Construction of

SHORT PANELLED CONCRETE PAVEMENT

(SPCP) in APRR Project (CC Roads)

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What is short paneled concrete pavement (SPCP)?

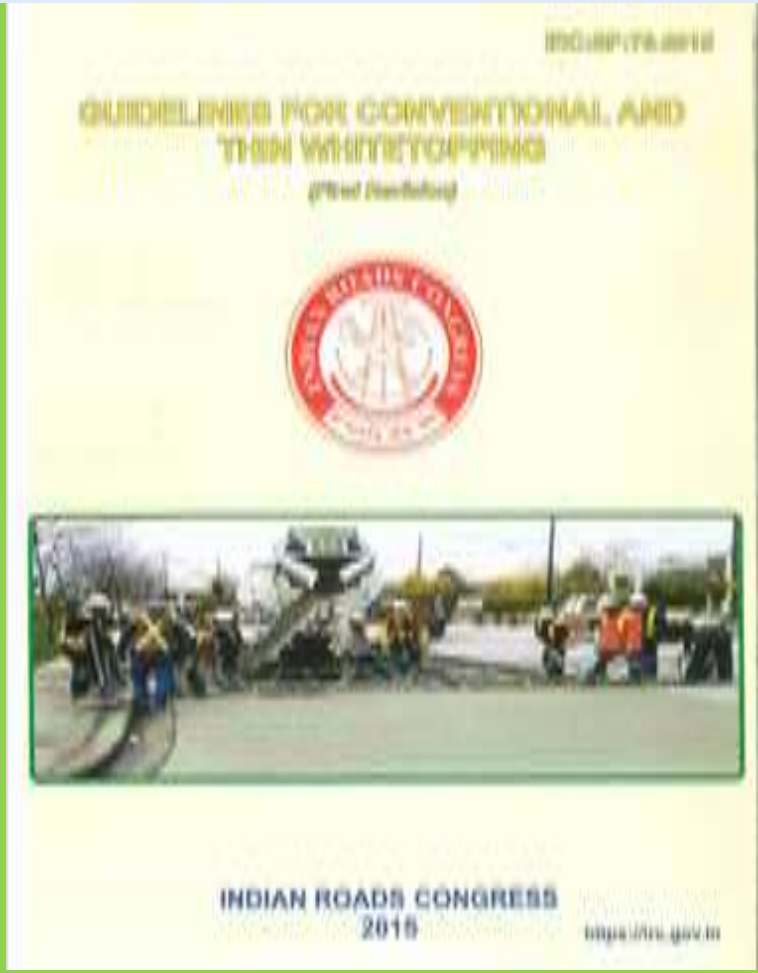
- A course of pavement quality concrete (PQC) of low to medium thickness **(100 – 150 mm)** laid over non-erodible unbound bases (like WMM) or bound base course (like Cement treated base, DLC or lean concrete or even bituminous road) with **small sizes of panels (from 0.5 m x 0.5 mt to 1.5 mt. x 1.5 mt) made by 1/3 or 1/4 depth of groove cutting (3 mm wide)** without any type of reinforcements or dowel bars is called **SHORT PANELED CONCRETE PAVEMENT**.

- It is similar to **WHITE TOPPING (WT)** which is done as PQC overlaying **essentially over bituminous pavement**.

SPCP Vs JPCP

Suitable sites for SPCP/WT

i) Rural Roads
ii) Medium to Moderately Heavy Volume Roads(e.g MDR,SH,Low Traffic NH)
3. Intersections
4. Minor Airports Pavements
5. Toll plaza
6. **Low volume metalled village roads**
7. New roads for heavy traffic as an alternate to flexible pavement/conventional rigid pavement
8. Bus bay and truck lay-bye



Features of Different Pavement Layers

Item	Conventional Concrete Pavement	Short Panelled Concrete Pavement (SPCP)	Whitetopping (WT)
Thickness	Normally>200 mm	Normally<200 mm	Normally<200 mm
Concrete Grade	M30 to M40	M30 to M40	M40 or more than M40
Construction Method	Manual,Semi Mechanised,& Fully Mechanised	Manual,Semi mechanical& Fully Mechanised	Manual, Semi Mechanical & Fully Mechanised
Joint Sealing	Normally Sealed	Not Mandatory	Not Mandatory

Features of Different Pavement Layers

Item	Conventional Concrete Pavement	Short Panelled Concrete Pavement (SPCP)	Whitetopping (WT)
Slab Size	3.75mx4.0m (Rural Roads)	1mx1m to 1.5 m x 1.5 m Square or Rectangular (Less than 1.0m should be avoided)	1m x 1m to 1.5 m x 1.5m Square or Rectangular (Less than 1.0m should be avoided)
Curling and Load Sresses	High	Low	Low

Features of Different Pavement Layers

Item	Conventional Concrete Pavement (Rural Roads)	Short Panelled Concrete Pavement (SPCP)	WhiteTopping (WT)
Base Layer	DLC (High Volume Roads)	DLC(High Volume Roads)	Existing Bituminous Pavement layers
Sub Base & Base Layers	GSB/ WBM/WMM (low volume roads)	GSB/WBM/WMM (low volume roads)	
Dowels	CC Pavement joins at Bridge/Culverts	Up to 150 mm- No dowel bars, 150 to 200 mm -Only at Tr. Construction Joint	Up to 150 mm- No dowel bars, 150 to 200 mm -Only at Tr. Construction Joint
Tie Bars	All Longitudinal Joints	Only at longitudinal Construction Joint	Only at longitudinal Construction Joint

Types of White - Topping

1.Conventional (CWT)	200 mm or more	Used on Heavily trafficked Corridors
2.Thin (TWT)	100mm and less than 200 mm	Used for Collector Streets
3.Ultra Thin (UTWT)	Equals to or less than 100 mm	Used for Collector and Local Streets

Design

Cement Concrete pavement

(IRC : SP: 62-2014)

Design:

- Traffic Up to ***50 CVPD***
- Min Sub grade CBR : 4%
- Granular Subbase : 100 mm(min CBR 30%)
- Base(WBMIII/WMM) : 75 mm
- SPCP Pavement Thickness :as per design based on joint spacing (1mx1m- 125 mm Thick etc)

Cement Concrete pavement

(IRC : SP: 62-2014)

Design:

Traffic from ***50 to 150 CVPD***

Min Sub grade CBR	: 4%
Granular Subbase	: 100 mm(min CBR 30%)
Base(WBMIII/WMM)	: 75 mm
SPCP Pavement Thickness	**: as per design . i.e., 1m x 1m with 125 mm thick**

Traffic from 150 to 450 CVPD :*

- **Sub grade CBR : 8%**
- **Sub base (GSB) : 100 mm**
- **Base (WMM/WBMIII) : 150 mm**

OR

- **Cementitious Subbase(Min UCS of 1.5MPa) : 100 mm**
- **Cementitious base (Min UCS of 3.0 MPa) : 100 mm**

(Note: UCS at 7 days if cement is used)

(* IRC 58 deals the traffic exceeding 450 CVPD)

Materials and Mix Design

Cement:

1. Ordinary Portland Cement :43 Grade (IS: 8112)
   (Preference to use 43 Grade)

2. Portland Blast Furnace Slag Cement : IS:455

3. Portland Pozzolana Cement : IS:1489

4. Ordinary Portland Cement :53 Grade (IS: 12269)
   (blended with fly ash – 25%)

Cement Content:

The mass of cementitious content(cement+fly ash/slag)or cement=360 to 425 kg/cum.

Coarse Aggregates :

Material: Crushed stone or crushed gravel

- **Combined gradation of aggregates** : Table 1500.1of MoRD 2014 (Design Mix)
- **Max size of Aggregate : 31.5 mm**
- **Water absorption :** <=2%,
- Los Angels(LA) Abration/**Aggregates Impact Value (AIV) :** 35% max,
- Combined **Flakiness and Elongation Index :** 35% (max)

Fine Aggregate:

- Clay Lumps : not more than 1.0%
- Coal & Lignite : not more than 1.0%

Material Passing IS Sieve No 75 mic :

- Natural Sand : max 3%
- Crushed stone sand : Maximum 12% (15% with caution- no shrinkage cracks)
- Blend of natural and crushed stone sand: Max 8% of total weight of fine aggregate

Material Passing IS Sieve No 150 mic :

- For crushed stone sand permissible limit on 150 mic sieve may be increased to 20%.

FINE AGGREGATES(MORTH 1000-2 & IS:383-2016 Table No.9)

SNo	I.S. Sieve designation	SAND FOR CONCRETE				SAND for PLASTER	SAND for MORTAR
		GRADING ZONES AS PER TABLE 9. OF IS:383 - 2016					
		Grading Zone I	Grading Zone II	Grading Zone III	Grading Zone IV	IS:1542-1992	IS:2116-1980
1	10 mm	100	100	100	100	100	
2	4.75 mm	90 - 100	90 - 100	90 - 100	95 - 100	95 - 100	100
3	2.36 mm	60 - 95	75 - 100	85 - 100	95 - 100	95 - 100	90 - 100
4	1.18 mm	30 - 70	55 - 90	75 - 100	90 - 100	90 - 100	70 - 100
5	600 micron	*15 - 34*	*35 - 59*	*60 - 79*	*80 - 100*	*80 - 100*	*40 - 100*
6	300 micron	5 - 20	8 - 30	12 - 40	15 - 50	20 - 65	5 - 70
7	150 micron	0 - 10	0 - 10	0 - 10	0 - 15	0 - 15	0 - 15
	Fineness Modulus	3.91 to 2.71	3.37 to 2.11	2.78 to 1.71	2.25 to 1.35	2.20 to 1.20	

Fixing of ZONES : (for the SAND used for CONCRETE) The limits of Percentage of passing of one Zone over laps the adjacent Zones in all sieve sizes, except 600 micron. Hence percentage passing 600 micron is used to decide sand Zone.

Sieves for Gradation

As per IS:383, all the four zones can be used in Plain Cement Concrete roads.

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Fineness Modulus (FM) of Sand should be in between 2.0 and 3.50 .

Generally, sand having FM more than 3.2 is not used for making good concrete.

Aggregate Gradaton as per MoRD 2014 & IRC:SP:62-2014 For Design Mix

1501.2.4.3 Aggregate gradation

The coarse and fine aggregates shall be blended so that the material after blending conforms to **Table 1500.1**:

Table 1500.1 Aggregate Gradation for Pavement Quality Concrete

Sl. No	Sieve Designation	Percentage by Weight Passing the Sieve
1)	31.50 mm	100
2)	26.50 mm	85-95
3)	19.0 mm	68-88
4)	9.50 mm	45-65
5)	4.75 mm	30-55
6)	600 micron	8-30
7)	150 micron	5-15
8)	75 micron	0-5

Tarle 6.2 Aggregate Gradation for Concrete

Sieve Designation	Percentage Passing the Sieve by Weight
26.50 mm	100
19.00 mm	80-100
9.50 mm	55-75
4.75 mm	35-60
600 micron	10-35
75 micron	0-8

Admixures :

- Admixtures confirming to IS:6925 and IS: 9103 :up to 2% by weight of cement .

  Plasticizers and Super Plasticizers

- **Improve workability or extension of setting time of concrete.**

Water: shall meet the requirements stipulated in IS:456

Table 1 Permissible Limit for Solids

(*Clause* 5.4)

Sl No.		Tested as per	Permissible Limit, *Max*
i)	Organic	IS 3025 (Part 18)	200 mg/l
ii)	Inorganic	IS 3025 (Part 18)	3 000 mg/l
iii)	Sulphates (as SO_3)	IS 3025 (Part 24)	400 mg/l
iv)	Chlorides (as Cl)	IS 3025 (Part 32)	2 000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced concrete work
v)	Suspended matter	IS 3025 (Part 17)	2 000 mg/l

Fibres :

- Steel/polypropylene/polyster/polyethylene/nylon
- Reduces the tendency to ***plastic shrinkage*** cracking and increases its ductility and abrasion resistance.
- Dosage: 0.5 to 1.5% by volume of concrete (4.5 to 14 kg/cum)

RECRON 3S Polypropylene Fibre

Shrinkage Cracks in CC Pavement

Premoulded Joint Filler board:

Bitumen impregnated filler board / pre-moulded synthetic, joint filler board for ***expansion joints*** which are provided at abutting structures ***like bridges and culverts,*** shall be of ***20 mm*** thickness as per IS: 1838.

PLANT, EQUIPMENT AND TOOLS

Plant, Equipment and Tools

1. **RMC Plant/Azax/Millers** with suitable weigh batching mechanism (Design mix)
2. **Vibrating screeds** of appropriate length so that the same can be supported on the side forms for tamping and compacting pavement surface. **One screed vibrator** shall have **straight bottom** for use on **super-elevation** and the other one will have specified **parabolic camber**.

Plant, Equipment and Tools

3. **Two needle vibrators**, with one stand-by.
4. **Plate compactor**.
5. **Core Cutting machine** for cutting Cores of Concrete of Minimum 100 mm diameter and depth from 100 mm to 250 mm.
6. **Wooden tamper** 100 mm x 100 mm x 125 mm size with mild steel shoe at bottom.
7. **Concrete saw cutter** for cutting contraction joints
8. **Hand held sprayer** for applying liquid curing compound with at least 10-20 litres capacity. **container/tank** to be used where there is acute scarcity of water.

Plant, Equipment and Tools

9. **Texturing brooms** of steel wires brush of adequate length.
10. **One straight edge of 3 m l**ength for routine checking, an additional master straight edge.
11. **Graduated wedge** – for measuring surface evenness
13. **Fixed side forms** measuring at least 100-150 m length.
14. **Stop-end and start-end made of steel** or wooden section.
15. Appropriate number of **wheel barrows and iron** pans.

Plant, Equipment and Tools

16. Adequate number of **spades, shovels and rakes**.
17. **Pump** to clean the holes/grooves of joints.
18. **Epoxy gun** for filling holes with epoxy, if any, expansion joints are needed near existing bridges/culverts.
19. **Two sets of bulk head** stop-end made of iron sheet in two halves with half diameter circular holes in each half to hold the **dowel bars** and with adequate clamps to hold the assembly together.

MIX DESIGN – M30

- **Mix design** shall be submitted at least 30 days prior to the paving of trial length. Shall be **approved by EE** as per Section 1803.24.1 of MoRD 2014
- ***Design Mix:*** As per IRC:44 or IS:10262. based on **flexural strength of concrete.**
- ***Cement Content:*** Shall **not be more than 425 kg nor less than 350 kg per cum of concrete**.
- ***Concrete Strength***: **Min M30 grade** and its design shall be based on the flextural strength of concrete.
- The characteristic flexural strength at 28 days shall be **not less than 3.8 Mpa.**

Execution Methodology

Various Operations involved in Construction of CC Roads

Preparation of subgrade/ Subbase as per design as per IRC:SP:62-2014	Mixing: Miller mixing/Ajax mixing/RMC	Laying of separation membrane: 125 mic thick	Placing of Concrete
Compaction	Finishing	Texturing	Curing : **Initial/Intermediate**
Cutting of Joints- 1.0mx1.0m size. Depth of groove: 1/3 rd thickness of slab	Curing: Final – Ponding	Sealing of Joints- Optional	Allowing Traffic

Short Panelled Concrete Pavement (SPCP)

Over

Cement Treated Base

With

Cement and Additive

Form Work:

Channels (Centering) arrangements for laying of concrete over Cement Treated Base with STABIL ROAD (additive)

Separation Membrane

Separation Membrane : 125 microns thick (White or Transparent)Laying in Progress

Note: Before laying separation membrane clean the existing **cement stabilized base** and apply Cement slurry to fill the cracks if any formed after completion of the stabilization.

Workability

- The **workability of the concrete shall be measured at the point of placing with slump cone test as per IS: 1199.**
- **Chemical admixtures/plasticizers as per IS:9103 may be used if needed to achieve the workability.**
- **Max water/cement ratio (W/C) shall not be more than 0.40 (Preferable: around 0.30 to 0.38)**

Effect of Water on Concrete

Test for Workability of Concrete – Slump Cone

- It is advisable to assess the workability of concrete mix using a slump cone
- Ensure that the cone is filled in a proper manner as indicated
- Notice the type of slump : Shear and Collapse Slump are ***undesirable***.
- Adjust the slump to the desired value by changing the proportion

Optimum Quantity of water results in Cohesive, denser and impervious concrete.

Slump Cone Test for Workability of Concrete

Metallic mould - bottom dia. 20 cm, top dia. 10 cm and 30 cm height, with a base plate

Steel tamping rod - 16 mm dia. and 60 cm height

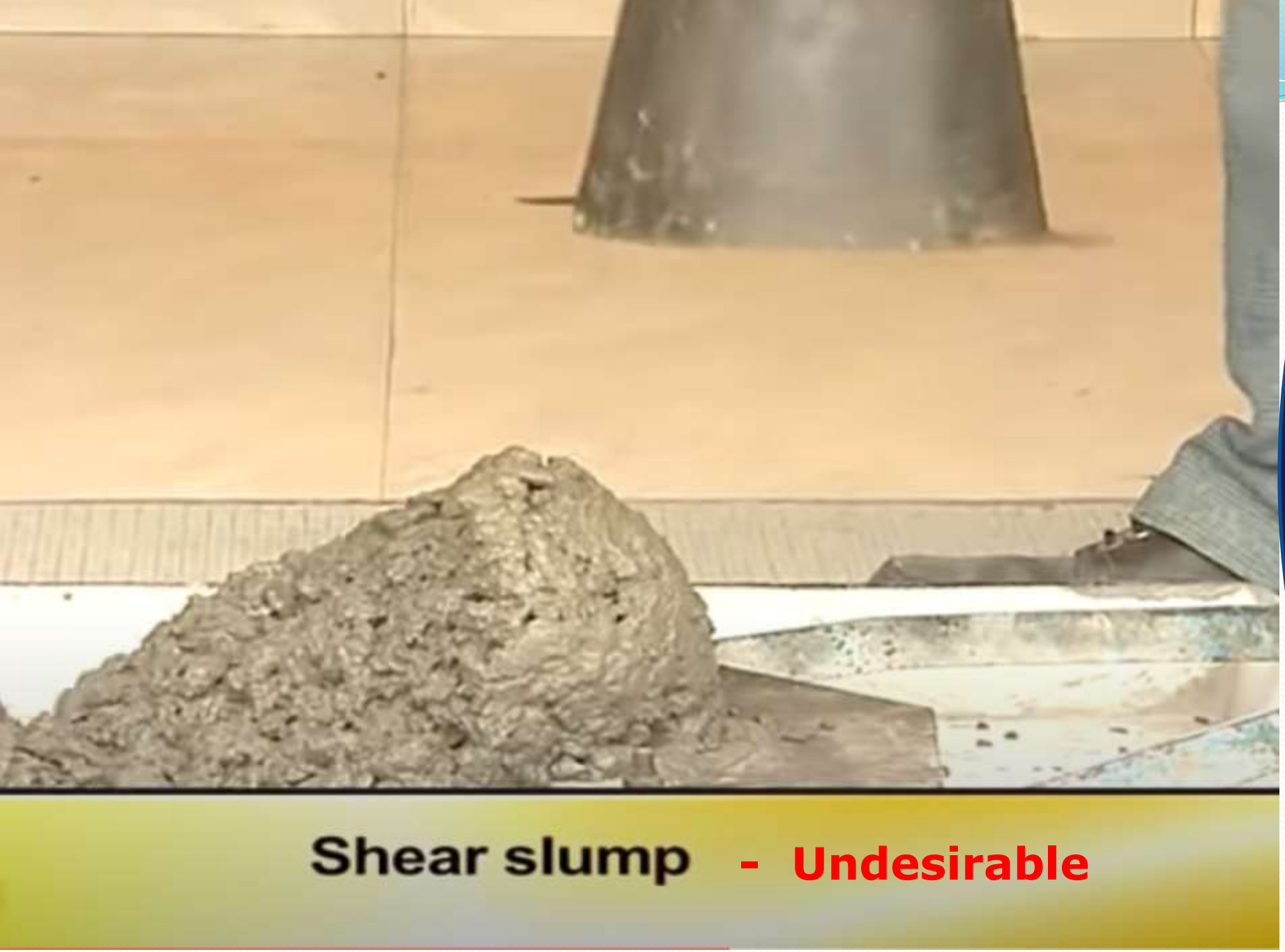
Tamp each layer 25 times

Four Layers with 1/4th of the height

Slump of Concrete after removal of cone

Measurement of Slump

True Slump refers to general drop of the concrete mass evenly all around without disintegration. This type of slump is most desirable.



Shear slump - Undesirable

Shear Slump indicates that the concrete lacks cohesion. It may undergo segregation and bleeding and thus is undesirable for the durability of Concrete.

Collapsible slump - **Undesirable**

Collapse slump indicates that concrete mix is too wet and the mix is regarded as harsh and lean.

7 WORKABILITY OF CONCRETE

7.1 The concrete mix proportions chosen should be such that the concrete is of adequate workability for the placing conditions of the concrete and can properly be compacted with the means available. Suggested ranges of workability of concrete measured in accordance with IS 1199 are given below:

Placing Conditions	*Degree of Workability*	*Slump* (mm)
(1)	(2)	(3)
Blinding concrete; Shallow sections; Pavements using pavers	Very low	*See* 7.1.1
Mass concrete; Lightly reinforced sections in slabs, beams, walls, columns; Floors; Hand placed pavements; Canal lining; Strip footings	Low	25-75
Heavily reinforced sections in slabs, beams, walls, columns; Slipform work; Pumped concrete	Medium	50-100 75-100
Trench fill; *In-situ* piling	High	100-150
Tremie concrete	Very high	*See* 7.1.2

NOTE—For most of the placing conditions, internal vibrators (needle vibrators) are suitable. The diameter of the needle shall be determined based on the density and spacing of reinforcement bars and thickness of sections. For tremie concrete, vibrators are not required to be used (*see also* 13.3).

For SPCP/WT: 25- 50 mm)

Construction of Concrete Pavements- Weather Limitations

Ambient Temperature:- Hot Weather- Concrete shall not be done when Ambient Temp is more than **35ºC**

Weather Limitations:- when

- **Ambient Temp above 35ºC,**
- **Rh below 25% and or**
- **Wind Velocity more than 15 Km/h** Special necessary precautions need to be taken

Temperature of Green Concrete at the laying should not be more than **30ºC** if it is more need chilled water should be used/ cooling of Aggregate

Rate of Evaporation should not be more than **1Kg/m^2 per hour** near the top of the green concrete to control the plastic shrinkage cracking.

Use of OPC 53Gr or Rapid Hardening cement should be avoided

Ambient Temperature:- Cold Weather- Where air Temp is expected to **fall below 20ºC** Air Temp of Green Concrete shall be maintained **at 15ºC at least 3 Days and not less than 4ºC for a period of not less than 7 days**

Covering with Plastic Sheet to prevent temperature effect in freshly laid concrete

Ready Mix Concrete

- Ready Mix Concrete is manufactured scientifically at plant and transported through truck mounted mixers
- Superior quality concrete is produced through stringent Quality assurance and Quality control system
- Chemical and mineral admixtures are used to achieve the desired strength which modify the behavior of the concrete.
- Concrete shall be discharged from the truck- mixer within 2 hours of the time of loading. However longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced.
- The concrete should be discharged within 30 minutes of arrival on site.

M40 Concrete Laying and levelling with Screeding machine

Concrete levelling and compaction with needle vibrators attached to the Screeding machine

Concrete – Slump test at site

Compaction of Concrete

- Effective compaction makes the concrete dense and impervious
- Over -compaction leads to segregation
- Compacting concrete using vibrators is more effective than manual compaction

Compaction of Concrete:

Needle of the vibrator should be immersed vertically

Concrete not be vibrated for more than for 15 seconds

Spacing of the vibrator - 15 cm for 20 mm needle and 30 cm for 40 mm needle

Compaction of Concrete with Needle Vibrator

Compaction with Plate Vibrator

Finishing of Concrete

- Finishing is done after compaction, to obtain level and smooth surface
- Steps involved are screeding, Floating followed by Troweling
- Spreading of dry Cement on wet surface should be avoided.

Screeding: Striking off excess concrete using a straight edge

Floating: Removes the irregularities left after screeding , firmly embed the large aggregate particles.

Troweling

To obtain very smooth and highly wear resistance surface. It is done using a steel trowel.

To obtain very smooth and highly wear resistance surface. It is done using a steel Rollers attached to the machine

CC Road under finishing with Power Trowel cum Floater

Texturing:

The texture ensures that vehicles maintain a good "grip" with their tires, especially during wet or slippery conditions.

To be done just after the **water sheen** has disappeared and just before the concrete becomes non-plastic.

- **Low Speed, Municipal or Urban projects**: Burlap drag, turf drag, or ***Coarse broom texture is sufficient***.

Water Sheen on the surface of CC road after Finishing

Texturing Tools

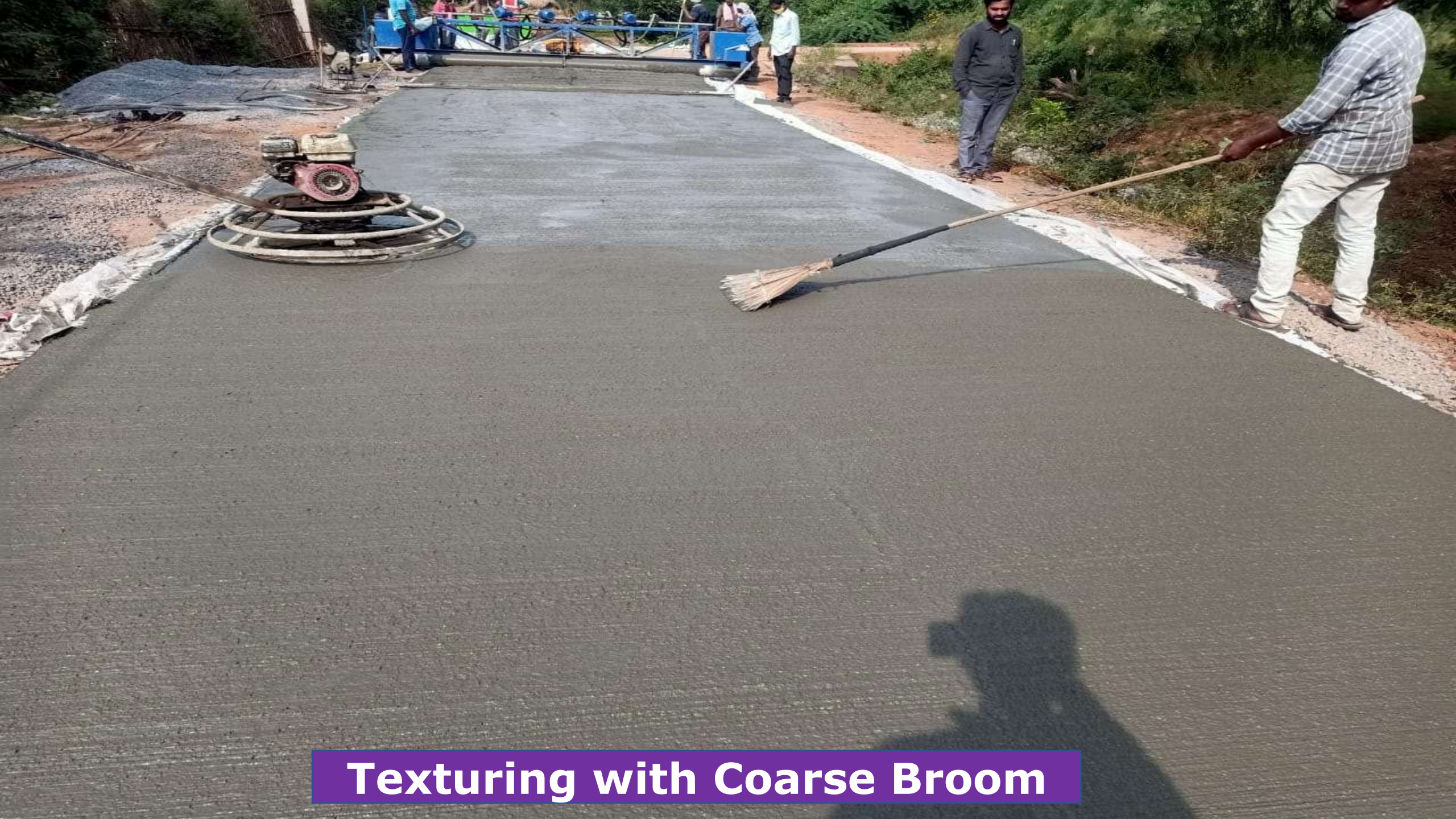
(a)

(b)

Photo 2 Long Handled Broom and Tining Brush

TEXTURING with Tining brush

TEXTURING with Local made Brush



Texturing with Coarse Broom

Curing: Initial Curing- Most Important

Curing Compound/water should be applied twice the normal rate, because SPCP is thin concrete slab which has high surface area to volume ratio and can loose surface moisture rapidly due to evaporation.

Spraying of Curing Compound

Road view after applying curing compound

- **Joints:**

Ratio of length(longest dimension) to width (shortest dimension) of any given panel is recommended to be not more than 1.20)

i) Contraction joints

ii) Expansion Joints

iii) Construction Joints

iv) Longitudinal Joints

- **Joint Cutting:**

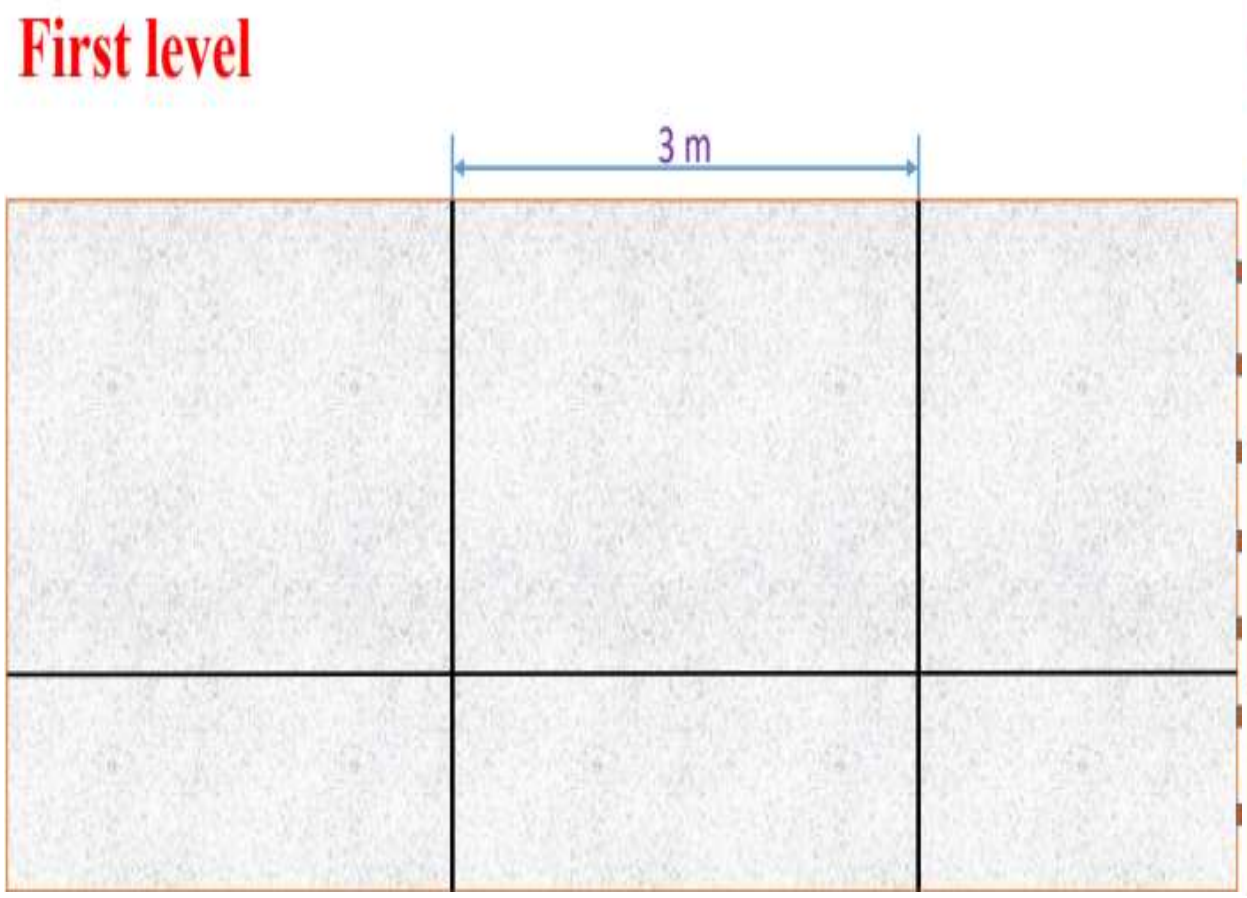
Initially 3-5 mm wide joint may be **cut within 6-18 hours** to a depth of 1/3 of the slab's depth.

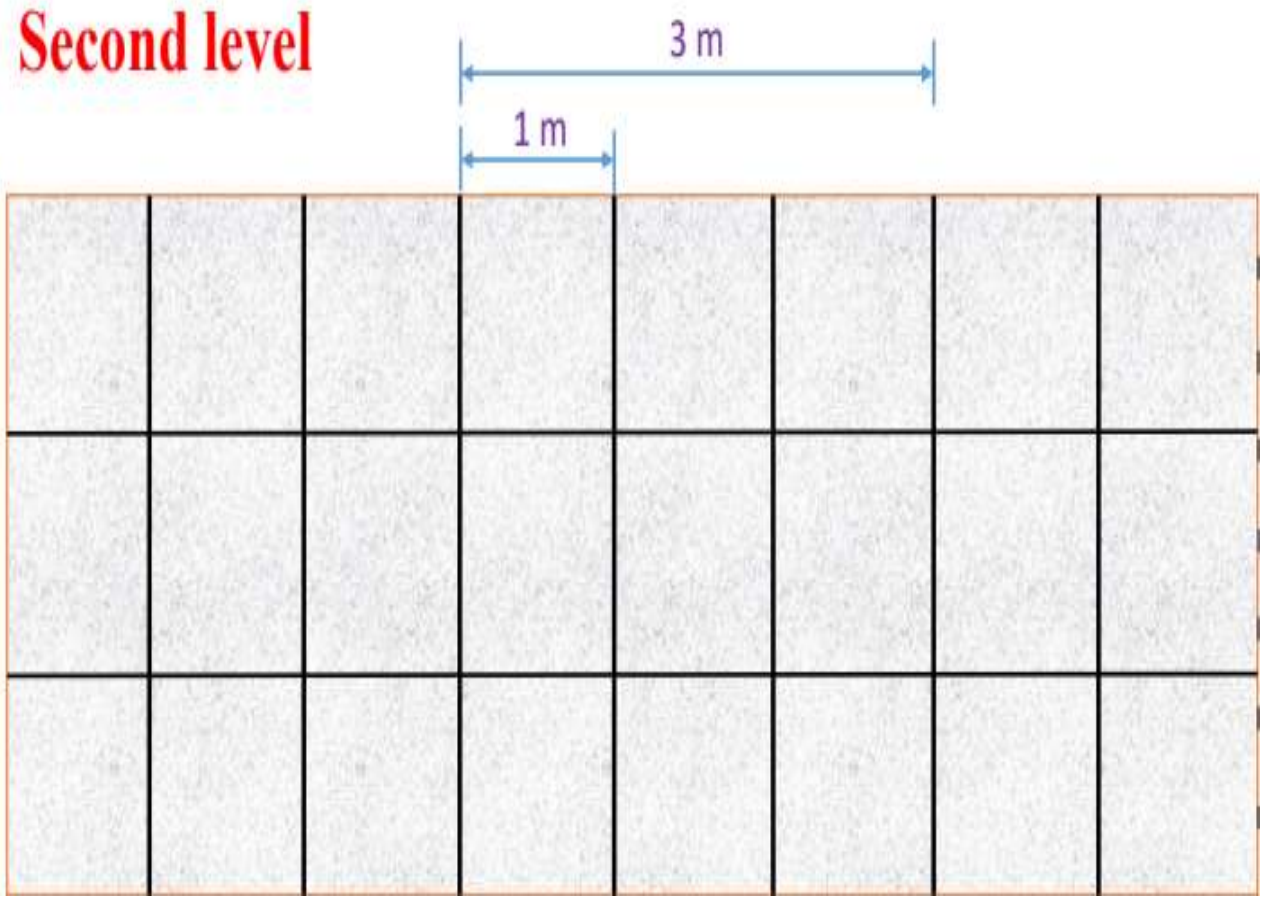
*** At first instance transverse joints may cut at 3mts interval and then cut 1mt interval joints to avoid cracking of concrete. (Skip-Sign)**

joints are not cut sequentially

- **Longitudinal construction butt Joint:**

Deformed steel tie bars of length 500 mm, 10 mm dia and spacing of 750 mm shall be provided.





Joint Saw Cutting

Making grooves by 3 mm with Diamond Cutter

- For cutting groove on such a small scale work, diamond cutters fitted in hand hold small machines with which marble slabs are cut shall be used.
- But the cutter should be concrete grade (tougher).
- Simple marble stone cutters will not do.

For large scale work, suitable machines are to be adopted

Cutting of Joints at 1.00mX1.00 m (Most Preferred)

Joint Cutting

Completed Panelled Concrete

Road View after Joint Saw Cutting

Joints:

Ratio of length(longest dimension) to width (shortest dimension) of any given panel is recommended to be not more than 1.20)

i) Contraction joints
ii) Expansion Joints
iii) Construction Joints
iv) Longitudinal Joints

Dowel Bars:

SPCP/TWT thickness is less than 150 mm , provision of dowel bars may be omitted.

Details of the joints and their sealing with sealant or preformed seals as shown in **Fig. 6** are given in IRC:15 and IRC:57.

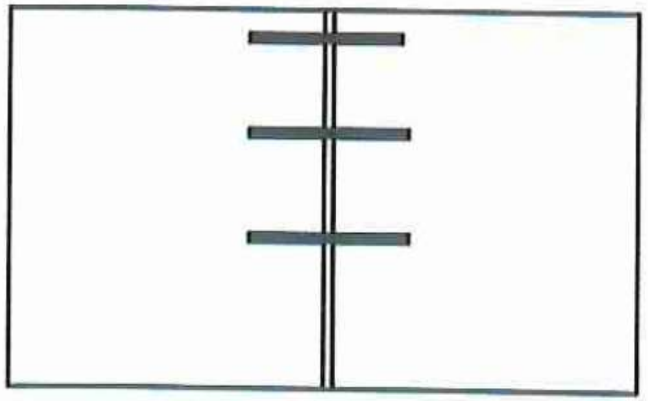


Fig. 6 (a): Plan of Two Adjoining Slabs (UTWT/TWT) at Butt Type Longitudinal Joint

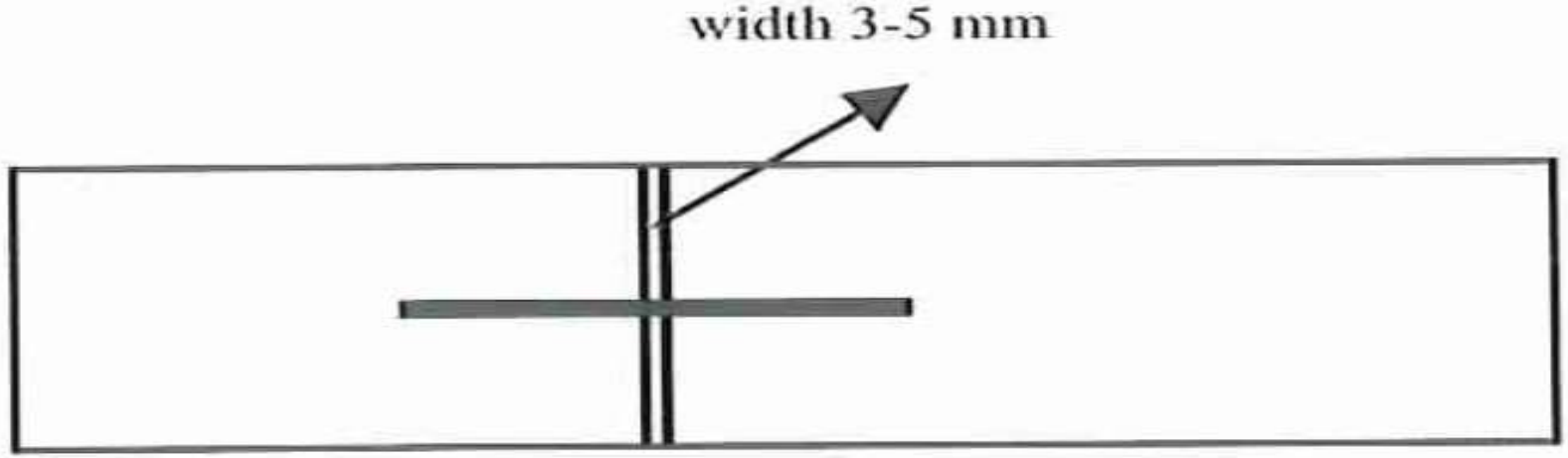


Fig. 6 (b): Cross Section View of Butt Type Longitudinal Joint

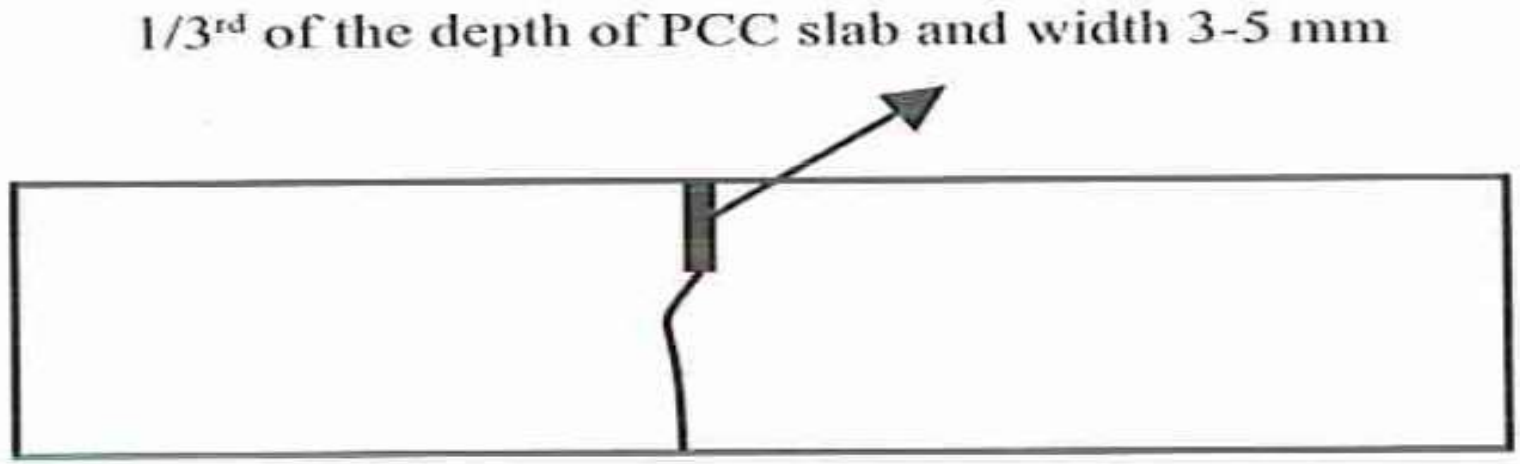


Fig. 6(c): Cross Section View of Contraction/Longitudinal Joint

If Thickness is 150 mm to 200 mm and At Bridges/Culverts

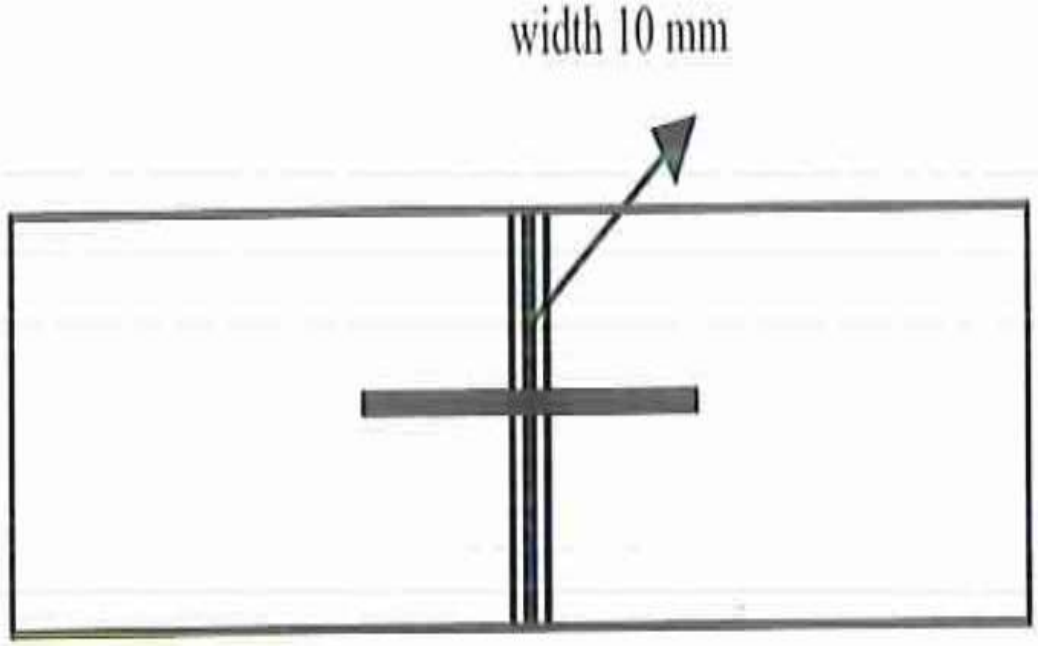


Fig. 6 (d): Cross Section View of Construction Butt Joint (Transverse Joint)

CURING OF CONCRETE- Final

- Curing helps maintains the moisture content in the concrete.
- This has the dual advantage of increasing the strength and durability of the concrete.
- Curing should be done when the surface of the structure is hard enough to walk easily.
- To cure slabs, you should make 15 mm water ponds on the surface.
- Keep filling water in the ponds and don’t allow the water to run dry.

This is called ‘ponding’.

Curing with Gunny Bags

Making Dykes for Ponding

Curing by Ponding

Removal of Forms

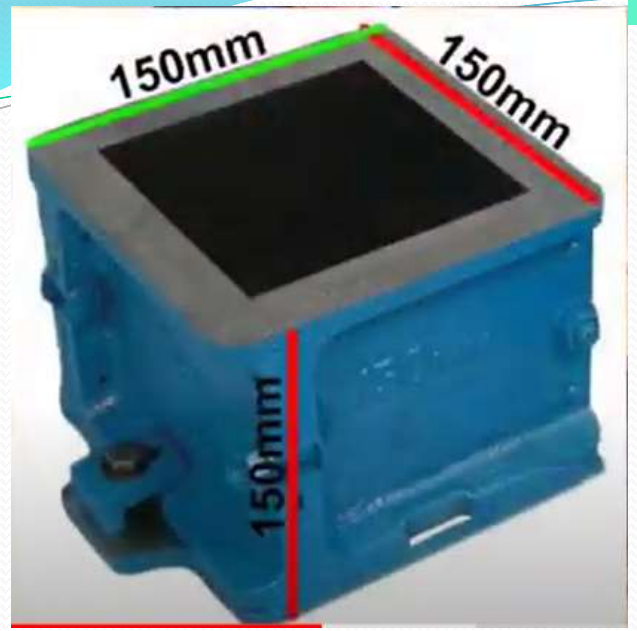
- Forms shall be removed only after the concrete has set for **at least 12 hours**.
- After removal, the ends shall be cleaned and honey–combed areas pointed with **1:2 cement-sand mortar**
- After which the sides of the slab shall be covered with earth to the level of the slab.

Honeycomb concrete

Opening to Traffic

- No commercial vehicles carrying construction materials shall be allowed for a period of **28 days**.

Cube Casting Procedure



A concrete cube must be filled in 3 layers. Each Un compacted layer of concrete must be filled about 25 mm more than the 1/3rd level, since concrete will settle after compacting.

Each layer must be compacted with the 600 mm long long rounded end of 16 mm Dia. Tamping bar, by roding 4times along each of the 4 side edge of the cube mould and 4 times from centre towards edge. This will ensure at least 32 times of minimum 35 strokes specified.

Curing of cubes

Cube Testing in CTM

Compressive Strength of cubes as per IS: 516

3 specimens of 150mm cubes from the same concrete are to be tested for compressive strength

Average value of 3 specimens represent a sample result. If the results of 3 specimens show more than 15% variation with average value, it be ignored

Compressive Strength- Acceptance Criteria(Cube Strength)- for PQC as per IRC:15-2017

Grade of Concrete	Minimum Average 28 days Compressive Strength (N/mm^2)	
	Mean of the Gr of 4 Non Consecutive sample (12 Nos) $f_{ck}+3N/mm^2$	Individual Cube test $f_{ck}-1N/mm^2$
M-30	33	29
M-35	38	34
M-40	43	39
M-50	53	49

Compressive Strength- Acceptance Criteria(Core Strength)- for PQC as per IRC:SP:62-2014/MORD

Grade of Concrete	28 days core strength (N/mm^2)- Min- 3 cores	
	Average core strength : 85% of cube strength in N/mm2	Individual core strength: 75% of cube strength in N/mm2
M-30 (Rural Roads)	25.5	22.5

References:

1) IRC:SP:76-2015:Guidelines for Conventional and Thin White topping.

THANK YOU