Training report of Sri Bijoy Chandra Tripathy EE PMU (WBP) on training at Indian Academy of Highway Engineers (GOI), .NOIDA from 3/2/13 to 9/3/13

As per letter of EIC (C) No.E-ID-Gaz-7/12/36790 (10) dt 30.10.12 and Government approval vide No.FE-I-VIA-21/2012/10200/W dt 10.10.12. I attended training programme at IAHE conducted from 4/3/13 to 8/3/13. Although the original programme was on HDM-4, IAHE combined the following programmes together under this course.

1. DPR Preparation
2. HDM-4
3. Road Maintenance

The details of presentation are contained in the soft copy submitted herewith. The key lessons/salient points are summarized below.

4.03.13 10:00-13.00	**Steps for preparation of Quality DPRs, General Deficiencies in DPRs and Estimates, Scrutiny of DPRs & Estimates, Case Studies – Do and don'ts for DPR finalization.** ***(Shri SK Nirmal, SE, M/o Road Transport & Highway, New Delhi)***

- DPR preparation in BOT and DBFO projects differs from conventional Deptt. run projects.
- As FIs insist for 100% LA, there has been reduction in BOT projects recently; NHAI has awarded 1000km against 9000km, that too after 2-3 times of tendering .
- The policy shift is towards DBFO i.e. " Design, Build, Finance and Operate "system.
- FSR is required for tenders.
- Financial viability is BOT viability.
- In DBFO projects the contractors may include designs/new technology different from conventional projects. Unless Government engineers acquire skills on the same, delay will be caused in the approval process. Currently consultants/experts are engaged to facilitate the approval process.
- Contactor is bound by the respective IRC codes and manuals on 2L, 4L and 6L which from part of the contract.
- Deviation to manual in the form of schedule D of the manual shall constitute the part of contract.
- New manuals for EPC are under process.
- Steps in DPR : - Inception Report
  -Feasibility Study Report
  -Preliminary project Report
  -Detailed project Report
- Peer review is done by retired CEs and bridge design is mostly reviewed by IITs.
- DPR is scrutinized by MoRTH funding agencies, and parliamentary committees and there for should be self-contained from these consideration.
- By-passes are now considered as standalone projects to avoid delay in the remaining length of the project due to LA.
- DPR preparation takes 6 months to more than 2 years depending on the region, terrain other constraints. As an example, in Rajasthan it may take 6 months to 1 year where as in Sikkim and Tripura it may take more than 2 years. Appx cost of DPR preparation is 75.000/- to 1 lakh per km.

- VGF for NHAI projects is maximum 40%; normally VGF is 20% for other projects / states.
- BOT (TOLL) may not attract contractor in adverse condition although otherwise strategic to region / Government. In later case, BOT (Annuity) is adopted. Big contractors may join BOT (Annuity) to avoid idling of their m/c, eqp.
- The capacity of IL is appx. IK PCUS and goes up to 35 k PCUs for 4L.
- The appx 4 laning cost is ` 15 cr/km.
- The up gradation of 4L to 6L projects are not preferred now. Instead, green field project is planned to divert traffic from 4L (on alternate alignment)
- IRR should be more than 2 to 3% over bank interest to attract contractors in BOT projects.

4.03.13 **14:00-17:00**	**MoRTH specification for Road and Bridge works and acceptance criteria for quality assurance.** **(Shri SK Nirmal, SE,M/oRT,New Delhi)**

- **MoRTH specs("orange book") is under revision (5th Revision 2013); prevail over IRC in conflicting situation/interpretation. The proposed revision incorporates the decade of innovation marked by the following development:**
  - Ban on Mining of aggregate in many states /by Hon'ble SC.
  - Allowing marginal aggregate.
  - New/substituted materials (more than 80 accredited by IRC).
  - Revision of IRC 53/2010 doing away names like polymer modified, crumb rubber, EVA etc and switching over to performance basis.
  - New IRC 34- embankment in water logged /marshy areas.
  - GSB in one table; Grade III, IV-lower S/B
    V, VI-S/B cum drainage lager
    Grade I (90mm-45mm) deleted.
  - Base/surface - IS-73; viscosity grade bitumen instead of penetration grade. (VG 30 in hot area, VG 20 in cold area).
  - OPL33 grade (IS: 269) deleted.
  - Curing: resin based aluminised reflect curing (ASTMC-C-309-81)/ wax based white pigmented curing (BS 7542).
  - Elaborate details on geo-textiles, - grids etc. and RE walls.
  - Use of Fe 500, Fe550.
- IN NHDP, 95% is flexible pavement, only 5% rigid.

5.03.13 **10.00 to 13.00**	Geotechnical investigation for Road & Bridge Construction– Soil Characterization, Material properties. ***(Dr.Vasant Havanagi, Principle Scientist, GTE. Diven, CRRI)***

- **Soil characteristics for embankment**
  LL < 50
  PL < 25
  FSI > 50 (not more than 50)
  TSC < 0.5%
  No salt content
  PI < 10 low plastic
  PI = 0; sand which is ok if confined.

- **Size**

  Sub grade < 50mm

  Embankment < 75 mm
- **Other properties :**

  Embankment < 3m high. Density = 15.2 kn/m^3

  < 3m high D = 16 kn/m^3.

  Max compacted Thickness = 20mm.

  Degree of compaction: s/g = 97

  Emb. = 95.

  Up to I m from top level of road expansive material (EM) is not permitted. Below 1m, a layer of EM is permitted along with sand/ drainage layer of 300mm under it (EM).
- **Widening existing road:**

  For stability of slope, Stone pitching is removed from existing slope and new embankment is done on 300mm benching for interlocking for existing slope stiffer than 1:4.
- **Embankment in pond:** Non-Plastic granular, well-graded material 75mm max size, uniformity coefficient >10 is specified.
- **Embankment in soft soil/water logged areas:** Ground improvement is required. Sand drains are provided under embankment for consolidation of sub-soil. Embankment is made in stages @ 2m high @ 2months interval to ensure consolidation Band drains are new technology replacing sand drains these days.
- Fly ash in embankment behaves like silt-sand non-plastic; its compaction curve is almost flat; intermittent layers are not required if embankment is done in winter and summer; cover is an absolute requirement in fly ash embankment.
- Slopes of embankment can be 1:1 (When land is limited) by using geo-textiles.
- **RE walls save RCC; length and spacing of RNF. is more at top: spacing is less at bottom.Bs-8006/1995 is used for design of REW. Instead of geo-grids, ties are also used.**
- **Sub-base:** In high rainfall area, gap graded material is preferred for drainage. Close-graded granular S/B is preferred for strength criteria. NHAI adopts two layers totaling 250mm (GSB); the gap-graded in bottom (for drainage) and well graded above (for strength) with fines (0.075mm) limited between 3 to 10%. PI is less than 6 to prevent undulation. A layer of 25mm thick screening is provided over GSB before laying WBM. This intermittent layer is called inverted choke.

  CBR and durabity are two integral criteria. Durability is assessed by wetting-drying- hitting in 12 cycles.
- **BASES:** WBM is onsite; Gr II, III; no heavy rolling, no &screening, floating; binder (PI< 6) is provided and rolling is done. WBM is not to be done on a soft s/b or s/g.

  WMM is prepared in plant; OMC must be utilized; should not be kept lying in dumps on the construction site.

5.03.13 14.00 to17.00	Design concept, Overlay design for of flexible pavement under different traffic conditions and Effective maintenance & Rehabilitation techniques of Flexible pavements. ***(Shri K Sitaramanjaneyulu, Head, PED, CRRI, NewDelhi)***

- Principle is superior material on top ; BM in SH ; DBM in NH ; BM and BC do not go together.

- Selected material mix should be structurally adequate and cheaply available.
- Horz strength below bitumen surface controls distress.
- Vert strength on top of s/g controls deformation.
- Design Factors:- Wheel/axle load (IRC 37 stipulates to find out VDF by vehicle axle Load survey)
  - s/g soil characteristics .
  - Climatic factor (temperature).
  - Pavement component material.
  - Environmental Factors (rainfall).
  - Traffic (CVPs guide axle/wheel load, PCUS guide laning).

- Vehicle Damage Factor (VDF)

  VDF = (Actual Load/ 8160) ^{4}

The damage occurs in 4th power have overloading (higher axle loading) damage road faster and greater.

- Overlay design (IRC-81/1997)

  Condition survey is imperative: good if less than 10mm rut and no crack Fair if 10mm to 20mm rut and single crack; poor if > 20mm rut and extensive crack Stretches are prioritised needing overlay and extent of overlay (Poor I, Fair II, Good III)
- Micro surfacing is thin, routine and fast; overlay is thick, based on requirement and involves time.

6.03.13 10.00 to 13.00	HDM programme Modules and Input-Output Option, Traffic Estimation, Economic Analysis, EIRR/NPV, and Life-cycle cost model, Sensitivity Analysis and Deterioration of a case Study. ***(Dr.Devesh Tiwari, Principle Scientist, CRRI, New Delhi)***

- HDM-4 is then windows based soft ware which covers the economics of highways /roads; MX is the design software.
- HDM-4 version 2.0/2000 is currently in use.
- HDM-4 adopts TTC approach. TTC is total transport cost which consists of onetime construction cost (3.4%), recurring maintenance cost (2 to 4%), road user cost (85 to 95%). Recently Pollution cost and Environment Impact costs have been added.
- **Parameters:**

  Texture – Size of aggregate within 20cm to 25cm and this relates to skid .

  Roughness – Size of aggregate more than 25cm and this relates to undulate our affecting riding quality.
- **40 BC Road Vrs Conc Road :**

  40BC road cheaper than conc. road but consumes more materials(aggregates).

  Continuous Reinforced Cement pavement is adopted in Japan but the cost is too high.In India CRC adopted is < 1% .

  Tyres are of three types; the modern ones super singers are meant for heavy vehicles ; but prone to overloading which adversely affects roads. Higher the roughness (IRI) higher is the VOC.

  Indicative norms (SP-16):850mm per 1km appx 1 IRI

  2000mm per 1km appx 2.5 IRI

  (Acceptable range 1500-1800mm). If IRI is 10, reconstruction is required .

- **Inputs and Options :**
  - Desire speed; free speed depending on geometric and traffic condition ; more rise and more fall more VOC ,more curves together with rise n fall result in refer to hilly terrain .
  - Optimum time of investment; not too early not too late for economic return.
  - NPV = 0 at Discount rate = IRR.
  - For viability , IRR > 12%.
  - Lifecycle cost.

It considers fundamental theory of pavement linked to poisons ratio, elastic modulus and thickness. The initiation of deteorntion is fusible pavement is long but its progression is fast ; with 1 year of initiations those is about 50% rise deterioration (This also implies timely interrentio in preventive maintenance.)

Thickness of layers are structurally converted to structural number (∑at) ; max SN being 7; coefficients for BC, DBM , WMM, GSB being 0.3; 0.25, 0.12, 0.14 respectively (implying that more thickness does not mean necessarily more strength.)

- **Key Factor in HDM-4, v-2 :**

  16 motoroised categories and 4 non-motorised categories of vehicles are considered in HDM-4 version 2; pedestrians are considered non-motorised vehicle)
  Congestion =1 = No congestion
  Road side friction= 1 = No encroachment
  It considers effective lane and passenger car space equivalent for strength criteria.
  Potholes – HDM4 considers 10L of waters (Vol) as one pothole unit.
  Salvage Value; Economic Price and finance price are considered.

- **Sensibility parameter in HDM4 :**

  These are factors having high impact
  - Structural ND.
  - SN modified.
  - Deflection .
  - Roughness.

7.03.13 10.00 to 13.00	Introduction to design concepts for Rigid pavements, Composite pavements & concrete Roads under different traffic condition and Effective maintenance & Rehabilitation techniques of concrete roads. ***(Shri Satandra kumar , Former Head ,Rigid Pavement Division,CRRI)***

- PQC (M30 – M40) over DLC (M10) separated by separation membrane (poly sheet); below DLC usual GSB, s/g and embankment.
- PMGSY road jointed plain C.C; L> 50%B and also in stiff terrain, RCC Pavement ; CRCB as per IRC 101.
- **Mix design :**

  W/C ratio critical for strength and durability; admixture (5 types based on different material composition) are to be properly selected.
- For M40 from RMC manufacture, order is to be placed for M43.
- 56% aggregate consumption in rigid pavement vrs 94% aggregate consumption in flexible pavement nence recommended for areas where there is scarce aggregates.
- Initial joint cutting 1mm only; after 14 days 15mm joint to be cut for application of seal ant .

- If wind speed > 30 kmph , water loss > 1kg per sqr mtr/hour relative, humidity <20, concreting becomes crack-prone and is not suitable under such conditions.
- Rigid pavement is not suitable in rocky areas because of high kvalues.
- Designed joints are to be treated with polysulphide sealant and not to be treated with epoxy.
- Weak aggregates are treated in low viscosity epoxy to qualify for concreting .
- RBI technology (patented by a German Company) has been succefully adopted in Mizoram roads and Leh runway using 2% RBI; useful where aggregates are not suitable / available and bitumen application not suitable ; no drainage layer / GSB required in this technology.
- Jamuna Express way: project cost ` 11,000 cr, 165 km long, design speed 100km, rigid pavement ,25% Fly ash, ` 800/- one way toll per taxi/car.(High cost of project and higher toll rate)

7.03.13 **14.00 to 17.00**	**Asset Management concept for Highway Sector and benefits of Asset Management based planning and methods of PMS.** ***(Shri. DP Gupta, Former DGRD & SS, M/O RT&H)***

- Planned maintenance is as important as new roads; maintenance management recognized by 13th FC.
- Huge annual loss due to poor maintenance of roads.
- Condition during maintenance is curative not preventive.
- Policy shift in PMGSY-II is now for balanced construction, maintenance in all regions.
- Maintenance levels (Serviceability Indicators) for NHs and SHs have been fixed by the Committee on norms for maintenance in 2001; roughness , pothole cracking , rutting ,skid resistance, bridge deck and approval condition and user info are used as indicators to rate maintenance levels 1,2,3
- Poor enforcement of axle load limit affects roads condition(VDF).
- Lack of maintenance hits the poor.
- Lack of maintenance of connecting / service/ others roads adds to pressure and mixed traffic in NHs/SHs.
- Short-term contract and long term contracts for maintenance are now advocated for effective maintenance management. (Refer: IRC performance based contracts documents)
- Maintenance contracts are to include incident management.
- It is important to log/ maintain condition / maintenance history of roads to monitor deterioration over time (traffic/weather) and implement preventive maintenance.
- Strengthening accountability and operational capacity is critical now.
- Maintenance management tools should be simple.

8.03.13 **10.00 to 13.00**	**Mobile Road Maintenance Technology & Pavement Recycling Technology and Mechanization in Road Construction.** ***(Shri. Hansraj,AVSM,VSM,Former CE, Mech, BRO)***

- MoRTH letter no. RW-22012/02/2012/mech dt 4.1.13 addressed Secretaries, EICs, CEs of Works Deptt. specifies mechanical patching.

- Bitumen mix prepared on the road side for patch repair does not last; specified temp range of bitumen 130^0 - 160^0 c and aggregate 170^0 c is not maintained; aggregate is not normally preheated as per required.
- Self contained whole patching units are now available and in used.
- Jet patching technology is suitable for NHs, city roads in India.
- Recycling – only when structureis sound top material(50mm) is recycled It saves cost, time,and environment.
- A whole unit patcher has been developed by Apollo equipment, Gujarat for Indian condition; a multi utility m/c using pug mill mixer, captive 3T hydraulic self-propelled roller for compaction ; price appx ` 50 lakhs ; claims to be 50% cost effective in 3 years patch life; within 1 hr of completion patch is opened to traffic ; only 4 people including the truck driver are involved.

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