Draft Study Material

BRICK MASONRY

(Qualification Pack: Ref. Id. CON/Q0113)

Sector: Construction

(Grade XII)

PSS CENTRAL INSTITUTE OF VOCATIONAL EDUCATION
(a constituent unit of NCERT, under Ministry of Education, Government of India)
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Preface

Vocational Education is a dynamic and evolving field, and ensuring that every student has access to quality learning materials is of paramount importance. The journey of the PSS Central Institute of Vocational Education (PSSCIVE) toward producing comprehensive and inclusive study material is rigorous and time-consuming, requiring thorough research, expert consultation, and publication by the National Council of Educational Research and Training (NCERT). However, the absence of finalized study material should not impede the educational progress of our students. In response to this necessity, we present the draft study material, a provisional yet comprehensive guide, designed to bridge the gap between teaching and learning, until the official version of the study material is made available by the NCERT. The draft study material provides a structured and accessible set of materials for teachers and students to utilize in the interim period. The content is aligned with the prescribed curriculum to ensure that students remain on track with their learning objectives.

The contents of the modules are curated to provide continuity in education and maintain the momentum of teaching-learning in vocational education. It encompasses essential concepts and skills aligned with the curriculum and educational standards. We extend our gratitude to the academicians, vocational educators, subject matter experts, industry experts, academic consultants, and all other people who contributed their expertise and insights to the creation of the draft study material.

Teachers are encouraged to use the draft modules of the study material as a guide and supplement their teaching with additional resources and activities that cater to their students' unique learning styles and needs. Collaboration and feedback are vital; therefore, we welcome suggestions for improvement, especially by the teachers, in improving upon the content of the study material.

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Module 1 RANDOM RUBBLE MASONARY

Module Overview

This module focuses on the key aspects of rubble masonry, a widely used construction technique. It explains the properties of stones, tools for dressing, and the classification of rubble masonry. The types of stones and adhesives such as cement paste used in masonry work are detailed. The procedure for carrying out various masonry tasks and the process of pointing work, which improves both durability and appearance, are also included.

Learning Outcomes

After completing this module, you will be able to:

- Identify the properties of stones used in construction.
- Recognize tools used for dressing rubble masonry.
- Classify different types of rubble masonry and their applications.
- Differentiate between types of stones used in rubble masonry.
- Understand the types of cement paste and adhesives suitable for masonry work.
- Describe the step-by-step procedure for various masonry tasks.
- Explain the importance and process of pointing work in masonry.

Module Structure

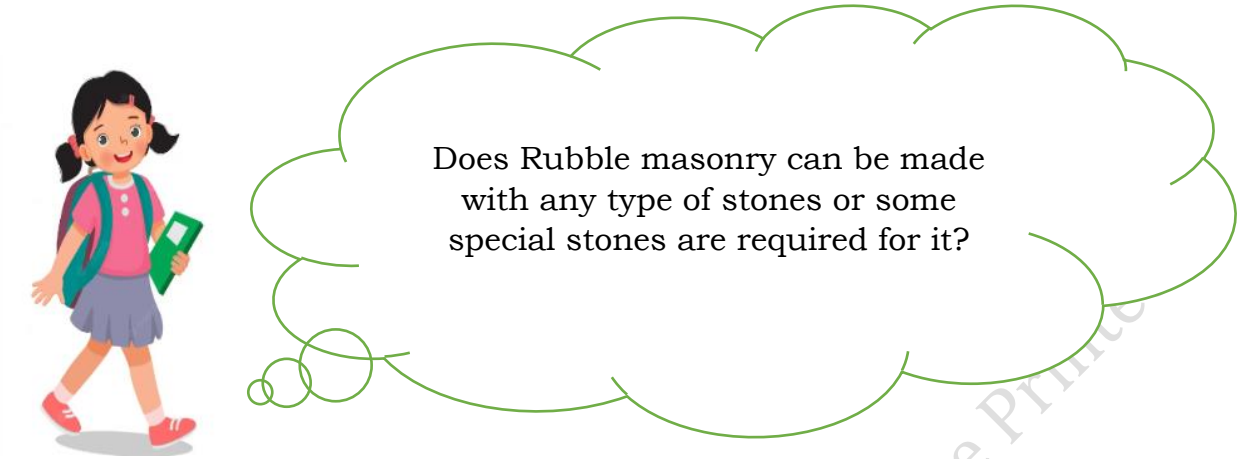
1.1 Properties of Stone
1.2 Tools for dressing of rubble masonry
1.3 Rubble Masonry
1.4 Classification of Rubble Masonry
1.5 Types of Stone used in Rubble Masonry
1.6 Various Types of Cement Paste/Adhesives used
1.7 Procedure for different Masonry works
1.8 Pointing work

As you know that stone is one of the important building materials used in construction. The properties of stones should be as per reference of IS 1123: 1975. Random rubble masonry is a construction technique that involves using irregularly shaped stones of varying sizes and shapes to create a structure. Unlike other forms of masonry that use uniform or cut stones, random rubble masonry celebrates the natural beauty and uniqueness of each stone, resulting in a visually appealing and rustic finish.

The process of constructing with random rubble masonry begins with carefully selecting stones that fit well together, considering factors such as size, shape, and texture. These stones are then placed and stacked in a random pattern, with mortar used to fill the gaps between them and provide stability to the structure. The irregularity of the stones requires skilled craftsmanship to ensure proper alignment and structural integrity.
Random rubble masonry offers both aesthetic and practical advantages. The irregularity of the stones creates a distinct and visually appealing texture, adding character and charm to the structure. Additionally, the varying shapes and sizes of the stones allow for better load distribution, enhancing the overall strength and stability of the construction.

In this chapter, we will explore the intricacies of random rubble masonry, from understanding the properties of different types of stones to mastering the techniques of stone selection, placement, and mortar application. Through theoretical knowledge, practical examples, and hands-on activities, you will develop the skills and appreciation necessary to engage with and create structures using random rubble masonry. So, let us embark on this journey into the world of random rubble masonry, where creativity and natural beauty converge to shape remarkable constructions.

Fig 1.1 Rubble Masonry



1.1 PROPERTIES OF STONE

Important properties of stone should be as;

1. **Quality:** All stones used for building purposes shall be strong, hard and durable.
2. **Strength:** The strength of building stones should be adequate to carry the loads imposed. For ashlar and coursed rubble masonry, the strength shall be as worked in accordance with IS 1905 : 1987, and also the type of mortar used. For random rubble masonry, the strength value shall be specified on the basis of local experience.
3. **Durability:** The stone shall be free from defects like cavities, cracks, flaws, sand holes veins, patches of soft or loose materials, etc. The percentage of water absorption
4. **Size of stone:** Normally stones used in rubble masonry should be small enough to be lifted and placed by hand. The length of the stone shall not exceed three times the height and the breadth on base shall not be greater than three-fourth of the thickness of wall nor less than 150 mm. The height of stone for rubble masonry may be up to 300 mm.

1.2 TOOLS USED FOR DRESSING OF MASONRY WORK

While carrying out masonry work, mason requires different types of tools. In stone masonry, tools are categorized as dressing tools and masonry construction tools. Stones are available in irregular size and shape. As per the construction requirements, to make them regular size and shape and to form correct shape, following tools are used by the stone dresser/mason. Following are the types of masonry tools:

(i) Trowel

(ii) Plumb rule and Bob

(iii) Spirit level

(iv) Square

(v) Line and pins

(vi) Bolster

(vii) Brick hammer

(viii) Scotch

(ix) Pick Axe

(x) Crowbar

(xi) Chisel

(xii) Mash Hammer

(xiii) Boaster

(xiv) Spall Hammer

(xv) Scrabbling Hammer

(xvi) Bevel

(xvii) Spade

(xviii) Picks and Beaters

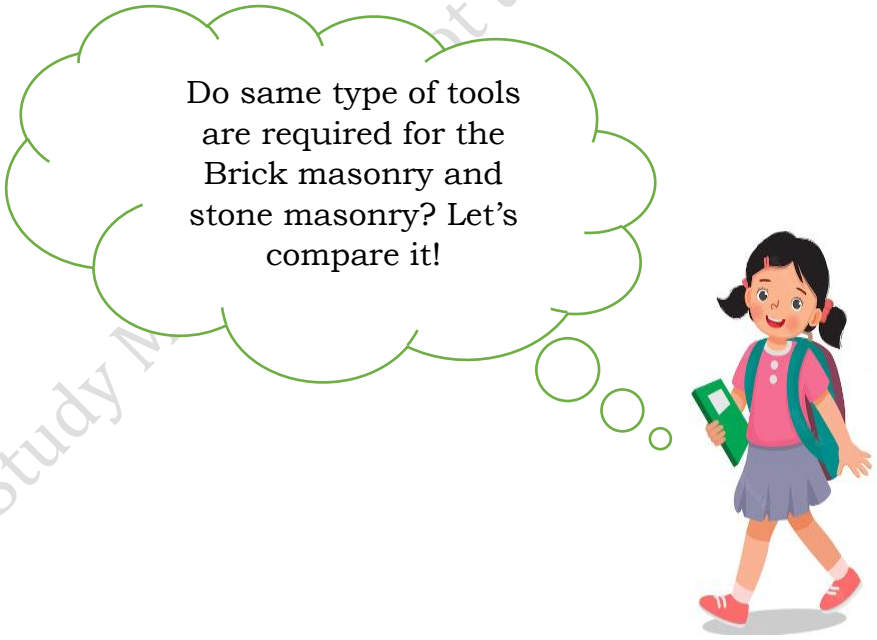
(xix) Wooden Float

(xx) Metal Float

(xxi) Floating Rule

(xxii) Racking Needle

(xxiii) Hacking tool



(xxiv) Scratcher

(xxv) Pointing Tools (Nayals)

(i) **Trowel:** A trowel is used to lift and spread mortar to form the joints and to cut the bricks. It is made of steel blade, shank and wooden handle (Fig.1.2).

Fig 1.2 Trowels

(ii) **Plumb Rule and Bob:** The plumb rule and bob is used to check the verticality of the wall, column, wooden frame i.e. door, window etc. It consists of a wooden pieces of two meters long, whose top portion is attached to a plumb bob. (Fig.1.3).

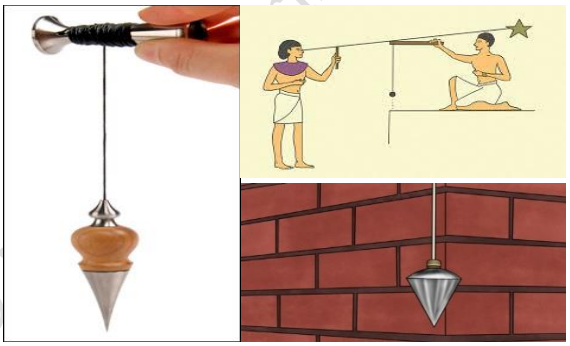


Fig 1.3 Plumb Rule and Bob

(iii) **Spirit Level:** A spirit level is used to check the horizontally of the floor, roof, door, window frame etc. (Fig.1.4)

Fig 1.4 Spirit Level

(iv) **Square:** A square is right angle steel piece, which is used to check the right angle (perpendicular) of the walls, columns etc. (Fig.1.5)

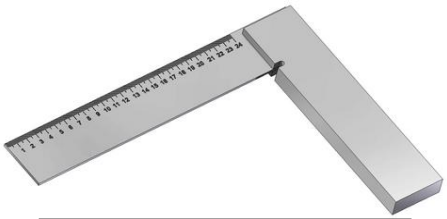


Fig 1.5 Square

(v) Line and Pins: Line and pins are used to maintain the alignment of the work in progress i.e. brick or stone masonry. It consists of good quality thread and two pin (Fig.1.6).

Fig 1.6 Line and Pins

(vi) Chisel: Chisels are used to dress the stones. Chisels are of different shapes and sizes, and are used for different stone cutting and dressing works (Fig.1.7).

(vii) Bolster: A bolster is used to cut the bricks accurately. The main part of bolster is a steel wide blade (Fig.1.8).

(viii) Mash Hammer: A mash hammer is used to dress the stones (Fig.1.9).

Fig.1.7: Chisel

Fig.1.8: Bolster

Fig.1.9: Mash Hammer

(ix) Scabbling Hammer: A scabbling hammer is used for breaking the small projection of the stones (Fig.1.10).

(x) Bevel: A bevel is used to set the angle of the stone, brick machinery, flouring, projections etc. It consists of two steel blades having slots and fixed together by a thumb screw. These two blades can be set at any desired angle (Fig.1.11).

(xi) Spade: A spade is used to lift the sand, soil, mortar etc. It is also used in excavation of soft soil (Fig.1.12)

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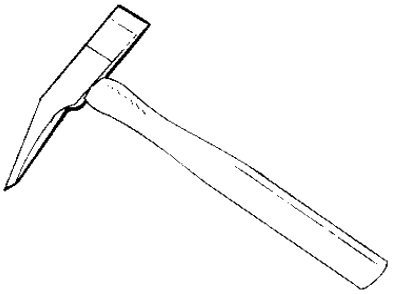


Fig.1.10: Scabbling hammer

Fig.1.11: Bevel

Fig.1.12: Spade

(xii) Pick Axe: A pick axes is used for rough dressing of the stones and to split stones in a quarry (Fig.1.13).

(xiv) Crowbar: A crowbar is used to make stones in a quarry (Fig.1.14).

(xv) Wooden Float: A wooden float is used to spread the mortar on the surface. It is also used to finish the coat of plaster. It is made of wood.

Fig.1.13: Pick Axe

Fig.1.14: Crow Bar

1.3 RUBBLE MASONRY

The stone masonry in which either undressed or roughly dressed stone are laid in a suitable mortar is called rubble masonry. In this masonry the joints are not of uniform thickness. In construction rubble masonry stones of irregular sizes are used. The stones as obtained from quarry are taken in use in the same or they are broken and shaped to suitable size by means of hammer as the work processed. The strength of rubble masonry depends upon the following three factors:

(i) The quality of mortar.

(ii) The use of long through h stones at frequent intervals.

(iii) The proper filling of mortar in the space between stones

1.4 CLASSFICATION OF RUBBLE MASONRY

Rubble masonry can be again classified into

a. Coursed Rubble Masonry

b. Uncoursed Rubble Masonry

c. Dry Rubble Masonry

d. Polygonal Masonry

e. Flint Masonry

a. Coursed Rubble Masonry

In coursed rubble masonry construction, the stones in a particular course are in equal heights. The stones hence used possess different sizes. In this type, all the courses do not have same height. This type is commonly employed in the construction of public buildings, abutments, residential buildings and piers of ordinary bridges. (Fig. 1.15 Coursed Rubble Masonry)

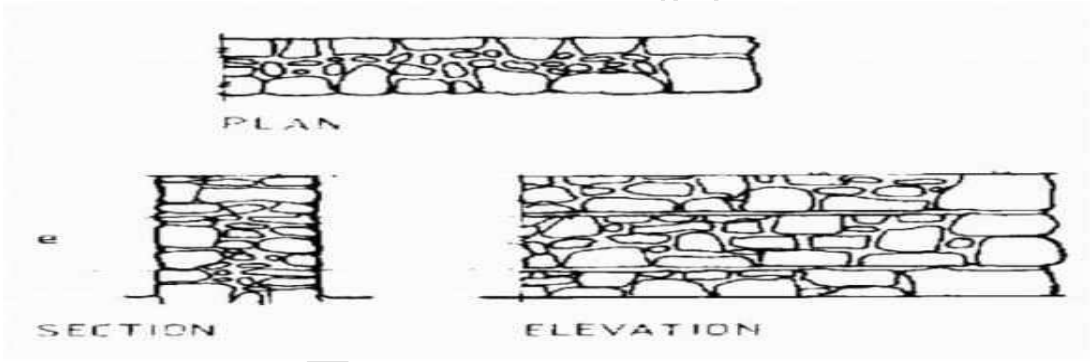


Fig.1.15: Coursed Rubble Masonry

b. Uncoursed Rubble Masonry

Uncoursed rubble masonry is the cheapest and roughest form of stone masonry construction. These constructions use stones of varied shape and size. The stones are directly taken from the quarry called as undressed stone blocks. The courses are not maintained regularly in this method of construction. Initially larger stones are laid first. The spaces between them are filled with spalls or sneeks. This is divided into two types:

(i) Random Uncoursed Rubble Masonry

(ii) Square Uncoursed Rubble Masonry

(i) Random Uncoursed Rubble Masonry: In this type, the weak corners and edges of the stone are removed with the help of a mason's hammer. At the quoins and jambs, bigger stones are employed in order to increase the strength of the masonry. (Fig 1.16)

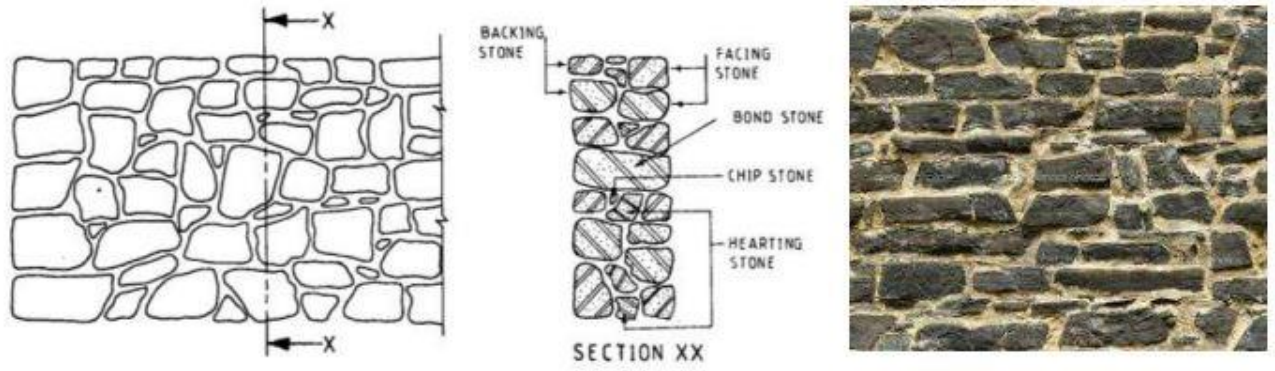


Fig.1.16: Random Uncoursed Rubble Masonry

(ii) Square Uncoursed Rubble Masonry: Here, the stones are made roughly square shape and used in construction. The facing stones are provided a hammer-dressed finish. Larger stones are used as quoins. Chips are not used as bedding. (Fig 1.17)

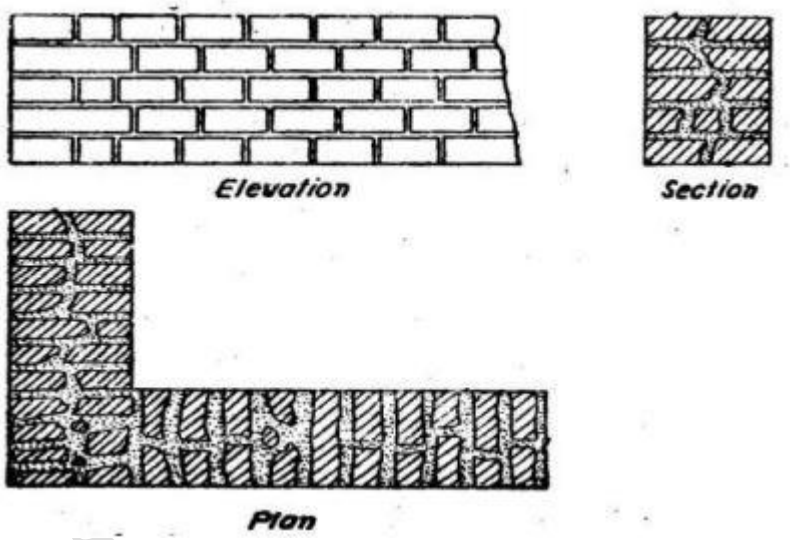


Fig.1.17: Square Uncoursed Rubble Masonry

c. Polygonal Rubble Masonry

Here, the stones for masonry are roughly shaped into irregular polygons. The stones are then arranged in such a way that it avoids vertical joints in the face work. Break the joints as possible. Use of stone chips to support the stones.(Fig 1.18)

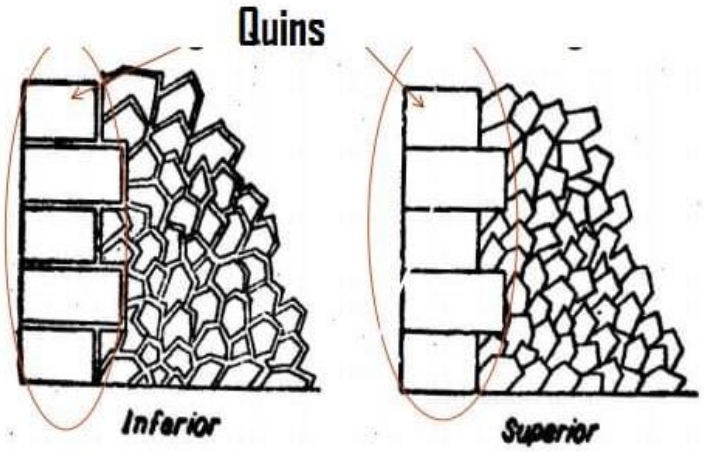


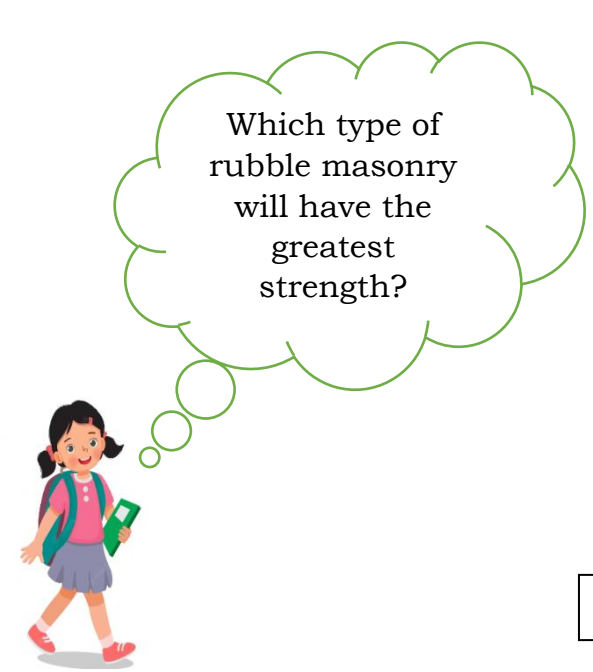
Fig.1.18: Polygonal Rubble Masonry

d. Flint Rubble Masonry

In areas where flint is available plenty, flint rubble masonry is employed. Flints are irregularly shaped nodules of silica. They are extremely hard but brittle in nature. The thickness of the flintstones varies from 8 to 15cm. Their length varies from 15 to 30cm.

e. Dry Rubble Masonry

These are rubble masonry construction performed without the use of mortar. Small spaces are filled with smaller stone pieces. It is used in pitching the earthen dams and the canal slopes.



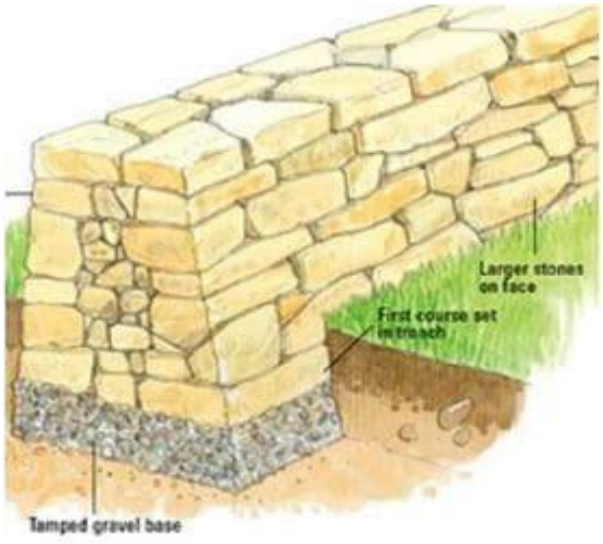


Fig.1.19: Dry Rubble Masonry

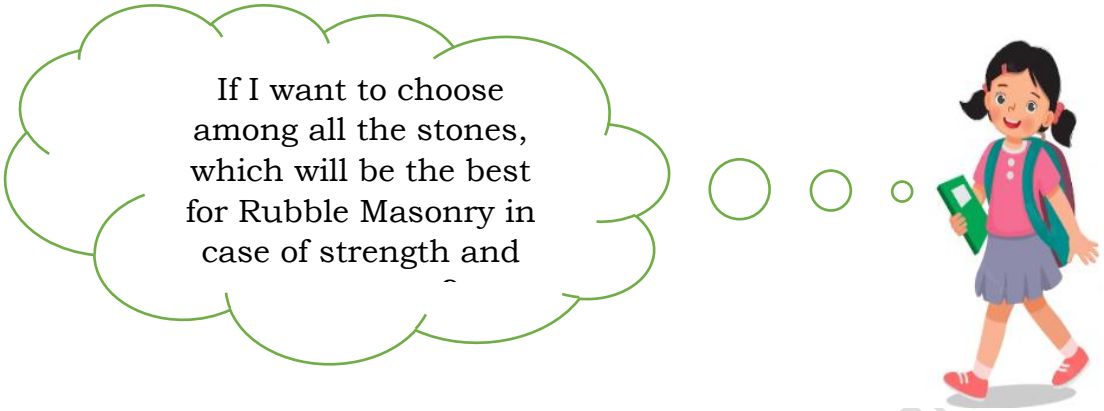
1.5 TYPES OF STONES USED IN RUBBLE MASONRY

1. **Granite:** It consists of grains of quartz in combination with felspar and mica. These are the hardest types of stones and difficult to work with. They are available in various colors ranging from white to green. These are used for the construction of steps, walls, sills and as facing over other masonry.

2. Sandstone: They are made of quartz cemented by a matrix of silica. They also contain mica, felspar and oxides of iron. The colors of sandstones are due to the presence other minerals in them. They can be worked easily to take any ornamental shape. Their texture being coarse, they give a good appearance when used along with brick masonry. Colored sandstones are used in the face work of building to give architectural treatment. They are used for walls, columns, facing, steps, flooring, etc.

3. **Limestone:** These are calcareous rocks and consist of carbonate of lime. They are available in various colors and easy to work with. They are used for walls, floors, steps, etc.

4. **Marbles:** They are like limestone, are calcareous rocks and consist and consist of carbonate of lime. They are very useful material for flooring and monumental structures. Marble is available in various colors and can very good polish.



5. **Slates:** These are available in hilly areas and are metamorphic rocks. Generally, they have a black color. Slates can be split in thin sheets along their bedding planes. They mostly used for roofing work.

6. **Basalt and trap**

The structure is medium to fine grained and compact. Their color varies from dark gray to black. Fractures and joints are common. Their weight varies from 18 kN/m^3 to 29 kN/m^3. The compressive strength varies from 200 to 350 N/mm^2. These are igneous rocks. They are used as road metals, aggregates for concrete. They are also used for rubble masonry works for bridge piers, river walls and dams. They are used as pavement.

7. Laterite

It is a metamorphic rock. It is having porous and sponges structure. It contains high percentage of iron oxide. Its color may be brownish, red, yellow, brown and grey. Its specific gravity is 1.85 and compressive strength varies from 1.9 to 2.3 N/mm2. It can be easily quarried in blocks. With seasoning it gains strength. When used as building stone, its outer surface should be plastered.

Different types of plasters and mortar requirements for the rubble masonry works as per the specification and aesthetics requirements:
Masonry in cement/lime mortar: 1:8
Masonry in cement/lime mortar: 1:6
Masonry in cement/lime mortar: 1:4
Masonry in cement/lime mortar: 1:2

1.6 VARIOUS TYPES OF CEMENT PASTE / ADHESIVES USED

Based on ISO 13007 -1:2004, adhesives fall into three major categories:

- Type C (Cementitious): Mixture of hydraulic binding agents, aggregates and additives; to be mixed with water or other liquid just before use.
- Type D (Dispersion): Ready -for-use mixture of binding agents in the form of polymer dispersion, additives and other mineral fillers.
- Type R (Reaction Resin): Single or multi-component mixture of synthetic resin, mineral fillers and other additives in which the curing occurs by chemical reaction.

1.7 PROCEDURE FOR DIFFERENT MASONRY WORKS

1.7.1 Sub base for random rubble masonry works for constructing such a footing, a bed of lean cement concrete (1:8:16) is first laid over the entire length of the wall.

- The thickness of this lean concrete bed is usually kept 15cm and its width is kept 20 to 30 cm more than that of the bottom course.
- In no case, the depth of the concrete bed should be less than its projection beyond the wall base.
- For foundations over firm soil or compacted ground, the concrete bed below the brick wall footing may be dispensed with.
- After laying the concrete for constructing the concrete bed, it should be properly compacted and cured before laying the base course of the wall.

1.7.2 Procedure for performing visual checks on the materials used in random rubble masonry works.

- Materials Stones used in masonry shall be of approved quality locally available black trap. They shall be hard, sound and free from decay, weathering and fissures. Stones with round surface shall not be used.
- Cement Mortar Cement mortar shall meet the requirements of IS: 2250 and shall be prepared by mixing cement and sand by volume. Proportion of cement and sand shall be 1:6 (one part of cement and six part of sand) or as specified. The sand being used shall be sieved before use. The mortar shall be used as soon as possible after mixing and before it has begun to set and in any case within initial setting time of cement, after the water is added to the dry mixture. Mortar unused for more than initial setting time or cement shall be rejected and removed from the site of work.
- The unit of measurement for cement shall be bag of cement weighing 50 KGs and this shall be taken as 0.035 cubic meter. Sand shall be measured in boxes of

suitable size on the basis of its dry volume. In case of damp sand, it quantity shall be increased suitably to allow for bulk age.

- The mixing of mortar shall be done in a mechanical mixer operated manually or by power. The Engineer-In-Charge may however, permit hand mixing, as a special case, taking in to account the magnitude nature and location of work. The Contractor shall take the prior permission of the Engineer-In-Charge in writing, for using hand-mix, before the commencement of work.

1.7.3 Procedure for cutting stones to prepare for sides, edges and bed of random rubble masonry works.

Dressing Stone shall be hammer dressed on the face, the sides and the beds to enable it to come in proximity with the neighboring stone. The "bushing" (projection) on the face shall not be more than 40 mm on an exposed face and 19 mm on the face to be plastered. It shall not have depression more than 10mm from the average wall surface. It shall also conform to the general requirements for dressing of stones covered in IS: 1129.

1.7.4 Procedure for preparation of mortar for random rubble masonry works

In case of Hand Mixing, following points must be taken care of:

- The measured quantity of sand shall be leveled on a clean masonry platform and cement bags emptied on top.
- The cement and sand shall be thoroughly mixed dry by being turn over and over, backward and forward, several times till the mixture is of uniform color.
- The quantity of dry mix which can be consumed within initial setting time of cement shall then be mixed with just sufficient quantity of water to bring the mortar to the consistency of stiff paste.

1.7.5 Procedure to work with undressed and hammer dressed stones used for un-course and course random rubble masonry

Dressing Stone shall be hammer dressed on the face, the sides and the beds to enable it to come in proximity with the neighbouring stone.

The "bushing" (projection) on the face shall not be more than 40mm on an exposed face and 19mm on the face to be plastered. It shall not have depression more than 10mm from the average wall surface. It shall also conform to the general requirements for dressing of stones covered in IS: 1129.

1.7.6 Procedure for building of wall in coursed and un-coursed random rubble masonry.

Building a wall in coursed and un-coursed random rubble masonry involves arranging irregularly shaped stones in either a regular pattern (coursed) or an irregular pattern

(un-coursed) with mortar in between. Here's a general procedure for both types of masonry:

1. Preparation:

Determine the location and dimensions of the wall. Mark the boundaries and excavate the foundation trench to the required depth and width.

Level the foundation trench and compact the soil at the bottom to provide a stable base for the wall.

2. Foundation:

Lay a concrete footing or base course using cement concrete mix (1:4:8 or as specified) to create a level and stable foundation for the wall. The thickness of the concrete footing should be at least 4-6 inches, depending on the wall height and load-bearing requirements.

3. Setting Out:

Set out the wall lines using strings and pegs. Use a level and plumb bob to ensure that the wall is straight and vertical.

4. Sorting Stones:

Sort the stones based on their size and shape. Separate larger stones for the base and smaller ones for the upper courses. This will help maintain stability and aesthetic appeal.

5. Mortar Mix:

Prepare the mortar mix using cement and sand in the ratio of 1:6 (for coursed masonry) or 1:8 (for un-coursed masonry). Mix the mortar with water to a workable consistency.

Here are the steps after general procedure for Coursed Random Rubble Masonry:

- Lay the first course of stones on the concrete footing, using mortar to create a level surface. Place larger stones first, ensuring they are stable and well-bonded with the mortar.
- Continue adding stones to create the desired height of the first course. Make sure each stone is level and plumb using a spirit level and plumb bob.
- Fill the gaps between stones with mortar, ensuring a strong bond between the stones and the mortar.
- Lay subsequent courses in a similar manner, ensuring that the stones are aligned and the joints are staggered for better stability.
- Use smaller stones towards the top courses to achieve a tapering effect if desired.

Here are the steps after general procedure for Un-coursed Random Rubble Masonry:

- Start laying stones without any regular pattern, allowing the stones to interlock naturally. Use larger stones for the base and gradually transition to smaller stones for the upper courses.

- Add mortar in between the stones to fill gaps and ensure stability.
- Keeps the wall surface as level as possible, adjusting the stones and mortar as needed.

After completion of work following work is to be carried out in both the above procedures:

1. **Finishing:**
   - Once the desired height is reached, allow the mortar to set and cure for a few days.
   - Use a wire brush to clean the wall surface of any excess mortar or dirt.
   - For coursed masonry, strike joints with a pointing tool to create a neat finish.
   - For un-coursed masonry, leave the irregular joints as they are to preserve the rustic appearance.
2. **Curing:**
   Protect the newly constructed wall from direct sunlight and excessive moisture during the curing period (typically 7-14 days).

Importance of bond stones (through stones) and jambs at corners of random rubble masonry wall.

1. Individual stones shall have thickness and width of not less than 150 mm and length not less than 1.5 times its height. Stones shall be dressed with a mason's hammer by knocking off weak corners and edges. Face stone shall be so dressed that busing on the exposed face shall not project by more than 40 mm from the general wall surface. In case plastering is to be done, projection shall be limited to 19 mm and depression to 10 mm.
2. Bond or through stones shall be 2 pieces (nos.) per sq.m. face area shall be 0.03 sq m and for full width of masonry for walls up to 600 mm stones shall be marked distinctly.
3. For massive work with a width of a meter and above, vertical header 450 mm long or with a depth of two courses whichever is more shall be provided at the rate of one for every sq m of area in the plan.
4. Quoins (corners) shall be dressed square to the face and rough tooled to 100 mm from face, and vertical joints dressed to 40 mm from face. No quoins shall be smaller than 0.025 cu m in volume and they shall also not be less than 300 mm in length, 25% of them being not less than 500 mm in length.
5. Hearting stone shall not be less than 150 mm in any direction. In walls up to 500 mm a minimum of 30% stone shall be 0.010 cu m (10 litres) For thicker walls minimum 30% stone shall be 0.015 cum (15 litres).

6. The jambs shall be made with stones specified for quoins except that stones provided on the jambs shall have their length equal to the thickness of the wall. For walls up to 600 mm, line of headers shall be provided as specified for bond.
7. A plum stone at about 900 mm intervals shall be provided.
8. Stones shall be laid with or without courses as specified. Quoins be laid header and stretcher alternatively. Laying shall be carefully done to form neat and close joints. Face stones shall extend and bond well in the back. These shall be arranged to break joints.

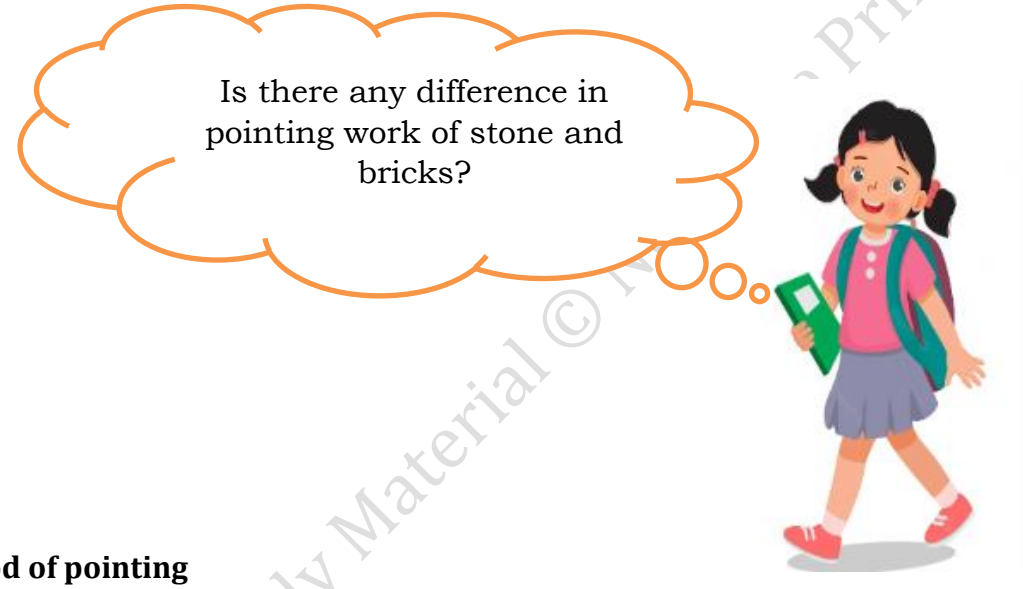
1.7.7 Procedure for laying course of dry rubble masonry works

- All stones shall be wetted before laying to prevent absorption of water from mortar.
- The stones shall be laid so that the pressure is always perpendicular to the natural bed.
- The courses (if any) shall be built perpendicular to the pressure which the masonry will bear. In case of battered walls, the base of stone and plan of courses (if any) shall be at right angles to the batter.
- The walls shall be carried up truly plumbed or to the specified batter.
- Every stone shall be carefully fitted to the adjacent stones, so as to form neat and close joints.
- Vertical joints shall be staggered as far as possible. Stone may be brought to level course at plinth, Window sills and roof level.
- Leveling up at plinth level, window sills and roof level shall be done with concrete comprising of one part of the mortar as used for the masonry and two parts of graded stone aggregate of 20mm nominal size.
- The bond shall be obtained by fitting in closely the adjacent stones. Transverse bonds shall be provided by the use of bond stones extended from the front to the back of the wall.
- At angular junctions the stones at each alternate course shall be well bonded into the respective courses of the adjacent wall.
- Face stones shall extend and bond well in the back. These shall be arranged to breaked joints as much as possible, and to avoid long vertical lines of joints.
- The depth of stone from the face of the wall inwards shall not be less than the height or breadth at the face.
- Where there is a break in the masonry work, the masonry shall be raked in sufficiently long steps for facilitating joining of old and new work.
- The stepping of the raking shall not be more than 45 degrees with the horizontal. The masonry work shall not be raised more than 1.2 meter per day.

- Toothed joints in masonry shall not be permitted.

1.8 POINTING WORK

Pointing work in masonry refers to the process of finishing the joints between stones or bricks with mortar after the main construction of the wall or structure is completed. The purpose of pointing is to improve the aesthetics, durability, and weather resistance of the masonry by filling the gaps and protecting the edges of the stones or bricks. Proper pointing is essential to prevent water penetration and maintain the structural integrity of the masonry.



1.8.1 Method of pointing

Pointing may be carried out either in lime mortar or in cement mortar. The materials for mortar are thoroughly mixed in dry condition on a impervious platform; water is then added and again it is thoroughly mixed. The quantity of mortar prepared should be such that it should be consumed within 30 minutes after adding water.

Pointing is then carried out as follows:

(i) Rake out the masonry joints at least up to a depth of 20 mm.
(ii) Remove the dust from masonry joints with a brush
(iii) Clean the surface with water and keep it wet for few hours.
(iv) Apply the mortar in desired shape in prepared joints.
(v) The finished surface is kept wet for at least 3 days in case of using lime mortar and 7 days in case of using cement mortar.

Fig.1.20: Pointing Work

1.8.2 Procedure for performing raking of joints for pointing in random rubble masonry works

Following are the steps to be carried out for performing raking of joints in random rubble works:

- The joints of masonry shall be raked at least 12mm deep whilst the mortar is green and not later than 48 hours of time of laying.
- The dust shall them be brushed out of the joints and the wall washed with water.
- The mortar shall be of specified mix.
- Mortar shall be filled into joints and well pressed with special steel trowels.
- The joints shall not be touched again after it has once begun to set.
- The joints of the pointed work shall be neat.
- The lines shall be regular and uniform in breadth and the joints shall be raced, flat, sunk or "V" as may be directed.
- No false joints shall be allowed. The work shall be kept wet for a week after the pointing is complete.

1.8.3 Various pointing works on random rubble masonry

Following are the types of pointing works carried out on random rubble works:

1. Flush pointing:

In This type of pointing mortar is pressed hard in the raked joints and by finishing off flush with the edge of masonry units. The edges are neatly trimmed with trowel and straight edge. It does not give good appearance. But, flush pointing is more durable

because of resisting the provision of space for dust, water etc., due to this reason, flush pointing is extensively used.

Fig.1.21: Flush Pointing

2. **Weathered pointing-** This pointing is made by making a projection in the form of V-shape.

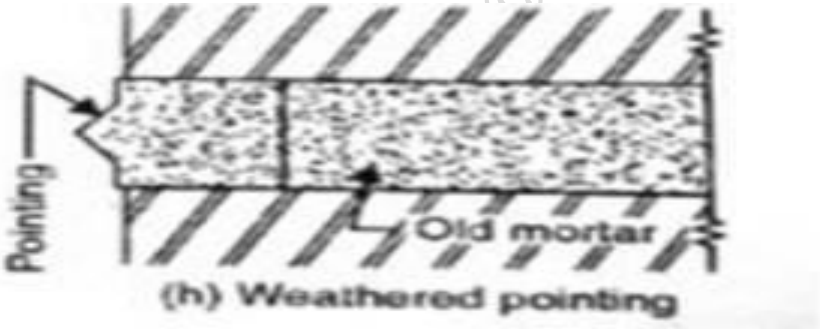


Fig.1.22: Weathered Pointing

ACTIVITIES

Activity 1: Building a Mini Random Rubble Masonry Wall
Materials Required:

1. Irregularly shaped stones of different sizes (collected from the surroundings or provided by the instructor)
2. Mortar mix (cement and sand in the ratio of 1:6 or as specified)
3. Water
4. Trowel
5. Spirit level
6. Measuring tape

Procedure:

1. Clear the designated area and create a level surface for the construction of the mini wall.
2. Sort the stones based on their size, keeping larger stones for the base and smaller ones for the upper layers.
3. Prepare the mortar mix by mixing cement and sand in the specified ratio and adding water to achieve a workable consistency.
4. Lay the first course of stones on the ground, using mortar to bond them together. Ensure that the stones are stable and level with the help of a spirit level.
5. Continue adding stones to create the desired height of the mini wall. Use smaller stones as you move upwards.
6. Fill the gaps between the stones with mortar, making sure to maintain a strong bond between the stones and mortar.
7. Allow the mini wall to cure for a few days, protecting it from extreme weather conditions.

Activity 2: Pointing the Random Rubble Masonry Wall

Materials Required:

1. Already constructed mini random rubble masonry wall (from Activity 1)
2. Pointing mortar mix (cement and sand in the ratio of 1:3 or 1:4)
3. Water
4. Pointing trowel
5. Wire brush
6. Damp sponge or cloth

Procedure:

1. Ensure that the masonry surface is clean by using a wire brush to remove any loose particles or old mortar.
2. Prepare the pointing mortar mix by mixing cement and sand in the specified ratio and adding water to achieve a workable consistency.
3. Apply the pointing mortar to the joints between the stones using a pointing trowel. Press the mortar firmly into the gaps, completely filling the joints.
4. Depending on the desired pointing style (flush, recessed, struck, or weathered), finish the pointing using the appropriate technique.
5. Clean any excess mortar from the masonry surface using a damp sponge or cloth while the mortar is still fresh.
6. Allow the pointing to cure for a few days, protecting it from direct sunlight and heavy rain.

CHECK YOUR PROGRESS

I. Answer the following

1. What are the different types of coursed and uncoursed rubble masonry?
2. Enlist the tools used in stone masonry work.
3. Mention the cement paste / adhesives used in stone masonry work.
4. What is the importance of providing through stones in stone masonry?
5. Explain the procedure of construction stone masonry wall in coursed rubble masonry.
6. Enlist the tools used in pointing work with sketch.
7. Explain with sketch types of pointing work.
8. Write down the procedure of mixing cement mortar (1:3) for pointing work?

II. Fill in the blanks

1. …….. Is used to lift and spread mortar to form the joints.

2. …….. is used to cut the bricks accurately.

3. ……Rubble Masonry are performed without use of mortar

4. ……..is made up of quartz cemented by matrix of silica.

5. ……..work refers to the process of finishing joints between stones or bricks.

III. Multiple Choice Questions

1. The properties of stones should be as per reference of:

(i) IS 1123:1975 (ii) IS1120:1975

(iii) IS 1125:1975 (iv) IS 456:2000

2. Pointing in which mortar is pressed hard in raked joints:

(i) Flush pointing (ii) Weathered Pointing

(iii) Both of the above (iv) None of the above

3. The tool used to dress the stones:

(i) Bolster (ii) Chisel

(iii) Mesh Hammer (iv) Pick Axe

4. Stone that is usually found in hilly and also is metamorphic rocks:

(i) Quartz (ii) Basalt

(iii) Limestone (iv) Slate

5. Which types of adhesives is ready for use mixture of binding agent in the form of polymer dispersion:

(i) Type R (ii) Type C

(iii) Type D (iv) None of the above

Module 2	IPS AND TREMIX FLOORING

Module Overview
This module will cover two popular types of flooring: IPS (Indian Patent Stone) flooring and Tremix flooring. It explains the materials, techniques, and processes involved in their construction. The module highlights the advantages of each type and their suitability for different applications in building works.

Learning Outcomes
After completing this module, you will be able to: • Explain the materials and methods used in IPS flooring. • Describe the process of Tremix flooring and its technique. • Identify the advantages and applications of IPS and Tremix flooring in construction. • Compare the two flooring types based on durability and usage.

Module Structure
2.1 IPS Flooring 2.2 Tremix Flooring

IPS, which stands for "Indian Patent Stone," and Tremix are widely used in the construction of industrial, commercial, and residential spaces. These methods offer

distinct advantages, making them popular choices for flooring applications. Meanwhile, Vacuum Dewatered Flooring (VDF) is a specialized flooring technique that enhances the strength and longevity of concrete floors.

Throughout this chapter, we will explore the fundamental principles behind IPS/Tremix and VDF, their applications, and the step-by-step process involved in their implementation. Additionally, we will discuss the benefits and limitations of each method, allowing you to grasp a comprehensive understanding of their role in modern construction practices.

1.1 IPS FLOORING

IPS flooring stands for Indian patent stone flooring, it is a basic type of flooring which provides good wearing properties. It is generally used for all types of floors and mix of concrete used for IPS flooring specification is 1:1.5:3 (cement, sand and stone aggregates). As per the nature of use the flooring thickness of concrete is decided from 25 mm to 50 mm. It is laid over the concrete base (1:4:8), which is almost 3 to 4 inches thick plain cement concrete (PCC) base.

Fig 1.1 IPS Flooring

Thickness of the IPS flooring can be decide the as per the requirement of work; in residential floor 75 mm floor thickness is sufficient whereas industrial floor thickness should be kept 150 mm.

1.1.1 Preparation work before IPS flooring

Prepare the sub-base by watering and ramming and ensuring no loose material are left. Level the surface and stone soling layer of 150mm to 230 mm to be provided as per the requirement.

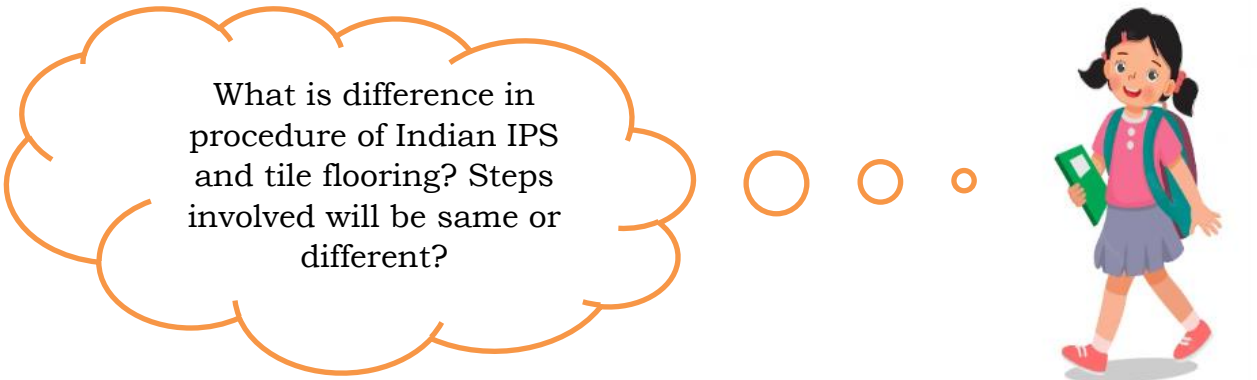
It is recommended to provide adequate slope in Plain cement concrete (PCC) in a base course as it will not be possible to maintain slope in IPS layer due to limited thickness. Door frames should be fixed prior to flooring work.

1.1.2 Procedure of IPS flooring

Following are the steps to be involved in the construction of IPS flooring:

1. First of all, make reference level on the wall transfer this marking to all location where flooring to be done with help of water level tube.
2. Ensure there is no air bubble present in water and then it is exactly matching the water level while keeping both ends together. Reference mark is to be transferred on all across the flooring area and it should be marked permanently with the help of line marker.
3. Flooring thickness level to be marked and dummy level dots provided in every 1 or 2 meter ensuring required slope of flooring.
4. After proper setting of these dummy concrete dots.
5. Concrete in specified mix should be poured in panels to minimize shrinkage cracks. The size of panel should not exceed more than 3 square meters for indoor and 2 square meter for outdoor flooring.
6. Glass, aluminium or brass strip are fixed in cement mortar with their tops at proper level according to slope and allowed to harden for minimum 36 hours.
7. After pouring of concrete, surface to be levelled with a Straight Edge and finished with a wooden float or trowel.
8. The final trowelling should be done before the concrete has become hard and sufficient pressure is required to make firm impression on the concrete surface. There should not be any mark left on the finished surface and care should be taken that no cement slurry spread on the surface.
9. If glossy or smooth IPS flooring surface required then neat cement punning, 2 to 3 mm thick is spread over the IPS concrete surface and allowed to soak into the concrete. The surface is finished with metal trowel 3 to 4 times to give surface a glossy look.
10. For curing of IPS concrete flooring surface pond or wet Hessian clothes are spread over surface for 15 days.

If required, Vacuum dewatered machine to be used for big work to give surface smooth and better finish. Further in this chapter we will discuss about vacuum dewatered flooring. This not only prevents concrete surface cracks but also increase the abrasion resistance of IPS concrete surface.



Note - Further to avoid surface cracks, polyurethane fibres are added to concrete, in small portion. This type of concrete is also called Ferro cement concrete. The casting of concrete flooring in panels to avoid shrinkage cracks and work as expansion joint. Therefore, it is advisable to use Tremix flooring especially when large areas like platform surface, pavements and industrial flooring are to be done.

1.2 TREMIX FLOORING

Tremix flooring method is defined as Vacuum Dewatered Flooring. It is a special type of flooring technique to achieve high strength, longer life, better finish and faster work.

Tremix system also known as Dewatering System. It is used in making Industrial floors, Concrete roads, Runways, Railways Platforms, Warehouse container Yards, Canal Lining, Pathways, Bridges, RCC Roads etc. In this process dewatering of concrete is done by Vacuum Process wherein surplus water from the concrete is removed immediately after placing and vibration. There by reducing the water cement ratio to the optimum level.

Tremix flooring increases the compressive strength, tensile strength and abrasion resistance and minimizes the shrinkage and floor wraps. This type of floor is suitable for high abrasion & heavy traffic movement areas floor in factories and industries have concrete being the most versatile of flooring material has been in use for a long time. To overcome the deficiencies of concrete a system was devised to improve the properties of such concrete floors.

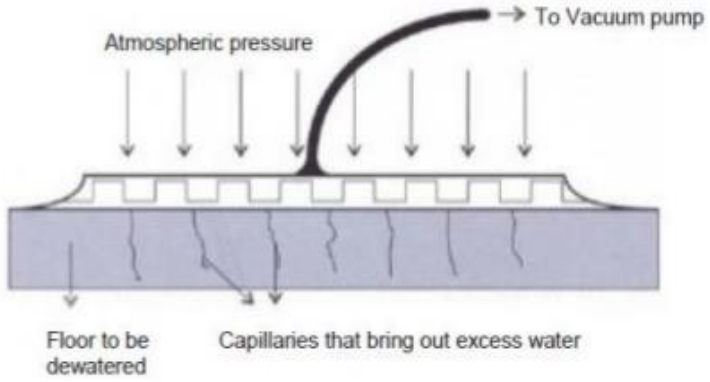


Fig 2.2 Tremix/VD Flooring

Tremix flooring is a special type of flooring mostly being done in the industrial sector. It is generally used for industrial purposes where rigid surface necessary for machine foundation, light load carrier vehicle and light weight cranes. By this method economic high quality concrete floors can be laid. This method improves the properties of concrete floors. Tremix flooring is also known as vacuum dewatering flooring, since in this method vacuum treatment is done to remove the surplus water from the concrete.

With the industrial revolution all over the world, the floor construction has been on the serious concerns of Architect, Engineers and users. A high-quality concrete floor not only be levelled perfectly but also it should have high compressive strength with minimum cost. In this flooring the water/cement ratio is drastically reduced after placing. A lowered water/cement ratio automatically leads to noticeable improvement of almost all properties of concrete.

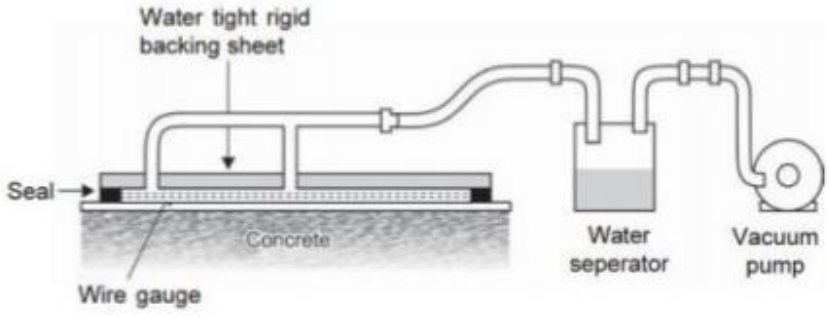


Fig 2.3 Vacuum Dewatered Flooring

This technique is effectively used in industrial floors, parking lots and deck slabs of bridges etc. By the adoption of Tremix vacuum flooring. more workable concrete floors can be done than the normal flooring. In this above figure the dewatering by using vacuum pump is being done, excess water is sucked through capillaries. Filter mat medium is used at the time of dewatering to prevent entry of cement other finer particles. Vacuum pump is connected on the top mat then process de watering is started and water is removed from the concrete floor/slab.

1.2.1 Tools and materials required in Tremix Flooring

All mason tools and tackles required to available at site. However, some special tools required as follows;

1. Vacuum de-watering pump
2. Floater machine
3. Tremix skin
4. Double beam screed vibrator

1. Vacuum de-watering pump

Vacuum de-watering machines removes excess water from the top layer of wet concrete without removing the cement of sand particles. Vacuum Pump is used to suck all the air bubbles that may have trapped during the laying of the concrete. A continuous discharge vacuum pump is a completely self-contained unit. Two number of matted areas can be dewatered in one single operation. The pump is powered by 7. 5 HP- 3 phase electric motor.

Fig 2.4 Vacuum dewatering Pump

Vacuum Pump is used to reduce water content in the concrete by l5-25‘Zé. The dewatered concrete is compacted and dried. Vacuum Pump is used to suck all the air bubbles that may have trapped during the laying of the concrete. It shows the cement to come up to upper layers and hence gives a superior strength to the floor. The three mats: filter mat, suction mat and top mat and these mats do not allow cement to come up but only sucks the extra water. Top mat size is 4.5 m x 5.5 m during working. It eludes a vacuum pressure of 450-500 mm/Hg. Maximum pump pressure which can be developed is 650 mm/Hg. It is powered by 7.5 HP motor.

2. Floater machine

This machine is used for rubbing and smoothing the surface area. Floating and Trowelling take place right after dewatering. Floating operation is done with Floating disc. This makes the cement more compact and enabling to generate a wry smooth finish. Trowelling is done with Trowel blades in order to further improve the wear resistance, minimize dusting and obtain smoother finish.

Fig 2.5 Floater Machine

Important features of floater machine are as:

- Two speed operation for electric version.
- Dead man's grip for operator safety
- Adjustable and foldable handle
- Dual function floating and trowelling
- Easy change over from disc to blades
- Blade angle adjustable while machine is in operation
- All controls on handle, easily accessible.
- Also, ideally suitable for Epoxy Screed finishing.
- Available in two diameters 900 mm and 700 mm.

Fig 2.6 Using Floater Machine

3. Tremix screen

Vacuum is immediately created between the filter pads and the top cover. Atmospheric pressure compresses the concrete and the surplus water is squeezed out. Suction mat of special grade multilayered polymer sheets along with reinforced distance cushions on the Filter pads ensure sufficient cross-sectional area to squeeze out and remove excess water from the concrete. This design is a prerequisite for effective dewatering.

Fig 2.7 Tremix screen

4. Double beam screed vibrator

Double beam screed vibrator consists of a Beam unit and a Vibrator unit. Double beam screed vibrator is used to vibrate the concrete to give a compact and levelled surface. These vibrators are self-travelling and only require guiding along the formwork, dragged at ends by two operators without working in the concrete. It is manufactured from M.S. channel or box pipe for durability. To get a really levelled & durable concrete surface the concrete should be compacted and levelled with Double Beam Screed Vibrator.

- Made from light weight hollow aluminium alloy beams.
- Vibrations adjustable from 30 to 100 %.
- Suitable for concrete depths up to 300 mm in conjunction with poker vibrators.
- Tensioning device for level correction.
- Specially designed vibrator motor and switches for operator safety.
- Sacrificial end ties for longer beam life.

Fig 2.8 Double Beam Screed Vibrator

1.2.2 Flooring Procedure

Following given are the general procedure for VD flooring:

- **Prepare the sub-base** by watering and ramming, properly ensure no loose material are left. Level the surface and lay 230 mm to 300 mm stone soling/boulder soling layer of 150 mm shall be provided and compacted properly.

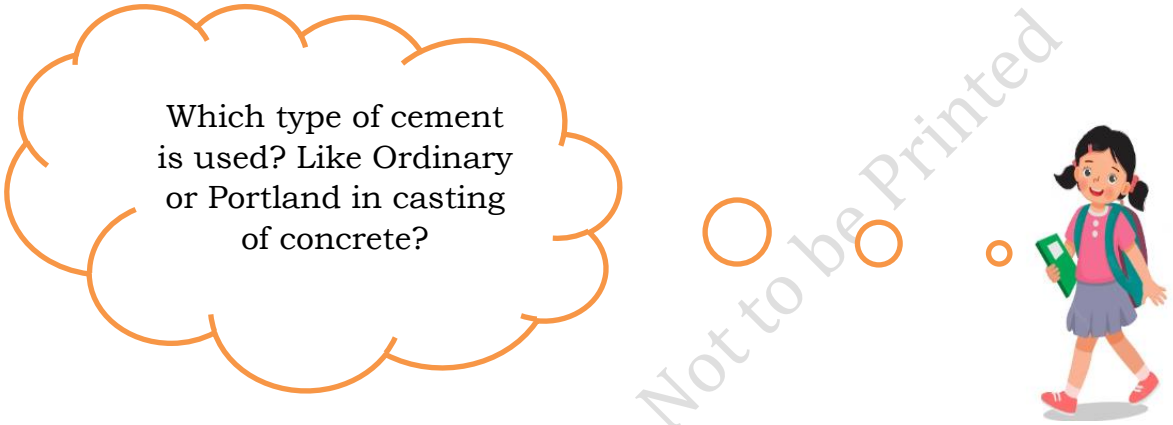
- **Floor slope** should be maintained in PCC work, which shall be laid above the stone soling. Thickness of PCC shall be kept 100 mm.

Fig 2.9 Floor Sloping

- Tremix has to be done in panel and each panel shall be of 3.5 meter and appropriate reinforcement bar shall be laid in layer of two or one keeping the concrete cover of 50 (it may differ as per standard).

- **Vacuum de-watering machines** are useful, which removes excess water from the top layer of wet concrete without removing the cement of sand particles. This is done soon after concerting, ramming or vibrating with screed vibrator and levelling first round trowelling, when the concrete is fresh. It will not only increase the strength of the concrete but also increase abrasion resistance of the floor, also it is always good if hardener to be used to increase abrasion resistance of floor while using floater machine at the time of finishing the floor surface. Shrinkage cracks are also minimized by using this system. Further to avoid shrinkage cracks and increase the abrasion floor hardener and polyurethane Fibers are added to concrete in small amount. The quantity of the fibres and hardener are prescribed by the manufacturers.

- **Casting of concrete** flooring in panels to avoid shrinkage cracks and work as expansion joints, it is slow and time-consuming process, especially when large area are to be floored. The concrete lay in panels without construction joint, then after panel joints shall be cut with help of cutting saw after 7 to 10 when concrete is not fully hardened. The gap so created is filled with poly sulfide or sealants.



1.2.3 Procedure for making Tremix

Generally, the mix of concrete used for Tremix is l: 1:5:3 (l cement: 1.5 sand m and 3 stone aggregates) mostly rich mix of l: l:2 preferred for better wear and tear. ln this flooring necessary reinforcement provides depending upon the thickness of the flooring, whereas the thickness of concrete is decided from 100 to zoo mm over PCC t 1:4:8) and well-prepared stone soling base ranging from 230 to 300 mm. ln industrial flooring PCC base should be kept up to l00 mm and same as floor concrete 150mm. It may be satisfactory for heavy duty was such as warehouses, garage and machine shops. The key of the method is dewatering concrete by the vacuum process. Through vacuum dewatering the surplus water is removed from the concrete, which means that water cement ratio automatically leads to a noticeable improvement of almost each of the concrete properties.

Immediately after vacuum dewatering the flatness of the concrete surface is checked and adjusted with a control tool and the finishing operation with a power trowel can start.

Vacuum pump is used for the dewatering process a top cover and filter pads. The top cover is made of special reinforced airtight plastic sheet with a suction channel on the bottom side. It is provided with two lifting tubes which makes it easier to unroll the top cover to the required length. The filter pad is made of perforated plastic sheet with distance cushions on the top side. It acts as a filter between the fresh concrete and the top cover.

Fig 2.10Filter pads are placed so that there will be a sealing edge around the entire filter pad surface

Fig 2.11 Top Cover is unrolled over filter pads

After compaction by surface vibrator, filter pad is placed leaving all sides. The top cover is then placed on the filter pods and rolled out till it covers the strips of exposed concrete on all sides.

The Top cover is then connected to the vacuum pump through a suction hose and the pump is started. Vacuum is immediately craned between the filter pads and the top cover.

Fig 2.12 Top cover is connected to the suction of the vacuum pump. It is important to check that top cover seals against the fresh concrete outside the filter pads

The finishing operation Floating & Trowelling take place right after de watering. Floating operation is done with Floating disc. This ensures after mixing of' sand & cement particles. Further compaction and closing the pores on the surface. Floating operation generates skid-free finish. Trowelling is done with trowelling blades in order to further improve the wear resistance, minimize dusting and obtain smoother finish

Fig 2.13 While vacuum is on, surface that has already been vacuum dewatered is floated with a power trowel fitted with a disc.

1.2.4 Steps for laying Tremix

Following are the steps for laying tremix -

- First tying line threads as per the slope requirements
- Laying guide rail to every 4 meters using MS channels or as required in straight lines along the line thread, taking levels as per the slope and fixing them using concrete also called grouting and left to set for a minimum of 24 hours
- Pouring the concrete in between the channels and spreading using shovel or hoe
- Vibrating the concrete with a poker vibrator especially to the sides of the panels
- Surface Vibration the concrete using Double Beam Screed Vibrator running over the guide rails twice to achieve maximum compaction for RCC with double mats
- Final levelling of the concrete using the straight edge.
- De-watering by vacuum pump.
- Application of power floater on the surface until the surface is sufficiently compacted and levelled with no major lines appearing any more
- Final finishing using Power Trowel and trowelling until the required finish is achieved. Finish could be any of the smooth finish, sand finish or Line Finish.

1.2.5 Tremix vacuum system stages

In the figure 2.13, we can understand easily the procedure of the tremix vacuum system. Construction is divided in to different stages like clearing, placing of reinforcement, placing of concrete, levelling and compacting by using double beam screed vibrator, placing of the mats, de watering is done by vacuum de-watering pump and top mat

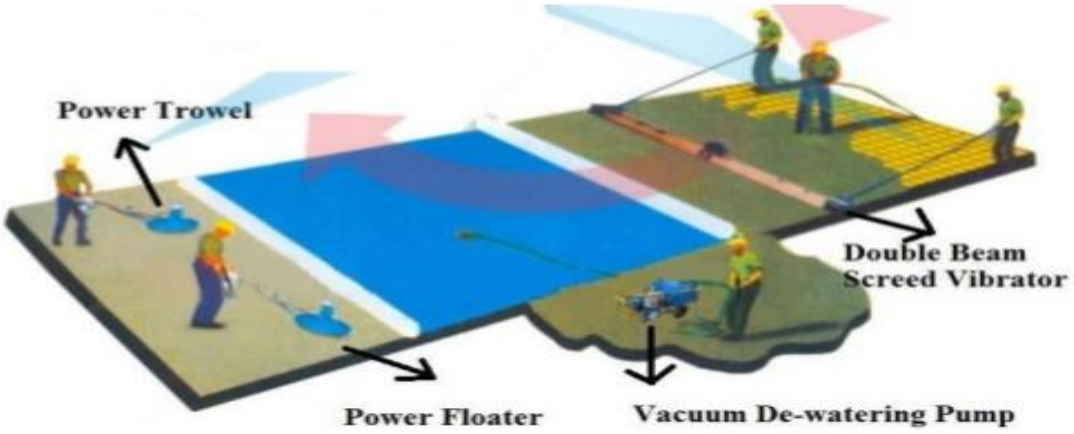


Fig 2.13 Tremix Vacuum System Stages

1.2.6 Need of vacuum dewatering concrete flooring

With the increasing demand for sustainable and efficient construction practices, vacuum dewatered flooring has emerged as a game-changer in achieving both speed and precision during the flooring process. Unlike conventional methods, which often involve long curing periods and leave behind imperfections, VDF offers a comprehensive approach to achieving a flawless and robust flooring surface. Following points define the needs of Vacuum Dewatered concrete flooring:

l) The mixing water added to a concrete mix exceeds the amount of water required to fully hydrate the cement constituent.

2) The additional water functions as a lubrication medium to allow mixing, placing. levelling and consolidation. In conventional concreting practice, an important challenge is the prevention or limiting of evaporation of mixing water out of the freshly placed concrete.

3) The uncontrolled removal of water from the concrete matrix can result in adverse effects such as plastic shrinkage cracking. Excessive bleeding of concrete can negatively interfere with surface characteristics such as resistance to wear. Thus, the durability and service life of the flooring element is in question. Concreting in areas exposed to the elements, specifically in hot and windy conditions poses even higher demands in order to produce quality, durable concrete.

1.2.7 Advantages and disadvantages

Following are the advantages of the vacuum dewatered flooring:

1. Reduction in W/C ratio leads to early setting and high strength.
2. This system removes the excess water after pouring of the concrete & thus an ideal water cement ratio can be achieved
3. Increase in compressive strength of concrete by 40-70%.
4. The surface hardness of the slab increases by l30%.
5. Water absorption is reduced enormously.
6. Minimum dusts.
7. Level floor, high flatness accuracy.
8. Minimized crack formation. Shrinkage reduced by 50%.
9. Improved wear resistance.
10. Elimination or minimization of overtime.
11. High and early strength. minimize damage to newly cast floors.
12. Void-freed and denser concrete.

Following are the disadvantages of the vacuum dewatered flooring:

1. High initial cost.
2. Need trained labour for the vacuum dewatering process.
3. Need specific equipment for vacuum dewatering like vacuum pump.
4. Need power consumption during dewatering process.

Typical application areas of VD Flooring

l. Warehouses
2. Roads. Sports Courts
3. Cellars. Parking Areas
4. Production Areas.
5. Industrial Shop floors

ACTIVITIES

Activity 1: Introduce students to the process of installation of Indian Patent Stone Flooring.

Materials Required:

1. IPS Flooring samples (small pieces)
2. Cement
3. Sand
4. Water
5. Trowel
6. Measuring instruments (scale or measuring tape)
7. Leveling instrument (Spirit level)
8. Safety equipment (gloves, goggles)

Procedure:

1. Divide the students into small groups.
2. Provide each group with a small piece of IPS flooring sample.
3. Instruct the students to examine the surface finish, smoothness, and overall quality of the sample.
4. Demonstrate how to mix cement and sand in the correct proportions (usually 1:2 or 1:3) and add water to create a semi-fluid mixture.
5. Guide the students on how to apply the cement-sand mixture on a level surface using a trowel, ensuring a uniform thickness.
6. Allow the IPS flooring sample to dry for a specific period, depending on the weather conditions.

7. After drying, check the hardness and adhesion of the IPS flooring sample.
8. Encourage students to discuss their observations and share their experiences.

Activity 2: Tremix Flooring Demonstration

Materials Required:

1. Tremix flooring materials (sample or images)
2. Cement
3. Coarse aggregate (stone chips or crushed stone)
4. Water
5. Tremix machine (can be a demonstration or video)
6. Trowel
7. Measuring instruments (scale or measuring tape)
8. Safety equipment (gloves, goggles)

Procedure:

1. Divide the students into smaller groups and provide them with the Tremix flooring materials (cement, coarse aggregate, and water).
2. Guide the students on how to mix the materials correctly to achieve the desired consistency.
3. Instruct the students on how to use a trowel to spread and level the Tremix mixture on a prepared surface.
4. Emphasize the importance of proper compaction and leveling during the installation process.
5. Allow the Tremix flooring to cure for a specific period, depending on the weather conditions.
6. Facilitate a discussion among students to share their experiences and observations regarding Tremix flooring.

Note: Since these practical activities involve working with construction materials, it's essential to prioritize safety. Ensure that students wear appropriate safety equipment and closely supervise the activity to prevent any accidents or injuries. Also, consider the availability of resources and permissions required for hands-on demonstrations, and use substitutes like images or videos if necessary.

CHECK YOUR PROGRESS

I. Answer the following:

1. What is the use of vacuum de-dewatering pump and screen vibrator?
2. Enlist the different types of aggregates with their uses.

3. Give the different grades of concrete used for flooring work.
4. What are the various admixtures used in concreting?
5. Which are the different types of vibrators used for concrete?
6. Explain the different types of construction and expansion joints.
7. Enlist the hardeners used in IPS and Tremix flooring.

II. Fill in the blanks:

1. IPS stands for Indian …….. Stone.,
2. Tremix method is also known as ……..flooring.
3. …….. machines are used for rubbing and smoothing the surface area.
4. …….. Beam screed vibrator consists of beam units and vibrator unit.
5. Floor slope should be maintained in PCC work. The thickness of PCC shall be kept …….. mm.

III. Multiple choice Questions:

1. The mix of the concrete used for tremix is
(i) 1:1.5:3 (ii) 1:2:4
(iii) 1:5:10 (iv) 1:4:8
2. After grouting the surface is kept dry for approximately for how many hours
(i) 1 (ii) 24
(iii) 10 (iv) 5
3. In VDF, the compressive strength of concrete is increased by
(i) 10-20% (ii) 20-30%
(iii) 30-50% (iv) 40-70%
4. In VDF, shrinkage is reduced by
(i) 10% (ii) 20%
(iii) 50% (iv) 70%
5. For curing of IPS concrete flooring surface ponding or wet clothes are spread over for
(i) 1 day (ii) 10 days
(iii) 15 days (iv) 24 days

Module 3	ENVIRONMENT HEALTH AND SAFETY

Module Overview

This module overviews the safety practices and procedures for construction sites. It introduces various types of hazards commonly encountered during construction activities and explains emergency safety control measures. The module covers essential topics like the process of first aid, proper use of fire extinguishers, and conducting safety drills. It emphasizes the importance of Personal Protective Equipment (PPE) and provides guidance on handling and storing materials safely. Additionally, it outlines the standard procedures for reporting emergencies to the concerned authorities, ensuring a safe and efficient work environment.

Learning Outcomes

After completing this module, you will be able to:

- Identify different types of hazards on construction sites.
- Understand and implement emergency safety control measures.
- Apply the correct process for administering first aid.
- Demonstrate the proper use of fire extinguishers.
- Use Personal Protective Equipment (PPE) appropriately.

Module Structure

3.1 Types of Hazards in construction site
3.2 Emergency Safety control Measures
3.3 First Aid process
3.4 Use of Fire extinguisher
3.5 Safety Drills
3.6 Use of PPE (Personal Protective Equipment)
3.7 Reporting Procedure to the concerned authority in emergency situations
3.8 Standard Procedure of handling, storing and stacking of materials

Environmental health and safety (EHS) considerations are crucial for brick masons to ensure their well-being, as well as the protection of the environment and those around them. Brick masonry involves the construction of structures using bricks as building materials, and it poses several potential hazards that need to be managed effectively.

Brick masons engage in physically demanding tasks that involve handling heavy materials, working at elevated heights, and using various construction chemicals. To safeguard their health, it is imperative that brick masons are provided with proper personal protective equipment (PPE) such as hard hats, safety goggles, gloves, and respiratory protection. Additionally, training on ergonomic techniques and safe lifting practices can help prevent musculoskeletal injuries. Moreover, brick masons should be educated about the proper handling and disposal of construction materials, including mortar and chemicals, to prevent environmental contamination. By adhering to stringent safety protocols, utilizing appropriate safety gear, and receiving comprehensive training, brick masons can carry out their work efficiently while mitigating potential risks to their health and the environment.

Fig 3.1 Environment, Health & Safety

3.1 TYPES OF HAZARDS INVOLVED IN CONSTRUCTION SITES

Construction sites present a multitude of hazards that necessitate vigilant attention to ensure the safety and well-being of workers and the surrounding environment. These hazards encompass a range of risks, including falls from heights due to inadequate scaffolding or unprotected edges, the potential for being struck by heavy machinery or falling objects, and the risks associated with working in confined spaces without proper ventilation. Moreover, exposure to hazardous materials like chemicals, asbestos, and dust can pose significant health threats to workers. Electrical hazards, from improper wiring to the use of faulty equipment, also present a substantial risk. Furthermore, construction

sites are susceptible to fires and explosions due to the presence of flammable materials and gases. To mitigate these dangers, comprehensive safety measures must be implemented, including thorough training, appropriate personal protective equipment, regular equipment inspections, and adherence to strict safety protocols.

Following are the types of main hazards which were identified via different operations:

1. Scaffold,
2. Power access equipment,
3. Ladder
4. Roof work,
5. Manual handling,
6. Plant and machinery,
7. Excavation,
8. Fire and emergency,
9. Hazardous substances,
10. Noise
11. Protective clothing
12. And protecting the public
13. Design hazards
14. Hazards due to the use of unqualified persons.
15. Hazards due to use of construction materials
16. Hazards due to Falls
17. Hazards due to Equipment
18. Hazards due to construction methods
19. Electrical hazards

3.1.1 TYPES OF HAZARDS INVOLVED IN MASONRY WORK

1. **Hazardous substances** - Cement, Lime and mortar mixing, chemical grouts and additives.
2. **Collapse** - caused by unsupported construction, overloaded elements, movement joints, storage and stacking of irregular units, horizontal chases etc.
3. **Handling hazards** - Caused by the weight, shape, transportation of units, handling at height, insufficient working space etc.
4. **Cuts and abrasions** - Caused by masonry texture, wall ties, insulation such as glass fiber etc. The cutting or chasing of stonework.

Some Control Measures

1. Plan to minimize manual handling.
2. Ensure provision of adequate personal protective clothing and equipment including weather protection.
3. Where possible use blocks of less than 20 Kg to allow ease of manual handling.
4. Ensure adequate storage, working and handling space.
5. Plan for the cutting and chasing of stonework off-site under controlled condition.

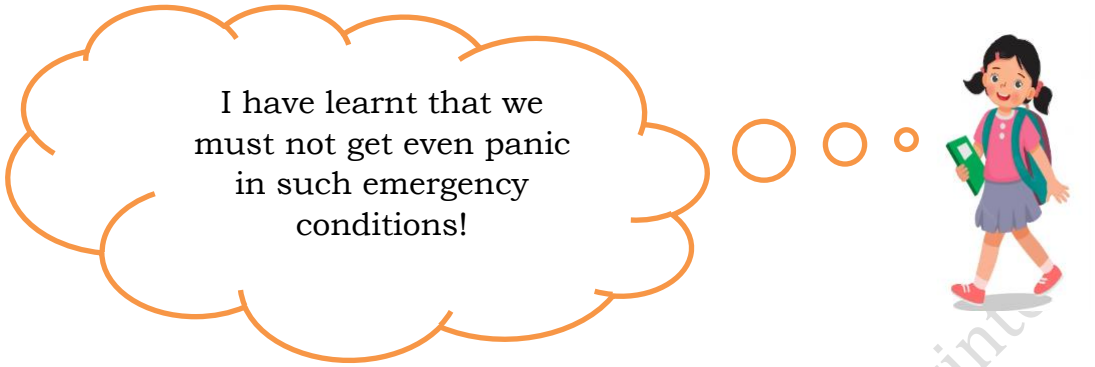
3.2 EMERGENCY SAFETY CONTROL MEASURES

Emergency safety control measures at construction sites are paramount to swiftly address unforeseen incidents and safeguard the well-being of workers and the surrounding environment. Adequate planning and preparation involve establishing clear evacuation routes and assembly points, ensuring that all workers are familiar with these procedures. Accessible and well-maintained first aid kits, fire extinguishers, and emergency contact information must be readily available throughout the site.

3.2.1 Actions to be taken under emergency situation

During emergency situations in a construction site hazard, it's crucial to have a well-defined plan and clear actions to ensure the safety of workers and minimize damage. Here are the key actions to be taken:

1. **Alert and Communicate:** Sound the site's emergency alarm to alert all personnel immediately. Establish a clear communication system, including radios, whistles, or megaphones, to relay instructions effectively.
2. **Evacuation:** Activate the evacuation plan. Designate safe assembly points away from the hazard where workers can gather. Ensure everyone is aware of the evacuation routes and assembly points through regular drills and training.
3. **First Aid:** If there are injuries, provide first aid promptly. Designate trained first aid responders who can assess the situation, administer basic medical aid, and call for professional medical assistance if needed.



4. **Fire Management:** If the emergency involves fire, use available fire extinguishers to control small fires. If the fire is uncontrollable, evacuate the area immediately and call the fire department.
5. **Hazard Containment:** If there's a hazardous material spill, establish a perimeter to prevent its spread. Trained personnel with proper protective gear should handle containment and cleanup. Inform relevant authorities about the spill.
6. **Shut down Equipment:** In cases where equipment poses a risk, shut down machines, tools, and electrical systems to prevent further hazards.
7. **Account for Personnel:** Ensure a reliable system is in place to account for all workers after evacuation. Designate a person responsible for checking off names and confirming that everyone is safe.
8. **Emergency Services:** Contact local emergency services, such as fire departments, paramedics, and law enforcement, depending on the nature of the emergency.
9. **Inform Management:** Notify management and project leaders about the situation, the actions taken, and the current status. They can coordinate with emergency services and make decisions about site operations.
10. **Investigation and Assessment:** After the situation is under control, conduct a thorough investigation to determine the cause of the emergency. Assess any damage to property and infrastructure and identify lessons learned for future prevention.
11. **Communication with Stakeholders:** Keep stakeholders, including workers, clients, and regulatory bodies, informed about the situation, the actions taken, and any ongoing impact on the project timeline.
12. **Review and Improve:** Use the incident as an opportunity to review the emergency response plan and identify areas for improvement. Adjust the plan and conduct additional training if necessary.

By having a well-structured emergency response plan, regularly training personnel, and fostering a culture of safety awareness, construction sites can minimize the impact of emergencies and prioritize the safety and well-being of all individuals involved.

3.3 FIRST AID PROCESS

To ensure that an injured or ill worker receives appropriate and timely first aid treatment, an employer should have a written first aid procedure as part of their Health and Safety Program. The procedure should cover

- Mandatory reporting and recording requirements
- Provision of first aid kits
- Availability of trained first aid providers and training recertification
- Transportation to medical treatment
- Document posting requirements.

Providing proper first aid to a brick mason who sustains an injury on a construction site is essential for their immediate well-being. Here's a general outline of the first aid process:

1. Assess the Situation: Ensure your own safety before approaching the injured brick mason. Assess the situation to determine the nature and severity of the injury. If there is an ongoing hazard, such as a collapsing structure, make sure the area is safe before proceeding.

2. Call for Help: If the injury is serious, call for professional medical assistance immediately. Dial emergency services or follow the site's established procedure for summoning medical help.

3. Provide Comfort and Reassurance: Approach the injured brick mason calmly and reassure them that help is on the way. Keep them as calm and still as possible to prevent further injury.

4. Control Bleeding: If there is bleeding, apply direct pressure using a clean cloth or sterile dressing. Elevate the injured area if possible, as it can help reduce bleeding. Do not remove any objects that are embedded in the wound, as they might be controlling bleeding.

5. Immobilize Fractures or Injuries: If you suspect a bone fracture or serious injury, avoid moving the injured area. Immobilize it using splints or materials like boards, rolled-up newspapers, or clothing to prevent further movement and pain.

6. Treat Shock: In the case of shock (pale, cold, clammy skin; rapid breathing; weak pulse), lay the person down, keep them warm, and elevate their legs slightly unless there are suspected spinal injuries.

7. Provide Pain Relief: If over-the-counter pain relievers are available and appropriate, administer them to help manage pain. Ensure you follow dosage instructions.

8. Monitor Vital Signs: Keep an eye on the injured person's breathing, pulse, and consciousness level. If any of these vital signs deteriorate, be prepared to provide CPR or other necessary interventions.

9. Keep Records: If possible, document the details of the incident, including the time, nature of the injury, and actions taken. This information may be valuable for later reporting and investigation.

10. Stay with the Injured Person: Do not leave the injured brick mason alone until professional medical help arrives. Offer emotional support and keep them comfortable.

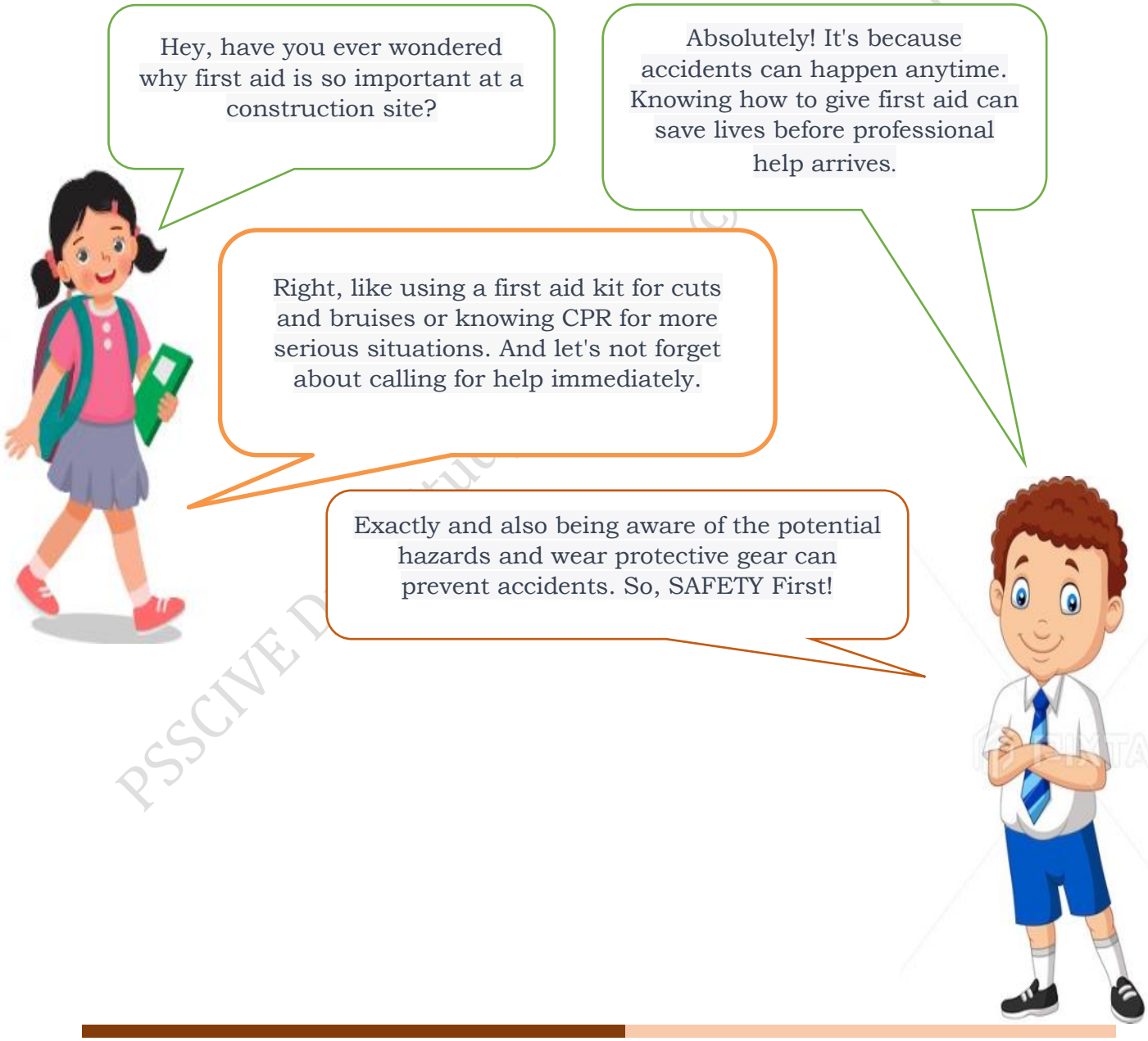


Fig 3.2 First Aid Readiness

3.4USE OF FIRE EXTINGUISHER

FIRE is a big hazard at construction site, it kills and injuries people, destroys property and may seriously disrupt production and the construction process. Practical steps can be taken to prevent and minimize the risk of fire in the site.

Fig 3.3 Use of Fire Extinguisher

3.4.1 Classification of fires and fire extinguisher

Fires are classified based on the type of materials that are burning and the most effective method for extinguishing them. The most commonly used classification system is based on the "fire triangle," which includes three elements necessary for a fire: fuel, oxygen, and heat. The classification of fire is denoted by a letter (A, B, C, D, or K), with each letter corresponding to a specific type of fuel. Here's a breakdown of the fire classifications:

Class A Fire: These fires involve ordinary combustibles like wood, paper, cloth, rubber, and some plastics. The primary method to extinguish Class A fires is by cooling the material and removing the heat source. Water, foam, and dry chemical extinguishers are commonly used.

Class B Fire: Class B fires involve flammable liquids and gases such as gasoline, oil, alcohol, propane, and natural gas. The aim is to smother the fire and prevent the release of flammable vapors. Foam, dry chemical, and carbon dioxide extinguishers are often used.

Class C Fire: Class C fires involve electrical equipment like wiring, outlets, and appliances. The main concern is to de-energize the equipment to cut off the electrical source, followed by using a non-conductive extinguishing agent like carbon dioxide or dry chemical.

Class D Fire: Class D fires involve combustible metals like magnesium, sodium, titanium, and potassium. Specialized dry powder extinguishing agents are designed for these types of fires. Water and ordinary fire extinguishers should not be used on Class D fires, as they can exacerbate the reaction.

Class K Fire: Class K fires involve cooking oils and fats, typically in commercial kitchens. The unique properties of these fires require special extinguishing agents designed to cool, saponify (convert to soap), and smother the flames.

It's important to note that some fires can involve a combination of these classes, and the appropriate fire extinguisher or firefighting method should be chosen based on the specific circumstances and materials involved.

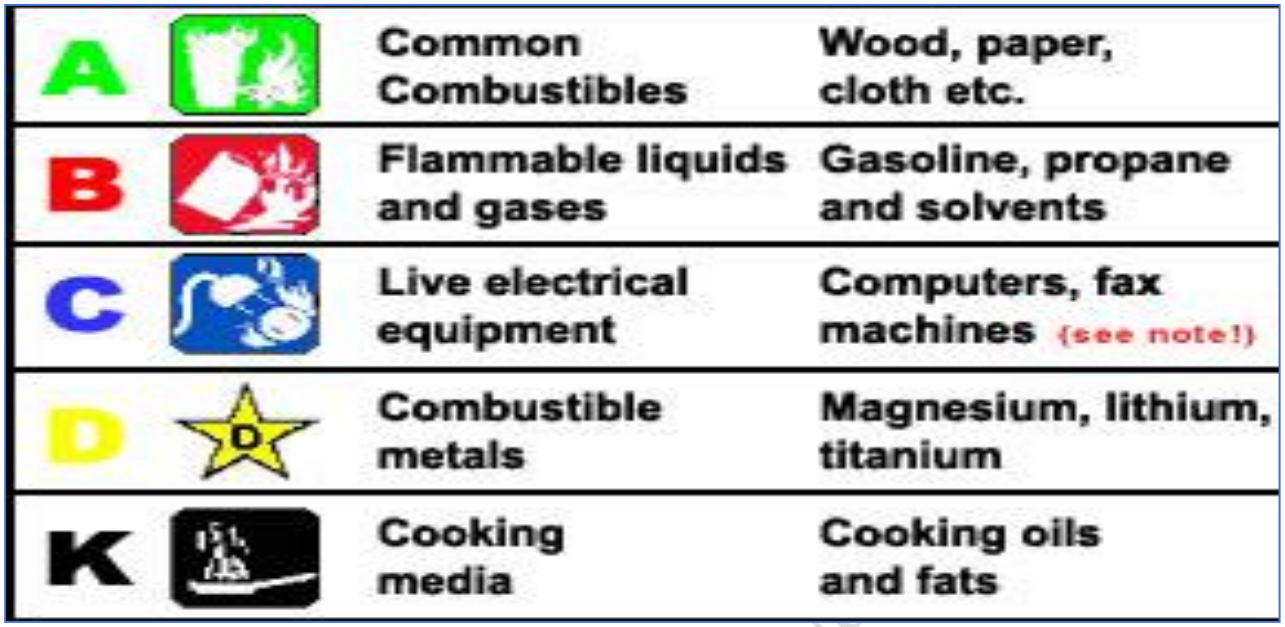


Fig 3.4 Types of fire

3.4.2 Classification of fire extinguisher

Fire extinguishers are categorized based on the types of fires they are designed to combat. The classification of fire extinguishers corresponds to the classes of fires they are effective against. Here's a breakdown of the classification of fire extinguishers:

Class A Fire Extinguisher: These extinguishers are suitable for Class A fires involving ordinary combustibles like wood, paper, cloth, rubber, and plastics. They typically contain water or foam as their extinguishing agent, which cools and suppresses the fire by removing heat.

Class B Fire Extinguisher: Designed for Class B fires involving flammable liquids and gases, these extinguishers use agents that smother the fire and prevent vapor release. They often contain dry chemical, foam, or carbon dioxide.

Class C Fire Extinguisher: Class C fire extinguishers are effective against electrical fires. They contain non-conductive agents that do not conduct electricity and are designed to de-energize the equipment while suppressing the fire. Carbon dioxide and dry chemical are commonly used.

Class D Fire Extinguisher: These extinguishers are intended for Class D fires involving combustible metals. The agents are specialized powders that create a barrier between the fuel and oxygen, preventing the reaction. They are specific to the type of metal involved in the fire.

Class K Fire Extinguisher: Class K fire extinguishers are suitable for fires involving cooking oils and fats, commonly found in commercial kitchens. They contain agents that cool the fire and create a soapy foam to smother the flames, preventing re-ignition.

Additionally, some fire extinguishers are multipurpose and labeled with multiple classes they can be used for. For instance:

ABC Fire Extinguisher: This type of extinguisher is effective against Class A, B, and C fires. It typically contains a dry chemical agent that can smother the fire and inhibit chemical reactions.
BC Fire Extinguisher: Designed for Class B and C fires, BC extinguishers also use dry chemical agents to suppress the flames and deactivate electrical equipment.

It's important to choose the appropriate fire extinguisher for the specific fire hazard present and to receive proper training on how to use extinguishers safely and effectively. Regular maintenance and inspections of fire extinguishers are also crucial to ensure they are in working condition when needed.

3.5 SAFETY DRILLS

Safety drills help your employees be prepared in case of emergency. A safety drill helps you practice your evacuation route for fires and other serious emergencies. The following are the different types of safety drills:

- **Chemical Spill Drill** – In the event that a hazardous chemical is spilled in your facility, everyone needs to know what to do. This type of drill needs to include both the responses of the general employees, and the responses of any emergency cleanup or containment crews.
- **Fire Drill** – Of course, fire drills are extremely important as this is one of the more common types of emergencies. Make sure everyone in the facility knows the best path out of the area, and where they should meet once they are outside.
- **Severe Weather –** If there is a tornado, hurricane or other strong storm you will need to make sure everyone knows to get to a location within the building that is safe. Like a fire drill, people need to know where to go and how to get there.
- **Toxic Fumes** – If toxic fumes, gasses or vapors escape their normal containment, people in the facility will need to know how to respond. Notifying the proper authorities is also important, and should be part of your drill.
- **Electrocution** – If someone is being electrocuted in the facility, people should know how to respond. Hitting the emergency power shutoff switch (if one exists)

and notifying paramedics. Making sure people know not to try to go in and rescue the individual is also important, as this could lead to additional victims.

3.6 USE OF PPE (PERSONAL PROTECTIVE EQUIPMENT)

PPE - Personal protective equipment is a safeguard against job hazards. When used as intended along with other preventative measures, PPE minimizes or eliminates risks to employees. Safety helmet & Safety shoes are Mandatory PPE. Following are the some important PPEs:

- Safety glasses / Face shields – Flying particles
- Hand Gloves – Protection from sharp objects and chemicals
- Ear muffs/ plugs – Protection against hearing loss
- Dust Mask / Escape Mask – Dust, Mist, Gas Hazards
- Harness – Protection from falling

Fig 3.5 Various Types of Personal protective equipment

3.7 REPORTING PROCEDURE TO THE CONCERN AUTHORITY IN EMERGENCY SITUATIONS

In Emergency situations / incidents / unhappening's like Accidents happened on site, following reporting procedure to Site In charge / Higher Authority (H.O.) should be followed:

- **In case of Accident:**

1) In above emergency situations, Mason should report to Site In charge immediately.
2) The information includes place, type of injuries, the cause of incident occurred.
3) First Aid box / kit should be made available, given to the victim of accident until the treatment of doctor can made available.
4) Follow the instructions given by Site In charge.

- **In case of theft:**

1) In case of theft, immediately reporting done to the Site In charge and Higher Authority regarding the type of theft, materials or machinery missing from site.

3.8 STANDARD PROCEDURE OF HANDLING, STORING AND STACKING OF MATERIAL

Following points define the standard procedure of handling, storing and stacking of materials:

1) Preliminary inquiry is done with detail inspection by Storekeeper and then by Engineer.
2) This information given to Project Engineer and allow the vehicle inside the project with watchmen's entry notebook.
3) Unloading of material at required place and also measurement checking for truck and material.
4) Preparation of challenge and corrections.
5) After that one Challen with Storekeeper and preparation of exit Gate pass to truck driver.
6) Watchman's noting with stamp and exit time / receipt of Gate Pass.
7) Then vehicle is allowed to go out.

3.8.1 Storing and stacking procedure of materials

Following are the precautions to be taken while storing different building materials as given below:

1. **Cement:**

- It should be stored on raised platform about 15 cm above Ground level.
- Flooring should be damp proof.
- Ventilator should be as minimum as possible in size and numbers.
- Water should not seep into the store through doors and windows.
- Max. 10 bags should be stored in each stack.

2. **Sand / metal / dust / grit**

- All these materials should be stacked separately.

- Avoid excess lead by unloading the truck at a minimum distance from the work place.
- Dust and grit should be unloaded near the block making machine.
- A base surface of flooring or P.C.C. bed of 7.5 cm laid in leveled surface should be prepared to avoid any possible direct contact of materials with the soil.

3. Bricks

- While unloading the truck, bricks should not be thrown.
- They should be stacked systematically, for easy use and counting.
- They should be unloaded on fairly leveled ground.
- Stacking arrangements should be as to prevent it from collapsing.
- The stacking place should be located so that the debris / scrap thrown from the building does not fall on the bricks below.

4. Tiles

- Store room should be free from dampness.
- Floor should be in level.
- Stacking should be done lot-wise, quality-wise, colour-wise & size-wise.
- It should be stored under locking arrangements.
- This procedure followed same like stone materials such as marble, granite etc.

ACTIVITIES

Activity 1: Demonstrate the importance of using personal protective equipment (PPE)

Materials Required:

1. Various types of PPE (hard hats, safety goggles, gloves, ear protection, safety vests, respiratory masks)
2. Notebook
3. Pen

Procedure:

1. Make a list of different PPE available to you.
2. Demonstrate to your fellows the use of each equipment separately.
3. Make of list of all the equipment's along with its usage.

CHECK YOUR KNOWLEDGE

I. Answer the following:

1. Enlist the types of hazards involved in construction sites?
2. What are the emergency safety control measures & actions to be taken under emergency situation?
3. Give the standard procedure for storing of following at the site :
   (i) Cement
   (ii) Bricks
   (iii) Tiles
4. Write down the reporting procedure in case of an accident.
5. What do you mean by safety drills? Explain few.

II. Fill in the blanks:

1. Fire has been classified into …… types.
2. Class D fire involves ……like magnesium, sodium, titanium and potassium.
3. Class…….. Fire extinguishers are effective against electrical pipes.
4. Maximum…….. bags of cement should be stored in each stack.
5. While using a fire extinguisher, PASS phenomenon is used, where P stands for…… the pin in the handle.

ANSWER KEY

Unit 1: Random Rubble Masonry

II. Fill in the blanks

1.Trowel
2. Bolster
3. Dry
4. Sandstone
5. Pointing

III. Multiple Choice Questions

1. (i)
2. (i)
3. (ii)
4. (iv)
5. (iii)

Unit 2: IPS & Tremix Flooring

II. Fill in the blanks

1.Patent
2. Vacuum Dewatered
3. Floater
4. Double
5. 100 mm

III.Multiple Choice Questions

1. (i)
2. (ii)
3. (iv)
4. (iii)
5. (iii)

Unit 3: Environment Health and Safety

II. Fill in the blanks

1. 5 (Five)
2. Combustible Metals
3. C
4. 10 (ten)
5. Pull

GLOSSARY

Abutment: a structure built to support the lateral pressure of an arch or span.

Ashlar: masonry made of large square-cut stones, used as a facing on walls of brick or stone rubble. Break water: refers to a wall built out into the sea to protect the shoreor harbour from the force of waves.

Brick bat: refers to the broken pieces of bricks. Brick bats: is defined as the cut portion of a brick Bridge piers: refers to structures used for supporting a bridge, embedded into the ground surface or into water under the bridge.

Ballast: is a material that is used to provide stability to a structure.

Bed: is the mortar upon which a brick is laid.

Cleated: a strip of wood or iron used to strengthen or support the surface to which itis attached.

Gneiss: is a metamorphic rock with a banded or foliated structure, typically coarse-grained and consisting mainly of feldspar, quartz, and mica.

Plinth: base course of a building Pier: is a solid support designed to sustain verticalpressure.

Ponding: refers to the act of pooling of unwanted water on a flat roof or road. **Sandstone**: is a stone that is formed of grains of sand tightly pressed together, usedin building construction.

Trowel: is a small tool with a flat blade used in building construction for spreading cement or plaster