# Module-III

Roof and roofing: Introduction, cast-in-situ reinforced concrete roofs, precast reinforced concrete roofs, roofs covered with sheets, water proofing over roofs. Finishing Work: Introduction, plastering, pointing, facing, glazing, flooring, painting, Construction joints-need and materials used, Plumbing and electrification- various types of fittings and laying procedure.

# ROOF AND ROOFING

## Introduction

A roof is constructed on top of a building to protect it from heat, rain, radiation, and other environmental agents.

Roofs are of two types-flat and pitched. Flat roof (most common type) may not be suitable for quick drain of rain water.

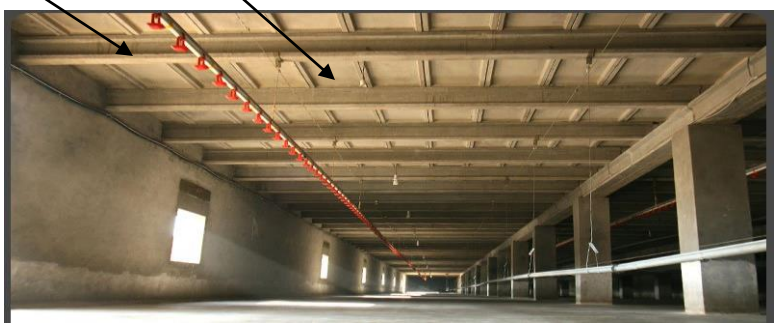

## CAST-IN-SITU REINFORCED CONCRETE ROOF

The roof should have appropriate designing and construction so as to make it more durable and to reduce maintenance problems.

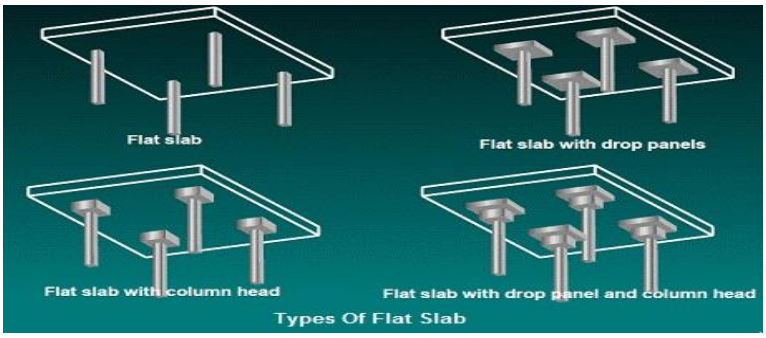
Depending upon various materials used, roofs may be flat with different kinds and pitched with different coverings.

There are two basic types of flat roof slab design:

• Beam/girder construction - slabs supported by and acting together with beams girders running in one or both directions ultimately transferring the load to the frames or walls



• Flat-slab construction - loads are carried directly by columns




Girder construction refers to floors formed by slabs acting together with beams/girders spanning in one or both directions ultimately transferring the loads to walls.

Flat slabs are supported directly on columns which are flared at the top. The fared portion is called capital.

Reinforced concrete roof slabs may be cast in-situ using • Temporary forms or •Permanent forms

The use of permanent formwork has the following benefits:

1. Eliminates the necessity of installation of false work
2. Reduces the need for skilled labour for carpentry
3. Increases the potential for standardization related to roof construction
4. Speeds up fixing time and eliminates stripping of forms on hardening of concrete

## PRECAST REINFORCED CONCRETE ROOF

In building construction, roof as well as floor slabs are designed as slabs supported by girders or beams. Width of precast slabs should be within the lifting capacity of the available lifting equipment. A precast roof element is designed as a single span beam in bending. The effective span is taken as the center-to-centre distance between its supports. Precast roof slabs are placed over purlins, which are supported on trusses.

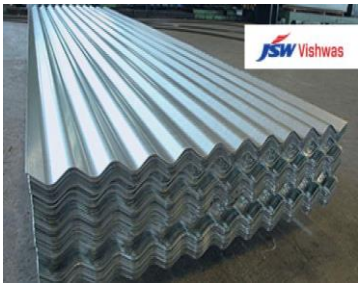
Roofing is built of the following materials • Grading under bed •Insulation• Waterproofing

The joints of the erected precast roof slabs are checked and sealed with mortar before the under bed is laid. The roof surface which is to receive the underbed should be thoroughly cleaned of oil, grease, and other slippery material and roughened up with wire brush after cleaning the surface with compressed air. The surface should be soaked with water and all excess water should be removed before laying of under bed of cement-sand screed as specified. The underbed should be laid maintaining gradient for drainage (1: 100) with a thickness of 25mm at the drainage on.

## ROOFS COVERED WITH SHEETS

Suitable materials for covering roofs are:

- Hot dip galvanized corrugated sheets (fig-a)
- Aluminium profiled sheets(fig-b)
- Asbestos cement sheets-not used any more on the ground of health and safety(fig-c)
- Asbestos free profiled sheets products (based on a mixture of Portland cement, mineral fibres, and density modifiers) (fig-d)




(fig-a)

(fig-b)

(fig-c)

(fig-d)

The **functional requirements** of roof covering are:

• Strength and stability • Resistance to weather Durability and freedom from maintenance Safe access during maintenance • Fire safety • Resistance to passage of heat-thermal insulation • Resistance to passage of sound • Security • Aesthetics

The strength of roof depends on the properties of materials used and their ability to sustain self-weight and imposed loads. Roof sheets should be of low self-weight to be cost-effective.

The thin sheets of steel and aluminium derive strength and stability mainly from the depth and spacing of profiles

Compared to such sheets, thick corrugated and profiled fibre cement cladding sheets have adequate strength for assumed loads, and rigidity in the material to resist distortion and loss of stability over moderate spans.

Thermal and structural movement is accommodated by the profiles.

Fibre sheets take care of moisture, thermal and structural movement through end/ laps and rather large fixing holes.

Durability of coated/galvanized sheets depends, to some extent, on careful handling and fixing as the sheets are easily damaged.

Sheets with light-coloured coatings are less susceptible to ultraviolet damages.

Fibre cement sheets do not deteriorate easily if a steep slope is provided for quick shedding of water.

There is safety hazard on carrying out maintenance work on sloped or pitched roof. The question of safe maintenance should be kept in view during both design and construction of such roofs. The question of fire hazard should also receive utmost attention, particularly in selecting both roof sheets and supporting materials.

Heat insulation can be an integral part of the roof sheets in composite panels. False ceiling under the truss bottom may also insulate the inside from heat apart from enhancing the aesthetics of the interior.

As regards sound insulation, fibre cement sheets provide much better airborne impact sound insulation. As far as security is concerned, roof sheets are susceptible vandalism. Curved sheeting with colour is available.

## WATERPROOFING OVER ROOF

Many roof failures have been caused by excessive water accumulation. Waterproofing provides protection against penetration of rainwater or leaking of accumulated water through the roof. Water may penetrate the roof concrete via interconnected voids within cement paste matrix or at the paste-aggregate interface.

Ignoring defects such as gross voids, cracks or open joints, the interconnected porosity is of two kinds: (i) micro pores in C-S-H gel, and (ii) capillary pores between cement hydration products.

Waterproofing of roof is carried out using membrane. The traditional low slope membrane roof covering is composed of bitumen (asphalt or coal tar pitch), usual applied hot; felt (hessian, glass fibre, or polyester); and a surfacing, such as aggregate coating, or cap sheet.

The membrane should be of one of the following types:

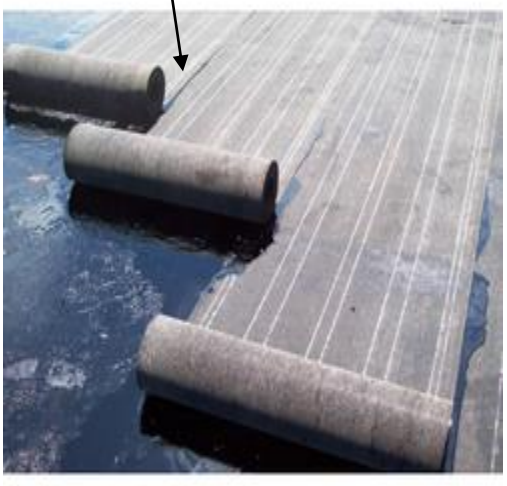
Two plies of hessian polyester base felt and three mopping of bitumen mopping of hot bitumen on the roof surface (ii) polyester/hessian base felt f mopping of hot bitumen on the felt (iv) polyester/hessian base felt (v) mopping of hot bitumen on the felt (vi) finishing with pea-sized gravel on bitumen

Three plies of hessian base felt and four mopping of bitumen-i) mopping of hor bitumen on the roof surface (ii) hessian base felt (iii) mopping of hot bitumen on the felt (iv) hessian base felt (v) mopping of hot bitumen on the felt (vi) hessian base felt (vil) mopping of hot bitumen on the felt (viii) finishing with pea-sized gravel on bitumen (the same thing can be done replacing hessian base felt with glass fibre felt)

Four plies of fibre base felt and five mopping of bitumen-(i) mopping of hot bitumen on the roof surface (ii) fibre base felt (iii) mopping of hot bitumen on the felt (iv) fibre base felt (v) mopping of hot bitumen on the felt (vi) fibre base feh (vii) mopping of hot bitumen on the felt (viii) fibre base felt (ix) mopping of hot bitumen on the felt (x) finishing with pea sized gravel on bitumen (the same thing can be done replacing fibre base felt with hessian base felt) In special cases, however, more courses or combination of hessian base felts and fibre base felts may be used. The number of moppings done exceeds the number of plies by one.

The roof surface that receives waterproofing treatment must be cleaned and dried satisfactorily. Concrete surfaces should be well cured before waterproofing is doneMembrane waterproofing should not be carried out in wet weather or when the temperature is as low as 10 C.

Polymer is used for modification of asphalt. The most used polymers for asphalt modification are **atactic polypropylene (APP) and styrene-butadiene-styrene (SBS)**.These prefabricated sheets are generally installed over a base sheet, which may not be composed of modified bitumen.



Waterproofing membranes laid on the flat roofs harden as time passes and **do not retain sufficient elasticity** or tensile strength to resist deterioration **due to** thermal movements resulting from considerable variation of temperature between day and nig and also seasonal temperature variations

# FINISHING WORK

## Introduction

Finishing work includes plastering, facing, glazing, flooring, and painting. Finishing work is executed for protection against environmental deterioration as well as for architectural attractiveness.


Plastering is required because plastered surfaces are hard, abrasion resistant, rigid, incombustible and provide a monolithic surface even at corners. In plaster work, mortar is the most important material.

The term facing' is used to describe materials used as non-structural, thin decorative, external finish. Facing is applied to the outside of base walls, building front, to brick or concrete backing to enhance architectural features.

Facing work is carried out with both natural and artificially made products.

Glazing is the act of fixing glass and the main factors be considered in choosing glasses are resistance to wind load, clear vision, privacy security, fire resistance, and aesthetic appeal.

Paint is a fluid material which when spread on a surface dry up and harden to form a continuous, adhering, and cohesive film to provide a protective surface as well as a visually attractive finish.

## PLASTERING

A thin plastic covering of different compositions applied using trowel on walls and ceiling of structures, buildings other installations and has architectural, decorative and protective functions.

Plastering is classified into ordinary, decorative and special based on the kind of surfaces to be plastered.

Plaster finishes are desirable as they are hard abrasion-resistant, rigid, incombustible, and provide a monolithic surface, even at corners.

Plastering should be properly applied so as to avoid cracking when movements due to drying, shrinkage or thermal changes are restrained.

Ordinary plastering is applied mainly for coating internal premises and fronts of industrial, residential, and civil buildings in one or several layers.

A **single-layer plastering** is done on flat brick masonry, concrete, and other similar surfaces. A **multilayer plastering** work comprises a preliminary coat, one or more floating coats and a final setting coat. The preliminary coat, a tough fluid mortar, is meant to bond the plaster with the surface that is to be protected. Floating coats are intended to remove unevenness plastered surfaces. The requirement of one or more floating costs would depend on the existing surface conditions. The thickness of each coat should not exceed **5mm** in case of cement mortars. The final setting coat, after application and smoothening with trowel should not be more than **2 mm** in thickness.

Decorative plastering is applied to meet architectural and decorative requirements.

This type of plasterwork comprises one or more floating coats and one or several setting coats to provide the desired architectural or ornamental effect. Special plasterwork is intended for protection against harmful effects of the environment.

**Plastering involves**: (i) preparation of mortar in a mixing plant; (ii) transportation of mortar to the actual location of plasterwork; (iii) delivery to the personnel for actual application; (iv) erection of scaffolding for facilitating actual plasterwork; (v) preparation of surfaces for receiving plaster; and (vi) application of plaster coats in sequence.

In plastering, mortar is the key material. Mortar comprises fine aggregates (sand) and a binder, which usually is cement. Additives like admixtures may be used with cement to improve workability.

The present trend is to use cement:sand mortars in various proportions depending on the nature of work and design strength. Properties of the mortar vary considerably on the basis of the properties of the cementitious materials used, ratio of the cementitious material to sand, characteristics and grading of the sand, water cement ratio, and ratio of water to solids.

Aggregates for mortar could be of two types-heavyweight and lightweight.

Heavyweight aggregates include river/sea sands, wastes resulting from grinding of heavy rocks like marble, granite, limestone, and so on. Lightweight aggregates are the wastes from grinding of lightweight rocks or artificial materials like pumice, tuffs, and so on.

Properties of the plaster mainly include strength, density, plasticity, water-retaining capacity, porosity, heat conductivity, water absorption, water impermeability, shrinkage, resistance to harmful environmental effects, and so on.

The **activities that need to be completed before** initiating plastering are: (i) installing and securing door and window frames; (ii) filling and sealing gaps between walls and frames; (ii) covering all orifices in walls; (iv) fixing inserts for plumbing, electrical, and piping work; (v) embedding pipe/ tubes that should not be exposed into walls and (vi) other miscellaneous work.

Brick, concrete, and other stone surfaces to be plastered should be roughened and cleaned of grease, stains/paints, oil, bitumen, dust, and other dirty objects.

After cleaning, all the surfaces to be plastered are flushed with water.

Swelling and projections of bedding mortars should be chipped off.

If bedding and side mortar joints are flushed with masonry, they must be raked to a depth of 10-20 mm or the surface should be scratched. If for any reason the thickness of the plaster exceeds 20 mm, wire mesh should be nailed on the wall to keep the plaster intact.

Every mason must possess a plumb bob so as to ensure that plastering work is executed true to the plumb.

Plastering is carried out in **sequence** as follows: (i) ceiling and top parts of walls; (ii) cornice, grooves, and other moulding work; (ii) ceiling internal angles; (iv) ceilings and top parts of walls - coated and floated; (v) top parts of window openings and bottom parts of walls and also door/window opening door window opening sides; (vi) internal and external angles; and (vii) bottom parts of walls and openings - covered with mortar and finished.

## FACING

Facing is used to describe materials used as a non-structural, thin, decorative, external finish such as natural stone facings applied to brick or concrete backing to enhance architectural beauty.

Facing is intended for -making surfaces attractive in appearance for decorative purposes and protecting building from harmful environmental effects-engineering protection.

Facing may be external or internal. Facing is applied to the outside of basement walls, building fronts, and internally in kitchens, toilets, industrial/chemical/utility plants, hospitals, subways, underground stations and so on.

The background wall or frame is required for supporting the whole of facing up to a storey height or at 3-m intervals vertically by means of corbels or angles. Apart from supporting the facing material, the question of resisting wind pressure forces should also be considered.

Facing work is carried out with both natural and artificially made products, Slabs of natural stones like marble, granite, sandstone, limestone and others are used for external facing.

Artificial products like ceramic materials, glass, polymer-coated cement-sand also used.

Granite is the natural stone which is very much in use as facing slabs for the hard durable finish.

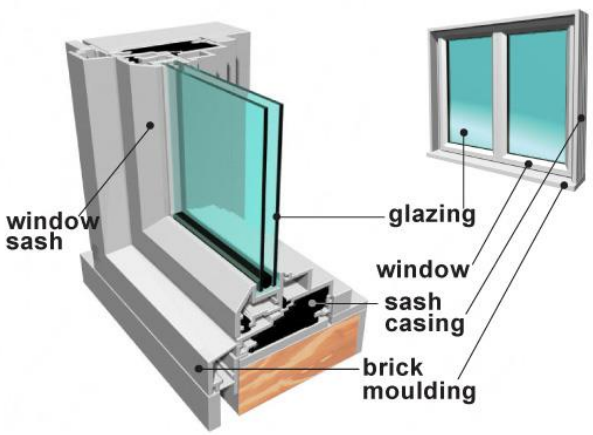
Sandstone is chosen for use as facing slabs for the colour and the grain of the natural material.

Joints between the stones are filled with mastic sealant to provide a weather tight joint to accommodate differential thermal and structural movement. After the completion of curing, the exposed surfaces should be cleaned and pointing, if specified, should be carried out.

Outside facing is generally carried out with ceramic tiles of ordinary clays with or without glazing of the face, which may be smooth patterned. For better bonding with mortar, the back of each tile is grooved.

## GLAZING

Windows, sashes, doors, skylights, shop windows, and other light-transmitting enclosures are glazed with the following kinds of glass.




**Heat-absorbing glass**-reduces heat and ultraviolet rays to a large extent

**Clear window glass**- most widely used type for windows in all classes of buildings (thickness ranges from 3 mm to 25 mm)

**Plate and float glass**-superior quality, more expensive, and better performance with no distortion of vision at any angle; ideal for showcase or quality windows.

**Obscure glass**-process and rolled figured sheet: polished surface on one side with pattern on the other side for obscurity

**Obscure wired glass**-have resistance against fire and breakage.

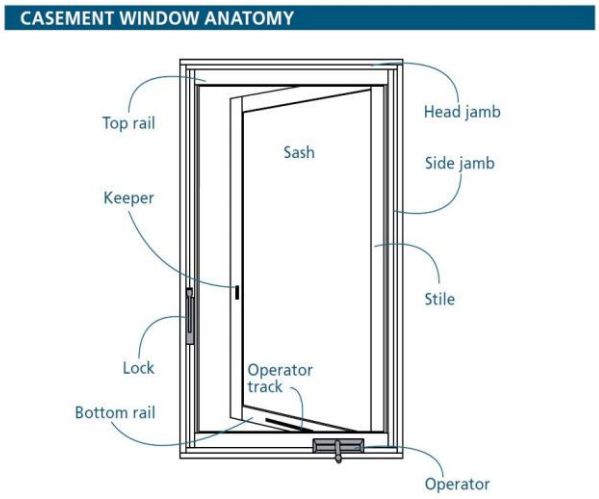
**Polished wired glass**-more expensive compared to obscure wired glass; used in schools and institutions

Corrugated glass, wired glass, and plastic panels - used for decorative treatments

**Laminated glass**-two or more layers of glass laminated together by one or more coatings of transparent plastic to add strength

**Bullet-resistant glass**-made of three or four layers of glass laminated under and pressure; thickness varies from 20 mm to 75 mm; transparent plastic bullet-resistant materials.

**Tempered glass** this is produced by a process of reheating and sudden cooling creasing strength substantially; all cutting and fabricating must be done before tempering.




Definitions Related to Glazing

**Glazing**- the act of fixing glass

**Bar**- either a vertical or horizontal component that extends to the full height width of the glass opening **Frame**- A group of wood or metal parts machined and assembled so as to form enclosure and support for a window or sash: plastics may be considered in special cases, aluminium, bronze, stainless steel, galvanized steel, steel are the metals used especially for fire resistance

**Jamb**-side jamb is the upright component forming the vertical side of the frame whereas head jamb is the horizontal component forming the top of the frame

**Rabbet**-rectangular groove along one or both edges to receive a window or sash

**Stiles**- upright or vertical, outside pieces of a sash or screen

**Rails**-cross or horizontal, pieces of the framework of a sash or screen

**Sash**-a single assembly of stiles and rails made into a frame for holding glass, with or without dividing bars. It may be supplied either open or glazed

**Sill**- The horizontal component forming the bottom of the frame

**Window**-one or more single sash made to fill a given opening. It may be supplied either open or glazed

The principal factors to be considered in choosing glasses are: (i) resistance to wind load, (ii) clear vision, (iii) privacy, (iv) security, (v) fire resistance, and (vi) aesthetics

Glazing involves the following processes and operations:

• Preparation of putty • Cutting of glass • Handling of materials •preparation of sashes •glazing

## FLOORING

Flooring is floor covering that would meet the maximum standards at reasonable cost.

The **functions** of flooring are as follows:

- Appearance- should be aesthetically attractive still having reasonable wearing
- High resistance-should have wearing and impact resistance properties for busy areas
- Hygiene-should have reasonable aesthetic appeal with impervious and easy-to clean surface

The ground floor of a residential building consists of hardcore, dpc (Damp-proof membrane is an impervious layer like polythene sheet to prevent moisture passing into the interior through the floor) and concrete slab.

Concrete bed is the ground floor cast-in-situ concrete slab for taking loads of men and materials and also to receive the desired floor finishes. Large **cast-in-situ ground floors** are designed to take medium-to-heavy loads as those used in factories, warehouses, shops, garages, and similar buildings.

Large floors are cast in panels with **expansion joints** wherever required to take care of thermal expansion/contraction.

Terrazzo (two parts of marble/granite chips to one part of Portland cement) can be cast in-situ over structural concrete slab in **three ways**: (i) sand cushion, (ii) bonded (iii) monolithic

Sand cushioning is provided where the possibility of structural movement exist due to settlement, expansion, contraction, or vibration. The underlying concrete slab covered with dry sand bed of 6-12mm in thickness. Then, a wire-fabric reinforcing membrane is laid over this. Then terrazzo is placed up to 16mm or as specified.

Bonded terrazzo is placed over the structural concrete slab after flushing the floor slab with water for cleaning. The slab surface is then covered with neat Portland cement to ensure good bonding with terrazzo.

Monolithic terrazzo is constructed as 16 mm topping (or as specified) monolithic with the green concrete floor slab. Using epoxy resin adhesive, monolithic terrazzo been successfully bonded with a topping thickness of only 10 mm. In-situ terrazzo should be completed by grinding and polishing.

Terrazzo in **precast** form is used in treads, risers, platforms, and stringers on stairs. As it is possible to attain a large variety of colours and textures with terrazzo, it is used extensively as interior and exterior decorative flooring. For laying terrazzo tiles underbed mortar should be evenly spread to bring it to proper grade and then compact it to a uniform surface. Before the underbed sets, cement slurry is applied and tiles are immediately placed and firmly pressed on to the underbed until the desired level of the tile is achieved. Tiles that are fixed should be cured for at least 7 days.

Ceramic tile is preferred in places like shower or swimming pool because of its attractive and water-resistant surface. The ceramic tile has body of clay, or a mixture of clay and other ceramic materials that has been fired above red heat.

**PAINTING**

Paint is a fluid material which when spread on a surface dries up and hardens to form a continuous, adhering and cohesive film.

Painting in buildings and structures is a finishing operation intended for protection and decoration purposes.

There are also paints for special purposes like electrical insulation, fire retarding, anti-fouling, and signalling.

The function of paints is to provide protective surface to materials like timber, steel, etc, and to provide visually attractive finish to the material.

Also it safeguards structures against attack by the environmental agents like moisture, acids, alkalis, and others.

Paint is composed of a number of ingredients. Each ingredient is added with a specific purpose. Paint is composed of: (i) binder, (ii) pigment, (iii) solvent, and (iv) additive.

Binder is the medium which dries and solidifies after application to develop into a protective surface film. Alkyd resins and vinyl or acrylic resins have replaced linseed oil as binders for the majority of paints. The addition of a dryer induced polymerization of the binder to ensure rapid drying.

Pigments are meant to provide colour to painting films. Pigment provides the body, colour, durability, and corrosion protection properties of the paint. White lead pigments are highly durable and moisture resistant but toxic. Their use is restricted to priming and undercoating paints. The lead pigment content must be declared on the container. The general pigment used in paint is titanium dioxide, which is not toxic.

The function of solvent is to lower the viscousity of drying oils and to dissolve resins.the solvent, either water or organic material, help to create fluidity to the paint to facilitate painting with a brush or roller or spray.

The additives used in paintings are driers, wetting agents, flow promoters, anti-skinning agents, anti-settling ingredients.

- ✓ Primer-The surface must be clean of all dirt and free from all loose materials so that primer can adhere and offer a good base for under coat .
- ✓ Undercoat-The primary function of undercoat is to provide an opaque surface. Undercoats are normally based on acrylic emulsion or alkide resins.
- ✓ Finishing coat-These are applied in one or more coat to impart required protective surface.

Following are different kinds of paints:

**Masonry paint**-white washing, dry distemper, oil bound, washable distemper

**Fungicide paint**-applied in kitchen and bathroom

**Water repellent paint**-silicon based paint are applied to porous surface

**Water proofing paint**- epoxy water proofing, bituminous paint provide an impervious surface

**Heat resisting paint**- aluminium paint is resistant to temperature uopto250 c

**Varnish for timber** – polyurethane varnishes