# POSTAL Book Package 2021

# CIVIL ENGINEERING

## Construction Materials

**Conventional Practice Sets**

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# 2 CHAPTER

# Lime and Mortar

**Q.1** What are the properties of a good mortar? Enumerate four main uses of mortar.

**Solution:**

The properties of a good mortar are:

(i) The most important properties of a good mortar are mobility, placeability and water retention.

(ii) It should be capable of developing good adhesion with the building units such as bricks, stones, etc.

(iii) It should be capable of developing the designed stresses.

(iv) It should be cheap.

(v) It should be durable.

(vi) It should be easily workable.

(vii) It should not affect the durability of materials with which it comes into contact.

(viii) It should set quickly so that speed in construction may be achieved.

(ix) The joints formed by mortar should not develop cracks and they should be able to maintain their appearance for a sufficiently long period.

Four main uses of mortar are:

(i) Cement mortar is used for damp-proof course below the ground level, exposed work such as exterior free standing walls and parapets.

(ii) Cement mortar is also used for pointing purpose in the joints of masonry, for plastering the surface of masonry to protect it from weather and to provide a pleasing and smooth finish.

(iii) Lime mortar is used in masonry to bind stones, bricks or concrete blocks together. It is suitable for masonry and plastering in cheap and light load bearing wall construction.

(iv) Gauged mortar is used for bedding and for thick brick walls.

**Q.2** Discuss the types of mortar which can be used for the following types of masonry work with suggested proportions :

(i) Masonry in foundation and plinth

(ii) Masonry in superstructure

(iii) Plastering work

(iv) Pointing

**Solution:**

(i) **Masonry in foundation and plinth:** A mortar in the ratio of 1 : 6 that means 1 part of cement and 6 parts of sand is considered of medium quality and strength and is considered suitable for heavy walls and foundation of heavy or multi-storey building.

(ii) **Masonary in super structure:** For lightly loaded above ground parts of building lime mortar can be used. It has high plasticity possesses good cohesiveness with other surfaces and shrinks very little.

For construction of multi-storey buildings, building pillars, heavy or load effective walls, boundary wall and other walls that require high strength, cement sand mortar in the ratio of 1 : 4 is used. For temporary structures, light walls and single storey construction etc. cement sand mortar in the proportion of 1 : 7 may be used.

(iii) The mortar used for **plastering work** are:

1. **Lime mortar:** Lime used for plastering may be either fat lime or hydraulic lime. The mix proportion (i.e., lime : sand) varies from 1 : 3 to 1 : 4 for fat lime and 1 : 2 for hydraulic or kankar lime.
2. **Cement mortar:** Cement mortar is the best mortar for external plastering work since it is practically non-absorbant. The mix proportion (i.e., cement : sand) may vary from 1 : 4 to 1 : 6. Sand used for plastering should be clean, coarse and angular.
3. **Lime-cement mortar:** Lime-cement mortar contains properties of both the lime mortar as well as cement mortar. Mix proportions generally used are 1 : 1 : 6 (cement : lime : sand), 1 : 1 : 8 or 1 : 2 : 8. Generally, fat lime is used.

(iv) **Pointing:** Pointing is done with the following mortar mixes:

1. Lime mortar 1 : 2 mix (1 lime : 2 sand or surkhi).
2. Cement mortar 1 : 3 mix (1 cement : 3 sand).

**Q3** **Explain with reasons the defects in Plastering.**

**Solution:**

The following defects may appear in plastering :

- **Unevenness :** This defect is purely due to poor workmanship.
- **Rust strains :** This type of defect may be seen on the plaster applied on metal laths
- **Efflorescence :** It is the appearance of whitish crystalline substance on the surface of wall. It is due to unburnt salt present in lime, cement, sand, brick and salt in water. When the wall dries, the soluble salts are drawn to the surface. They get deposited in patches in the form of while crystalline patches. The patches disappear in wet weather and reappear when the weather is dry.
- **Blistering :** Swellings in the form of small patches of plastered surface is known as blistering. This defect is due to late slaking of lime particles in the plaster.
- **Cracking :** It can result from following reasons:
  (a)Imperfect preparation of background
  (b)Movement in the background due to thermal expansion or rapid drying.
  (c)Excessive shrinkage due to application of thick coat, etc.
- **Flaking :** It is the formation of very loose mass of plastered surface, due to poor bond between successive coats.
- **Peeling :** It is the complete dislocation of some portion of plastered surface. It results from imperfect bond.
- **Popping :** It is the formation of conical hole in the plastered surface due to presence of some particles which expand on setting.

**Q4** **What are different types of lime? Give their composition, source of manufacture, characteristics and uses.**

**Solution:**

According to percentage of calcium oxide and clayey impurities in it, lime can be classified as lean, hydraulic and fatlime.

1. **Lean or Poor lime:** It consists of CaO + MgO < 70% with MgO less than 5% and clayey impurities of more than 30% in the form of silica, alumina and iron-oxide. It sets on absorbing $CO_2$ from atmosphere.

   **Characteristics:**

   1. Slaking requires more time and so it hydrates slowly. Its expansion is less than that of fatlime.
   2. It makes thin paste with water.
   3. Setting and hardening is very slow.
   4. The colour varies from yellow to grey.

   **Uses:** It gives poor and inferior mortar and is recommended for less important structure.

2. **Hydraulic lime:** It is a product obtained by moderate burning (900°-1100°c) of raw limestone which contains small proportions of clay (silica and alumina) 5-30% and iron oxide in chemical combination with calcium oxide content (CaO + MgO 70-80%) with MgO less than 5%. Depending upon percentage of clay, hydraulic lime is classified as:

| Feebly Hydraulic Lime | Moderately Hydraulic Lime | Eminently Hydraulic Lime |
|---|---|---|
| • < 5-10% of silica and alumina<br>• Slaking time 5-15 min.<br>• Setting time 21 days<br>• Used in damp places | • <10-20% clay,<br>• Slaking time 1-2 hours<br>• Setting time 7 days<br>• Used in damp places and for superior type of masonry work | • 20-30% content,<br>• Initial setting time – 2 hours<br>• Slakes with difficulty<br>• Used in damp places and oil structural purposes |

3. **Pure, Rich or Fat lime:** It is a soft lime (CaO + MgO more than 85% with MgO less than 4%) obtained by calcination of nearly pure limestone, marble, chalk powder and oolitic limestone. Also while washing lime it should not have impurities of clay and stone more than 5%. Fat lime is nearly pure calcium oxide and when it is hydrated with the required amount of water the solid lumps fall to a soft fine powder of $Ca(OH)_2$ and high heat of hydration produces a cloud of steam.

   **Characteristics:**
   1. Slaking is vigorous and the volume becomes 2-3 times.
   2. It sets slowly in contact with air and hence not suitable for thick walls or in wet climate.
   3. Specific gravity of pure lime is about 3.4.
   4. If kept under water, fat lime waste does not lose its plasticity and consequently does not set and hard.

   **Uses:** Fat lime finds extensive use in making mortar, matrix for concrete, base for distemper and in whitewash, manufacturing of cement and metallurgical industry.

**Q.5** **Describe the various stages in the making of cement mortar. Why cement mortar is not ground like lime mortar?**

**Solution:**

**Cement mortar is prepared in the following way:**

(i) First clean dry sand is spread in a uniform layer on a watertight platform. On it the requisite quantity of cement is uniformly spread. Then the whole mass is mixed dry by working with spades till the whole mass becomes uniform in colour.

(ii) Then a depression is made in the middle of the mass and the required quantity of water is added. Dry material from sides is placed on the edge of the depression containing water. It is done gradually till the water is completely absorbed by the dry mass. Care is taken not to let the water breach the banks and flow out. The wet mass of mortar is then worked with spades to have a mortar of uniform consistency.

(iii) When mortar is required in large quantity, it is prepared by mixing in mechanical mixers. Normally a pan mixer is used for mixing the mortar. The mixer consists of a cylindrical container in which a rotor with blades rotate for turning the material for mixing. The rotor is rotated mechanically by an electric motor or a power engine. Sand, cement and water are added to the mixer and mixed for sometime till the mixture has a uniform consistency. The mixed mortar is then poured out for use.

Lime mortars are ground unlike cement mortars in order:

(i) To crush the particles of unslaked lime, if any, so as to ensure slaking.

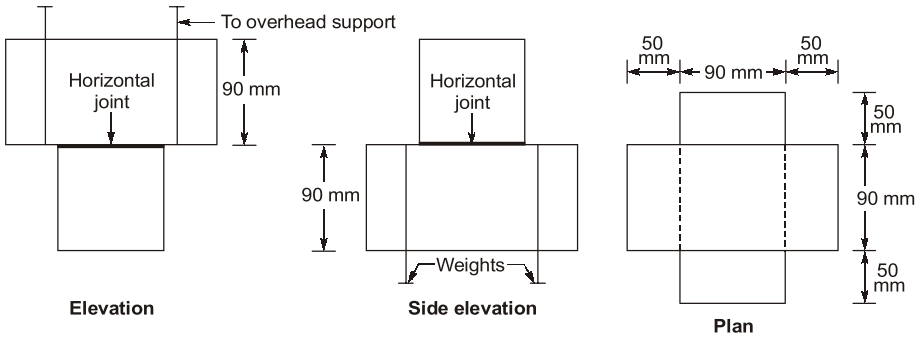
(ii) To make an intimate mixture of the whole mass so that no two grains of sand are without an intervening film of the binding material.

**Q.6** Describe the different types of tests for mortars.

**Solution:**

Following are the usual tests for mortar:

1. **Adhesiveness to building units:** Following procedure is adopted to carry out this test:
   (i) The two bricks are placed at right angles to each other as shown in figure.
   (ii) The mortar is placed to join them so as to form a horizontal joint. If the size of brick is 190 mm × 90 mm × 90 mm, a horizontal joint of 90 mm × 90 mm = 8100 $mm^2$ will be formed.
   (iii) The upper brick is suspended from an overhead support and the weights are attached to the lower brick.
   (iv) The weights are gradually increased till separation of bricks occurs.
   (v) The ultimate adhesive strength of mortar per $mm^2$ area is obtained by dividing maximum load with contact area i.e. 8100 $mm^2$.




**Test for adhesiveness**

2. **Crushing strength:** For this test, the brickwork is carried out with mortar to be tested. A sample of this brickwork is taken and it is gradually loaded in a compression testing machine till failure occurs due to crushing. The ultimate crushing strength is obtained by dividing maximum load with cross-sectional area.
3. **Tensile strength:** For this test, the mortar to be tested is placed in the briquette mould as shown in figure. The briquettes are then tested in a tension testing machine. The cross-sectional area of central portion is 38 mm × 38 mm or 1444 $mm^2$. The ultimate tensile stress per $mm^2$ is obtained by dividing failing load with cross sectional area of 1444 $mm^2$.

**Q.7** While listing, discuss the mortar classification.

**Solution:**

The mortars are classified into the following five categories:

1. Lime Mortar:
   - In this type of mortar, the lime is used as a binding material.
   - The lime may be fat lime or hydraulic lime
   - The fat lime shrinks to a great extent and hence it requires 2 to 3 times its volume of sand. The lime should be slaked before use.
   - It is generally used for lightly loaded above-ground parts of buildings.
2. Surkhi Mortar:
   - It is prepared by using fully surkhi instead of sand or by replacing half of sand in case of fat lime mortar.
   - The powder of surkhi should be fine enough to pass BIS No. 9 sieve and the residue should not be more than 10% by weight.
   - It is used for ordinary masonry work of all kinds in foundation and superstructure.
   - It cannot be used for plastering or pointing.