5.9 Work Safety and Traffic Diversion

a) Before the repair work is carried out, the proper traffic diversion shall be planned and implemented in consultation with the Engineer-in-Charge having full regard to the statutory and contractual provisions for safety.

b) All signals required for traffic diversion and work safety shall be brought to the site and placed at appropriate sections and distances.

c) When the work is finished and curing completed all debris and traffic control measures shall be removed and normal traffic conditions restored (For details refer Chapter 15).

5.10 Disposal of Dismantled Materials

The concrete dismantled during partial depth repair/full depth repair/grinding and grooving etc. shall be suitably disposed off as provided in the contract. In absence of any such provisions the MoRT&H specification clause 202 and IRC:121 should be followed. That is:-

a) The concrete should be broken to sizes not greater than 0.02 cum and stacked neatly in the ROW (Right of Way) for later reuse or till it is finally disposed of as per contract.

b) The chunks should be sorted into range of sizes, with larger chunks (less than 0.02 cum in size) broken further by hand or put in the crusher to break them into smaller size particles so they can be reused as an recycled aggregate for nonstructural purpose. For example it can be:-

- Used in GSB by mixing 20% - 25% of the broken particles (75 mm down) with new material if required after satisfying necessary laboratory tests for the layer concerned.
- Mixed with gravel/moorum mixture for protecting the earthen shoulder after satisfying necessary laboratory tests.
- Used in the Dry Lean Concrete (DLC) or foundation levelling course (M-10) after satisfying necessary laboratory tests.
- Used for the mechanical stabilization of weak soils after satisfying necessary laboratory tests.

c) Any unused material may be auctioned or disposed of according to the environmental rules and instructions of the Engineer.

6 CRACK SEALING AND JOINT RESEALING

6.1 General

6.1.1 This is a frequently applied preventive repair technique normally used as a part of periodic maintenance. If the edges of the crack are severely broken (spalled) the slab should be cut 30 mm deep on both sides of the crack at a distance of 10-12 mm each side. The concrete is removed between the cuts and the crack is filled with a fine epoxy resin mortar.

The pit is cleaned and prime coat is applied on sides and at the bottom of the pit. The pit is filled with Epoxy Concrete with 10 mm down aggregates. The cuts have dried as shown in **Fig. 6.1 (b)**. Crack widening and sealing follows the same work procedure as joint grooving and resealing.

6.1.2 Different methods to seal and patch cracks are illustrated in **Fig. 6.1** and are briefly described below:

a) **Gravity application of low viscosity epoxy resin:** Cracked area is first cleaned by blasting with air. A low viscosity, free flowing, fast curing epoxy resin can be applied from a plastic beaker or from end of a nail by gravity into cracks 0.5 mm- 5 mm wide to secure broken concrete pieces together to prevent it from breaking out. Epoxy resin to be used should be with viscosity in range of 300 centipoise @ 20°C and 110 centipoise @ 30°C. **See Fig 6.1 (a)**.

b) **Epoxy Resin Injection:** Resin injection can be used to make structural repair of deep cracks, particularly corner breaks, by following the method described in MoRT&H Specification. The resin is injected at high pressure in previously bored holes along the crack. The resin fills the crack and sometimes the interface of the slab with the sub-base if the pressure is maintained for a long period. The broken slab is thus secured together and better supported by the sub-base. See **Figs. 6.1 (b)** and **6.1 (c)**. Care has to be taken not to fill the adjoining construction joints with resin.

c) **Retaining as a "Working Crack" with Elastomeric Sealant:** Suitable as a short term measure at cracks which do not display faulting and rocking under the traffic load. Route along the crack to provide a uniform groove and apply an elastomeric sealant. The life expectancy will generally depend on the volume of the traffic and the condition of the sub-base.

6.1.3 Overfilling of cracks or joints should be avoided as the residue will struck to the tyres of the vehicle which often leads to uprooting of entire sealant. This can be prevented by bevelling the edges of the joint. This will also eliminate edge spalling (FOD).

6.1.4 Crack sealing between untied/bituminous shoulder shall be filled with a mixture of emulsion rejuvenator and topped off with sand.

6.1.5 Low viscosity epoxy shall also be poured along the boundaries of the patch thus repaired with epoxy/epoxy mortar/epoxy concrete. Dry fine sand shall be spread over these. Different methods to seal/cracks are given in **Fig. 6.1**.

Pouring Low Viscosity Epoxy Resin

(b)

(a)

Treatment of Shallow Spalling at Joints by Gravity Sealing with Low Viscosity Epoxy

(c)

Fig.6.1 Treatment of Cracks with Epoxy Resin Formulations

6.2 Joint Resealing

6.2.1 Over time all types of joint sealants suffer distress. They lose flexibility, bond to the walls of the joint groove and may crack. The sealant may be subject to very harsh conditions. Accordingly the material selected for joint sealing, shall be capable of:

(i) Withstanding horizontal extension and compression and vertical shear;

a) The Liquid Sealant Adhesion Failure

b) Sand blasting the groove after raking out the sealant residue and rubbish from the joint.

c) Compressed Air used to clean

Fig. 6.7 Preparation for Joint Resealing

a) Typical cross-section of Compression Seal

b) Loosening of Compression seal

Fig. 6.8 Baker Rod Insertion into the Joint Groove

7 CRACK STITCHING (CROSS STITCHING)

7.1 General

7.1.1 Crack stitching with inclined tie bars (cross-stitching) or U-bars (stapling) may be used for full depth longitudinal cracks in reasonably good condition i.e. the width of crack is less than

3 mm and length is more than 1 m in order to arrest movement of slabs and slab pieces. Stitching maintains aggregate interlock, prevents the crack from vertical and horizontal movement or widening and provides added reinforcement and strength. **Table 4.5** shall be referred to for selecting suitable cases for this type of repair.

7.1.2 Cross-stitching serves the same purpose as tie bars and bent tie bars (stapling) but requires less surface disruption than the installing tie bars.

7.1.3 Cross-Stitching shall not be used as an alternative for treating cracks that are severely deteriorated/spalled. It is normally used for the treatment of narrow longitudinal and diagonal cracks which do not display spalling or other types of distress. Full depth transverse cracks which have assumed the role of an adjacent joint should not be stitched. Stitching will not allow joint movement (open and closure), so a new crack is likely to develop near a stitched working crack or the concrete will spall over the reinforcing bars and along the crack. For safety measure, the longitudinal joint(s) adjacent to the cross stitched slab, should be cleaned thoroughly and resealed for effective joint movement. In such cases otherwise, dowel bar retrofit, full depth repair or whole slab replacement should be used depending on alignment and position of the crack.

7.2 Methodology for Cross Stitching

The cross-stitching procedure is illustrated in **Figs. 7.1** & **7.2**. The same is as follows:

(i) Preliminary vertical holes (diameter Ø = 36 - 45 mm), 30 mm deep are drilled in an alternating pattern at 500 mm - 750 mm spacing apart, where the inclined hole starts to facilitate its drilling.

(ii) Alternate inclined holes (12 to 20 mm) at an angle of about 30° to 40° from the slab surface normal to the line of the crack are drilled; the length of the holes shall be equal to 1.7 times slab thickness. The holes should be spaced as for (1) above and alternate from each side of the crack. Whilst a 500 spacing is generally recommended, a 750 mm spacing is adequate for light traffic and lightly loaded inner highway lanes. For heavy traffic and outer lanes, a spacing of 500 mm c/c is preferred. The dimensions and spacing also depend on the slab thickness in a similar manner as dowel bars.

(iii) The holes are cleaned thoroughly using oil-free compressed air.

(iv) The hole is filled with epoxy resin/elastomeric concrete in enough quantity for the bar to be completely coated when inserted in the hole.

(v) A high yield deformed epoxy coated reinforcing bar (12-16 mm) is placed conforming with IS:1786 & IS: I3620 in every hole.

(vi) A groove shall be made along the line of cracks displaying spalling and filled with a low viscosity resin, fine epoxy mortar or elastomeric cement as appropriate as per Para 6.1.1.

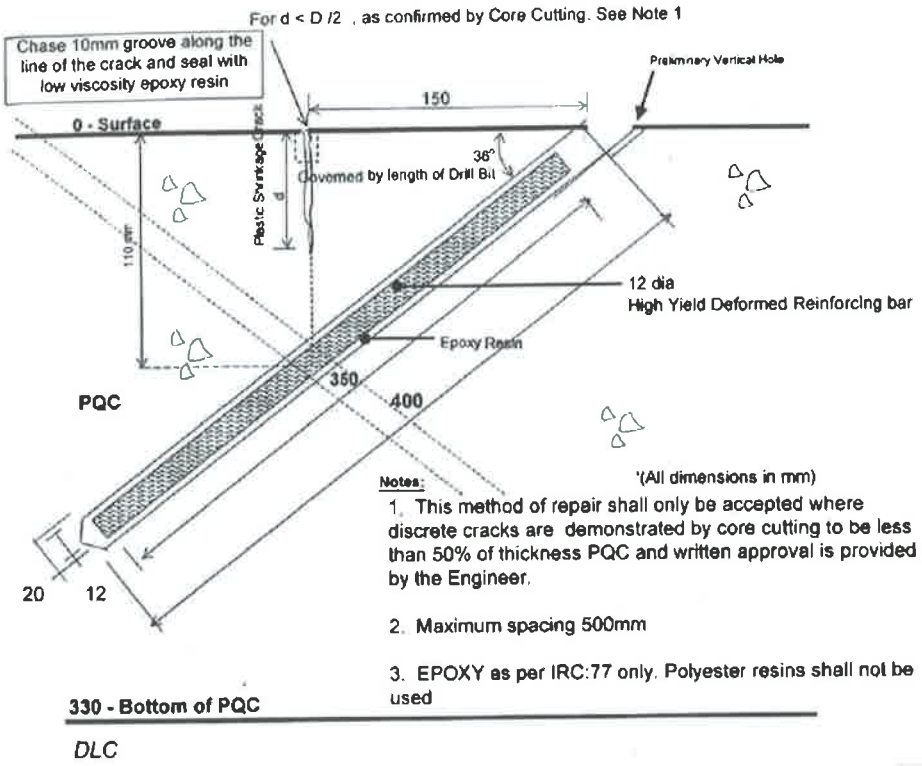

Fig. 7.1 Typical Arrangement for Cross Stitching with 12 mm Dia Straight Bars

Fig. 7.2 Drilling Inclined Holes with Angle Template

7.3 Methodology for Stapling

Stapling or slot stitching is a technique used to provide positive mechanical interconnection at longitudinal crack or joint between two slabs or segments. 16 to 20 mm dia epoxy coated U-shaped deformed bars placed in the slots hold the segment together, serving to maintain aggregate interlock and provide added reinforcement and strength (**Fig. 7.3**). These bars prevent further migration of slabs. Larger diameter bars may also serve the function of load transfer. The procedure for the same is as follows:

1. Mark the position of vertical holes of dia 30 mm at a distance of 228 mm from the crack at a spacing of 600 mm c/c.

2. Drill 30 mm dia holes upto maximum depth of D/2.
3. Cut the slots of 30 mm width and of a depth of 50 mm less than the depth of drilled holes.
4. Remove debris and clean the slots and the holes.
5. Roughen the sides of holes and slots by sand blasting/sand paper.
6. Insert U-shaped deformed steel staple bars into the slots and anchor the ends into holes with high modulus epoxy.
7. Fill the slot with 1:3 epoxy-sand mortar or elastomeric concrete upto 10 mm above the top surface of staple bar. Vibrate or tamp the mix to ensure proper compaction of the material surrounding the staple.
8. Fill the remaining volume of the slot with non-shrinkable concrete or any other equivalent material upto the top level of PQC and finish it properly.

(a) Slot Cutting and U-Shaped Staples **(b) Slot Filled with Elastomeric Concrete**

Fig. 7.3 Stapling of Longitudinal Joint

7.4 Methodology for Slot Stitching

Slot-stitching (**Fig. 7.4**) is a repair technique for longitudinal cracks and joints. It provides mechanical interconnection between two slabs or segments on opposite sides of longitudinal joint or crack respectively. The deformed steel bars placed in the slots not only hold the segments together to maintain aggregate interlocking but also provide added reinforcement and strength to the joint or crack. Bars provided into slots also prevent horizontal and vertical movement of segments at crack or joint. Larger dia bars (> 25 mm) also help load transfer across the joint or crack. Slot-stitching involves the following steps:

1. Cut slots approximately perpendicular to the longitudinal joint or crack using a saw cut or any other machine.
2. Remove the concrete and clean the slot. Prevent concrete debris from entering into the joint or crack.
3. Place deformed 16 mm to 20 mm dia bars into slots.
4. Fill the slot with non-shrinkable or very low shrinkage material.
5. Finish flush with the surface and cure as per the curing instructions for the material.