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भारत सरकार – GOVERNMENT OF INDIA
रेल मंत्रालय – MINISTRY OF RAILWAYS

छत का जलरोधी उपचार

WATERPROOFING ROOF TREATMENT

कैमटेक / 2014 / सि / वाटरप्रूफिंग / 1.0
CAMTECH/2014/C/WATERPROOFING/1.0
अक्टूबर – 2014
October – 2014

Indian Railways
Centre for Advanced Maintenance Technology

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प्राक्कथन

अधिकांश नवनिर्मित या पुरानी सिविल इंजीनियरिंग संरचनाओं को रखरखाव से मुक्त रखने के लिए पर्याप्त उपायों की आवश्यकता होती है. यह देखा गया है कि छतों पर जलरोधी प्रणाली अपक्षय प्रभाव के कारण खराब हो जाती है, और दरारें/ जलरोधी सामग्री के विघटन इत्यादि के उत्पन्न होने के कारण अप्रभावी हो सकती है. जलरोधी प्रणालियाँ जो कि छतों से रिसाव / टपका की समस्याओं के प्रभावी समाधान के लिए सामान्यतः इस्तेमाल की जाती हैं, की इस पुस्तिका में चर्चा की गई है.

यह आशा की जाती है कि कैमटेक द्वारा तैयार पुस्तिका सिविल संरचनाओं के रखरखाव की गतिविधियों में लगे भारतीय रेलवे के इंजीनियरिंग कर्मियों को काफी उपयोगी होगी.

कैमटेक,ग्वालियर **(ए. आर. तुपे)**

दिनांक 30.10.2014 **कार्यकारी निदेशक**

Foreword

Most of the civil engineering structures either newly constructed or old in nature require adequate measures to keep them maintenance-free. It has been noticed that the waterproofing system on roofs get deteriorated due to weathering effect, and may become ineffective due to development of cracks/ disintegration of waterproofing materials etc. The waterproofing systems, commonly used as effective solutions to the problems of leakage/ seepage through roofs are discussed in this booklet.

It is expected that the booklet prepared by CAMTECH will be quite helpful to the engineering personnel of Indian Railways engaged in maintenance activities of civil structures.

CAMTECH, Gwalior ***A.R. Tupe***
Date 30.10.2014 ***Executive Director***

भूमिका

एक बड़ा संगठन होने के नाते भारतीय रेलवे के पास सिविल इंजीनियरिंग संरचनाओं और इमारतों की विशाल सम्पदा मौजूद है जिनकी सेवा अवधि के दौरान रखरखाव की आवश्यकता होती है. कंक्रीट की गुणवत्ता और इसके बाद के जलरोधीकरण संरचना के स्थायित्व में महत्वपूर्ण भूमिका निभाते हैं. कंक्रीट छत से रिसाव और टपका एक बहुत ही आम घटना है और आम तौर पर बरसात के मौसम के दौरान घटित होती है. वास्तव में, अच्छा कंक्रीट कार्य लगभग 80% जलरोधी समस्या का समाधान करता है. जलरोधी प्रक्रिया के एक भाग के रूप में, सामग्री, डिजाइन और निर्माण प्रथाओं में प्रमुख तकनीकी परिवर्तन निरंतर जारी है.

'जलरोधी छत उपचार' पर यह पुस्तिका आमतौर पर इस्तेमाल की जाने वाली जलरोधी प्रणालियौ जो कि छत रिसाव/ टपका की समस्याओं के प्रभावी समाधान के रूप में उपयोग की जाती हैं, के बारे में सूचनात्मक जानकारी प्रदान करने के उद्देश्य से तैयार की गई है. यह पुस्तिका, रखरखाव कार्य में शामिल सिविल इंजीनियरिंग स्टाफ के मार्गदर्शन के लिए है.

यह पुस्तिका वैधानिक नहीं है तथा इसमें दी गई सामग्री का उद्देश्य केवल मार्गदर्शन है. इसमें दी गई अधिकांश जानकारी और डेटा किसी न किसी रूप में विभिन्न पुस्तकों और अन्य मुद्रित सामग्री में तथा इंटरनेट पर उपलब्ध है. अधिक जानकारी के लिए, इस पुस्तिका में वर्णित किसी भी तकनीक/ या विधि को अंतिम रूप से लागू करने से पहले विषय पर उपलब्ध प्रासंगिक कोड, मैनुअल और रिपोर्ट का अध्ययन संदर्भ रूप में किया जाना चाहिए.

हम आगे सुधार के लिए पाठकों से किसी भी सुझाव का स्वागत करते हैं.

कैमटेक,ग्वालियर **(एस. के. सक्सेना)**

दिनांक 30.10.2014 **उप निदेशक / सिविल**

Preface

Indian Railways is a big organisation having large assets of civil engineering structures and buildings, which require maintenance throughout their service life. Quality of concrete application and its subsequent waterproofing plays an important role in the durability of the structure. The seepage and leakage through concrete roof is a very common phenomenon and generally occurs during rainy season. In fact good concrete practice solves around 80% of the waterproofing problem. As a part of waterproofing process, major technological changes continue to occur with respect to the material, design and construction practices.

This booklet on *'Waterproofing Roof Treatment'* is prepared with the objective to provide informative details including commonly used waterproofing systems, which are used as effective solutions to the problems of roof leakage/seepage. The booklet is meant for the guidance of civil engineering staff involved in maintenance work.

This booklet is not statutory and contents are only for the purpose of guidance. Most of the data & information mentioned herein are available in some form or the other in various books and other printed matter and at Internet. For more in-depth information, the relevant codes, manual and reports on the subject may be referred before final implementation of any technique/ or method described in this booklet.

We welcome any suggestions from readers for further improvement.

CAMTECH, Gwalior ***S. K. Saxena***
Date 30.10.2014 ***Dy. Director/Civil***

संशोधन पर्चियों का प्रकाशन

इस लघु पुस्तिका के लिये भविष्य में प्रकाशित होने वाली संशोधन पर्चियों को निम्नानुसार संख्यांकित किया जायेगा।

केमटेक/सि/2014/वाटरप्रूफिंग/1.0 सीएस # **XX** दिनांक----------

जहॉ **"XX"** सम्बन्धित संशोधन पर्ची की क्रम संख्या है (01 से प्रारम्भ होकर आगे की ओर)

प्रकाशित संशोधन पर्चियॉ

क्र.सं.	प्रकाशन की तारीख	संशोधित पृष्ठ संख्या तथा मद संख्या	टिप्पणी

ISSUE OF CORRECTION SLIPS

The correction slips to be issued in future for this handbook will be numbered as follows:

CAMTECH/C/2014/WATERPROOFING/1.0/CS. # XX date .....

Where "XX" is the serial number of the concerned correction slip (starting from 01 onwards).

CORRECTION SLIPS ISSUED

Sr. No. of C.Slip	Date of issue	Page no. and Item No. modified	Remarks

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1.0 प्रस्तावना / Introduction

Waterproofing systems that are prevalent in our country and used as effective solutions to the problems of roof leakage/ seepage are briefly summarized. As per ASTM D 1079, waterproofing is defined as *treatment of surface or structure to prevent the passage of water under hydrostatic pressure*. It has often been found that the seepage and leakage through concrete is a very common phenomenon. In fact good concrete practice (having proper mix design, low water-cement ratio and sound aggregate) solves around 80% of the waterproofing problem.

In the last twenty years, the use of polymer modified roofing system has grown substantially. 80 per cent of the waterproofing in the developed countries is being executed with polymeric material. In India, these materials have been introduced recently and accepted as one of the durable solution for waterproofing.

2.0 रिसाव के कारण / Cause of Leakage/Seepage

- The basic defects in concrete are due to usage of excess water that leads to formation of capillaries and pores through which, structure allows water under pressure to pass slowly through the material.
- Water proofing system on the roofs gets deteriorated due to weathering effect and may become ineffective due to development of cracks/de-bonding/disintegration of water proofing material etc.
- Stagnation of water due to undulation in roof surface, provision of less no. of drainage pipes or choking of same and improper detailing at junction of parapet and roof etc., are major contributors in making the roof leaky.
- Ingress of water through wild growth of vegetation and deterioration of sealant material (in case of expansion joints) may become the main source of leakage/ seepage, if not attended timely.

3.0 लीक छत का निरीक्षण / Inspection of Leaking Roof

It is necessary that the roofs should be inspected thoroughly and preferably during rainy season. Minor repairs at isolated locations may be carried out immediately on dry day. Major repairs, like complete replacement of water proofing system, may be carried out after rainy season prior to next monsoon. Following aspects should be specifically covered during inspection of roof:

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 source of permanent leakage of water like
   - over head water storage tanks
   - 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.

4.0 छत रिसाव को रोकने के लिए बुनियादी आवश्यकता / Basic Requirement to prevent Roof Leakage

At the very outset it is necessary to emphasize certain basic requirements which must be taken into account for prevention of roof leakage. The following should be ensured prior to the treatment:

- **Provision of adequate slopes:** For efficient drainage of rain water from the roof, the slope should not be less than 1 in 100 and preferably 1 in 60 so that water gets drained off quickly by achieving adequate velocity under influence of gravity.

- **Provision of adequate openings:** In general, one 100 mm diameter pipe is considered to be suitable for every 40 sqm of the roof area to be drained and spacing in between them should not be more than 6 m.

- **Proper detailing at junction of roof with parapet wall:** It is necessary that detailing at the junction of roof and vertical face of parapet wall should be done very carefully. Following should be ensured:

  i) The fillet (angular or concave, not convex) of 75 mm 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) Grating should be fixed at the mouth of rain water pipe to prevent entry of leaves/other waste material from roof. Rain water pipe and fittings should be properly secured to the walls.

- **Expansion Joints:** Expansion joints in buildings/ other structures may become source of perennial seepage due to failure of expansion joint fillers and 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 conforming to IS: 3414-1968 (reaffirmed 1995) or IS:1838 (Pt.I-1983 or Pt.II-1984) (reaffirmed 1995):** The joint filler is a strip of compressible material used to form and fill the expansion joints in structures. Joint filler may be produced from a

variety of materials, such as bitumen, bitumen containing cellular materials, cork strips or granules, natural or cellular rubber, expanded plastics, mineral fibre, polythene foam, etc.

- **Sealing compound conforming to IS: 1834-1984 (reaffirmed 1995):** Joint sealing compounds, composed of suitable mixtures of materials, shall form a resilient and adhesive barrier in concrete joints and shall be capable of resisting the infiltration of water and the ingress of solid particles. They shall not be unduly affected by temperature variation, and shall resist any tendency to flow out of the joint under hot weather conditions. They shall not become brittle or suffer loss of resiliency during cold weather conditions.

5.0 जलरोधी प्रणाली के लक्षण / Characteristics of Waterproofing System

A water proofing system should have the following properties:

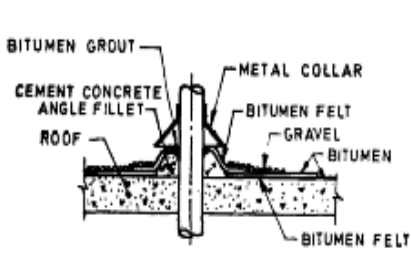
- It should be impermeable or should have very low permeability.
- It should have strong adhesion with substrata.
- It should be sufficiently elastic so as to withstand expansion and contraction of substrata due to temperature fluctuations.
- It should have high resistance to abrasion and cracking.
- It should be resistant to ultra violet rays.
- It should be breathable i.e. permit vapour transmission.
- Its application should be easy.
- It should be durable.

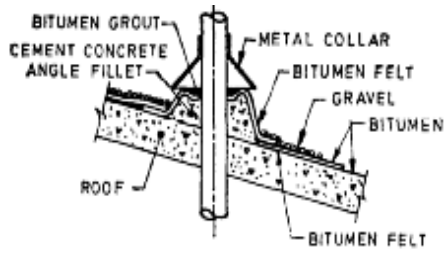
6.0 निर्माण से पहले छत उपचार के लिए तैयारी / Preparatory Works prior to Roof Treatment

Good workmanship plays a vital role in prevention of water seepage. Roof surface should be properly prepared, dried and cleaned before application of the waterproofing material. Waterproofing membrane should be applied

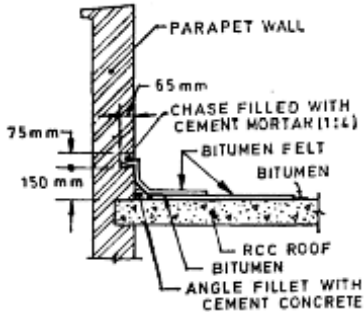
in accordance with the manufacturer's specifications, and special attention should always be paid to the critical locations such as joints, upturns, downturns and penetrations. The following preparatory works shall be carried out as per IS: 3067-1988.

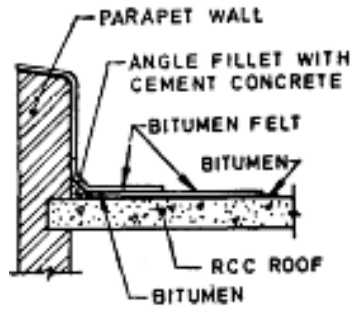
- Well defined cracks other than hair cracks on the surface is cut to "V section, cleaned and filled up flush with cement sand slurry or with cold applied bituminous caulking compound conforming to IS:1580-1969.
- The surface of roof and that part of the parapet and gutters, drain mouths, etc. over which the waterproofing treatment is to be applied shall be cleaned of all foreign matter, namely, fungus, moss and dust, by wire brushing and dusting.
- In the case of lime concrete treatment, the structural roof surface shall be finished rough to provide adequate bond.
- In the case of gunite treatment, the roof surface shall be prepared by removing all loose and disintegrated materials and shall be cleaned by compressed air and water prior to guniting. Concrete surfaces shall be roughened by light chipping and the joints in the masonry walls shall be raked out to a depth of 12 mm to form good bond for the gunite.
- Drain outlets shall be suitably placed with respect to the roof drainage and prevent local accumulation of water on the roof surface. Masonry drain mouths shall be widened two and half times the diameter of the drain and rounded with cement mortar.
- For cast iron drain outlets, a groove shall be cut all around to tuck the treatment.
- When a pipe passes through roof on which waterproofing treatment is to be laid, a cement concrete angle fillet shall be built round it and the waterproofing treatment taken over the fillet.



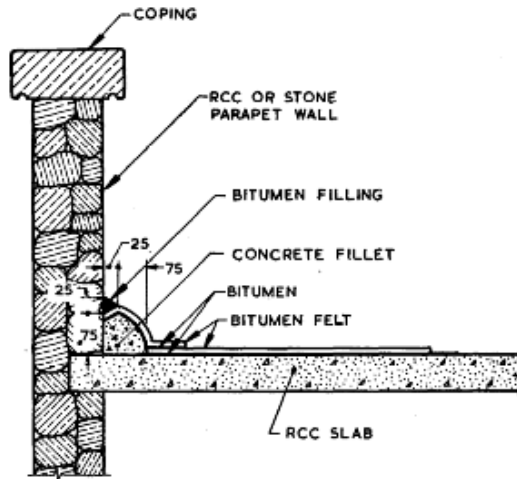


- In case of parapet walls over 450 mm in height, for tucking in waterproofing treatment, a groove at a minimum height of 150 mm above roof level may be left in the vertical face at the time of construction, this groove shall be 75 mm wide and 65 mm deep. The horizontal face of the groove shall be shaped with cement mortar. At the junction between the roof and the vertical face of the parapet wall, a fillet 75 mm in radius shall be constructed. In case of low parapets where the height does not exceed 450 mm, no groove shall be provided and the waterproofing treatment shall be carried right over the top.





- In the case of existing RCC and stone walls, cutting the chase for tucking in the waterproofing treatment is not recommended as the cutting of groove in stone wall is not possible.



- At the drain mouths, the fillet shall be suitably cut back and rounded off for easy application of the waterproofing treatment and easy flow of water.
- Outlets at every low dividing wall, say less than 300 mm in height, shall be cut open to full depth and the bottom and sides shall be rendered smooth and corners rounded off for easy application of waterproofing treatment.

7.0 छतों के लिए आमतौर पर इस्तेमाल होने वाली जलरोधी प्रणाली/ Commonly Used Water Proofing System for Roofs

Some of the water proofing systems, which are extensively used in our country, is as under:

7.1 Terracing with Lime Concrete, Brick Bat Coba and Mud Fuska

The conventional methods of lime concrete, brick bat coba and mud fuska are still in use as waterproofing systems but these methods are slowly

becoming obsolete due to their short life and complexity of their application. In between asphalt (bitumen) as a waterproofing coating gained popularity because of its abundant availability as a by-product from petroleum at a cheaper price.

Some of the problems that these systems have are:

- High loading on the slab
- Cracks on the surface, specially in case of brick bat coba
- Expertise levels of application in lime terracing/ mud fuska not as good as in olden days
- Offer more insulation rather than a leak proof or a water tight system
- As they age, breaking them and re-doing the same system is risky for the slab; cracks caused in the slab increase the problem of leakage.

If the terrace surface is an existing one already done with Brick Bat Coba, Lime terracing treatment or with mud fuska as is done in North India, then, the systems based on acrylic coating and polymer based formulations would be the most suitable.

7.2 Water Proofing using Polymer Cementitious Slurry Coatings

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

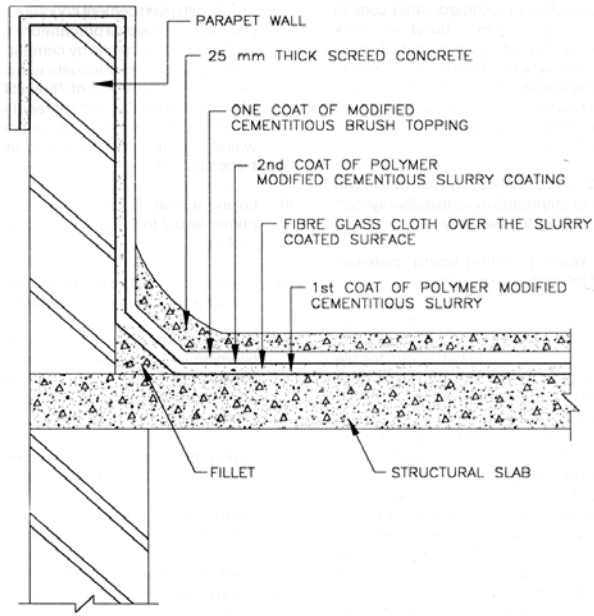
Surface preparation: The surface shall be cleaned to remove all dust, foreign matters, lose materials or any other deposits of contamination. Cracks and depression shall be filled up by fillers (cement sand mortar as per recommendation of suppliers). Prepared surface shall be thoroughly pre-wetted for one hour.

Mix preparation: Polymer modified cementitious slurry coatings consist of a liquid blend and a dry blend. Dry blend (consisting of locally available

Portland cement and aggregates) and liquid blend (consisting of the polymer, liquid additives and clean water) shall be mixed into the specified ratio generally 2:1 (cement: polymer) by weight or 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.

Application Method:

- First coat of polymer modified cementitious slurry shall be applied by brush on wet cleaned surface.
- Subsequently, fibre glass cloth shall be laid over first coat of polymer modified cementitious slurry.
- Second coat of polymer modified cementitious slurry shall be laid over fibre glass cloth.
- Polymer modified cementitious brush topping shall be applied over second coat of polymer modified coating.
- On brush topping, screed concrete, 1:2:4 admixed with suitable integral water proofing compound 25 to 40 mm thick to a min. slope of 1 in 100 with aggregate size down 10 mm with maximum water cement ratio 0.45, shall be laid.



नोट / *Note:*

1. *Since, there is no relevant Indian or any other standard available, this system needs to be adopted carefully. 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.*
2. *Commercially available acrylic based polymer waterproofing compound is TAPECRETE from CICO Technologies Limited, New Delhi. The item based on TAPECRETE is specified in the Item No. 105010 of USSOR-2010 of N C Railway.*
3. *The items based on polymer cementitious slurry coatings are specified in item nos.171220 and 171230 of USSOR-2010 of N C Railway.*

7.3 Water Proofing using Polyethylene Films

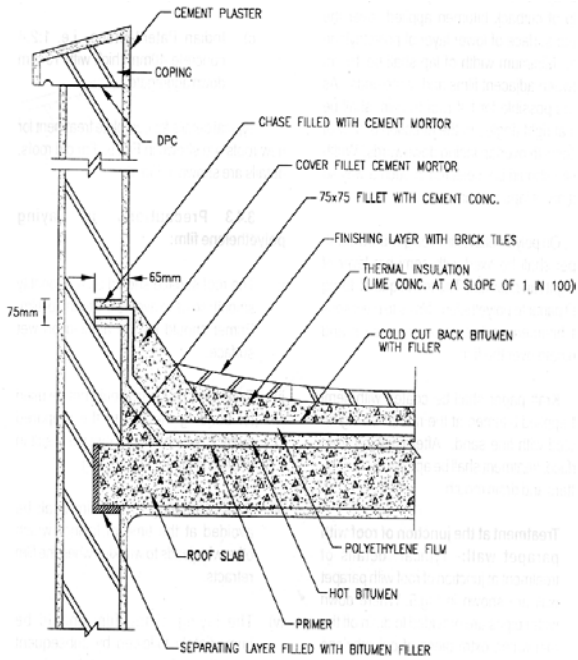
It consists of laying of polyethylene film on slopped roof surface. This system is suitable for new as well as old roofs. This treatment generally consists of application of following courses:

Surface preparation: After providing adequate slope (minimum slope of 1 in 100 with cement concrete or cement sand mortar), all preparatory works as detailed in Para 6.0 should be completed.

Application Method:

- A coat of bitumen primer conforming to IS: 3384 shall be applied on the prepared roof surface by brushing at the rate of 0.3 to 0.5 kg/m^2 and allowed it to dry for 6 to 12 hours.
- A coat of hot bitumen (straight run bitumen conforming to IS: 73) at the rate of 0.70 kg/m^2 minimum 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 conforming to IS: 2508 with cold cutback adhesive in overlaps shall be carefully laid and 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.



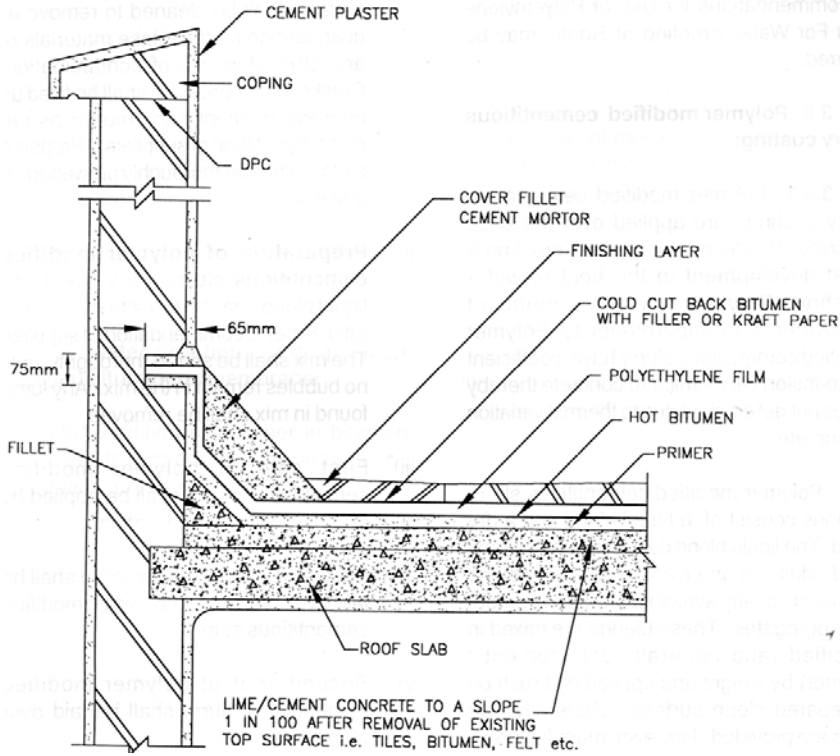
- On polyethylene film 100 gm brown kraft paper shall be fixed with semi hot layer of straight run bitumen. The technique of fixing kraft paper to polyethylene film is to paint semi hot bitumen on the paper, reverse it and laminate over the film. Kraft paper shall be coated with semi hot applied bitumen at the rate of 0.7 kg/m2 dusted with fine sand.

- 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 (Part-1) or IS: 2690 (Part-2);
  c) Indian Patent Stone i.e. 1:2:4 concrete 40mm thick with 10 mm down aggregate.
- 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.

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.

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



Waterproofing using Polyethylene Film (For Old Roof)

7.4 Water Proofing using Polymer Modified Bituminous Membranes

Bitumen is a dark brown to black material in which the predominating constituents are mixture of hydrocarbons of natural origin. The useful properties of bitumen are, Cementing, Waterproofing, Thermoplastic, Mild alkali/ Mild acid resistance, Electrical insulation. Bitumen has been used in waterproofing for long time; modification of bitumen has been made to meet the requirement of modern construction. As bitumen becomes hard and is susceptible to cracking at very low temperature whilst becoming too soft and susceptible to plastic flow at high temperatures.

Polymers when used to modify a Bitumen or Bitumen Emulsions improve not only the performance of Bitumen at temperature extremes, but will also confer the following benefits for waterproof coating.

- Improved adhesion to difficult surfaces.
- Improved weathering resistance.
- Improved water resistance.
- Improved toughness

Polymer modified bitumen can be made into three types:

1) Polymer Modified Bitumen in solid form.
2) Polymer Modified Bitumen in cutback form (Solvent base)
3) Polymer Modified Bitumen in Emulsion form (Water base)

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. APP (Atactic Polypropylene) is a polymer compatible with the base material bitumen, which enhances almost all properties of bitumen membrane. The polymerization improves certain aspects of the physicals parameters of the base material to counter extreme service conditions. APP modified membrane are generally stronger and stiffer, which gives greater resistance at higher temperature. For country like India, APP modified has been found to be suitable for extreme conditions.

Surface preparation: After providing adequate slope (min.1 in 100 with cement concrete or cement sand mortar), all preparatory works as detailed in Para 6.0 should be completed.

Five/ or Seven course Waterproofing Treatment with APP modified bituminous membrane: The item for treatment based on APP modified bituminous membrane is specified in the Item No. 105110 (seven course),

105120 (five course) and 105130 (seven course) of USSOR-2010 of N C Railway.

In selecting the combinations of layers (courses) 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 is suitable for very heavy conditions of rainfall (more than 150 cm).

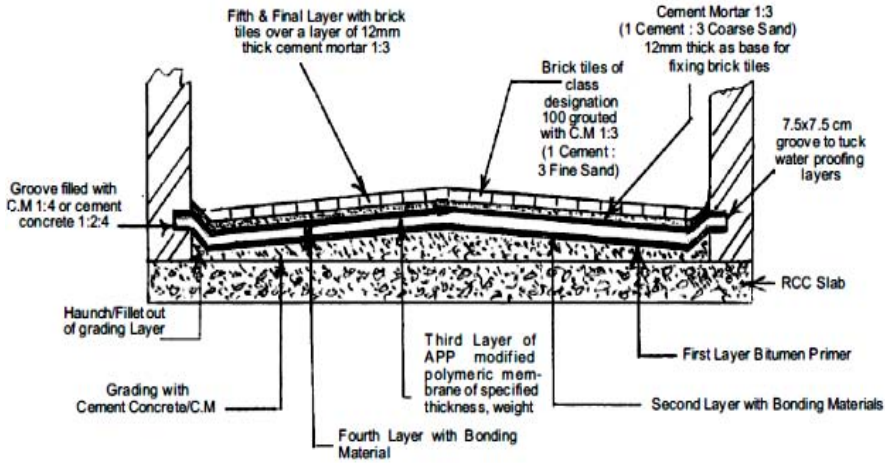
Method of Application: The treatment shall be of five or seven course. In seven course treatment, the first four courses shall be the same as for five course treatment. The fifth course shall be a layer of APP modified polymeric membrane. The sixth course shall be a coat of bonding material and the top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

Five course treatment:

- **1st Course:** Laying a coat of cold applied bitumen primer (conforming to IS: 3384) @ 0.2 to 0.4 l/sqm on entire roof surface.
- **2nd Course:** Laying 85/25 grade hot blown bitumen (conforming to IS: 73) @ 1.2 kg/sqm all over the surface.
- **3rd Course:** Laying of APP modified polymeric bituminous membrane with non-woven polyester fibre glass mat reinforcement, applied by torch with sealing all the joints.
- **4th Course:** Another layer of bonding material (85/25 grade) applied hot @ 1.20 kg per square meter of roof area.
- **5th Final Course:** Final finish with brick tiles on a 12 mm thick grey cement plaster (1:3).

Seven course treatment: In this treatment, first four course are the same as in five course treatment and fifth, sixth and seventh will be as follows:

- **5th Course:** Laying of APP modified polymeric bituminous membrane with non-woven polyester fibre glass mat reinforcement, applied by torch with sealing all the joints.



- **6th Course:** Another layer of bonding material (85/25 grade) applied hot @ 1.20 kg per square meter of roof area.
- **7th and Final Course:** Final finish with china mosaic tiles on a 15 mm thick grey cement plaster bed.

Five layered Waterproofing Treatment with APP Modified Prefabricated Membrane: The item for treatment based on APP Modified Prefabricated Membrane is specified in the Item No. 105140 (five layered) and 105150 (seven layered) of USSOR-2010 of N C Railway.

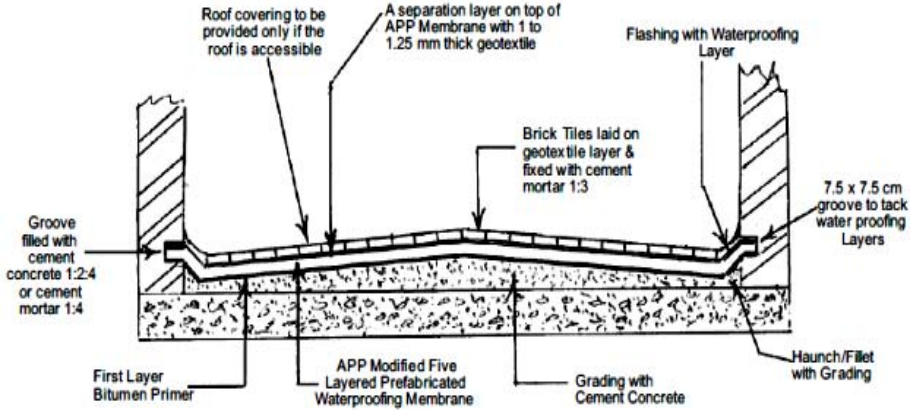
Five layered 2.00 mm thick with glass fibre is a normal duly treatment suitable for pitched roofs. Five layered 3.00 mm thick with glass fibre matt treatment is suitable for moderate condition of rainfall (50 to 150 mm) and five layered 3.00 mm thick with non-woven polyester matt treatment is suitable for heavy condition of rainfall.

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 @ 0.40 litre/sqm.

Atactic Polypropylene Polymer Modified Prefabricated Membrane: It is a polymeric waterproofing membrane. This shall be one of the following types: 2 mm thick with glass fibre matt, 3 mm thick glass fibre matt and 3 mm thick with non-woven polyester matt.

Method of Application: The choice of 2 mm or 3 mm prefabricated five layered waterproofing membrane will depend on the type of roof i.e. pitched or flat and importance of building, durability, cost and rainfall etc.

- The roof surface shall be cleaned and bitumen primer @ 0.40 lts/sqm shall be applied to the prepared roof, drain and all other surfaces.
- The APP polymer modified prefabricated waterproofing membrane shall be cut to the required length, normally in 6 to 8 metre and shall be laid in the direction of the slope with butane torch.
- 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, a separation layer on top of APP modified five layered membrane with 1 to 1.25 mm thick Geo-textile (120 gsm, non-woven 100% polyester) should be laid before any protected treatment is done.
- A protective layer of brick tiles in 12 mm thick cement mortar in 1:3 or 25 mm thick cement concrete 1:2:4 shall be laid as final layer.

Note:

1. *Since, there is no relevant Indian or any other standard available, this system needs to be adopted carefully. 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.*
2. *Commercially available polymer modified bitumen membrane, Dr. Fixit's TORCHSHIELD is used in waterproofing roof treatment in Lumding division of N F Railway.*

7.5 Water Proofing using Bitumen Felts

Waterproofing treatment consists of laying of bitumen felts over sloped roof surface. Life of this treatment is limited to 4-6 years only. This system consists of four or six courses. The choice of four or six course treatment depends upon the climatic conditions and extent of rainfall. 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.

Four course treatment with Hessian based self finished bitumen felt:
The item for treatment based on bitumen felt is specified in the Item No. 105040 of USSOR-2010 of N C Railway.

- **1st Course:** Initial layer of bonding material i.e. blown bitumen 85/25 or 90/15 conforming to IS: 702-1988 applied hot @1.45 kg per square meter of area.

- **2nd Course:** Laying of Bitumen felt/membrane Type 3 grade-I (Hessian based self finished bitumen felt) conforming to IS:1322
- **3rd Course:** Another layer of bonding material (bitumen) applied hot as in first course @ 1.20 kg per square meter of roof area.
- **4th and Final Course:** Final layer of pea size gravel or stone grit 6mm and down size or spread at 6 cubic deca meter per square meter in case of non accessible roofs. Where the roof is to be used for sleeping or other purposes, brick or precast concrete tiles (or any other suitable cladding) are laid in cement mortar to the required slope over the waterproofing treatment. In such cases, the final course of grit or pea size gravel is not necessary.

Six course treatment with Hessian based self finished bitumen felt:
The item for treatment based on bitumen felt is specified in the Item No. 105050 of USSOR-2010 of N C Railway.

- **1st Course:** Initial layer of bonding material i.e. blown bitumen 85/25 or 90/15 conforming to IS: 702-1988 applied hot @1.45 kg per square meter of roof area.
- **2nd Course:** Laying of Bitumen felt/membrane Type 3 grade-I (Hessian based self finished bitumen felt) conforming to IS:1322
- **3rd Course:** Another layer of bonding material (bitumen) applied hot as in first course @ 1.20 kg per square meter of roof area.
- **4th Course:** The fourth layer consists of bitumen felt laid as in 2nd course; care should be taken that laps in the felt are staggered from those in the previous layer.
- **5th Course:** Another layer of bonding material (bitumen) applied hot as in first course @ 1.45 kg per square meter of roof area.
- **6th and Final Course:** Final layer of pea size gravel or stone grit 6mm and down size or spread at 6 cubic deca meter per square meter in case of non accessible roofs. Where the roof is to be used for sleeping or other purposes, brick or precast concrete tiles (or any other suitable cladding) are laid in cement mortar to the required slope over the waterproofing treatment. In such cases, the final course of grit or pea size gravel is not necessary.

Six course treatment with Fibre based self finished bitumen felt: The item for treatment based on bitumen felt is specified in the Item No. 105060 of USSOR-2010 of N C Railway.

- **1st Course:** Initial layer of bonding material i.e. blown bitumen 85/25 or 90/15 conforming to IS: 702-1988 applied hot @1.45 kg per square meter of roof area.
- **2nd Course:** Laying of Bitumen felt/membrane Type 2 grade-I (Fibre based self finished bitumen felt).
- **3rd Course:** Another layer of bonding material (bitumen) applied hot as in first course @ 1.20 kg per square meter of roof area.
- **4th Course:** The fourth layer consists of bitumen felt laid as in 2nd course; care should be taken that laps in the felt are staggered from those in the previous layer.
- **5th Course:** Another layer of bonding material (bitumen) applied hot as in first course @ 1.70 kg per square meter of roof area.
- **6th and Final Course:** Final layer of pea size gravel or stone grit 6mm and down size or spread at 6 cubic deca meter per square meter in case of non accessible roofs. Where the roof is to be used for sleeping or other purposes, brick or precast concrete tiles (or any other suitable cladding) are laid in cement mortar to the required slope over the waterproofing treatment. In such cases, the final course of grit or pea size gravel is not necessary.

Six course treatment with Glass Fibre based self finished bitumen felt: The item for treatment based on bitumen felt is specified in the Item No. 105070 of USSOR-2010 of N C Railway.

- **1st Course:** Initial layer of bonding material i.e. blown bitumen 85/25 or 90/15 conforming to IS: 702-1988 applied hot @1.45 kg per square meter of roof area.
- **2nd Course:** Laying of Bitumen felt/membrane Type 2 grade-II (Glass Fibre based self finished bitumen felt).
- **3rd Course:** Another layer of bonding material (bitumen) applied hot as in first course @ 1.20 kg per square meter of roof area.

- **4th Course:** The fourth layer consists of bitumen felt laid as in 2nd course; care should be taken that laps in the felt are staggered from those in the previous layer.
- **5th Course:** Another layer of bonding material (bitumen) applied hot as in first course @ 1.70 kg per square meter of roof area.
- **6th and Final Course:** Final layer of pea size gravel or stone grit 6mm and down size or spread at 6 cubic deca meter per square meter in case of non accessible roofs. Where the roof is to be used for sleeping or other purposes, brick or precast concrete tiles (or any other suitable cladding) are laid in cement mortar to the required slope over the waterproofing treatment. In such cases, the final course of grit or pea size gravel is not necessary.

***

सन्दर्भ
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3.	**Relevant BIS Codes**
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10.	**Treatment of Leaky Roof by using APP Coat (Torchshield)** Source: www.iricen.indianrailways.gov.in

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गुणवत्ता नीति

रेलों में यात्री और माल यातायात की बढती माँग को पूरा करने के लिए गुणवत्ता प्रबंध प्रणली में अनुसंधान, डिजाइनों और मानकों में उत्कृष्टता तथा सत्त सुधारों के माध्यम से सांविधिक और नियामक अपेक्षाओं को पूरा करते हुए सुरक्षित, आधुनिक और किफायती रेल प्रौद्योगिकी का विकास करना।

QUALITY POLICY

To develop safe, modern and cost effective Railway technology complying with Statutory and Regulatory requirements, through excellence in Research, Designs & Standards and Continual improvements in Quality Management System to cater to growing demand of passenger and freight traffic on the Railways.

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हमारा उद्देश्य

अनुरक्षण प्रौद्यौगिकी और कार्यप्रणाली को उन्नयन करना तथा उत्पादकता और रेल्वे की परिसम्पत्ति एवं जनशक्ति के निष्पादन में सुधार करना जिससे अन्तर्विषयों में विश्वसनीयता, उपयोगिता और दक्षता प्राप्त की जा सके।

यदि आप इस सन्दर्भ में कोई विचार और सुझाव देना चाहते हों तो कृपया हमें इस पते पर लिखें।

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To upgrade Maintenance Technologies and Methodologies and achieve improvement in Productivity and Performance of all Railway assets and manpower which inter-alia would cover Reliability, Availability and Utilisation.

If you have any suggestion & any specific comments, please write to us:

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