



# New Technology Initiatives in Rural Roads and Use of Marginal Materials

## MoRD Specifications for Low Volume Roads

National Rural Infrastructure  
Development Agency



Ministry of Rural Development

National Institute of  
Technology



Warangal, Hyderabad



## Lecture 5

### **MoRD Specifications for Low Volume Roads**





# Presentation Outline

- Introduction
- Development LVR Specifications
- Background of Low Volume Roads
- Need for Book of Specifications
- MoRD- New Changes
  - General Changes
  - Embankment and Subgrade
  - GSB layer Construction
  - Bituminous Construction
  - Bridges-Foundations and Super Structures
  - Cement Concrete Pavement



# Introduction: LVRs

- ♣ Own appropriate number (Oglesby et al.1976)
- ♣ Average fewer than 400 vpd (TRB)
- ♣ LVRs initially moorum or locally materials
- ♣ LVRs in India low cost low grade specifications
- ♣ No pavement design procedure before 2000
- ♣ Pradhan Mantri Gram Sadak Yojana (PMGSY)
- ♣ IRC:SP: 20 - 2002; SP:72-2007 and 2015
- ♣ Stabilization of Pavements IRC:SP:89-2018

The PHVRR of low volume is about 15% of the daily traffic.15% of 400 is 60 vehicles i.e. 60 veh/h translates to 1 veh/min.





# Definition of Low Volume Roads!!

- How low is “low” in terms of TV? Weights?

Weight of typical vehicles	Heavy	Heavy haul roads (Mining,Sand,Oil and Forestry)	Express ways National Highways State Highways
	Light	Traditional “Low Volume Roads”	City Streets and Local Streets
		Low	High
		Traffic Volume	

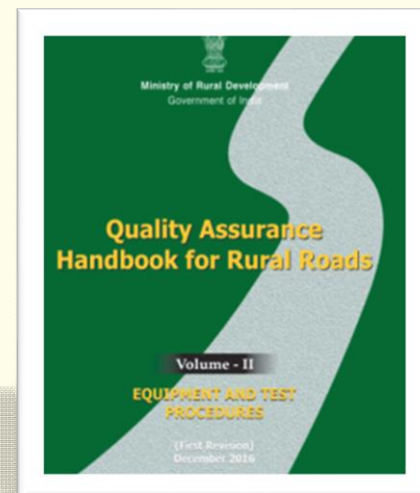
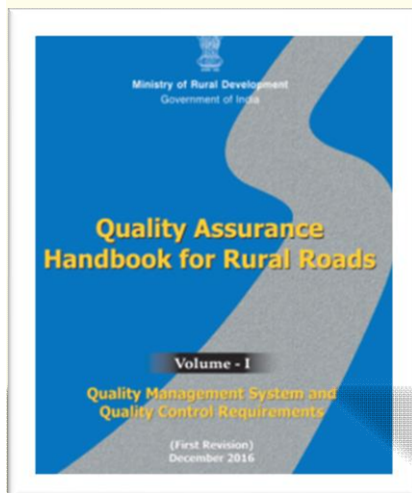
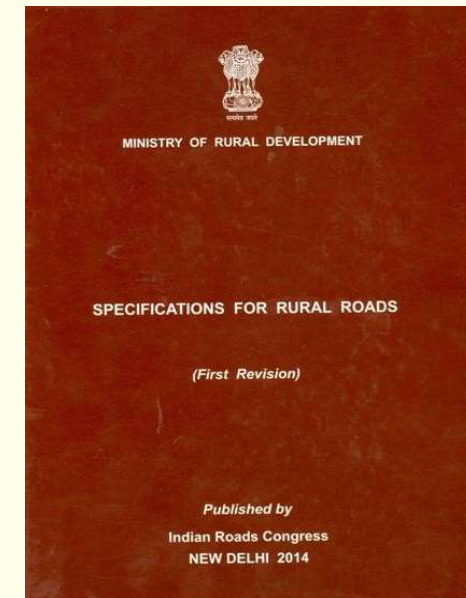
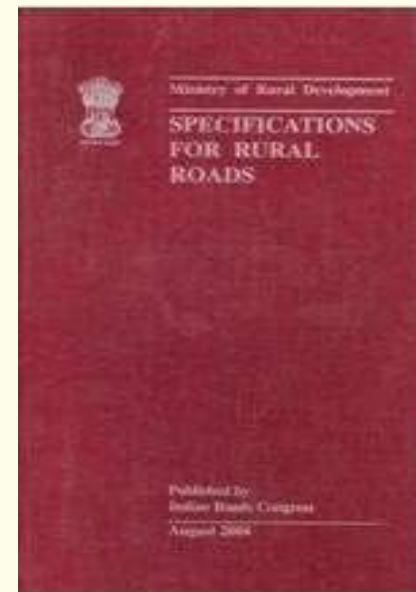
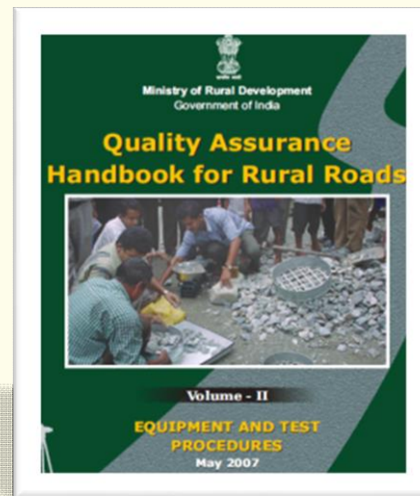
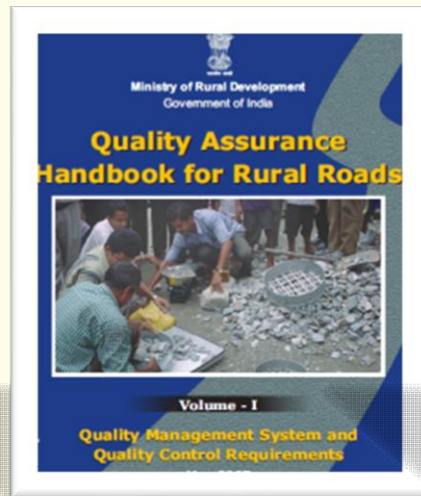


# Development of LVR Specifications

- **The Rural Road Manual IRC:SP:20:2002**
- **National Rural Road Development Agency (NRRDA)**
  - **To provide Technical and Management support to MoRD**
- **Developed Standard Bidding and QAHV Vol-I and II**
- **On Request of NRRDA to IRC-IRC:SP62-2004 for Rigid pavement and IRC: SP:72-2007 for FP**
- **On Request of NRRDA – IRC brought MoRD,2004**
- **First Revision MoRD,2014 and IRC:SP:72-2015**



# Need for Specifications of LVRs



- Innovative Materials
- Technology Developments
- New Polices and Regulations



# Eye ball on Quality of Woks :Investigations



9/22/2022





# Contd...

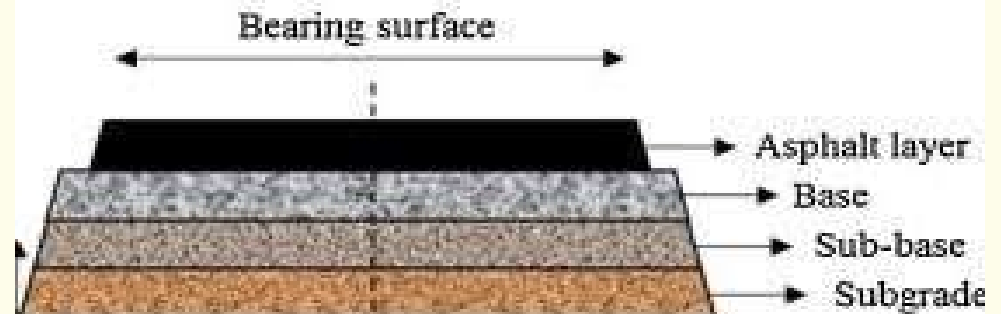
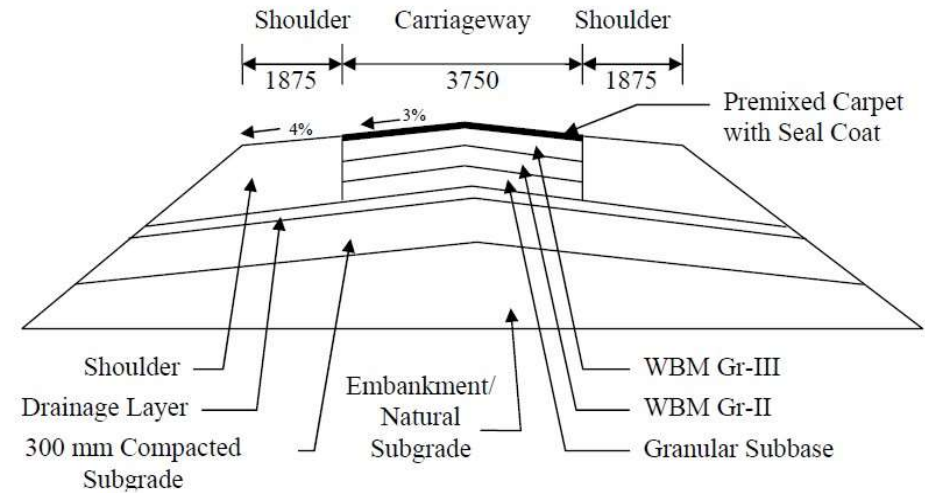
S. No.	Grading-II (Layer 1) 100 mm	Grading-I (Layer 2) 150 mm	Total thickness (Gr-I and Gr-II)
1	105 mm	101 mm	205 mm
2	90 mm	139 mm	225 mm
3	77 mm	125 mm	207 mm
4	59 mm	106 mm	175 mm
5	77 mm	126 mm	202 mm
6	87 mm	111 mm	195 mm
7	119 mm	0.0 mm	119 mm
8	91 mm	120 mm	216 mm
9	93 mm	105 mm	205 mm
10	92 mm	152 mm	255 mm
11	104 mm	139 mm	231 mm
12	96 mm	141 mm	232 mm
13	90 mm	114 mm	198 mm



**Burried ..who will see...**

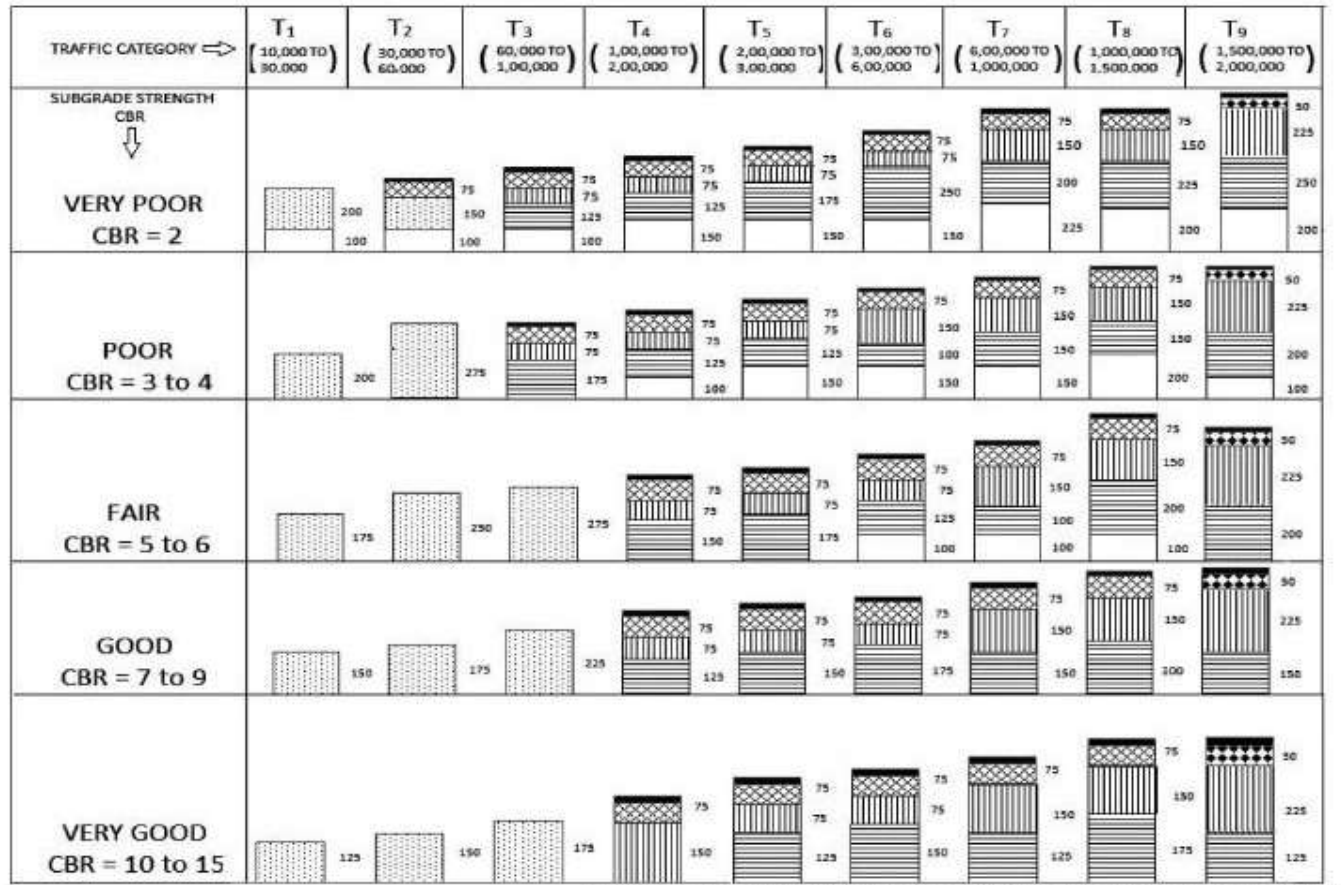


# Typical Cross Section of LVRs





# PD for Gravel/Granular Bases and Subbases



**LEGEND**

- Modified Soil/Improved Subgrade(CBR not < 10)
- Granular Subbase (CBR not < 20) in exceptional case can be 15
- Gravel Base (CBR not<80). In Lower base course shall not be less than 50 Clause 2.3.5 (in exceptional case may be relaxed suitably)
- Base of Gravel/CRMB/WBM (CBR not<100) Where 100mm thickness is recommended it to be modified to 75 mm for WBM with corresp. increase of 25 mm in Subbase
- WBM Grade-3
- Bituminous Macadam
- Premix/OGPC

Fig. 4 Pavement Design Catalogues for Gravel/Granular Bases and Sub-bases



# PD for Cement Treated Bases and Subbases

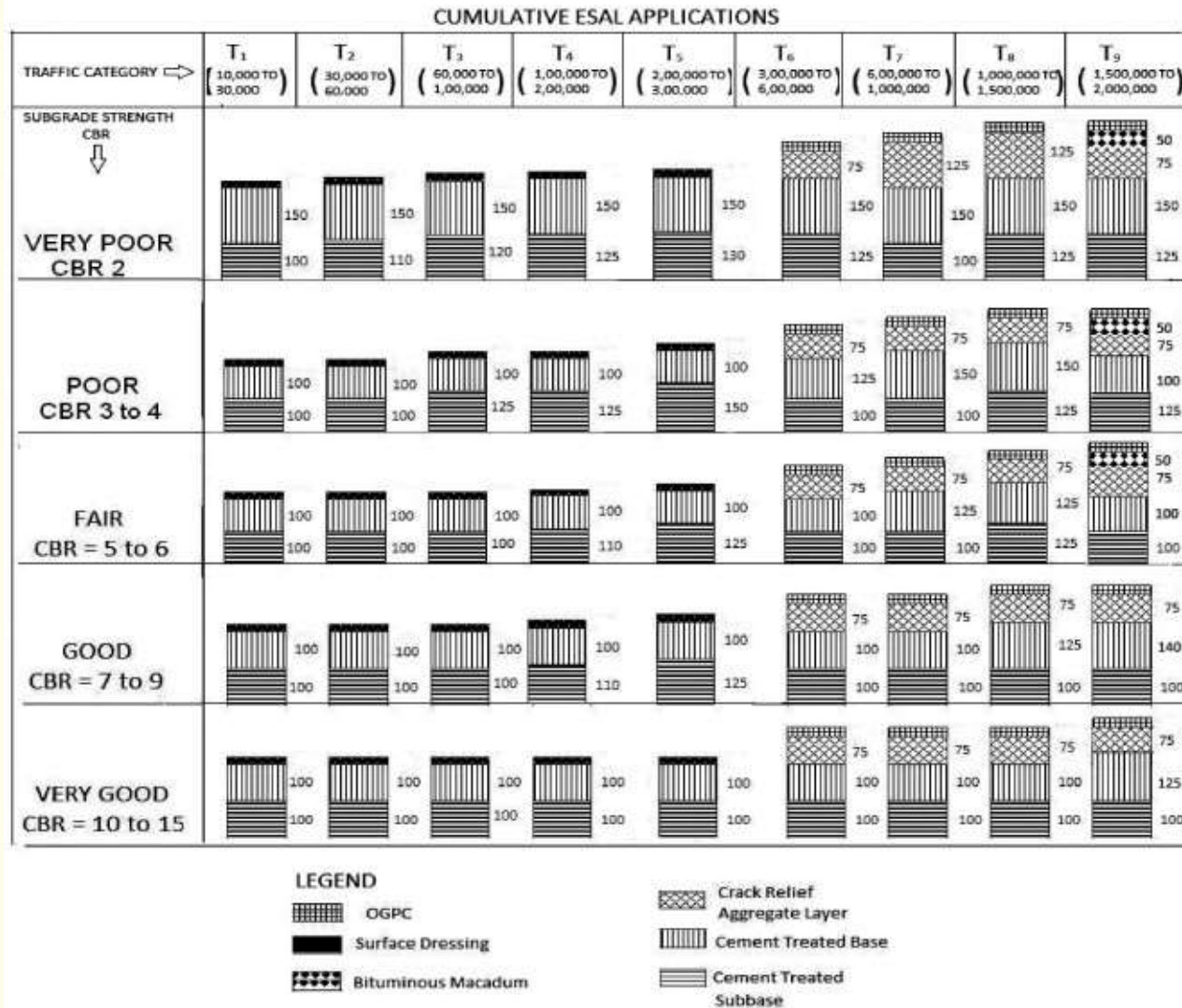


Fig. 6 Pavement Design Catalogues for Cement Treated Bases and Sub-Bases



# New Supplements in Specifications

- General Changes in MoRD Specifications

Section	Supplement
400 and 402	Gravel / Soil-Aggregate Subbases
408 and 410	Local and Industrial Materials
509 and 512	SDBC and Waste Plastic in Surface
1000 & 1100	Structural Steel and Vented Causeway
1200 & 1400	Bridge Founds ,Superstrs and bearings
1900	CC Road maintenance and Traffic Signs
2000 & 2100	Materials, Envi and Social Safeguard

## Deletions

- X Built up Spraygrout
- X Modified Penetration Macadam



## Embankment & Subgrade Unsuitability and Requirements

- **Marshy areas**
- **Susceptible to spontaneous combustion**
- **LL < 70 and PI < 45 ; MoRTH < 50 and PI < 25**
- **Salts (pH > 8.5) in leaching in the embankment**
- **FSI > 50% should not be used as a fill material**
- **FSI- subgrade and top 500 mm portion of Embankment below the subgrade should be non-expansive in nature**
- **Coarse mat. 75 mm 50 mm for Embankment & SG**
- **The max. particle size shall not > 2/3<sup>rd</sup> of the compacted layer thickness**
- **Gravel, Flyash, moron, slag and other combination.**

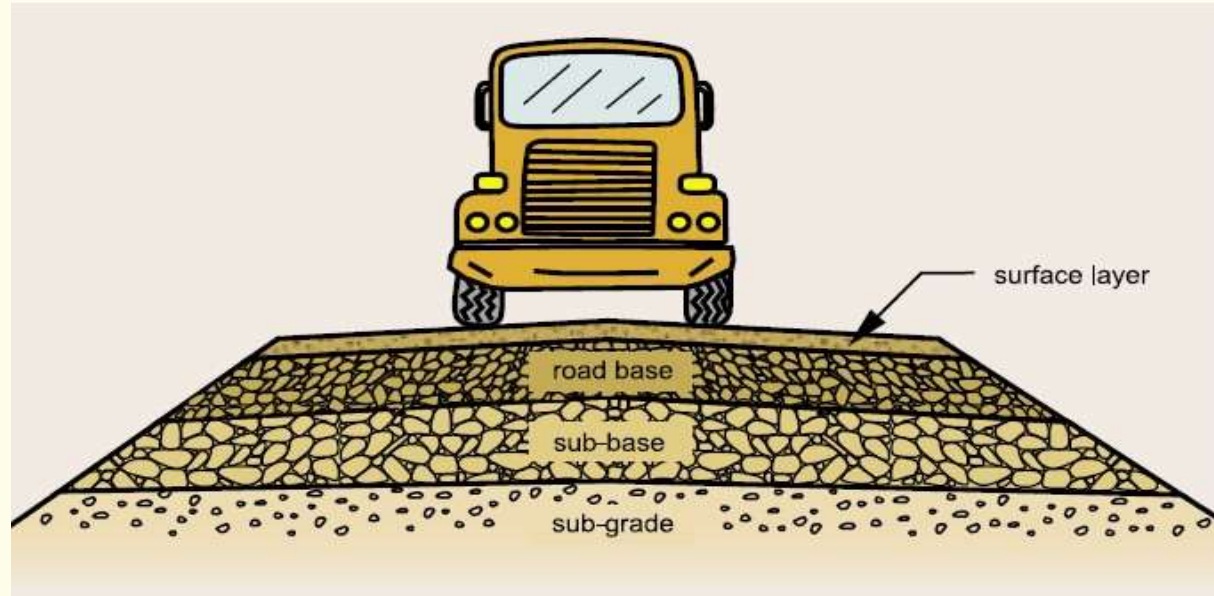


# Density- Compaction of Embankment of Subgrade

- **Density Requirements:**
  - Not subjected to extensive flooding :  $\leq 14.4 \text{ kN /m}^3$
  - >3 m height or any ht long periods :  $\leq 15.2 \text{ kN /m}^3$
  - Subgrade, earthen shoulders and backfill :  $\leq 16.5 \text{ kN /m}^3$
- **Compaction Requirements (LVRs)**
  - S G and ES : Not < 100%
  - Embankment :  $\leq 98\%$  (97%)
  - Expansive Clays : 90-95 % (90%)
- **Compaction is the key Importance parameter!**
- **Cut formation to be loosened to 500mm for 100% SPD**
- **Subgrade to be compacted in two layers**
- **Erosion control by turving method is added**



# Role GSB Layers..



- **To provide drainage and stability**
- **Capillary effect- saturation of subgrade**
- **Protect S G and reduce stresses over subgrade**
- **Load-bearing and strengthens the pavement structure**
- **Support of Construction equipments loads**





# Physical Requirements of GSB Layers

- **Natural Sand**
    - Rock & mineral by size finer than gravel and coarser than silt
  - **Crushed gravel**
    - Breaking to the desired size using crushers
  - **Crushed stone**
    - Better interlocking with angular face
  - **Crushed Slag**
    - Metals during the smelting/refining of iron ore
- CBR and AIV – WAIV > 50 and Min CBR 20% reliable to 15%





## GSB Gradation and Gravel Subbase ( Natural gravel)

IS Sieve	% by weight passing IS Sieve (GSB)		
	Gr-I	Gr-I1	Gr-III
75mm	100	-	-
53mm	-	100	-
26.5 mm	55-75	50-80	100
4.75 mm	10-30	15-35	25-45
75 micron	<15	<15	<15

IS Sieve	% by weight passing IS Sieve ( Natural Gravel- Subbase-New)	
	Gr-I	Gr-I1
53mm	100	-
37.5mm	-	100
26.5 mm	75-95	-
19mm	-	80-100
9.5mm	40-75	55-80
4.75mm	30-60	40-60
425 μ	15-30	15-30
75 μ	< 15	<15



## PI for GSB/Gravel Subbase (New)

Rainfall (mm)	Liquit Limit	Plasticity Index	Note
>1000 mm	< 35	< 10	DT Upto 1 msa
<1000 mm	< 40	< 15	DT Upto 1 msa
All areas	< 25	< 6	DT > 1 msa

**Note : Min Soaked CBR 20% for GSB, GSB not meeting economical leads-  
CBR 15% , WIV < 50%**



## Gravel/ Soil aggregate- SB, Base and Surface

- Natural gravel or a mix of crushed stone, crushed gravel, crushed slag, moorum, sand, fine sized particles or combination- New definition
- Subbase is included in new revision
- Lower base 50% CBR and upper base 80%
- Wet AIV shall not exceed (50) 40 & 30 (base/surf)
- FI-25% and 20% base and surfacing
- Gradation fails- Blending by crushing, screening and mixing should be mechanically by mix in place method



# Soil aggregate Grading: Subbase and Base (New)

Sieve size	Per cent by weight passing IS sieve		
	A	B	C
53 mm	100	–	–
37.5 mm	97 – 100	100	–
26.5 mm	–	97 – 100	100
19 mm	67 – 81	–	97 – 100
9.5 mm	–	56 – 70	67 – 79
4.75 mm	33 – 47	39 – 53	47 – 59
425 micron	10 – 19	12 – 21	12 – 21
<b>75 micron</b>	<b>4 – 15</b>	<b>4 – 15</b>	<b>4 – 15</b>

Soil aggregate Subbase and Base (New addition )

Sieve size	Per cent by weight passing (Nominal Size)		
	80 mm	40 mm	20 mm
80 mm	100	–	–
40 mm	80 – 100	100	–
20 mm	60 – 80	80 – 100	100
10 mm	45 – 65	55 – 80	80 – 100
4.75 mm	30 – 50	40 – 60	50 – 75
2.36 mm	–	30 – 50	35 – 60
600 micron	10 – 30	15 – 30	15 – 35
<b>75 micron</b>	<b>5 – 15</b>	<b>5 – 15</b>	<b>5 – 15</b>



## Soil Aggregate Mixture for Surface Course (New )

Sieve Size	% wt passing ( NS 10mm)
10mm	100
4.75mm	80-100
2.36mm	50-80
1.18mm	40-65
300 μ	20-40
75μ	10-25

Climate	LL (Max)	PI
High Annual rain fall >1500 mm	<35	4-9
Medium Annual rainfall 750-1500 mm	<40	6-15
Low -Rain fall areas < 750 mm	<55	15-30

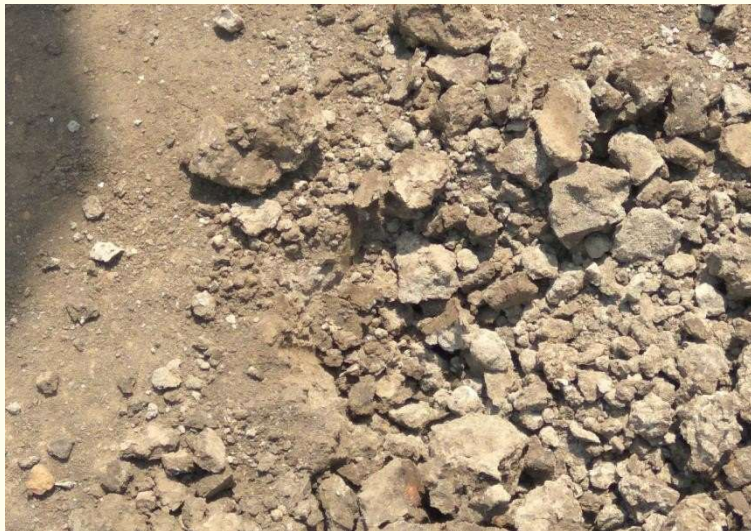


## Lime Treated Soil-Improved Subgrade/Subbase

- Physical requirements: Soil, Sand, Gravel, brick btas, crushed rock, Slag and fly ash etc.
- **Cement treated sub-base and base to CS SB and Base.**
- Cement needed – Sand/Sandy Soils/Soil grave: 3-5%
- **Silts/ Silty clays of  $PI > 30$  : 4-8%**
- **Clays and BC Soil : 8-15%**
- **BC Soils of  $PI > 30$ - Lime + Cement Stabilization**
  - **Mix Design: 7 days UCC = 2.76 Mpa**
  - **For Base 3 Mpa and 1.70 Mpa for subbase**
- Soil, Sand, Gravel, Kankar, brick bats and locally materials/blend
- **$Cu > 5$  ,  $LL > 45$  and  $PI < 20$**
- **Compact within 2 hours after mixing**
- **Cement Stabilization – Gradation Combined (Base and Subbase)**



# Cement Stabilization-Field visit in Guntur







# Grannular Courses

- **WBM-Subbase/base and Surfacing**
- **W M M for base course**
- **Local material for road construction**
- **Industrial Waste for road construction**
- **Crusher Run Macadam**
- **Gradation for aggregates should be met before using for construction**
- **Allow 5% deviation for UPL and LL**
- **Screening for WBM materials**
  - **Stone chips of size 13.2mm and Stone dust 11.2 mm**



## Bituminous Pavements - Prime coat Granular Surface

- **Primer slow setting(SS1) cationic emulsion**
- **Rate of application(kg/10 sq.m)**
  - 7to 10 for WBM
  - Stablized base 9 to 12
  - Gravel /CRM 12 to 15
- **No heating of emulsion at site is required**
- **Tack Coat**
- **V G 10 (80/100) can be used apart from RS1**
- **Quantity as suggested**



# Bituminous Macadam

- **Open graded mixture-** new suggestion is that in cooler region bitumen content can be increased by 0.5%
- **50 to 75 mm layer using paving grade bitumen**
- **VG 10 to VG 30 -3.3 to 3.5%) and crushed agg hot mix**
- **Modified bitumen not recommended! Aggregate properties, grading and bitumen quantity not changed!!**
- **Properties of aggregate, grading and Bt qty same**
- **Inclusions in Mixing as follows**
  - **Laying 5 to 10 degrees increased**
  - **Rolling 10 to 20 degrees increased**

Bitumen Viscosity Grade	Bitumen Temperature	Aggregate Temperature	Mixed Material Temperature	Laying Temperature	Rolling Temperature*
VG-40	160-170	160-175	160-170	150 Min	100 Min
VG-30	150-165	150-170	150-165	140 Min	90 Min
VG-20	140-165	145-170	145-165	135 Min	85 Min
VG-10	140-160	140-165	140-160	130 Min	80 Min



## Surface Dressing

- **MB not recommended! Deleted.**
- **Aggregate grading of N M S A is added (19mm)**
- **V G grading bitumen recommended**
- **O G P C**
  - **V G bitumen is used**
  - **Binder quantity 14.6 /10<sup>2</sup>m**
  - **Emulsion-20 to 30kg/ 10<sup>2</sup>m (21.5 in earlier)**
  - **S D B C and Bitumen Wearing course using waste plastic are new recommended**
- **Bituminous Construction and procedure follows.**
  - **Finer cracks – SS1 emulsion is used**
  - **Wider cracks to be filled with stone dust (finer than 4.75)**



# SDBC MIX Design Requirements

Properties	Viscosity Grade Paving Bitumen	Modified Bitumen		Test method
		Hot Climate	Cold Climate	
Compaction level (no of blows)	75 blows on each face of the bitumen			
Minimum stability (kN at 60°C)	9	12	110	AASHTO T245
Marshall flow (mm)	2-4	2.5-4	3.5-5	AASHTO T245
Marshall Quotient (Stability flow)	2-5	2.5-5.0		
Air Voids (%)	3-5			MS-2 and STM D2041
VFB (%)	65-75			MS-2
TSR	80%			AASHTO 283
Coating of aggregate particle with bitumen	95%			IS6241
Void sin Mineral aggregates (%)				
Nominal Maximum Particle Size	Min % VMA related to design percent air voids			
9.5 mm	14	15	16	



## MoRD-LVR: Bridges CD Works and Form Work

- **Stone and Concrete Block- 200 mm concrete block of minimum strength of 10.5 Mpa is added.**
- **Change in Cement Content and Grade of Concrete**
  - **M15 to M 45 (Earlier M10 to M30)**
  - **Min Cement Cont. (340 -380kg/m<sup>3</sup>) ( old 250- 400kg/ m<sup>3</sup>.**
- **Fe500, Fe 550 added and Fe 415 retained)**
- **Submersible bridges deleted! Wells and piles added.**
- **PCC- M20 and above, RCC M25 and above**
- **Minimum cement content 320 to 380 kg /m<sup>3</sup> depending on type of concrete and severity of weather.**
- **Removal of form work for superstr-14 days after concreting using OPC.**
- **For vertical faces like column, abutments,-0.5 to 2 days.**



# Steel, Foundations and Substructures

- Use new steel for works don't use rerolled steel
- For pipe culverts and vented cause ways bedding pipes
  - Type A: Fill more than 4 meter
  - Type B: less than 4m fill
- NP3 or NP4 RCC pipes of 900mm dia ,exceptional cases 600 or 750 mm dia.
- If CC pavement is constructed over causeway of 200mm thick, M30 or more, camber 2.5% and joints of 4 to 6 m.
- No submersible bridges if the velocity  $>$  than 6m/sec
- Provide concrete piles of 1 m dia for river bridges.
- If Velocity of flow is 2.5 m /sec provide stone pitching minimum 25 kg and 40kg for aprons.



# Cement Concrete Pavement-Glimpses

- **OPC 33 removed and -PPC and Slag and PPC**
- **43 or 53 grade( Mandatory to use fly sash for 53 is optional and 43 with fly ash usage is allowed)**
- **Cement content 425 kg/m<sup>3</sup> and 350kg minimum**
  - (previously 310 kgby MoRD and 360 by MoRTH)
- **Cement replacement by fly ash- 30% maximum**
  - (Max was not given earlier and MoRTH says 20%)
  - After fly ash addition 270 kg/m<sup>3</sup>
- **Aggregate properties no change**
  - LA (35%max ) ,WAIV (30% max),FI (35% max),Water absorption (5% max)





# Plain Cement Concrete Pavement

- **Max size of aggregate**
  - Increased to 31.5 mm from 26.5mm
  - M30 grade (28days-3.8Mpa,w/c-0.5 max, slump30+-10)
- **Treated Marginal materials**
- **Dowel bars remain unchanged**
- **Roller compacted concrete**
  - **Cement content- 425kg/m<sup>3</sup> 350 kg min (earlier310kg)**
  - **Cement replacement by fly ash max 30 %of OPC (Earlier 15 to 35 %)**
  - **Transverse contraction joints at 4 m spacing**
    - **(Earlier 5 m for P Q C spacing2.5 to 3.75 m)**



# Gradation for PQC

Sieve size	Per cent by weight passing IS sieve	
	Revised MORD Specifications	Previous (Old)
31.5 mm	100	–
26.5 mm	85 – 95	100
19.0 mm	68 – 88	80 – 100
9.5 mm	45 – 65	80 – 100
4.75 mm	30 – 55	55 – 80
600 micron	8 – 30	35 – 60
150 micron	5 – 15	10 – 35
75 micron	0 – 5	0 – 8



# Roller Compacted Concrete Grading

Sieve size	Per cent by weight passing IS sieve	
	RCCP Specifications	PQC For Comparison
26.5 mm	100	85 – 95
19.0 mm	80 – 100	68 – 88
9.5 mm	55 – 75	45 – 65
4.75 mm	35 – 60	30 – 55
600 micron	10 – 35	8 – 30
75 micron	0 – 5 (0 – 8 Previously)	0 – 5



# Rural Roads Example - Real Indicators



**Other Factors**



**Time**



**Education**



**Trade**



**Cost**



**Environment**



**Health**



**Jobs/Profits**



**Poverty Reduction**

