Clay products (Tiles)

Objectives: At the end of this lesson you shall be able to
- **define ceramic**
- **state clay for ceramic**
- **explain technical terms of ceramic products**
- **classify and describe the tiles.**

Introduction

Ceramic means the technology and the art of making objects with clay and similar Materials by treating with fire. Clay products, refractories and glass come under this. As tiles in various forms are the principal ceramic products used in building.

Clay for ceramic:

The special ceramic product requires its own type of special clay, even though ordinary earthenware's can be made from many types of ordinary clay. Fine white clay is required to manufacture porcelain articles. Refractory clay, which is special heat-resisting clay, is necessary for making refractories for chimney and ovens.

Technical terms:

1 **Earthenware:** Ordinary cooking pots and pans usually used in village come under this.

2 **Stoneware:** It is a product of refractory clay. Stoneware jars are very popular. Earthenware and stoneware together is called pottery.

3 **Porcelain:** Dinner plates, tea cups and saucers come under this category.

4 **Terracotta:** It is a hard brownish, unglazed vitrified ceramic material used for architectural ornamentation.

5 **Faience:** It is a city in Italy. It is earthenware or pottery to which heavy glazing has been applied and fired. It differs from porcelain. Faience has a porous shell and porcelain a solid shell.

6 **Glazing:** The provision of a transparent or opaque glass like coating is called glazing. It improves the appearance, provides a smooth surface and protects the surface from atmospheric as well as chemical action.

7 **Tiles:** It is a thin slab of baked clay of different shapes and sizes. Terrazzo tiles made of concrete and rubber tiles made of rubber to be used on floors and clay tiles to be used on roofs and floors.

Classification of tiles:

1 Common clay tiles for floors

2 Clay tiles for terraces

3 Clay tiles for ceiling

4 Glazed tiles for floors and walls

5 Vitrified tiles

6 Common clay roof tiles

7 Country roof tiles

(Encaustic tiles are the tiles initially painted with colours and the colours get fixed to the tiles with heat)

Clay floor tiles:

There are generally salt glazed to give a good appearance. Floors made of these tiles, unlike cement floors, are more suitable for walking barefooted.

Clay terracing tiles: These tiles are to be made according to IS: 2690-1964.

Clay ceiling tiles:

(IS: 1464-1959) these tiles are usually placed on reepers, over these ceiling tiles, Mangalore tiles are laid. They are generally given a floor pattern decoration on the exposed faces.

Glazed ceramic tiles:

These tiles were exclusively used as wall tiles for bathrooms in hospitals etc. large size with thick glazing are being used for flooring in offices, airports, etc.

Fully-vitrified tiles:

These tiles bridge the gap between ordinary ceramic tiles and marble floors. These tiles are especially used in kitchen floors as ordinary ceramic tiles are brittle and the full of any heavy object is liable to chip the ceramic tiles.

Porcelain tiles:

These are available in many forms as plain, coloured and also with decorative patterns and sizes. They are rather expensive compared to the traditional floors.

Common clay roof tiles:

There are many types of clay roof tiles. They are mostly used for covering sloped roofs, e.g.,

1 Mangalore pattern roofing tiles(Fig 1)

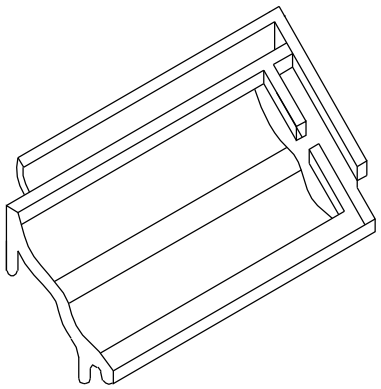
2 Half round country tiles (Spanish tiles)(Fig 2)

3 Allahabad tiles (Italian tiles)(Fig 3)

Mangalore pattern roofing tiles(Fig.1)

(IS: 654-1972) These are available in various shape and dimensions. They overlap on the tile below and also lock with the adjacent tile.

Fig 1



MANGALORE TILE

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Clay half round country tiles (spanish tiles)(Fig.2,3)

These are laid in pairs as under tiles and over tiles. These tiles are also sometimes placed over A.C. or G.I. sheets.

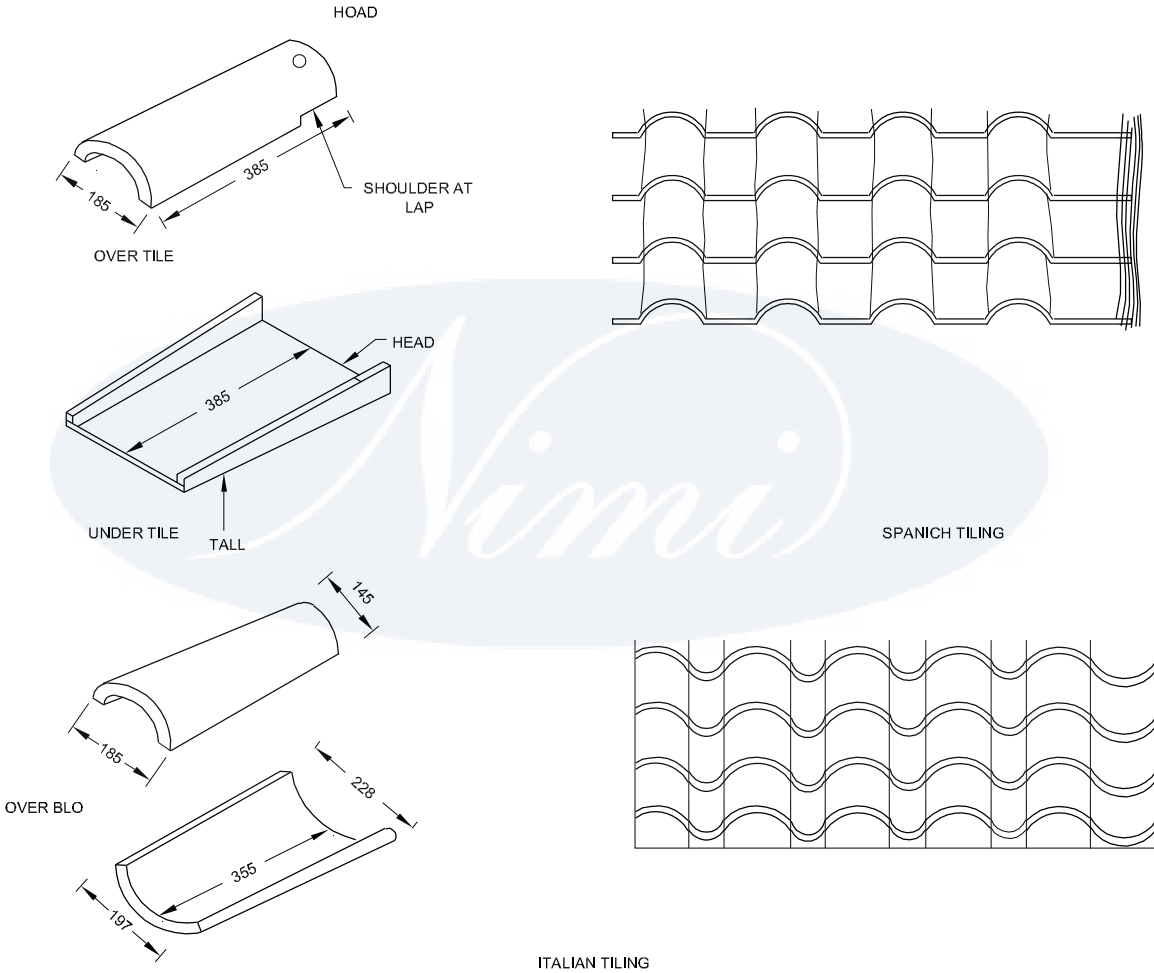
Allahabad tiles (italian tiles): (Fig.4)

These are two types-the bottom and top tiles. The bottom tiles are flat, tapered with upturned flanges at the sides. The over tiles are half round and tapered.

Terra - cotta

The terra means earth and cotta means baked. Hence terrra-cotta means baked earth. It is thus a type of earthenware or porous pottery made from local clays and glazed with glazes contianing galena.It is soft enough to be scratched by a knife.

Fig 2



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Varities of terra-cotta

The terra-cotta articles are of the following two types:

Porous terra-cotta **Polished terra cotta**

Porous terra cotta : To prepare porous terra-cotta, the saw dust or ground cork is added in clay before the stage of moulding. When articles from such clay are burnt in a kiln, the organic particles are brunt and they have leave pores in the articles. The porous terra-cotta is a fire-proof and a sound-proof material. It can be chiselled, sawn and nailed easily with nails, screws, etc. It is light in weight, but it is structurally weak.

Polished terra-cotta

This is also known as fine terra-cotta or faience. To obtian this variety of terra-cotta, the article are burnt at a lower temperatrue of about 650^{0}C. This first buring is known as biscuiting. The articles brought to biscuit stage are removed from kiln and are allowed to cool down.

They are then coated with glazing compound and burnt again in the kiln at a temperature of about 1200^{0}C .The faience is svailable in a variety of colours and it indicates superior quality of terra-cotta.It is used for ornamental purposes and in industrial areas since it is ordinarily unaffected by the adverse atmospheric conditions.

Advantages of terra-cotta

Following are the advantages of terra-cotta

It is strong and durable material

It is available in different colours

It is cheaper than ordinay finely dressed stones

It is easily cleaned

It is easily moulded in desired shapes

It is fire-proof and can, therefore, be conveniently used with R.C.C work.

It is light in weight

It is not affected by atmospheric agencies and acids and is capable of withstanding weathering actions better than most kinds of stone.

Disadvantages of terra-cotta

Following are the disadvantages of terra-cotta:

It can not be fixed during the progress of work. But it is to be fixed when the work is in final stage of completion.

It is twisted due to unequal shrikage in drying and burning.

Uses of terra-cotta

Following are the uses of terra-cotta:

The hollow terra-cotta blocks are used for various ornamental purposes such as facing work, arches, cornices, casing for coloumns,etc.

It is adopted for all sorts of ornamental work

It is used as a decorative material in place of stones for ornamental parts of buildings such as cornices, string courses, sills, copings, bases of pillars, fire places etc.

Earthenware: The term earthenware is used to indicate wares or articles prepared from clay which is burnt at low temperatrue and cooled down slowly. The clay is mixed with required quantity of sand, crushed pottery, etc.

The addition of such Materials prevents the shrinkage during drying and burning. The earthenwares are generally soft and porous. When glazed, the earthenwares become impervious to water and they are not affected by acids or atmospheric agences. The terra-cotta is a kind of earthenware.

The earthenware is used for making ordinary drain pipes, electrical cable, conduits, partition blocks etc.

Stoneware

The term stoneware is used to indicate wares or articles prepared for refractory clays which are mixed with stone and crushed pottery. Such a mixture is then burnt at a high temperature and cooled down slowly.

The stoneware is more compact and dense than earthenware.When glazed, the stoneware become impervious to water and they are not affected by acids or atmospheric agences. The sound stonewares give clear ringing sound when struck with each other.

The stoneware are strong impervious durable and assistant to corrosive fuluids and they resemble fire bricks. The stoneware can be kept clean easily and hence, they have become very popular as sanitary articles such as wash basins sewer pipes, glazed tiles, water closets, gully traps etc. They are also used as jars to store chemicals

Porcelain

The term poreclain is used to indicate fine earthenware which is white thin an semi-transparent. Since the colour of porcelain is white, it is also referred to as whiteware.

The clay of sufficent purity and possessing high degree of tenacity and plasticity is used in preparing porcelain. It is hard, brittle and non-porous. It is prepared from clay, felspar.

Refractories

The term refractories is used to indicate substances that are able to resist high temperature. The desired properties of refactories are as follows:

It must possess excellent resistance to rapid changed in temperature i.e. thermal shocks

Its dimensional stability i.e. resistance to change in volume at high temperature should be excellent.

It should be able to withstand abrasion and rough usage and should give reasonably long life without cracking or spalling.

It should be strong i.e. it must be capable of resisting compressive crushing and tensile forces in hot or cold conditions.

It should not fall into pieces at high temperatures

Its melting point should be high.

Its thermal conductivity should be suitable for the purpose for which it is to be used.

Classification of refractory materials

The refractory Materials are classified in the following two ways

i according to chemical properties and

ii according to resistance to temperature

According to chemical properties

The refractory Materials are divided into the following three categories as per their chemical properties , acidic, basic and neutral.

According to resistance to temperature

The refractory Materials are divided into the following two categories as per their capacity to resist temperature.

low quality and high quality

The low quality refractory Materials are used in the manufacture of fire-bricks, as lining material for furnances, etc. The melting point of such Materials is more than 1580^0C.

The high quality refractory Materials containing pure clay are pure oxides of alumina, magnesia, etc. or nitrides or carbides. Those metals which melt at a temperature of about 1600^{0}C can be used as metal refractories. Such metals are molyblendum, tungsten, zirconium etc. These metals and their alloys are used as refractory materials.

The term cermet (cer from ceramics and met from metals) is used to indicate the refractory Materials containing a combination of clay and metal. The usual percentages are 80% clay and 20% metal. The usual metals employed for cermets are aluminium, chromium, cobalt, iron, etc. The cermets are widely used where shocks due to sudden changes of temperature are to be resisted.

The high quality refractory Materials are stable even at high temperature and they are used in the construction of modern aeroplanes such as rockets, jets, etc. These Materialsare composed of either pure clay or metals or combination of clay and metals.

High Voltage Porcelain

Sl.No.	Name	Properties	Uses
1	Carbon and graphite	Its is a refractory material of high quality. But it is oxidized at high temperature	It is used for making electrodes and in the construction of atomic reactor rockets.
2	Carbon brick	It is prepared from powder coke and tar. It can resist high temeprature	It is used as lining material for electric furnance
3	Cordierite porcelain	It contains 22% alumina, 35% clay and 43% silicate of magnesia. It is available in porous, partly porous and glassy form	It is used for electric furnance, refractory bricks, etc.
4	Steatic porcelain	It contains 70 to 90% silicate of magnesia. etc.	It is used as electrical insulator for high intensity electric current, vacuum tubes,
5	Zircon porcelain	It contains 45 to 60% zircon, 15 to 30% clay and 15 to 30% silicate of zircon. Its dielectric constant at high temperature is good	It is used in the manufacture of spark plugs.

Acidic refractory materials

Sl.No.	Name	Properties	Uses
1	Fire - clay	Its important constituents are alumina and silica.	It is used for manufacture of firebricks, crucibles, lining material for furnances, hollow tiles, etc.
2	Quartzite	It is a metamorphic stone. It is hard, brittle, crystalline and compact. Its metling point varies from 1650^{0}C to 1720^{0}C	It is used as lining material for electric furnance
3	Silica	It is available in the form of sand with some impurities from river bed. It melts at 1730^{0}C	It is used for preparing sillica bricks, coke oven and lining for glass furnance.

Basic refractory materials

Sl.No.	Name	Properties	Uses
1	Dolomite	It is carbonate of lime and magnesium. Its melting point varies from 2300^{0}C to 2600^{0}C	It is used for making refractory bricks
2	Magnesia	It is available in crystalline form. It melts at 2800^{0}C	It is used for preparing magnesia bricks

Neutral refractory materials

Sl.No.	Name	Properties	Uses
1	Bauxite	It is mixed with clay and finely ground. Its melting point is 1200^{0}C. It is an amosphous substance with dirty-white, brown or reddish-brown colour.	It is used for preparing fire-bricks containing more percentage of silica.
2	Carbon	It is available in three forms-amorphous carbon, graphite and diamond. Its melting point is 3500^{0}C	It is used as activated carbon, absorbent, catalyst, etc. It is also used as lining material for furnaces.
3	Chromite	It is the oxide of iron and chromium. Its melting point is 2180^{0}C	It is the most powerful neutral refractory material.
4	Forsterite	It does not spall easily and it maintains well its volume at high temperature. Its melting point is 1890^{0}C	It is widely used in the furnance for melting copper.

Mortar & concrete

Objectives: At the end of this lesson you shall be able to
- **define mortar**
- **describe ingredients of mortar**
- **state the functions of mortar**
- **explain properties of good mortar**
- **List out the uses of mortar.**
- **State the types of mortar**
- **State preparation of mortar**
- **List out the tests for mortar**
- **Select the mortars for different engineering works.**

Inroduction

For construction of buildings, nowadays, we mostly use cement mortar and cement plasters. A large amount of cement is consumed for these works. The total consumption is about 3 bags per square metre of plinth area in residential buildings and about 4 bags per square metre of plinth area in office buildings of this a major part is used for making mortar and plasters.

Definition

A paste formed by the addition of water to a mixture composed of an aggregate such as sand and a matrix or binding material like lime or cement is called mortar.

Ingredients of mortar:

1 Binding or cementing materials…..such as cement or lime

2 Fine aggregates……such as sand, surkhi, ashes, cinder, etc.

3 Water……should be free from oils, acids, alklies and other inorganic impurities.

Functions of mortar

- It's binds together stones or bricks properly.
- In any concrete, it holds coarse aggregates together.
- In stone masonry and brick masonry, it fills up empty joints; a thin liquid mortar used for such purposes is termed as grout.
- It provides a durable / weather resisting layer between different course of masonry in the structure.
- It forms a homogeneous mass of the structure so that it may resist all the loads coming over it and transfer the same uniformly to its foundation.
- It does pointing or plastering to the structure.

Properties of a good mortar

- It should be capable of developing good adhesion with the building units.
- It should be easily workable
- It should be cheap.
- It should be durable
- It should be capable of resisting penetration of rain water
- It should be capable of developing the design stresses.
- It should be durable and should not affect the durability of other materials.
- The joints formed by mortar should not develop cracks and they should be able to maintain their appearance for quite a long period.

Uses of mortar

1 To bind the building units such as bricks, stones, etc. into a solid mass.

2 To carry out pointing and plaster work on exposed surfaces of masonry.

3 It is employed for moulding purposes.

4 It is used to form joints of pipes.

5 It is used to improve general appearance of structure.

6 It is used to hide open joints of a masonry work.

7 It is used as a matrix in concrete.

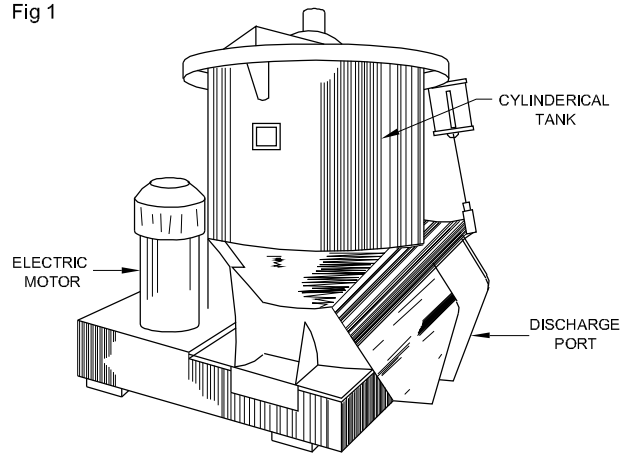
Preparation of mortar(Fig 1)

It may prepare by Hand mixing or Machine mixing. When a small quantity of mortar required, hand mixing method is adopted. When large quantity of mortar is required continuously at a fast rate, it is prepared by mixing of the ingredients in mechanical mixtures.

In order to test the quantity of mortar, the following tests are usually conducted:

1. Adhesiveness to building units test.
2. Crushing strength test.

Fig 1



TURBULENT MORTAR MIXER

3. Tensile strength test.
4. Setting time test

SELECTION OF MORTARS FOR DIFFERENT ENGINEERING WORKS

S. No.	Nature of Work	Mortar - Type and Composition
1	Thick joints in stone masonry	Hydraulic time sand mortar (1:2:3)
2	Stone masonry in foundations and superstructure of ordinary buildings.	1:2 fat lime surkhi mortar or 1 part lime, 1 part surkhi and 1 part sand.
3	Brickwork in arches, plastering inside of walls. mortar (1:2) or lime, surkhi and sand. (1:1:1)mortar.	1:5 to 1:6 cement mortar, or lime surkhi
4	Reinforced brickwork.	1:3 cement mortar.
5	Mass concrete in foundations, paving tiles, cavity walls, plastering of ceiling and external plastering work etc., where good finish is required.	1:4 cement sand mortar or 1:2 to 3hydraulic lime mortar.
6	Massive work below ground level especially in water logged areas.	1:3 cement sand mortar or 1:3 lime (eminently hydraulic) sand mortar.
7	Massive works, dams, retaining walls, damp proofing, flooring, etc. where very high finish is required.	1:3 cement sand mortar.
8	Pointing work	1:1 to 1:2 cement sand mortar.
9	General R.C.C. works such as slabs, beams and columns cement concrete flooring etc	1:2 cement sand mortar.
10	Damp proof course and cement concrete roads.	1:2 cement sand mortar.
11	R.C.C tanks and other retaining structures etc.	1:1½ cement sand mortar.
12	Highly stressed numbers of structure	1:1 cement sand mortar.
13	Laying fire-bricks.	Fire- resisting, mortar consisting of 1 part of luminous cement to 2 parts of finely crushed of fire-bricks.

Substitute for sand

In place of sand attain materila such as stones screenings burned clay or sunkhi ashes from coal, coke dust it may be used to prepaie mortor, The steps screenings are obtained by screening crushed stones. They are sharp and impart more strength to the mortor. They are generally used in big construction projects like concrete dams, bridges etc. Where sand in high quantities is not available where the place of work they should used the stone dust. The surkhi is the popular substitute for sand. It is obtained by finally grinding burned clay it is clean and face from any impurities. It gives strength and improves hydraulic property of mortor. Mortar with surkhi should not be used for external plaster or pointing work etc it disintegrates under the action of air and humididty.

Classification of mortars

The mortars are classified on the basis of the following

Bulk density

Kind of binding material

Nature of application

Special mortar

Bulk density : According to the bulk density of mortor in dry state there are two ways of mortor.

1 Heavy mortor 2 light weight mortor

The mortor having bulk density of 15KN/MM^3 or more are known as heavy mortor. If it is less than 15kn/mm^3 known as light weight mortor.

Kinds of binding materials

According to the kind of binding material mortars are classified into following five categories.

Lime mortar

Surkhi mortar

Cement mortar

Gauged mortar

Gypsum mortar

Lime mortar

In these type lime fat lime or hydraulic lime is used in binding material. The lime should be slaked before use. This mortar is not suitable for water logged areas or in damp situation. The proportion of lime to sand by volume is about 1:2 as so. It is durable and hardens slowly. It is generally used for lightly loaded above ground parts of building.

Surkhi mortar

In this type of mortar using fully surkhi instead of sand or half surkhi instead of lime. The powder of surkhi should be fine enough to pass BIS No.9.

The residure should not exceed more than 10% by weight. Surkhi mortor is used for ordinary masonry work of all kinds of foundations and super structure. But is cannot be used for plastering or pointing. Since surkahi is likely to desintegrate after some time.

Cement mortar

In this type of mortor the cement is used as binding material. Depending upon the strength required and important of work the proportion of cement to sand by volume varies from 1:2 to 1:6 the sand only can be used to form cement mortar. The proportion should be determine with due regard to the specified durability and working condition. The cement mortar is used where a mortar required such as underground constructions water saturated soils etc.

Gauged mortar

To improve the quality of lime mortar and to achieve only strength the cement is sometimes added to it.This process is known as gauging. It makes mortar economical, strong and dense. The usual proportion of cement to lime by volume is about 1:6 - 1:8 . This mortar is also known as composite mortar or lime cement mortar.

Gypsum mortar

These mortar are prepared from gypsum as binding material.

Properties of good mortar

It should be capable of developing good whole vision with the building units such as bricks.

It should be capable of developing the designed stresses

It should be capable of resisting penetration of rain water.

It should be cheap

It should be durable and easily workable

It should not effect the durability Materials with which it comes into contact

It should set quickly so that speed in construction may be achieved

It should not develop crakcs and to maintian these apperances for a long period.

Preparation of mortar

For preparing mortar water is added to a intimate mixture of binding material and sand. The water to be used for the purpose should be fit for drinking.

Preparation of different mortars

Lime mortar

The time mortar is prepared within by pounding or grinding. For preparing small quantities the pounding is adopted. And for large quantities or a continuous supply grinding is adopted. The following are the objects of pounding or grinding.

To crush the particles of unslaked lime if any so as to and ensure slaking

To make and intimate mixtue of whole mass so that no gains of sand are without a film of binding material

Pounding

In this method the pits are formed in hand ground with lining of bricks or stones at there side and bottom. The pits are 180cm long 40 cm wide at bottom and 500m wide at topand 50cm deep. The dry mixture is then placed in pits. Small quantity of water is added and 4-5 persons with heavy mortar wooden poundans or beaten as work on mortar. They turn mortar up and down and required quantity of water is added at intervels. When desired consistency is achieved the mortar from pits is taken out.

Grinding

In the method grinding mills are used to prepare mortar. This grinding mills are either bullock driven or power driven.

Surkhi mortar

The mix of fat time and surkhi or fat lime surkhi and sand is decided and it is converted into a good paste by grinding in a mortar mill or pounding

Cement mortar

It does not require pounding or grinding. The cement and sand are mixed in required proportion in dry state twice or thrice on water tight platform and the water is then added and the ingrediants are again throughly mixed.

Gauged mortar

The lime mortar is prepared as per about and the required quantity of cement is then added and the ingredient are throughly turn up and down to cause intimate mixing.

Uses of mortor

To bind the building units such as bricks, stones etc into a solid mass.

To carryout pointing and plastering on on expossed surface of masonary

To form a bedding layer for building units

To form joins of pipes

To improve the general apperance of structures

To prepares moulds for coping, corbels, cornice etc

To servcie as martix to hold coarse aggregates.

To hide the open joints of brick work and stone work

To fill up the cracks detected in the structures during maintenance process etc.

Precautions in using mortar

Following precautions to be taken while making use of mortar

Consumption of mortar

After prepartion the mortar should be consumed as only as possible the lime mortar should be consumed within 30 minutes after adding water. Therefore it is advisable to prepare cement mortar of 1 bag of cement at a time. The gauged mortar should be used with 2 hrs of the addition of cement.

Staking of building units

The presence of water in mortar is essential to cause its salting action of mortar. Hence the building units should be soaked in water before mortar is applied this precaution is not taken, the water of mortar will be absorbed by the building units and the mortar will become weak.

Sprinkling of water

The water may be sprinkling for about 7-10 days.

To avoid rapid drying of mortar the exposed surfaces are some times correct to give protection against sun.

Workability

The excess mortar from joints should be neatly taken of by a travel. The mortar should not contain excess water and it should be as stiff as can be conveniently used.

Selection of mortar

Depending upon the nature of civil engineering work suitable type of mortar should be selected.

Plain cement concrete

Objectives: At the end of this lesson you shall be able to
- **define concrete**
- **state the proportioning of concrete**
- **describe the advantages of concrete**
- **state the disadvantages of concrete**
- **list out the uses of concrete.**

Introduction

Cement concrete is a major building material used in modern building constructions. It is used in all parts of a building like, foundations, superstructure and roofs. It is prepared at site by hand mixing or machine mixing, it is now available as a factory made product known as' Ready Mixed Concrete (RMC)'.

Deinition:

Concrete is a mixture obtained by mixing a binder (cement or lime), aggregate (fine and coarse) and water in certain proportions.

Proportioning concrete:

The process of selection of relative proportions of cement, sand, coarse aggregate and water, so as to obtain a concrete of desired quality is known as the proportioning concrete.

There are different methods of proportioning concrete:

a Arbitrary method

b Fineness modulus method

c Minimum voids method

d Maximum density method

e Water-cement ratio method

The concrete as per BIS: 456:1978 is designed in several grades, M10, M15, M20, M25, M30, M35 and M40. The letter M refers to the mix and the number indicates the specified compressive strength of that mix at 28 days expressed in N /mm².

GRADE	PROPORTION	GRADE	PROPORTION	GRADE	PROPORTION
M5	1:5:10	M10	1:3:6	M20	1:1½:3
M7.5	1:4:8	M15	1:2:4	M25	1:1:2

Advantage of concrete

High compressive strength

Corrosive and weathering effect minimized

Economical

Durable

Fire resistant

Very little maintenance

Molded to any shape

Can be sprayed and filled in cracks

Strong in compression

When reinforcement is added it is good in compression and tension also.

Ingredients of concrete

Cement

Sand or fire aggregate

Course aggregate

Water

Admixtures (in case of special conditions)

Properties of cement concrete

Properties of cement may be considered through two states

Fresh state

Hardened state

Fresh state

Workability

Hardened state

Permeability of concrete

Permeability of concrete depends on cement content grading aggreagate quality of water, mixing compaction and curing of concrete.

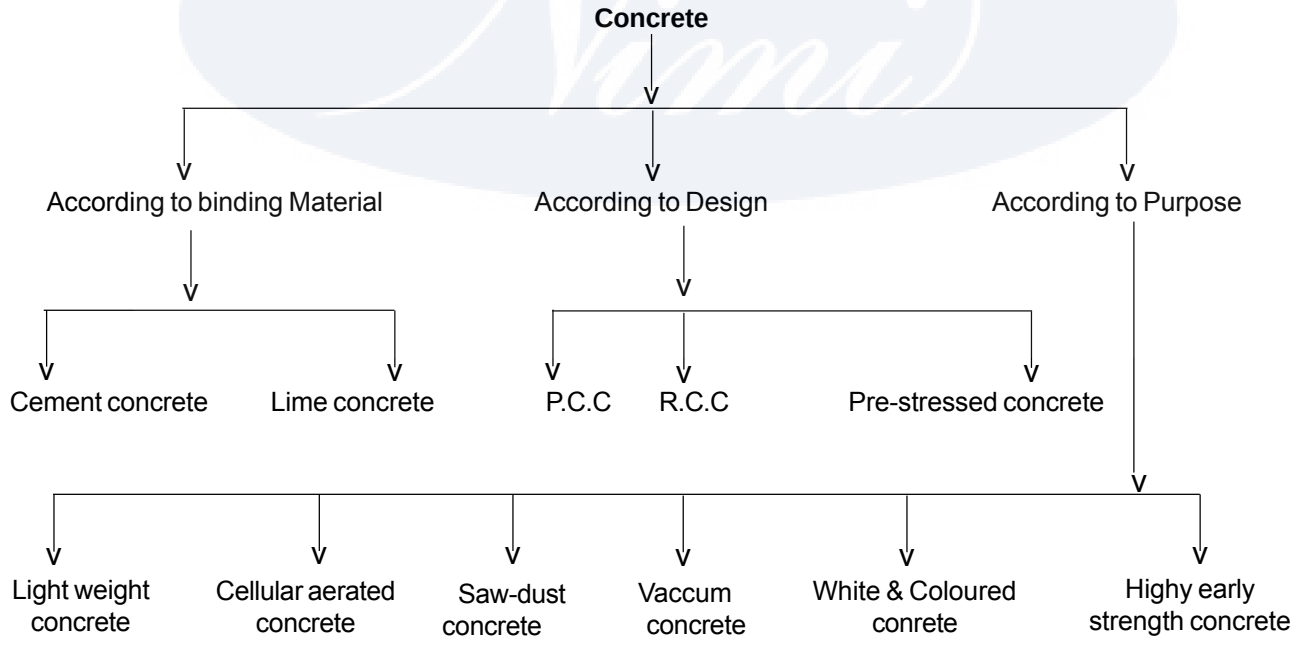
Durability of concrete

High compressive strength

Free from corrosion

Hardness increase with age

Economical



Recommended mixes of concrete

S.No.	Proportion of concrete mix	Maximum size of aggregate	Maximum size of aggregate
1	1:1:2	12 to 20mm	Heavily loaded R.C.C column and R.C.C. arches of long span
2	1:2:2	12 to 20mm	Heavily loaded R.C.C column and R.C.C. arches of long span

S.No.	Proportion of concrete mix	Maximum size of aggregate	Maximum size of aggregate
3	1:2:2	12 to 20mm	Small precast memebrs of croncrete such as poles for fencing Long piles water tight construction
4	$1:1^{1/2}:3$	20 mm	Water retaining structures, piles, precast product etc.
5	1:2:3 or 1:2/3:31/3	20 mm	Water tank, concrete deposited under water, bridge constrution and sewers. For all general RCC work in building
6	1:2:1/2:3 1/2	25 mm	Foot path and road work
7	1:2:4	40 mm	For all general RCC work in building such as stair, beam, column etc
8	1:3:6	50 mm	Mass concrete work in culvert, retaining wall etc.
9	1:4.:8 or 1:5:10 or 1:6:12	60 mm	Mass concrete work for heavy wall foundation footing etc

Recommended mixes of concrete

S.No.	Proportion of concrete mix	Maximum size of aggregate	Maximum size of aggregate
Grade of concrete	M10	1:3:6	Compressive strength 10N / mm2
	M15	1:2:4	Compressive strength 15N / mm2
	M20	1:1:5:3	Compressive strength 20N / mm2
	M25	1:1:2	Compressive strength 25N / mm2

Grade of concrete	Total quantity of dry aggregates by mass per 50kg of cement to be taken as the sum of individual masses of fine and coarse aggregate Maximum (Kg)	Proportion of fine aggregate to coarse aggregate (by mass)	Quantity of water per 50kg of cement mix-litres
M5	800	Generally 1:2 but subject to an upper limit of 1:1:5 and lower limit of 2.5	60
M 7.5	675		45
M 10	480		34
M 15	390		32
M 20	250		30

Grading of concrete

In order to obtain concrete of denser quality the fine and coarse aggregate are properly graded

- gradation of fine aggregates as determined by sieve analysis
- gradation of aggregates effects on workability uniform and finishing quality of concrete
- grading of fine aggregate is expressed in terms of BIS test sieve nos 480,240,120,60,30 and 15

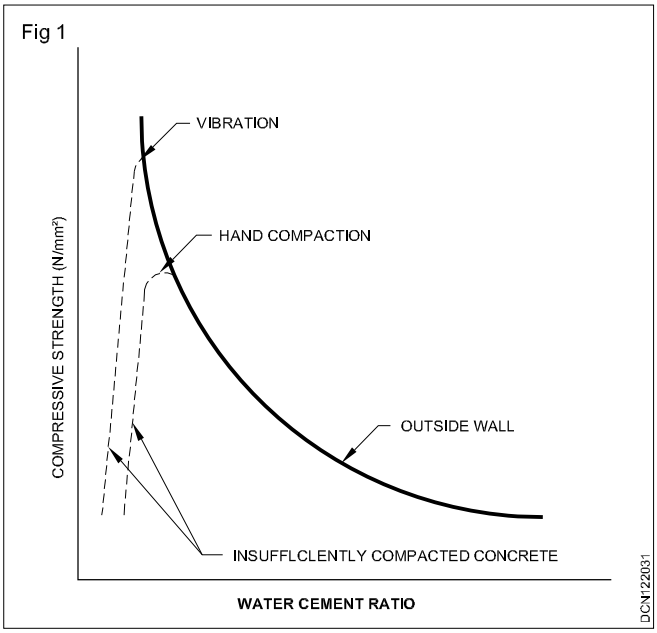
Water cement ratio

It is the ratio of water to cement and is expressed as the ratio of weight or volume of water to the weight of the cement to the concrete mixture.

Workability

The term workability is used to describe ease on difficulty in which concrete is handled, transported and placed between the forms with minimum less homogeneity workability some easily determine by slump test.

Fig 1



Recommended slumps of concrete

S.No	Type of concrete	Slump (mm)
1	Concrete for road construction	20 to 40
2	Concrete for top of kerb, parapet, slabs, walls, etc.	40 to 50
3	Concrete for canal lining	70 to 80
4	Concrete for arch and side wall of tunnel	90 to 100
5	Normal R.C.C work	80 to 150
6	Mass concrete	25 to 50
7	Concrete to be vibrated	10 to 25

Classification of concrete mixture

S.No	Slump	Nature of concrete mix
1	No slump	Stiff and extra stiff mix
2	From 10mm to 30 mm	Poorly mobile mix
3	From 40 to 150 mm	Mobile mix
4	Over 150 mm	Cat mix

Mixing the material of concrete

The process of rolling, folding and spreading of particles is known as mixing of concrete

Mixing of ingredients

To impart uniform colour

Distribute various sizes of particles uniformly and evenly

To spread evenly the binding material over every particles of aggregate.

To impart required consistency to concrete

Ingredients of concrete are mixed by following methods

Hand mixing

Machince mixing

Hand mixing

- Ingredients are measured and mixed in dry state
- Mixed on a water tight platform so as not to avoid loss of water
- Water is then added in correct concrete quantity and wet mixing is done
- Mix throughly till the concrete becomes uniform in colour and consistency
- It is preferred to add about 8 to 10 percent extra cement considering lesser efficiency of hand mixing.

Machine mixing

Mixing the ingredients by a machine

Ensures a better and more uniform concrete

Ensure thorough mixing

Cement consumption less than hand mixing

Transportation and placing of concrete

Transportation is the transporting the concrete and placing the concrete on the form work with suitable equipments or machines. The important precautions should take care

No chance of water should be added the concrete during its transportation

No segregation of aggregate

Precautions in placing of concrete

Clean the form work properly

Desirable to deposit the concrete as near as practible to its final position

Large quantity of concrete should not be deposited at a time

Concrete should be dropped vertically from a reasonable height.

Concrete should be deposited horizotal layers of 150 mm

As far possible concrete should be placed in single thickness

Concrete should thoroughly worked around the reinforcement

Concrete should be placed on the form work as soon as possible.

During placing it should be seen that all edges and corners of concrete surface remains unbroken

Placing of concrete should be carried out without obstruction of construction joint