Standard Operating Procedure (SOP)

Patch and Pothole Repair of Bituminous Roads

Himachal Pradesh Public Works Department (HPPWD)

1. INTRODUCTION

- Patch repair and pothole filling are critical maintenance interventions to ensure traffic safety, extend pavement life, and restore riding quality. This is especially true given the challenging climatic (heavy rainfall, snowfall, frost action) and topographic (steep gradients, drainage issues) conditions of Himachal Pradesh.
- This SOP provides a standardized procedure aligned with national best practices to ensure durable, uniform, and auditable repairs.

2. PURPOSE

- To provide field engineers, supervisors, and contractors with a uniform, step-by-step procedure for executing patch and pothole repairs.
- To ensure all repairs are compliant with established national standards, specifically **IRC: 82**
- To minimize premature patch failures by emphasizing correct procedure, material quality, and compaction.
- To create a basis for transparent measurement and quality assurance.

3. SCOPE

- This SOP applies to all pothole filling and patch repair activities on Bituminous / Flexible Pavement surfaces across the entire road network (NH, SH, MDR, ODR, and Rural Roads) maintained by HPPWD.

4. KEY REFERENCES

- This procedure is based on the guidelines laid out in the following codes of practice:
- **IRC: 82-2023:** Code of Practice for Maintenance of Bituminous Roads.
- **MoRTH:** Specifications for Road and Bridge Works (Relevant Clauses).
- **HPPWD:** Internal Quality Management Guidelines.

5. DISTRESS IDENTIFICATION & ASSESSMENT (Ref: IRC: 82)

1. **Inspection:** Field inspections shall be conducted systematically, especially post-monsoon and post-winter, to identify and log defects.
2. **Categorization:** Defects shall be categorized (e.g., Cracking, Ravelling, Deformation, Potholes) as per clause 7 of IRC 82 -2023
3. **Pothole Assessment:** For potholes repair the Junior Engineer must assess:
   - **Extent:** The full area of failure, including adjacent cracking.
   - **Depth:** Critically, determine if the failure is limited to the bituminous layers (Partial-Depth) or has penetrated to the granular base/sub-base (Full-Depth). This assessment dictates the repair method.

6. MATERIAL & EQUIPMENT

6.1 Materials

- **Bituminous Mix:** Hot Mix (preferred, as per original specification) or approved Readymade/Cold Mix. The material to be used should be similar to the material used in original Pavement.
- **Binder:** Bitumen (VG-30/VG-10) or Bitumen Emulsion (SS-1/MS-1) as appropriate.
- **Tack Coat:** Rapid Setting (RS-1)
- **Prime Coat:** Medium Curing (MC) Cutback Bitumen or Emulsion (SS-1). (As per site requirement)
- **Aggregates:** Clean, hard, angular, and well-graded aggregates as per HPPWD specifications.
- **Base Material:** WMM, WBM, or other approved granular material for full-depth repairs.
- **Additives:** Anti-stripping agents are mandatory for mixes used in moisture-prone areas of H.P.

6 MATERIAL & EQUIPMENT

6.2 Equipment

- **Safety:** Barricades, reflective cones, signage, blinkers, and PPE (jackets, helmets, gloves) for all crew.
- **Cutting:** Mechanical Pavement Cutter (preferred), jackhammer, Pick Axes.
- **Cleaning:** Wire brushes, brooms, and **Compressed Air Blower/Jet**.
- **Application:** Bitumen sprayer/distributor, pouring cans.
- **Compaction:** Plate Compactor small Vibratory Roller (1-3 ton). (Preferred)
- **Tools:** Shovels, rakes, wheelbarrows, 3-meter straight edge.

7. SAFETY & TRAFFIC MANAGEMENT

1. **No work shall begin** without deploying proper traffic control measures.
2. Advance warning signs (e.g., "WORK IN PROGRESS," "SPEED LIMIT 20") must be placed at sufficient distance (as per terrain) to warn oncoming traffic.
3. The immediate work area must be cordoned off with reflective cones or barricades.
4. For roads with continuous traffic, flagmen shall be deployed on both sides to guide vehicles.
5. All personnel in the work zone must wear high-visibility reflective jackets and safety boots.
6. Jackets wear (IRC SP:55)

8. STANDARD OPERATING PROCEDURE (SOP) FOR REPAIR

(Based on IRC: 82) Explained in Following 9 Steps

1. **STEP 1: MARKING THE AREA**
2. **STEP 2: CUTTING**
3. **STEP 3: REMOVAL OF FAILED MATERIAL**
4. **STEP 4: CLEANING THE CAVITY**
5. **STEP 5: PREPARING THE BASE (For Full-Depth Repairs)**
6. **STEP 6: APPLYING TACK COAT**
7. **STEP 7: FILLING WITH BITUMINOUS MIX**
8. **STEP 8: COMPACTION**
9. **STEP 9: FINISHING AND OPENING**

STEP 1: MARKING THE AREA

1. Identify the full extent of the defect, including the pothole and any surrounding cracks or unstable material.
2. Mark the area to be cut in a regular shape (Square or Rectangle).
3. The marked lines must extend 50mm to 100mm into the sound, healthy pavement around the defect to ensure a stable boundary.

Step-1: Marking

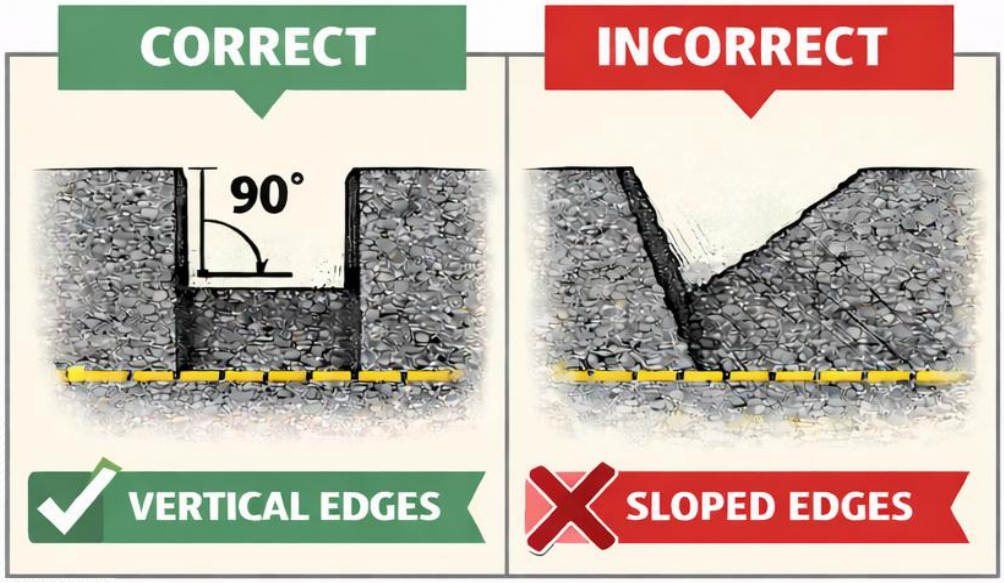
STEP 2: CUTTING

1. Cut along the marked lines using a mechanical means
2. **CRITICAL:** The cuts **must be vertical** (90 degrees). Sloped or "feathered" edges are not permissible as they lead to weak, un-compacted edges and premature failure.

Step-2: Cutting

Cut on the marked area.

Square or Rectangle shape

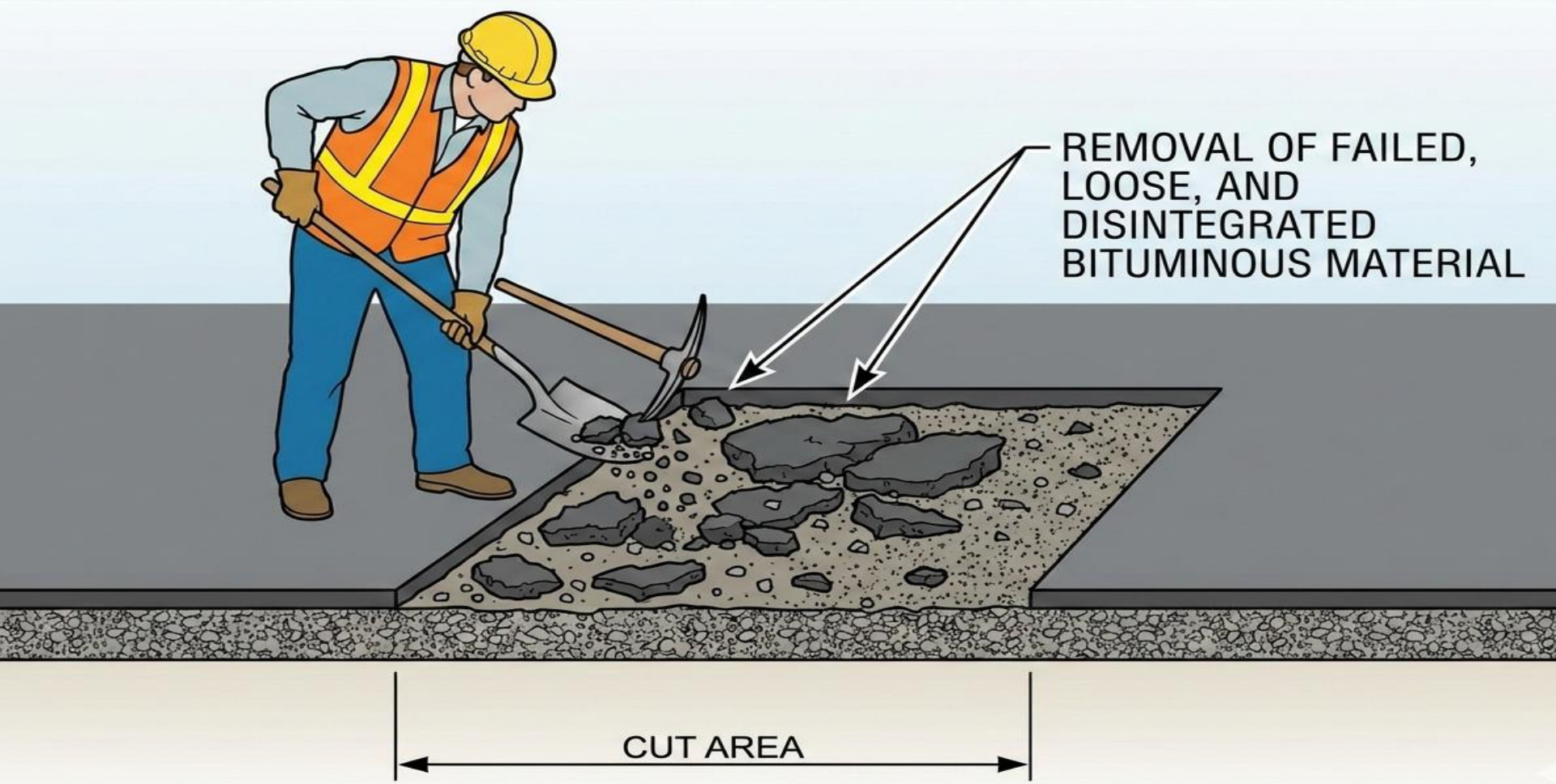


CRITICAL: Cuts must be 90° vertical.
No sloped or feathered edges!

STEP 3: REMOVAL OF FAILED MATERIAL

1. Remove all failed, loose, and disintegrated bituminous material from within the cut area.
2. If the base is intact (Partial-Depth), proceed to Step 4.
3. If the base is soft, wet, or unstable (Full-Depth), it must also be excavated until a firm, stable substrata is reached.

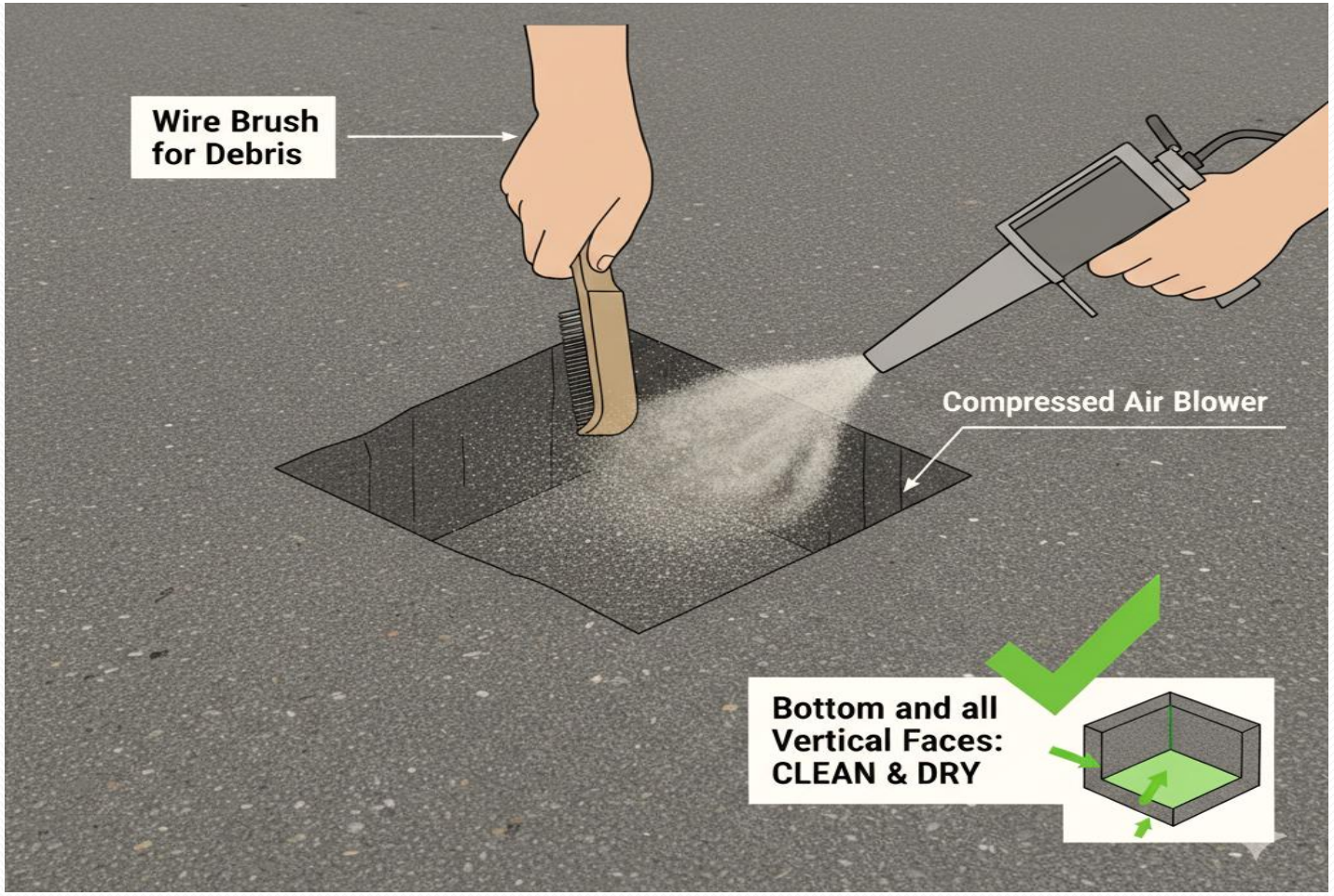
Step-3: Removal of failed material



STEP 4: CLEANING THE CAVITY

1. Thoroughly clean the excavated cavity of all dust and debris using wire brushes and brooms.
2. **CRITICAL:** Use a **Compressed Air Blower** to blow all fine dust from the bottom and vertical faces. This step is essential for a good bond.
3. The cavity must be suitably **dry** before proceeding further.

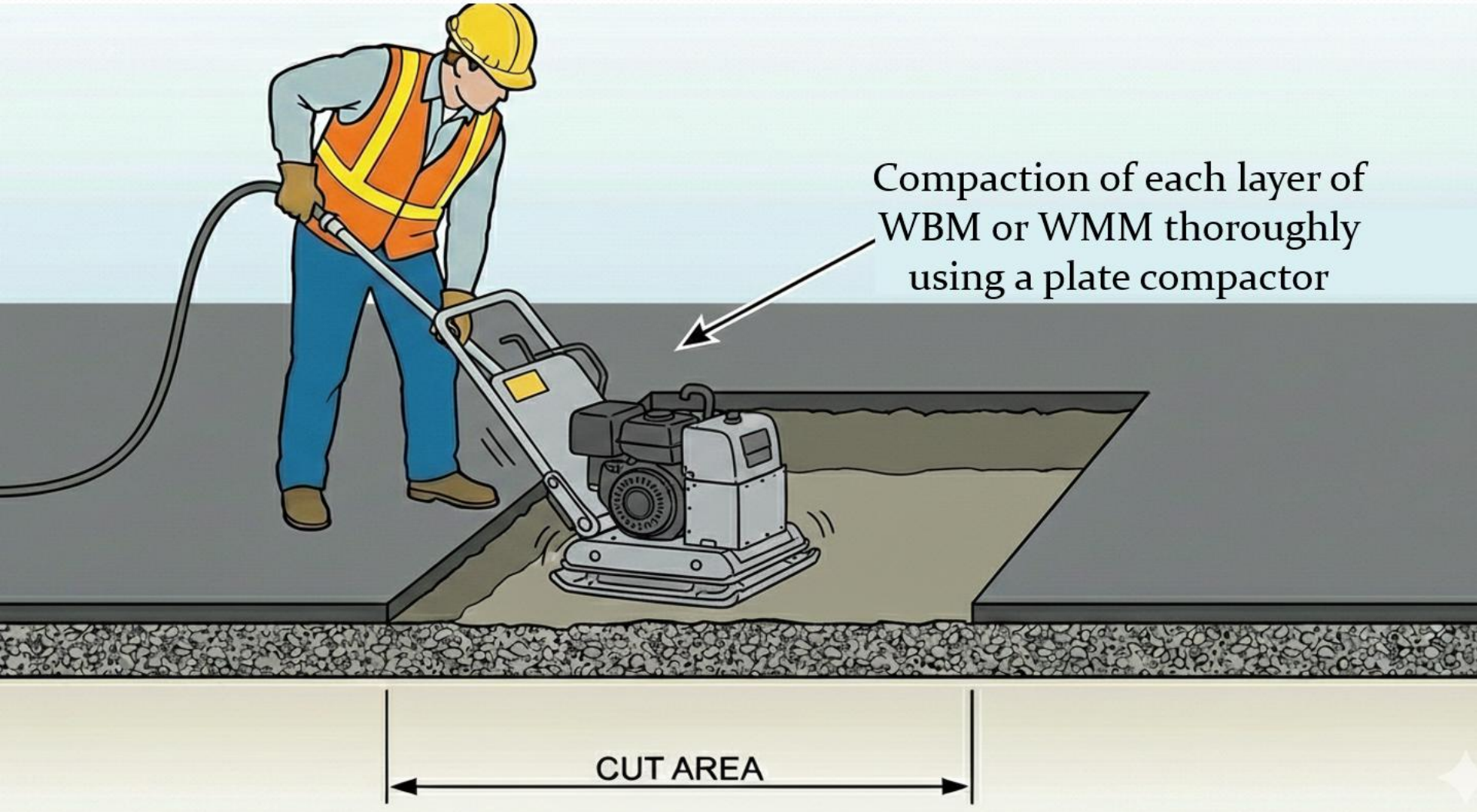
STEP 4: CLEANING THE CAVITY



STEP 5: PREPARING THE BASE (For Full-Depth Repairs)

1. If the granular base was excavated, backfill the area with approved granular material (WMM/WBM) in layers not exceeding 100mm.(Loose)
2. Compact each layer thoroughly using a plate compactor.
3. Apply a Prime Coat (e.g., Emulsion SS-1) to the new granular base and allow it to cure (set) as per specifications (As per site requirement)

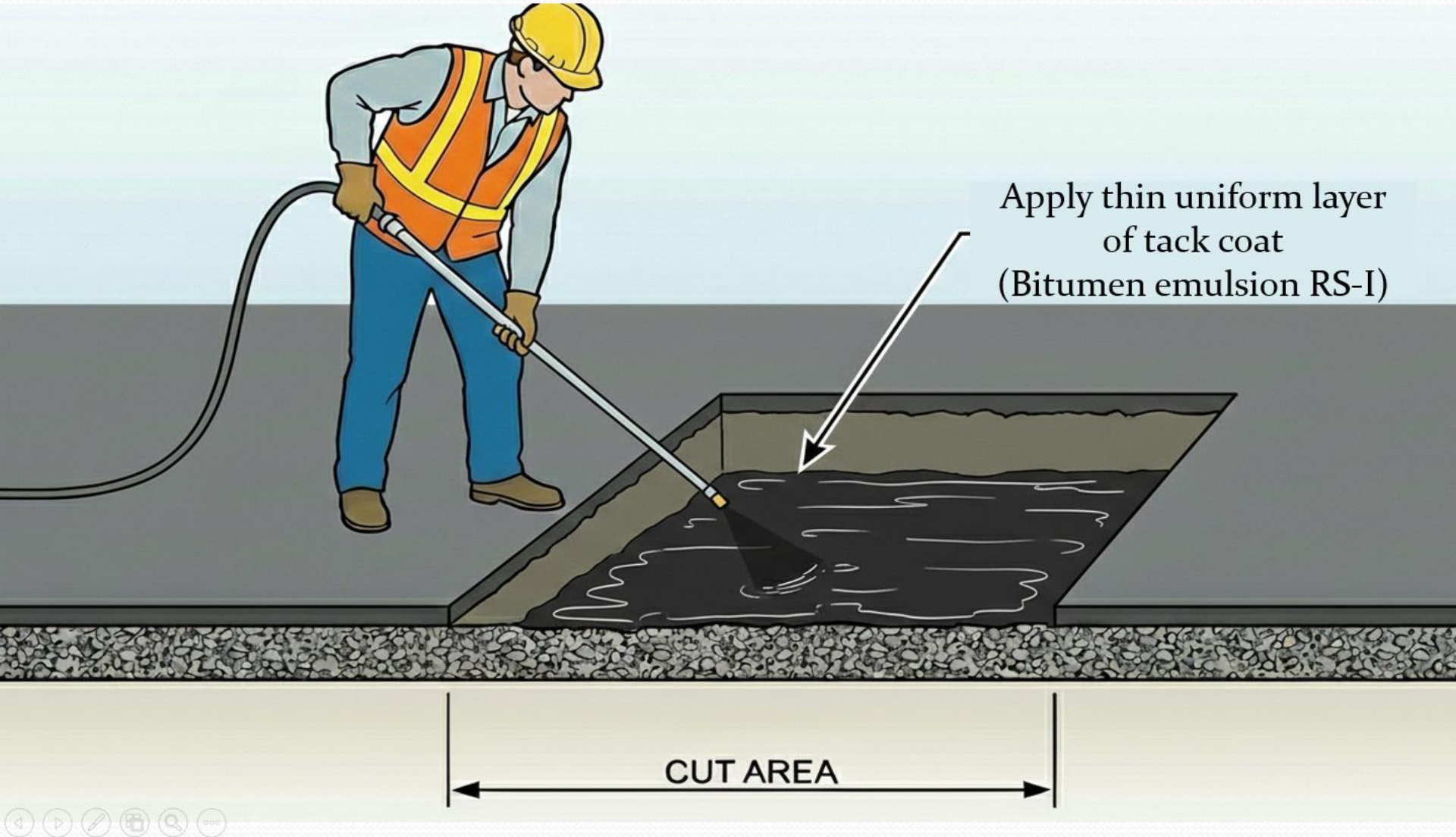
Step-5: Preparing the base



STEP 6: APPLYING TACK COAT

1. **CRITICAL:** Apply a thin, uniform layer of Tack Coat (Bitumen Emulsion RS-1) to the **bottom** and all **vertical faces (sides)** of the clean cavity.
2. Application should be a thin film, not a thick pool. Over-application can create a slip plane.
3. Allow the emulsion to "break" (turn from brown to black) before placing the mix.

Step-6: Applying tack coat



STEP 7: FILLING WITH BITUMINOUS MIX

1. Place the approved bituminous mix (Hot Mix preferred) into the prepared cavity.
2. If the repair depth is greater than 75 mm, the mix must be placed and compacted in multiple layers. No single compacted layer should exceed 75 mm.
3. The material should be spread uniformly with a rake, ensuring corners are filled.
4. The loose height of the final layer should be 20-25% above the road surface to allow for compaction.
5. The gradation of Bituminous mix / should confirm to clause 5.6, (Premix with seal coat) 5.7 (Dense graded patching material) of IRC 82-1982.

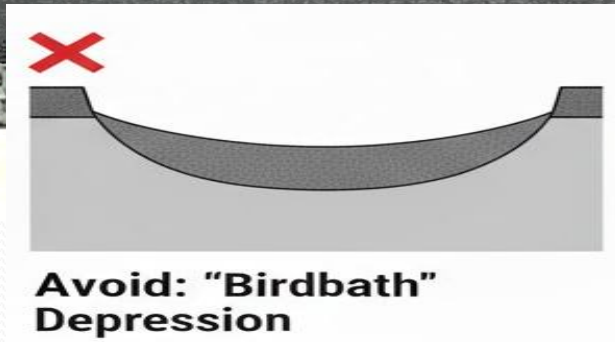
Step-7: Filling with bituminous mix

STEP 8: COMPACTION

1. **CRITICAL:** Begin compaction with a Roller/Plate Compactor from the **edges and move inwards** towards the center. This ensures the patch is locked tightly against the existing pavement.
2. Continue compaction until the patch is dense and no further movement is visible. The surface achieved should be not be open and seal coat may be used for achieving non porous surface
3. **CRITICAL :**The final compacted surface of the patch must be **3mm to 5mm higher** than the surrounding road surface.

   This slight "over-build" allows for secondary compaction by traffic and prevents a "birdbath" (depression) from forming, which would collect water and cause new failures.

Step-8: Compaction



STEP 9: FINISHING AND OPENING

1. Check the final level and smoothness using a 3-meter straight edge.
2. The edges of the patch can be sealed with a thin application of binder and blotted with fine sand to prevent water ingress.
3. Remove all tools, equipment, and debris from the site.
4. Do not open the patch to traffic until the mix has cooled to the ambient temperature (Hot Mix) or cured (Cold Mix) and is stable. Remove all traffic management devices only after the patch is ready. If stopping of traffic is unavoidable then lime spreading may be done

Step 9. QUALITY / SAFETY CONTROL CHECKS

The supervising JE/AE must ensure:

- Traffic safety measures are in place before work starts.

Traffic safety measures must be in place before work starts to control vehicle and pedestrian movement.

- The cut shape is rectangular/square.

- The cut edges are vertical.

- The cavity is clean and dry (compressed air used).

- Tack coat is applied to all faces (bottom and sides).
- Compaction is done in layers (if >75mm) using plate compactor/Roller

- Compaction is done from edges to centre.

- The final patch level is 3-5mm (higher) than the road.

10. DOCUMENTATION

For all patch repairs, the following records must be maintained:

1. **Road Maintenance Register:** Location (Chainage), date, and defect type, Vehicle, Quantity and Temperature of Bituminous mix temperature at the time of laying and Rolling is to be recorded. The location of patches of two continuous years would be checked by JE , if same then cause of failure would be further reported for proper rectification.

2. **Photographic Record:** Pre-repair (with marking), during-repair (cleaned cavity), and post-repair (finished patch) photos.

3. **Measurement Book (MB):** Entry with accurate dimensions (Length, Width, Depth) for payment and record-keeping. As applicable

4. One test for gradation and Bitumen content of both open graded and dense graded Bituminous pre-mix be carried for each day's work.

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and is resorted to for filling pot-holes, shallow depressions, rutting and edge irregularities. Patching when used for filling the ruts and depressions, can also be termed as "levelling".

5.2. Liquid Seal

5.2.1 **Description** : Liquid seal consists of an application of liquid bitumen (penetration grade, cut-back or an emulsion) and covering the same with agggregate. This is applicable for the rectification of fatty surfaces, stripping, loss of aggregates, and ravelling.

5.2.2. **Materials** : Penetration grade bitumen should be of suitable grade. A cold application cut-back such as RC-3 or MC-3 is also suitable. If emulsion is to be used, it should be of the rapid setting type. The quantity of binder shall be as follows :

	Binder	*Quantity for 10 sq. m (kg.)*
1.	Penetration grade bitumen	9.8
2.	Cold application cut-back, RC-3 or MC-3 (Quantity in terms of penetration grade bitumen)	9.8
3.	Emulsion, RS	10—12

The cover aggregates should be of a nominal size of 6.3 mm, viz. passing through 10 mm IS Sieve and retained on 2.36 mm IS Sieve. The quantity of cover aggregate should be 0.09 cu. m. per 10 sq. m.

5.2.3. **Construction method** : The area to be treated shall be thoroughly cleaned. If penetration grade or cut-back bitumen is to be used, the wet areas should be allowed to dry. However, if emulsified bitumen is to be used, the surface requires to be dampened. But such patching with emulsified bitumen should not be done when it is raining.

The binder is applied either by a spray nozzle or, only where permitted, by pouring pots at the appropriate temperature and rate. Cover aggregates are then spread at the specified rate and rolled in position with a 6-8 tonne steel wheel roller. When penetration grade bitumen is used, the road can be opened to traffic on the following day or if required to be opened immediately, a speed restriction of 16 km/h shall be enforced till the following day. When cut-back bitumen is used, the finished surface shall be closed

to traffic until it has sufficiently cured to hold the cover aggregate in position. If emulsion is used, the road can be opened to traffic after 4-6 hours.

5.3. Fog Seal

5.3.1. **Description** : Fog seal is a light application of emulsified bitumen, usually without a cover aggregate. It is used to increase the binder content of bituminous surfaces, rejuvenate oxidised and old surfaces, fill in cracks and prevent ravelling. It can also be used as an emergency treatment measure for hungry surfaces.

5.3.2. **Construction method** : The bituminous binder is a slow setting emulsion. The emulsion is diluted with an equal amount of water and sprayed at the rate of 0.5—1.0 litre/sq. m (of diluted material) depending upon the texture and dryness of the old pavement. The seal sets in about 30 minutes. The traffic can be allowed on the area after the seal has set to a firm condition so that it is not picked-up by the traffic.

5.4. Slurry Seal

5.4.1. **Description**: Slurry seal is a mixture of fine aggregates, mineral filler and emulsified bitumen with water added to achieve slurry consistency. The ingredients are mixed and spread evenly on to bituminous surfaces to fill cracks, repair ravelled pavements, smooth or hungry surfaces, rectify loss of aggregates, rejuvenate oxidised and open-textured old bituminous surfaces, and to provide a skid resistant surface.

5.4.2. **Materials** : The aggregate gradation is very important. The following grading is found suitable :

Gradation of aggregates for slurry seal

Sieve designation	*Per cent by weight passing the sieve*
4.75 mm	100
2.36 mm	80-100
1.18 mm	50-90
300 micron	15-50
150 micron	10-25
75 micron	3-10

In order to obtain the above gradation, fine grit, sand and filler can be mixed in suitable proportions.

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The binder is a slow-setting emulsified bitumen. The mix has to be designed to have a consistency such that the slurry when spread, would flow in a wave approximately half a metre ahead of the strike-off squeegee. This would ensure that the slurry would not bridge over the cracks without filling them. About 18-20 per cent emulsion and 10-12 per cent of water by weight of the aggregates would approximately make a satisfactory mix.

5.4.3. **Construction method** : The area is thoroughly cleaned after carrying out patching where necessary, and a tack coat consisting of a light application of bitumen emulsion diluted with three parts of water is applied at the rate of 2.5—3.5 kg/10 sq.m. The slurry seal can be mixed by a continuous machine or a batch type unit. For smaller works batch type unit is preferable. Measured quantity of aggregate is taken in the slurry mixer. Water for pore-wetting is mixed with the aggregates. Bitumen emulsion is added to the mixer and the slurry is then spread on the road. The slurry may be spread and forced into voids by hand squeegees or spreader boxes. Spreader boxes are suitable for controlled laying. The slurry is laid at an approximate coverage rate of 200 sq. m. per tonne giving a thickness of about 2 to 5 mm. No rolling is required. The traffic can be allowed on the area after the slurry seal has set to a firm condition so that the mixture is not picked-up by the traffic.

5.5. Sand Bituminous Premix Patching

5.5.1. **Description :** Sand bituminous premix patching consists of laying a mixture of fine aggregate and bituminous binder to rectify cracks, slippage, corrugations, shoving, shallow depressions and ravelling. The fine aggregate shall be a medium coarse sand (fineness modulus of more than 2.5) or fine grit passing 1.70 mm IS Sieve and retained on 180-micron IS Sieve. The binder can be a paving bitumen of suitable penetration grade, rapid curing cut-back such as RC-3, or a medium curing cut-back such as MC-3.

5.5.2. **Construction method :** The area is thoroughly cleaned and a tack coat with penetration grade bitumen, RC-3 or MC-3 is applied at the rate of 7.5 kg per 10 sq. m. (quantity in terms of penetration grade bitumen). The mix is prepared in suitable mechanical or hand-operated mixers by mixing binder and sand. The quantity of sand and binder shall be 0.06 cu. m. and 6.8 kg (quantity of binder in terms of penetration grade bitumen) per 10 sq. m. area respectively. The mix is spread and laid wherever required. When smoothening a corrugated surface, it may be expedient to use a drag spreader with its blade adjusted

to clear the high spots. The mixture is then rolled thoroughly till it is compacted.

5.6. Premix Open-graded Patching

5.6.1. **Description :** Premix open-graded patching consists of making up the area to be patched by a premix open-graded material consisting of a binder and aggregates, compacting and finishing with a seal coat. This repair method is applicable for fatty surfaces, slippage, rutting, shoving, shallow depressions and pot holes.

5.6.2. **Materials :** Stone aggregates of the following sizes and at the quantities specified below shall be used for premixing :

	Quantity for 10 sq.m. area (For a thickness of 20 mm)
(i) Coarse aggregates—12.5 mm size (passing 20 mm IS Sieve and retained on 10 mm IS Sieve).	0.18 cu.m.
(ii) Coarse aggregates—10 mm size (passing 12.5 mm IS Sieve and retained on 6.3 mm IS Sieve).	0.09 cu.m.
Total :	0.27 cu m.

The binder can be paving bitumen of suitable penetration grade, rapid curing cut-back such as RC-3, medium curing cut back such as MC-3, or a medium setting bitumen emulsion. The quantities of binder for various operations are indicated below :

		Quantity for 10 sq.m. area (kg.)	
		Tack coat	Premix (for a thickness of 20 mm)
1.	Penetration grade bitumen	7.5	14.6
2.	Cold application cut-back, RC-3 or MC-3 (Quantity in terms of penetration grade bitumen)	7.5	14.6
3.	Emulsion, MS	7.5	15-18

The materials for seal coat will depend on the type of seal coat provided ; for a liquid seal coat it shall be as per Clause 5.2.2., and for a premix seal coat it shall be as per Clause 5.5.

5.6.3. **Construction method :** The area to be patched should be thoroughly cleaned. For rectifying unevenness, the uneven

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area is first defined by a string line and marked ; the area upto at least 0.3 m beyond the marked area on all sides is thoroughly cleared. A tack coat is applied on the uneven area and then the patching material is applied. For rectifying pot-hole, the edges of the hole are squared and the hole cut to solid material with vertical edges, before applying the tack coat and patching material. The surface is allowed to dry if it is wet and the work is to be done by penetration grade bitumen or cut-back. If a bituminous emulsion is used, slight dampness is required. Patching of permanent nature should be allowed only when it is not raining. However, if it is raining continuously, as an emergency measure, pot-holes can be temporarily filled with stone or brick ballast laid and compacted to WBM specifications using non-plastic filler, till such time when regular maintenance measures can be taken. If an emulsion is used the tack coat is not applied earlier than ten minutes before laying the premix. A mechanical mixer should be preferred. A drier unit for the aggregates will be an added advantage. For use with cold application cut-back and emulsion, a power mixer should be preferred. If no power mixers are available, mixing for small size jobs can be done in hand operated drum mixers. For still smaller jobs, hand mixing by shovels on a platform can be resorted to. When using a cold application cut-back, the premix should be prepared at least 3 days in advance of use. If necessary such a mixture can be stock-piled and covered with a tarpaulin and stored for 2-3 weeks. The patch is filled with the prepared premix, care being taken to see that filling is done in layers not exceeding 40 mm thickness. Each layer is compacted thoroughly either by rolling using a roller or a truck wheel or by means of vibratory tampers. The final surface should be sealed with a liquid seal coat as per Clause 5.2. in areas having rainfall of over 150 cm per year or with a premix seal coat as per Clause 5.5. in areas having rainfall of under 150 cm per year. The resultant surface shall conform to the adjacent levels. Humping for compaction by traffic should not be allowed.

5.7. Premix Dense-graded Patching

5.7.1. **Description** : Premix dense-graded patching consists of making up the area to be patched by a dense-graded premix material consisting of a binder, aggregates and filler, compacting and finishing. This is a high quality, thoroughly controlled hot mixture for which the mix design is to be invariably got done before the start of the work in a suitably equipped laboratory. For existing superior types of surfaces, the use of this type of patching may be considered. This type of patching can be used for repairing slippage, rutting, shoving, shallow depressions, or pot-holes.

5.7.2. **Materials:** The coarse aggregates, fine aggregates and filler shall be mixed in suitable proportions to obtain a final composition satisfying any of the two gradings set forth below:

Gradation of mineral aggregates

Sieve designation	(Per cent by weight passing the sieve) Grading 1	Grading 2
20 mm	—	100
12.5 mm	100	80-100
10 mm	80-100	70-90
4.75 mm	55-75	50-70
2.36 mm	35-50	35-50
600 micron	18-29	18-29
300 micron	13-23	13-23
150 micron	8-16	8-16
75 micron	4-10	4-10

The binder shall be a paving bitumen of suitable penetration grade. The quantity of binder by weight of total mix shall be 5.7.5 per cent.

5.7.3. **Design requirements** : The design requirements of the mix shall be as under :

Number of compaction blows, on each end of Marshall specimen	50
Marshall stability in lb.	750
Marshall Flow-0.01 in.	8-16
Per cent voids in mix	3-5
Per cent voids in mineral aggregates filled with bitumen	75-85

The design criteria for repair materials should preferably be the same as for the earlier mix.

5.7.4. **Construction method** : The area to be patched should be thoroughly cleaned. For rectifying unevenness, the uneven area is first defined by a string line and marked; the area upto at least 0.3 m beyond the marked area on all sides is thoroughly cleared. A tack coat is applied at the rate of 7.5 kg per 10 sq. m. on the uneven area and then the patching material is applied. For rectifying pot-hole, the edges of the hole are squared and the hole cut to solid material with vertical edges, before applying the tack coat and patching material. The surface is allowed to dry, if it is wet. Patching work of permanent nature shall be allowed only when it is not raining. However if it is raining continuously, as an emer-

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gency measure, pot-holes can be temporarily filled with stone or brick ballast laid and compacted to WBM specifications using non plastic filler till such time when regular maintenance measures can be taken. The mixing shall be done in a hot mix plant. A small capacity portable hot mix plant will be very convenient for small patching jobs. The patch is filled with the prepared mix, care being taken to see that filling is done in layers not exceeding 40 mm thickness. Each layer is compacted thoroughly either by rollers or by means of vibratory tampers before the mix cools below 100°C. The resultant surface shall conform to the adjacent levels. Humping for compaction by traffic should not be allowed. Adequate quality control shall be exercised at every stage of the work as per IRC:29-1968 and IRC Special Publication: 11-1977.

5.8. Penetration Patching

5.8.1. **Description:** Penetration patching consists of making up the area to be patched by a course of aggregates, compacting the same, applying bitumen and key aggregates and finishing off with a seal coat. The patch is used for surface disintegration over 12 mm deep. The patching may be done in layers, but the depth of the individual layers should not exceed 50 mm.

Although it is known from experience that penetration patching does not produce as good a patch as premix material due to lack of accurate control of the amount of bitumen to be used, emergency patches of this type may be necessary as a last resort in the absence of premix material. Hence use of penetration patch should be very limited.

5.8.2. **Materials:** The coarse aggregates should conform to the following grading requirements:

Sieve designation	*Per cent by weight passing the sieve* (for 50 mm compacted thickness)
50 mm	100
25 mm	35-70
12.5 mm	0-15
2.36 mm	0-5

The key aggregates should conform to the following grading

requirements :

Sieve designation	*Per cent by weight passing the sieve* (for 50 mm compacted thickness)
20 mm	100
12.5 mm	35-70
4.75 mm	0-15
2.36 mm	0-5

The quantities of the aggregates for 50 mm compacted thickness should be as under :

	Quantity for 10 sq. m. area
Coarse aggregates	0.60 cu.m.
Key aggregates	0.15 cu.m.

The binder shall be a paving bitumen of suitable penetration grade, rapid curing cut back such as RC-3, or medium curing cut-back such as MC-3. The quantities of binder are indicated below:

	Quantity for 10 sq. m. area (kg.) Tack coat	Grouting (for 50 mm compacted thickness)
1. Penetration grade bitumen	7.5	50
2. Cold application cut-back, RC-3 or MC-3 (Quantity in terms of penetration grade bitumen)	7.5	50

The materials for seal coat will depend on the type of seal coat provided; for a liquid seal coat it shall be as per Clause 5.2.2. and for a premix seal coat, it shall be as per Clause 5.5.

The gradation and quantities of the materials shall be modified depending on the thickness of the layers to be achieved.

5.8.3. **Construction method:** The area to be patched should be thoroughly cleaned. If it is a pot-hole, the edges of the hole should be squared and the hole cut to solid material with vertical edges. All loose materials are removed. The surface should be allowed to dry if it is wet. Patching of permanent nature shall be done only if the weather is dry and free from dust storm. However if it is raining continuously, as an emergency measure, pot-holes can be temporarily filled with stone or brick ballast laid and compacted to WBM specifications using non-plastic filler, till such time when regular maintenance measures can be taken. A tack coat with

Thank You