IRC:57-2018

RECOMMENDED PRACTICE FOR SEALING OF JOINTS IN CONCRETE PAVEMENTS

(Second Revision)

INDIAN ROADS CONGRESS

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RECOMMENDED PRACTICE FOR SEALING OF JOINTS IN CONCRETE PAVEMENTS

1 INTRODUCTION

IRC:57, "Recommended Practice for Sealing of Joints in Concrete Pavements" was first published in the year 1974. It was revised in the year 2006. Due to considerable changes in the technology for road construction, a need was felt to further update this document and accordingly the task of revision of this document was assigned to Rigid Pavements Committee (H-3). The revised draft was prepared by the subgroup comprising Shri R.K. Jain, Col. (Retd.) V.K. Ganju, Shri M.C. Venkatesha and Shri Satander Kumar. Other than the H-3 Committee members, valuable inputs were received from the officers of S&R Zone of the Ministry. The draft was deliberated in several meetings of H-3 Committee and was finalized in its meeting held on 9th September, 2017. The revised draft was placed before the Highways Specifications and Standards Committee (HSS) in its meeting held on 24th October, 2017. The HSS Committee approved the draft subject to the consideration of the observations of members. The draft document after carrying out the modifications was considered and approved by the Executive Committee of IRC in its meeting held on 2nd November, 2017 for placing before the Council of IRC. The Council in its meeting held on 3rd November, 2017 at Bengaluru considered and approved the document for printing.

The composition of H-3 Committee is as given below:

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2 SCOPE

The document prescribes about the practices of forming joints in a concrete pavement and sealing them either using field-moulded sealants or pre-formed compression seals. The technique of resealing of failed old joints has also been given in the document.

3 GENERAL

3.1 Cement concrete pavements (roads, streets, airport apron, taxi-ways and runways, etc) are subjected to volumetric changes (expansion and contraction) caused by changes in their moisture content and/or temperature which leads to initial drying, shrinkage and irreversible creep. These changes cause movements of slabs. If contraction movements are excessively restrained, they will result in cracking of the pavement. On the other hand, the restraint of expansion movements may result in development of compressive stresses that are borne by abutting faces of the slab. Transverse joints are provided to accommodate these movements and thereby prevent development of distress in the pavement. Longitudinal joints are provided to relieve stresses due to wrapping and dividing the pavement into convenient lanes. Joints are also required to facilitate construction.

3.2 Details of different types of joints in concrete pavements are outlined in IRC:15, “Code of Practice for Construction of Jointed Plain Concrete Pavements”. The present standard is intended to augment the provisions contained in IRC:15.

3.3 The introduction of joints creates openings in the slab which must be sealed in order to prevent ingress of rain water to the sub-base/subgrade or other unwanted substances, like, grit into the openings. Foreign solid matter which is incompressible must be prevented from accumulating in the joints, otherwise the joints cannot close freely later. Should the joints get clogged with foreign solid matter, malfunctioning of the joints may occur and high stress may be generated in the slab leading to spalling of concrete and development of cracks. Sealing of these joints is done using either field-moulded sealants or preformed compression seal.

3.4 The performance and life of a sealing compound depend not only on the properties of the sealing compound and the mode of application but also on the design of the joints. The types of joints normally formed in concrete pavements are described below.

4 SHAPE OF THE JOINT SEALING GROOVE

Shape of field-moulded sealant is important as the sealant is subjected to compression and tension during expansion and contraction phases of concrete slab. The sealants which are solid at service temperatures are likely to change in their shape but their volume will remain same during opening off these sealants. The shape of the sealant is important as strains developed in them during expansion and contraction should not exceed the permissible limit. The stresses generated in sealants during expansion and contraction phases are shown in **Fig. 1**.

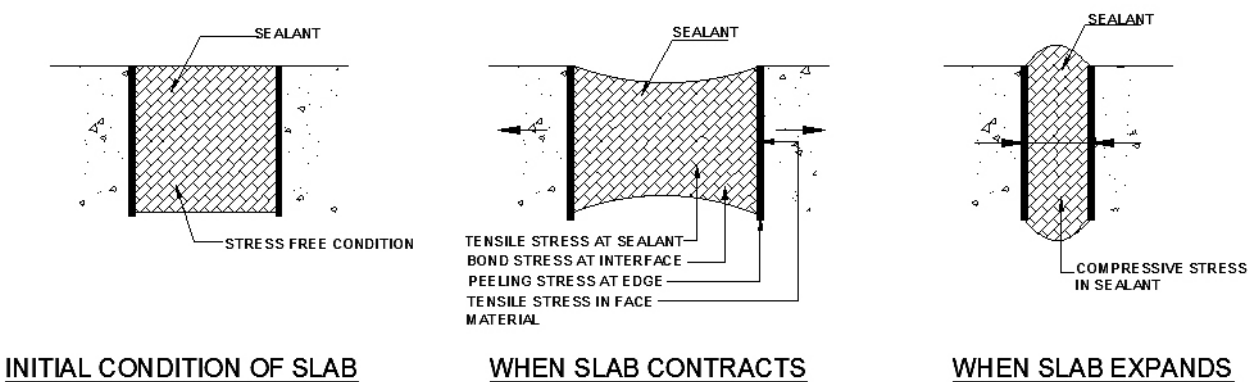


Fig. 1 Stresses Generated in Field-Moulded Sealants due to Temperature Changes

The shape of the joint groove intended as a reservoir of sealant largely depends upon the type of sealant used. Shape factor of a sealant is defined as:

$$\text{Shape Factor} = \frac{Depth\ of\ sealant}{Width\ of\ sealant}$$

Shape factors normally recommended for various sealants are as under:

Hot-poured sealant	:	1.0-1.25
Cold poured sealant like Polysulphide	:	1.0-1.25
Silicone	:	0.75
Shape factor for expansion joints can be	:	0.5

Although theoretically the above shape factors are desirable, some authorities feel that ratio of 3:2 is to be preferred. Therefore, a compromise has to be made in deciding the shape factor based on the field experience so that the stress produced within sealant body is within the allowable limit specified by the manufacturers.

5 TYPE OF JOINTS

5.1 In cement concrete pavements, the following types of joints are commonly provided:

(a) Contraction joints
(b) Expansion joints
(c) Construction joints
(d) Longitudinal joints

A typical pavement layout generally adopted in a two-lane road is shown in **Fig. 2**.

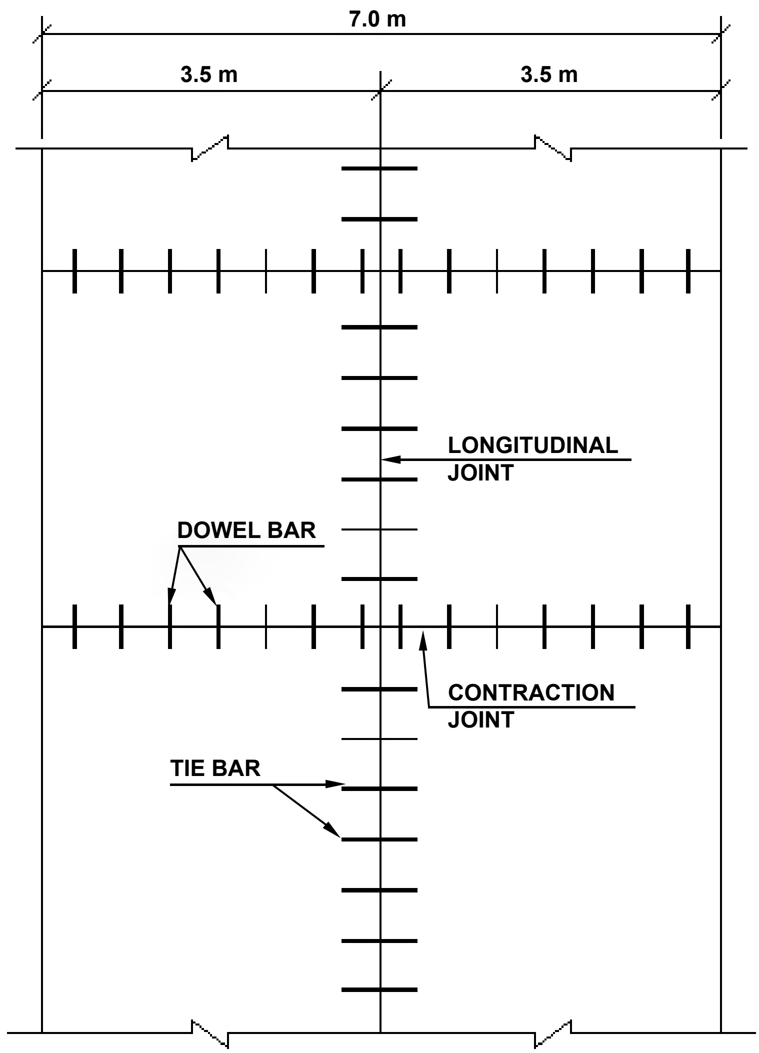


Fig. 2 Joint Configuration of Two Lane Road without Tied Shoulder

5.2 Contraction Joints

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

Details of the contraction joints are given in IRC:15. They are formed initially by sawing a groove of 3-5 mm width up to about one-fourth to one-third the slab thickness as shown in **Fig. 6**. 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 8-10 mm as shown in **Figs. 3, 4** and **5**. For heavy duty roads, these joints are provided with steel dowel bars to improve the continuity of slab and improved performance of joints, including load transfer. Typical cross-section of a contraction joint is given in **Fig. 6(a)**.

Note: Width of contraction joint play an important role to improve the riding quality. As good quality saw cutting machines are available, which can ensure very thin joint as low as 3 mm, low viscosity sealants with higher Movement Accommodation Factor (MAF), good pouring tools are also available and therefore contraction joints with sealing groove width of 6 mm resulting in lower maintenance cost and better riding quality are possible to be designed and constructed.

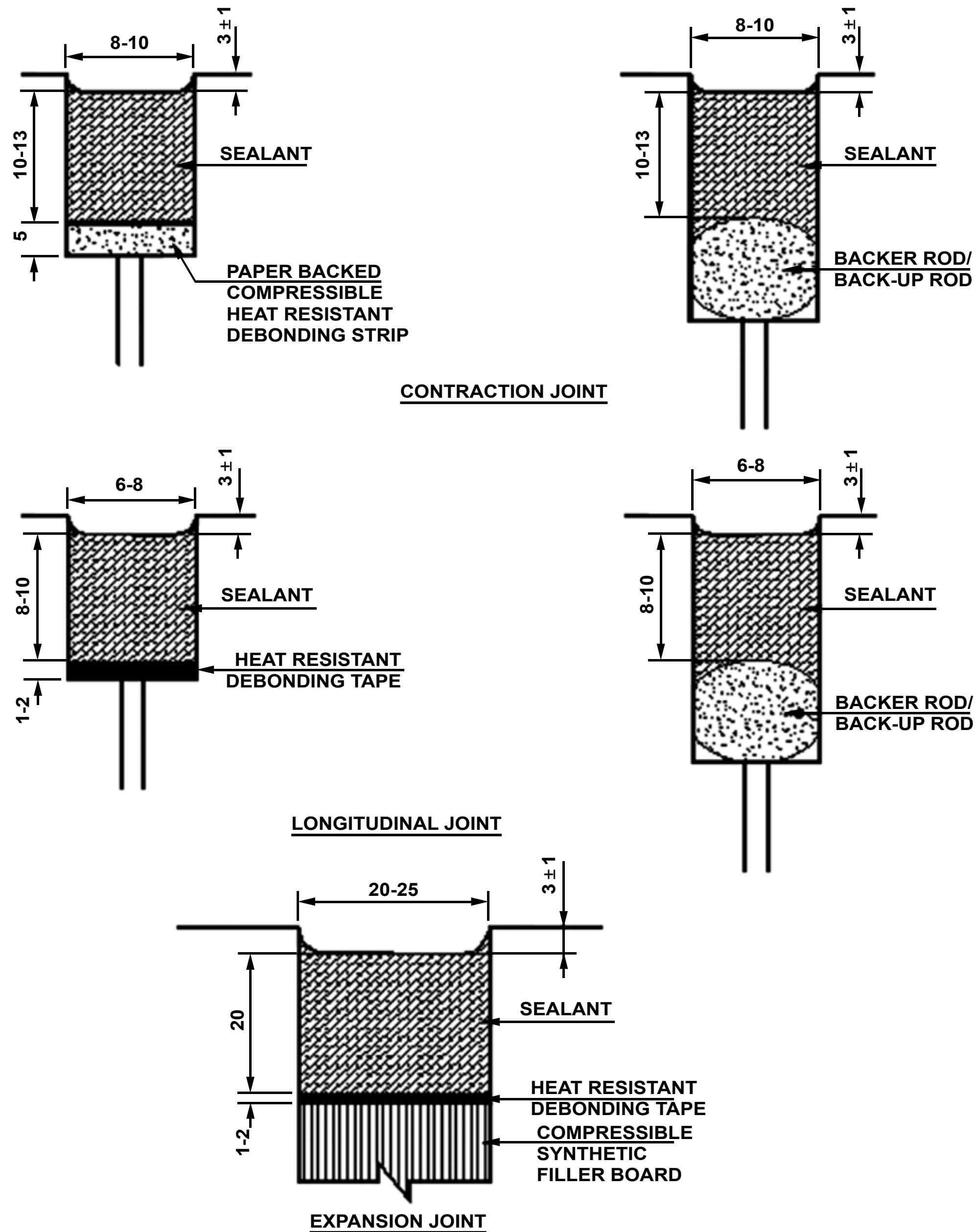
5.3 Longitudinal Joints

Longitudinal joints are provided in multi-lane pavements and also when the pavement is more than 4.0 m wide. They also relieve stresses due to wrapping. Initially joint is cut to a depth 1/4 to 1/3 of the slab. 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:15. The top 10-20 mm depth of the joint is sawn to a width of 6-8 mm for sealing. Typical cross-section of a joint is given in **Fig. 6(b)**.

5.4 Expansion Joints

These are full-depth butt 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. Details of these joints are given in IRC:15. They are about 20-25 mm in width.

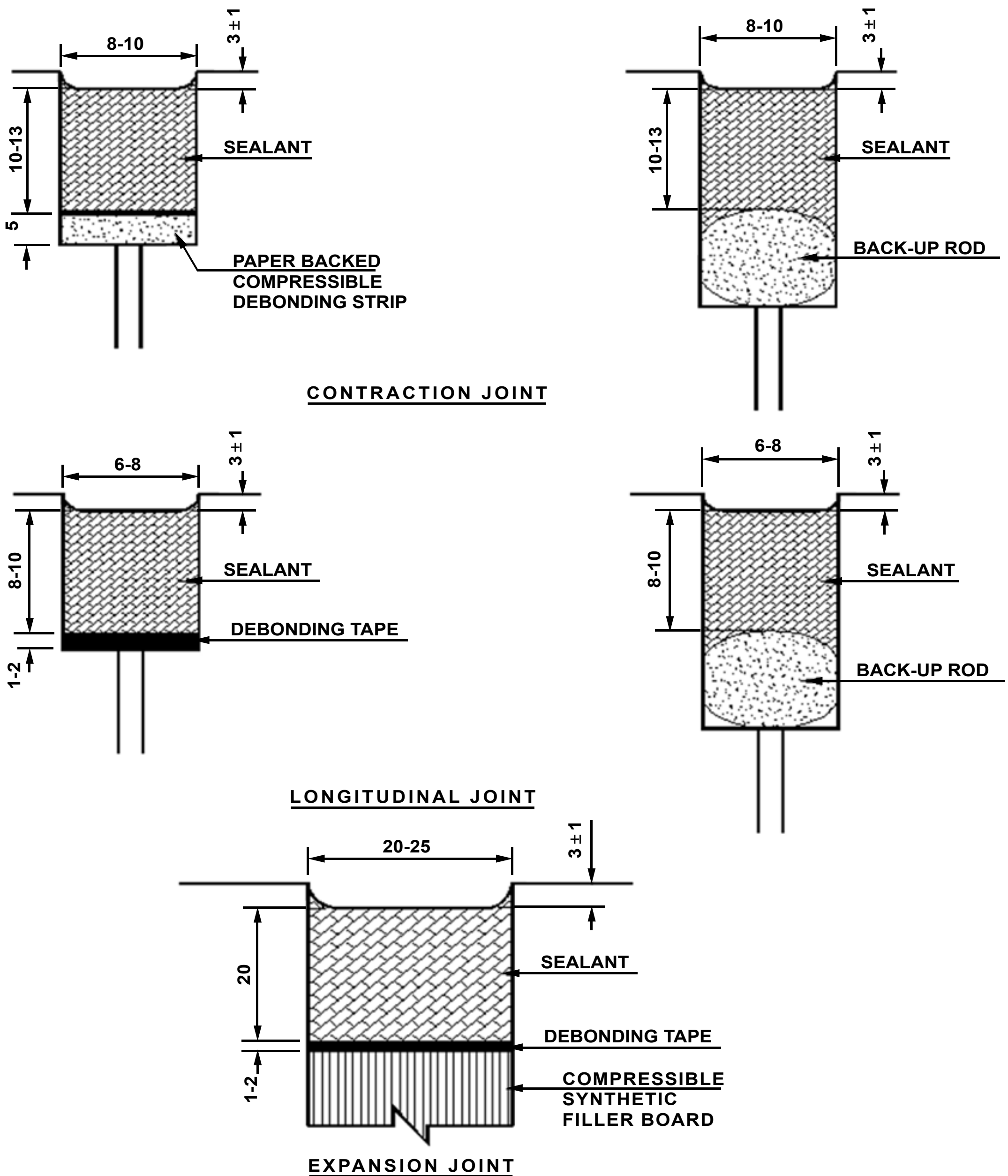
A joint filler board of compressible material conforming to IRC:15 is used to fill the gap between the adjacent slabs at the joint. The height of the filler board is such that its top is 23-25 mm below the surface of the pavement. The joint groove is filled by a sealant as shown in **Figs. 3, 4** and **5**. Typical cross-section of an expansion joint is given in **Fig. 6(c)**.



NOTES:

1. PAPER BACKING OF COMPRESSIBLE DEBONDING STRIP IS NOT NECESSARY IF THE STRIP IS NON-ABSORBENT TYPE.
2. JOINTS CAN BE SEALED BY ADOPTING ONE OF THE TWO OPTION OF DEBONDING STRIP/BACKER-ROD AS SHOWN.
3. DEPENDING UPON THE SEALANT MANUFACTURER'S RECOMMENDATION, THE SIDES OF THE GROOVE MAY HAVE TO BE SAND BLASTED/SAND PAPERED AND PRIMED.
4. THE GROOVE AND SEALANT DIMENSIONS SHOWN ARE ONLY FOR GUIDANCE.
5. BACKER ROD/BACK-UP ROD SHALL BE EXPANDED CLOSED-CELL POLYETHYLENE FORM.
6. ENDS OF THE SEALANT GROOVE SHALL BE PLUGGED BEFORE POURING SEALANT TO AVOID SPILLAGE LATERALLY.
7. ALL DIMENSIONS ARE IN mm.

Fig. 3 Sealing Details of Joints
(Grooves Suitable for Hot Poured Rubberised Bitumen Sealant)



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7. ALL DIMENSIONS ARE IN mm.

**Fig. 4 Sealing Details of Joints
(Grooves Suitable for Cold Polysulphide Sealant)**

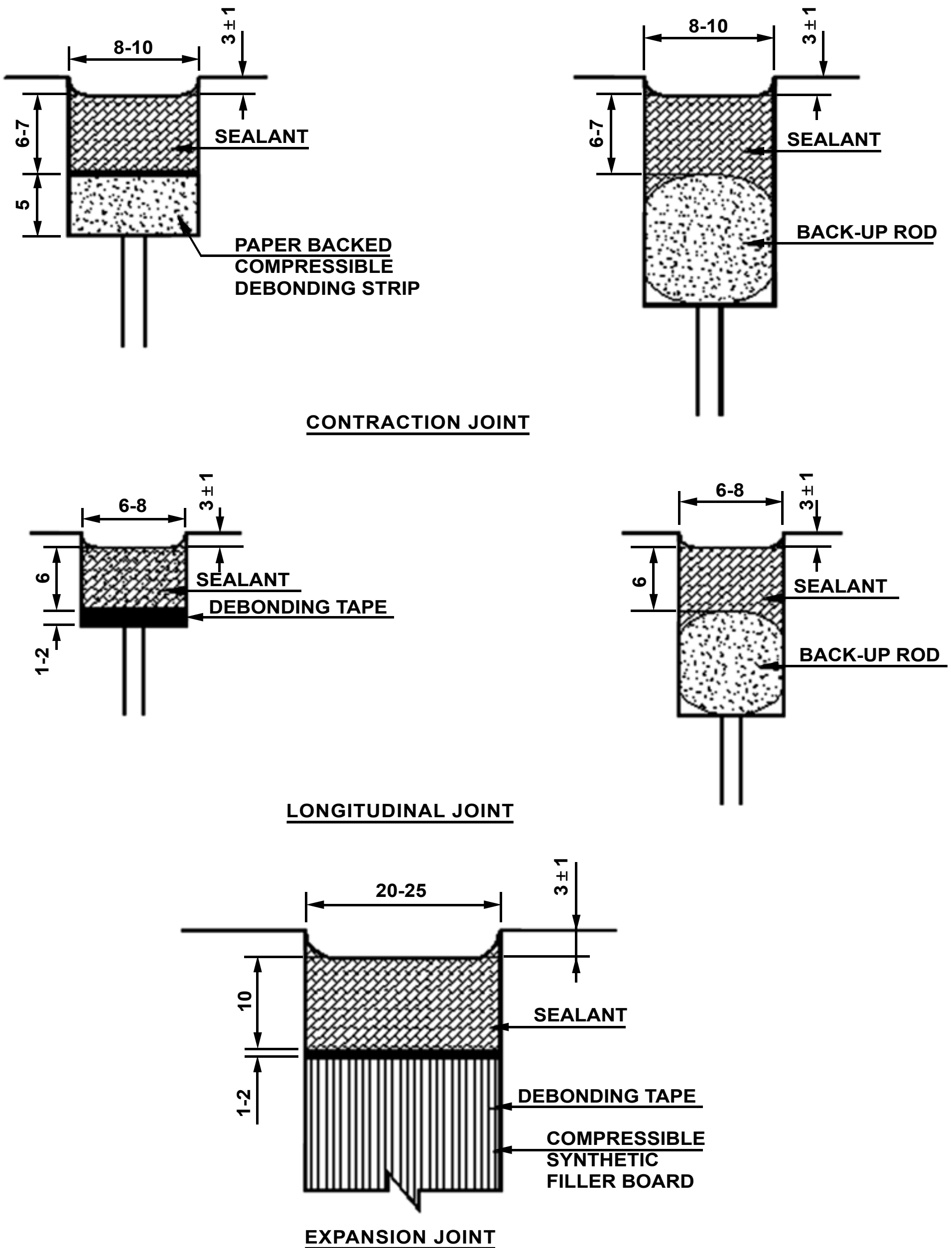

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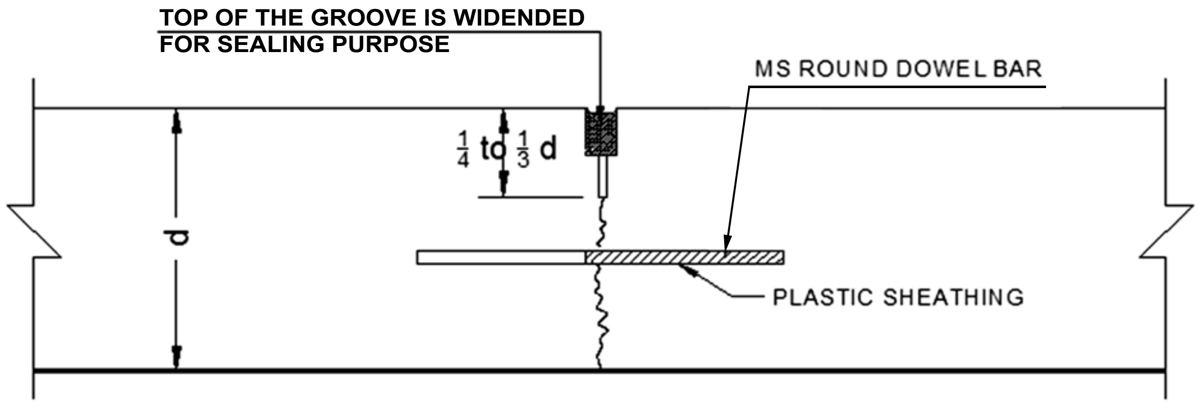
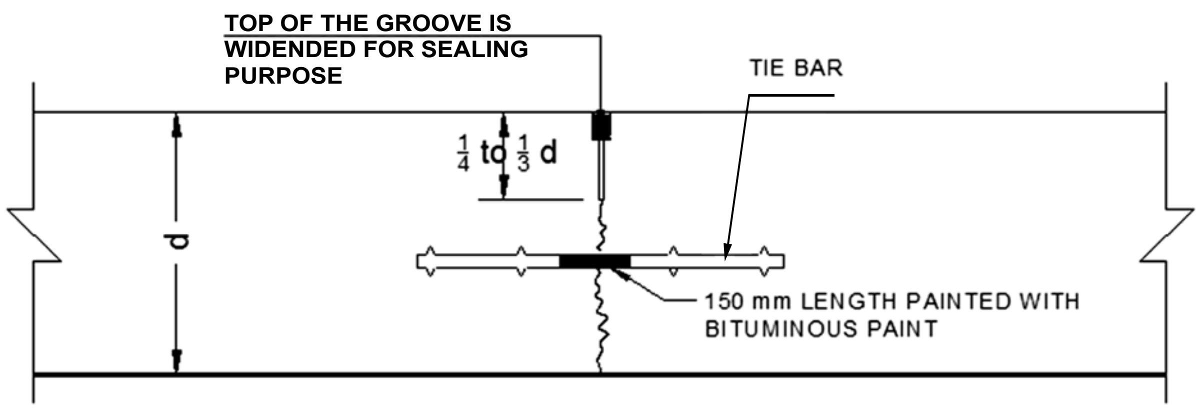
Fig. 5 Sealing Details of Joints (Grooves Suitable for Cold Silicone Sealant)



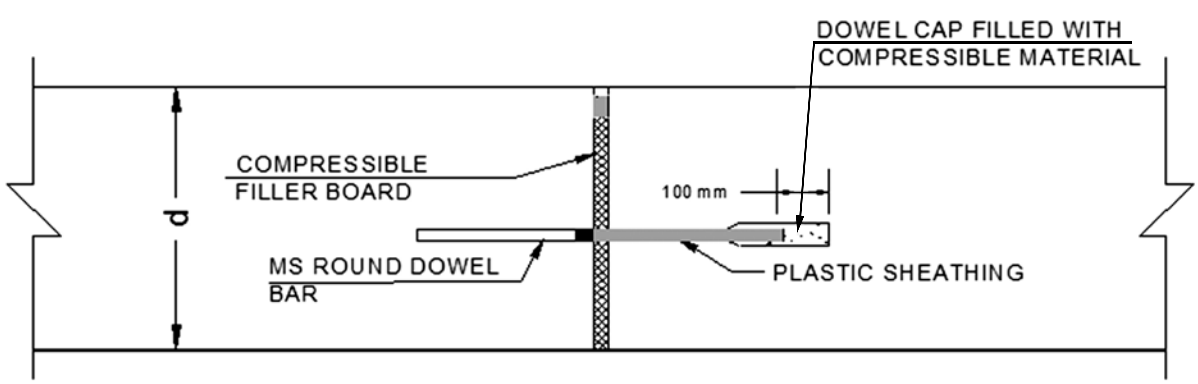
CONTRACTION JOINT WITH DOWEL BAR

(a)



LONGITUDINAL JOINT WITH THE-ROD BETWEEN TWO LANES

(b)



EXPANSION JOINT WITH DOWEL

(c)

Fig. 6 Typical Cross-Section of Joints

5.5 Construction Joints

The need for such joints 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. The work should normally be stopped at the regular location of contraction or expansion joint.

5.6 Groove Dimensions

The size of the joint grooves is shown in **Figs. 3, 4** and **5**. The grooves shall not deviate from the specified size by ± 1 mm both in depth and width.

A sample calculation for the width of contraction joint is attached as **Annexure-I**.

6 SEALING DETAILS

6.1 Steps involved in sealing operation of field-moulded sealant:

- Widening of the first saw cut of 3-4 mm to the required dimension as shown in **Figs. 3, 4** and **5**. The grooves shall be checked for tolerance using width and depth gauges.
- Sand blasting the groove face if the sealant manufacturer recommends it.
- Cleaning the groove with air compressor
- Insertion of debonding strip
- Priming the sides of the sealant, if the sealant manufacturer recommends it
- Pouring of sealant

The sealants shall be applied only after the concrete slabs have been cured to the specified duration, and there is no trace of moisture in the exposed faces of the joint groove.

6.2 Sawing of Groove

All joints (except the construction and expansion joint) be sawn. The sawing of joints should be a two-phase operation. In the first phase, the initial sawing is done to the required depth (one-fourth to the one-third the depth) with a 3 mm blade soon after concrete sets and is capable of taking the load of cutting machine and the weight of the operator. This cut is intended to induce the full-depth crack at the intended location. Since the next phase of sawing may be taken up after a lapse of time, the joint should be filled with a temporary seal such as jute rope. This seal will keep the incompressible material like stone pieces and dirt out of the joint and reduce the potential spalling. The second phase of saw cut is then made prior to the installation of the sealant. This saw-cut widens the groove to the finally designed size and provides a reservoir for the sealant material. When the second saw-cut is made, the temporary seal is pushed into the bottom of the widened groove so as to prevent all extraneous material from entering the joint including slurry generated during sawing process. Depth/width gauges shall be used to control the dimension of the groove. If rough arises develop when grooves are made, they shall be ground to provide a chamfer of 3 mm width. If the groove is at an angle upto 10 degrees from the perpendicular to the surface, the overhanging edge of the sealing groove shall be sawn or ground perpendicular. If spalling occurs or the angle of the former is greater than 10 degrees, the joint sealing groove shall be sawn wider and perpendicular to the surface to encompass the defects upto a maximum width, including any chamfer, of 35 mm for transverse joints and 20 mm for longitudinal joints. If the spalling cannot be eliminated then the arises shall be repaired by an approved thin bonded arises repair material using epoxy mortar. All grooves shall be cleaned of any dirt or loose material by air blasting with filtered, oil-free compressed air. If need arises, the cleaning may be done by pressurized water jets. Depending upon the requirement of the sealant manufacturer, the sides of the grooves may be sand blasted to increase the bondage between the sealant and the concrete. Based on the recommendation of manufacturer, the joint grooves shall be primed before applying sealant. At the time of priming and sealing, the groove shall be clean and dry.

As per IRC:15, joint cutting equipment which can be used to cut joint at the early age of concrete is called as early-entry saw. This is light weight equipment and has a plate called 'skid plate' on both sides of saw to keep concrete pressed at the location of saw cutting to basically control raveling. With use of early-entry joint cutting equipment, joints can be cut even earlier than that mentioned above with the permission of the Engineer. The depth of cut shall be minimum 10 % of slab thickness subject to 30 mm minimum.

Early-entry saw cutting are dry-cuts so their blades are designed for use without water for cooling. They are also "up-cut" saws, meaning that the cutting edge of the blade moves upward during operation. This helps to push debris out of the joint. In addition, they have a skid plate, which slides on the concrete surface and has slot through which the saw blade is inserted. The skid plate holds the concrete in place during cutting to minimize crumbling/raveling/dislodging of aggregates from the joint edges. The gap between the blade and the edge of the slot is extremely narrow. Over time, abrasion may cause widening of the slot and increases the chance for edge ravelling of the joint. Therefore, early-entry saw cutting requires replacement of skid plate each time the blade is replaced for maximum effectiveness.

6.3 Paper-Backed Debonding Strip

Before sealing, the temporary seal provided for blocking the ingress of dirt, soil, stone chips etc. shall be removed carefully. A debonding strip is then inserted in the groove to break the bond between the sealant and the bottom of the groove and to plug the groove so that the sealant may not leak through the initial groove and ultimately into the cracks. The details are given in **Figs. 3, 4** and **5**. The heat resistant debonding strips are required for those cases where hot poured sealant is used. In the case of compressible debonding strip to be used in contraction joint, normally the strip is provided with a paper-back so that sealant is not absorbed by the debonding strip. If the strip is non-absorbant type no paper-back is required.

The width of the debonding strip shall be more than the width of joint groove so that it is held tightly in the groove.

In the case of longitudinal joints there is no need to install compressible debonding strip but a debonding tape of 1.0-2.0 mm thickness is sufficient to plug the groove so that sealant does not flow downwards in the first cut groove. Heat resistant debonding strip, however, is to be used when hot-poured sealant is used.

6.4 Debonding Strip and Backer Rod/Back-up Rod

In the case of sealing of joint grooves with field moulded technique, debonding strip of backer roads are required to prevent sealant flowing through bottom of the joint and prevent sealant adhesion to the bottom of the groove. The debonding strip is normally of rectangular cross-section and of about 5 mm thickness and is provided with a paper backing to reduce the loss of sealant by absorption. The backer rod with round section is used without any paper backing as the closed cell foam used does not absorb sealant. The types of materials used for debonding strip and backer rod are:

- Polyethylene foam: This is a closed-cell foam that does not absorb water and is moderately compressible. As this material gets affected by heat, this is used for cold-poured joints.
- Cross linked polyethylene foam: This is compatible with hot-poured sealants. It is a closed-cell foam that does not absorb water and is moderately compressible, but will not melt in contact with hot-poured sealant.
- Polyurethene foam: It is of open cell foam which can absorb moisture but does not get affected by hot-pour sealant. It is very compressible and normally used with hot-pour sealant.

The backer/back-up rods shall conform to ASTMC 5249-95 or ASTMD 3575.

6.5 Cleaning/Sand Blasting of Sides of the Groove

During the widening of the joint groove, water is fed to the diamond edged saw as coolant for grooving. The slurry produced normally gets coated as a thin film on the sides of the groove which acts as a barrier between sealant and concrete. Therefore, there is a need to clean the sides of the groove with sand blasting, water jet and subsequently, with an air jet as recommended by the manufacturer. As the surface of sides becomes smoother during grooving/widening it is generally necessary to sand blast the sides. The pitted surface of sides of the groove is helpful in improving the bond between sealant and concrete.

6.6 Priming

A primer is used to improve the adhesive bond between sealing compound and concrete, to penetrate the pores of the concrete and to coat it with a thin film of viscous sticky material. The primer must have a very low viscosity so as to penetrate the pores of the concrete. The primer to be used shall be a recommended by the sealant manufacturer.

The primer shall be applied to the joint faces by spray or brush as soon as the surface is prepared, cleaned and dried as per specification. The primer shall be applied carefully so that the joint surfaces are evenly coated. Pools of excess primer shall be avoided as these may be detrimental to the subsequent performance of the sealant.

Some sealant manufacturers do not recommend use of primer with their product, but cleaning and sand blasting sides may be necessary.

6.7 Types of Sealants

There are two main categories of materials for sealing of joints in cement concrete pavements, viz:

- Hot-poured sealants
- Cold poured sealants

Table 1 gives the brief details of various joint sealants in use.

Table 1 Common Joint Sealants

Sealant Type	Specification	Properties
Hot Poured Joint Sealants		
Rubberized Bitumen Sealant	IS 1834	Self leveling
Polymeric Asphalt Based	AASHTO MO173 ASTM D 34005 US Federal Highways Administration Specification SS-S-1401 C ASTM D 1190	Self leveling Self leveling Self leveling Self leveling Self leveling
Polymeric Sealant	ASTM D 3405	Self leveling
Low Modulus	Modified	Self leveling
Elastomeric Sealant	US Federal Highways Administration Specification SS-S-1614, ASTM D 3406	
Coal Tar, PVC	ASTM D 3406	Self leveling
Cold Poured Sealants/Single Components		
Silicone Sealant	ASTM 5893-96	Non sag. Toolable Low modulus
Silicon Sealant	ASTM 5893-96	Self-leveling (no tooling) low modulus

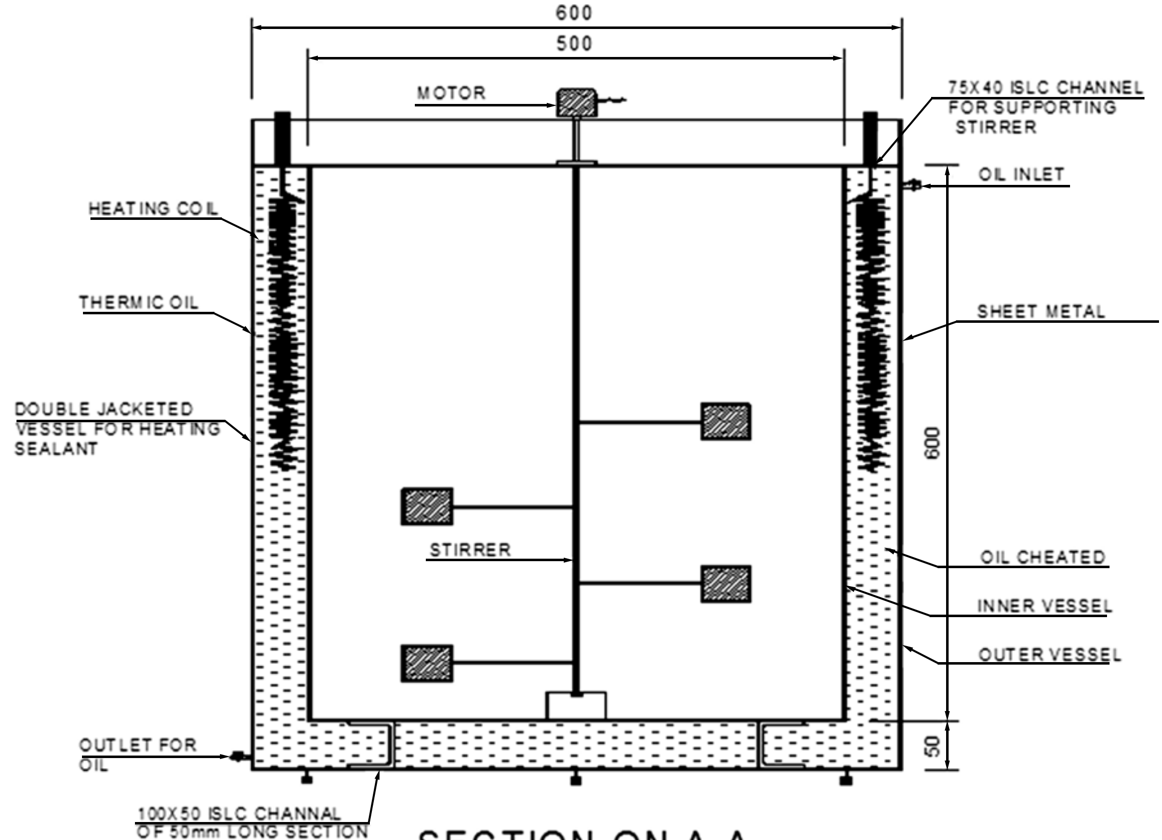
Sealant Type	Specification	Properties
Polysulphide Sealant	BS 5212-1990 IS 11433-1986 (Reaffirmed in 1995)	Self-leveling (no tooling) low modulus
Polyurethane Sealant	BS 5212	
Polyurethene Polymer Sealant	US Federal Specification item 4.4.7	• High chemical resistance (as per US federal specification item 4.4.7) • High mechanical resistance (as per US federal specification item 4.4.9) • Density is 1.6 kg/l • Curing time is approx 24 hrs. • MAF is 25% • Non sag properties are self leveling, can be used with a slope of 3% (depending on the temperature) • Service temperature is minus 40ºC up to 80ºC

6.8 Hot-Poured Sealants

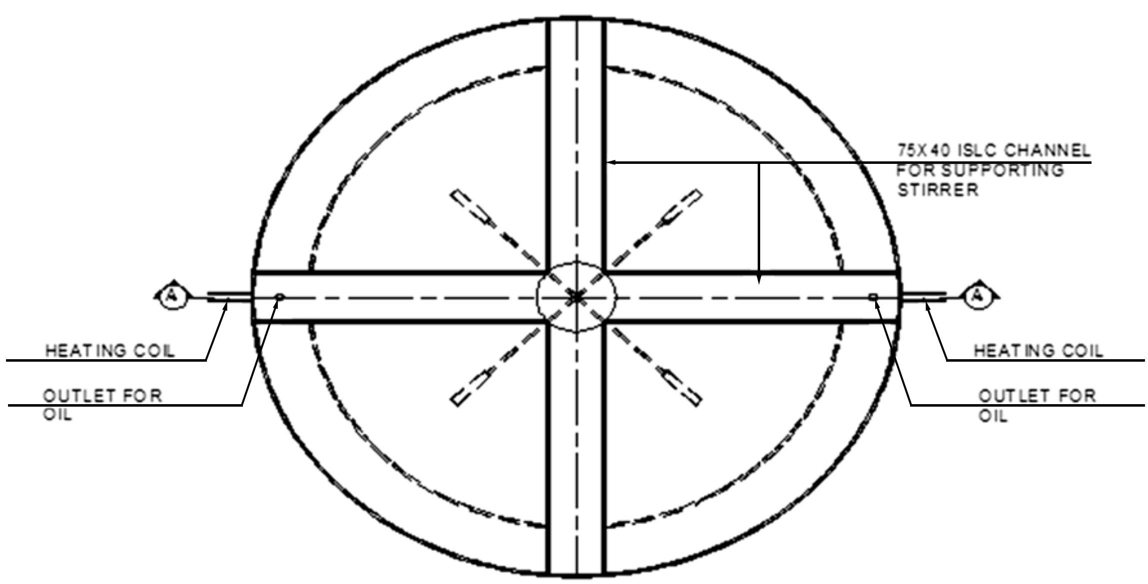
Rubberized-bitumen sealant is normally heated in the range of 120ºC-180ºC as per the recommendation of the manufacturer before using it. The relevant specifications for different hot poured sealants are given in **Table 1**.

In hot application sealant should be heated in a Melter and storage vessel to specified temperature, using oil jackets and thermometers for controlling the heat. A schematic view of a heating kettle is show in **Fig. 7**.

The sealant should be continuously agitated to avoid local overheating throughout the heating and pouring operation. The temperature of the material should not be allowed to rise above that stated by the manufacturer nor should the material be maintained at application temperature for a longer period of time than indicated by the manufacturer. The sealant shall be poured by means of pouring kettle or using extruding machines which pump the material into the sealing groove. The sealant shall be applied such that the top surface of the cooled sealant is at the required depth below the pavement surface within a tolerance of 3±1 mm.



SECTION ON A-A



PLAN

Fig.7 Schematic View of a Sealant Melter

The minimum depth of the sealant shall not be less than that specified. On super-elevated portions where the cross-fall is greater than 2.5 per cent, measures should be taken to ensure that the sealant does not flow along the joint by (i) placing the material in thin layers and allowing each layer to stiffen before placing the next or (ii) forming dams at intervals along the joint to check the flow. The dams should be thereafter cut and replaced with sealant. In order to avoid spillage of sealant on the concrete surface card-board or tape should be stuck on both edges before pouring sealant. The sealant may be pressed by a tool to have smooth surface. Sealing operation can be done by sophisticated melter and pourer. A kettle used for sealing manually is shown in **Fig. 8**.

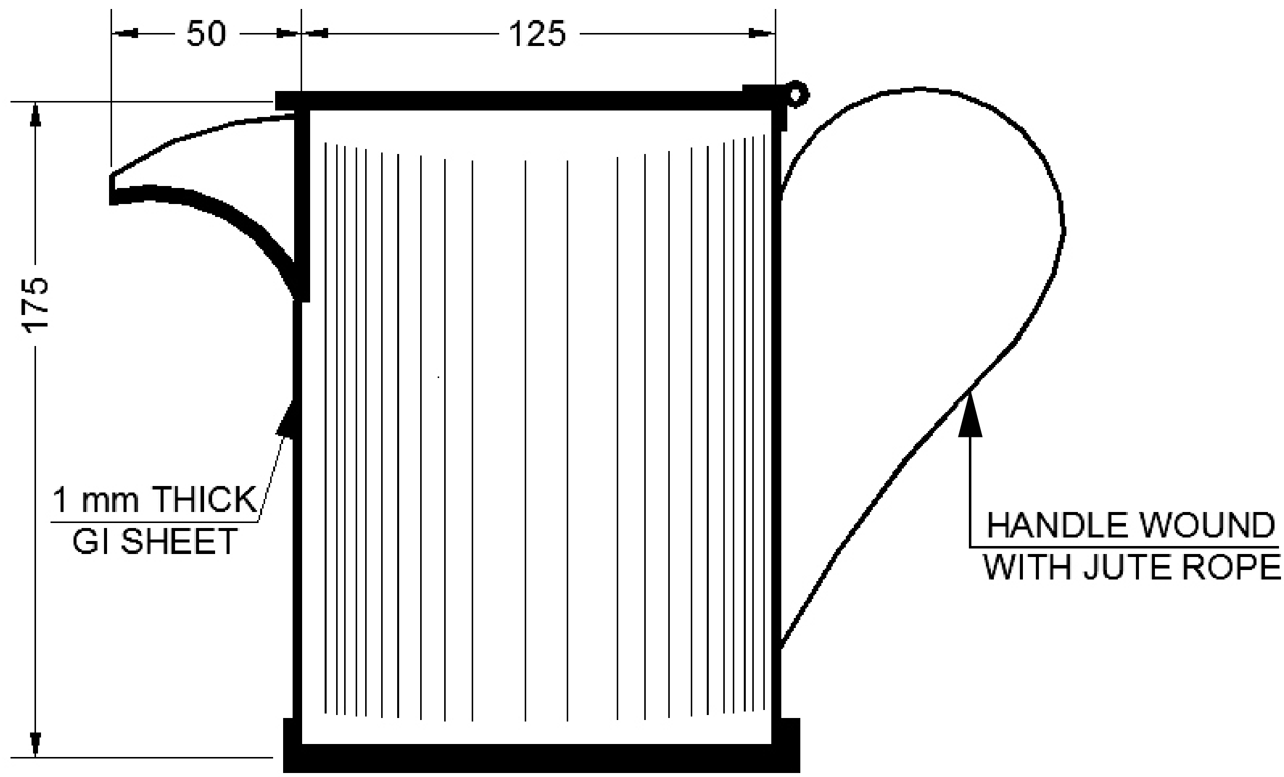


Fig. 8 A Pouring Kettle for Hot-poured Sealant

6.9 Cold Poured Sealants

There are three main sealants under this category which are used for pavements:

- Polysulphide conforming to IS:11433 (Part 1) or BS 5212
- Silicone conforming to ASTM: 5893, ASTM C 793 and BS/EN 14187-5
- Polyurethane conforming to BS:5212 – Part II

They are poured at atmospheric temperature and after being poured, undergo a chemical reaction and give a seal of the desired consistency. They allow for repeated larger extension of 30 per cent. As against 20 per cent in the case of hot poured bitumen-based sealants. Because they do not need heating, the applications is simple. At the same time, a great care is needed in selecting the product and applying them. They require greater care in preparing the edges and the bottom of the groove (drying, cleaning and coating with primer). They are costlier than hot applied sealants. But their higher cost is justified by longer life.

6.10 Movement Accommodation Factor (MAF)

This is an important property of sealant which defines the capacity of the sealant to undergo expansion or contraction without any change in volume. The material will revert back to original shape on removal of load.

It can be defined as :

$$\mathrm{MAF} = (-)\frac{Compressed\ Width - Original\ Width}{Original\ Width} \mathrm{X}\ 100$$

$$= (+)\frac{Expanded\ Width - Original\ Width}{Original\ Width} \mathrm{X}\ 100$$

For highly elastic material, MAF value will be higher. Polysulphide sealants have MAF of more than ±25%. The MAF of silicone sealants is in the range of -50% to +100%. This sealant can be compressed to its 50% size whereas it can be stretched to 100% of its original length without any change in the volume of sealant.

Polysulphide sealants are generally supplied in the form of two components packed separately. They are to be mixed immediately before being used. They shall confirm to BS 5212-Part II. Sealing details of joints when polysulphide sealant is used are given in **Fig. 4**. Silicon sealants are single component type. They shall conform to ASTM Designation D 5893-96. This sealant hardens by absorbing moisture from the atmosphere. For it to harden in reasonable time, the sealant is placed in thin section.

The cold application sealants are applied in the field either by hand-held guns/syringe or machine in accordance with the manufacturer's instructions. The surface of the sealant shall be recessed by not less than 2 mm nor more than 4 mm below the pavement surface. Sealants applied at contraction phase of the slabs would result in bulging of the sealant over and above the slab. Therefore, the right temperature and time shall be established for applying the sealant. A thermometer shall be hung on a pole at the site for facilitating control during the sealing operation.

Details of sealing grooves are given for guidance in **Figs. 3, 4** and **5**. The groove dimensions are different for silicone sealants as thin sections are preferred for early curing.

During the sealing operations, it shall be seen that no air bubbles are introduced into the sealant either by vapours or during the sealing process.

Manufacturer's certificate shall be produced for establishing that the sealant is not more than six months old or the shelf-life of the sealant.

The cold applied sealants shall be tooled so that the final surface of the sealant has a parabolic shape in the surface cross-sectional area or as per the recommendation of the manufacturer.

Any sealant that pulls loose from the joints or shows excessive bubbling within one week after opening of the pavement to traffic shall be replaced by a fresh application.

7 PREFORMED SEALS

The pre-formed joint scaling material shall be a vulcanized elastomeric compound using polychloroprene (Neoprene) as the base polymer.

The Joint Seal Shall conform to requirements of ASTM D 2628 as given in **Table 2**.

Table 2 Requirements of ASTM D 2628

Sl. No.	DESCRIPTION	REQUIREMENTS	ASTM TEST METHODS
1.	Tensile Strength, min.	13.8 M Pa	D 412
2.	Elongation at break	Min. 250%	D 412
3.	Hardness, Type a durometer	55 +/- 5 points	D 2240
4.	Oven aging, 70 h at 100 ºC Tensile strength loss	20% max	D 573
5.	Elongation loss	20% max	
6.	Hardness Change Type a durometer	0 to +10 points	D 471
7.	Oil Swell, ASTM Oil 3. 70 h at 100 ºC weight change	45% max	D 1149
8.	Ozone resistance 20% strain, 300 pphm in air, 70 h at 40 ºC	No cracks	D 2240
9.	Low temperature stiffening, 7 days at -10 ºC Hardness change type a durometer	0 to +15 points	
10.	Low temperature recovery, 22h at -10 ºC, 50% deflection	88% min	D 2628
11.	High temperature recovery, 22h at -29 ºC, 50% deflection	83% min	D 2628

Sl. No.	DESCRIPTION	REQUIREMENTS	ASTM TEST METHODS
12.	Low temperature recovery, 22h at 100 ºC, 50% deflection	85% min	D 2628
13.	Compression, deflection at 80% of normal width (min)	613 N/m	D 2628

The groove width and depth shall depend upon the manufacturers specifications. They shall be installed preferably by a machine after cleaning the groove as described in para 6.5.

8 RESEALING OLD JOINTS

When existing sealant has cracked or has detached from the sides, the sealant shall be removed with a raker, and the surface are cleaned by brushing or using special tools or by sawing the groove afresh and air jet upto a depth of at least 20-25 mm. A raker normally used for cleaning the joints as shown in **Fig. 9**. Temporary seal with a jute rope shall be inserted to protect the joints from ingress of dirt etc. before resealing joints. If the grooves are too narrow, widening by sawing may be necessary. Any spalled edges shall be repaired with a cementitious material (epoxy or polymer based fine concrete). Primer shall be applied to the cleaned surface in the manner described earlier. If recommended and resealing done as described earlier.

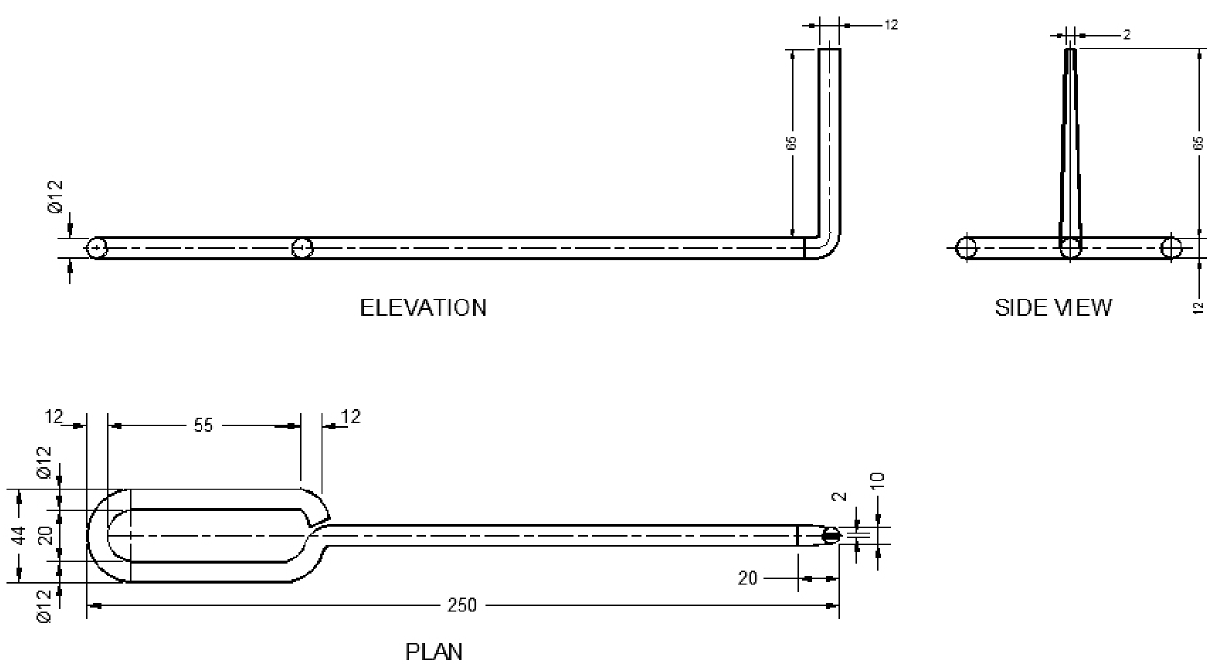


Fig. 9 Details of Raker

REFERENCES

1. Steffes, R and Siljenberg, B J 2003, Early Entry Sawed Portland Cement Concrete Transverse Joint Ends, Iowa Department of Transportation, 800 Lincoln Way Ames, I A United States 50010, The National Academies of Sciences, Engineering, and Medicine, 500 Fifth Street, NW | Washington, DC 20001
2. http://texascurbcut.com/services/early-entry-sawing-with-vacuum-system/
3. https://www.ussaws.com/early-entry-joint-saw.html
4. https://www.constructionequipment.com/.../cardinal-saws-and-blades-inc

Annexure-I

SAMPLE CALCULATION FOR WIDTH OF JOINT

Coefficient of Thermal Expansion, α = 10×10^{-6}/ ºC

(as per IRC:58-2015)

Temperature Differential considered (maximum), 21 ºC (as per IRC:58-2015)

PQC Panel Size considered is, 4.5 m X 3.5 m

The longest side shall be in the direction of traffic or as per design

Thermal Expansion of the slab, a = $10 \times 10^{-6} \times 21 \times 4.5 \times 1000$

Total Expansion of Slab in longitudinal direction = 0.945 mm

Movement Accommodation Factor is 25%

Therefore, Contraction Joint width (minimum) = 0.945 x 100/25

= 3.78 mm (say 4 mm)

It is therefore recommended to adopt width of 6-8 mm for contraction joints and for longitudinal joints also.

(The Official amendments to this document would be published by the IRC in its periodical, 'Indian Highways' which shall be considered as effective and as part of the Code/Guidelines/Manual, etc. from the date specified therein)