

V. Road Safety Assessment – Key Findings

The detailed findings of road safety assessment and the suggested engineering countermeasures to improve the road safety at these hazardous locations are given in chapters 3 to 14 of this report. The typical drawings of engineering countermeasures are given in Appendix III in Volume II of this report. The key findings (major hazards) for different road categories are summarized below.

Road Safety Hazards on National Highways
<u>Four lane dual carriageway</u> • Frequent number of side roads joining NH carriageway in hazardous manner • Unsafe geometric profile of side roads joining main carriageway and lack of speed reduction measures on side roads • Inappropriate locations of median opening encouraging contra flow in 4-lane highway • Poor visibility at median opening due to overgrown vegetation in median on 4-lane highway • Poorly delineated sharp curves • Lack of warning signs for pedestrian crossing and side roads and direction signs • Poor condition of road markings – Edge lines and centre lines • Hazardous geometry at median openings (unsafe level difference between carriageways in two

directions)

- Lack of facilities for pedestrians (crossing and walking along in built up areas)
- Lack of designed designated comfort space for trucks, buses and other long distance travelers forcing vehicles to park on the road side creating hazardous situations
- Lack of street lighting in built up areas
- Lack of protection on locations of high embankments and approaches to bridges
- Poor junction layouts

Two Lane, Intermediate Lane & Single Lane roads

- Sharp horizontal curves without delineation, warning signs and traffic calming measures
- Lack of reflective centre line road markings (normal, warning and no overtaking) on intermediate and two lane roads
- Lack of reflective edge lines
- Poor junction layouts (major and minor)
- Poor visibility at junction locations due to encroachments and other road side objects like trees
- Unprotected and poorly delineated high embankment and approach to bridges
- Lack of warning signs and speed reduction measures on side roads
- Presence of road side objects such as trees and poles on road edges
- Unsafe vertical profile of side roads at junction locations with the main carriageway
- Roadside villages lacking speed control measures on approaches, and lack of facilities of pedestrians and cyclists
- Unsafe horizontal bend after vertical crest, without delineation, warning signs and other speed control measures

Road Safety Hazards on State Highways and Other Roads

General

- Lack of reflective road markings – Centre line markings on two lane and intermediate lane roads and edge markings on single lane roads;
- Lack of traffic warning, information and direction signs;
- Poorly maintained shoulders forcing pedestrians to use the road space;
- Lack of facilities for cyclists and pedestrians on highly trafficked road sections;
- Poor forward visibility on certain sections due to overgrown vegetation, encroachments and huge trees;
- Unprotected and poorly delineated high embankment and approach to bridges;
- Lack of designated bus stop/ bus bay locations;
- Speeds are not assigned and no information provided on the operating speed of the road; and
- Unprotected high embankment on curves and straight sections having water bodies on the embankment toe.

Curves

- Sharp horizontal curves without delineation, warning signs and traffic calming measures;
- Poor visibility at curves due to overgrown vegetation and large trees on shoulders;
- Protection measures (crash barriers) are not provided on curves in high embankments;
- On certain sections, horizontal bend after vertical crest has been observed, which is significantly hazardous in the absence of delineation, warning signs and speed control measures;
- On Ghat sections, the valley side of curves are not delineated and provided with crash barriers; and

- On certain sharp curves, super elevation has not been provided.

Junctions

- Poor visibility at junction locations due to encroachments and other road side objects like trees;
- Poor junction layouts (major and minor);
- Lack of warning signs and speed reduction measures on side roads;
- Unsafe vertical profile of side roads at junction locations with the main carriageway;
- Lack of pedestrian and parking facilities at major junctions; and
- Lack of junctions markings and traffic signs (direction and warning signs).

Road side objects

- Presence of large trees on road edge – a major hazard;
- Street lighting and electric poles on road edge without delineators;
- Parapet walls of narrow bridges are not delineated with hazard markers; and
- Broken or missing parapets of bridges.

Road side villages/ built up areas

- Roadside villages lacking speed control measures on approaches, and lack of facilities of pedestrians and cyclists;
- Congested commercial areas along the road without pedestrian and parking facilities hampering visibility;
- High level of encroachments affecting visibility; and
- Schools inside road side villages – lack of warning signs and speed control measures.

VI. Assessment of road safety management capacity and responsibility framework

The management of road safety is complex and involves many sectors. A safe road traffic system has many actors – safe road network, safe road user and safe vehicle – and the optimum interplay depends on underlying institutional management functions. To achieve an efficient road transport system, it is important for the State to have an effective road safety management mechanism. The consultants have reviewed different departments to understand the road safety responsibility framework of the State.

The review was carried out by having one to one consultations with various key stakeholders in the State during the period December 2012 to January 2013. The list of stakeholders consulted during this process is shown in Appendix IV in Volume II of this report.

The review was carried out based on the World Bank guideline concerning the implementation of the *World Report* recommendations (Bliss, 2004). The road safety management system framework shown in **Figure I** was referred to while assessing the safety management capacity.

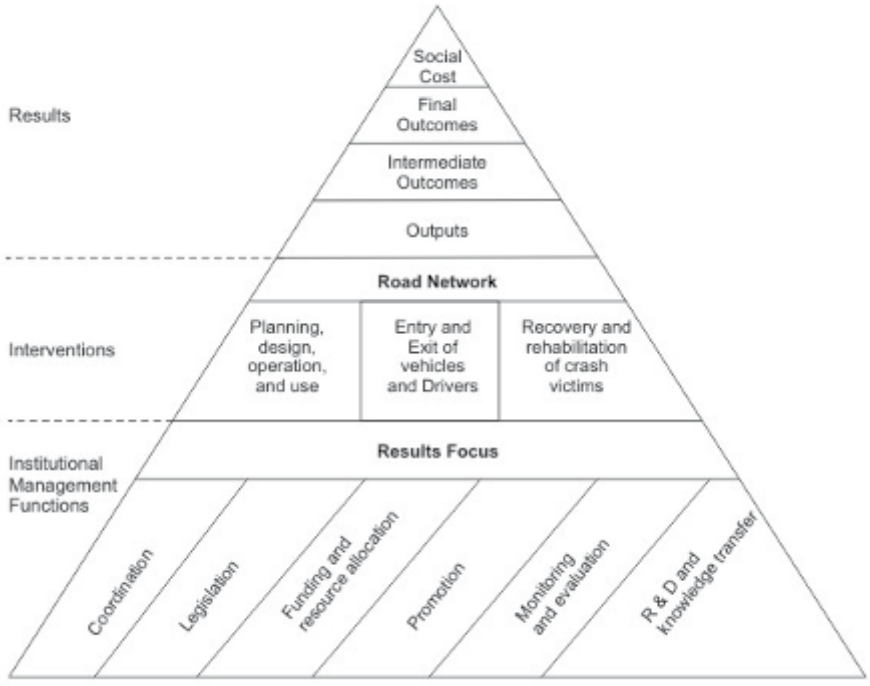

Figure 1: Road Safety Management System

The details of the assessment of road safety management capacity and responsibility framework have been discussed in detail in chapter 16 of this report. The key finding of the assessment is as follows:

The main strengths in road safety management in Odisha are:

- general acknowledgement about the severity of the problem amongst all key agencies and general understanding among all that there is a need of new institutional arrangement
- the proposed trauma care and post-crash care facilities by the health department to implement across Odisha is quite extensive
- the initiatives of transport department to reduce the road accidents
- the existence of a road safety fund with some existing sources of funds
- the recognition of the stakeholders for the need to work together, and determination across departments and sectors
- the existence of an extensive accident database with its network of collection through District SP Offices, though in a crude form
- the existence and initiative of various road safety NGOs

The main weaknesses in road safety management in Odisha are:

- the absence of a lead agency to co-ordinate the road safety efforts of various departments, although leadership of the Transport Department is implicit due to its role and function within the existing legal system
- the absence of effective institutional ownership of road safety, to address the many challenges involved in road safety
- the absence of a road accident database management system, to enable scientific crash analysis and to implement accident prevention and management techniques

- lack of clearly mandated targets and goals, and also the required capacity and the resources to work for the targets
- lack of road safety engineering experience among roads authorities, although efforts are on to build capacity among the engineers of road authorities
- Different ownerships of the roads of different categories, with poor co-ordination and non-uniform understanding of the needs to improve road safety

VII. Way Forward to Road Safety Action Plan

Based on the above findings, the consultants will generically recommend the measures to be adopted as part of safe system approach, in due considerations of the network and traffic requirements, for different categories of the roads. These will be duly categorized for implementation in short, medium and long term horizons with the view to develop a safer road network in Odisha. The Safe system projects will form part of the Road Safety Action Plan, which is expected to be delivered by the Consultants as the next deliverable under the road safety task.

In addition to road safety engineering measures to be taken up for the network, capacity building measures of GOO Departments will also form part of the detailed road safety action plan. This action plan will also include additional legislation, requirements of road safety campaign, and similar other activities focusing on road safety problems of the state.

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CHAPTER 1

INTRODUCTION

1. Introduction

1.1. Road Accidents in Odisha – Overview

Road accidents constitute a major economic and social trauma and significant health hazard in Odisha, as in other states of India. It is the leading cause of all accident types in Odisha, and is a major drain to the economy of Odisha and it absorbs huge resources of Odisha's health sector, which has more pressing concerns like dealing with other contagious diseases.

Figure 1.1 illustrates the trend of fatalities due to road accidents in Odisha during the years 2009 to 2011. It can be seen from the figure that there is a sharp increase in fatalities from 2009 to 2010 and slight dip in fatalities from 2010 to 2011. **Figure 1.2** illustrates the cost of accidents (based on IRC SP 30: 2009) and it can be seen that Rupees 725 crores were the direct cost of accidents during the year 2010, in addition to the social trauma the road accidents inflict on families/ communities.

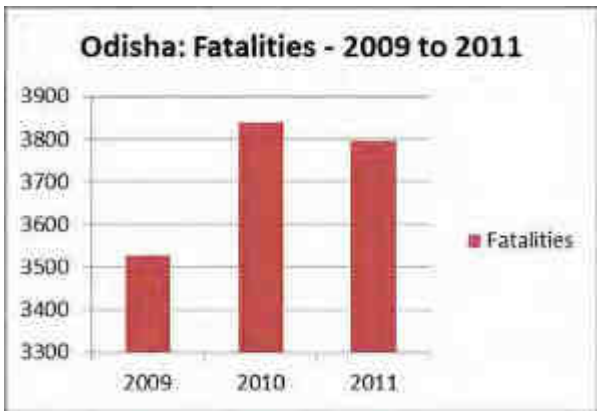

Figure 1.1: Fatalities in Odisha(2009-11)

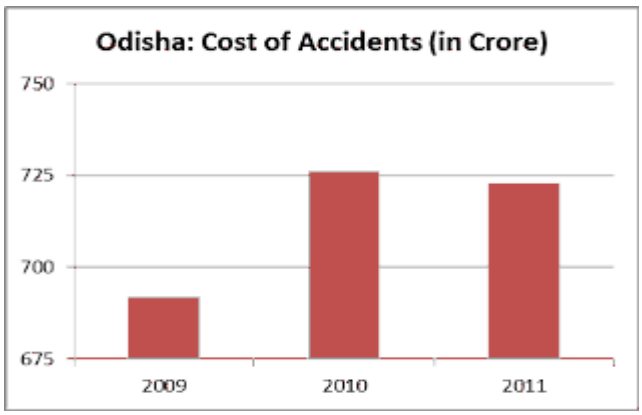

Figure 1.2: Cost of accidents (2009-11)

Odisha is rich in mineral resources and it is expected that the economy will grow at a rate faster than the national average rate of growth. It is inevitable that this will lead to increase in transportation demand of goods, personnel and services through its road network, and consequent expansion of road network. However, one of the negative aspects of traffic growth (demand on road transport) is the increase in road accidents/ fatalities. Thus, it is important for the state to develop road safety management capacity and put in place processes for improved road safety management for its state road network to reduce road accidents and fatalities.

1.2. Background of the Study

In the absence of adequate rail network, a safe and sustainable road network is critical for the social and economic development of Odisha. The State has a total road length of approximately 250,000 km out of which 52,500 km of roads (NH, SH, District roads, Irrigation roads, urban roads and rural roads) carry high to low volume of traffic.

During mid to late 1990s, GOO has initiated the Odisha State Roads Project (OSRP), funded by the World Bank,to upgrade the major road network in Odisha. This project was intended to enhance both the major road transport infrastructure as well as the institutional capacity of the Orissa Works Department (OWD) which has primary responsibility for the State's main road network.

The Snowy Mountains Engineering Corporation (SMEC) was commissioned to review the prevalent institutional and financial structures and processes associated with the OWD and develop an Institutional Development Strategy (IDS) which is focused on the OWD and its linkages with other road sector agencies.

The recommendations suggested in IDS could not be followed up since the original OSRP project did not materialize. However, during mid-2000s, GOO has initiated the new OSRP, with the support of World Bank, and developed an Institutional Strengthening Action Plan (ISAP) in a phased manner. The ISAP recommendations were built largely on the ideas of the IDS prepared by M/s SMEC.

Among others, the ISAP 2008-18 has identified key result areas to be implemented in road safety within a short term (2 years) to a medium term (2 to 5 years) horizon, as shown in **Table 1.1**.

Table 1.1: Key Actions - Short Term and Medium Term

Short term (0 to 2 years) actions	Medium term (2 to 5 years) actions
1. Establish traffic engineering and road safety cell in OWD 2. Initiate GOO steering body for evolving road safety action plan 3. Establish road safety councils at state & district level 4. Develop road accident recording and analysis system duly training the staff in consultation with police and State Transport Authority (STA) departments 5. State wide road safety database initiated 6. Identify accident-prone areas/ black-spots on all roads under OWD and improve 7. Evolve state road safety policy and action plan 8. Provide sufficient funds to improve the accident-prone areas/ black-spots	1. Establish an empowered and funded state road safety apex body, with active community linkages, for road safety action plan (RSAP) oversight 2. Implement phased plan for highway patrol operations on the core road network (CRN) 3. Integrate black-spots remedial actions into all road plans/ programs

Following the recommendations of ISAP, the OWD called for consultancy services for Odisha Road Sector Institutional Development Study (RSID), in which '**Road Safety Engineering and Planning**' is initiated among various other tasks.

1.3. Objectives and Approach to the Study

The following are the major objectives to achieve under the task 'Road Safety Engineering and Planning'.

- Develop a road safety action plan for the State including engineering and institutional improvements, which if implemented can reduce the rate of accidents in Odisha
- Assist the capacity building of OWD design units in road safety engineering

The terms of reference for the task 'road safety engineering and planning' require the consultants to:

1. Execute a road infrastructure safety management review of relevant OWD engineering functions and of a limited sample survey of road network;

2. Conduct a preliminary assessment of the current road safety responsibility framework in the state;
3. Provide technical capacity building in road safety design to OWD units;
4. Facilitate a high level workshop to explore GOO's concerns, aims and priorities to improve road safety management; and
5. Facilitate GOO planning for more strategic externally-assisted multi-sectoral measures to improve overall road safety management strategy, capacity and outcomes in Odisha.

To prepare a road safety action plan, it is important to understand the root causes of road accidents in the state and identify the high risk user groups and locations in the road network. In addition, it is essential to understand the responsibility framework of various stakeholder departments, such as Transport, Police, Health and Education, in road safety management in the state. To identify the safety engineering and planning interventions required for the road network through understanding of the nature of hazards and possible causes of accidents, the consultants have collected and analysed crash data and conducted field road safety assessment on a selected road network of 2000 km, which covers all categories of roads in the state. This is considered to be a representative sample of the roads in the state to derive the strategy and conclusion for the entire network.

1.4. Objective of the report

The report will satisfy the ToR requirements 1 and 2 listed above and aims to achieve the following objectives:

- Explain the methodology adopted in determining the level of safety hazards, which causes road accidents in the road network of the state by crash data analysis and field road safety assessment;
- Identify the types of hazardous locations and high risk user groups from crash data analysis and key findings of road safety assessment;
- Explain the potential types of crashes due to various inadequacies in the existing road infrastructure;
- Suggest engineering countermeasures for various typical road safety hazards observed at site during the assessment; and
- Identify the areas, where capacity building measures are required for designers/ engineers of OWD.

Therefore, the structure and the contents of the report include the following:

- Methodology adopted for field road safety assessment (Chapter 2);
- Detailed report on crash data analysis and road safety assessment of selected roads in 12 selected districts (Chapters 3 to 14);
- Discussion of crash data analysis and key findings of road safety assessment (Chapter 15); and
- Assessment of road safety management capacity and responsibility framework (Chapter 16).

The report has presented and provided systematic process, which enabled the Consultants to identify the typical hazardous locations on the road network in the State, and high risk user groups exposed to the deficient road infrastructure in Odisha. It also identifies the suitable engineering countermeasures required to be implement, which are likely to make the road network safer and reliable for the road user.

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CHAPTER 2

METHODOLOGY

2. Methodology

2.1. Introduction

The consultants are required to prepare a Road Safety Action Plan. It is well known that collection, compilation and analysis of crash and injury database are crucial for drafting a robust road safety action plan and strategy. ToR identified the potential sources of data as police crash database, hospital and medical data, insurance data and special sample surveys of road network sections covering at least selected stretch of 2000 km of roads in rolling/ plain/ mountainous terrains besides major urban roads. While the network is extensive, the safety outcome of the road network is very poor due to deficiencies in infrastructure as well as safety management.

The methodology adopted for selection of the sample network and road safety assessment of the selected stretch of 2000 km is explained in this chapter, which covers the following in the subsequent sections.

- Selection of districts for road safety assessment
- Selection of roads for assessment within the districts
- Reporting of field assessment

2.2. Selection of districts for road safety assessment

The district level data collected from the State Crime Record Bureau (SCRB) indicate the districts where crashes and fatalities are high. The average number of road traffic fatalities in all the districts of Odisha during the years 2009 to 2011 is shown in **Figure 2.1**.

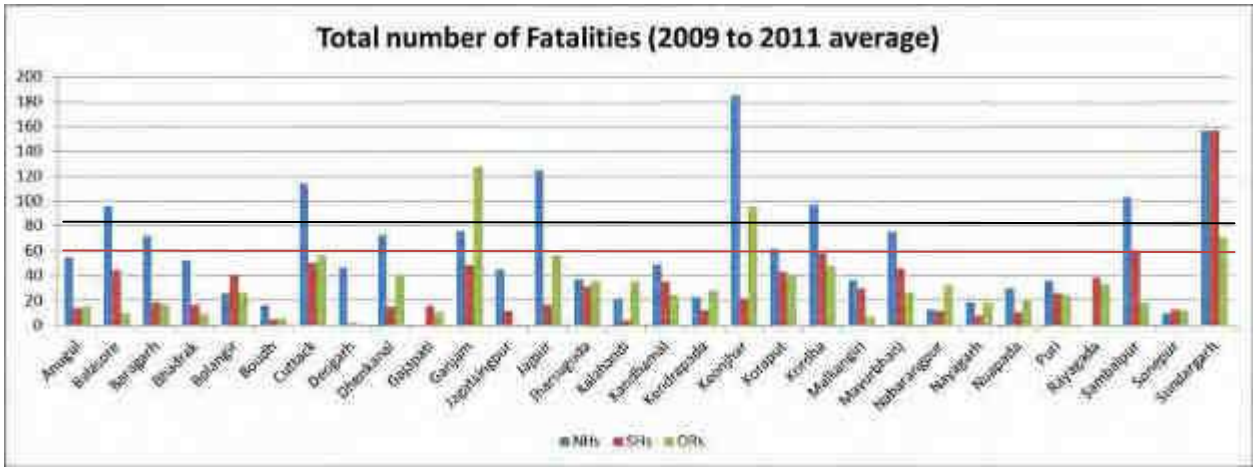


Figure 2.1: Total number of road traffic fatalities (2009-11 average)

Two different approaches were adopted for the selection of districts:

1. Select the districts where average number of fatalities in NHs are greater than 80
2. Select the districts, where average number of fatalities in SHs are greater than 50

Based on the above, the following districts were selected to carry out road safety assessment.

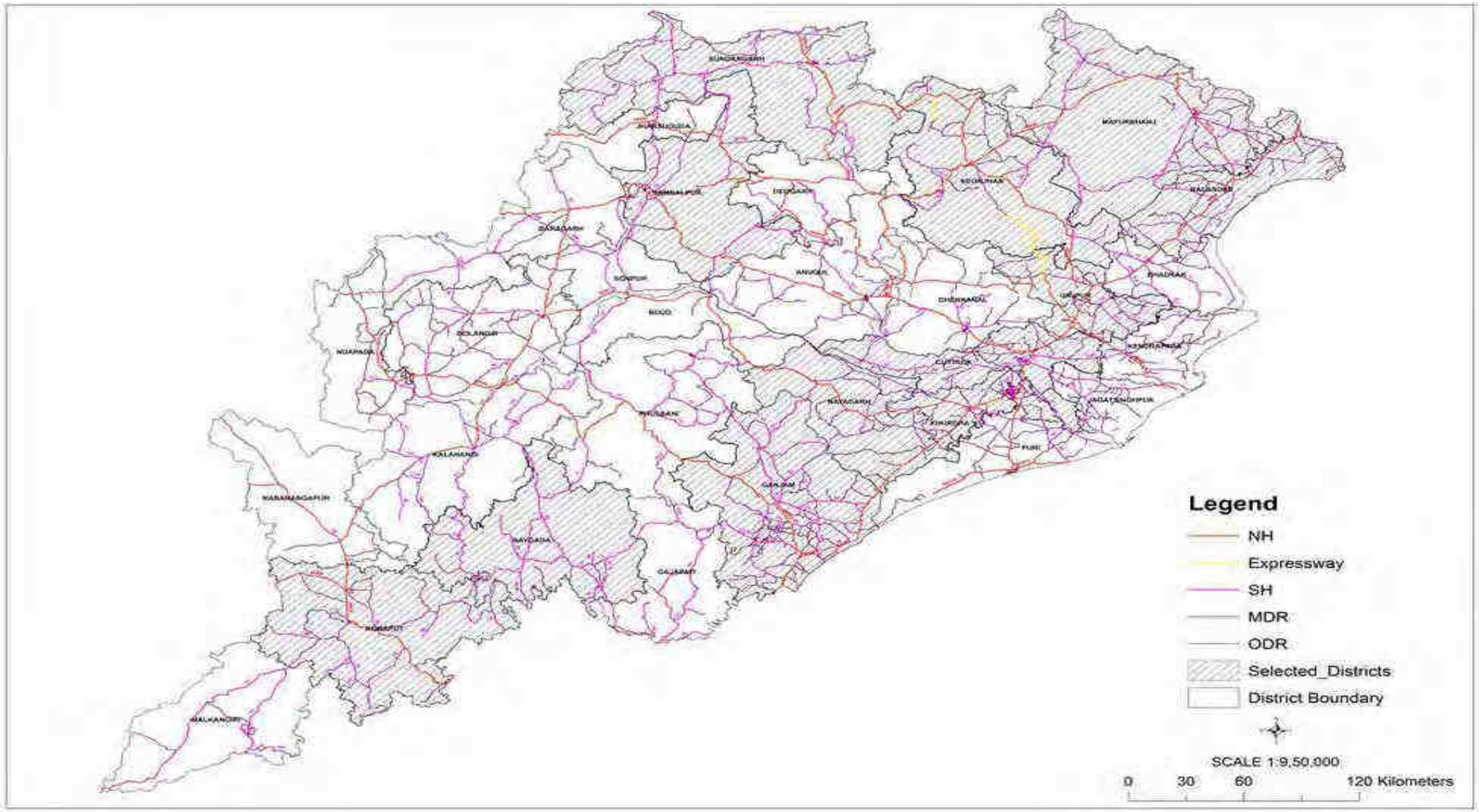
- Balasore
- Cuttack
- Ganjam
- Jajpur
- Keonjhar
- Khordha
- Sambalpur
- Sundargarh

Further, following discussions with PMU, OWD, the following districts were also included to reflect an even spread of the districts across the state to represent the statewide road network and to include assessment of specific hazardous road sections suggested by OWD.

- Koraput
- Mayurbhanj
- Nayagarh
- Rayagada

The selected districts for road safety assessment are shown in **Figure 2.2.**

Figure 2.2: Selected Districts for Road Safety Assessment



2.3. Selection of roads for assessment within the districts

Consultants had discussions with PMU, OWD, and it was decided not to consider the roads managed by NHAI, since it is recognized that the same will be taken up for improvements by NHAI irrespective of OWD's interventions. Hence, it was decided to focus more on SHs and MDRs and some selected NHs managed by Ministry through the OWD.

The consultants had drawn up an initial list of roads to be assessed in all the selected districts, discussed and agreed the same with PMU, OWD before the initiation of assessment. As assessment progressed, the list has been modified in each district, after consultations with Executive Engineers of respective districts (and in consultation with OWD), where the assessment was carried out. The list of roads, where the road safety assessment has been conducted, is shown in **Table 2.1 to Table 2.12.**

Table 2.1: Roads Assessed – Balasore District

Sl No.	Road Name	From	To	Length
1	SH19	Sergarh-Nilagiri	Jharnaghati	32.0
2	MDR	Jaleswar	Chandaneswar	35.7
3	MDR6	Soro-Kupari	Ranital	50.0
			Sub-Total	**117.7**

Table 2.2: Roads Assessed – Cuttack District

Sl No.	Road Name	From	To	Length
1	SH12	OMP Chowk	Jagatsingpur Border	14.0
2	ODR	Paga (SH9A)	Tangi (NH16)	12.0
3	SH9A	Jagatpur (NH16)	Asureswar	34.0
4	ODR	Salipur (SH9A)	Chhatia	28.0
5	SH65	Khuntuni	Panchmukhi Chhak (Km 76+000)	76.0
6	ODR	Kuanpal	Balichandrapur	7.0
			Sub-Total	**171.0**

Table 2.3: Roads Assessed –Ganjam District

Sl. No.	Road Name	From	To	Length
1	SH-17	Digapahandi (Km 41+000)	Taptapani (Km 51+000)	10.0
2	SH-29	Digapahandi (Km 36+000)	Sorada (Km 62+000)	26.0
3	SH-36	Sheragada (Km 54+200)	Sorada (Km 96+000)	41.8
4	NH-59	Sorada (Km 270+000)	Hinjilicut (Km 320+000)	50.0
5	MDR-64	Chattarapur (Km 0+000)	Hinjilicut (Km 40+200)	40.2
6	SH-32	Purushottampur (Km 0+000)	Jagannathpur (24+700)	24.7
7	ODR	Sorada (Km 21+000)	Kanteipalli (Km 0+000)	22.0
8	SH-31	Huma (Km 0+000)	Boirani (Km 39+200)	39.2
			Sub-Total	**253.9**

Table 2.4: Roads Assessed –Jajpur District

Sl No.	Road Name	From	To	Length
1	MDR	Choroda	Duburi	15.0
2	EW	Duburi	Tamaka (Phuljhar)	19.0
3	ODR	Panikoili	Ragadi	19.0
4	ODR	Kuakhia (Km 0+000)	Kalamatia (Km 23+000)	23.0
5	MDR 14	Sathipur	Kayangola (Km 47+000)	45.0
6	ODR	Jajpur	Baruan	8.0
			Sub-Total	**129.0**

Table 2.5: Roads Assessed –Keonjhar District

Sl No.	Road Name	From	To	Length
1	EW2	Joda	Bamberi	18.0
2	ODR	Keonjhar	Saharpada	17.0
3	ODR	Baunsuli	Patna	28.3
4	NH49	Km 433+000	Km 479+000	46.0
5	NH49	Keonjhar (Km 481+000)	Turmunga (Km 510+000)	30.0
6	SH 49	Gurandijodi	Dhenkikote	33.2
7	MDR	Naranpur	NH16	48.8
			Sub-Total	**221.3**

Table 2.6: Roads Assessed – Koraput District

Sl No.	Road Name	From	To	Length
1	SH-25	Jeypore	Mahuli	18.2
2	MDR	Boipariguda	Malkangiri Border	22.0
3	MDR	Koraput	Laxmipur (Km 43+000)	66.0
4	NH 26	Jeypore	Koraput	43.0
5	NH 26	Pottangi	Andhra Border	24.0
			Sub-Total	**173.2**

Table 2.7: Roads Assessed – Mayurbhanj District

Sl No.	Road Name	From	To	Length
1	NH-18	Naharpatna	Baripada	80.4
2	SH-19	Baripada	Udala	46.0
3	SH-19	Udala	Boisinga	40.0
			Sub-Total	**166.4**

Table 2.8: Roads Assessed – Nayagarh District

Sl No.	Road Name	From	To	Length
1	SH-21	Nayagarh (0+000)	Bhanjanagar (Km 82+000)	82.0
			Sub-Total	**82.0**

Table 2.9: Roads Assessed – Rayagada District

Sl No.	Road Name	From	To	Length
1	SH-4	Rupkona (Km 78+000)	Bangi (Km 160+800)	82.8
2	SH-46	TandikonaChowk (Km 0+000)	Bissam Cuttack (Km 33+200)	33.2
3	MDR-48B	Rayagada (Km 0+000)	Kairada (Km 25+000)	25.0
			Sub-Total	**141.0**

Table 2.10: Roads Assessed – Sambalpur District

Sl No.	Road Name	From	To	Length
1	SH15	Sambalpur (0 km)	Dhama	25.0
2	SH10	Sambalpur – Sundargarh – Rourkela		162.5
3	SH24	Bamra	Kuchinda	42.4
4	NH49	Kuchinda	Bhojpur	18.1
			Sub-Total	**248.0**

Table 2.11: Roads Assessed – Sundargarh District

Sl No.	Road Name	From	To	Length
1	SH31	Karamdihi	Lulkidihi	40.0
2	SH31	Gariamal	Bamra	14.0
3	MDR26	SH10	Tumran Village	14.0
4	SH10A	Lahunipada	Muchurunali	30.6
5	RD Road	Garjan Road		7.0
6	ODR	Koida	Kaleiposh via Tensa	41.2
7	RD Road	Koida	Patmunda	9.0
8	RD Road	Khandadhar Waterfall Road		15.0
			Sub-Total	**170.8**

Table 2.12: Roads Assessed – Khurdha District

Sl No.	Road Name	From	To	Length
1	MDR77	Pitapalli (NH16)	Barang	30.0
2	NH-16	Chhandikhol Chhak	Rasulgarh Chhak	53.0
3	NH-224	Khurdha	Nayagarh	52.0
			Sub-Total	**135.0**

The total length of sample road network covered in 12 districts has totaled to 2,021 kilometers covering all categories of roads in the state.

2.4. Road Safety Assessment - Field Work

Considering the enormity of the task – RSA of 2000 km in 12 different districts – the consultant has formed four different teams, led by experienced road safety engineer in the team. A data sheet was prepared to use by all the teams uniformly for all roads to conduct the assessment in a consistent manner. The data sheet is shown in **Appendix I,** which has separate considerations for link and the intersection.

The four teams started the assessment programme on 23 November 2012 and completed the same by last week of December 2012. The representatives from OWD of respective divisions joined the assessment team for most of the roads assessed. The details of the assessment programme of all roads including dates of assessment, personnel (OWD and Consultant), length of road and others are given in **Appendix II** in a summary sheet of each District.

2.5. Reporting structure of field assessment

The reporting of field assessment follows the tried and tested approach to the reporting of road safety assessment earlier carried out in other states and internationally. Based on what the assessors observed in the field, the following format has been followed for all districts uniformly, to keep the reporting in a consistent manner.

Chapter - *District A*

Crash data analysis of district A – *A brief summary of crash data analysis to guide the assessment so as to systematically determine the hazardous locations and hazardous user groups in the district A*

Locational features and details of audited/assessed roads in district A –This component includes the list of deficiencies as well as the map location and photographs of all roads assessed in district A.

RSA of Road 1 in district A – The safety assessment has been carried out for each selected road in district A, and the problems identified were classified into following broad categories every time, for better comprehension and understanding.

- Delineation
- Alignment – Sharp Curves
- Alignment – Bend after the crest
- Minor Junctions – Skew & Perpendicular
- Major Junctions
- Approach to the bridges/ structures
- Narrow bridges/ culverts

- Roadside objects – Trees, Street lighting poles and others
- Roadside villages/ built up areas along the road

Each situation under these broad categories has been presented in the following format.

Reasons for concern:	The problems observed and safety concerns have been narrated, supported with pictures, to appreciate the gravity of the issue
Recommendations:	The assessment recommends road safety engineering measures for each observed problem. More details have been included as drawings of all the countermeasures recommended, compiled collectively in **Appendix III**, so that executive engineers of OWD, in charge of each of the districts/ departments, can implement the recommendations easily.

2.6. Conclusion

This chapter has described the complete methodology of road safety assessment carried out for the sample network of 2,021 kilometers of road network across 12 representative districts of Odisha. This has given a complete overview of the road safety issues of the road network of different categories, and the required engineering interventions in case of each road assessed. The findings of these 12 districts are now to be generalized for the total network of Odisha, which is done in a later chapter after the findings of the road assessments in 12 districts are presented in next twelve chapters.

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CHAPTER 3

BALASORE DISTRICT

3.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Balasore district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified in to various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Balasore district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of accidents

3.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 3.1**. It can be seen from **Figure 3.1** that number of maximum number of fatalities and crashes occur on NHs in Balasore district followed by SHs.

The length of road network (NH, SH, MDR, ODR and VR) is shown in **Figure 3.2**. It can be seen from **Figure 3.2** that length of 'other roads' is much more than the length of NHs and SHs put together in Balasore district. However, **Figure 3.1**indicates that fewer numbers of crashes and fatalities occur on other roads compared to NHs and SHs. This can be partly attributed to the low level of traffic carried by other roads on in Balasore district.

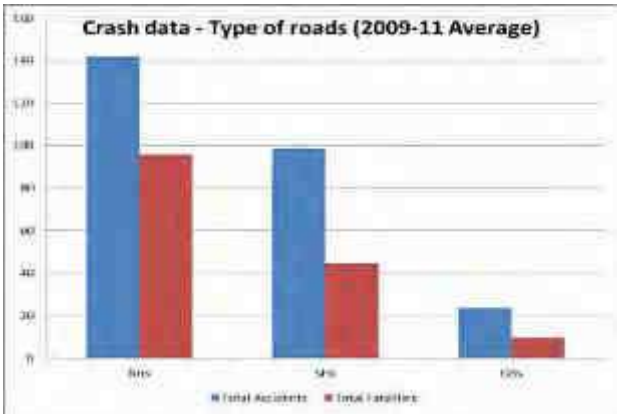


Figure 3.1: Crash data – Type of roads

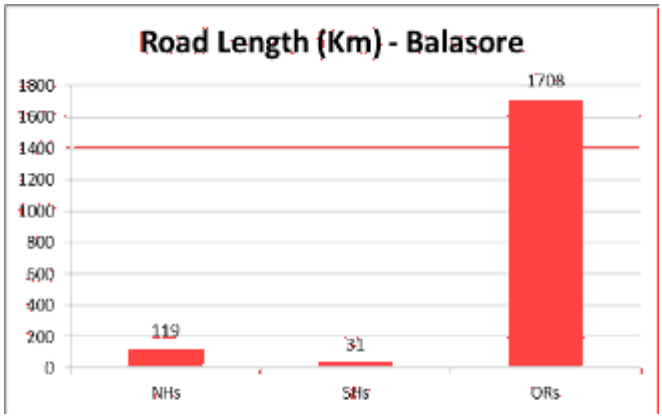


Figure 3.2: Road Network Length

The crash data classified on the basis of location type in Balasore district is shown in **Figure 3.3** below.

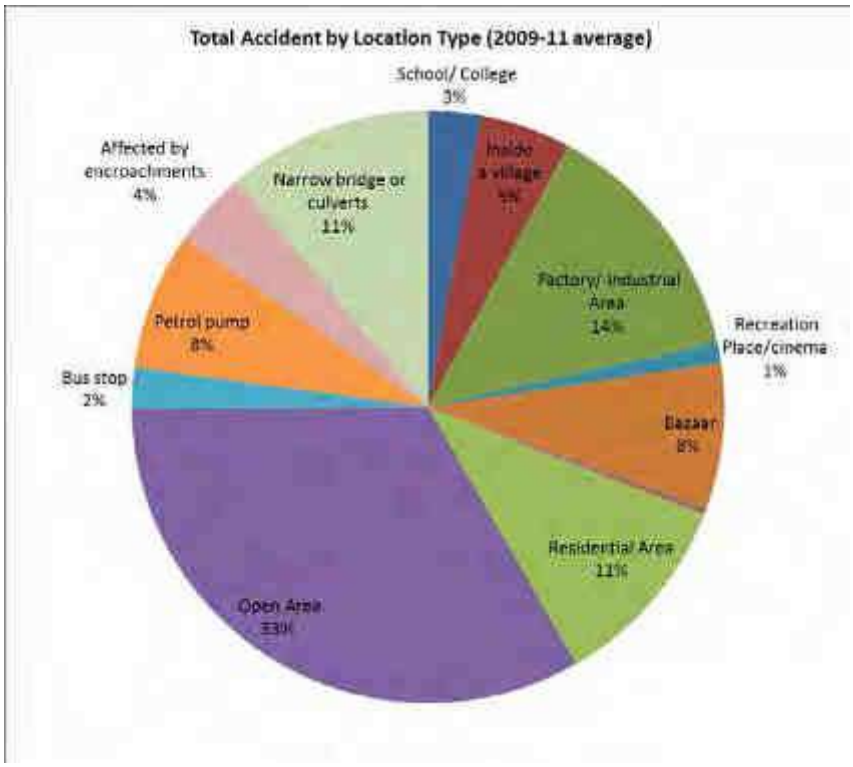


Figure 3.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 3.3** that more than quarter of crashes occur in 'open area' in Balasore district followed by crashes near narrow bridge or culverts (11%) and residential area (11%). However, it is not clear from the above set of data that whether crashes in 'open area' occur more in NHs or SHs. Further, the 'open area' is not clearly defined to be used for thorough crash investigation and prevention techniques.

From the above, only the following conclusions can be drawn for Balasore district:

- Maximum number of crashes and fatalities occur in NHs, followed by SHs; and
- Significant number of crashes occurs in 'open area' followed by the locations near or on narrow culverts/ bridges and residential areas.

3.1.2. High risk road users/ user groups

The average number of accidents occurred during 2009-11, classified according to the vehicle type are shown in **Figure 3.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 3.5**.

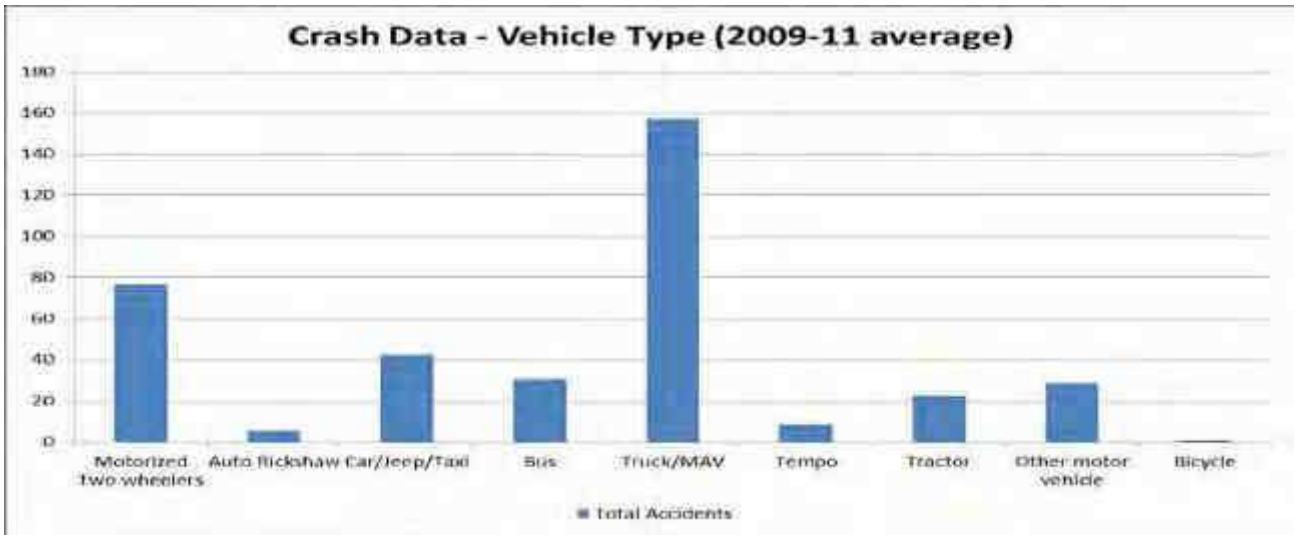


Figure 3.4: Total Accidents based on Vehicle Type (2009-11 average)

From **Figure 3.4**, it can be seen that trucks are involved in maximum number of accidents (approximate 160) followed by motorized two wheelers. Again, it is not clear from the SCRB data, the locations or road category on which these accidents occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

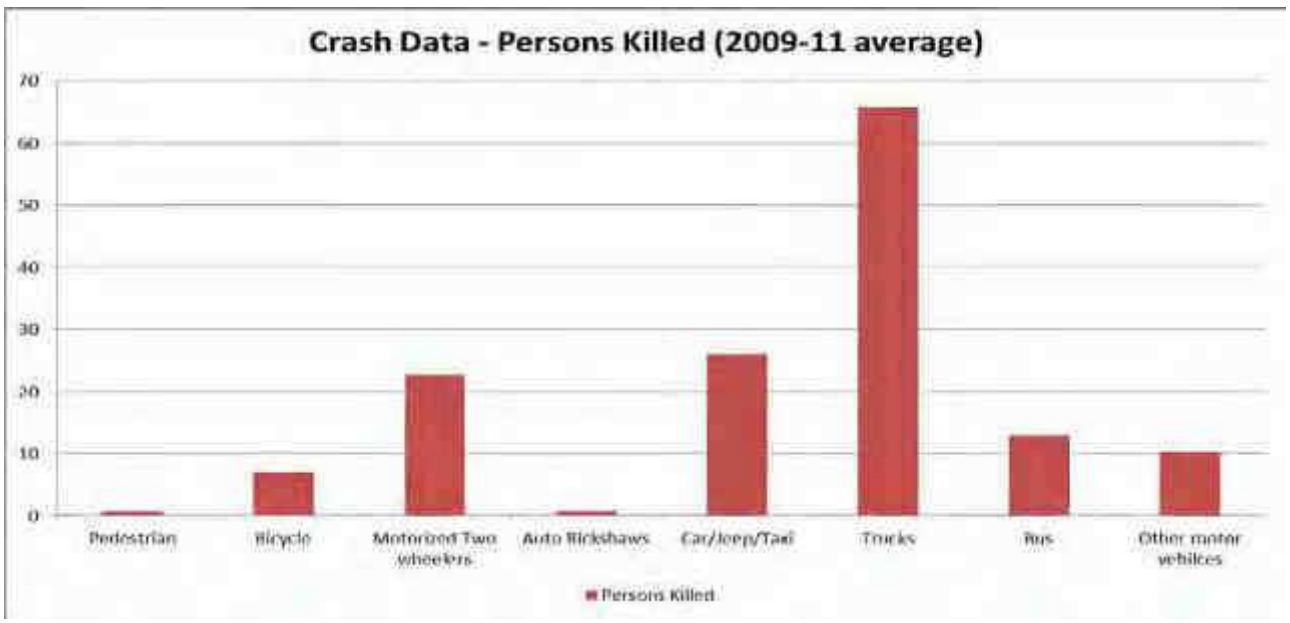


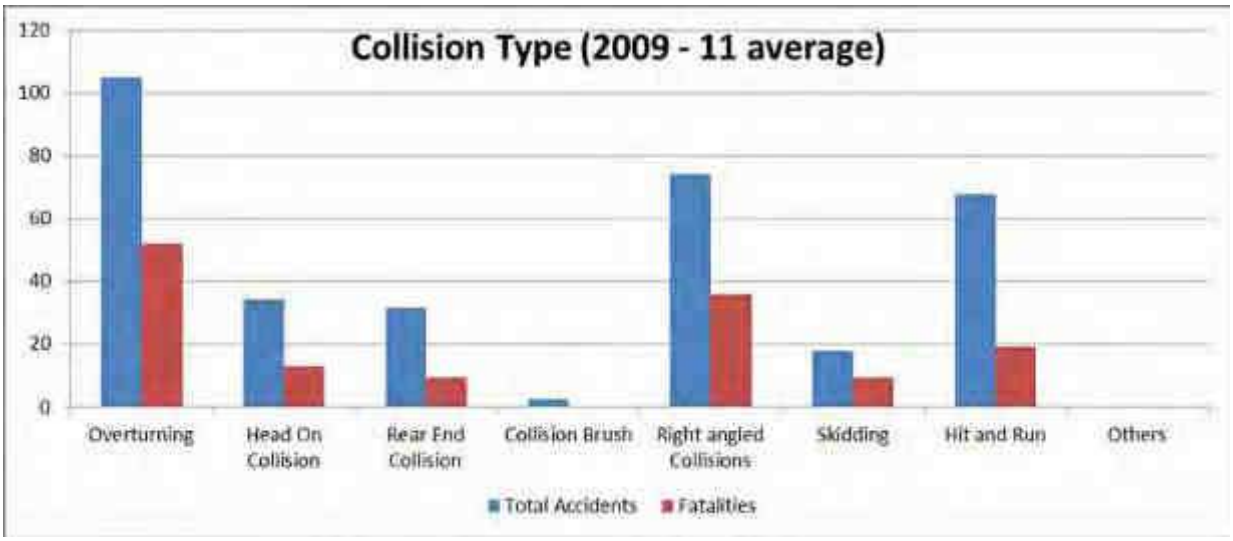
Figure 3.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 3.5,** it can be seen that maximum fatalities (approximate 65 lives) occur among the Truck users (both driver & passenger) followed by passenger cars and motorized two wheelers. It is interesting to note that cars are involved in fewer accidents (Fatal, major and minor), but higher number of fatalities. This may be due to the fact that cars carry multiple number of persons, and single crashes might be leading to multiple fatalities.

It can be seen from **Figures 3.4 and 3.5** that out of 75 crashes where motorcycles are involved, approximately 22 fatalities occurred. This means, out of every 3 accidents involving motorcycles, one person is getting killed. This is significant since approximately 80 percent of motor vehicles registered in

Balasore district are motorcycles. However, from the available data, it is difficult to ascertain the locations/ road types, where the motorcyclists are at higher risk.

Further analysis of the nature of accident occurred in Balasore district reveal a better correlation of accidents/ fatalities between type of vehicle and road category. The average number of crashes and fatalities based on type of collision is shown in **Figure 3.6.**



It can be seen from **Figure 3.6** that predominant nature of accidents in Balasore district are 'Overturning' (105 crashes) and 'Right angle collision' (75 crashes). This is followed by head-on collisions and rear end collisions.

It can be seen from the above figures that maximum number of accidents/ fatalities happens on NHs, trucks has a major share in accidents and the number one category of persons getting killed on roads in Balasore are truck drivers and passengers, and the predominant cause of accidents in Balasore district is due to overturning of vehicles. Further, the above figures show that motorized two wheelers and passenger cars and are involved in most number of accidents after trucks and right angled collision are the second most predominant cause of accidents in Balasore district followed by head on collision and rear end collision. In addition, crashes occur more on SHs after NHs.

From the above, though not supported by desirable detail of data, the following can be inferred for Balasore district:

- Though NHs constitute only 9 percent of the road network having low to high level of road traffic, 54 percent of road crashes occur on NHs
- Trucks are the predominant vehicle type involved in road crashes and truck drivers are passengers are the predominant user group killed in road crashes
- Motorized two wheelers are the second most high risk road user group, when it comes to number of crashes and fatalities
- Overturning accidents are the predominant nature of crashes followed by right angles collision, which indicate that junction locations and sharp curves might be particularly hazardous locations on rod network in Balasore
- According to the data, pedestrians and cyclists are less exposed to risk and hence cannot be considered and hazardous users or hazardous user groups

3.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 3.7** and the corresponding figures for urban area is shown in **Figure 3.8**.

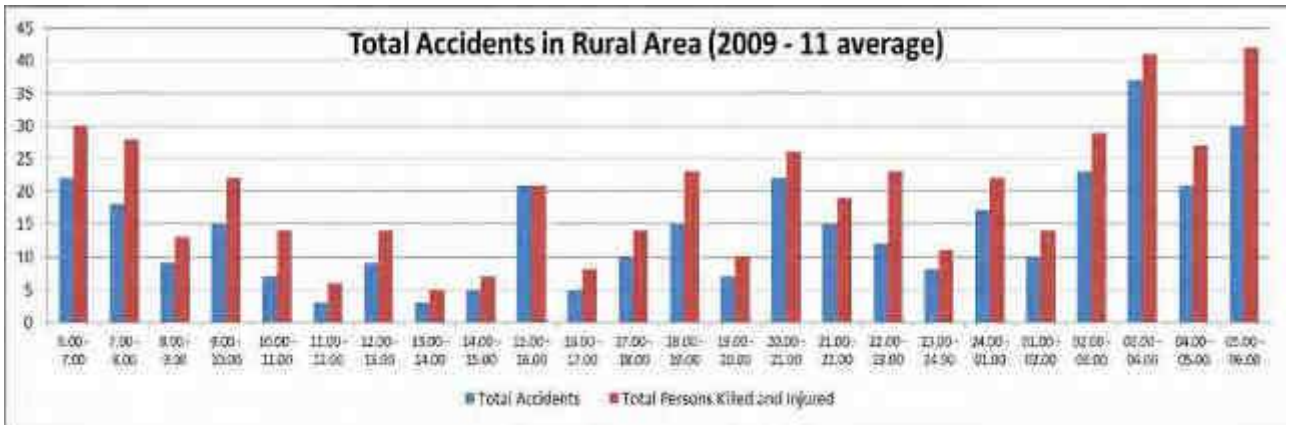


Figure 3.7: Total number of accidents in rural area (2009 – 11 average)

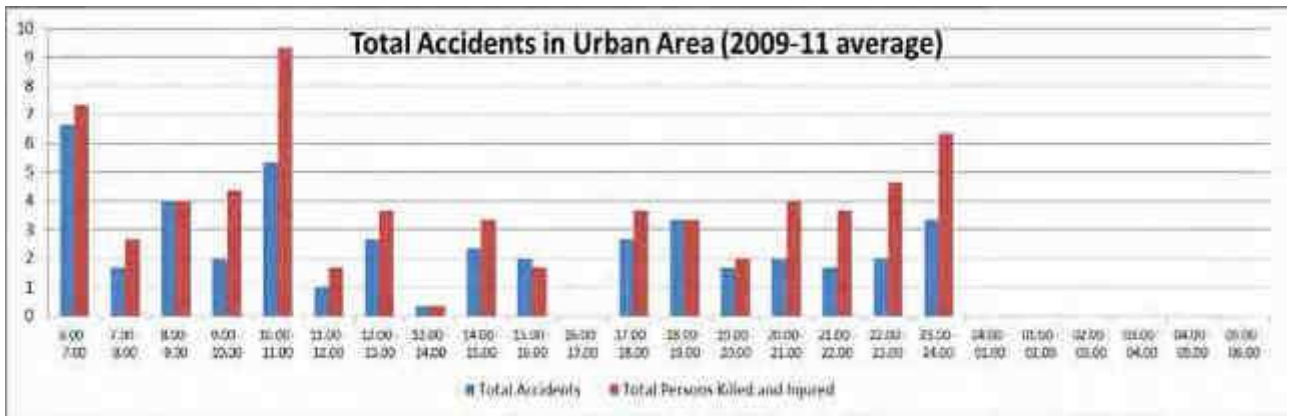


Figure 3.8: Total number of accidents in urban area (2009 – 11 average)

The above data is inconclusive to arrive at a correlation between the time of the day and accidents. It can be stated that early morning hours are a problem in rural areas. However, it is not clear what category of road is at more risk during early morning hours. Further, data shows no accidents during early morning hours in urban areas, which shall be considered as unreliable for the analysis.

3.2. Locations and Details of Audited Roads

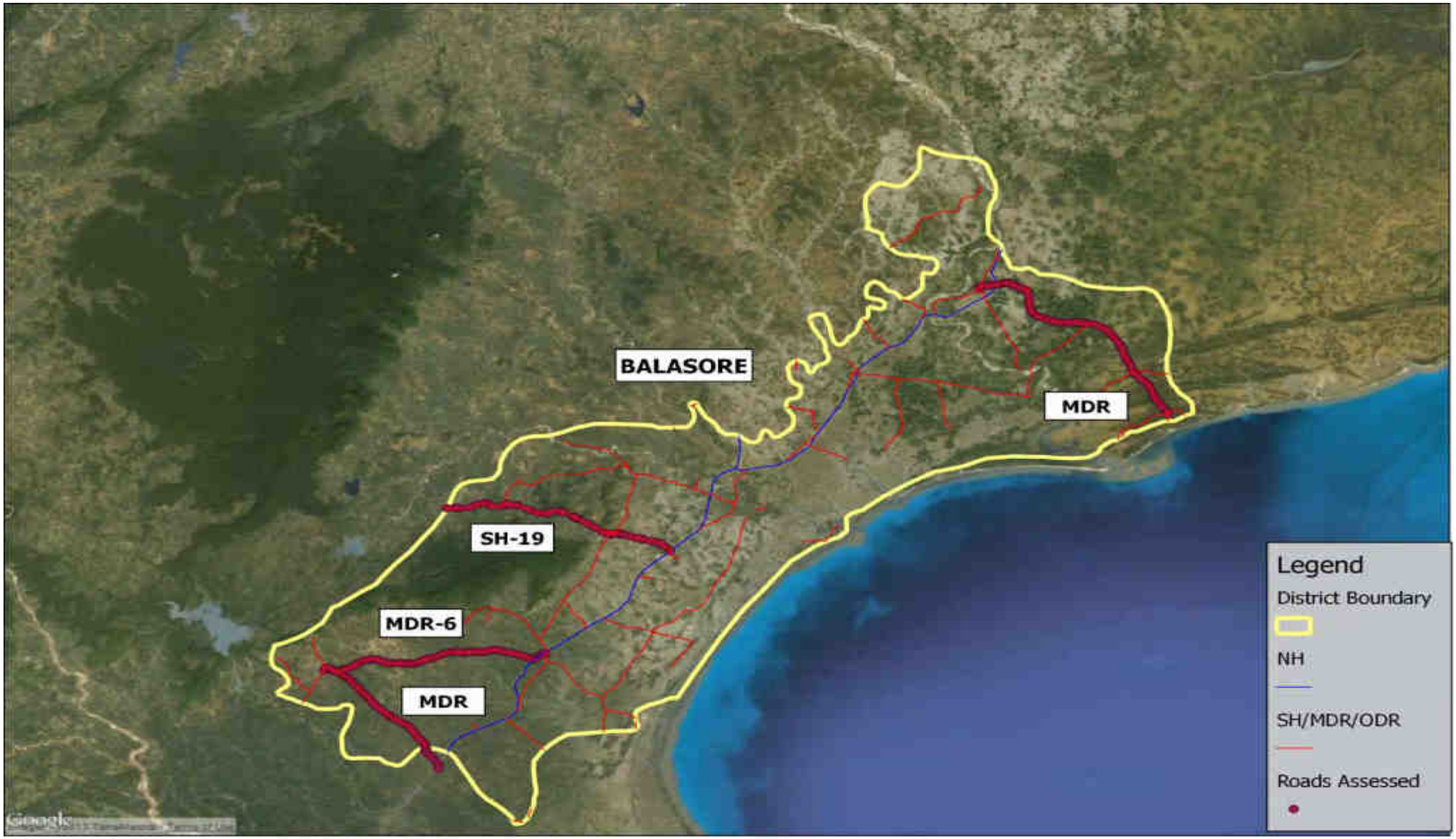
The road network where road safety assessment was carried out in Balasore District is shown in **Table 3.1** below:

Table 3.1: List of audited roads – Balasore District

Road Name	From	To	Length
SH19	Sergarh-Nilagiri	Jharnaghati	32.00
MDR	Jaleswar	Chandaneswar	35.70
MDR6	Soro-Kupari	Ranital	50.00
		Total	**117.70**

The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.** The map of road network assessed in Balasore district is shown in **Figure 3.9** below.

Figure 3.9: Road Network Assessed for Road Safety in Balasore District



3.3. Road Safety Assessment – State Highways

3.3.1. SH – 19: Sergarh–Jharnaghati Section

This section of the state highway between Sergarh and Jharnaghati is an intermediate / single lane road in a plain terrain with earthen shoulder (width 1-2 m) in good condition.

Majority of the land use along this road are small habitations and reserve forests. The traffic mix consists of majorly four wheeler passenger traffic with cyclists and pedestrians near the influence area of the habitations. The road condition is good with lot of access road joining the main road leading to the habitations. The alignment of road provides for good sight distances except for the curves, where the speed of the vehicles traversing the section is reduced.

3.3.1.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	Centerline and edge line road markings are absent in the some sections of the road section.
Recommendations:	• Provide edge line with thermoplastic material on whole road (refer to IRC: 35-1997 for details). • Provide centre line with thermoplastic material on road with intermediate lane. • Provide edge and centre line RRPMs on sharp curves

3.3.1.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 200 m were observed at Km. 1+500; 6+700; 7+400; 8+400; 8+750; 8+850; 9+150; 20+170; 21+500; 22+300; 23+050; 23+300; 25+160; 26+150

Ch: 1+500

Ch: 23+050

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

3.3.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 1+500; 1+900; 4+300; 4+700; 7+810; 8+980; 9+370; 17+400; 21+800; 24+600; 26+900; 26+930; 28+800

Location of Side roads at skew with the major road

Km 4+000; 6+600; 6+700; 8+000; 8+220; 8+500; 9+400; 11+400; 16+384; 19+900; 23+700; 26+550; 30+200

Ch: 6+700

Ch: 19+900

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions. of intersections.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also

result in rear-end collisions at high speeds.

Recommendations: Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

3.3.1.4. Major Junctions

Two major junctions at Ch: 7+400 and Ch: 8+700 were located along this road. In both the cases, the junctions are located at the end of a sharp curve with limited visibility.

Ch: 7+400

Ch: 8+700

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to Appendix III for guidelines on standard layout on 3-arm and 4-arm junctions.

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm and 4-arm junctions.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm and 4-arm junctions.

Reasons for concern:	**Provision for VRUs** • Shoulder spaces in the junction area are encroached by the commercial establishments. • Pedestrians were observed using the road for commuting, instead of the footpath, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	• Remove encroachments from the shoulder spaces and provide 2 m wide clear shoulder space.

3.3.1.5. Approach to Bridge at high embankment

The unprotected bridge approaches of three minor bridges present along the road at the chainages shown below:

- 13+500
- 23+050
- 30+400

Ch: 23+050

Ch: 30+400

Concerns & Recommendations

Reasons for concern:	**Unprotected high embankment** If vehicles lose control while approaching the bridge, run-off accidents may occur this may lead to multiple fatalities/ major injuries.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges.*

3.3.1.6. Roadside Hazards - Trees, Poles, and Buildings

Along the road, there are road side objects like electricity poles, signs, trees were present at significant number of locations.

Ch: 7+400

Ch: 30+400

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Remove encroachments from the right of way • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips • Remove encroachments on at least 2m from the road edge

3.3.1.7. Road side Villages/ Built-up Areas (BUA)

There are many small hamlets along the road. The presence of houses/schools along the road generates vehicular traffic / pedestrians / cyclists on the road in the stretches. The roadside villages, which are particularly exposed to hazards were observed on the following chainages:

- 4+000
- 9+500
- 23+050

Ch: 9+500

Ch: 23+050

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided
Recommendations:	• Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages. • Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas • Provide STOP' signs with road humps on all access roads in roadside villages in rural areas • Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools • Provide adequate traffic calming measures *Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages*

3.3.1.8. Specific Hazardous Locations

It was informed by the OWD that this intersection location is accident – prone. This stretch of the road is straight and vehicles tend to go at a high speed. The general type of accidents occurring here are angled collision culminating from the speeding side road colliding with vehicle on the main road.

Ch: 1+900

Concerns & Recommendations

Reasons for concern:	**Side road joining the main road, on a long straight section** The layout of the junction of the side road with the main road on a long straight section has become very dangerous. The vehicles on the straight section of the main road are at a high speed, the vehicles from the side road joining the main road without yielding and ending in a fatal accident.
Recommendations:	Provide road hump with associated warning signs and markings on the side road. Provision of advance warning signs to notify the road user to be cautious of the traffic from the side road.
Reasons for concern:	**Excess visibility to the left & Constrained visibility to the right** Wherever extra visibility is available, the accidents tend to happen due to the wrong judgment of the speed in the major road by the users of side road.
Recommendations:	Improve the visibility on the off side of the minor road and reduce the visibility on the near side by erecting screens/ plantations on the shoulder

3.4. Road Safety Assessment – Major District Roads

3.4.1. MDR 6: Sorro – Kupari - Ranital Section

This section of the major district road from Sorro – to Ranital via Kupari is a bituminous single lane road having earthen shoulder in plain terrain. The road is in generally poor condition.

Majority of the land use along this road are small habitations. However, it was observed that few side roads leads to mines and are trafficked by heavy commercial vehicles. The traffic mix consists of majorly truck traffic which is carrying raw materials from the mines. Because of the poor condition of road (except Ch: 11+000 – Ch: 21+000), the operational speed of vehicles is observed to be approximately 20 – 30 km/h with huge vehicular costs to the vehicles.

3.4.1.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	**Edge line road markings are not provided on the road.**
Recommendations:	• Provide edge line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details)

3.4.1.2. Alignment - Sharp horizontal Curves

Along the Sorro – Kupari road, Horizontal curves of radius less than 200 m were observed at Km.16+400, 17+700, 20+200, 20+400, 22+500, 25+500, 25+800, 27+300, 30+300, 31+400, 31+800, 32+600, 37+500, 38+800, 39+200, 39+500, 39+700 and 39+800.

Along the Kupari – Ranital road, Horizontal curves of radius less than 200 m were observed at Km.3+500, 13+200 and 13+300.

Concerns & Recommendations	
Reasons for concern:	**Poor Visibility** Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	**Poor Delineation** No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators** as appropriate. *Refer to Appendix III for guideline on treatment of curves.*
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment.

3.4.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations along Sorro – Kupari road where the above are noted are given below.

Location of Side roads perpendicular to major road
Km 14+400; 14+500; 14+700; 15+800; 17+600; 30+700; 31+600; 33+200; 33+900; 38+050; 39+600; 39+900
Location of Side roads at skew with the major road
Km 16+200; 16+500; 16+600; 17+400; 19+100; 19+500; 20+500; 21+500; 22+500; 25+900; 27+300; 27+800; 29+300; 29+900; 33+500; 33+800; 34+400; 34+800

The locations along Kupari – Ranital road where the above are noted are given below.

Location of Side roads perpendicular to major road
Km 0+400; 1+700; 3+400; 7+600; 7+900; 12+700; 13+100; 13+300; 13+900; 18+800
Location of Side roads at skew with the major road
Km 18+300; 19+500; 20+050

Concerns & Recommendations	
Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to • Encroachments at Junctions • Overgrown vegetation or presence of trees • Poor layout of the side roads.
Recommendations:	• Improve visibility by clearing vegetation; • Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle of junctions.*
Reasons for concern:	**Poor delineation** • No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:	Provide traffic signs and road markings pertaining to junction control. *Refer to Appendix III for guidelines on traffic signs and road markings at junctions*
Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
Recommendations:	Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.*

3.4.1.4. Bridge approaches on high embankment

Bridges/ Culverts with high embankment approached were noted in the following locations along Sorro - Kupari Rd.

- 17+000 – 20+000
- 25+000 – 26+000
- 27+000 – 28+000
- 29+000 – 30+000
- 30+000 – 31+000
- 33+000 – 35+000
- 35+000 -36+000
- 36+000 – 37+000

Bridges/ Culverts with high embankment approached were noted in the following locations along Kupari – Ranital Rd.

- 10+000 – 11+000
- 11+000 – 12+000
- 12+000 – 13+000
- 14+000 – 15+000

Concerns & Recommendations

Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges.*

3.4.1.5. Roadside Villages/ Built-up Areas (BUA)

There are many small hamlets along the road.

Locations along Sorro - Kupari Rd.

- 14+400
- 14+700
- 27+800
- 29+300

- 15+800
- 16+600
- 19+500
- 27+300
- 30+700
- 33+500
- 38+050
- 39+900

Locations along Kupari – Ranital Rd.

- 1+050
- 7+600
- 7+900
- 12+700
- 13+300
- 13+900

Concerns & Recommendations

Reasons for concern:

- No clear shoulder width is available, and the pedestrians are forced to share the road space with motorized traffic, which expose them to significant risk
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead

Recommendations:

- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide a Gateway effect on either approached to the roadside village
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages.

3.4.1.6. Specific Locations

There is no specific location pointed out by OWD / Police which is having accident history.

3.5. Road Safety Assessment – Other District Roads

3.5.1. MDR: Chandaneshwar – Jaleshwar Section

This section of the major district road between Chandaneshwar and Jaleshwar is bituminous intermediate / two lane road in plain terrain having 1m to 2m wide earthen shoulder. The shoulder was generally observed to be in poor condition.

Majority of the land use along this road are small habitations. The traffic mix consists of majorly four wheeler passenger traffic with cyclists and pedestrians near the influence area of the habitations. The road condition is good with lot of access roads joining the main road leading to the habitations.

The spot speed Survey conducted on the approach of a curve revealed that speeds of vehicles vary from 33 KMPH (Truck) to 62 KMPH (Car) and the 85th Percentile Speed is 50 KMPH.

3.5.1.1. Delineation of the road

Ch: 13+000

Ch: 33+000

Concerns & Recommendations	
Reasons for concern:	**Centerline and edge line road markings are not provided on the road.**
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

3.5.1.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 200m were observed at Km.4+300, 4+600, 6+500, 10+800, 17+600, 18+200, 21+500, 22+400, 23+900, 29+000, 29+500, 29+700, 31+500, 32+800, 33+000 and 33+500.

Ch: 6+600

Ch: 21+500

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which can cause: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	**Curves on high embankment** In the worst case of a run-off accident on curves with high embankment, the chances of fatalities are high
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*

3.5.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road
Km 9+750, 11+500, 16+100, 17+400, 19+200, 26+450, 28+200, 29+800, 30+700, 35+600, 35+670

Location of Side roads at skew with the major road
Km 3+600; 4+250; 6+600; 10+000, 20+400; 24+300; 27+750; 28+200; 31+200; 33+100; 33+600

Ch: 4+300

Ch: 26+550

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions.

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
Recommendations:	Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.*

3.5.1.4. Major Junctions

The major junctions were noted on the following chainages:

- 0+000
- 2+000
- 17+400
- 35+600

Ch: 0+000

Ch: 2+000

Ch: 17+400

Ch: 35+600

In the existing conditions, these junctions are characterized by roundabouts or T junction, There is a grade-separated junction with NH-16, with slip roads to enter and exit from the National Highway to this road.

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** • The junction layout in all cases is non-standard and has no control over the traffic movement, since priority is not established. This encourages lawless traffic movement and is hazardous. The existing splitter islands are non-standard and hamper visibility at the junction.
Recommendations:	• Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to Appendix III for guidelines of standard layout on 3-arm junction and roundabout.*
Reasons for concern:	**Direction Signs** • No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.
Recommendations:	• Provide direction signs on approaches to the junction to guide the traffic through the junction layout. *Refer to Appendix III for guidelines of direction signs on 3-arm junction and roundabout.*
Reasons for concern:	**Poor delineation** • Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	• Provide edge line markings, centerline markings and other junction road markings pertaining to junction control. *Refer to Appendix III for guidelines on road markings & traffic signs 3-arm junction and roundabout.*
Reasons for concern:	**Provision for VRUs** • Shoulder spaces in the junction area are encroached by the commercial establishments.
Recommendations:	• Remove encroachments from the shoulder spaces and provide clear 2 m wide shoulder.

3.5.1.5. Roadside Hazards - Trees, Poles, and Buildings

Along the road, road side objects like electricity poles, signs, trees are present at significant number of locations.

Ch: 10+100

Ch: 10+700

Concerns & Recommendations

Reasons for concern: Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

3.5.1.6. Roadside Villages/ Built-up Areas (BUA)

There are many small hamlets along the road. The presence of houses / schools along the road generates vehicular traffic / pedestrians / cyclists on the road in the stretches. The chainages of roadside villages observed to be hazardous for vulnerable road users and motorized traffic alike is given below.

- 3+600
- 6+600
- 9+800
- 17+100
- 18+000
- 24+300
- 28+200
- 33+600
- 35+600

Ch: 6+600

Ch: 18+000

Concerns & Recommendations

Reasons for concern:

- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- No speed limit signs provided
- Street lighting not provided on some of the roadside villages

Recommendations:

- Provide Gateway signs at either approach to the built up areas; provide a Gateway effect on approaches to road side villages.

Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas

- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools

Refer to Appendix III for guidelines for treatments on for roadside villages and commercial areas

3.5.1.7. Specific Locations

It was informed by OWD, that this junction near Nachimpur village Chainage:3+600 is a black spot. This is a three arm uncontrolled junction on a curve after a long straight section.

Ch: 3+600

Reasons for concern:

Side road joining the main road at a sharp curve, after a long straight section

The final layout of the junction of the side road with the main road making a sharp curve, after a long straight section has become very dangerous. The vehicles turning at this junction are at a high speed, after a long straight section and sometimes unable to negotiate the curve or traverse the curve safely in case of traffic from the side road.

Recommendations:

Provision of sets of rumble strips to slow the traffic entering the junction. Provision of advance warning signs to notify the road user to be prepared to safely negotiate the sharp and the conflicting traffic.

CHAPTER 4

CUTTACK DISTRICT

4.1. Crash Data Analysis

The road crash data have been collected from State Crime Records Bureau (SCRB) for Cuttack district for years 2009, 2010 and 2011. The data consist of total number of crashes, fatalities and injuries classified into various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of the driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Cuttack district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

4.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 4.1**. It can be seen from **Figure 4.1** that maximum number of fatalities and crashes occur on NHs in Cuttack district followed by 'other roads'.

The length of road network in Cuttack district is shown in **Figure 4.2**. It can be seen from **Figure 4.2**that length of other roads is more than the length of NHs and SHs put together in Cuttack district. NHs constitute 32 percent of the road network, but 54 percent of crashes occur on NHs. This means that NHs are more prone to crashes and fatalities than SHs and other roads in Cuttack district.

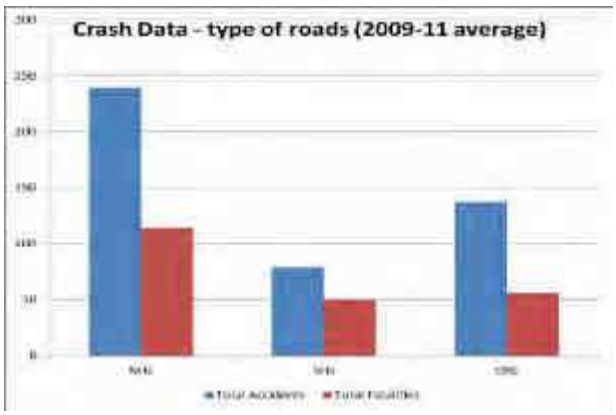


Figure 4.1: Crash data – Type of roads

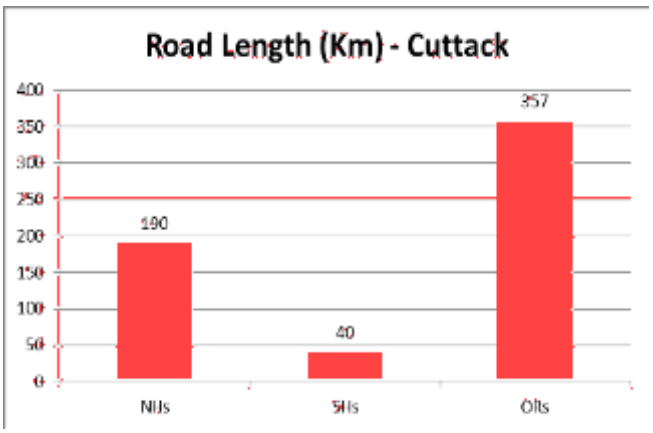


Figure 4.2: Road Network Length – Cuttack Dist

The crash data classified on the basis of location type in Cuttack district is shown in **Figure 4.3** below.

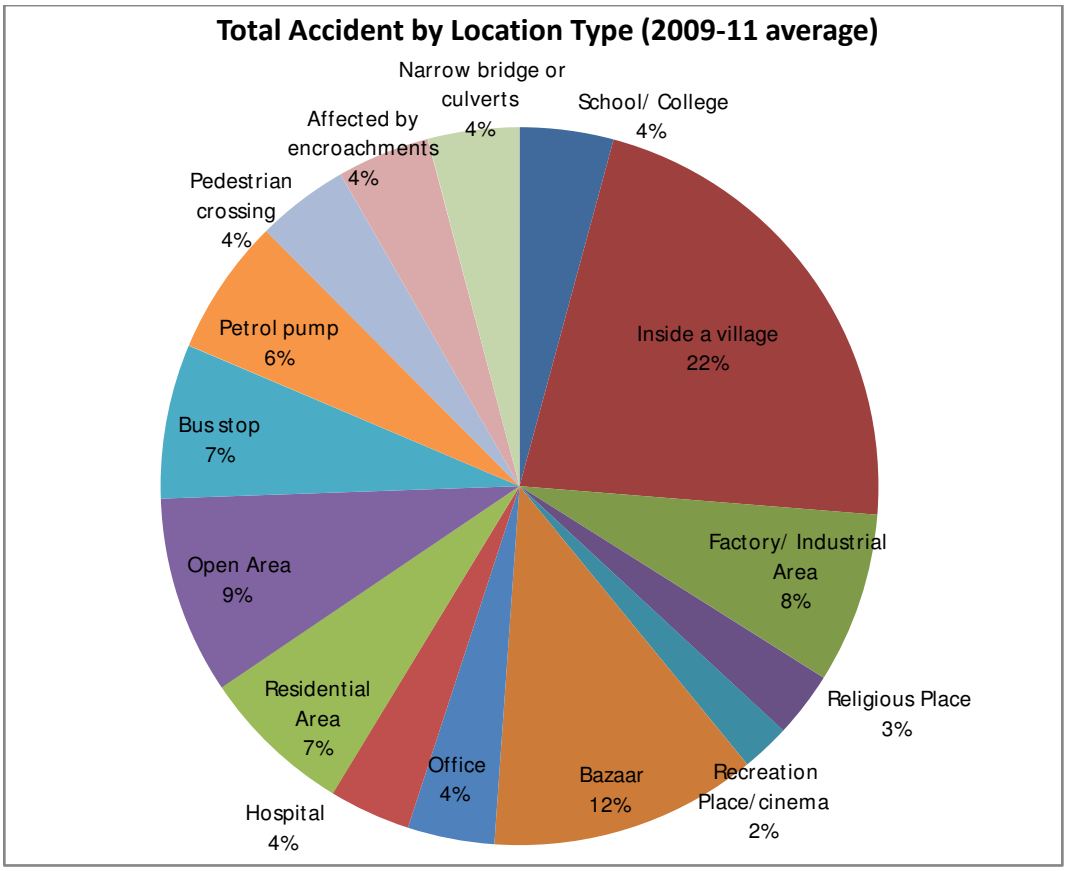


Figure 4.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 4.3** that maximum number of crashes occur 'inside a village' (22%) followed by 'bazaar' (12%). Based on the above data it may be inferred that majority of crashes (almost 60%) occur around populated areas where significant number of pedestrian, bicycles and other slow moving vehicles are present. However, it is not clear from the above set of data that whether crashes in 'inside village', 'open area' or 'bazaar' occur more in NHs or district roads or SHs.

4.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 4.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 4.5**.

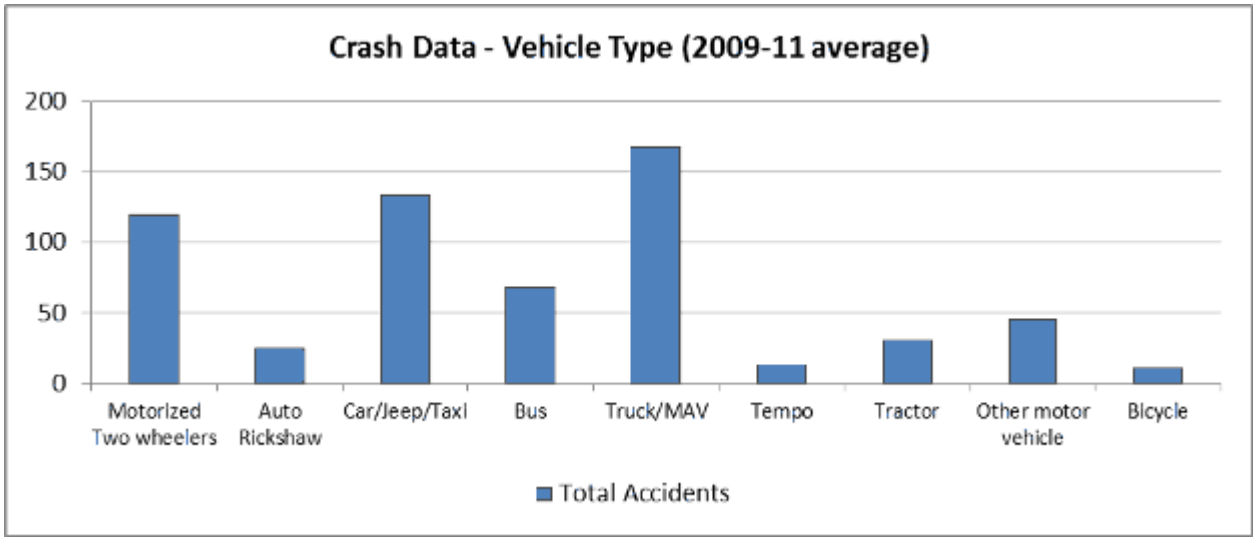


Figure 4.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 4.4** it can be seen that trucks are involved in maximum number of crashes (approximate 170) followed by cars and motorized two wheelers. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

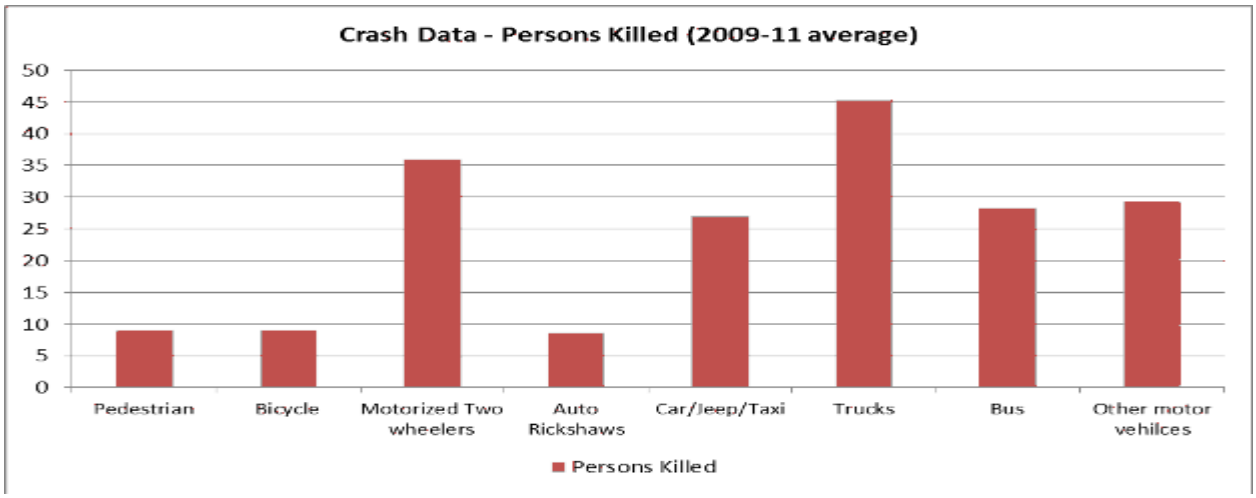


Figure 4.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 4.5** it can be seen that maximum fatalities (approximate 45 lives) occur among the truck users followed by motorized two wheeler riders, car and bus users. Significant number of fatalities is reported under the road user type 'others', but this category is not defined in the crash database. From the available data, it is difficult to ascertain the locations/ road types, where the truck users and motorcyclists are at higher risk.

Further to analysis the nature of crashes occurred in Cuttack district which may reveal a better correlation of crashes/ fatalities between type of vehicle and road category, the average number of crashes and fatalities based on type of collision are plotted as shown in **Figure 4.6.**

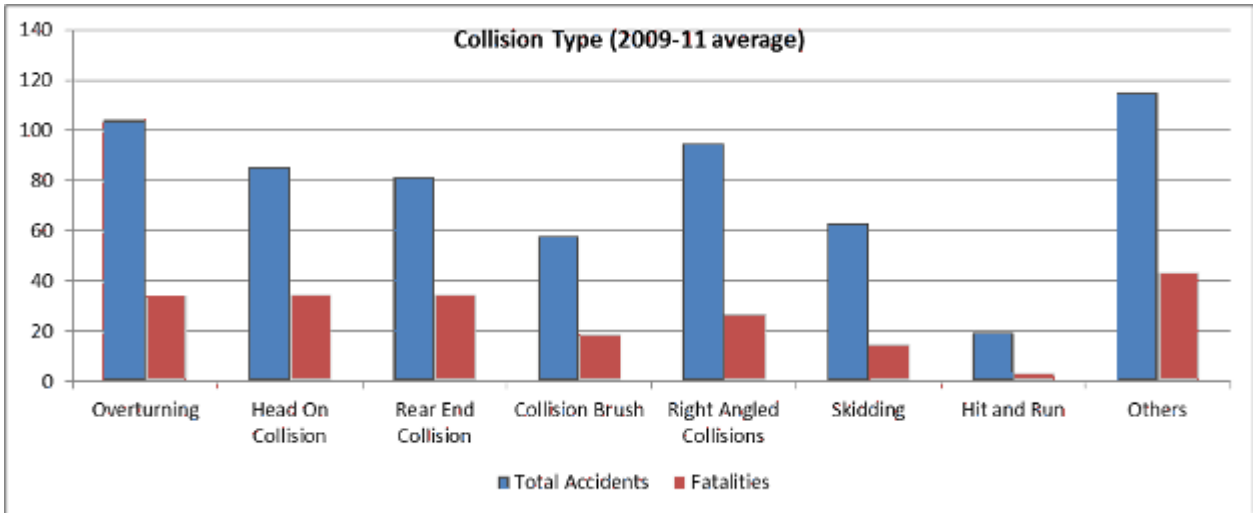


Figure4.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 4.6** that predominant nature of crashes in Cuttack district is under the category of 'others' (120 crashes). The type of collisions included in the category 'others' is not defined; hence it is not possible to draw any conclusion based on this data. It is assumed that the category 'others' include nature of accidents such as hit road side objects such as trees and run-off accidents. In the remaining categories, crashes reported under 'overturning' and 'head on collision' are highest.

It can be seen from the above figures that maximum number of crashes/ fatalities happens on NHs, trucks have a major share in crashes and the number one category of persons getting killed on roads in Cuttack are truck drivers and passengers, and the predominant nature of crashes are overturning of vehicles (neglecting 'others').

From the above, the following conclusions can be drawn from the crash data of Cuttack district:

- NHs are the most hazardous road type followed by SHs; NHs constitute 32 percent of the road network, but 54 percent of crashes occur on NHs.
- The populated areas along the road network in SH and NH are particularly hazardous
- Trucks, motorized two wheelers and passenger cars are high risk groups exposed to higher number of crashes and fatalities
- Overturning accidents, hit road side objects and run-off accidents are the most predominant nature of accidents, followed by head-on collisions, rear end collisions, and right angled collision, which indicates sharp curves, junction locations, overloading on NHs, poor visibility might be particular hazardous features on the road network
- According to the data, pedestrian, bicycle riders, and motorized two wheelers are exposed to risk and hence can be considered as hazardous users or high risk user groups.

4.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 4.7** and the corresponding figures for urban area is shown in **Figure 4.8.**

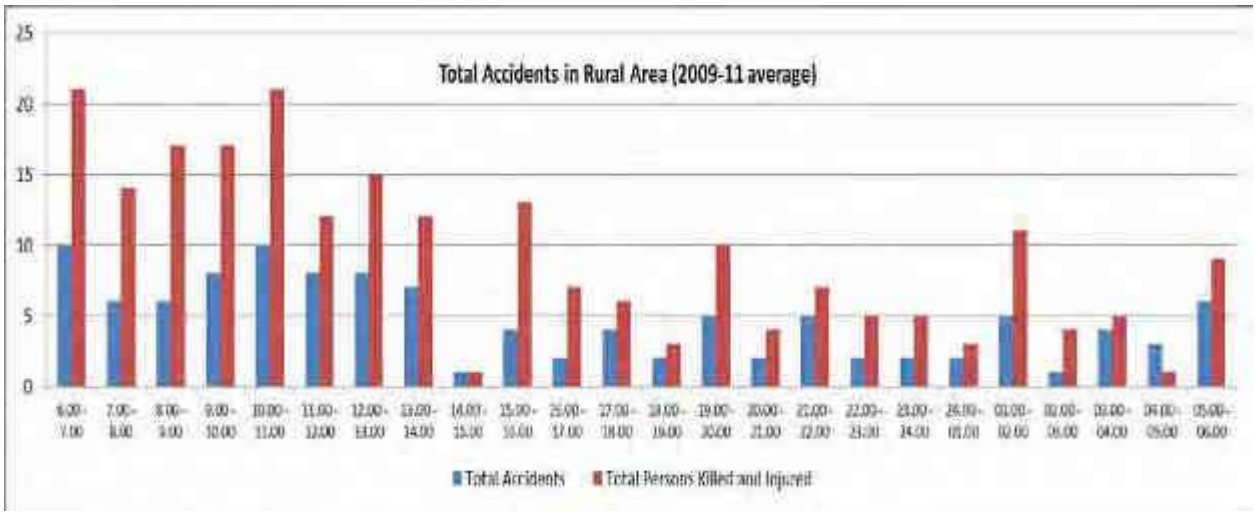


Figure 4.7: Total number of crashes in rural area (2009 – 11 average)

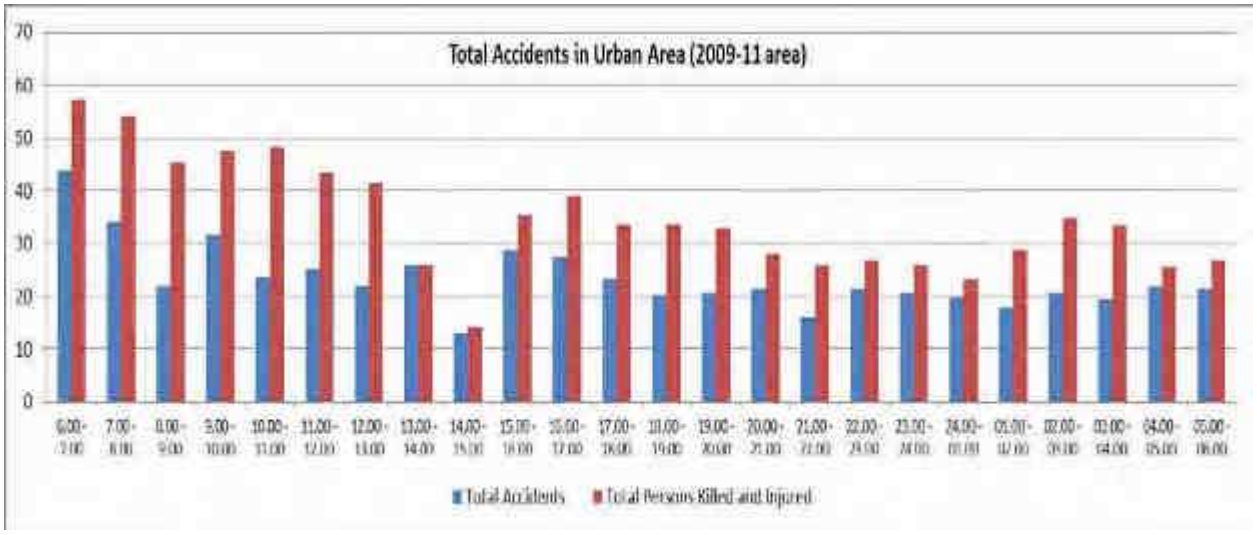


Figure 4.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 4.7** that maximum numbers of crashes are occurring during morning period (06:00 to 11:00 hrs), and during night hours also there are significant number of crashes. There is no proper trend observed and no correlation can be obtained between number of crashes and time of the day for rural areas.

In urban areas also, (**Figure 4.8)** it is observed that more number of crashes are occurring during morning hours and for rest of the day it remains more or less uniform. The data is inconclusive to arrive at a correlation between the time of the day and crashes for urban areas.

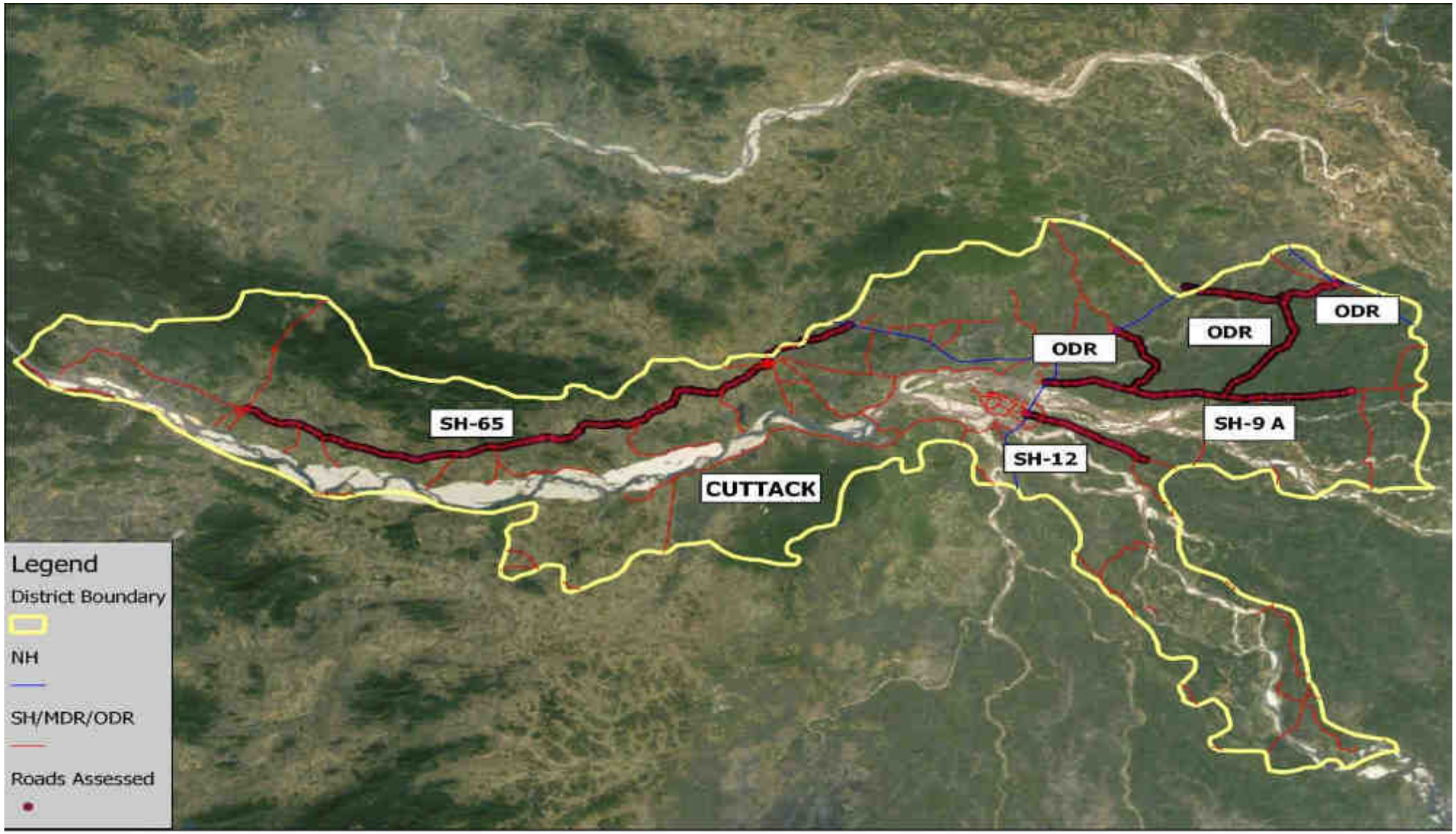
4.2. Location and Detail of Audited Roads

The assessment was carried out on the following six roads:

1. SH-65 (Khuntuni to Narsinghpur)
2. SH-12 (OMP Chhak to Jagatpur Border)
3. SH-9A (Jagatpur to Asureswar)
4. ODR (Salipur to Chhatia)
5. ODR (Paga to Tangi)
6. ODR (Kuanpal to Balichandrapur)

The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II**. The map of roads assessed is shown in **Figure 4.9.**

Figure 4.9: Roads assessed for Cuttack District



4.3. Road Safety Assessment – State Highways

4.3.1. SH-65 (Khuntuni to Narsinghpur)

The assessment was carried out on this road on a length of 76 km, starting from Khuntuni and ending in Narsinghpur. The general features of this road are as follows:

- Bituminous intermediate lane road in reasonably good condition;
- Less than 1m wide earthen shoulder and at some stretches width is less than 0.5 m because of over grown vegetation and bushes;
- The condition of the shoulder is generally poor;
- Traffic is mixed but has higher number of motorcycles, bicycles and pedestrians;
- Built up areas are highly encroached and also have high demand for commercial parking;
- Small towns and villages have very high number of motorcycles, bicycles and pedestrians; and
- Speed observed during spot speed survey varies from 30 km/ hour to more than 90 km/ hour, but 85th percentile speed is 60 km/hour.

The following sections detail the major hazards observed on this road, the reasons for concern and the recommendations to improve road safety in each of these hazards observed.

4.3.1.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	Edge line and centre line road markings were not provided, the presence of which should have delineated the road, particularly during night conditions
Recommendations:	• Provide edge line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide centre line markings throughout the road section • Provide RRPMs on edge line and centre line on sharp curves
Reasons for concern:	No road markings on access road to warn the road user of the junction ahead • Potential right angle collisions
Recommendations:	Provide **Give Way/ STOP road marking** using thermoplastic material as appropriate on side roads

4.3.1.2. Alignment – Sharp Horizontal Curves

Project road have many curves, some of them observed to be sharp which requires slowing down the vehicles to more than 20 km/ hour than the approach speed for safe maneuvering of the vehicle. Such curves need warning signs, chevron marking and edge lines.

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 17:00 hours to 18:00 hours, from 0+000 to 12+100. An average speed of 36.5 km/ hour and a maximum speed of 50 km/ hour were noted during this survey.

Sharp Curves (radius less than 100-150 m) are observed at the following chainages:

5+700	11+100	14+900	20+100	24+900	30+400	64+050
6+100	11+700	15+500	21+000	27+300	36+800	65+800
8+900	12+700	16+950	21+600	27+950	44+900	
9+500	13+600	18+200	22+400	28+700	45+100	
10+000	13+700	20+000	23+000	28+850	55+500	

Sharp Curves on Project Road at Km 36+800 and Km 24+900 respectively

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate. Refer to Appendix III - Engineering Countermeasures, for guidelines on situations where to install the above
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents and resultant fatalities.
Recommendations:	Provide crash barriers with delineators on the outer edge on such curves.

4.3.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road								
1+330	8+650	11+900	24+900	29+800	34+600	46+600	60+000	69+250
4+600	9+400	12+700	25+200	31+950	35+450	51+700	61+200	71+050
5+300	9+800	18+050	26+300	32+100	38+800	51+700	62+700	72+300
6+050	10+800	19+050	26+300	32+400	42+900	51+900	62+700	72+350
6+500	11+100	19+900	27+500	32+700	44+700	52+000	63+600	73+400
8+600	11+400	20+500	27+500	32+720	44+900	53+500	66+000	
8+610	11+500	21+900	28+850	33+700	45+850	54+950	67+800	

Location of Side roads at skew with the major road					
1+000	15+800	30+400	42+900	49+300	57+150
4+100	16+100	36+800	43+900	52+500	66+300
8+300	16+950	41+160	46+650	54+500	66+800
11+000	23+100	41+900	47+200	56+500	68+200
15+500	28+850	41+900	49+300	57+100	74+200

Skewed Side road at Km 28+850

Perpendicular Side Road at Km 27+500

Concerns & Recommendations

Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-15 are due to buildings/ encroachments on the corners.
Recommendations:	Remove encroachments at least from the visibility triangle required for such junctions.
Reasons for concern:	**Poor delineation** No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead. Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.
Recommendations:	• Provide warning signs to provide drivers of advance notice of the upcoming junction • Provide Give Way/ Stop signs as applicable, on side roads • Provide Give Way/ Stop road marking at side roads Refer to Appendix III for typical 3-arm junctions layouts with appropriate road markings and traffic signs.
Reasons for concern:	**High approach speeds** High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.
Recommendations:	• Provide road humps on the side road at junctions having history of accidents • Provide raised markings on the entry to the side road • Provide adequate warning signs on major road and side road Refer to Appendix III for standard details of road humps.
Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner. This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.
Recommendations:	Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. Refer to Appendix III for safe geometrical arrangements of junction with side road.

4.3.1.4. Major Junctions

5-arm Junction at Km. 11+700 – Gopabandhu Chowk

The salient features of this intersection are as follows:

- Junction point of two ODRs and one VR with SH65;
- Junction is built-up with shops and consequently on-street parking pose a problem;
- Heavy two wheelers, pedestrians, cyclists are present on the junction;
- Layout of the junction is poor with no established traffic control anda non-standard central island is present obstructing the sight of the approaching traffic; and
- Street lighting is provided, but no traffic signs or road markings to warn, delineate and establish junction control.

Km 11+700

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users. A roundabout will work better in 5 arm situation, but require detail study and design.
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead
Recommendations:	Establish control in the junction by providing 'Give Way' and 'Stop' signs, edge markings and other road markings pertaining to junction control

Reasons for concern:	**Provision for VRUs** Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	Provide wide shoulders/ footpaths for pedestrians to commute in the junctions without interfering with the motorized traffic
Reasons for concern:	**On-street Parking** There are no parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space. This hampers visibility at the junction and force pedestrians to move into the center of the road resulting in hazardous situation.
Recommendations:	Provide designated parking spaces for commercial vehicles

3-arm Junction at Km. 51+000

The salient features of this intersection are as follows:

- Junction of ODR (towards Sambalpur) with SH-65;
- Poor layout of the junction;
- On street boarding of buses, which obstructs visibility;
- Built up structures are present very near to junction;
- Junction control is not established; and
- No street lighting, traffic signs and road markings provided.

Km 51+000

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction is a non-standard Y-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.
Recommendations:	• Re-design the junction layout • Provide splitter islands to enable safe movement of motorized and non-motorized traffic Refer to Appendix III for standard layouts of 3-arm junctions
Reasons for concern:	**Poor delineation** No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided. Direction signs are important on the approaches to this junction to inform the road user of the routes ahead.
Recommendations:	• Provide advance direction and direction signs to inform the road user • Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road • Provide edge lines • Provide Splitter islands using road markings to establish improved traffic control Refer to Appendix III for guidelines for design and installation of direction signs
Reasons for concern:	**High approach speed** Traffic coming from the Cuttack side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality
Recommendations:	• Provide traffic calming measures on the minor road • Provide warning signs on the minor road • Provide information signs and road markings at the junction to warn the road user of the layout
Reasons for concern:	**On street Bus stop** Buses stops at the mouth of the junction in the minor road hampering visibility
Recommendations:	Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction
Reasons for concern:	**Provision of VRUs** Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.
Recommendations:	Provide footpaths to segregate pedestrians from high speed traffic at the junction approaches;

5-arm uncontrolled junction at Km. 75+700 – Panchmukhi Chowk

The salient features of this intersection are as follows:

- Poor junction layout;
- Priority is not established;
- Shops noted around the corners and approaches of the junction;
- No designated bus stop provided, leading to buses stopping in hazardous manner;
- No road markings or traffic signs (direction, warning and informatory) are provided; and
- Street lighting and provision for VRUs are not provided.

Km 75+700

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

Junction has no form and the layout is confusing for the road user. No proper control is established either through road markings or signals.

Recommendations:

- Redesign the junction after traffic studies and considering the requirement of all road users;
- A roundabout may be the best form for 5-arm intersections, but this needs to be decided after traffic studies
- Provide designated spaces for bus stops
- Provide designated parking spaces

Reasons for concern:

Poor delineation and information

No traffic signs and markings are provided at the junction and its approaches to delineate and establish control. The absence of road markings and appropriate signs will encourage drivers to behave in a hazardous manner in the junction and create unsafe situation.

Recommendations:

- Redesign the junction layout and establish traffic control by providing appropriate traffic signs and road markings
- Road markings to be provided – Edge lane and Centre line, Splitter island markings and Give Way/ Stop markings
- Traffic signs to be provided – Advance direction and direction signs and Give

Way/ Stop signs
- Provide advance direction signs on all approaches to the junction

Reasons for concern: **On-street parking**

Commercial activities are high on such junctions where interchange takes place and thus junction is crowded. On street parking obstructs visibility and forces pedestrians to use the road space exposing them to risk.

Recommendations:
- Provide designated parking spaces near the shops

Reasons for concern: **On street Bus stop**

The approaches does not have a designated bus stop and hence buses stops at the mouth of the junction hampering visibility.

Recommendations:
- Provide designated bus stops on road (by road markings) at appropriate location or provide bus bays where space is available

Reasons for concern: **Provision of VRUs**

Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.

Recommendations: Provide footpaths, where it is economically feasible; and Provide wide earthen shoulders (at least 2m wide), clear of all encroachments for use by pedestrians.

4.3.1.5. Approach to Bridges

At chainage 5+700, approach to bridge is found. Major issues observed are as given below:

- Sharp Curve on approaches;
- No protection on outside curve;
- Very high embankment; and
- No road markings and traffic signs to delineate and inform the road user of the impending hazards

Approach to Bridge at high embankment at Km 5+700

Concerns & Recommendations

Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the bridge on the curve loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be major or fatal.
Recommendations:	Provide crash barriers on either approaches to the bridge with delineators
Reasons for concern:	**Poor Delineation** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents.
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets
Reasons for concern:	**High approach speed** In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.
Recommendation:	• Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits • In case the location has a history of accidents, provide speed tables/ humps on either approaches Refer to Appendix III for guidelines of countermeasures required on approach to bridges/ structures on curves.

4.3.1.6. Road Side Objects - Parapet Walls

At the following chainages, parapet wall is broken or no parapet wall at all, water bodies along these structures are hazardous and can increase the severity of accident.

- 13+600
- 35+800
- 41+150
- 50+400

Broken Parapet wall at Km 13+600

Absence of Parapet wall at Km 41+150

Bridges/ Parapets having parapets on the road edge were observed on the following locations where delineation is not present.

2+100	18+300	35+400	39+950	54+500	67+900
2+400	21+650	35+800	41+150	58+400	71+300
2+600	24+100	36+400	45+100	64+600	
5+700	26+600	38+300	48+700	65+700	
10+300	33+200	38+700	50+400	67+100	
13+600	35+100	38+850	50+700	67+800	

Culvert at Km 2+600

Minor Bridge at Km 48+700

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on SH-10, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.
Recommendations:	Provide continuous parapets on all culverts and bridges.

4.3.1.7. Roadside objects - Trees and Street lighting Pole

Project road have many locations where trees and street lighting poles are very near to pavement edge.

Several trees near pavement edge

Concerns & Recommendations

Reasons for concern:

The road side objects like trees and street lighting poles, buildings and unprotected deep drains which are near the edge of road poses significant safety hazard. At night time it becomes very difficult for drivers to judge the position of such hazards, in the absence of proper delineation.

If the road side objects are not protected and/or delineated/ illuminated, in the event of driver losing control, the resulting injury can be fatal.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 3m from the road edge

4.3.1.8. Roadside Villages/ Built-up Areas (BUAs)

Roadside villages are particularly hazardous points on a rural road network. SH 65 has many such roadside villages, where the vulnerable road users, including school children are particularly at risk from high speed traffic. It is important to inform the road user in advance of the impending roadside village and if necessary, traffic calming measures needs to be provided for improved speed management through such villages/ built up areas.

Tigria Village at Km 26+100

Badamba Town at Km. 45+600

Roadside villages are of the following types:

- Residential units only along the roadside having 100m to 200m length
- A mix of residences and commercial establishments like small shops, the length ranging from 200m to less than a kilometer
- Purely commercial areas where heavy commercial activity, on street parking and high number of pedestrian presence is noted. This is generally longer than the other 2 categories.

Roadside villages/ built up areas were noted on the following locations:

- 4+200 (Kulelo Village)
- 8+100 (Isra Village)
- 8+600 (Dorudo Village)
- 15+700 (Radhadarshanpur Village)
- 16+900 (Khuntu Kota Village)
- 25+100 (Panchagaon Village)
- 27+200 (TIgriaSashan)
- 33+300 (Vidhyarpur Village)
- 35+900 (Maniyabandh Village)
- 41+800
- 42+800 (Sambarsingh Village)
- 43+800 (Nuatoila Village)
- 48+800 (Sunapal Village)
- 52+000 (Gopupura Village)
- 53+50 (KrishnapurVilalge)
- 56+500 (Amantya Village)
- 57+050 (Gopalpur Village)
- 58+700 (Rathpat Village)
- 59+600 (Balijhari Village)
- 61+100 (Baselihafta Village)
- 61+300 (Athendo Village)
- 62+650
- 65+200 (Kandhoverini Village)
- 65+950 (Chambeshwar Town)
- 69+000 (Badholia Village)
- 71+400 (Kamladaipur Village)
- 72+200 (Lukhapura Village)
- 74+400 (Start of Narsighpur Town)

Following sections can be classified as commercial areas.

- 10+800 (Atthgarh Town)
- 31+500 (Nuapatna Village)
- 36+700 (Maniyabandh Village)
- 26+100 (Tigria Village)
- 34+800 (Abhimanpur Village)
- 45+900 (Badamba Town)
- 60+300 (Kuranjha Village)

- In above villages/town wherever schools are present, a warning sign "School Ahead" is provided on both approaches.
- On street Parking and on street bus stops are present
- Significant pedestrians/school children, cyclists, motorcycles noted
- The level of encroachment is high.

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to control the speed of vehicles approaching at high speeds
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided
- Significant number of access roads within the roadside village, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- On-road bus stops hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided inform the road user of the safe speed to be adopted
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:

- Provide traffic calming measures on either approaches to the roadside village/ built-up area
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban/ commercial areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines to improve road safety on road section near and inside the roadside village.

4.3.2. State Highway-12 (OMP Chowk to Jagatpur Border)

SH-12 starts at OMP Chowk (NH-16) and ends at Jagatpur Border. It is a two lane cement concrete road with paved shoulder. The road was assessed for road safety on a length of 14 km from OMP Chowk, beyond which the road is under construction. Mixed traffic was observed, with a higher number of motorcycles, bicycles and pedestrians. Built up areas along the road have high encroachments and also have high demand for commercial parking. Speed observed during spot speed survey varies from 30 KPH to more than 80 KPH and 85th percentile speed is lesser than 60 KPH.

4.3.2.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	**Edge line and center line road markings were not provided, which can lead to:** • Traffic not keeping to their lanes and dangerous overtaking • Cyclists mixing with other fast moving traffic and exposed to speed
Recommendations:	• Provide edge line and center line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide RRPMs on edge line and centre line on all sharp curves

4.3.2.2. Alignment – Sharp Horizontal Curves

Project road have few sharp curves where high approach speed is observed. Such curves need warning signs, and traffic calming measures to manage the speed of the approaching vehicles.

Curves having radius in the range of 100m to 200m were observed on the following locations:

4+400 8+600

8+400

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 10:00 hrs to 11:00 hrs, from chainage12+000 to 2+000. An average speed of 60 km/ hour and a maximum speed of 80 km/ hour is noted during this survey. A spot speed survey was conducted at location 4+400, and the 85th percentile speed at this location was found to be 56km/ hour.

Curve at Km 4+400

Curve at Km 8+600

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed. In the worst case, this may lead to • Potential run-off accidents • Potential head-on collisions
Recommendations:	• Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate Refer to Appendix III for curve treatments
Reasons for concern:	**Poor visibility on the curve due to trees and overgrown vegetation**, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.
Recommendations:	For delineation at all these sharp curves provide chevron signs.
Reasons for concern:	On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.
Recommendations:	Provide crash barriers with delineators on the outer edge on such curves.
Reasons for concern:	Dangerous overtaking on sharp curves may lead to head-on collisions
Recommendations:	Provide 'no overtaking' traffic signs along with no overtaking lines on full length of the curve

4.3.2.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The above junction types were observed on the following chainages:

Location of Side roads perpendicular to major road
14+300

Location of Side roads at skew with the major road	
8+600	8+600

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-15 are due to buildings/ shops on the corners.

Recommendations:

- **Desirable** - Remove encroachments at least from the visibility triangle required for such junctions.
- **Essential** – Provide road hump on the side road and install appropriate warning signs coupled with junction markings

Refer to Appendix III for the layout of side roads with required markings and road signs

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ Stop signs as applicable, on side roads
- Provide Give Way/ Stop road marking as applicable, on side roads

Refer to Appendix III for the layout of side roads with associated markings and road signs.

Reasons for concern:

High approach speeds

High approach speeds were observed by traffic (especially motorcycles) turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side roads at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for the layout of side roads with associated markings and road signs.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the vertical profile of the side road joins the edge of main carriageway in an unsafe manner. This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for the desired geometric arrangement for 3-arm junctions.

4.3.2.4. Major Junctions

4-arm Junction at chainage 1+600

The salient features observed on this junction are as follows:

- The layout of the junction is poor, and no junction control has been established;
- Junction is heavily built-up with commercial establishments
- High presence of pedestrians and cyclists, but no separate provisions has been made which forces pedestrians and cyclists to mix with the motor traffic on the road to travel within the junction area; and
- Street light is provided.

Km 11+700

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations: Re-design the junction after traffic studies and considering the requirements of all road users. A roundabout will work better in 5 arm situation, but require detail study and design.

Reasons for concern:

Poor delineation

Traffic signs and road markings are absent in any of the arms of the junction, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control

Reasons for concern:

Provision for VRUs

Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations: **Essential** – Provide footpaths for pedestrians to commute in the junction area without interfering with the motorized traffic

Reasons for concern:

On-street Parking

There are no parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and the shoulder space. This hampers visibility at the junction and force pedestrians to move into the center of the road resulting in hazardous situation.

Recommendations:

- Provide designated parking spaces for commercial vehicles

Refer to Appendix III for parking arrangements in roadside commercial areas.

Reasons for concern:

High approach speed

Traffic coming from the Cuttack side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

3-arm Junction at Km 13+700

The salient features observed on this junction are as follows:

- Poor layout of the junction with no established traffic control
- Junction area has high commercial activity and the level of encroachment is high
- Significant presence of pedestrians and cyclists, but no separate provisions has been provided
- Street lighting is not provided

Km 13+700

Concerns & Recommendations	
Reasons for concern:	**Poor Junction layout with no provision of traffic signs and road markings** Junction has no form and the layout is confusing for the road user. No proper control is established either through road markings, traffic signs or signals.
Recommendations:	• Redesign the junction after detail traffic studies and considering the requirement of all road users; Refer to Appendix III for safe layout of major 3-arm junctions
Reasons for concern:	**On street Bus stop** Buses stops at the mouth of the junction in the minor road hampering visibility
Recommendations:	Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction
Reasons for concern:	**Provision of VRUs** Significant presence of pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.
Recommendations:	Provide footpaths or wide shoulders to segregate pedestrians from high speed traffic at the junction approaches;

4.3.2.5. Approach to Bridges

- At chainage 8+600, a curve leads to a bridge on both approaches in high embankment, but it has been observed that no safety measures has been provided.

Approach to Major Bridge at high embankment

Google Image for Major Bridge and access road

Concerns & Recommendations

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Reasons for concern: **Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents.

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

Reasons for concern: **High approach speed**

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches, along with warning signs for 'road hump'.

Reasons for concern: **Poor Geometry**

The level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for vertical profile arrangement for 3-arm junction.

4.3.2.6. Road Side Villages/Built-up Areas (BUAs)

Roadside villages are particularly hazardous points on a rural road network. This sections of the road has many such roadside villages, where the vulnerable road users, including school children are particularly at risk from high speed traffic. It is important to inform the road user in advance of the impending roadside village and if necessary, traffic calming measures needs to be provided for improved speed management through such villages/ built up areas. The major issues affecting road safety are:

- Most of the villages have schools along the roads, but no separate provisions (wide shoulders of footpaths and safe crossing points)are provided for school children to cross or walk along the road in a safe manner
- On street Parking was observed, which hampers visibility
- Roadside is heavily encroached, leaving little or no space for pedestrians to walk along the road in a safe manner. In addition, encroachments encourage parking on the road, which further hampers visibility and create hazardous situations.

Commercial Area at Km 2+000

School at Km 8+400 in Biribati Village

The roadside villages were observed on the following chainages:

5+700 6+000 8+100

The following locations were noted for heavy commercial activities.

1+000 13+100

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area;
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road or to cross the road inside the village zone/ built up area;
- Significant number of access roads within the built up area, the visibility of which has been hampered due to shops/ establishments on all corners of the junction;
- No road markings or warning signs to warn/ inform the road user of the

built up nature of the area ahead;
- No speed limit signs provided; and
- Hazardous on-street parking observed on commercial/ encroachment zones, which hampers the visibility of oncoming vehicles and resulting in unsafe situations.

Recommendations:

- Remove all encroachments and make available the road space up to road edge free of hindrances;
- Develop a 'Gateway effect' on both approaches to the roadside village/ built up area;
- Provide street lighting on all roadside villages/ built up areas, the lighting shall be provided at least beyond 100m from the start point of roadside village;
- Provide pedestrian crossings, wherever deemed necessary;
- Provide footpaths in urban areas or well-maintained wide shoulders (min. 2m wide) clean of encroachments and overgrown vegetation in rural areas;
- Provide road humps with 'STOP' signs on all access roads in roadside villages in rural areas; and
- Provide designated parking spaces where the demand of parking is high.

Refer to Appendix III for safe infrastructure arrangement for roadside villages in rural areas and for heavily built up sections

4.3.3. SH-9A (Jagatpur to Asureswar)

SH-9A starts at Jagatpur and ends at Asureswar. It is an intermediate lane, bituminous road having good condition except between chainage 22+000 to 26+000 where road condition was poor. The width of the earthen shoulder is less than 0.5 m on most of the section, and the condition of the shoulder was found to be generally poor. This section of the road has mixed traffic, having higher number of motorcycles, bicycles and pedestrians.

The level of traffic was noted to be on the lower side after the Paga town. Built up areas have high encroachment and also have high demand for commercial parking. Speed observed during spot speed survey varies from 20 KPH to more than 60 KPH and 85th percentile speed is lesser than 50 KPH.

4.3.3.1 Delineation of the Road

Concerns & Recommendations

Reasons for concern:	**Edge line and centre line road markings were not provided, the provision of which should have delineated the road and encourage improved lane driving**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide RRPMs on edge line and centre line for sharp curves

4.3.3.2 Alignment-Sharp horizontal Curves

Project road have many curves, some of them observed to be sharp which requires slowing down the vehicles to more than 20 km/ hour than the approach speed for safe maneuvering of the vehicle.

Curves having radius in the range of 100m to 150m were observed on the following locations:

- 2+000
- 10+200
- 24+950
- 2+100
- 17+300
- 33+800
- 5+400
- 22+900

During the course of the assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 13:00 hrs to 14:00 hrs, from Asureswar to Salipur. An average speed of 45 km/ hour and a maximum speed of 80 km/ hour was noted during this survey. A spot speed survey was conducted at chainage2+000, and the 85th percentile speed at this location was found to be 46 km/ hour.

Sharp Curves on Project Road at Km 17+300 and Km 22+900

Concerns & Recommendations	
Reasons for concern:	Sharp curve after straight section in rural open areas is observed. No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed. This may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate Provide extra widening on curves, where deemed appropriate as per IRC 73: 1980 *Refer to Appendix III for guidelines on treatment of curves*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the forward visibility by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.
Recommendations:	Provide crash barriers on the outer edge on such curves.

4.3.3.3 Minor Junctions

Various types of junctions were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road								
1+900	7+900	8+900	9+700	9+800	10+900	10+900	13+600	13+950
13+950	15+700	16+800	17+000	18+800	18+800	19+500	19+600	20+000
20+100	22+400	22+400	24+400	25+700	26+700	26+900	28+000	33+200

Location of Side roads at skew with the major road

24+100 29+000 29+700

Perpendicular Side Roads at Km 1+900 and Km 10+900

Skewed Side Road at Km 24+100

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The

Concerns & Recommendations

major reasons for poor visibility at such junctions on SH-15 are due to buildings on the corners.

Recommendations: Remove encroachments at least from the visibility triangle required for such junctions.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead. . In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ Stop signs and markings as applicable, on side roads

Refer to Appendix III for safe layout of 3-arm junctions.

Reasons for concern:

High approach speeds

High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for safe layout of 3-arm junctions.

Reasons for concern:

Level difference between side road and major road

It has been observed that on few junctions, the level difference between the side road and major road is greater than 1m and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

This requires hazardous maneuvers from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for safe arrangement for vertical profile at 3-arm junctions.

4.3.3.4 Major Junctions

3-arm Junction at Km 9+800& 19+900

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users.
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junction, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	• Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control.
Reasons for concern:	**Provision for VRUs** Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	• Provide wide shoulders/ footpaths for pedestrians to commute in the junctions without interfering with the motorized traffic.
Reasons for concern:	**On-street Parking** There are no parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space. This hampers visibility at the junction and force pedestrians to move into the center of the road resulting in hazardous situation.
Recommendations:	• Provide designated parking spaces for commercial vehicles
Reasons for concern:	**On street Bus stop** Bus stops at the mouth of the junction in the minor road hampering visibility.
Recommendations:	• Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction

4.3.3.5 Approach to Bridges (Chainage 2+300)

Concerns & Recommendations

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Reasons for concern: **Poor delineation - Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

Reasons for concern: **High approach speed**

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches

Reasons for concern: **Poor Geometry**

The vertical profile of side road joining the major road is hazardous

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for safe vertical profile of side road at a junction with major road

Refer to Appendix III for safe treatment options on approach to bridges/ structures on high embankments.

4.3.3.6 Road Side Objects - Parapet Walls

At the following chainages parapet wall was either broken or found missing. In the event of a vehicle loses control, the resultant injury will be fatal or major, due to the presence of water body.

20+000 24+800 31+100

absence of parapet wall at Km 24+800

There is no hazard marker present on structures and major/minor bridges. Such locations are

- 2+000
- 10+800
- 5+900
- 16+900
- 20+000
- 22+400
- 22+800
- 23+900
- 24+400
- 24+800
- 25+600
- 26+000
- 26+200
- 27+100
- 28+200
- 29+200
- 31+100
- 33+000

Km 26+000

Km 22+800

Concerns & Recommendations

Reasons for concern:	**Delineation of the parapet walls** The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be delineated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on SH-10, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.
Recommendations:	Provide continuous parapets on all culverts and bridges.

4.3.3.7 Trees and Street Pole

Project road have many locations where trees and street poles are very near to pavement edge.


Tree and street pole near pavement edge

Concerns & Recommendations

Reasons for concern:

The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

4.3.3.8 Road Side Villages/ Built-up Areas

Many roadside villages/ commercial areas were noted during the assessment. The chainages of roadside villages noted are shown below:

- 2+700
- 13+900
- 22+100
- 3+000
- 15+650
- 26+500
- 6+000
- 16+600
- 27+400
- 10+200
- 20+000
- 32+600

Busy commercial areas were noted at the following chainages:

- 1+000
- 9+300
- 2+700
- 17+100
- 7+000

The general features concerning road safety at these locations are given below.

- Primary schools are observed in many roadside villages
- On street Parking and on street bus stops are observed
- Significant pedestrians/ school children, cyclists, motorcycles are present
- Very high encroachments are observed
- Visibility is hampered due to structures present along the road and stopped vehicles, buses on the road

Nishint Kunj Commercial Area at Km 27+400

Built up area at Km 7+000

Concerns & Recommendations

Reasons for concern: High level of encroachment on certain village zone hinders visibility, forces pedestrians and cyclists to mix with the motor traffic leading to hazardous situations.

Recommendations:

- **Essential** – Remove encroachments particularly in roadside village zones and junction areas, and provide good forward visibility

Reasons for concern:

- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road;
- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area;
- On road bus stops which hampers visibility and encourage dangerous overtaking;
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead; and
- On street parking hampers the visibility and resulting in unsafe situations.

Recommendations:

- Provide pedestrian facilities – Footpaths in commercial areas, wide shoulders in rural villages and crossing facilities in designated points;
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas;
- Provide road humps and associated traffic signs and road markings on all

side roads within the built up area;

- Provide 1m wide cycle lanes on roadside village zones and zones having high commercial activity;
- Provide traffic calming measures on approaches to the school zone;
- Provide designated parking spaces, where it deemed necessary; and
- Provide designated spaces for Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for countermeasures in road side village zones.

4.4. Road Safety Assessment – Other District Roads

4.4.1. ODR - Salipur to Chhatia

This ODR starts at Salipur and ends at Chhatia. It is a single lane, bituminous road and is in generally good condition. The width of earthen shoulder was found to be less than 0.5 m and in poor condition. Mixed traffic is observed, having a higher number of motorcycles, bicycles and pedestrians. Built up areas are heavily encroached and parking on built up areas along the road poses a road safety hazard. Small towns and villages along the road have very high number of motorcycles, bicycles and pedestrians.

4.4.1.1. Delineation of Road

Concerns & Recommendations	
Reasons for concern:	**No edge line markings are provided** • Edge line markings delineate the road during day and night conditions, and this will help the driver stay focus on the road on the road and generally encourage the road user not to stray to the shoulder
Recommendations:	• Provide edge line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves
Reasons for concern:	**No road markings on access road to warn the road user of the junction ahead** • Potential right angle collisions
Recommendations:	Provide **Give Way/ STOP road marking** using thermoplastic material as appropriate on side roads

4.4.1.2. Alignment – Sharp Horizontal Curve

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 16:30 hrs to 17:00 hrs, from Kuanpal to Salipur. An average speed of 39 km/ hour and a maximum speed of 61 km/ hour was noted during this survey.

Sharp Curves (radius less than 100-150 m) are observed at following Chainages –

- 1+950
- 11+000
- 16+400
- 21+800
- 3+550
- 11+200
- 20+900
- 22+100
- 7+950
- 12+500
- 20+650
- 22+650
- 9+950
- 12+950
- 20+900
- 22+700
- 10+300
- 15+600
- 21+000
- 25+900

Sharp Curves on Project Road at Km 26+600 and Km 3+550

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed.
Recommendations:	• Provide **curve warning sign and raised pavement markers at sharp curves** Refer to Appendix III for curvet treatment on single lane roads
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.
Recommendations:	Provide crash barriers on the outer edge on such curves.

4.4.1.3. Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road								
2+600	3+950	4+000	4+700	5+500	6+000	6+500	6+600	6+600
7+900	8+000	8+500	8+700	9+300	9+700	10+700	12+000	12+500

12+980	15+600	16+400	16+850	17+500	20+500	21+000	22+150	23+600
23+700	24+700	25+700	27+700	28+000				

Location of Side roads at skew with the major road

11+000	11+200	14+350
16+000	16+500	16+800
17+500	20+200	22+650

Perpendicular Side Road at Km 5+500

Side roads skewed to Major Road at Km 22+650

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-15 are due to buildings/ shops on the corners.

Recommendations:

Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner. This may lead to collisions resulting in major injury/ fatalities.
Recommendations:	• Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. Refer to Appendix III for desirable vertical profile of side road in junction with major road.

4.4.1.4. Major Junctions

3-arm Junction at 22+100

The salient features of this intersection are as follows:

- One arm of the junction is approach of minor bridge
- Side road is on outside curve, 90° curve
- Approach to bridge on one arm of the junction is not protected
- Significant number of two wheelers, pedestrians and cyclists use the junction.
- No traffic islands/ splitter islands were provided for safe and effective maneuver of traffic

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users
- A roundabout will work better in this situation, but require detail study and design.

Refer to Appendix III for standard layout of a roundabout.

Reasons for concern:

Poor delineation

Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead

Recommendations:

Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control after designing the junction form

Reasons for concern:

Provision for VRUs

Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Provide wide shoulders free of encroachments for pedestrians to commute in the junctions without interfering with the motorized traffic.

Reasons for concern:

High approach speed

Traffic coming from the Cuttack side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

4.4.1.5. Road Side Objects – Parapet Walls

There is no hazard marker present on structures and major/minor bridges. Such locations are

4+500	12+950	16+800	20+180	20+200
20+700	23+050	24+200	26+700	26+800

Absence of OHM at Km 24+200 and Km 16+800

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on SH-10, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.
Recommendations:	Provide continuous parapets on all culverts and bridges.

4.4.1.6. Roadside Objects - Trees and Street lighting Poles

Tree near pavement edge

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street lighting poles or other posts, buildings, and unprotected deep drains poses significant road safety hazard. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	**Desirable:** • Remove Trees from the road shoulders and relocate street lighting poles • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips

4.4.1.7. Road Side Villages/ Built-up Areas (BUAs)

Roadside villages observed on this ODR have the following features:

- Traffic is observed not to be very high, but still poses a hazard to cyclists and pedestrians inside village zones
- Heavy encroachments observed on all roadside villages
- Visibility is hampered due to structures present along the road and stopped vehicles, buses on the road


Commercial Sections at Km 16+900 (Kalayanpur Village) and Km 16+400

Following locations have road side villages.

- 0+000
- 6+000
- 11+200
- 26+600
- 1+000
- 8+000
- 16+900 (Kalyanpur Village)
- 17+700 (Kotha Puda Village)
- 2+000
- 8+400

Following sections can be classified as commercial areas.

- 6+200
- 25+900 (Ananda Bazar)
- 16+400
- 28+000
- 22+150 (Kunmuda Jaipur)

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:

- Provide a 'Gateway' effect on the approaches to the roadside villages/ built up areas as a traffic calming measure.

  Refer to Appendix III for layout of safe infrastructure provisions on approaches to roadside villages

- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of

encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SCHOOL AHEAD' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

4.4.1.8. Specific Locations – Junction at chainage 16+800

This client's representative pointed out this junction as 'accident prone'. The salient features of the junction as follows:

- Two ODRs meet at this point to form a 3-arm junction
- The minor road is wider than the single lane major road
- The minor road leads to a major bridge in less than 50m length from the mouth of the junction
- Layout of the junction is hazardous, and no traffic control/ priority has been established
- Dangerous Overtaking is observed
- No signs and markings provided leaving this junction significantly hazardous during dark conditions

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.
Recommendations:	• Re-design the junction after traffic studies and considering the requirements of all road users. • Provide splitter islands to allow free left-in left-out movements • Provide road humps on the minor roads

Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead
Recommendations:	• Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control. Refer to Appendix III for safe layout options for 3-arm junctions
Reason for concern	**Dangerous Overtaking** As bridge entry exit is too wide and thus motorized vehicles try to overtake at the junction and then hit the vehicles coming from side road.
Recommendations:	Design a well laid out junction with traffic splitter islands and appropriate road markings. Provide warning sign before junction.

4.4.2. ODR - Paga to Tangi

This ODR starts at Paga and ends at Tangi. It is a **single lane, bituminous road having good condition**. Project Road is 12 km long. It has earthen shoulder and width is less than 0.5 m with poor condition because of over grown vegetation and bushes. Traffic is mainly composed of motorcycles, cyclists, pedestrians and a few four vehicles/heavy vehicles. Road side villages have high encroachment. Speed observed during survey is 40 KPH or so.

4.4.2.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Edge line road markings were not provided**
Recommendations:	• Provide edge line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves
Reasons for concern:	**No road markings on access road to warn the road user of the junction ahead**
Recommendations:	Provide **Give Way/ STOP road marking** using thermoplastic material as appropriate on side roads

4.4.2.2. Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 17:00 hrs to 18:00 hrs, from 0+000 to 12+100. An average speed of 36 km/ hour and a maximum speed of 50 km/ hour is noted during this survey.

Sharp Curves (Radius less than 100-150 m) are observed at following Chainages –

1+300	1+450	4+800	4+900
5+300	8+800	10+300	

Sharp Curves on Project Road at 1+300 and 1+450

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed. This can result in: • Potential head-on collisions
Recommendations:	• Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

4.4.2.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road				
0+500	1+600	2+900	3+300	6+500

Location of Side roads at skew with the major road
7+700

Perpendicular Side Road at 0+500

Perpendicular Side Road at 3+300

Concerns & Recommendations

Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-15 are due to buildings on the corners.
Recommendations:	Remove encroachments at least from the visibility triangle required for such junctions.
Reasons for concern:	**Poor delineation** No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead. Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.
Recommendations:	• Provide warning signs to provide drivers of advance notice of the upcoming junction • Provide Give Way/ Stop signs as applicable, on side roads • Provide Give Way/ Stop road marking at side roads
Reasons for concern:	**High approach speeds** High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.
Recommendations:	• Provide road humps on the side at junctions having history of accidents • Provide raised markings on the entry to the side road • Provide adequate warning signs on major road and side road

4.4.2.4. Approach to Bridge at Chainage 4+950

At this location, cross roads are noted on approaches to the bridge on either side. The corners of the junctions are unprotected and the traffic is exposed to the gaps in high embankment. At night conditions, this situation becomes significantly hazardous. In the event of the vehicle losing control, fatalities or major injuries may occur due to the exposure to the waterbed.

Junction at Km 4+950

Concerns & Recommendations	
Reasons for]concern:	**Corners of the bridge is unprotected** Traffic is exposed to deep water body and in the event of vehicle losing control, fatalities or major injuries may occur.
Recommendations:	Provide crash barriers to prevent traffic run-off into the canal, in the event of a run-off accident
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead
Recommendations:	• Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control
Reason for concern	Broken Parapet wall of narrow bridge which makes it vulnerable for motorized traffic. Two wheelers may fall into ditch in absence of proper light during night time.
Recommendations:	Construct continuous parapet wall having at least 1.2 m height from the road level.

4.4.2.5. Road Side Objects - Parapet Walls

There is no hazard marker present on structures and major/minor bridges. Such locations are

4+900	5+700	6+000
9+600	10+000	

Missing bridge approach protection at Km 9+600

Culvert at Km 10+000

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on SH-10, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.
Recommendations:	Provide continuous parapets on all culverts and bridges.

4.4.2.6. Road Side Objects - Trees and Street lighting Poles

Project road have many locations where trees and street poles are very near to pavement edge.

Tree near pavement edge

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders

- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips

4.4.2.7. Road Side Villages/ Built-up Areas

- In villages/town wherever schools are present, 'School Ahead' and 'Slow' warning signs are not provided on either approaches.
- On street Parking and on street bus stops are observed
- Significant pedestrians/school children, cyclists, motorcycles are present
- Very high encroachments are present
- Visibility is hampered due to structures present along the road and stopped vehicles, buses on the road

Built up area at Km 4+200

Built up area at Km 0+100 in Paga

Following locations have road side villages.

0+100	1+300	1+700	4+200
7+500	8+000	11+000	

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- On road bus stops which hampers visibility and encourage dangerous overtaking

- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.

Recommendations:

- Provide Warning signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SCHOOL AHEAD' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines for installation of object hazard markers

4.4.2.8. Specific Locations

Damaged Road Edge and Approach Slab at chainage 6+100

- Two major bridges are connected by intermediate lane at high embankment
- Pavement is broken on both side
- Broken pavement is not visible from a distance ahead
- High speeds observed on the approaches to this bridge
- Broken section is used by pedestrians and cattle to get down on sides of the road

Concerns & Recommendations

Reasons for concern:	Broken pavement is not visible from distance, road is straight thus high speed is observed which is very dangerous for fast moving traffic , in particular for two wheelers. Small vehicles may fall into ditch and bigger vehicles may undergo overturning.
Recommendations:	• Pavement correction should be made by reconstructing the base slab and then correcting the shoulder; finally reconstruct the pavement.
Reason for concern	**High Embankment** Embankment height is about 5 m and which can be hazardous if vehicles loses control and then fall.
Recommendations:	• As the embankment height is more than 3 m thus provide crash barrier throughout the high embankment.

4.4.3. ODR (Kuanpal to Balichandrapur)

This ODR starts at Kuanpal and ends at Balichandrapur. It is an **intermediate lane, bituminous road and is in generally good condition.** Project Road is 7 km long. It has earthen shoulder and width is less than 0.5 m or because of over grown vegetation and bushes, thus condition of shoulder is poor. Traffic is mixed but have higher number of motorcycles, bicycles and pedestrians. Built up areas have high encroachment and also have high demand for commercial parking.

During the course of assessment, the consultant has carried out average speed. The average speed and maximum speed were noted for one trial run on the road during 14:00 hrs to 15:00 hrs, from 0+000 to 0+000. An average speed of 40 km/ hour and a maximum speed of 60 km/ hour is noted during this survey.

4.4.3.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Edge line road markings are absent on the project road.** • Run off accidents can happen, in particular during night • At sharp curves overtaking may result into head-on collision
Recommendations:	• Provide edge line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

4.4.3.2. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads with narrow minor bridge on approach
2. Side roads with normal approaches

The major features of side roads in this ODR is given below.

- Almost all of the right hand side roads have minor bridge approach on side road.
- Such minor bridge is too narrow and only protected by concrete guard post.
- Approach protection is not provided.

Location of Side roads with narrow minor bridge on approach		
2+400	4+000	5+500

Location of Side roads with normal approaches		
0+600	1+200	2+400
5+500	5+800	


Side Roads at 5+500 and 0+700

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.
  Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead. Poor delineation may result in late braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in collisions at high speeds.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ Stop signs as applicable, on side roads
- Provide Give Way/ Stop road marking at side roads
  Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

High approach speeds

High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious

injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

4.4.3.3. Road with high Embankment

- Project road is along the irrigation canal
- Embankment is high throughout the road
- At some locations project road have water bodies on both side of project road

Road with high embankment and water bodies on either side at Km 6+200 and 3+400;

Concerns & Recommendations

Reasons for concern:

Unprotected high embankment

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations:

Provide crash barriers on the canal side to prevent fatalities and major injuries in the event of a run-off accidents

Reasons for concern:

Absence of traffic signs and road markings

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide delineator posts along the shoulder

CHAPTER 5

GANJAM DISTRICT

5.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Ganjam district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified into various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of the driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Ganjam district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

5.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 is shown in **Figure 5.1**. It can be seen from **Figure 5.1** that maximum number of fatalities and crashes occur in other roads in Ganjam district followed by NHs and SHs. The length of 'other roads' in Ganjam district is shown in **Figure 5.2**. It can be seen from **Figure5.2** that length of NH is not even half of the SHs, but number of crashes and fatalities occurring on NHs are more than SHs. This may be attributed to higher volume of traffic moving on NHs than SHs.

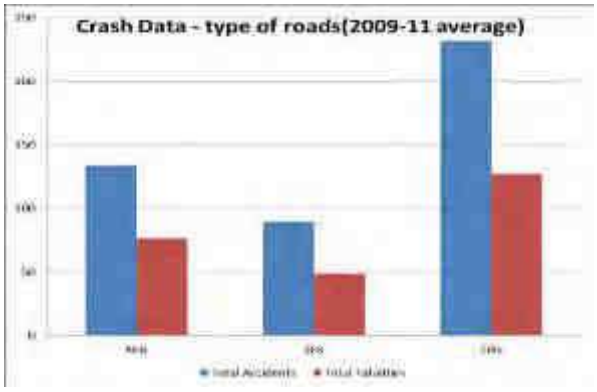


Figure 5.1: Crash data – Type of roads

Figure 5.2: Road Network Length – Ganjam Dist

The crash data classified on the basis of location type in Ganjam district is shown in **Figure 5.3** below.

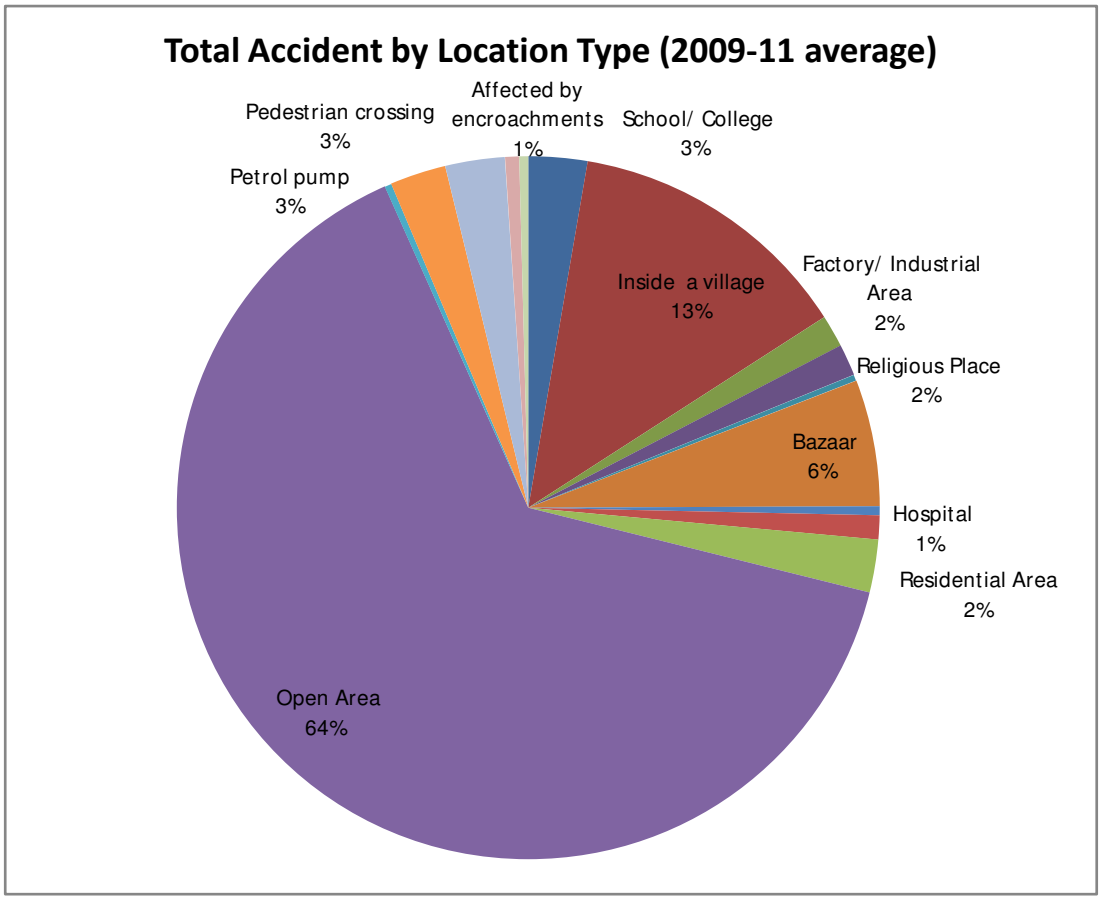


Figure 5.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 5.3** that significant numbers if crashes (64%) occur in 'open area' in Ganjam district followed by crashes inside village (13%). It is not clear from the above set of data that whether crashes in 'open area' occur more on NHs or SHs. It is obvious from the above data that crashes occurring in open area are much more than crashes occurring in populated areas. This might be attributed to the high speed traffic and/or inappropriate geometry of roads.

5.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type is shown in **Figure 5.4** and the average number of persons killed according to road user type during the period 2009-11 is shown in **Figure 5.5**.

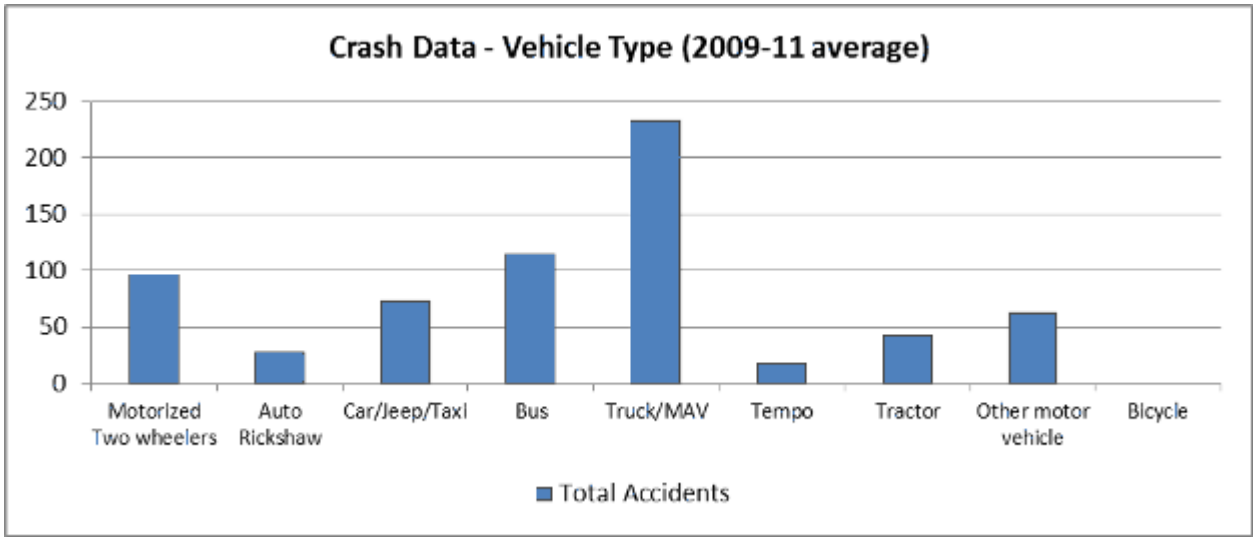


Figure 5.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 5.4,** it can be seen that trucks are involved in maximum number of crashes (approximately230) followed by cars (approximately 45). Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

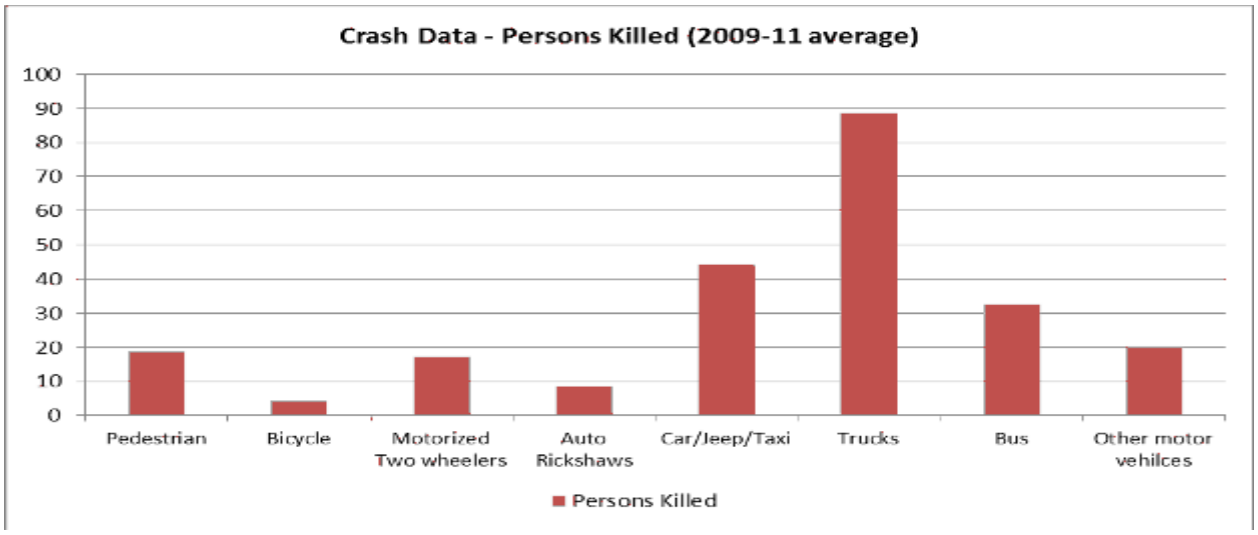


Figure 5.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 5.5** it can be seen that maximum fatalities (approximate 90 lives) occur among the truck users followed by car users. It is observed that crashes in which cars are involved are more severe than any other vehicle type, as out of 75 crashes 45 fatalities occur. This means that for every two car crashes, there is a fatality.

Further, the average number of crashes and fatalities based on type of collision are plotted as shown in **Figure 5.6.**

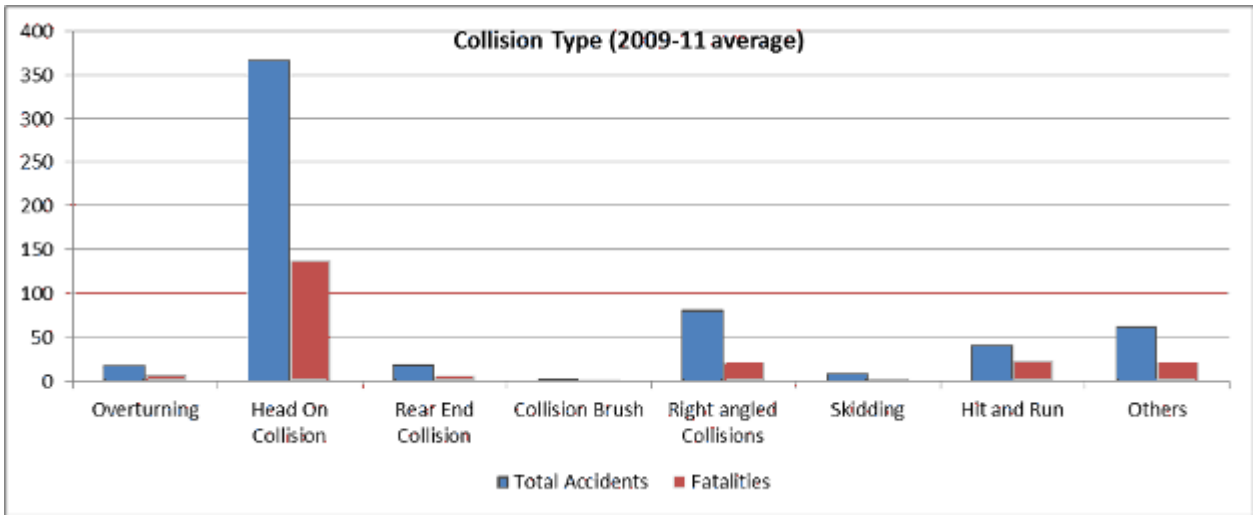


Figure 5.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 5.6** that predominant nature of crashes in Ganjam district are head on collision (>350 crashes) followed by right angle collision. The high number of crashes for different collision types is resulting in high number of fatalities.

The above figures reveal that maximum crashes/ fatalities occur on district roads where trucks cause major number of crashes and number of fatalities, and the predominant nature of crashes is head-on collision.

From the above, though unsubstantiated with full details and data, the following can be inferred for Ganjam district:

- Trucks, buses and cars are involved in head-on collisions predominantly
- Maximum crashes are occurring on district roads but in terms of crashes per km of road length NHs seem to be more unsafe due to high number of accidents on them than SHs
- Fatalities of pedestrians is highly significant (20 pedestrians were killed)
- 25% crashes are occurring in populated areas

5.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether there is a correlation between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 5.7** and the corresponding figures for urban area is shown in **Figure 5.8**.

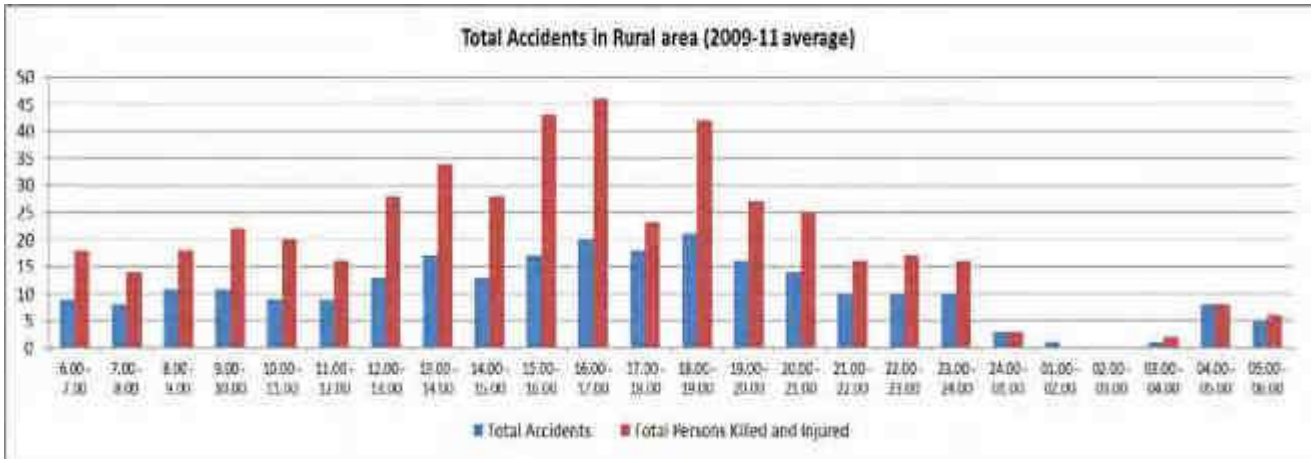


Figure 5.7: Total number of crashes in rural area (2009 – 11 average)

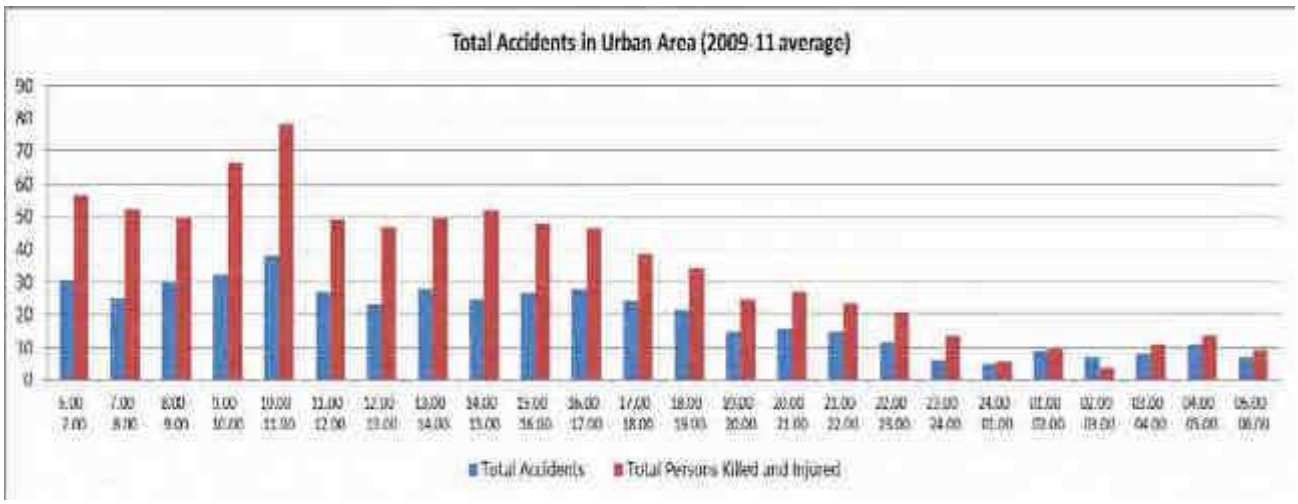


Figure 5.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 5.8** that the number of crashes and fatalities is maximum at 16:00 to 17:00 hrs. Distribution of crashes and fatalities during 24hrs is in relation to the traffic level in rural area. In urban area, maximum number of crashes and fatalities occur during 10:00 to 11:00 hrs, and then it is gradually decreasing which seems to be peculiar.

5.2. Location and Details of Audited Roads

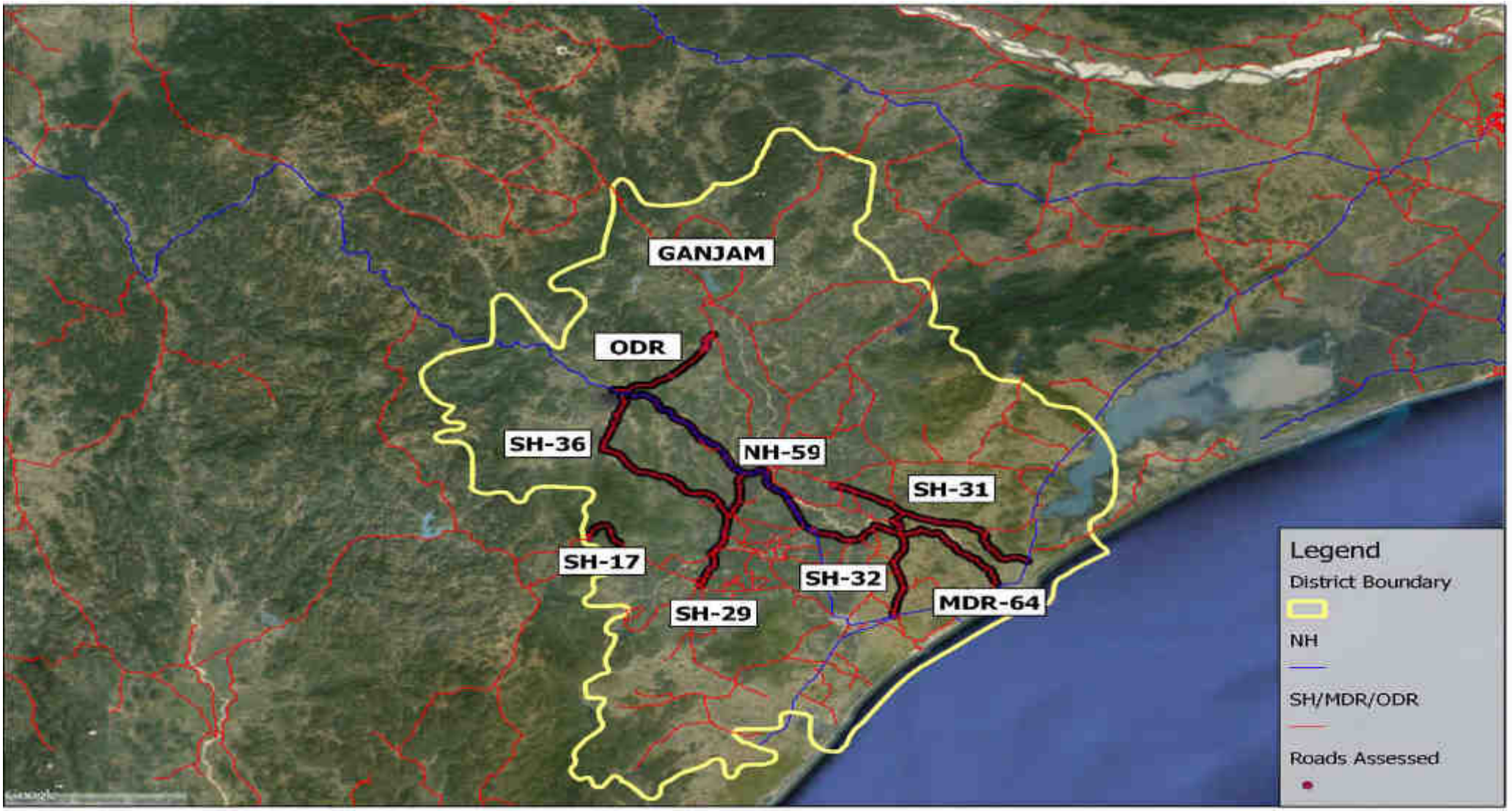
The schedule of road safety assessment in the Ganjam district is **Table 5.1**given below.

Table 5.1: List of roads assessed in Ganjam District

Sr. No.	Name of Road (from to location)	Length in Km	Date	Assessed by	OWD Representatives
1	SH-17 (Dighapandi to Taptapani:Km 41+000 to Km 51+000)	10.00	12-Dec-2012	Tony Mathew, Ashif Hussain and Ramachandra	Mr.S.Padhy,AE
2	SH-29 (Dighapandi to Sheragada:Km 36+000 to Km 62+000)	26.00	12-Dec-2012	Tony Mathew, Ashif Hussain and Ramachandra	Mr.S.Padhy,AE
3	SH-36 (Sheragada to Sorada:Km 54+200 to Km 96+000)	41.80	13-Dec-2012	Tony Mathew, Ashif Hussain and Ramachandra	Mr.P.K.Das,AE and Mr.Rajgopal,JEBhanjanagar Sub-Division
4	ODR (Kanteipalli to Sorada:Km 0+000 to Km 21+000)	21.00	13-Dec-2012	Tony Mathew, Ashif Hussain and Ramachandra	Mr.P.K.Das
5	NH-59 (Sorada to Hunjilicut:Km 270+000 to Km 320+000)	50.00	14-Dec-2012	Tony Mathew, Ashif Hussain and Ramachandra	Mr.P.K.Sahu
6	MDR-64 (Chattrapur to Hinjilicut:Km 0+000 to Km 40+200)	40.20	15-Dec-2012	Tony Mathew, Ashif Hussain and Ramachandra	Mr.A.K.Subdhy,AE,Chattrapur Sub-Division Mr.P.Samanthara,AE,Behrampur Division
7	SH-32 (Purushottampur to Jagannathpur:Km 0+000 to Km 24+700)	24.70	16-Dec-2012	Ashif Hussain and Ramachandra	Mr.A.K.Subdhy,AE,Chattrapur Sub-Division Mr.P.Samanthara,AE,Behrampur Division Mr.UmashankarPadhy,JE,Purushottampur section
8	SH-31 (Huma to Boirani:Km 0+000 to Km 39+200	39.20	17-Dec-2012	Ashif Hussain and Ramachandra	Mr.UmashankarPadhy,JE,Purushottampur section and MrPhakir Mohan Mishra,JE,Huma to Purushottampur

The map of the roads assessed in Ganjam district is shown in **Figure 5.9**.The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II**.

Figure 5.9: Map of Road Assessed in Ganjam District



5.3. Road Safety Assessment – National Highways

5.3.1. NH-59: Sorada (Km 270+000) to Hinjilicut (Km 320+000)

The project road starts from Sorada (Km 270+000) to Hinjilicut (Km 320+000) which is mainly Plain terrain. The road is generally single lane from Km 275+000 to Km 290+000 and rest are 2-lane with 0.5 to 1m earthen shoulder. The road surface is bituminous. The traffic flowing through the road is mixed traffic conditions-Cyclists, 2-Whlr, Buses, Cars, Trucks and Pedestrian observed. Speed observed during spot speed survey varies from 30 KPH to more than 75 KPH but 85th percentile speed is lesser than 60 KPH.

5.3.1.1. Delineation of the Road

Road Marking

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline road markings are not provided in many sections of the road.**
Recommendations:	• Provide edge line throughout the road and centre line on intermediate lane with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.3.1.2. Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 10 hrs to 3 hrs, from Km 270+000 to 320+000. An average speed of 36.30 km/ hour and a maximum speed of63.5 km/ hour is noted during this survey. A spot speed was conducted at location Km 313+000, and the 85th percentile speed at this location was found to be 50 km/hr. Curves having radius in the range of 100m to 120m were observed on the following locations:

Km 271+000	Km 275+540	Km 308+770
Km 271+290	Km 276+800	Km 309+640
Km 271+580	Km 282+900	Km 317+530
Km 273+150	Km 308+360	
Km 273+350	Km 308+720	

Km 273+150

Km 275+540

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*

5.3.1.3. Alignment - Reverse Curves

These are observed at chainages Km 272+770 and Km 316+300;

Km 272+770

Km 316+300

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs** before and after the curve and continuous **chevron signs and delineators** throughout the curve. *Refer to Appendix III for guidelines on treatment of curves.*

5.3.1.4. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road
Km 282+900,Km 285+900,Km 288+800, Km 292+440, Km 292+600, Km 294+000, Km 294+900, Km 296+000, Km 300+000, Km 303+150, Km 306+000, Km 308+711, Km 309+400, Km 309+600, Km 311+460, Km 313+680, Km 313+710, Km 315+020, Km 318+200 and Km 319+170
Location of Side roads at skew with the major road
Km 286+900, Km 287+200, Km 293+500, Km 297+000, Km 298+130, Km 299+000, Km 300+800 and Km 302+350

Km 292+440

Km 302+350

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in late braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in collisions at high speeds.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

Poor Geometry

- It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
- This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from

side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

5.3.1.5. Major Junctions

- In this section of road all the major junctions are 3-arm uncontrolled junction.
- Medium to high encroachments
- Commercial activities nearer to the road edge.
- Street lights is missing

A. Major 3-arm Junctions

- Km 270+700
- Km 299+050
- Km 303+700 and
- Km 317+000

Km 270+700

Km 303+700

Concerns & Recommendations

Reasons for concern: **Poor Junction layout**

The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-motorized traffic

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern: **Poor delineation**

No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead

Recommendations:

- Provide advance direction and direction signs to inform the road user
- Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road

- Provide edge lines
- Provide Splitter islands using road markings to establish improved traffic control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern: **On street Bus stop**

Buses stops at the mouth of the junction in the minor road hampering visibility

Recommendations: Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction

Refer to Appendix III for guidelines for design of bus bays and on-street bus stops

Reasons for concern: **Provision of VRUs**

Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.

Recommendations: Provide footpaths to segregate pedestrians from high speed traffic at the junction approaches;

5.3.1.6. Approach to Bridge

Bridges/Culverts are observed at chainages:

- Km 282+680
- Km 287+900
- Km 289+264
- Km 292+050
- Km 306+550
- Km 317+110 and
- Km 318+460

Km 282+680

Km 318+460

Concerns & Recommendations

Reasons for concern: The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.

Recommendations: Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines on approaches to bridges.

Reasons for concern: **Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

5.3.1.7. Road side hazards/Objects

Road side objects present along this stretch of road are few trees and high embankment.

Trees/ Embankment are on the edges of the carriageway

Concerns & Recommendations

Reasons for concern: The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations: Either remove such objects or provide crash barrier where such objects are <2m from the edge of road.

To improve delineation of such objects,

- Provide continuous edge line on the road
- Put retro-reflective delineators on stems of trees, poles, and buildings

5.3.1.8. Road Side Villages/Built-up Areas

Road side villages and built-up areas were observed at following locations on NH-59.

Chainage	Village	Chainage	Village
Km 273+670	Karabadi	Km 275+700	Tatabali
Km 280+230	Suramani	Km 281+100	Nuagada
Km 283+250	Brahmanadei	Km 283+900	Khariguma
Km 285+090	Baradbali	Km 286+350	Kahirapalli
Km 287+100	Dasamil	Km 288+300	Janibili
Km 290+000	Gadadamodarpalli	Km 290+580	Talapatana
Km 294+500	Bhandaribasa	Km 297+150	Kusharaba
Km 298+000	Ramchandrapur	Km 299+850	Pankalabadi
Km 301+800	G.Damodarpalli	Km 303+000	Kalasandhapur
Km 305+100	Nalabanta	Km 307+670	Khadabhaga
Km 309+250	Chermeria	Km 313+450	Pittalachaka
Km 314+200	Ramchandrapur	Km 317+000	Semulai
Km 318+850	Hinjicut		

Km 287+100 (Dasami village)

Km 317+000 (Semulai village)

Concerns & Recommendations	
Reasons for concern:	Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide pedestrian crossings (either marked or speed tables), footpaths, and streetlights.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any. *Refer to **Appendix III** for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages.*

5.4. Road Safety Assessment – State Highways

5.4.1. SH-17: Dighapandi (Km 41+000) to Taptapani (Km 51+000)

This section of the road comes under Vijayawada-Ranchi Corridor (VRC).This road starts from Behrampur (Km 0+000) to Taptapani (Km 51+000),out of which from Km 0+000 to Km 41+000 (Dighapandi) is under construction funded by World Bank. Road safety assessment is done for Dighapandi (Km 41+000) to Taptapani (Km 51+000) which is mainly Plain and ghat terrain. Plain section is start from Km 41+000 to Km 46+000 and ghat section is from Km 46+000 to Km 51+000.The road is generally 2-lane with 0.5 m earthen shoulder. The road surface is bituminous. The traffic flow in this section is generally low.

5.4.1.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	**Centerline and edge line road markings are not provided throughout section of the road.**
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.4.1.2. Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed survey. In this section, the traffic flow is low, so spot speed survey doesn't conducted. Curves having radius in the range of above 100m were observed on the following locations:

Km 41+160	Km 43+470	Km 46+850
Km 41+340	Km 43+580	Km 47+300
Km 41+600	Km 43+720	Km 47+600
Km 42+000	Km 43+900	Km 47+800
Km 42+420	Km 46+300	Km 49+800

Km 41+160

Km 43+720

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*

5.4.1.3. Alignment - Reverse Curves

These are observed at chainages Km 49+250 and Km 49+450;

Km 49+250

Km 49+450

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs** before and after the curve and continuous **chevron signs and delineators** throughout the curve. *Refer to Appendix III for guidelines on treatment of curves.*

5.4.1.4. Minor Junctions

Only few types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway. There is no any major junction. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads skewed to main road

In this section, there is no any skewed junction. The above junction types were observed on the following chainages:

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road
Km 41+900,Km 47+930 and Km 49+000

Km 41+900

Concerns & Recommendations

Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.
Recommendations:	• Improve visibility by clearing vegetation; • Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle of junctions.*
Reasons for concern:	**Poor delineation** • No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	Provide traffic signs and road markings pertaining to junction control. *Refer to Appendix III for guidelines on traffic signs and road markings at junctions*
Reasons for concern:	**High approach speeds** • High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road
Recommendations:	• Provide road humps on the side at junctions having history of accidents • Provide raised markings on the entry to the side road • Provide adequate warning signs on major road and side road *Refer to Appendix III for guidelines on traffic calming measures.*
Reasons for concern:	**Poor Geometry** • It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
Recommendations:	• Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.*

5.4.1.5. Approach to Bridge

The bridge parapets adjacent to road will be hazardous and few bridges have damaged parapets and hence may cause accident in future.

Bridges/Culverts are observed at the following chainages:

- Km 41+200
- Km 41+450
- Km 42+240
- Km 44+200
- Km 47+300
- Km 48+200
- Km 48+580
- Km 48+770

Km 41+450

Km 44+200

Concerns & Recommendations

Reasons for concern: The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.

Recommendations: Install Object Hazard Marker (OHM) on both sides and for both approaches (ie. Four numbers of each OHM for each structure.

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

Reasons for concern: **Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

Reasons for concern: **High approach speed**

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches

Refer to Appendix III for guidelines to treatments on approaches to bridges.

5.4.1.6. Road side hazards/Objects-Trees, street poles

Road side objects present along this stretch of road are few trees and high embankment.

Concerns & Recommendations

Reasons for concern: The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations: Either remove such objects or provide crash barrier where such objects are <2m from the edge of road.

To improve delineation of such objects,

- Provide continuous edge line on the road
- Put retro-reflective delineators on stems of trees, poles, and buildings

5.4.1.7. Road Side Villages/Built-up Areas(BUAs)

Road side villages and built-up areas were observed at following locations on SH-17.

Chainage	Village	Chainage	Village
Km 45+200	Gobindapur	Km 49+450	Taptapani
Km 50+450	Belajada		

Km 49+450 (Taptapani village)

Km 50+450 (Belajada village)

Concerns & Recommendations

Reasons for concern:	Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide pedestrian crossings (either marked or speed tables), footpaths, and streetlights.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment.

*Refer to **Appendix III** for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages.*

5.4.2. SH-29: Dighapandi (Km 36+000) to Sheragada (Km 62+000)

The road starts from Dighapandi (Km 36+000) to Sheragada (Km 62+000) which is mainly Plain terrain. Project Road does not have any curves. The road is generally 2-lane with 1 m to 2 m earthen shoulder. The road surface is bituminous. The traffic flowing through the road is mixed traffic conditions-Cyclists, 2-Whlr, Buses, Cars, Trucks and Pedestrian observed. Speed observed during spot speed survey at Km 39+000 varies from 30 KPH to more than 45 KPH but 85th percentile speed is lesser than 50 KPH. During speed and delay survey, it is observed that maximum and average speed are 61 km/hr and 43 km/hr respectively.

5.4.2.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline road markings are not provided in many sections of the road.**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.4.2.2. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road
Km 37+500,Km 37+600,Km 38+350,Km 38+850,Km 42+900,Km 43+600,Km 45+060,Km 47+800,Km 50+800,Km 55+520,Km 57+000 and Km 58+170

Location of Side roads at skew with the major road

Km 46+000, Km 55+670 and Km 60+220

Km 37+500

Km 60+220

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on situations where to install the above

5.4.2.3. Major Junctions

- In this section of road the major junctions are 3-arm & 4-arm uncontrolled junction.
- Medium to high encroachments
- Street lights is missing

A. Major 3-arm Junctions

- Km 43+100 and
- Km 62+000

Km 43+100

Km 62+000

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-motorized traffic

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern:	**Poor delineation** No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead
Recommendations:	• Provide advance direction and direction signs to inform the road user • Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road • Provide edge lines • Provide Splitter islands using road markings to establish improved traffic control *Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection*
Reasons for concern:	**High approach speed** Traffic coming from the Dighapandi side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality
Recommendations:	• Provide traffic calming measures on the minor road • Provide warning signs on the minor road • Provide information signs and road markings at the junction to warn the road user of the layout *Refer to Appendix III for guidelines for design of road humps*
Reasons for concern:	**On street Bus stop** Buses stops at the mouth of the junction in the minor road hampering visibility
Recommendations:	Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction *Refer to Appendix III for guidelines for design of bus bays and on-street bus stops*
Reasons for concern:	**Provision of VRUs** Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.
Recommendations:	Provide footpaths to segregate pedestrians from high speed traffic at the junction approaches;

B. 4-arm Intersection at Km 51+200

This intersection is located on Sheragada of SH-29. The Sheragada Junction is joining SH-29 from left and a village road is joining from right side at this location. The intersection layout is non-standard and has no control over the traffic movement, and the priority is also confusing. This encourages lawless traffic movement and may be hazardous for the traffic. This Junction is completely built up.

Km 51+200, Sheragada Junction

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction is a non-standard 4 arm junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-motorized traffic

Refer to Appendix III for standard layouts of 4-arm junctions

Reasons for concern:

Poor delineation

Traffic signs and road markings are absent, the presence of which would have informed and warned the road user of the intersection ahead.

Recommendations:

Provide edge line markings, centerline markings and other road markings pertaining to junction control.

Provide "intersection ahead" warning sign before the intersection on all approaches.

Provide give way or STP sign with road markings on both the town road and village road.

Refer to Appendix III for guidelines for traffic signs and road markings on 4-arm intersection

Reasons for concern:

Direction Signs

There are no proper direction signs to guide the traffic through the junction layout which may result in to frequent or sudden stopping of vehicles and may lead to rear-end collision.

Recommendations:

Provide proper direction signs to guide the traffic through the junction layout.

Refer to Appendix III for standard layouts of 4-arm junctions

Reasons for concern:	**Provision for VRUs** There is no provision for walking along the road or crossing by pedestrians/ bicycles.
Recommendations:	Provide clear 2 m wide shoulder space on all the approaches in the intersection area. Provide marked crossings or speed tables for safe crossing by pedestrians and bicycles. *Refer to Appendix III for standard layouts of 4-arm junctions*
Reasons for concern:	**On-street Parking** There are no parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space. This hampers visibility at the junction resulting in hazardous situation.
Recommendations:	Provide designated parking spaces for commercial vehicles

5.4.2.4. Approach to Bridge/Culverts

Bridges/ Culverts are observed at chainages:

- Km 38+650
- Km 44+800
- Km 53+250
- Km 57+504
- Km 58+840
- Km 59+080 and
- Km 43+500

Km 38+650

Km 43+500

Concerns & Recommendations

Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.

Refer to Appendix III for guidelines for installation of object hazard markers.

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

Reasons for concern: **Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

Reasons for concern: **High approach speed**

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches

Refer to Appendix III for guidelines to treatments on approaches to bridges.

5.4.2.5. Road side hazards/Objects-Trees, street poles

Road side objects present along this stretch of road are few trees. Trees are on the edges of the carriageway, which has no any protection.

Trees are on the edges of the carriageway

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	Either remove such objects or provide crash barrier where such objects are <2m from the edge of road. To improve delineation of such objects, • Provide continuous edge line on the road • Put retro-reflective delineators on stems of trees, poles, and buildings

5.4.2.6. Road Side Villages/Built-up Areas (BUAs)

Road side villages and built-up areas were observed at following locations on SH-29.

Chainage	Village	Chainage	Village
Km 36+000	Dighapandi	Km 39+000	Chundangapur
Km 40+850	Sahaspur	Km 42+600	Patapura
Km 47+700	Jagannathpur	Km 51+000	Sheragada
Km 55+000	Sobhachandrapur	Km 56+900	Dhenkisala
Km 60+100	Baraguda		

Km 39+000 (Chundangapur village)

Km 40+850 (Sahaspur village)

Concerns & Recommendations

Reasons for concern:	Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide pedestrian crossings (either marked or speed tables), footpaths, and streetlights.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any.

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

5.4.3. SH-36: Sheragada (Km 54+200) to Sorada (Km 96+000)

The road starts from Sheragada (Km 54+200) to Sorada (Km 96+000) which is mainly mix of Plain and hilly terrain. The road is generally single lane with 0.5 to 1m earthen shoulder. The road surface is bituminous. The traffic flowing through the road is very low. The construction of widening of road is going on from Km 67+400 to Km 68+400.

5.4.3.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Edge line road markings are not provided throughout section of the road.** • Run off accidents can happen, in particular during night • At sharp curves overtaking may result into head-on collision
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.4.3.2. Alignment – Sharp Horizontal Curves

Curves having radius in the upto 100m were observed on the following locations:

Km 54+500	Km 57+400	Km 68+500	Km 89+800
Km 54+700	Km 59+600	Km 74+300	
Km 56+000	Km 59+950	Km 74+700	
Km 56+200	Km 62+900	Km 78+100	
Km 56+600	Km 65+700	Km 78+250	

Km 59+950

Km 78+100

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

5.4.3.3. Alignment - Reverse Curves

These are observed at chainages Km 73+600 and Km 93+300;

Km 73+600

Km 93+300

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs** before and after the curve and continuous **chevron signs and delineators** throughout the curve. *Refer to Appendix III for guidelines on treatment of curves.*

5.4.3.4. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road
Km 54+500,Km 69+100,Km 74+200,Km 77+300,Km 80+200 and Km 90+200
Location of Side roads at skew with the major road
Km 56+425,Km 58+400,Km 59+800,Km 60+200,Km 62+600,Km 76+000,Km 82+900 and Km 87+000

Km 74+200

Km 58+400

Concerns & Recommendations	
Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.
Recommendations:	• Improve visibility by clearing vegetation; • Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle of junctions.*
Reasons for concern:	**Poor delineation** No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead

Recommendations: Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern: **High approach speeds**

High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

5.4.3.5. Major Junctions

- In this section of road the major junctions are 3-arm and 4-arm uncontrolled junction.
- Street lights is missing

A. Major 3-arm Junctions at Km 96+000

This intersection is located on Sorada of SH-36. The Sorada Junction is joining with NH-59 at this location.

Km 96+000

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.
Recommendations:	• Re-design the junction layout • Provide splitter islands to enable safe movement of motorized and non-motorized traffic *Refer to Appendix III for standard layouts of 3-arm junctions*
Reasons for concern:	**Poor delineation** No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead
Recommendations:	• Provide advance direction and direction signs to inform the road user • Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road • Provide edge lines • Provide Splitter islands using road markings to establish improved traffic control *Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection*
Reasons for concern:	**Provision of VRUs** Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.
Recommendations:	Provide clear 2m wide shoulder space to segregate pedestrians from high speed traffic at the junction approaches;

B. 4-arm Intersection at Km 54+200

This intersection is located on Sheragada of SH-36. The Sheragada Junction is joining SH-29 from left and a village road is joining from right side at this location.

Km 54+200, Sheragada Junction

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction is a non-standard 4-arm junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.
Recommendations:	• Re-design the junction layout • Provide splitter islands to enable safe movement of motorized and non-motorized traffic *Refer to Appendix III for standard layouts of 4-arm junctions*
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent, the presence of which would have informed and warned the road user of the intersection ahead.
Recommendations:	Provide edge line markings, centerline markings and other road markings pertaining to junction control. Provide "intersection ahead" warning sign before the intersection on all approaches. Provide give way or STP sign with road markings on both the town road and village road. *Refer to Appendix III for guidelines for traffic signs and road markings on 4-arm intersection*
Reasons for concern:	**Direction Signs** There are no proper direction signs to guide the traffic through the junction layout which may result in to frequent or sudden stopping of vehicles and may lead to rear-end collision.
Recommendations:	Provide proper direction signs to guide the traffic through the junction layout. *Refer to Appendix III for standard layouts of 4-arm junctions*
Reasons for concern:	**Provision for VRUs** There is no provision for walking along the road or crossing by pedestrians/bicycles. Pedestrians were observed using the road for commuting, instead of the footpath, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	Provide clear 2m wide shoulder space to segregate pedestrians from high speed traffic at the junction approaches;

5.4.3.6. Approach to Bridge

Bridges/Culverts are observed at chainages:

- Km 58+900
- Km 77+500

- Km 78+700
- Km 80+200 and
- Km 93+100

Km 78+700

Km 93+100

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (ie. Four numbers of each OHM for each structure. *Refer to Appendix III for guidelines for installation of object hazard markers*
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets

5.4.3.7. Road side hazards/Objects-Trees, street poles

Road side objects present along this stretch of road are few trees. Trees are on the edges of the carriageway, which has no any protection.

Trees are on the edges of the carriageway

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	Either remove such objects or provide crash barrier where such objects are <2m from the edge of road. To improve delineation of such objects, • Provide continuous edge line on the road • Put retro-reflective delineators on stems of trees, poles, and buildings

5.4.3.8. Road Side Villages/Built-up Areas(BUAs)

Road side villages and built-up areas were observed at following locations on SH-36.

Chainage	**Village**	**Chainage**	**Village**
Km 54+200	Sheragada	Km 55+200	Ramgarh
Km 58+300	Baramundi	Km 60+800	Brindavan
Km 61+700	Sadangipalli	Km 66+300	Ghambaribanah
Km 68+800	Manikpur	Km 69+500	Mahuli
Km 71+200	Dhaupada	Km 76+000	Oshta
Km 80+100	Gangapur	Km 82+400	Badagarh
Km 84+800	Patapur	Km 85+800	Surukhadai
Km 90+200	Dorabandh	Km 91+900	Khariguda

Km 54+200 (Sheragada village)

Km 69+500 (Mahuli village)

Concerns & Recommendations

Reasons for concern: Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.

Recommendations:

- Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

5.4.4. SH-32: Purushottampur (Km 0+000) to Jagannathpur (Km 24+700)

The road starts from Purushottampur (Km 0+000) to Jagannathpur (Km 24+700) which is mainly Plain terrain. The road is generally Intermediate lane with 0.5 to 1m earthen shoulder. The road surface is bituminous. The traffic flowing through the road is mixed traffic conditions-Cyclists, 2-Whlr, Buses, Cars, Trucks and Pedestrian observed. Speed observed during spot speed survey varies from 25 KPH to more than 70 KPH but 85th percentile speed is lesser than 60 KPH.

5.4.4.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline road markings are not provided in many sections of the road.**
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.4.4.2. Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 14:00hrs to 17:00hrs, from Km 0+000 to 24+700. An average speed of 36.30 km/ hour and a maximum speed of63.5 km/ hour is noted during this survey. A spot speed was conducted at location Km 6+800, and the 85th percentile speed at this location was found to be 50 km/hr. Curves having radius in the range of 100m to 120m were observed on the following locations:

Km 0+400 Km 3+800

Km 0+500 Km 7+100

Km 0+700 Km 9+300

Km 1+200 Km 12+700

Km 2+400 Km 24+200

Km 0+700

Km 2+400

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

5.4.4.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road

Km 3+150,Km 4+000,Km 5+800,Km 6+000,Km 7+450,Km 7+800,Km 18+700,Km 19+800,21+000,Km 21+800,Km 23+100 ,Km 23+200 and Km 23+800

Location of Side roads at skew with the major road

Km 1+050,Km 2+400,Km 12+700 and Km 19+900

Km 2+400

Km 19+800

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

High approach speeds were observed by motorcyclists turning from side roads into

the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions

5.4.4.4. Major Junctions

- In this section of road all the major junctions are 3-arm uncontrolled junction.
- Street lights is missing

A. Major 3-arm Junctions

- Km 0+000
- Km 14+900 and
- Km 24+700

Km 0+00

Km 14+900

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout

- Provide splitter islands to enable safe movement of motorized and non-motorized traffic

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern:

Poor delineation

No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead.

Recommendations:

- Provide advance direction and direction signs to inform the road user
- Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road
- Provide edge lines
- Provide Splitter islands using road markings to establish improved traffic control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern:

High approach speed

Traffic coming from the Purushottampur side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality.

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

Refer to Appendix III for guidelines for design of traffic calming measures.

Reasons for concern:

Provision of VRUs

Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.

Recommendations:

- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation.

5.4.4.5. Approach to Bridge

Bridges/Culverts are observed at chainages:

- Km 4+700
- Km 6+700 and
- Km 17+500

Km 4+700

Km 17+500

Concerns & Recommendations

Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure. *Refer to Appendix III for guidelines for installation of object hazard markers*
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal. *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Recommendations:	Provide crash barriers on either approaches of the structures with delineators
Reasons for concern:	**High approach speed** In the absence if any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.
Recommendation:	• Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits • In case the location has a history of accidents, provide speed tables/ humps on either approaches

5.4.4.6. Road side hazards/Objects – Trees, Street poles

Road side objects present along this stretch of road are few trees.

Trees are on the edges of the carriageway

Concerns & Recommendations

Reasons for concern: The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations: Either remove such objects or provide crash barrier where such objects are <2m from the edge of road.

To improve delineation of such objects,

- Provide continuous edge line on the road
- Put retro-reflective delineators on stems of trees, poles, and buildings

5.4.4.7. Road Side Villages/Built-up Areas(BUAs)

Road side villages and built-up areas were observed at following locations on SH-32.

Chainage	Village	Chainage	Village
Km 0+200	Purushottampur	Km 3+100	Ranjasali
Km 5+800	Taratani	Km 10+400	Bhatakamala
Km 13+000	Bhabanda	Km 16+000	Keranditola/Ketians
Km 18+000	Tengatapalli	Km 22+800	Nalandapur
Km 24+200	Jagannathpur		

Km 0+200 (Purushottampur village)

Km 22+800 (Nalandapur village)

Concerns & Recommendations	
Reasons for concern:	Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide pedestrian crossings (either marked or speed tables), footpaths, and streetlights.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any.

5.4.4.8. Specific locations

In this section, accident prone area as per directed by OWD representative are at chainage Km 24+000 (level crossing near Jagannathpur) due to bad road condition and also level crossing on curve.

Accident prone area (Level Crossing)

Concerns & Recommendations	
Reasons for concern:	• Level Crossing on curve • Poor road condition • Poor delineation
Recommendations:	• Improve the condition of road • Improve delineation by providing the warning signs for level crossings and also for the curve.

5.4.5. SH-31: Huma (Km 0+000) to Boirani (Km 39+200)

The road starts from Huma (Km 0+000) to Boirani (Km 39+200) which is mainly Plain terrain. The road is generally Intermediate lane with 0.5 m earthen shoulder. The road surface is bituminous. The traffic flow in this section is generally low. Speed observed during spot speed survey varies from 33 KPH to more than 65 KPH but 85th percentile speed is lesser than 60 KPH.

5.4.5.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline road markings are not provided in many sections of the road.**
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.4.5.2. Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 09:00hrs to 12:00hrs, from Km 0+000 to 39+200. An average speed of 40.2 km/ hour and a maximum speed of 60.3 km/ hour is noted during this survey. A spot speed was conducted at location Km 27+000, and the 85th percentile speed at this location was found to be 55 km/hr. Curves having radius in the range of 100m to 120m were observed on the following locations:

Km 3+050	Km 8+100	Km 17+300
Km 5+300	Km 8+800	Km 17+800
Km 5+900	Km 12+400	Km 19+100
Km 6+300	Km 14+700	Km 29+300
Km 6+600	Km 16+800	Km 30+100

Km 6+600

Km 19+100

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

5.4.5.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road

Km 1+300,Km 2+100,Km 3+500,Km 11+100,Km 14+150,Km 14+300,Km 18+150,Km 20+550,Km 23+000,Km 26+600,Km 35+700,Km 35+800 and Km 37+900

Location of Side roads at skew with the major road

Km 17+200 and Km 28+600

Km 17+200

Km 37+900

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

High approach speeds were observed by motorcyclists turning from side roads into

the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions

5.4.5.4. Major Junctions

- In this section of road all the major junctions are 3-arm uncontrolled junction.
- Street lights is missing

A. Major 3-arm Junctions

- Km 0+000
- Km 26+300 and
- Km 39+200

Km 0+000

Km 26+300

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-

motorized traffic

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern: **Poor delineation**

No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead

Recommendations:

- Provide advance direction and direction signs to inform the road user
- Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road
- Provide edge lines
- Provide Splitter islands using road markings to establish improved traffic control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern: **High approach speed**

Traffic coming from the Huma side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

Refer to Appendix III for guidelines for design of traffic calming measures

Reasons for concern: **Provision of VRUs**

Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.

Recommendations: Provide footpaths to segregate pedestrians from high speed traffic at the junction approaches;

5.4.5.5. Approach to Bridge

Bridges/Culverts are observed at chainages:

- Km 4+100
- Km 6+700
- Km 7+400
- Km 8+100
- Km 8+900
- Km 10+800
- Km 11+100
- Km 13+050
- Km 13+070
- Km 13+300
- Km 26+350
- Km 27+100
- Km 27+200
- Km 27+700
- Km 28+200
- Km 29+300
- Km 30+500
- Km 32+700
- Km 34+050
- Km 35+400
- Km 36+050

- Km 13+850
- Km 17+500
- Km 17+950
- Km 20+600
- Km 23+800
- Km 38+050 and
- Km 38+800

Km 17+500

Km 27+700

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure. *Refer to Appendix III for guidelines for installation of object hazard markers*
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal. *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Recommendations:	Provide crash barriers on either approaches of the structures with delineators
Reasons for concern:	**High approach speed** In the absence if any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.
Recommendation:	• Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits • In case the location has a history of accidents, provide speed tables/ humps on either approaches

5.4.5.6. Road side hazards /Objects- Trees, street poles

Road side objects present along this stretch of road are few trees.

Trees are on the edges of the carriageway

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	Either remove such objects or provide crash barrier where such objects are <2m from the edge of road. To improve delineation of such objects, • Provide continuous edge line on the road • Put retro-reflective delineators on stems of trees, poles, and buildings

5.4.5.7. Road Side Villages/ Built-up Areas (BUAs)

Road side villages and built-up areas were observed at following locations on SH-31.

Chainage	**Village**	**Chainage**	**Village**
Km 0+000	Huma	Km 1+100	Kalajamuna
Km 1+900	Borigaon	Km 2+300	Baladhia
Km 3+500	Loughari	Km 4+200	Panibondho/Kushanpalli
Km 7+800	Gopalpur	Km 9+300	Santospur
Km 13+050	Poiresi	Km 14+300	Chatabasa
Km 15+300	Kaluabari	Km 18+100	Balia/Kenpur
Km 20+100	Pratappur	Km 22+800	Achuli
Km 24+000	Purushottampur	Km 28+300	Bhutasarasingi
Km 31+300	BadaKharidi	Km 33+100	Banarai
Km 35+700	Jarada	Km 39+050	Gudiali

Km 0+000 (Huma village)

Km 9+300 (Santospur village)

Concerns & Recommendations

Reasons for concern:	Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any.

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

5.5. Road Safety Assessment – Major District Roads

5.5.1. MDR-64: Chattrapur (Km 0+000) to Hinjilicut (Km 40+200)

The road starts from Chattrapur (Km 0+000) to Hinjilicut (Km 40+200) which is mix of Plain and rolling terrain. The road is generally Intermediate lane with 0.5 m earthen shoulder. The road surface is bituminous. The traffic flowing through the road is very low.

5.5.1.1. Delineation of the Road

Concerns & Recommendations

Reasons for concern:	**Centerline and edge line road markings are not provided in many sections of the road.**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.5.1.2. Alignment- Sharp Horizontal Curves

Curves having radius in the range of 80m to 100m were observed on the following locations:

Km 0+250	Km 2+500	Km 7+770	Km 17+330	Km 28+700	Km 33+800
Km 0+480	Km 4+600	Km 8+500	Km 20+500	Km 30+580	
Km 1+000	Km 4+850	Km 8+750	Km 20+940	Km 31+880	
Km 1+750	Km 5+650	Km 9+550	Km 21+180	Km 32+150	
Km 1+950	Km 6+400	Km 13+830	Km 25+620	Km 33+200	

Km 25+620

Km 32+150

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions

Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

5.5.1.3. Alignment - Reverse Curves

These are observed at chainages Km 6+100, Km 19+500 and Km 24+200;

Km 6+100

Km 19+500

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which can lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs** before and after the curve and continuous **chevron signs and delineators** throughout the curve. *Refer to Appendix III for guidelines on treatment of curves.*

5.5.1.4. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road

Km 6+500,Km 8+750,Km 9+450,Km 15+450,Km 18+200,Km 20+760,Km 22+880,Km 27+900,Km 33+300 and Km 35+350

Location of Side roads at skew with the major road

Km 1+800,Km 3+550,Km 10+220,Km 17+330,Km 21+390 and Km 22+000

Km 22+880

Km 17+330

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

5.5.1.5. Major Junctions

- In this section of road all the major junctions are 3-arm uncontrolled junction.
- Street lights is missing

A. Major 3-arm Junctions

- Km 23+880 and
- Km 36+550

Km 23+880

Km 36+550

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-motorized traffic

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern:

Poor delineation

No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead

Recommendations:

- Provide advance direction and direction signs to inform the road user
- Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road
- Provide edge lines
- Provide Splitter islands using road markings to establish improved traffic control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern:

High approach speed

Traffic coming from the Chattrapur side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

Refer to Appendix III for guidelines for traffic calming measures.

Reasons for concern:

Provision of VRUs

Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.

Recommendations: Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation to segregate pedestrians from high speed traffic at the junction approaches;

5.5.1.6. Approach to Bridge

Bridges/Culverts are observed at chainages:

- Km 0+500
- Km 4+850
- Km 9+620
- Km 10+200
- Km 25+660
- Km 28+850
- Km 31+520
- Km 37+080 and
- Km 38+100

Km 0+500

Km 38+100

Concerns & Recommendations

Reasons for concern: The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.

Recommendations: Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Refer to Appendix III for guidelines to treatments on approaches to bridges

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Reasons for concern: **Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

5.5.1.7. Road side hazards/Objects- Trees, Street poles

Road side objects present along this stretch of road are few trees, high embankment and Pool.


Road side objects are on the edges of the carriageway

Concerns & Recommendations

Reasons for concern: The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations: Either remove such objects or provide crash barrier where such objects are <2m from the edge of road.

To improve delineation of such objects,

- Provide continuous edge line on the road
- Put retro-reflective delineators on stems of trees, poles, and buildings

5.5.1.8. Road Side Villages/Built-up Areas

Road side villages and built-up areas were observed at following locations on MDR-64.

Chainage	Village	Chainage	Village
Km 1+750	Aliabad	Km 2+900	Karapada
Km 6+880	Housapur	Km 8+800	Potlampur
Km 11+420	Badamadhapur	Km 16+600	Hindura
Km 19+100	Raipur	Km 22+000	Taratari
Km 24+750	Pichuli	Km 26+050	Khusalapali
Km 28+650	Bucutulu	Km 29+300	Jamuni
Km 31+520	Putiabadan	Km 32+300	Nandika
Km 34+050	Ralaba	Km 35+650	Sikri
Km 38+200	Hinjilicut		

Km 11+420 (Badamadhapur village)

Km 19+100 (Raipur village)

Built up area/ Road side villages

Concerns & Recommendations

Reasons for concern: Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of clear shoulder space and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.

Recommendations:

- Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas

5.6. Road Safety Assessment – Other District Roads

5.6.1. ODR: Kanteipalli (Km 0+000) to Sorada (Km 22+000)

The road starts from Kanteipalli (Km 0+000) to Sorada (Km 22+000) which is mainly Plain terrain. The road is generally single to Intermediate lane with 0.5 to 1m earthen shoulder. The road surface is bituminous. The traffic flowing through the road is very low. Speed & delay survey, it is observed that average and maximum speed are 30 km/hr and 55 km/hr respectively.

5.6.1.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Centerline and edge line road markings are not provided throughout sections of the road.**
Recommendations:	• Provide edge line throughout the road and centre line on intermediate section with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

5.6.1.2. Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed survey. The average speed and maximum speed were noted for one trial run on the road during 14:00hrs to 17:00hrs, from Km 0+000 to 21+000. An average speed of 30 km/ hour and a maximum speed of 55 km/ hour are noted during this survey. Curves having radius in the range of 100m to 120m were observed on the following locations:

Km 2+700 Km 12+800 Km 16+600 Km 19+600

Km 8+200 Km 13+800 Km 18+800

Km 2+700

Km 8+200

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which can lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

5.6.1.3. Alignment - Reverse Curve

These are observed at chainage Km 14+300;

Reverse Curve

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which can lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs** before and after the curve and continuous **chevron signs and delineators** throughout the curve. *Refer to Appendix III for guidelines on treatment of curves.*

5.6.1.4. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road
Km 6+680,Km 9+150,Km 17+000,Km 18+300,Km 21+000
Location of Side roads at skew with the major road
Km 18+000 and Km 21+150

Km 18+000

Km 21+000

Concerns & Recommendations	
Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.
Recommendations:	• Improve visibility by clearing vegetation; • Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle of junctions.*
Reasons for concern:	**Poor delineation** No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	Provide traffic signs and road markings pertaining to junction control. *Refer to Appendix III for guidelines on traffic signs and road markings at junctions*
Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
Recommendations:	• Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions*

5.6.1.5. Major Junctions

- In this section of road only one major junctions is 3-arm uncontrolled junction.
- Street lights is missing

A. Major 3-arm Junctions

- Km 0+000

Km 0+000

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.
Recommendations:	• Re-design the junction layout • Provide splitter islands to enable safe movement of motorized and non-motorized traffic *Refer to Appendix III for standard layouts of 3-arm junctions*
Reasons for concern:	**Poor delineation** No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead
Recommendations:	• Provide advance direction and direction signs to inform the road user • Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road • Provide edge lines • Provide Splitter islands using road markings to establish improved traffic control *Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection*
Reasons for concern:	**Provision of VRUs** Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.
Recommendations:	• Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation to segregate pedestrians from high speed traffic at the junction approaches;

5.6.1.6. Approach to Bridge

Bridges/Culverts are observed at chainages:

- Km 2+800
- Km 4+400
- Km 7+150
- Km 14+100
- Km 18+200
- Km 19+720
- 21+200

Km 19+720

Km 21+200

Concerns & Recommendations

Reasons for concern: The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.

Recommendations: Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

Reasons for concern: **Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

5.6.1.7. Road side hazards/Objects- Trees, Street pole

Trees are on the edges of the carriageway

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	Either remove such objects or provide crash barrier where such objects are <2m from the edge of road. To improve delineation of such objects, • Provide continuous edge line on the road • Put retro-reflective delineators on stems of trees, poles, and buildings

5.6.1.8. Road Side Villages/Built-up Areas(BUAs)

Road side villages and built-up areas were observed at following locations on ODR.

Chainage	**Village**	**Chainage**	**Village**
Km 0+000	Kanteipalli	Km 3+820	Dubulunda
Km 5+300	Badabarasing	Km 7+050	Kaliaguda
Km 11+700	Lathipara	Km 17+300	Khapragonda
Km 18+050	Nuaga	Km 19+000	Gopalpur Sason
Km 20+300	Sorada		

Km 5+300 (Badabarasing village)

Km 20+300 (Sorada village)

Concerns & Recommendations

Reasons for concern: Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in proper shoulder space. Absence of street light worsens the situation for VRUs during night hours.

Recommendations:

- Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas

CHAPTER 6

JAJPUR DISTRICT

6.1. Crash Data Analysis

The road crash data have been collected from State Crime Records Bureau (SCRB) for Jajpur district for years 2009, 2010 and 2011. The data consist of total number of crashes, fatalities and injuries classified into various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of the driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Jajpur district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

6.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 6.1**. It can be seen from **Figure 6.1** that maximum number of fatalities and crashes occur on NHs in Jajpur district followed by other roads and SHs.

The length of road network in Jajpur district is shown in **Figure 6.2**. It can be seen from Figures 6.1 and 6.2 that, though NHs constitute only 8 percent of road network having some level of traffic, 58 percent of crashes occur on NHs. This can be partly attributed to the higher level of traffic moving at higher speed on NH network in Jajpur district.

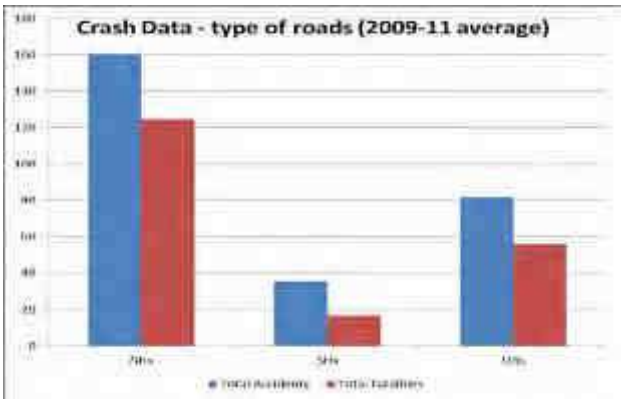


Figure 6.1: Crash data – Type of roads

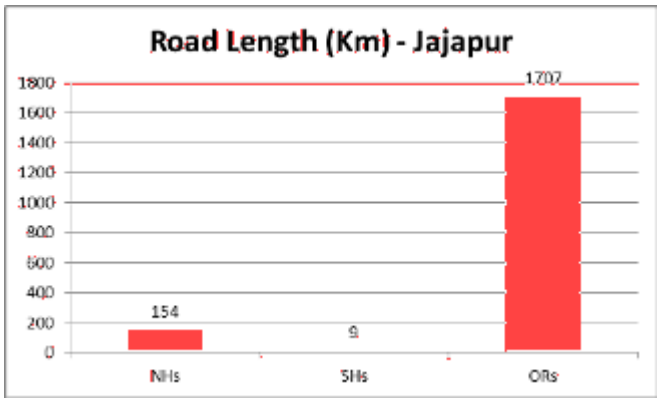


Figure 6.2: Road Network Length

The crash data classified on the basis of location type in Jajpur district is shown in **Figure 6.3** below.

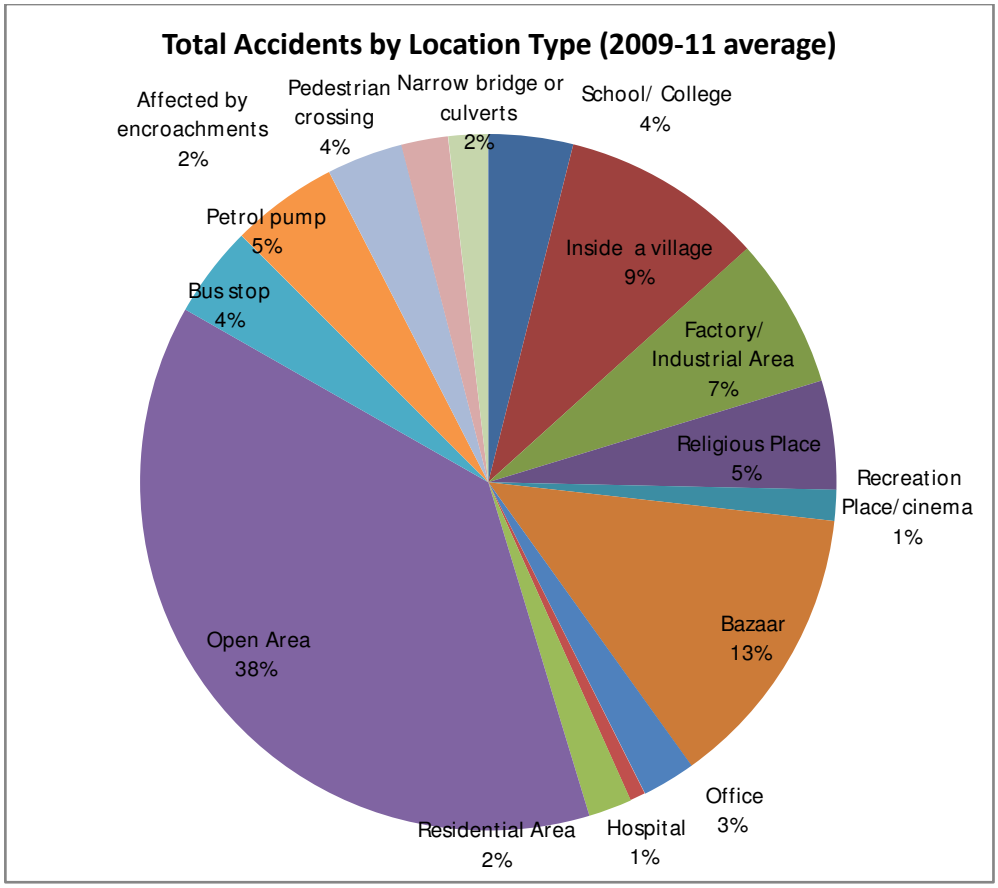


Figure 6.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 6.3** that maximum number of crashes occur in open area (38%) in Jajpur district followed by crashes in bazaar area (13%). It is not clear from the above set of data that whether crashes in 'open area' occur more on NHs or SHs.

6.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 6.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 6.5**.

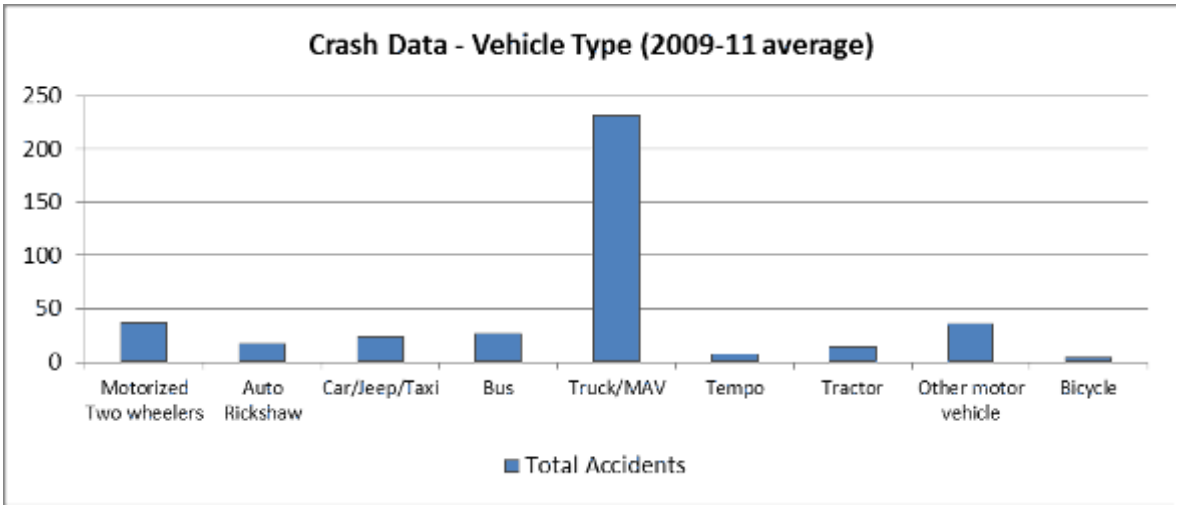


Figure 6.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 6.4**, it can be seen that trucks are involved in maximum numbers of crashes (approximate 240) followed by motorized two wheelers. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

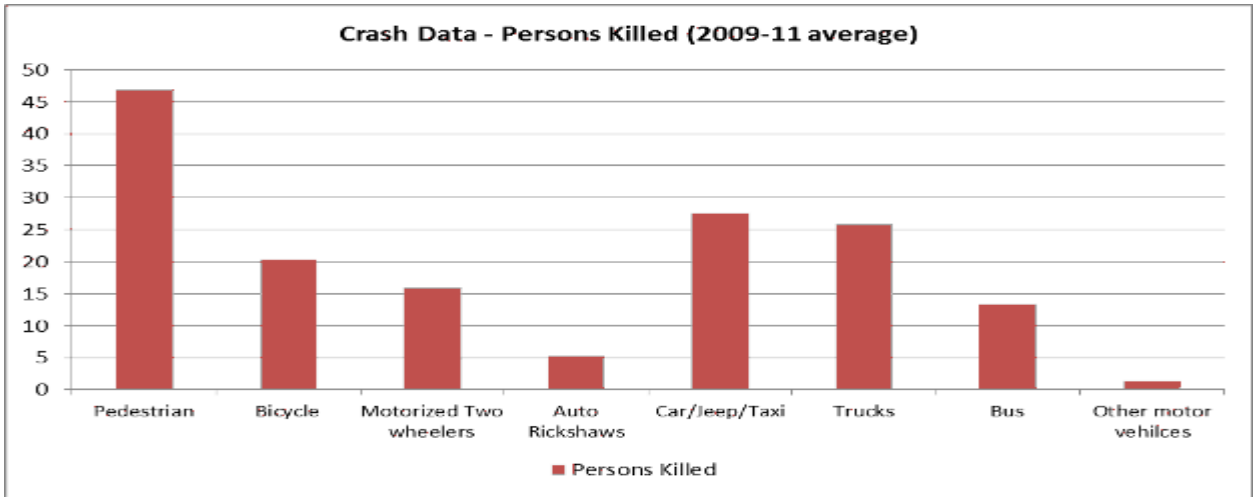


Figure 6.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 6.5**, it can be seen that maximum fatalities (approximate 45 lives) occur among the pedestrians followed by cars and trucks. The severity of crashes is very high in which cars are involved, as with 24 crashes the fatalities are 27. This may be due to the fact that multiple passengers travel in cars and single crashes might be leading to multiple fatalities.

Also it is observed that out of 38 crashes where motorcycles are involved, approximately 16 fatalities occur. This means, in two crashes involving motorcycles, one person is getting killed. This is significant since approximately 67 percent of motor vehicles registered in Jajpur district are motorcycles. However, from the available data, it is difficult to ascertain the locations/ road types, where the motorcyclists and car users are at higher risk.

The average number of crashes and fatalities during the period 2009-11, classified based on the nature of accidents are shown in **Figure 6.6**.

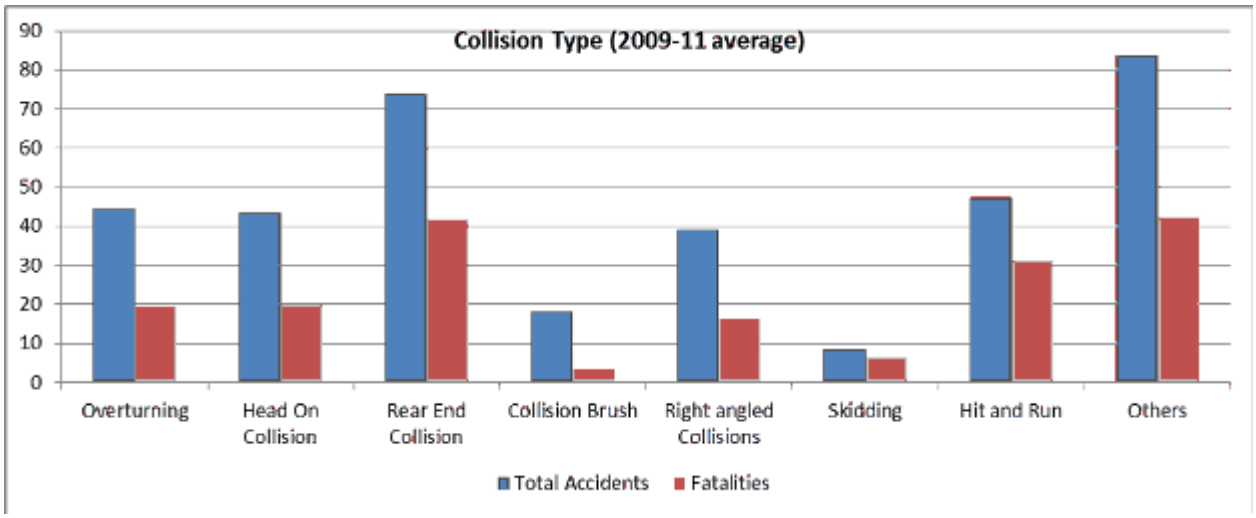


Figure 6.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 6.6** that predominant nature of crashes and fatalities in Jajpur district are 'others' (80 crashes) followed by rear end collision. Considering the other nature of crashes given in the chart, it is assumed that 'others' include crashes like 'hit road side objects' like trees and run-off accidents. Almost equal number of crashes reported under the categories of 'head on', 'overturning', 'right angle', and 'hit and run'.

It can be seen from the above figures that maximum number of crashes/ fatalities happens on NHs, trucks have a major share in crashes and the number one category of persons getting killed on roads in Jajpur are pedestrians, and the predominant nature of crashes are rear end collision of vehicles (after 'others').

From the above, the following can be inferred from the crash data of Jajpur district:

- Most hazardous road types are NHs with maximum number of fatalities and crashes recorded on NHs
- Trucks are involved in the most number of accidents, but pedestrians are the major road user group killed on roads in Jajpur and hence can be deemed as high risk user groups
- The users of passenger cars and trucks are the second most high risk user groups exposed to crashes and fatalities on road network in Jajpur
- The nature of accident 'others' ate the most predominant nature of accident, indicating that road side objects like trees and sharp curves might be key road safety issues to consider
- Rear end collisions are the second highest type of crashes indicating junction locations are hazardous on the road network in Jajpur district
- Pedestrians and cyclists are highly exposed to risk of motorized vehicles and might be victims of hit and run type of crashes

6.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 6.7** and the corresponding figures for urban area is shown in **Figure 6.8**.

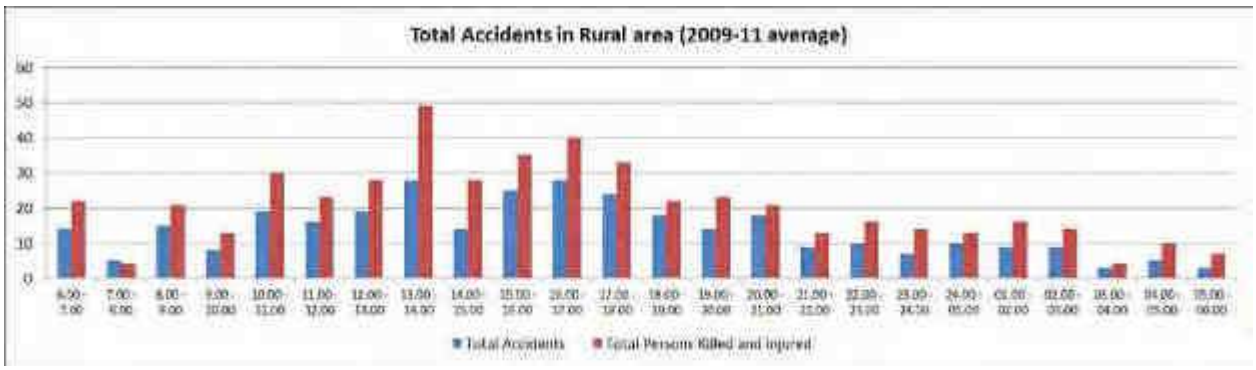


Figure 6.7: Total number of crashes in rural area (2009 – 11 average)

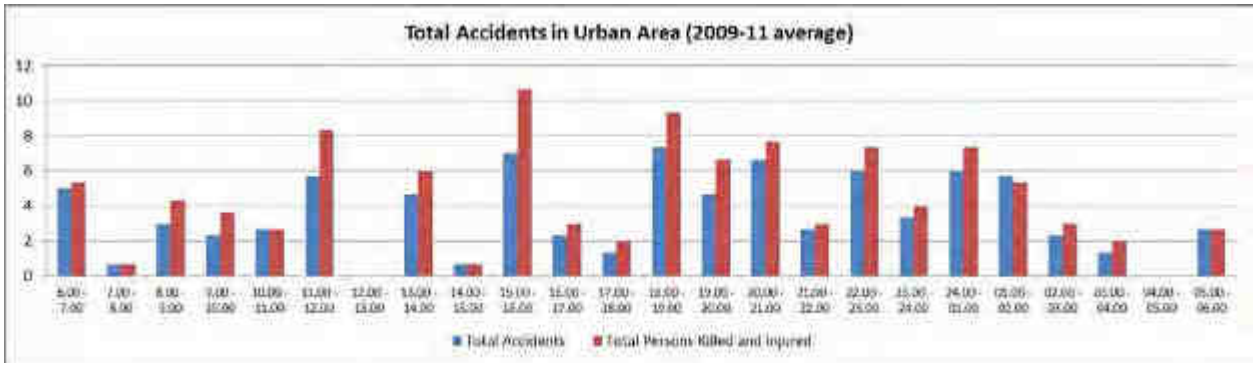


Figure 6.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 6.7**, that maximum number of crashes and fatalities occur during 13:00 to 14:00 hrs in rural area. Distribution of crashes throughout the 24hrs is in relation to the traffic levels.

It can be seen in **Figure 6.8**, that there is no particular trend or pattern of number of crashes and fatalities through the day, and the data seems to be inconclusive to arrive at a correlation between the time of the day and crashes in urban area.

6.2. Locations and Details of Audited Roads

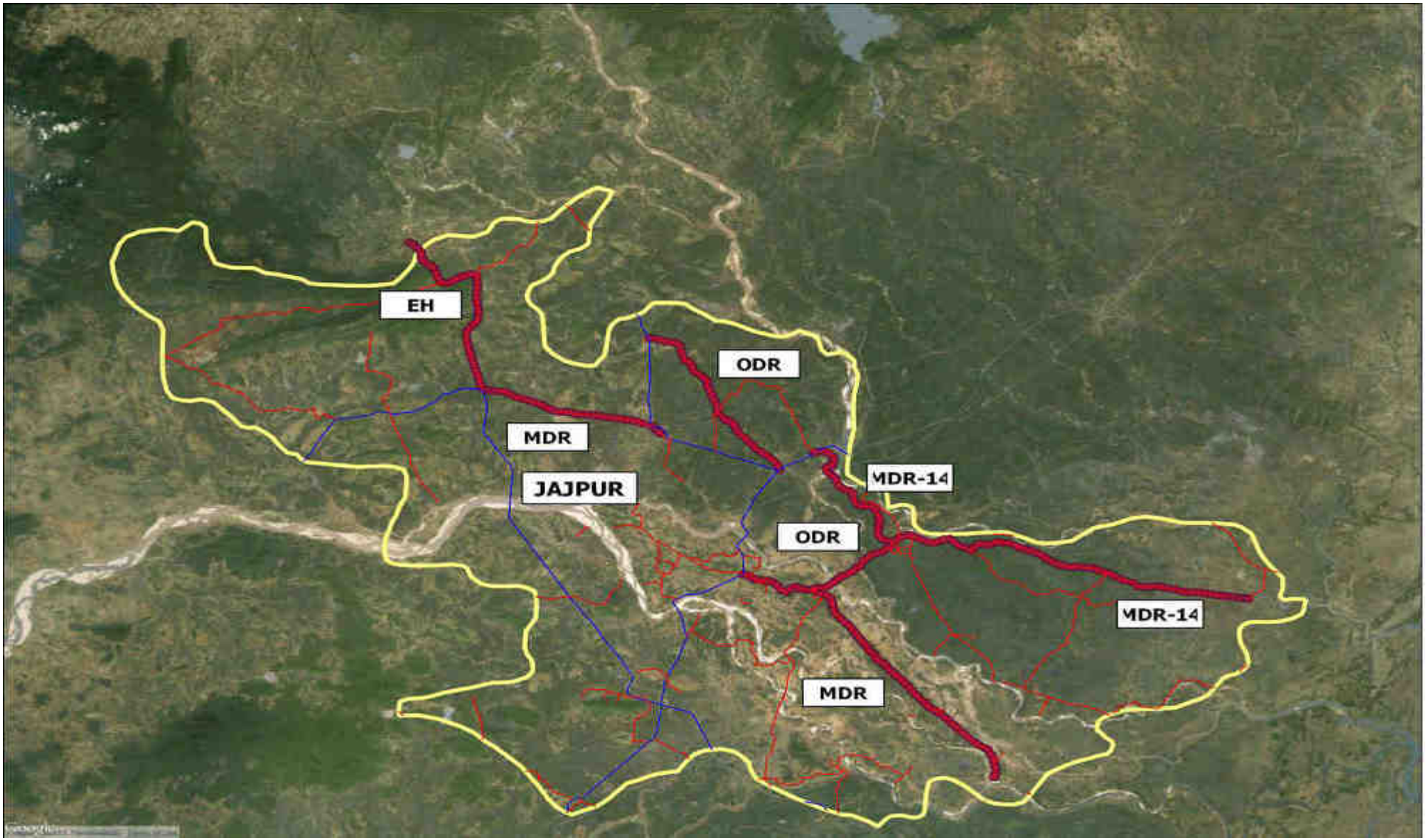
The following roads were assessed to inadequacies in the road infrastructure which can contribute to road accidents.

Table 6.1: List of Roads Assessed – Jajpur District

Sl No.	Road Name	From	To	Length
1	EW	Duburi	Tamaka (Phuljhar)	19.00
2	MDR	Choroda	Duburi	15.00
3	MDR	Kuakhia (Km 0+000)	Kalamatia (Km 23+000)	23.00
4	MDR14	Sathipur (Km 5+000)	Kayangola (Km 47+000) (Excluding 2 Km)	40.00
5	MDR14	Sathipur (Km 0+000)	Kayangola (Km 5+000)	5.00
6	MDR	Kuakhia (Km 23+000)	Kalamatia (Km 33+000)	10.00
7	ODR	Panikoili	Ragadi	19.00
8	ODR	Jajpur	Baruan	8.00
			Total	**139.00**

The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.** The location of the above roads is illustrated in the **Figure 6.9** below.

Figure 6.9: Roads Assessed in Jajpur District



6.3. RSA – State Highways

6.3.1. Express Highway: Duburi – Tomka Section

This section of the Express Highway (partly under construction) from Duburi to Tomka is a four lane divided road in plain terrain with earthen shoulder (less than 1 m) in good / fair condition.

Majority of the land use along the road are forests and small habitations. Hence the mix of traffic majorly consists of heavy vehicles carrying industrial raw or finished goods along with other modes as generated in the habitations. Given the adequate day time sight distances available and good condition of the road, the survey vehicle was able to travel above 60 KMPH.

6.3.1.1. Alignment - Sharp horizontal Curves

In the existing situation, the alignment of this two lane divided EH consists of many curves with good daytime sight distances. The wide turning radius of majority of the curves provides for safe travel along this road.

During the course of the assessment, the following hazardous locations were noted, which needs engineering countermeasures to improve the safety of these locations:

Horizontal curves of radius less than 200 m were observed at Km.6+000, 8+300, 10+600, 11+900, 15+200, 15+500, 17+100 and 18+900.

Ch: 8+300

Ch: 11+900

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatments of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:

- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern:

Curves on high embankment without safety barriers noted

- Run-off accidents on high embankments will lead to fatalities

Recommendations:

Provide metal beam crash barrier with delineators on sharp curves in high embankment

Refer to Appendix III for guidelines on situations where to install the above.

6.3.1.2. Alignment - Horizontal bend after a vertical crest

In the existing situation, there are two instances of horizontal bends occurring after a vertical crest along this road at the following chainages:

- 15+100
- 15+800

Ch: 15+800

Ch: 15+100

Concerns & Recommendations

Reasons for Concern:

Insufficient sight distance

The sight distance on a vertical crest is limited in day light and even less in night time. The presence of a horizontal bend after a vertical crest decreases the sight distance available further for the driver to react and could be a potential unsafe location. The vertical deflection of the alignment prevents the road user from being prepared to negotiate the curve and could lead to run off accidents.

Recommendations

Desirable: Provide advance curve warning signs, no overtaking pavement markings chevrons and delineators.

Refer to Appendix III for guidelines on treatments of curves.

6.3.1.3. Minor Junctions

In the existing situation, the major land use along the stretch of road is industrial. There are many intersections, but with wide roads and large turning radius.

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 0+800; 0+950; 7+100; 7+900;12+100; 14+100; 15+300; 22+100

Location of Side roads at skew with the major road

Km 9+200; 11+900; 24+200

Ch: 22+100

Ch: 24+200

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to:

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at the junctions.

Reasons for concern: **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide 'Side Road Ahead' signs on the major road
- Provide STOP/ Give Way markings and signs on side road, as appropriate

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern: **High approach speeds**

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safe vertical profile of side roads at the junction location.

6.3.1.4. Major Junctions

There is one major junction at Duburi, Ch: 15+000 along this road.

Ch: 15+000

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 4-arm junctions.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Reasons for concern:

Provision for VRUs

- Footpaths in the intersection area are encroached by overgrown vegetation or the commercial establishments.
- No provision for crossing by pedestrians/bicycles despite of significant presence of pedestrians and bicyclists.
- Pedestrians were observed using the road for commuting, instead of the footpath, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Remove encroachments from the footpaths.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Reasons for concern:

On-street Parking

- No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space, hampering visibility.
- This forces pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations:

- Provide designated parking spaces for commercial vehicles

6.3.1.5. Road side hazards - Parapets of narrow Culverts/ Bridges

At following locations the parapets of bridge/culvert were found either missing or broken resulting in highly hazardous situation for VRUs and motorized road users.

- 2+100
- 7+500
- 12+000
- 14+800
- 15+900
- 17+200
- 17+300
- 18+600
- 19+100
- 20+800

Ch: 2+100

Ch: 7+500

Concerns & Recommendations

Reasons for concern:

No delineation of bridge parapet

- The bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations:

- Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure)

Refer to Appendix III for guidelines for installation of object hazard markers.

Reasons for concern:

Broken or missing parapets

The absence of parapet on bridge/culvert increases the risk of vehicles falling on to the canal. In the context of high speed traffic movement observed on SH-10, the absence of parapets at such locations is hazardous for traffic, especially for VRUs.

Recommendations: Provide continuous parapets on all culverts and bridges.

6.3.1.6. Roadside Villages/ Built-up Areas (BUA)

In the existing situation, there are a lot of vulnerable road users present in the built-up area of Duburi town area at the following chainages:

- 0+000
- 8+100

Ch: 0+000

Ch: 8+100

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- On road bus stops which hampers visibility and encourage dangerous overtaking

- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.
- The shared usage of road space by the different modes of vehicle puts at risk the safety of vulnerable road users (pedestrians and cyclists). There could be head on/ rear end collisions.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines safe treatment options inside roadside villages/ built-up areas

6.3.1.7. Specific Locations

There is no specific location pointed out by OWD / Police which is having accident history.

6.4. RSA – Major District Roads

6.4.1. MDR: Choroda – Duburi Section

This section of Major District Road from Choroda to Duburi is a two / four lane road in plain terrain with earthen shoulder (less than 1 m) in good condition

Majority of the land uses along the road are industrial and town areas. Hence the mix of traffic majorly consists of trips generated by trucks bringing in raw materials and taking back finished goods and other local trips of small distance trips. Spot speed survey at a random location along this road revealed that the speed varies from 24 Kmph to 64 Kmph, while the 85th percentile speed is 55 Kmph.

6.4.1.1. Delineation of the road

Ch: 0+000

Ch: 15+100

Concerns & Recommendations	
Reasons for concern:	**Centerline and edge line road markings** are absent in the some stretches of road section
Recommendations:	• Provide edge line and centre line markings with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

6.4.1.2. Alignment - Sharp horizontal Curves

In the existing situation, majority of the curves along this section of the road have good sight distance. Horizontal curves of radius less than 200 m were observed at Km.7+000, 12+150, 13+300 and 13+800.

Ch: 7+000

Ch: 12+150

Concerns & Recommendations	
Reasons for concern:	**No warning signs** to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatments of curves.*
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*

6.4.1.3. Minor Junctions

Various types of junctions were noted on this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road
Km 1+200; 1+250; 1+500; 2+500; 2+600; 3+300; 5+000; 5+200; 5+300; 5+500; 5+700; 7+300; 7+600; 7+700; 10+600; 13+400; 13+600

Location of Side roads at skew with the major road

Km 0+800; 3+300

Ch: 0+800

Ch: 2+500

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

Provide 'Side Road Ahead' signs on the major road

Provide STOP/ Give Way markings and signs on side road, as appropriate

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the

side road.

- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above

6.4.1.4. Major Junctions

There are two major junctions along this road at following chainages:

- 0+000
- 15+100

Ch: 0+000

Ch: 15+100

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic

through the junction layout.

Refer to Appendix III for guidelines of direction signs on 4-arm junction

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at roundabouts

Reasons for concern:

Provision for VRUs

- Footpaths in the intersection area are encroached by overgrown vegetation or the commercial establishments.
- No provision for crossing by pedestrians/bicycles despite of significant presence of pedestrians and bicyclists.
- Pedestrians were observed using the road for commuting, instead of the footpath, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Remove encroachments from the footpaths.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the roundabout

Reasons for concern:

On-street Parking

- No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space, hampering visibility.
- This forces pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations:

- Provide designated parking spaces for commercial vehicles

6.4.1.5. Bridge approaches on high embankment

In the existing condition, there is a minor bridge at chainage 2+800.

Ch: 2+800

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

6.4.1.6. Roadside Hazards - Trees, Poles, and Buildings

Hazardous road side objects such as, trees (in BUA) were observed on this road very near to the edge of road (within 1 to 2m from the edge of road).

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Remove encroachments from the right of way • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips • Remove encroachments on at least 2m from the road edge

Ch: 2+000

6.4.1.7. Roadside Villages/ Built-up Areas (BUA)

In the existing situation, significant number of vulnerable road users present in the built-up area of Jajpur Road town and near Duburi town area.

- 0+000
- 15+000

Ch: 0+000

Ch: 15+000

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction

- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.
- The shared usage of road space by the different modes of vehicle puts at risk the safety of vulnerable road users. These are pedestrians, cyclists or two-wheelers. There could be head on / rear end collisions.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.
- Provide appropriate warning signs various hazards encountered inside the roadside village
- Provide adequate traffic calming measures
- Provision of 2 m wide clear shoulder free of obstructions/ encroachments to segregate the pedestrian traffic.

Refer to Appendix III for guidelines on safer treatments in roadside villages/ built up areas

6.4.1.8. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

6.4.2. MDR: Kuakhia to Kalamatia Section

This section of the Major District Road from Kuakhia to Kalamatia is a single / intermediate lane in plain terrain with earthen shoulder (less than 1 m width).

Majority of the land use along the road are agricultural and small inhabitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic. Spot Speed Survey conducted at a random location reveals that the speed varies from 27 kmph to 63 kmph, while the 85th Percentile speed is 57 KMPH.

6.4.2.1. Delineation of the road

Ch: 0+000

Ch: 5+500

Concerns & Recommendations	
Reasons for concern:	**Centerline / edge line road markings are** absent in the road section, the presence of which could have delineated the road during night conditions and encourages the driver to keep to the designated lanes
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

6.4.2.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 250 m were observed at chainages0+300, 0+700, 1+400, 2+500, 3+800, 5+100, 5+200, 5+500, 5+800, 6+400, 9+900, 12+600, 15+600, 25+100,; 29+100 and 31+200.

Ch: 5+800

Ch: 25+100

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

6.4.2.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km. 2+400; 13+400; 13+900; 14+100; 21+900; 22+050; 23+400;

Location of Side roads at skew with the major road

Km. 0+300; 0+600; 1+200; 1+300; 2+100; 3+300; 3+900; 4+100; 4+400; 4+600; 5+400; 5+600; 6+100; 6+500; 6+900; 7+300; 7+500; 7+900; 8+200; 8+600; 9+200; 9+300; 9+350; 9+400; 9+900; 10+860; 11+300; 11+600; 11+950; 12+100; 12+400; 12+500; 12+650; 12+800; 13+100; 13+500; 13+700; 13+950; 14+300; 14+400; 14+700; 15+100; 15+400; 16+400; 16+800; 16+950; 17+200; 17+400; 18+200; 18+500; 18+600; 18+800; 21+100; 22+700; 22+900; 23+100; 23+200; 23+300; 23+450; 23+500; 23+550; 23+750; 24+050; 24+150; 26+100; 26+800; 26+850; 27+850; 28+900; 29+800; 30+400; 30+700; 30+900; 31+500; 32+400; 32+500; 32+900

Ch: 3+300

Ch: 15+100

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the

layout ahead.

Recommendations:

- Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at minor junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures at minor junctions

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines for safer vertical profile of side road at junctions.

6.4.2.4. Major Junctions

In the existing situation, there are two major junctions along this road at the following chainages:

- 7+000
- 7+250

Ch: 7+000

Ch: 7+250

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** • The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.
Recommendations:	• Re-design the junction after traffic studies and considering the requirements of all road users.
Reasons for concern:	**Poor delineation** • Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	• Provide edge line markings, centerline markings and other junction road markings pertaining to junction control. *Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm& 4-arm junction*
Reasons for concern:	**Provision for VRUs** • Pedestrian space in the intersection area is encroached by commercial establishments. • Pedestrians were observed using the road for commuting, instead of the footpath/ shoulders, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	• Remove encroachments from the shoulder and provide a 2m wide shoulder space free of encroachments *Refer to Appendix III for guidelines for safe layout of 3-arm and 4-arm junctions*
Reasons for concern:	**On-street Parking** • No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space, hampering visibility. • This forces pedestrians to move into the centre of the road resulting in hazardous situation.
Recommendations:	• Provide designated parking spaces for commercial vehicles

6.4.2.5. Bridge approaches on high embankment

In the existing situation, following are the chainages of the unprotected bridge approaches on high embankment;

- 7+200
- 16+100
- 16+600
- 20+500

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle loses control while approaching the bridge, run-off accidents may occur, which may lead to multiple fatalities/ major injuries.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

6.4.2.6. Roadside Hazards - Trees, Poles, and Buildings

Hazardous road side objects such as, trees (in BUA) were observed on this road very near to the edge of road (within 1 to 2m from the edge of road) at the following chainages:

- 2+900
- 3+600
- 13+250
- 17+700
- 18+500
- 23+150

Ch: 3+600

Ch: 23+150

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Remove encroachments from the right of way • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips • Remove encroachments on at least 2m from the road edge

6.4.2.7. Roadside Villages/ Built-up Areas (BUA)

Roadside villages/ built up areas were noted on this road section at the following chainages:

- 6+300
- 6+900
- 10+100
- 20+000
- 22+100
- 23+300
- 24+500
- 26+000

Ch: 10+100

Ch: 22+100

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction • On road bus stops and on-street parking which hampers visibility and encourage dangerous overtaking • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided • The shared usage of road space by the different modes of vehicle puts at risk the safety of vulnerable road users (pedestrians and cyclists).
Recommendations:	• Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages. • Provide pedestrian crossings, wherever deemed necessary • Provide footpaths in urban areas and well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in

roadside villages in rural areas

- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for safe treatments inside roadside villages and BUAs

6.4.2.8. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

6.4.3. Sathipur - Kayongola Rd/ MDR 14 & Sathipur – Kayongola Section

This section of Major District Road from Sathipur to Kayongola is a single / intermediate / two lane in plain terrain with earthen shoulder (less than 1 m width).

Majority of the stretches of the road is in high embankment with irrigation canals on the sides without any crash protection. Majority of the land use along the road are agricultural and small habitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic.

6.4.3.1. Delineation of the road

Ch: 6+500

Ch: 44+500

Concerns & Recommendations

Reasons for concern: **Centerline / edge line road markings are absent in the road section**

Recommendations:

- Provide centre line markings with thermoplastic material on locations having two lane and intermediate lane sections (refer to IRC: 35-1997 for details)
- Provide edge line markings on whole road length

6.4.3.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 200 m were observed at Km. 2+100; 3+100; 3+800; 4+700; 5+020; 19+950; 20+400; 22+400; 22+600; 23+700; 23+900; 24+100; 24+700; 32+300; 32+700; 33+000; 33+700; 36+400.

Ch: 3+100

Ch: 36+400

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment at curve locations*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted, which may lead to run-off accidents, which can result in fatalities/ major injuries
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

6.4.3.3. Minor Junctions

Various types of junctions were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km. 5+020; 5+200; 6+200; 7+200; 9+400, 9+900; 10+300;11+700; 11+750; 11+800; 18+100; 18+900; 26+700; 27+100; 29+100; 29+700; 31+900; 35+400; 37+900; 42+300; 42+500

Location of Side roads at skew with the major road

Km. 2+400; 2+500; 2+700; 2+900; 9+100; 19+100; 19+200; 19+400; 20+000, 21+600; 21+850; 22+300; 22+400; 23+600; 23+900; 24+700; 24+800; 26+750; 26+800; 27+700; 27+950; 29+400; 29+500; 30+100; 30+300; 30+700; 33+300; 35+100; 35+600; 36+800; 37+700; 37+800; 38+200; 38+900; 41+900; 42+700; 42+750; 43+400; 45+300; 45+700; 46+500; 47+600

Ch: 5+200

Ch: 47+600

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at junctions

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations: Provide road markings and traffic signs pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions.

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures at minor junctions

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safe vertical profile of side roads at junctions

6.4.3.4. Major Junctions

In the existing situation, there are three major junctions along this road at the following chainages:

- 0+000,
- 14+400
- 22+600

Ch: 0+000

Ch: 14+400

Ch: 22+600

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm junction

Reasons for concern: **Poor delineation**

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction

Reasons for concern: **Provision for VRUs**

- Footpaths in the intersection area are encroached by overgrown vegetation or the commercial establishments.
- Pedestrians were observed using the road for commuting due to lack of designated footway space, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Remove encroachments from the footways

6.4.3.5. Bridge approaches on high embankment

In the existing situation, there are many minor bridges culverts along the road, the approaches of which are not protected. The following are the chainages:

- 0+900
- 1+800
- 47+600

Ch: 1+800

Ch: 47+600

Concerns & Recommendations

Reasons for concern: **Unprotected high embankment**

If a vehicle loses control while approaching the bridge, run-off accidents may occur, which may lead to multiple fatalities/ major injuries.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

6.4.3.6. Roadside Hazards - Trees, Poles, and Buildings

Hazardous road side objects such as trees and Poles (Telephone & Street lighting) were observed nearer to the edge on this road.

Ch: 1+000

Ch: 21+850

Concerns & Recommendations

Reasons for concern: Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities

Recommendations: **Desirable:**

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

6.4.3.7. Road side Villages/ Built-up Areas (BUA)

Roadside villages were observed at the following chainages:

- 3+000
- 16+000
- 22+600
- 29+000
- 31+500
- 35+700
- 37+500
- 41+500

Ch: 16+000

Ch: 37+500

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided • The shared usage of road space by the different modes of vehicle puts at risk the safety of vulnerable road users.
Recommendations:	• Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages. • Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas • Provide STOP' signs with road humps on all access roads in roadside villages in rural areas • Provide 'School Ahead' and 'SLOW' signs on appropriate locations near

schools
- Provide appropriate warning signs various hazards encountered inside the roadside village
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for safer treatments at locations of roadside villages

6.4.3.8. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

6.5. RSA – Other District Roads

6.5.1. Panikoili - Ragada Rd/ ODR & Panikoili – Ragadi Section

This section of the Other District Road from Panikoili to Ragadi is single lane in plain terrain with earthen shoulder (less than 1 m width) in fair condition.

Majority of the land use along the road are agricultural and small habitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic.

6.5.1.1. Delineation of the road

Ch: 0+000

Ch: 14+500

Concerns & Recommendations	
Reasons for concern:	**Centerline / edge line road markings are absent in the road section**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

6.5.1.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 100 m were observed at Km.2+400; 3+100; 3+400; 4+400; 6+200; 6+500; 7+100; 7+200; 7+400; 8+100; 8+300; 8+500; 13+500; 14+500; 14+700; 15+100; 15+400.

Ch: 3+100

Ch: 6+300

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on curve treatments*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*

6.5.1.3. Minor Junctions

Various types of junctions were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km. 5+700; 7+700; 7+800; 7+950; 8+600; 8+700; 14+900; 18+200

Location of Side roads at skew with the major road

Km. 0+900; 1+700; 5+900; 6+900; 11+200; 11+400; 11+500; 13+500; 13+700; 14+050; 14+600; 15+700; 15+900; 16+100; 16+500; 16+600; 17+900

Ch: 5+900

Ch: 6+900

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at the junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

6.5.1.4. Major Junctions

In the existing situation, there are two major junctions along this road at the following chainages:

- 0+000
- 19+000

Ch: 0+000

Ch: 19+000

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** • The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.
Recommendations:	• Re-design the junction after traffic studies and considering the requirements of all road users.
Reasons for concern:	**Poor delineation** • Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	• Provide edge line markings, centerline markings and other junction road markings pertaining to junction control. *Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction*
Reasons for concern:	**Provision for VRUs** • Shoulders in the junction area are encroached by the commercial establishments. • No provision for crossing by pedestrians despite of significant presence of the same.
Recommendations:	• Remove encroachments from the shoulders • Provide well maintained 2m wide shoulders at junction zone free of encroachments. *Refer to Appendix III for guidelines for safe treatments in roadside villages.*

6.5.1.5. Roadside Hazards – Trees, Poles, and Buildings

Ch: 3+400

Ch: 8+100

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Remove encroachments from the right of way **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips • Provide reflectors on poles • Remove encroachments on at least 2m from the road edge

6.5.1.6. Roadside Villages/ Built-up Areas (BUA)

Roadside villages/ BUAs were noted at the following locations:

- 5+800
- 9+700

Ch: 5+800

Ch: 9+700

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant number of pedestrians were noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • The shared usage of road space by the different modes of vehicle puts at risk the safety of vulnerable road users.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide appropriate warning signs various hazards encountered inside the roadside village
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for treatments at roadside villages

6.5.1.7. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

6.5.2. ODR:Jajpur to Baruhan Section

This section of Other District Road from Jajpur to Baruhan road is an intermediate lane in plain terrain with earthen shoulder (less than 1m width) in fair condition.

There are 2 major bridges and 2 minor bridges along this road. Majority of the stretch of the road is in high embankment. This road passes through two habitations viz. Jajpur and Baruan. Hence the mix of traffic majorly consists of trips generated between two habitations or through traffic of nearby network including pedestrian, cyclist, two-wheeler and four-wheeler traffic. Because of the built-up area type land use, the speed of the vehicles is reduced by the roadside friction and is in the range of 30-40 km/h.

6.5.2.1. Delineation of the road

Ch: 0+750

Ch: 7+920

Concerns & Recommendations	
Reasons for concern:	**Centerline / edge line road markings are absent in the road section**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

6.5.2.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 100 m were observed at Km.4+100; 4+600; 7+200; 7+800; 8+000

Ch: 4+100

Ch: 7+200

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on curve treatments*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

6.5.2.3. Minor Junctions

Various types of junctions were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km. 3+200; 4+000; 4+600; 4+900; 6+000; 6+400; 7+200

Location of Side roads at skew with the major road

Km. 0+400; 0+900; 1+300; 1+800; 2+900; 6+600; 7+300

Ch: 7+200

Ch: 7+300

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at junctions

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at minor

junctions.

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions

6.5.2.4. Major Junctions

There is a major junction along this road at Baruan, Ch: 8+000.

Ch: 8+000

Concerns & Recommendations

Reasons for concern: **Poor Junction layout**

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Reasons for concern: **Direction Signs**

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm junction

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction

Reasons for concern:

Provision for VRUs

- Shoulders in the junction area are encroached by shops and other such establishments.
- Pedestrians were observed using the road for commuting, instead of the footpath, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Remove encroachments from the shoulders
- Provide a well maintained 2m wide shoulder space for pedestrians in rural areas

6.5.2.5. Roadside Hazards - Trees, Poles, and Buildings

Ch: 0+500

Ch: 3+000

Concerns & Recommendations

Reasons for concern:

Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

6.5.2.6. Roadside Villages/ Built-up Areas (BUA)

Ch: 4+100

Ch: 7+920

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant number of pedestrians were noted, but no separate facilities are provided • Access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided • The shared usage of road space by the different modes of vehicle puts at risk the safety of vulnerable road users.
Recommendations:	• Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages. • Provide pedestrian crossings, wherever deemed necessary • Provide footpaths in urban areas • Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas • Provide adequate traffic calming measures *Refer to Appendix III for guidelines on safer treatments at locations of roadside villages*

6.5.2.7. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

CHAPTER 7

KEONJHAR DISTRICT

7.1 Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Keonjhar district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified into various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of the driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Keonjhar district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

7.1.1 Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 is shown in **Figure 7.1**. It can be seen from **Figure 7.1** that maximum number of fatalities and crashes occur in NHs followed by other roads in Keonjhar district.

The length of road network for three categories of roads in Keonjhar district is shown in **Figure 7.2. Figure 7.1** indicates that more numbers of crashes and fatalities occur on NHs than other two categories of roads. It is also observed that number of crashes and fatalities occurring per km length of NHs is much more than SHs and other roads. This can be attributed to the higher volume of traffic moving on NHs (vehicle-kilometers of travel catered by NH is high) and also at higher speeds, in Keonjhar district.

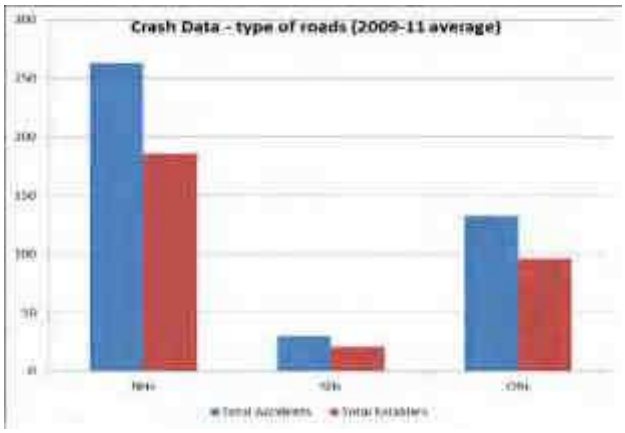


Figure 7.1: Crash data – Type of Roads

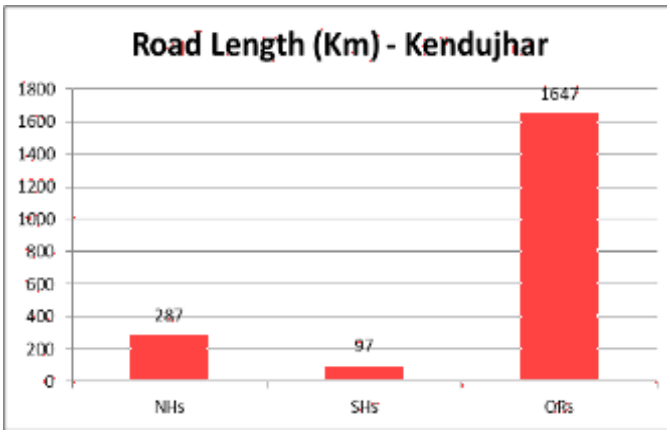


Figure 7.2: Road Network Length

The crash data classified on the basis of location type in Keonjhar district is shown in **Figure 7.3**.

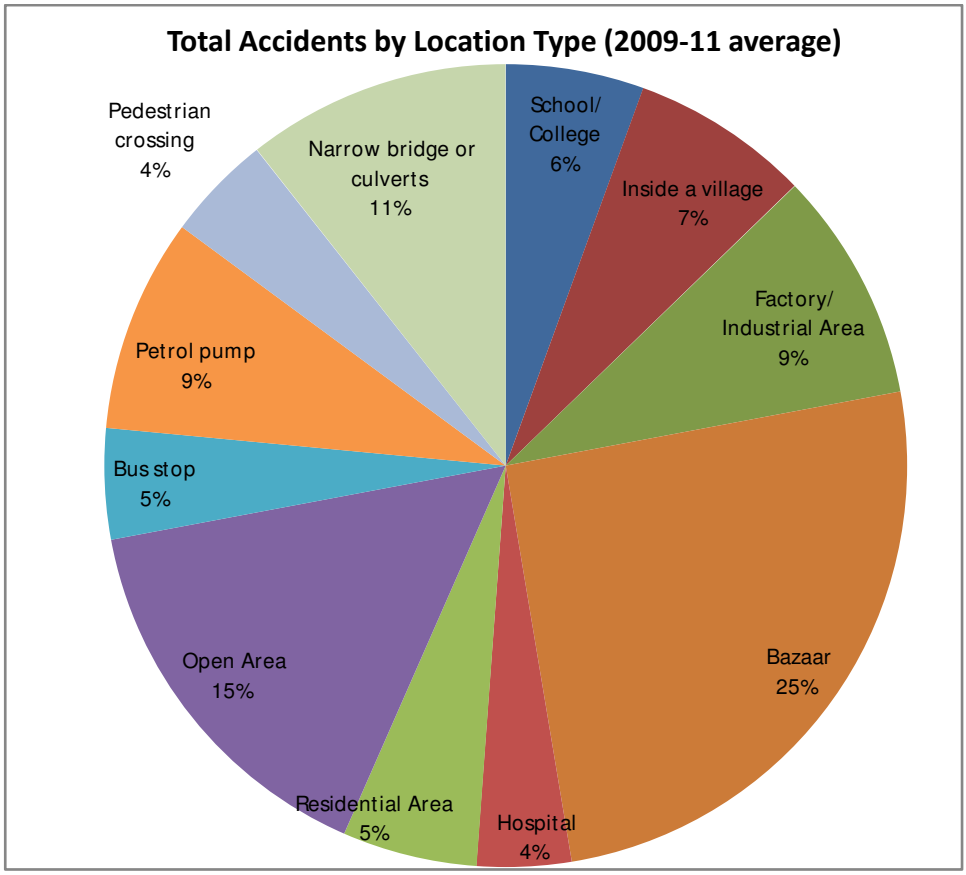


Figure 7.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 7.3** that maximum number of crashes occur around commercial areas (25 percent) followed by 'open area' (15 percent), and near narrow bridge or culvert (11 percent). Almost 50 percent of crashes are occurring in populated areas (bazaar, residential area, industrial area, inside village, near school/college). However, it is not clear from the data whether crashes in these location categories are occurring on NHs or SHs or other roads.

From the above analysis, the following conclusions can be drawn for Keonjhar district:

- Though the length of NHs constitute only 14 percent of the road network, 62 percent of crashes occur on NHs
- NHs are more prone to crashes than SHs and other roads
- Almost 50 percent of the crashes occur around populated areas where pedestrians, bicycles and other slow moving traffic are present in large numbers

7.1.2 High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 7.4**and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 7.5**.

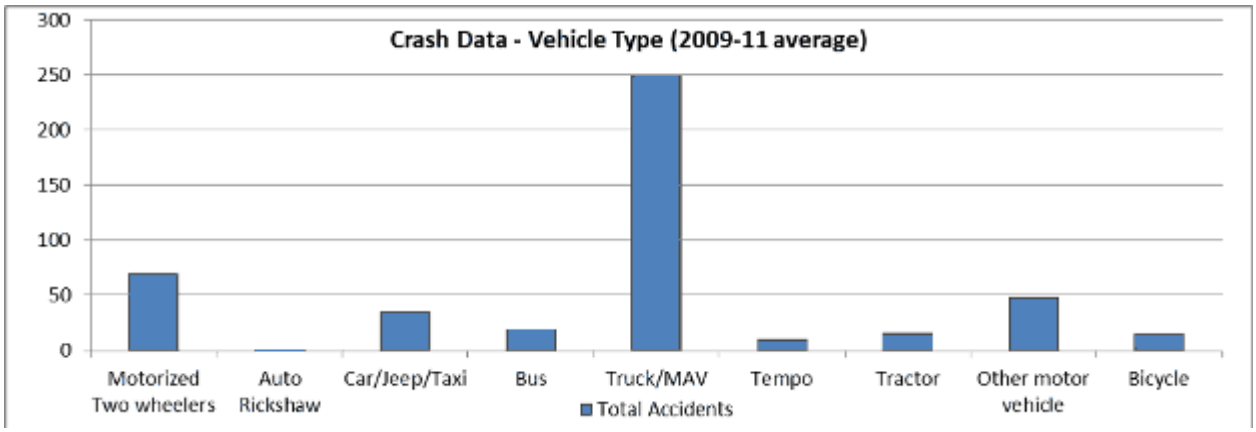


Figure 7.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 7.4**, it can be seen that trucks are involved in 250 crashes in Keonjhar district. Again, it is not clear from the SCRB data, about the locations and/or road category on which these crashes occur. This relationship is difficult to deduce from the existing pattern of data collection and recording by SCRB.

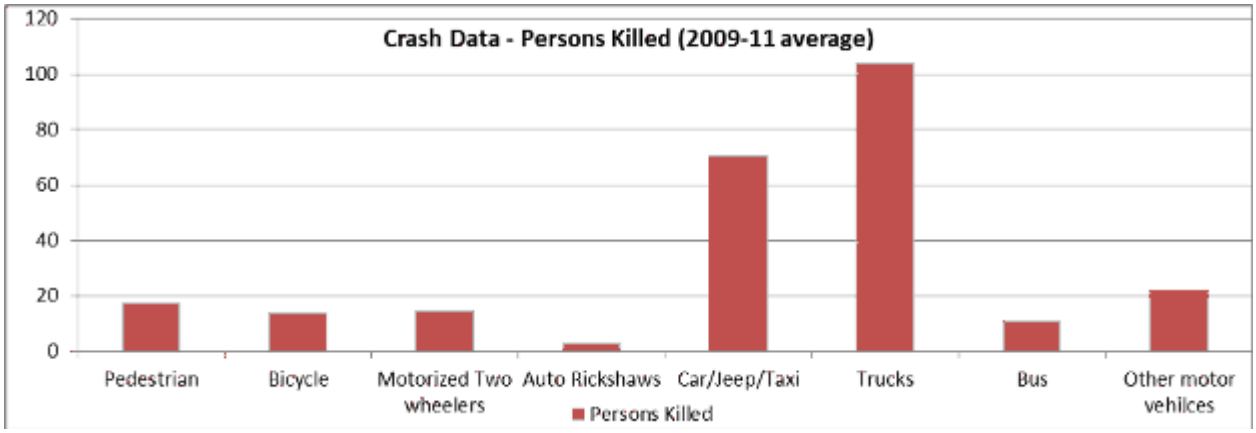


Figure 7.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 7.5**, it can be seen that maximum fatalities (more than 100 lives) are noted with truck users (both driver & passenger) followed by car users. It is observed that the severity of crashes involving cars is quite high as there are around70 fatalities from 35 crashes. This may be due to the fact that cars carry multiple numbers of persons, and single crash might be leading to multiple fatalities. However, from the available data, it is difficult to ascertain the locations/ road types, where the truck users or car users are at higher risk.

The average number of crashes during 2009-11 classified based on nature of accidents occurred in Keonjhar district is shown in **Figure 7.6**.

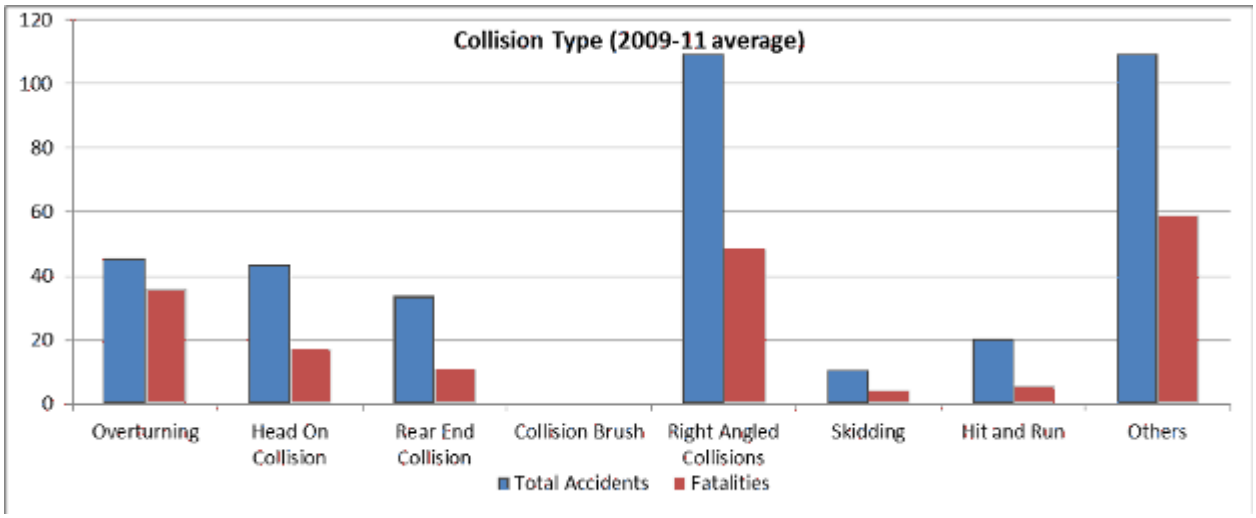


Figure 7.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 7.6** that predominant nature of crashes in Keonjhar district are right angle collisions and 'others' category (both 110 crashes each). Under crash type 'others', more than 100 crashes and 60 fatalities are reported. The type of collisions included in the category 'others' is not defined, it is assumed that the 'others' might include hit road side objects like trees and run-off accidents. Among the remaining categories 'overturning', 'head on', and 'rear end' collisions are predominant.

The following can be inferred from crash data analysis of Keonjhar district:

- Though the length of NHs constitute only 14 percent of the road network, 62 percent of crashes occur on NHs
- Almost 50 percent of the crashes occur around populated areas where pedestrians, bicycles and other slow moving traffic are present in large numbers
- Right angled collisions and others which include hit road side objects and run-off accidents are the predominant nature of crashes/ fatalities, which indicate junction locations, road side objects like trees and sharp curves might be the major problems on the road network in Keonjhar district
- Trucks and four wheeler passenger cars are the high risk road user group
- Pedestrians, bicyclists, and motorized two wheelers are exposed to risk of other traffic mainly in populated areas

7.1.3 Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural areas classified according to the time of the day is shown in **Figure 7.7** and the corresponding figures for urban areas are shown in **Figure 7.8**.

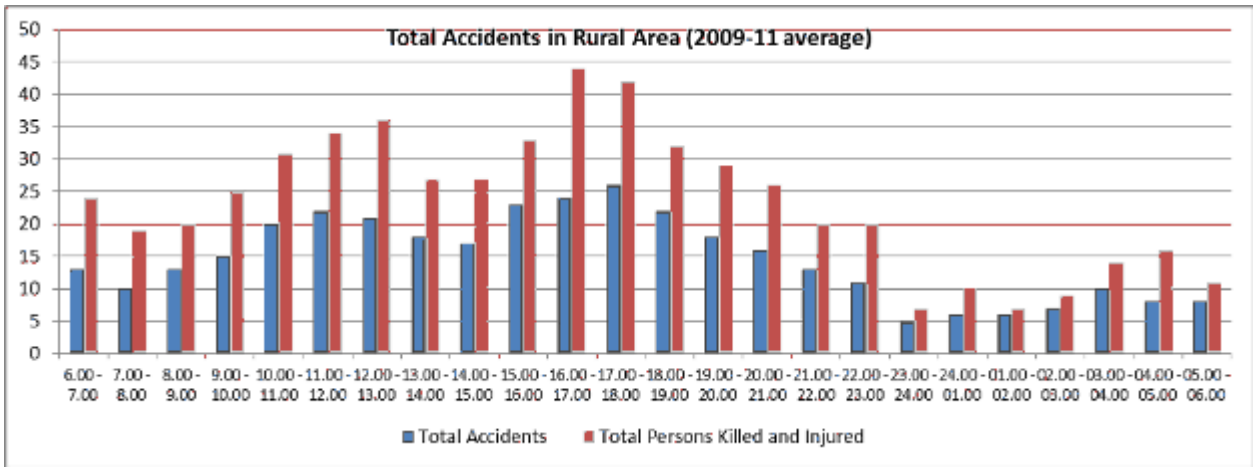


Figure 7.7: Total number of crashes in rural area (2009 – 11 average)

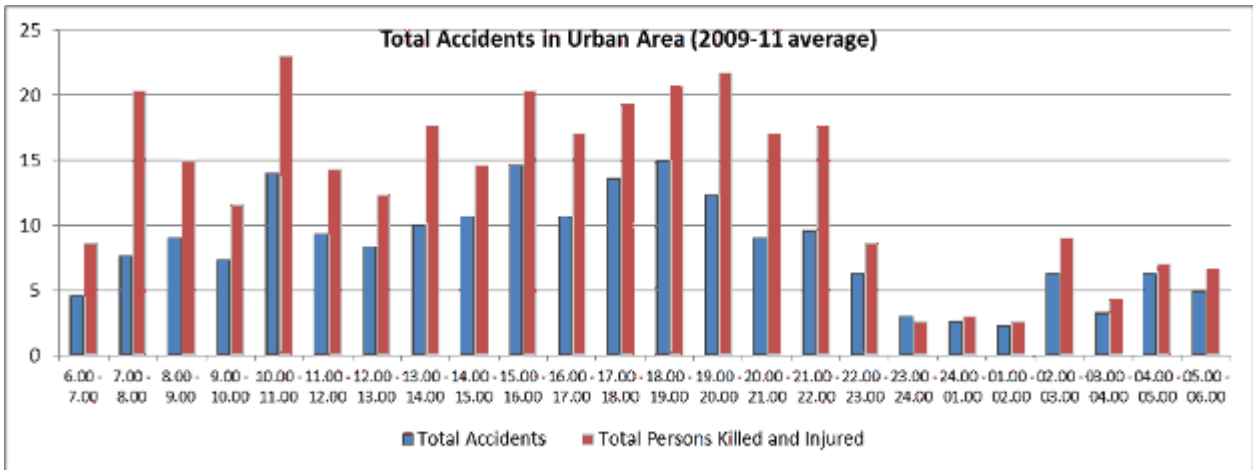


Figure 7.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 7.7,** that the number of crashes, fatalities, and persons injured are highest during 16:00 to 17:00 hrs. It can be inferred that the variation of crashes during 24 hrs is more or less corresponding with the traffic levels.

In urban areas also, the pattern of crashes is more or less in relation with traffic levels. Numbers of crashes is more during morning and evening peak times (10:00 to 11:00 hrs and 19:00 to 20:00 hrs). Significant number of crashes are occurring during night hours in the urban areas, which may be due to through traffic moving on regional roads passing though urban areas during this time, when the local traffic of the urban areas is also maximum.

7.2 Location and Details of Roads Audited

The list of selected links for road safety assessment in the Keonjhar district is given below in **Table 7.1.**

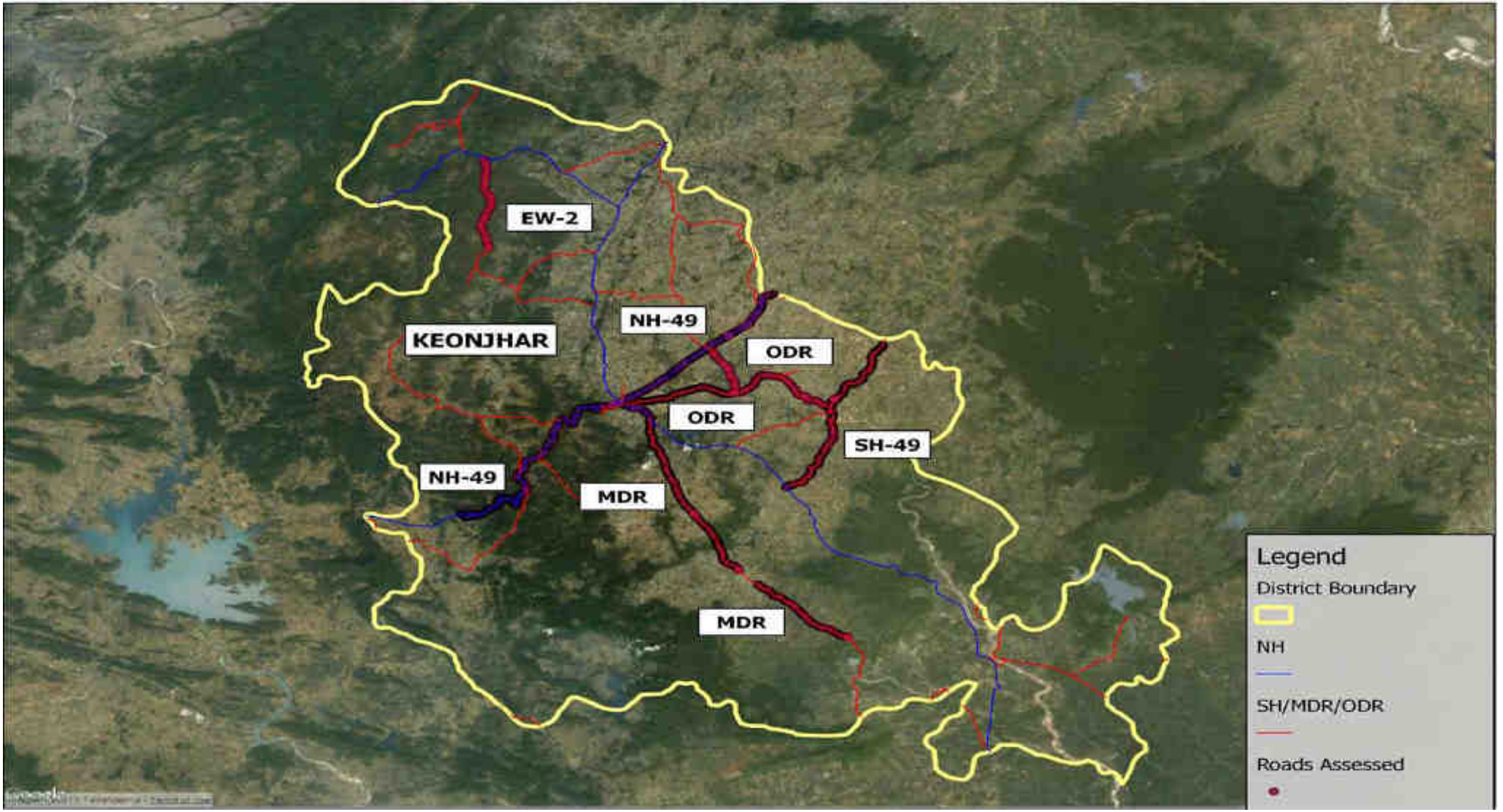
Table 7.1:- List of Roads Assessed in Keonjhar District

Sr. No.	Road Name	Assessed Road Section	Length in Km
1	NH49	Kanjipani Ghat to Keonjhar (Ch. 433+000 to Ch. 479+000)	46.00
2	NH49	Keonjhar to Turmunga (Ch. 481+000 to Ch. 511+000)	30.00

3	EW2	Joda to Bamberi (Ch. 0+000 to Ch. 18+000)	18.00
4	SH49	Gurandijodi to Dhenkikot (Ch. 66+000 to Ch. 99+150)	33.15
5	MDR	Naranpur to NH-16 (Ch. 0+000 to Ch.32+500 and Ch. 7+000 to Ch. 23+300)	48.8
6	ODR	Keonjhar to Saharpada (Ch. 0+000 to Ch. 17+000)	17.00
7	ODR	Bansuli to Patna (Ch. 38+700 to Ch. 67+000)	28.30

The map of the road links assessed in Keonjhar district is shown in **Figure 7.9**. The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II**.

Figure 7.9: Map of Roads Assessed in Keonjhar District



7.3 Road Safety Assessment – National Highways

7.3.1 NH-49: Kanjipani Ghat to Keonjhar

Part of NH49 is assessed starting at Keonjhar (433+000) and ending at Kanjipani Ghat (479+000). Project road is 46 km long. It is two lane road in good condition. Most of the shoulders in ghat section are less than 0.5 m wide and in poor condition. Rest of the section has shoulder width as 1 -2 m and in good condition. Traffic is composed of mainly trucks and a few other vehicles.

7.3.1.1 Delineation of Road

Concerns & Recommendations	
Reasons for concern:	Only center line is marked on the project road. Edge line road markings are not provided on the road.
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

7.3.1.2 Alignment – Sharp Horizontal Curve

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 09:00 hrs to 10:00 hrs, from Keonjhar to Kanjipani Ghat. An average speed of 39km/ hour and a maximum speed of 77 km/ hour is noted during this survey. Spot speed study on the road is conducted which gives 85th percentile speed as 63 km/ hour. In ghat sections sharp curve is not the only problem, but also series of curves, reverse curves, curves with valley and/or hill on either side were also observed, which were at chainages as follows.

433+200	433+500	434+100	435+200	437+600	438+600
439+900	440+100	441+250	441+300	442+200	443+400
444+650	446+700	447+400	447+900	448+700	448+950
449+000	449+400	450+700	454+000	461+800	467+000
467+400	469+800	471+300	471+700	475+400	476+000
476+600					

A. Curve with Valley on outside the curve


B. Reverse Curve


C. Series of Curves


Concerns & Recommendations

Reasons for concern (1): No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to

- Potential run-off accidents
- Potential head-on collisions

Recommendations: Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate

Refer to Appendix III for guidelines on treatment on curves.

Reasons for concern (2): Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:

- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern (3): On outer edge of some of these curves, Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.

Recommendations: For delineation, at all these sharp curves provide chevron signs.

Reasons for concern (4): On the curves with high embankment and without any protection on outer edge, there is high risk of run-off accidents.

Recommendations: Provide crash barriers on the outer edge on such curves.

Reason for concern (5) **Valley on outside Curves**

Ghat section have valley on outer side of sharp curves, thus it is very dangerous for vehicles negotiating the curve with high speed. They may fall in valley.

Recommendations:

- Provide Crash Barrier on the outer side of curves
- Warning sign before the curve and traffic calming on down gradient
- Proper chevron signs
- 'No overtaking' sign board

Reason for concern (6) **Reverse Curve**

- Reverse curve are vulnerable as driver has to negotiate two curves and collision between the vehicles from opposite direction is very likely.
- Some of the reverse curves have valley on one side which makes it more dangerous.

Recommendations:

- Provide Crash Barrier on the outer side of curves
- Warning sign before the curve and traffic calming on down

gradient

- Continuous chevron signs
- 'No overtaking' sign board

Reason for concern (7) **Hair Pin Bend Curve**

It is very sharp curve which requires traffic calming specially in hilly sections. Visibility is almost zero thus very dangerous for motorized vehicles.

Recommendations:

- Warning sign before the curve and "no overtaking" sign board
- Traffic calming measures
- Proper delineation

Reason for concern (8) **Series of Curves**

While a few sharp curves are present in short distances then vehicles are at great risk as they are not aware of this.

Recommendations:

- Provide warning sign and traffic calming on down gradient
- Provide continuous delineation

Refer to Appendix III for guidelines on different type of hazardous curves in hilly section.

7.3.1.3 Minor Junctions

Various types of intersections were observed to be existing along this road, and majority of them are single lane side roads joining the main carriageway, in addition to a few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of side roads perpendicular to major road		
459+900	472+500	477+500
Location of side roads at skew with the major road		
451+600	451+600	453+300
455+200	467+400	469+900

Skwed Minor Junctions at Km 451+600 and Km 467+400

Concerns & Recommendations

Reasons for concern (1): **Inadequate Visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions are due to buildings on the corners.

Recommendations: Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern (2): **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road users of the layout ahead.
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations: Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern (3): **High approach speeds**

- High approach speeds of traffic turning from side roads into the main carriageway were found to be high and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings at the junction of the side road
- Provide appropriate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern (4):

Poor Geometry

- It has been observed that on a few junctions, the level difference between the side road and major road, and the vertical profile of the side road joining the main carriageway is very unsafe.
- This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main road at the junction, and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads have adequate length on the side road to slow down/ stop before entering into the main road.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

7.3.1.4 Approach to Bridges/Culverts

Approach to bridge is found to be highly hazardous in the following locations;

453+900	454+300	456+100	457+800
461+800	465+000	470+250	473+200

Absence of OHM and absence of approach protection at Km 461+800 and Km 470+250

Concerns & Recommendations

Reasons for concern (1):

Unprotected high embankment

If a vehicle approaching the curved bridge loses control, it will fall into the side of the bridge in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

Reasons for concern (2):	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions, and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge line markings • Provide hazard markers on either end of the parapets
Reasons for concern (3):	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be delineated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure.

7.3.1.5 Road side Villages/ Built-up Areas (BUAs)

Road side villages and built up areas are found on following locations.

459+850	467+000 (Sukati Village)
477+500 (Sanghagar waterfall)	478+000 (Commercial Area)

Concerns & Recommendations

Reasons for concern (1) :	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians are observed, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided • On street parking and structures hamper the visibility, and resulting in unsafe situations • On road bus stops observed, which hampers visibility and unsafe overtaking maneuvers.

Recommendations:

- Provide warning signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas respectively
- Provide STOP signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SLOW' signs (traffic calming measure) on appropriate locations near schools
- Provide designated parking spaces, where it deemed necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

7.3.1.6 Specific Conditions

(a) Settlement of pavements on curves

Such cases are found in the following locations:

440+100	441+300	443+400	443+900
444+000	444+200	444+250	

Reasons for concern:

Reasons for concern: These are major hazard observed on some of the curves having valley on outside curves.

- Improper profile of the road
- Unsafe camber
- Inadequate width of formation, and thus leading to sharp fall after edge of pavement
- Settlement of culvert

Recommendations:

- Needs profile corrections
- Extra widening of shoulders
- Widening of culverts

(b) Truck Resting Area

At chainage 473+000 truck resting area is present which is used by trucks before entering into Ghat section and after coming from Ghat section in the opposite direction.

Concerns & Recommendations	
Reasons for concern:	Absence of proper entry/exit is created for trucks in resting areas which can lead to collision between vehicles moving on NH and vehicles leaving/entering the resting area.
Recommendations:	• Provide Warning on National Highway for Resting areas • Design proper entry/exit of resting areas with marked spaces for proper parking

7.3.2 NH-49: Keonjhar to Turmunga

It is part of NH-49, and is assessed starting at Keonjhar (481+000) and ending at Turmunga (511+000). Road section assessed is 30 km long. It is two lane road in good condition. Most of the shoulders are less than 1 m wide and in fair to poor condition except a few stretches where no shoulder is present. Traffic is composed of trucks, cars, motorized two wheelers, bicycles and pedestrians.

7.3.2.1 Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	Only center line is marked on the road. Edge line and other road markings are absent on the road.
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

7.3.2.2 Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 16:00 hrs to 17:00 hrs,

from 481+00 to 500+000. An average speed of 55km/ hour and a maximum speed of 65 km/ hour is observed during this survey.

Sharp curves with radius less than 200 m are found at locations as mentioned below.

489+500	494+500	495+000	510+300

Concerns & Recommendations

Reasons for concern (1):	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment on curves.*
Reasons for concern (2):	Poor visibility on the curve due to trees and overgrown vegetations, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern (3):	On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger than10cm X 10cm in cross section is hazardous to the traffic.
Recommendations:	For delineation at all these sharp curves provide chevron signs.
Reasons for concern (4):	On the curves with high embankment and without any protection on outer edge, there is high risk of run-off accidents.
Recommendations:	Provide crash barriers on the outer edge on such curves.

7.3.2.3 Minor Junctions

Various types of intersections were observed along this road, and in majority of cases single lane side road joining the main road, in addition to a few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of side roads perpendicular to major road

481+200	489+000	493+500
493+800	494+400	508+050

Location of side roads at skew with the major road

483+300	485+500	488+050
490+600	499+700	

Minor Junctions at Km 481+200

Concerns & Recommendations

Reasons for concern (1): **Inadequate visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions are due to buildings on the corners.

Recommendations: Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern (2): **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the junction ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern (3): **High approach speeds**

High approach speeds were observed for the traffic turning from side roads into the main road, and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings at the junction of the side road
- Provide appropriate warning signs on major road and on side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern (4):	**Poor geometry** • It has been observed that on a few junctions, the level difference between the side road and major road, and the vertical profile of the side road is in an unsafe condition.
Recommendations:	Correct the vertical alignment of side road so that vehicles approaching from side roads have adequate length on the side road to slow down/ stop before entering into the main road. *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.*

7.3.2.4 Major Junctions

A. 4-arm uncontrolled Junction at 496+500

The salient features of this intersection are as follows:

- This junction is called as Bouncali Junction.
- Significant volume of two wheelers, pedestrians, and cyclists are present in the junction.
- Street light is not present on the junction.

Concerns & Recommendations

Reasons for concern (1):	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing about who has priority in the junction. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to Appendix III for standard layouts of 4-arm junctions*
Reasons for concern (2):	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead
Recommendations:	Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control
Reasons for concern (3):	**Provision for VRUs** Significant presence of pedestrians and cyclists noted, but no provisions have been made for these traffic.
Recommendations:	Provide wide shoulders/ footpaths for pedestrians to use the junctions safely without interfering with the motorized traffic
Reasons for concern (4):	**On-street Parking** There are no parking spaces provided for commercial vehicles, and vehicles are parked encroaching the road and shoulder space. This hampers visibility at the

junction and force pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations: Provide designated parking spaces for commercial vehicles

7.3.2.5 Approach to Bridges

Locations of structures are observed at the locations as follows –

484+900 489+400 502+400 509+800

Absence of OHM on the structure at Km 484+900 and absence of approach protection at Km 509+800

Concerns & Recommendations	
Reasons for concern (1):	**Unprotected high embankment** If a vehicle approaching the curved bridge approach loses control, it will fall into the side of the bridge in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the bridge structure with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Reasons for concern (2):	**Absence of traffic signs and road markings** In the absence of appropriate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions, and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either end of the parapets

7.3.2.6 Road side Villages/ Built-up Areas (BUAs)

- In villages/town sections of the road wherever schools are present, warning sign "School Ahead" is provided, but traffic calming measures to slow down the traffic is not provided on either approaches.
- Significant pedestrians/school children, cyclists, motorcycles are present
- Such situations exist in the following locations

487+000 (School Area)	488+600 (Belda Village)	493+400 (Khurei Tangi Village)	507+500 (Turmunga Village)

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up areas
- Significant pedestrians including school children are observed, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On road bus stops observed, which hampers visibility and cause unsafe overtaking maneuvers.

Recommendations:

- Provide warning signs at a location before start and also after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages and in rural areas respectively
- Provide STOP signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SLOW' signs at appropriate locations near schools
- Provide designated parking spaces, where it is deemed necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

7.3.3 EW-2: Joda to Bamberi

Assessment of EW2 is started at Joda and ended at Bamberi. Road assessed is 18 km long. It is mainly two lane road in fair condition except few sections where intermediate lane is present with fair or poor condition. Most of the shoulders are less than 1 m wide and poor condition. Traffic is composed of mainly heavy vehicles. It has been found that some of the truck drivers are teenager and they are not educated enough to understand and react the situations accordingly.

7.3.3.1 Delineation of the road

Concerns & Recommendations	
Reasons for concern:	Edge line and center line road markings are not provided on the project road.
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

7.3.3.2 Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 16:00 hrs to 17:00 hrs, from 481+00 to 500+000. An average speed of 55km/ hour and a maximum speed of 65 km/ hour is noted during this survey. A spot speed survey indicates the 85th percentile speed on the road is 63 km/ hour. Sharp curves with radius less than 200 m are found at following locations.

Sharp Curves (radius less than 100-150 m) are observed at following locations –

0+200	7+200	7+600	8+000
8+400	8+800	11+000	12+900
14+100	14+250	15+100	

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed
	• Potential run-off accidents

- Potential head-on collisions

Recommendations: Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate

Refer to Appendix III for guidelines on treatment on curves.

Reasons for concern: Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:
- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern: On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.

Recommendations: For delineation at all these sharp curves provide chevron signs.

Reasons for concern: On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.

Recommendations: Provide crash barriers on the outer edge on such curves.

Reason for concern Visibility is also hampered because of

- Open loaded trucks carrying stone dust
- Most of the roads coming from mining are unpaved

Recommendations:
- Vehicles Carrying stone dust and similar kind of material should be covered
- If the visibility is very less than use speed calming measures and provide warning sign

7.3.3.3 Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road		
3+000	5+000	11+900
Location of Side roads at skew with the major road		
1+550	2+100	17+300

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on ROAD are due to buildings on the corners. Open trucks carrying stone dust also hamper the visibility.

Recommendations:

Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead. Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

7.3.3.4 Major Junctions

A. 3 –arm uncontrolled junction at 2+300

The salient features of this intersection are as follows:

- This junction is intersection of urban road and expressway.
- Heavy two wheelers, pedestrians, cyclists are present on the junction.
- No traffic islands are present for safe and effective maneuver of traffic. A non-standard central island is present obstructing the sight of the approaching traffic.
- Street light is present on the junction.

Concerns & Recommendations

Reasons for concern: **Poor Junction layout**

The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations: Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern: **Poor delineation**

Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead

Recommendations: Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control

Reasons for concern:	**Provision for VRUs** Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	Provide wide shoulders/ footpaths for pedestrians to commute in the junctions without interfering with the motorized traffic
Reasons for concern:	**High approach speed** Traffic coming from the Cuttack side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality
Recommendations:	• Provide traffic calming measures on the minor road • Provide warning signs on the minor road • Provide information signs and road markings at the junction to warn the road user of the layout

7.3.3.5 Road Side Objects - Parapet Walls

Bridges/ Parapets having parapets on the road edge is observed on the following locations where delineation is not present.

2+250 11+050

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on SH-10, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.
Recommendations:	Provide continuous parapets on all culverts and bridges.
Reason for Concern	**Approach Protection** • Some of the structures do not have approach protection and have pond on road side. Chance of fatality increases if a vehicles undergoes run off accident or hit wall of the structure.

Recommendations: Provide approach protection with proper crash barrier and crash cushion at start of such crash barriers

Refer to Appendix III for guidelines on approach to bridge.

7.3.3.6 Road side Villages/ Built-up Areas (BUAs)

Following locations have road side villages and schools.

1+500	2+000	3+000	4+000
9+100	10+000	16+400	

- In above villages/town wherever schools are present, a warning sign "School Ahead" is provided on both approaches.
- Very high encroachments are present.

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:

- Provide Warning signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

7.4 Road Safety Assessment – State Highways

7.4.1 SH-49: Gurandijodi to Dhenkikote

Road assessment of SH-49 starts at Gurandijodi (66+000) and ends at Dhenkikote (99+150). Road section assessed is 33.15 km long. It is two lane road in good condition except the section from 77+800 to 82+800 where single lane road in poor condition is present. Earthen shoulders are less than 1 m wide and in good condition except a few stretches where no shoulder is present. Traffic is mixed.

7.4.1.1 Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	Center line is present on the project road and edge line is marked only near to curves. Edge line road markings are not provided on remaining length of the road.
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

7.4.1.2 Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed surveys. The average speed and maximum speed were noted for one trial run on the road during 09:00 hrs to 10:00 hrs, from 66+000 to 83+000. An average speed of 59 km/ hour and a maximum speed of 69 km/ hour is noted during this survey.

Sharp curves with radius less than 200 m are observed along the road at locations as mentioned below.

66+450	72+000	80+000	87+200
88+900	93+500	96+600	

Sharp Curves on Project Road at Km 80+000 and Km 75+200

Concerns & Recommendations	
Reasons for concern (1):	No warning signs/ delineation to inform the road user to make him/her to slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents

- Potential head-on collisions

Recommendations: Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate

Refer to Appendix III for guidelines on treatment on curves.

Reasons for concern (2): Poor visibility on the curves due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:
- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern (3): On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger than10cm X 10cm in cross section is hazardous to the traffic.

Recommendations: For delineation at all these sharp curves provide chevron signs.

Reasons for concern (4): On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.

Recommendations: Provide crash barriers on the outer edge on such curves.

7.4.1.3 Minor Junctions

Various types of intersections were noted in this road, a majority of them are single lane side roads joining the main road, in addition to a few major junctions. The types of junctions observed in this road are as follows:

1. Side roads with narrow minor bridge on approach
2. Side roads with normal approaches
   - Almost all of the right hand side roads have minor bridge approach on side road.
   - Minor bridge is on canal
   - Such minor bridge is too narrow and only protected by concrete guard post.
   - Approach protection is not provided.

Location of side roads with narrow minor bridge on approach				
66+600	66+950	67+750	69+900	70+700
72+200	73+400	73+500	75+400	76+800
76+800	86+500	86+500		

Location of side roads with normal approaches			
67+300	68+400	73+600	76+500
82+800	87+050	88+100	88+800
93+800	96+200		

Minor Junctions at Km 66+950 and at Km 76+800

Skewed Side Road at Km 73+600 and Km 88+100

Concerns & Recommendations

Reasons for concern (1):

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions, 2) Overgrown vegetation or presence of trees, and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.
  Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern (2):

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the junction ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control.

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern (3): **High approach speeds**

High approach speeds were observed by motorcyclists turning from side roads into the main road, and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings in the junction of the side road
- Provide adequate warning signs on major road and on side road

Refer to Appendix III for guidelines on traffic calming measures.

7.4.1.4 Major Junctions

A. 3-arm Uncontrolled Junction at 99+150

The salient features of this intersection are as follows:

- This junction is intersection of two major roads viz. NH-215 and SH-49
- Very high two wheelers, pedestrians, cyclists are present in the junction.
- No traffic islands are present for safe and effective maneuver of traffic
- Street light is not present on the junction.

Concerns & Recommendations

Reasons for concern (1): **Poor Junction layout**

The junction layout is non-standard and has no control over the traffic movement. It is confusing about who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations: Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to Appendix III for standard layouts of 4-arm junctions

Reasons for concern (2): **Poor delineation**

Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the junction ahead

Recommendations: Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control

Reasons for concern (3): **Provision for VRUs**

Significant presence of pedestrians and cyclists observed, but no provisions have been provided. Pedestrians were observed to be using the junction and this exposed them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:	Provide wide shoulders/ footpaths for pedestrians to use the junctions safely without interfering with the motorized traffic
Reasons for concern (4):	**On-street Parking** There are no parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder spaces. This hampers visibility at the junction and force pedestrians to move into the centre of the road resulting in hazardous situation.
Recommendations:	Provide designated parking spaces for commercial vehicles
Reasons for concern (5):	**On street Bus stop** Buses stop at the mouth/approach of the junction in the minor road hampering visibility
Recommendations:	Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction *Refer to Appendix III for guideline on street bus stop and bus bays.* *SEEN UPTO HERE; it is all the same every time*

7.4.1.5 Approach to Bridges

Locations of structures are as follows –

66+450	75+200	76+00	89+800	92+850
93+050	94+600	96+500	96+827	

Absence of OHM on structure at Km 76+000 and Km 94+600

Concerns & Recommendations

Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines on approach to bridges..

Reasons for concern:

Absence of traffic signs and road markings

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

7.4.1.6 Road Side Objects - Trees and Street Poles

At several locations on the project road, many trees and/or street light poles are found,

Concerns & Recommendations

Reasons for concern: The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

7.4.1.7 Road side Villages/ Built-up Areas (BUAs)

- In villages/town wherever schools are present, warning sign "School Ahead" and "Slow" are not provided on either approaches.
- Significant pedestrians/school children, cyclists, motorcycles are present
- Very high encroachments are present Locations of built up area and villages are-

66+000 (Gurandijodi Village)	66+600 (Saharapada Village)	70+700 (Tilaveda Village)
72+300 (Barbil Village)	74+800 (Tabhasirua Village)	76+800 (Khajuridiha Village)
77+600 (Dhanaveni Village)	77+800 (Patna Village)	84+100 (Dianali Village)
86+200 (Mallipassi Village)	87+600	91+600 (Dhanurjaypura Village)
93+400 (Mudara Pada Village)	95+900 (Kapasapada Village)	

Village Barbil at 72+500 and Town Dhenkikote (99+000)

Locations of commercial areas are:–

79+400 (Patna Village)	98+000 (Dhenkikot Village)

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the

built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:
- Provide Warning signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SCHOOL AHEAD' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

7.4.1.8 Specific Locations

- Location 87+200 have some past accident record history.
- A curve is present with good visibility
- Super elevation is not proper

Concerns & Recommendations

Reasons for concern: **Profile Correction**

On curve proper super elevation is not provided thus vehicles negotiating curve have chance to run off

Recommendations: Correct the profile of the curve by providing the designed super elevation.

Reason for concern **Concrete Guard Post**

Most of the curves have concrete guard post on outside curve to protect the vehicles from falling into ditch, which is not appropriate as per standard guidelines. These concrete guards post are not effective during night.

Recommendations:
- Provide crash barrier on outside curve with high embankment
- Provide proper chevron signage for delineation

7.5 Road Safety Assessment – Major District Roads

7.5.1 MDR: NPHBD Road – Naranpur to NH-16

This road is assessed in two sections. First section starts at Naranpur (0+000) and ends at 32+500, second section starts at Harichandanpur (7+000) and ends at 23+300. Total length of MDR assessed is 48.8 km. It is a two lane, bituminous road with good condition. It has paved shoulders. Earthen shoulders have width less than 1m, and condition is poor. Traffic is low on the road and in some stretches construction work is in progress. Following section are under construction.

Section I

a. At 7+600 structure under construction
b. Ghat Section 25+400 to 28+600
c. At 32+500 Bypass of Town Harichandanpur

Section II

a. Section 18+000 to 18+500
b. After chainage 23+300

7.5.1.1 Delineation of the Road

Centre line, edge line is present on the road except 2.7 km section. Condition of markings are good. Road do not have any kilometer stone.

Concerns & Recommendations	
Reasons for concern:	Centre line, edge line is present on the road except 2.7 km section. Condition of markings is good. Road do not have any kilometer stone.
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

7.5.1.2 Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 18:00 hrs to 18:30 hrs, from 7+300 to 0+000. An average speed of 73 km/ hour and a maximum speed of 103 km/ hour is noted during this survey. A spot speed was conducted at location 20+100, and the 85th percentile speed at this location was found to be 87Km/ hour.

Curves having radius in the range of 100m to 300m were observed on the following locations:

Section I

0+900	2+600	3+900	5+800	30+500

Section II

7+800	8+200	12+700	15+800	22+400


Curves on Project Road

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment on curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.
Recommendations:	For delineation at all these sharp curves provide chevron signs.
Reasons for concern:	**High Embankment** On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.
Recommendations:	Provide crash barriers on the outer edge on such curves.

7.5.1.3 Alignment - Reverse Curve

At following locations reverse curves are located.

Section II

7+800 22+400

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate
Reason for concern	Two sharp curve together with opposite curvature can make high speed vehicles unstable on the road and then vehicle can lead to crashes.
Recommendations:	• Provide proper warning sign before starting of the reverse curve • Provide continuous chevron marking

7.5.1.4 Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Section I-

Location of Side roads perpendicular to major road				
1+100	2+000	2+090	3+200	7+150
12+450	14+050	14+050	15+700	15+700
21+600	24+950	29+750		

Location of Side roads at skew with the major road				
0+600	1+100	2+570	2+570	3+830
5+240	5+240	5+600	6+300	6+650
11+600	17+100	17+500	19+300	20+300
20+400	21+600	24+450	24+450	

Section II

Location of Side roads perpendicular to major road			
8+380	10+050	17+000	18+700
Location of Side roads at skew with the major road			
10+500	11+650	17+700	

Skewed Side Road at Km (Section I)and Km 10+500 (Section II)

Concerns & Recommendations	
Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on ROAD are due to buildings on the corners.
Recommendations:	Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle.*
Reasons for concern:	**Poor delineation** No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	Provide traffic signs and road markings pertaining to junction control. *Refer to Appendix III for guidelines on traffic signs and road markings at junctions*

Reasons for concern:	**High approach speeds** High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
Recommendations:	• Provide road humps on the side at junctions having history of accidents • Provide raised markings on the entry to the side road • Provide adequate warning signs on major road and side road *Refer to Appendix III for guidelines on traffic calming measures.*
Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner. s
Recommendations:	Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.*

7.5.1.5 Approach to Bridges

Locations of structures are as follows

Section -I

7+050	11+700	12+050	14+300
14+800	16+050	20+300	29+500

Section -II

9+300	17+200	17+400

Gap in Crash Barrier and New Jersey Barrier and Absence of OHM on structure

Concerns & Recommendations

Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guideline on approach to bridge.*
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.

7.5.1.6 Road Side Objects - Crash Barrier on Shoulder

Crash Barrier very near to pavement edge

Concerns & Recommendations	
Reasons for concern:	**Placement of Crash Barriers** Crash Barrier are places very near to pavement edge. Thus leaves no space for non-motorized traffic and also for pedestrians
Recommendations:	Provide crash barrier after earthen shoulder.
Reason for concern:	High Embankment
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators

7.5.1.7 Roads Side Objects - Trees and Street Poles

At several locations on the project road, many trees and/or street light poles are found, which obstruct the view and also potential hazard during night if not visible, vehicle may collide with it and severity may be very high.


Concerns & Recommendations

Reasons for concern:

The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

In BUA where buildings are very near the road edge provide traffic calming measures, as at reduced speed the severity of run-off crash will be much less.

7.5.1.8 Road side Villages/ Built-up Areas (BUAs)

- In villages/town wherever schools are present, warning sign "School Ahead" and "Slow" are not provided on either approaches.
- Significant pedestrians/school children, cyclists, motorcycles are present


Section I

13+750 (Babdrapur)	15+650	17+400
17+800	21+500 (Deovan Village)	29+500 (Pitapeti Village)

Section II

17+650 (Bhagamunda Village)

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:

- Provide Warning signs at before start and after the end of BUA
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SCHOOL AHEAD' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

7.6 Road Safety Assessment – Other District Roads

7.6.1 ODR: Keonjhar to Saharpada

Road assessment of this ODR starts at Keonjhar and ends at Saharpada. Road is 17 km long. It is mainly a single lane road in poor condition except the section of initial 4 km where road is two lane/intermediate lane and 2 km stretch is under construction. Earthen shoulders are less than 0.5 m wide and in poor condition. Road passes through forest area starting at Km 7+000 and ending at Km 10+000. Traffic is mixed with higher number of bicycles and pedestrians near built up area and commercial area.

7.6.1.1 Delineation of the road

Concerns & Recommendations	
Reasons for concern:	**Initial section of 4km has center line and pedestrian crossing. Remaining section of road does not have edge line/center line.**
Recommendations:	• Provide edge line and center line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

7.6.1.2 Alignment – Sharp Horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 18:00 hrs to 19:00 hrs, from 17+000 to 0+000. An average speed of 31 km/ hour and a maximum speed of 45 km/ hour is noted during this survey.

Sharp curves with radius less than 100 m are mentioned below.

1+300	1+600	2+650
6+300	12+100	

Sharp Curves on Project Road at Km 2+650 and Km 12+100

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her

slow down to negotiate the curve in a safe speed

- Potential run-off accidents
- Potential head-on collisions

Recommendations: Provide **curve warning signs, chevron signs and delineators** as appropriate

Refer to Appendix III for guidelines on treatment on curves.

Reasons for concern: Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:

- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern: On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.

Recommendations: For delineation at all these sharp curves provide chevron signs.

Reasons for concern: On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.

Recommendations: Provide crash barriers on the outer edge on such curves.

7.6.1.3 Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The above junction types were observed on the following chainages:

Location of Side roads perpendicular to major road				
		14+300		
Location of Side roads at skew with the major road				
0+700	0+750	0+750	0+900	1+00
1+650	1+670	5+100	11+700	12+100

Minor Junctions at Km 0+700 and at 1+670

Skewed Side Road

Concerns & Recommendations

Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on ROAD are due to buildings on the corners.
Recommendations:	Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle.*
Reasons for concern:	**Poor delineation** No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	Provide traffic signs and road markings pertaining to junction control. *Refer to Appendix III for guidelines on traffic signs and road markings at junctions*

Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
Recommendations:	Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.*

7.6.1.4 Major Junctions

A. 3 –arm uncontrolled junction at 17+000

Salient features are –

- Medium commercial activities are present
- Significant pedestrians, cyclists and motor cyclists are present.
- Street light is absent
- No Traffic island is present

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users *Refer to Appendix III for standard layouts of 3-arm junctions*
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the

presence of which would have informed and warned the road user of the layout ahead

Recommendations: Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control

7.6.1.5 Road Side Objects - Parapet Walls

Locations of structures are as follows –

4+100 7+400 10+300

Absence of protection and OHM on structure at Km 7+400 and Km 10+300

Concerns & Recommendations

Reasons for concern: The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.

Recommendations: Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.

Refer to Appendix III for guidelines on installing OHM.

Reasons for concern: **Broken or missing parapets**

The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on SH-10, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.

Recommendations: Provide continuous parapets on all culverts and bridges.

7.6.1.6 Road Side Objects - Trees and Street Poles

Several trees and street pole near pavement edge

Concerns & Recommendations

Reasons for concern:

The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

7.6.1.7 Road side Villages/ Built-up Areas (BUAs)


Built up area at Km 0+500 and School at Km 11+250

Following locations have road side villages.

0+000	1+000	2+000
4+000	11+000 (Hariharpur Village)	12+000 (Meidankal Village)

Following sections can be classified as commercial areas.

0+000 (Keonjhar)

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead

Recommendations:

- Provide Warning signs at before start and after the end of BUA
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'SLOW' signs on appropriate locations near schools

Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages

7.6.2 ODR: Bansuli to Patna

Road assessment of this ODR starts at Bansuli (38+700) and ends at Patna (67+000). Project road is 28.3 km long. It is mainly an intermediate lane road in good condition except last 8 km where road is single lane and condition is poor. Earthen shoulders are 1-2 m wide and in fair condition except last 8 km where shoulders are less than 0.5 m wide and have poor condition. Traffic is mixed with higher number of bicycles and pedestrians near built up area and commercial area.

7.6.2.1 Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**Center line is present on the intermediate lane section. Remaining section do not have any other road markings.**
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

7.6.2.2 Alignment-Sharp horizontal Curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 17:00 hrs to 18:00 hrs, from Patna to Bansuli. An average speed of 55 km/ hour and a maximum speed of 65 km/ hour is noted during this survey.

Curves having radius in the range of 100m were observed on the following locations:

40+100	41+400	43+950	44+050	44+300
44+800	44+950	45+050	45+500	45+800
45+850	45+950	46+300	47+100	47+500
49+950	51+400	52+050	55+950	61+400
61+700	61+850	62+950		

Sharp Curves on Project Road at Km 41+400 and Km 45+800

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed

- Potential run-off accidents
- Potential head-on collisions

Recommendations: Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate

Refer to Appendix III for guidelines on treatment on curves.

Reasons for concern: Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:
- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern: On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.

Recommendations: For delineation at all these sharp curves provide chevron signs.

Reasons for concern: On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.

Recommendations: Provide crash barriers on the outer edge on such curves.

Reason for concern **Series of Curve**

In a short distance many sharp curves are present and thus very dangerous

Recommendations: Provide continuous delineation on all curves

7.6.2.3 Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road				
41+500	41+500	47+700	51+350	54+900
57+100	60+500	60+500	63+400	64+700
Location of Side roads at skew with the major road				
42+900		45+800		56+900

Minor Junctions at Km 63+400

Skewed Side Road at Km 42+900 and Km 45+800

Concerns & Recommendations

Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on road are due to buildings on the corners.
Recommendations:	Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle.*
Reasons for concern:	**Poor delineation** No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:	Provide traffic signs and road markings pertaining to junction control. *Refer to Appendix III for guidelines on traffic signs and road markings at junctions*
Reasons for concern:	**High approach speeds** High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
Recommendations:	• Provide road humps on the side at junctions having history of accidents • Provide raised markings on the entry to the side road • Provide adequate warning signs on major road and side road *Refer to Appendix III for guidelines on traffic calming measures.*
Reasons for concern:	**Poor Geometry** It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
Recommendations:	Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. *Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.*

7.6.2.4 Major Junctions

A. 4-arm Uncontrolled Junction at Km 38+700

The salient features of this intersection are as follows:

- This junction is intersection of ODR and NH149
- High Accident prone zone
- No warning for NH ahead
- Significant two wheelers, pedestrians, cyclists are present on the junction.
- No traffic islands are present for safe and effective maneuver of traffic.
- Street light is not present on the junction.


Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to Appendix III for standard layouts of 4-arm junctions*
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead
Recommendations:	Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control
Reasons for concern:	**Provision for VRUs** Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	Provide wide shoulders/ footpaths for pedestrians to commute in the junctions without interfering with the motorized traffic

B. 3-arm Uncontrolled Junction at Km 48+900

The salient features of this intersection are as follows:

- This junction is intersection of ODR and ODR
- Significant two wheelers, pedestrians, cyclists are present on the junction.
- No traffic islands are present for safe and effective maneuver of traffic.

- Street light is not present on the junction.

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to Appendix III for standard layouts of 3-arm junctions*
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead
Recommendations:	Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control
Reasons for concern:	**Provision for VRUs** Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	Provide wide shoulders/ footpaths for pedestrians to commute in the junctions without interfering with the motorized traffic

C. 3-arm Uncontrolled Junction at Km 67+000

The salient features of this intersection are as follows:

- This junction is intersection of ODR and SH
- Significant two wheelers, pedestrians, cyclists are present on the junction.
- No traffic islands are present for safe and effective maneuver of traffic.
- Street light is not present on the junction.

Concerns & Recommendations	
Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to Appendix III for standard layouts of 3-arm junctions*
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in any of the arms of the junctions , the presence of which would have informed and warned the road user of the layout ahead
Recommendations:	Establish control in the junction by providing Give Way and Stop signs, edge markings and other road markings pertaining to junction control
Reasons for concern:	**Provision for VRUs** Significant presence of pedestrians and cyclists noted, but no provisions have been provided. Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	Provide wide shoulders/ footpaths for pedestrians to commute in the junctions without interfering with the motorized traffic

7.6.2.5 Approach to Bridges

Approach to bridge is found on following locations;

39+700	44+500	55+600	58+900

Salient features are-

- Curves approaches to major/minor bridges
- High embankment
- No approach protection
- Dangerous overtaking is observed
- No traffic signs are present on the road.


Absence of OHM on structure at Km 44+500 and submersible structure at Km 58+900

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix xxx for guidelines to treatments on approaches to bridges*
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets

7.6.2.6 Road Side Objects - Pond

Between chainage 61+400 and 61+500, pavement is on high embankment and pond is very near to pavement edge.

Concerns & Recommendations	
Reasons for concern:	Nearby pond on high embankment road is very dangerous for motorized vehicles during night as it is not visible and no warning is provided. It is vulnerable for pedestrians and cyclist.
Recommendations:	• Provide warning • Provide crash barrier on the side of road to protect vehicles falling in pond.

7.6.2.7 Road side Villages/ Built-up Areas (BUAs)

- In villages/ town wherever schools are present, warning sign "School Ahead" and "Slow" are not provided on either approaches.
- Significant pedestrians/ school children, cyclists, motorcycles are present.

Built up area at Km 67+000

Following locations have road side villages.

41+900 (Kantrapada Village)	42+000	43+000
48+000 (Jodichakar Village)	52+200	54+200
56+000 (Khurdapada Village)	59+400 (Vhmapada)	60+300 (Tangarpada Village)
64+000 (Patulia Village)		

Following sections can be classified as commercial areas.

67+000 (Patna Village)

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided
Recommendations:	• Provide Warning signs at before start and after the end of BUA • Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas • Provide 'SCHOOL AHEAD' and 'SLOW' signs on appropriate locations near schools *Refer to Appendix III for guidelines to implement a gateway effect on approaches to roadside villages and improve the road safety in zones near roadside villages*

CHAPTER 8

KORAPUT DISTRICT

8.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Koraput district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified in to various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Koraput district:

- Hazardous locations
- Hazardous road users/ user groups
- Predominant nature of crashes

8.1.2. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 8.1**. It can be seen from **Figure 8.1** that more fatalities and crashes occur in NHs in Koraput district followed by SHs.

It can be seen from **Figure 8.2** that length of other roads is more than the length of NHs and SHs put together in Koraput district. However, **Figure 8.1** indicates that fewer numbers of crashes and fatalities occur in other roads compared to NHs and SHs. Hence, it may be inferred that NHs and SHs are more prone to crashes than other low category roads. It is also observed that in other roads, number of fatalities is more than number of crashes. This means that in each crash occurring on other roads at least one fatality occurs in Koraput district.

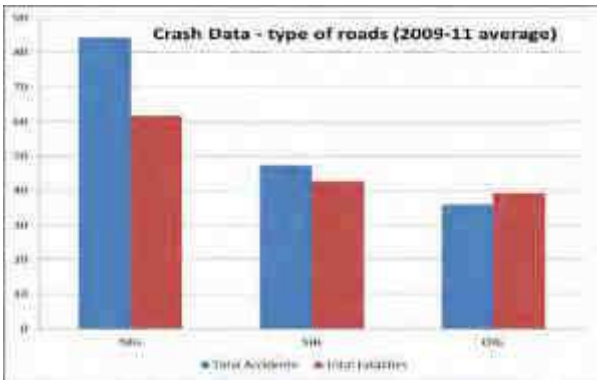


Figure 8.1: Crash data – Type of roads

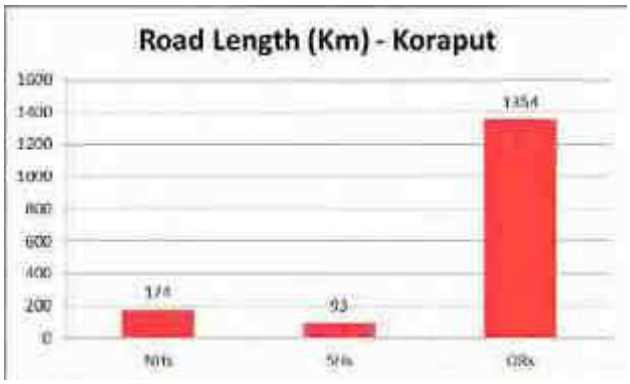


Figure 8.2: Road Network Length

The crash data classified on the basis of location type in Koraput district is shown in **Figure 8.3** below.

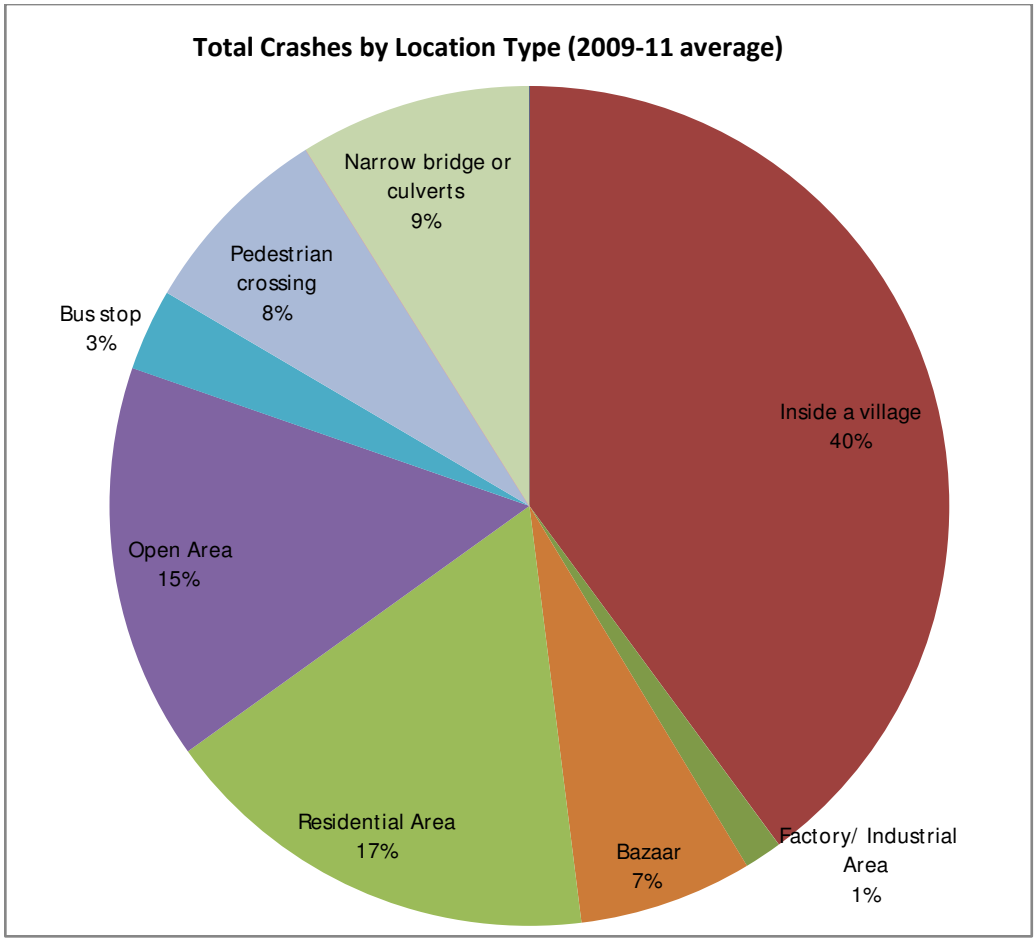


Figure 8.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 8.3** that 40% of crashes occur in 'inside village' in Koraput district followed by crashes around 'residential area' (17%), and 'open area' (15%). However, it is not clear from the above data that whether crashes in 'open area' or 'inside village' occur more in NHs or SHs. It may be inferred that majority of crashes might be occurring around populated area (almost 65%) where significant numbers of pedestrian, bicyclists and other slow moving vehicles are present.

From the above, only the following conclusions can be drawn for Koraput district:

- Maximum number of crashes and fatalities occur in NHs, whereas in each crash occurring on district roads at least one person is killed; and
- A significant number of crashes (almost 65%) occur around populated areas like inside village, bazaar, and residential area;
- In each crash occurring on district roads at least one fatality occurs.

8.1.3. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 8.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 8.5**.

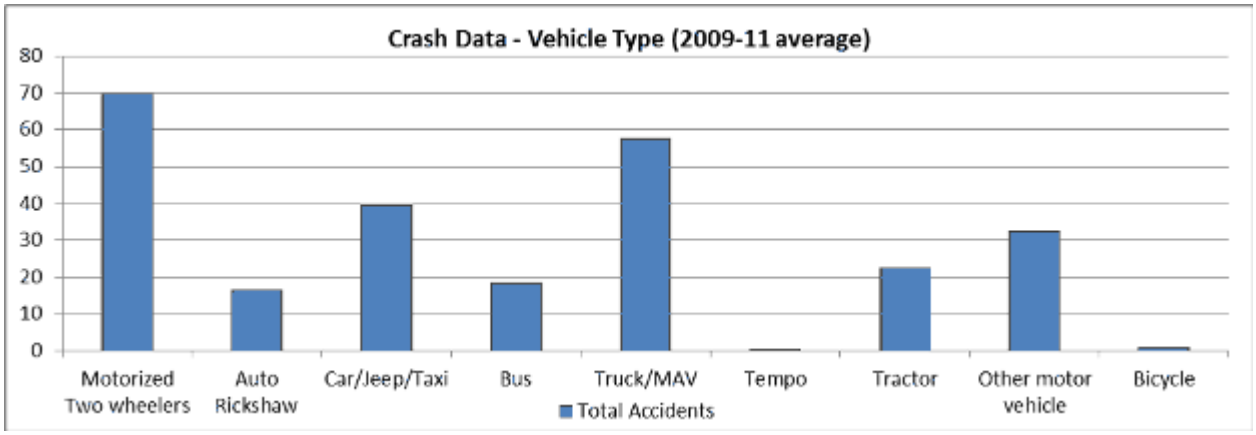


Figure 8.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 8.4**, it can be seen that motorized two wheelers are involved in maximum number of crashes (approximate 70) followed by trucks and cars. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

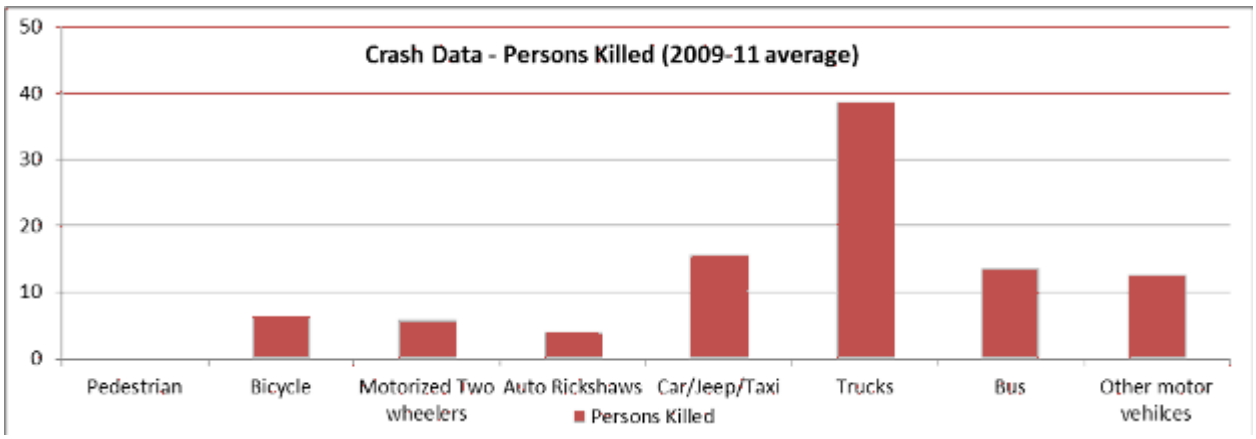


Figure 8.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 8.5**, it can be seen that maximum fatalities (approximate 40 lives) occur among the Truck users (both driver & passenger) followed by cars and buses. It can be seen from the above Figure that out of 60 crashes where trucks are involved, approximately 40 fatalities occur. This means, out of every 3 crashes involving trucks, two persons are getting killed. Similarly in case of buses, 15 fatalities occurred out of 20 crashes. However, from the available data, it is difficult to ascertain the locations/ road types, where the truck and bus users are at higher risk.

Further to analysis the nature of crashes occurred in Koraput district which may reveal a better correlation of crashes/ fatalities between type of vehicle and road category, the average number of crashes and fatalities based on type of collision are plotted as shown in **Figure 8.6**.

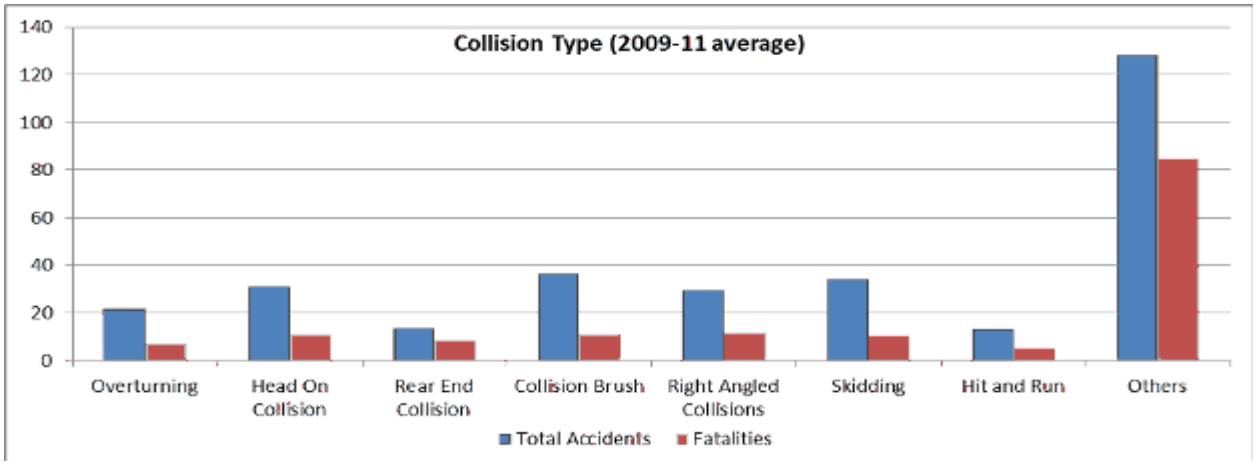


Figure 8.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 8.6** that predominant nature of crashes in Koraput district is under the category of 'others' (120 crashes). The type of collisions included in the category 'others' is not defined in the crash database. After the category of 'others', significant number of crashes and fatalities are reported under 'collision brush', 'right angle collision', 'head on collision', and 'skidding'. Considering the other nature of crashes mentioned in the charts, 'others' might include crashes like hit pedestrian, run-off accidents and hit road side objects.

It can be seen from the above figures that maximum number of crashes/ fatalities happens on NHs, motorcycles have a major share in crashes and the number one category of persons getting killed on roads in Koraput are truck driver and passengers.

From the above, though not supported by desirable detail of data, the following can be inferred for Koraput district:

- Cars and motorcycles are predominantly exposed to risk in SHs and other roads
- Majority of accidents occur on NHs, maximum share of fatalities is due to others, and most number of fatalities are among Truck drivers and passengers. Hence, this can be inferred that Koraput might have significant problems of trucks involving in run-off accidents or hot road side objects on NHs.
- According to the data, bicyclists and motorcyclists are exposed to risk in populated areas and may be categorized as vulnerable road users or vulnerable user groups as well.

8.1.4. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 8.7** and the corresponding figures for urban area is shown in **Figure 8.8**.

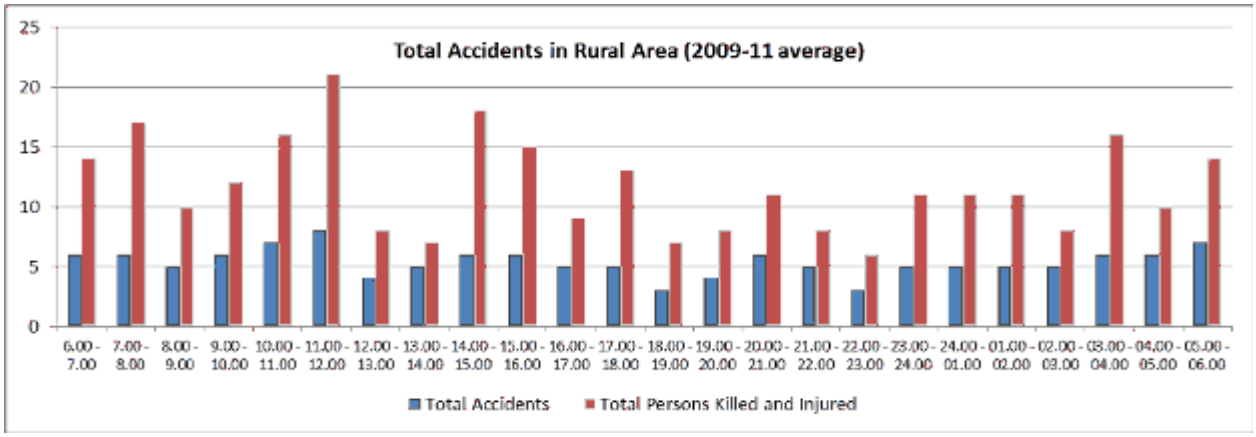


Figure 8.7: Total number of crashes in rural area (2009 – 11 average)

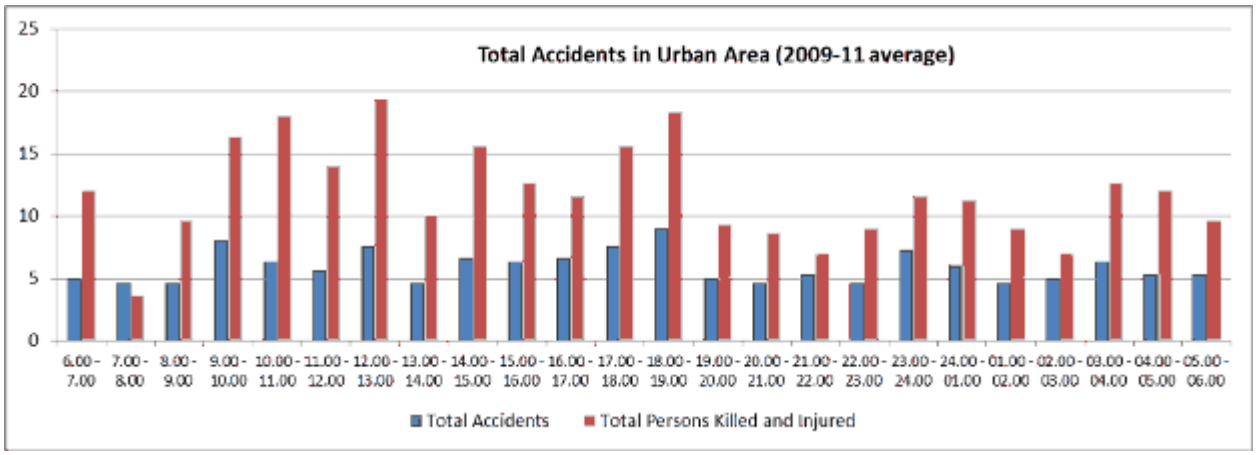


Figure 8.8: Total number of crashes in urban area (2009 – 11 average)

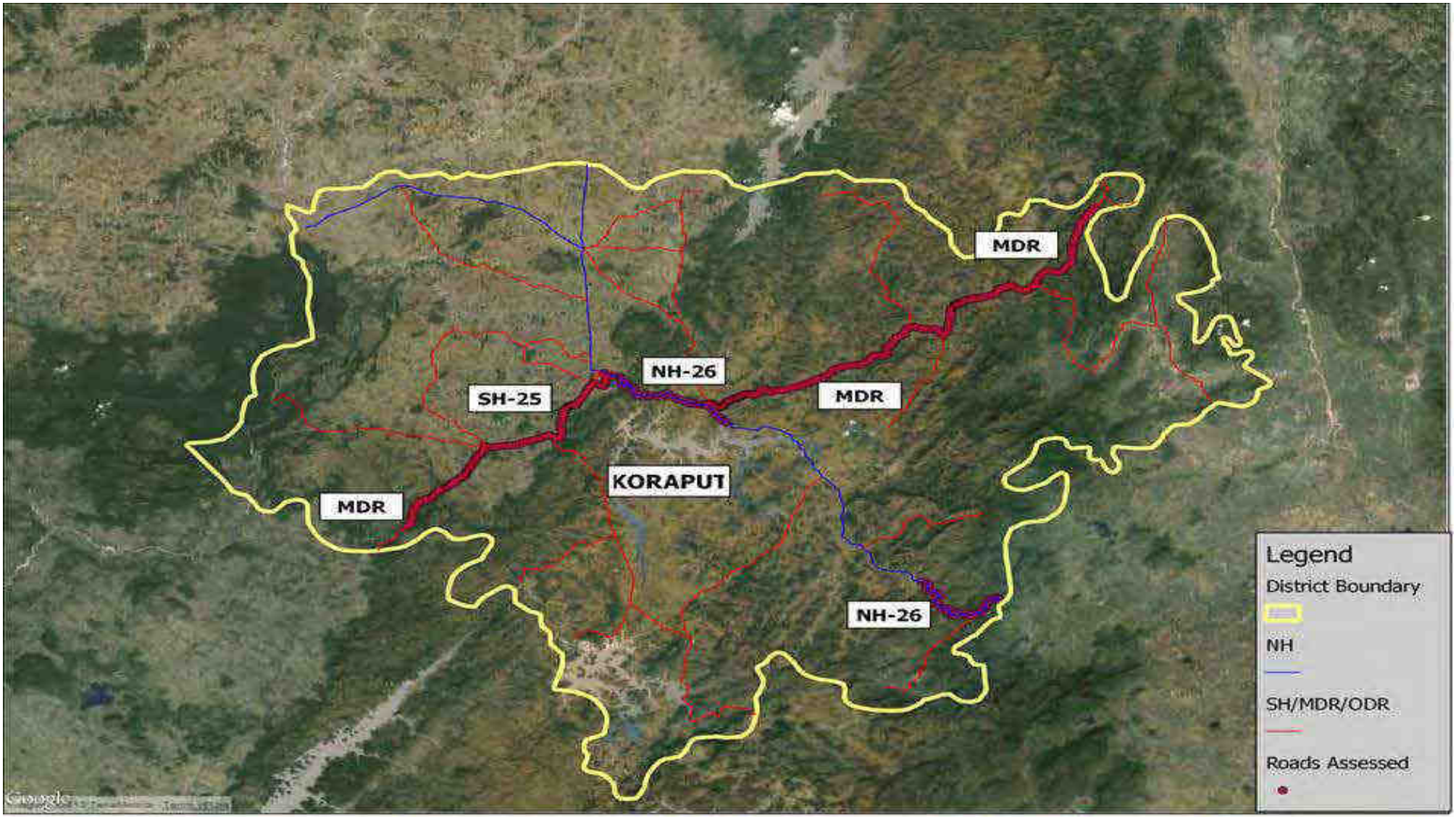
It can be seen in **Figure 8.7**and in **Figure 8.8** that the number of crashes, fatalities, and persons injured are almost uniform throughout the day with more crashes occurring during 09:00 to 18:00 hours. Also, the numbers of crashes and fatalities are increasing during early morning hours. The available data seems to be inconclusive to arrive at a correlation between the time of the day and crashes.

8.2. Location and details of audited roads

Road Name	From	To	Length
SH-25	Jeypore	Mahuli	18.16
MDR	Boipariguda	Malkangiri border	22.00
MDR	Koraput	Laxmipur (Ch. 43)	43.00
MDR	Laxmipur (Ch. 43+000)	Laxmipur-Raygada (Ch. 66+000)	23.00
OLD NH-43 (NEW NH-26)	Jaypore	Koraput	24.00
OLD NH-43 (NEW NH-26)	Pottangi	Andhra border	24.00
		Total	**154.16**

The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II**. The map showing roads assessed is shown in **Figure 8.9** below.

Figure 8.9: Map of Roads Assessed in Koraput District



8.3. RSA – National Highways

8.3.1. NH – 26: Jeypore - Koraput Section

This section of the National Highway from Jeypore to Koraput is an intermediate / two lane road in hilly terrain with earthen shoulder (less than 1 m – 2m) in fair condition.

The daytime visibility of the road / the availability of sight distances are good. Majority of the land use along the road are forests and agricultural. Hence there was hardly any traffic found on this stretch of road.

8.3.1.1. Delineation of the road

Ch: 390+500

Ch: 400+100

Concerns & Recommendations	
Reasons for concern:	**Centerline / edge line road markings are not provided in the some sections of the road section.**
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

8.3.1.2. Alignment – Sharp Horizontal Curves

Horizontal curves of radius less than 100m were observed at Km.380+400; 382+100; 382+350; 382+750; 382+900; 383+080; 388+320; 388+700; 389+250; 391+400; 392+700; 393+850; 397+100; 397+500; 398+900; 399+200; 399+700; 403+600.

Ch: 392+700

Ch: 397+100

Concerns & Recommendations	
Reasons for concern:	**Poor Delineation** No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

8.3.1.3. Alignment - Horizontal bend after a vertical crest

At Chainage 383+500 horizontal bend after a vertical crest is found.

Ch: 383+500

Concerns & Recommendations	
Reasons for Concern:	**Insufficient sight distance** The sight distance on a vertical crest is limited in day light and even less in night

time. The presence of a horizontal bend after a vertical crest decreases the sight distance available further for the driver to react and could be a potential unsafe location. The vertical deflection of the alignment prevents the road user from being prepared to maneuver required to negotiate the curve and could lead to run off accidents.

Recommendations **Desirable**: The presence of advance warning signs, no overtaking pavement markings and guard posts on the inner side of the curve for delineation.

8.3.1.4. Alignment - Reverse Curves

At following locations reverse curves are found:

- 380+300
- 380+800
- 387+000
- 396+800

Ch: 396+800

Ch: 387+000

Concerns & Recommendations

Reasons for Concern: **Successive changes of horizontal elevation**

The change of horizontal elevation of the alignment because of two successive curves may sometime lead a speeding errant vehicle to a run – off accident.

Recommendations The provision of guard posts along the points of maximum curvature of the two curves and continuous warning signs/ chevron signs to warn the road user.

8.3.1.5. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 380+050; 380+400; 380+750; 381+250;382+750; 382+800; 382+850; 384+100; 388+250; 389+900; 391+000; 397+100; 399+800; 400+100; 401+300; 401+400; 401+900; 402+000

Location of Side roads at skew with the major road

Km 391+900; 400+500; 400+700; 402+300; 402+600

Ch: 383+400

Ch: 383+850

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for the desired geometric arrangement for T-junctions.

8.3.1.6. Major Junctions

A major junction at chainage 401+100 is found.

Ch: 401+100

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to Appendix III for standard layout of 3-arm junctions

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm junction

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction.

Reasons for concern:

Provision for VRUs

- Shoulder spaces in the junction area are encroached by commercial establishments.
- No provision for crossing by pedestrians/bicycles despite of significant presence of pedestrians and bicyclists.

Recommendations:

- Remove encroachments from the shoulder space.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.

Reasons for concern:

On-street Parking

- No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space, hampering visibility.
- This forces pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations:
- Provide designated parking spaces for commercial vehicles

8.3.1.7. Approach to Bridge at high embankment

In the existing situation, there are two approaches of bridges/ culverts along this road.

- 383+500
- 389+600

Ch: 383+500

Ch: 389+600

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

8.3.1.8. Roadside Hazards - Trees, Poles, and Buildings

In the existing situation, there are road side objects like electricity poles, pool, trees and parapets of bridges / culverts along the road, which could pose as a road safety hazard.

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

Ch: 390+600

Ch: 380+500

8.3.1.9. Road side Villages/ Built-up Areas (BUA)

On the project road, at following locations road side villages/ BUAs are found.

- 381+500
- 402+100

Ch: 381+500

Ch: 402+100

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the

junction
- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:
- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide pedestrian crossings, wherever deemed necessary
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.
- Provide appropriate warning signs various hazards encountered inside the roadside village
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for treatment options in roadside villages/built-up areas.

8.3.1.10. Vertical Sag Curves / Depressed Causeways

At chainage 384+500 vertical Sag curve is found.

Ch: 384+500

Concerns & Recommendations

Reasons for Concern:

Simultaneous change in horizontal and vertical elevation

The abrupt change of horizontal and vertical alignment may be difficult to

negotiate for an errant vehicle and lead to unsafe condition.

Recommendations The provision of retro – reflective guard posts along the entire sag curve with provisions of advanced warning signs and pavement markings to delineate the center and edge line of the road.

8.3.1.11. Specific Locations

There is no specific location identified by OWD / Police with accident history.

8.3.2. NH – 26: Sunkhi Ghat Section (Pottangi – Andhra Border Rd)

This section of National Highway from Pottangi to Andhra Border is a two lane road in hilly terrain with earthen shoulder (less than 1 m width).

The daytime visibility of the road / the availability of sight distances are good. Majority of the land use along the road are agricultural and small habitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic.

It may be noted that the Chainages of the new NH-26 are being revised as the old NH-43 are being replaced. The conversion is NH-26 + 38.52 = NH – 43 chainage.

8.3.2.1. Delineation of the road

Ch: 472+500

Ch: 464+000

Concerns & Recommendations	
Reasons for concern:	**Centerline / edge line road markings are not provided in the some sections of the road section.**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

8.3.2.2. Alignment – Sharp Horizontal Curves

Horizontal curves of radius less than 100m were observed at significant number of location along the project road.

Ch:457+000

Ch:464+000

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

8.3.2.3. Alignment - Horizontal bend after a vertical crest

In the existing situation, there are many instances of horizontal bends after a vertical crest at 453+000 – 454+000 (4).


Ch: 453+000 - 454+000

Concerns & Recommendations

Reasons for Concern:	**Insufficient sight distance** The sight distance on a vertical crest is limited in day light and even less in night time. The presence of a horizontal bend after a vertical crest decreases the sight distance available further for the driver to react and could be a potential unsafe location. The vertical deflection of the alignment prevents the road user from being prepared to maneuver required to negotiate the curve and could lead to run off accidents.
Recommendations	**Desirable**: The presence of advance warning signs, no overtaking pavement markings and guard posts on the inner side of the curve for delineation.

8.3.2.4. Alignment - Reverse Curves

In the existing situation, there are two reverse curves along the road at Chainages, Ch: 433+500 & 452+000.


Ch: 433+500

Ch: 452+000

Concerns & Recommendations	
Reasons for Concern:	**Successive changes of horizontal elevation** The change of horizontal elevation of the alignment because of two successive curves may sometime lead a speeding errant vehicle to a run – off accident.
Recommendations	The provision of guard posts along the points of maximum curvature of the two curves.

8.3.2.5. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 449+650; 455+800; 467+000

Location of Side roads at skew with the major road

Km 455+830; 462+000

Ch: 462+000

Ch: 455+830

Concerns & Recommendations	
Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern: **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern: **High approach speeds**

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

8.3.2.6. Approach to Bridge at high embankment

In the existing situation, there is only one approach to bridge / culvert at Ch: 466+500, which is unsafe.

Ch:466+500

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major juries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

8.3.2.7. Roadside Hazards - Trees, Poles, and Buildings

Road side objects like electricity poles, pool, trees are found at significant number of location on the project road.

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

8.3.2.8. Road side Villages/ Built-up Areas (BUA)

In the existing situation, there are two road side villages at Ch: 455+400 & 466+600.

Ch: 455+400

Ch: 466+600

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide pedestrian crossings, wherever deemed necessary
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.
- Provide appropriate warning signs various hazards encountered inside the roadside village
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for treatment options in roadside villages/built-up areas.

8.3.2.9. Specific Locations

There is no specific location identified by OWD / Police, which is having accident history.

8.4. RSA – State Highways

8.4.1. SH-25: Jeypore - Mahuli Section

This section of state highway from Jeypore to Mahuli is a single lane road with in rolling terrain with earthen shoulder (more than 1m) in good / fair condition.

Majority of the land use along the road are agricultural and small habitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic.

8.4.1.1. Delineation of the road

Ch: 3+700

Ch: 10+300

Concerns & Recommendations	
Reasons for concern:	**Edge line road markings is not providedon the project road.**
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

8.4.1.2. Alignment – Sharp Horizontal Curves

Horizontal curves of radius less than 250m were observed at Km. 2+160; 3+700; 5+700; 6+600; 7+700; 8+400; 8+900; 9+600; 11+000; 11+390; 12+200

Ch: 2+160

Ch: 11+390

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

8.4.1.3. Alignment - Horizontal bend after a vertical crest

The horizontal bend after a vertical crest were observed at the following chainages:

- 10+000
- 11+000
- 11+650

Ch: 10+000

Ch: 11+650

Concerns & Recommendations

Reasons for Concern:

Insufficient sight distance

The sight distance on a vertical crest is limited in day light and even less in night time. The presence of a horizontal bend after a vertical crest decreases the sight distance available further for the driver to react and could be a potential unsafe location. The vertical deflection of the alignment prevents the road user from being prepared to maneuver required to negotiate the curve and could lead to run off accidents.

Recommendations

Desirable: The presence of advance warning signs, no overtaking pavement markings and guard posts on the inner side of the curve for delineation.

8.4.1.4. Alignment - Reverse Curves

In the existing situation, there are three instances of reverse curves along the road at the following Chainages.

- 4+800
- 11+300
- 12+200

Ch: 4+800

Ch: 11+300

Concerns & Recommendations

Reasons for Concern:

Successive changes of horizontal elevation

The change of horizontal elevation of the alignment because of two successive

curves may sometime lead a speeding errant vehicle to a run – off accident.

Recommendations The provision of guard posts along the points of maximum curvature of the two curves and provide continuous warning signs and chevron signs to warn road users.

8.4.1.5. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 2+160; 3+350; 3+400; 3+500; 3+550; 3+600; 6+700; 7+100; 8+200; 8+800; 9+900; 10+000; 10+700; 13+600; 13+900

Location of Side roads at skew with the major road

Km 1+300; 1+350; 4+550; 4+800; 5+500; 5+800; 13+950; 14+300; 14+390; 15+200

Ch: 1+300

Ch: 4+850

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern: **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on on traffic signs and road markings at junctions

Reasons for concern: **High approach speeds**

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines traffic calming measures.

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

8.4.1.6. Major Junctions

In the existing situation, there is one major junction along this road at Ch: 3+700.

Ch: 3+700

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to the Appendix III for guideline to standard layout of 3-arm junctions.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction

Reasons for concern:

Provision for VRUs

- Shoulder spaces in the intersection area are encroached by commercial establishments.

Recommendations:

- Remove encroachments from the footpaths.
- Provide well maintained 2m wide shoulders at junction zone free of encroachments.

Refer to Appendix III for guidelines for safe treatments in roadside villages

8.4.1.7. Approach to Bridge at high embankment

The unprotected bridge approaches of two minor bridges present along the road at the chainages shown below:

- 4+700
- 7+500

Ch: 4+700

Ch: 7+500

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

8.4.1.8. Roadside Hazards - Trees, Poles, and Buildings

Along the road, there aresignificant number of location where road side objects like electricity poles, signs, trees were present.

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips • Remove encroachments on at least 2m from the road edge

8.4.1.9. Road side Villages/ Built-up Areas (BUA)

At following locations road side villages/ BUAs are found.

- 3+700
- 4+800
- 5+700
- 9+000

Ch: 3+700

Ch: 5+700

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided
Recommendations:	• Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages. • Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas • Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools • Provide appropriate warning signs various hazards encountered inside the roadside village • Provide adequate traffic calming measures • Provision of 2 m wide clear shoulder free of obstructions/ encroachments to segregate the pedestrian traffic. *Refer to Appendix III for guidelines for treatment options in roadside villages/built-up areas.*

8.4.1.10. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

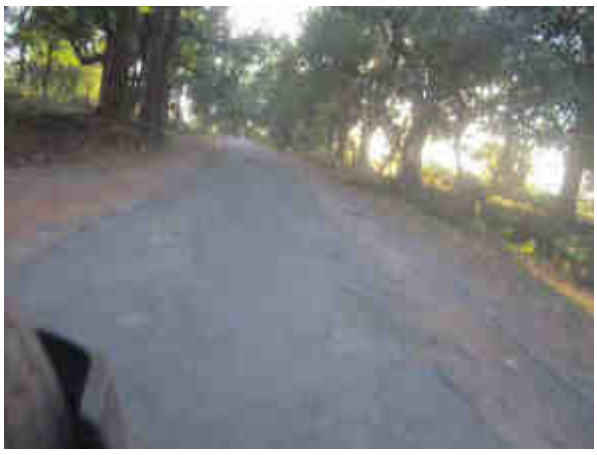
8.5. RSA – Major District Road

8.5.1. MDR: Boipariguda - Malkangiri Section

This section of the Major District Road from Boipariguda to Malkangiri is a single / intermediate / two lane roads in hilly terrain with earthen shoulder (less than 1 m width).

Majority of the land use along the road are forests. There is hardly any traffic found on the road during the survey.

8.5.1.1. Delineation of the road



Concerns & Recommendations	
Reasons for concern:	**Centerline / edge line road markings are not provided on the road.**
Recommendations:	• Provide centre line with thermoplastic material on intermediate lane and two lane road (refer to IRC: 35-1997 for details). • Provide edge line throughout the road. • Provide edge and centre line RRPMs on sharp curves

8.5.1.2. Alignment – Sharp Horizontal Curves

Horizontal curves of radius less than 150m were observed at significant number of location along the road.

Ch: 41+700

Ch: 39+700

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs and delineators** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

8.5.1.3. Alignment - Horizontal bend after a vertical crest

The following are the chainages of the instances of the horizontal bend after a vertical crest:

- 40+500
- 40+900

Ch: 40+900

Ch:40+500

Concerns & Recommendations	
Reasons for Concern:	**Insufficient sight distance** The sight distance on a vertical crest is limited in day light and even less in night time. The presence of a horizontal bend after a vertical crest decreases the sight

distance available further for the driver to react and could be a potential unsafe location. The vertical deflection of the alignment prevents the road user from being prepared to maneuver required to negotiate the curve and could lead to run off accidents.

Recommendations **Desirable**: The presence of advance warning signs, no overtaking pavement markings and guard posts on the inner side of the curve for delineation.

8.5.1.4. Alignment - Reverse Curves

In the existing situation, there are two reverse curves located along the road at the chainages:

- 37+300
- 41+500

Ch: 37+300

Ch: 41+500

Concerns & Recommendations

Reasons for Concern: **Successive changes of horizontal elevation**

The change of horizontal elevation of the alignment because of two successive curves may sometime lead a speeding errant vehicle to a run – off accident.

Recommendations The provision of guard posts along the points of maximum curvature of the two curves and provide continuous chevron signs along the curves.

8.5.1.5. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 26+400; 27+800; 29+700; 29+800

Location of Side roads at skew with the major road

Km 26+900;

Ch: 29+700

Ch: 26+900

Concerns & Recommendations	
Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to • Encroachments at Junctions • Overgrown vegetation or presence of trees • Poor layout of the side roads.
Recommendations:	• Improve visibility by clearing vegetation; • Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle.*
Reasons for concern:	**Poor delineation** • No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	Provide traffic signs and road markings pertaining to junction control *Refer to Appendix III for guidelines on traffic signs and road markings at junctions*
Reasons for concern:	**High approach speeds** • High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
Recommendations:	• Provide road humps on the side road at junctions having history of accidents • Provide raised markings on the entry to the side road

- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

8.5.1.6. Approach to Bridge at high embankment

The unprotected bridge approaches of two minor bridges present along the road at the chainages shown below:

- 26+700
- 41+400

Ch: 26+700

Ch: 41+400

Concerns & Recommendations

Reasons for concern: **Unprotected high embankment**

If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

8.5.1.7. Specific Locations

No specific location has been identified by OWD / Police as a black spot location. The Police Official described the occurrence of accidents more prominent in hilly terrain and reason of occurrence to be random than that, which could be attributed to a pattern.

8.5.2. Koraput – Laxmipur Rd/ MDR & Koraput - Laxmipur Section

This section of the Major District Road from Koraput – Laxmipur is a single / intermediate / two lane road in rolling terrain with earthen shoulder (less than 1 m width).

Majority of the stretches of the road is in high embankment with provisions of minor bridges / causeways / culverts. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic. Spot Speed Survey at a random location reveal that speed varies from 17 KMPH to 49 KMPH, while the 85th percentile speed is appx 45 KMPH.

8.5.2.1. Delineation of the road

Ch: 18+000

Ch: 38+100

Concerns & Recommendations	
Reasons for concern:	**Centerline / edge line road markings are not provided on the road.**
Recommendations:	• Provide edge line with thermoplastic material throughout the road. • Provide centre line with thermoplastic material on intermediate lane and two lane road (refer to IRC: 35-1997 for details). • Provide edge and centre line RRPMs on sharp curves

8.5.2.2. Alignment – Sharp Horizontal Curves

Horizontal curves of radius less than 100m were observed at Km. 0+650; 1+500; 1+850; 2+800; 3+400; 3+600; 4+100; 4+300; 5+580; 6+600; 7+140; 7+880; 8+100; 8+260; 9+020; 9+500; 10+250; 11+920; 12+200; 16+250; 16+800; 20+600; 21+700; 22+900; 23+300; 23+500; 23+950; 24+600; 24+900; 25+100; 25+500; 25+800; 27+500; 28+300; 28+650; 28+750; 30+100; 30+850+ 31+250; 31+450; 32+300; 36+850; 37+150; 38+800; 42+400; 44+300; 44+550; 44+900;

Ch: 1+500

Ch: 38+800

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs and delineators** as appropriate *Refer to Appendix III for guidelines on treatment at curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

8.5.2.3. Alignment - Horizontal bend after a vertical crest

The following are the chainages of the instances of the horizontal bend after a vertical crest:

- 0+650
- 1+500
- 3+400
- 3+600
- 4+640
- 15+500
- 30+000
- 49+500

Ch: 1+500

Ch: 30+000

Concerns & Recommendations

Reasons for Concern:	**Insufficient sight distance** The sight distance on a vertical crest is limited in day light and even less in night time. The presence of a horizontal bend after a vertical crest decreases the sight distance available further for the driver to react and could be a potential unsafe location. The vertical deflection of the alignment prevents the road user from being prepared to maneuver required to negotiate the curve and could lead to run off accidents.
Recommendations	**Desirable**: The presence of advance warning signs, no overtaking pavement markings and guard posts on the inner side of the curve for delineation.

8.5.2.4. Alignment - Reverse Curves

Reverse curve is found at following locations:

- 9+500
- 11+500
- 16+500
- 22+100
- 22+300
- 24+200
- 25+500
- 45+000
- 46+500
- 48+500
- 49+600
- 53+100
- 53+600
- 61+500

Ch: 11+500

Ch: 45+000

Concerns & Recommendations	
Reasons for Concern:	**Successive changes of horizontal elevation** The change of horizontal elevation of the alignment because of two successive curves may sometime lead a speeding errant vehicle to a run – off accident.
Recommendations	The provision of guard posts along the points of maximum curvature of the two curves and provide chevron signs throughout the curves.

8.5.2.5. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 0+500; 0+700; 1+000; 1+100; 2+150; 2+350; 2+950; 5+900; 6+100; 12+800; 14+800; 18+900; 22+030; 25+900; 32+400; 35+950; 36+700; 38+900; 50+000; 61+050; 63+000

Location of Side roads at skew with the major road

Km 0+600; 2+600; 4+800; 8+000; 13+700; 13+750; 17+800; 29+200; 33+500; 39+100; 42+900; 44+000; 56+100; 57+100; 57+250; 57+400; 60+500; 60+550; 60+700

Ch: 0+900

Ch: 32+400

Concerns & Recommendations

Reasons for concern: **Inadequate Visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern: **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

8.5.2.6. Major Junctions

In the existing situation, there are two major junctions along this road at the following Chainages,

- 0+000
- 57+300

Ch: 0+000

Ch: 57+300

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to Appendix III for standard layout of 3-arm junctions

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction.

Reasons for concern:

Provision for VRUs

- Shoulder spaces in the intersection area are encroached by the commercial establishments.

Recommendations:

- Remove encroachments from the shoulder space.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.

8.5.2.7. Approach to Bridge at high embankment

In the existing situation, the following are the chainages of unprotected approaches of bridge / culvert along this road which are vulnerable to accidents.

- 2+700
- 5+840
- 14+700
- 21+500
- 30+000
- 32+000
- 33+500
- 42+500
- 61+500
-

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

8.5.2.8. Roadside Hazards - Trees, Poles, and Buildings

Along the road there are many road size hazards like trees and street light poles were present.

Ch: 2+900

Ch: 42+500

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

8.5.2.9. Road side Villages/ Built-up Areas (BUA)

There are a number of road side villages / built – up areas along the road, which are tabulated below:

- 0+300
- 0+500
- 2+600
- 8+000
- 13+700
- 22+030
- 25+900
- 29+200
- 32+400
- 33+500
- 36+700
- 46+250
- 58+000
- 60+500
- 61+050

Ch: 0+300

Ch: 0+500

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided

Recommendations:

- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide appropriate warning signs various hazards encountered inside the roadside village
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for treatment options in roadside villages/built-up areas.

8.5.2.10. Vertical Sag Curves / Depressed Causeways

- 30+000
- 44+000
- 51+000
- 60+000
- 61+500

Ch: 44+000

Ch: 60+000

Concerns & Recommendations

Reasons for Concern:

Simultaneous change in horizontal and vertical alignment

The abrupt change of horizontal and vertical alignment may be difficult to negotiate for an errant vehicle and lead to unsafe condition.

Recommendations

The provision of retro – reflective guard posts along the entire sag curve with provisions of advanced warning signs and pavement markings to delineate the center and edge line of the road.

8.5.2.11. Specific Locations

It was pointed out by OWD that the stretch of 1 km road from Ch: 64+000 – Ch: 65+0000 is the location of many accidents. After the reconnaissance, it was found that there are thirteen (13) curves in this stretch of

1 km with varying gradient and sharp curves. It was also found that there is end protection on the valley side of the road and some accident impact traces were found on the hill side of the road.




Ch: 64+300 – 64+500

Concerns & Recommendations

Reasons for Concern:

Quick rate of change of horizontal and vertical alignment without delineation.

The change of horizontal alignment because of the presence of 13 sharp curves within a distance of 1 km has created a factor of fatigue in the driver's psyche. The lack of forgiving crash protection on the valley and hill side to absorb the impact of the erring vehicle has aggravated the problem. Since the road is passing through the reserve forest, additional right-of-way is not being provided to widen the road or straighten the curves.

Recommendations

The provision of forgiving crash protection on both sides of the road and advanced warning signs of the situation of the road to the road user.

CHAPTER 9

MAYURBHANJ DISTRICT

9.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Mayurbhanj district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified into various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of the driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Mayurbhanj district:

- Hazardous locations
- Hazardous road users/ user groups
- Predominant nature of crashes

9.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 is shown in **Figure 9.1**which reveals that maximum fatalities and crashes occur on NHs followed by SHs.

The length of road network comprising of NHs, SHs and other roads in Mayurbhanj district is shown in **Figure 9.2**. It shows that the combined length of other roads (MDRs, ODRs and rural roads) is more than the lengths of NHs and SHs in the district. The number of crashes and fatalities occurring on the above mentioned road categories are inversely proportional to respective road lengths. It can be seen that the NHs (length less than both the SHs and district roads) are more accident-prone compared to the other two road categories in Mayurbhanj district.

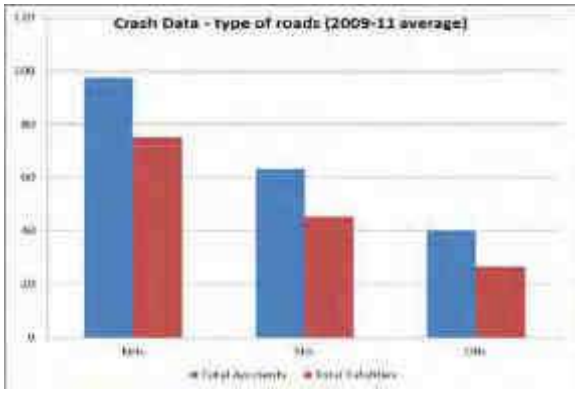


Figure 9.1: Crash data – Type of roads

Figure 9.2: Road Network Length – MayurbhanjDist

The crash data classified on the basis of location type in Mayurbhanj district is shown in **Figure 9.3** below.

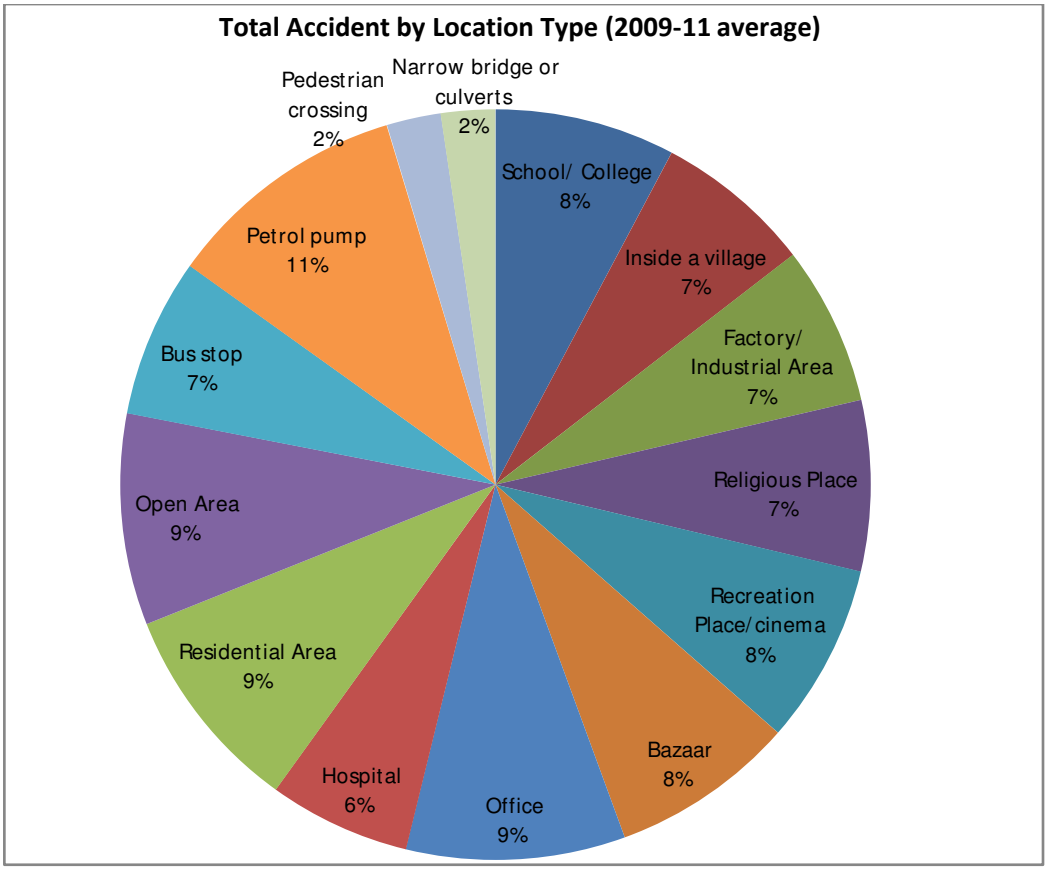


Figure 9.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 9.3** that the number of crashes is more or less equally distributed among various location types. It may be inferred that majority of crashes occur around populated areas (>60%) where significant numbers of pedestrians, bicyclists and other slow moving vehicles are present.

9.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 9.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 9.5**.

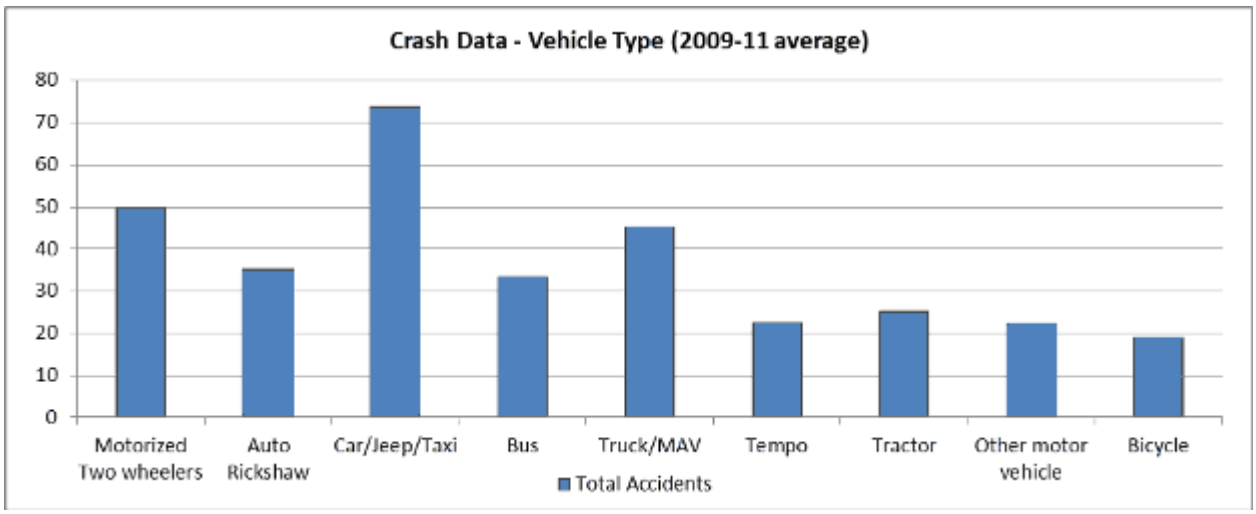


Figure 9.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 9.4,** it can be seen that cars are involved in maximum number of crashes (approximate 70) followed by motorized two wheelers and other vehicle types. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

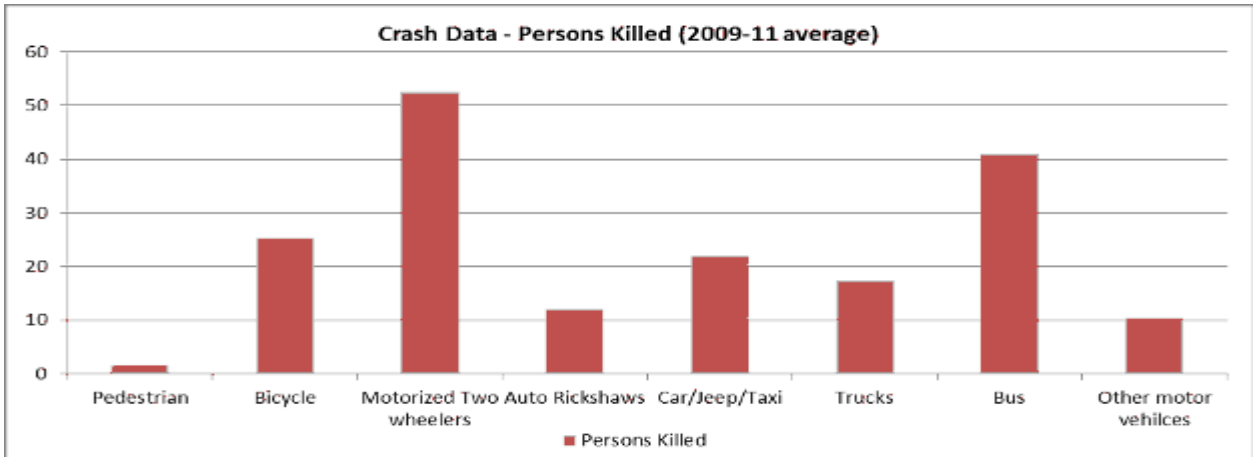


Figure 9.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 9.5** it can be seen that maximum fatalities (approximate 50 lives) occur among the motorized two wheeler riders followed by bus passengers, bicycles and remaining road user types.

It is interesting to note that buses are involved in fewer crashes (approximate 30), but higher number of fatalities (approximate 40). This may be due to the fact that buses carry more number of passengers, and single crashes might be leading to multiple fatalities.

It can be seen from **Figures 9.4 and 9.5** that out of 50 crashes where motorcycles are involved, approximately 50 fatalities occur. This means, in each crash involving motorcycles, one person is getting killed. This is significant since approximately 78 percent of motor vehicles registered in Mayurbhanj district are motorcycles. However, from the available data, it is difficult to ascertain the locations/ road types, where the motorcyclists are at higher risk.

Further to analysis the nature of crashes occurred in Mayurbhanj district which may reveal a better correlation of crashes/ fatalities between type of vehicle and road category, the average number of crashes and fatalities based on type of collision are plotted as shown in **Figure 9.6.**

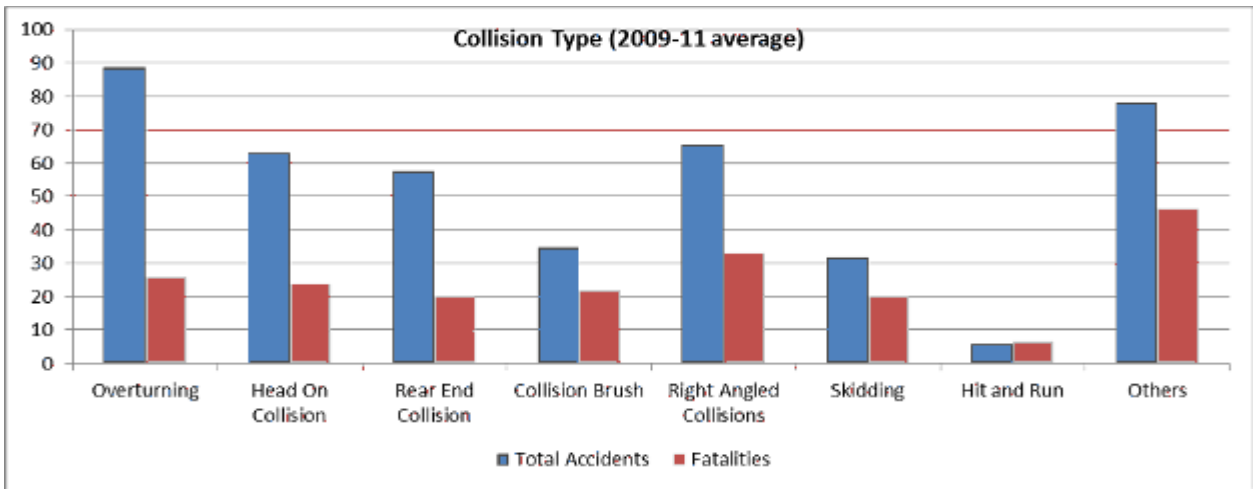


Figure 9.6 Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 9.6** that predominant nature of crashes in Mayurbhanj district are 'overturning' of vehicles (90 crashes) followed by 'Others'. Crashes reported under 'head on', 'rear end', and 'right angle' collision are also significant.

It can be seen from the above figures that maximum number of crashes/ fatalities happens on NHs, cars have a major share in crashes and the number one category of persons getting killed on roads in Mayurbhanj are motorized two wheeler riders, and the predominant nature of crashes are overturning of vehicles.

9.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 9.7** and the corresponding figures for urban area is shown in **Figure 9.8**.

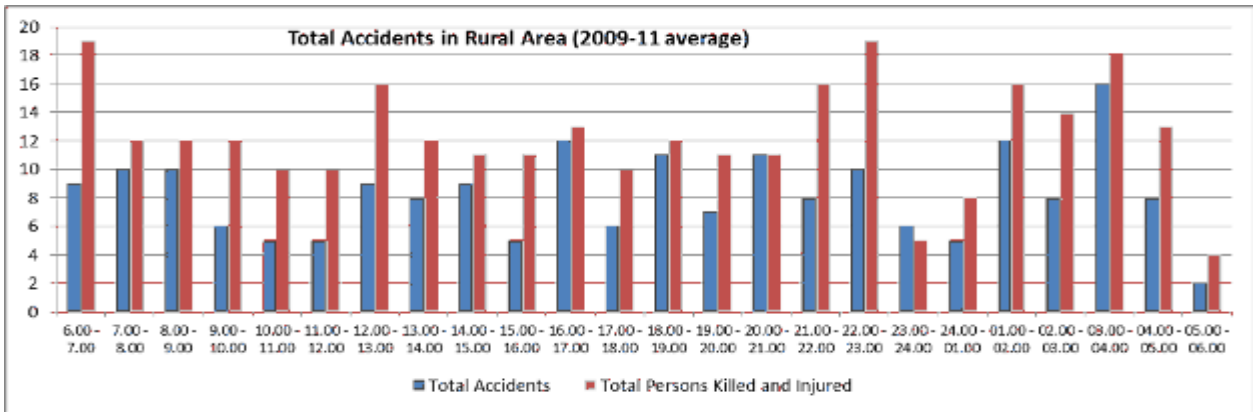


Figure 9.7: Total number of crashes in rural area (2009 – 11 average)

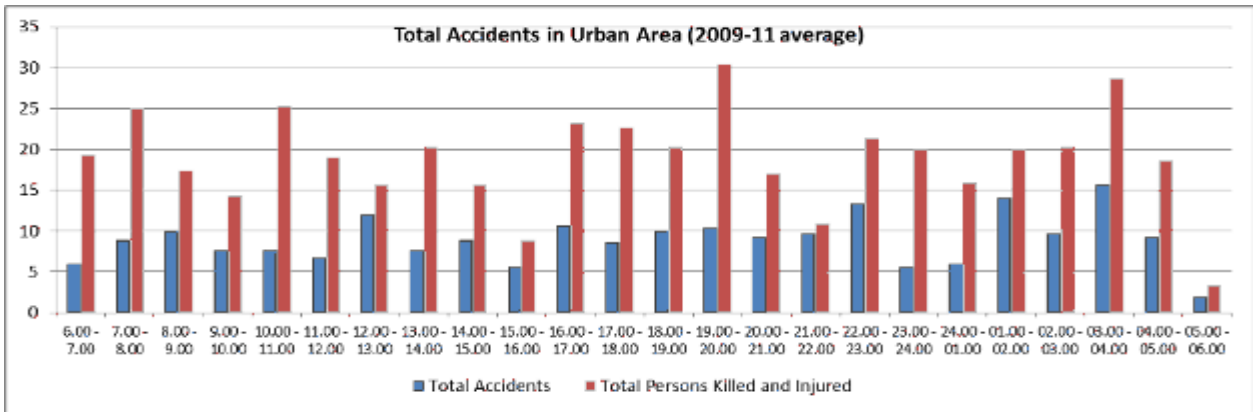


Figure 9.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 9.7** and **Figure 9.8** that the number of crashes, fatalities, and persons injured are almost uniform throughout the day with several spikes. There are significant numbers of crashes recorded during night hours which is not logical and the data seems to be inconclusive to arrive at a correlation between the time of the day and crashes.

9.2. Location and details of audited roads

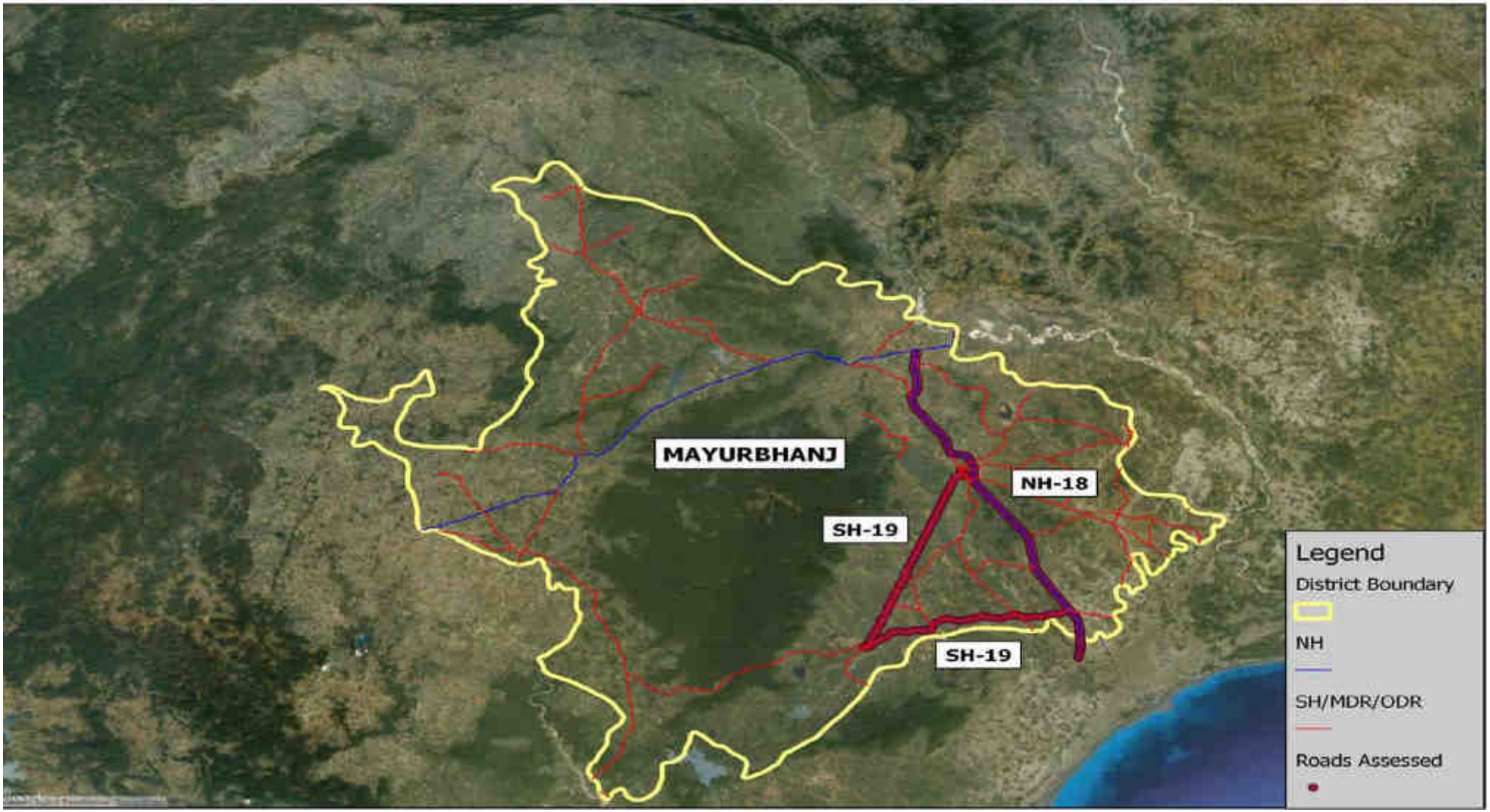
The road safety assessment was carried out on the road links shown in **Table 9.1.**

Table 9.1: List of roads audited in Mayurbhanj District

Sl No.	Road Name	From	To	Length
1	NH-18	Naharpatna	Jharkhoparia (NH 49 Junction / Bombay Chhak)	80.44
2	SH-19	Baripada	Udala	46.00
3	SH-19	Udala	Rupsa	40.00
			Total	**166.44**

The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.** The map of roads assessed in Mayurbhanj district is shown in **Fig. 9.9** below.

Figure 9.9: Roads Assessed in Mayurbhanj District



9.3. RSA – National Highways

9.3.1. NH-18: Neharpatna - Jharkhoparia Section

This section of the national highway from Neharpatna to Jharkhoparia is a bituminous two lane road in plain terrain with earthen shoulder (upto 2m width) in good / fair condition.

Majority of the land use along the road are agricultural and small habitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic. Spot Speed Survey at a random location along this road revealed that the speed varies from 40 KMPH to 90 KMPH, while the 85th percentile speed is around 72 KMPH.

9.3.1.1. Delineation of the road

0+500

Ch: 72+000

Concerns & Recommendations	
Reasons for concern:	Centerline / edge line road markings are absent in some of the sections of the project road, the presence of which should have delineated the road, particularly during night conditions
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

9.3.1.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 200 m were observed at Chainages: 0+950; 1+750; 2+300; 3+750; 6+210; 7+570; 9+500; 10+150; 11+100; 22+700; 51+550; 71+700; 73+500

Ch: 29+000

Ch: 22+700

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

9.3.1.3. Alignment - Horizontal bend after a vertical crest

In the existing situation, there is one instance of horizontal bends occurring after a vertical crest at Chainage, Ch: 29+000.

Ch: 29+000

Concerns & Recommendations	
Reasons for Concern:	**Insufficient sight distance** The sight distance on a vertical crest is limited in day light and even less in night time. The presence of a horizontal bend after a vertical crest decreases the sight distance available further for the driver to react and could be a potential unsafe location.
Recommendations	• The presence of advance warning signs, no overtaking pavement markings and guard posts 100 m from the approach. *Refer to Appendix III for guidelines on treatment of curves.*

9.3.1.4. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road
Km. 1+400; 3+400; 4+264; 7+250; 9+578; 9+700; 10+600; 11+150; 14+300; 16+600; 19+050; 22+500; 25+200; 30+700; 32+800; 33+200; 33+700; 33+800; 36+100; 38+900; 40+100;

Location of Side roads at skew with the major road
Km. 4+300; 10+200; 10+300; 13+550; 13+600; 27+334; 29+000; 31+100; 31+200; 31+700; 40+800; 41+200; 42+400; 43+300; 44+800; 45+600; 45+800; 47+700; 50+200; 52+500; 53+700; 55+900; 56+669; 57+980; 57+363; 57+541; 57+729; 57+934; 58+003; 59+640; 61+359; 61+592; 62+068; 63+229; 65+439; 68+063; 69+210; 69+450; 70+218; 70+680; 70+715; 71+752; 71+935; 73+003; 74+419; 76+129; 76+363;

Ch: 73+000

Ch: 62+068

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidance on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in **right angle collision** with vehicles coming from the major road leading to serious

injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

9.3.1.5. Major Junctions

In the existing situation, the following are the chainages of the four major junctions:

- 0+000
- 30+050
- 31+965
- 34+210

Ch: 0+000

Ch: 30+050

Ch: 31+965

Ch: 34+210

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to Appendix III for standard layout of 3-arm junctions.

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junctions.

Reasons for concern:

Provision for VRUs

- Shoulders in the junction area are encroached by the commercial establishments.
- No provision for crossing by pedestrians/bicycles despite of significant

presence of pedestrians and bicyclists.

Recommendations:

- Remove encroachments from the footpaths.
- Provide well maintained 2m wide shoulders at junction zone free of encroachments.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the roundabout

Reasons for concern:

On-street Parking

- No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space, hampering visibility.

Recommendations:

- Provide designated parking spaces for commercial vehicles

9.3.1.6. Road side hazards - Parapets of narrow Culverts/ Bridges

At followingchainagesculverts/bridges are found:

- 5+500
- 15+500
- 27+500
- 29+500
- 41+500

Ch: 29+500

Ch: 41+500

Concerns & Recommendations

Reasons for concern:

No delineation of bridge parapet

- The bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations:

- Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each

structure)

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern:

Broken or missing parapets

The absence of parapet on bridge/culvert increases the risk of vehicles falling on to the canal. In the context of high speed traffic movement observed on SH-10, the absence of parapets at such locations is hazardous for traffic, especially for VRUs.

Recommendations: Provide continuous parapets on all culverts and bridges.

9.3.1.7. Roadside Hazards - Trees, Poles, and Buildings

Along the road, significant number of electricity poles, trees are found:

Concerns & Recommendations

Reasons for concern: Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

*9.3.1.8. Road side Villages/ Built-up Areas (*BUA*)*

At following locations roadside villages and BUAs are found:

- 0+400
- 14+400
- 58+135
- 69+000

- 22+700
- 30+000
- 45+700
- 57+000
- 72+500
- 75+150
- 76+275

Ch: 69+500

Ch: 14+000

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:

- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.

- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for treatment options in roadside villages/ BUAs

9.3.1.9. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

9.4. RSA – State Highways

9.4.1. SH-19:Baripada - Udala Section

The section of the State Highway from Baripada – Udala Road is a single / intermediate lane road in plain terrain with earthen shoulder in fair / good condition.

Majority of the land use along the road are agricultural and small habitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic. Spot Speed Survey at a random location along this road revealed that the speed varies from 26 KMPH to 72 KMPH, while the 85th percentile speed is around 65 KMPH.

9.4.1.1. Delineation of the road

Ch: 88+500

Ch: 73+500

Concerns & Recommendations	
Reasons for concern:	**Centerline road marking on the intermediate lane and edge line road markings on single lane are absent in the some sections of the road section**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road with intermediate lane and edge line on single lane road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

9.4.1.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 200 m were observed at Km. 48+800; 49+700; 64+400; 67+300; 70+200; 70+700; 73+600; 91+000

Ch: 49+700

Ch: 73+700

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

9.4.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km. 45+100; 45+500; 45+700; 50+750; 51+900; 54+500; 55+600; 57+200; 57+300; 62+600; 65+000; 68+300; 68+700; 70+900; 71+250; 72+750; 73+500; 87+450; 87+500; 87+700; 87+900; 88+100; 88+250; 88+300; 88+450; 88+700; 88+800; 89+400; 89+500; 89+800; 90+000; 90+400; 90+600; 90+800;

Location of Side roads at skew with the major road

Km. 45+200; 47+700; 49+800; 55+700; 55+750; 55+850; 56+200; 60+300; 60+400; 60+700; 60+900; 63+800; 64+100; 66+400; 66+600; 71+220; 75+300; 75+600; 76+550; 76+800; 76+960; 77+060; 78+600; 78+900; 79+100; 80+500; 81+300; 83+200; 84+500; 86+400; 86+900; 87+200; 88+150; 88+200; 88+400

Ch: 73+500

Ch: 75+600

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidance on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

9.4.1.4. Major Junctions

There are three major junctions along this road at the following chainages;

- 87+300
- 88+500
- 91+450

Ch: 87+300

Ch: 88+500

Ch: 91+450

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** • The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	• Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to the Appendix III for guideline to standard layout of 3-arm junctions.*
Reasons for concern:	**Direction Signs** • No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.
Recommendations:	• Provide direction signs on approaches to the junction to guide the traffic through the junction layout. *Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junctions.*
Reasons for concern:	**Poor delineation** • Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	• Provide edge line markings, centerline markings and other junction road markings pertaining to junction control. *Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction*
Reasons for concern:	**Provision for VRUs** • Shoulder space in the junction area is encroached by overgrown vegetation or the commercial establishments. • No provision for crossing by pedestrians/bicycles despite of significant presence of pedestrians and bicyclists.
Recommendations:	• Remove encroachments from the shoulders. • Provide well maintained 2m wide shoulders at junction zone free of encroachments. *Refer to Appendix III for guidelines for safe treatments in roadside villages*
Reasons for concern:	**On-street Parking** • No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space, hampering visibility. • This forces pedestrians to move into the centre of the road resulting in hazardous situation.
Recommendations:	• Provide designated parking spaces for commercial vehicles

9.4.1.5. Bridge approaches on high embankment

In the existing situation, following are the chainages of the unsafe bridge approaches on high embankment:

- 63+000
- 63+460
- 73+300
- 76+500
- 78+200
- 86+500
- 90+200

Ch: 86+500

Ch: 73+300

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

9.4.1.6. Roadside Hazards - Trees, Poles, and Buildings

On the project road, at significant number of locations trees, street light poles are found.

Concerns & Recommendations	
Reasons for concern:	Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Remove encroachments from the right of way

- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

9.4.1.7. Road side Villages/ Built-up Areas (BUA)

At following locations roadside villages and BUAs are found:

- 44+000
- 60+500
- 66+500
- 68+500
- 73+500
- 74+500
- 76+000 – 91+000

Ch: 68+500

Ch: 87+000

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe

overtaking maneuvers.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages.
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.
- Provide appropriate warning signs various hazards encountered inside the roadside village
- Provide adequate traffic calming measures

Refer to Appendix III for guidelines for treatment options in roadside villages/BUAs.

9.4.1.8. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

9.5. RSA – Major District Roads

9.5.1. MDR-70: Udala–Baisinga Section

This section of Major District Road from Udala to Baisingais a single / intermediate lane in plain terrain with earthen shoulder (less than 1 m width) in fair / good condition.

Majority of the land use along the road are forest and small habitations. Hence the mix of traffic majorly consists of trips generated by these habitations including pedestrian, cyclist, two-wheeler and four wheeler traffic. Some of the stretches of the road is forest with provisions of minor bridges / causeways / culverts. The daytime visibility of the road / the availability of sight distances are good.

9.5.1.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	Centerline and edge line road markings at intermediate lane road and edge line at single lane road are absent in the some sections of the road section
Recommendations:	• Provide edge line and centre line on intermediate lane road with thermoplastic material and edge line on single lane road with thermoplastic material (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

9.5.1.2. Alignment - Sharp horizontal Curves

Horizontal curves of radius less than 250 m were observed at Km.51+000; 55+050; 55+550; 61+000; 61+400; 62+200; 62+300; 64+220; 64+800; 65+300; 67+500; 68+100; 68+600; 69+400; 71+800; 72+300; 73+200; 75+050; 78+050; 82+000; 83+700; 84+250; 85+600; 87+700; 87+950; 89+070; 89+800; 94+500

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment of curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

9.5.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km. 55+100; 55+350; 55+800; 55+830; 55+900; 56+010; 56+020; 56+025; 56+050; 56+055; 63+150; 63+350; 64+950; 68+800; 70+100; 71+900; 72+450; 73+500; 74+100; 75+200; 76+600; 77+400; 77+500; 79+100; 79+150; 82+400; 82+800; 85+150; 87+000; 88+600; 89+000; 90+250; 90+500; 90+900; 91+500; 93+800

Location of Side roads at skew with the major road

Km. 55+550; 55+700; 56+000; 56+070; 57+000; 63+600; 65+700;66+300; 72+300; 72+400; 73+700; 74+050; 77+450; 82+200; 82+850; 83+300; 86+000; 90+000

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to

- Encroachments at Junctions
- Overgrown vegetation or presence of trees
- Poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidance on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on situations where to install the above

9.5.1.4. Major Junctions

In the existing situation, there are two major junctions along this road at the following chainages;

- 55+800
- 68+900

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to the Appendix III for guideline to standard layout of 4-arm junctions.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 4-arm junction

Reasons for concern:

Provision for VRUs

- Shoulder spaces in the intersection area are encroached by commercial establishments.

Recommendations:

- Remove encroachments from the shoulders.
- Provide well maintained 2m wide shoulders at junction zone free of encroachments.

Refer to Appendix III for guidelines for safe treatments in roadside villages

9.5.1.5. Approach to Bridge on high embankment

At following location approach to bridge is found at high embankment:

- 55+500
- 56+500
- 62+300
- 67+300
- 83+900
- 84+300
- 84+900
- 89+850
- 92+500

Concerns & Recommendations

Reasons for concern: **Unprotected high embankment**

If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges.

9.5.1.6. Roadside Hazards - Trees, Poles, and Buildings

At significant number of locations on the project road, trees and street light poles are found.

Concerns & Recommendations

Reasons for concern: Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities

Recommendations: **Desirable:**

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

9.5.1.7. Road side Villages/ Built-up Areas (BUA)

At following locations road side villages and BUAs are found.

- 55+500
- 56+500
- 63+500
- 65+700
- 72+700
- 73+500
- 74+100
- 77+000
- 82+000
- 83+000
- 87+350
- 89+070
- 90+500

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided
Recommendations:	• Provide Gateway signs at before start and after the end of BUA. Provide a Gateway effect on approaches to road side villages. • Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas • Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools • Provide appropriate warning signs various hazards encountered inside the roadside village • Provide adequate traffic calming measures *Refer to Appendix III for guidelines for treatment options in roadside villages/ BUAs.*

9.5.1.8. Specific Locations

No specific location has been identified by OWD / Police as a black spot location.

CHAPTER 10

NAYAGARH DISTRICT

10.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Nayagarh district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified in to various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Nayagarh district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

10.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic, other than NHs and SHs, has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 10.1.** It can be seen from **Figure 10.1** that maximum number of fatalities and crashes occur on NHs in Nayagarh district followed by district roads.

The length of road network (NH, SH, MDR, ODR and VR) in Nayagarh district is shown in **Figure 10.2**. It indicates that number of crashes and fatalities occurring on NHs and other roads are almost equal, but the length of NHs is only one third of other roads. This means NHs are much more prone to crashes than the lower category 'other roads'. This may be attributed to the higher volumes of traffic, and higher speed of traffic moving on NH network in Nayagarh district.

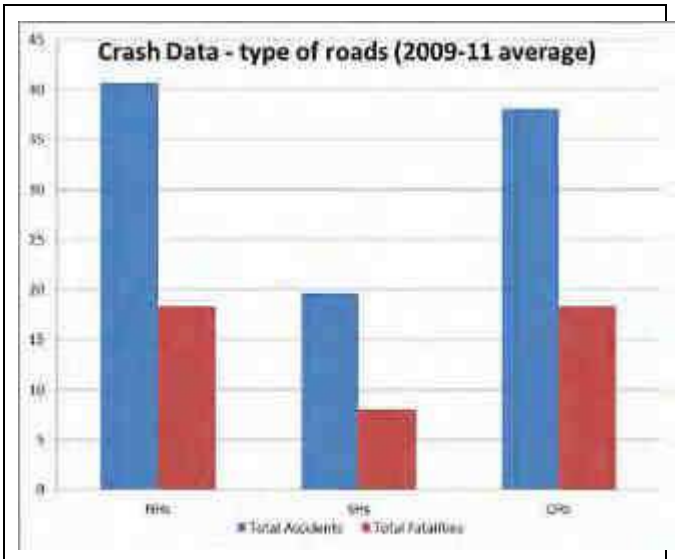


Figure 10.1: Crash data – Type of roads

Figure 10.2: Road Network Length – Nayagarh District

The crash data classified on the basis of location type in Nayagarh district is shown in **Figure 10.3** below.

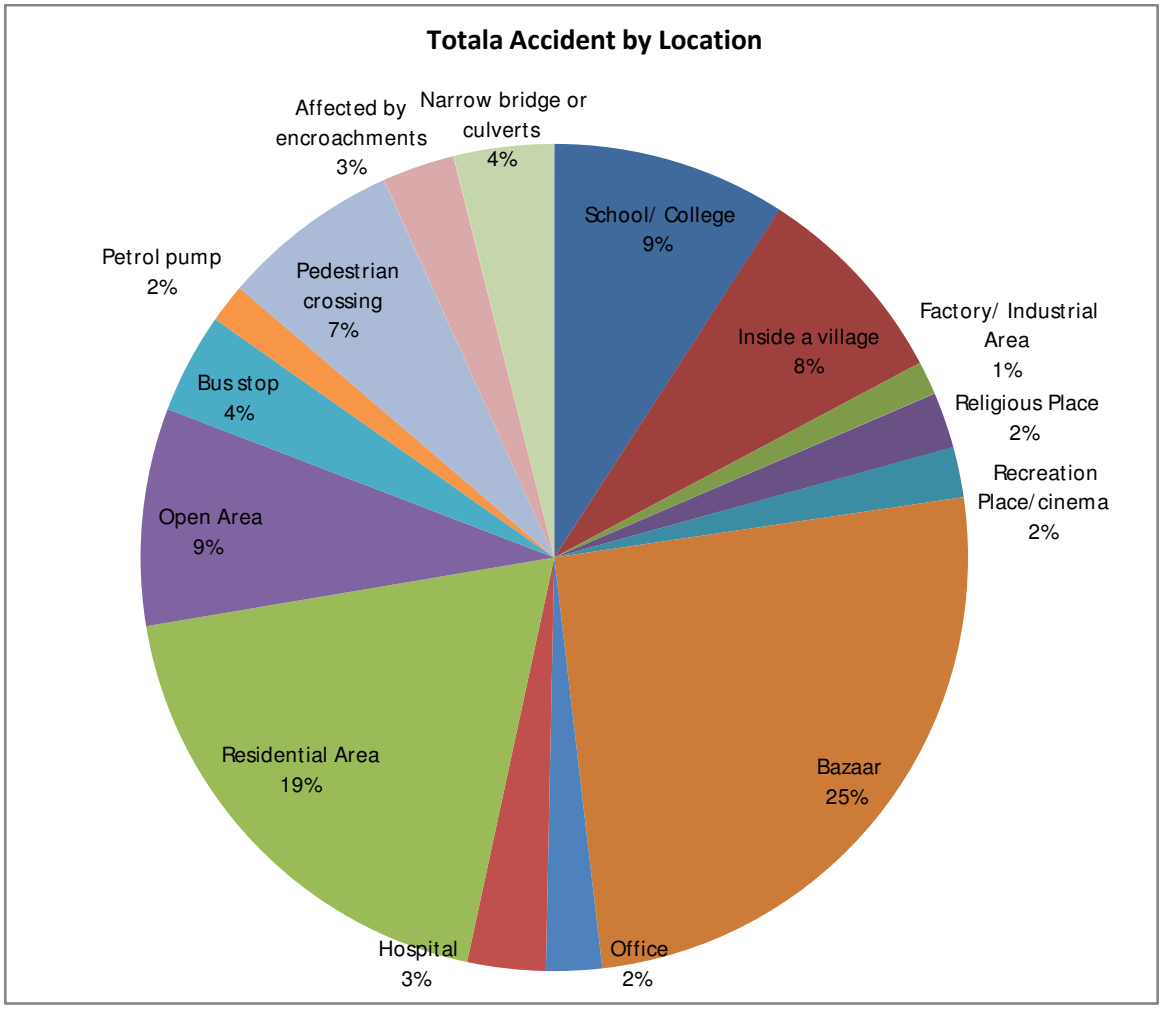


Figure 10.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 10.3** that quarter of crashes occur in commercial area (bazaar) in Nayagarh district followed by crashes in 'residential area' (19%). Significant amount of crashes have been reported occurring on 'pedestrian crossing' (7%), 'school/college' (9%), and 'inside a village' (8%), whereas crashes occurring in 'open area' are only 9%. It may be inferred that more than 65% of crashes are occurring around populated areas where pedestrians, bicycles, and other slow moving traffic is significant. However it is not clear from the above set of data that whether crashes around commercial or residential area occur more in NHs, SHs or district roads, and what categories of road users are involved.

From the above, only the following conclusions can be drawn for Nayagarh district:

- Maximum number of crashes and fatalities occur in NHs followed by other roads;
- Significant numbers of crashes (65%) occur around populated areas.

10.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 10.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 10.5**.

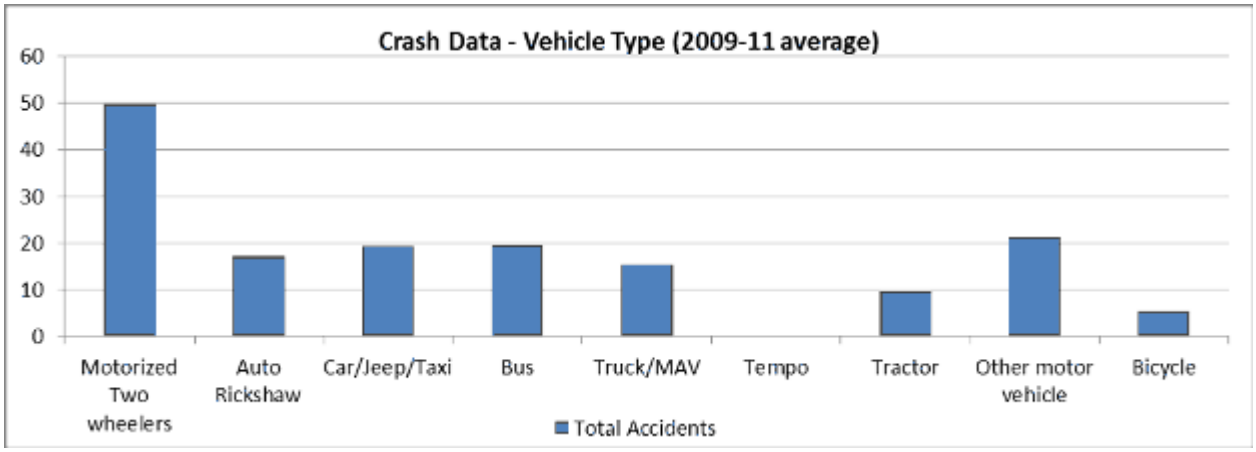


Figure 10.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 10.4**, it can be seen that motorized two wheelers were involved in maximum number of crashes (approximate 50) followed by cars and buses. The number of crashes reported under 'other motor vehicle' category is also significant but the vehicle type considered under this category was not defined. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

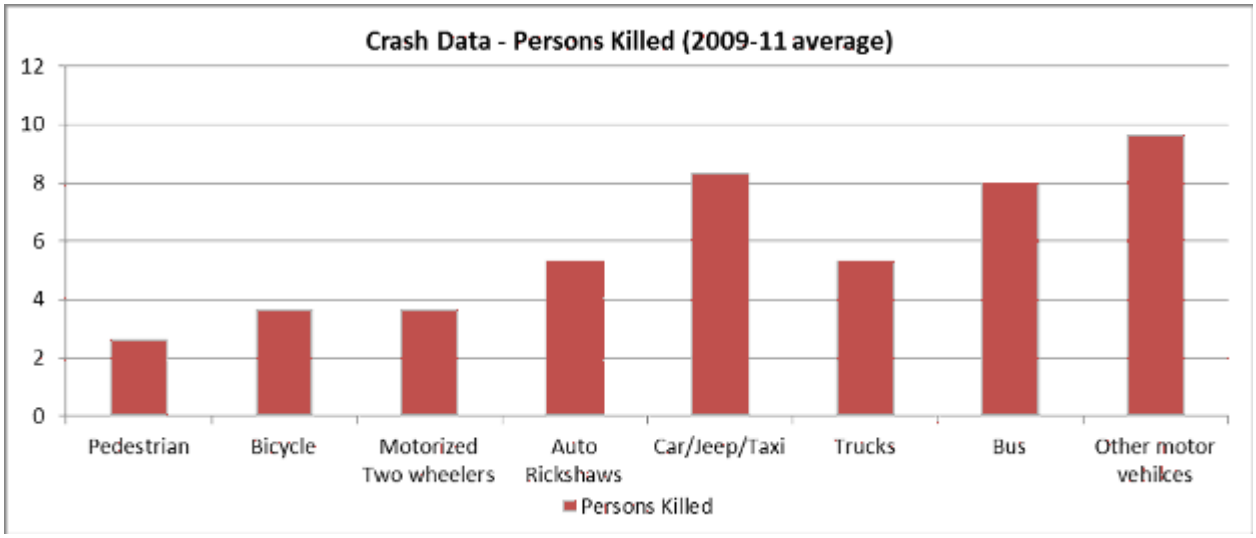


Figure 10.5 Total number of persons killed in road crashes (2009-11 average)

From **Figure 10.5**, it can be seen that maximum fatalities (approximate 10 lives) occur among the 'other vehicles' followed by cars and buses. The vehicle types considered in 'others' category are not defined and hence it is not possible to arrive at conclusion based on the above data. However, it may be noted that out of 5 crashes where bicycles were involved, approximate 4 fatalities occurred. This means the severity of crashes involving bicycles were very high.

The average number of crashes and fatalities occurred during the period 2009-11, based on type of collision is shown in **Figure 10.6.**

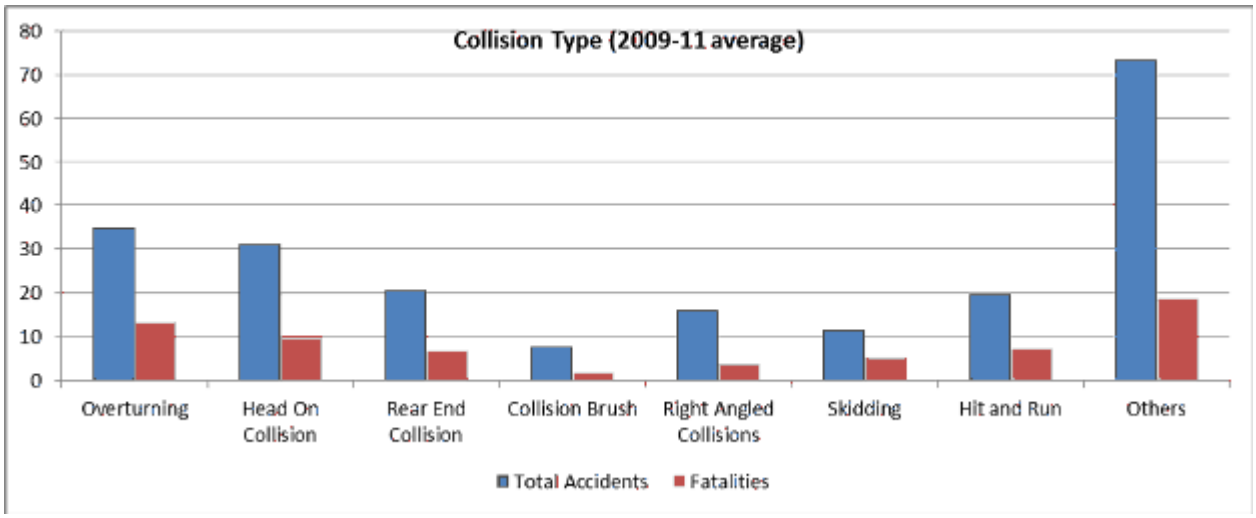


Figure 10.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 10.6** that predominant nature of crashes are reported under category 'others' in Nayagarh district. This is followed by 'overturning' and 'head-on' collisions. The type of collisions included in the category 'others' is not defined, however, considering the other nature of accidents reported, it can be assumed that 'others' might include collisions such as 'Hit road side objects' or 'run-off accidents.

It can be seen from the above figures that maximum number of crashes/ fatalities happen on NHs, motorized two wheelers has a major share in crashes and the high risk road user groups killed on roads in Nayagarh are car users (after 'others' category), and the predominant nature of crashes in Nayagarh district might be hit road side objects and run-off accidents.

From the above, though not supported by desirable detail of data, the following can be inferred for Nayagarh district:

- Maximum number of crashes and fatalities occur in NHs followed by other roads;
- Significant numbers of crashes (65%) occur around populated areas.
- Vulnerable road users (pedestrians, motorcyclists and cyclists) and passenger car users are the high risk road user groups
- The nature of significant number of accidents and fatalities might be hit road side objects and run-off accidents.

10.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 10.7** and the corresponding figures for urban area is shown in **Figure 10.8**.

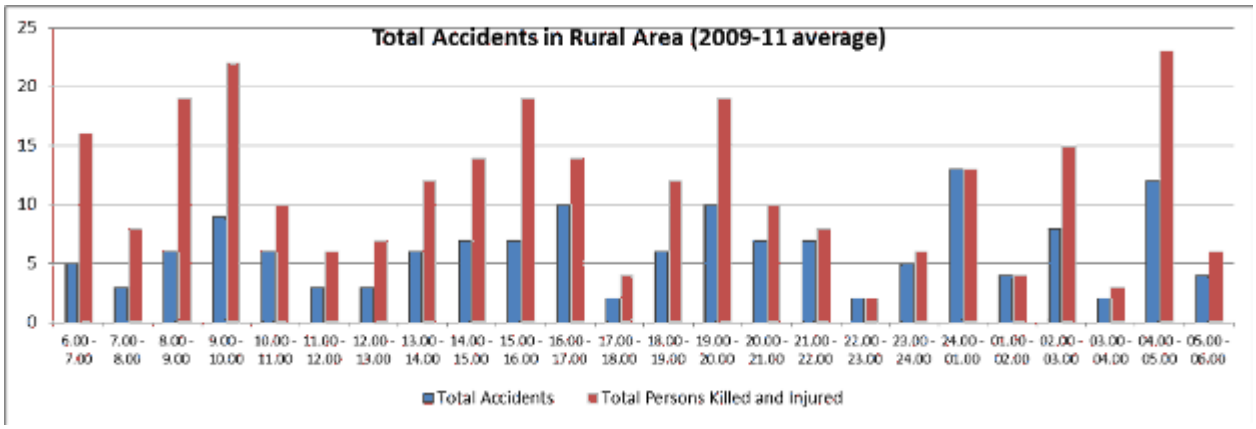


Figure 10.7: Total number of crashes in rural area (2009 – 11 average)

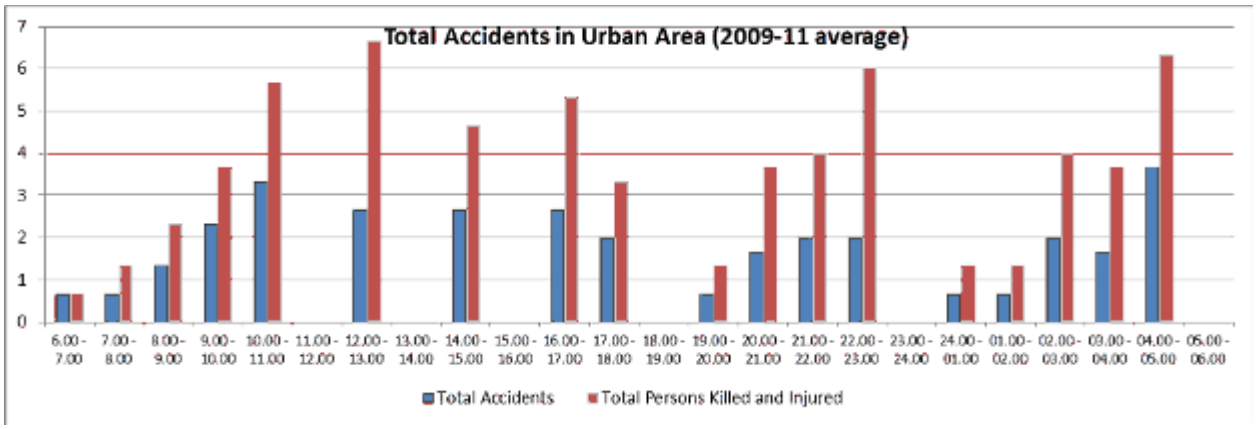


Figure 10.8: Total number of crashes in urban area (2009 – 11 average)

The above data is inconclusive to arrive at a correlation between the time of the day and crashes as there is no proper pattern observed. In several hours there are no crashes recorded which shall be considered as unreliable for the analysis.

10.1. Location and Details of Audited Roads

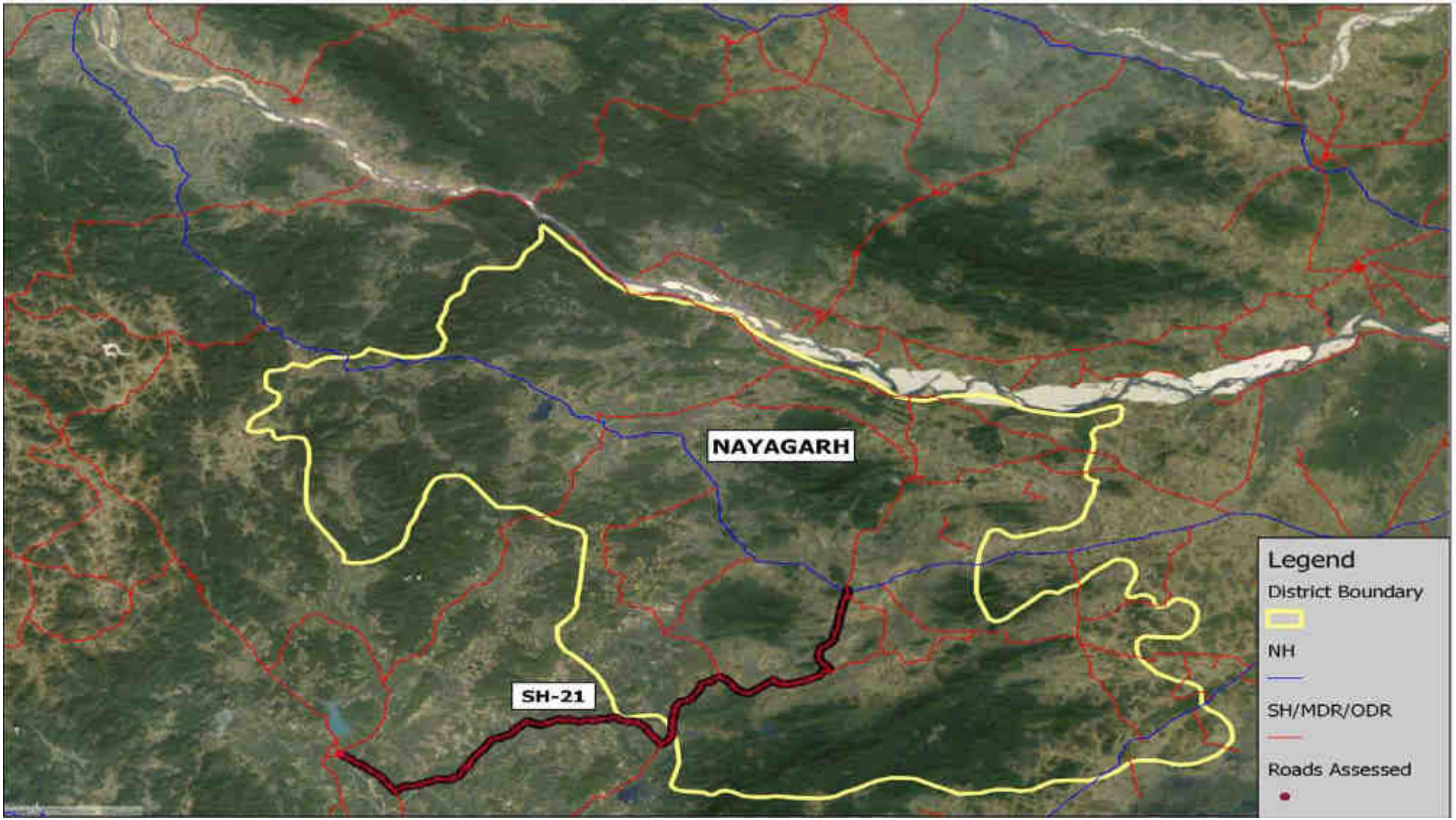
The schedule of road safety assessment in the Nayagarh district is given in **Table 10.1**below.

Table 10.1: List of roads assessed in Nayagarh District

Sr. No.	Road Name	Details of Road &Chainage	Length in Km
1	SH-21	(Nayagarh to Bhanjanagar: Km 0+000 to 82+000)	82.00

The map of the roads assessed in Nayagarh district is shown in **Figure 10.9**.The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.**

Figure 10.9: Map of Road Assessed in Nayagarh District



10.2. Road Safety Assessment – State Highway

10.3.1.SH-21: Nayagarh (Km 0+000) to Bhanjanagar (Km 82+000)

The road starts from Nayagarh (Km 0+000) to Bhanjanagar (Km 82+000) which is mainly Plain terrain and few section of the road it's a hilly terrain. The road is generally Intermediate lane (Km 2+000 to Km 40+000) to two lane (Km 40+000 to Km 82+000) except few sections of start of the road which has four lane carriageway near Nayagarh city i.e. Km 0+000 to Km 2+000. The road surface is generally bituminous but near built up areas it is cement concrete road with 0.5m earthen shoulder from km 0+000 to km 50+000 and 1-2 m earthen shoulder from km 50+000 to km 82+000. The traffic flowing through the road is mixed traffic conditions-Cyclists, 2-Whlr, Buses, Cars, Trucks and Pedestrian observed. Speed observed during spot speed survey varies from 35 KPH to more than 70 KPH but 85th percentile speed is lesser than 60 KPH.

10.3.1.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline road markings are not provided in almost 50 percent of the road section.**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

10.3.1.2. Alignment- Sharp horizontal curves

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 9hrs to 12hrs, from Km 0+000 to 82+000. An average speed of 32.55 km/ hour and a maximum speed of 64.35 km/ hour are noted during this survey. A spot speed was conducted at location Km 37+000 and Km 57+000, and the 85th percentile speed at this location was found to be55 km/hr.

Curves having radius in the range of 100m to 150m were observed on the following locations:

Km 6+800	Km 13+350	Km 27+900	Km 49+500	Km 53+100	Km 60+500
Km 8+100	Km 14+050	Km 45+300	Km 51+300	Km 54+850	Km 66+100
Km 8+300	Km 18+800	Km 46+500	Km 51+800	Km 55+100	Km 69+000
Km 8+800	Km 22+400	Km 47+300	Km 52+350	Km 56+300	Km 70+050

Km 10+450 Km 27+300 Km 48+850 Km 52+800 Km 57+900

Km 8+800 Km 46+500

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment on curves*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*

10.3.1.3. Alignment - Blind Curve

These are observed at chainages Km 11+400, Km 11+800 and 28+400

Km 11+800

Km 28+400

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment on curves*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

10.3.1.4. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road
Km 2+900, Km 21+800, Km 72+800 and 77+000.
Location of Side roads at skew with the major road
Km 8+800,Km 13+580,Km 50+650 and Km 51+250.

Km 2+900

Km 13+580

Side Roads perpendicular and skew with the Main Road

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in late braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in collisions at high speeds.

Recommendations:

- Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at minor junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road

- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

- It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
- This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines for safer vertical profile of side road at junctions.

10.3.1.5. Major 3-arm Junctions

- Km 0+000
- Km 26+600
- Km 38+750
- Km 74+000 and
- Km 82+000

Km 38+750

Km 82+000

Major Junctions

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-motorized traffic.

Refer to Appendix III for standard layouts of 3-arm junctions.

Reasons for concern:

Poor delineation

No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead.

Recommendations:

- Provide advance direction and direction signs to inform the road user
- Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road
- Provide edge lines
- Provide Splitter islands using road markings to establish improved traffic control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection.

Reasons for concern:

High approach speed

Traffic coming from the Nayagarh side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality.

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout.

Refer to Appendix III for guidelines for design of road humps

Reasons for concern:

On street Bus stop

Buses stops at the mouth of the junction in the minor road hampering visibility

Recommendations:

Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction

Refer to Appendix III for guidelines for design of bus bays and on-street bus stops

Reasons for concern:

Provision of VRUs

Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.

Recommendations:

Provide footpaths to segregate pedestrians from high speed traffic at the junction approaches;

10.3.1.6. Approach to Bridge

Bridges/Culverts are observed at chainages:

- Km 32+700
- Km 38+700
- Km 77+300
- Km 78+100
- Km 78+700
- Km 4+600
- Km 13+300
- Km 27+900
- Km 55+150
- Km 57+500
- Km 59+300
- Km 60+050
- Km 68+050
- Km 77+900 and
- Km 80+100

Km 13+300

Km 59+300

Bridge/ Culverts

Concerns & Recommendations

Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure. *Refer to Appendix III for guidelines for installation of object hazard markers*
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets
Reasons for concern:	**High approach speed** In the absence if any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.
Recommendation:	• Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits • In case the location has a history of accidents, provide speed tables/ humps

on either approaches

Refer to Appendix III for guidelines to treatments on approaches to bridges

10.3.1.7. Road side hazards/Objects

Road side objects present along this stretch of road are mainly trees. Lots of trees are on the edges of the carriageway from Km 2+000 to Km 40+000, which has no any protection. Some of them protected by providing studs near the trees but it is not sufficient.

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	Either remove such objects or provide crash barrier where such objects are <2m from the edge of road. To improve delineation of such objects, • Provide continuous edge line on the road • Put retro-reflective delineators on stems of trees, poles, and buildings

10.3.1.8. Road Side Villages/Built-up Areas

Road side villages and built-up areas were observed at following locations on SH-21.

Chainage	**Village**	**Chainage**	**Village**
Km 0+000	Nayagarh City	Km 4+300	Machhipada
Km 6+400	Gottisahi	Km 7+700	Kalyanpur
Km 10+500	Katarajari	Km 11+200	Sarankul
Km 14+100	Nuasahi	Km 15+700	Boroputa
Km 17+500	Petabali	Km 18+100	Nandighar

Chainage	Village	Chainage	Village
Km 21+000	Ghasadeipur	Km 23+100	Kadalibandh
Km 24+100	Odgaon	Km 27+300	Jamosai
Km 33+000	Kamarda	Km 34+600	Rohibanka
Km 37+700	Laukhala	Km 38+000	Kairasinghi
Km 42+000	Kumpapada	Km 44+500	Panchahuli
Km 52+000	Nuajirapali	Km 53+600	Jirabari
Km 55+300	Jagannathprasad	Km 59+600	Chikili
Km 60+000	Gondadhora	Km 61+500	Jamugoroda
Km 63+800	Jhababhuj	Km 66+000	Biddupur
Km 68+300	Baragaon	Km 69+500	Adhaibara
Km 71+500	Udhula	Km 73+600	Bellaguntha
Km 77+000	Tamalada	Km 81+000	Jamapali
Km 82+000	Bhanjanagar		

Km 11+200 (Sarankul village)

Km 27+300 (Jamosai village)

Built up area/ Road side villages

Concerns & Recommendations

Reasons for concern: Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.

Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide pedestrian crossings (either marked or speed tables), footpaths, and streetlights.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any.

Refer to Appendix III for guidelines on safer treatments in roadside villages/ built up areas

CHAPTER 11

RAYAGADA DISTRICT

11.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Rayagada district for years 2009, 2010 and 2011. The data consist of total number of crashes, fatalities and injuries classified into various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Rayagada district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

11.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 11.1**. It can be seen from **Figure 11.1** that an almost equal number of crashes and fatalities occur on SHs and other lower category roads in Rayagada district.

The length of road network in Rayagada district is shown in **Figure 11.2**. It can be seen from **Figure 11.2** that there are no NHs, and length of SHs is almost one third of other lower category roads. However, the rate of crashes and fatalities are much more in SHs than the lower category 'other roads'. IT can be attributed to the high speed traffic plying on the SHs.

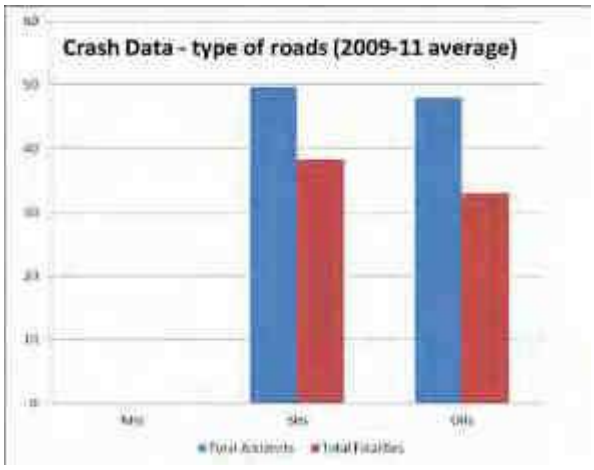


Figure 11.1: Crash data – Type of roads

Figure 11.2: Road Network Length – Rayagada Dist.

The crash data classified on the basis of location type in Rayagada district is shown in **Figure 11.3** below.

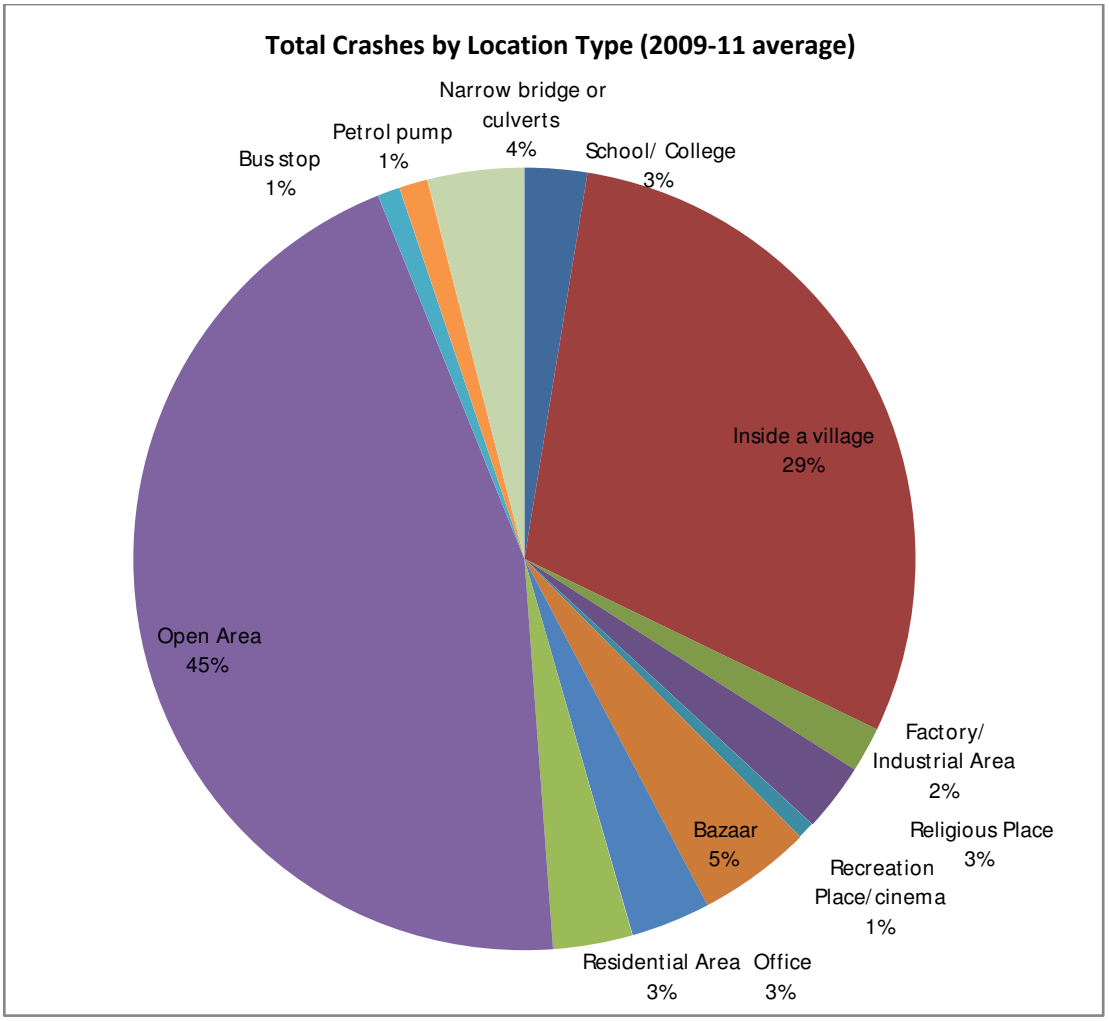


Figure 11.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 11.3** that almost half of crashes (45%) occur in 'open area' in Rayagada district followed by crashes occurring inside village area (29%). However, it is not clear from the above set of data that whether crashes in 'open area' occur more in SHs or district roads. Further, the 'open area' is not clearly defined to be used for thorough crash investigation and prevention techniques.

From the above, only the following conclusions can be drawn for Rayagada district:

- The rate of accidents in SHs were high and can be deemed as the hazardous road type;
- Almost half (45 percent) of the total crashes occur in open areas.

11.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 11.4** and the average number of persons killed, classified according to road user type during the period 2009-11 is shown in **Figure 11.5**.

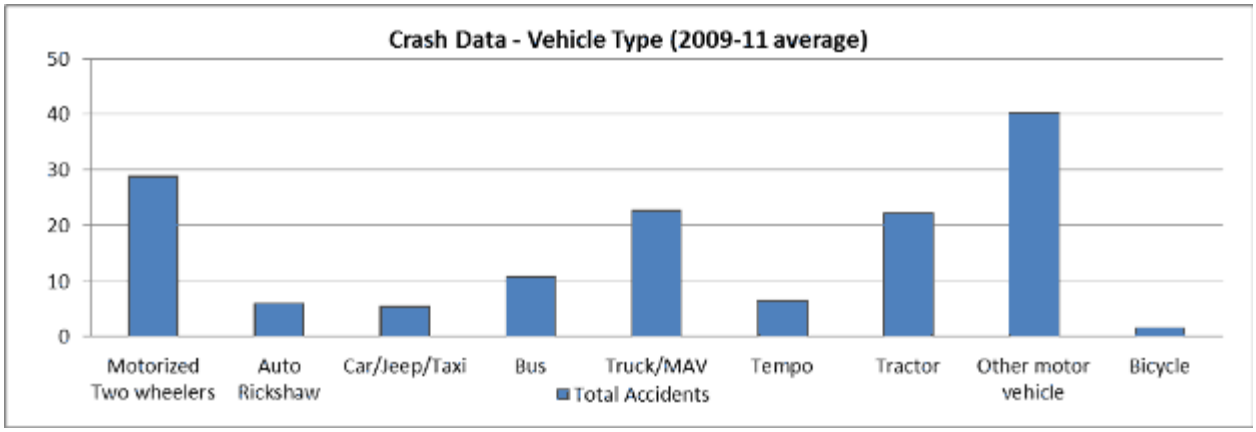


Figure 11.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 11.4,** it can be seen that maximum number of crashes (approximate 40) are recorded under the category of 'other motor vehicle'. Among remaining vehicle types, maximum numbers of crashes are recorded under motorized two-wheelers and trucks. The type of vehicles covered under 'other' category is not mentioned. Again it is not clear from the SCRB data, the locations or road category on which these crashes occur, and hence it may not be possible to derive any relationship from the existing pattern of data collection and recording by SCRB.

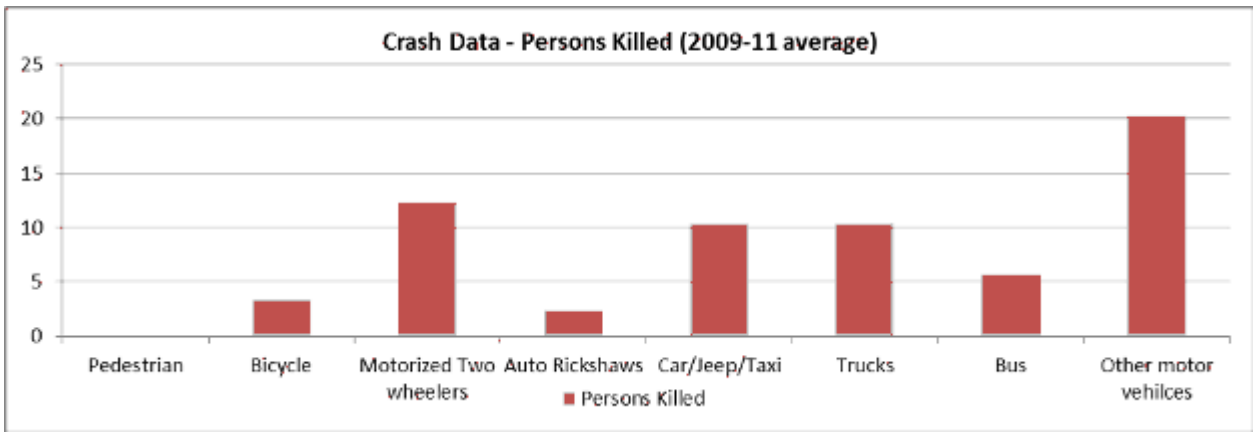
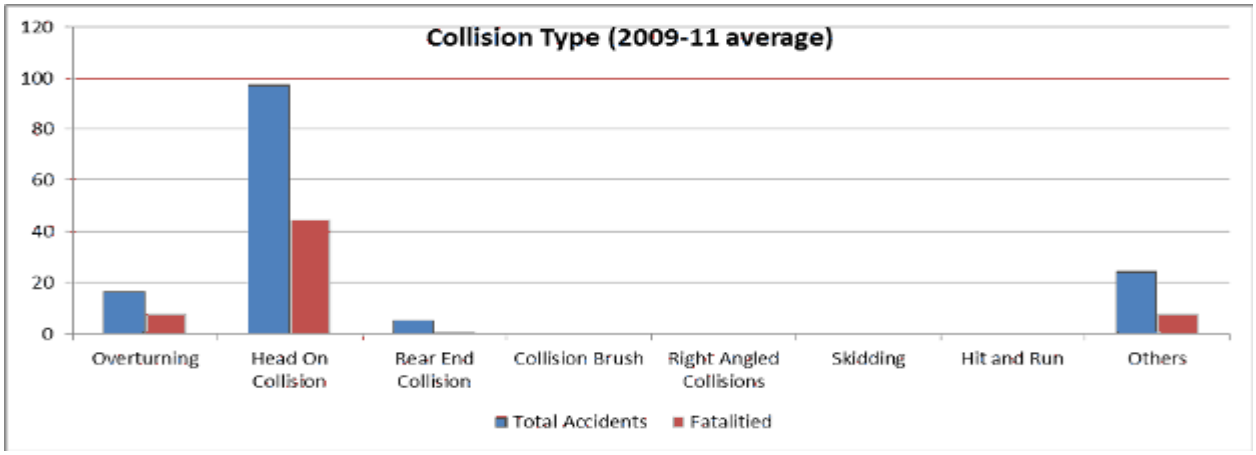


Figure 11.5:Total number of persons killed in road crashes (2009-11 average)

From **Figure 11.5** it can be seen that maximum fatalities (approximate 20 lives) occur among the 'other motor vehicle' category. Among remaining road users, motorized two wheeler riders, cars and truck users (both driver & passenger) are the major victims of road crash. It is interesting to note that cars are involved in fewer crashes (Fatal, major and minor), but higher number of fatalities. This may be due to the fact that cars carry multiple passengers, and single crashes might be leading to multiple fatalities.

It can be seen from **Figures 11.4 and 11.5** that out of 30 crashes where motorcycles are involved, approximately 12 fatalities occur. This means, out of every 3 crashes involving motorcycles, one person is getting killed. This is significant since approximately 65 percent of motor vehicles registered in Rayagada district are motorcycles. However, from the available data, it is difficult to ascertain the locations/ road types, where the motorcyclists are at higher risk.

The average number of crashes and fatalities occurred during the period 2009-11, based on type of collision is shown in **Figure 11.6.**



It can be seen from **Figure 11.6**that predominant nature of crashes in Rayagada district are 'head on collision' (100 crashes). This is followed by 'overturning' and 'other' collision type.

It can be seen from the above figures almost equal number of crashes/ fatalities occur on SHs and the predominant nature of crash is 'head on collision'. Further, the above figures show that motorized two wheelers and passenger cars are involved in most number of crashes after 'other motor vehicles' in Rayagada district.

From the above, though not supported by desirable detail of data, the following can be inferred for Rayagada district:

- Motorized two wheelers and cars might be predominantly exposed to head on collision in the district road network
- According to the data, pedestrians and cyclists are less exposed to risk and hence cannot be considered and hazardous users or hazardous user groups

11.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 11.7** and the corresponding figures for urban area is shown in **Figure 11.8**.

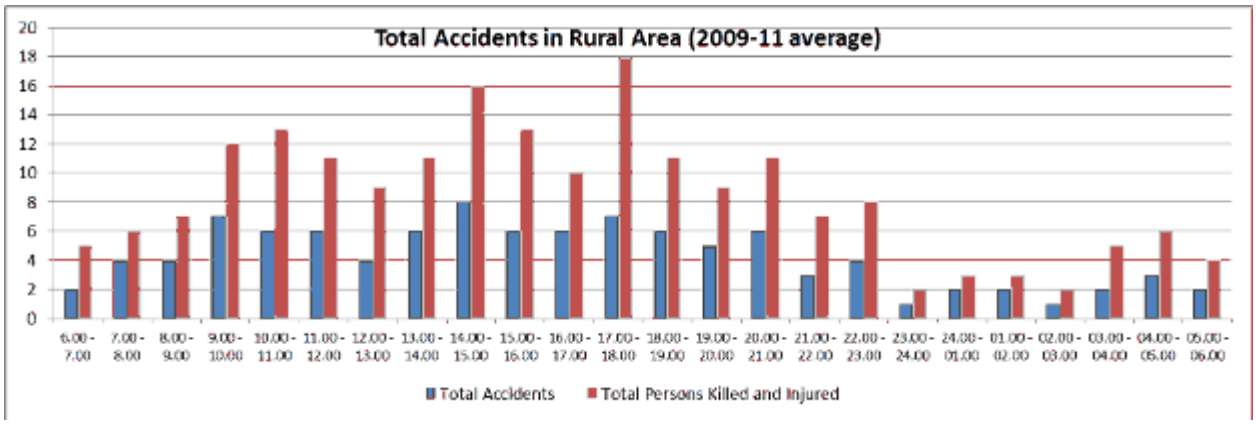


Figure 11.7: Total number of crashes in rural area (2009 – 11 average)

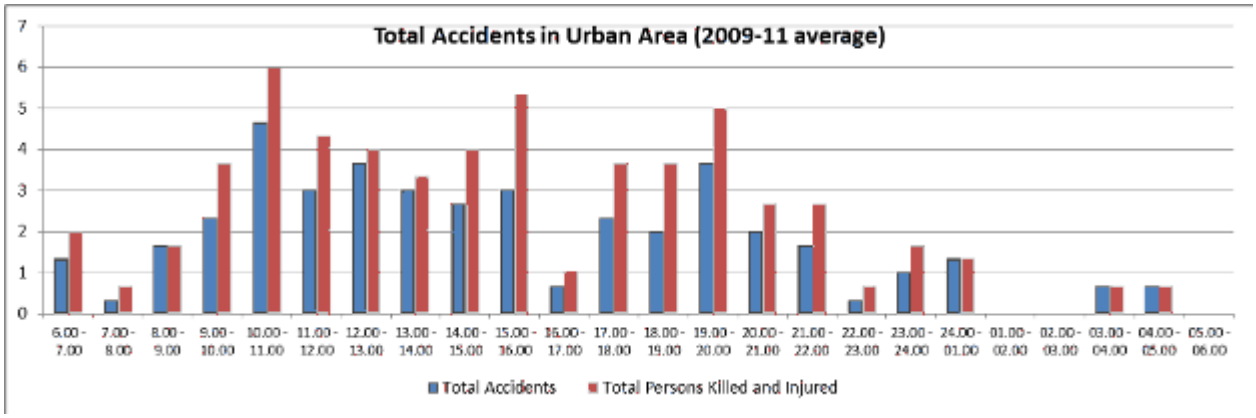


Figure 11.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 11.8**, that the number of crashes, fatalities, and persons injured are highest during 17:00 to 18:00 hrs in rural area. It can be inferred that the variation of crashes during 24 hrs is more or less in relation with the traffic level.

In urban area also the pattern of crashes is more or less in relation with the traffic level. Numbers of crashes are more during morning peak time (09:00 to 12:00 hrs) and evening peak time (17:00 to 20:00 hrs). But, more number of crashes occurring during early morning hours (06:00 to 07:00) in urban area is differing from the above observation. This may be due to higher speed of through traffic passing through urban area during this time.

11.2. Location and Details of Audited Roads

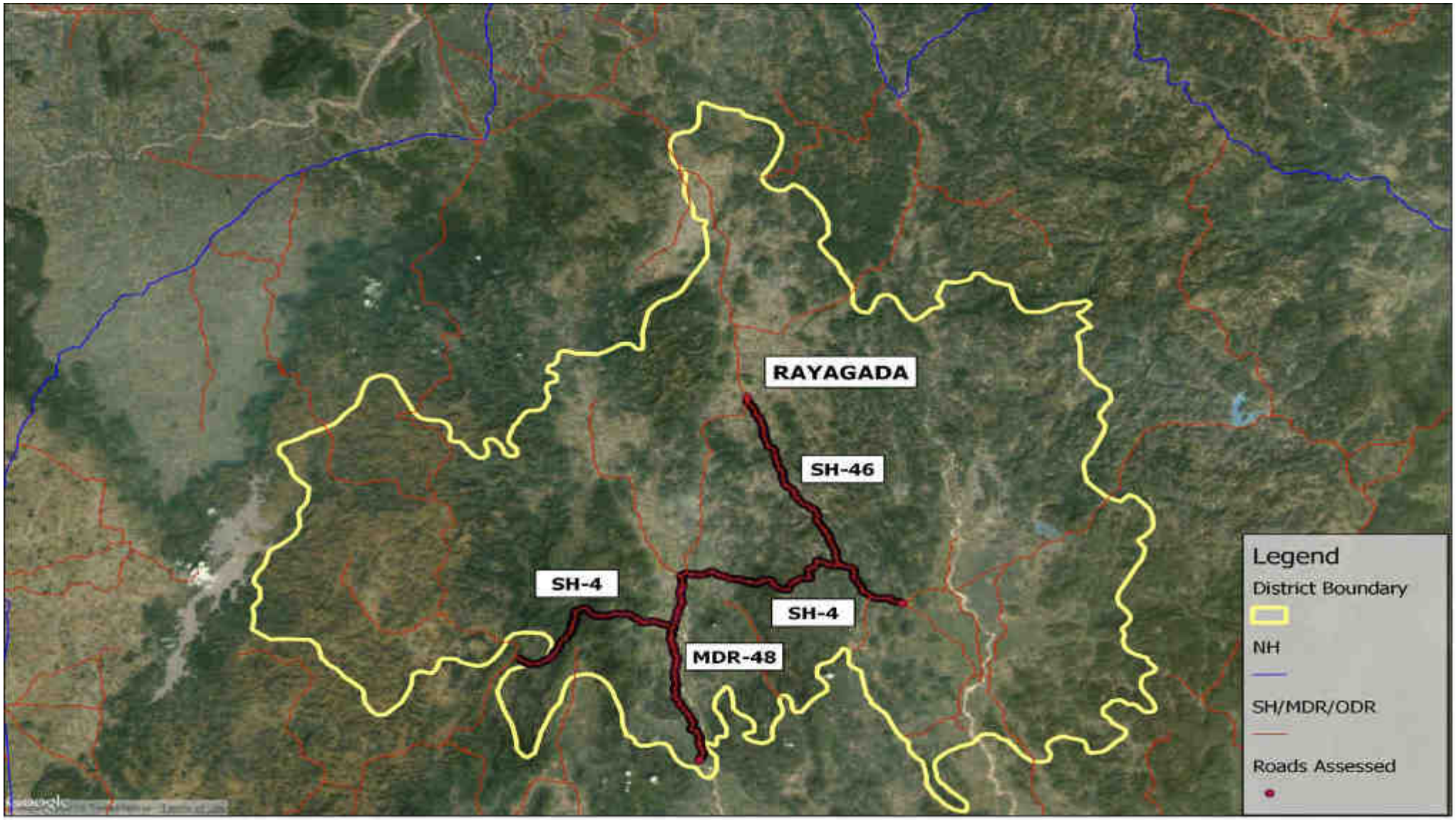
The road safety assessments were carried out on the road links shown in **Table 11.1**.

Table 11.1: List of roads assessed in Rayagada District

Sl. No.	Name of Road (from to location)	Details of Location & Chainage	Length in Km
1	SH-4	(Rupkona to Bangi: Km 78+000 to Km 160+800)	82.80
2	SH-46	(Tandikona chowk to Bissam Cuttack: Km 0+000 to Km 33+200)	33.20
3	MDR-48B	(Rayagada to Kerada: Km 0+000 to Km 25+000)	25.00

The Map of the roads assessed in Rayagada district is shown in **Figure 11.9**.The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.**

Figure 11.9: Map of Road Assessed in Rayagada District



11.3. RSA – State Highways

11.3.1. SH-4: Rupkona (Km 78+000) to Bangi (Km 160+800)

This section of the road comes under Vijayawada-Ranchi Corridor (VRC).The road starts from Rupkona (Km 78+000) to Bangi (Km 160+800) which is mix of Plain and hilly terrain. The plain terrain section is from Km 109+000 to Km 127+000 and rest section of the road is ghat/hilly section. The road is generally single to Intermediate lane except few sections of road which has two and four lane carriage way viz. from Km 99+000 to Km 106+000 and Km 112+000 to Km 120+000 are two lane carriageway while from Km 106+000 to Km 112+000 are four lane carriageway near Rayagada town. The road surface is bituminous with 1 to 2 m of earthen shoulder. The traffic flowing through the road is mixed traffic conditions-Cyclists, two wheelers, buses, cars, trucks and pedestrians observed. Speed observed during spot speed survey varies from 40 KPH to more than 65 KPH but 85th percentile speed is lesser than 60 KPH.

11.3.1.1. Delineation of the road

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline road markings are absent in many sections of the road** Road markings delineate the road lanes and encourage the traffic to be in designated lanes. In the absence of centre line road markings, drivers tend to drive on the middle of the road and this, in the worst case, may lead to head-on collisions. The provision of edge line markings will prevent the traffic from straying into the shoulder space and thereby damage the road edges.
Recommendations:	• Provide edge lines with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide centre line marking on intermediate and two lane road sections • Provide RRPMs on centre line/ edge line on the location of sharp curves
Reasons for concern:	**No road markings on access road to warn the road user of the junction ahead.** This encourages the road user to approach the major road in high speed, and, in the worst case, may result in right angle collisions
Recommendations:	Provide **Give Way/ STOP road marking** using thermoplastic material as appropriate on side roads

11.3.1.2. Alignment-Sharp horizontal Curves

The curves in this road section vary from sharp, blind to hair pin bend types. Due to bushes/overgrown vegetation, the approach to many of these curves has poor visibility on curves which may lead to accidents. The lack of visibility due to substandard gradient of the road also poses a problem at many sections. In this section, many blind curves and hair pin bends with high embankment is noted, which, in the absence of adequate road safety engineering, can lead to fatal/ major accidents.

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 9hrs to 12hrs, from Km 78+000 to 160+800. An average speed of 36.80 km/ hour and a maximum speed of 59.65 km/ hour have been noted during this survey. A spot speed was conducted at location Km 121+000, and the 85th percentile speed at this location was found to be 50 km/hr. Curves having radius in the range of 100m to 150m were observed on the following locations:

Km 78+500	Km 85+100	Km 102+100	Km 127+200	Km 147+900	Km 158+400
Km 79+800	Km 85+700	Km 102+500	Km 128+500	Km 149+200	Km 158+900
Km 81+000	Km 97+550	Km 120+400	Km 133+400	Km 150+550	Km 160+100
Km 82+100	Km 99+500	Km 122+500	Km 142+800	Km 151+300	Km 160+300
Km 83+700	Km 99+700	Km 125+100	Km 145+900	Km 157+100	Km 160+500

Km 127+200

Km 160+100

Sharp Curves on Project Road

Concerns & Recommendations

Reasons for concern: No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed. This may lead to

- Potential run-off accidents
- Potential head-on collisions

Recommendations: Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern: Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:

- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern: Curves on high embankment without safety barriers noted

- Run-off accidents on high embankments will lead to fatalities

Recommendations: Provide metal beam crash barrier with delineators on sharp curves in high embankment

Refer to Appendix III for guidelines on situations where to install the above

Reasons for On two lane roads, the constricted width will cause the rear of trucks/ big vehicles

concern:	to protrude on to the opposite lane and can be hazardous
Recommendations:	Provide extra widening on sharp curves, with 'no overtaking' markings (refer to IRC 35 for details)

11.3.1.3. Alignment - Horizontal bend after a vertical crust

The 'horizontal bend after a vertical crest' situations were observed at chainages Km 98+150, Km 126+700 and Km 129+000.This situation is particularly hazardous, particularly, if this geometry follows after a long straight section. The drivers tend to expect a straight section after the vertical crest and may not be able to negotiate the horizontal bend after the vertical crest, if appropriate safety measures are not provided. The reverse curves were observed on the chainages Km 85+500, Km 128+280, Km 141+500, Km 143+200and Km 154+400.

Km 126+700

Km 129+000

Horizontal bend after a vertical crest

Concerns & Recommendations	
Reasons for concern:	Insufficient sight distance and absence of warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed
Recommendations:	Provide **curve warning signs, chevron signs, SLOW Signs** as appropriate *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	High speed approach may lead to multiple fatal accidents, in particular, the bend after a crest is in a hilly terrain.
Recommendations:	Provide appropriate traffic calming measures

11.3.1.4. Alignment - Hair Pin Bend

These are observed at following chainages:

- 89+100
- 90+400
- 90+500
- 90+600
- 90+800
- 91+600
- 91+800
- 92+500
- 92+800
- 129+300
- 129+500
- 129+700
- 129+800
- 130+000
- 130+150
- 130+300
- 131+300
- 135+050
- 136+300
- 140+400
- 141+200
- 141+500
- 141+700
- 141+800
- 143+200
- 145+100

Km 89+100

Km 129+500

Hair pin bend

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the hair pin bend in a safe speed. This may lead to • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	**Bends on high embankment** and safety barriers are not provided. In the case of run-off accidents, fatalities may occur.
Recommendations:	Provide metal beam crash barrier with delineators on valley side of hair pin bends in high embankment. *Refer to Appendix III for guidelines on situations where to install the above*

11.3.1.5. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The locations where the above are noted are given below:

Location of Side roads perpendicular to major road
Km 86+900
Location of Side roads at skew with the major road
Km 80+000,Km 80+300,Km 94+300 and Km 150+000

Km 86+900

Km 94+300

Side roads Perpendicular and skewed to Main Road

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Encroachments at Junctions 2) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead. Poor delineation may result in late braking behavior by road users and can be hazardous.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ Stop signs as applicable, on side roads
- Provide Give Way/ Stop road marking at side roads

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

High approach speeds

High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road

- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner. This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on situations where to install the above

11.3.1.6. Major Junctions

The major features affecting road safety noted at the major junctions in this road section is listed below.

- In this section of road all the major junctions are 3-arm uncontrolled junction
- Low to high level of encroachments noted in junction zones
- High level of on-street parking
- No facilities are provided for Pedestrians
- Haphazard on-street stopping of buses in the road

The major junctions are noted on the following chainages:

- Km 108+500
- Km 119+250
- Km 122+100
- Km 137+100
- Km 148+800
- Km 156+100 and
- Km 160+800

Km 122+100 Km 156+100

Major 3-arm Junctions

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and no traffic control has been established through road markings/ signs and traffic signals
Recommendations:	• Re-design the junction layout after detail traffic studies • Provide splitter islands to enable safe movement of motorized and non-motorized traffic *Refer to Appendix III for standard layouts of 3-arm junctions.*
Reasons for concern:	**Poor delineation** No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided. Direction signs are important on the approaches to major junctions to inform the road user of the routes ahead.
Recommendations:	• Provide advance direction and direction signs to inform the road user; • Provide Give Way/ STOP signs on the minor road at appropriate locations before it merges into the major road; • Provide edge lines; and • Provide Splitter islands using road markings to establish improved traffic control. *Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm junctions.*
Reasons for concern:	**High approach speed** Traffic coming from the Rayagada side and traffic merging on to the major road It has been observed that vehicles, in particular motorcycles, approach the junction at high speed. At the worst case, this may lead to crashes resulting in serious injury or fatality.
Recommendations:	• Provide traffic calming measures on the minor road • Provide warning signs on the minor road • Provide information signs and road markings at the junction to warn the road user of the layout *Refer to Appendix III for guidelines for design of road humps.*
Reasons for concern:	**On street Bus stop** Buses stops at the mouth of the junction in the minor road hampering visibility
Recommendations:	Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction. *Refer to Appendix III for guidelines for design of bus bays and on-street bus stops.*
Reasons for concern:	**Provision of VRUs** Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.
Recommendations:	Provide footpaths to segregate pedestrians from high speed traffic at the junction

approaches;

Refer to Appendix III for standard layouts of 3-arm junctions

11.3.1.7. Approach to Bridge

At chainage Km 80+200, sharp curve approaching a bridge on high embankment.

Bridge/ Culverts

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators.
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets
Reasons for concern:	**High approach speed** In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.
Recommendation:	• Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits • In case the location has a history of accidents, provide speed tables/ humps on either approaches *Refer to Appendix III for guidelines to treatments on approaches to bridges.*

11.3.1.8. Road side hazards/Objects - Parapets of narrow Culverts/ Bridges

The bridge parapets adjacent to road will be hazardous and mostly bridges have damaged parapets and hence may cause accident in future. In general, it has been noted that crash barrier were not provided on the approach to the bridges/ structures.

Bridges/Culverts with parapets were observed at the following chainages:

- Km 79+250
- Km 80+700
- Km 80+950
- Km 83+050
- Km 100+200
- Km 118+800
- Km 120+100
- Km 131+500
- Km 131+050
- Km 83+350
- Km 85+500
- Km 94+700
- Km 95+200
- Km 96+300
- Km 97+300
- Km 98+600
- Km 99+050
- Km 117+800
- Km 120+400
- Km 122+300

Km 85+500

Km 94+700

Road side hazards-Parapet of narrow culverts/bridges

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (ie. Four numbers of each OHM for each structure. *Refer to Appendix III for guidelines for installation of object hazard markers.*

11.3.1.9. Roadside objects - Trees

It has been noted that huge trees near to road edge pose a significant hazard in this road section, which is one of the major hazard identified in this road section.


Road side hazards-Trees and high embankment

Concerns & Recommendations	
Reasons for concern:	Trees on shoulders pose a significant hazard. If the road side objects are not protected and/or illuminated, in the event of driver losing control, fatalities/ major injuries can occur.
Recommendations:	**Desirable** – Remove trees from the road shoulders and keep the road shoulders free of trees, street lighting poles and other objects. Essential – Delineate the trees on the shoulder by: • provide continuous edge line on the road • provide retro-reflective delineators or object hazard markers on stems of trees and street lighting poles • paint the trees with black and white stripes

11.3.1.10. Road Side Villages/Built-up Areas

Roadside villages pose a significant hazard to road safety. In this road section, roadside villages and built-up areas were observed at the following locations:

Chainage	Village	Chainage	Village
• Km 78+000	Rupkona	• Km 82+900	Kumbhikota
• Km 94+100	Guma	• Km 105+000	Rayagada
• Km 113+400	Kutupeta	• Km 118+000	J.K.Pur
• Km 119+250	Amlabhata	• Km 122+000	Kolsora
• Km 127+000	Lokhaipai	• Km 136+500	Mubundpura
• Km 148+800	Tandikona	• Km 150+000	Pallupai
• Km 151+000	Kondajamk	• Km 155+800	Ramnaguda

Km 122+000 (Kolsara village)

Km 136+500 (Mubundpura village)

Built up area/Road side villages

Concerns & Recommendations	
Reasons for concern:	Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide pedestrian crossings (either marked or speed tables), footpaths, and streetlights.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any. *Refer to Appendix III for guidelines for installation of object hazard markers*

11.3.1.11. Specific Locations

In this section, accident prone area as per directed by OWD are at chainages Km 98+150 (Horizontal bend after a vertical crest), Km 128+500 and Km 129+000 (Sharp curve), landslide area at Km 132+050 and also at hair pin bend (chainages are given above).

Accident prone area

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

11.3.2. SH-46: Tandikona chhak (Km 0+000) to Bissam Cuttack (Km 33+200)

The road starts from Tandikona chhak (Km 0+000) to Bissam Cuttack (Km 33+200) and passes through plain and hilly terrain. This was a single lane road with 0.5m earthen shoulder and found to be generally in good condition except from km 21+000 to km 33+200, the road was noted in poor condition. The road surface is bituminous and only near Bissam cuttack portion the road is cement concrete. The traffic has been very low throughout the section of road. Maximum and average speeds noted during the assessment are 49 km /hour and 23 km/hour respectively.

11.3.2.1. Delineation of the Road

Road marking missing

Concerns & Recommendations	
Reasons for concern:	**Edgeline road markings are absent in throughout the road section**
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves
Reasons for concern:	**No road markings on access road to warn the road user of the junction ahead** • Potential right angle collisions
Recommendations:	Provide **Give Way/ STOP road marking** using thermoplastic material as appropriate on side roads

11.3.2.2. Alignment- Sharp horizontal curves

Project road have few curves, some of them observed to be sharp which requires slowing down the vehicles to more than 20 km/ hour than the approach speed.

During the course of assessment, the consultant has carried out average speed survey. The average speed and maximum speed were noted for one trial run on the road during 9 hrs to 12 hrs, from Km 0+000 to 33+200. An average speed of 23 km/ hour and a maximum speed of 49 km/ hour is noted during this survey. Curves having radius in the range of 100m to 150m were observed on the following locations:

- Km 0+700
- Km 3+200
- Km 3+400
- Km 4+300
- Km 6+400
- Km 6+800
- Km 8+600
- Km 13+850
- Km 14+800
- Km 16+200
- Km 19+050
- Km 23+600
- Km 24+050
- Km 25+500
- Km 26+800
- Km 27+300
- Km 31+500

Km 3+400

Km 14+800

Sharp Curves on Project Road

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collision
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*

11.3.2.3. Alignment - Horizontal bend after a vertical crest& Reverse curves

The horizontal bend after a vertical crest were observed at chainages mm 20+500 and mm 31+350 and reverse curves were observed on chainages km 18+300 and km 19+500.

Km 20+500

Km 31+350

Horizontal bend after a vertical crest

Concerns & Recommendations	
Reasons for concern:	Insufficient sight distance and absence of warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed. This may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate Provide traffic calming measures on approaches to the vertical crest *Refer to Appendix III for guidelines on situations where to install the above*

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above*

11.3.2.4. Alignment - Gradient

It has been noted that on few locations (Km 0+300, Km 20+500 and Km 31+200), desired sight distance/ visibility for safe maneuver of vehicles are not available due to few sub-standard vertical gradient. At chainage 20+500, road leads to a sudden dip after a horizontal curve bend, which is significantly hazardous.

Km 0+300

Km 20+500

Unsafe Steep Gradient

Concerns & Recommendations	
Reasons for concern:	Lack of sight distance/ forward visibility due to sub-standard vertical gradient
Recommendations:	**Desirable** – Correct the vertical gradient to achieve safe forward visibility **Essential** - Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate. *Refer to Appendix III for guidelines on situations where to install the above.*

11.3.2.5. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road
Km 11+400,Km 15+500,Km 17+700,Km 24+700 and Km 27+200
Location of Side roads at skew with the major road
There is no any skew type side road

Km 11+400

Km 15+500

Side roads perpendicular to Main Road

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at junctions on this road are due to 1) Overgrown vegetation or presence of trees and 3) poor layout of the side roads.

Recommendations:

- Improve visibility by clearing vegetation;
- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:

Poor delineation

No traffic signs or road markings are observed on any of the junctions, the presence of which would have informed and warned the road user of the layout ahead. Poor delineation may result in late braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in collisions at high speeds.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ STOP signs on side roads, as appropriate
- Provide Give Way/ STOP road marking on side roads, as appropriate

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

High approach speeds

High approach speeds were observed by motorcyclists turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above

11.3.2.6. Major3-arm Junctions

Major 3-arm junctions were noted in chainages Km 0+000 and Km 33+200.

Km 0+000

Km 33+200

Major Junction

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction is a non-standard T-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-motorized traffic

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern:

Poor delineation

No road markings and traffic signs are provided to establish safe movement of traffic. No direction signs are provided Direction signs are important on the approaches to this junction to inform the road user of the routes ahead

Recommendations:

- Provide advance direction and direction signs to inform the road user
- Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road
- Provide edge lines
- Provide Splitter islands using road markings to establish improved traffic control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern:	**High approach speed** Traffic coming from the Rayagada side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality
Recommendations:	• Provide traffic calming measures on the minor road • Provide warning signs on the minor road • Provide information signs and road markings at the junction to warn the road user of the layout *Refer to Appendix III for guidelines for design of road humps*
Reasons for concern:	**On street Bus stop** Buses stops at the mouth of the junction in the minor road hampering visibility
Recommendations:	Provide designated bus stop at a safer location so that required visibility is available for road users approaching from all arms of the junction *Refer to Appendix III for guidelines for design of bus bays and on-street bus stops*
Reasons for concern:	**Provision of VRUs** Pedestrians and cyclists observed at the junction, but no separate provisions have been made. Pedestrians are particularly vulnerable at such junctions having high approach speed.
Recommendations:	Provide footpaths or well-maintained wide shoulders to segregate pedestrians from high speed traffic at the junction approaches; *Refer to Appendix III for standard layouts of 3-arm junctions.*

11.3.2.7. Bridge/Culverts

The road section has few numbers of submersible bridges, where parapets are not provided due to the nature of their function. However, if sufficient warning/ delineation are not provided, these locations can become potentially hazardous, in particular, if the submersible bridge follows after a bend.

Bridges/ Culverts are noted in the following locations.

- Km 5+850
- Km 0+500 and
- Km 26+020
- Km 31+400

Km 0+500

Km 5+850

Concerns & Recommendations

Reasons for concern: The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.

Recommendations:

- Provide edge line markings with RRPMs on the approaches to the submersible bridges
- Provide advance warning signs
- Provide 'SLOW' traffic signs boards

Reasons for concern: **Unprotected high embankment**

If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Reasons for concern: **Absence of traffic signs and road markings**

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

Reasons for concern: **High approach speed**

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches

Refer to Appendix III for guidelines to treatments on approaches to bridges

11.3.2.8. Road Side Villages/Built-up Areas

Road side villages and built-up areas were observed at following locations on SH-46.

Chainage	Village	Chainage	Village
Km 10+000	Durgi	Km 12+600	Baleri
Km 17+000	Kumardhameri	Km 31+800	Bissam Cuttack

Km 17+000 (Kumardhameri village)

Km 31+800 (Bissam Cuttack village)

Built up areas/Road side villages

Concerns & Recommendations	
Reasons for concern:	Accidents between high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures. Provide pedestrian crossings (either marked or speed tables), footpaths, and streetlights. Refer to Appendix III for treatment options for roadside villages.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any.

11.4. RSA – Major District Roads

11.4.1.MDR-48B: Rayagada (Km 0+000) to Kerada (Km 25+000)

The road starts from Rayagada (Km 0+000) to Kerada (Km 25+000) which is mix of Plain and hilly terrain. Many container trucks ply on this road section. The road is intermediate lane to single lane with less than 1m shoulder, and the road is generally in poor to fair condition. The road surface is bituminous. Mixed traffic conditions -Cyclists, 2-Whlr, Buses, Cars, Trucks and Pedestrian – were observed on this road section. Speed noted during spot speed survey varies from 40 kph to more than 80 kph but 85th percentile speed is lesser than 70 kph.

11.4.1.1. Delineation of the Road

It has been noted that centre line markings were provided on few sections, but is in a deteriorated state and hence is not performing its function. No edge lines are provided on his road section. Retro reflective material is not provided on parapets of the culverts/bridges and also the road side objects are not been marked to warn the drivers while driving at night.

Road Marking

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline road markings** are not provided/ properly visible in throughout the section of the road.
Recommendations:	• Provide edge line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide centre line marking on the sections where intermediate lane width is available • Provide edge and centre line RRPMs on sharp curves at intermediate curves
Reasons for concern:	**No road markings on access road to warn the road user of the junction ahead**
Recommendations:	Provide **Give Way/ STOP road marking** using thermoplastic material as appropriate on side roads

11.4.1.2. Alignment – Sharp horizontal curve

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 9 hrs to 12 hrs, from Km 0+000 to 25+000. An average speed of 24.3 km/ hour and a maximum speed of 57.90 km/ hour is noted during this survey. A spot speed was conducted at location Km 18+000, and the 85th percentile speed at this location was found to be 65 km/hr. For these conditions of operating speed, various sharp curves (100m to 150m radius) were observed on the following locations:

Km 1+600, Km 1+800, Km 4+500, Km 7+800, Km 8+400, Km 9+200,Km 10+800, Km 11+300, Km 16+800,Km 17+050,Km 17+300,Km 19+100,Km 19+200,Km 21+200 and Km 24+100;

Km 4+500

Km 19+100

Sharp Curves

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment

Refer to Appendix III for guidelines on situations where to install the above

11.4.1.3. Alignment - Reverse Curves

These are observed at chainages Km 14+100 and Km 18+400;

Km 14+100

Km 18+400

Reverse Curves

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above.*

11.4.1.4. Bridge Parapets and Approaches

The bridge parapets adjacent to road will be hazardous and these bridges have damaged parapets and hence may cause accident in future. There is no any crash barrier and protection towards the approaching to the bridge.

These are observed at chainages:

- Km 9+400
- Km 17+800 and
- Km 23+800

Km 9+400

Km 23+800

Bridge Parapets and Approaches

Concerns & Recommendations	
Reasons for concern:	The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.
Recommendations:	Install Object Hazard Marker (OHM) on both sides and for both approaches (ie. Four numbers of each OHM for each structure.
Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the curve bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets
Reasons for concern:	**High approach speed** In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.
Recommendation:	• Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits • In case the location has a history of accidents, provide speed tables/ humps on either approaches *Refer to Appendix III for guidelines to treatments on approaches to bridges.*

11.4.1.5. Roadside objects/ hazards

Road side hazards/objects present along this stretch of road are predominantly trees at Km 17+050, Km 17+800 and Km 24+500.

Road side hazards-Trees

Concerns & Recommendations	
Reasons for concern:	At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	**Desirable** - Either remove such objects or provide crash barrier where such objects are <2m from the edge of road. **Essential** – Provide improved delineation by: • providing continuous edge line on the road • retro-reflective delineators on stems of trees

11.4.1.6. Road Side Villages/Built-up Areas

Road side villages and built-up areas were observed at following locations on SH-48B.

Chainage	Village	Chainage	Village
• Km 0+000	Rayagada city	• Km 4+000	Pitamphall
• Km 14+800	Jamadeipada	• Km 24+000	Kerada

Km 0+000 (Rayagada)

Km 14+800 (Jamadeipada village)

Built up area/Road side villages

Concerns & Recommendations

Reasons for concern:	Accidents involving high speed motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use the road space in absence of footpath and proper shoulder. Absence of street light worsens the situation for VRUs during night hours.
Recommendations:	• Provide gateway signs with speed restriction on start and end of BUA, in addition to rumble strips, speed humps, or speed tables as traffic calming measures. • Provide pedestrian crossings, footpaths, and streetlights.
Reasons for concern:	Buses are stopping on the road obstructing the through traffic. There are chances of head-on collision of overtaking vehicles.
Recommendations:	Provided bus-bays with proper signage and road markings.
Reasons for concern:	Road side commercial activities result into parking and encroachment.
Recommendations:	Regulate roadside commercial activities and remove encroachment, if any.

CHAPTER 12

SAMBALPUR DISTRICT

12.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Sambalpur district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified in to various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Sambalpur district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

12.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic, other than NHs and SHs, has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 12.1**. It can be seen from **Figure 12.1** that maximum number of fatalities and crashes occur on NHs in Sambalpur district followed by SHs.

The length of road network (NHs, SHs, MDRs, ODRs and VRs) in Sambalpur district is shown in **Figure 12.2**. It can be seen from **Figure 12.2** that length of 'other roads' is much more than the length of NHs and SHs in Sambalpur district. However, **Figure 10.2** indicates that fewer numbers of crashes and fatalities occur on 'other roads' compared to NHs and SHs. This can be partly attributed to the low level of traffic carried by the lower category 'other roads' on its network in Sambalpur district. It is also to be noted that the severity of crashes occurring in SHs is more than crashes occurring in NHs.

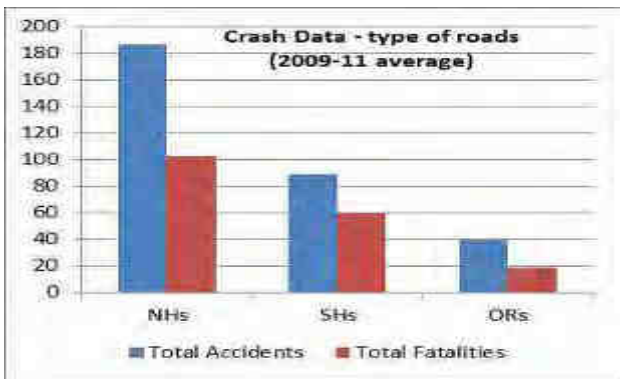


Figure 12.1: Crash data – Type of roads

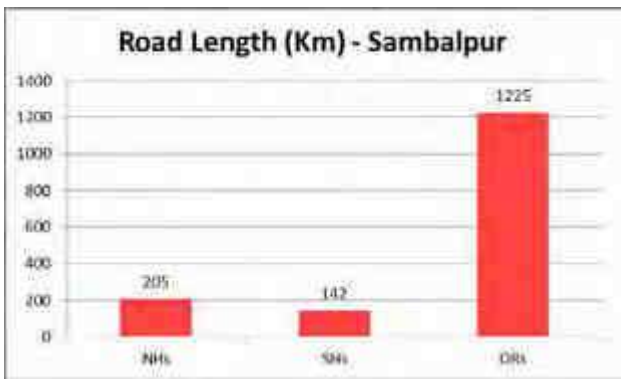


Figure 12.2: Road Network Length – Sambalpur District

The crash data classified on the basis of location type in Sambalpur district is shown in **Figure 12.3** below.

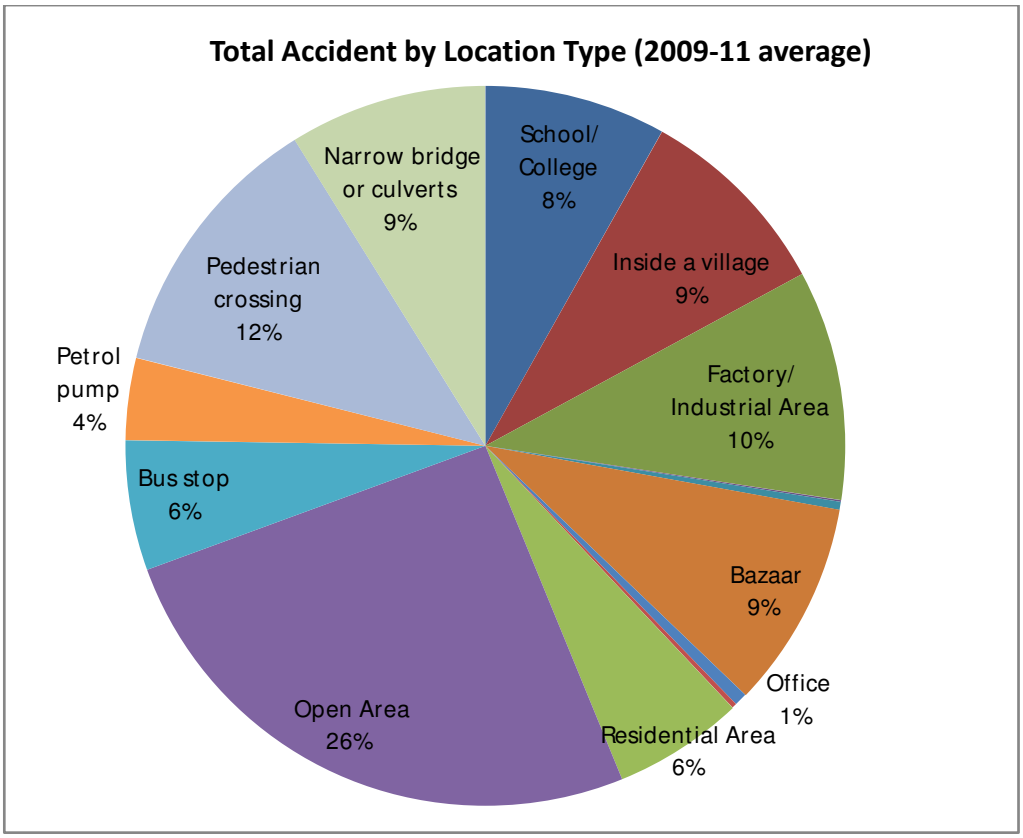


Figure 12.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 12.3** that almost a quarter of crashes occur in 'open area' in Sambapur district followed by crashes on 'pedestrian crossing' (12%) and industrial area (10%). However, it is not clear from the above set of data that whether crashes in 'open area' or 'pedestrian crossing' occur more on NHs or SHs. Further, the 'open area' is not clearly defined to be used for thorough crash investigation and prevention techniques.

From the above, only the following conclusions can be drawn for Sambalpur district:

- More number of crashes and fatalities occur on NHs than SHs, but the severity of crashes on SHs is more than NHs
- More than 60% of crashes occur around populated areas
- 12% of crashes occur on pedestrian crossings which is quite significant

12.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 12.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 12.5**.

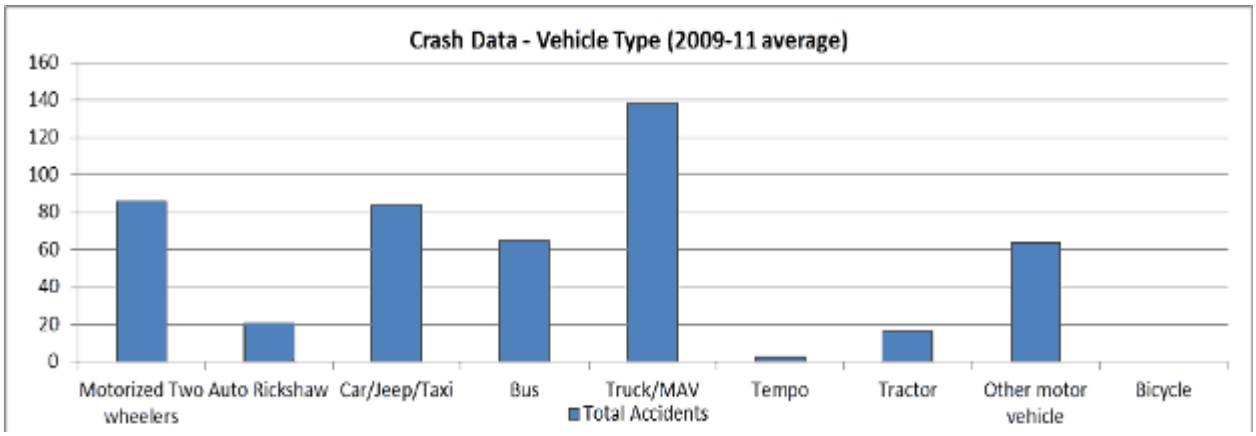


Figure 12.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 12.4,** it can be seen that trucks are involved in maximum number of crashes (approximate 140) followed by motorized two wheelers and cars. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

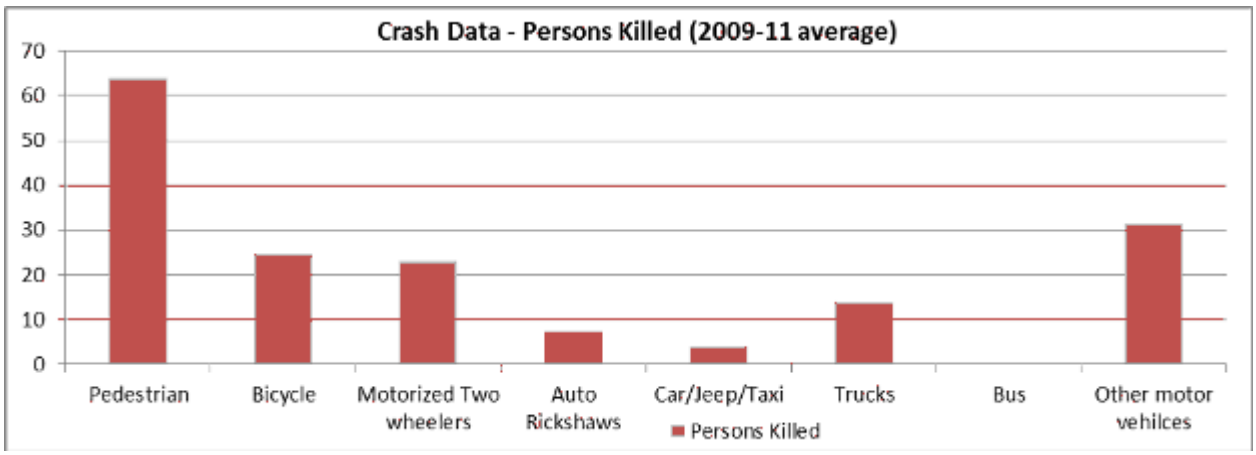


Figure 12.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 12.5**, it can be seen that maximum fatalities (approximate 60 lives) occur among the pedestrians, followed by bicycles and motorized two wheelers.

It can be seen from the above Figure that out of 80 crashes where motorcycles are involved, approximately 20 fatalities occur. This means, out of every 4 crashes involving motorcycles, one person is getting killed. This is significant since approximately 80 percent of motor vehicles registered in Sambalpur district are motorcycles. However, from the available data, it is difficult to ascertain the locations/ road types, where the motorcyclists are at higher risk.

12.1.3. Nature of crashes

Further analysis of the nature of crashes occurred in Sambalpur district, reveal a better correlation of crashes/ fatalities between type of vehicle and road category. The average number of crashes and fatalities based on type of collision is shown in **Figure 12.6.**

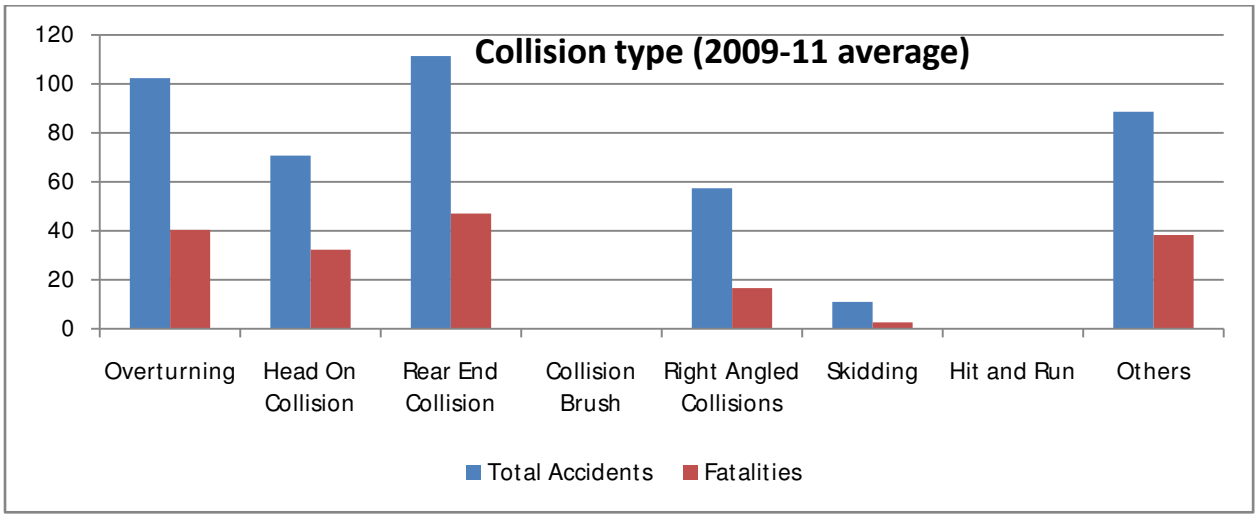


Figure 12.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 12.6** that predominant nature of crashes in Sambalpur district are 'Rear end collision' (111 crashes) and 'Overturning' (102 crashes). This is followed by 'others' and 'head-on' collisions. The type of collisions included in the category 'others' is not defined and as number of crashes and fatalities under this category are significant, it is not possible to draw any conclusion based on this data. Considering the other nature of crashes mentioned in the charts, 'others' might include crashes like hit pedestrian, run-off accidents and hit road side objects

It can be seen from the above figures that maximum number of crashes/ fatalities happens on NHs and trucks have a major share in crashes. Pedestrians get killed more than any other road users and the predominant nature of crashes in Sambalpur district is rear end collision. Further, the above figures show that and cars and motorized two wheelers are involved in most number of crashes after trucks.

The following inferences can be drawn from Sambalpur district based on the above data:

- Though NHs constitute only 13 percent of the road network carrying low to high volume of traffic, 60 percent of accidents occur on NHs
- Though SHs constitute only 9 percent of the road network, 28 percent of accidents occur on SHs
- More than 60 percent of crashes occur around populated areas
- Though trucks and cars are involved in more number of crashes, it is the pedestrians, bicyclists and two wheelers, who are more among the fatalities than other road users
- Maximum number of crashes occur due to rear end collisions, which indicate problems at junction locations or lack of forward visibility on the road, forcing vehicles to apply sudden brakes on unexpected occasions
- Overturning is also a predominant nature of accident, and trucks are the major vehicle type involved in crashes. This indicate that trucks might be involved in high number of overturning crashes in NHs

- 'Others' is also a major nature of accident, which might involve accidents like 'hit pedestrian' and run-off accidents. Since pedestrians are the major victims of road traffic fatalities, it can be inferred that 'motor vehicle hitting pedestrian' might be a major issue in Sambalpur road network.

12.1.4. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 12.7** and the corresponding figures for urban area is shown in **Figure 12.8**.

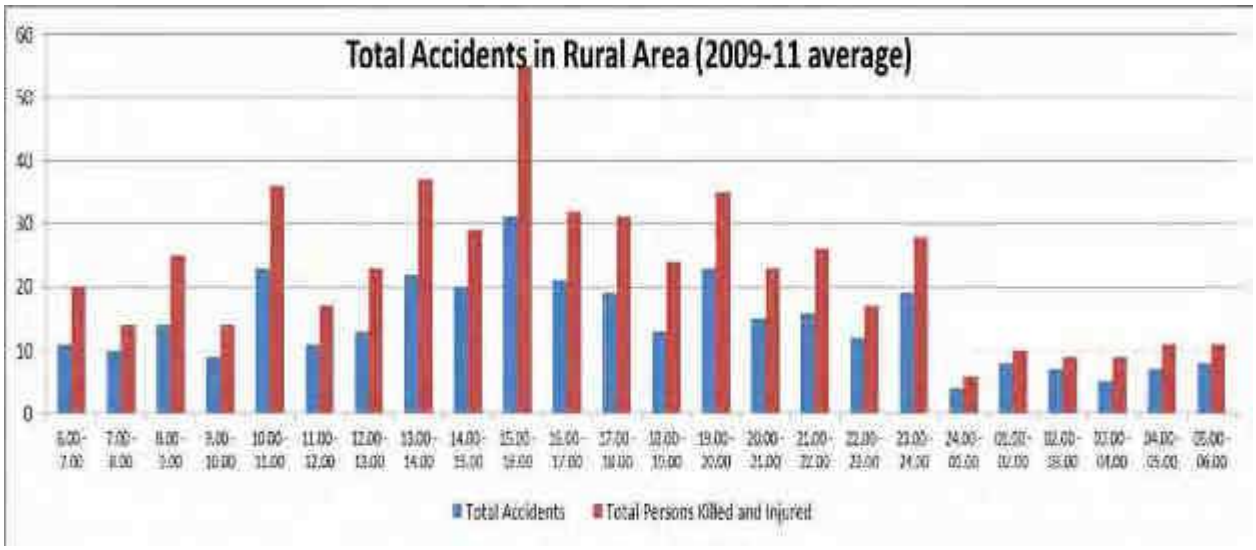


Figure 12.7: Total number of crashes in rural area (2009 – 11 average)

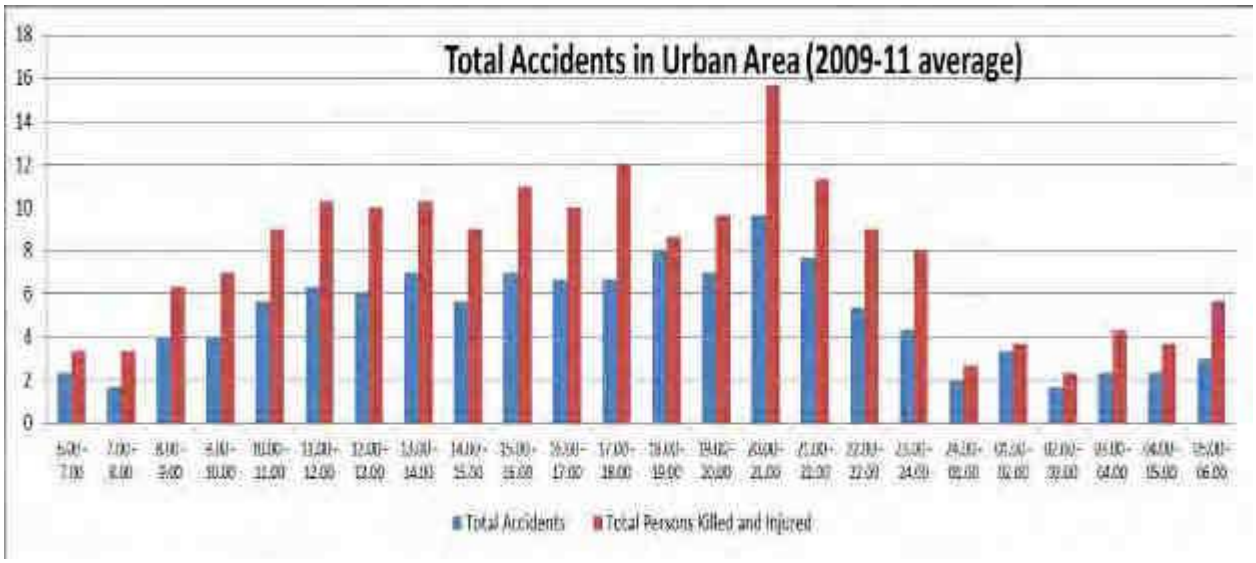


Figure 12.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 12.7,** that the number of crashes, fatalities, and persons injured are highest during 15:00 to 16:00 hrs in rural area. It can be inferred that the variation of crashes during 24 hrs is in relation with the traffic level, as number of crashes are less during night and early morning hours.

In urban area also the pattern of crashes is in relation with the traffic level. As number of crashes are gradually increasing from morning 06:00 and reaching to maximum level during evening peak hours (20:00 to 21:00).

12.2. Location and details of audited roads

The road safety assessment in Sambalpur district was conducted on the roads from 29-Nov to 5-Dec 2012.

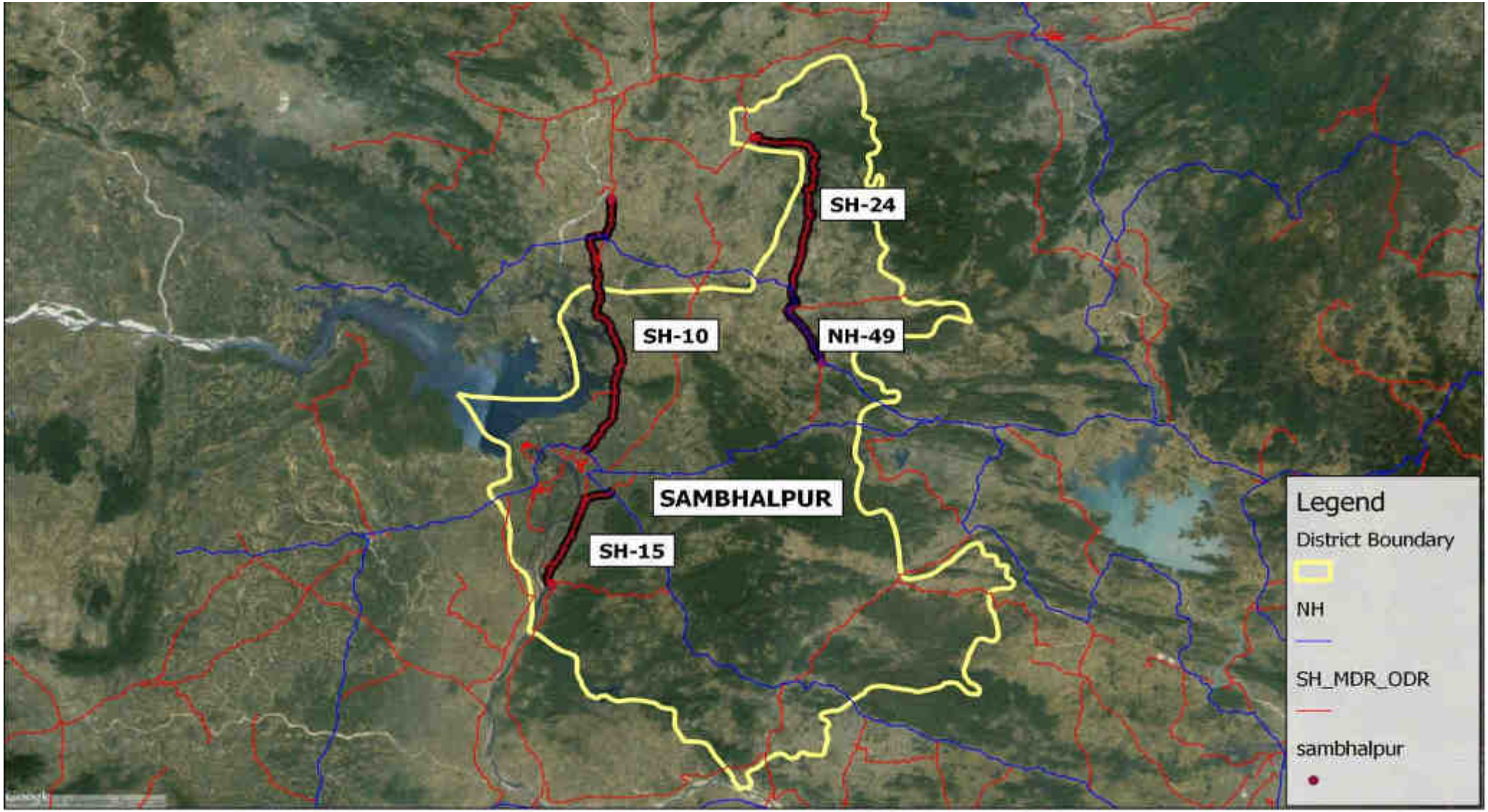
Table 12.1: List of roads assessed in Sambalpur District

Sr. No.	Road Name	Location & Chainage	Length in Km
1	SH-15	(Sambalpur to Dhama: Km 0+000 to Km 24+000)	24.00
2	SH10	(Sambalpur-Jharsuguda-Sundargarh-Rourkela: Km 4+900 to Km 167+400)	162.50
3	SH24	(Bamra to Kuchinda: Km 196+600 to Km 154+200)	42.40
4	NH49	(Kuchinda to Bhojpur Km 310+2 to Km 328+300)	18.10

Note: SH-10 travels through Sambalpur, Jharsuguda and Sundargarh districts, however the report of safety assessment has been presented under Sambalpur district for the entire stretch of road.

The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.** The map of the road assessed in Sambalpur district is shown in **Figure 12.9.**

Figure 12.9: Map of Roads Assessed in Sambalpur District



12.3. RSA – National Highways

12.3.1. NH-49: Kuchinda – Bhojpur (Km 310+200 to Km 328+300)

- The safety assessment of NH-49 was conducted from Km 310+200 which is an intersection with SH-24 (Bamra-Kuchinda Road) up to Km 328+300 which is an intersection with MDR (Bhojpur-Jamankira Road) at Bhojpur village.
- The initial stretch of road up to Km 311+000 is single lane and beyond up to Km 328+300 is intermediate lane (5.5m wide).
- The entire stretch of road is having bituminous surface with good condition, except the stretch of road through BUA of Bhojpur which is in poor condition.
- The width of earthen shoulder is <=1m in the stretch from Km 310+200 to 322+000, and beyond the width is in the range of 1m to 2m.
- The road alignment passes largely through open/agricultural land use.
- The observed traffic mix comprises of few heavy commercial vehicles; and significant numbers of 2-wheelers, 3-wheelers, buses, small commercial vehicles, and bicycles.

12.3.1.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**The centerline was observed to be marked in almost entire section of road whereas the edge line is present only from Km 315+000 to Km 328+000**.
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

12.3.1.2. Alignment – Sharp Horizontal Curves

Sharp horizontal curves of radius less than 75m were observed at,

- Km 313+600
- Km 316+000
- Km 317+300
- Km 317+500
- Km 317+700
- Km 325+600

Sharp horizontal curves of radius in the range of 75m to 150m were observed at,

- Km 312+000
- Km 312+800
- Km 323+700

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 12:00 hrs to 13:00 hrs, from Km 328+000 to Km 316+900. An average speed of 65 km/ hour and a maximum speed of 70 km/ hour was noted during this survey. A spot speed was conducted on approach of the curve at Km 312+000, and the 85th percentile speed was found to be 61 kmph.

Sharp curve at Km 312+000 and Km 316+000 (in BUA)

Concerns & Recommendations

Reasons for concern:	Unexpectedly sharp horizontal bends will lead to crashes when drivers try to negotiate them at high speed; which can lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	**Desirable** – Improve the line of sight by removing obstructing trees or buildings or improve horizontal alignment on such tight bends. **Essential**: Provide curve treatments with a combination of traffic signs, road markings, delineators and crash barriers; Traffic signs for curve treatment include curve warning signs and chevron signs. *Refer to Appendix III for guidelines on treatment on curves.*
Reasons for concern:	On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.
Recommendations:	For delineation at all these sharp curves provide chevron signs.
Reasons for concern:	On the curves with high embankment (at Km 312+800 and 313+600) without any protection on outer edge there is high risk of run-off accidents.
Recommendations:	Provide crash barriers on the outer edge on such curves.

12.3.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to main road
- Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road

- Km 312+900
- Km 314+100
- Km 320+900
- Km 321+500
- Km 321+500

Location of Side roads at skew with the major road

- Km 319+800
- Km 320+400
- Km 327+800

Photographs of side roads joining SH-10 with unsafe situations are given below.

Restricted visibility from access road due to buildings and trees on corners, Km 312+900

Access road joining NH-49 at skew angle, Km 319+800

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on NH-49 are due to buildings or trees on the corners.

Recommendations:

Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

12.3.1.4. Major Junctions

3-armed junction at Km 310+200

The salient features of the junction are as follows:

- NH-49 intersects with SH-24 (Kuchinda – Bamra road) at this place forming a y-type junction
- There is no control over traffic movement at this junction
- There are buildings in the middle of intersection forming island which obstructs visibility
- Lack of street lights

Km 310+200, intersection of NH-49 with SH-24 – built up area and buildings in the middle of intersection

3-armed junction at Km 314+600

The salient features of the junction are as follows:

- A major town road of Kuchinda intersects with NH-49 at this place
- Lack of street lights

Km 314+600, intersection of NH-49 with Kuchinda town road (north of Kuchinda)

3-armed junction at Km 315+200

The salient features of the junction are as follows:

- At this place Kuchinda-Kusumi Road (MDR) joins with NH-49
- There is no control on traffic movement at this junction
- The shoulders are encroached by roadside vendors and the buildings are very near the road edge

Km 315+200, intersection of NH-49 with MDR (Kuchinda-Kusumi Road)

3-armed junction at Km 316+900

The salient features of the junction are as follows:

- A major town road of Kuchinda intersects with NH-49 at this place
- This is a y-type non-standard junction without any provision for traffic control
- There is an island with buildings and trees at the intersection which restricts the visibility of two approaches

Km 316+900, intersection of NH-49 with Kuchinda town road (south of Kuchinda) – non-standard island with buildings and trees obstructing visibility

3-armed junction at Km 328+300

The salient features of the junction are as follows:

- Bhojpur-Jamankira road (MDR) joins NH-49 at this place.
- The visibility from all the three approaches of the intersection is severely restricted due to the buildings quite close the road edge.
- There is no control on traffic movement at this junction

Km 328+300, intersection of NH-49 with MDR (Bhojpur-Jamankira road)

The concerns and recommendations to improve safety at the above mentioned intersections are given below.

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The layout at all these junctions is non-standard and has no control over the traffic movement.
- It is confusing who has priority in such a situation which encourages lawless traffic movement.
- There are buildings and trees on some of these junctions which obstructs visibility of approaching traffic.

Recommendations:

- Remove the encroachment/obstruction

- Provide road markings pertaining to junction layout
- Provide acceleration and deceleration lanes on both the approaches
- Provide channelization to control the traffic movement

Refer to Appendix III for standard layout of 3-arm junction

Reasons for concern:

Poor delineation

- Traffic signs and road markings are not provided, the presence of which would have informed and warned the road user of the intersection ahead.

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.
- Provide "intersection ahead" warning sign before the intersection on all approaches.
- Provide Give Way or STOP sign with road markings on both the town road and village road.

Refer to Appendix III for guidelines road markings and traffic signs on 3-arm junction

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm junction

Reasons for concern:

Provision for VRUs

- No provision for walking along the road or crossing by pedestrians/bicycles.
- Pedestrians were observed using the road for commuting, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Provide footpath on all the approaches to the junction
- Provide pedestrian crossings for safe crossing by pedestrians and bicycles.
- Provide on the road cycle lanes (1m wide) on approaches to the junction

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.

12.3.1.5. Approach to Bridges

Approaches of bridges/culverts with high embankment without any protection were noted in the following locations

- Km 313+300
- Km 317+400

Bridge at Km 313+300, no edge protection on approaches

Bridge at Km 317+400, Sharp curve on approaches

Concerns & Recommendations

Reasons for concern:	**Sharp curve at the approach at Km 317+400** There is no delineation or warning signs at the sharp curve just before the narrow culvert. The vehicles may run-off trying to negotiate the curve at higher speeds. As there are no parapets on the culvert, the vehicle may fall in the drain.
Recommendations:	Improve delineation of the approach curve by providing, • Chevron signs and curve warning signs • Edge marking and continuous center line *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Reasons for concern:	**Unprotected approach to bridge at Km 313+300** If a vehicle approaching the bridge loses control, it will fall into the ditch/drain in the absence of any protection, which may result into serious injuries or may prove to be fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

12.3.1.6. Road side hazards - Parapets of narrow bridges

At following locations the parapets of bridge are not delineated,

- Km 313+300
- Km 317+400

Parapets of bridge not delineated, Km 313+300 and Km 317+400

Concerns & Recommendations	
Reasons for concern:	**No delineation of bridge parapets** The bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.
Recommendations:	Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure). *Refer to Appendix III for guidelines for installation of object hazard markers*

12.3.1.7. Road side hazards - Trees, Poles, and Buildings

There are several road side objects observed on NH-49 such as, trees, poles or shops (in BUA) in the range of 1-3m from the edge of road.

Concerns & Recommendations	
Reasons for concern:	• The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be protected and/or delineated. • At night time it becomes very difficult for drivers to judge the position of such road side hazard. • If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Remove encroachments from the right of way • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips • Remove encroachments on at least 2m from the road edge

Trees very near the road edge, Km 319-320

Buildings and poles very near the road edge in BUA, Km 321-322

12.3.1.8. Road side Villages/ Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations on NH-49,

- Km 310+200 to 311+000
- Km 312+800 to 313+000
- Km 314+000 to 316+000 Kuchinda
- Km 321+000 to 321+60
- Km 328+000 to 328+300 Bhojpur

On-street parking and commercial activities on road in Kuchinda, Km 14+000 to 16+000

Buildings near the road edge in Bhojpur, Km 328+000 to 328+300

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead

- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools

Refer to Appendix III for safe infrastructure arrangement for roadside villages in rural areas and for heavily built up section.

Reasons for concern: Road side commercial activities result into parking and encroachment.

Recommendations: Regulate roadside commercial activities and remove encroachments, if any.

12.4. RSA – State Highways

12.4.1. SH-15, Maneshwar – Dhama (Km 0+000 to Km 25+000)

The road takes off from Maneshwar on NH-42. The stretch of SH-15 from Km 0+000 to Km 5+100 is having intermediate lane (5.5m wide) and passes through largely agricultural land use. The motorized traffic on this section of SH-15 is very less, whereas significant movement of non-motorized traffic comprising of bicycles and pedestrians was observed. At Km 5+100 there is an intersection with link road, which connects SH-15 with Sambalpur city.

From Km 5+100 to Km 25+000 the road is having 2-lane width with 1.5m wide earthen shoulder. This section carries significant motorized traffic as compared to the previous section; also the non-motorized traffic is significant as many small villages are located along the road. The condition of road is good over entire stretch. The general speed of motorized traffic observed during day time was in the range of 50-70 kmph.

12.4.1.1. Delineation of the Road

Concerns & Recommendations	
Reasons for concern:	**The centerline was observed to be marked in the section form Km 0 to Km 19, and from Km 19 to Km 25 it was missing. The edge line was observed missing in the entire road length assessed.**
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

12.4.1.2. Alignment – Sharp Horizontal Curves

Sharp horizontal curves of radius less than 75m were observed at,

- Km 0+400
- Km 2+100
- Km 3+800
- Km 4+500
- Km 12+700
- Km 22+500

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 10:00 hrs to 11:00 hrs, from Km 10+000 to Km 25+000. An average speed of 59 km/ hour and a maximum speed of 78 km/ hour was noted during this survey. A spot speed was conducted on approach of the curve at Km 22+500, and the 85th percentile speed was found to be 48 kmph.


Image 1.1: Sharp curve with restricted visibility at Km 0+400 and Km 3+800

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment on curves.*
Reasons for concern:	**Poor visibility on the curve due to trees and overgrown vegetation**, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.
Recommendations:	For delineation at all these sharp curves provide chevron signs.
Reasons for concern:	On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment on outside curves. *Refer to Appendix III for guidelines on situations where to install the above*

12.4.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road

Km 2+200; 6+500; 7+800; 9+000; 10+800; 11+900; 12+700; 14+600; 15+700; 20+300; 22+900; 22+900; and Km 23+100.

Location of Side roads at skew with the major road

Km 4+400; Km 18+900; and Km 24+200.

Photographs of side roads joining SH-10 with unsafe situations are given below.

Restricted visibility from access road due to buildings on corners, Km 6+500

Access road joining SH-15 at skew angle and with steep gradient, Km 24+200

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-15 are due to buildings on the corners.

Recommendations:

Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the

concern: main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:
- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern: **Poor Geometry**

- It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations: Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for the desired geometric arrangement for T-junctions.

12.4.1.4. Major Junctions

(i) Km 0+000

SH-15 takes-off from NH-42 (which connects Bhubaneswar with Sambalpur) from this location forming a 3-arm intersection with NH-42.

The salient features of this intersection are as follows:

- NH-42 is having 2-lanes and carries significant motorized traffic, whereas SH-15 is having intermediate lane with less motorized traffic but significant amount of non-motorized traffic.
- There are no street lights or facilities for pedestrian crossing and footpath.

Km 0+000 Intersection of SH-15 wih NH-42 –
building in the middle of intersection, vehicles parked on road and presence of VRUs

Concerns & Recommendations

Reasons for concern: **Poor layout**

There is a building and street light poles in the middle of intersection obstructing visibility and smooth flow of traffic.

Recommendations: Remove the encroachment/obstruction and provide splitter islands to enable safe movement of motorized and non-motorized traffic.

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms, the presence of which would have informed and warned the road user of the layout ahead

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction.

Reasons for concern:

Direction Signs

There are no proper direction signs to guide the traffic through the junction layout which may result in to frequent or sudden stopping of vehicles and may lead to rear-end collision.

Recommendations: Provide proper direction signs to guide the traffic through the junction layout.

Reasons for concern:

Provision for VRUs

- There is no provision for walking along or crossing the road by pedestrians/bicycles despite of significant presence of pedestrians and bicyclists.
- Pedestrians were observed using the road for commuting and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Remove encroachments from the shoulder space.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.

Reasons for concern:

On-street Parking

- There are no parking spaces provided and vehicles are parked on road encroaching the road and shoulder space.
- This hampers visibility at the junction and force pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations: Provide designated parking spaces for vehicles.

Refer to Appendix III for parking arrangements in roadside commercial areas.

(ii) Km 5+100

At this location the link road from Sambalpur city joins with SH-15 forming a 3-arm intersection.

The salient features of this intersection are as follows:

- There is no built-up area and hence this location is free from any encroachment, on road parking, and presence of pedestrians and other VRUs.
- There is no control on movement of traffic.

Km 5+100 intersection of SH-15 with link road - lack of road markings and delineation

Concerns & Recommendations

Reasons for concern:

Poor layout

The junction is a non-standard Y-junction. The layout is confusing to the road user to decide the route to take in the absence of any direction signs and traffic control.

Recommendations:

- Re-design the junction layout
- Provide splitter islands to enable safe movement of motorized and non-motorized traffic

Refer to Appendix III for standard layouts of 3-arm junctions

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms, the presence of which would have informed and warned the road user of the layout ahead

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern:

Direction Signs

There are no proper direction signs to guide the traffic through the junction layout which may result in to frequent or sudden stopping of vehicles and may lead to rear-end collision.

Recommendations:

Provide proper direction signs to guide the traffic through the junction layout.

Reasons for concern:

Provision for VRUs

There is no provision for walking along or crossing the road by pedestrians/bicycles.

Recommendations:

- Remove encroachments from the shoulder space.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.

12.4.1.5. Approach to Bridges

At following locations the approaches of bridge/culvert are not protected,

- Km 0+400; Km 8+500; and Km 20+600.

Culvert at Km 0+400, sharp curve at the approach

Bridge at Km 20+600, No protection on approaches

Concerns & Recommendations	
Reasons for concern:	**Sharp curve at the approach at Km 0+400** There is no delineation or warning signs at the sharp curve just before the narrow culvert. The vehicles may run-off trying to negotiate the curve at higher speeds. As there are no parapets on the culvert, the vehicle may fall in the drain.
Recommendations:	Improve delineation of the approach curve by providing, • Chevron signs and curve warning signs • Edge marking and continuous center line To control the approach speed, provide rumble strips before the sharp curve. Provide parapet walls on the culvert.
Reasons for concern:	**Unprotected high embankment/approach to culvert/bridge at Km 8+500 and Km 20+600** If a vehicle approaching the culvert/bridge loses control, it will fall into the ditch/drain in the absence of any protection, which may result into serious injuries or may prove to be fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*

12.4.1.6. Road side hazards - Parapets of narrow Culverts/ Bridges

At following locations the parapets of bridge/culvert are either missing or broken,

- Km 0+400
- Km 3+100
- Km 12+000
- Km 20+000


No parapets on Culvert/Bridge highly unsafe for VRUs as well as other traffic, Km 12+000 and Km 20+000

At following locations the parapets of bridge/culvert are not delineated,

- Km 0+400
- Km 3+100
- Km 8+500
- Km 11+700
- Km 12+000
- Km 20+000
- Km 20+600


Parapets of Culvert/Bridge not delineated, Km 8+500 and Km 11+700

Concerns & Recommendations

Reasons for concern:	**No delineation of culvert/bridge parapets** The culvert/bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.
Recommendations:	Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure) *Refer to Appendix III for guidelines for installation of object hazard markers*
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on SH-15, the absence of parapets at such locations are hazardous for traffic, especially for VRUs.
Recommendations:	Provide continuous parapets on all culverts and bridges.

12.4.1.7. Roadside Hazards - Trees, Poles, and Buildings

There are several road side objects observed on SH-15 such as, trees, poles or shops (in BUA) in the range of 1-3m from the edge of road.

Concerns & Recommendations

Reasons for concern:

- The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

Tree very near the road edge, Km 19-20

Buildings very near the road edge in BUA, Km 23-24

12.4.1.8. Road side Villages/ Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations on SH-15,

- Km 0+000 to 0+200
- Km 6+200 to 6+600
- Km 9+900 to 10+000
- Km 10+700 to 11+000
- Km 12+300 to 12+800
- Km 14+600 to 14+800
- Km 15.600 to 15.900
- Km 22+800 to 24+000 (Dhama village)

- Although there is significant movement of VRUs at these locations, the facility for VRUs such as pedestrian crossing or footpath are not provided, except marked pedestrian crossing in the BUA at Km 12+300 to 12+800.
- At none of the above mentioned locations the street lights are provided.

On-street parking and commercial activities on road in BUA, Km 15.600 to 15.900

Buses stopping on the road in BUA, Km 9+900 to 10+000

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- On road bus stops which hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:

- Provide Gateway signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for safe infrastructure arrangement for roadside villages in rural areas and for heavily built up sections and design of on street bus stops and bus bays.

Reasons for concern: Road side commercial activities result into parking and encroachment.

Recommendations: Regulate roadside commercial activities and remove encroachments, if any.

12.4.2. SH-10: Sambalpur – Sundargarh - Rourkela (Km 4+922 to Km 167+400)

The road starts from junction of SH 10 with NH6 at Sambalpur and entire length has 2-lane undivided carriageway with 1.5m paved shoulders. The road passes through diverse land use and connects Sambalpur with Jharsuguda, Sundargarh, and Rourkela. As there are many industries located on SH-10 around Jharsuguda and Rourkela there is heavy commercial traffic on the entire stretch. The road is generally in good condition.

12.4.2.1. Delineation of the road

Lack of any road markings on the stretch from Km 6+000 to 7+000 and Km 36+000 to 37+000

Concerns & Recommendations	
Reasons for concern:	Centerline and edgeline road markings are not provided in almost 50 percent of the road section, in particular between km. 38+000 to km. 108+000.
Recommendations:	• Provide edge line and centre line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

12.4.2.2. Alignment – Sharp Horizontal Curves

Horizontal curves of radius less than 200m were observed at,

- Km 18+400
- Km 20+900
- Km 27+800
- Km 39+100
- Km 58+000
- Km 66+500
- Km 86+500
- Km 97+200
- Km 98+000
- Km 101+000
- Km 101+800
- Km 108+500
- Km 110+500
- Km 129+000
- Km 135+700
- Km 149+000
- Km 153+900
- Km 154+900
- Km 160+000

Horizontal curves of radius less than 200m with access road were observed at,

- Km 22+800
- Km 23+400
- Km 45+800

Horizontal curves of radius less than 200m with embankment (more than 2m height) were observed at,

- Km 42+100
- Km 45+000
- Km 93+600
- Km 100+700
- Km 103+900
- Km 153+500

Horizontal curves of radius less than 200m with combination of access road and embankment were observed at,

- Km 107+800
- Km 112+000
- Km 149+800

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 17:00hrs to 18:00hrs, from Km 153+000 to Km 86+000. An average speed of 56 km/ hour and a maximum speed of 72 km/ hour was noted during this survey. A spot speed was conducted on approach of the curve at Km 36+000 and Km 93+600, and the 85th percentile speed was found to be 56 kmph and 54 kmph.

Sharp curve where visibility is obstructed due to wall and trees (on LHS), Km 107+800

Sharp curve with high embankment without any protection on outer edge, Km 93+600

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment on curves.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down

vegetation which hampers visibility along the curves

Reasons for concern: Curves on high embankment without safety barriers noted

- Run-off accidents on high embankments will lead to fatalities

Recommendations: Provide metal beam crash barrier with delineators on sharp curves in high embankment

Refer to Appendix III for guidelines on situations where to install the above

12.4.2.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

Km 6+000; 10+400; 16+200; 18+200; 19+700; 22+800; 25+900; 34+000; 37+200; 46+600; 48+100; 48+000; 50+100; 50+700; 50+700; 56+900; 57+300; 58+700; 58+900; 60+300; 60+600; 62+500; 63+500; 64+800; 68+400; 68+600; 68+600; 71+500; 72+200; 72+800; 75+300; 76+700; 78+000; 79+400; 81+300; 82+300; 82+300; 94+400; 98+000; 99+300; 102+100; 105+100; 107+900; 107+900; 112+000; 112+900; 112+900; 116+600; 118+200; 119+100; 121+800; 124+700; 125+900; 130+800; 139+600; 141+000; 142+000; 146+100; 148+200; 151+000; 155+700; 156+900; 159+100; 162+500; 165+600; and Km 166+900.

Location of Side roads at skew with the major road

Km 6+300; 12+900; 13+600; 23+300; 34+600; 35+800; 39+300; 40+000; 45+800; 49+000; 53+300; 54+600; 54+600; 90+900; 98+400; 101+400; 107+800; 111+600; 115+900; 137+700; 149+800; 153+200; and Km 153+400.

The selected photographs of side roads joining SH-10 on the assessed section are given below.

Side Road joining SH-10 at acute angle, Km 149+800

Side Road joining SH-10 at steep gradient, Km 12+900

Side road joining SH-10 on curve, Km 35+800

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

- This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-10 are due to encroachments.

Recommendations:

Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:

Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for the desired geometric arrangement for T-junctions.

12.4.2.4. Major Junctions

4-armed roundabout at Km 4+922

The salient features of the roundabout are as follows:

- Junction layout is fine.
- Busy junction of NH6 with SH10, having significant movement of heavy vehicles
- Traffic signal lights provided, but in not synchronized
- Footpaths are provided in the junction area on all the approaches, but there are no facility for pedestrian crossing
- There are no encroachments in the junction area on SH-10 approach, however the footpaths are encroached with trees and small shops
- Street lights are provided on the approaches of the junction

Round-about at Km 4+922, commercial establishments and on-street parking on its approach

Concerns & Recommendations

Reasons for concern: **Poor delineation**

- Traffic signs and road markings are absent in any of the arms, the presence of which would have informed and warned the road user of the layout ahead

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at roundabouts

Reasons for concern: **Direction Signs**

- No direction signs to guide the traffic through the junction which may result in frequent or sudden stopping of vehicles and may lead to rear-end collision.

Recommendations:

- Provide proper direction signs (over-head gantry and shoulder mounted) to guide the traffic through the junction layout.

Refer to Appendix III for guidelines for design of direction signs.

Reasons for concern: **Provision for VRUs**

- Footpaths in the intersection area are encroached by overgrown vegetation or the commercial establishments.
- No provision for crossing by pedestrians/bicycles despite of significant presence of pedestrians and bicyclists.
- Pedestrians were observed using the road for commuting, instead of the footpath, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Remove encroachments from the footpaths.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the roundabout

Reasons for concern: **On-street Parking**

- No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space, hampering visibility.
- This forces pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations:

- Provide designated parking spaces for commercial vehicles

4-arm Intersection at Km. 83+800

The intersection is located on Sundargarh bypass section of SH-10 and Sundargarh town road and a village road joins SH-10 from either sides. The major road safety issues at this location are as follows:

- Junction layout is non-standard and has no established control over the traffic movement

Km 83+800, intersection of SH-10 with Sundargarh town road

Concerns & Recommendations

Reasons for concern:

Poor Layout

The junction layout is non-standard and has no established control over the traffic movement

Recommendations:

- Provide road markings pertaining to junction layout
- Provide acceleration and deceleration lanes on both the approaches
- Provide channelization to control the traffic movement

Refer to Appendix III for standard layout of 4-arm junction

Reasons for concern:

Poor delineation

- Traffic signs and road markings are not provided, the presence of which would have informed and warned the road user of the intersection ahead.

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.
- Provide "intersection ahead" warning sign before the intersection on all approaches.
- Provide Give Way or STOP sign with road markings on both the town road and village road.

Refer to Appendix III for guidelines road markings and traffic signs on 4-arm junction

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Concerns & Recommendations

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 4-arm junction

Reasons for concern:

Provision for VRUs

- No provision for walking along the road or crossing by pedestrians/bicycles.
- Pedestrians were observed using the road for commuting, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Provide footpath on all the approaches to the junction
- Provide pedestrian crossings for safe crossing by pedestrians and bicycles.
- Provide on the road cycle lanes (1m wide) on approaches to the junction

Reasons for concern:

On-street Parking

- No parking spaces provided for commercial vehicles and vehicles are parked encroaching the road and shoulder space. This hampers visibility at the junction resulting in hazardous situation.

Recommendations: Provide designated parking spaces for commercial vehicles

Major 3-arm Junctions

The road has numerous major 3-arm intersections, at the following locations, where channelization/ splitter islands have been provided.

3- arm Junctions with Splitter Islands

- Km. 47+000
- Km 52+500
- Km. 55+700
- Km 78+400
- Km 79+700
- Km 85+500
- Km 91+300
- Km 167+400

3-arm Junctions without Splitter Islands

- Km 12+400
- Km 15+700
- Km 109+700
- Km 133+600
- Km 142+300
- Km 145+600
- Km 166+400

Concerns & Recommendations

Reasons for concern:

Poor Layout

The layout of junctions is non-standard and has no established control over the traffic movement

Recommendations:

- Provide road markings pertaining to junction layout
- Provide acceleration and deceleration lanes on both the approaches
- Provide channelization to control the traffic movement, at junctions without splitter islands

Refer to Appendix III for standard layout of 3-arm junction

Reasons for concern:

Poor delineation

- No road markings and traffic signs are provided to establish safe movement of traffic.

Recommendations:

- Provide "intersection ahead" sign before the intersection on all approaches
- Provide Give Way/ Stop signs on the minor road at appropriate locations before it merges into the major road
- Provide edge lines, center lines, and other road markings required for junction control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern:

Unsafe/ non-standard splitter islands

The channelization at some of the junctions has been provided in the form of splitter islands, however some of these are non-standard type and unsafe for pedestrians.

Recommendations:

- Provide channelization with proper splitter islands, and road markings.
- Provide refuge for pedestrians on the splitter islands so that pedestrians can safely cross the road.

Refer to Appendix III for standard layout of 3-arm junction

Reasons for concern:

High approach speed

- Traffic approaching from both SH-10 and intersecting roads were observed with high approach speeds. This may lead to crashes resulting in serious injury or fatality.

Recommendations:

- Provide traffic calming measures such as road humps or cross bar markings on the minor roads
- Provide warning signs (Give Way)on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

Refer to Appendix III for guidelines for design of road humps

Reasons for concern:

Provision for VRUs

- Significant movement of pedestrians and bicyclists are noted, but no separate provisions have been made
- Pedestrians are particularly vulnerable at such junctions having high approach speed of traffic
- Existing shoulder space at junctions are encroached by overgrown vegetation or by commercial activities
- Pedestrian crossing facility not provided on any of the intersection.

Recommendations:

- Remove encroachments from the shoulder space and provide clean and wide shoulder space for pedestrians to walk along the junction without getting exposed to high speed motorized traffic

Provide marked pedestrian crossings at appropriate safe locations.

Reasons for concern:	**Hoarding obstructing visibility** At some of the above listed intersections the hoardings obstruct visibility of approaching traffic as well as distract the attention of drivers. This may result in intersection collision (head-on / right-angle / rear-end).
Recommendations:	Remove such hoardings from the intersection area.
Reasons for concern:	There are no street lights on many of the above listed intersections. During dark hours the pedestrians and bicycles are at higher risk as they are exposed to high speed traffic and this may result in to fatal accidents.
Recommendations:	Provide street lights on the intersection where there is significant movement of VRUs during dark hours.
Reasons for concern:	**On street Bus stop** • Buses were observed stopping on the road on intersection obstructing the visibility and flow of through traffic
Recommendations:	• Provide bus-bays with appropriate traffic signs and lane markings *Refer to Appendix III for guidelines for design of bus bays and on-street bus stops*

12.4.2.5. Bridge approaches on high embankment

Approaches of bridges/ culverts with high embankment without any protection were noted in the following locations.

- Km 29+500
- Km 49+900
- Km 65+500
- Km 101+600
- Km 108+400
- Km 117+100
- Km 119+900
- Km 134+600
- Km 153+800
- Km 165+400

No edge protection on approaches of ROB at Km 49+900 and Bridge at Km 101+600

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** If a vehicle lose control while approaching the bridge, run-off accidents may occur which may lead to multiple fatalities/ major injuries
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Reasons for concern:	**Poor delineation** • Traffic signs are not provided to warn the road user of the curve and structure ahead • In the absence of warning/ information, road users may approach the curve in undesirable speed which can lead to run-off accidents
Recommendations:	• Provide 'Curve Ahead' warning signs to warn the road user of the layout ahead.

12.4.2.6. Road side hazards - Parapets of narrow Culverts/ Bridges

At following locations the parapets of bridge/culvert were found either missing or broken resulting in highly hazardous situation for VRUs and motorized road users.

- Km 11+500
- Km 56+900
- Km 61+700
- Km 65+500
- Km 100+800
- Km 101+600
- Km 117+100
- Km 153+800

Broken parapets of Bridge highly unsafe for VRUs as well as other traffic, Km 117+100 and Km 154+200

In addition, at the following locations, it has been observed that the parapets of bridge/culvert are not delineated.

- Km 11+500
- Km 22+900
- Km 29+500
- Km 32+200
- Km 34+800
- Km 41+800
- Km 49+900
- Km 51+100
- Km 56+900
- Km 61+700
- Km 65+500
- Km 105+500
- Km 108+400
- Km 117+100
- Km 118+500
- Km 119+900
- Km 122+000
- Km 134+600
- Km 138+500
- Km 141+700
- Km 144+300
- Km 153+800
- Km 159+400
- Km 165+400

Parapets of Bridge not delineated, Km 32+200 and Km 165+400

Concerns & Recommendations

Reasons for concern:	**No delineation of bridge parapets** • The bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.
Recommendations:	• Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure) *Refer to Appendix III for guidelines for installation of object hazard markers*
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling on to the canal. In the context of high speed traffic movement observed on SH-10, the absence of parapets at such locations is hazardous for traffic, especially for VRUs.
Recommendations:	Provide continuous parapets on all culverts and bridges.

12.4.2.7. Roadside Hazards - Trees, Poles, and Buildings

Hazardous road side objects such as, trees, poles or shops (in BUA) were observed on SH-10 at several locations very near to the edge of road (within 1 to 2m from the edge of road).

Building (LHS) and Tree (RHS) very near to the road edge, Km 60+000 to 61+000

Deep drain and property access very near to the road edge, Km 74+000 to 75+000

Concerns & Recommendations

Reasons for concern: Roadside objects constitute a significant hazard, if the driver loses control and will result in major injuries/ fatalities

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

12.4.2.8. Road side Villages/ Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations on SH-10.

- Km 5+000 to 6+000
- Km 11+000 to 11+100
- Km 16+000 to 16+200
- Km 18+000 to 18+300
- Km 22+700 to 22+900
- Km 23+300 to 24+000
- Km 24+000 to 25+000
- Km 25+800 to 26+000
- Km 32+500
- Km 34+400 to 34+600
- Km 39+000 to 39+500
- Km 39+800 to 40+600
- Km 43+000 to 43+300
- Km 60+500 to 60+700
- Km 68+300 to 68+600
- Km 72+700 to 72+900
- Km 75+200 to 75+400 Bhedabahal
- Km 76+500 to 76+800 Kandabahal
- Km 78+000 to 78+400
- Km 91+000 to 91+800 Karamdihi
- Km 99+000 to 99+400 Jaranglvi
- Km 111+900 to 112+200 Bargaon
- Km 112+500 to 112+800 Badagaon
- Km 113+000 to 113+400 Badagaon
- Km 124+600 to 124+800 Diringatoli
- Km 130+000 to 131+000 Kutra

- Km 45+000 to 46+000
- Km 46+000 to 47+000
- Km 52+000 to 53+000
- Km 53+000 to 54+000
- Km 54+000 to 55+000
- Km 55+000 to 56+000
- Km 56+500 to 56+900
- Km 62+400 to 62+600 Talpatia
- Km 144+300 to 146+000 Rajgampur
- Km 146+000 to 146+300
- Km 149+700 to 150+000 Laing
- Km 153+200 to 153+400 Pilaigarh
- Km 154+300 to 154+500 Kansbahal
- Km 154+800 to 155+700 PIET Edu. Institute
- Km 158+600 to 159+000

Industrial and commercial built up areas were observed at following locations on SH-10,

- Km 28+000 to 29+000
- Km 118+200
- Km 127+000 to127+100
- Km 140+900 to 141+000
- Km 141+000 to 141+300
- Km 159+000 to 159+800
- Km 160+500 to 160+700
- Km 161+000 to162+000
- Km 164+400 to 164+700
- Km 166+000 to 167+000
- Km 167+000 to 167+400

Vehicles parked on road in BUA, Km 5-6

Buildings very close to edge of road in BUA, Km 62-63 Talpatia village

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA

- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for safe infrastructure arrangement for roadside villages in rural areas and for heavily built up sections.

12.4.2.9. Specific Locations - ROB at the end of sharp curve at Km 18+400

The key issues affecting road safety are:

- ROB is at the end of a sharp curve (radius <75m) and there is an access road merging with SH-10 at this location
- No traffic calming measures on major road and side road

As informed by engineers from OWD, the approach to the ROB is a black-spot location having frequent number of accidents, especially during night conditions.

Access Road (on Left), ROB and Sharp Curve.

Traffic approaching sharp curve and ROB (view from the Access Road)

Concerns & Recommendations	
Reasons for concern:	**Poor visibility and poor delineation** The south-bound drivers, not able to recognize the sharp curve and ROB, may collide with the wall of ROB while trying to negotiate the curve. The situation may result in fatal accident of vehicles moving at high speed.
Recommendations:	• Provide edge lines in the entire section of road. • Provide road studs on both the edges and center line. • Provide no-overtaking (continuous center line) line in the section of sharp curve and on the ROB • Provide curve warning sign and no-overtaking sign before the curve • Provide rumble strip before sharp curve and after the ROB • For improved delineation paint the wall of ROB in yellow and white strips • Provide rumble strips with warning sign, and STOP sign on the side road

12.4.3. SH-24: Kuchinda – Bamra (Km 154+200 to Km 196+600)

- The safety assessment of SH-24 was conducted from Km 154+200 which is an intersection with NH-49 up to Km 196+600 at Bamra which is an intersection with SH-31 Gariamal-Bamra road.
- The road is having single lane up to Km 193+000 and beyond it is having intermediate lane (5.5 m wide) in the Bamra town.
- The entire stretch of road is having bituminous surface with condition ranging from fair to good. The earthen shoulder is less than1m wide in the entire stretch.
- The condition of earthen shoulder is very poor in some stretches which may prove to be hazardous for the VRUs (as shown in photographs below).


Poor condition of earthen shoulder, Km 155-156 and Km 191-192

The road alignment passes largely through open/agricultural land use, except forest/ghat section from Km 171+500 to Km 184+500. The observed traffic mix comprises of few heavy commercial vehicles; and significant numbers of 2-wheelers, 3-wheelers, buses, small commercial vehicles, and bicycles.

12.4.3.1. Delineation of the Road


Photographs of SH-24 in rural and urban areas where no road markings are provided
(Km 154 to 155, and Km 155 to 156)

Concerns & Recommendations	
Reasons for concern:	**Centerline and edgeline (road markings) are absent in entire stretch of the road**.

Recommendations:

- Provide edge line with thermoplastic material throughout the road.
- Provide centre line with thermoplastic material on intermediate lane road (refer to IRC: 35-1997 for details).
- Provide edge and centre line RRPMs on sharp curves

12.4.3.2. Alignment – Sharp Horizontal Curves

There are many curves with radius less than 100m on SH-24.

Sharp horizontal curves of radius less than 100m were observed at,

- Km 173+500
- Km 175+900
- Km 195+300

Series of sharp horizontal curves within distance of 200m were observed at,

- Two curves at Km 169+100 in BUA of Kesaibahal village;
- Two curves at Km 169+700;
- Two curves at Km 174+900 in forest/ghat section;
- Two curves at Km 175+900 in forest/ghat section;
- Three curves at Km 183+300 in forest/ghat section; and
- Three curves at Km 198+700 near railway crossing in BUA of Bamra town

The sharp curve after the railway crossing in Bamra is on high embankment without any edge protection and the condition of earthen shoulder is very poor, hence there is high risk of run-off accidents at this location.

During the course of assessment, the consultant has carried out average running speed survey. The average speed and maximum speed were noted for one trial run on the road during 12:00 hrs to 13:00 hrs, from Km 154+200 to Km 196+600. An average speed of 45 km/ hour and a maximum speed of 64 km/ hour was noted during this survey. The spot speed survey on approaches of sharp curves could not be conducted as all the sharp curves are either in BUA or in the forest/ghat section.

Sharp curve with restricted visibility in forest/ghat section at Km 174+900

Sharp curve on high embankment without edge protection near railway crossing at Bamra (Km 198+700)

Concerns & Recommendations	
Reasons for concern:	Unexpectedly sharp horizontal bends will lead to crashes when drivers try to negotiate them at high speed. On SH-24 where a number of sharp curves are in the forest/ghat section with severely restricted visibility the vehicles can lose control and this can result in serious injuries or fatalities. Possible type of collisions are: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on treatment on curves.*
Reasons for concern:	Curves on high embankment without safety barriers noted • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	Overtaking on such sharp curves may lead to head-on collision
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves • Provide "no-overtaking" mandatory signs • Provide extra widening (sealed shoulder)
Reasons for concern:	**Sharp curves in BUA** VRUs in the BUA are at high risk as they share space with the high speed traffic
Recommendations:	Provide all the curve treatments mentioned above in addition to traffic calming measures and speed restriction signs in the BUA

12.4.3.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road

- Km 156+600
- Km 159+300
- Km 159+600
- Km 162+100
- Km 165+100
- Km 165+100
- Km 166+400
- Km 180+600
- Km 184+500
- Km 191+700
- Km 195+300

Location of Side roads at skew with the major road

- Km 157+400
- Km 170+100

Photographs of side roads joining SH-24 with unsafe situations are given below.

Side road joining at skew angle Km 157+400

Side road joining on curve, Km 170+100

Concerns & Recommendations

Reasons for concern: **Inadequate Visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-24 are due to buildings or trees on the corners.

Recommendations: Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle of junctions.

Reasons for concern: **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern: **High approach speeds**

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

12.4.3.4. Major Junctions

3-armed junction at Km 154+200

The salient features of the roundabout are as follows:

- SH-24 intersects with NH-49 (Kuchinda – Bhojpur road) at this place forming a y-type junction.
- There is no control over traffic movement on this junction.

4-armed junction at Km 196+600

The salient features of the roundabout are as follows:

- SH-24 intersects with SH-31 (Gariamal-Bamra road), and a town road forming a 4-arm intersection in the heart of Bamra town.
- There is no control over traffic movement on this junction.
- The buses were observed stopping on the road near the intersection obstructing visibility and smooth flow of traffic.

Km 154+200, intersection of SH-24 with NH-49– built up area and buildings in the middle of intersection

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout at both the junctions is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users. A roundabout will work better for the intersection at Km 196+600, but require detail study and design. *Refer to Appendix III for standard layout of 3-arm and 4-arm junctions.*
Reasons for concern:	**Poor delineation** • Traffic signs and road markings are not provided, the presence of which would have informed and warned the road user of the intersection ahead.

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.
- Provide "intersection ahead" warning sign before the intersection on all approaches.
- Provide Give Way or STOP sign with road markings on both the town road and village road.

Refer to Appendix III for guidelines road markings and traffic signs on 3-arm and 4-arm junctions

Reasons for concern: **Hampered visibility due to buildings/structures**

The buildings and trees in the middle of intersection obstructs visibility of traffic approaching the intersection.

Recommendations: Remove the buildings and trees and provide traffic island for smooth flow of traffic

Refer to the Appendix III for guidelines on visibility triangle at junctions.

Reasons for concern: **Direction Signs**

- No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm and 4-arm junctions

Reasons for concern: **Provision for VRUs**

- No provision for walking along the road or crossing by pedestrians/bicycles.

Recommendations:

- Provide shoulder space clear from encroachments and vegetation on all the approaches to the junctions.

12.4.3.5. Approach to Bridges

Approaches of bridges/culverts with high embankment without any protection were noted in the following locations.

- Km 155+200
- Km 164+700
- Km 168+100
- Km 172+700
- Km 175+000
- Km 187+700

Unprotected approach to bridge with high embankment, Km 164+700 and Km 187+700

Concerns & Recommendations

Reasons for concern: **Unprotected approaches to culvert/bridge**

If a vehicle approaching the culvert/bridge loses control, it will fall into the ditch/drain in the absence of any protection, which may result into serious injuries or may prove to be fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges.

12.4.3.6. Road side hazards - Parapets of narrow Culverts/ Bridges

At following locations the parapets of bridge/culvert are either missing or broken,

- Km 155+200
- Km 175+000

No parapets on Culvert/Bridge highly unsafe for VRUs as well as other traffic, Km 155+200 and Km 175+000

At following locations the parapets of bridge/culvert are not delineated,

- Km 155+200
- Km 164+700
- Km 168+100
- Km 172+700
- Km 175+000
- Km 177+000
- Km 187+700

Parapets of Culvert/Bridge not delineated, Km 172+700 and Km 187+700

Concerns & Recommendations

Reasons for concern:	**No delineation of culvert/bridge parapets** The culvert/bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.
Recommendations:	• Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure) *Refer to Appendix III for guidelines for installation of object hazard markers*
Reasons for concern:	**Broken or missing parapets** The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. The absence of parapets at such locations is hazardous for traffic, especially for VRUs.
Recommendations:	• Provide continuous parapets on all culverts and bridges.

12.4.3.7. Road side hazards – Poles, and Buildings

There are several road side objects observed on SH-24 such as, poles or buildings (in BUA) in the range of 1-3m from the edge of road.

Poles very near the road edge in BUA, Km 169+000-169+700

Concerns & Recommendations

Reasons for concern:

- The road side objects like, street light or other poles, and buildings which are near the edge of road needs to be protected and delineated.
- At night time it becomes very difficult for drivers to judge the position of such road side hazard.
- If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations:

Desirable:

- Remove street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

12.4.3.8. Built-up Areas (BUA)

Road side villages and built-up areas were observed at following chainages on SH-24.

- Km 156+300 to 156+700
- Km 159+500 to 159+700
- Km 165+000 to 165+200
- Km 169+000 to 169+700 (Kesaibahal)
- Km 195+100 to 196+600 (Bamra)

- Kesaibahal and Bamra are the only two major town/village on the section of SH-24 assessed.
- At none of the above mentioned locations the street lights are provided.

Built up area of Kesaibahal and Bamra village

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided

Recommendations:

- Provide Gateway signs at before start and after the end of BUA
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools

Refer to Appendix III for guidelines for safe infrastructure arrangement for roadside villages in rural areas and for heavily built up sections.

Reasons for concern: Road side commercial activities result into parking and encroachment.

Recommendations: Regulate roadside commercial activities and remove encroachments, if any.

CHAPTER 13

SUNDARGARH DISTRICT

13.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Sundargarh district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified in to various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Sundargarh district:

- Hazardous locations
- High risk road users/ user groups
- Predominant nature of crashes

13.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic, other than NHs and SHs, has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 13.1**. It can be seen from **Figure 13.1** that maximum number of fatalities and crashes occur in SHs in Sundargarh district followed by NHs.

The length of road network in Sundargarh district is shown in **Figure 13.2**. It indicates that fewer numbers of crashes and fatalities occur in other roads compared to NHs and SHs. This can be partly attributed to the low level of traffic carried by the lower category 'other roads' on its road network in Sundargarh district. It is also observed that severity of crashes on NHs is more than that on SHs, as fatalities are almost equal in both the NHs and SHs whereas numbers of crashes are less on NHs.

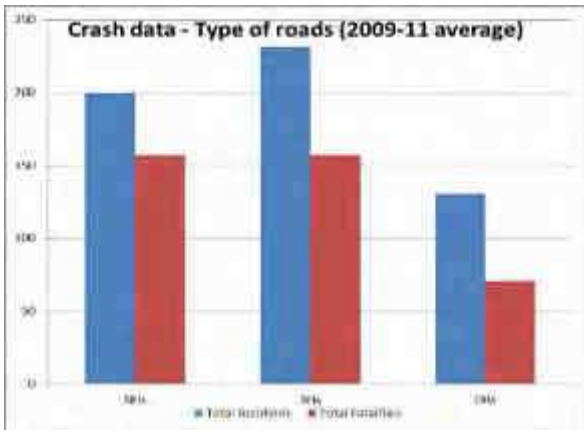


Figure 13.1: Crash data – Type of roads

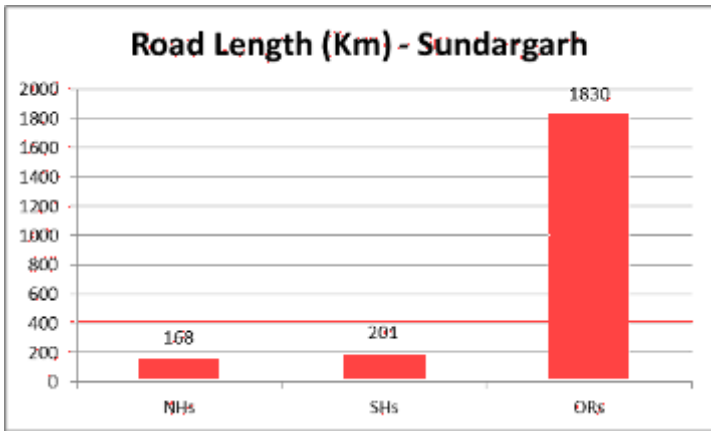


Figure 13.2: Road Network Length – Sundargarh Dist.

The crash data classified on the basis of location type in Sundargarh district is shown in **Figure 13.3** below.

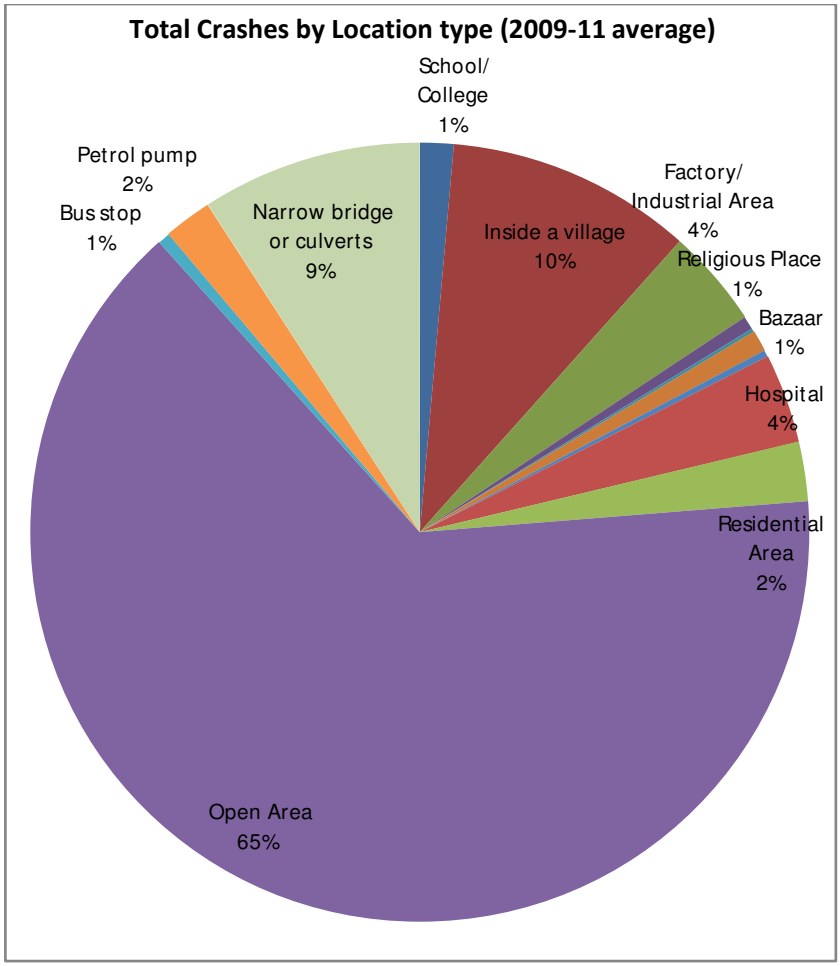


Figure 13.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 13.3** that majority of crashes (65 percent) occur in 'open area' in Sundargarh district followed by crashes on 'inside a village' (10 percent)', and 'narrow bridge or culvert' (9 percent). However, it is not clear from the above set of data that whether crashes in 'open area' or 'inside village' occur more in NHs or SHs. Further, the 'open area' is not clearly defined to be used for thorough crash investigation and prevention techniques.

From the above, only the following conclusions can be drawn for Sundargarh district:

- Maximum number of crashes and fatalities occur in SHs followed by NHs, but severity of crashes is more on NHs than SHs; and
- Significant number of crashes occurs in 'open area'.

13.1.2. High risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type are shown in **Figure 13.4** and the average number of persons killed classified according to road user type during the period 2009-11 is shown in **Figure 13.5**.

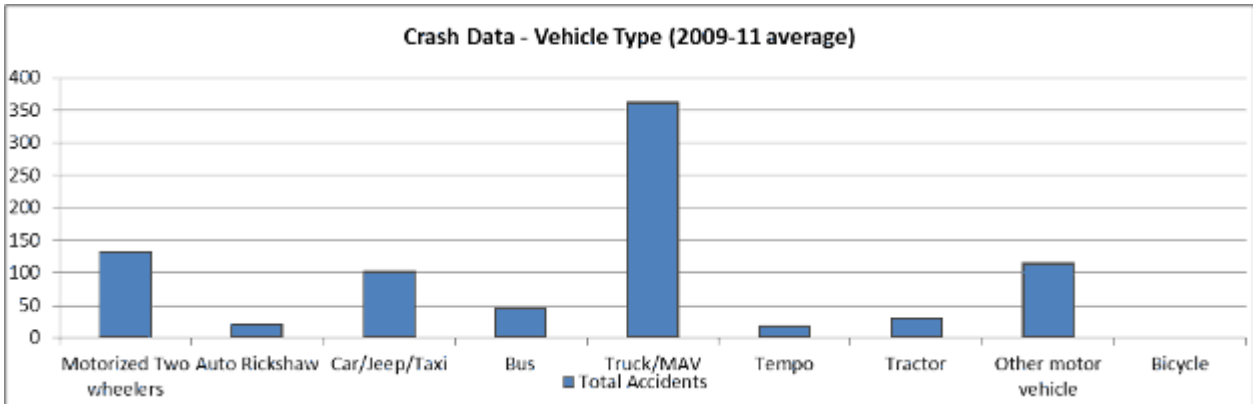


Figure 13.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 13.4**, it can be seen that trucks are involved in maximum number of crashes (approximate 160) followed by motorized two wheelers. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

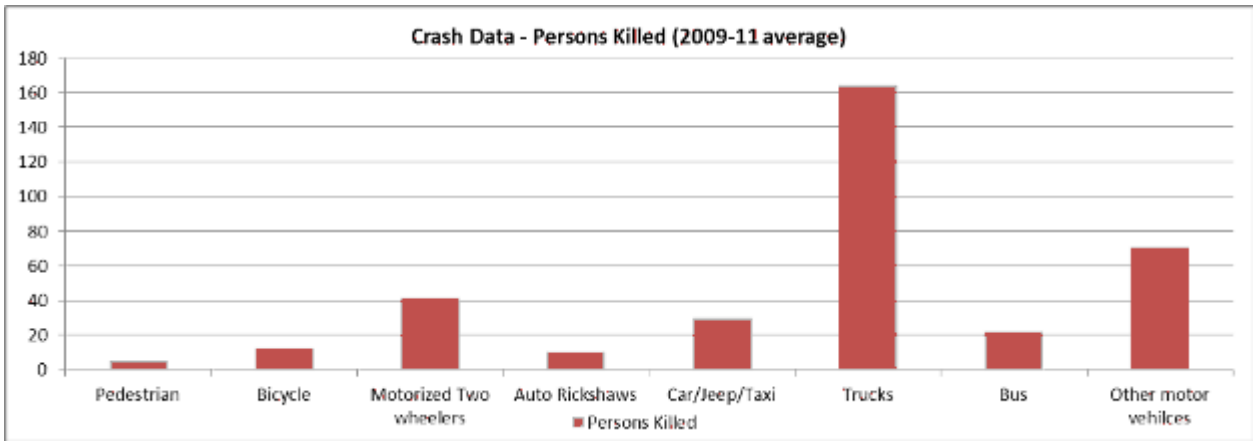


Figure 13.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 13.5**, it can be seen that maximum fatalities (approximate 160 lives) occur among the Truck users (both driver & passenger) followed by 'other motor vehicles', and motorized two wheelers. It is observed that severity of crashes involving trucks is high as approximate 160 truck users died in 350 crashes.

It can be seen from **Figures 13.4 and 13.5** that out of 130 crashes where motorcycles were involved, approximately 40 fatalities occur. This means, out of every 3 crashes involving motorcycles, one person is getting killed. This is significant since approximately 70 percent of motor vehicles registered in Balasore district are motorcycles. However, from the available data, it is difficult to ascertain the locations/ road types, where the motorcyclists are at higher risk.

The average number of crashes and fatalities occurred during the period 2009-11, based on type of collision are plotted as shown in **Figure 13.6**.

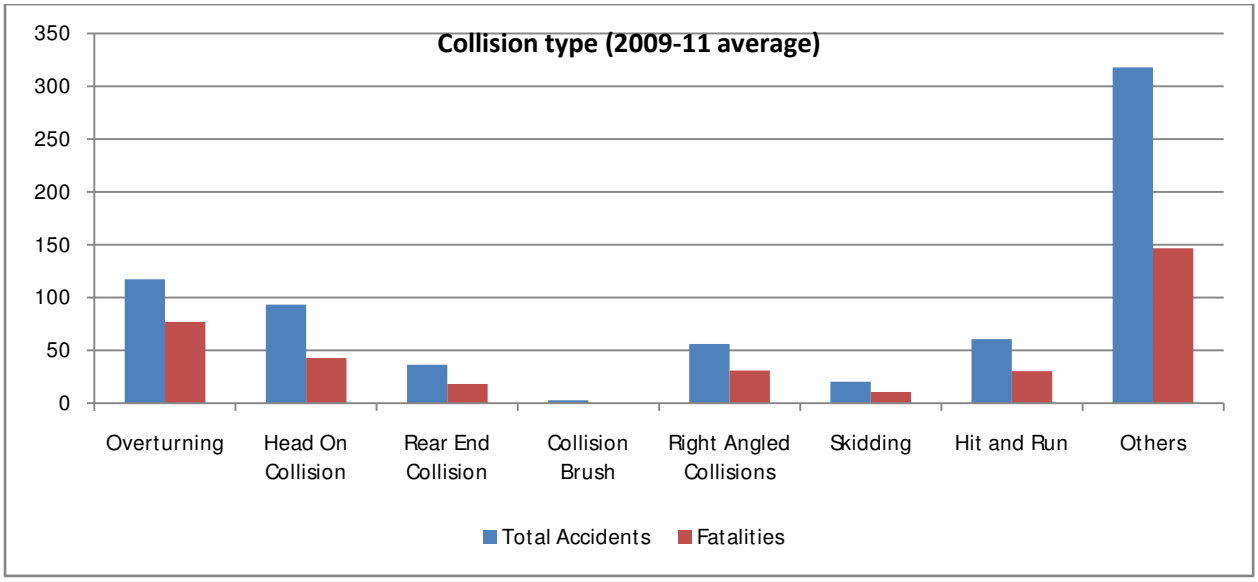


Figure 13.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 13.6** that predominant nature of crashes in Sundargarh district is under the category of 'others' (318 crashes). The type of collisions included in the category 'others' is not defined, however, it can be assumed that this might include collisions such as 'hit road side objects', run-off accidents and 'hit pedestrian' accidents. In the remaining categories, crashes reported under 'overturning' and 'head on collision' are highest.

It can be seen from the above figures that maximum number of crashes/ fatalities happens on SHs, trucks has a major share in crashes and the number one category of persons getting killed on roads in Sundargarh are truck driver and passengers, and the predominant nature of crashes in Sundargarh district are classified under 'others', which might include 'hit road side objects', run-off accidents and 'hit pedestrian' accidents.

From the above, though not supported by desirable detail of data, the following can be inferred for Sundargarh district:

- Maximum number of crashes occur in SHs, but severity is higher in NHs
- Trucks are the predominant user group involved in larger number of crashes and fatalities, and can hence deemed the high risk road user groups.
- Significant number of accidents are recorded under the nature of accident 'others', which might include hit road side objects, run-off accidents and hit pedestrian.
- According to the data, pedestrians and cyclists are less exposed to risk and hence cannot be considered and hazardous users or hazardous user groups

13.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 13.7**and the corresponding figures for urban area is shown in **Figure 13.8**.

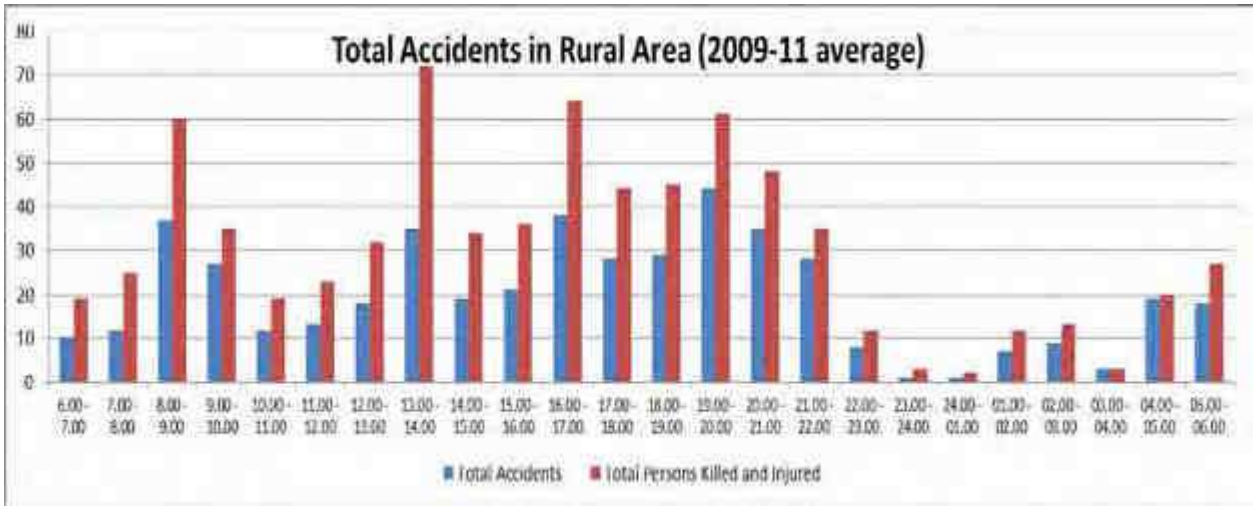


Figure 13.7: Total number of crashes in rural area (2009 – 11 average)

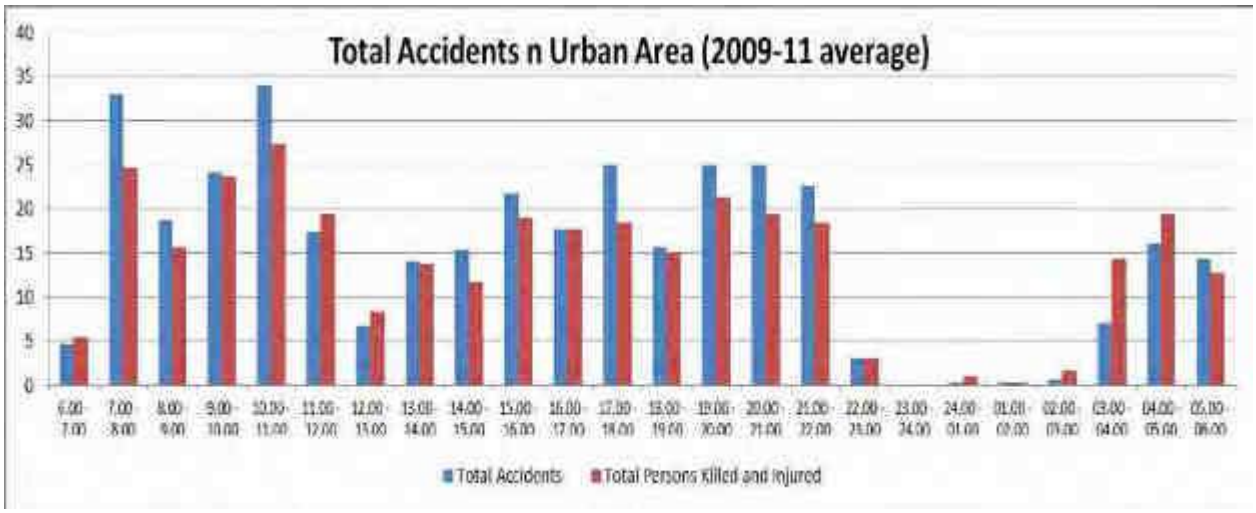


Figure 13.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 13.7** that the number of crashes, fatalities, and persons injured are highest during 13:00 to 14:00 hrs in rural area. It can be inferred that the variation of crashes during 24 hrs is more or less in relation with the traffic level, except a dip in morning hours from 9:00 to 12:00.

In urban area also the pattern of crashes is more or less in relation with the traffic level. Number of crashes are more during morning peak time (07:00 to 12:00 hrs) and evening peak time (15:00 to 21:00 hrs). However, more number of crashes occurring during early morning hours (03:00 to 06:00) is in contrary to the above observation. This may be due to high speed through traffic moving on regional roads passing through urban area during this time.

13.2. Location and Details of Audited Roads

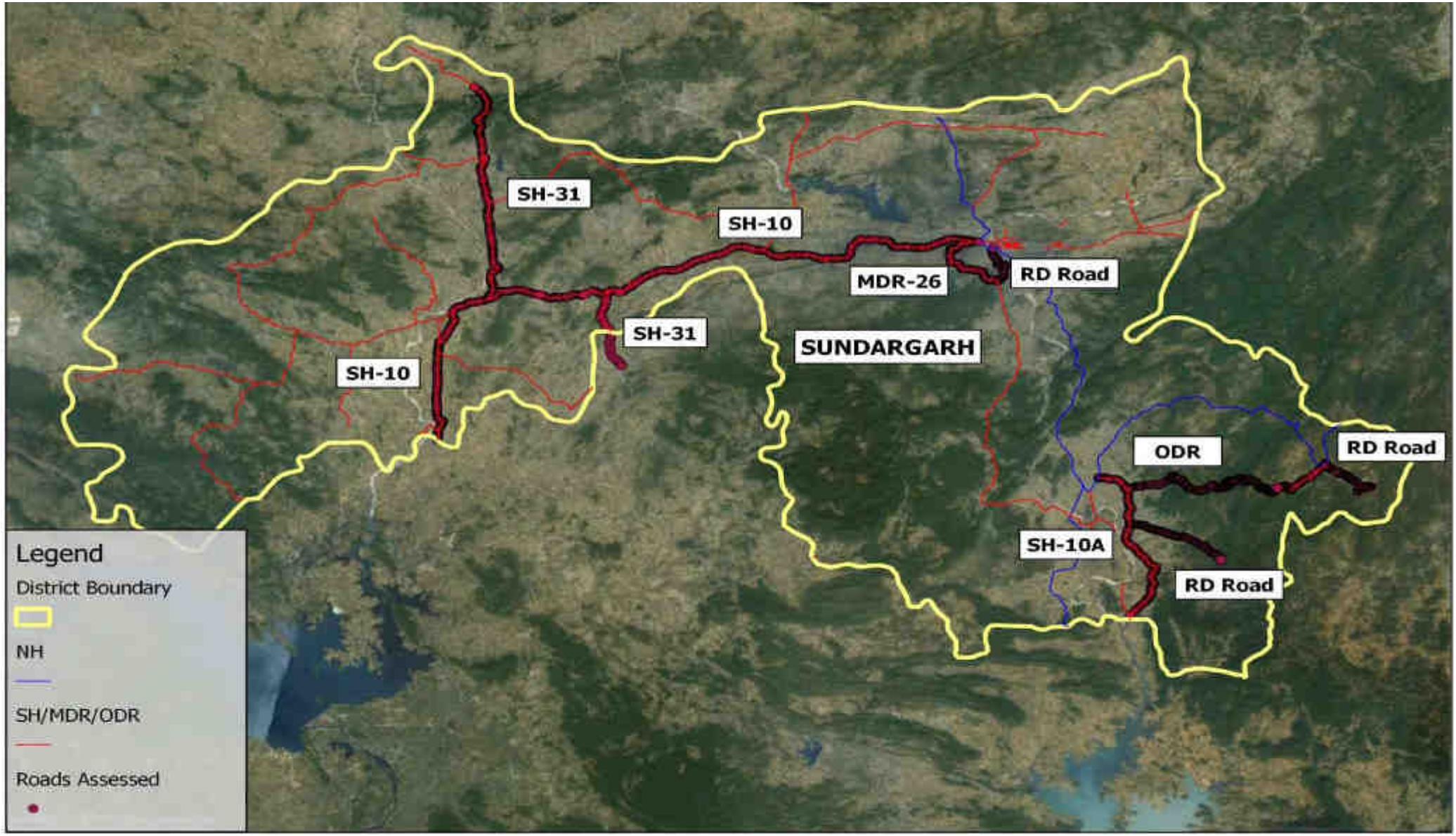
The road safety assessment in Sundargarh district was conducted on 9 roads from 2-Dec to 8-Dec 2012. The list of the roads is shown in **Table 13.1**below.

Table 13.1: List of roads audited in Sundargarh district

Sl. No.	Road Name	Road Section	Length in Km
1	SH31	Karamdihi to Lulkidihi: Km 0+000 to Km 39+300	40.00
2	SH31	Gariamal to Bamra: Km 0+000 to Km 14+000	14.00
3	MDR26	SH10 to Tumran Village: Km 0+000 to Km 14+000	14.00
4	RD Road	Garjan Road: Km 0+000 to Km 7+000	7.00
5	SH10A	Lahunipada to Muchurunali: Km 48+500 to Km 17+900	30.60
6	ODR	Koida-Kaleiposh- via Tensa: Km 41+200 to Km 0+000	41.20
7	RD Road	Koida – Patmunda: Km 0+000 to Km 9+000	9.00
8	RD Road	Koida – Khajurdihi: Km 0+000 to Km 8+000	8.00
9	RD Road:	KDK Waterfall Road: Km 0+000 to Km 15+000	15.00

The map of the roads assessed in Sundargarh district is shown in **Figure13.9.** The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.**

Figure 13.9: Map of Roads Assessed in Sundargarh District



13.3. RSA of State Highways

13.3.1.SH-31: Karamdihi – Lulkidihi (Km 0+000 to Km 39+300)

The safety assessment of this road was conducted from Km 0+000 at Lulkidihi which is an intersection with SH-10 upto Km 39+3400 Sagbahal village. The assessment of road section between Sagbahal village and Lulkidihi could not be conducted as the condition of road was very poor.

The road is a mix of single lane, intermediate lane and two lane sections as shown below.

- Intermediate lane section from Km 0+000 to Km 23+800
- Two lane section from Km 23+800 to Km 35+000
- Single lane section from Km 35+000 to Km 39+300

The entire section of the road is having bituminous surface with condition ranging from poor to good. The stretch of road from Km 35+000 to Km 39+300 is in poor condition, whereas from Km 35+000 to Km 36+000 is under construction (being widened to 7m). The earthen shoulder is <=1m wide in almost entire section with condition ranging from poor to good.

The road alignment passes largely through open/agricultural land use, except forest/ghat section from Km 29+000 to Km 37+000. The motorized traffic on this road was less as compared to other state highways assessed in this district. The traffic mix comprises of very few heavy commercial vehicles, and some two wheelers, three wheelers, buses, and bicycles. The presence of pedestrians and other VRUs were observed in and around major built-up areas.

13.3.1.1. Delineation of the Road

Lack of any road markings on the stretch from Km 0+000 to 1+000 and Km 6+000 to 7+000

Concerns & Recommendations	
Reasons for concern:	The centerline is marked in the section of road which is having 2-lane (7m wide), i.e. from Km 23+800 to 35+000. The edge line is marked only in the forest/ghat section from Km 29+000 to Km 35+000, which is very necessary to delineate the edge of pavement.
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on the length of the road, having intermediate and two lane sections (refer to IRC: 35-1997 for details).

- Provide edge line markings on single lane road sections
- Provide edge and centre line RRPMs on sharp curves

13.3.1.2. Alignment – Sharp Horizontal Curves

There are many curves with radii less than 100m on SH-31. At such sharp radii the safe negotiating speed are much less than design speed and hence curve warning signs, chevrons for delineation, and outer edge protection in case of embankment are necessary to ensure safety of traffic.

Sharp horizontal curves of radii <=100m were observed at the following chainages:

- Km 1+600
- Km 3+200
- Km 4+900
- Km 5+900
- Km 6+500
- Km 16+200
- Km 20+800
- Km 25+000
- Km 25+200
- Km 30+500
- Km 31+800
- Km 34+200

Series of sharp horizontal curves in the forest/ghat section were observed at the following sections:

- 5 sharp curves of (radii 20m to 55m) from Km 29+400 to Km 29+800
- 5 sharp curves of (radii 30m to 50m) from Km 31+250 to Km 31+600

Project road has above listed sharp curves, where it is required for the approaching vehicle to slow down by more than 20 km/ hour from the approach speed.

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 17:00 hrs to 18:00 hrs, from Km 0+000 to Km 29+000. An average speed of 50 km/ hour and a maximum speed of 64 km/ hour was noted during this survey. A spot speed was conducted on approach of the curve at Km 4+900, and the 85th percentile speed was found to be 59kmph.

As the sharp curve at Km 16+200 is on gradient, fast moving vehicles were observed overtaking the slow vehicles. Due to BUA of Sabdega village, there are buildings on the inner edge of curve which restricts the visibility of approaching traffic. There is a side road merging with SH-31 at the curve. In this situation the risk of head-on collision of overtaking vehicles, and collision with the vehicles entering from side road is more. Photographs of sharp curve with unsafe situation are given below.

Sharp curve with gradient, side road, and restricted visibility in BUA at Km 16+200

Sharp curve on high embankment without edge protection near approaching culvert (under construction), Km 31+800

Concerns & Recommendations	
Reasons for concern:	Unexpectedly sharp horizontal bends will lead to crashes when drivers try to negotiate them at high speed. On SH-31 where a number of sharp curves are in the forest/ghat section with severely restricted visibility the vehicles can lose control and this can result in serious injuries or fatalities.
Recommendations:	Provide traffic calming and warning measures as appropriate *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	Overtaking on such curves may lead to head-on collision
Recommendations:	• Provide continuous 'no overtaking' centerline supported with mandatory 'no-overtaking signs • Provide extra widening (sealed shoulder) on the inside of the curve where required
Reasons for concern:	**Sharp curves in BUA** VRUs in the BUA are at high risk as they share space with the high speed traffic
Recommendations:	Provide all the curve treatments mentioned above in addition to traffic calming measures and speed restriction signs in the BUA
Reasons for concern:	**Sharp curves with high embankment** • There are sharp curves with high embankment and some of the sharp curves are in ghat section where there is valley side on the outer edge. • If vehicle lose control while negotiating the curve it may fall in to the ditch or valley resulting into severe injury or fatality.
Recommendations:	Provide crash barrier on the outer edge with delineators. *Refer to Appendix III for guidelines on situations where to install the above*

13.3.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)
3. Side roads meeting the main road in steep gradient

Location of Side roads perpendicular to major road

- Km 0+600
- Km 3+800
- Km 9+700
- Km 10+700
- Km 13+600
- Km 16+200
- Km 16+300
- Km 16+300
- Km 17+000
- Km 20+500
- Km 20+800
- Km 25+000
- Km 27+200
- Km 27+500

Location of Side roads at skew with the major road

- Km 4+900
- Km 13+800
- Km 15+800
- Km 21+000
- Km 28+500
- Km 39+300

At following locations side roads are merging at steep gradient with the major road

- Km 6+400
- Km 9+000
- Km 25+200

Photographs of side roads joining SH-31 with unsafe situations are given below.

Side road joining at skew angle Km 21+000

Side road joining with steep gradient, Km 9+000

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-31are due to buildings or trees on the corners.

Recommendations:

Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidance on visibility triangle at junctions.

Poor delineation

Reasons for concern:

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ Stop signs as applicable, on side roads
- Provide Give Way/ Stop road marking at side roads

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on situations where to install the above.

13.3.1.4. Major Junctions

3-armed junction at Km 0+000

The salient features of the junction are as follows:

- SH-31 takes off from this place, i.e. Km 91+300 of SH-10 (Sudargarh-Rourkela road) forming a 3-arm intersection.
- At this intersection all the approaches are divided by provision of median, and the acceleration and deceleration lanes are also provided but there are no islands to guide the turning traffic
- The edge lines and other lane markings pertaining to intersection layout are missing
- There are no traffic signs and direction signs at this intersection
- There is built-up area with a few small shops/ hotel at the intersection
- The intersection is free from any encroachment and on-street parking, however buses stop on the road near intersection obstructing the flow and visibility of through traffic.
- There is no footpath or pedestrian crossing at this junction.

Km 0+000, intersection of SH-31 with NH-10

3-armed junction at Km 23+800

The salient features of the junction are as follows:

- SH-31 intersects with MDR connecting Talsara with Luhakera near Orissa/Chattisgarh border.
- The layout of this intersection is non-standard y-type on the horizontal curve.
- There is no control over traffic movement and the building in middle of intersection obstructs the visibility of approaching traffic.
- There are no direction signs and the layout is confusing as the MDR looks like major road and the SH-31 is joining from RHS.
- There is no built up area at the intersection except the building in the middle of intersection.
- There were few auto-rickshaws parked on the road.
- There is no provision for VRUs at this intersection.
- There are no street lights at this intersection.

Km 23+800, intersection of SH-31 with

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction layout at both the junctions is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.

Recommendations:

- Provide road markings pertaining to junction layout
- Provide acceleration and deceleration lanes on both the approaches
- Provide channelization to control the traffic movement, at junctions without splitter islands

Refer to Appendix III for standard layout of 3-arm junction.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are not provided, the presence of which would have informed and warned the road user of the intersection ahead

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.
- Provide "intersection ahead" warning sign before the intersection on all approaches.

Refer to Appendix III for guidelines road markings and traffic signs on 4-arm junction

Reasons for concern:

Direction Signs

- There are no proper direction signs to guide the traffic through the junction layout which may result in to frequent or sudden stopping of vehicles and may lead to rear-end collision.

Recommendations:

- Provide proper direction signs to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm junction

Reasons for concern:

Provision for VRUs

- No separate provision for pedestrians/bicycles.
- Pedestrians were observed using the road for commuting, and this exposes them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Provide footpath on all the approaches to the junction
- Provide pedestrian crossings for safe crossing by pedestrians and bicycles.
- Provide on the road cycle lanes (1m wide) on approaches to the junction

Reasons for concern:

Buses stopping on road

There are no bus-bays and hence the buses stop on road in the middle of intersection obstructing visibility and smooth flow of traffic

Recommendations:

- Provide bus-bays at a safe distance from the intersection on approaches of SH-31.

Reasons for concern:

On-street Parking

There are no parking spaces provided and vehicles are parked on road encroaching the road and shoulder space. This hampers visibility at the junction and force pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations:

- Provide designated parking spaces for vehicles.

13.3.1.5. Bridge approaches on high embankment

Approaches of bridges/culverts with high embankment without any protection were noted in the following locations

- Km 2+700
- Km 6+100
- Km 8+800
- Km 13+700
- Km 19+300
- Km 31+800

Unprotected approach to bridge with high embankment, Km 6+100

Concerns & Recommendations

Reasons for concern:

Unprotected approach to culvert/bridge

If a vehicle approaching the culvert/bridge loses control, it will fall into the ditch/drain in the absence of any protection, which may result into serious injuries or may prove to be fatal.

Recommendations:

Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

Reasons for concern:

Sharp horizontal curve on approach

In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings

- Provide hazard markers on either edge of the parapets

Reasons for concern:

High approach speed

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches

13.3.1.6. Road side hazards - Parapets of narrow Culverts/ Bridges

At following locations the parapets of bridge/culvert were found either missing or broken resulting in highly hazardous situation for VRUs and motorized road users,

- Km 2+700
- Km 8+800


Parapets on Culvert/Bridge highly unsafe for VRUs as well as other traffic, Km 2+700 and Km 8+800

At following locations the parapets of bridge/culvert are not delineated,

- Km 2+700
- Km 6+100
- Km 8+800
- Km 13+700
- Km 19+300
- Km 31+800


Parapets of Culvert/Bridge not delineated, Km 13+700 and Km 8+800

Concerns & Recommendations

Reasons for concern:

No delineation of culvert/bridge parapets

- The culvert/bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations:

- Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure)

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern:

Broken or missing parapets

The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. The absence of parapets at such locations is hazardous for traffic, especially for VRUs.

Recommendations: Provide continuous parapets on all culverts and bridges.

13.3.1.7. Road side hazards -Poles, and Buildings

Seceral road side objects were observed on SH-31such as trees and street lighting poles in the within 1m from the edge of the road. Photograph showing trees very near to road edge are given below.

Trees very near to road edge Km 4+000 to 5+000, and in forest area Km 29+000 to 30+000

Concerns & Recommendations

Reasons for concern:

In the event of driver losing control, crashes with trees and other road side objects will lead to fatalities

In the absence of delineation of road side objects, it is difficult to judge the road side objects and keep a safe distance during dark hours

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Provide reflectors on Street lighting poles

13.3.1.8. Roadside villages/ Built-up Areas (BUAs)

Road side villages and built-up areas were observed at following locations on SH-31,

- Km 0+000 to 0+600 Karamdihi
- Km 7+400 to 7+600
- Km 8+200 to 8+400
- Km 15+900 to 16+900 Sabdega village
- Km 20+400 to 20+600
- Km 25+000 to 25+300 Talsara village
- Km 27+000 to 27+400
- Km 39+100 to 39+300 Sagbahal village

All the above listed BUA son SH-31 are small villages, but the presence of VRUs and their interaction with high speed traffic is significant. At few BUAs the buildings and boundary wall are very close to the road edge. There is no facility for VRUs such as pedestrian crossing or footpath in any of the above listed BUAs. At none of the above mentioned locations the street lights are provided.

Photographs showing buildings and bus stops in BUAs are given below.

Built up area from27+000 to 27+400 and Km 20+400 to 20+600 – buildings very near to road edge, and access to bus stop obstructed by tree

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No street lights are provided in the BUA
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking

maneuvers.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines for treatment options in roadside villages/ built-up areas

Reasons for concern: Road side commercial activities result into parking and encroachment.

Recommendations: Regulate roadside commercial activities and remove encroachments, if any.

13.3.1.9. Specific Locations - Road Construction Work

The road construction work is in progress in the stretch of SH-31 from Km 35+000 to 36+000. Construction of a culvert is under progress at Km 31+800. Photographs of the traffic diversion and construction work are given below.

Km 31+800 – Traffic diversion at the site of construction of culvert

Road construction Km 35+000 to 36+000

Concerns & Recommendations	
Reasons for concern:	**Traffic diversion without proper treatment at Km 31+800** • The traffic diversion is very unsafe for traffic as there are no warning signs and delineators. • During night time the site is very hazardous as there is no provision for illumination of the site.
Recommendations:	• Provide advance warning signs for diversion with delineation and barricades. • Provide illumination of the diverted route for better visibility during night hours.
Reasons for concern:	**Construction work without barricading or traffic diversion, Km 35+000 to 36+000** • There are no warning sign for road construction, no barricades and no traffic diversion plan.
Recommendations:	• Provide proper barricades to separate the construction zone from operating road. • Provide traffic warning signs and delineators.

13.3.2.SH-31, Gariamal – Bamra (Km 0+000 to Km 14+000)

The road section was noted to be predominantly two lane except for a single lane section from Km 11+000 to Km 13+000 which was under construction. The entire section of the road is having bituminous surface and was noted to be in good condition. The width of earthen shoulder is in the range of 1 to 2m except in the section under construction where it was noted to be less than 1m wide.

The road alignment passes largely through open/agricultural land use. There are no major built-up areas on this road except Bamra town at the end. At few locations where side road joins with SH-31, few small shops and huts around the intersection area were noted. The observed traffic mix comprises of few heavy commercial vehicles; and significant numbers of two wheelers, three wheelers, buses, small commercial vehicles, and bicycles.

13.3.2.1. Delineation of the Road

Lack of edge line in the stretch from Km 4+000 to 5+000

Lack of center line and edge line in the stretch from Km 12+000 to 13+000

Concerns & Recommendations	
Reasons for concern:	**Centerline marking were not provided,** except on the section between Km 2+000 and Km 11+000, the absence of which encourage the drivers to keep the middle of the road, which is a contributory factor to head-on collisions. **Edge line markings were not provided**, which should have delineated the road edges and assist the road user to be in the designated lane.
Recommendations:	• Provide centre line with thermoplastic road markings on whole length of the road having two lane sections(refer to IRC: 35-1997 for details) • Provide edge lines on the whole road section • Provide edge and centre line RRPMs on sharp curves

13.3.2.2. Alignment – Sharp Horizontal Curves

Many curves with radii less than 100m were noted on SH-31. At such curves having sharp radius, the safe negotiating speed were much less than the design speed and hence curve warning signs, chevrons for delineation, and outer edge protection in case of embankment are necessary to ensure safety of traffic.

During the course of the assessment, the following hazardous locations were noted, which needs engineering countermeasures to improve the safety of these locations.

Sharp horizontal curves of radii <=100m were observed at the following chainages:

- Km 3+800
- Km 9+200

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 15:00 hrs to 16:00 hrs, from Km 0+000 to Km 14+000. An average speed of 74 km/ hour and a maximum speed of 81 km/ hour was noted during this survey. A spot speed was conducted on approach of the curve at Km 3+800, and the 85th percentile speed was found to be 66 kmph.

Sharp curve with restricted visibility due to building, Km 3+800

Sharp curve on high embankment without edge protection, Km 9+200

Concerns & Recommendations

Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which in the worst case may lead to: • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above.*
Reasons for concern:	Overtaking on such curves may lead to head-on collision
Recommendations:	• Provide "no-overtaking" mandatory signs • Provide continuous centerline • Provide extra widening (sealed shoulder)
Reasons for concern:	**Sharp curve with high embankment (Km 9+200) without safety barrier** • Run-off accidents on high embankments will lead to fatalities
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment

Refer to Appendix III for guidelines on situations where to install the above.

13.3.2.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road	
• Km 5+800	• Km 10+400
• Km 7+100	• Km 12+800
Location of Side roads at skew with the major road	
• Km 13+200	

Photographs of side roads joining SH-31 with unsafe situations are given below.

Side road joining at Km 7+100 – visibility restricted due to buildings on both the corners(view from side road)

Concerns & Recommendations	
Reasons for concern:	**Inadequate Visibility** The major reasons for poor visibility at such junctions are due to buildings or trees on the corners.
Recommendations:	Remove encroachments at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangle at 3-arm junctions.*
Reasons for concern:	**Poor delineation** • No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead. • Poor delineation may result in sudden braking behaviour by road users who

are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ Stop signs as applicable, on side roads
- Provide Give Way/ Stop road marking at side roads

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above

13.3.2.4. Major Junctions

3-armed junction at Km 0+000

The salient features of the junction are as follows:

- SH-31 takes off from this place, i.e. Km 107+700 of SH-10 (Sudargarh-Rourkela road) forming a 3-arm intersection.
- At this intersection all the approaches are divided by providing median, and the acceleration and deceleration lanes are also provided but there are no islands to guide the turning traffic.
- The edge lines are provided but lane markings pertaining to intersection layout are missing.
- There are no traffic signs and direction signs at this intersection.
- There is no built-up area, except a few small shops/hotel at the intersection. The intersection is thus free from any encroachment and on-street parking.
- No footpaths or pedestrian crossings are provided at this intersection.
- No street lights are provided at this intersection.

Km 0+000, intersection of SH-31 with SH-10

Concerns & Recommendations

Reasons for concern: **Unsafe/ non-standard splitter islands**

The channelization at the junction has been provided in the form of splitter islands, however some of these are non-standard type and unsafe for pedestrians.

Recommendations:

- Provide channelization with proper splitter islands, and road markings.
- Provide refuge for pedestrians on the splitter islands so that pedestrians can safely cross the road.

Refer to Appendix III for standard layout of 3-arm junction

Reasons for concern: **Poor delineation**

Traffic signs and road markings are not provided, the presence of which would have informed and warned the road user of the intersection ahead.

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.

Refer to Appendix III for guidelines road markings and traffic signs on 3-arm junction

Reasons for concern: **Direction Signs**

No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to Appendix III for guidelines of direction signs on 3-arm junction

Reasons for concern: **Provision for VRUs**

- No provision for walking along the road or crossing by pedestrians/bicycles.
- Pedestrians were observed using the road for commuting, and this expose them to the fast moving traffic which can lead to crashes

resulting in serious injuries.

Recommendations:

- Provide footpath on all the approaches to the junction
- Provide pedestrian crossings for safe crossing by pedestrians and bicycles.
- Provide on the road cycle lanes (1m wide) on approaches to the junction

Reasons for concern: **Buses stopping on road**

There are no bus-bays and hence the buses stop on road in the middle of intersection obstructing visibility and smooth flow of traffic

Recommendations: Provide bus-bays at a safe distance from the intersection.

4-armed junction at Km 14+000

The salient features of the roundabout are as follows:

- SH-31 intersects with SH-24 (Bamra-Kuchinda road), and a town road forming a 4-arm intersection in the heart of Bamra town.
- The junction is heavily built-up with shops on all corners.
- Visibility is severely obstructed due to buildings very near the road edge.
- Traffic control has not been established on this junction.
- The buses were observed stopping on the road near the intersection obstructing visibility and smooth flow of traffic.
- There were no footpaths and road crossing facility for pedestrians.

Concerns & Recommendations

Reasons for concern: **Poor Junction layout**

- The junction layout is non-standard and has no control over the traffic movement.
- It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.
- The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Redesign the junction after careful studies providing facilities for right turn lanes, free left turn and provisions for vulnerable road users.

Refer to Appendix III for standard layout of 4-arm junction.

Reasons for concern: **Poor delineation**

Traffic signs and road markings are not provided, the presence of which would have informed and warned the road user of the intersection ahead.

Recommendations:

- Provide edge line markings, centerline markings and other road markings pertaining to junction control.
- Provide “intersection ahead” warning sign before the intersection on all approaches.

Concerns & Recommendations	
	• Provide Give Way or STOP sign with road markings on both the town road and village road. *Refer to Appendix III for guidelines on road markings and traffic signs on 4-arm junction.*
Reasons for concern:	**Direction Signs** • No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collision.
Recommendations:	• Provide direction signs on approaches to the junction to guide the traffic through the junction layout. *Refer to Appendix III for guidelines of direction signs on 4-arm junction.*
Reasons for concern:	**Provision for VRUs** • No provision for walking along the road or crossing by pedestrians/bicycles. • Pedestrians were observed using the road for commuting, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.
Recommendations:	• Provide footpath on all the approaches to the junction • Provide pedestrian crossings for safe crossing by pedestrians and bicycles. • Provide on the road cycle lanes (1m wide) on approaches to the junction
Reasons for concern:	**On-street Parking** • There are no parking spaces provided and vehicles are parked on road encroaching the road and shoulder space. • This hampers visibility at the junction and force pedestrians to move into the centre of the road resulting in hazardous situation.
Recommendations:	Provide designated parking spaces for vehicles.

13.3.2.5. Bridge approaches on high embankment

Approaches of bridges/culverts with high embankment without any protection were noted in the following locations.

- Km 6+500
- Km 9+200

Unprotected approach to bridge with high embankment, Km 6+500

Unprotected approach to culvert under construction – lack of warning signs and barricades, Km 9+200

Concerns & Recommendations

Reasons for concern: **Unprotected approach to bridge at Km 6+500**

If a vehicle approaching the bridge loses control, it will fall into the ditch/drain in the absence of any protection, which may result into serious injuries or may prove to be fatal.

Recommendations: Provide crash barriers on either approaches of the structures with delineators

Refer to Appendix III for guidelines to treatments on approaches to bridges

Reasons for concern: **Unprotected approach to culvert under construction at Km 9+200**

The culvert is under construction but there are no warning signs or traffic diversion signs and any barricades. The vehicles approaching the site may lose control and fall in the deep ditch which may result into serious injury or fatal.

Recommendations: Provide warning sign for construction activity and barricades to protect the traffic from deep ditch.

Reasons for concern: **No warning/ information signs**

- Traffic signs are not provided to warn the road user of the curve and structure ahead
- In the absence of warning/ information, road users may approach the curve in undesirable speed which can lead to run-off accidents

Recommendations:

- Provide 'Curve Ahead' warning signs to warn the road user of the layout ahead.

13.3.2.6. Road side hazards - Parapets of narrow Culverts/ Bridges

At following locations there is no delineation of the parapets of bridge/culvert resulting in highly hazardous situation for VRUs and motorized road users.

- Km 6+500
- Km 9+200

- Km 9+400

Parapets of culvert/bridge not delineated, Km 6+500 and Km 9+400

Concerns & Recommendations

Reasons for concern:

No delineation of culvert/bridge parapets

- The culvert/bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations: Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure)

Refer to Appendix III for guidelines for installation of object hazard markers

13.3.2.7. Road side hazards - Trees

The trees observed near road edge were in the range of 1 to 3m in the stretch from Km 7+000 to 8+000 and near the Bamra town as shown in photographs below. Except for these two stretches the trees were noted to be greater than 3m away from the road edge.

Trees near the road edge, Km 7+000 to 8+000 and near Bamra town

Concerns & Recommendations	
Reasons for concern:	In the event of vehicle losing control, crashes with roadside objects may lead to fatalities/ major injuries
Recommendations:	**Desirable:** • Remove Trees from the road shoulders • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips

13.3.2.8. Roadside hazards/ Built-up Areas (BUA)

There are no built-up areas on this road section except the stretch of road (Km 13+600 to Km 14+000) passing through Bamra town. At this location, the section of road observed to be congested due to shops and residences on both sides of the road. There are no facilities for VRUs such as pedestrian crossing or footpath in this BUA.

Photographs showing the section of SH-31 in BUA of Bamra are given below.

Built-up area of Bamra

Concerns & Recommendations	
Reasons for concern:	• No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area • No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead • No speed limit signs provided
Recommendations:	• Provide Gateway signs at before start and after the end of BUA • Provide pedestrian crossings, wherever deemed necessary • Provide well maintained wide shoulders (min. 2m wide), free of

encroachments and overgrown vegetation in roadside villages in rural areas
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern: Road side commercial activities result into parking and encroachment.

Recommendations: Regulate roadside commercial activities and remove encroachments, if any.

13.3.3.SH-10A: Lahunipara – Muchurinal (Km 48+500 to Km 17+900)

The safety assessment of this road was conducted from Km 48+500 at Lahunipara which is an intersection with SH-10 up to Km 17+900 i.e. border of Sundargarh district. The entire stretch of road is having 2-lanes (7m wide) with 2 to 3m wide earthen shoulder in good condition. The road alignment passes largely through open/agricultural land use and there are few villages built-up along the road side. The traffic flow observed on this road is medium and traffic mix comprises of heavy commercial vehicles, two wheelers, three wheelers, buses, and bicycles. The presence of pedestrians and other VRUs were observed in and around the built-up areas.

13.3.3.1. Delineation of the Road


Lack of delineation in the stretch of road from Km 45+000 to 43+000

Concerns & Recommendations	
Reasons for concern:	Centre line and edge line markings were found to be missing from Km 45+000 to 43+000.
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves
Reasons for concern:	**No road markings on access road to warn the road user of the junction ahead** • Potential right angle collisions
Recommendations:	Provide **Give Way/ STOP road marking** using thermoplastic material as appropriate on side roads

13.3.3.2. Alignment – Sharp Horizontal Curves

Unexpectedly sharp horizontal bends will lead to crashes when drivers try to negotiate them at high speed. There are many curves with radius less than 100m on SH-10A. At such curves having sharp radius, the safe negotiating speed will be much less than the operating speed and hence curve warning signs, chevrons for delineation, and outer edge protection in case of embankment are necessary to ensure safety of traffic.

During the course of the assessment, the following hazardous locations were noted, which needs engineering countermeasures to improve the safety of these locations.

Horizontal curves of radii <=100m were observed at the following locations:

- Km 44+100
- Km 43+700
- Km 39+500
- Km 37+300
- Km 33+300
- Km 27+900
- Km 26+600
- Km 25+700
- Km 24+700
- Km 23+000

Reverse curves or S-curves were observed at the following locations:

- Km 47+100
- Km 42+850
- Km 40+000
- Km 39+000
- Km 27+000
- Km 21+300

Project road has above listed sharp curves, where it is required for the approaching vehicle to slow down by more than 20 km/ hour from the approach speed.

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 12:00 hours to 13:00 hours, from Km 17+900 to Km 48+200. An average speed of 53 km/ hour and a maximum speed of 62 km/ hour were noted during this survey. A spot speed was conducted on approach of the curve at Km 27+900, and the 85th percentile speed was found to be 58 kmph.

Photographs of sharp curves and reverse curves are given below.

Reverse curve at Km 42+850

Sharp curve with BUA and access road (LHS), Km 27+900

Concerns & Recommendations	
Reasons for concern:	**Lack of warning signs/ delineation** to inform the road user to make him/her slow down to negotiate the curve in a safe speed, which may lead to run-off accidents or head-on collisions
Recommendations:	• Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above.*
Reasons for concern:	Overtaking on such curves may lead to head-on collision
Recommendations:	• Provide "no-overtaking" mandatory signs • Provide continuous centerline • Provide extra widening (sealed shoulder)
Reasons for concern:	On outer edge of these curves, Concrete Guard Posts (CGP) are provided to delineate the curve. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic. As the CGP provided on SH-10A are larger by 10cm X 10cm in cross section these may be cause serious injury to the road user if the vehicle loses control negotiating the curve.
Recommendations:	• Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*
Reasons for concern:	**Sharp curves in BUA** VRUs in the BUA are at high risk as they share space with the high speed traffic
Recommendations:	Provide all the curve treatments mentioned above in addition to traffic calming measures and speed restriction signs in the BUA

13.3.3.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)
3. Side roads meeting the main road with steep gradient

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road		
• Km 48+400 • Km 47+500	• Km 41+400 • Km 41+400	• Km 36+200 • Km 36+200

Location of Side roads at skew with the major road

- Km 45+700
- Km 29+200

Locations of side roads merging at steep gradient with the major road,

- Km 31+500
- Km 27+900
- Km 27+000
- Km 23+500
- Km 21+500
- Km 21+300
- Km 20+800
- Km 19+700

Photographs of side roads joining SH-10A with unsafe situations are given below.

Side road joining with steep gradient at Km 27+000

Side road joining on curve at Km 27+900

Concerns & Recommendations

Reasons for concern: **Inadequate Visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-10A are due to buildings or trees on the corners.

Recommendations:

- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern: **Poor delineation**

- Many of such junctions are without any traffic signs or road markings, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide 'Side Road Ahead' signs on the major road
- Provide STOP/ Give Way markings and signs on side road, as appropriate

Refer to Appendix III for guidelines on situations where to install the *above*.

Reasons for **High approach speeds**

concern:

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road.

Refer to Appendix II for guidelines on situations where to install the above

Reasons for concern: **Poor Geometry**

- It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on situations where to install the above

13.3.3.4. Major Junctions

3-armed junction at Km 48+500

Salient safety features observed at this junction are noted below:

- The layout of this intersection is non-standard Y-type and no control has been established
- Many vehicles are parked on the road obstructs visibility of approaching traffic.
- There is main market of Lahunipara village around this intersection and hence there are many shops and roadside hotels encroaching the shoulders.
- Buses and 4-wheeler passenger vehicles were observed stopping on the road for passenger pickup/drop-off.
- There are no provisions for VRUs at this intersection despite of significant number of VRUs present.

Km 48+500, intersection of SH-10A with NH-520

3-armed junction at Km 43+200

Salient features of this junction are as follow,

- The layout of this intersection is non-standard, and there is no control over traffic movement.
- There are no lane markings or traffic channelization at this intersection.
- The direction sign board is on the arm of Kaleiposh-Koida road which is not visible to traffic approaching from Lahunipada arm of SH-10A.
- There is no provision for VRUs at this intersection.

Km 43+200, intersection of SH-10A with Kaleiposh-Koida ODR

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout at both the junctions is non-standard and has no control over the traffic movement.
- It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.

Recommendations:

- Redesign the junction and provide facilities for right turn, free left turn and provisions fir vulnerable road users.

Refer to Appendix III for standard layouts of 3-arm junctions.

Reasons for concern:

Poor delineation

- No road markings and traffic signs are provided to establish safe movement of traffic.

Recommendations:

- Provide road markings pertaining to junction control

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern:

Direction Signs

There are no proper direction signs to guide the traffic through the junction layout which may result in to frequent or sudden stopping of vehicles and may lead to rear-end collision.

Recommendations:

- Provide direction signs to guide the traffic through the junction layout.

Refer to Appendix III for guidelines for traffic signs and road markings on 3-arm intersection

Reasons for concern:

Provision for VRUs

- Significant movement of pedestrians and bicyclists were noted, but no separate provisions have been made.
- Pedestrians are particularly vulnerable at such junctions having high approach speed of traffic.
- Pedestrian crossing facility not provided.

Recommendations:

- Remove encroachments from the footpaths and provide clean and wide footpath for pedestrians to walk along the junction without getting exposed to high speed motorized traffic
- Provide marked pedestrian crossings at appropriate safe locations.

Reasons for concern:

On street Bus stop

- Buses were observed stopping on the road on intersection obstructing the visibility and flow of through traffic

Recommendations:

- Provide bus-bays with appropriate traffic signs and lane markings

Refer to Appendix III for guidelines for design of bus bays and on-street bus stops

13.3.3.5. Approach to Bridges

At **Km 46+900** and **Km 33+500** the approaches of bridge are with sharp curve. Photographs are shown below.

Approach to bridge with sharp curve, Km 46+900 and Km 33+500

Concerns & Recommendations

Reasons for concern:

Sharp horizontal curve on approach

- In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal

accidents.

- On outer edge of these curves Concrete Guard Posts (CGP) are provided to delineate the curve. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic. As the CGP provided on SH-10A are larger by 10cm X 10cm in cross section these may be cause serious injury to the road user if the vehicle loses control negotiating the curve.

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide chevrons to delineate the alignment of sharp curve
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

Refer to Appendix III for guidelines to treatments on approaches to bridges

Reasons for concern:

High approach speed

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches

Refer to Appendix III for guidelines to treatments on approaches to bridges.

13.3.3.6. Road side hazards - Parapets of narrow Culverts/ Bridges

At the following locations, the parapets of bridge/culvert were not delineated.

- Km 46+900
- Km 42+200
- Km 40+300
- Km 38+500
- Km 33+500
- Km 30+200
- Km 27+200
- Km 23+800
- Km 19+500

Parapets of Culvert/Bridge not delineated, Km 38+500 and Km 30+200

Concerns & Recommendations

Reasons for concern:

No delineation of bridge parapets

- The bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations:

- Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (ie. Four numbers of OHM for each structure)

Refer to Appendix II for guidelines for installation of object hazard markers.

13.3.3.7. Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations on SH-10A,

- Km 46+000 to 45+700 Kendudihi
- Km 32+500 to 32+400 Poigaon
- Km 31+400 to 31+500 Surapali
- Km 29+200 to 28+000 Khuntgaon
- Km 23+600 to 23+400 Mahuldihi
- Km 21+600 to 21+300
- Km 19+700 to 19+500 Muchurunali

At all the above listed BUAs, the presence of VRUs and their interaction with SH-10A is significant. At few BUAs, the marked cross-walk for pedestrians is provided but there is no provision for footpath. At none of the above mentioned locations the street lights are provided. There are no bus-bays and hence the buses were observed stopping on the road obstructing visibility and the smooth flow of traffic. Some of the BUAs are on sharp horizontal curve which may be dangerous with traffic moving at high speed.

Built-up area on sharp curves, Km 23+600 to 23+400 and Km 21+600 to 21+300

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road (except marked cross walk at few locations)
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built

up nature of the area ahead
- No speed limit signs provided
- On street parking and bus stops were observed, which hampers visibility and leads to unsafe overtaking maneuvers.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to Appendix III for guidelines for safer treatments in roadside villages/ built-up areas

13.3.3.8. Accident prone location: Reverse curve at Km 27+000

The salient features affecting safety at this junctions are as follows:

- Reverse curve at Km 27+000 where the radius of two curves noted to be less than 75m and the two curves are less than 100m apart
- There is a structure/building on outer edge of the curve which is very near to the road edge (at a distance of 2 to 3m)
- There is a culvert in between the two curves with partial parapet, however the depth of drain is shallow.
- Although for delineation of the curve, CGP are provided these may not be visible during night time.

Photographs of the reverse curve are shown below.

1st curve of the reverse curve

2nd curve of the reverse curve

Building very near to road edge

Concerns & Recommendations

Reasons for concern: **Poor Delineation**

- On outer edge of these curves Concrete Guard Posts (CGP) are provided to delineate the curve. These may not be visible (not retro-reflective) during night time.
- As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic. As the CGP provided on SH-10A are larger by 10cm X 10cm in cross section these may be cause serious injury to the road user if the vehicle loses control negotiating the curve.

Recommendations:

- Provide road studs on the road edge for improved delineation
- Provide chevron signs on outer edge for guiding the traffic through the reverse curve
- Provide metal beam crash barrier with delineators on sharp curves in high embankment

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern: **High approach speed**

It was observed that the traffic approaching the curve was at higher speeds. In such situation the driver may not judge the alignment, lose control and hit the building.

Recommendations:

- Provide traffic calming measure, such as rumble strips or road humps on both the ends of curves with warning signs.
- Provide crash barrier on the outer edge of curve.
- Provide continuous parapets on the culvert.

13.4. RSA – Major District Roads

13.4.1. MDR-26: Kalunga Chowk (on SH-10) – Tumran (Km 0+000 to Km 14+000)

The road is a two lane bituminous road and is found to be in generally good condition.

On the initial section of road from Km. 0+000 to Km. 5+000, several industries and residences were noted along the road. Beyond Km 5+000, the road alignment passes through open/agricultural land use. The road carries significant motorized traffic including heavy vehicles up to the Kalunga Industries and beyond this location, low level of motorized traffic was noted. The traffic mix comprises of heavy commercial vehicles, significant numbers of 2-wheelers, 3-wheelers and bicycles.

13.4.1.1. Delineation of the Road


Lack of delineation in the stretch of (i) Km 0+000 to 1+000, and (ii) Km 6+000 to 7+000

Concerns & Recommendations	
Reasons for concern:	The centerline is marked in almost entire stretch of the road, whereas the **edge lines are missing .**
Recommendations:	• Provide edge lines with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

13.4.1.2. Alignment – Sharp Horizontal Curves

There are many curves with radius less than 75m on MDR-26. At such curves, the safe negotiating speed will be much less than the operating speed and hence curve warning signs, chevrons for delineation, and outer edge protection in case of embankment are necessary to ensure safety of traffic.

During the course of the assessment, the following hazardous locations were noted, which needs engineering countermeasures to improve the safety of these locations.

Sharp horizontal curves of radii <=100m were observed at,

- Km 0+200
- Km 3+600

- Km 1+400
- Km 2+800
- Km 3+100
- Km 5+900
- Km 13+800

Project road has above listed sharp curves, where it is required for the approaching vehicle to slow down by more than 20 km/ hour from the approach speed.

During the course of assessment, the consultant has carried out average speed and spot speed survey. The average speed and maximum speed were noted for one trial run on the road during 12:00 hrs to 13:00 hrs, from Km 0+000 to Km 14+000. An average speed of 54 km/ hour and a maximum speed of 60 km/ hour was noted during this survey. A spot speed was conducted on approach of the curve at Km 0+200, and the 85th percentile speed was found to be 58 kmph.

Sharp curve at Km 0+200 and Km 5+900

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed • Potential run-off accidents • Potential head-on collisions
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above.*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	Curves on high embankment without safety barriers noted. In the event of vehicles losing control, run-off accidents may happen leading to fatalities/ major injuries.
Recommendations:	Provide metal beam crash barrier with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above.*

13.4.1.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)
3. Side roads meeting the main road with steep gradient

Location of Side roads perpendicular to major road

- Km 2+700
- Km 5+900
- Km 6+000
- Km 6+000
- Km 7+200
- Km 7+600
- Km 8+200

Location of Side roads at skew with the major road

- Km 7+300
- Km 7+600
- Km 14+000

Location of Side roads merging with steep gradient with the major road

- Km 3+100
- Km 3+600
- Km 4+600
- Km 5+900

Photographs of side roads joining MDR-26 in an unsafe manner are given below.

Side road joining on curve, Km 3+600
(view from side road)

Side road joining at acute angle, Km 4+600

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on MDR-26 are due to buildings or trees on the corners.

Recommendations:

- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to *Appendix III* for guidelines on visibility triangles at junctions.

Concerns & Recommendations

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction
- Provide Give Way/ Stop signs as applicable, on side roads
- Provide Give Way/ Stop road marking at side roads

Reasons for concern:

High approach speeds

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.
- Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to *Appendix III* for guidelines on situations where to install the above

Reasons for concern:

Poor Geometry

- It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on safe vertical profile of side road.

13.4.1.4. Major Junctions

3-armed junction at Km 0+000


Km 0+000, intersection of MDR-26 with SH-10

- At this intersection there is no control over traffic movement despite of movement of heavy vehicles on both the SH-10 and MDR-26.
- No traffic signs or road markings at the junction to control, warn and inform the road user
- No facilities for VRUs were provided
- Junction is heavily built-up, and on street parking were observed
- As there are no bus bays/ designated bus stop, buses were observed to be stopping on the main road obstructing the visibility of approaching traffic.

Concerns & Recommendations

Reasons for concern:

Junction Layout

The junction layout is non-standard and has no established control over the traffic movement

Recommendations:

- Provide road markings pertaining to junction layout
- Provide acceleration and deceleration lanes on both the approaches
- Provide channelization to control the traffic movement

Refer to *Appendix III* for standard layout of 3-arm junction.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are not provided, the presence of which would have informed and warned the road user of the intersection ahead.

Recommendations:

- Provide appropriate traffic signs and road markings applicable to junction control

Refer to *Appendix III* for guidelines on road markings and traffic signs on 3-arm junction.

Reasons for concern:

Direction Signs

- No direction signs to guide the traffic through the junction layout which

may lead to hazardous driving and may lead to rear-end collision.

Recommendations:

- Provide direction signs on approaches to the junction to guide the traffic through the junction layout.

Refer to *Appendix III* for guidelines of direction signs on 4-arm junction.

Reasons for concern:

Provision for VRUs

- No provision for walking along the road or crossing by pedestrians/bicycles.
- Pedestrians were observed using the road for commuting, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Provide footpath on all the approaches to the junction
- Provide pedestrian crossings for safe crossing by pedestrians and bicycles.
- Provide on the road cycle lanes (1m wide) on approaches to the junction

Reasons for concern:

Buses stopping on road

- There are no bus-bays and hence the buses stop on road in the middle of intersection obstructing visibility and smooth flow of traffic

Recommendations:

- Provide bus-bays at a safe distance from the intersection on approaches of MDR-26.

Reasons for concern:

On-street Parking

- There are no parking spaces provided and vehicles are parked on road encroaching the road and shoulder space.
- This hampers visibility at the junction and force pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations:

- Provide designated parking spaces for vehicles.

13.4.1.5. Road side hazards - Parapets of narrow Culverts/ Bridges

At following locations the parapets of bridge/culvert are not delineated,

- Km 3+300
- Km 7+200
- Km 9+300

Parapets of Culvert/Bridge not delineated, Km 3+300 and Km 9+300

Concerns & Recommendations

Reasons for concern:

No delineation of culvert/bridge parapets

- The culvert/bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations:

- Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure)

Refer to Appendix III for guidelines for installation of object hazard markers

13.4.1.6. Road side hazards - Trees, Poles, and Buildings

Several road side objects were observed on MDR-26 such as, trees and poles or buildings (in BUA) in the range of 1-3m from the edge of road. Photograph showing trees and poles nearer to road edge are given below.

Trees and poles very near to road edge
Km 3+000 to Km 4+000

Buildings very near to road edge in BUA
Km 3+000 to Km 4+000

Concerns & Recommendations

Reasons for concern:

- The road side objects like, trees, street lights or other poles, and buildings which are near the edge of road needs to be protected and delineated.
- At night time it becomes very difficult for drivers to judge the position of such road side hazard.
- If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard

and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge

13.4.1.7. Roadside villages/ Built-up Areas (BUA)

Due to proximity to Rourkela and Kalunga Industrial Estate, there are many small industries on MDR-26 from **Km 0+800 to 3+600**. The BUA of Kalunga village is from **Km 3+600 to Km 5+000**. In both of these stretches there are a number of side roads (including industries access roads) join the MDR-26 without any proper treatment at the junction. In the Kalunga village there are commercial buildings on both the side which are very near to the road edge. Many vehicles were parked on both sides of road in the stretch passing through Kalunga village. There is no facility for VRUs such as pedestrian crossing or footpath in these BUAs. At none of the above mentioned locations the street lights are provided. There are no bus-bays and hence the buses were observed stopping on the road obstructing visibility and the smooth flow of traffic.

Photographs showing buildings and bus stops in BUAs are given below.

Built-up area of Kalunga town

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.

Recommendations:

- Provide traffic calming measures
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs.

Refer to Appendix III for guidelines on safe treatments in roadside villages/ commercial areas

13.5. RSA – Other District Roads

13.5.1. ODR: Kaleiposh – Koida (Km 41+200 to Km 0+000)

The safety assessment of this road was conducted from Km 41+200 near Kaleiposh village on SH-10A to Koida at Km 0+000. This road is having 2-lanes (7m wide) in the entire stretch. The road alignment is passing though plain terrain, from Km 41+200 to Km 35+000, and beyond up to Koida the alignment passes through ghat/hilly terrain. In the ghat section the road construction is on progress in few stretches. There are many sharp curves and hairpin bends where visibility of approaching traffic is severely restricted. With lack of proper delineation and outer edge protection these locations are very unsafe for traffic.

The traffic observed on this road comprises largely of trucks carrying mining material as there are several mines and industries on this road near Koida. The presence of pedestrians and other VRUs were observed in and around built-up areas.

13.5.1.1. Delineation of the Road

Lack of delineation in the stretch of (i) Km 34+000 to 35+000, and (ii) Km 30+000 to 31+000

Concerns & Recommendations	
Reasons for concern:	The centerline is marked only in the section of road from Km 41+200 to Km 30+000, and the edge line is marked from Km 41+200 to Km 37+000. In the rest of the stretch of road there are no lane markings.
Recommendations:	• Provide edge line and centre line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

13.5.1.2. Alignment – Sharp Horizontal Curves

Many sharp curves with radius less than 50m were noted. At such curves, the safe negotiating speed will be much less than the operating speed of the road and hence traffic calming measures, curve warning signs, chevrons for delineation, and outer edge protection in case of hilly road are necessary to ensure safety of traffic.

Horizontal curves of radius less than 50m were observed at the following chainages:

- Km 39+900
- Km 32+600
- Km 32+500
- Km 30+300
- Km 30+200
- Km 25+400
- Km 25+350
- Km 27+700
- Km 26+450
- Km 24+500
- Km 23+200
- Km 16+800
- Km 16+000
- Km 12+900
- Km 11+850
- Km 7+300

Series of sharp horizontal curves in the forest/ghat section were observed at the following chainages:

- 3 sharp curves (radii around 50m) from Km 27+300 to Km 27+000
- 4 sharp curves (radii around 40m) from Km 23+000 to Km 22+700

Project road has above listed sharp curves, where it is required for the approaching vehicle to slow down by more than 20 km/ hour from the approach speed.

During the course of assessment, the consultant has carried out average speed survey. The average speed and maximum speed were noted for one trial run on the road during 17:00 hrs to 18:00 hrs, from Km 30+000 to Km 41+200. An average speed of 50 km/ hour and a maximum speed of 62 km/ hour were noted during this survey. The spot speed survey on approaches of sharp curves could not be conducted as majority of the sharp curves are located in the forest/ghat section.

Sharp curve at Km 39+900

Sharp curve in ghat section at Km 30+200

Concerns & Recommendations

Reasons for concern:	Unexpectedly sharp horizontal bends will lead to crashes when drivers try to negotiate them at high speed. On ODR where a number of sharp curves are in the forest/ghat section with severely restricted visibility the vehicles can lose control and this can result in serious injuries or fatalities.
Recommendations:	• Provide curve treatments with a combination of traffic signs, road markings, delineators and crash barriers. *Refer to Appendix III for safe treatment options on roads in Ghat sections*
Reasons for concern:	Overtaking on such curves may lead to head-on collision

Recommendations:

- Provide "no-overtaking" mandatory signs
- Provide continuous centerline
- Provide extra widening (sealed shoulder).

Reasons for concern:

Sharp curves with valley on outer edge

The majority of sharp curves are in ghat section where there is valley side on the outer edge. If vehicle lose control while negotiating the curve it may fall in to the ditch or valley resulting into severe injury or fatality.

Recommendations: Provide crash barrier on the outer edge with delineators.

13.5.1.3. Alignment – Hairpin bends in ghat section

Hairpin bends were observed at the following locations:

- Km 34+000
- Km 34+300
- Km 31+700
- Km 29+000
- Km 25+300
- Km 22+500
- Km 22+100
- Km 21+900
- Km 21+150
- Km 21+450
- Km 20+800
- Km 19+250
- Km 17+750
- Km 13+600
- Km 13+350
- Km 13+100
- Km 11+000
- Km 10+800
- Km 10+650
- Km 10+300
- Km 10+000

Series of hairpin bends were observed at following locations:

- 4 hairpin bends from Km 32+300 to 31+900
- 6 hairpin bends from Km 20+000 to Km 19+000

Hairpin bend with steep gradient at Km 22+100

Hairpin bend with poor road condition at Km 11+400

Concerns & Recommendations

Reasons for concern:

Lack of delineation and outer edge protection

- There is no delineation or warning signs on these bends.
- There is no protection on the outer edge (valley side) on these bends.
- Hairpin bends in hilly areas may lead to run-off crashes when drivers try to negotiate them at high speed.
- On ODR where a number of hairpin bends are there with steep gradient, severely restricted visibility, and poor road condition the vehicles can lose control and this can result in serious injuries or fatalities.

Recommendations:

- Provide crash barriers on the outer edge.
- Provide curve treatments with a combination of traffic signs, road markings, and delineators.
- Traffic signs for curve treatment include curve warning signs, chevron signs for improved delineation, and mandatory sign to blow horn on approach of such bends.

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:

Overtaking on such bends may lead to head-on collision

Recommendations:

- Provide "no-overtaking" mandatory signs
- Provide continuous centerline
- Provide extra widening (sealed shoulder)

13.5.1.4. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to two major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road

- Km 36+800
- Km 9+500

Location of Side roads at skew with the major road

- Km 24+350
- Km 9+000
- Km 0+500

Photographs of side roads joining ODR with are given below.

Side road joining with steep gradient Km 36+800

Side road joining at skew angle Km 24+350

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on ODR are due to trees on the corners.

Recommendations:

Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at junctions.

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide 'Side Road Ahead' signs on the major road
- Provide STOP/ Give Way markings and signs on side road, as appropriate

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:

High approach speeds

High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road. Coupled with inadequate visibility, in the worst case, this may result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side at junctions having history of accidents
- Provide raised markings on the entry to the side road

- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on situations where to install the above.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner. This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter into the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on situations where to install the above.

13.5.1.5. Major Junctions

3-armed junction at Km 41+200

The salient features of this junction are as follow,

- Poor layout and inadequate traffic control
- No facilities for VRUs at this junction
- The direction sign board is on the arm of Kaleiposh-Koida road which is not visible to traffic approaching from Lahunipada arm of SH-10A.
- Street-lights were not provided

Km 41+200, intersection of ODR with SH-10A

3-armed junction at Km 23+650

The salient features of this junction are as follow,

- This is a 3-arm intersection of ODR with Barsuan road.
- The junction layout is poor and no control over traffic movement despite of heavy movement of trucks on both the ODR and Barsuan road.
- There are no direction signs or advance warning signs for intersection.

- The condition of road surface is very poor at this intersection.
- There is no built-up area at the intersection except small roadside hotels near the intersection.
- There is no provision for VRUs at this intersection.


Km 23+650, intersection of ODR with Barsuan road

3-armed junction at Km 14+000

The salient features of this junction are as follow,

- This is a 3-arm intersection of ODR with road leading to Jindal mines and township.
- At this intersection there is no control over traffic movement despite of heavy movement of trucks on both the ODR and the road leading to mines.
- There are no direction signs or advance warning signs for intersection.
- The condition of road surface is very poor at this intersection.
- There are shops and roadside hotels at the intersection which are encroaching on the shoulder of road.
- There were many trucks parked on the approach of intersection due to shops and roadside hotel.
- There is no provision for VRUs at this intersection.


Km 14+000, intersection of ODR with road leading to Jindal mines and township – trucks parked on approach and gate of mines and township

3-armed junction at Km 13+600

The salient features of this junction are as follow,

- This is a 3-arm intersection of ODR with road leading to mines of SAIL.
- The layout of this intersection is Y-type with a non-standard central island.
- The intersection is located very near to a hairpin bend where visibility of approaching traffic is severely restricted.
- There are no direction signs or advance warning signs for intersection.
- There is no built-up area around this intersection.
- There is no provision for VRUs at this intersection.

Km 13+600, Intersection of ODR with road from SAIL mines – trees in the central island and approach to intersection descending from the hairpin bend

3-armed junction at Km 0+000

The salient features of this junction are as follow,

- This is a 3-arm intersection (within Koida town) of ODR with road leading to Joda town.
- There are no traffic island and lane markings to guide the traffic through layout of the intersection.
- As the intersection is within BUA of Koida town there is commercial area around and the buildings are very near to the road edge.
- There is on-street parking on all the approaches of intersection and the buses were observed stopping on the road obstructing the visibility of approaching traffic.
- There is no provision for VRUs at this intersection.
- There are no street-lights at this junction.


Km 0+000, intersection of ODR with Joda road in Koida

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout at all the junctions is non-standard and has no control over the traffic movement.
- It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous.

Recommendations:

- Redesign junction and establish traffic control through properly designed splitter islands, road markings and traffic signs

Refer to *Appendix III* for standard layout of 3-arm junction.

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms, the presence of which would have informed and warned the road user of the layout ahead.
- As the road surface condition is poor, on most of the junctions, there are no lane markings and this encourages lawless traffic movement.

Recommendations:

- Provide appropriate road markings and traffic signs pertaining to traffic control at the junction

Refer to *Appendix III* for guidelines for traffic signs and road markings on 3-arm intersection.

Reasons for concern:

Direction Signs

- There are no proper direction signs to guide the traffic through the junction layout which may result in to frequent or sudden stopping of vehicles and may lead to rear-end collision.

Recommendations:

- Provide proper direction signs to guide the traffic through the junction layout.

Refer to *Appendix III* for guidelines of direction signs on 4-arm junction

Reasons for concern:

Provision for VRUs

- Significant movement of pedestrians and bicyclists are noted, but no separate provisions have been made
- Pedestrians are particularly vulnerable at such junctions having high approach speed of traffic
- Existing footways at intersections are encroached by commercial activities
- Pedestrian crossing facility not provided on any of the intersection.

Recommendations:

- Provide footpath on all the approaches to the junction
- Provide pedestrian crossings for safe crossing by pedestrians and bicycles
- Provide on the road cycle lanes (1m wide) on approaches to the junction

Reasons for concern:

On street Bus stop

- Buses were observed stopping on the road on intersection obstructing the visibility and flow of through traffic

Recommendations:

- Provide bus-bays with appropriate traffic signs and lane markings

Refer to Appendix III for guidelines for design of bus bays and on-street bus stops

Reasons for concern:

On-street Parking

- There are no parking spaces provided and vehicles are parked on road encroaching the road and shoulder space. This hampers visibility at the junction and force pedestrians to move into the centre of the road resulting in hazardous situation.

Recommendations: Provide designated parking spaces for vehicles.

3-armed round-about at Km 12+350

The salient features of this junction are as follow,

- This is a 3-arm intersection of ODR with road leading to Tensa township and mines.
- There is a round-about at the intersection.
- The condition of road surface is very poor and there are no lane markings or direction signs to guide the traffic through the intersection.
- The boundary wall of township is very close to the road edge.
- Two other access roads of SAIL guest house are joining ODR near the round-about without any warning or direction signs.
- There is no provision for VRUs at this intersection.

Km 12+350, intersection of ODR with township road – round-about and an approach

Concerns & Recommendations

Reasons for concern: **Poor delineation**

- Traffic signs and road markings are absent in any of the arms, the presence of which would have informed and warned the road user of the layout ahead

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings pertaining to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at roundabouts

Reasons for concern: **Provision for VRUs**

- No provision for crossing by pedestrians/ bicycles despite of significant presence of pedestrians and bicyclists.
- Pedestrians were observed using the road for commuting, instead of the footpath, and this expose them to the fast moving traffic which can lead to crashes resulting in serious injuries.

Recommendations:

- Provide footpath on all the approaches to the junction
- Provide pedestrian crossings for safe crossing by pedestrians and bicycles
- Provide on the road cycle lanes (1m wide) on approaches to the junction

Refer to Appendix III for guidelines for design of pedestrian crossing on approach to the roundabout.

13.5.1.6. Approach to Bridges

There is a causeway at **Km 24+000** where approaches are not protected and there are no parapets which may be hazardous for traffic.

Photographs of unsafe situation at the causeway are given below.

Unprotected approaches to the causeway, Km 24+000

No delineation or edge protection on the causeway, Km 24+000

Concerns & Recommendations

Reasons for concern: **Unprotected approach and edge of the causeway**

- If a vehicle approaching or traveling on the causeway loses control, it will fall into the ditch/drain in the absence of any protection, which may result into serious injuries or may prove to be fatal.

Recommendations:

- Provide metal crash barriers on both the approaches and on the causeway (which will serve the purpose of parapet, but also allow the high water to overflow) with delineators.

Reasons for concern: **High approach speed**

- In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approaches.

Refer to Appendix III for guidelines to treatments on approaches to bridges

13.5.1.7. Roadside Villages/ Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations on ODR,

- Km 40+300 to 40+000
- Km 1+000 to 0+000 (Koida)

The presence of VRUs and their interaction with ODR is significant on all these BUAs on ODR. There is no facility for VRUs such as pedestrian crossing or footpath and there are no street lights in these BUAs. There are no bus-bays and hence the buses were observed stopping on the road obstructing visibility and the smooth flow of traffic.

Photographs showing buildings and bus stops in BUAs are given below.

Built-up area from Km 40+300 to 40+000 and Km 1+000 to 0+000 (Koida)

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided
- On street parking hampers the visibility and resulting in unsafe situations
- On street bus stops observed, which hampers visibility and unsafe overtaking maneuvers.

Recommendations:

- Provide Gateway signs at before start and after the end of BUA
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas

- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to *Appendix III* for guidelines for installation of object hazard markers

13.5.1.8. Specific Location - Hair pin bend on a descending gradient at Km 19+250

The salient features of this location are as follows:

- There is a hairpin bend at Km 19+250 with deep valley on the outer edge without any edge protection or delineation.
- There are no warning signs or traffic calming measures on the approaches.
- The road width is not sufficient for turning of heavy vehicles and the profile is inadequate.
- The risk of run-off accidents of high speed descending vehicles and head-on collisions is very high in such situation.
- There is high probability of fatal or major injuries for all motor vehicle user groups; in particular truck and car traffic.
- As informed by the OWD staff this place is having a history of several accidents.

Km 19+250, dangerous hairpin bend

Concerns & Recommendations	
Reasons for concern:	**Lack of road width** At such locations, extra widening is required inside the curves for the vehicles to safely negotiate the curve
Recommendations:	**Provide extra widening on curve as per IRC standards**
Reasons for concern:	**High approach speed** The nature of the slope encourages the drivers to approach the curve in high speed which may lead to run-off accidents or head on collisions.
Recommendations:	• Provide traffic control measures Refer to *Appendix III* for traffic control measures in ghat section.

Reasons for concern:	**Lack of Edge protection and delineation** The risk run-off of the high speed descending vehicles in such situation is high. With lack of delineation it becomes very difficult for drivers to judge the position of such road side hazard, especially during night time.
Recommendations:	• Provide warning sign for hairpin bend and mandatory sign to blow horn on both the approaches • Provide crash barrier on the edge of the hairpin bend and its approaches. • Provide continuous edge line markings on the road edge. • Provide chevron signs and road studs for improved delineation.
Reasons for concern:	**Overtaking in such situation may lead to head-on collision**
Recommendations:	• Provide "no-overtaking" mandatory signs • Provide continuous centerline • Provide extra widening (sealed shoulder)

13.6. RSA – Rural Roads

13.6.1. Garjan Road (RD): Tumran-Panposh (Km 7+300 to Km 0+000)

The safety assessment of this road was conducted from Km 7+300 at Tumran village which is an intersection with MDR-26 up to Panposh on SH-10. The road is having single lane (3.5m wide) in the entire stretch assessed. The entire stretch of road is having bituminous surface with fair condition. The earthen shoulder is less than 1m wide in entire stretch with fair condition.

There are few small villages located on the road. As this is a village road, the motorized traffic is quite less whereas the non-motorized traffic is significant.

13.6.1.1. Delineation of the Road

Lack of delineation on the entire stretch of road.
Photographs of stretches (i) Km 6+000 to 7+000, and (ii) Km 4+000 to 5+000

Concerns & Recommendations	
Reasons for concern:	There are no road markings on this road
Recommendations:	• Provide edge line with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge and centre line RRPMs on sharp curves

13.6.1.2. Alignment – Sharp Horizontal Curves

There are many curves with radii less than 50m on this road. At such sharp radii the safe negotiating speed are much less than design speed and hence curve warning signs, chevrons for delineation and outer edge protection in case of embankment are necessary to ensure safety of traffic.

During the course of the assessment, the following hazardous locations were noted, which needs engineering countermeasures to improve the safety of these locations.

Horizontal curves of radii <=50m were observed at the following chainages:

- Km 6+200 (S-curve)
- Km 5+800
- Km 5+150
- Km 3+100
- Km 2+400 (S-curve)

Project road has above listed sharp curves, where it is required for the approaching vehicle to slow down by more than 10-15 km/ hour from the approach speed.

During the course of assessment, the consultant has carried out average speed survey. The average speed and maximum speed were noted for one trial run on the road during 13:00 hrs to 14:00 hrs, from Km 0+000 to Km 7+300. An average speed of 45 km/ hour and a maximum speed of 55 km/ hour was noted during this survey. The spot speed survey could not be conducted as the motorized traffic was very less on this road.

Sharp curve at Km 6+200 and Km 2+400

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed
Recommendations:	Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	**Sharp curves in BUA** VRUs in the BUA are at high risk as they share space with the high speed traffic
Recommendations:	Provide all the curve treatments mentioned above in addition to traffic calming measures and speed restriction signs in the BUA

13.6.1.3. Minor Junctions

All the intersections noted in this road comprise of single lane side roads joining with Garjan road, except at the start and end intersection with 2-lane roads.

Location of Side roads merging with Garjan road

- Km 6+200
- Km 5+800
- Km 5+700
- Km 4+900
- Km 4+200
- Km 3+200
- Km 1+700
- Km 0+000

Photographs of some of the side roads joining Garjan Road are given below.

Side road joining Garjan Road at Km 6+200 and Km 4+200

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-31 are due to buildings or trees on the corners.

Recommendations:

- Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

Poor delineation

- No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
- Poor delineation may result in sudden braking behaviour by road users who are required to stop, or wish to make turns. In the worst case, it can also result in rear-end collisions at high speeds.

Recommendations:

- Provide warning signs to provide drivers of advance notice of the upcoming junction

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern:

Poor Geometry

- It has been observed that on few junctions, the level difference between the

side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway

Refer to Appendix III for guidelines on safe vertical profile of side roads

13.6.1.4. Road side hazards - Parapets of Culverts/ Bridges

At following locations the parapets of bridge/culvert are not delineated,

- Km 2+700
- Km 6+100
- Km 8+800
- Km 13+700
- Km 19+300
- Km 31+800

Parapets of Culvert/Bridge not delineated, Km 6+200 and Km 0+600

Concerns & Recommendations

Reasons for concern:

No delineation of culvert/bridge parapets

- The culvert/bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations:

- Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure)

Refer to *Appendix III* for guidelines for installation of object hazard markers

13.6.1.5. Road side hazards - Trees, Poles, and Buildings

There were several road side objects observed on Garjan Road such as, trees and poles or buildings (in BUA) close to the edge of road.

Photograph showing trees and buildings near to road edge are given below.


Trees, poles and buildings very near to road edge in BUA

Concerns & Recommendations

Reasons for concern:

- The road side objects like, trees, street light or other poles, and buildings which are near the edge of road needs to be protected and delineated.
- At night time it becomes very difficult for drivers to judge the position of such road side hazard.
- If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects.
- In BUA, due to buildings very near to road edge there is no space left for pedestrians and other VRUs for movement along the road. This increases the risk for VRUs.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge
- In BUA where buildings are very near the road edge provide traffic calming measures and footpaths or wide shoulder for along movement of VRUs.

13.6.1.6. Roadside Villages/ Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations on Garjan Road,

- Km 7+300 to 6+500 Tumran
- Km 5+900 to 5+700
- Km 4+200 to 4+000 Garjan
- Km 2+000 to 1+800
- Km 1+000 to 0+000 Panposh

As the road assessed is a village road and all the above listed BUAs are small villages, congestion and on-street parking are less significant, however the presence of VRUs and their interaction with the road is significant. In these BUAs the buildings are very close to the road edge, and there is no facility for VRUs

such as pedestrian crossing or footpath. In such situation the risk of VRUs being involved in accident with motorized traffic is high.

BUA at Km 7+300 and Km 1+000

Concerns & Recommendations

Reasons for concern:

- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- Significant number of access roads within the BUA, the visibility of which has been hampered due to shops/ establishments on all corners of the junction
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided

Recommendations:

- Provide Gateway signs at before start and after the end of BUA
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools and road humps/ bar markings on the approaches to the schools

13.6.2. Koida-Patmunda and Koida-Khajurdihi Road, Km 0+000 to Km 8+500

The safety assessment of this road was conducted from Km 0+000 (intersection with Kaleiposh-Koida ODR) up to village Patmunda at Km 8+500. The road connecting village Khajurdihi with Koida-Patmunda road was also assessed. The road is in very poor condition (gravel road) with width ranging from 5m to 7.5m.

As this is a village road the traffic observed was quite less except a few trucks and other local traffic. There are a few small villages located along the road where significant movement of VRUs was observed. The general speed of motorized traffic observed during day time was in the range of 10-20 kmph due to poor road condition.

13.6.2.1. Delineation of the Road

Poor road condition and lack of delineation on (i) Koida-Patmunda Road, and (ii) Koida-Khajurdihi Road.

Concerns & Recommendations	
Reasons for concern:	**No edge line markings**
Recommendations:	• Provide edge line markings with thermoplastic road markings on whole length of the road (refer to IRC: 35-1997 for details)

13.6.2.2. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

The locations where the above are noted are given below.

Location of Side roads perpendicular to major road

- Km 6+200
- Km 6+700
- Km 7+400

Location of Side roads at skew with the major road

- Km 0+500
- Km 2+150
- Km 3+400

Photographs of some of the side roads joining this road are given below.

Side road joining with Patmunda/Khajurdihi Road at Km 2+150 and Km 3+400

Concerns & Recommendations

Reasons for concern:	**Inadequate Visibility** This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on this road are due to trees on the corners.
Recommendations:	Remove trees at least from the visibility triangle required for such junctions. *Refer to Appendix III for guidelines on visibility triangles at junctions*
Reasons for concern:	**Poor delineation** • No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	Provide 'Side Road Ahead' signs on the major road Provide STOP/ Give Way markings and signs on side road, as appropriate *Refer to Appendix III for guidelines on situations where to install the above*.
Reasons for concern:	**Poor Geometry** • It has been observed that on few junctions, the level difference between the side road and major road and the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.
Recommendations:	• Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway. *Refer to Appendix III for guidelines on situations where to install the above*

13.6.2.3. Road side hazards - Parapets of Culverts/ Bridges

At **Km 4+100** the parapets of bridge are not delineated.

Parapets of culvert not delineate, Km 4+100

Concerns & Recommendations	
Reasons for concern:	**No delineation of culvert/bridge parapets** The culvert/bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.
Recommendations:	Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of OHM for each structure) *Refer to Appendix III for guidelines for installation of object hazard markers.*

13.6.2.4. Road side hazards - Trees, Poles, and Buildings

There are several road side objects observed on this road such as, trees and poles or buildings (in BUA) close to the edge of road.

Trees and buildings very near to road edge in BUA

Concerns & Recommendations

Reasons for concern:

- The road side objects like, trees, street light or other poles, and buildings which are near the edge of road needs to be protected and delineated.
- At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects.
- In BUA, due to buildings very near to road edge there is no space left for pedestrians and other VRUs for movement along the road. This increases the risk for VRUs.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge
- In BUA where buildings are very near the road edge provide traffic calming measures. Provide wide shoulders for along movement of VRUs.

13.6.2.5. Roadside Villages/ Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations,

- Km 0+000 to 0+400
- Km 7+700 to 8+500 Patmunda village

BUA at Km 0+000 and Km 7+700 on Koida-Patmunda Road

Concerns & Recommendations

Reasons for concern:

- Accidents between motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of footpath and proper shoulder.

Recommendations:

- Provide gateway signs with speed restriction on start and end of BUA, additionally provide rumble strips, speed humps, or speed tables as traffic calming measures.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas

Refer to Appendix III for guidelines for installation of object hazard markers

13.6.3. KDK Waterfall Road (Rd), Km 0+000 to Km 15+000

The safety assessment of this road was conducted from Km 0+000 at Lalei Chowk on SH-10A up to KDK Waterfall at Km 15+000. The road is in very poor condition (gravel road) with width of 7.5m.

As the road connects SH-10A with Waterfalls, which is a popular tourist place of the region, the traffic volume observed is low and mainly comprises of few tourist bus/jeeps and local traffic. There are few small villages located along the road where significant movement of VRUs was observed.

13.6.3.1. Alignment – Sharp Horizontal Curves

There are many curves with radii less than 50m on this road. At such sharp radii the safe negotiating speed are much less than design speed and hence curve warning signs, chevrons for delineation, and outer edge protection in case of embankment are necessary to ensure safety of traffic.

Sharp horizontal curves of radii <50m were observed at,

- Km 2+200
- Km 8+200 (S-curve)
- Km 11+150 (S-curve)
- Km 13+100
- Km 14+900

Project road has above listed sharp curves, where it is required for the approaching vehicle to slow down by more than 10-15 km/ hour from the approach speed.

During the course of assessment, the consultant has carried out average speed survey. The average speed and maximum speed were noted for one trial run on the road during 12:00 hrs to 13:00 hrs, from Km 0+000 to Km 15+000. An average speed of 35 km/ hour and a maximum speed of 45 km/ hour was noted during this survey. The spot speed survey could not be conducted as the motorized traffic was less on this road.

Sharp curves at Km 2+200 and Km 14+900

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed
Recommendations:	Provide **curve warning signs, delineators and speed limit sign** as appropriate

Refer to Appendix III for guidelines on situations where to install the above

Reasons for concern: Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:

- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

13.6.3.2. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

- Side roads perpendicular to major road
- Side roads meeting the major road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road

- Km 0+900
- Km 2+250
- Km 2+550
- Km 5+400
- Km 8+800

Location of Side roads at skew with the major road

- Km 2+000
- Km 4+900
- Km 14+750

Photographs of some of the side roads joining Waterfall Road are given below.

Side road joining Waterfall Road at Km 0+900 and Km 8+800

Concerns & Recommendations

Reasons for concern:

Inadequate Visibility

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on SH-10 are due to encroachments.

Recommendations: Remove encroachments at least from the visibility triangle required for such junctions.

Refer to Appendix III for guidelines on visibility triangle at junctions

13.6.3.3. Road side hazards - Parapets of Culverts/ Bridges

At following locations the parapets of bridge/ culvert are either not provided or broken

- Km 4+500
- Km 8+250
- Km 11+200

No parapets at low level bridge, Km 8+250

Parapets broken on culvert at Km 11+200

At following locations the parapets of bridge/ culvert are not delineated,

- Km 0+500
- Km 2+600
- Km 4+500
- Km 8+250
- Km 11+200

Parapets of Culvert/ Bridge not delineated, Km 0+500 and Km 4+500

Concerns & Recommendations

Reasons for concern:

No delineation of bridge parapets

- The bridge parapets adjacent to high speed traffic movement are hazardous especially at night if not delineated as the driver cannot judge the position of such road side hazards.

Recommendations:

- Provide edge line markings and Object Hazard Marker (OHM) on both sides and for both approaches (ie. Four numbers of OHM for each structure)

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern:

Broken or missing parapets

The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of significant movement of VRUs on this road, the absence of parapets is hazardous for them.

Recommendations:

- Provide continuous parapets on all culverts and bridges.
- On low level bridge or causeway provide w-beam crash barrier.

13.6.3.4. Road side hazards - Trees, Poles, and Buildings

There are several road side objects observed on Waterfall Road such as, trees and poles or buildings (in BUA) close to the edge of road. Photograph showing trees very near to road edge are given below.

Poles and buildings very near to road edge in BUA

Concerns & Recommendations

Reasons for concern:

- The road side objects like, trees, street light or other poles, and buildings which are near the edge of road needs to be protected and delineated.
- At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects.
- In BUA, due to buildings very near to road edge there is no space left for pedestrians and other VRUs for movement along the road. This increases the risk for VRUs.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant

hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 2m from the road edge
- In BUA where buildings are very near the road edge provide traffic calming measures. Provide wide shoulders free of encroachments for movement of VRUs.

13.6.3.5. Road side hazards - Pond very near to road edge

At **Km 2+200** there is a pond on RHS which is very near to the edge of road and there is no delineation or protection on the road edge.

Pond near the road without delineation or any edge protection,
Km 2+200

Concerns & Recommendations

Reasons for concern:

Lack of Delineation and Edge Protection

- There is no delineation or edge protection at this place.
- At night time it becomes very difficult for drivers to judge the position of the pond.
- If the edge is not protected and/or illuminated there are chances of vehicle losing control and falling in to the pond.
- This may result in to fatal severe injury.

Recommendations:

To improve delineation,

- Provide road studs on the edge line

To provide edge protection

- Provide crash barrier along the road edge

13.6.3.6. Roadside Villages/ Built-up Areas (BUA)

Road side villages and built-up areas were observed at following locations on Waterfall Road,

- Km 1+800 to 2+200 Kurda
- Km 4+300 to 4+500 MahakulSahi
- Km 6+900 to 7+100 Mahulata
- Km 9+300 to 9+500

BUA at Km 1+800 and Km 6+900

Concerns & Recommendations

Reasons for concern:

- Accidents between motorized traffic and VRUs in BUA are more likely as pedestrians and cyclists use road in absence of wide shoulders.

Recommendations:

- Provide gateway signs with speed restriction on start and end of BUA, additionally provides speed humps as traffic calming measures.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'School Ahead' and 'SLOW' signs on appropriate locations near schools

Refer to Appendix III for guidelines on treatments near roadside villages.

CHAPTER 14

KHURDHA DISTRICT

14.1. Crash Data Analysis

The road crash data has been collected from State Crime Records Bureau (SCRB) for Khurdha district for years 2009, 2010 and 2011. The data consists of total number of crashes, fatalities and injuries classified into various categories like, type of collision, vehicle type, type of area, time of occurrence, type of location, type of road category (NH, SH and Other Roads), age of the driver, age of vehicle, weather condition, etc.

The data has been analyzed to determine the following in Khurdha district:

- Hazardous locations
- High-risk road users/ user groups
- Predominant nature of crashes

14.1.1. Hazardous Locations

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include rural roads, MDRs and ODRs. The length of Gram Panchayat roads, Panchayat Samiti roads and Forest roads are omitted from the 'other roads' category for consideration of crash data analysis.

The average number of crashes and fatalities during the years 2009-11 are shown in **Figure 14.1.** It can be seen from **Figure 14.1** that maximum number of fatalities and crashes occur on NHs and SHs. The length of road network up to ODR in Khurdha district is shown in **Figure 14.2.** It can be seen from **Figure 14.2**that length of other roads is much more than the length of NHs and SHs put together in Khurdha district. It is observed that the length of SHs is only 18km, but number of crashes and fatalities is significantly high making SHs more prone to crashes than other roads in Khurdha district.

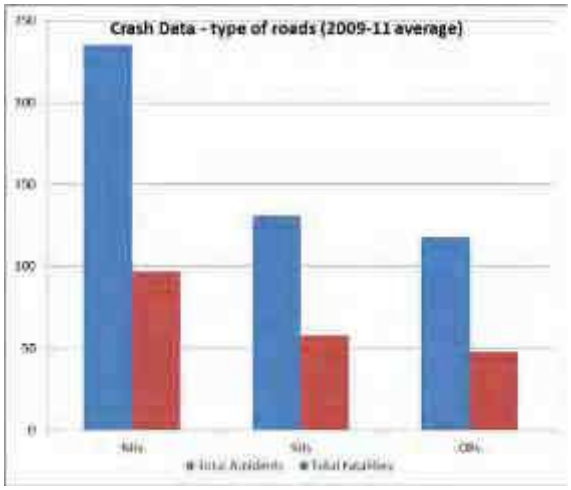


Figure 14.1: Crash data – Type of roads

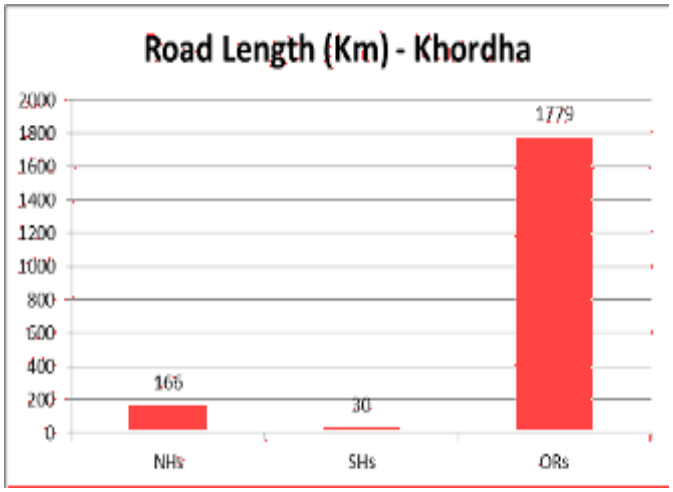


Figure 14.2: Road Network Length – Khurdha Dist

The crash data classified on the basis of location type in Khurdha district is shown in **Figure 14.3** below.

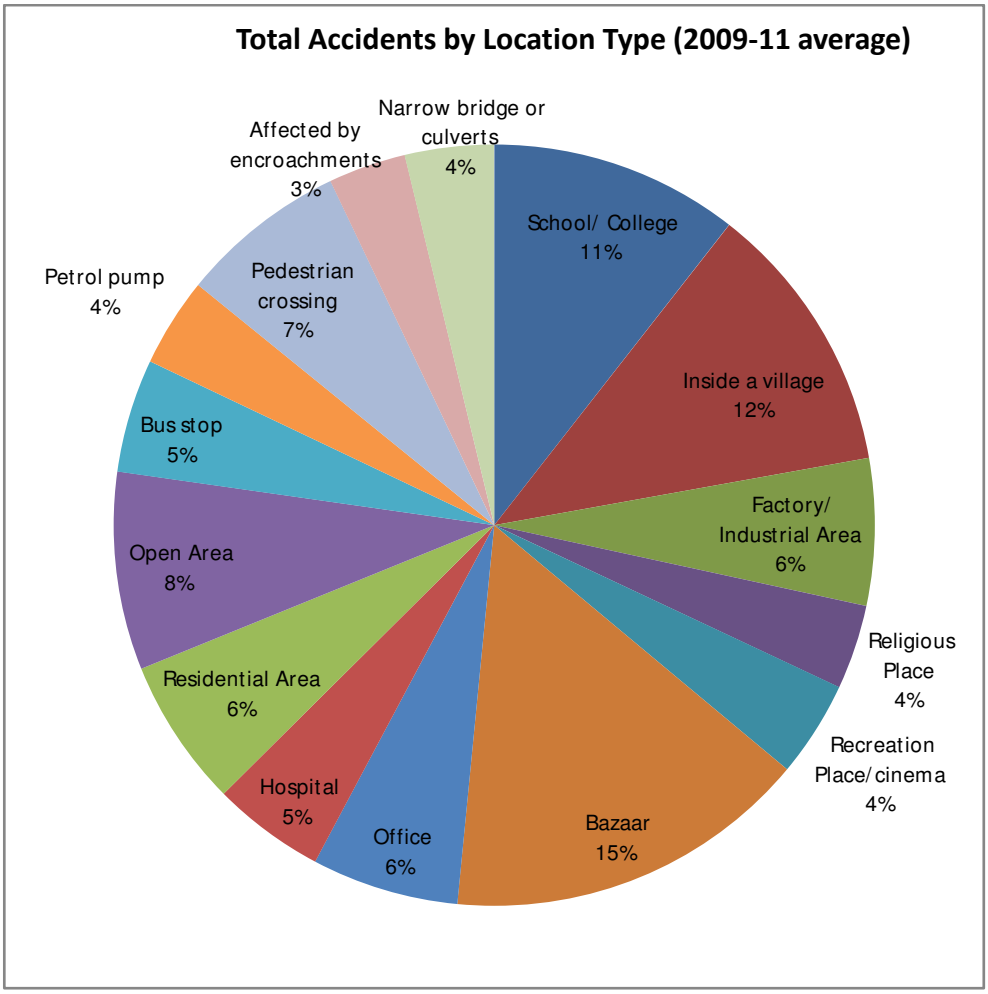


Figure 14.3: Crash data based on location type (2009-11 average)

It can be seen from **Figure 14.3** that maximum number of crashes occur in commercial areas (15%) followed by 'inside village' (12%), and near schools/colleges (11%). Significant numbers of crashes occur on pedestrian crossings (7%). However, it is not clear from the above data whether crashes in these location categories occur in NHs or SHs.

The following conclusions can be drawn for Khurdha district based on the findings of the above referred data:

- Maximum number of crashes and fatalities occur on NHs
- Number of crashes and fatalities per km length of SHs is higher than NHs and district roads
- Significant number of crashes occurs in populated areas (almost 70%)

14.1.2. High-risk road users/ user groups

The average number of crashes occurred during 2009-11, classified according to the vehicle type is shown in **Figure 14.4** and the average number of persons killed and classified according to road user type during the period 2009-11 is shown in **Figure 14.5**.

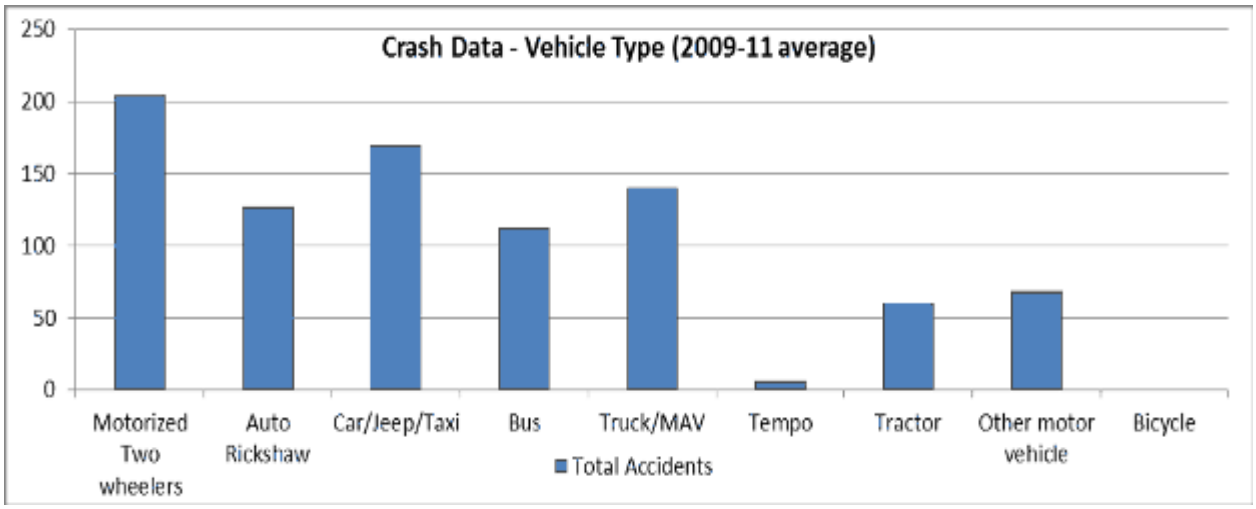


Figure 14.4: Total Crashes based on Vehicle Type (2009-11 average)

From **Figure 14.4**, it can be seen that motorized two wheelers are involved in maximum number of crashes (approximate 200) followed by cars and trucks. Again, it is not clear from the SCRB data, the locations or road category on which these crashes occur. This relationship is difficult to deduct from the existing pattern of data collection and recording by SCRB.

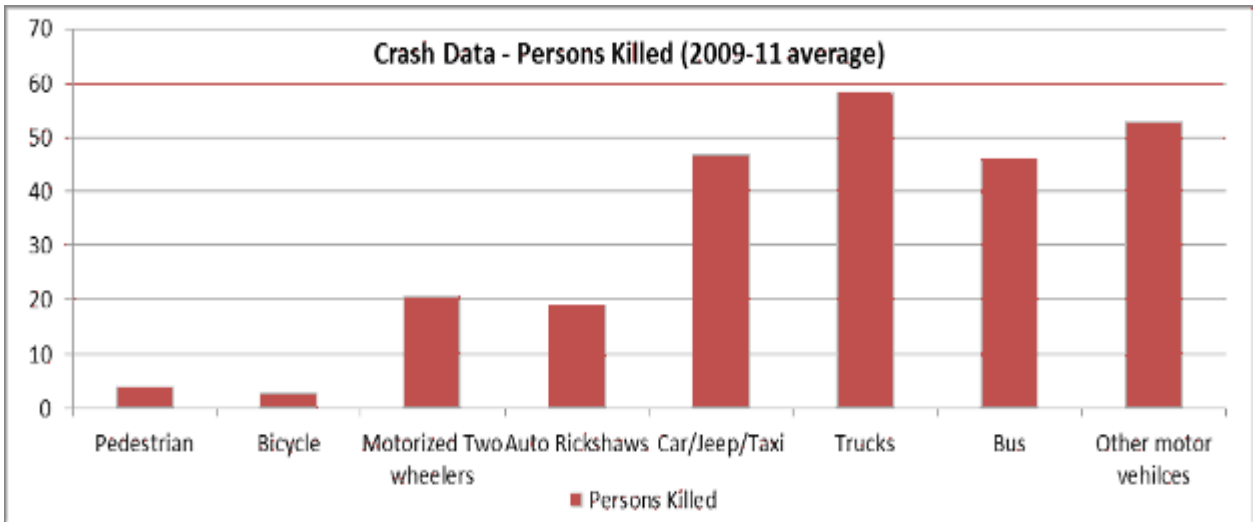


Figure 14.5: Total number of persons killed in road crashes (2009-11 average)

From **Figure 14.5,** it can be seen that maximum fatalities have occurred among the truck users (both drivers & on-board passengers) followed by 'other motor vehicles', car users and bus passengers. However, from the available data, it is difficult to ascertain the locations/ road types, where the truck users or car users are at higher risk.

Further to analysis the nature of crashes occurred in Khurdha district which may reveal a better correlation of crashes/ fatalities between type of vehicle and road category, the average number of crashes and fatalities based on type of collision are plotted as shown in **Figure 14.6**.

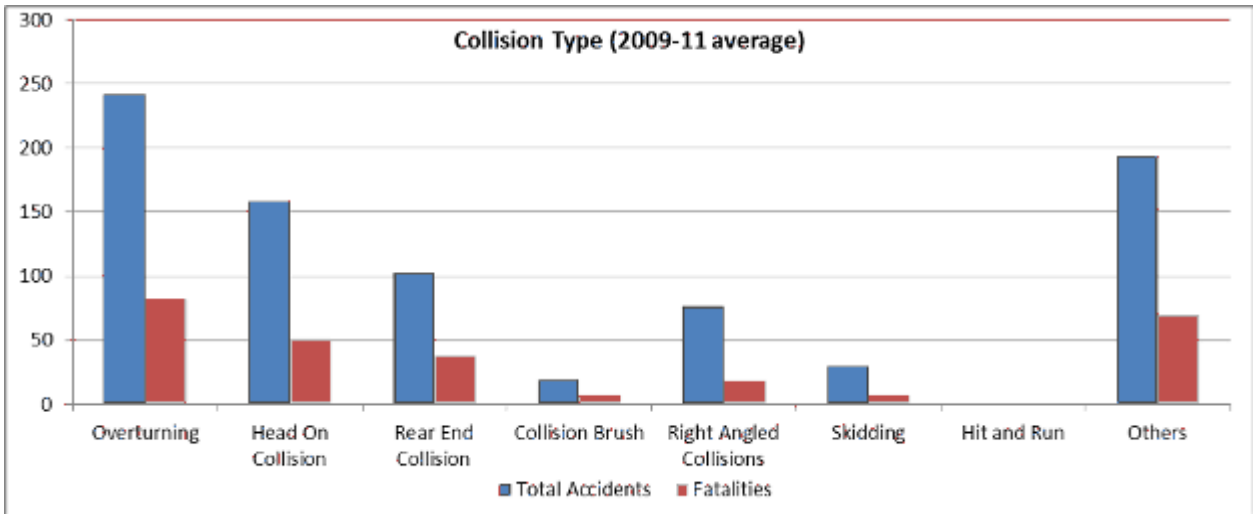


Figure 14.6: Crash data based on type of collision (2009-11 average)

It can be seen from **Figure 14.6** that predominant nature of crashes in Khurdha district are overturning of vehicles (248 crashes), followed by 'others' category (198 crashes). The type of collisions included in the category 'others' is not defined in the crash data base. In the remaining categories, crashes reported under 'head on collision' and 'rear end collision' are highest.

It can be seen from the above figures that maximum number of crashes/ fatalities happens on NHs, motorized two wheelers have a major share in crashes and the major number of accidents killed on roads in Khurdha are truck drivers and passengers, and the predominant nature of crashes in Khurdha district are overturning of vehicles.

The following can be inferred for Khurdha district:

- Trucks are exposed to overturning accidents on the NH and SHs
- Motorized two wheelers and cars are involved in head on collision and intersection related crashes (rear end and right angle collision)
- According to the data, pedestrians and cyclists are less exposed to risk

14.1.3. Time of the day

Prior to the field assessment, the consultants carried out an analysis to determine whether any trend exists to correlate between time of the day and number of crashes. The average number of crashes occurred during the years 2009-11 in rural area classified according to the time of the day is shown in **Figure 14.7** and the corresponding figures for urban area is shown in **Figure 14.8.**

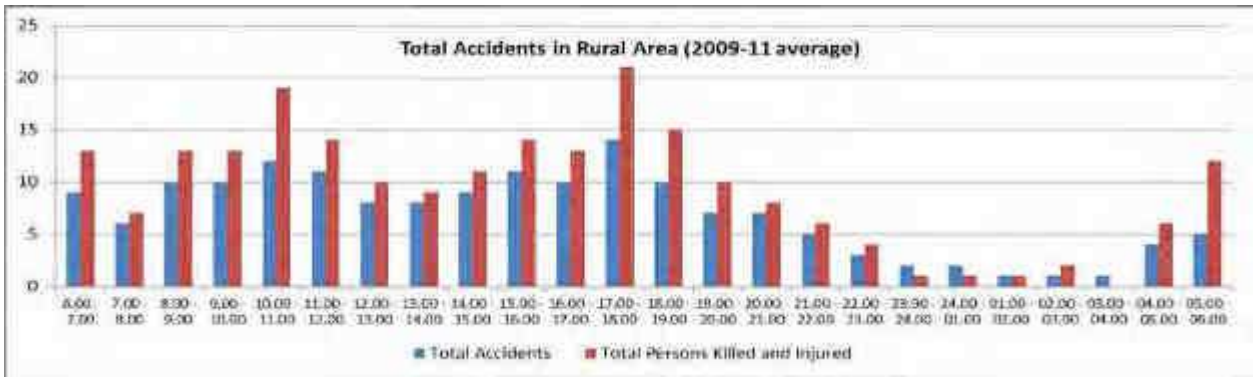


Figure 14.7: Total number of crashes in rural area (2009 – 11 average)

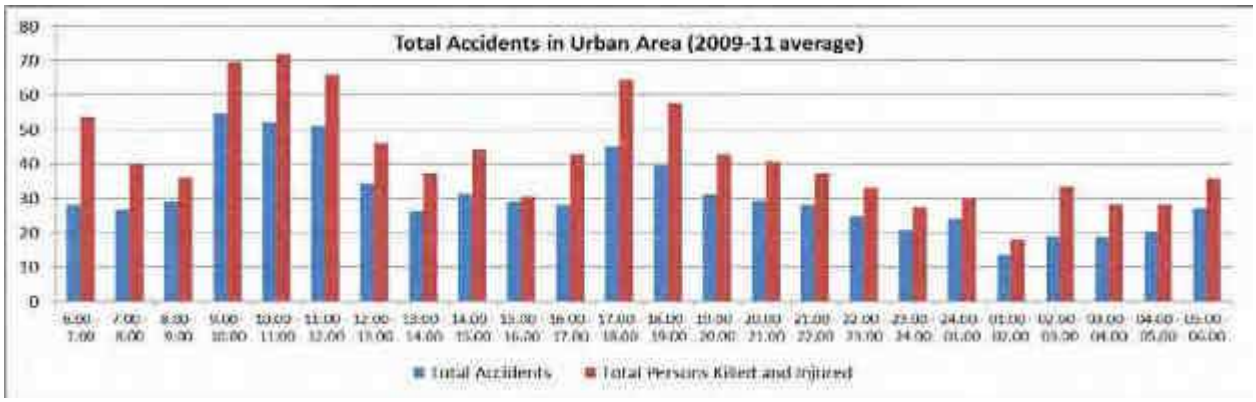


Figure 14.8: Total number of crashes in urban area (2009 – 11 average)

It can be seen in **Figure 14.8**, that the number of crashes, fatalities, and persons injured is highest during 09:00 to 11:00 hours and 17:00 to 18:00 hours in rural areas. It can be inferred that the variation of crashes during 24 hrs is more or less in relation with the traffic levels except for more number of crashes occurring during early morning hours on rural roads (04:00 to 06:00). This may be due to higher speeds of traffic during this time.

In urban areas also, the pattern of crashes is more or less in relation with the traffic level. Number of crashes is more during morning peak time (09:00 to 12:00 hrs) and evening peak time (17:00 to 19:00 hrs). Significant number of crashes occur during night hours in the urban areas, which may be due to regional traffic passing though urban areas during night hours.

The consultant proceeded to conduct the field assessment based on above analysis/ conclusions to determine the hazards in the road infrastructure which contribute to the crashes and fatalities in Khurdha district.

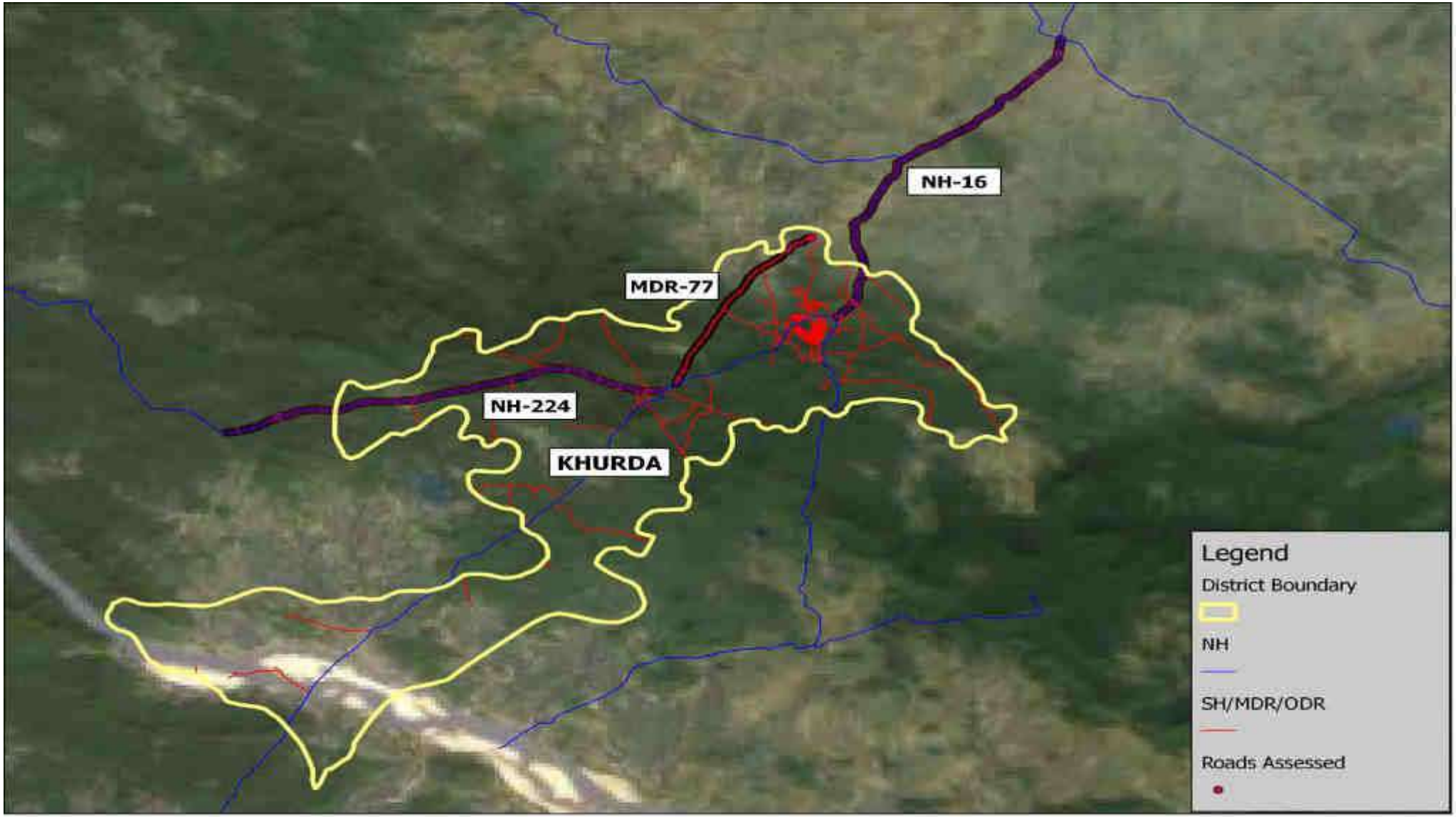
14.2. Location and Details of Audited Roads

The assessment was carried out on the following three roads:

1. NH-16 (Chhandikhole Chhak to Rasulgarh Chhak)
2. NH-224 (Khurdha to Nayagarh)
3. MDR-77 (Barang to Peetapalli)

The summary of details of the roads assessed including the dates and personnel involved are shown in **Appendix II.**

Figure 14.9: Map of Roads Assessed in Khurdha District



14.3. Road Safety Assessment – National Highways

14.3.1.NH-16: Chhandikhole Chhak to Rasulgarh Chhak

The assessment was carried out on this road over a length of 53 km, starting from Chhandikhole Chhak and ending in Rasulgarh Chhak. The general features of this road are as follows:

- Bituminous 4 lane divided carriageway road is in reasonably good condition
- Paved shoulder is present; service lanes are also present at some stretches
- The condition of the shoulder is reasonably good
- Traffic is mixed in character but has higher passenger vehicles than other vehicles
- Small towns and villages have very high number of motorcycles, bicycles and pedestrians
- Absence of safety measures at some stretches under construction
- Speed observed during day time ranges from 60 km/ hour to more than 80 km/ hour.

The following sections detail the major hazards observed on this road, the reasons for concern and the recommendations to improve road safety in each of these hazards observed.

14.3.1.1. Delineation of the road

Absence of Centre line and edge line road marking at Km 225+480 and Km 219+500 respectively

Concerns & Recommendations	
Reasons for concern:	Centre line is present at most of the stretches but edge line road markings were not provided, the presence of which should delineate the road, particularly during night conditions
Recommendations:	• Provide edge line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide centre line markings throughout the road section • Provide RRPMs on edge line and centre line on sharp curves

14.3.1.2. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to a few major junctions. The types of junctions observed in this road are as follows:

Location of Side roads

- 222+370
- 230+950
- 242+600
- 222+910
- 233+200
- 244+520
- 225+480
- 235+630

Side road with poor visibility due to vegetation at Km 225+200

Level difference between side road and main road at Km 251+800

Concerns & Recommendations

Reasons for concern: **Inadequate Visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on the road are due to buildings/ encroachments on the corners.

Recommendations: Remove encroachments at least from the visibility triangle required for such junctions

Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern: **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which would inform and warn the road user of the layout ahead
- Poor delineation may result in sudden braking behavior by road users who are required to stop, or wish to make maneuvers. It can also result in rear-end collisions at high speeds.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern: **High approach speeds**

- High approach speeds were observed of traffic turning from side roads into

the main carriageway and no traffic calming measures/ warnings are provided on the side road.

- In addition to inadequate visibility, this may also result in right angle collision with vehicles coming from the major road leading to serious injury or fatal accidents.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that at a few junctions, the level differential between the side road and major road and the vertical profile of the side road joining the edge of main carriageway are in an unsafe manner.

This requires special skills from the drivers of vehicles coming from the side road to stop/ slow down before they enter the main carriageway at the junction and most of the drivers in such circumstances tend to drive into the major road without stopping/ slowing down. This may lead to collisions resulting in major injury/ fatalities.

Recommendations:

Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to Appendix III for guidelines on safer vertical profile of side roads at junctions.

Reason for concern:

Unsafe location of median opening and poor geometry layout

- Median openings are staggered with respect to side roads thus creating conflicting movement
- T junction layouts are not properly designed for turning traffic

Recommendations:

- Relocate the median opening for safer and non-conflicting movement
- Refer to *Appendix III* for design of median openings for turning traffic

14.3.1.3. Major Junctions

4-arm Roundabout at Km. 219+000

The salient features of this intersection are as follows:

- Junction is built-up with shops and resulting in on-street parking problems
- Heavy two wheelers, pedestrians, cyclists are present at the junction
- Heavy vehicle volume is significant
- Layout of the junction is poor
- Street lighting is provided, but no traffic signs or road markings exist to warn, delineate and establish junction control
- No provision for VRUs


Poor junction layout and on street parking at roundabout at Km 219+000

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** The junction layout is non-standard and has no control over the traffic movements. It is confusing who has priority in such situations. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to Appendix III for standard layout of 4-arm junctions*
Reasons for concern:	**Direction Signs** • No direction signs to guide the traffic through the junction layout which may lead to hazardous driving and may lead to rear-end collisions
Recommendations:	• Provide direction signs on approaches to the junction to guide the traffic through the junction layout *Refer to Appendix III for guidelines of direction signs on 4-arm junction*
Reasons for concern:	**Poor delineation** Traffic signs and road markings are absent in all arms of the junctions, the presence of which would enable the road user to be sufficiently alerted regarding the layout
Recommendations:	• Provide edge line markings, centerline markings and other junction road markings pertaining to junction control *Refer to Appendix III for guidelines on road markings & traffic signs at 4-arm junction*
Reasons for concern:	**Provision for VRUs** • Shoulder spaces around the junction are encroached by commercial establishments • No provision for crossing by pedestrians/ bicycles despite of significant

presence of pedestrians and bicyclists

Recommendations:	Provide wide shoulders/ footpaths for pedestrians to commute in the junctions without interfering with the motorized traffic *Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.*
Reasons for concern:	**On-street Parking** • No parking spaces are provided for commercial vehicles and forcing them to park and encroach the road and shoulder space thus hampering visibility • This forces pedestrians to move into the centre of the road exposing them to hazardous situations
Recommendations:	Provide designated parking spaces for commercial vehicles

14.3.1.4. Median Opening

Project road is a divided carriageway with several median openings provided for traffic to take 'U' turn or making right turning movements. For safer movement of traffic, median openings are needed to be designed properly.

Salient features for present median openings on project road are:

- Median openings are not designed properly for safer movement of traffic
- Possible type of conflicts are – Rear End Collision, Right Angled Collision, Side Swipe Collision
- No warning signs are provided to warn the road users about the median
- No provision of VRUs and pedestrians
- At some locations visibility is hampered by the vegetation

Concerns & Recommendations

Reasons for concern:	**Poor layout** The median openings are non-standard. These are provided in staggered manner with respect to the side roads or 'T' junction. This encourages lawless traffic movement and is hazardous.
Recommendations:	Re-design the median openings for safe traffic maneuver. Refer to *Appendix III* for design of median openings for turning traffic
Reason for concern:	**Poor Delineation** Some locations with median opening and 'T' junctions do not have traffic signs to warn the road users.
Recommendations:	Provide the warning signs on both sides of the median openings.

14.3.1.5. Approach to Bridges

At Km 253+000, 271+000 approach to bridge is found. Major issues observed are as given below:

- Sharp Curve on approaches;
- No protection on outside curve;

Unsafe Approach to Bridge at Km 253+000 and Km 271+200 respectively

Concerns & Recommendations

Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the bridge on the curve loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be major or fatal.
Recommendations:	Provide crash barriers on either approaches to the bridge with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Reasons for concern:	**Poor Delineation** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions which may lead to serious injuries/ fatal accidents
Recommendation:	• Provide curve warning signs in addition to crash barriers with delineators • Provide edge lane markings • Provide hazard markers on the edges of the parapets
Reasons for concern:	**High approach speed** In the absence of any warning of the layout ahead, vehicles will tend to drive fast and approach at a high speed. This may cause head-on or run-off collision.
Recommendation:	• Provide bar marking on approaches to make vehicles slow down, in addition to curve warning signs and mandatory speed limit signs • Provide speed tables/ humps on approaches Refer to *Appendix III* for guidelines of countermeasures required on approach to bridges/ structures on curves.

14.3.1.6. Road Side Objects

Project road has several trees and street light poles very near to the pavement edge which are hazardous for fast moving traffic. At some sections, the crash barriers are damaged probably due to accidents need to be fixed.

Drain located near to pavement edge at Km 219+100

Broken crash barrier at Km 250+300

Concerns & Recommendations

Reasons for concern:

The road side objects like trees and street lighting poles, buildings and unprotected deep drains pose significant safety hazard. At night time it becomes very difficult for drivers to judge the position of such hazards, in the absence of proper delineation.

If the road side objects are not protected and/or delineated/ illuminated, in the event of driver losing control, the resulting injury can be fatal.

Recommendations:

Desirable:

- Remove Trees/ street lighting poles from the road shoulders
- Remove encroachments from the right of way
- Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier

Essential:

- Delineate the hazards by installing OHMs or painting of the trees in black and white strips
- Remove encroachments on at least 3m from the road edge

14.3.1.7. Roadside Villages/ Built-up Areas (BUAs)

Roadside villages are particularly hazardous points on a rural road network. Project road has many such roadside villages. It is important to inform the road user in advance of the impending roadside village and if necessary, traffic calming measures needs to be provided for improved speed management through such villages/ built up areas.

Built up area and high encroatchments at Km 265+400

Roadside Villages on NH-16

Roadside villages are of the following types:

- Residential units over 100m to 200m length along the roadside
- A mix of residences and commercial establishments like small shops, the length ranging from 200m to less than a kilometer
- Purely commercial areas where heavy commercial activity, on-street parking and high number of pedestrian presence is noted
- On-street Parking and on street bus stops is prevalent
- Significant movements of pedestrians/school children, cyclists, motorcycles noted
- The level of encroachment is high
- Commercial establishments have direct access to national highway

Roadside villages/ built up areas were noted on the following locations:

- 219+000 to 220+000
- 243+000 to 244+000
- 246+000 to 247+000
- 251+000 to 252+000
- 263+000 to 264+000
- 265+000 to 266+000

Following sections can be classified as commercial areas.

- 241+970 to 242+00
- 247+000 to 249+000
- 255+300 to 256+000
- 257+600 to 258+250
- 270+000 to 270+520

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to control the speed of vehicles approaching at high speeds
- Large number of pedestrians including school children are noted, but no separate pedestrian facilities are provided
- Significant number of access roads within the roadside village, the visibility of which has been hampered due to shops/ establishments on all corners of the junction

- On-road bus stops hampers visibility and encourage dangerous overtaking
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided inform the road user of the safe speed to be adopted
- On street parking hampers the visibility and resulting in unsafe situations

Recommendations:

- Provide traffic calming measures on either approaches to the roadside village/ built-up area
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban/ commercial areas
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide 'STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SCHOOL AHEAD' signs wherever schools are present
- Provide designated parking spaces, where it deems necessary
- Provide Bus Bays/ Bus Stops as appropriate, with associated road markings and traffic signs

Refer to *Appendix III* for guidelines to improve road safety on road section near and inside the roadside village.

14.3.2.NationalHighway-224(Khurdha to Nayagarh)

NH-224 starts at Km 5+000 and ends at Km 57+000. Thus assessment was carried out on this road on a length of 52km. General features of this road are

- It is an intermediate lane till Km 48+000 and two lanes from 48+000 to 57+000
- Bituminous intermediate lane with reasonably good condition except for a few stretches where pot holes are present and condition is poor
- Most of the section has less than 1m wide earthen shoulder. Condition is poor.
- Mixed traffic was observed, with a higher number of motorcycles, bicycles and pedestrians
- Speed observed during spot speed survey varies from 60 KPH to more than 80 KPH

14.3.2.1. Delineation of the road

Absence of center line road marking at Km 11+200

Absence of road marking at Km 35+300

Concerns & Recommendations	
Reasons for concern:	**Edge line and center line road markings were not provided**
Recommendations:	• Provide edge line and center line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide RRPMs on edge line and centre line on all sharp curves

14.3.2.2. Alignment – Sharp Horizontal Curves

Curves having radius in the range of 100m to 200m were observed on the following locations:

- 6+500
- 39+500
- 51+640

Curve at Km 6+500

Curve at Km 51+640

Concerns & Recommendations	
Reasons for concern:	No warning signs/ delineation to inform the road user to make him/her slow down to negotiate the curve in a safe speed. In the worst case, this may lead to • Potential run-off accidents • Potential head-on collisions
Recommendations:	• Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate Refer to *Appendix III* for curve treatments.
Reasons for concern:	**Poor visibility on the curve due to trees and overgrown vegetation**, which can lead to head-on collisions
Recommendations:	• Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves
Reasons for concern:	On outer edge of some of these curves Concrete Guard Posts (CGP) are provided to protect the errant vehicles. As per international standards and practices, any concrete structure which is near the edge of road and larger by 10cm X 10cm in cross section is hazardous to the traffic.
Recommendations:	Provide chevron signs for delineation at all the curves
Reasons for concern:	On the curves with high embankment and without any protection on outer edge, there is high risk of run-off accidents.
Recommendations:	Provide metal beam crash barriers with delineators on sharp curves in high embankment *Refer to Appendix III for guidelines on situations where to install the above*
Reasons for concern:	Dangerous overtaking on sharp curves may lead to head-on collisions
Recommendations:	Provide 'no overtaking' traffic signs along with no overtaking lines on full length of the curve

14.3.2.3. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

The above junction types were observed on the following chainages:

Location of Side roads perpendicular to major road		
• 6+110	• 7+190	• 7+780

- 11+320
- 21+000
- 34+400
- 40+100
- 11+950
- 26+840
- 34+700
- 16+300
- 32+400
- 35+750

Location of Side roads at skew with the major road

- 6+340
- 30+100

Total 70 paved side roads and 54 unpaved side roads were found on the project road.

Perpendicular side road at Km 11+320

Skewed side road at Km 30+100

Concerns & Recommendations

Reasons for concern: **Inadequate Visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on the road are due to buildings/ shops on the corners.

Recommendations:

- Improve visibility by clearing vegetation
- Remove encroachments at least from the visibility triangle required for such junctions

Refer to Appendix III for guidelines on visibility triangle.

Reasons for concern: **Poor delineation**

- No traffic signs or road markings are observed on any of such junctions, the presence of which will alert and inform the road users about poor layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for **High approach speeds**

concern:

- High approach speeds were observed by traffic turning from side roads into the main carriageway and no traffic calming measures/ warning is provided on the side road.

Recommendations:

- Provide road humps on the side road at junctions having history of accidents
- Provide raised markings on the entry to the side road
- Provide adequate warning signs on major road and side road

Refer to Appendix III for guidelines on traffic calming measures.

Reasons for concern:

Poor Geometry

It has been observed that on few junctions, the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads have adequate length on the side road to slow down/ stop before entering the main carriageway.

Refer to *Appendix III* for the desired geometric arrangement for T-junctions.

14.3.2.4. Major Junctions

3-arm ('Y') Junction at chainage 16+300

Km 16+300

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

The junction layout is non-standard and hence traffic movement tends to be irregular encouraging lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

Re-design the junction after traffic studies and considering the requirements of all road users

Refer to Appendix III for standard layout of 3-arm junctions

Reasons for

Poor delineation

concern:

- All the arms of the intersection are devoid of traffic signs and road markings resulting in a serious safety hazard for intersection approaching road users.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings as applicable to junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction.

Reasons for concern:

Provision for VRUs

- Shoulder spaces in the junction area are encroached by commercial establishments
- No provision for crossing by pedestrians/bicycles is provided despite significant presence of pedestrians and bicyclists

Recommendations:

- Remove encroachments from the shoulder space.
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles.

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.

Reasons for concern:

On-street Parking

No parking spaces are provided for commercial vehicles because of which vehicles are parked haphazardly encroaching the road space and shoulders. This hampers visibility at the junction and forces pedestrians to move along the center of the road resulting in hazardous situations.

Recommendations:

- Provide designated parking spaces for commercial vehicles

Refer to Appendix III for parking arrangements in roadside commercial areas.

Reasons for concern:

High approach speed

Traffic coming from Cuttack side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor layout. This is a dangerous trend which may lead to serious accidents.

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

Refer to Appendix III for guidelines on traffic calming measures.

3-arm ('Y') Junction at Km 40+100

The salient features observed at this junction are as follows:

- Poor layout of the junction with no established traffic control
- Junction area has moderate commercial activity and the level of encroachment is medium
- Big trees and statue obstructs the visibility for vehicles coming from side road
- Street lighting is not provided

Km 40+100

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- This poorly laid out junction creates confusion to the road users regarding the priority for maneuvering causing disorganized traffic movement and is hazardous. The existing central island is non-standard and hampers visibility.

Recommendations:

- Re-design the junction after traffic studies considering the requirements of all road users

Refer to Appendix III for standard layout of 3-arm junctions

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent creating a hazardous situation.

Recommendations:

- Provide edge line markings, centerline markings and other junction road markings towards better junction control.

Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction.

Reasons for concern:

Provision for VRUs

- Shoulder spaces in the junction area are encroached by commercial establishments
- No provision for crossing by pedestrians/bicycles despite of significant presence of pedestrians and bicyclists

Recommendations:

- Remove encroachments from the shoulder space
- Provide pedestrian crossings at appropriate locations for safe crossing by pedestrians and bicycles

Refer to Appendix III for guidelines for design pedestrian crossing on approach to the 3-arm junction.

Reasons for concern:

High approach speed

Vehicles from the Cuttack and other traffic merging on to the major road travel in high approach speeds which may lead to crashes resulting in serious injury or

fatality

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout
  Refer to Appendix III for guidelines on traffic calming measures

14.3.2.5. Approach to Bridges

At chainage 51+640, a curve leads to a bridge on both approaches in high embankment, but it has been observed that no safety measures have been provided.

Approach to Major Bridge at high embankment at Km 51+640

Concerns & Recommendations	
Reasons for concern:	**Unprotected high embankment** In the absence of any protection, if a vehicle approaching the bridge loses control there is a danger of overturning and falling into the trench. There is a danger of resulting in serious injuries or fatalities due to this serious safety hazard.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions and in worst conditions, this will lead to serious injury/ fatal accidents.
Recommendation:	• Provide curve warning sign in addition to crash barrier with delineators • Provide edge lane markings • Provide hazard markers on either edge of the parapets
Reasons for concern:	**High approach speed** In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approach, along with warning signs for 'road hump'

14.3.2.6. Road Side Objects - Parapet Walls

At the following chainages parapet wall was either broken or found missing. In the event of a vehicle loses control, the resultant injury will be fatal or major, due to the presence of water body.

- 49+350

Absence of OHM and broken parapet wall at Km 14+750 and at Km 49+350 respectively

There is no hazard marker present on structures and major/minor bridges. Such locations are

- 14+750
- 18+100
- 31+100
- 33+100
- 35+900
- 56+710

Concerns & Recommendations

Reasons for concern:

Delineation of the parapet walls

- The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be delineated for a driver to judge the position of such road side hazard.

Recommendations:

- Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. four numbers of each OHM for each structure.

Refer to Appendix III for guidelines for installation of object hazard markers

Reasons for concern:

Broken or missing parapets

The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on the road, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.

Recommendations: Provide continuous parapets on all culverts and bridges.

14.3.2.7. Road Side Objects - Trees and Street Pole

Project road have many locations where trees and street poles are very near to pavement edge.

Trees near pavement edge

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street light or other poles, buildings, and unprotected deep drains which are near the edge of road needs to be. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	**Desirable:** • Remove Trees/ street lighting poles from the road shoulders • Remove encroachments from the right of way • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips • Remove encroachments on at least 2m from the road edge

14.3.2.8. Road Side Villages/ Built-up Areas (BUAs)

Roadside villages are particularly hazardous points on a rural road network. This section of the road has many such roadside villages, where the vulnerable road users, including school children are particularly at risk from high speed traffic.

Commercial Area at Km 53+800

On street parking at Km 49+800

The roadside villages were observed on the following chainages:

5+450 to 6+620 (Shradhapur Village)	7+190 to 7+540 (Jagulipatana Village)	11+000 to 11+390 (Jaimangal Village)
24+400 to 24+850 (Ghodathora Village)	25+000 to 26+000 (Chakapada Village)	26+720 to 26+950 (Tikatala Village)
36+800 to 37+500 (Kapasia Village)	38+000 to 39+000 (Chuda Village)	39+500 to 40+800 (Bolgarh Village)
49+900 to 51+400 (Purusottampur and Harikrishnapur Village)	51+900 to 54+000 (Pandura Village and Itamati Village)	

The following locations were noted for heavy commercial activities.

9+050 to 9+670 (Pubusahi Village)	12+800 to 13+300 (Sarua Village)	15+400 to 16+400 (Baghamari Village)
33+400 to 35+220 (Rajsunakhala Village)	45+200 to 48+000 (Dighiri Village)	

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area;
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road or to cross the road inside the village zone/ built up area;
- Significant number of access roads within the built up area, the visibility of which has been hampered due to shops/ establishments on all corners of the junction;
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead;
- No speed limit signs provided; and

- Hazardous on-street parking observed on commercial/ encroachment zones, which hampers the visibility of oncoming vehicles and resulting in unsafe situations.

Recommendations:

- Remove all encroachments and make available the road space up to road edge free of hindrances
- Develop a 'Gateway effect' on both approaches to the roadside village/ built up area
- Provide street lighting on all roadside villages/ built up areas, the lighting shall be provided at least beyond 100m from the start point of roadside village
- Provide pedestrian crossings, wherever deemed necessary
- Provide footpaths in urban areas or well-maintained wide shoulders (min. 2m wide) clean of encroachments and overgrown vegetation in rural areas
- Provide road humps with 'STOP' signs on all access roads in roadside villages in rural areas
- Provide designated parking spaces where the demand of parking is high

Refer to *Appendix III* for safe infrastructure arrangement for roadside villages in rural areas and for heavily built up sections and design of bus stops and bus bays

14.4. Road Safety Assessment – Major District Roads

14.4.1. MDR-77: Barang to Peetapalli

Assessment of this MDR starts at Barang (0+000) and ends at Peetapalli (30+000).

- It is a two lane road with reasonably good condition.
- Road surface is bituminous.
- The width of earthen shoulder was found to be 1-2 m and some sections have width less than 1 m and in poor or fair condition.
- Mixed traffic is observed on the project road.
  Delineation of Road

Concerns & Recommendations	
Reasons for concern:	**Centre line and edge line road markings are not provided throughout the assessed road.**
Recommendations:	• Provide edge line and center line with thermoplastic material on whole length of the road (refer to IRC: 35-1997 for details) • Provide edge line RRPMs on sharp curves

14.4.1.1. Alignment – Sharp Horizontal Curve

Sharp Curves (radius less than 100-150 m) are observed at following Chainages –

- 3+100
- 3+400
- 3+500
- 4+000
- 4+500
- 5+200
- 12+900
- 14+000
- 21+700

Sharp Curves on Project Road at Km 3+300 and Km 4+000

Concerns & Recommendations	
Reasons for concern:	**Poor Delineation** No warning signs/ delineation to inform the road user to make him/her slow down

to negotiate the curve in a safe speed, which may lead to:

- Potential run-off accidents
- Potential head-on collisions

Recommendations: Provide **curve warning signs, chevron signs, delineators and speed limit sign** as appropriate

Refer to Appendix III for guidelines on treatments at curves.

Reasons for concern: Poor visibility on the curve due to trees and overgrown vegetation, which can lead to head-on collisions

Recommendations:

- Improve the line of sight by removing trees from the shoulder and cut down vegetation which hampers visibility along the curves

Reasons for concern: On the curves with high embankment and without any protection on outer edge there is high risk of run-off accidents.

Recommendations: Provide crash barriers on the outer edge on such curves.

Refer to Appendix III for guidelines on situations where to install the above

14.4.1.2. Minor Junctions

Various types of intersections were noted in this road, majority of them are single lane side roads joining the main carriageway, in addition to few major junctions. The types of junctions observed in this road are as follows:

1. Side roads perpendicular to main road
2. Side roads meeting the main road at acute angles (Skewed junctions)

Location of Side roads perpendicular to major road							
7+600	8+400	10+800	10+900	11+200	16+900	17+800	20+200
21+400	21+500	23+800	23+700	24+400	26+300	27+300	21+000

Location of Side roads at skew with the major road

- 4+700
- 8+800
- 21+600
- 4+900
- 11+900
- 23+600
- 5+800
- 15+750
- 25+400

Skewed Side Road at Km 5+800

Side roads perpendicular to Major Road at Km 16+900

Concerns & Recommendations

Reasons for concern: **Inadequate Visibility**

This is a major hazard observed on most of the 3-armed uncontrolled junctions. The major reasons for poor visibility at such junctions on MDR-77 are due to buildings/ shops on the corners and overgrown vegetation.

Recommendations: Remove encroachments at least from the visibility triangle required for such junctions.

Refer to *Appendix III* for guidelines on visibility triangle.

Reasons for concern: **Poor delineation**

No traffic signs or road markings are observed on any of such junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations: Provide traffic signs and road markings pertaining to junction control

Refer to Appendix III for guidelines on traffic signs and road markings at junctions

Reasons for concern: **Poor Geometry**

It has been observed that on few junctions, the vertical profile of the side road joins the edge of main carriageway in an unsafe manner.

Recommendations:

- Correct the vertical alignment of side road so that vehicles approaching from side roads has adequate length on the side road to slow down/ stop before entering into the main carriageway.

Refer to *Appendix III* for the desired geometric arrangement for T-junctions.

14.4.1.3. Major Junctions

3-arm Junction at 0+000

The salient features of this intersection are as follows:

- Significant number of two wheelers, pedestrians and cyclists use the junction;
- Non-standard central traffic islands/ splitter were provided. Garbage is dumped near central traffic island; and
- Street light is absent.

Concerns & Recommendations

Reasons for concern:	**Poor Junction layout** • The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.
Recommendations:	• Re-design the junction after traffic studies and considering the requirements of all road users. *Refer to Appendix III for standard layout of 3-arm junctions*
Reasons for concern:	**Poor delineation** • Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.
Recommendations:	• Provide edge line markings, centerline markings and other junction road markings pertaining to junction control. *Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction.*
Reasons for concern:	**High approach speed** Traffic coming from the Cuttack side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality

Recommendations:

- Provide traffic calming measures on the minor road
- Provide warning signs on the minor road
- Provide information signs and road markings at the junction to warn the road user of the layout

Refer to Appendix III for guidelines on traffic calming measures.

3-arm Junction at 8+400

The salient features of this intersection are as follows:

- Significant number of two wheelers, pedestrians and cyclists use the junction;
- Non-standard central traffic islands/ splitter were provided. Garbage is dumped near central traffic island; and
- Street light is absent.

Concerns & Recommendations

Reasons for concern:

Poor Junction layout

- The junction layout is non-standard and has no control over the traffic movement. It is confusing who has priority in such a situation. This encourages lawless traffic movement and is hazardous. The existing central island is non-standard and hampers visibility at the junction.

Recommendations:

- Re-design the junction after traffic studies and considering the requirements of all road users.

Refer to Appendix III for standard layout of 3-arm junctions

Reasons for concern:

Poor delineation

- Traffic signs and road markings are absent in any of the arms of the junctions, the presence of which would have informed and warned the road user of the layout ahead.

Recommendations:	• Provide edge line markings, centerline markings and other junction road markings pertaining to junction control. *Refer to Appendix III for guidelines on road markings & traffic signs at 3-arm junction.*
Reasons for concern:	**High approach speed** Traffic coming from the Cuttack side and traffic merging on to the major road travel in high approach speeds at this junction due to the poor junction layout. At the worst case, this may lead to crashes resulting in serious injury or fatality
Recommendations:	• Provide traffic calming measures on the minor road • Provide warning signs on the minor road • Provide information signs and road markings at the junction to warn the road user of the layout *Refer to Appendix III for guidelines on traffic calming measures.*

14.4.1.4. Approach to Bridges

At chainage 7+900, approach to bridge at high embankment is found, but no safety measures have been provided.

Approach to Major Bridge at high embankment at Km 51+640

Concerns & Recommendations

Reasons for concern:	**Unprotected high embankment** If a vehicle approaching the bridge loses control, it will fall into the ditch in the absence of any protection, and resulting injuries will be serious injuries or fatal.
Recommendations:	Provide crash barriers on either approaches of the structures with delineators *Refer to Appendix III for guidelines to treatments on approaches to bridges*
Reasons for concern:	**Absence of traffic signs and road markings** In the absence of adequate warning signs and reflective markings, the road layout and the hazard will not be clear for the road user, particularly during night conditions

and in worst conditions, this will lead to serious injury/ fatal accidents.

Recommendation:

- Provide curve warning sign in addition to crash barrier with delineators
- Provide edge lane markings
- Provide hazard markers on either edge of the parapets

Reasons for concern:

High approach speed

In the absence of any warning of the layout ahead, vehicles will tend to drive faster and approach the hazard in high speed. This may cause head-on or run-off collision.

Recommendation:

- Provide bar marking on either approaches to make vehicles slow down, in addition to curve warning signs and advisory speed limits
- In case the location has a history of accidents, provide speed tables/ humps on either approach, along with warning signs for 'road hump'.

14.4.1.5. Road Side Objects – Parapet Walls

There is no hazard marker present on structures and major/minor bridges. Such locations are

- 3+500
- 16+700
- 7+900
- 17+600
- 12+200
- 19+500
- 12+500
- 15+750

Absence of OHM at Km 12+500 and Km 19+500

Concerns & Recommendations

Reasons for concern: The bridge/ culvert parapets on the edge of the road adjacent to high speed traffic movement will be hazardous, particularly at dark conditions, and needs to be illuminated for a driver to judge the position of such road side hazard.

Recommendations: Install Object Hazard Marker (OHM) on both sides and for both approaches (i.e. Four numbers of each OHM for each structure.

Reasons for concern:

Broken or missing parapets

The absence of parapet on bridge/culvert increases the risk of vehicles falling in to the drain. In the context of high speed traffic movement observed on the road, the absences of parapets at such locations are hazardous for traffic, especially for VRUs.

Recommendations: Provide continuous parapets on all culverts and bridges.

14.4.1.6. Roadside Objects - Trees and Street lighting Poles

Tree and street light pole near pavement edge

Concerns & Recommendations	
Reasons for concern:	The road side objects like trees, street lighting poles or other posts, buildings, and unprotected deep drains poses significant road safety hazard. At night time it becomes very difficult for drivers to judge the position of such road side hazard. If the road side objects are not protected and/or illuminated there are chances of driver losing control and hitting these objects which may result into fatal accident.
Recommendations:	**Desirable:** • Remove Trees from the road shoulders and relocate street lighting poles • Provide crash barriers on locations where trees acts as a significant hazard and where the space is available to install crash barrier **Essential:** • Delineate the hazards by installing OHMs or painting of the trees in black and white strips

14.4.1.7. Road Side Villages/ Built-up Areas (BUAs)

- Roadside villages observed on this ODR.

Built up Sections at Km 24+000 and Km 0+000

Following locations have road side villages

- 0+000 (Barang Junction)
- 10+900 to 11+000
- 21+400 to 21+700
- 7+600 to 7+900
- 12+700 to 12+800
- 24+000 to 24+500
- 7+900 to 8+500
- 16+000 to 16+200

Concerns & Recommendations

Reasons for concern:

- No traffic calming measures are provided to slow down vehicles approaching at high speeds to the built up area
- Significant pedestrians including school children are noted, but no separate pedestrian facilities are provided along the road inside the BUA or to cross the road
- No road markings or warning signs to warn/ inform the road user of the built up nature of the area ahead
- No speed limit signs provided

Recommendations:

- Provide a 'Gateway' effect on the approaches to the roadside villages/ built up areas as a traffic calming measure.
- Provide well maintained wide shoulders (min. 2m wide), free of encroachments and overgrown vegetation in roadside villages in rural areas
- Provide STOP' signs with road humps on all access roads in roadside villages in rural areas
- Provide 'SCHOOL AHEAD' and 'SLOW' signs on appropriate locations near schools

Refer to Appendix III for layout of safe infrastructure provisions on approaches to roadside villages

CHAPTER 15

RESULT AND DISCUSSION

15. Results and Discussion

15.1. Introduction

This chapter presents the critical analysis of crash data of Odisha and the broad summary of key findings of the road safety assessment conducted in 12 selected districts over a network length of 2,021 kilometers of road in all categories. The discussion will focus to determine the hazardous road type, locations and conditions, high risk road user groups with typical hazardous locations on the road network in Odisha.

An attempt has been made to find a correlation between the nature of accidents happening on various categories of roads and road type, road user and the locations. It shall be noted that this is a systematic analysis informed by the accident data and experience of the consultants, since the data available from SCRB does not help to establish such a direct correlation. Hence, it is essential to point out that Odisha requires an efficient and scientific road accident database system to implement accident prevention and investigation techniques based on data gathered in scientific manner.

15.2. Hazardous road type

It can be seen from **Figures 15.1 and 15.2** that, though the length of National Highways is only 5 percent of the road network carrying low to high volume of traffic, it contribute to around 50 percent of the accidents and fatalities in Odisha. It can also be seen from these figures that the length of State Highways is only 7 percent of the road network carrying low to high volume of traffic, whereas it contributes to about 25 percent of the road traffic accidents and fatalities. Thus, it can be seen that National Highways constitutes the major hazardous road network followed by State Highways, whereas the other lower categories of roads can be considered less hazardous.

It shall be noted that the SCRB data does not define what all road types are included in 'other roads'. Hence for the purpose of this analysis, all roads expected to carry a certain level of motorized traffic has been considered in the 'other roads' category, which include Urban roads, Rural roads, MDRs, ODRs and Irrigation roads, amounting to 66,227 km. The roads omitted from the consideration of analysis of roads safety are Gram Panchayat roads, Panchayat Samiti roads and Forest roads, amounting to 167,729 km length.

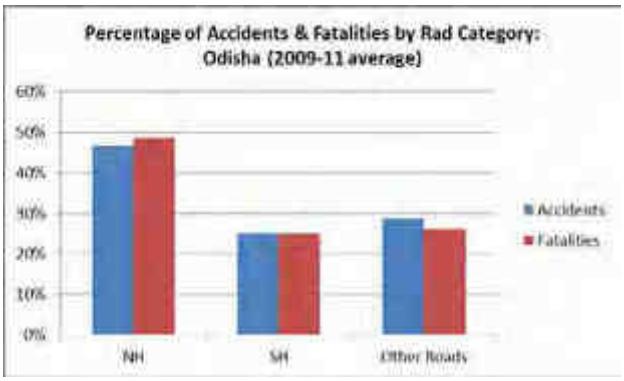


Figure 15.1:Percentage of accidents & fatalities

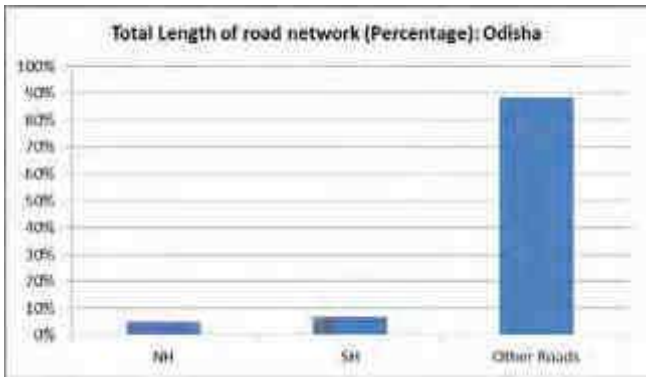


Figure 15.2:Length of road network (Percentage)

The following are the reasons that can be attributed to the vulnerability of National Highways and State Highways to the high proportions of accidents and fatalities of the entire network:

- National Highways and State Highways carry higher volume of traffic and these are generally high speed traffic such as trucks and cars, which ply on un-segregated carriageway along with other slow moving and vulnerable traffic such as bicycles, autorickshaws and motorcycles;
- Compared to district roads and other rural roads, the differential speed is high on NHs and SHs, and this itself is a significant hazard for safe movement of vehicles.

Because of the much higher vehicle-kilometer of travel taking place in NH and SH network of the state, naturally it is expected that they will have higher proportion of the accidents, unless the safe system approach is adopted totally with utmost care. Further, notwithstanding the realization that NHs constitute the biggest hazard in terms of the accident data led conclusions, the road safety assessment was carried out predominantly on State Highways, district roads and other lower categories of roads, after consultations with the client. The following were the reasons for giving more focus on State Highways, district roads and other rural roads:

- A significant length of National Highways are managed by NHAI, and the NHAI has developed separate safety management and improvement programmes for their road network;
- The ministry is also providing separate funds allocated from Central Road Fund (CRF) accrued from fuel cess to improve the road safety of the National Highways managed by their state offices, and the State roads. State Departments will also be taking up separate projects, where the state will have direct control over the project funding, prioritization and execution utilizing the allocated road safety funds.

Notwithstanding the above reasoning, a few National Highway links were selected for field assessment to determine the typical road safety issues associated with all types of roads in Odisha including NHs. The following sections present the key findings and the recommendations.

15.3. Hazardous location types

Figure 15.3 shows the average number of fatalities classified by location type during the years 2009-11 as obtained from the analysis of SCRB data.

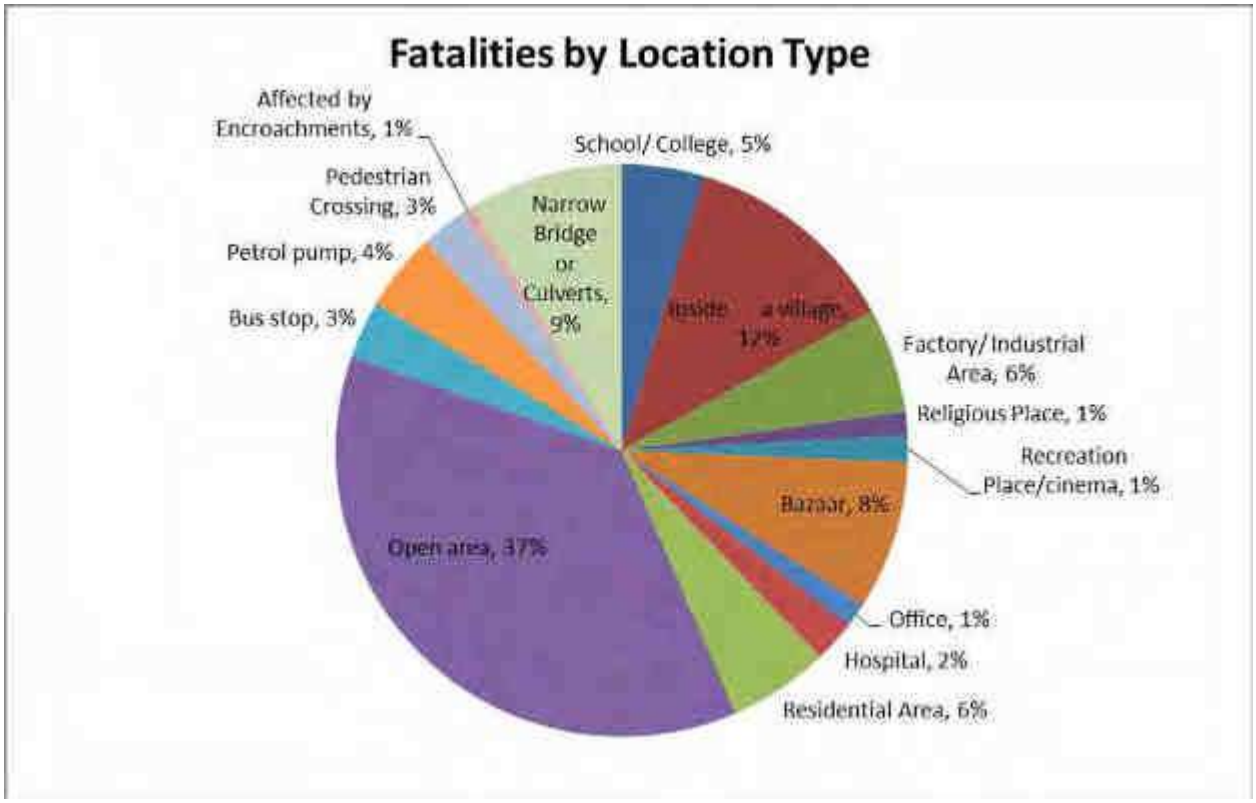


Figure 15.3: Fatalities by Location Type (2009-11 average)

It can be seen from the above figure that 37 percent of fatalities occur in open areas, while the rest 63 percent occur around populated areas like inside a village, residential areas, market place, etc. The hazardous situations in open area can be attributed to:

- Sharp curves after long straight sections, with high operating speed
- Median opening in four lane highways, often found with deficient design
- Side roads forming junction with the major road in rural areas, without speed change lanes and desired junction control

However, the SCRB data does not indicate the type of accidents or the road type including specific location type, in the case of crashes in open areas and populated areas.

The field assessment carried out by consultant in various road types revealed the following locations as particularly hazardous. This is explained in detail for each road assessed, in chapters 3 to 14.

- Sharp curves after long straight sections in rural areas operating with high speed
- Roadside villages/ Built up areas along the road, without any development control nor any enforcement on traffic
- Junctions with side roads in rural areas, poorly designed and controlled
- At grade junctions in NHS and SHs, evolved without proper design
- Narrow bridges/ culverts, without warning and hazard markers
- Unprotected Ghat sections, where the terrain is one side hilly and the other side valley, without the required level of delineation of the road
- Intermediate/ single lane roads having high volume of mixed traffic, with congestion and unsafe operational controls

- Locations where roadside objects are placed on the road shoulder, without logical delineation and hazard marking
- High speed roads passing through commercial areas and roadside villages, exposing vulnerable road users to high speed traffic
- Locations where shops/ commercial establishments have direct access to the highway, making the hazardous operation of traffic accessing the highway
- Median openings in four lane National Highways, which are with design deficiencies

15.4. High risk road users/ user groups

Figure 15.4 shows the average number of persons killed in road crashes during the years 2009-11 in the state of Odisha based on the detailed analysis of the SCRB data.

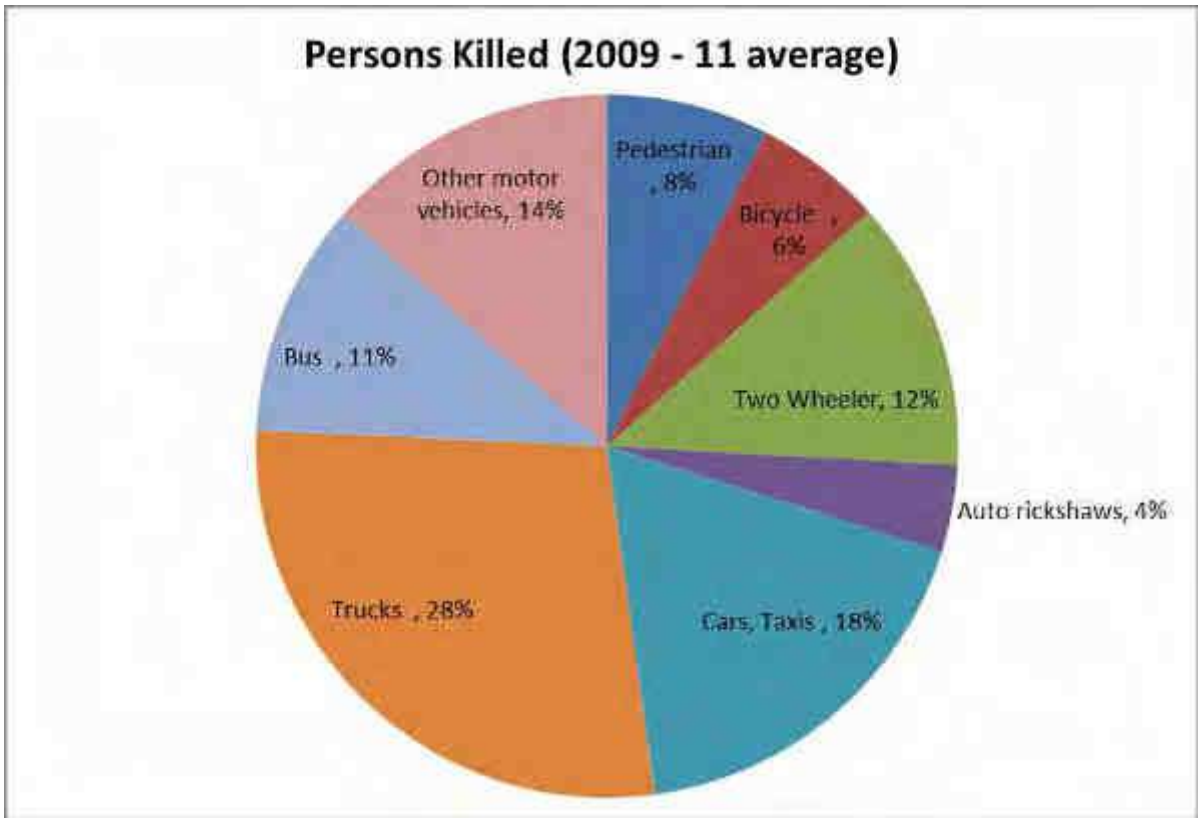


Figure 15.4: Persons killed in road crashes (2009-11 average)

It can be seen from the above figure that truck drivers and passengers constitute 28 percent of all fatalities, while cars and taxis (drivers and passengers) constitute 18 percent, and two wheeler drivers and pillion riders 12 percent.

It can be seen from **Figure 15.4** that vulnerable road users (pedestrians, cyclists and motorcyclists) form a significant high risk group – average 26 percent of all the victims of the road crashes in Odisha during 2009-11. The above data analysis also indicates that Truck users (driver and passenger) as well as users of passenger cars can also be considered as high risk user groups for the road network in Odisha.

The major limitation of this data is that it is impossible to determine the road type where one or the other of the above road user groups is more vulnerable to road crashes. The consultant has carried out further analysis of nature of crashes/ fatalities to determine a sensible correlation between road type, hazardous locations, high risk user groups and nature of accidents.

15.5. Nature of accidents/ fatalities

It is important to study the nature of accidents to derive a sensible understanding of the isolated data sets of crashes and fatalities. **Figure 15.5** shows the nature of the accidents (2009-11 average) occurred on the road network of Odisha, and **Figure 15.6** shows the average number of fatal accidents during the years 2009-11, classified based on the nature of accidents.

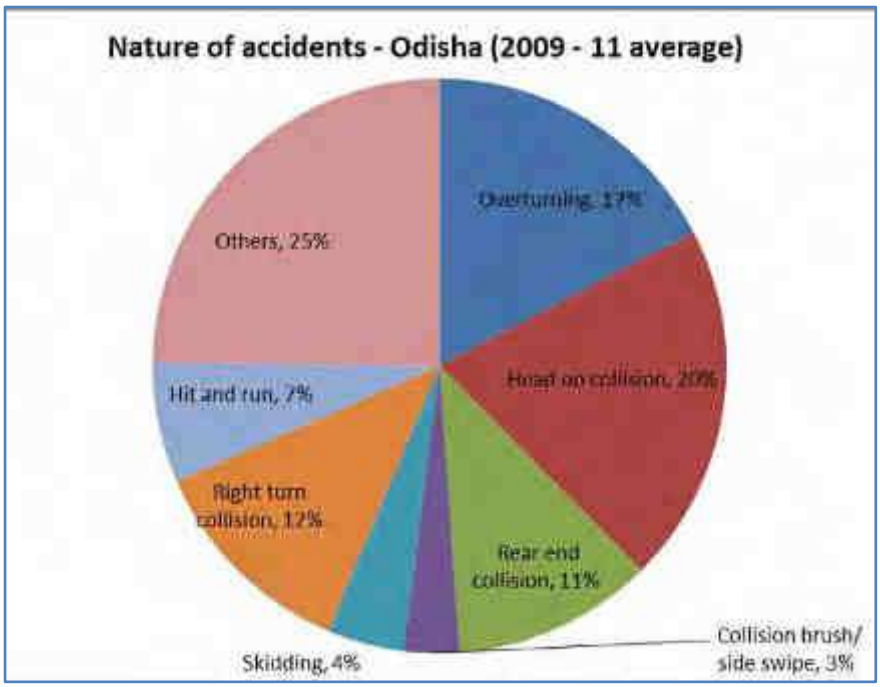


Figure 15.5: Nature of road accidents in Odisha (2009-11 average)

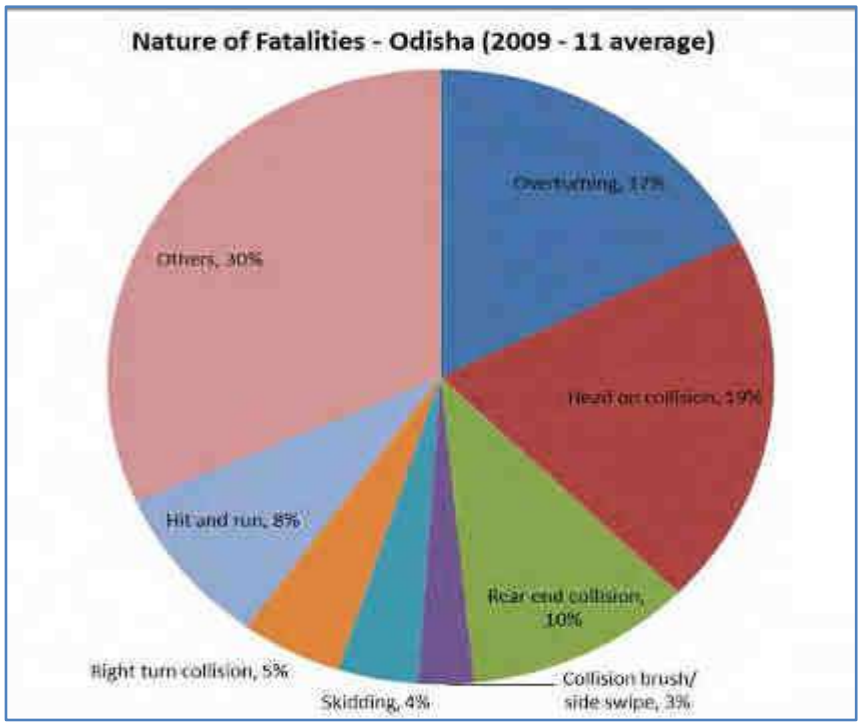


Figure 15.6: Nature of fatal accidents (2009-11 average)

It can be seen from the above figures that there is high correlation of type of accident and fatality in these types of accidents. The data analysis establishes that 20 percent of head-on collisions contribute 19% of the total fatality. Similarly, while overturning contributes to 17 percent, and rear end collision and right angle collision contributes to 11 percent and 12 percent respectively in the accidents, they contribute to 17%, 10% and 5% fatalities respectively.

From the figures, it can be seen that a significant 25 percent of crashes are classified as 'others'. It is assumed that crashes like run off the road, hitting road side object, and other single vehicle accident might be covered under this classification.

Crashes such as right angle collision and rear end collision tend to happen more in junction areas, whereas overturning collisions occur more on sharp curves and where there are deficiencies in the vertical alignment. Head on collisions occur, when the road users misjudge the overtaking opportunity or where opportunities of overtaking are less over a long distance. In some instances, it was also noted that head on collisions on divided highways occur when drivers travel wrong-way to avoid a short detour and U-turn. Head on collisions can also happen on sharp curves of 2-lane highways with higher operating speed, where vehicles tend to swerve to the other lane in an attempt to reduce the effect of low radius of the curve. The road safety assessment in various districts have found many such locations, where extra widening of curves with delineation will be required to minimize such hazards.

15.6. Crash data – State scenario

As it is stated earlier above, the level of details in the data determines the level of detailed analysis that can be done, and accordingly how accurately the cause and effect relationships can be derived. SCRB data is not available with such details that the entire facts of the accidents can be revealed. Thus, the broad summary analysis of crash data, based on the consultants' experience, can be listed as follows:

- Major hazardous locations are 'Open areas' and populated areas such as inside a village, residential areas, markets/built up stretches, and industrial areas;
- Narrow bridges and culverts, without proper delineation, are also found to be a major contributory factor to road accidents;
- Vulnerable road users (pedestrians, cyclists & motorcyclists) and truck users constitute the high risk user groups on Odisha road network;
- Passenger cars (cars, jeeps & taxis) also constitute a significant hazardous user group;
- Predominant nature of accidents involving fatalities are overturning, head on collisions, rear end collisions, right turn collisions, and 'others'(possibly single vehicle out of control, or hitting road side objects) which may include accidents involving tractors also;
- Rear end collisions and right turn crashes tend to occur more on junctions and median openings, hence junction locations and median openings can be deemed as significantly hazardous locations;
- It is assumed that major vehicle type involved in overturning accidents might be trucks and cars on sharp curves and on locations where vertical alignment is in poor geometry; and
- Cars and motorcyclists might be involved in large number of fatalities due to head-on collisions because of the limited overtaking opportunities on narrow roads(single/intermediate lane and congested 2-lane roads), and also at locations of inappropriate geometry for the road without adequate warning and operational controls.

15.7. Crash data – Key finding in selected districts

The summary of analysis of crash data in the selected 12 districts where road safety assessment was carried out is shown below in **Table 15.1** to Table **15.12**.

Table 15.1: Key Findings of Crash Data – Balasore District

Crash Data - Findings
• Though NHs constitute only 9 percent of the road network having low to high level of road traffic, 54 percent of road crashes occur on NHs • Trucks are the predominant vehicle type involved in road crashes and truck drivers and passengers are the predominant user group killed in road crashes • Motorized two wheelers are the second most high risk road user group, when it comes to number of crashes and fatalities • Overturning accidents are the predominant nature of crashes followed by right angled collision, which indicate that junction locations and sharp curves might be particularly hazardous locations on rod network in Balasore • According to the data, pedestrians and cyclists are less exposed to risk and hence cannot be considered and hazardous users or hazardous user groups

Table 15.2: Key Findings of Crash Data – Cuttack District

Crash Data - Findings
• NHs are the most hazardous road type followed by SHs; NHs constitute 32 percent of the road network, but 54 percent of crashes occur on NHs. • The populated areas along the road network in SH and NH are particularly hazardous • Trucks, motorized two wheelers and passenger cars are high risk groups exposed to higher number of crashes and fatalities • Overturning accidents, hit road side objects and run-off accidents are the most predominant nature of accidents, followed by head-on collisions, rear end collisions, and right angled collision, which indicates sharp curves, junction locations, overloading on NHs, poor visibility might be particular hazardous features on the road network • According to the data, pedestrian, bicycle riders, and motorized two wheelers are exposed to risk and hence can be considered as hazardous users or high risk user groups.

Table 15.3: Key Findings of Crash Data –Ganjam District

Crash Data - Findings
• Trucks, buses and cars are involved in head-on collisions predominantly • Maximum crashes are occurring on other roads but in terms of crashes per km of road length, NHs seem to be more unsafe due to high number of accidents on them than SHs • Fatalities of pedestrians is highly significant (20 pedestrians were killed) • 25% crashes are occurring in populated areas

Table 15.4: Key Findings of Crash Data – Jajpur District

Crash Data - Findings
• Most hazardous road types are NHs with maximum number of fatalities and crashes recorded on NHs • Trucks are involved in the most number of accidents, but pedestrians are the major road user group killed on roads in Jajpur and hence can be deemed as high risk user groups • The users of passenger cars and trucks are the second most high risk user groups exposed to crashes and fatalities on road network in Jajpur • The nature of accident 'others' ate the most predominant nature of accident, indicating that road side objects like trees and sharp curves might be key road safety issues to consider • Rear end collisions are the second highest type of crashes indicating junction locations are hazardous on the road network in Jajpur district • Pedestrians and cyclists are highly exposed to risk of motorized vehicles and might be victims of hit and run type of crashes

Table 15.5: Key Findings of Crash Data –Keonjhar District

Crash Data - Findings
• Though the length of NHs constitute only 14 percent of the road network, 62 percent of crashes occur on NHs; • Almost 50 percent of the crashes occur around populated areas where pedestrians, bicycles and other slow moving traffic are present in large numbers; • Right angled collisions and others which include hit road side objects and run-off accidents are the predominant nature of crashes/ fatalities, which indicate junction locations, road side objects like trees and sharp curves might be the major problems on the road network in Keonjhar district; • Trucks and four wheeler passenger cars are the high risk road user group; • Pedestrians, bicyclists, and motorized two wheelers are exposed to risk of other traffic mainly in populated areas.

Table 15.6: Key Findings of Crash Data – Koraput District

Crash Data - Findings
• Cars and motorcycles are predominantly exposed to risk in SHs and other roads; • Majority of accidents occur on NHs, maximum share of fatalities is due to others, and most number of fatalities are among Truck drivers and passengers. Hence, this can be inferred that Koraput might have significant problems of trucks involving in run-off accidents or hot road side objects on NHs; • According to the data, bicyclists and motorcyclists are exposed to risk in populated areas and may be categorized as vulnerable road users or vulnerable user groups as well.

Table 15.7: Key Findings of Crash Data –Mayurbhanj District

Crash Data - Findings
• NHs constitute only 6 percent of the road network, but 59 percent crashes occur on NHs • SHs contribute to only 8 percent of the road network, but 28 percent of crashes occur on SHs • Majority of crashes occur around populated areas such as inside a village • Passenger cars, Trucks and motorized two wheelers are involved in maximum number of crashes, but fatality is high among motorized two wheelers • 50 crashes involving motorized two wheelers resulted in 52 fatalities, putting them in a high risk road user group • Buses are involved in 33 crashes resulting 40 fatalities • Among the nature of crashes, overturning are the most predominant followed by 'others' which might include collision types such as hit pedestrian, run-off accidents and hit road side objects • Among the nature of crashes, the collision type 'others' and 'right angled collision' results in maximum number of fatalities.

Table 15.8: Key Findings of Crash Data – Nayagarh District

Crash Data - Findings
• Maximum number of crashes and fatalities occur in NHs followed by other roads; • Significant numbers of crashes (65%) occur around populated areas. • Vulnerable road users (pedestrians, motorcyclists and cyclists) and passenger car users are the high risk road user groups • The nature of significant number of accidents and fatalities might be hit road side objects and run-off accidents.

Table15.9: Key Findings of Crash Data – Rayagada District

Crash Data - Findings
• The number of crashes and fatalities are more or less similar on state highways and other roads, but the length of SHs is only one third of that of other roads • Forty five percent of crashes occur in open areas, indicating rashes in rural areas • Proportion of accidents and fatalities involving other motor vehicles are high compared to other types, but the other motor vehicles are not clearly defined • Passenger cars are involved in 6 crashes resulting in 10 fatalities; Trucks are involved in 10 crashes resulting in 23 fatalities • The users of 'other motor vehicles' are clearly the high risk road user group in Rayagada district • Among the nature of crashes, maximum number of crashes and fatalities occur due to head on collisions • According to the data, pedestrians and cyclists are less exposed to risk and hence cannot be considered among high risk road user groups.

Table 15.10: Key Findings of Crash Data – Sambalpur District

Crash Data - Findings
• Though NHs constitute only 13 percent of the road network carrying low to high volume of traffic, 60 percent of accidents occur on NHs • Though SHs constitute only 9 percent of the road network, 28 percent of accidents occur on SHs • More than 60 percent of crashes occur around populated areas • Though trucks and cars are involved in more number of crashes, it is the pedestrians, bicyclists and two wheelers, who are more among the fatalities than other road users • Maximum number of crashes occur due to rear end collisions, which indicate problems at junction locations or lack of forward visibility on the road, forcing vehicles to apply sudden brakes on unexpected occasions • Overturning is also a predominant nature of accident, and trucks are the major vehicle type involved in crashes. This indicate that trucks might be involved in high number of overturning crashes in NHs • 'Others' is also a major nature of accident, which might involve accidents like 'hit pedestrian' and run-off accidents. Since pedestrians are the major victims of road traffic fatalities, it can be inferred that 'motor vehicle hitting pedestrian' might be a major issue in Sambalpur road network.

Table 15.11: Key Findings of Crash Data – Sundargarh District

Crash Data - Findings
• Maximum number of crashes occur in SHs, but severity is higher in NHs; • Trucks are the predominant user group involved in larger number of crashes and fatalities, and can hence deemed the high risk road user groups; • Significant number of accidents is recorded under the nature of accident 'others', which might include hit road side objects, run-off accidents and hit pedestrian; and • According to the data, pedestrians and cyclists are less exposed to risk and hence cannot be considered and hazardous users or hazardous user groups.

Table 15.12: Key Findings of Crash Data – Khurdha District

Crash Data - Findings
• NHs constitute 8 percent of the road network, but contributes 49 percent of crashes; • SHs constitute 2 percent of the road network, but contributes to 27 percent of the crashes; • Majority of the crashes occur in road network around populated areas like 'inside a village', bazaar' etc.; • Motorized two wheelers are involved in maximum number of crashes, but severity of crashes is low; • Crashes involving Trucks, Buses and passenger cars resulted in maximum fatalities and hence these groups can be deemed as high risk road user groups; • Among the nature of accidents, 'Overturning' and 'others' resulted in maximum number of crashes and fatalities; and • According to the data, pedestrians and cyclists are less exposed to risk.

15.8. Key Road Safety Hazards on State Road Network

The objective of the road safety assessment was to determine the typical hazardous locations in the network, the risk groups who are most vulnerable at a given hazardous situation, so as to develop a short, medium and long term programme for the roads authority, with systematically identified countermeasures as part of the safe system, to be implemented to improve the safety of the road infrastructure in the State. These key findings with the recommendations will also form as the part of the road safety action plan.

The key road safety hazards identified in different categories in the 12 districts selected for road safety assessment is shown below.

Road Safety Hazards on National Highways
Four lane dual carriageway • Frequent number of side roads joining NH carriageway in hazardous manner • Unsafe geometric profile of side roads joining main carriageway and lack of speed reduction measures on side roads • Inappropriate locations of median opening encouraging contra flow in 4-lane highway • Poor visibility at median opening due to overgrown vegetation in median on 4-lane highway • Poorly delineated sharp curves • Lack of warning signs for pedestrian crossing and side roads and direction signs • Poor condition of road markings – Edge lines and centre lines • Hazardous geometry at median openings (unsafe level difference between carriageways in two directions) • Lack of facilities for pedestrians (crossing and walking along in built up areas) • Lack of designed designated comfort space for trucks, buses and other long distance travelers forcing vehicles to park on the road side creating hazardous situations • Lack of street lighting in built up areas • Lack of protection on locations of high embankments and approaches to bridges • Poor junction layouts

Two Lane, Intermediate Lane & Single Lane roads

- Sharp horizontal curves without delineation, warning signs and traffic calming measures
- Lack of reflective centre line road markings (normal, warning and no overtaking) on intermediate and two lane roads
- Lack of reflective edge lines
- Poor junction layouts (major and minor)
- Poor visibility at junction locations due to encroachments and other road side objects like trees
- Unprotected and poorly delineated high embankment and approach to bridges
- Lack of warning signs and speed reduction measures on side roads
- Presence of road side objects such as trees and poles on road edges
- Unsafe vertical profile of side roads at junction locations with the main carriageway
- Roadside villages lacking speed control measures on approaches, and lack of facilities of pedestrians and cyclists
- Unsafe horizontal bend after vertical crest, without delineation, warning signs and other speed control measures

Road Safety Hazards on State Highways and Other Roads

General

- Lack of reflective road markings – Centre line markings on two lane and intermediate lane roads and edge markings on single lane roads;
- Lack of traffic warning, information and direction signs;
- Poorly maintained shoulders forcing pedestrians to use the road space;
- Lack of facilities for cyclists and pedestrians on highly trafficked road sections;
- Poor forward visibility on certain sections due to overgrown vegetation, encroachments and huge trees;
- Unprotected and poorly delineated high embankment and approach to bridges;
- Lack of designated bus stop/ bus bay locations;
- Speeds are not assigned and no information provided on the operating speed of the road; and
- Unprotected high embankment on curves and straight sections having water bodies on the embankment toe.

Curves

- Sharp horizontal curves without delineation, warning signs and traffic calming measures;
- Poor visibility at curves due to overgrown vegetation and large trees on shoulders;
- Protection measures (crash barriers) are not provided on curves in high embankments;
- On certain sections, horizontal bend after vertical crest has been observed, which is significantly hazardous in the absence of delineation, warning signs and speed control measures;
- On Ghat sections, the valley side of curves are not delineated and provided with crash barriers; and
- On certain sharp curves, super elevation has not been provided.

Junctions

- Poor visibility at junction locations due to encroachments and other road side objects like trees;
- Poor junction layouts (major and minor);
- Lack of warning signs and speed reduction measures on side roads;
- Unsafe vertical profile of side roads at junction locations with the main carriageway;
- Lack of pedestrian and parking facilities at major junctions; and
- Lack of junctions markings and traffic signs (direction and warning signs).

Road side objects

- Presence of large trees on road edge – a major hazard;
- Street lighting and electric poles on road edge without delineators;
- Parapet walls of narrow bridges are not delineated with hazard markers; and
- Broken or missing parapets of bridges.

Road side villages/ built up areas

- Roadside villages lacking speed control measures on approaches, and lack of facilities of pedestrians and cyclists;
- Congested commercial areas along the road without pedestrian and parking facilities hampering visibility;
- High level of encroachments affecting visibility; and
- Schools inside road side villages – lack of warning signs and speed control measures.

The **Table 15.13** illustrates the typical hazardous locations and the user groups at risk in the Odisha road network in the form of a matrix.

Table 15.13: Typical hazardous locations and high risk user groups

Sl No.	Hazardous locations	Potential nature of accident	High risk user groups
1	Sharp curves in open areas	Overturning and head on collisions, run-off accidents	Trucks, cars & motor cyclists
2	Built up areas/ villages on road side	Hit pedestrian & cyclists	Pedestrians and cyclists
3	Major and minor junctions;	Right turn and rear end collisions	Motorcyclists, cars and trucks
4	Roads with poorly maintained shoulders in village areas and along built up areas	Hit pedestrians, cyclists and rear end collisions	Pedestrians and cyclists
5	Narrow bridges and culverts	Hit roadside objects/ parapets and hit pedestrian/ cyclists	All user groups
6	Approach to bridges, on high embankments	Run-off accidents	Trucks, cars and motorcyclists
7	Roadside objects, in particular large trees	Hit objects	Trucks, cars and motorcyclists
8	Median opening at hazardous locations and deficient design	Right turn and rear end collisions	Trucks, cars and motorcyclists
9	At grade junction of side roads in poor geometry	Right turn, right angle, and rear end collisions	Trucks, cars and motorcyclists

15.9. Way Forward – Safe System Projects

Based on the above findings, the consultants will generically recommend the measures to be adopted as part of safe system approach, in due considerations of the network and traffic requirements, for different

categories of the roads. These will be duly categorized for implementation in short, medium and long term horizons with the view to develop a safer road network in Odisha. The Safe system projects will form part of the Road Safety Action Plan, which is expected to be delivered by the Consultants as the next deliverable under the road safety task.

Road safety assessment results of 12 districts will be generalized for the categories of the road links subjected to the safety review at this stage, and a common and phased action plan shall be developed for separate categories of the roads in the state, suggesting interventions to be implemented in a time bound manner for enhancing safety of the state road network. In addition to road safety engineering measures to be taken up for the network, capacity building measures of GOO Departments will also form parts of the detailed road safety action plan. This action plan will also include additional legislation, requirements of road safety campaign, and similar other activities focusing on road safety problems of the state.

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CHAPTER 16

ASSESSMENT OF ROAD SAFETY MANAGEMENT CAPACITY AND RESPONSIBILITY FRAMEWORK

16.1. Introduction

The management of road safety is complex and involves many sectors. A safe road traffic system has many actors – safe road network, safe road user and safe vehicle – and the optimum interplay depends on underlying institutional management functions.

Like as in other states and India in general, the legislations and regulations affecting road safety places considerable emphasis on the driver by establishing rules and penalties and expecting subsequent changes in behaviour. Placing the complete onus or blame on the road traffic victim acted as a major impediment to the appropriate agencies fully embracing their responsibilities for a safer road traffic system.

The recent studies in road safety indicate that the countries/ states have to shift to a Safe System Approach to achieve sustainable reduction of road traffic fatalities. However, the weaknesses in safety management capacity of the governments present a formidable barrier to progress in the sustainable reduction of road crashes and fatalities, and to achieve a safe road traffic system.

A stakeholder workshop was conducted on 9th November 2012, in which the "Road Safety Engineering and Planning" task with the ideas of road safety management capacity was discussed. A variety of Government officials attended the Workshop, and the specific members who contributed through discussion on Road Safety are shown in **Appendix IV**.A focused assessment of road safety management capacity and responsibility framework in Odisha was carried out between 18 January 2013 to 30 January 2013 in Bhubaneswar and Cuttack. During this period, the consultants had individual meetings with a wide range of governmental and non-governmental stakeholders as outlined in **Appendix IV**.

On the basis of these consultations, the assessment identified strengths and weaknesses in road safety management in Odisha using guidelines provided in the World Bank Transport Note 1'Implementing the Recommendations of the World Report on Road Traffic Injury Prevention'. The appraisal checklist which was used to assess the safety management capacity is shown in **Appendix V**.

16.2. Road Safety Management System

The World Bank guideline concerning the implementation of the *World Report* recommendations (Bliss, 2004) used the road safety management framework shown in **Figure 16.1** to introduce prototype safety management capacity review tools. This road safety management framework and the system model was derived from New Zealand's comprehensive target setting framework which linked desired results with interventions and related institutional arrangements.

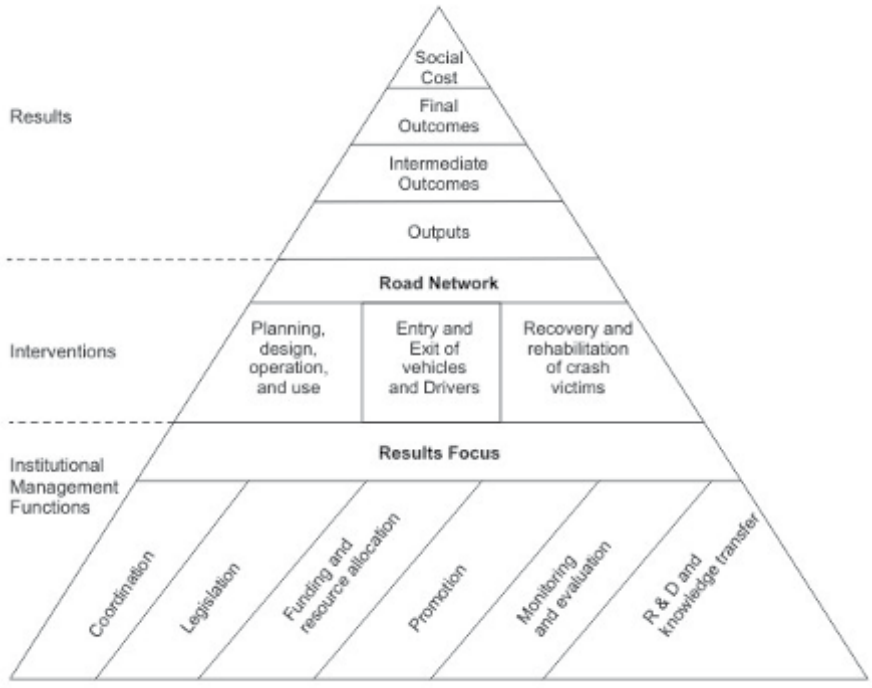

Figure 16.1: Road Safety Management System

The note shown in Box 1 briefly explains the major components involved in the road safety management system.

Institutional management functions: The institutional management functions are the foundation on which road safety management systems are built. They are essential for the production of interventions which, in turn, achieve road safety results and they must receive the highest priority in road safety planning and policy initiatives. The institutional management functions relate to all government, civil society and business entities that produce interventions and ultimately results.

Interventions: Interventions address the safe planning, design, operation and use of the road network, the conditions under which vehicles and road users can safely use it, and the safe recovery and rehabilitation of crash victims. They seek to manage exposure to the risk of crashes, prevent crashes and reduce crash injury severity. They comprise safety designs, standards, and rules as well as a combination of activity to secure compliance with th*ese.*

Results: In good practices of management systems, the road safety results are expressed in the form of long term goals and interim quantitative targets. Targets specify the desired safety performance endorsed by governments at all levels, stakeholders and the community. To be credible, interim targets must be achievable with cost-effective interventions. Targets are usually set in terms of final outcomes, intermediate outcomes and outputs.

Box 1: Institutional Management Functions, Interventions and Results

16.3. Overview of Institutional Management Functions

An overview of seven institutional management functions (refer to **Figure 16.1**) – *Results focus, Coordination, Legislation, Funding and Resource Allocation, Promotion, Monitoring and Evaluation, Research & Development and Knowledge Transfer* - is given below:

Results focus is the practical specification of its determination to improve road safety and the means agreed to achieve this determination. It defines the level of safety that the State wishes to achieve expressed in terms of a vision, goals, objectives and related targets.

Coordination concerns the alignment of the interventions and other related institutional management functions delivered by main government departments (e.g., Transport, Police, Works and Health)and other key community and business partnerships,(e.g. NGOs and business houses) to achieve the desired focus on results.

Legislation concerns the Parliamentary specification of the legitimate bounds of institutions, their interventions and related institutional management functions, where necessary, to govern through appropriate legal instruments and the delivery of all measures required to achieve the desired focus on results.

Funding and resource allocation concerns the financing of interventions and related institutional management functions on a sustainable basis using a rational evaluation framework to allocate resources to achieve the desired focus on results. This function seeks to ensure that the road safety funding mechanisms are sufficient and sustainable.

Promotion concerns the sustained communication of road safety as a core business for Government and society with an emphasis on the shared societal responsibility to support the delivery of the interventions required to achieve the desired focus on results.

Monitoring and evaluation concerns the systematic and on-going measurement of interventions in terms of road safety outputs and outcomes to achieve the desired focus on results.

Research and development and knowledge transfer concerns research on all factors that may influence road safety outputs and outcomes, and on the basis of research findings the development of improved institutional management functions and improved interventions to achieve the desired focus on results.

16.4. Detailed findings of the review

The detailed findings of the capacity review, following the format presented in World Bank Transport Note 1'Implementing the Recommendations of the World Report on Road Traffic Injury Prevention' is shown in **Table 16.1**.

Table 16.1: Detailed Safety Management Capacity Review

Road Safety Management Function	**Strategic Review**
Institutional Management Functions	
Results Focus	**Official position on acceptable levels of road safety in Odisha** There is no long term vision on the level of road safety to be achieved in Odisha, and no short, medium or long term targets have been set at the government level for reduction of road accidents/ fatalities. As part of the World Bank funded Odisha State Roads Project (OSRP), the GOO has conducted an Institutional Strengthening Action Plan (ISAP) 2008-18, which recommended key actions required in short (0 to 2 years) and medium (2 to 5 years) term to improve road safety in the state by approaching the problem in a comprehensive manner. The key short term recommendations given in ISAP matrix are given below. • Establish road safety councils at state and district level; • Establish highway patrolling units in core road network along with clear duties and responsibilities; • Establish traffic engineering unit at headquarters; • Develop accident recording system duly training the staff in consultation with police and transport departments; • Establish road safety database; • Identify accident prone areas on all roads; • Evolve road safety guidelines specifying roles and responsibilities of the organization involved; and • Provide necessary funds to improve the accident prone areas Though road safety has been recognized as a concern, there is little ownership for road safety across Odisha. Evidences are available of fragmented initiatives across departments like Transport, Traffic police and Health, but the efforts are not coordinated and no targets has been set for focus on results. The agencies – Transport, Roads authorities, Police, Health and Education – have little accountability to their actions for improved safety performance.
	Definition of Governmental Responsibilities <u>Transport Department –</u> The primary objective of the Transport Department is to implement the Motor Vehicle Acts and Rules, collection of taxes, fee on motor vehicles and regulation on passenger and goods transport by road for providing services to the travelling public. State Transport Authority and Regional Transport Authorities are the two major organizations under Transport Department whose key responsibilities have significant bearing on road safety. <u>State Transport Authority (STA) and Regional Transport Authorities (RTAs)</u> – STAs and RTAs have the responsibility to issue drivers' licenses, new permits and renewal of old permits to both passengers and good vehicles, in addition to

	collection of motor vehicle taxes and fees etc. RTAs are also responsible for enforcement of regulatory measures influencing road safety (wearing of helmets and seat belts, over loading, drunken driving etc.) under MV Act under the rules applicable in the State. STA is headed by Transport Commissioner-cum-Chairman. STA and RTAs also carry out activities mentioned below for improvement of road safety in the State, albeit in an uncoordinated manner. • Refresher driver training for HMV drivers, using funds available from MoRT&H • Road safety awareness campaigns • Deployment of ambulances and cranes on some accident prone locations • Providing retro reflective tapes to paste on the rear side of the vehicles • Observance of Road Safety Week in January every year and other sporadic activities. Motor Vehicle Inspectors (MVIs), attached to the RTAs, can impose spot fines in other districts, where Urban Police Act is not applicable, to enforce drunken driving, helmets, seat belts, using of mobile phones while driving, over speeding etc. Roads Authorities – The major agencies responsible for design, construction and management of the road network in Odisha are Odisha Works Department (OWD), Rural Development (RD) Department, Urban Local Bodies (MCs), National Highway Authority of India (NHAI) and Panchayat Raj Department. Among the above, OWD and NHAI are the key agencies since they are responsible for the planning, design, construction and management of the road network in the state carrying any significant traffic. Odisha State Police – The role of Odisha State Police in road safety is limited to collection and compilation of accident records in State Crime Records Bureau (SCRB).However, Bhubaneswar-Cuttack Police Commissionerate, established in 2008, is responsible for enforcement of road safety measures in Cuttack and Bhubaneswar under Urban Police Act, 2003. The major responsibilities of traffic police in commissionerate areas are: • Enforcement of overloading of bikes and autos • Removal of black film (tinted glass) • Wearing of helmets & seat belts • Drunken driving (breathalyzers available in each police station) In other districts, RTAs are responsible for the above functions. The traffic police is under resourced for managing the affairs in commissionerate areas also. It has been noted that 150 police per 12 lakh population is available for 2 districts, and 80 police personnel are available per day on an average to work in Cuttack city. In urban areas, municipal corporations are responsible to give permission to erect hoardings, and pole advertisements, which are significant road safety hazards. Under Urban Police Act, hoardings cannot be installed without consulting traffic police. Traffic police has the powers to remove hoardings which are erected without permission, and they do so regularly. Health Department - Trauma care centre, emergency ward facilities and arrangements for handling of patients (accident victims) in the state government hospitals and other various hospitals in the State, are regulated by health

	department. At present, the provision of post-crash care in the State is very poor. SCB hospital in Cuttack has department of trauma and emergency medicine, in addition to similar lower level facilities at all major district centres in Odisha. Hospitals in district headquarters are equipped with Trauma Care facilities, and sub-divisional hospitals have facilities for Surgery, Gynecology, Pediatrics and Medicine, but no trauma facilities. Government is planning to introduce ICUs in district hospitals with networking facilities for telemedicine. School and Mass Education Department – Road accidents are recognized as a problem, but no concrete measures have been taken to create awareness to children through interventions in curriculum. Children crossing and walking along the road was a major hazard earlier, but the risks has been reduced due to opening up of more schools in all neighbourhoods resulting in reduction of walking distance to school from home. Primary schools are provided in every 1 km radius and high schools in every 5 km radius. NCC, Scouts and Guides operate in most of the schools and colleges, where they are they are trained for road safety and traffic control, etc.
	Lead Agency Form Although, by virtue of its function and responsibilities, Transport Department can be termed as the lead agency for road safety in Odisha, a lead agency/ department for road safety has not been formally appointed for Odisha. Besides its routine functions and responsibilities, STA has started many initiatives like Odisha Road Safety Society with a view to improve the road safety situation in the State. **Odisha Road Safety Society (ORSS)** was formed in early 2000's, but was not funded in a sustainable manner. Transport Commissioner is the chairman of the society and all RTOs and representatives of truck and bus operator unions as its members. The initiatives by ORSS are not focused and are sporadic, and hence yield little sustainable results. There is a Road Safety Cell within the STA, but the activities by the road safety cell are not yielding the desired results. Following instructions from the central government in 2011, **Odisha State Road Safety Council** was proposed by Department of Transport with Minister of Transport as the chairman and secretaries of different departments as its members. It is proposed to collect the necessary funds for the functioning of this Council from 50 percent share of the penalties collected from the Vehicle Check Report. The proposal is with the Department of Commerce & Transport for further action. **District Road Safety Councils (DRSCs)** has already been formed with District Collectors as the Chairmen and they had their first meeting organized in 2012. However, the DRSCs have not yet been provided with funds to carry out any significant activities in road safety. The absence of a lead agency is seriously inhibiting the development of well-orchestrated, multi-sectoral, evidence based action to achieve road safety results. The Transport Department currently is responsible for most road safety functions and seems to be in the best position to take on the lead agency role on behalf of government, although its functional and structural capacity would need to be enhanced.

	Crash data – Crash data is available in crime index and case diary; the level of detail is basic in crime index, however, the case diary has exact details of crash, but is a voluminous record; State Crime Records Bureau (SCRB) compiles crash data in prescribed formats, but this data is not coherent to carry out accident analysis and to be used by various agencies for safety improvements. **Accident reporting** – As per MV Act, MVI needs to give a report on each accident and police will decide (as per IPC provisions), whether a MVI needs to be called. In general, no responsibility lies with the MVI in respect of the safety compliance of the vehicles involved for occurrence of accidents.
Coordination	**Horizontal Co-ordination** – The horizontal co-ordination is practically non-existent in the State. Odisha State Road Safety Council is yet to come into existence. However, in Cuttack and Bhubaneswar, city management groups comprising all departments meet every month. There is no system of data sharing on a regular basis. The traffic police identify the hazardous locations, and then communicate to Works Department and Municipal Corporations with suggestions for improvement. Coordination among departments is poor with different ownership of road network and compounding the problems. NHAI owns many roads, but it is generally felt that local safety issues are not addressed by NHAI in either design or construction. Various agencies are involved, while a road has been improved in urban areas, and these are GRIDCO, Municipal Corporation, Public Health Department (PHD), General Electric Department (GED), and PWD; an integrated committee is proposed for coordinating all activities in relation to construction/improvement of roads in the urban areas. In 2011, Honourable High Court in Odisha has formed a Traffic Management Committee (TMC) for Cuttack, with Commissioner of Police as the chairman. At least one meeting is held every month for review of traffic management and safety issues. Members of the committee include Roads & Bridges Department, Municipality, Irrigation Department, Electrical Department etc. and so far 21 meetings have been held. The committee has been given statutory powers and it handles many issues of traffic management in the city, including road safety.
	Vertical Coordination–District Road Safety Councils (DRSCs) are inactive and its members do not include agencies that are fully accountable and funded for road safety results. There is practically no vertical coordination between State and district agencies for road safety activity in general.

	NGO Engagement –NGOs are involved in road safety campaigning but this has been restricted and not sustained owing to lack of funds. Pappu Zebra Campaign has been initiated in 2011 in Cuttack and Bhubaneswar to make aware the road users of pedestrian safety. NGO FPRA has carried out training for selected college lecturer son wearing of helmets. This initiative is supported by Red Cross Society and the programme started in 2011. Until date, 200 colleges all over Odisha have been covered under this training programme. However, co-ordination between NGOs, Transport Department and Traffic/ Road authorities is patchy and no systemic co-ordination exists.
	Business Engagement – There are a few signs of business engagement in road safety. A Public Private Partnership (PPP) project for driver training has been established in collaboration with the automobile manufacturer Ashok Leyland, but this does not seem to be fully operational yet. Business houses sponsor road safety devices (delineators, cones, road studs etc) in Bhubaneswar and Cuttack and some of the business houses (automobile dealers, banks, business establishments etc.) have different budgets for road safety. Municipal corporations and traffic police are jointly involved in design of traffic signals and the same is installed by private parties. However, no sustainable plans for private sector engagement in road safety activities have yet been drawn.
Legislation	The laws governing speed limits, wearing of seat belts and helmets, drunken driving, contra flow and encroachments are as per the MV Act notified by the Government of India, and no amendments has been made by the state government. The following pieces of legislation deal with the above: • Central Motor Vehicle Act 1988 • Central Motor Vehicle Rules (CMVR) 1989 • State Rule 1973 • Urban Police Act, 2003 **Motor Vehicle Act** has laws pertaining to enforcement of drunken driving, seat belt wearing, helmet usage and speed limits. The Police are primarily responsible to maintain law and order and they are not empowered to implement spot fines for violation of traffic rules pertaining to road safety. The enforcement powers lie with Transport Department, who can enforce provisions in the MV Act in all regions in Odisha except Bhubaneswar and Cuttack. Rural police (Police other than in Bhubaneswar and Cuttack) cannot enforce MV Act, and only transport department can enforce MV Act in rural areas. **Urban Police Act** gives powers to Traffic Police in Cuttack and Bhubaneswar to enforce spot penalties for drunken driving, not wearing helmets and seat belts. Under this Act, traffic police is also empowered to enforce speed limits in Bhubaneswar & Cuttack, which is also called Commissionerate areas. **Speed management** – As per MV Act, the following speed limits are prescribed for motor vehicles along different categories of roads in India. • Taxis – 65 Km/ hour on NHs • Bus/ Trucks – 55 Km/ hour on NHs

	• Private Cars – No limit on NHs CMVR does not prescribe speed limits on state roads. District Collectors issue speed limits for state and district roads. Provision under law exists for District Collectors to amend speed limits in all roads in districts. The notification of speed limits is already being done in Bhubaneswar and Cuttack by Commissioner of Police. The responsibilities of road authorities to some extent are covered under the TORT. For effective improvements in road safety, the existing legislative settings need to be reviewed against potential interventions required to improve safety. Though interventions are not planned and focused, the existing law caters for all major interventions required, though certain acts / provisions need update. A mechanism for regular review and reform of legislative instruments and procedures and other institutional management functions need to be established. **Drunken driving** – GoI has directed states to remove liquor shops from the areas along National Highways; Excise department has been assigned the responsibility for the removal; Law exists which bans drinking alcohol in the open; Removal of liquor shops on National Highways is acted upon by police in Bhubaneswar and Cuttack.
Funding and resource allocation	At State level, an official value of Statistical Life and related value for injuries to guide resource allocation decisions has not been made. Since interventions are not targeted and efforts are not coordinated, there is no systematic funding mechanism available to identify and improve the problem areas concerning road safety. However, different stakeholders work in silos and some efforts have been made to channelize funding to certain interventions aiming to improve road safety. **For safer roads –**The road network in the state is owned by NHAI, Odisha Works Department, Rural Development Department, Urban Local Bodies, Irrigation Department and Panchayat Department. From 2012 onwards, the central ministry provides 10 percent of funds (allocations from CRF to States by MoRT&H) to state PWDs for road safety improvement works. OWD does not have a separate safety budget and urban bodies do not recognize road safety as a problem to have separate funding mechanism. Hence, no dedicated funds/ funding mechanism have been established in any of the agencies responsible for design and management of road network to support interventions required to improve the safety of the road infrastructure. However, certain road safety interventions (like provision of road signs and markings) are in-built into the project cost of road works and this is being implemented in certain divisions in the state. Since these interventions are not made mandatory, the implementation of the same is not uniform across the sector. **For safer road users/ vehicles** – No separate funding arrangements from Police budget to focus on interventions required for road safety with linkage to targeted safety output. Transport Department has targets for collection of fines in the form of spot fines for non-compliance of traffic rules (helmets, over speed, vehicle standards etc), but these are not targeted and focused on results to

	improve road safety. Road Safety funds from annual budgets are available with transport department, and the same are transferred to State Transport Authorities. These funds are utilized for buying solar blinkers, cranes and ambulances, and some of these funds are earmarked for the department to carry out road safety campaigning. An **Odisha Road Safety Fund** exists and is managed by ORSS but not given to other agencies to improve road safety. The available funds with this agency are in the tune of 1.5 to 2 crore per year and funds for Odisha Road Safety Society are collected from check gates at inter-state border. Twenty percent of fines collected by 1 interceptor only come to the Society, and Society uses these funds to hire home guards and conduct awareness programmes. 15 interceptors and 14 breathalyzers are available for 31 RTOs, and the funding source for these is different. In general, though some efforts have been made, particularly by Transport department, to implement a sustainable funding mechanism, these are not enough and not targeted to interventions focusing on results**. Hence the situation of funding and resource allocation for road safety can best be considered as partial and uncoordinated.**
Promotion	Since last few years, Road Safety Week is organized every year in the first week of January, during which a number of activities are undertaken by NGOs, Transport Department, Traffic Police and Road Authorities to spread the message of road safety among school/college students and road users. It has been recognized by stakeholders that public awareness is essential on topics such as pedestrian crossing, wearing of helmets and seat belts, safe parking, drunken driving etc. However, the promotional activities are patchy and there is little or no championing at a higher level of the government for the need of such intervention. **Therefore, status of the institutional management function of 'Promotion' can be best considered as very marginal and partial.**
Monitoring and evaluation	**Data Systems –** A robust road accident database is useful for monitoring and evaluation, and this has not been established in Odisha across all stakeholder departments. However, various stakeholder departments collect data, which are useful for their primary responsibilities, and this data is not shared between departments.
	Road Accident Data – The key agency that collects, records and maintains basic accident data is the Police Department. Police Stations collect the accident data manually from site and transfer the same to State Crime Records Bureau (SCRB). Among many, SCRB keeps the following types of crash data in paper copies: • Location type – Accidents and Fatalities • Age of vehicle & driver's age • Nature of accident • Particulars of vehicles • Type of persons • Time & Area • Vehicle Type

	• Weather However, no provision has been made to transfer of the above data to roads authorities, and the same is insufficient in the level of details to suggest complete road safety needs.
	Vehicle and driver registries – This is available with the Transport Department, but are not yet centrally computerized State-wide and not easily accessible to enforcement agencies.
	Traffic volume data – The OWD carries out traffic surveys on the road network up to ODR at regular intervals and the records have been kept in the CE's office in Bhubaneswar, which is not accessible as these are not computerized.
	Trauma – Data is collected manually on deaths and injuries following road crashes, and are not recorded into any state-wide computerized system. No compliance regimes set to achieve specified safety standards for rescue operation of road accident victims. Trauma is the fourth common cause of death in Odisha and is recognized as a major health problem and road traffic accidents are the number one trauma in Odisha. Among the road traffic trauma, neurosurgical trauma (head injury) is the number one followed by limb injuries (ortho). The above findings were summarized from the manual data kept by the hospitals in Cuttack and Bhubaneswar.
	Intermediate outcome data systems – No system to collect data on helmet and seat belt usage, average / mean speed etc. in an area are not in place. Data collection systems are not in place to collect, monitor and evaluate the road environment, risk ratings and road protection scores, vehicle safety and helmet testing etc. Hence, in the absence of relevant datasets and database systems which can be shared with different stakeholders, monitoring and evaluation of interventions and outcomes is practically non-existent. **Hence, the status of monitoring and evaluation can be best described as a 'Pending' issue.**
Research & Development and knowledge transfer	**National level research and professional organisations –** International Road Federation (IRF), in association with Central Road Research Institute (CRRI) and Australian Road Research Board (ARRB) has been conducting training on road safety engineering for engineers from various states and central governmental agencies. The National Institute for Training of Highway Engineers (NITHE, now called IAHE) and CRRI organizes in service training programmes for highway engineers of Central/ State governments, consultants and contractors on all areas relating to roads and road transport, including road safety. The international organization, Global Road Safety Partnership (GRSP) has held several national workshops, and selected officers from Works department participated.
	Contribution of research and professional organizations to policy development - The international NGO, IRF conducts annual seminars/ workshops, where topic son road safety are discusses/ debated, which contributes to policy development in road safety.

	However, a crash data led research and development strategy has not been established in Odisha. Though many states have taken up pilot safety improvement programs, Odisha is yet to develop and implement a pilot project in road safety. **Hence, the status of research and development and knowledge transfer can be best described as 'Pending' for Odisha.**
Interventions	
Planning, design, operation and use	As per SCRB data, NHs and SHs contribute to 75 percent of road traffic fatalities in the state. The design and construction of NHs owned by NHAI has been done as per the guidelines of Indian Roads Congress (IRC). The major focus in all these has been more on to design and build high speed roads (multi-lane divided highways), where the consideration for safety of all road users has not been taken into account. Comprehensive safety standards and associated performance targets have not been set for the planning, design, operation and use of roads. Though the IRC guidelines are applicable for design and construction of all types of roads, this has not been generally followed, in particular, for designs and construction of roads of lower categories below SHs. Insufficient attention has been given to the need of proactive engineering design for the needs of vulnerable road users in the sections where there are road side villages and urban areas, separation of slow and fast moving traffic in high speed roads, removal/ reduction of encroachments and speed management are to be proactively pursued. In the absence of a proper traffic management centre in urban areas (ULBs), traffic police handles the function of traffic engineering, without basic training in traffic engineering. The decision to provide key traffic engineering features like traffic signals are based on requests from public/ NGOs, rather than a data driven scientific study of the situation. Bhubaneswar Municipal Corporation has traffic engineering unit, but in other districts police does all the functions in traffic engineering. **Speed management** – Most of the National Highways taken up under National Highway Development Project (NHDP) has been designed to achieve an operating speed of 80 km/ hour, but the ignorance of mixed speed conditions, absence of road safety engineering and lack of facilities for vulnerable road users make these NHs highly prone to accidents and fatalities. The design of SHs and other state roads generally developed in stages followed the existing tracks, but of late, the projects funded by multilateral funding agencies are designed for a certain design speed with required standards. Otherwise, the geometry of existing SHs and other lower categories of roads do not encourage a consistent operating speed across the network, and the speed limits vary significantly on the state road network depending on the local administration of the road network. Over and above, on most of the road network, the road user is not informed of the speed limit through traffic signs or road markings. Though, ideally, all categories of road shall be operating on a certain consistent speed limit, this has not been the case in Odisha. **Safety standards and procedures** - None of the good safety management practices like road safety audit, black-spot improvement programs, network

	safety management etc. has not been adopted in Odisha yet. **Overall, the status of planning, design, operation and use of safe road network can be described as a 'Pending' issue.**
Entry and exit of vehicles and drivers	**Safety standards for road users** **Driver Licensing** – Like in other States, Odisha has set up a process for issue of driver licenses. The eligibility or access to driving on the road network is 18 years for car drivers and 16 for motorcycles without gears. The applicants for driving licenses are far too high for the capacity of RTOs to handle the process in an efficient and truthful manner. The stipulated test time is 30 minutes, but there are approximately 300 applications per day, and there is no graduated licensing system in Odisha. Driver licensing and testing requirements in Odisha need to be reviewed and revamped against good practices. **Driver training** - Private driver training institutes provide driver training and these training centres need to be certified by RTOs. The present system/arrangement is very loosely structures and completely ineffective. However, certificate of training is not mandatory to apply for license, except for applicants of licenses for transport vehicles. In Commissionerate areas, computer simulators are available in RTOs. An advanced driver training institute is opened at Chandikhol, but is dysfunctional. There is a PPP project for driver training, which has been established in collaboration with Ashok Leyland, but this also seems to be not started. Heavy motor vehicle driver training institute is also established in Chhatiya, which is also not fully functional yet. Transport department received 12 crores from Government of India to set up driver training institutes in Odisha. The primary focus of private driver training institutes is to get the applicant to know the mechanical aspects of driving and very little focus and awareness of road safety is found to be existing among the training institutes in their training contents. State Transport Authority own driver training institutes in Bhubaneswar, and stimulators are also available in Bhubaneswar and Cuttack, but not provided in other districts. **Awareness and education -** Except for the primary level curriculum prescribed by NCERT, the state board syllabus does not have provisions in the school syllabus to impart road safety education in a sustainable manner. NGOs are involved in road safety campaign, but this has been restricted and not sustained owing to lack of funds. Pappu Zebra Campaign has been initiated in 2011 in Cuttack and Bhubaneswar to make aware the road users of pedestrian safety. NGO FPRA has carried out training for selected college students and lecturers on wearing of helmets. This initiative is supported by Red Cross Society and the programme started in 2011. Until date, 200 colleges all over Odisha have been covered under this training programme. In schools, State is following the curriculum prepared by NCERT and operates within the National Curriculum framework. SCERT develops syllabus for classes up to class VII and State Board of Secondary Education (BSE) is responsible for the same from classes VIII to X. Road safety is included in curriculum in the

	primary level only. The revision of curriculum is due next year. As of now, road safety is not planned to be taken up in the next revision. **Insurance** – Commercial vehicles and Taxi drivers are under stress to meet deadlines and most of the drivers are not insured in the state. Insurance arrangements in the State needs to be reviewed against the best practices. **Drunken driving** – The data indicates that 15 breathalyzers are available in 31 districts with RTOs. In 6 districts, police are empowered to implement spot fines and in other areas, enforcement of road safety measures lies with the RTOs/ MVIs. All penal provisions regarding seatbelts, helmets, triple riding and overloading can be implemented by RTO only.
	Standards set for vehicles The standards of the vehicle fleet are, in general, of low standard with many commercial vehicles and cars more than 10 year old operating on the state road network. The powers to set standards for production and maintenance of vehicles are vested with central government. India has joined the WP-29 by acceding to 1998 agreement on Global Technical Regulations and this is expected to accelerate the pace of harmonization of the country's standards with world standards. In Odisha like most of the other States, as per the CMV Rules, it has been made mandatory for commercial vehicles to renew certificate of fitness every year. However, the interval for checking of road worthiness of private vehicles has been set as 15 years, as per its tax life. The condition of fleet of public buses is improving owing to the new standards of buses delivered under JNNRUM project; however large number of old buses still operate on the roads.
Recovery and rehabilitation of crash victims	**Emergency Care** - Trauma care centre, emergency ward facilities and arrangements for handling of patients (road accident victims) in the state are very poor. Lack of paramedical staff is also cited as a major reason in poor after-crash care. In addition, private hospitals are not entertaining accident victims, and in government hospitals also it has been told that unless the victim is influential or is known to somebody in the hospital, it is difficult to get timely treatment. The health facilities available in the rural areas are exceptionally poor and this leads to poor after-crash care of the victims, which further results in increase in fatalities. **Existing Ambulance services** - Ambulances purchased using the funds available with ORSS have been given to different truck operators association. The statistics show every 100 accidents result in 39 fatalities. St. John's ambulance services are available in the State, but not anywhere near enough as required. National Highway has ambulance services in the NH network. Trained paramedics are available in NH provided and St John's ambulances. In addition, private ambulances operate from inside hospitals. SCB hospital in Cuttack has department of trauma and emergency medicines in addition to all major district centres in Odisha. Hospitals in district headquarters are equipped with Trauma Care facilities, as reported, and sub-divisional hospitals have facilities for Surgery, Gynecology, Pediatrics and Medicine, but no trauma facilities. Government is planning to introduce ICUs in district hospitals

	networked appropriately for telemedicine. **Future plans for post-crash care** - GOO is planning to introduce 108 ambulance services in Odisha, which will have a driver, helper and pharmacist/paramedic for each ambulance operating in rural areas. Fifteen districts are identified for implementation. Four hundred and twenty ambulances are planned exclusively for trauma care, out of which 280 will be rolled out in the first phase, by around June 2013 and the rest by end of 2013. Two types (basic and advance) of ambulances will be provided. 81 trauma care centres are planned along the highways and is in various stages of implementation. JIGITSA healthcare has been awarded the responsibility to implement the ambulance project. The first roll out of ambulance services will be done by 5th March 2013 (as reported). **Short term strategy for post-crash care** – 13 district centres shall be fitted with advanced trauma care centres. ICUs are planned for 17 districts and will further roll out on the rest of the districts.
Results Focus at System Level	
Social cost	The social cost of road accidents has not been recognized in high level government circles. An effort has not been made to collect data and present the social and economic costs of road accidents to the state. However, there is recognition among high level officers in health department of the enormous trauma inflicted by road accidents, though the same is not quantified. Road traffic accidents are identified as the number one cause of trauma in Odisha.
Final outcomes, Intermediate outcomes and Outputs	**Results focus -** No targets has been fixed. The enforcements are not measured and the enforcement measures do not have road safety targets as well, and only have some fine collection targets. Accident data collection is not scientific and no standard formats are used for accident data collection. Data for enforcement are not kept, and no enforcement targets fixed to improvement of road safety. Verbal instructions were given to increase the fines by Traffic Police Department. **Final Outcomes –**Final outcomes are expressed as a long term vision of the future of safety of the road traffic system and short to medium term targets expressed in terms of social costs, fatalities and serious injuries presented in absolute terms and also in terms of rates per capita, vehicles and volume of travel. As of date, no such targets have been fixed for Odisha. **Intermediate Outcomes** –Intermediate outcomes are linked to improvements in final outcomes and typical measures include average traffic speeds, the proportion of drunk drivers in fatal and major injury crashes, wearing rate of seat belts and helmets, safety rating of the network and safety rating of the vehicle fleet. SCRB has the data on drunken driving, but the same has not been quantified and monitored to achieve results. Though there are sporadic efforts to enforce wearing of seat belts and helmets by traffic police and RTAs, the same has not yielded any considerable result in the absence of clearly defined targets, and also consistent efforts of enforcement. Techniques to define and assign safety ratings of road network such as International Road Assessment Programme (IRAP) are available, but awareness of road network safety is still in rudimentary stages across the road engineering community in the state.

	Outputs- Outputs represent physical deliverables that seek improvements in intermediate and final outcomes. Typical measures of outputs include kilometers of engineering safety improvements and the number of police enforcement operations required to reduce average traffic speed or incidents of drunken driving. Transport department has set targets for fines to be collected per year; but no targets as such have been identified for enforcement measures, like reduction of drunken driving, over speeding, etc. Targets have been set for collection of revenues through taxes and penalties, but no targets have been set for enforcement measures linking these to the ultimate objective to improve road safety.

16.5. Summary of Key Findings

Notwithstanding the proposed individual excellences like in the health sector and attempts to improve co-ordination in urban areas, effective road safety management across the government system needs to be established urgently and on a sustainable basis.

The main strengths in road safety management in Odisha are:

- general acknowledgement about the severity of the problem amongst all key agencies and general understanding among all that there is a need of new institutional arrangement
- the proposed trauma care and post-crash care facilities by the health department to implement across Odisha is quite extensive
- the initiatives of transport department to reduce the road accidents
- the existence of a road safety fund with some existing sources of funds
- the recognition of the stakeholders for the need to work together, and determination across departments and sectors
- the existence of an extensive accident database with its network of collection through District SP Offices, though in a crude form
- the existence and initiative of various road safety NGOs

The main weaknesses in road safety management in Odisha are:

- the absence of a lead agency to co-ordinate the road safety efforts of various departments, although leadership of the Transport Department is implicit due to its role and function within the existing legal system
- the absence of effective institutional ownership of road safety, to address the many challenges involved in road safety
- the absence of a road accident database management system, to enable scientific crash analysis and to implement accident prevention and management techniques
- lack of clearly mandated targets and goals, and also the required capacity and the resources to work for the targets
- lack of road safety engineering experience among roads authorities, although efforts are on to build capacity among the engineers of road authorities

- Different ownerships of the roads of different categories, with poor co-ordination and non-uniform understanding of the needs to improve road safety

In the process of the road safety capacity review, it has been confirmed by many of the stakeholders that road safety initiatives and intervention in Odisha is largely fragmented. There is hardly any measurement done in terms of inputs and outputs in relation to road safety performance in the state, and there is very little appetite also for this as it is not mandated. Road safety being a multi-sectoral initiative and approach, which makes the difference, the State needs to take it as a priority. State has to accept the fact that road safety is no longer a transport or enforcement problem, it is a health, economic and social problem, which is to be guided and directed from the highest level of political echelon. Road safety management is to be delivered in Odisha with full and effective institutional ownership to face the many challenges involved in improving road safety. Therefore, the first and foremost task is to establish the lead agency with resources to deliver the mandated goals, by developing partnerships with all other key stakeholders. This agency is to be implementing effective interventions through sustainable and transparent funding mechanism and a convenient legislative framework by developing systematic and scientific understanding of the road safety problems and their solutions.

The appropriate responses to the capacity review finding are not provided at this stage of submission of deliverable. Those will be evolved and discussed with the Client in detail and included in the subsequent deliverable report. The strategy and priorities will be formulated for inclusion in the next report. The entire road safety initiative to be implemented through a lead agency shall involve the salient distinct orientations with responsibility framework as follows:

- Results focus
- Coordination
- Legislation
- Funding and resource allocation
- Promotion
- Monitoring and evaluation
- Research, development and knowledge transfer

All these will be duly elaborated in distinct actions on the part of the Government to achieve the road safety targets and goals. Thus, the targets will be achieved through phased implementation of specific strategic actions like, setting of targets, road safety engineering, enforcement and legislative review, safety promotion, vehicle safety, management of post-crash care, and careful monitoring and evaluation.

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CHAPTER 17

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17. REFERENCES

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