



सत्यमेव जयते

GOVERNMENT OF INDIA

भारत सरकार

MINISTRY OF RAILWAYS

रेल मंत्रालय

# **Guidelines on Waterproofing in New/Old Construction**

**Report no. RDSO/WKS/2015/1 Revision -2**

**October - 2019**

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## **PREFACE**

This report covers water proofing methods in new as well as old building constructions, roads and new construction chemicals. This report supersedes Guidelines on Waterproofing on New /old construction (Guideline No. RDSO/WKS/2015/1 Rev.1: January 2019). Repair of damaged structure due to seeping water is a very costly affair. Hence proper waterproofing of building at construction stage is essential. This report also covers the system of roof overhangs and extending part of roof as parapet wall. Besides this modern water proofing methods including the use of nano technology and construction chemicals has also been incorporated in the report. This guideline aims to bring together various water proofing practices available in scattered forms in various text books, handbooks, codes & manuals and Industries for the benefit of field engineers. It is hoped that engineers in the field will find it a useful source of knowledge and guidance. If there is any suggestion for improving or if any error/ discrepancy is noticed in its contents, kindly suggest.

## Water Proofing of Buildings

A building may be a house, office or service building is an important asset involving large investment. Water is the most destructive weathering element of these structures; water continues to damage or completely destroy more buildings and structures than natural disasters. It is very costly to repair if a building structure is damaged by water. Roof /Terrace is the most crucial segment of a building from water leakage point of view and assumes greater significance in case of large plan terraces of buildings, and it is exposed to direct climatic variations, extremes of rainfall and structural movements caused thereby and every effort should be taken at the design stage, to ensure that a proper protection system has been incorporated. It has often been found that the economic solution is not always the best solution. So, the system, which assures maximum protection, should be selected even though it may cost little more.

Waterproofing is the formation of an internal or external membrane which is designed to prevent water from entering or escaping the concrete. Internal membranes are created with waterproofing admixtures. External membranes are applied to the surface of the concrete

Basic concept behind various methods used for water proofing, is use of material such as admixtures, impregnation, film forming membranes, surfacing, joint seal and grouting.

**Admixtures:** Mineral admixtures and Chemical admixtures widely used for specific purposes. These help to reduce the water content of mix and make the concrete dense, compact and durable.

**Impregnation:** For water proofing of old and new structures, impregnation type is used. In this method the solution is penetrated into the pore structures considering three different actions such as hydrophobic, partial filling and filling. For hydrophobic phase silane, siloxane, diffused quartz carbide solution are used. For partial filling phase silicone, sodium silicate solutions are being used. For filling low viscosity epoxy and methacrylate solutions are being used.

**Film forming membranes:** This may be liquid applied waterproofing coating or a preformed elastomeric membrane.

**Surfacing:** For water proofing, asphalt, concrete, epoxy mortar, polymer concrete, polymer modified mortar etc. are used as an overlayment or cover over a concrete.

**Sealants** : Joints are the necessary important parts of the structures as it acts as a link between parts of structures as column-beam joint , column-slab joint, slab-slab joint , beam-beam joint, floor-floor joint etc. all these shall be sealed with proper sealants.

## **1.0 Water Proofing during Construction stage:**

Waterproofing of building at construction stage will not only prevent damage caused by the water but also add value to it over the period of time through reduced maintenance cost. In new construction, water proofing treatment is required from the foundation stage in case of basement/ underground tanks etc. to the roofing stage.

Due to inadequate workmanship/ poor material quality, dampness may be seen at the later stage. Stagnation of water due to undulation in roof surface, provision of less number of drainage pipes or choking of same and improper detailing at junction of parapet and roof etc., are some major contributors in making the roof leaky.

## **2.0 General precautions during construction of building:**

Since precaution is better than cure, necessary precautions should be taken during the construction of building itself. Some of the essential precautions to be taken at the time of construction are as follows:-

- 2.1 Every building plan, whether of new building OR of addition/alteration to a building, adequate thought into orientation of building and design of roofing system, chajja, openings in buildings etc should be given. It must give details of terracing to be provided, water proofing system for roof with details of joint with parapet wall, sunken floor and down water pipes in scale not smaller than 1:20.
- 2.2 It is absolutely essential that roofs are provided with adequate slope to ensure effective drainage. The slope of roof should be such that the water gets drained off quickly by achieving adequate velocity under influence of gravity. Even areas with light rainfall will require adequate slope as continuous light drizzling without dry spell will induce roof leakage problem badly. For the guidance of the field Staff, each building plan must also incorporate a roof plan, showing the position of drainage Pipes and direction and extent of slope on the roof. Drainage slope should not be flatter than 1 in 80 and should preferably be 1 in 40. There should be no undulations in the roof surface, which may result in accumulation of rain water. Extra care is necessary for construction of golas, coping and joints.

- 2.3 At the expansion joints of buildings, water proofing should be strengthened by inserting a PVC or a copper plate to prevent water seeping. These joints should also be plugged by a good sealant. Poly-sulphide based flexible sealants have good adhesion to concrete surfaces and can be compressed or stretched upto 50% of the width of the joints and are good material for sealing of expansion joints. Depth of the expansion joints above the copper/PVC plate should normally be kept half of the joint width and should not exceed 20 mm.
- 2.4 Special precautions should be taken for sealing of area around the water spouts to make them water proof.
- 2.5 Any impermeable layer/coating should never be applied on both faces of the wall as the wall must be allowed to “breathe”. A non-permeable finish or waterproof finish should not be applied on a wet wall, as it takes a long time to lose water used during construction.
- 2.6 Dense and low permeability of concrete also ensures relief-from dampness and comes by adequate cement content and low water cement ratio in concrete apart from required level of compaction and adequate curing. Use of Mineral and chemical admixtures are widely used for specific purpose. These all help to reduce the water content of the mix and make concrete dense and compact, crack free and durable. Compatibility of Chemical admixtures with the concrete mix ingredients, should be checked before going for casting of Slab or any concreting activity, as RMC plants readily supply concrete mixes. Use of Integral waterproofing compounds for cement mortar and concrete shall comply IS 2645-2003.
- 2.7 Area surrounding plinth of the building should be filled with good earth and rammed with slope away from the building, preferably with plinth protection apron.
- 2.8 Proper drip course should invariably be provided on parapet wall copings, sun-shades, chajjas etc. Particular care to be taken to seal architectural façade with Main structure of building so that these joints, which may open during its designed life, do not become a source of water ingress locations.
- 2.9 Sunken floors are a constant source, of leakage and dampness. These floors are provided for accommodating the toilet seats. Sunken floors must invariably be coated with suitable epoxy or polyurethane compound or polymer cementitious waterproofing compound.
- 2.10 Joints of the W.C. pans and the trap should not be sealed with cement mortar, as it has poor adhesion to ceramic surfaces. Also shrinkage cracks develop in

the cement mortar. Such joints should be sealed with epoxy putty, which has good adhesion to ceramic surface and is not affected by acids and chemicals.

- 2.11 Joints in tiles provided in floors of toilets and bath rooms are a source of leakage. A specially formulated solvent based polymer sealant is commercially available for sealing these joints. It is a clear transparent compound, having low viscosity and excellent adhesion to ceramic surfaces.
- 2.12 Floors of bath rooms should be constructed of materials which do not readily absorb moisture. Entire floor to be sunk 25 mm from adjoining floor. Slope towards outlet 1 in 60 is recommended.
- 2.13 Bath room walls to a height of at least 1 M from floor (2 M where shower is provided) should be made of impervious material such as cement plaster (smooth finish) with water proofing compound, Mosaic, Ceramic tiles or stone lining.
- 2.14 Any Concealed water supply (Hot and Cold) pipeline network needs to be checked thoroughly at the time of installation and checked personally by SSE, particularly joints, to ensure it does not leak, after tiles are placed on walls. The same applies to drainage pipelines of Wash Basins which may be encased in flooring tiles. A sketch showing concealed pipe network and distribution layout of bathroom shall be fixed on the back of bathroom door for reference in future.
- 2.15 Specifications laid down by the manufacturers of the water proofing products should be followed to ensure that no air bubbles are left between the under lying surface and the water proofing layer. Adequate overlaps should be provided for the water proofing layers, including cover up to the parapet wall. There are a large number of relevant Indian Standards and Code of practice available. Their provisions regarding material & execution may be followed.
- 2.16 Adequacy of drainage must be ensured. As a general guide line for every 40 M<sup>2</sup> of roof area, one 100 mm diameter rain water pipe must be provided. Drainage will also depend upon the intensity of rain fall in the area. As per provisions of IRWM-2000, The size of rain water pipes, depending upon the average rate of rain fall and roof area, should be as given in Table, for its adequacy.



Diameter of pipes in mm	Average rate of Rainfall in mm/hr (Roof area, m <sup>2</sup> )					
	50 m <sup>2</sup>	75 m <sup>2</sup>	100m <sup>2</sup>	125m <sup>2</sup>	150m <sup>2</sup>	200m <sup>2</sup>
50	13.4	8.7	6.6	5.3	4.4	3.3
65	24.1	16.0	12.0	9.6	8.0	6.0
75	40.8	27.0	20.4	16.3	13.6	10.2
100	85.4	57.0	42.7	34.2	28.5	21.3
125	-	-	80.5	64.3	53.5	40.0
150	-	-	-	-	83.6	62.7

### 3.0 Integral cement based treatment for water proofing on horizontal surface of under-ground structure/Basement: (CPWD DSR 2018 : Item No. 22.1 & Specification 2009 Vol.-2 Item No. 22.1)

#### 3.1 Water Proofing of Horizontal Surfaces of Under-ground Structure:

3.1.1 **Preparation of Surface:** The Water Proofing Treatment over the lean concrete/levelling course surface should adhere to the surface firmly; the surface of levelling course should be roughened properly when the concrete is green. In case the surface is not made rough before the concrete is set, the work of water proofing should not be executed till proper key is provided for the base layer of Cement Mortar.

3.1.2 **Blending Cement/Water with Water Proofing Compound:** The required quantity of cement bags to be used for a particular portion of work should be emptied on a dry platform. Water proofing compound conforming to IS 2645 should then be mixed properly with the cement. The quantity of water proofing compound to be mixed should be as prescribed by the manufacturer but not exceeding 3% by weight of cement. The quantity of cement and water proofing compound thus mixed should be thoroughly blended and the blended cement should again be packed in bags. For the water proofing compound in liquid form, the blending is to be done with water. This can be done by taking the just required quantity of water to be mixed in the particular batch of dry cement mortar. The required quantity of dry cement mortar to be prepared should be mixed with liquid water proofing compound from sealed tins with ISI mark. The water mixed with water proofing compound shall be thoroughly stirred so that the water is blended with water proofing compound properly.

3.1.3 **Rough Kota Stone:** Rough kota stone slabs of 22 mm to 25 mm thickness may be laid over the base course. Larger size of stone slabs i.e. 550 mm x 550 mm or 550 mm x 850 mm shall be used to minimise the number of joints. Besides kota stone, rough Shahabad tiles of suitable size may also be used. Now a days, various other materials in the form of 'Sheet Membranes' and

'Liquid Membranes' are also available in the market and are extensively used. Examples of sheet membranes are Multilayer bituminous paper system with gravel topping, Butyl rubber sheeting, Bitumen/polyethylene sheets, Neoprene rubber sheets and modified polypropylene bitumen sheets. Examples of liquid membrane are Mastic asphalt, modified polyurethane tar, Flexible epoxy resins, Acrylic co-polymers and epoxy based paints.

**3.1.4 Preparation of Cement Slurry:** Cement slurry shall generally be prepared by using 2.2 kg of blended cement per sqm. area. Each time only that much quantity shall be prepared which can be covered on the surface and the entire surface in turn should be covered with 25 mm thick cement mortar base within half an hour. Slurry prepared and remained unused for more than half an hour shall be rejected.

**3.1.5 Preparation of Cement Mortar for base course:** Cement mortar 1:3 (1 blended cement: 3 coarse sand) shall be prepared with cement/ water duly blended as explained in clause 3.1.2 with water proofing compound. Only that much quantity of cement mortar which can be consumed within half an hour, shall be prepared. Any cement mortar that is prepared and remains unused for more than half an hour shall not be used in the work and shall be rejected.

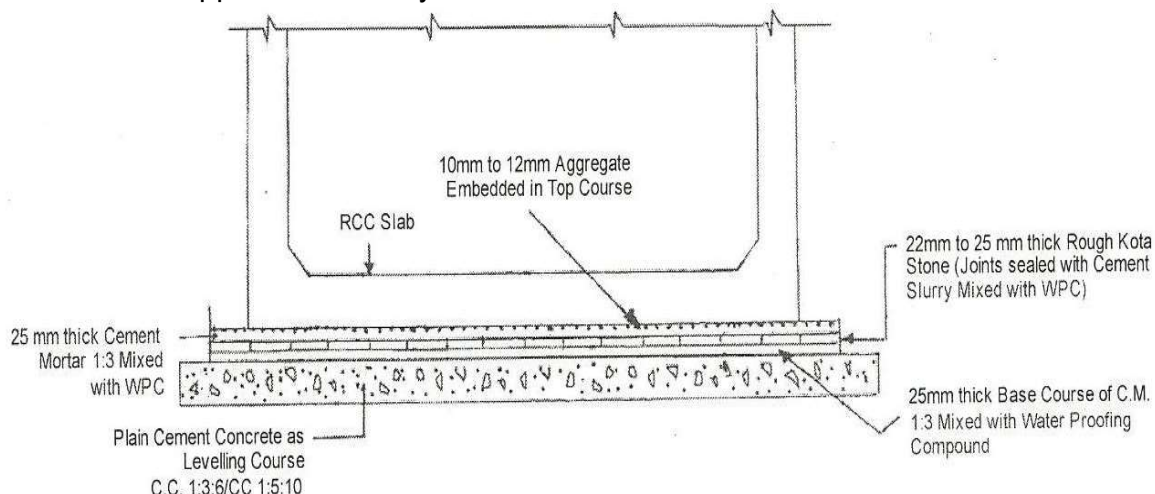
**3.1.6 Laying Water Proofing Course:**

- Before laying the base course of cement mortar, the lean concrete surface shall be cleaned neatly with water.
- Cement slurry prepared as per clause 3.1.4, shall be applied only on the area of the concrete surface, that can be covered with the cement mortar (1:3) base course within half an hour.
- The cement slurry should cover every spot of the surface and no place shall remain uncovered. Just after the application of cement slurry on the surface, the cement mortar prepared as per clause 3.1.5 should be used for laying the base course.
- Base Course should be laid to a perfect level with wooden / aluminium straight edge of at least 2 m long.
- The top surface of cement mortar should be finished neatly and later scratched when green with a suitable instrument before the base course dries and gets hard that is just before the base course takes up initial set.
- When the 25 mm thick base course is just getting set, the cement slurry prepared as per clause 3.1.4 should be spread over the base course upto the area that shall be covered with just two to three stone slabs.
- The cement slurry shall be spread in such a way that the area of base course to be covered immediately shall be covered with slurry without any gap or dry spots. Then immediately on applying cement slurry on the base course, the rough Kota Stone slabs (or other material as specified in clause 3.1.3) may be laid over the base course and pressed gently so that the air gap can be removed.
- The slurry applied on the surface which gets spread when the stone slab is pressed shall get accumulated in the joints of adjacent stone slabs and if any

gap still remains between the stone slabs the same should also be filled with additional quantity of cement slurry.

- Cement mortar 1: 3 prepared as per clause 3.1.5 shall be used for laying the next course.
- For laying this course 25 mm high wooden strips shall be used and the top surface shall be finished smooth without using additional cement or slurry.
- After laying 3<sup>rd</sup> course and before the mortar layer takes the initial set, Stone aggregate of 10mm to 12 mm nominal size shall be uniformly spread and lightly pressed into the finished surface @.008cubic meter/sqm (approx.1/2 Bag).
- The aggregates shall not be embedded totally inside the mortar and shall be visible on the top surface.
- In cases where slope is to be provided for the water proofing layer, grading with additional cement concrete/cement mortar shall be provided and then the water proofing layer shall be laid on the graded surface.

**3.1.7 Curing:** Immediately after completing the fourth layer, arrangements shall be made for the top RCC slab as quickly as possible and in the mean time till the top slab is casted the water proofing treatment shall be kept wet continuously. In case the concreting of slab gets delayed for more than 2 weeks the curing can be stopped after 14 days.

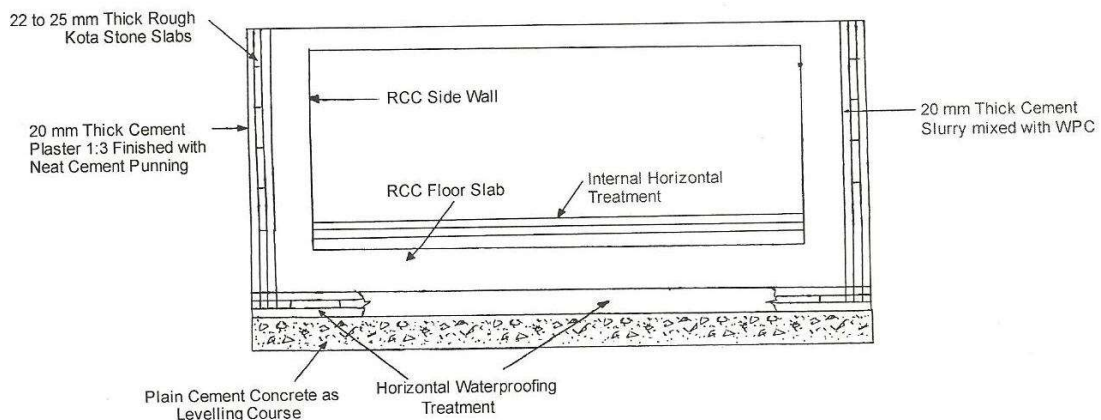


**Fig.1**

#### **4.0 Integral cement based water proofing treatment on the vertical surface of underground structures (CPWD DSR 2018: Item No. 22.2 & Specification 2009 Vol.-2 Item No. 22.2)**

**4.1 Preparing the Surface:** The surface of the structure to be treated shall be roughed either by raking of joints in case of brick/ stone masonry or by hacking the cement concrete surface with a specifically made hacking tool just after removing shuttering. Alternately, the surface should be roughened by providing spatter dash key as explained under clause 3.1.1. While doing water proofing to vertical faces from inside, it shall be ensured that water proofing treatment of floor slab is not damaged. Preferably, water proofing of vertical surface shall be done before that of horizontal surface.

- 4.2 **Blending Cement/Water with Water Proofing Compound:** As explained under clause 3.1.2.
- 4.3 **Rough Kota Stone Slab:** As explained under clause 3.1.3.
- 4.4 **Preparation of Cement Slurry:** As explained under clause 3.1.4.
- 4.5 **Preparation of Cement Mortar:** As explained under clause 3.1.5.
- 4.6 **Laying Water Proofing Course:** As explained under clause 3.1.6. In order to hold stone slabs in vertical position, the grip for the stone slab may be increased by planting 12 mm to 15 mm nominal size stone aggregate fixed with araldite on surface of each sand stone slab.
- 4.7 **Curing:** Same as explained under clause 3.1.7. Further till the water proofing work on vertical face is in progress, the water proofing work done on floor slab shall be kept wet for a minimum period of 14 days. Immediately after completion of water proofing on vertical faces of side walls, the water tank shall be gradually filled with water for testing.

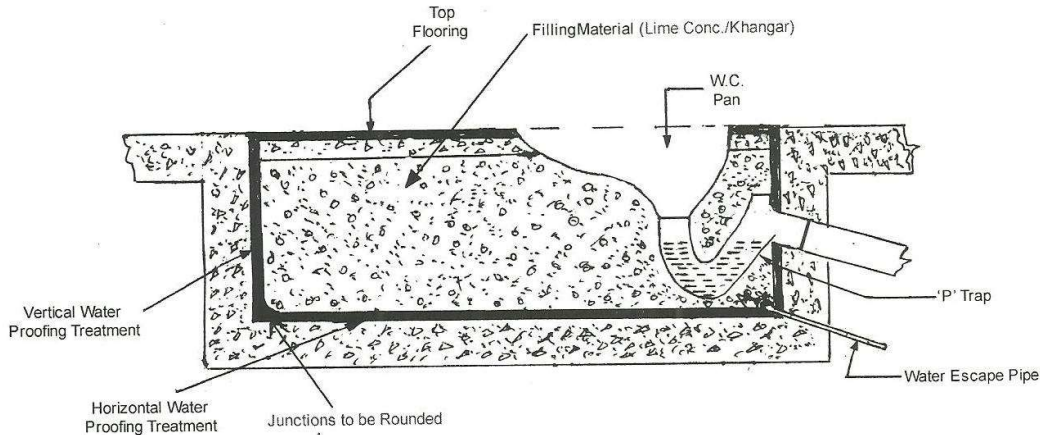


**Fig.2**

- 5.0 **Water proofing treatment to vertical and horizontal surface of depressed portion of WC, Kitchen etc. (CPWD DSR 2018 : Item No. 22.3 & Specification 2009 Vol.-2 Item No. 22.3)**
- 5.1 **Before the Water Proofing Treatment:** Before the water proofing treatment, the internal plaster of ceiling and walls of WC block leaving the portion for dado/skirting should be completed. Grooving / chasing for doing the concealed work of GI/CI pipes/Electrical conduits should be completed. Clean the depressed/sunken portion of WC of all debris, extra mortar sticking to the vertical and horizontal surface etc. Necessary holes for 'P' trap /Nhani trap/Water escape pipe etc should be completed.
- 5.2 **Preparing Surface and Fixing Pipes and Fittings:** Before the water proofing treatment work, proper key in the concrete surface should be provided. The depressed/sunken portion should be hacked by a hacking tool, after the

concrete slab is cast and when this concrete is still green. The vertical surfaces of the depressed /sunken portion should be hacked with a hacking tool just after the shuttering is removed. In case of old work, the water proofing treatment on such surfaces shall be permitted after making proper spatter dash key. Fixing the 'P' trap in position and all other pipes work including the water escape pipe shall be fixed properly and the holes should be plugged carefully before taking up the water proofing work.

- 5.3 **1<sup>st</sup> Course:** Cement duly blended with water proofing compound as explained in clause 3.1.2 shall be used for preparing the cement slurry. The consistency of the slurry should be such that 4.4 kg of blended cement with water proofing compound is used per sq. metre area of surface to be treated. The slurry should be started from the vertical faces towards the bottom of the floor as shown in Fig. 3 below. Particular care should be taken to see that the slurry is applied to corners without leaving any gap.
- 5.4 **2<sup>nd</sup> Course:** Immediately on applying the blended cement slurry on the surface to be treated cement plaster 20mm thick in cement mortar 1:3 (1 blended cement: 3 coarse sand) shall be applied both on vertical and horizontal surfaces taking particular care to complete the entire depressed/ sunken portion of WC within a day so that the plaster can be done without any joint. Junctions shall be properly rounded. The surfaces of the plaster shall be left rough but finished in one plain and cured for a week. On completion of the curing period both horizontal and vertical surfaces shall be cleaned properly and gently and allowed to dry.
- 5.5 **3<sup>rd</sup> Course:** Only after the surface is completely dried the blown or residual bitumen shall be applied @ 1.7 kg of bitumen per sqm area.
- 5.6 **4<sup>th</sup> Course:** 400 micron thick PVC sheet shall be spread evenly without any kink immediately, so that the PVC sheet sticks to the surface firmly. PVC sheet shall be continued to be laid over the main slab upto 100mm. Overlapping of PVC sheet should be done with a minimum overlap of 100 mm, duly pasting the overlapped sheet with an application of bitumen @ 1.7 kg./ sqm. The projections of pipes and 'P' trap outlet etc. inside the depressed/sunken portion of WC shall also be cladded with water proofing treatment layer upto a height of 150 mm, using a coat of bitumen with PVC sheet complete. The surfaces of depressed/sunken portion of WC shall not be left without covering with specified filling material and base concrete, otherwise the PVC sheet layer may be tampered by the labour working in the vicinity. Fixing up of WC pan, filling specified material and the top base concrete should be done as early as possible and the top horizontal layer of water proofing may be taken up later i.e. just before laying the floor tiles.



**Fig.3**

## **6.0 Water Proofing Treatment in Sunken portion of WCs, Bathrooms etc. (CPWD DSR 2018 : Item No. 22.5 & Specification 2009 Vol.-2 Item No. 22.5)**

### **6.1 Preliminaries to be Attended**

The preliminaries shall be attended as described in relevant clause 5.1.

### **6.2 Preparing Surface, Fixing Pipes and Fittings**

In this case, unlike as described in clause 5.2, no hacking of surface need be made, but only extra mortar sticking to the surface should be removed and the surface should be cleaned thoroughly. Fixing 'P' trap etc. shall be done as described in Clause 5.2.

### **6.3 Providing and Laying of Slurry for First Layer**

The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of blended cement per sqm of area. On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of grey cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for first application. The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface. The surface on application shall be air cured for 4 hours.

### **6.4 Providing and Laying of Slurry for Second Layer**

The quantity of slurry required for second application to be covered within an hour of mixing shall be prepared with 0.242 kg. cement + 0.126 kg. water

proofing compound + y litres of water per sqm. area and the required quantity of slurry thus prepared should only be used for second application. The application of 2nd layer of slurry is same as for first layer as detailed in clause 6.3. The applied surface shall be allowed to air cure for 4 hours and thereafter water curing shall be done for full 48 hours. In case no further work as described above is to be taken up immediately on completion of water proofing treatment due to any reason it is recommended to protect the treated portion with cement plaster 1:4 as a protective layer .

## **7.0 Junction of roof with parapet wall in New Construction:**

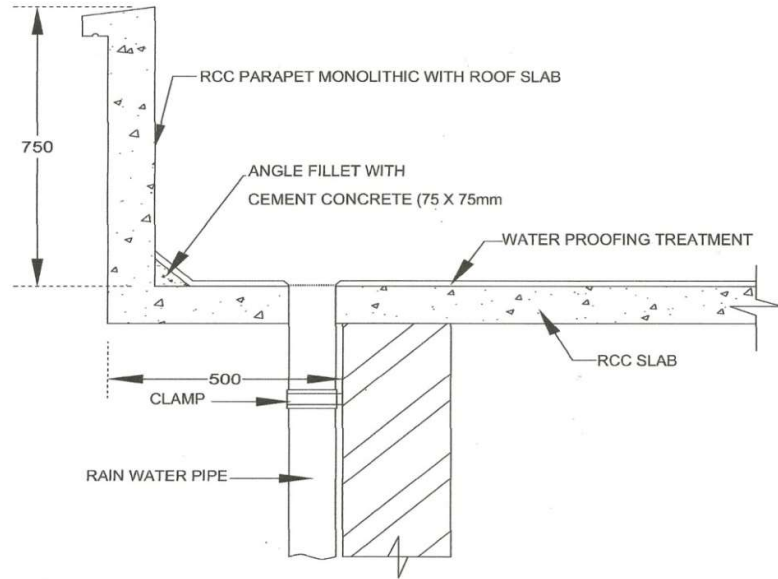
Junction of roof with parapet wall is a vulnerable location for leakage. Hence detailing at the junction of roof and vertical face of parapet wall is a necessary and complicated issue requiring careful planning.

Providing sufficient roof overhangs of about 0.50m and extending part of roof as parapet wall can address this issue to large extent as it avoids the junction points of roof with parapet wall. It also provides shade from rains and solar heat and help in saving energy, providing some spill over space and increase the life span of the building.

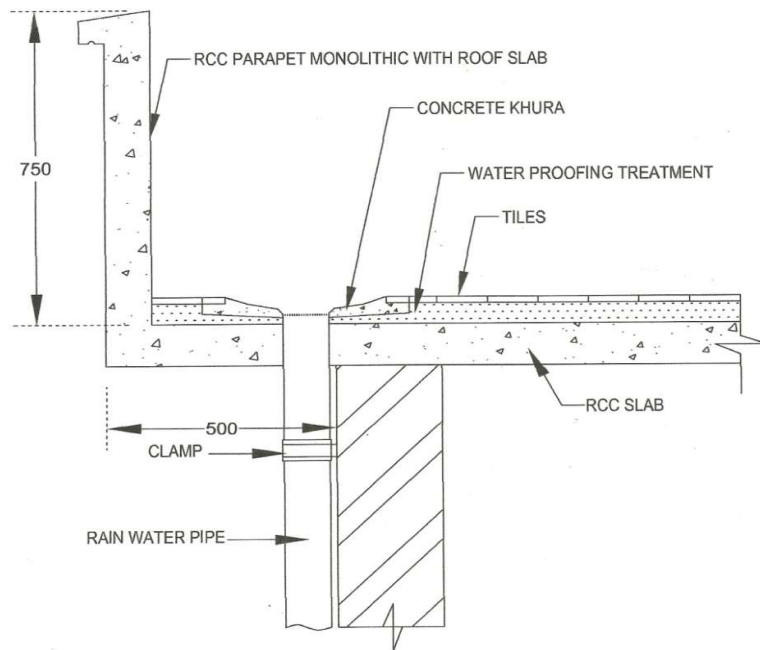
The following points should also be ensured at junction point:

- i) The fillet (angular or concave, not convex) of adequate size should be provided all along the junction of parapet wall with roof.
- ii) Coping on top of the parapet wall should also be provided with adequate slope along with the provision of drip course on either side.
- iii) Water proofing system should be extended from roof to parapet wall for a minimum height of 150 mm with a chase.
- iv) Typical details of junction arrangement of rain water pipe with roof are indicated in Fig. 5. Invert level of rain water pipe should be approx. 25 mm below the level of top of adjacent tiles/water proofing work. Grating should be fixed at the mouth of rain water pipe to prevent entry of leaves/other waste material from roof. Unless, specified otherwise, rain water pipe and fittings should be properly secured to the walls.

General arrangements at junction of roof with roof overhang and extending part of roof as parapet are given in fig.4& 5.



**Fig. 4**



**Fig. 5**

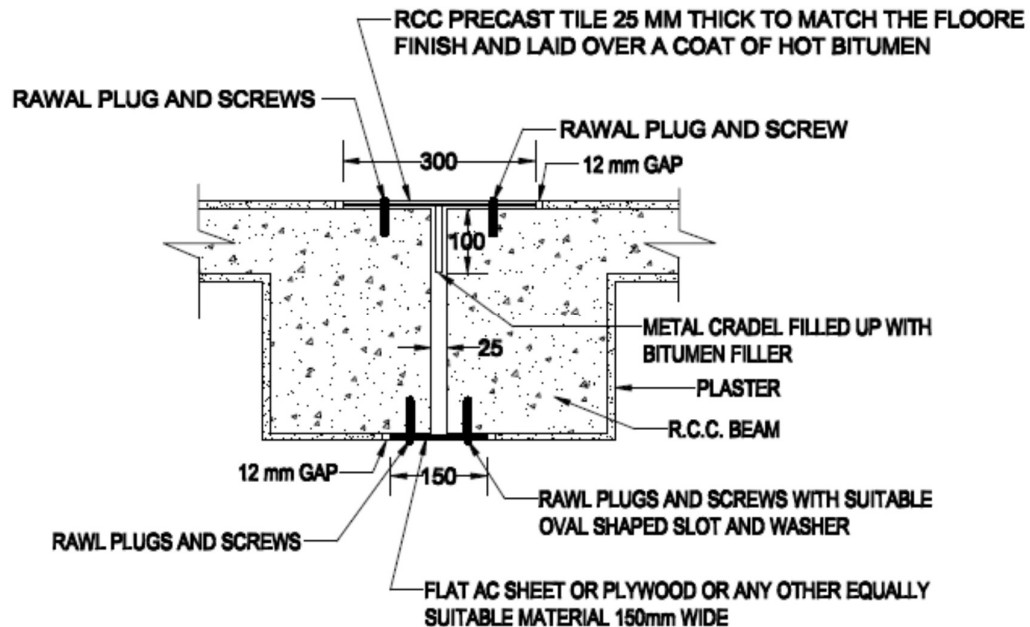
## GENERAL ARRANGEMENTS AT JUNCTION OF WALL AND ROOF WITH OVERHANG

### 8.0 Expansion Joints:

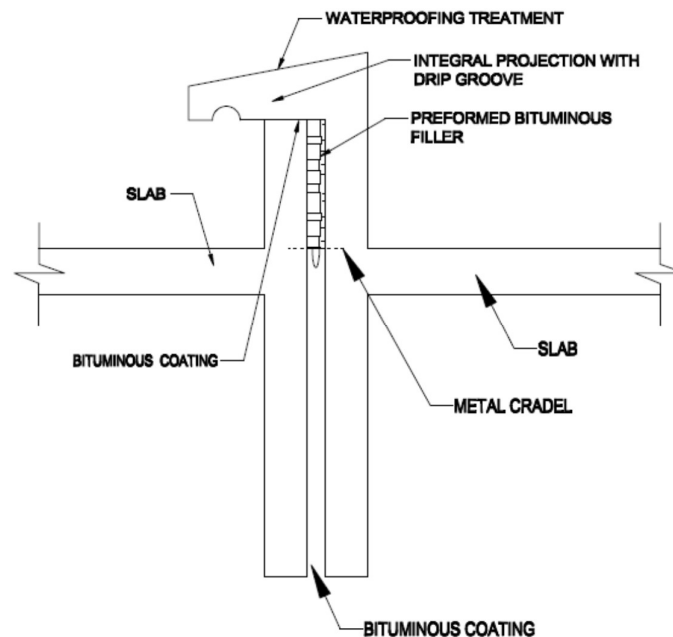
Expansion joints in buildings/ other structures may become source of perennial seepage due to failure of expansion joint filler sand sealants. Expansion joint should be treated with suitable non-absorbent, compressible, non-brittle and



water tight sealants so that no leakage occurs through joint. Joint fillers should confirm to IS: 3414-Code of Practice for Design & Installation of Joints in Buildings or IS:1838 (Pt.I and Pt.II)-Specification for Preformed Fillers for Expansion Joint in Concrete Pavement and Structures. Sealing compound should confirm to IS:1834-Specification for Hot Applied Sealing Compounds for Joints in Concrete. General Arrangements for an expansion joint are shown in Fig. 6.



**(a) EXPANSION JOINT AT FLOOR LEVEL**



(b) EXPANSION JOINT AT ROOF LEVEL TYPICAL DETAILS EXPANSION JOINT  
Fig. 6

## 9.0 Water Proofing Treatments on Roof Slab

A building or structure needs waterproofing as concrete itself will not be watertight on its own. All the flat roofs in the modern age are generally constructed of reinforced cement concrete. This material removes all the problems of flat roofs except that the roof should be made water proof by employing any of the various methods available for moisture proofing.

Ideally concrete, the most widely and regularly used construction material is supposed to be water tight. A well-made concrete with proper mix design and with proper pouring and curing practices is regarded as a very low porous material. However it is seen in practice that concrete loses its permeability due to the following reasons:

1. Improper gradation of materials
2. Excessive water cement ratio
3. Less compaction
4. Awkward architectural section
5. Improper shuttering
6. Cold joints shuttering either in mass concreting or in tall vertical structures
7. Use of bad quality construction materials such as corrosive reinforcement or reactive aggregates
8. Lack of curing: timely curing specially in high cement content concrete mix or where high grade cement is used in plastering
9. Damage to structures due to earthquake effects
10. Failure of plumbing

9.1 Water proofing methods can be broadly classified into the following types:

- Traditional Waterproofing Methods
- Modern/New Waterproofing Methods
- **Traditional Water Proofing Methods** are
  1. Lime Concrete Terracing
  2. Mud Phuska Terracing
  3. Terracing With Brick Bat Coba
  4. Bituminous Surface Treatment:-
  5. Water Proofing with Bitumen Felt
- **New/Modern methods of waterproofing:** Some of the Modern Water Proofing Methods are
  1. Polymerized Bitumen.
  2. Water proofing by APP(Atactic Polypropylene Polymeric ) Membrane
  3. Water Proofing By Crystallization (Cement and Liquid Polymer)

5. Fibre Reinforced Elastomeric liquid Water proofing membrane.
6. Swellable Type water stop tape.
7. Water proofing by nano technology

Before taking up the water proofing work, the construction of parapet walls including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to tack the fibre cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

## 10.0 New Developments in Water Proofing:

### 10.1 Bitumen/Polymer base Systems: -

A number of new products with different combination have come to the market in the recent past, to overcome the disadvantages of normal bitumen based products. Several recognized waterproofing companies have come up that manufacture many of these products with the different trade name.

Salient features and recommended areas of applications are given below:

Sl. No.	Product	Salient features	Recommended Area of Application
1	Polymer modified bitumen coatings	i) More flexible and elastic ii) Their elastic recover is high and are best suited for cooler climates. Better resistance to fracture over a wide range of temperature and moisture variations. iii) Provide protective coating after curing time of 690 days. iv) Cracks under weathering action. v) Black in colour and therefore not pleasing in appearance	i) Water proofing of roof slabs, foundation, basements, floors, and underground structures, storage tanks, pipelines etc. ii) Heavy duty roof coating new or old construction. iii) Water proofing of domes shells.
2	Polymer Modified bitumen felts.	i) Treated or reinforced felt sandwiched between polymer modified bitumen layers. ii) Laying by pour of roll method and joints sealed by flow torch. iii) Behaves like a continuous membrane.	Roofs and basements require protection on top with grit/sand from ultraviolet rays of sun.
3	Prefabricated elastic membrane.	i) Polymeric bitumen reinforced with non woven plastic fabric.	Terraces, water tanks swimming pools.

		ii) Provided with a thin polyurethane film on outer surface. iii) Available under various brands name also in rolls of 20 x 2 sqm. iv) Life 5-15 years. High crack resistant and heat resistant.	
4.	Polymer Emulsions/ membranes water based coatings based on. PVA, SBR etc. – acrylic based polymers are the best.  Polymers -Solvent Based -Water Based	i) Performance is good. ii) Allows concrete to breathe without allowing diffusion of Oxygen, CO <sub>2</sub> , rainwater etc. from outside. iii) Acrylic emulsion have better compatibility with the substrates and better weatherability. iv) These are transparent after drying. v) Excellent adhesion to all types of building materials such as Concrete stone, brick and timber. vi) Resistance to high temperature variations, ultra-violet rays etc. i) Weight of treatment approx. 0.4 kg/sqm. viii) Not suitable for surfaces having macropores. ix) Solvent based polymer waterproofing compounds applied on dry surface by spray only.	To prevent dampness and efflorescence and for water proofing of terraces, walls, chhajjas and all other concrete surfaces.
5	Alkali proof synthetic felt	i) Gives water proofing, thermal insulation on walls as and alkali resistance. ii) Synthetic polymeric membrane of 4 layers including LPDE and HDPE iii) Available also in brand name of 'Roof guard' is fire retardant. iv) Life 40 years (claimed by manufactures)	Terrace gardens.
6	Silicon based emulsions	Colourless water repellent, limited life, poor bridging capacity, do not withstand hydrostatic pressure.	Vertical walls, specially stone facades.

7	Epoxy based coatings	<ul style="list-style-type: none"> <li>i) Very good adhesion and bonding properties.</li> <li>ii) Resistant to more of the chemicals.</li> <li>iii) Costly, limited resistance when exposed to sunlight.</li> <li>iv) Water thinable epoxy coating cannot be use for external walls.</li> <li>v) Cannot withstand expansion/contraction.</li> </ul>	<ul style="list-style-type: none"> <li>i) Used as water proofing, damp proofing, protective coatings for internal application.</li> <li>ii) Water thinable epoxy coatings can be applied on wet surfaces for damp proofing.</li> <li>iii) Useful for coating in water tanks, surface floors, swimming pools, treatment plants.</li> <li>v) For Grouting of cracked CC/RCC elements</li> </ul>
8	Polyurethane compounds	<p>Forms impervious membrane. Has good adhesion to concrete. Resistant to mild acids/alkalis. High elasticity, strong addition to substrate, high abrasion and cracking resistance and high resistant to biological defacement. Adverse effect of ultraviolet rays and requires covering by materials resistant to sun rays. Should be applied on dry surfaces.</p>	<p>Waterproofing/ damp proofing of floorings and internal surfaces i.e. water tanks, basements, inside of treatment plants.</p>
9	Cementious Polymer Waterproofing compound.	<ul style="list-style-type: none"> <li>i) Available in two packs part-A– Cement and chemical additives Part-B Polymer emulsion.</li> <li>ii) Suitable for application on surfaces having macropores also.</li> <li>iii) Can be applied on wet surface.</li> <li>iv) Resistant to aggressive environment and abrasion.</li> <li>v) Can be applied by brush on dry &amp; wet surfaces. Weight of treatment 1 kg/ sq m.</li> </ul>	<p>Terraces walls, water tanks effluent, treatment plants, lagoons etc.</p>

## 10.2 **Water Proofing Treatment with APP (Atactic Polypropylene Polymeric) Membrane (CPWD DSR 2018: Item No. 14.86-14.88 & Specification 2009 Vol.-2 Item No. 22.11):**

Water proofing treatment of roofs with APP modified polymeric membrane shall be either five course, seven course as specified in the item. In selecting the combinations of layers of APP membrane, consideration shall be given to the type and construction of buildings, climate and atmospheric conditions and the degree of permanence required. Five course treatment is a normal treatment suitable to moderate rainfall conditions (less than 50 cm.) and seven course treatment is suitable for heavy rainfall (50 cm and above). Seven course treatment with APP modified polymeric membrane 2.00 mm thick and weight 3.00 kg./sqm. to suitable for very heavy conditions of rainfall (more than 150 cm).

### 10.2.1 **Materials** - The bitumen primer shall conform to the requirements laid down in IS 3384.

**APP Modified Membrane:** It is a polymeric water proofing membrane manufactured to high standards. It is five layered APP modified polymeric membrane with centre core as 20 micron HMHDPE/100 micron HMHDPE High Molecular High Density Polyethylene Film, is the heart of the membrane and protects against water and moisture. The centre core is sandwiched on both sides by high quality polymeric mix with properties of high softening point, high heat resistance and cold resistivity to make it ideal for all water proofing treatment. The polymeric mix is protected on both sides with 20 micron HMHDPE film. The membrane is available in variable thickness and weights. Usual width is 1.0 m.

Important physical and chemical parameter of the membrane shall be as given in Table for guidance.

Centre Core	Film	Thickness	Weight
20 micron HMHPDE	20 micron HMHPDE	1.5 mm	2.25 kg/ sqm.
100 micron HMHPDE	20 micron HMHPDE	2.00 mm	3.00 kg./ sqm.

Where proprietary brands Atactic Polypropylene modified polymeric membrane is proposed to be used by the contractor, they shall conform in all respect to the specification in the preceding paras and manufactured by a company of repute.

### 10.2.2 **Bonding Material:** This shall consist of blown type bitumen conforming to IS 702 or residual bitumen 85/25 conforming to IS 73 heated to the correct working temperature of 180°C. The penetration of the bitumen shall not be more than 40 when tested in accordance with IS 1203, unless otherwise specified each coat of bonding material shall be of blown type bitumen of grade

85/25 heated to a working temperature of 180 degree C and applied @ 1.20 kg. per square metre of the surface area.

**10.2.3 Surface Finish:** Surface finish shall be with brick tiles of class designation 100 grouted with cement mortar 1:3 (1 cement : 3 fine sand ) with 2% integral water proofing compound by weight of cement over a 12 mm thick layer of cement mortar 1:3 (1 cement: 3 fine sand) and finished neat.

**10.2.4 Preparation of Surface:**

- The surface to be treated shall have a minimum slope of 1 to 120.
- This grading shall be carried out with cement concrete or cement plaster with coarse sand, as desired, to the average thickness required and finished smooth.
- Junctions between the roof and vertical faces of parapet walls, chimneys etc. shall be chased by running triangular fillets 7.5 x 7.5 cm. size, cement concrete.
- At the drain mouths, the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water.
- Cement concrete where shall be 1:2:4 mix (1 Cement: 2 Coarse sand: 4 Graded stone aggregate 20 mm nominal size). The provision of fillets shall be deemed to be covered by the item of water proofing and shall not be measured or paid for separately.
- In existing roof where gola and drip course are provided at the junction of roof and vertical face of parapet wall, chimney stacks, etc. These shall be dressed suitably and finished smooth so as to ensure an easy and gradual turning of the flashing.
- Any dismantlement or forming and finishing smooth the junction for forming the base of the flashing shall not be measured or paid for separately and shall be deemed to form part of the preparation of the surface.
- While the grading of roof surface is being done, it shall be ensured that the outlet drain pipe have been fixed and mouth at the entrance have been eased and rounded off properly for easy flow of water.
- When any pipe passes through the roof to be treated, angular fillet shall be built around it for the water proofing treatment to be taken over it. These fillets shall not be measured or paid for separately.
- For carrying over and tucking in the water proofing felts into the parapet walls, chimneys stacks etc. a horizontal groove 6.5 cm. deep, 7.5 cm. wide section with its lower edge at not less than 15 cm. above the graded roof surface shall be left on the inner face of the same; during construction if possible.
- When such groove has not been left, the same shall be cut out neatly and the base at rear of the groove shall be finished smooth with cement plaster 1:4 (1 cement: 4 coarse sand).
- Such cutting of the groove and its finishing smooth shall be part of the water proofing or paid for separately.
- No deduction shall be made either for not making the groove or when the latter has already been left in the masonry by the construction agency.
- Tucking in the water proofing felt will be required where the parapet wall exceeds 45 cm. in the height from the graded surface.

- Where the height is 45 cm. or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness.
- In the case of low dividing walls of height 30 cm. or less, outlets therein shall be cut open for full height and the bottom and sides shall be rendered smooth and corners rounded and such treatment shall not be measured and paid for separately.
- Where expansion joints are left in the slab the provision of dwarf walls and/or RCC slabs for covering them and finishing the surface smooth shall be the responsibility of the construction agency, which had laid the roof slab and will not be included in the operation of water proofing.
- The graded surface of the roof and concrete fillets and the faces of walls shall be thoroughly cleaned with wire brushed and all loose scales etc. removed. The surface shall then be dusted off.
- Any crack in the roof shall be cut to V section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement : 4 coarse sand) or blown type petroleum bitumen of IS grade 85/25, or approved quality conforming to IS 702. Such cleaning of the surface or treating the cracks shall not be paid for separately.

**10.2.5 Treatment:** The water treatment shall be of five or seven course as specified.

In seven course treatment, the first four courses shall be the same as for five course treatment. The fifth course shall be a layer of APP modified polymeric membrane. The sixth course shall be a coat of bonding material and the top most seventh course shall be of specified surface finish.

**10.2.6 Laying:**

- (a) First course shall be a coat of bitumen primer @ 0.40 kg per sq mt followed by subsequent course as per treatment required.
- (b) Drain outlets shall be given a four or six course treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.
- (c) The APP modified polymeric membrane shall be cut to the required length, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked up to crest. The membrane shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m are suitable lengths. The roof surface shall be cleaned and dry before starting the membrane treatment. Each length of membrane shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled membrane as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of



bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be levelled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner.

Each strip shall overlap the preceding one by at least 7.5 cm. at the longitudinal edges and 10 cm. at the ends. All overlaps shall be firmly bonded with a blow lamp and levelling down unevenness. The fourth layer of bonding material in the five course treatment shall be carried out in a similar manner after the flashing has been completed.

- (d) In a seven course treatment the fifth layers of membrane shall be laid in the manner already described, taking care that laps in the membrane are staggered from those in the earlier layer. The sixth layer of bonding material shall be carried out after the flashing is done.
- (e) *High Parapet Walls, Chimney Stacks etc.:* Membrane shall be laid as flashing wherever junctions of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The lower layer of flashing membrane in a six course treatment shall overlap the roof water proofing by not less than 20 cm. while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing membrane in five course treatment over the roofing membrane shall be 10 cm.

The flashing shall consist of the same five or seven course treatment as for the roof except that the final course shall be replaced by an application of 12 mm thick cement plaster 1:3 on the vertical and sloping faces only, of the flashing. The overlap along the length of flashing shall stagger with those in the second layer of flashing membrane (in a seven course treatment and with the joints in the roof membrane).

The upper edge of the finishing membrane shall be well tucked into the flashing grooves in the parapet, chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing.

After the top flashing membrane layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing membrane and the horizontal overlaps and vertical and sloping surfaces of the flashing at the specified rate.

- (f) **Low Parapet Walls:** Where parapet walls are of height 45 cm. or less, membrane flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried upto the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm.
- (g) **Low Dividing Walls:** Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carried down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls.

Drain outlets where formed in the low dividing walls, shall be given water proofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

- (h) **Expansion Joints:** Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and dwarf walls by not less than 7.5 cm. and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roofs slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs. The formation of the expansion joints and provision of the cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. Nothing extra shall be paid for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.
- (i) **Pipes:** Where vertical pipe outlets are met with, 7.5 x 7.5 cm fillets of lime or cement concrete of the type shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid. The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

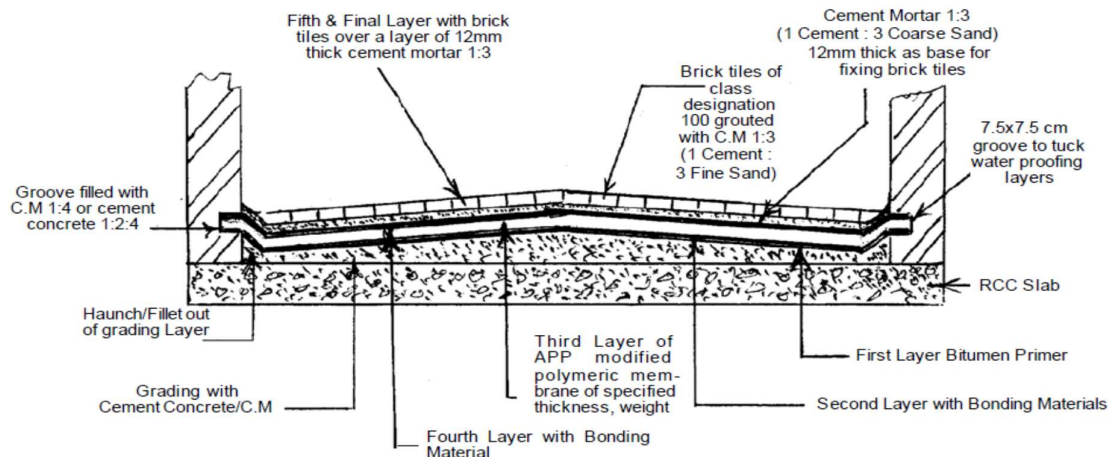


Fig. 7

### 10.3 Five Layered Water Proofing Treatment with Atactic Polypropylene Polymer Modified Prefabricated Membrane (CPWD DSR 2018: Item No. 14.89-14.91 & Specification 2009 Vol.-2 Item No. 22.12):

Atactic Polypropylene Polymer modified prefabricated five layer water proofing membrane shall be of thickness as specified. In selecting thickness of membrane due consideration shall be given to the type and construction of building, climate and atmospheric condition and permanence required. Five layered treatment 2.00 mm thick with glass fibre is with a normal duly treatment suitable for pitched roofs. Five layered 3.00 mm thick with glass fibre matt treatment is suitable for moderate condition of rainfall (50 to 150 mm) and fine layered 3.00 mm thick with non-woven polyester matt treatment is suitable for heavy condition of rainfall.

#### 10.3.1 Materials:

**Bitumen primer** for bitumen membrane shall have density at 25°C in the range of 0.87 - 0.89 kg./litre and viscosity of 70-160 CPS primer shall be applied @ of 0.40 litre/sqm.

**Atactic Polypropylene Polymer Modified Prefabricated Membrane:** It is a polymeric water proofing membrane. This shall be one of the following types:

- (i) 2 mm thick with glass fibre matt.
- (ii) 3 mm thick glass fibre matt.
- (iii) 3 mm thick with non-woven polyester matt.

It is prefabricated five layered black finish water proofing membrane comprising of centre core of 50 gsm. Glass fibre matt/170 gsm nonwoven polyester matt sandwiched on both sides by APP polymer modified bitumen which is protected on both sides by 20 micron thermo fusible polyethylene sheet. Composite thickness of the membrane including all five layers shall be 2/3 mm with glass fibre matt and 3 mm with non-woven polyester matt. It is available in 1 m width and variable lengths.

Physical and chemical parameters of the membrane shall be as given in Table below.

Sl. No.	No. of Layers	Thickness	Elongation at 23° C in longitudinal transverse direction	Joint strength in longitudinal and Transverse direction	Tear strength in longitudinal Transverse direction	Softening Point	Cold flexibility
1	2	3	4	5	6	7	8
1	Five Layered reinforced with fibre glass	2 mm	3 N/5 cm.	350/300 N/5 cm.	60/80 N	150°	-2°C
2	Five layered reinforced with fibre glass	3 mm	3.3 N/5 cm.	350 / 3000 N/ 5 cm.	60/80 N	150°	-3°C
3	Five layered reinforced with non-woven polyester matt.	3 mm	40/50 N/5 cm.	650 N/450 N/5 cm.	300/250 N	150°	-2°C

**10.3.2 Preparation of Surface:** The surface to be treated shall have a minimum slope of 1 in 120 or as specified, provision specified in clause 10.2.4 shall apply for preparation of surface except for pitched roof where surface shall be cleaned off any loose material dust etc. To ensure good adhesion between the surface and water proofing treatment suitable method to dry the surface shall be adopted. All hair line cracks in the surface should be filled with approved sealant.

**10.3.3 Treatment:** The water proofing shall consist of prefabricated five layered 2 mm / 3 mm membrane as shown in Fig.8 . The choice of 2 mm or 3 mm membrane will depend on the type of roof i.e. pitched or flat and importance of building, durability, cost and rainfall etc.

**10.3.4 Laying:**

- Bitumen primer @ 0.40 lts/sqm shall be applied to the prepared roof, drain and all other surfaces where polymer modified membrane is to be laid.

- The five layered water proofing membrane shall be laid using Butane torch and sealing all joints and preparing the surface complete.
- Drain outlets shall be given same treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface.
- Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm.
- The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.
- The APP polymer modified prefabricated water proofing membrane shall be cut to the required length.
- Water proofing membrane shall normally be laid in length in the direction of the slope and laying shall be commenced at the lowest level and worked upto crest.
- APP water proofing membrane shall be laid in 6 to 8 m lengths.
- The roof surface shall be cleaned and bitumen primer shall be applied in the correct quantity, over this specified water proofing membrane shall be laid with butane torch after allowing 24 hours for primer to dry.
- Each strip shall overlap the preceding one by at least 10 cm. at the longitudinal edges and 15 cm. at the ends.
- All overlaps shall be firmly bonded with bitumen primer and levelled by heating the overlap with butane torch.
- If the roof is accessible the treatment is protected by brick tiles laid over 12 mm thick cement mortar of specified grade bedding and joints sealed with cement mortar of which shall be measured and paid for separately.
- APP water proofing membrane shall be laid as flashing wherever junction of vertical and horizontal surfaces occur.
- Longitudinal laps shall be 10 cm.
- The upper edge of flashing membrane shall be well tucked into the flashing grooves in the parapets, chimney stack etc. to a depth of not less than 6.5 cm; corresponding applications of primer coat shall also be made.
- The flashing treatment shall be firmly held in the grooves and it shall be sealed with the approved sealant after terminating the membrane.
- Where parapet walls are of height 45 cm or less AP water proofing membrane flashing shall be provided in the same manner as for splashing in the core of high parapet walls except that upper edge shall be carried out the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm.
- Where low dividing walls or inverted beams are met with, the same treatment shall be provided as for the main roof, the lateral bearing carried down both sides of the wall and overlapping the roof treatment.
- Drain outlets where formed in the low dividing walls, shall be given water proofing treatment same as for the main roof.
- Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing treatment.
- The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length.
- The water proofing treatment shall be taken up the slopping junction fillets and the vertical faces of the walls to the underside of the cover slabs are given the

water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm. width of roofing felt struck to them with bitumen.

- The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness.
- Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs.
- The formation of the expansion joints and provision of cover slabs shall be the responsibility of construction agency.
- The formation of the junctions fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency.
- No extra shall be paid for the junction fillets or for the sealing of the cross joints in the cover slab with 15 cm. width of bitumen strips.

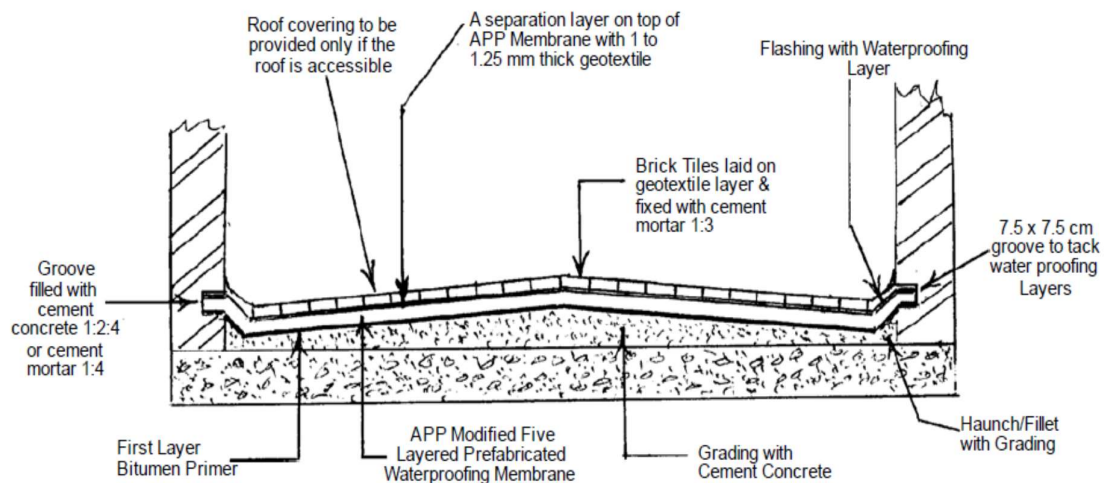


Fig.8

#### 10.4 Concrete water proofing by Crystallization:

An innovative technology is changing the way concrete structures around the world are waterproofed and repaired. Used for more than 30 years worldwide, "Integral Crystalline Waterproofing (ICW)" utilizes a chemical reaction to turn concrete into a permanent, waterproof barrier.

While conventional waterproofing involves applying a coating or membrane to the concrete surface, crystalline technology permanently seals concrete by plugging its natural pores and capillaries and blocking the movement of water. It also reacts with incoming water to self-seal the cracks that inevitably develop in concrete, protecting structures against water and contaminants that can weaken or destroy concrete and corrode steel reinforcement. The ability of crystalline products to self-seal new cracks in concrete is one of its most unique and dramatic benefits

These products comprise mineral based hydraulically setting products, which when applied to concrete as a cementitious slurry which reacts with concrete to form a crystalline structure deep within the capillary and pore structures, thereby blocking voids and producing a water proofing effect. Cement and sand used in the product are used as a carrying agent for the chemicals.

The active components in slurry react with the by-products of cement hydrations and give rise to insoluble crystals. The system becomes permanent, integral part of the concrete itself. There is no other preparation of concrete required beyond the cleaning of surface. The product comes in different trade name.

Once the concrete has cured, the crystalline chemicals sit dormant until another dose of water (such as through a new crack) causes the chemical reaction to begin again. The ability to reactivate in the presence of water gives crystalline-treated concrete the ability to “self-seal”. When cracks form due to curing shrinkage, settling, seismic activity, etc., water entering through them causes new crystals to form and grow, blocking and filling the cracks. Its ability to self-seal cracks is one of crystalline technology’s most unique and useful features, and can help to dramatically reduce the long-term maintenance and repair costs of a concrete structure.

Incorporating crystalline technology into the concrete ensures that minor cracking that occurs even years later can self-seal without any intervention needed. This can help to dramatically reduce the long-term maintenance and repair costs of a concrete structure.

Such treatments can be used as solution to dampness due to capillary action of poorly executed plinth damp course. For better results however, downwardly inclined holes are to be bored in the masonry where the liquid compound can be grouted. This will diffuse into the masonry and give plinth protection from dampness.

## **10.5 Water proofing treatment with integral crystalline admixture: (CPWD DSR 2018: Item No. 22.22)**

- 10.5.1 General:** One method that can simplify the protective process is to make concrete with Integral Crystalline Admixtures that reduce its permeability in effect to make the concrete itself waterproof. Apart from the regular workability admixtures, Integral Crystalline Durability admixtures shall be added to all concrete, structural and otherwise, to waterproof & enhance the Concrete Durability. The Crystalline Admixture shall be added either at the time of

batching at the batching plant or in the drum of the transit mixer, when the concrete arrives the point of pouring.

The concrete water proofing industry redefined their terminology a short time ago. American Concrete differentiates between those suitable for concrete exposed to Non Hydrostatic Conditions (PRAN) and other beneficial characteristics such as reduced drying shrinkage, reduced chloride-ion penetration, and improved freeze thaw resistance and enhanced autogenously sealing.

**10.5.2 Material:** Integral crystalline water-proofing admixture is one part cementitious powder added to the concrete mix at the time of batching. Integral crystalline water-proofing admixture consists of hydrophilic chemicals such as Portland cement, very fine treated silica sand and various active, proprietary chemicals. These active chemicals react with moisture in fresh concrete and with the by-products of cement hydration to cause a catalytic reaction, which generates a non-soluble crystalline formation throughout the pores and capillary tracts of the concrete. Thus, the concrete becomes permanently sealed against the penetration of water or liquids from any direction. The concrete is also protected from deterioration due to harsh environmental conditions. Integral crystalline water-proofing admixture is specially formulated to meet varying project and temperature conditions. This reaction continuous over the life of the concrete serving to seal not only initial shrinkage cracks, but also cracks that occur over time.

**10.5.3 Technical Specifications / Parameters:** The specifications of the materials should match or exceed the requirements mentioned in nomenclature of the item the product should be stored under dry condition. The shelf life of the integral crystalline admixture should be treated as one year when stored under normal conditions.

The water proofing compound used in integral crystalline water proofing treatment shall satisfy all the requirements indicated in relevant standards or as specified in concerned relevant codes etc. and the same shall be got tested and get approved from the Engineer-in-charge before its use.

The integral crystalline waterproofing admixtures of hydrophilic in nature shall confirm to the following requirements:

1. Dosage as specified in the item or higher as recommended by manufacturer's specification, material shall fulfil the requirements of American Concrete Institute Guidelines ACI-212- 3R10 Chapter 15 and fall under PRAH (Permeability reducing Admixtures for HYDROSTATIC conditions) and must reduce Coefficient of Permeability of concrete by more than 90% (preferably zero Permeability), when compared to control concrete and tested as per DIN



1048 Part 5 by carrying out 4 cycles each of 5 bar hydrostatic pressure for 72 hours and drying for 48 hours between the cycles & co-efficient of permeability calculated as per Darcy' formula/ Valenta equation by incorporating penetration values obtained at the end of fourth cycle pressure.

2. The crystalline admixture shall be compatible with any other concrete admixture confirming to ASTM C494 and IS 9103.
3. The performance of the crystalline admixture must not be restricted by water-cement ratio of concrete mix. In other words, the crystalline admixture must perform at any water-cement ratio of the concrete mix.
4. It shall possess CE mark approval as per EN934-2 and shall be procured from CE mark approved manufacturing unit. It shall also possess approval certificate from any national apex institution mandated to issue design codes. The product has no corrosion effect on reinforcement steel according to test norm DIN V18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.
5. The material must be capable of withstanding high hydrostatic pressure. It is important that the civil contractor chooses the best material available in the market and the product meeting all the required criteria and demonstrating highest resistance to the high hydrostatic pressure will be given preference.

In addition to recognizing the use of Integrate Crystalline Admixtures, ACI 212-3R-10 has also provided some guideline in para 15.3- "Selection and Evaluation" to select the best quality PRAH's materials as maximum permeability reducing admixtures at maximum Hydrostatic Pressure. Para 15.3 stated that the effect of the admixture can be evaluated by testing the permeability of concrete both directly and indirect methods. The US Army Corps of Engineers CRC C48-92 (1992) test method is a direct measurement of concrete permeability resistance during exposure to water under 200 psi or 13.8 bars or 1.38 MPa of hydrostatic pressure.

6. The material must reduce Chloride diffusion Co-efficient by minimum 45% when tested as per ASTM C 1556-4 and compared with the control concrete, thereby prolonging the durability & service life of the treated concrete structure.
7. The material must demonstrate minimum reduction of 20% in shrinkage cracks as compared to control concrete when tested as per standard BSISO1920-8:2009 & no internal expansion under Sulphate attack, when tested as per ASTM C-1012-12.

8. The crystalline admixture must be capable of self-healing of cracks up to a width of 0.5mm.
9. Product must possess third party assurance, confirming that the product, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of steel re-enforcement etc.
10. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.
11. The crystalline admixture shall be non-toxic and shall confirm to NSF-61 USA.

**Note:** The manufacturer shall produce relevant test certificates of Integral Crystalline Admixture Material from reputed laboratories as per relevant codes stated above. To support the claim of crystal formation, national/ international test report of scanning electrons microscopic (SEM) Photographs dandified and mature crystal formation to plug all the capillary track and pores of the concrete shall be provided.

Total quantity of Integral Crystalline Admixture Material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall associate himself with anyone of the specialist firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

- 10.5.4 **Recommended uses:** Foundations/Rafts, Reservoirs, Bridges and Dams, Sewage and Water Treatment Plants, Secondary Containment structures, Tunnels and Subway Systems, Underground Vaults, Parking Structures, Swimming Pools and water tanks, Pre-Cast, Cast-in-Place and Shotcrete applications, Basement Retaining Walls
- 10.5.5 **Dosage:** 0.8% (minimum) to the weight of cement content per cubic meter of concrete or higher dosage as recommended by manufacturer's specification
- 10.5.6 **Mixing:** The integral crystalline admixture shall be used @ 0.8% (minimum) to the weight of cement content per cum of concrete or higher as recommended by manufacturer's specification desired to meet water proofing and durability criteria. Integral crystalline Admixture must be added to the

concrete at the time of batching at the batching plant or in the drum of the transit mixer, when the concrete arrives the point of pouring.

The sequence of procedures for addition will vary according to the type of batch plant operation and equipment. The mixing shall be followed as below unless & until specified otherwise. For any detailing and mixing guidelines recommended by manufacturer's specification should be followed.

**10.5.7 Ready mix plant- Dry batch operation:** Add integral crystalline admixture in power form to the drum of the ready-mix truck under the batch plant and add 60%- 70% of the required water, along with required aggregate. Mix the materials for 2-3 minutes to ensure that the integral crystalline admixture is distributed evenly throughout the mix water. Add the balance of materials to the ready-mix truck in accordance with standard batching practices.

**10.5.8 Ready mix plant- Central mix operation:** Mix integral crystalline admixture with water to form a very thin slurry (e.g. 18kg of powder mixed with 22.7 litre of water). Pour the required amount of material into the drum of the ready-mix truck. The aggregate, cement, sand and water should be batched and mixed in the plant in accordance with standard practices (taking into account the quality of water that has already been placed in the ready-mix truck). Pour the concrete into the truck and mix for at least 5 minutes to ensure even distribution of integral crystalline admixture throughout the concrete.

**10.5.9 Precast batch plant:** Add integral crystalline admixture to the aggregate and sand, then mix thoroughly for 2-3 minutes before adding the cement and water. The total concrete mass should be blended using standard practices.

It is important to obtain a homogeneous mixture of integral crystalline admixture with the concrete. Therefore dry integral crystalline admixture powder should never be mixed directly to wet concrete as this may cause clumping and hence thorough dispersion in the concrete mix may not occur.

**10.5.10 Setting time and strength:** The setting time of concrete mix is directly affected by the chemical and physical composition of ingredients, temperature of the concrete and prevailing climatic conditions. Retardation of set may occur when using integral crystalline admixture. The amount of retardation will depend upon the concrete mix design and the dosage rate of integral crystalline admixture. However, under normal conditions, integral crystalline admixture will provide a normal set concrete. Concrete containing integral crystalline admixture may develop higher ultimate strengths than plain concrete. Trial mixes of the concrete should be carried out under project conditions to determine setting time and strength of the concrete.

10.5.11 **Application:** Concrete treated with Integral Crystalline Admixture should be placed and finished in accordance with good concrete practices. ACI guidelines and recommendations should be observed.

10.5.12 **Precaution / Special Consideration:** It is important to obtain a homogeneous mixture of Crystalline Admixture with the concrete. Therefore, do not add dry Crystalline Admixture power directly to wet concrete as this may cause clumping and through dispersion will not occur.  
When incorporating Integral Crystalline Admixture, the temperature of the concrete mix should be above 4° C.

10.5.13 **Storage / Shelf Life:** Integral Crystalline Admixture must be stored dry at a minimum temperature of 7° C and its shelf life is one year when stored under proper conditions.

#### 10.6 **Water proofing treatment with integral crystalline water proofing coating / slurry: (CPWD DSR 2018: Item No. 22.23)**

10.6.1 **General:** This Integral crystalline water proofing coating / slurry of hydrophilic in nature is applied to surface of the concrete to water proof and protect the concrete in-depth. It consists of Portland cement, specially treated quartz sand and a compound of active chemicals. Integral crystalline water proofing coating material needs only to be mixed with water prior to application.

When integral crystalline water proofing material is applied to a concrete surface, the active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction that generates an insoluble, crystalline structure. These crystals fill the pores and minor shrinkage cracks in the concrete to prevent any further water ingress (even under pressure). However, integral crystalline water proofing material will still allow the passage of vapour through the structure (i.e. The concrete will be able to “breathe”).

In addition to water proofing the structure, integral crystalline water proofing Slurry protects concrete against seawater, wastewater, aggressive groundwater and many other aggressive chemical solutions. Integral crystalline water proofing material is approved for use in contact with potable water and is therefore suitable for use in water storage tanks, reservoirs, water treatment plants, etc. Integral Crystalline Slurry is not a decorative material.

10.6.2 **Material:** This Integral crystalline water proofing material consists of Portland cement, specially treated quartz sand and a compound of active chemicals.

The water proofing compound used in integral crystalline water proofing treatment shall satisfy all the requirements indicated in relevant standards or

as specified in concerned relevant codes etc. and the same shall be got tested and get approved from the Engineer-in-charge before its use.

**10.6.3 Technical Specification/ Parameters:** The integral crystalline slurry / coating material of hydrophilic in nature shall confirm to the following requirements:

1. Dosage as specified or at the manufacturer's recommended reduction of co-efficient of Permeability of concrete more than 90% at 56 days curing, when tested as per DIN 1048 Part 5 (after applying 4 cycle each 5 bar hydrostatic pressure) and permeability co-efficient calculated as per Valenta/ Darcys formula.
2. It shall confirm to EN1504-3 (For structural repairs-R3, Compressive Strength > 25 Mpa) supplied from an approved manufacturing unit having CE approval confirming to EN1504-3R3.
3. The product has no corrosion effect on reinforcement steel according to test norm DIN V18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.
4. The material must be capable of withstanding high hydrostatic pressure. It is important that the civil contractor chooses the best material available in the market and the product meeting all the required criteria and demonstrating highest resistance to the high hydrostatic will be given preference.
5. The Integral Crystalline Slurry must be capable of self-healing of cracks up to a width of 0.5mm.
6. Product must possess third party assurance, confirming that the product, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.
7. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.
8. Potable Water Compatibility: Nontoxic & suitable for use in potable water facilities- NSF listed as per ANSI 61 listing.

**Note:** The manufacturer shall produce relevant test certificates of Integral Crystalline water proofing slurry material from reputed laboratories as per relevant codes as stated above.

Total quantity of the Integral Crystalline water proofing slurry material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall associate himself with anyone of the specialist

firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

**10.6.4 Recommended uses:** Foundations/Rafts, Reservoirs, Bridges and Dams, Sewage and Water Treatment Plants, Secondary Containment structures, Tunnels and Subway Systems, Underground Vaults, Parking Structures, Swimming Pools and water tanks, Pre-Cast, Cast-in-Place and Shotcrete applications, Basement Retaining Walls

**10.6.5 Preparation of surface:** All concrete to be treated with integral crystalline water proofing slurry material must be clean and have an “open” capillary surface. Remove laitance, dirt, grease etc. by means of high pressure water jetting, wet sandblasting or wire brushing. Faulty concrete in the form of cracks, honeycombing, etc. must be chased out, treated with the same material and filled flush with the mortar mixture as specified by the manufacturer. Surface must be carefully pre-watered prior to the application of integral crystalline water proofing material. The concrete surface must be damp but with no wet sheen on the surface.

**10.6.6 Mixing:** Integral crystalline water proofing slurry / coating material should be mechanically mixed with clean water to a creamy consistency resembling to thick oil. Only that much material should be mix as can be used within 20 minutes and mixture should be stirred frequently. The mixture should not be allowed to set, if it happens, simply re-stir to restore workability but no more water should be added to it. The ratio of integral crystalline water proofing material with water should be as below

- i) Vertical surface: - For applying with brush the ratio should be 5 parts of integral crystalline water proofing material to 2 parts of water.

For applying with spray the ratio should be 5 parts of Integral Crystalline water proofing coating material to 2.75 - 3.25 parts of water.

- ii) Horizontal surface: - The ratio should be 3 parts of Integral Crystalline water proofing coating material to 1 part of water. This should be applied by brush only.

**10.6.7 Application Procedure:** The slurry mix of the Integral Crystalline water proofing slurry material shall be applied in one or two coats as specified/ required according to work situation in the item. After preparation of surface as described in para 9.6.4, and making the surface saturated with water before application of Crystalline Slurry, then first coat of the slurry mix shall be applied

by the brush or appropriate power spray equipment. The second coat as specified shall be applied while the first coat is still green.

The other method of application known as Dry powder consistency can also be applied on horizontal surfaces only. The specified amount of integral crystalline water proofing material is distributed in powder form through a sieve or a semi mechanical barrow spreader and troweled into the freshly placed concrete as this reaches the initial set.

The integral crystalline water proofing material to be used shall be as following:-

- i. Vertical surface: - Two coats of integral crystalline water proofing material slurry coat shall be applied @ of 0.70 kg per sqm. per coat or as specified.
- ii. Horizontal surface: - One coat of integral crystalline water proofing material slurry coat shall be applied @ of 1.10 kg per sqm or as specified by the manufacturer to harden concrete. Alternatively integral crystalline water proofing material mix can be dry sprinkled @ of 1.00 kg per sqm and trowel applied to fresh concrete when it has reached initial set.
- iii. Construction joint: - Integral crystalline water proofing material mix shall be applied either as slurry coat or dry powder consistency immediately prior to placing the next lift/ bay of concrete @ 1.60 kg per sqm. or as specified.
- iv. Binding concrete: - Integral crystalline water proofing material mix shall be applied either as slurry coat or dry powder consistency immediately prior to placing the overlying concrete slab.

10.6.8 **Curing:** The treated surfaces should be kept damp for a period of five days and must be protected against direct sun, wind and frost, by covering with polyethylene sheeting, damp burlap or similar material.

10.6.9 **Precaution / Special Consideration:** Do not apply Integral Crystalline Slurry at temperatures at or below freezing or to frozen or freezing surfaces. Integral Crystalline slurry cannot be used as an additive to concrete or plasters. (Integral Crystalline Admixture should be considered for these applications).

10.6.10 **Storage / Shelf Life:** When properly stored in a dry place in unopened and undamaged original packaging its shelf life is 12 months.

**10.7 Water proofing treatment with integral crystalline water proofing dry-shake: (CPWD DSR 2018: Item No. 22.24)**

**10.7.1 General:** Crystalline water proofing dry-shake of hydrophilic in nature is a unique Integral Crystalline chemical treatment for the waterproofing and protection of concrete. Crystalline water proofing dry-shake has been formulated for dry-shake applications on horizontal concrete surfaces where greater impact and abrasion resistance is required.

**10.7.2 Material:** Integral Crystalline water proofing dry-shake (dry powder) compound consists of Portland cement, various active proprietary chemicals, and a synthetic aggregate hardener that has been crushed and graded to particle sizes suitable for concrete floors.

Crystalline water proofing dry-shake becomes an integral part of the concrete surface, thereby eliminating problems normally associated with coatings (e.g. scaling, dusting, flaking and delaminating). The active chemicals react with the moisture in the fresh concrete causing a catalytic reaction that generates a non-soluble crystalline formation within the pores and capillary tracts of the concrete.

**10.7.3 Technical Specification/ Parameters:** The Integral Crystalline dry shake material of hydrophilic in nature shall confirm to the following requirements:

1. Dosage as specified or at the manufacturer's recommended reduction of co-efficient of Permeability of concrete more than 90% at 56 days curing, when tested as per DIN 1048 Part 5 (after applying 4 cycle each 5 bar hydrostatic pressure) and permeability co-efficient calculated as per Valenta/ Darcy' s formula.
2. It shall confirm to EN1504-3 (For structural repairs-R3, Compressive Strength > 25 Mpa) supplied from an approved manufacturing unit having CE approval confirming to EN 1504-3R3.
3. The product has no corrosion effect on reinforcement steel according to test norm DIN V18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.
4. The material must be capable of withstanding high hydrostatic pressure. It is important that the civil contractor chooses the best material available in the market and the product meeting all the required criteria and demonstrating highest resistance to the high hydrostatic will be given preference.



5. The Integral Crystalline dry shake must be capable of self-healing of cracks up to a width of 0.5mm.
6. Product must possess third party assurance, confirming that the product, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.
7. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.
8. Potable Water Compatibility: Nontoxic & suitable for use in potable water facilities- NSF listed as per ANSI 61 listing.

**Note:** The manufacturer shall produce relevant test certificates of Integral Crystalline water proofing dry shake material from reputed laboratories as per relevant codes as state above.

Total quantity of the Integral Crystalline water proofing dry shake material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall associate himself with anyone of the specialist firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

- 10.7.4 **Application Rate (Dose):** Crystalline water proofing dry-shake material to be used under normal conditions should cover the application surface @ minimum 0.60 kg per sqm. depending upon of the degree of abrasion resistance required.

If the surface is to be used under heavy traffic conditions or where greater abrasion resistance is required, the manufacturers recommendation should be taken into account while applying crystalline water proofing dry-shake on the concrete surface.

10.7.5 **Application Procedure**

- i. After fresh concrete is placed. Consolidated and levelled, wait until concrete can be walked on leaving an indentation of 6-8mm.
- ii. Concrete should be free of bleed water and be able to support the weight of a power trowel. Float open the surface.

- iii. Immediately after floating open the surface and within one hour of finishing the concrete, apply one-half of the Integral Crystalline water proofing dry-shake material by hand or mechanical spreader, in one direction only. The Integral Crystalline water proofing dry-shake material must be spread evenly.
  - iv. As soon as the Integral Crystalline water proofing dry-shake material has absorbed moisture from the base slab, it should be power floated to the surface.
  - v. Immediately after power floating, apply remaining Integral Crystalline water proofing dry-shake material at right angles to the first application.
  - vi. Allow remaining Integral Crystalline water proofing dry-shake material to absorb moisture from the base slab and then power float the material into the surface. When concrete has hardened sufficiently, power trowel surface to the required finish.
- 10.7.6 **Curing:** Curing is important and shall begin as soon as final set has occurred but before surface starts to dry. Conventional moist curing procedures such as water spray, wet burlap or plastic covers may be used. Curing should continue for at least 48 hours. In hot dry sunny or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab conditions due consultations should be made from the technical representatives of the manufacturer for specific instructions. In lieu of moist curing, concrete sealers and curing compounds may be used. In all cases, recommended guidelines for proper curing should be followed.
- 10.7.7 **Recommended uses:** Foundations /Rafts Slabs, Water tank base slab , Sewage and Water Treatment Plants, Below Grade Structures, Warehouses Floors, Traffic Bearing Surfaces, Parking Structures
- 10.7.8 **Precaution / Special Consideration:** For the best results when applying Integral Crystalline dry shake materials, the air content of the concrete shall not exceed 3% (a high air content can make it difficult to achieve a proper application).  
In hot, dry, or windy conditions, it is advisable to use an evaporation retardant on the fresh concrete surface to prevent premature drying of the slab. Chronic moving cracks or joints will require a suitable flexible sealant.

**10.7.9 Storage / Shelf Life:** Integral Crystalline dry shake must be stored dry at a minimum temperature of 7° C and its shelf life is one year when stored under proper conditions.

**10.8 Crystalline water proofing mortar: (CPWD DSR 2018: Item No. 22.25)**

**10.8.1 Material:** Crystalline water proofing mortar consists of Portland cement, specially treated quartz sand and a compound of active chemicals.

The active chemicals react with moisture and the by-products of cement hydration to cause a catalytic reaction, which generates an insoluble integral crystalline complex. These crystalline complexes grow in the presence of water and block the capillaries of the concrete and minor shrinkage cracks, thus water proofing the concrete. Chemicals activation begins when the powder is mixed with water and may take several days to completely block the capillaries, depending on ambient temperature and environmental conditions. It can be applied to the positive or negative water pressure sides of a structure.

**10.8.2 Technical Specification/ Parameters:**

1. It shall conform to EN1504-3 (For structural repairs-R3, Compressive Strength > 25 Mpa) supplied from an approved manufacturing unit having CE approval confirming to EN 1504-3R3.
2. The product has no corrosion effect on reinforcement steel according to test norm DIN V 18998. The maximum chloride content lies less than 0.1% and maximum alkali content less than 9.3%.
3. Product must possess third party assurance, confirming that the product, when used in the concrete, will have no detrimental side effects in terms of Alkali Silica Reaction (ASR), corrosion of Steel Reinforcement etc.
4. The product performance shall not be affected by wear abrasion of the treated concrete surface and crystalline treated concrete shall not require protection layer.
5. Potable Water Compatibility: Nontoxic & suitable for use in potable water facilities- NSF listed as per ANSI 61 listing.

**Note:** The manufacturer shall produce relevant test certificates of Crystalline Mortar from reputed laboratories as per relevant codes as state above.

Total quantity of the water proofing Crystalline Mortar material required shall be arranged only after obtaining the prior approval of the Engineer-in-Charge in writing. Materials shall be kept under double lock and key and proper account of water proofing compound used in the work shall be maintained. It shall be ensured that the consumption of the compound is as per specified requirements. Contractor shall associate himself with anyone of the specialist

firms mentioned in approved list of specialized agencies for the work relating to the Water Proofing Treatment.

**10.8.3 Recommended Uses:** This material can be applied in conjunction with crystalline water proofing coating for:

- (i) Installation of seal strips, reglets and coves at joints to assure water tightness
- (ii) Patching and filling / sealing of routed out cracks.
- (iii) Patching of tie holes and faulty construction joints.
- (iv) Repairing of spalled and honeycombed area.

**10.8.4 Preparation of Surface:** All surfaces to be patched, repaired or sealed with crystalline water proofing mortar must be clean and sound. Crack should be routed out to a U-shaped configuration, approximately 25 mm wide and a minimum of 25 mm deep. Tie holes should be roughened prior to filling. Spalled and honeycombed area must be thoroughly cleaned and chiseled back to sound concrete prior to repair. Remove all dirt, cement laitance, form release agents, curing compounds, paints, coating, etc. by means of wet or dry sandblasting, high pressure water jet or other approved mechanical means. Surfaces must be well moistened to a dull dampness at the time of application. The concrete should be damp with no wet sheen on the surface.

**10.8.5 Mixing**

- i. For routed cracks, coves and non-moving joints: Add water to crystalline water proofing mortar powder until a medium stiff, trowel able consistency reached. The texture of the mix should be pliable enough to be trowelled into the cracks with some pressure, but not so pliable that it would run out or sag out of the crack.

Approximate mixing ratio (by volume) is 4.5 parts crystalline water proofing mortar powder to 1 part water. Alternatively, 450gm of crystalline water proofing mortar powder to 100 ml of water is to be mixed.

- ii. Tie holes and pointing applications: Add only a small amount of water. Mixed consistency should be that of “dry earth” holding a shape when squeezed but easily crumbled when pressed between fingers. Mix only as much material as can be used within 20 minutes.

**10.8.6 Application Procedure:**

- i. For sealing cracks and faulty construction joints, routed out/making U-shape groove size 25x25mm and then priming the surface with integral crystalline slurry @0.05 kg per running meter and while the surface is tacky filled the cavity upto surface crystalline mortar @1.50 kg per running meter. Once crystalline mortar is touch dry then finally applying two coats of integral crystalline slurry @0.05 kg per running meter per coat.

- ii. For repairing spalled & honeycombed areas, prepared the surface and chiesel back upto sound concrete and then primed the area with integral crystalline slurry @0.70 kg per sqm. and while the surface is tacky repair and level the honeycomb area with crystalline mortar @ 22.70 kg per sqm. for an average thickness of 10mm. Once crystalline mortar is touch dry then finally two coats of integral crystalline slurry @ 0.70kg per sqm. per coat.
  - iii. For patching of tie rod holes, prepared tie rod hole surface and primed the area with integral crystalline slurry @ 0.07 kg per sqm and while the surface is tacky repair and filled the tie rod holes with crystalline mortar @ 0.040 kg per hole. The crystalline mortar shall be tightly rodded into tie holes or packed tightly. For 25x25x25 mm hole, use 0.040 kg per hole to fill the tie hole.
- 10.8.7 **Curing:** Provide protection against extreme weather conditions, such as heavy rain or freezing conditions, during the setting period. Curing is not normally required except during hot, low humidity weather. In these conditions, a light mist of water approximately 25 hours after the repair is completed will help to ensure a controlled cure. In extreme dry heat, water misting may be carried out at required intervals more frequently.
- 10.8.8 **Precaution / Special Consideration:** Crystalline mortar shall not applied at temperatures below 40°F (4°C), to a frozen substrate or if temperatures will drop below freezing during the curing period (approximately 24 hours). This product is not recommended for use in expansion or construction joints. Crystalline mortar can be applied in (13 mm) layers not exceeding 2.5 inch (approximately 6.5 cm) to prevent shrinkage cracks in the mortar.
- 10.8.9 **Storage / Shelf Life:** Crystalline mortar shall be stored in a dry enclosed area off the ground at a minimum temperature of 7°C. Shelf life when stored in proper conditions in unopened, undamaged packaging is 12 months.
- 10.9 **Fibre reinforced elastomeric liquid water proofing membrane having sun reflectivity index (SRI) of 105: (CPWD DSR 2018: Item No. 22.22A)**
- 10.9.1 **Material:** Fibre reinforced elastomeric liquid water proofing membrane is a ready-to-use waterproofing, white product, with high solar reflectance and thermal index SRI of 105, for external applications. This is made from resilient acrylic polymers and synthetic resins in water dispersion, and when dry forms a continuous, flexible waterproofing membrane. This is resistant to all atmospheric conditions and UV rays, and guarantees long-lasting protection for the substrate.

**10.9.2 Technical Specification/ Parameters:** The Fibre reinforced elastomeric liquid water proofing membrane shall confirm the following requirements:

1. Fibre reinforced elastomeric liquid water proofing membrane with fibers in water emulsion with high reflectance and emissivity with a solar reflectance index SRI of 105 should comply with the requirements of EN 1504-9 ( 'Products and system for protecting and repairing concrete structures: definitions, requirements, quality control and conformity assessment. General principles for the use of products and systems'), EN1504-2 coating (C) principles PI, MC and IR ("concrete surface protection systems")
2. This should possess a paste like consistency having highly reflective white colour.
3. This should have density of 1.35 with dry solid content of 61.4%.
4. This should be applied within a temperature range of 5°C to 35°C
5. This should have minimum tensile strength (ISO 37) of 1.5N/mm<sup>2</sup>
6. This should confirm to results after testing as per EN1062-11 for exposure to artificial weather conditions.
7. The Sun Reflectivity Index when tested as per ASTM E1980 should be 105 minimum

**10.9.3 Applications:** It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces to form a string, flexible, tack-free dry surface, suitable for occasional light foot traffic. This can with stand normal expansion and contraction stresses caused by temperature variations due to its flexibility. This also helps lower the working temperature of roofs and guarantees good energy performance properties of all the layers of the roof. The SRI value of 105 helps in reducing the heat island effect of roofs.

**10.9.4 Preparation of Surface:** All the substrates, whether they are new or old, must be sound, clean, dry and free of all traces of oil, grease, old paint, rust, mould and nay other material which could compromise the bond.

Concrete and in general mineral substrates must be sound and dry with no rising damp. Any loose parts must be removed. All wax, water-repellent treatments, etc. must be removed from the surface of ceramic substrates with a suitable detergent and/ or by sanding. Any hollows and gaps in the surface must be repaired properly with appropriate material as described and instructed by the manufacturer of this product. The tools to be used must be properly cleaned.

**10.9.5 Application Procedure:** All the area of operation shall be thoroughly cleaned as described in para 10.9.3 above. Mix the content in such a manner that they are perfectly blended into a homogenous state of liquid which can be applied by long haired roller or airless spray. For applying 1<sup>st</sup> coat of self-priming

elastomeric water proofing liquid the material should be diluted with water in the ratio of 3:1 (3 parts of elastomeric water proofing liquid and 1 part of water). Wait until the 1<sup>st</sup> coat is completely dry and becomes slightly darker in colour. After the 1<sup>st</sup> coat has dried completely apply 2<sup>nd</sup> coat with undiluted elastomeric water proofing liquid in a criss-cross direction to the previous coat. After the drying of 2<sup>nd</sup> coat completely apply the final coat of undiluted elastomeric water proofing liquid in a direction perpendicular to previous coat. The minimum thickness of the dry film of complete application should not be less than as recommended by manufacturer's specification. The overall dry thickness should not be in any case less than 500 microns. Protect the membrane from rain unless it is completely dry. The overall consumption of the material should be as per nomenclature of the item and should also adhere to the specifications detailed in the approved schedule of the manufacturer.

#### 10.10 **Flexible cementitious negative side waterproofing coating with elastic waterproofing polymers (CPWD DSR 2018: Item No. 22.23A)**

10.10.1 **Material:** Flexible cementations negative side waterproofing coating with elastic waterproofing polymer is a one-component, concentrated liquid admixture used to enhance the performance of cementations repair mortars, plasters, stuccos, concrete mixes and toppings for restoration of horizontal, vertical and overhead concrete; concrete masonry units (CMU); and masonry surfaces.

**Technical Specification/ Parameters:** Flexible cementations negative side waterproofing coating with elastic waterproofing polymer shall confirm the following requirements:

1. Flexible cementations negative side waterproofing coating with elastic waterproofing polymer should have PH value of 7 and consist of liquid state with the application temperature range of 7°C to 35°C.
2. This should have the density of 1.02 gm per ml.
3. This should possess the property of application in undiluted as well as diluted form.
4. This should be non-re emulsifiable.

10.10.2 **Applications:** It is to be applied using a long-haired roller, brush or spray on any horizontal, sloping or vertical surfaces to form a string, flexible, tack-free dry surface. This is easy to use and control in construction works for water proofing of the surface and optimizes bond to concrete substrates. It also improves resistance to abrasion and freeze/ thaw cycles.

10.10.3 **Preparation of Surface:** All substrates must be structurally sound, stable and solid, with all loose material removed. Thoroughly clean the surface of any

substance that could interfere with the bond of the installation material, including dirt, paint, tar, asphalt, wax, oil, and grease, latex compounds, from release agents, laitance, loose toppings, foreign substances and any other residues. Concrete surfaces must be mechanically profiled and prepared by shot blasting, sandblasting, diamond-grinding, water-jetting, scarifying or other engineer-approved methods to obtain an acceptable profile. Concrete substrate and ambient room temperatures must be maintained between 45°F and 95°F (7°C and 35°C) before application. Temperatures must be maintained within this range for at least of 72 hours after the application coating.

**10.10.4 Application Procedure:** Apply the coating on to this sound and dry surface using a long-haired roller, brush or spray. The dilution of the compound the water should be done in a clean mixing pail. The ratio of mixing with water is to be done in accordance with the nomenclature of the item along with corresponding coats and manufacturer specifications. The number of coats to be applied should be as directed under the nomenclature of the item and the total material used in complete process should not be less than 14.35 kg per 10 sqm under any circumstances. The 1st coat should be applied on to the properly prepared and dried surface. More coats should be applied when the coat below is still wet. All the coats should be applied in perpendicular direction to each other. The final surface is to be protective from excessive heat or draft conditions during the first 24 to 72 hours. Final surface should be cured for at least 5 to 7 days. Use of damp burlap, polyethylene sheeting or water-based curing compound is also recommended to be used for curing.

#### **10.11 Swellable type water stop tape (CPWD DSR 2018: Item No. 22.26)**

**10.11.1 General:** Swellable type water stop tape of size 19 mm x 25 mm is a unique sealing compound designed to expand rapidly when exposed to moisture, making it a self-healing joint material for construction joint applications / treatment.

**10.11.2 Material:** This is a swellable type sealing compound which expand rapidly after coming in to contact or exposed to moisture. This acts as a self-healing material and is used for applications in construction joints.

#### **10.11.3 Physical Properties**

- i. Specific gravity (ASTM D71):  $1.35 \pm 0.05$  (ASTM D-71)
- ii. Volatile matter: 1% maximum (ASTM D-6)
- iii. Penetration, 150g cone at 25°C, 5sec :  $40 \pm 5$ mm (ASTM D-217)



- iv. Rate of Rapid Expansion: (a) Fresh Water Exposure: 24 Hours-140%, 48 Hours- 175%, 72 Hours-190% & 120 Hours-210%
- (b) Salt Water Exposure: 24 Hours-7%, 48 Hours-12%, 72 Hours-14%, 120 Hours-18%

The water stop material should meet the requirements to EU REACH Regulation (EC) No 1907/2006.

#### 10.11.4 **Physical Properties of Swellable Water stop Primer**

- i. % Solid : Min 20%
- ii. Flash Point: 93 deg C
- iii. Dry Time : 25 deg C:10 min
- iv. Dry Time : 4 deg C : 60 min

10.11.5 **Recommended Uses:** Typical applications for swellable type waterstop tape include building foundations, slabs, retaining walls, storage tanks, and similar non-moving cold construction joints

#### 10.11.6 **Application:**

- i. The entire surface length where the water stop is to be applied is cleaned thoroughly by using blower and brush. Apply one coat of required primer throughout the length of the joint @ 3.78 litre per 240 running metre. Allow the primer to dry for 10 to 15 minutes at the temperature of 25°C. This should be allowed to dry for some longer time in the areas where the temperature are low.
- ii. By using the heel of the hand and moderate pressure, press the self expanding joint material firmly into the position on the structure on the entire area which has been primed and dried. Make sure that the product has bonded with the primed area.
- iii. Where required, splice ends to form a continuous, uninterrupted seal. For best results, cut each end at opposite 45deg. angles and tightly butt ends together. DO NOT OVERLAP ENDS. Gently knead the spliced ends creating an uninterrupted seal.
- iv. Peel the protective covering from the exposed side of the installed expandable joints sealing compound.
- v. Pour the matting structural member in position.

#### Notes:

Always use sellable type waterstop primer to avoid displacement of the swellable type waterstop tape during concrete pouring. It may be necessary to utilize masonry nails or other mechanical means to hold the sealant in place on vertical surfaces.

Place swellable type water stop tape so that it is not closer than 5 cm away from the outer surface of poured structure. If a Keyway is utilized, place the swellable type water stop tape into the bottom of the formed Keyway area.

**10.11.7 Precaution / Special Consideration:** Always use swellable type water stop primer to ensure tight adhesion and to aid in preventing swellable type water stop tape from moving during the concrete pour. For vertical surfaces, nails may be used to hold the product in place in conjunction with swellable type water stop primer. Swellable type water stop tape shall be used at a minimum depth of 50 mm inside the concrete. When used on pipes and other structural penetrations, swellable type water stop tape shall be cut to measured length and placed around the penetration with ends butted. In all cases, swellable type water stop tape shall be in direct contact with the substrate along the entire length of the installation. Swellable type water stop tape is not an expansion joint sealant and only suitable for non-moving concrete joints. Swellable type water stop tape should not be installed in standing water or on frozen or icy surfaces.

**10.11.8 Storage / Shelf Life:** When stored in a dry enclosed area off the ground at a minimum temperature of 45°F (7°C) in unopened, undamaged cartons, its shelf life is unlimited.

**10.12 Water proofing by Nano Technology (CPWD DSR 2018: Item No. 26.59 - 26.60):**

Nanotechnology, shortened to “Nanotech”, is the study of the controlling of matter on an atomic and molecular scale. Generally, Nanotechnology deals with structures of the size 100 nanometers or smaller in at least one dimension, and involves developing materials within that size. Nanotechnology is very diverse approach based upon molecular self assembly, from developing new materials with dimensions on the nanoscale to investigating whether we can directly control matter on the atomic scale. Any technology based on particles size less than 10 nm is considered Nano Technology. Molecule of modern nanotechnology based water proofing compounds, when dissolved in solvent has estimated size of 5-6 nm.

Polymers contain many thousands of monomers attached with each other and form a long chain molecule. These polymers form clusters in a solution or emulsion. When this polymers form a film on the substrate surface, polymer molecular clusters are forced to adhere to the surface. Then polymers further undergo shear stress because of exposed heat and moisture. As a result, the cohesive forces are weakened. Additionally, Polymers are visco-elastic i.e. they always move to attain thermodynamically stable format. Under these circumstances, molecular bonds are weakened and UV, a high energy source, can attack the polymer network to form free radicals. Free radicals are reactive centers on the molecule and can easily react with oxygen (oxidation),

eventually break down molecular structure. Nanotechnology based waterproofing uses monomeric water repellent compounds that can penetrate several millimeters inside the core of the substrate. 2000 hours of UV test results for such compounds indicates that nanotechnology based water proofing compounds are very stable and does not change chemically and protect the bulk of the substrate structure.

#### 10.12.1 Technical details of NANO Technology Based Water Proofing compounds:

Flash Point	>100°C, Non flammable
Specific Gravity (25°C)	1.05-1.10
Viscosity (25°C)	500-800 CPS
Solubility	Mixable with water
Dilution	One part waterproofing compound with 10 Parts water/solvent (horizontal surface) One part waterproofing compound with 20 Parts water/solvent (Vertical Surface)
Suitable for	Concrete, Expose aggregates, Brick, Mortar, Plaster, Lime stone, Sandstone, Granite, Tile and Grout, Cement sheets
Water repellence Mechanism	By Nano level hydrophobation
Diluents	Water/solvent
Ensure protection	As Micro level crack filler.
Weathering Cycle	UV exposure according to ASTM G-154 (21 hours), followed by rain showers (1 hour) and drying at 110 oC (2 hours)
Life	>15 years

#### Nanotechnology Based Water proofing compounds should comply:

- ASTM D 6489 regarding Concrete water penetration Less than 15% after 24 & 48 Hours
- ASTM G 154 regarding Accelerated Weathering Less than 5% Loss after 2000 hours

- ASTM E514 regarding Brick/Masonry Standard Test for Water Penetration- Passes 85% Reduction
- ASTM 1653:03 regarding Masonry Vapor Transmission (breathability)
- ASTM E 303:93 regarding Wet Concrete Slip Resistance
- IS 3067-1988 regarding Masonry Damp proofing of Building
- IS 13182-1991 regarding Masonry Damp proofing & Waterproofing of Buildings

#### 10.12.2 Effectiveness of Nanotechnology Based Water proofing compounds:

Almost all material commonly used for construction can be treated with these water proofing compounds. This includes Concrete, Bricks, Sand Stone, Granite, Lime stone, Marble, Plaster, Cement sheet and Natural stones.

Nanotechnology based Water proofing compounds are generally a monomeric compound. The size of the molecule is less than 6-8 nm. They can easily enter into the pores of the substrates. Because of their small size, the molecules flows through the pores branches inside the substrate. Normally they are applied as water solution though other solvent may also be used as indicated by manufacturer. Such water proofing compounds are found to be very efficient in covering the surface and provide deep penetration as below:

- (a) They with stand hydraulic pressure generated by high wind driven rains.
- (b) They give protection against micro cracks
- (c) They also protect the structures from water damage after abrasion due to heavy traffic or natural weathering of the surface
- (d) Protects the reinforcement from corrosion.

- **Protection at the joints:**

Joints are relatively small but important and vulnerable component of a structures. Joints are normally under more stress then the rest of the structures. Water penetrates easily because of the porous nature of the joints components, due to high concentration of reinforcement and difficult shuttering including poor workmanship. Water swells the joints and it de-swells when ever water leaves the joints. Swelling and de-swelling process generates void sand develops cracks. Waterproofing treatment of joints prevents water penetration in to the joints thus avoiding swelling and de-swelling process.

- **Protection of structures after the cracks are formed:**

There are two types of concrete: concrete that is cracked and concrete that has the potential to crack. When exposed to wetting and drying conditions, concrete will expand and contract. If the stress associated with these volume changes exceeds the tensile capacity of the concrete, cracks will form. Such cracks are referred as a shrinkage cracks. Besides this, normal RCC is also designed as cracked section, in order to transfer tensile stresses to reinforcement bars.

Potential Cracks are also expected to develop in joint area as it acts as a "pressure release valve". At junction, members of different thickness are joined together, for example beam & slab junction where slab of less thickness is

joined to a beam. This allows a crack to form along a straight line within the joint since the thin section provides a path with less resistance than a thicker section. These micro cracks are normally 0.1 to 0.2 mm width and 2-3 mm deep. Nanotechnology based hydrophobic water proofing compound penetrates inside the concrete structures and protect it from water infiltration.

- **Prevention of surface developed black spots on new structures:**

The black spots are remains of biological growth (Mildew, Fungi). Concrete surface is very coarse and porous. Therefore concrete traps moisture in these pores and biological growth occurs where moisture and food are available. Concrete and plaster surfaces retains moisture very effectively and promotes fungus growth. These biological growths die and leaves organic residue (black spots). This residue becomes food for the next generation. These vicious cycles continues and covers the entire surface within few monsoon cycles.

These stains are generally removed by high pressure water jet and 3-5% solution of bleach (Sodium hypochlorite). First the surface is cleaned by high pressure water jets to loosen the residue. Then 3-5% Bleach solution is sprayed over the surface. Allow 30-60 minutes to Oxidize the residue before cleaning again with high pressure water jet.

This biological growth can also be eliminated by removing one of the important component, i.e. moisture. Use of nanotechnology based water proofing compounds changes the surface characteristics from hydrophilic to hydrophobic thereby prevent moisture accumulation in the pores. Hence formation and growth of fungus or mold is prevented for a longer period.

#### 10.12.3 **Application of Nanotechnology Based Water proofing compounds**

##### **Preparation of surface:**

The substrate should be made clean and dry. Surface should be free from loose particles, wax, sealers, curing compounds, grease and efflorescence. Concrete should be fully cured for at least 28 days. Now surface sealers should be applied to surfaces that are above 50°F. Surface should be dry with no rain expected within 2 hours following application.

##### **Vertical Surfaces:**

- Pressure washing (min. 1400 psi) followed by drying.
- Chemical cleaners may be used to remove and/ or neutralize surface contamination.
- Remove all traces of dirt, efflorescence, mold, mildew, grease, oil, asphalt, laitance, curing compounds, paint, coatings or any other surface contaminant.
- Repair all visible cracks greater than 1/32 of an inch.
- Insure all caulking or sealants have formed a heavy skin prior to application of nanotechnology based water proofing compounds.

##### **Horizontal Surface**

- Pressure washing (minimum 1400 psi) followed by drying or shot blasting prior to application is suggested. Preparation should include all surfaces to be

sealed, plus 10 cm of the vertical surface adjacent to the horizontal surface if possible.

- Chemical cleaners should be used to remove and/ or neutralize surface contamination
- Remove all traces of dirt, efflorescence, mold, mildew, grease, oil, asphalt, laitance, curing compounds, paint, coatings or any other surface contaminant.
- Repair all visible cracks greater than 1/32 of an inch.
- Insure all caulking or sealants have formed a heavy skin prior to application.

#### 10.12.4 **Mixing Instructions:**

- Use cool, clean water, clean tools and clean containers
- Take water; slowly pour in water proofing concentrate as per manufacturer's recommendations. Stir slowly for 3-5 minutes or with a very slow speed paddle mixer for two minutes. Avoid creating foam.
- The sealer is concentrated and needs to be diluted with clean water/solvent at the rate advised by manufacturer.
- Mix only the quantity that can be used within 24 hours. Discard excess material that is not used.

10.12.5 **Application:** Applications requiring a warranty require approval and sign off of a product representative prior to application. Safety instructions on the container and the information manual/sheet prior to the application should be read carefully.

- a) Diluted sealer is applied by low pressure pump up airless spray (15-20 psi)
- b) Insure that all windows and metal trim have been cleaned during the cleaning process. The sealer will not react with metal or glass, but will react with dirt making removal more difficult.
- c) Cover or pre-wet with clean water any vegetation to reduce the chances of temporary browning. Check if the active ingredient is toxic.
- d) Cover or pre-wet asphalt to avoid any asphalt residue from leaching out and staining adjacent surfaces.
- e) On horizontal surfaces, apply enough material to flood the surface. Move around any material which has not penetrated the surface after 5-10 seconds. Keep traffic off the surface until the sealer has dried.
- f) On vertical surfaces, work from the bottom up. Saturate the surface with the sealer; run downs are not required as with other sealers.
- g) After the surfaces have dried, rinse off any over spray on windows or metal trim with water. If the windows or metal trim were not cleaned prior to the application of the sealer, warm soapy water will be required.

#### 10.12.6 **Treatment of Cold Joint in Reinforced Cement Concrete (RCC):**

Concrete are cast in parts. The junction of new and old structure will always create cold joint. The waterproofing of the cold joints is a critical requirement in order to have a water tight structure. Water proofing procedure for the cold joints is as below:

- Treat the cold Joint Vertical surface of PCC/RCC with one coat of diluted waterproofing solution.
- Pour concrete mix for the first 100mm of the cold joint. Use mechanical vibrator for compaction followed by wet-on-wet pouring of design specified concrete. This reduces water breakout from the cold joint.
- Grade slab should be cured completely and dried before treatment.
- Prepare the surface by removing loose particles, laitance, dust and dirt by manual cleaning and water jet cleaning. Dry the surface.
- Apply diluted waterproofing solution on the grade slab by flooding procedure.
- Test the dry surface for water absorption.
- Prepare the treated surface free from dirt by water spray then dry.
- Apply one coat of sealant before further works like screed, concreting, plastering as per designed specification.

#### 10.12.7 Limitations of Nanotechnology Based Water proofing compounds:

- These are generally not suitable for frozen or frosted surface and the sealer should not be applied below 50°F, nor should the sealer be exposed to freezing conditions during the first 24 hours of drying.
- Water proofing materials should be used within 24 hours of mixing.
- These compounds should not be applied over previously sealed/painted surfaces.
- These should not be applied during windy conditions or when rain is expected within 2 hours.
- Should not be applied over concrete that has not reached 80% design strength and until completely dry.

### 11.0 Traditional Water Proofing Methods

11.1 **Lime Concrete Terracing:** This system consists of laying, ramming & compaction of lime concrete to a desired slope. Lime concrete used in this system is a mixture of hydrated fat lime (conforming to IS 712) pozzolanic material (calcinated clay pozzolana conforming to IS1344) and concrete aggregate (broken burnt clay bricks conforming to IS: 3068 or natural stone aggregate conforming to IS 383) having maximum size 25mm. This system is suitable for new as well as old roofs.

11.1.1 **Application Procedure:** Various steps involved in this system areas under:

#### i) Preparation of Lime Concrete:-

- One part of slaked lime and two parts of burnt brick pozzolana / surkhi, by volume, shall be mixed on a water tight platform.
- This shall then be sprinkled with required quantity of water and well ground in a mill or using mechanical grinder to obtain lime pozzolana mortar.

- Coarse aggregate and lime pozzolana mortar, in proportion of 2½:1 parts by volume, shall be used for preparation of lime concrete.
- In case of hand mixing, coarse aggregate shall be staked to an even surface on the platform and lime Pozzolana mortar shall than be evenly spread over the aggregate and the whole thoroughly mixed in just sufficient quantity of water to obtain concrete of uniform consistency. The mixing shall be done by turning it over and over several times - until all the aggregate are covered with mortar and a concrete of uniform consistency is obtained.
- In case of machine mixing, two and a half parts by volume of clean saturated surface dry coarse aggregate shall first be fed in to the mixer and then one part, by volume, of lime.
- Pozzolana mortar shall than be added to the mixer and the content mixed well.
- Mixing shall be continued until there is a uniform distribution of the material.
- Final adjustment of water, to obtain concrete of required consistency may be made by adding clear water, if necessary, and turning the ingredients in the mixer.

**ii) Laying, ramming & compaction of lime concrete:-**

- Before laying of lime concrete, all preparatory work described in IS 3067 i.e. cleaning of roof surface, attention to cracks by filling with cement sand slurry, provision of adequate numbers of opening and fillet at the junction of roof and parapet wall shall be completed.
- Roof surface should be made rough to develop sufficient bond between lime concrete and base concrete.
- After cleaning, roof surface shall be painted with hot bitumen 80/100@ 1.7 kg/m<sup>2</sup> blended with coarse sand. Subsequently, laying of lime concrete shall be started from a corner of a roof and proceed diagonally towards centre and other sides considering the slopes required for draining the rain water smoothly.
- The average thickness of lime concrete shall not be less than 100mm.
- On flat roof, slope of 1 in 60 shall be given. However, in heavy rainfall area, slope of 1 in 40 is recommended.
- After laying it shall be initially rammed with a rammer weighing not more than 2 kg and then finished to the required evenness and slopes.
- Further consolidation shall be done using wooden 'thapies' with rounded edges.
- The workmen will sit close together and beat the surface lightly.
- The beating will normally have to be carried on for at least seven days until the 'thapi' makes no impression on the surface and rebounds readily from it when struck.
- During compaction the surface shall be sprinkled liberally with lime mortar and small proportion of sugar solution (i.e. solution prepared by mixing, 3 kg of jaggery, 1½ kg of Bael fruit to 100 litre of water by boiling), for obtaining improved water proofing of concrete.
- On completion of beating, the mortar that comes on the top shall be smoothened with a trowel or float.



- iii) **Curing :-** The lime concrete after compaction shall be cured for a minimum of 10 days or until it hardens by covering with a thin layer of grass or straw which shall be kept wet continuously.
- iv) **Treatment at junction of roof and parapet:-** All along the junction of roof surface with parapet wall, a strip of lime concrete fillet shall be laid and finished smooth.
- v) **Finish:-** In case of accessible roof, one layer of burnt clay flat terracing tiles (according to IS:2690 Part-1 and Part-2) may be laid over a thin layer of lime mortar. However, in the extreme condition where there is considerable expansion and contraction, two layers of tiles may be put on the top of lime pozzolana concrete. These tiles should be joined with non-shrinking impervious cement mortar.

For more details, IS: 3036 – Laying Lime Concrete for Water Proofed Roof Finish, may be referred.

## 11.2 **Mud Phuska Terracing:**

### 11.2.1 **Material:**

- i) **Soil for Mud Phuska:** The soil for mud phuska shall be free from gravel and coarse sand (of particle size greater than 2mm), vegetable matter and fine kankar particles. The soil shall also be free from harmful and efflorescent salts. The coarse material shall not exceed 25% by mass. The plasticity index of the soil shall be between 10- 15 percent. Generally soil suitable for brick making is suitable for mud-phuska.
- ii) **Soil for Mud Plaster and Mud Mortar:** The soil shall be free from vegetable roots, gravel and coarse sand of particle size greater than 2mm. The coarse material shall not exceed 10% by mass. The soil shall also be free from harmful and efflorescent salts. The plasticity index of the soil shall be between 10-15 percent.
- iii) **Mud Plaster:** The mud plaster shall be prepared from soil conforming to above ii). The dry soil shall be reduced to fine powder and mixed with water in a pit, adding wheat straw 6% by mass and cow dung 12% by mass. The mixture shall be allowed to rot for a period of not less than 7 days. During this period, it shall be pugged manually using spades, if necessary, to get a homogeneous mass free from lumps and clods. The consistency of the mortar shall be adjusted by taking it in a trowel and observing how it slides off the face of trowel. The mortar shall readily slide off, but at the same time shall not be so wet as to part into large drops before falling. Alternatively, slump test may be

performed in accordance with the procedure laid down in IS: 1199. The slump should be about 70mm.

- iv) **Mud Mortar:** Mud mortar, used as bedding under brick tile layer, shall be prepared in the same manner as mud plaster but without any addition of fibrous reinforcing material and binding material. The mud mortar may be used immediately without any rotting period.
- v) **Brick Tiles:** These shall conform to the requirements given in IS: 2690 (Part-1) or IS: 2690 (Part-II).

**11.2.2 Application Procedure:** Various steps involved in this system are as under:

- i) **Preparatory Works:** Prior to application of treatment, preparatory works like filling of cracks by cement sand slurry, provision of adequate number of drain outlets, provision of 75mm fillet at junction of roof slab with parapet wall, provision of a groove /chase in parapet wall etc. as described in IS: 3067- Code of Practice for General Design Details & Preparatory Works for Damp Proofing and Water Proofing of Buildings, shall be completed.
- ii) **Cleaning of Roof Surface:** The surface of roof and the part of the parapet and gutters, drain mouths, etc. over which the water proofing treatment is to be applied shall be thoroughly cleaned of all foreign matter, namely fungus and dust etc. by wire brushing and dusting.
- iii) **Application of Bitumen over Cleaned Roof Surface:** After cleaning of roof surface, a coat of hot bitumen (Residual type bitumen 80/100) over the roof surface shall be applied evenly over the entire surface without any gap. Bitumen coat is extended over the vertical surfaces meeting with the slab. Bitumen commonly used is residual type petroleum bitumen of grade 80/100 or hot cut back bitumen. Residual type bitumen is heated to a temp of not less than 165°C and not more than 170° C. The quantity of bitumen to be spread per 10sqm of the surface is approx. 17 kg.
- iv) **Laying of Mud-Phuska:**
  - a) **Preparation:** The soil shall be stacked in required quantities in about 300mm high stacks over a level ground and the top surface divided into suitable compartments of convenient size by bunding. The estimated quantity of water corresponding to optimum moisture content shall be added about 12 hours before the use and allowed to soak. The stacks of soil shall then be worked up with spades and hands to ensure proper distribution of moisture at the time the soil is to be used.

**b) Laying:**

- The Mud-Phuska prepared as above shall be carried to the surface to be covered and laid in loose thickness not greater than 150mm.
- The surface shall then be brought to the slope of 1 in 40.
- It shall then be rammed manually with wooden rammers and 'thappies' so as to obtain maximum density.
- Normally a Mud Phuska layer, laid to a compacted thickness of not less than 100mm, is considered adequate.
- The surface shall be allowed to dry for a period of not less than 24 hours. If any cracks appear, these shall be filled with a grout of the binder material.

v) **Applying Mud Plaster:** After laying the mud phuska, mud plaster shall be laid to a total thickness of not less than 25mm over the surface. The plaster may be applied in a single coat or two coats of 15mm and 10mm. After the application, the coat of plaster shall be allowed to dry. The surface shall be checked once more for slope and evenness with a straight edge and spirit level and made up wherever necessary by application of the plaster.

vi) **Paving with Brick Tiles:** After application of mud plaster, the brick tiles shall be laid flat on a thin layer of mud mortar. The tiles shall be laid close to each other and the thickness of joints shall not be less than 6mm and not more than 15mm. It shall be ensured while laying tiles that mud mortar rises vertically in joints to a height of about 15mm. The brick tile shall be allowed to dry for a period of 24 hours before grouting the joint. After drying, the joint shall be grouted with cement sand mortar (1:3). It shall be ensured that the joints are completely filled by mortar. The mortar shall be allowed to set for a minimum of 12 hours before further pointing of the joints which need to be done only if necessary. Before pointing, the grouted joints shall be brushed clean with a soft brush.

vii) **Curing:** The surface of finished roof shall be kept wet for a period of not less than 7 days.

For more details IS: 2115 – Code of Practice for Flat Roof Finish: Mud- Phuska, may be referred.

**11.3 Integral cement based water proofing treatment with Brick Bat Coba (CPWD Specification 2009: Item No. 22.7):**

Before taking up the water proofing work the construction of parapet walls, including finishing should be completed. Similarly, the ancillary items like haunches, khurras, grooves to tack the fibre cloth layer, fixing up of all down take pipes, water pipes and electric conduits etc. should be completed and no

such work should be allowed on the area to be treated during the progress of water proofing treatment or even later.

#### **11.3.1 Preparing the Surface**

The surface of the slab should be roughened by scrapping when the slab concrete is still green, however, the surface need not be hacked. In case the slab is already cast and surface fairly finished, the same shall be cleaned neatly of all mortar droppings, loose materials etc. with brooms/cloth.

#### **11.3.2 Providing and Laying of Slurry under Base Coat**

The consistency of the slurry should be such as to cover the 1 sqm by using 2.75 Kg of cement.

Depending upon the area of surface that has to be covered, the required quantity of slurry should be prepared using 2.75 kg cement + water per sqm area to be covered, taking particular care to see that only that much quantity of slurry shall be prepared which can be used within half an hour of preparation i.e. before the initial setting time of cement.

The prepared slurry shall be applied over the dampened surface with brushes very carefully, including the joints between the floor slab and the parapet wall, holes on the surfaces, joints of pipes, masonry/concrete etc.

The application of the slurry should continue upto a height of 300 mm on the parapet wall and also in grooves. Slurry should also be applied upto a height of 150 mm over pipe projections etc.

#### **11.3.3 Laying Base Coat 20 mm thick**

Immediately after the application of slurry and when the application is still green, 20 mm thick cement plaster as base coat with cement mortar 1:5 (1 part cement: 5 part coarse sand) shall be evenly applied over the concrete surface taking particular care to see that all the corners and joints are properly packed and the application of the base coat shall be continued upto a height of 300 mm over the parapet wall.

#### **11.3.4 Laying Brick Bat Coba**

- Brick bat of size 25 mm to 115 mm out of well burnt bricks shall be used for the purpose of brick bat coba.
- The brick bats shall be properly dampened for six hours before laying.
- Brick bats shall be laid to required slope/gradient over the base coat of mortar leaving 15-25mm gap between two bats. Average thickness of Brick-bat Coba shall be 120mm.
- Cement mortar 1:5 (1 cement: 5 coarse sand) shall be poured over the brickbats and joints filled properly. Under no circumstances dry brick bats should be laid over the base coat.

- The haunches/gola at the junction of parapet wall and the roof shall be formed only with brick bat coba.
- In case the brick bat coba is laid on the base coat immediately on initial set there will be no necessity of applying cement slurry over the base coat before laying the brick bat coba.
- However, if the brick bat coba is to be laid on the subsequent day, cement slurry prepared as described in clause 11.3.2 shall be applied over the top surface of the base coat, then only the brick bat coba shall be laid.

#### **11.3.5 Application of Slurry over Brick Bat Coba.**

After two days of curing of brick bat coba cement slurry prepared as per clause 11.3.2 shall be applied on the surface of brick bat coba. The application of slurry shall be the same as described in clause 11.3.5 (i) which should cover the haunches/gola, and the remaining small portion of parapet wall and also inside the groove.

##### **(i) Providing and Laying of Slurry for First Layer –**

- The consistency of the slurry should be such as to cover the desired area by using 0.488 kg of cement per sqm of area.
- On deciding the correct quantity of water required per sqm. area the required quantity of slurry should be prepared which can be applied over the desired surface within half an hour of mixing with 0.488 kg. of cement + 0.253 kg. water proofing compound as per manufacturer specifications + x litres of water per sqm. Area and the required quantity of slurry thus prepared should only be used for first application.
- The first layer shall be applied with painting brushes over the specified and dampened area carefully including the corners, holes on the surfaces and joints of pipes in concrete etc. and the application should continue at least upto 150 mm height of fixtures of pipes from the surface.
- The surface on application shall be air cured for 4 hours.

#### **11.3.6 Laying Finishing Layer (Protective Coat)**

- Immediately on applying the cement slurry over the surface of the brick bat coba and when the slurry applied is still green, the fiber glass cloth as specified in clause 11.3.6.(ii) shall be spread evenly on the surface without any kink & pressed to see that no air spaces exist.
- The fiber glass cloth shall be taken up to a height of 300 mm on parapet walls & tucked in the groove specially prepared at that height. 20mm thick layer of cement plaster, without leaving any joints shall be applied with cement mortar 1:4 (1 cement: 4 coarse sand) over the entire fibre glass cloth including the haunches/gola and the small portion on the parapet wall.
- The groove in the parapet wall over the haunches shall also be filled neatly packing the mortar firmly in the groove.
- The surface of the finishing layer (protective coat) shall be neatly finished with cement slurry prepared as per clause 11.3.2.

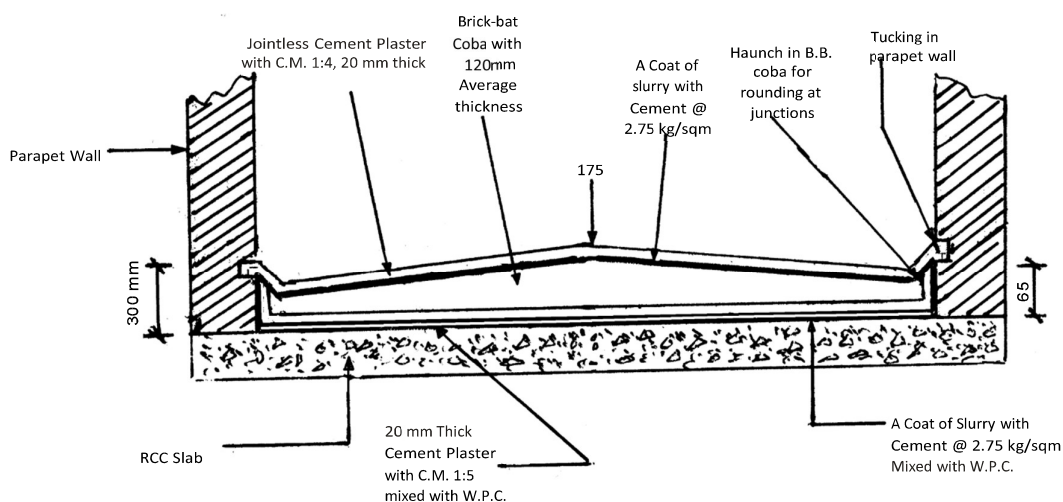
- The finished surface shall be allowed to dry for a while and then pattern of 300 mm x 300 mm groove, 8 mm deep shall be made over the entire surface.

(i) **Providing and Laying of Cement Slurry** - The procedure to prepare and apply the cement slurry shall be same as detailed in clause 11.3.5.(i) except that over projected pipes etc. slurry shall be applied just upto 100 mm height instead of 150 mm height. The slurry shall be applied upto a height of 300 mm on parapet walls and in the groove where the fibre glass cloth is to be tucked.

(ii) **Providing and Laying of Fibre Glass Cloth (2<sup>nd</sup> Layer) –**

- The fibre glass cloth shall be of approved brand and shall be thin, flexible uniformly bonded mat composed of chemically resistant borosilicate glass fibre distributed in random open porous structure bonded together with a thermosetting resin.
- Immediately on applying the slurry on a sufficiently workable area as detailed above in clause 11.3.6.(i) when the slurry applied is still green the fibre glass as specified shall be spread evenly on the surface without any kink and pressed in such a way that no air spaces exist.
- The fibre glass cloth shall be taken upto a height of 30 cm on parapet walls and tucked in the groove specially prepared at that height.
- A minimum overlap of 100 mm width shall be provided when the fibre cloth has to be joined. The joining of 100 mm overlap shall be done with the same slurry used for the application on surface as first layer.
- The fibre cloth shall also be extended upto a height of 100 mm over pipes projecting from the surface.

**11.3.7 Curing and Testing the Treatment:** The entire surface thus treated shall be flooded with water by making kiaries with weak cement mortar, for a minimum period of two weeks.



**Fig. 9**

#### 11.4 **Water proofing Treatment with Bitumen Felt (CPWD DSR 2018: Item no. 22.8-22.11& Specification 2009 Vol.-2: Item No. 22.8):**

Water proofing treatment with self-finished felt shall be four courses or six courses as described in the item. Four course water proofing treatment with self-finished felt is a normal duty treatment suitable for buildings where the cost of roof treatment is required to be restricted.

Six course water proofing treatment with self-finished felt is a heavy duty treatment suitable for important structures.

##### 11.4.1 **Materials**

1. Self finished felt (Appendix A and B) shall conform to the type and grade given in the description of the item. This shall be one of the following types:
  - (i) Type 3 grade 1 hessian base felt conforming in all respects to IS 1322.
  - (ii) Type 2 grade 1 fibre base bitumen felt conforming to IS 1322.
  - (iii) Type 2 grade 2 glass fibre base felt conforming in all respects to IS 7193.
2. **Bonding Materials:** This shall consist of blown type petroleum bitumen conforming to IS 702 or residual petroleum bitumen conforming to IS 73. The bonding material shall be so selected as to withstand the local condition of temperature and gradient satisfactorily. The penetration of bitumen used shall not exceed 40 in any case. Suitable residual type petroleum bitumen of penetration 30/40 (IS grade S-35), residual type petroleum bitumen with higher penetration and low softening point and suitable blown type petroleum bitumen of IS grade 85/25 or 90/15 of approved quality shall be used.

Where proprietary brands of bonding materials are proposed to be used they shall conform in all respects to the specifications in the preceding paras.

Sl. No	Description	1st course	3rd course	5th course
		kg/sqm	kg/sqm	kg/sqm
I	Four course treatment:	1.45	1.45	-
II	Six course treatment			
	(a) With type 3 grade 1 hessian base self finished bitumen felt.	1.45	1.20	1.45
	(b) With felts other than type 3 grade 1 hessian base.	1.45	1.20	1.70

3. **Stone Grit and Pea- sized Gravel:** Stone grit shall be 6 mm and down size. Where pea sized gravel is used it shall be hard, round and free from dust, dirt etc. The stone grit or pea-sized gravel shall not be spread over vertical and sloping faces of flashings and at drain mouths. At these places the surface shall be painted with two coats of bituminous solution.

The quantity of stone grit or pea-sized gravel required for the final course of four or six course treatment with hessian base self finished bitumen felt type 3 grade 1 shall be 6 cubic decimetre/ sqm.

#### 11.4.2 Preparation of Surface

- a. The surface to be treated shall have a minimum slope of 1 in 120. This grading shall be carried out with cement concrete or cement plaster with coarse sand, as per direction of Engineer-in charge, to the average thickness required and finished smooth. Such grading shall be paid for separately.
- b. Junctions between the roof and vertical faces of parapet walls, chimneys etc. shall be cased by running triangular fillets 7.5 x 7.5 cm size, in cement concrete. At the drain mouths, the fillets shall be suitably cut back and rounded off for easy application of water proofing treatment and easy flow of water. Cement concrete where used shall be 1:2:4 mix (1 cement: 2 coarse sand: 4 graded stone aggregate 20 mm nominal size). The provision of fillets shall be deemed to be covered by the item of water proofing and shall not be measured or paid for separately.
- c. In existing roof where gola and drip course are provided at the junction of roof and vertical face of parapet wall, chimney stacks etc., these shall be dressed suitably and finished smooth so as to ensure an easy and gradual turning of the flashing. Any dismantlement or forming and finishing smooth the junction for forming the base of the flashing shall not be measured or paid for separately and shall be deemed to form part of the preparation of the surface in the water proofing treatment.
- d. While the grading of roof surface is being done, it shall be ensured that the outlet drain pipe have been fixed and mouth at the entrance have been eased and rounded off properly for easy flow of water.
- e. When any pipe passes through the roof to be treated, angular fillet of shape shown in Fig. 10 shall be built around it for the water proofing treatment to be taken over it. These fillets shall not be measured or paid for separately.
- f. For carrying over and tucking in the water proofing felts into the parapet walls, chimney stacks etc. a horizontal groove 6.5 cm deep, 7.5 cm wide section with its lower edge at not less than 15 cm above the graded roof surface shall be left on the inner face of the same during construction if possible. When such groove has not been left, the same shall be cut out neatly and the base at rear of the groove shall be finished smooth with cement plaster 1:4 (1 cement: 4 coarse sand). Such cutting of the groove and its finishing smooth shall be deemed to be part of the water proofing item and shall not be measured or paid for separately. No deduction shall be made either for not making the groove or when the later has already been left in the masonry by the construction agency.



- g. Tucking in the water proofing felt will be required where the parapet wall exceeds 45 cm in the height from the graded surface. Where the height is 45 cm or less, no groove will be required as the water proofing treatment will be carried over the top of the parapet wall to its full thickness. In the case of low dividing walls of height 30 cm or less, outlets therein shall be cut open for full height and the bottom and sides shall be rendered smooth and corners rounded and such treatment shall not be measured and paid for separately.
- h. Where expansion joints are left in the slab, the provision of dwarf walls and/or RCC slabs for covering them and finishing the surface smooth shall be the responsibility of the construction agency, which had laid the roof slab and will not be included the operation of water proofing.
- i. The graded surface of the roof and concrete fillets and the faces of walls shall be thoroughly cleaned with wire brushes and all loose scales etc. removed. The surface shall then be dusted off. Any crack in the roof shall be cut to 'V' section, cleaned and filled up flush with cement mortar slurry 1:4 (1 cement: 4 coarse sand) or blown type petroleum bitumen of IS grade 85/25, or approved quality conforming to IS 702. Such cleaning of the surface or treating the cracks shall not be paid for separately.

#### 11.4.3 Priming Coat

Where so specified, or required by the Engineer- in-Charge for example under slightly damp conditions a priming coat consisting of a bitumen primer conforming to IS 3384 should be applied with brush on the roof and wall surface at 0.24 litres per sqm to assist adhesion of the bonding material (i.e. bitumen). Such application of primer shall be paid for separately, unless specifically included in the water proofing item.

#### 11.4.4 Underlay

Where a floating treatment of water proofing with self finished bitumen felt is required i.e. where water proofing treatment is required to be isolated from the roof structure, a layer of bitumen saturated felt (underlay) shall be spread over the roof surface and tucked into the flashing groove. No bonding material shall be used below the underlay in order to keep the underlay free of the structure. The adjoining strips of the underlay shall overlap to a minimum of 7.5 cm at sides and 10 cm at ends. The overlaps shall be sealed with the same bonding material as used for the self finished felt treatment. Unless specifically included in the water proofing item, the underlay treatment shall be paid for separately. The underlay shall be of type 1 saturated felt conforming to IS 1322 in all respects and having a total minimum weight of the finished bitumen felt in dry condition with mica dusting powder @ 6.8 kg per 10 sqm. The roll shall not be damaged or crack on being unrolled on a fairly smooth and flat surface.

#### 11.4.5 Treatment

- a. The water proofing shall consist of a four or six course treatment, as given in the description of the item, each layer of bonding materials, self finished bitumen felt or stone grit or pea sized gravel being counted as a course.

- b. The choice of a four or six course treatment will depend on the climatic condition, the importance of the building, the durability required, cost and other relevant considerations.
- c. A four course treatment shall consist of the following layers:
  - i. Initial layer of bonding material applied hot at specified weight per unit area.
  - ii. 2nd layer of self finished bitumen felt conforming to the type and grade given in the description of the item.
  - iii. Third layer of bonding material.
  - iv. Final layer of stone grit of pea sized gravel spread at specified volume of material per unit area.
- d. In a six course treatment, the first, second and third layer shall be of the same as in the four course treatment. The fourth and fifth layer shall consist of self finished felt and bonding material respectively. The sixth layer shall consist of stone grit or pea sized gravel.
- e. The primer or underlay where required to be provided shall not count against the number of courses specified.

#### 11.4.6 Laying

- a. Bitumen bonding material of required grade shall be heated to the working temperature specified for the particular grade by the bitumen manufacturers and conveyed to the roof in buckets or pouring canes in weighed quantities.

Suitable working temperature for different grades of bitumen are as under:

- (i) Blown type petroleum bitumen of IS grade 85/25 or 90/15 - 180 degree C.
- (ii) Residual type petroleum bitumen of penetration 30/40 - 180 degree to 190 degree C (IS grade S35).
- b. Drain outlets shall be given a four or six course treatment as specified for the roof in the description of the item in the manner specified for the flat roof surface. Water proofing treatment shall be carried into the drain pipe or outlets by at least 10 cm. The water proofing treatment laid on the roof surface shall overlap the upper edge of the water proofing treatment in the drain outlets by at least 10 cm.
- c. The self finished felt shall be cut to the required length, brushed clean of dusting material and laid out flat on the roof to eliminate curls and subsequent stretching. The felt shall normally be laid in length at right angles to the direction of the slope and laying shall be commenced at the lowest level and worked upto crest. The felt shall not be laid in single piece of very long lengths as they are likely to shrink; 6 to 8 m are suitable lengths. The roof surface shall be cleaned and dried before the felt treatment is begun. Each length of felt

shall be laid in position and rolled up for a distance of half its length. The hot bonding material shall be poured on the roof across the full width of the rolled felt as the latter is steadily rolled out and pressed down. The pouring shall be so regulated that the correct weight of bonding material per unit area is spread uniformly over the surface. Excess bonding material that gets squeezed out at the ends shall be levelled up as laying proceeds. When the first half of the strip of felt has been bonded to the roof, the other half shall be rolled up and then unrolled on the hot bonding material in the same way. Subsequent strips shall also be laid in the same manner. Each strip shall overlap the preceding one by at least 7.5 cm at the longitudinal edges and 10 cm at the ends. All overlaps shall be firmly bonded with hot bitumen. Streaks and trailings of bitumen near edges of laps shall be levelled by heating the overlap with a blow lamp and levelling down unevenness. The third layer of bonding material in the four course treatment shall be carried out in a similar manner after the flashing has been completed.

- d. In a six course treatment the third and fourth layers of bonding material and self finished felt shall be laid in the manner already described, taking care that laps in the felt are staggered from those in the second layer. The fifth layer of bonding material shall be carried out after the flashing is done (See Fig. 10).
- e. **High Parapet Walls, Chimney Stacks etc.:** Felts shall be laid as flashings wherever junctions of vertical and horizontal surfaces occur. Longitudinal laps shall be 10 cm. The lower layer of flashing felt in a six course treatment shall overlap the roof water proofing by not less than 20 cm while the upper layer shall overlap the roofing felt by 10 cm. The minimum overlap of the flashing felt in four course specification over the roofing felt shall be 10 cm. The flashing shall consist of the same four or six course treatment as for the roof except that the final course of stone grit or pea-sized gravel shall be replaced by an application of bituminous solution of approved quality in two coats on the vertical and sloping faces only, of the flashing. The overlap along the length of flashing shall stagger with those in the second layer of flashing felt (in a six course treatment and with the joints in the roof felt). The upper edge of the flashing felt shall be well tucked into the flashing grooves in the parapet, chimney stacks etc. to a depth of not less than 6.5 cm. Corresponding applications of bonding material shall also be made. The flashing treatment shall be firmly held in place in the grooves with wood edges at intervals and the grooves shall be filled up with cement mortar 1:4 (1 cement: 4 coarse sand) or cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded stone aggregate 6 mm nominal size) and surface finished smooth with the rest of the wall. The cement work shall be cured for 7 days. When dry, the exposed plaster joints of grooves shall be painted with bitumen and two coats of bituminous solution shall be applied on the vertical and sloping surface of flashing (see Fig. 10). After the top flashing felt layer has been fixed, the penultimate layer of bonding material shall be applied over the roofing felt and the horizontal overlaps and vertical and sloping surfaces of the flashings at the specified rate. Stone grit or pea sized gravel shall then be spread uniformly over the hot bonding material on the horizontal roof surface at the specified quantity per unit area and pressed into it with a wooden roller.

**f. Low Parapet Walls:**

Where parapet walls are of height 45 cm or less, bitumen felt flashings shall be provided in the same manner as for flashings in the case of high parapet walls except that the upper edge shall be carried upto the full height of the wall and taken right across the top of the parapet and down on the external vertical faces to a minimum distance of 5 cm (see Fig. 10).

**g. Low Dividing Walls:**

Where low dividing walls or inverted beams are met with, the same shall be covered with a four or six layer treatment as for the main roof, the latter bearing carried down both sides of the wall and overlapping the roofing treatment as in the case of flashing of high parapet walls (see Fig. 10). Drain outlets where formed in the low dividing walls, shall be given water proofing treatment of the same number of courses as specified for the flat roof surface. The bottom and sides shall be so treated that all overlaps are in the direction of flow of drainage.

**h. Expansion Joints:**

Where the expansion joints are provided in the slabs, the joints and their cover slabs shall be suitably treated with water proofing. A typical sketch of an expansion joint with the RCC slabs on either side of the joint turned vertically up and covered with precast RCC cover slabs as given in Fig. 10. The cover slabs shall cover the vertical turned up dwarf walls by not less than 7.5 cm and are provided with throatings on their underside along their length. The water proofing treatment shall be taken up the sloping junction fillets and the vertical faces of the walls to the underside of the cover slabs. The cover slabs are given the water proofing treatment like the roof slabs, after the cross joints between adjacent cover slabs are first sealed with 15 cm width of roofing felt struck to them with bitumen. The water proofing treatment shall be carried down the sides of the cover slabs to their full thickness. Care shall be taken to see that overlaps if any in the roofing over the cover slabs stagger with the joints between cover slabs. The formation of the expansion joints and provision of cover slabs shall be the responsibility of the construction agency. The formation of the junction fillets and the water proofing treatment of the joint and cover slabs shall be carried out by the water proofing agency. No extra shall be paid for the junction fillers or for the sealing of the cross joints in the cover slab with 15 cm width of bitumen strips.

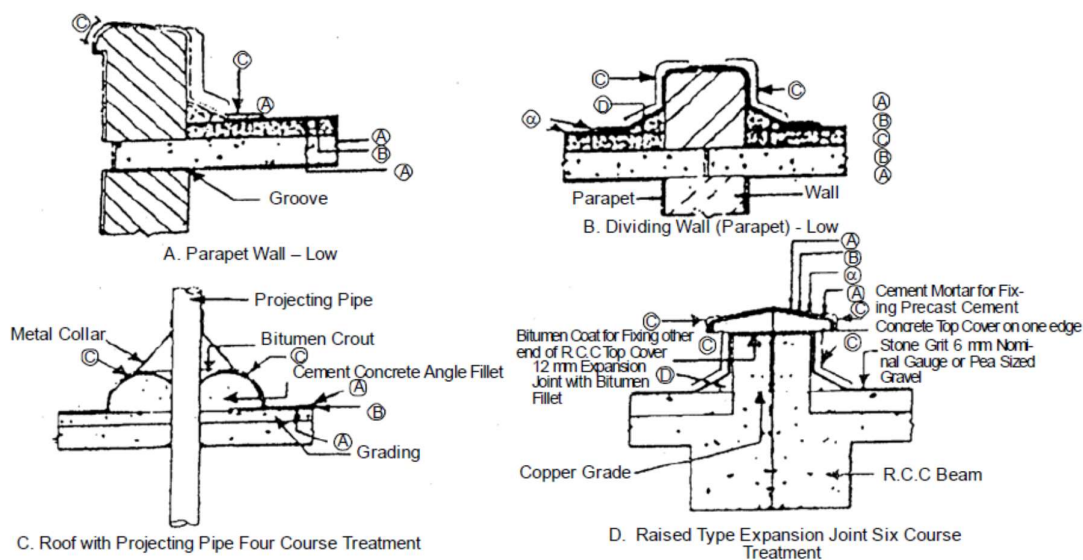
**i. Pipes:**

Where vertical pipe outlets are met with 7.5 x 7.5 cm fillets of lime or cement concrete of the type and section shown in Fig. 10 shall be provided and flashing of four or six course treatment, same as for the roofing treatment shall be laid. The upper edge of the flashing shall be laid sloping down forward and butted against the pipe and annular depression so formed shall be filled with hot

bitumen. A circular metal collar in the shape of an inverted truncated cone shall be fixed on the pipe to throw off the rain water clear of the flashing and this shall be paid for separately.

j. **Terrace:**

Where roof surfaces are expected to be used precast cement concrete tiles or 40 mm thick cement concrete shall be laid on the water proofing treatment. In such cases, the final course of stone grit or pea sized gravel shall not be laid in the water proofing treatment. Suitable adjustment in the rates will be effected for not providing the stone grit or pea sized gravel layer. Cement concrete in situ flooring shall be laid in panel not exceeding 0.4 square metres each. Precast tiles or in situ concrete flooring where laid shall be paid for separately unless included in the description of the water proofing item.



**Fig. 10**

**11.5 Water proofing using polyethylene film:**

- 11.5.1 i) On slopped roof surface, polyethylene film can be laid. This system is suitable for new as well as old construction. This treatment generally consists of application of following courses:
- A coat of bitumen primer conforming to IS: 3384 applied to the prepared surface at the rate of 0.3 to 0.5 kg/m<sup>2</sup>.
  - Application of hot applied bitumen (straight run bitumen conforming to IS:73 ) at the rate of 0.70 kg/m<sup>2</sup> minimum.
  - Laying of polyethylene film conforming to IS: 2508 with cold cutback adhesive in overlaps.
  - Laying of 100 gm brown kraft paper laminated in situ over the film with semi hot layer of straight run bitumen.
  - Application of semi hot applied bitumen at the rate of 0.7 kg/m<sup>2</sup> dusted with fine sand.
  - Laying of finishing layer of tiles or Indian Patent Stones i.e. 1:2:4 cement concrete with 10mm down aggregate or cement concrete.

### 11.5.2 Application procedure:

Various steps involved in this system areas under:

- i) **Provision of slope and completion of preparatory works:-** Prior to application of water proofing treatment roof surface shall be provided with a minimum slope of 1 in 100 with cement concrete or cement sand mortar or lime surkhy mortar. After provision of slope all preparatory works like filling up of cracks in roof structures by cement sand slurry, provision of adequate number of drain outlets, provision of 75mm fillet at junction of roof slab with parapet wall, provision of a groove/ chase in parapet wall etc. as described in IS:3067-1988" shall be completed.
- ii) **Method of laying:-**
  - After completion of preparatory works, a coat of primer shall be applied on the prepared roof surface by brushing and allow it to dry for 6 to 12 hours.
  - Then a coat of hot bitumen shall be spread on the roof surface and allowed to cool to a temperature so that the film may be laid without any damage to it.
  - The polyethylene film shall be carefully laid and pressed on the bituminous layer.
  - The film shall be pressed down with the help of a gunny cloth so as to prevent any damage to the film.
  - The next length of the polyethylene film shall be similarly laid down with proper longitudinal and end overlaps firmly pressed on the bituminous layer.
  - The joints and overlaps shall be carefully sealed with the help of cutback bitumen applied over the upper surface of lower layer of polyethylene film.
  - Minimum width of lap shall be 10 cm between adjacent films and at the ends.
  - As far as possible for flat roof the film shall be laid at right angles to the direction of flow of water with overlap facing downwards.
  - Width of film should be selected in such a way so that no. of laps are minimum.
  - On polyethylene film 100 gm brown kraft paper shall be fixed with semi hot layer of straight run bitumen.
  - The technique of fixing kraft paper to polyethylene film is to paint semi hot bitumen on the paper, reverse it and laminate over the film.
  - Kraft paper shall be coated with semi hot applied bitumen at the rate of 0.7 kg/m<sup>2</sup> dusted with fine sand.
  - After finishing roof surface, treatment shall be applied to parapet, gutters and drain mouth.
- iii) **Treatment at the junction of roof with parapet wall:-** Where down water pipes are provided to drain off the rain water, extra piece of polyethylene film shall be provided in the opening covering the edge of the water pipe and covered with cement plaster 1:6.
- iv) **Surface Finish:-** After completion of treatment, roof shall be provided with any one of the following:
  - a) Cement concrete flooring tiles conforming to IS: 1237;

- b) Burnt clay flat terracing tiles conforming to IS:2690 (Pt-1) or IS: 2690 (Pt-2);
- c) Indian Patent Stone i.e. 1:2:4 concrete 40mm thick with 10 mm down aggregate.

### 11.5.3 Precautions in laying polyethylene film:

- The roof surface should be reasonably smooth so as to avoid puncturing of film. Primer should not be applied on wet surface.
- Excessive bitumen should not be used for bonding the film to the prepared surface, which may otherwise result in the film sliding and wrinkling.
- Over stretching of the film shall be avoided at the time of laying, which otherwise leads to wrinkles when the film retracts.
- The laying of the film should be immediately followed by subsequent operations of covering with bituminous compositions. It is found that if the film is left, exposed, it can lead to softening of bitumen layer underneath causing wrinkles, which may possibly lead to damage. The work should not be carried out at high temperature.
- The workman should preferably walk barefooted or with canvas shoes to prevent damage to the film.

For more details IS: 7290 -Recommendations for Use of Polyethylene Film for Water Proofing of Roofs, may be referred.

### 11.6 Polymer modified cementitious slurry coating:

- 11.6.1 Polymer modified cementitious slurry coatings are applied over the base Concrete. This system can be used over new as well as old roofs. This technique of water proofing is latest development in the field of water proofing. Polymer imparts significant improvement in impermeability. Polymer modified cementitious slurry have coefficient of expansion very similar to concrete thereby it does not get cracked due to thermal variation of concrete.

Polymer modified cementitious slurry coatings consist of a liquid blend and a dry blend. The liquid blend consists of the polymer, liquid additives and clean water. Dry blend consist of locally available Portland cement and aggregates. These blends are mixed in specified ratio generally 2:1 (cement: polymer) by weight and applied by brush on a prepared clean surface. Generally, two coats are provided. However, manufacturer's recommendations should be followed in this regard. To impart more flexibility, it is desirable to use some reinforcement like fiber glass cloth sandwiched between two coats. This coating should be covered by screed concrete to protect it against physical damage.

- 11.6.2 **Application of polymer modified cemenetitious slurry coating:** - Broadly following steps are involved in application of this system:

- i) **Preparation of roof surface:-** The surface shall be cleaned to remove all dust, foreign matters, lose materials or any other deposits of contamination.

Cracks and depression shall be filled up by fillers (cement sand mortar as per recommendation of suppliers). Prepared surface shall be thoroughly pre-wetted for one hour.

- ii) **Preparation of polymer modified cementitious slurry:-** Dry blend and liquid blend shall be mix into the desired ratio as per recommendation of supplier. The mix shall be stirred thoroughly, until no bubbles remain in the mix. Any lump found in mix shall be removed.
- iii) First coat of polymer modified cementitious slurry shall be applied by brush on wet cleaned surface.
- iv) Subsequently, fiber glass cloth shall be laid over first coat of polymer modified cementitious slurry.
- iii) Second coat of polymer modified cementitious slurry shall be laid over fibre glass cloth.
- iv) Polymer modified cementitious brush topping shall be applied over second coat of polymer modified coating.
- viii) On brush topping, screed concrete, 1:2:4 admixed with suitable integral waterproofing compound 25 to 40mm thick to a min. slope of 1 in 100 with aggregate size down 10mm with maximum water cement ratio 0.45, shall be laid. Above system may slightly differ from case to case depending upon the instruction of supplier of water proofing system. There is no relevant Indian standard/ other code of practice for this system. Therefore, work should be carried out as per manufacturers'/suppliers instructions. Users are advised to collect complete literature from manufacturer and study carefully prior to application of treatment.

11.6.3 Since, there is no relevant Indian or any other standards available, this system needs to be adopted carefully.

#### 11.7 **Waterproofing using Polymer modified Bituminous Membrane:**

Addition of polymer in bitumen improves its workability characteristics, penetration and softening behaviour, tensile and fatigue properties and capacity to bridge movement of cracks / joints in the substrate. Non-woven fibre glass mat and non-woven polyester mat are generally used as reinforcement to improve their characteristics like lap joint strength, tensile strength and flexibility. Polymer modified bituminous membrane are obtained by sandwiching nonwoven polyester fabrics or fiber glass mat between layers of high quality polymer modified bituminous membranes. These membranes have high softening point, high tensile strength, high tear & puncture resistance, high joint strength and low water vapour transmission. This system is suitable for new as well as old roofs.

11.7.1 **Method of application :-** Steps involved in this water proofing system may be as given below:



- i. **Provision of slope and cleaning of roof surface:-** Prior to application of water proofing treatment roof surface should be provided with a minimum slope of 1 in 100 with plain cement concrete. After provision of slope all preparatory works like filling up of cracks by cement sand slurry, provision of adequate number of drain outlets, provision of 75mm fillet at junction of roof slab with parapet wall, provision of a groove/ chase in parapet wall etc. as described in IS:3067 should be completed.
- ii. Laying a coat of cold applied bitumen primer @ 0.2 to 0.4 l/sqm on entire roof surface.
- iii. Laying 85/25 grade hot blown bitumen @ 1.2kg/sqm all over the surface.
- iv. Laying 2.5-3mm thick polymer modified bituminous membrane with non-woven polyester fibre glass mat reinforcement, applied by torch with sealing all the joints.
- v. Laying 85/25 grade hot blown bitumen @ 1.2 kg/sqm all over the surface.
- vi. Final finish with china mosaic tiles on a 15mm thick grey cement plaster bed. Method of application may slightly differ depending upon product and manufacturers' recommendations. As there is no relevant IS code of practice for this water proofing system, work should be carried out as per manufacturers' recommendations. Users are advised to collect complete literature from manufacturers and study completely prior to application of treatment.

11.7.2 Since there is no relevant Indian or any other standards available, this system needs to be adopted carefully.

#### 11.8 **Integral Waterproofing Compound for Plaster & Concrete (Cement Based):**

Concrete having proper mix design, low water – cement ratio and sound aggregate will be impervious and needs no additives. However, resistance of concrete to penetration of moisture can be improved by adding, chemically active water repelling agents like soda and potash soap. These admixtures prevent water penetration of dry concrete. So far, no established track records are available to prove life of chemical water proofing. These products have a tendency to become brittle and crack up due to stress in buildings, especially the thermal stresses. These products are cement, silica or polymer based and are specially formulated and designed to control the capillary pores. These products not only make concrete water proof, but also help in resisting water penetration.

Admixture used for reducing permeability of concrete are termed integral water proofing Admixtures, while admixtures imparting the property of water repellency are termed as damp proofing admixtures. These admixtures are manufactured and marketed by a large number of firms.

**11.8.1 Method of Application/Use:****A. Hand Mixing:**

With normal concrete & sand /cement mortar mix use 1kg of Waterproof Powder to the dry mix and mix it evenly with a spade until an even color is obtained or as instructed by manufacturer. Cure the surface as per regular practices.

**B. Machine Mixing:**

With normal concrete and sand/cement mortar mixes use 1kg of Water Proof Powder for every 50kgs bag of Cement. Mix the dry materials for at least 2 minutes or as instructed by manufacturer. Add the normal measured quantity of water and mix it evenly as usual practice to completion. Cure the surface as per regular practices.

**12.0 Diagnosis of dampness and remedial action in existing building****12.1 General:**

Water proofing needs to be done not only during construction stage, but it also may happen that existing building may experience dampness. A table to help in analysis of reason of dampness in existing building is given below-

<b>Visual effects</b>	<b>Occurrence</b>	<b>Time</b>	<b>diagnosis</b>
Lime efflorescence more or less horizontal with stained and damp area below	Just above floor level	All the time although height may vary with season	A rising ground moisture by Capillary
Persistent dampness	One spot	All the time, but may Dry up for a while in summer	Leakage from some pipe.
Widespread efflorescence and moulds	Mainly on massive constructions	During first year after building or longer, there are impervious surface	Entrapped water introduced during construction.
Dampness widespread on patches, without efflorescence but often with moulds	On or behind cold surface	In cold weather or on sudden changes from cold to warm humid weather	Condensation
Dampness in patches with a little or no efflorescence	On plastered surface	Appears when air is humid, disappears when air is dry.	Condensation encouraged contamination with deliquescent salts

Efflorescence in patches often with rings spreading cut from focal points	In walls where external side exposed to rain	After heavy rain for longer period without a good dry weather	Rain penetration through walls
Water drops spreading	Internal surface	After heavy rain for longer period	Rain penetration through walls

**12.2 Inspection and maintenance for leaky roofs:** Before taking any decision regarding remedial measures to be adopted for leaky roofs, it is necessary that the roofs are inspected thoroughly. The inspection should preferably be done during rainy season. Based on the observations, future course of action should be decided depending upon the condition of leakage in the roofs. Minor repairs at isolated locations may be carried out immediately on dry day and performance of repair should be observed after next rainfall. Major repairs, like complete replacement of water proofing system, may be carried out after rainy season prior to next monsoon.

**12.3 Thorough inspection:** The inspection of roof should cover all the essential aspects, which may affect waterproofing system and may cause leakage in the roofs. Following aspects should be specifically covered:

- a) Availability of adequate slopes (minimum 1 in 100)
- b) Provision of 75mm fillet at the junction of roof and parapet walls.
- c) Provision of adequate number and size of openings.
- d) Provision of slope and drip course in copings.
- e) Any sources of permanent leakage of water like overhead water storage tanks or leaking water supply pipe, broken down water drainage pipes, leakage at joints of down water drainage pipes (causes wetness in walls).
- f) Undulations/ minor depression in roof surface where water may stagnate.
- g) Growth of plants on the roof.
- h) Condition of water proofing treatment, especially development of cracks/ de-bonding etc.
- i) Condition of ceiling/ walls below the roof etc.

**12.4 Attention to roof leaking at isolated points:** During inspection, if it is observed that the leakage through roof is at isolated location, then such location should be carefully studied. It should be examined whether basic requirement for waterproofing has been fulfilled. If basic requirement for a leak proof roof are not fulfilled, any type of water proofing system will not work satisfactorily. Thus, first of all, action should be taken to ensure that basic requirement of leak proof roof are fulfilled. Leakage at isolated locations may be due to some defects at that particular location. Depending upon the water

proofing system adopted on roof, action should be taken to rectify the defect. In case of roofs provided with bitumen felt, there may be debonding or leakage through joints. In that case, defective locations have to be identified, cut and removed and new layer of bitumen felt may be provided duly keeping desired overlap length. Similarly, in other bituminous treatment, existing bituminous layer may be removed and fresh layer may be laid. In case of roofs provided with lime terracing with tiles, there may be depression on roof surface or loss of cement mortar between tiles. Such defects may be rectified by fresh pointing/ plaster. Preferably pointing should be done with non-shrink polymer modified cement mortar. In case wetness is observed on the wall just below the junction of roof & parapet wall, condition of fillet & drain outlets need to be examined. Broken pipes may be replaced and fillet may be constructed again after dismantling old fillet. Plaster on walls and coping should also be examined and repaired, if necessary.

- 12.5 **Course of action for roofs leaking at isolated points:** Following course of action should normally be followed for repairs of roofs leaking at isolated points:
  - 12.5.1 **Cleaning of roof surface and openings:** First of all, entire roof surface and all the openings should be cleaned so as to ensure effective and un-obstructed flow of rain water through the openings provided on the roofs. Weeds and any other foreign material on roof surface should be removed. The blockage in the openings should be cleared. It should be ensured that openings are functional.
  - 12.5.2 **Arresting permanent leakage of water from its sources:** If continuous leakage of water is observed on roof from any source, like over head water storage tank or leaking water supplying pipe lines etc., the same should be arrested by repairing over head water storage tank/ pipeline.
  - 12.5.3 **Identification and attention to locations of stagnated water:** Leakage of roof takes place only when water does not drain off quickly and stagnates over the roof surface. Generally, water stagnates over the depression formed in the roof surface. Thus, locations having depression in roof surface should be attended. Subsequently, it should be ensured that there is no location on roofs where water stagnates.
  - 12.5.4 **Repair of filet at junction of roof on parapet wall:** Condition of fillet at junction of roofs on parapet wall should be examined and any damage/ defective portion should be repaired.
  - 12.5.5 **Repair to joints of tiles :** Condition of pointing at joints in between tiles should be examined and wherever mortar has come out, fresh pointing in cement mortar 1:3 should be done. After pointing curing should also be ensured.

- 12.5.6 **Repair to plaster and coping on parapet:** Broken/ decayed plaster on parapet wall should be replaced by fresh plaster. Coping should also be attended along with provision of slope.
- 12.5.7 After taking above steps, behaviour of roof surface should be watched and if leakage still persists, following steps have to be taken:
- (a) **Removal of complete top surface and repair of lime concrete:** Entire top surface which may be consisting of tiles and bitumen felts etc. should be removed and conditions of the layer below it i.e. lime concrete/ mud plaster should be examined. Minor cracks should be sealed with cement sand slurry or bitumen compounds after making 'V' groove in case of lime concrete. Defective concrete should be replaced by fresh lime concrete. In case of mud-phuska, minor cracks may be filled up by bituminous compound. Decayed mud plaster and mud- phuska should be replaced by fresh mud-phuska and mud-plaster.
  - (b) **Provision of adequate slope:** Many of the old roofs may not have adequate slope. For lime concrete terracing, a minimum slope of 1 in 60 is necessary. Therefore, after removal of top surface, slope of existing roof should be examined and if necessary, re-grading of roof surface should be carried out using lime concrete/ cement concrete. Prior to re-grading of roof surface, level should be marked on roof and parapet. Subsequently existing lime concrete surface should be made rough. After that re-grading work should be taken up. After re-grading, top surface should be made smooth using cement plaster 1:3 and surface should be cured for 7 days. Similarly, on mud-phuska roofs a slope of 1 in 40 shall be ensured. If necessary, roof surface should be re-graded using mud-phaska and mud plaster. After regarding, layer of mud-plaster should be allowed to dry before relaying of top surface.
  - (c) **Re-laying of top surface:** After completion of re-grading, a layer of burnt clay tiles should be laid. Old tiles may be used if they are in good condition. Tiles should be laid over 20 mm cement mortar 1:3. Tiles should be joined with impervious cement mortar.
- 12.5.8 **Attention to roofs leaking heavily:** If heavy leakage is observed at large number of location on the walls and on the ceiling it is an indication of ineffective water proofing treatment. In such cases, it will be necessary to remove entire existing water proofing material like bitumen felts/ mastic etc. After removing the existing water proofing material, fresh water proofing treatment has to be provided. In case of lime concrete terracing, tiles needs to be removed first. After removal of tiles, condition of lime concrete should be examined. If large number of cracks is observed, it is desirable to remove complete lime concrete. If lime concrete is in good condition with few isolated

cracks, these cracks should be filled up with cement slurry or bituminous caulking compound conforming to IS:1580. Subsequently, if necessary, re-grading of roof should be done as suggested. After re-grading fresh waterproofing system may be provided. Water proofing treatment may be any among various systems as mentioned above except bituminous felt treatment. While providing fresh water proofing system, care should be taken that instructions as given in relevant standard/ literature are strictly followed. Prior to provision of fresh water proofing system, provision of basic requirement of water proofing of roof should also be ensured.

**ANNEXURE**

*The products of manufacturers' detailed below is based on the information provided by firm / internet and no actual testing or trial of the product has been carried out by this office. Details are provided only for the ease of field Engineers. Before selecting suitable product please go through the product broacher provided by firm. At initial stage, the product of the firm may be used as trial.*

**(A) DETAILS OF SOME OF THE KNOWN WATERPROOFING PRODUCTS MANUFACTURERS (Products of other manufactures may be available in market)**

**1. STP Limited:**

707, Chiranjiv Tower, 43, Nehru Place

New Delhi - 110019, Delhi, India

Telephone: +(91)-(11)-46561359

Fax: +(91)-(11)-46561358

Email- info@stpltd.com, hasan@stpltd.com

Sri Hasan Rizvi (Sr. VP STP Ltd.)

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	Two Component Cementitious Elastomeric Coating	ShaliCem EWP	Waterproofing coating in water tanks, Swimming pools, Toilets, water retaining structures.
2.	PU Based waterproofing: solvent based	ShaliUrethane LHM	Waterproofing of Roof, Terrace, Podium, Terrace garden.
3.	PU Based waterproofing: water based	ShaliUrethane BTM	Waterproofing of corrugated roof, Basement.
4.	Waterproof Exterior Acrylic Paint	ShaliCryl 215	Waterproof paint on Exterior walls.
5.	Expansion Joint Polysulphide Sealant	ShaliSeal PS PG	For Expansion joints in all structure.
6.	Expansion Joint Polyurethane Sealants	ShaliSeal PU / PU2K	For Expansion joints in all structure.
7.	APP waterproofing Membrane for Roof & Basement	SuperThermoLay	For roof, basement, sunken slabs, terrace garden, car parking, tunnels and bridge decks/ ROB.
8.	PVC membrane	ShaliPVC	For roofs, reservoirs, basements.
9.	SBS (Styrene Butadiene styrene) Membrane	SuperTene	Self-adhesive membrane for waterproofing of roof and basement.
10.	Cement based waterproofing	ShaliCrete	Bonding new concrete to old concrete, making mortar for repairing as well as waterproofing. Suitable for toilets, sunken slabs, kitchen, sewers, aquariums,

			walls, planters and small concrete terraces.
11.	Bituminous Anti-Corrosive Coating	TankMastic /HB	Used as non toxic corrosion protection coating to all types of iron, steel, masonry / concrete surfaces.
<b>Waterproofing / Repairing of Roads</b>			
12.	Preventive maintenance of Roads	ShaliSeal RSTC	Used as Coal tar sealer coat on top surface of roads in residential complex/ housing society, Expressway, Highway, Parking Lots, Driveways, taxiways.
13.	Pot holes Repairing	ShaliPatch	Used as pot hole repair in bituminous roads.
14.	Cold applied bituminous emulsions	ShaliMulsion A/C	It is used as tack coat / grouting , lean mix curing, patching , sealing of formation and sub- bases of road.
15.	Crack Repair in Concrete Roads	ShaliPatch EC	Used as Crack Repair in concrete roads
<b>Misc.</b>			
16.	Coal Tar Epoxy coating for STP Tanks	ShaliPoxy CTE 103/ 303	Coating protects the concrete against corrosive environment in Sewage treatment plant Tanks.
17.	Anti Corrosive coating	ShaliUrethane PC	It is a two component spray applied solvent free PU coating for Concrete and Steel.
18.	Epoxy mortar	ShaliFix EM	Used for repairing of any concrete surface.
19.	Epoxy Paint	ShaliPoxy 400	It is a food grade epoxy coating for internal surface of pipes and vessels used for potable water.
20.	Water repellent coating	ShaliWaterpellar	It is used on exterior of building to repel water from exterior surface.
21.	Coloured cycle track paint	ShaliSeal CSS-A	It is used for demarcation at Railway platform near train boarding area, bus lane marking etc. It is anti skid paint.
22.	Fire retardant coating / flooring	ShaliFloor SL 3E FR	It is a three component epoxy based fire retardant coating for wall and floor.
23.	Epoxy injectable grout	ShaliGrout EI	To seal porous concrete and provide structural strengthen.
24.	Bipolar corrosion inhibitor additive for RCC	ShaliPlast LW+++	Used as bipolar corrosion inhibitor in RCC floors, walls, slabs and mass concrete casting.
25.	Super Plasticizer for concrete and mortar	ShaliPlast PCE	Ether based super plasticizer for concrete and mortar



26.	Anti-carbonation coating	ShaliKote AC WB/SB	Anti-carbonation UV resistant coating for multi-storeyed bldgs.
27.	Cold applied bituminous compound with mineral fillers	TarPlastic	Sealing J bolts & cracks in corrugated sheets.

**2. SIKA India Private Limited:**

301-302, 3<sup>rd</sup> Floor,  
Elegance Tower,  
Jasola Vihar, New Delhi-110025

Mob.: +91 9136601610 / 9839065007 (Mr. S.M.Hasan, Sr. Sales Manager)

Tel: +91 1141030264-65-66

Email : hasan.syedmarghoob@in.sika.com & info.india@in.sika.com

Website: ind.sika.com

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	APP Waterproofing membranes	Sika WP Shield 103 P/104 P / SikaBit T 130 PG / 140 PG	Plain finish polyester reinforced APP membrane
		Sika WP Shield 103PM / 104PM / SikaBit T 140 MG/ SikaBit T 130 MG	Mineral finish polyester reinforced APP membrane
		SikaBit T 130 SG/140 SG	Sand finish polyester reinforced APP membrane
		Sika WP Shield 103F/102F	Plain finish fibre glass reinforced APP membrane
2.	PVC Based Waterproofing membrane	Sikaplan WP membranes	Basement / Tunnel Waterproofing
		Sarnafil S/ G membranes	Roof Waterproofing
3.	Polyurethane based Liquid polymer membrane	Sikalastic 450I	Tar extended Polyurethane for exposed and covered roofs
		Sikalastic 560	Modified Polyurethane for exposed roofs
		Sikalastic 851R	Spray applied liquid membrane for exposed and covered roofs
		Sikalastic 851	Spray applied liquid membrane for concrete bridge decks
4.	Cementitious Waterproofing	Sika Topseal 107	2 component Acrylic coating
		Sika Topseal 109hi	2 component Elastomeric Acrylic coating
		Sika Raintite I/Cemcrete	Polymer for Waterproofing coating

S.No.	Product Category	Name/s of Products	Description / Area of Application
		Sika Flexicoat 1K	One component Cementitious Waterproofing coating
5.	Integral Waterproofing compound	Plastocrete Plus Sikacim Pink	Liquid Waterproofing compound
		Sika Noleek	Powder Waterproofing compound
6.	Expansion Joint Waterproofing	SikadurCombiflex SG	Expansion Joint Treatment
7.	Bonding agent	Sikadur 32, Sikadur 32LP, Sika Hibond	Bonding agent for new concrete to old concrete
8.	Anti-Carbonation coating	Sikagard 550W Elastic, Sikagard 551S Primer, Sikagard 680 MY	Protective coating for concrete exposed structures
9.	Interior / Exterior Protective coating	Sikagard PU UR/ Sikagard PU UR (W), Sikagard XT, Sika Primer W	Protective cum waterproofing coating for concrete & masonry
10.	Bridge Deck Waterproofing systems	Sikalastic 851, Sikalastic 8902, Sikalastic 827HT, Sikalastic 841ST, Sikalastic 8800, SikaBit T 130/140 SG	Waterproofing and protection of Bridges, Flyovers, Underpass
11.	Quick repair tape	Sika MultiSeal	Self-adhesive bituminous sealing tape
12.	Crystalline Waterproofing	Sika 101h	Crystalline waterproofing coating
13.	Fully bonded membranes	SikaProof P 12/ A 12HC	Basement / UG Waterproofing
14.	Drainage Board	Sika Drain 500 Felt/ 1000 Felt	Drainage board with prefixed geotextile for tunnel waterproofing
		Sikaflex PRO-3	PU based joint sealant for PQC
		Sikaflex 11FC	High modulus sealant for different substrates
	<b>Misc.</b>		
15.	Injection Grouting chemicals	Sika Injection 101h	Polyurethane injection foam
		Sika Injection 202IN	Polyurethane injection resin
		Sika Injection 306	Acrylic Injection resin
		Intraplast EP / N200 / NN	Cement grouting admixtures non shrink grouting chemicals
		Sikadur 52	Epoxy Injection resin for dry locations

S.No.	Product Category	Name/s of Products	Description / Area of Application
		Sikadur 53UF	Epoxy Injection resin for damp locations
		Sikadur 52 LP (IN)	Epoxy Injection resin with long pot life
16.	Heat reflective cool roof coatings	Sika CoolCoat	Fibre reinforced acrylic waterproofing cum heat reflective coating
17.	Water stopper / Waterbar	Sika Swell A Profile	Acrylic based Hydro swelling Water stopper
		Sika Swell S2	PU Based hydro swelling liquid
		Sika Waterbar h	PVC based Water stopper
18.	Coal Tar coating for ETP / STP tanks	InertolPoxitar	Coal tar epoxy coating for STP/ETP tanks
19.	Repair mortar	Sika Top 122HS, Sika Monotop 122R, Sika Monotop 122F	Ready-to-use repair mortar for concrete structures
		Sika Top 77, Sika Latex, Sika SBR 100	Multipurpose polymer for site batch mortar for repair and waterproofing
20.	Epoxy mortar / adhesives	Sikadur 31 (IN), Sikadur 41, Sikadur 43, Sikadur-43 HE (h), Sikadur-52 (IN) SLV Mortar, Sikadur 53UF Mortar, Sikadur 31C	Epoxy based adhesive and mortars for repair works in concrete structures

### 3. Conschem Technologies (India) Ltd.:

Conschem House, 56,  
New Idgah, Agra (U.P.) India.

Tele Phone: 91 9412255042, 9411961943

Customer care No.: +91 8755529092

Email- conschem@live.com

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	Water Proofing System	CONSPROOF WP	It confirms to IS 2645. 200 ml per bag of cement used in plaster and concrete work.

		CONSPROOF BC	It conforms to IS 2645. Used for brick coba work, reduce shrinkage cracks, make mortar more dense and water tight.
		CONSGUARD A	Two part polymer modified cementitious waterproofing coat used for waterproofing of roof, water tank swimming pool wall dampness etc.
		CONCRETE AP	Single component flexible waterproofing coating prevent salt penetration. Used for waterproofing of roof, water tank, swimming pool wall dampness etc.
		CONSCOAT EP	Two part epoxy waterproofing coating provides protection for concrete and steel structure. Suitable for overhead tanks underground tanks, swimming pool ,dams and portable water.
2.	Admixture	i. CONSFLO S ii. CONSFLO HP 90 iii. CONSFLO XLR	Water reduction up to range of 30 to 40%, flowing and self levelling concrete. Provides high strength for concrete work
3.	Industrial Grout	CONSGROUT 60	Cementitious grout for Bolt grouting washing apron work & grouting of PSC sleepers.
4.	Industrial Floor	CONS FLHD	Non matalic non dusty and anti slip flooring compound for hard wearing.
5.	Sealants Repairs and Bonding Agent	CONSBOND SBR	Polymer latex based bonding agent for old to new concrete joints.
		CONSBOND EP	Epoxy based bonding agent for old to new concrete joint.
		CONSPATCH M	Pre packed polymer modified cementations mortar for repair and plaster work
		CONS MICROCONCRTE	High strength non shrink flowable mortar for jacketing work for repair of various structure for high strength
6.	Protective Coating	CONS CORROGUARD	Polymer base protective anti corrosive coating for steel and reinforcement
		CONS CORROGUARD EP	Two part Epoxy base protective anti corrosive coating for steel and reinforcement
		CONS RUST R	Remove rust most effectively from steel .Suitable for removing rust from reinforcement and structural steel.

**4. Pidilite Industries,**  
 Ramkrishna Mandir Road  
 Off Sir Mathuradas Vasanji Road,  
 Andheri (East) Mumbai - 400059 Maharashtra.  
 INDIA Phone: +91 22 3308 7000  
 Fax: +91 22 2835 7700  
 E-mail: pil@pidilite.com

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	Waterproofing system & chemicals for terraces, roofs, water tanks basement and walls.	Dr.Fixit URP or Dr.FixitBitufix	Below Ground.
		Dr.Fixit URP Dr.FixitPidifin 2K Dr.FixitFastflex	Bathroom / kitchen
		Dr.FixitPidifin 2K Dr.FixitFastflex	Water Tanks
		(i) Undercoat : Dr.Fixit URP Dr.FixitRoofseal Flex Dr.FixitFastflex (ii) Topcoat : Dr.FixitNewcoatEzeeDr.FixitNewcoat	Roof
		Dr.Fixit Raincoat Dr.Fixit Raincoat Cool	Exterior walls

#### 5. CICO Technologies Limited

C-44/2, 1st & 2nd Floor,  
 Okhla Industrial Area,  
 Phase-II, New Delhi-110020  
 Ph. # 91-11-40509400  
 Fax: 91-11-40509413  
 Emil: cicotech@cicogroup.com

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	Waterproofing chemicals for underground structure, sunken portion, roof, foundation.	CICO Tapecrete P 151 CICO Super CICO NO 1 CICO SHIELD CICO B MEN	Underground Structure
		CICO Tapecrete P 151 CICO Super CICO NO 1 COCO POXY 2125	Sunken Portion

		CICO Tapecrete P 151 CICO NO 1 CICO SHIELD CICO B MEN CORCHEM 206 I CORCHEM 2P CICO Aquapur	Roof / Roof Garden
		CICO Tapecrete P 151 CICO Super	Foundation / DPC

**6. BASF India Ltd.**

Construction chemicals divisions,  
Plot No.37, Chandivali Farm Road,  
Chandiveli, Andheri (E),  
Mumbai- 400072  
Ph. 022-28580210

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	Waterproofing liquid membrane	CONIBASE CONIDECK CONIROOF MASTERPREN	waterproofing membranes either can be spray or hand-applied
2.	Polyurethane and polysulphide elastomeric joint sealants	MASTERFLEX SONOLASTIC	For joint sealing.

**7. TEXSA INDIA LTD.**

Headquarters Gurgaon  
345, Ground Floor,  
Udyog Vihar, Phase-II  
Gurgaon - 122 016 Haryana  
Tel. (+91) 124 405 2078  
texsaindia@texsa.in  
www.texsa.in

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	APP Membrane	MOPLY N FP 3 mm MOPLY N FP 4 mm MOPLY N FV 2 mm MOPLY N FV 3 mm	Roof
2.	SBS	MORTERPLAS PARKING MORTERPLAS SBS ALU 3 KG MORTERPLAS SBS FM 3 KG	Waterproofing of bridge decks on railway structures, foundation slabs and flooring.

**8. Bengal Bitumen New Delhi**

G- 003, SalconAurum,  
District Center Complex,  
Jasola, New Delhi - 110025  
Telephone: +(91)-(11)-40516589

S.No.	Product Category	Name/s of Products	Description / Area of Application
1.	Bitumen felt	the Great Bengal Felt, Bengal Supermat	Waterproofing bitumen felt

**(B) DETAILS OF SOME OF THE KNOWN CRYSTALLIZATION WATERPROOFING PRODUCT MANUFACTURERES (Products of other manufactures may be available in market)**

S.No.	Brand Name	Firm
1.	PeneSeal CWP	<b>STP Limited</b> 707, Chiranjiv Tower, 43, Nehru Place New Delhi - 110019, Delhi, India Telephone: +(91)-(11)-46561359 Fax: +(91)-(11)-46561358 Email- co@stpltd.com
2.	Dr. FixitKrystalline	<b>Pidilite Industries Limited</b> Construction Chemicals Division Ramkrishna Mandir Road, Post Box No. 17411 Andheri (E) Mumbai 400059 INDIA Tel +91-22-2835 7000 • Fax +91-22-2835 7008 Toll Free No.: 1800-209-5504
3.	Xypex Crystalline	<b>Xypex Chemical Corporation</b> H.O. 13731 Mayfield Place Richmond BC, Canada Email: <a href="mailto:enquiry@xypex.com">enquiry@xypex.com</a> Website: <a href="http://www.xypex.com/India">http://www.xypex.com/India</a> Distributor in India
4.	Monoproof	<b>Monarch Industrial Products India Private Limited,</b> No. 25, S.I.D.C. Industrial Estate, Theni- 625531, TamilNadu Contact: 08373904238

**(C) DETAILS OF SOME OF THE KNOWN NANO TECHNOLOGY WATERPROOFING PRODUCTS MANUFACTURERES (Products of other manufactures may be available in market)**

S.No.	Brand Name	Firm
1.	Zycosil+ (Waterproofing) Zycopriime+ (Bonding Agent) Elastobar (Membranes)	<b>Zydex Industries,</b> Zydex House, 61, Gotri-Sevasi Road, Sevasi, Vadodara- 391101 Phone: +91 265 3312000 Email: <a href="mailto:info@zydexindustries.com">info@zydexindustries.com</a>
2.	POLYSIL WR POLYSIL C	<b>S. M. Adhesives</b> Shop No. 4, Ganga Bhuvan, SRPS Road, Opposite Chetna Apartment, Bhandup West Mumbai - 400001 Cell : +(91)-8805186896 +(91)-9322237077 Telephone: 022-32608690 Fax: 022-25349588
3.	ChlororubBase Primer Chlororub Base Finish Anti-damp Nano Powder Salt/Leaching Arrester - water base Salt/Leaching Arrester - solvent base	<b>Innovation Center for Applied Nanotechnology</b> (I-CanNano) 2771 Garia Main Road Garia, Kolkata -700084 Tel: +91-33-32985444 Email: <a href="mailto:arup@icannanopaints.com">arup@icannanopaints.com</a> <a href="mailto:info@icannanopaints.com">info@icannanopaints.com</a>

**References:**

1. Indian Railway Works Manual 2000.
2. CPWD Specification 2009 (Vol. – I & II) & DSR 2018.
3. Details of Item no. 10.5 to 10.11 taken from Draft CPWD Specification 2019 (Vol.II).
4. Literature available on internet.
5. Product details provided by some of the known manufacturers.