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UNIT 1

FUNDAMENTALS OF BUILDING MATERIALS

IV- SAND

Sand plays an important part as an engineering material. Sand can be divided into three main classes depending upon the source from which it is obtained. These are:

1. River sand
2. Sea sand
3. Pit sand

1.River sand: It is obtained from the bed and banks of rivers. It is considered to be the best sand for important works. It is white in colour having round, clean and sharp particles.

2. Sea sand: It is brownish in colour and obtained from sea-shores. It is also clean having rounded particles. Sea sand cannot be used in civil engineering works for the following reasons:

1. It contains salts and hence structure will remain damp. The mortar is affected by efflorescence and blisters appear.
2. It contains shells and other organic matter, which decompose after some time, reducing the life of the mortar.
3. Sea sand retards the setting of cement and has a considerable effect on the strength of mortar or concrete.

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3. Pit sand: It is obtained by digging pits in the soil. The pit sand usually occurs 1 to 2m below the ground level. Clean pit sand forms an excellent material for mortars and concrete.

Sand may be obtained artificially by crushing hard stones. Usually artificial sand is obtained as a by-product while crushing stones to get jelly (coarse aggregate).

The properties of good sand are:

1. It should be chemically inert.
2. It should be free from organic or vegetable matter.
3. It should be free from salt.
4. It should contain sharp, angular and coarse grains.
5. It should be well graded.
6. It should be hard.

Sand is used in mortar and concrete for the following purpose:

1. It sub-divides the paste of binding material into thin films and allows it to adhere and spread.
2. It fills up the gap between the building blocks and spreads the binding material.
3. It adds to the density of the mortar.
4. It prevents the shrinkage of the cementing material.
5. It allows carbon dioxide from the atmosphere to reach some depth and thereby improve setting power.
6. The cost of cementing material per unit volume is reduced as this low cost material increases the volume of mortar.
7. Silica of sand contributes to formation of silicates resulting into the hardened mass.

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Bulking of sand The increase in the volume of sand due to increase in moisture content is known as *bulking of sand*. A film of water is created around the sand particles which forces the particles to get a side from each other and thus the volume is increased. The increase in moisture in sand increases the volume of sand. Bulking of sand depends on the quantity of moisture in the sand and also the size of the particles. Five to eight percent of the increase in moisture in the sand can increase the volume of sand up to 20 to 40 percent. Bulking of sand is more in finer sand than with coarser sand.

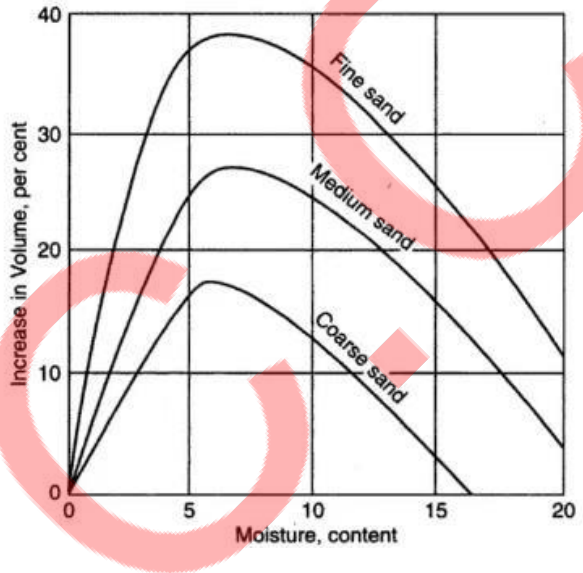

Fig 1: Bulking of sand

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Fineness of sand: Fineness is defined as the sum of the cumulative percentages of material retained on the I.S standard sieves (4.80mm, 2.40mm, 1.20mm,600 micron, 300micron and 150 micron. All these sieves are placed one above the other in the same order. The sieves are shaken on an electric sieve shaker for 15 minutes and the percentage material retained is carefully weighed and cumulatively added. Total of cumulative percentages retained is divided by 100 to get the fineness modulus. **The fineness modulus of fine sand is 2.0-2.60, of medium sand is 2.61-2.90 and coarse sand is 2.91-3.50**.

MORTAR

1. Cement Mortar

For preparing mortar, first a mixture of cement and sand is made thoroughly mixing them in dry condition. Water is gradually added and mixed with shovels.

Curing: Cement gains the strength gradually with hydration. Hence it is necessary to see that mortar is wet till hydration has taken place. The process to ensure sufficient moisture for hydration after laying mortar/concrete is called curing. Curing is ensured by spraying water. Curing normally starts 6–24 hours after mortar is used. It may be noted that in the initial period water requirement is more for hydration and gradually it reduces. Curing is recommended for 28 days.

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Properties of Cement Mortar:

The following are the important properties of cement mortar:

1. When water is added to the dry mixture of cement and sand, hydration of cement starts and it binds sand particles and also the surrounding surfaces of masonry and concrete.
2. A mix richer than 1:3 is prone to shrinkage.
3. Well proportioned mortar provides impervious surface.
4. Leaner mix is not capable of closing the voids in sand and hence the plastered surface is porous.
5. The strength of mortar depends upon the proportion of cement and sand.

Uses of Cement Mortar

Mortar is used
1. to bind masonry units like stone, bricks, cement blocks.
2. to plaster slab and walls make them impervious.
3. to give neat finishing to walls and concrete works.
4. for pointing masonry joints.
5. for preparing building blocks.
6. as a filler material in ferro cement works.
7. to fill joints and cracks in walls.
8. as a filler material in stone masonry.

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Lime Mortar

Fat lime and hydraulic limes are used for making lime mortar. If fat lime is used sand mixed is normally 2 to 3 times its volume. If hydraulic lime is used sand mixed is only 2 times the volume of lime. Lime is prepared by pounding, if quantity required is small or by grinding, if the required quantity is more.

Pounding: For pounding pits are formed in hard grounds. The size of pit is usually 1.80 m long, 0.4 m wide and 0.5 m deep. It is provided with lining of bricks or stones. Lime and sand dry mixed with required proportion is placed in the pit. Small quantity of water is added at intervals. In each interval the mix is pounded with wooden pounders and mortar is turned up and down. The process is continued till uniform colour and desired consistency is achieved.

Grinding: This is the better way of getting good mix. The grinding may be carried out in bullock driven grinding mill or in power driven grinding mill. It consists of a circular trench of radius 3 to 4.5 m, 0.3 m wide and 0.4 m deep. A wooden shaft pivoted at centre carries a stone wheel of width just 50 mm to 100 mm less than that of trench. Bullock drive this wheel in the trench for grinding mortar. The dry mix is placed in the trench. Water is added gradually and bullock driven stone wheels grind the mix. A worker turns the mix up and down regularly. This method of preparing mortar needs 6 hours and can produce about 1.7 m^3 of mortar. Two rollers rotate in a pan of diameter 1.8 to 2.4 m. Either pan or roller is rotated with the help of oil engine or electric power. During mixing required quantity of water is added gradually.

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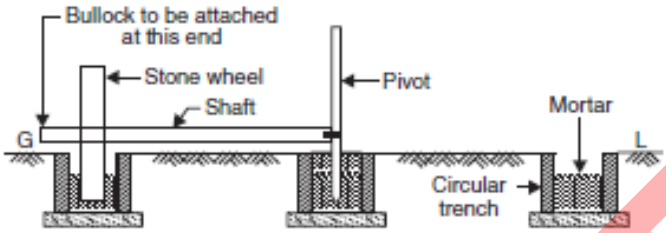

Figure 1: Bullock driven grinding mill

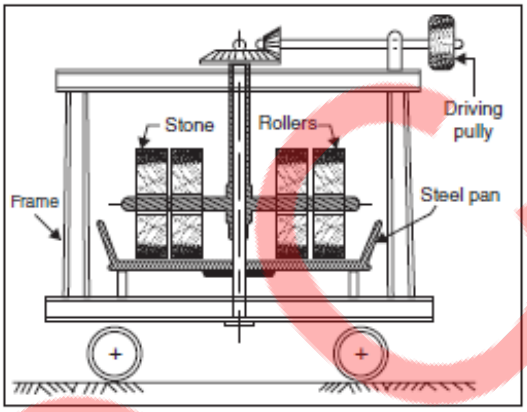

Figure 2: Power driven grinding mill

Lime mortar is also having good grinding property. Fat lime mortar is used for plastering while hydraulic lime mortar is used for masonry construction. This mortar was considered cheap in olden days and was commonly used in small towns. However the cumbersome process of preparation and ease in availability of cement in market has almost replaced the use of lime mortar.

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Mud Mortar

Clay lumps are collected and are wetted with water and allowed to mature for 1 or 2 days. It is kneaded well until it attains required consistency. Sometimes fibrous materials are added in the mix. It prevents cracks in the plaster. If plaster is to be used for outer walls, it is sprayed or painted with bitumen. It is cheap mortar. Its durability is less. It is normally used for the construction of temporary sheds and cheap houses in rural areas.

The following are some of the special mortars:
1. Cement clay mortar
2. Gauged mortar
3. Decorative mortar.

1. Cement Clay Mortar: Quality of clay mortar can be improved by adding cement to the mix. Normal proportion of clay to cement is 1:1. It maintains the economy to some extent and there is sufficient improvements in the durability of mud-mortar.

2. Gauged Mortar: It is the mortar obtained by adding cement to lime mortar. The usual proportion of cement, lime and sand are 1:1:6, 1:2:9 and 1:3:12. This mortar is to be used within half an hour after mixing cement. Obviously, it is cheaper than cement mortar and its quality is between that of cement mortar and lime mortar.

3. Decorative Mortar: These mortars are obtained by using coloured cement. They are used to give pleasant appearance to outer walls.

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TESTS ON MORTAR

The following tests are conducted on the prepared mortars to ensure their quality:
1. Crushing Test
2. Tensile Strength Test
3. Adhesive Test.

1. **Crushing Test:** This test is carried out on a brick work with the mortar. This brick work is crushed in a compression testing machine and the load is noted down. Then the crushing strength is obtained as load divided by cross-sectional area.
2. **Tensile Strength Test:** The mortar prepared is placed in a mould of briquette which has central cross-sectional area as 38 mm × 38 mm. After curing the briquette is pulled under the grips of tensile testing machine. The ultimate load noted. Then the tensile strength of mortar is load divided by the central cross-sectional area.

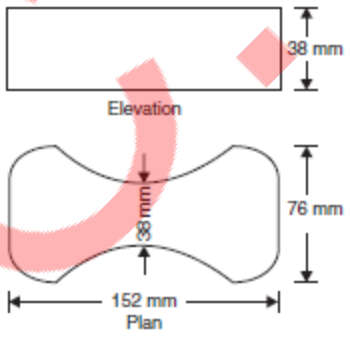

Fig 3: Briquette for tensile test

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3. Adhesive Test: Two bricks are joined together with mortar to be tested . The upper brick is suspended from an overhead support. A board is hung from the lower brick. Then weights are added to the board till the bricks separate. The adhesive strength is the load divided by area of contact.

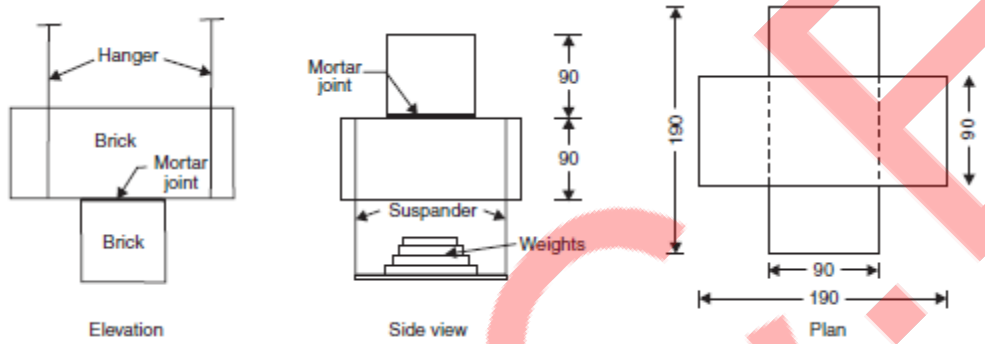

Fig 4: Adhesiveness test arrangement

Plastics

Plastic may be defined as a natural or synthetic organic material which are having the property of being plastic at some stage of their manufacture when they can be moulded to required size and shape. Shellac and bitumen are the natural resins used as plastic for a long time. These materials are mainly carbon compounds.

Types of plastics

1. *Thermosetting Plastics*: It needs momentary heated condition and great pressure during shaping. When heated cross linkage is established between the molecules and chemical reaction takes place. During this stage shape can be changed with pressure. This change is not reversible. The scrap of such plastic is not reusable. Bakelite is an example of such plastic.

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2. Thermoplastic: In this variety, the linkage between the molecules is very loose. They can be softened by heating repeatedly. This property helps for reuse of waste plastic. These plastics need time to cool down and harden. These plastics are to be kept in moulds till cooling takes place completely. Bitumen, cellulose and shellac are the examples of this variety of plastics.

Properties of Plastics

1. *Colour:* Some plastics are completely transparent. Using pigments the plastics of any attractive colour can be produced.
2. *Dimensional Stability:* It is dimensionally stable to a great extent.
3. *Durability:* Plastic offers great resistance to moisture and chemicals and hence more durable.
4. *Electrical Insulation:* The plastics possess excellent electrical insulating property.
5. *Fire Resistance:* The phenol-formaldehyde and urea-formaldehyde plastics resist fire to a great extent and hence they are used as fire proofing materials.
6. *Strength:* The plastics are reasonably strong. Their strength may be increased by reinforcing with various fibrous materials. Attempts are being made to produce structurally sound plastics.
7. *Specific Gravity:* The specific gravity of plastics is very low and hence convenient to handle.
8. *Ductility:* The plastics are not ductile and hence they fail without giving warning.
9. *Fixing:* Plastics can be bolted, drilled, glued, clamped or simply push fitted in position.
10. *Maintenance:* There is no maintenance cost for plastic articles *i.e.*, they do not need painting and polishing.

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Uses of Plastics

There are variety of plastics made to suit different uses. The typical uses of plastics in buildings is listed below:

1. Corrugated and plain sheets for roofing.
2. For making joint less flooring.
3. Flooring tiles.
4. Overhead water tanks.
5. Bath and sink units.
6. Cistern hall floats.
7. Decorative laminates and mouldings.
8. Window and door frames and shutters for bathroom doors.
9. Lighting fixtures.
10. Electrical conduits.
11. Electrical insulators.
12. Pipes to carry cold waters

Recycling of construction and demolition wastes

Construction and demolition (C &D) wastes are generated during construction, demolition and renovation of buildings and other structures. Recycling and reusing of C & D wastes has significant environmental benefits and economic profit. It's important because:

1. It supports local markets and businesses.
2. Helps in creating jobs.
3. Revenue from sale of salvaged materials.
4. Reduces greenhouse gas emissions
5. Reduces or avoids transportation costs.

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Major components : Cement concrete · Bricks · Cement plaster · Steel (from RCC, door/window frames, roofing support, railings of staircase etc.) · Rubble · Stone (marble, granite, sand stone) · Timber/wood (especially demolition of old buildings).

Minor components :Conduits (iron, plastic) · Pipes (GI, iron, plastic) Electrical fixtures (copper/aluminium wiring, wooden baton, bakelite/plastic switches, wire insulation) · Panels (wooden, laminated) · Others (glazed tiles, glass panes).

It is estimated that the construction industry in India generates about 10-12 million tons of waste annually. Construction and demolition waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, fly over, subway, remodelling etc. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc. A part of this waste comes to the municipal stream. While retrievable items such as bricks, wood, metal, titles are recycled, the concrete and masonry waste, accounting for more than 50% of the waste from construction and demolition activities, are not being currently recycled in India. Recycling of concrete and masonry waste is, however, being done abroad in countries like U.K., USA, France, Denmark, Germany and Japan.

Concrete and masonry waste can be recycled by sorting, crushing and sieving into recycled aggregate. This recycled aggregate can be used to make concrete for road construction and building material. Work on recycling of aggregates has been done at Central Building Research Institute (CBRI), Roorkee, and Central Road Research Institute (CRRI), New Delhi.

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RECYCLING AND REUSE

- Reuse (at site) of bricks, stone slabs, timber, conduits, piping railings etc. to the extent possible and depending upon their condition.
- Sale / auction of material which cannot be used at the site due to design constraint or change in design.
- Plastics, broken glass, scrap metal etc. can be used by recycling industries.
- Rubble, brick bats, broken plaster/concrete pieces etc. can be used for building activity, such as, levelling, under coat of lanes where the traffic does not constitute of heavy moving loads.
- Larger unusable pieces can be sent for filling up low-lying areas.
- Fine material, such as, sand, dust etc. can be used as cover material over sanitary landfill.

Envirnmental impact of C&D wastes

- These wastes increase the demand of landfills as existing landfills are already drowning in C&D waste.
- The disposal of C&D waste in landfills could also contaminate groundwater and surface water.
- Contaminated surface water may get its way to water bodies like ponds and rivers affecting aquatic life as well as animals consuming water directly from the ponds and rivers.
- Dumping of C&D waste in water bodies also results in increasing level of water which could lead to floods in the nearby areas.
- C&D waste also leads to air pollution as it may carry dusts , asbestos and other pollutants that may get mixed with air.