3.5 Flooring -Roofing — Joints in concrete – Contraction Construction Expansion joints

There are various types of flooring materials used in building construction and their selection depends on applications, aesthetics and choice of user. A floor in building construction is a leveled surface which can support the objects, occupants etc. Different flooring types are there based on different factors. The flooring material is chosen as per requirement of the user and based on applications which provides the most satisfying results for objective, either it may be economically or durability wise.

Types of Flooring Materials and Applications in Building Construction

Following are the different types of flooring materials generally used in building construction works:

- Cement or lime concrete
- Bricks
- Flagstones
- Marble
- Glass
- Ceramic
- Plastic
- Mud and murram
- Wood
- Cork
- Linoleum
- Asphalt
- Rubber

Concrete is most commonly used flooring material. It is suitable for any type of construction and is cheaper than others and durable. Cement Concrete mix of 1:3:6 to 1:5:10 or lime concrete with 40% 1:2 lime sand mortar and 60% coarse aggregate is used as base course. After hardening, 1:2:4 cement concrete mix with 40 mm thick layer is laid as topping. In industrial buildings, granolithic finish is provided to obtain hard wearing surface. Granolithic finish can be obtained from rich concrete with tough quality coarse aggregate mix.

Bricks can also be used for flooring purposes, but they are not suitable floor materials for residential or public buildings. Brick floorings are generally used in unimportant rooms, godowns, etc. For this well burnt bricks are preferable and bricks should be in uniform size and have same color.

Flagstone is a type of sedimentary rock which is obtained by splitting along bed planes. It consists silica, calcite and iron oxide. Flag stone is used to manufacture tiles of different sizes in different shapes.

Marble is a type of metamorphic rock and is used widely for floorings in commercial buildings, kitchens, bathrooms etc. they are stain proof and easily cleanable. Hence, they are used where extra cleanliness is required especially in bathrooms. They are also available in different colors and designs.

Glass is used as flooring material for special conditions like to transmit light from upper floor to lower floor etc. They are available in tiles which are fixed in closely spaced frames. Even though it is very costly it provides beautiful appearance.

Ceramic tiles are famous floor covering materials. Ceramic is inorganic material and it possess properties like good compressive resistance, brittleness and hardness etc..

Plastic tiles or poly vinyl chloride (PVC) tiles are widely used nowadays which are laid on concrete base. These tiles are available in different shapes, sizes and colors. Plastic tiles are of slippery nature and can get easily.

Mud is nothing but moist earth which is being used as flooring material in since olden days. It has good thermal insulation property. Chopped straw is added to mud to prevent it from the cracking. Sometimes cow dung is also used in this mixture.

Wood or timber is one of the most common method of flooring. It is preferred when the timber is cheaply available, such as in hilly areas. Timber blocks or timber bards are provided as flooring covers. Wooden floors are most suitable for dance floors, auditoriums etc

Cork is obtained from the cork oak tree. It is used as flooring material in the form of carpets. These carpets are noiseless and are required mainly in libraries, theaters etc. Cork tiles are also available which are made from high graded cork bar using compression in moldings.

Linoleum is the product obtained by oxidizing linseed oil in gum, resins, pigments, cork dust etc. It is available in sheets which is generally used as covering for concrete or wooden flooring. The sheets may be plain or design printed.

Asphalt is highly viscous liquid form of petroleum. Asphalt is used as flooring material in different ways. If asphalt and sand are mixed in 1:2 proportion then it is called asphalt mastic which is poured on concrete base as flooring cover. If sand is replaced by marble chips then it is called as asphalt mosaic. Asphalt tiles are also available which are prepared from the asphalt fibers, inert materials and mineral pigments.

Rubber tiles or sheets are also available in market for flooring purposes. They are made from pure rubber which is mixed with cotton fibers, asbestos fiber. Suitable adhesives are used to fix the rubber tiles with concrete or wooden base. Rubber flooring is noiseless and provided in libraries, offices etc.

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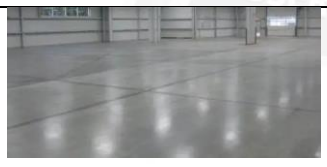
<td> 
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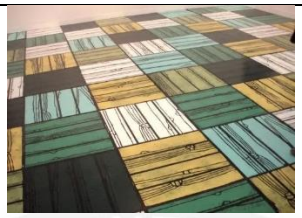
 Plastic	 Mud and murram	 Wood
 Cork	 Linoleum	 Asphalt

Factors Affecting Selection of Flooring Material

The selection of flooring material is done based on the following factors:

- Initial costDurability
- Hardness
- Smoothness
- Cleanliness
- Appearance
- Sound insulation
- Thermal insulation
- Damp proof
- Fire resistance
- Maintenance

Roofing

It may be defined as the uppermost part of the building, provided as a structural covering, to protect the building from weather. ′ Structurally, a roof is constructed in the same way as an upper floor, though the shape of its upper surface may be different. ′ Roof consists of structural elements which support roof is roof covering. ′ The roof coverings may be A.C. sheets, G.I. sheets, wooden shingles, tiles, slab itself.

Requirements of a Roof

- It should be durable against the adverse effects of various agencies such as wind, rain, sun etc.
- It should grant the desirable insulation against sound and heat.
- It should be structurally stable and sound, it should be capable of taking the loads likely to come over it.
- It should be well-drained.
- It should have efficient water-proofing arrangement.

Types of Roof

- Pitched or Sloping Roofs
- Flat Roofs or terraced Roofs
- Curved Roof

Pitched Roof

A sloping roof is known as pitched roof. ′ these are suitable in those areas where rainfall/ snowfall is very heavy.

Forms of pitched roof

- Lean-to-roof -it is the simplest form of a pitched roof and it is known as pent roof. in this type of roof, one wall is carried up sufficiently higher than the other to give necessary slope to the roof.
- Gable roo:- this is the common type of sloping roof which slopes in two direction. the two slopes meet at the ridge
- Gambrel roof - this roof like gable roof, slopes in two directions but there is break in each slope.
- Hip roof:- this roof is formed by four sloping surfaces in four directions.
- Mansard roof - this roof like a hip roof, slopes in four directions but each slope has a break.
- Deck roof - a deck roof has slopes in all the four directions, like a hip roof but a plane surface is formed at the top

Flat Roofs or terraced Roofs

A roof laid at an angle of less than 10° to the horizontal is known as *flat roof*. **Flat roof** may be of reinforced cement concrete, reinforced brick work, precast concrete with channel units, waffle units etc, flag stones supported on rolled steel joists or jack arch type.

The most important requirement of flat roof is efficient water proofing and roof drainage. The roof surface has therefore to be provided with proper water proofing treatment and necessary slopes to satisfy these requirements. In addition a layer of insulating material (mud, lime, concrete) is laid over the roof surface to provide adequate thermal insulation to the space below. This space is known as terracing or grading.

A particular slope can be given to roof by adjusting the thickness of the terracing material or the roof slab can be constructed in slope. In situations where thermal insulation is not essential, the slope for drainage of the roof is provided in the roof slab itself and the roof surface is given adequate water proofing treatment by using bitumen felts etc. In places where the terraced roof is to be used for outdoor living, the top surface of the terracing should be made resistant to wear besides making provisions for efficient water proofing and drainage for the roof.

Advantages of Flat Roof

- The construction of flat roof is simplified and maintenance is easy.
- The roof can be used as terrace for playing, gardening, sleeping and for celebrating functions.
- It is easier to make the flat roof fire-proof than a sloping roof.
- They avoid the enclosure of the triangular space. This improves the architectural appearance of the building.
- Flat roofs have better insulating properties and they are more stable against high winds.
- The construction work of upper floors can be easily started. In case of a pitched roof, the entire roof is to be removed and is to be replaced by a new roof under such circumstances. It is therefore considered to be the best choice for multi-storeyed buildings.

- They do not require false ceiling, which is essential in pitched roofs.
- Flat roofs are proved to be overall economical.

Disadvantages of Flat Roof

- Intermediate columns in flat roofs give them a free hand during the construction of the span.
- Self weight of roof is more. Due to this, the sizes of beams, columns and other structural members are heavy.
- Flat roofs are exposed to sun and are subjected to violent temperature changes which may lead to cracks in the surface of the roof.
- They are unsuitable at the places of heavy rainfall, hilly areas or areas where there is heavy snowfall.
- The progress of work in a flat roof is slow as compared to that of a pitched roof.
- The initial cost of flat roof is also more than the pitched roof.

Types of Flat Terrace Roofing

- Mud- Terrace Roofing
- Brick- Jelly or Madras Terrace Roofing
- Bengal- Terrace Roofing

Mud-Terrace Roofing :

This type of terracing is suitable where rainfall is less. It can be provided either on tiles or on wood boards. In both the case, terracing is made with white earth mud containing large percentage of sodium salt. The mud-terracing in Punjab is provided over roof which consists of 50 mm x 50 mm x 6 mm T-sections spaced at 32 cm centre to centre over R.S.J. well-burnt tiles of size 30 cm x 30 cm x 5 cm or 30 cm x 15 cm x 5 cm are placed between the flanges of the T-sections: using lime mortar.

Over the tiles, a 15 cm thick layer of stiff mud, white in colour and containing sodium salts is spread and beaten with sticks till the surface becomes hard and the beater rebounds. The surface is then plastered with mud and cow-dung mix plaster. Finally, the surface is finished with 1 : 4 cement-cowdung plaster. In Maharashtra and Madhya Pradesh practice, mud terracing is done on teak wood boards (4 to 5 cm thick) nailed to the wooden joists. On the boards, a 2.5 cm thick layer of wood shaving is spread over which bricks are laid on edge in lime or mud mortar.

Brick Jelly Roofing or Madras Terrace Roofing:

Construction Procedure:

The teakwood wood joists are placed on rolled steel joists with a furring piece between the joists and rolled steel joists. The furring is placed sloping and it gives necessary slope to the flat roof. A course of specially prepared terrace bricks is laid diagonally across the joists. The size of the bricks is generally 150 mm x 75 mm x 25 mm and they are placed on edge in lime mortar. After the brick course has set, a course of brick bat concrete is laid.

The thickness of this course is about 75 mm and it consists of 3 parts of brickbats, one part of gravel and sand and 50% of lime mortar by volume. The concrete is well-rammed for a period of three days and allowed to set. The flat tiles are then laid over the layer of concrete. The tiles are laid in two courses, making the thickness of about 50 mm. Alternatively, the china mosaic pieces may be used in place of flat tiles.

Finally, the surface of the roof is finished by three coats of plaster. The surface is then rubbed and polished and given a slope of 1 in 30. As the type of flat roof construction is widely used in old madras state, it is known as madras terrace roof.

Bengal Terrace Roofing:

The roof is generally used in Bengal to cover verandah and hence it is commonly known as Bengal terrace roofing. The construction procedure of such a roof is described below

The rafters are placed in position, sloping outward from main wall at a spacing of 30 to 50 cm centre-to-centre. One end of the rafter is inserted into the main wall for a length of 20 cm and their other end is fixed on a verandah wall-plates or bressummers. The battens or reepers are fixed to the upper surface of the rafters at right angles and are spaced at 15 cm centers. On the battens, a course of flat tiles well soaked in white wash is laid in lime or cement mortar. The roof is finally finished in following 2 methods :

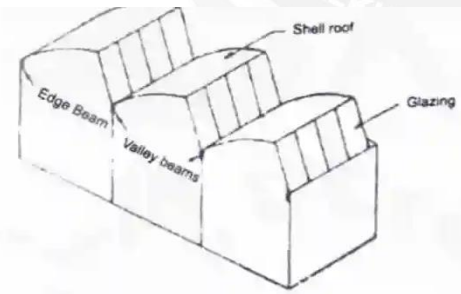
a) Two more courses of flat tiles are laid on mortar and finally finished off with 2 or 3 coats of plaster. The outer top surface of the last coat is rubbed smooth and polished.

b) A layer of fine jelly concrete 4 to 5 cm thick is laid over the first course of tiles. Over this concrete layer, another course of flat tiles is laid and the surface is finally finished off with 2 or 3 coats of plaster. The outer top surface of the last coat is rubbed smooth and polished.

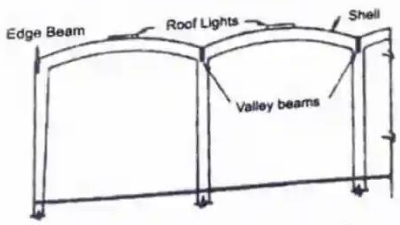
3. Curved roof

These are the modifications of pitched roofs and are frequently employed in modern age to cover large areas shed/roofs and domes are the varieties of curved roof. Curved roofs are mostly used in big structures such as monumental works, factories etc. They can be constructed of materials such as timber, R. **There are 2 common forms of shell roof**

- A north light shell roof
- A barrel vault shell roof



North-light shell roof



Barrel vault shell roof

A dome is generally a round vault which is forming a roof. It is commonly used when roof is to be provided on circular regular polygon shaped walls or brick works. These roofs afford pleasing appearance and due to arch action, the stresses are considerably reduced which results in thin sections for curved roofs.

Construction Procedure & Details of Curved Roof

- Pre-cast units of cement concrete tiles of size 70 x 70 cm with a uniform minimum thickness of 20 mm in the form of domes with a rise of about 50 mm are used.

- Pre-cast units of R.C.C. 1 : 2 : 4 beams are prepared as per design usually 90 mm deep and 130 mm wide as per design usually 90 mm deep and 130 mm wide.
- The beams are suitably laid on the supporting walls.
- After spreading some mortar on the edges of beams the tiles are then placed in proper position. The minimum bearing of tiles on beams should be 25 mm and that on walls should be 50 mm to 70 mm.
- The haunches between the humps of tiles are filled up with cement concrete of proportion 1:2:4.
- Suitable water-proofing treatment to the roof is given at the top. The roof thus exhibits a flat surface at the top and curved surface at bottom.

Advantages of Curved Roof

- It can be constructed in short time.
- It does not require skilled supervision.
- Cheap in construction.
- Requires less frame work.
- Curved roof mainly reduced the emission of harmful CO2 gases.
- The construction of these roof is simple in technique and it is and much similar to standard flat roof and moreover it is wind resistant. These qualities make it low maintenance roof.
- The curved roof is generally designed by architect, hence they are well planned according to the location of construction.

Disadvantages of Curved Roof

- As the complexity of the design of curved roof increases, the cost of the roof also increases.
- Height, Curve and Materials used for covering the roof are generally considered while estimating.

Joints in concrete construction - Contraction Construction Expansion joints

Joints in concrete construction are construction, expansion, contraction and isolation joints. These joints are placed in concrete slabs and pavements at regular intervals to prevent development of cracks in concrete.

Types of joints in concrete constructions are:

1. Construction Joints
2. Expansion Joints
3. Contraction Joints
4. Isolation Joints

1. Construction Joints

Construction joints are placed in a concrete slab to define the extent of the individual placements, generally in conformity with a predetermined joint layout. Construction joints must be designed in order to allow displacements between both sides of the slab but, at the same time, they have to transfer flexural stresses produced in the slab by external loads. Construction joints must allow horizontal displacement right-angled to the joint surface that is normally caused by thermal and shrinkage movement. At the same time they must not allow vertical or rotational displacements

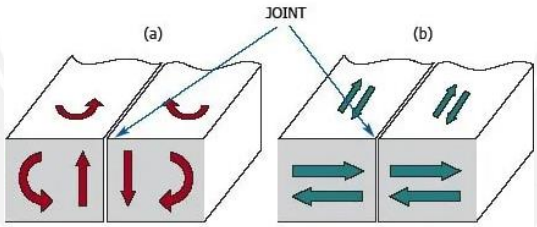


Figure 1 – Relative movements which must be (b) allowed and (a) not allowed by a con-struction joint for concrete slabs

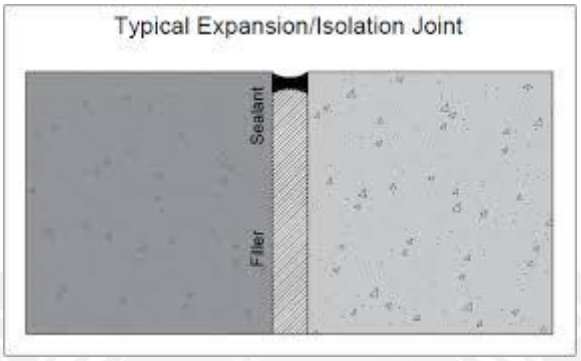
2. Expansion joints

The concrete is subjected to volume change due to many reasons. So we have to cater for this by way of joint to relieve the stress. Expansion is a function of length. The building longer than 45m are generally provided with one or more expansion joint. In india recommended c/c spacing is 30m. The joints are formed by providing a gap between the building parts

Expansion joints

3. Contraction Joints

A contraction joint is a sawed, formed, or tooled groove in a concrete slab that creates a weakened vertical plane. It regulates the location of the cracking caused by dimensional changes in the slab. Unregulated cracks can grow and result in an unacceptably rough surface as well as water infiltration into the base, subbase and subgrade, which can enable other types of pavement distress. Contraction joints are the most common type of joint in concrete pavements, thus the generic term "joint" generally refers to a contraction joint. Contraction joints are chiefly defined by their spacing and their method of load transfer. They are generally between 1/4 - 1/3 the depth of the slab and typically spaced every 3.1 - 15 m



4.Isolation Joints

An isolation joint in concrete structures is a type of separation provided to isolate a given structural member (slab) from the adjacent sections of the concrete structure to allow relative movement in three directions.

- American Concrete Insititute (ACI) and Portland Cement Institute (PCI) define isolation joint as a joint that completely separates one structural unit from another.
- Isolation joints are gaps between two concrete structures, like a slab and a wall, that are filled using a preformed joint material for the full depth of the slab. This gap allows the slab to move without disturbing the nearby column or wall.
- Consider a slab surrounding the column footing, separated by an isolation joint, as shown in the figure below. In case of settlement of the column, the slab around is undisturbed or won't crack. Similarly, the slab is allowed to undergo expansion or contraction due to temperature changes.
- he joint material used for isolation joints can be foam insulation, plastic, cork, rubber, neoprene, or asphalt-impregnated material.
- Isolation joints are designed and placed in the desired location before the concrete slab is poured. The reinforcing steel provided stops at the joint and should not continue through the joint.
- Isolation joint fillers are filled in a full-depth in the concrete and must accommodate expansion, contraction and allow horizontal and vertical movement.
- Isolation joint width ranges between 1/2 to 1 inch. Greater widths may cause excessive movement.