A Technical Presentation

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Construction of Rigid Pavements for low volume roads as per IRC:SP:62-2004

egis International
Formerly Egis Bceom International

In Joint Venture

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consulting engineers pvt. ltd.

IRC: 58-2002, Guidelines for the design of Plain Jointed Rigid Pavements for Highways

IRC: 15-2002, Code of practice for Construction of Cement Concrete Roads

IRC: 44-2008, Guidelines for cement concrete mix design for pavements

IRC:SP 62 – 2004, Guidelines for desgn of CC roads for Rural Roads

Design Guidelines of IRC:58-2011 are applicable for roads having a daily commercial traffic (vehicles with laden weight more than 3t) over 450

Design guidelines contained in IRC:SP:62-2004 are applicable only for low volume rural roads. It is also applicable for conventional screed-compacted pavements and roller compacted concrete pavements.

Modulus of sub-grade reaction k corresponding to CBR

CBR Values %	2	3	4	5	7	10	15	20	50
K-Value $N/mm^2/mm \times 10^{-3}$	21	28	35	42	48	55	62	69	140

Effective k value may be taken as 20% more than sub-grade k value when sub base is provided.

Sub base for Rural Roads as per IRC:SP:62-2004

1) It provides a uniform and reasonably firm support

2) It prevents mud-pumping on sub-grade of clays and silts

3) It acts as a levelling course on distorted, no-uniform and undulating sub-grade

4) It acts as a capillary cut-off

Thickness of sub-base

1)For a designed wheel load of 51 kN, 150mm thick WBM or GSB may be provided

2) For a designed wheel load of 30 kN, 75mm thick WBM or GSB may be provided.

Note: When the above type of sub-base is provided, effective k value may be taken as 20% more than k value of the sub-grade.

A plastic sheet of 125 micron thick shall be provided over the sub-base to act as a separation layer between the sub-base and concrete slab.

Recommended Temperature Differentials for Concrete Slabs as per IRC: SP:62-2004

Zone	Stages	Temperature Differential, ºC in Slabs of Thickness			
		15 cm	20 cm	25 cm	30 cm
1	Punjab, U.P. Rajasthan, Haryana and North M.P. excluding hilly regions and coastal areas	12.5	13.1	14.3	15.8
2	Bihar, West Bengal Assam and Eastern Orrisa excluding hilly regions and coastal areas	15.6	16.4	16.6	16.8
3	Maharashtra, Karnataka, South M.P., Andhra Pradesh, Western Orissa and North Tamil Nadu excluding hilly regions and coastal areas	17.3	19.0	20.3	21.0
4	Kerala and South Tamil Nadu excluding hilly regions and coastal areas	15.0	16.4	17.6	18.1
5	Coastal areas bounded by hills	14.6	15.8	16.2	17.0
6	Coastal areas unbounded by hills	15.5	17.0	19.0	19.2

TYPES OF JOINTS

a) CONTRACTION JOINTS

b) LONGITUDINAL JOINTS

c) EXPANSION JOINTS

d) CONSTRUCTION JOINTS

FORMATION OF JOINTS

- Use of Preformed strips for forming joints
- Metal T
- Crack inducers
- Sawn joints

a) CONTRACTION JOINTS:

These are purposely made weakened planes which relieve the tensile stresses in the concrete caused due to changes in the moisture content (Drying shrinkage) and/or temperature and prevent the formation of irregular cracks due to restraint in free contraction of concrete.

They are also provided to

1) Relieve stresses due to warping.

2) To permit the contraction of the slab

Details of the contraction joints are given in IRC:SP 62. They are formed initially by sawing a groove of 3-5 mm with up to about one-fourth to one-third the slab thicknesses. This facilitates the formation of a natural crack at this location extending to the full depth. In order to seal the joint, the top 10-20 mm of this groove is widened to 6-10 mm.

Spacing of contraction joints may be kept at 2.50m to 3.75m. Length of panel shall not be more than width of panel.

b) LONGITUDINAL JOINTS:

Lanes are jointed together by joint known as Longitudinal joint

Longitudinal joints are provided in multilane pavements and also when the pavement is more than 4.5 m wide.

They are provided normally at 3.5m c/c to

1) **Relieve stresses due to warping.**
2) **To allow differential shrinkage & swelling due to changes of sub grade moisture**
3) **To prevent longitudinal cracking**

Initially joint is cut to a depth 1/3rd slab thick ± 5mm. Tie bars are provided at the joints not for load transference but for keeping the adjoining slabs together. The details of such joints are given in IRC:SP 62. The top 15-20 mm of the joint is sawn to a width of 6-8 mm for sealing .

c) Expansion joints

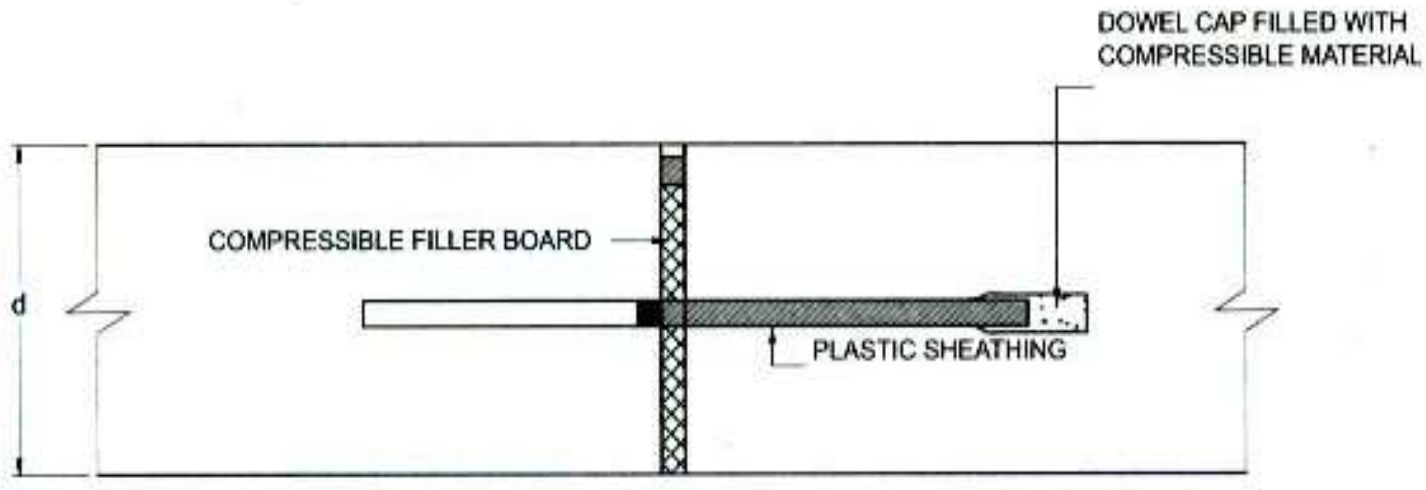
There are full-depth joints provided transversely into which pavement can expand, thus relieving compressive stresses due to expansion of concrete slabs, and preventing any tendency towards distortion, buckling, blow-up and spalling. The current practice is to provide these joints only when concrete slab abuts with bridge or culvert.

- They allow expansion of slabs due to temperature
- They permit contraction of slabs

Normal Details of these joints are given in IRC:SP62. They are about 20 mm in width and at a maximum spacing of 50m.

A joint filler board of compressible material conforming to IRC:SP:62 is used to fill the gap between the adjacent slabs at the joint. The height of the filler board is such that its top is 23-25mm below the surface of the pavement. The joint groove is filled by a sealant .

Expansion Joint
Dowels: 25mmdia., 500mm long and spaced at 250mmc/c



EXPANSION JOINT WITH DOWEL

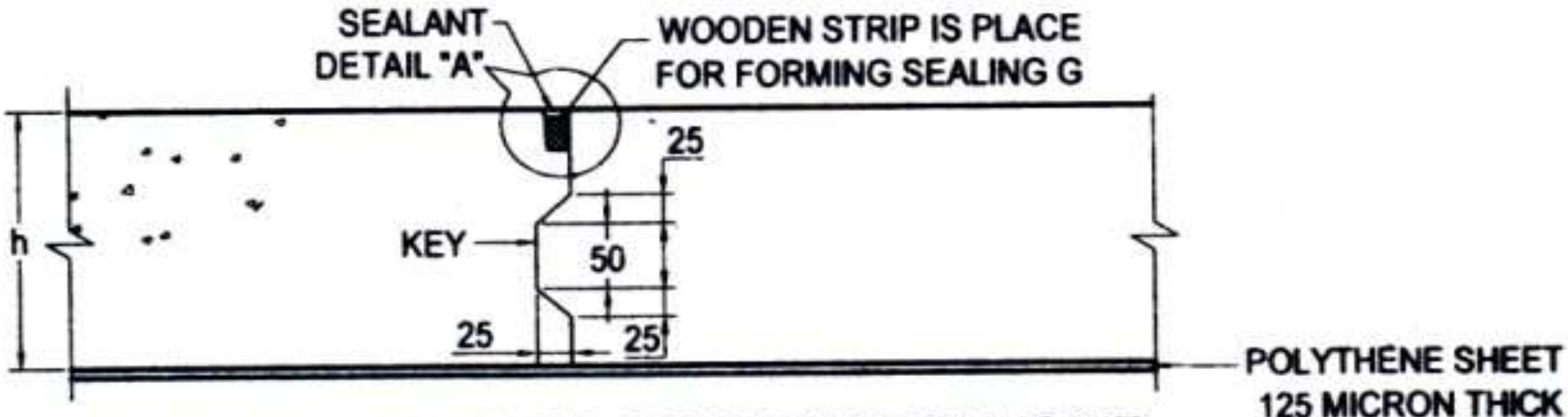
Filler board: compressible Joint filler 20mm ± 1.5mm
Filler depth 25mm ± 3mm lower than slab thickness
Dowel bars (MS rounds) to be covered with plastic sheathing for ½ length +50mm

d) Construction joints:

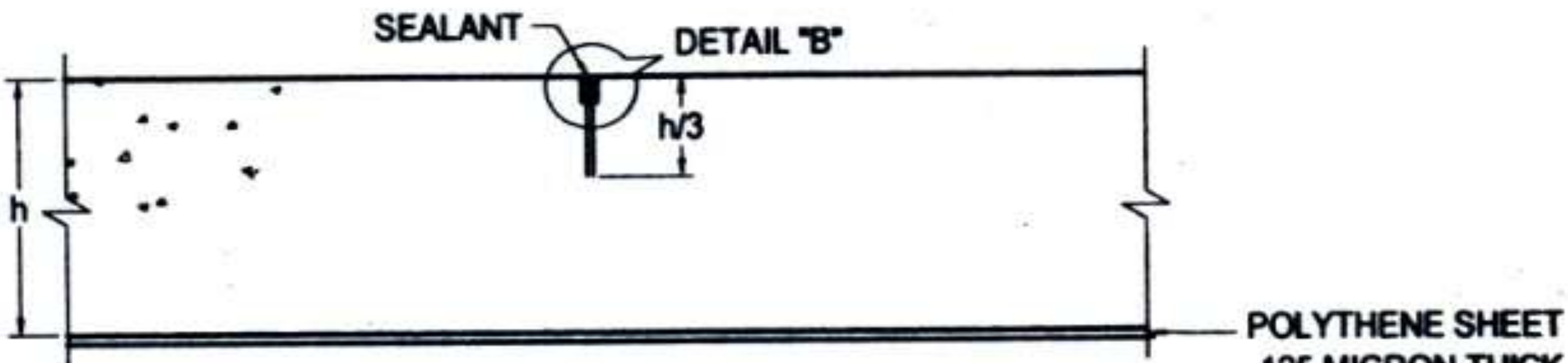
The need for such joint arises when construction work is required to be stopped at a place other than the location of contraction or an expansion joint, due to some breakdown of the machinery or any other reason. Such joints are of butt type and extend to the full depth of the pavement. The sealing of such joints shall be done in the same manner as for contraction joints, by cutting a groove 10-12 mm wide and 20-25 mm deep. Generally, such joints are avoided in highways. The work is normally terminated at a contraction or expansion joint.

Mild steel dowell rods with sheathing and caps. Groove cutting in progress

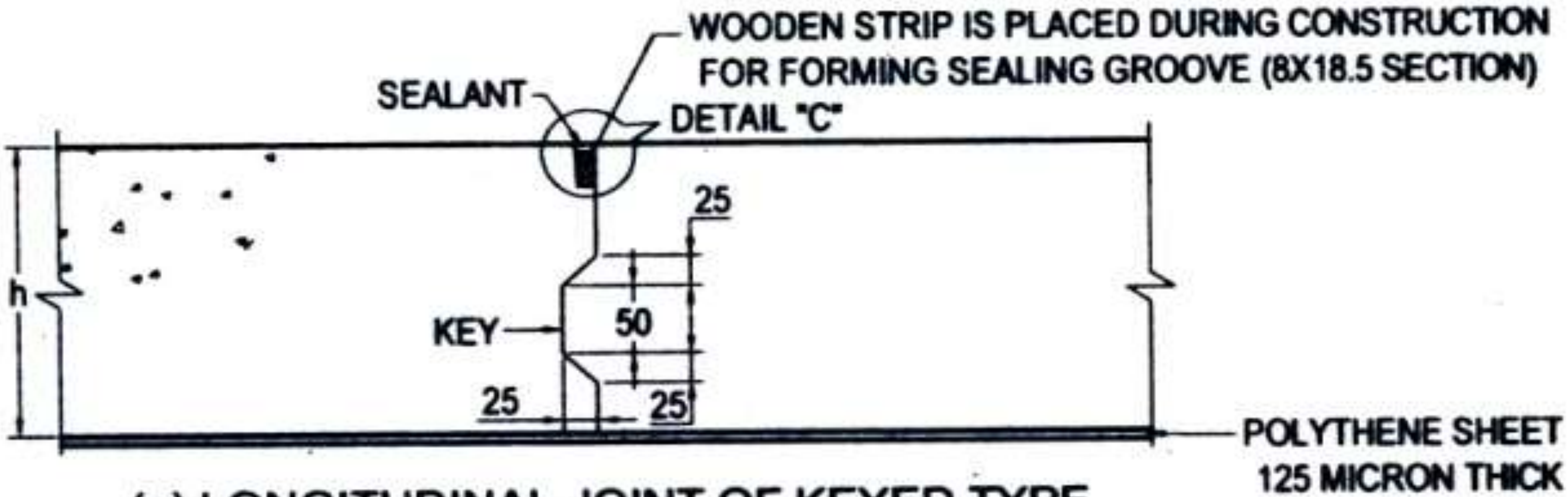
Shuttering sheets for MS dowels just removed



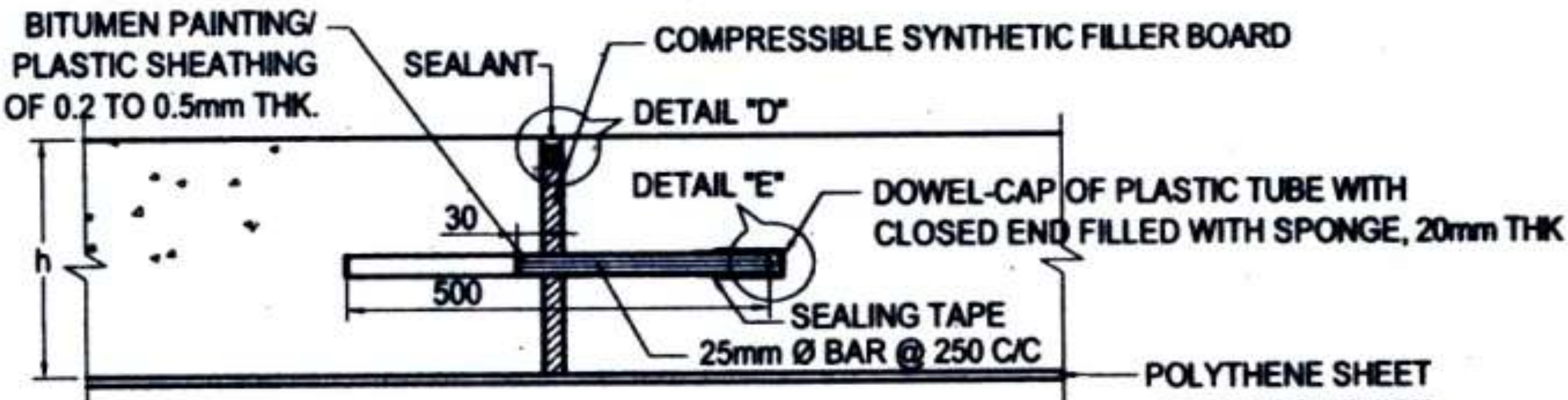
(a) DETAILS OF KEYED CONSTRUCTION JOINT
(WHEN ALTERNATE SLABS ARE CONSTRUCTED)
(FOR SLABS THICKER THAN 200mm)



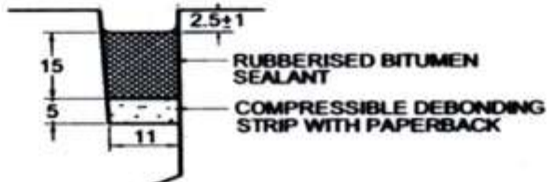
(b) DETAILS OF SAWN OR FORMED CONTRACTION JOINT
(WHEN SLABS ARE CAST CONTINUOUSLY)



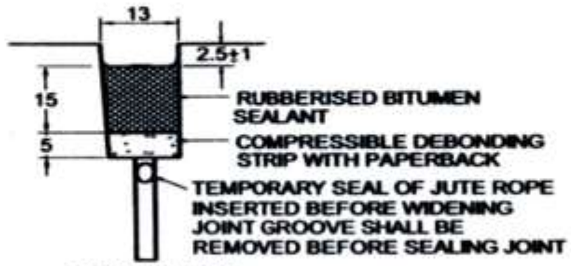
(c) LONGITUDINAL JOINT OF KEYED TYPE
(WHEN SLAB WIDTH EXCEEDS 4.5m, A LONGITUDINAL JOINT IS PROVIDED)
(FOR SLABS THICKER THAN 200mm)



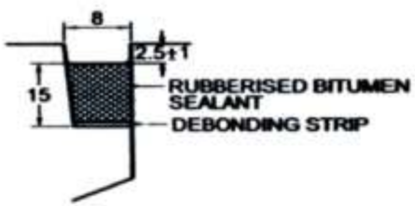
(d) EXPANSION JOINT



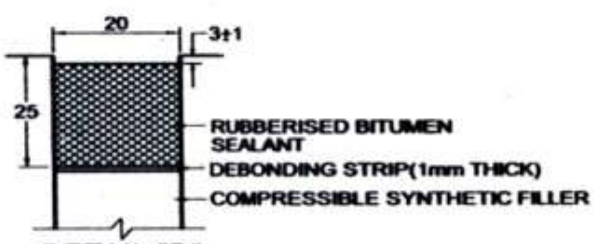
DETAIL "A"
SEALING DETAILS OF CONSTRUCTION JOINT



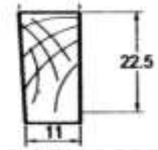
DETAIL "B"
SEALING DETAILS OF CONTRACTION JOINT FORMED BY SAWING



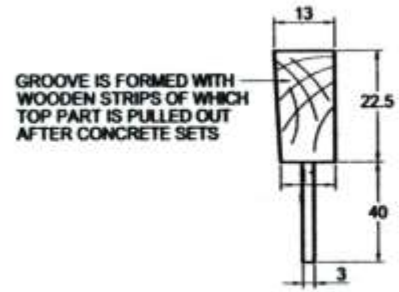
DETAILS "C"
SEALING DETAILS OF LONGITUDINAL JOINT



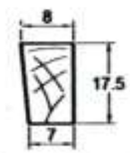
DETAIL "D"
SEALING DETAILS OF EXPANSION JOINT



DETAILS OF WOODEN STRIP, 22.5 X 13 SECTION

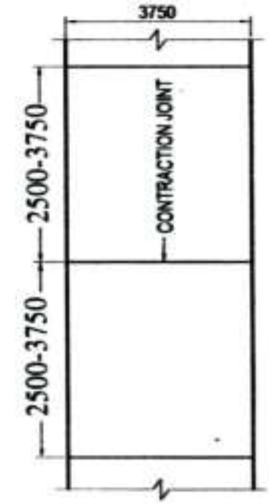


DETAILS OF WOODEN STRIP NEEDED FOR FORMING CONTRACTION JOINT GROOVE

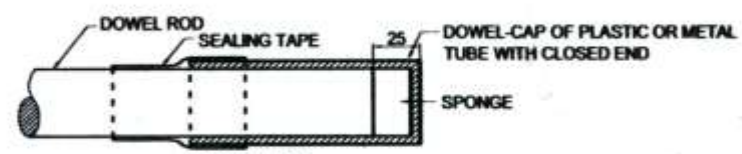


DETAILS OF WOODEN STRIP
(8 X18.5 SECTION)

WOODEN STRIPS USED IN FORMING JOINTS

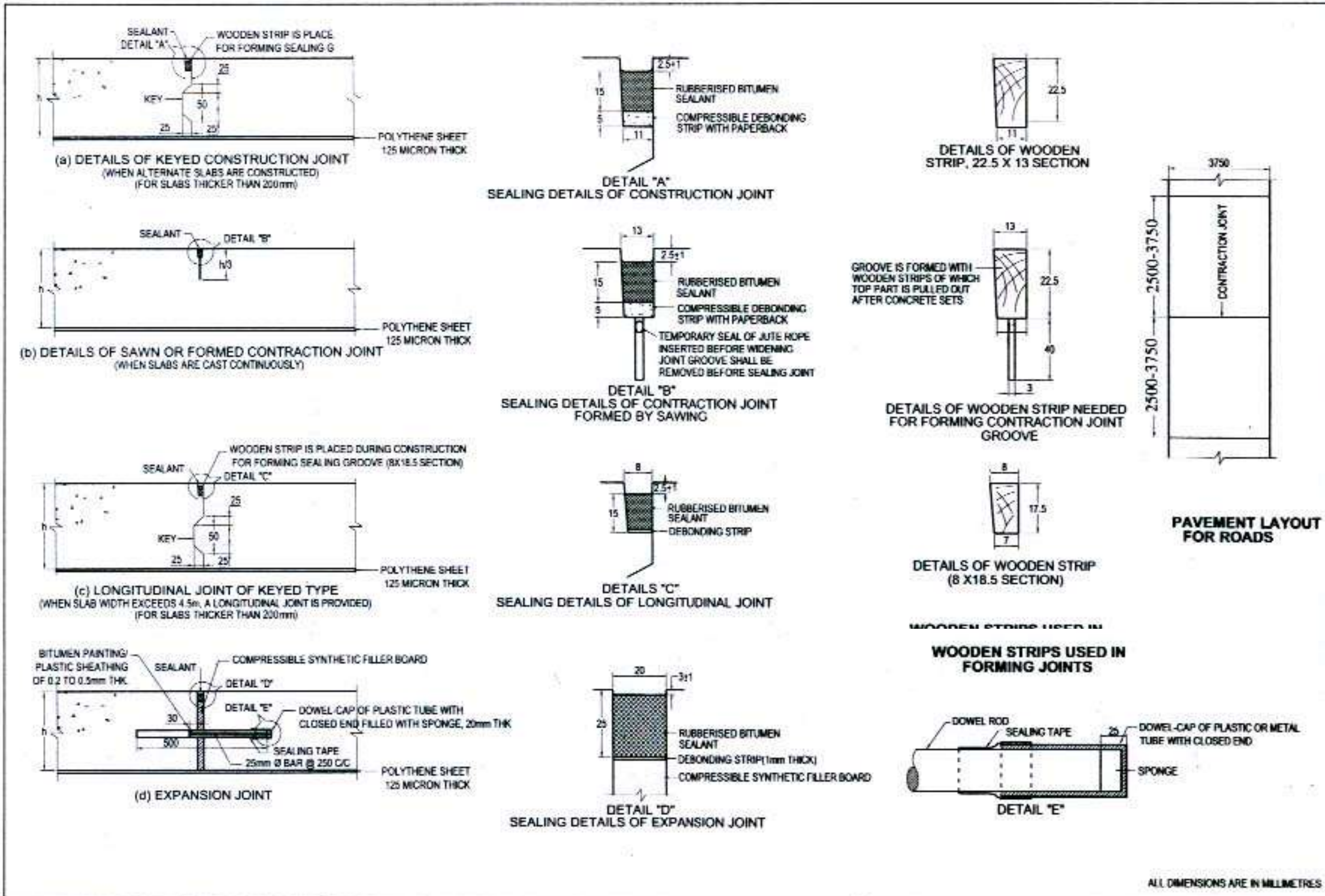


PAVEMENT LAYOUT FOR ROADS



DETAIL "E"

ALL DIMENSIONS ARE IN MILLIMETRES



Details of joints in cement concrete pavement for rural roads
As per IRC:SP:62-2004

TABLE 5 : CONCRETE PAVEMENT THICKNESS FOR RURAL ROADS as per IRC:SP 62-2004

Concrete grade	Pavement Thickness(mm)					
	Low Traffic (Wheel Load-30 kN)			Heavy Traffic (Wheel Load-51kN)		
	Zone-I	Zone-II, IV,V,VI	Zone-III	Zone-I	Zone-II, IV,V,VI	Zone-III
	Temperature Differential °C					
	≤ 15°	15.1° to 17°	17. 1° to 20°	<15°	15.1° to 17°	17. 1° to 20°
30	150	160	170	190	190	200
35	150	150	160	180	180	190
40	150	150	150	170	180	180

Note: 1) maximum temperature is considered in the computation.
2) design thickness values are based on the 90-day strength.
CBR =4%, E=3.0X10^4 MPa, μ (Poisson's ratio)=0.15,
Tyre Pressure=0.50MPa(For wheel load 30kN), 0.7MPa (for wheel load 51 kN),
Configuration of slab=3.75m x 3.75m

Cements that can be used as per IRC: 44-2008

Any of the following types of cements capable of achieving the design strength and durability may be used with the prior approval of the Engineer.

1. **Ordinary Portland Cement, 33 grade, IS: 269**
2. **Ordinary Portland Cement, 43 grade, IS: 8112**
3. **Ordinary Portland Cement, 53 grade, IS: 12269**
4. **Portland Pozzalona Cement (fly ash based, IS: 1489, part1**
5. **Portland Slag Cement, IS: 455**

Physical characteristic requirement of cement

Characteristic	Requirements		
	33 grade IS: 269-1989	43 grade IS: 8112-1989	53 grade Is: 12269-1987
Minimum compressive strength in N/mm^2			
3 days	16	23	27
7 days	22	33	37
28 days	33	43	53
Fineness (minimum) (M^2/Kg)	225	225	225
Setting time (minutes)			
Initial – (minimum)	30	30	30
Final – (maximum)	600	600	600
Soundness, expansion			
Le Chatleier– (maximum) mm	10	10	10
Autoclave test–(maximum) %	0.80	0.80	0.80

MORD Table 1500.1: Combined Gradation of Coarse and fine aggregates for CC roads

IS Sieve Size	Percent by Weight Passing the Sieve
26.5mm	100
19 mm	80-100
9.5 mm	55-80
4.75 mm	35-60
0.600mm	10-35
0.075mm	0-8

WET AIV ≤ 30%

Maximum size is 25mm. Water Absorption ≤ 5%. If it exceeds 3%, soundness test as per IS:2386 part V shall be done. Loss shall not be more than 12% in Sodium Sulphate solution and 18% in Magnesium sulphate solution.

FIV ≤ 35%

Requirements of fine Aggregate as per Table 1000-2 of MORT&H or table 4 of IS: 383

IS Sieve Designation	Percent passing for		
	Grading Zone-I	Grading Zone-II	Grading Zone-III
10mm	100	100	100
4.75mm	90 – 100	90 – 100	90 – 100
2.36mm	60 – 95	75 – 100	85 – 100
1.18mm	30 – 70	55 – 90	75 – 100
600microns	15 – 34	35 – 59	60 – 79
300microns	5 – 20	8 – 30	12 – 40
150microns	0 – 10	0 – 10	0 – 10

Cay lumps ≤ 4%

coal and lignit ≤ 1%

Material passing 75micron IS sieve

≤4% for natural sand.

It shall not be more than 15% in case of crushed sand.

Water for mixing and curing

Potable water is generally considered satisfactory for both mixing and curing. Ph value shall not be less than 6

Permissible limits for solids in Water Cl. 5.4 of IS: 456-2000		
	Tested as per	Permissible limt maximum
Organic	IS 3025 part 18	200 mg/l
Inorganic	IS 3025 part 18	3000 mg/l
Sulphate as SO_3	IS 3025 part 24	400 mg/l
Chloride as cl	IS 3025 part 32	2000 mg/l for PCC 500 mg/l for RCC
Suspended matter	IS 3025 part 18	2000 mg/l

Fly ash can be as a partial replacement of cement (OPC) up to an extent of 35%.

Fly ash for blending shall satisfy the following properties conforming to IS:3812-2004

1	Specific surface area	Greater than 3,20,000 mm^2/gm
2	Lime reactivity	Greater than $4.5 N/mm^2$
3	Loss on ignition	Maximum 5%

Advantages in adding Fly Ash

a) Increases CSH volume
b) Denser CSH formed by secondary reaction
c) Better Pore structure and composition
d) Low heat of hydration
e) Resistance to adverse exposure conditions

Reaction when Fly Ash is added:

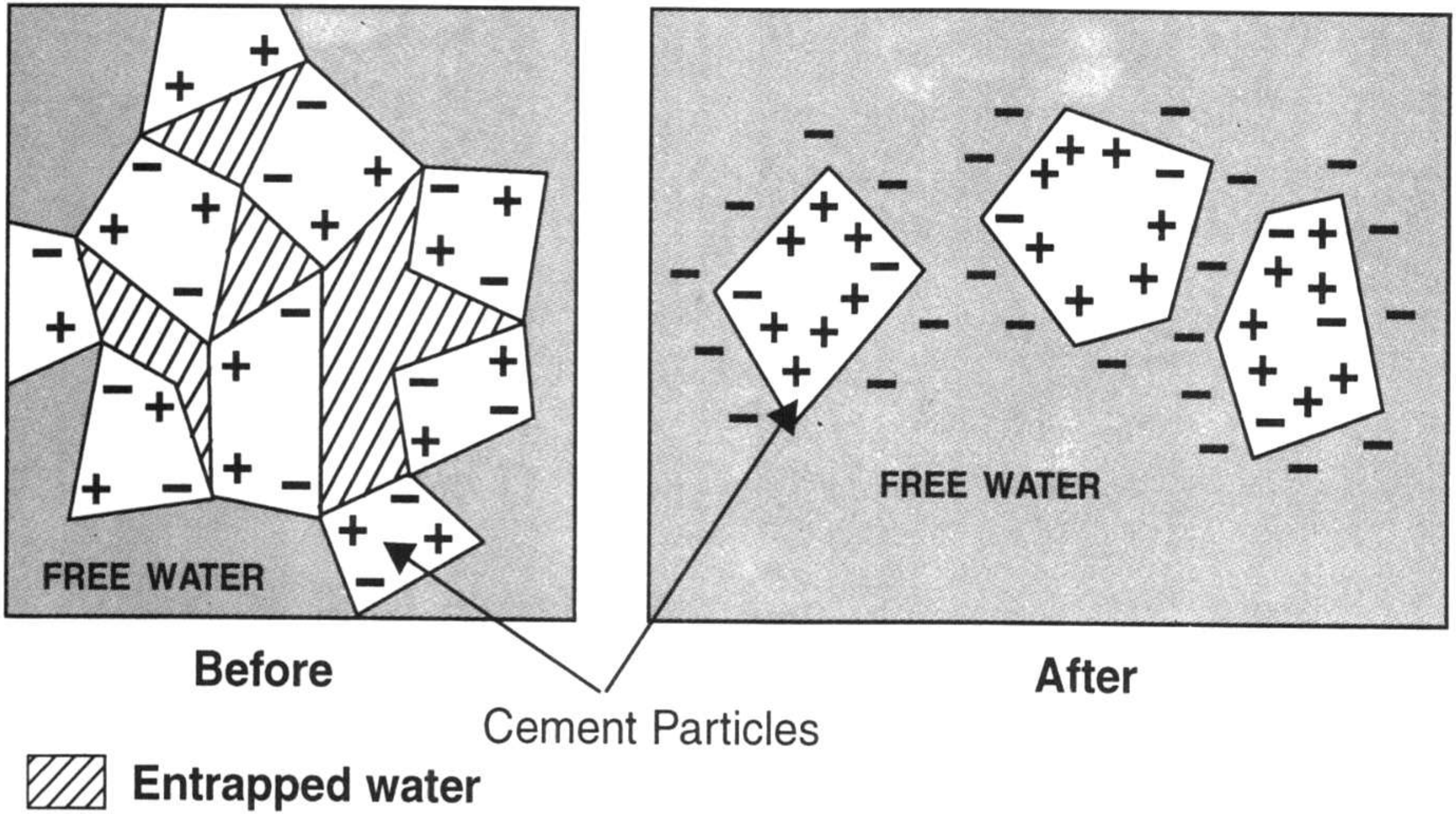
CS + H → CSH + CaOH

CaOH + Fly Ash → CSH (cementing gel)

Function of Plasticizers

(Admixtures conforming to IS:6925 and IS:9103 may be used upto 2% by weight as per IS:456)

Fine cement particles being very small clump together and flocculate when water is added to concrete. This ionic attraction between the particles trap considerable volume of water and hence water required for workability of concrete mix is not fully utilised. Negative charges are induced on the fine cement particles causing flocks to disperse and release the entrapped water. Water reducing admixtures or plasticizers therefore help to increase the flow of the concrete mix considerably.



Dispersion of entrapped air with the addition of plasticizer

Chemical Admixtures - Plasticizers

Plasticizers are also called water reducing admixtures. Ordinary water reducing plasticizers which enable up to 15% of water reduction. High range water reducing super plasticizers which enable up to 30% of water reduction. Air entraining admixtures are useful in freeze – thaw conditions.

The plasticizers are generally used to achieve the following:

In fresh concrete: 1) Increase workability and / or pump ability without increasing the water/cement ratio. 2) Improve cohesiveness and thereby reducing segregation or bleeding 3) Improve to some extent set retardation

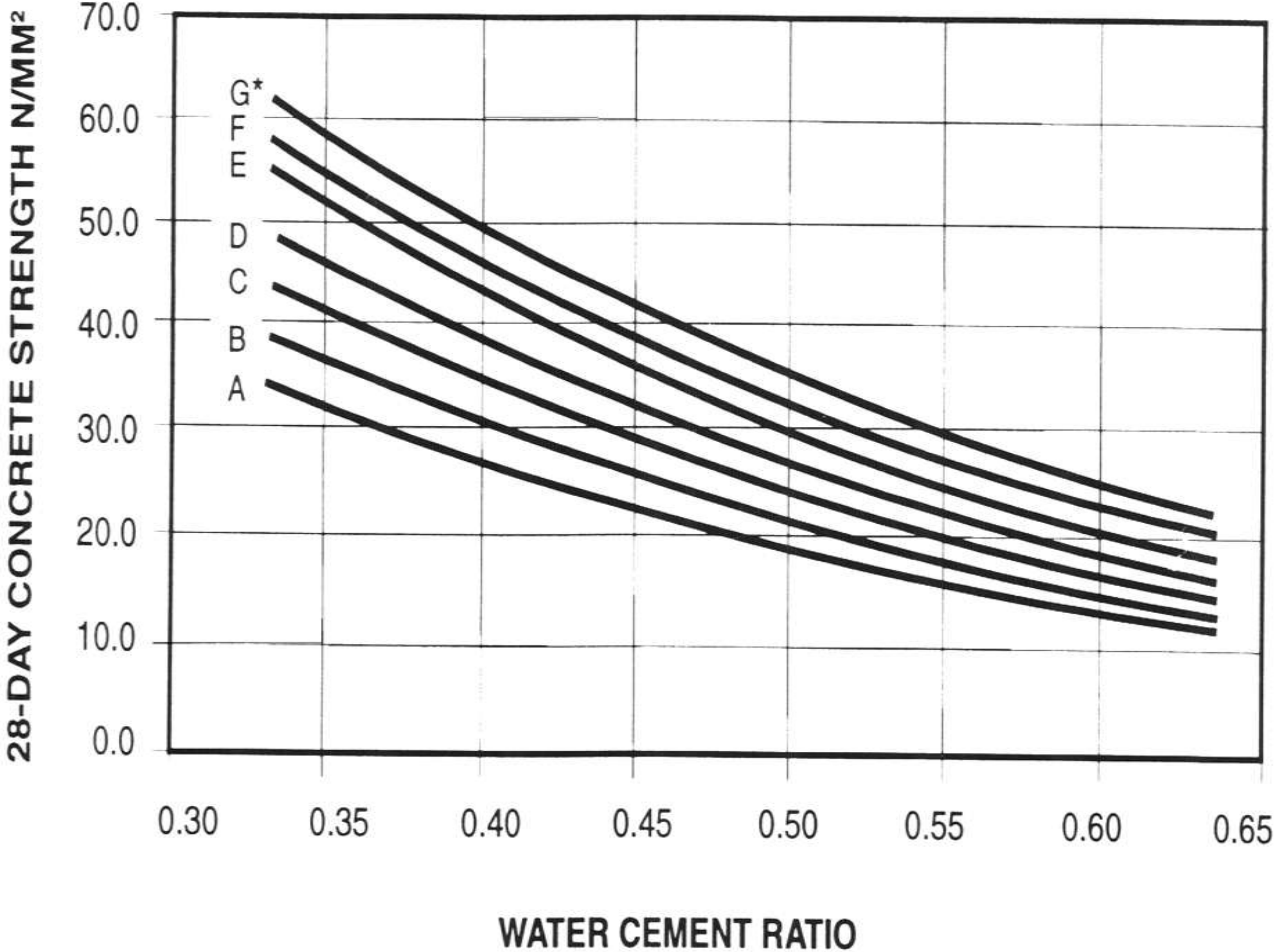
In Hardened concrete: 1) Increase strength by reducing the water/cement ratio, maintaining same workability. 2) Reduce permeability and improve durability by reducing water/cement ratio. 3) Reduce heat of hydration and drying shrinkage by reducing cement content

Increase in Slump by adding plasticizer without changing cement content, water cement ratio					
Concrete Mix	Cement Content (Kg/M^3)	W/C	Slump (mm)	Strength (Kg/cm^2) at	
				7 days	28 days
Reference mix without Plasticizer	440	0.37	25	390	540
Mix with Plasticizer	440	0.37	100	411	541

Increase in Compressive strength by reducing W/C ratio without increasing cement content					
Concrete Mix	Cement Content (Kg/M^3)	W/C	Slump (mm)	Strength (Kg/cm^2) at	
				7 days	28 days
Reference mix without Plasticizer	315	0.60	95	218	291
Mix with Plasticizer	315	0.53	90	285	375

Similar Compressive Strength achieved with reduced cement content

Concrete Mix	Cement Content (Kg/M^3)	W/C	Slump (mm)	Strength (Kg/cm^2) at	
				7 days	28 days
Reference mix without Plasticizer	460	0.43	100	320	420
Mix with Plasticizer	395	0.43	100	336	435


28-DAY CONCRETE STRENGTH N/MM²
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
G*
F
E
D
C
B
A
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
WATER CEMENT RATIO

Coefficient of Permeability for different W/C ratios

S.No	W/C ratio	Coefficient of Permeability
1	0.35	1.05×10^{-3}
2	0.50	10.30×10^{-3}
3	0.65	1000×10^{-3}

Mix Design for Roller compacted concrete pavement

Mix design is based on flexural strength and the mosture content about 4 to 7%. OMC that gives maximum density shall be established. Exact water content may be established after field trial condition.

Using the OMC, 6 beams and cubes shall be cast for testing on the 7th and 28th days. If required flexural strength is not achieved trials should be repeated after increasing the cement /fly ash content till the desired strength is achieved.

Mix Design for concrete compacted by vibratory screeds, needle vibrators, hand tampers and plate compactors

Mix design shall be done based on the basis of any recognised procedure, such as IRC:44. A slump of 25mm to 45mm is acceptable.

The laboratory trial mixes shall be tried out in the field and any adjustments that are needed are carried out during trial length constructions.

Placing of concrete

Concrete shall be deposited on the sub base to the required depth and width in successive batches and in continuous operation. Care shall be taken to see that no segregation takes place. Spreading shall be as uniform as possible and shall be accompanied by shovels. While being placed, the concrete shall be rodded with suitable tools so that formation of voids or honeycomb pockets are avoided.

Compaction of Concrete

Compaction is necessary to remove entrapped air present in concrete after it is mixed, transported and placed. Compaction also eliminates stone pockets and remove all types of voids. Consolidation is the process of making the freshly placed PCC into a more uniform and compact mass by eliminating undesirable air voids and causing it to move around potential obstructions (such as reinforcing steel).

Vibrators work by rotating an eccentric weight which causes the entire vibrator to move back and forth. This movement excites particles within the PCC mass, causing them to move closer together and better flow around obstructions.On vibration, concrete mix gets fluidized resulting in entrapped air raising to the surface and concrete becoming denser

Compaction

Spreading, compacting and finishing of the concrete shall be carried out shall not exceed 90 minutes when concrete temperature is from 25ºC to 30ºC. It shall not exceed 2 hours when concrete temperature is less than 25ºC. Work shall not proceed when concrete temperature exceeds 30ºC or when the ambient temperature is more than 35ºC.

For RCCP, number of passes required sall be assessed in trial stretch construction. First and last passes of rolling shall be without vibration. Use of plate vibrator may be resorted near joints, kerbs, channels, side forms, around gullies and manholes. 95% relative compaction shall be achieved when compared with trial construction.

Compaction by screed vibrators

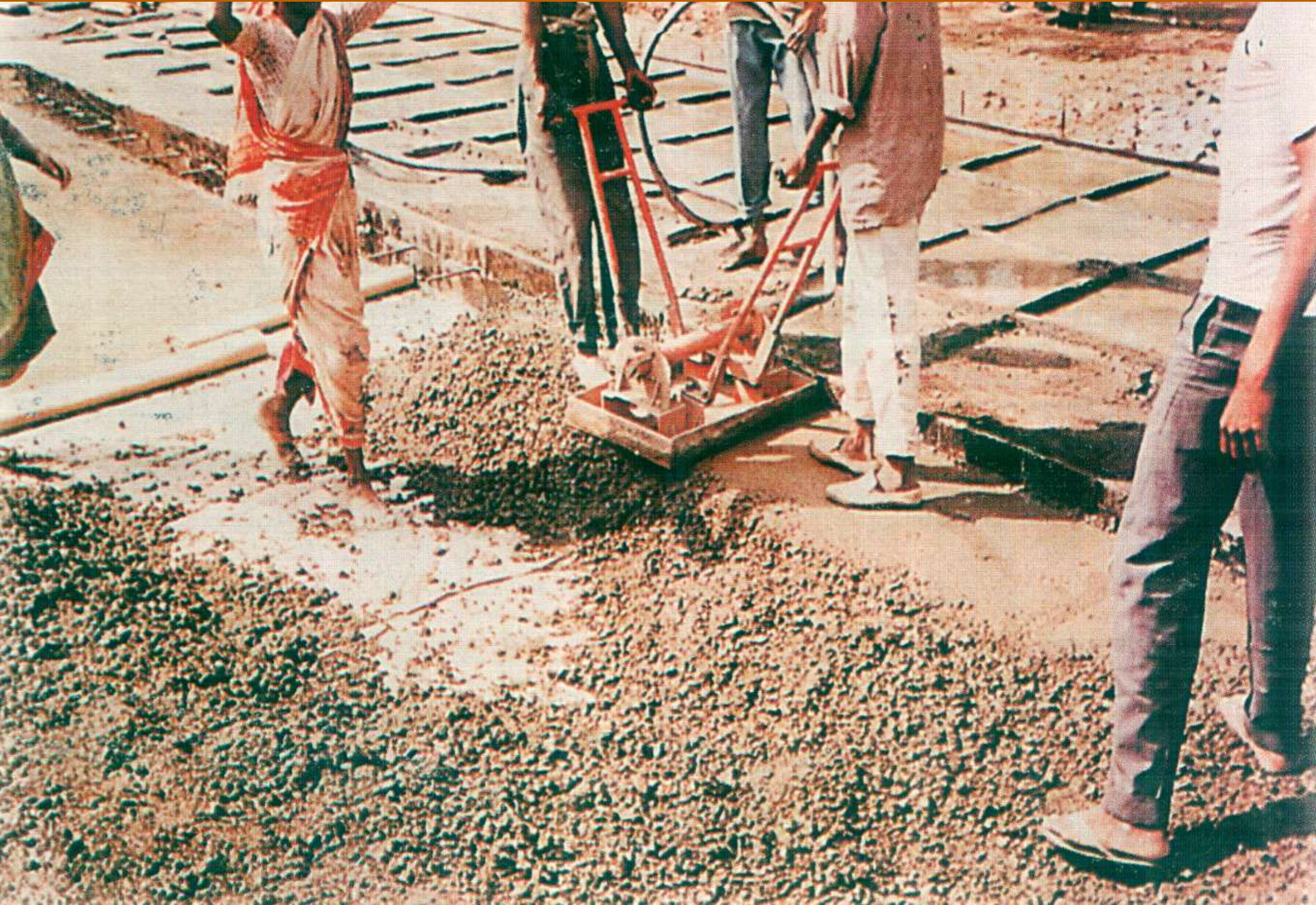
Compaction shall by a vibrating hand screed. As soon as concrete is placed, it shall be struck off uniformly and screeded to the desired cross-section. Needle vibrators may be employed near the farms etc., The entire surface shall then be vibrated with screed resting on the side forms and being drawn ahead with sawing motion, in combination with a series of lifts and drops alternating with lateral shifts. The surface shall be inspected for any irregularities with a profile checking template and any needed correction made by adding or removing concrete, followed by further compaction.

Finishing

In case of normal concrete just before concrete becomes non-plastic, the surface shall be belted transversely in quick strokes with a two-ply canvas belt not less than 200mm wide and atleast 1m longer than the width of the slab.

After belting, the pavement shall be given a broom finsh with an approved clean steal or fiber broom not less than 450mm wide. The broom shall be pulledgently over the surface from edge to edge and the adjacent strokes shall be slightly overlapped. Brooming shall be done transversely and corrugations formed not more than 1.5mm. After belting and brooming completed, but before the initial set of concrete, the edges shall be carefully finished.

Concrete comaction using plate vibrator



Mohammadalipalem road in Guntur District

Mohammadalipalem road in Guntur District. Key wall shuttering

Mohammadalipalem road in Guntur District.
Plate vibratory compaction.

Mohammadalipalem road in Guntur Distric
Dowel bars and 125 micron seperation membrane are seen.

Mohammadalipalem road in Guntur District

Mohammadalipalem road in Guntur District

Mohammadalipalem road in Guntur District

Mohammadalipalem road in Guntur District

Mohammadalipalem road in Guntur District

Mohammadalipalem road in Guntur District

Hanumantnagar road in Bapatla mandal in Guntur District. CC road under finishing

Hanumantnagar road in Bapatla mandal in Guntur District.

Hanumantnagar road in Bapatla mandal in Guntur District. CC road thickness being verified.

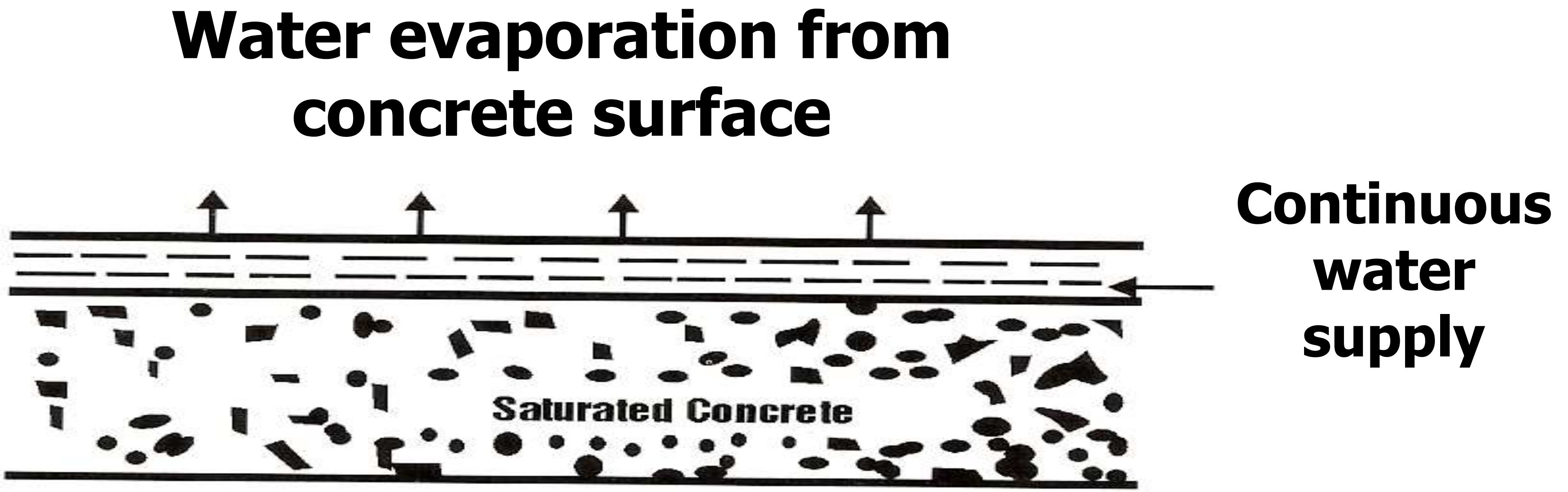
TPQA inspection of R&B road to Mohammadalipalem road in Guntur District 0n 22-11-2011. Verifying outside measurements.

TPQA inspection of R&B road to Mohammadalipalem road in Guntur District 0n 22-11-2011. Concrete strength testing by rebound hammer which gives an approximate indication

TPQA inspection of R&B road to Mohammadalipalem road in Guntur District 0n 22-11-2011. Cube testing in the laboratory.

Concrete Curing

Curing is the process of maintaining a satisfactory moisture content and favourable temperature in the concrete during hydration of cementetious material so that the desired properties of the concrete are developed. Its objective is specifically to keep the concrete saturated until the water filled spaces in the fresh cement paste are filled to the desired extent by products of the hydration.



Factors Affecting Water Evaporation from Concrete Surface

- Air Temperature
- Fresh Concrete Temperature
- Relative Humidity
- Wind Velocity

Methods of Curing

- ❖Ponding with water
- ❖Covering concrete with wet burlaps which are maintained close to the concrete surface
- ❖Intermittent spraying with water and continuous sprinkling of water
- ❖Covering concrete with wet sand, saw dust etc.,
- ❖Covering with polyethylene sheets or water proof paper and holding it in position
- ❖Curing with liquid membrane forming curing compounds

Effects of Improper Curing

- Lowering of compressive and flexural strengths
- Sanding and dusting of surface and lower abrasion resistance
- Higher permeability and lower durability
- Cracks due to plastic shrinkage, drying shrinkage and thermal cracking
- Increased rate of Carbonation and chloride ingress
- Lower weathering and frost resistance

Curing

Initial curing shall be done by curing compound followed by covering with wetted burlap or jute mats. They shall be placed from suitable bridges without having to walk on the fresh concrete. After the initial curing, final curing shall be done by ponding or continuing with wetted burlap. It shall be done for 14 days.

Forms shall be removed after the concrete has set for at least 12 hours. After the removal of forms, the ends shall be cleaned and any honey-combed areas pointed wit 1:2 cement sand mortar and sides are covered with earth.

No traffic shall be allowed before 90days.

CURING OF DLC – Wax Based Curing Compound

Moist curing after concrete hardens

In this photo, the burlap and plastic sheeting have been applied. For most applications of concrete, wet curing will provide better in-place concrete quality than the use of curing compound alone.

Watering the concrete

Curing by Ponding

Surface due to ineffective curing before ponding

Groove cutting machine

Contraction joint 3 to 5 mm wide
1/3 to 1/4 in depth

JOINT FILLER

- Joint spaces are first filled with compressible filler materials and top of the joints are sealed using sealer
- Joint filler should possess following properties
  - Compressibility
  - Elasticity
  - Durability

DURAboardHD100

[Formerly SILFLEX/ CAPCELL HD100]

A pre-moulded, compressible filler board, with high performance closed-cell joint filler material. Suitable for use as expansion joint filler in concrete, brick, block work and isolation joints, where readily compressible, low load transfer joint filler is required.

Features

• Closed cell & prevents from water leakage • Thermally stable (from -40°C to +70°C) • Resilient • Non-deteriorating • Bitumen free • Environment friendly and easy to handle • Rot proof & bacteria resistant

DURAboardHD100 used in expansion joints in roads

DURAboardHD100 used in expansion joints in columns

Other products from the DURA range:

DURAmembrane: A high performance waterprofing membrane used in basements and roofs.

DURArods [Formerly SILSEAL]: A closed cell polymer based product with a circular profile which helps to maintain desired thickness of sealant at the joint's centre.

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Email: dura@supreme.co.in • **Website:** www.supreme.co.in

TYPES OF SEALANTS

- Hot poured rubberised asphalts (Thermoplastic type)
- Cold applied poly sulphide sealants
- Cold silicone Sealants

Cleaning of Longitudinal Joint

Fixing of Back up Rod after Initial Cut

Widened Groove after 14 days

Cleaning of Groove with Compressed Air

Finished PQC surface with Sealed Joints

Mohammadalipalem road in Guntur District. Joint cutting

Mohammadalipalem road in Guntur District. Joint cutting

Mohammadalipalem road in Guntur District.

Causes of cracking in concrete roads

1) Plastic shrinkage of concrete surface due to rapid loss of moisture

2) Drying shrinkage

3) High wind velocity associated with low humidity

4) High ambient temperature

5) Delayed sawing of joints

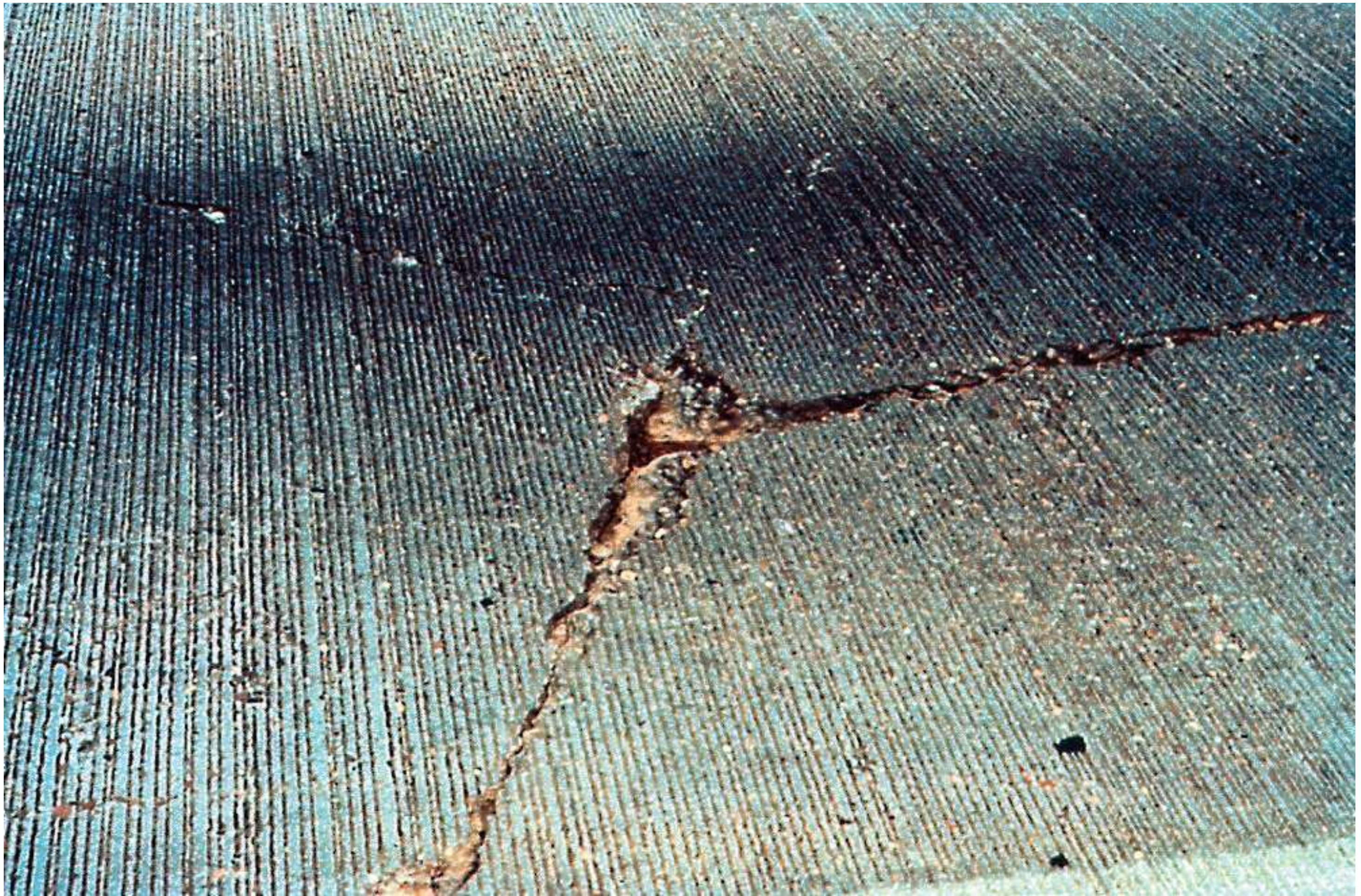
Transverse cracking is a common type of structural distress in concrete pavements, but not all transverse cracks (also called mid-panel cracks) are indicative of structural failure. Moreover, many transverse cracks may have little or no impact on long-term performance.

Transverse cracking can be due to a number of factors, including excessive early-age loading, poor joint load transfer, inadequate or non uniform base support, excessive slab curling and warping, insufficient slab thickness, inadequate sawing, and materials deficiencies.

Longitudinal cracking may or may not be considered a structural distress, depending on whether the crack remains tight and nonworking. Figure shows a longitudinal crack typical of poor support conditions. Note that the crack has significant separation and shows differential vertical movement, which indicates a structural distress. Longitudinal cracking is generally associated with poor or non uniform support conditions related to frost heave, moisture-induced shrinkage/swelling in the sub grade, or poor soil compaction.

Longitudinal cracking may also result from inadequate placement of longitudinal joints, over-reinforcing of longitudinal joints, or too-shallow joint saw cuts.

Shattered slabs are divided into three or more pieces by intersecting cracks. These working cracks allow for differential settlement of the slab sections at a rapid rate. This type of distress can be attributed to numerous factors, the most important being too-heavy loads, inadequate slab thickness, and poor support.



Damaged Edges due to early initial cut

Crack development at the location Contraction Joint

Corner cracks or corner breaks caused by structural failure under loads, particularly when a pavement has aged and repeated loadings create voids under slab corners. Factors that contribute to corner cracks include excessive corner deflections from heavy loads, inadequate load transfer across the joint, poor support conditions, curling, insufficient slab thickness, inadequate curing, and/or inadequate concrete strength.

It is critical that uniform support be provided to prevent excessive stresses resulting from varying support conditions. In addition, the slab is best able to distribute wheel loads at the centre of the slab, rather than at the edges; therefore, longitudinal joints in the wheel track should be avoided. Corner breaks are not common when realistic traffic projections are used in the design and where effective, uniform base support and joint load transfer exist.

Why are Controlled Cracks at contraction Joints Preferable to Random Cracks?

1) Properly constructed contraction joints have many benefits.

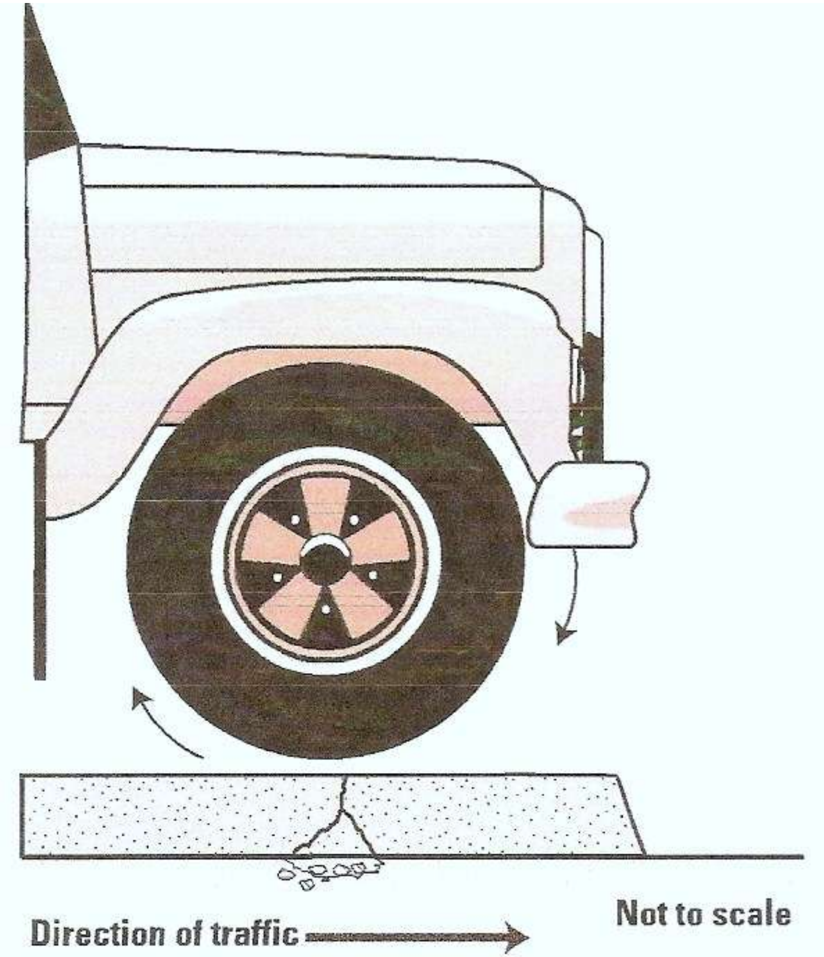
2) Joints can be sealed more efficiently to limit infiltration of harmful materials.

3) Joints prevent the slab from randomly cracking into small, weak pieces.

4) Joints can be constructed with dowel bars and tie bars to prevent slab deflection at the joints and to allow proper transfer of vehicle loads between pavement sections (panels).

5)Joints help designate lanes.

6) Joints generally provide a smoother ride than random cracks

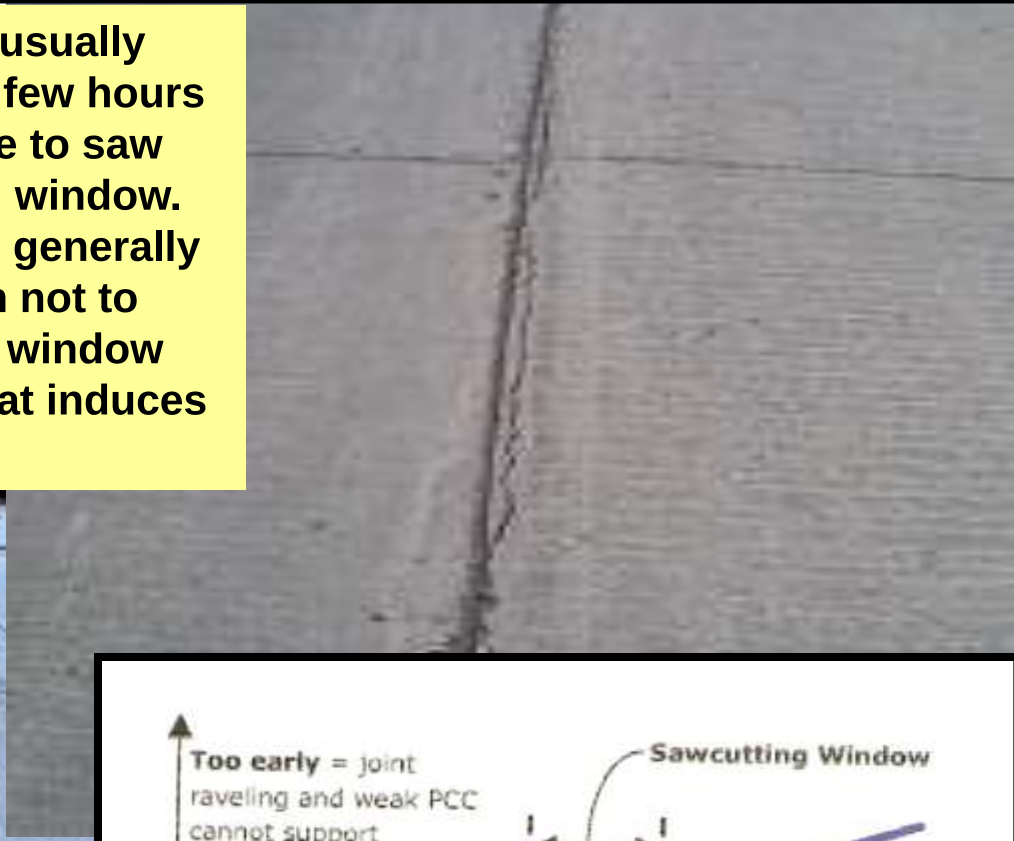


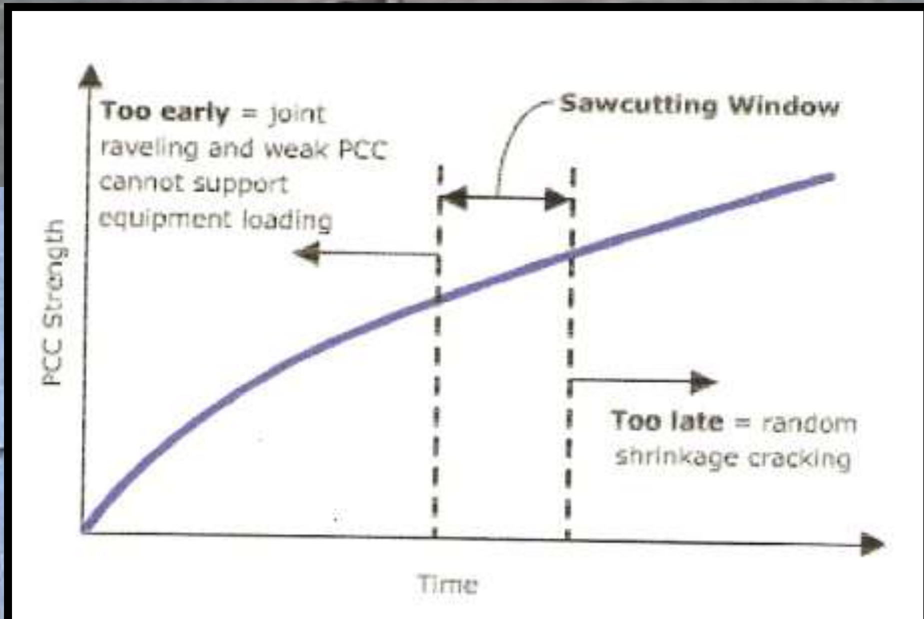
An eroded base can lead to high tensile stresses, resulting in cracking

A saw cut that has cracked through as planned

Shrinkage cracking probably due to late sawing (left) Joint raveling due to early sawing (right)

Timing the Sawing Window: **Joints are usually constructed by saw-cutting the concrete a few hours after placing. The optimum period of time to saw contraction joints is known as the sawing window. The sawing window for conventional saws generally begins when concrete is strong enough not to ravel excessively along the saw cut. The window ends when significant shrinkage occurs that induces uncontrolled cracking**





Crack caused by late joint sawing

Settlement Cracks

Settlement of the sub grade and sub-base can cause the cracking of the concrete pavement. Cracks resulting from settlement of sub-grade are normally variable in direction but most commonly they appear diagonally and extend continuously to many slabs. Repeated heavy truck loads may further cause breaking of slabs into several pieces due to loss of support beneath the slab.

Cracks Over Slab &Box Culverts

If concrete pavement slabs are constructed over an underlying slab or box culvert and the transverse joint locations do not match with the boundary of underlying slab of the culvert, then it is most likely that full depth transverse cracks will develop in the concrete pavement slabs just above the extreme boundaries of culvert slab on both sides . Many such instances have been observed in recently completed concrete pavements in the country. Occurrence of such cracks in more prevalent where pavement quality concrete (PQC) and dry lean concrete (DLC) layers are laid directly over the culvert slab without any intermediate layer of granular sub-base.

If a granular layer is placed over culvert slab before laying PQC and DLC, then this layer acts as a crack arresting layer and possibility of developing transverse cracks in pavement slab is reduced if not eliminated completely.

Plastic Shrinkage Cracks

The weather almost always play an important role in the occurrence of uncontrolled cracking of concrete pavement. Air temperature, wind velocity, relative humidity and sunlight influence the hydration and shrinkage of concrete. These factors may heat or cool concrete or draw moisture from exposed concrete surface. Plastic shrinkage cracking is a result of rapid drying of concrete pavement surface due to either high ambient temperature, high wind velocity, low humidity or a combination of these factors. These cracks are generally tight and appear in the form of parallel groups perpendicular to the direction of the wind soon after the placement of concrete Adequate curing measures are necessary to prevent their occurrence

PQC concreting commenced over 125 micron thick plastic sheet as separation membrane

Preparation for slump test, casting cubes (150 mm) and beams(70 x 15 x 15 cm)

Quality Control

Surface regularity: Tolerance with 3m length straight edge shall not exceed 8mm.

At least 6 beam and cube specmens shall be sampled, onset of 3 cubes and beams each for 7-day and 28-day strength tests for every 100 cum of concrete or a day’s work.


Concrete Cores in CC roads:

Crushing strength of cylindrical specimens =0.8×crushing strength of cubes when the height to diameter ratio of core is 2.

Crushing strength of cylinders with height to diameter ratio between 1 and 2 may be multiplied by a correction factor $f = 0.11n+0.78$ where n is height to diameter ratio.

Number of cores = minimum 3

The concrete in the core test shall be considered acceptible if the average equivalent cube strength of the cores is at least 85% of the cube strength of the grade of concrete specified for the corresponding age and no individual core has a strength less than 75%

Acceptance Criteria for Cracked Concrete Slabs

Slabs with full depth cracks are totally unacceptable as it amounts to structural failures. Other cracks which are deep and are likely to progress in depth with time are also to be considered as serious in nature. Fine crazy cracks are not serious.

Slabs with cracks having depth more than half slab depth shall not be accepted.

Following type of cracked slabs are acceptable:

1) Length of single crack shall not be more than 750mm, eventhough its depth is less than half of slab depth.
2) Cumulative length of cracks with depth of crack less than half depth of slab in a panel not more than 1250mm

TPQA inspection of R&B road to Mohammadalipalem road in Guntur District 0n 11-02-2012. Core cutting to verify inner depth and compressive strength.

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TPQA inspection of R&B road to Mohammadalipalem road in Guntur District 0n 14-02-2012. Core testing for assessing compressive strength of M30 concrete.

TPQA inspection of R&B road to Mohammadalipalem road in Guntur District 0n 14-02-2012. Core testing for assessing compressive strength of M30 concrete.

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