GOVERNMENTPOLYTECHNICBARGARH
DEPARTMENT OF CIVIL ENGINEERING

LECTURENOTES
ON
BUILDING MATERIAL AND CONSTRUCTION TECHNOLOGY

SEMESTER-3rd

PreparedBy:
Mansi Pradhan
Lecturer in Civil Engineering

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Lecturer in Civil Engineering

CONTENT

CHAPTER1

STONES

1. INTRODUCTION

Naturallyoccurring compact, solid and massive material in the earth's crust or onthe surface are known as rocks. Rocks don't have definite shape and chemical composition. They are mixture of two or more minerals. Stones are derived fromrocks and are used as construction material.

Mineralsarenaturallyoccurringinorganicsubstancehavingdefiniteatomicstructureand chemicalcomposition. Minerals are divided into two types.

1. Rockformingminerals
2. Oreminerals

2. CLASSIFICATIONOF ROCKS

Therocksfromwhichstonesarederivedarebroadlyclassifiedintothreetypes.Theyare:

1. Geologicalclassification
2. StructuralorPhysicalclassification
3. Chemical classification

Geologicalclassification:

The classification of rock based on the mode of formation or the process of formation is known as geological classification. According to this classification rocks/ stones are are of three types.

1. Igneous rocks
2. Sedimentaryrocks
3. Metamorphicrocks

Igneousrocks

Molten rock materials found below the earth's crust are known as magma. During volcanic eruption, this magma, under very temperature and pressure, and varieties of complex phenomena occurring below earth's crust beyond the comprehension of human being, comes out to the surface.The rocks formed due to cooling and consolidation of molten magma on the surface is known as igneous rock. Not all themagma during a volcanic eruption comes out to the surface of earth.

Dependingonthedepthofthesolidificationofmoltenmagma, igneousrocksaredivided into three types.

1. Plutonicrocks
2. Volcanicrocks
3. Hypabyssalrocks

Plutonicrocks

The igneous rocks formed at a greater depth below the surface of earth are called plutonic rocks. These rocks are exposed on the surface due to erosion of overlying secondary rocks. These are coarsely crystallised. Examples ofplutonic rocks are granite, syenite, gabbro.

Volcanic rocks

Theseare formeddueto coolingand solidificationofmoltenmagma fromnumerousvolcanic eruptions onthe surface ofearth. Examples ofsuch rocks are basalt, trap and rheolite.

Hypabyassalrocks

The rocks formed on account of cooling and solidification of molten magma at a shallower depthofabout 2to 3 kmbelow the surface ofearth. Theyshow crystals that arepartlycoarse and partly fine. Examples ofsuch rocks are aplites, dolerites, etc.

Igneousrocksarefurther dividedintothreetypesdependinguponthesilicacontentinthem.

a. Acidrocks

b. Basicrocks

c. Ultrabasicrocks

Acid rocks: in acid rocks amount of silica content is more than 66%. Examples: granite, rhyolite.

Basicrocks:Amount ofsilicacontent intheserocks isbetween45to 55%.

Ultra-basicrocks:Amount ofsilicacontent intheserocksislessthan45%.

Sedimentary rocks

The secondary rocks which are formed by chemical or mechanical activities oftheweathering agents such as temperature, water, air, ice, etc. on the pre-existing rocks are knownas sedimentaryrocks. Weathering agents like wind, water, ice, atmospheric gases, etc. cause disintegration of the pre-existing rocks and thus sediments (particles)areformed. These sediments are transported and deposited by the agencies like river, seas, oceans, etc. The particles sodeposited are gradually compressed and compacted under their own weight so asto formmassiverocks. Rocksthus formed areknownassedimentaryrocks. Theprocess of formation of sedimentary rocks takes place for millions of years. Sedimentary rocks are also known as secondary rocks as they are formed due to weathering and erosion of primary rocks. These are also called stratified rocks because these rocks are formed in layers. Limestone and sandstone belong to this categoryof rocks.

Like igneous rocks, sedimentary rocks are formed in different ways. On the basis of the formation, sedimentaryrocks are divided into three different categories.

a. Clasticrocks
b. Chemicallyformedsedimentaryrocks
c. Organicallyformedsedimentaryrocks

Clastic rocks

The sedimentary rocks formed by deposition andconsolidation of disintegrated sediments and fragments from previously formed rocks. These are formed in river basins, lake basins and sea basins. These types of stones are most widespread. They include sandstones, shales, breccias and conglomerates. Sandstones are verysuitable as building stones.

Chemicallyformedsedimentaryrocks

Many sedimentary rocks are precipitated from river, lake and especially from sea water by evaporation. Some of the components of the previous rocks are taken in solution during the process of weathering and erosion. The waters may get saturated with these compounds with passage oftime and precipitate them. The huge accumulation ofthese precipitates evaporates ultimately may form rock deposits of considerable importance. Limestones, gypsum, anahydrite and rock salts are few examples of chemically formed sedimentary rocks. These are not used as building stone.

Organicallyformedsedimentaryrocks

A great variety of life exists in the water bodies such as seas and oceans. Many sea animals have their hard parts made of bones which are a mixture of calcium and magnesium carbonates. After the death of these marine animals, the dead parts accumulate on the sea beds. Graduallyhuge thickness ofsuchdeposits gets formed and compacted and consolidated with passage of time. These are the organically formed sedimentary rocks. Limestone is an example of this rock.

Metamorphicrocks

Igneous rocks and sedimentary rocks undergo structural change under the influence of high temperature, pressure and chemical action and thus the original character of the parent rock are partly or wholly changes. Such process is known as metamorphosis and the rocks so formed are known as metamorphic rocks. Examples: marble, slate, gneiss, etc. Marble is formed from limestone ($CaCO_3$) bygradual heating over a very large period oftime.

ChemicalClassification

Onthe basisofdominantchemicalcomposition,three maintypes ofrocksare:

a. Siliciousrocks

b. Calcareousrock

c. Argillaceousrocks

Siliciousrocks

Silica is the predominant constituent of this rock and is more than 50% of the bulk compositionoftherock.Somesedimentaryandmetamorphicrocksareentirelymadeof

silica. These rocks are very strong and hence may be treated as good building stones. Examples of these rocks are granite, sandstone, gneiss.

Calcareousrocks

In these rocks carbonate is the dominant chemical component. These rocks generally belong to sedimentary and metamorphic rocks. Limestone, dolomite and marbles are entirely carbonate rocks and are very good building stones.

Argillaceous rocks

In these rocks clay (hydrous alumina silicate of K, Na, Ca and Mg) is the dominant component. These are mostly sedimentary and metamorphic rocks. These are very soft and hence not recommended as building stones. Examples ofthese rocks are slates and schists.

StructuralClassification

Onthe basis ofphysicalcharacteristics ofthe rocks, the manner and arrangement ofdifferent particles rocks are classified into three categories. Theyare:

1. Stratified
2. Unstratified
3. Foliated

UnstratifiedRocks

These rocks occur in huge masses without showing any layered structure in them. Igneous rocks and many metamorphic rocks are unstratified in nature. Some ofthe sedimentaryrocks may be of unstratified in nature.

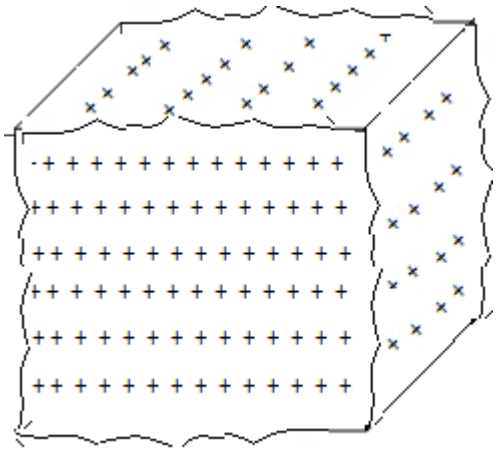
StratifiedRocks

These rocks occur in distinct layers ofsame or different colour and composition. Most ofthe sedimentaryrocks are stratifiedrocks.The differentlayers are calledbeds andseparatedby

planes, called bedding planes. These bedding planes arethe planes ofweakness and thus play an important role in deciding the structuralbehaviourofthe rocks as building material.

Foliatedrocks

Some rocks have in them profuse development of well defined bands of different composition. Such rocks are known as foliated rocks. Examples ofsuch rocks are schists and gneiss. Sometimes such layers are induced under pressure. These are not very good building stones.



Unstratified rock

3. USES OF STONES

Stones on account of numerous advantages they have in terms of theirstrength characteristics, durability and bountiful availability as a natural resource have awide spectrum of application including their use as very good and construction material for numerous civilengineering structures. Some oftheir uses are enlisted below.

a. Stoneisusedfor generalbuildingwork,i.e., walls, foundationsand superstructure.

b. It is also used for heavy engineering works such as docks, bridges,lighthouses and harbours.

c. Itisusedinindustrialconstructions.

d. Itisused roadmetaland railwayballast.

e. Itisused asrawmaterialformanufactureoflime.

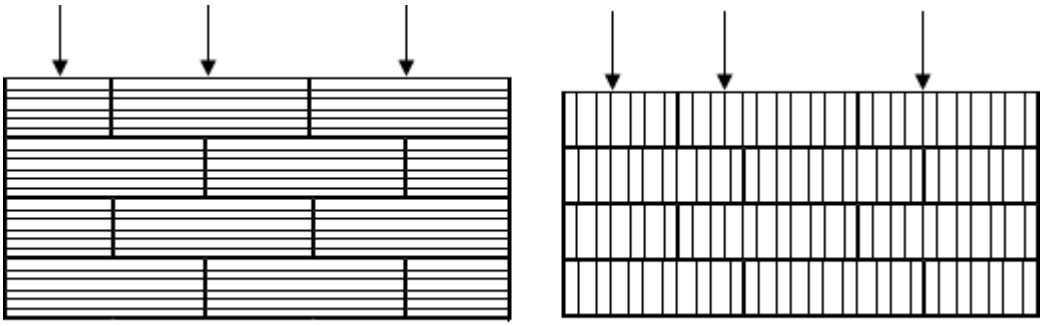
f. Itisalsousedas fluxsteelplantinthemanufactureofiron.

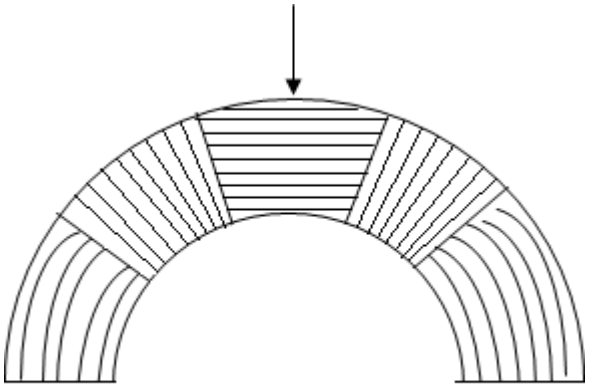
4. NATURALBED OFSTONE

The plane ofcontact (junction) oftwolayers ofrocks in a stone obtained fromstratified rock is knownas the naturalbed. It is also knownas plane ofcleavage or weakness.

The strength and durability of stratified stone depend on its position in a structure i.e., if the loadis perpendicular or parallel to the bedding plane of the stone. The compressive strength of stone with the load acting perpendicular to the direction of 'natural bed of the stone' or plane ofcleavage is always greaterthanthat when the load acts paralleltothe bedding plane.

In case of walls and columns where the load acts verticallydownwards, the stones should be placed with natural bed horizontal so that thrusts act normal to the bedding plane. In arches where the load acts transverse, the stones are placed with natural bed vertical or inclined so that it is almost normalto the resultant forces.





(c)

Figure 1.2Forceswithrespecttonaturalbed

5. QUALITIESOFGOODBUILDINGSTONE

Stones have wider applications in construction of heavy structures such as buildings, dams, harbours, weirs, bridges, etc. The qualitiesand suitability of good building stones should have the following characteristics with the attributes given in each ofthem.

1. Appearance

   The stones shouldbe of uniform and appealing colour. Lighter colours are preferred to darker ones as darker ones are less durable. For face work, the appearance of the stones very important.

2. Strength

   Stonesusedfor buildingconstructionaresubjectedto compressive load. Sothestones should have high value ofcompressive strengthto withstand the compressionwithout getting crushed. closed grain and uniform textured stones are generally good in compressive strength.

3. Structure

A good stone if broken should not give dull appearance. Closed grain and crystalline structured stones are good building stones. Good building stone should have uniform texture. Theyshould be free from cavities and cracks.

4. Hardness

   A good stone should be hard enough to resist the abrasion due to friction. Generally thestonesused infloors, pavementsandapronsofbridgeshould havegreater valueof hardness. Hard stones should show no sign ofscratching if scratched byknife.

5. Toughness

   Goodstonesshouldalso betoughtowithstand thevibrationmachineriesand vibration due to moving loads over them. Stones used in construction of roads should be hard and tough.

6. Heaviness

   Specific gravity is the measure of heaviness of a substance. The specific gravity of a good building stone should be between 2.4 to 2,8.

7. Durability

   A good building stone should be long lasting. They should resist the action of weathering agents such as wind, rain, ice and temperature. Durability ofstonesdepend upon their chemical composition and physical structure. A compact, homogeneous and free from chemicals susceptible to the action of hydrochloric acid and sulphuric acid.

8. Porosityand waterabsorption

   Porosity is the percentage of void spaces available in a given volume of stone. Good building stone should have less water absorption. The water absorption of good building stone should be less than 5%.

9. Resistancetofire

   Stone whenexposed to fire should be able to resist temperature. The stones should be freefrommineralssuchas$CaCO_3$andironoxidewhichlikelytodecomposeon

heating.Quartzexpandsonlowtemperature.Hencestonesshould not becomposedof minerals of different coefficient of thermal expansion.

10. Dressing

    Stonesshouldpossessgooddressingproperties for carving. Marble isagoodexample of stone which has good dressing properties. However stones having good dressing qualities are weak in strength, less durable. Their hardness is also low.

11. Seasoning

    Stones after quarrying and dressing should be left for a period of 6 to 12 months for seasoning beforeused for construction. Awellseasoned stone is free fromquarrysap.

6. STONEQUARRYING

The process of extraction of suitable stones from their natural place of occurrence is called quarrying. Quarrying is also known as open cast mining for extraction ofstones fromnatural rock. However, quarrying is different from mining in the way that in various operations are carried outfor exploration and extraction of minerals such as coal, quartzite, etc., from amine under the earth.

There are different methods employed for quarrying ofstones depending uponthe geological structureofrock, amount of materialrequired and their availability. Theyare:

a. Quarrying without blasting (Quarrying by hand tools such as crowbars, jumpers, pickaxe, feathers and wedges, channellizers, etc.

b. Quarrying byblasting

Quarryingby handtools

The rocks in the earth's crust are accompanied by the bedding planes, joints, fissures and cracks, etc. these offer least resistance for to splitting. In these methods light hand tools or even light channelling machines called channellizers are used for removal of block of rocks. In these methods noexplosivematerial is usedfor breaking the stone. Some of the methods of quarrying by hand tools are:

1. Digging

This method is used to quarry small pieces of stones. They are broken by pick-axe and taken out bycrowbar. Laterite stones are quarried by digging.

2. Splitting

Splitting method is used for obtaining large blocks from hard and tough rock. Large blocks can be split by heating to get rectangular pieces. Wood, leaves or any other form of fuels is burnt on the surface of stone for few hours. Due to unequalexpansion, stone splits and upper layer is separated. Separated stone pieces aretakenout and giventhe desired shape for use.

3. Wedging

In this method a few holes are dug at selected places on the rock surface by using chisels and hammers or hammer drills. Steelwedges are inserted into each holes betweentwo steelstrips called feathers. The inserted wedges are struck simultaneously with hammers. As a result of hammer blows, cracks appear along the lines joining the holes. Then long iron bars are inserted into the holes and the cracks so caused help removing the block of rocks. Quarrying by wedging is shown in the Figure 1.3.

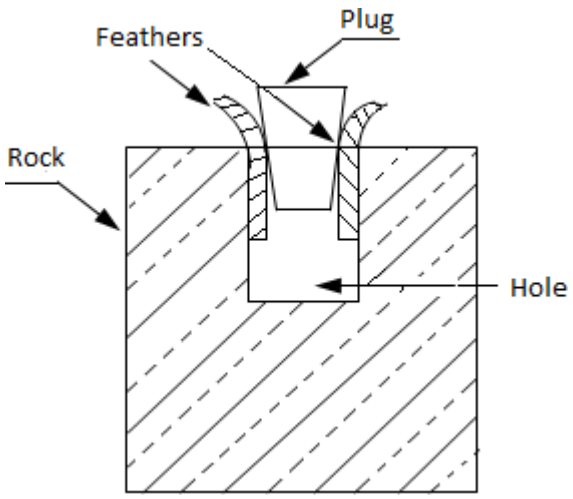


Figure1.3 Plugand Feathers

4. Channelling

In this method big machines called channellizers are used for quarrying. the machines are power driven. Channellizers are used for cutting large size single block of costly stones like marbles andlime stones. The channellizers cancut a groove up to3 mdepth, 3 m length and 5 m width. Holes are then drilled horizontally from the free side to meet the groove at the back at itsbase. Wedgesand steelbarsare used toremove the block(B) fromtherock. Figure 1.4showsquarrying bychannelling.

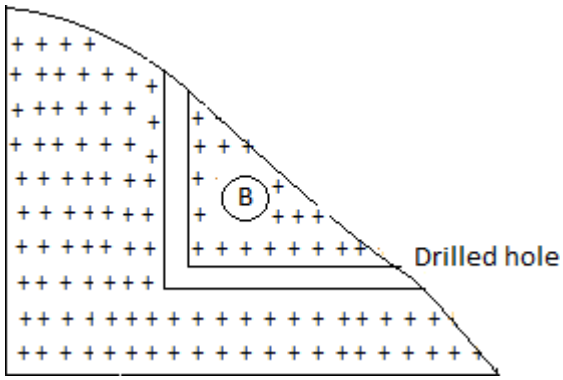


Figure1.4Quarryingbychannelling

7. DRESSING

The process of giving proper size, shape and finish to the stone obtained from the quarry is known as dressing. Dressing is done either by manuallyor mechanically or both.

ObjectiveofDressing

a. To reduce the size of the blocks topotable units: Dressing reduces the size of the block and hence the weight. Reduction of weight decreases the cost of transportation of stones from the quarry site.

b. To give propershape to the stone: Different structuralunitsrequire stonesofdifferent shape. Hence, stones are to be dressed before use as structuralunits.

c. To give appealing finish: Stones used in exposed face of the walls in temples and monuments should be dressed to give aesthetic appearance.

MethodsofDressing

Therearedifferentmethodsofdressing.Somemanualmethodsofdressingareasfollows.

Pitchedfacedressing

In this method, only the edges ofa block ofstone are made level with skilfuluse of hammer. Thesurface is left inoriginalcut.The minimumwidthofpitched facedressingroundthe four edges of the face shall be 2.5 cm.

Hammerdressing

In this dressing, the edges as well as faces are dressed to give an even regular surfaces. A hammer dressed stone is given rough tooling for a minimum width of 2.5 cm along the four edges of the face of the stone.

Chiseldrafting

In this method, straight grooves are made with the help of chisel at all the four edges. The superfluous stone at the centre is removed by chisels. The stones so dressed are usedin plinths and corners of the buildings.

Roughtooling

In this method, a series of bands 4 to 5 cm wide with grooves inbetween are made all over thesurface. Eachband hastoolmarks inthem. thesetoolmarks maybe horizontal, verticalor at an angle of 45^0 etc. The edges and the corners are made squareby using chisel and hammer.

Puncheddressing

Punched dressing is done on the stones that have already been rough-tooled. In this method a seriesofparallelridgesare made byusing hammer andchisel. Thesestonesareusedat places where even surfaces are required.

Closepickedfine tooling

Inthistypeofdressing, almosteverytype ofirregular projection isremoved fromallthe four sides ofa stone. Its surface is given fine finish and appealing look.

Polishing

Polishingofstones isdone byrubbingwithsuitableabrasive material. Polishingof stone may be done by holding them firmly on the top of a revolving table to which some abrasive material like sand or carborandum are fed.

8. CHARACTERISTICS OFDIFFERENTTYPES OFSTONES ANDTHEIRUSES

Granite: It is a coarse to mediumgrained igneous rock. It is essentially made up of felspar, quartz and mica.

Characteristics

a. Itsspecificgravityis2.64andwater absorptionislessthan1%.

b. Ithasmottled(spotted) appearance.

c. Most granites excellentbuilding properties and are significantly strong and durable. Crushing strength varies from110 to 140 MN/m^2.

d. Graniteshavepoor fireresistanceandcrackunder strongfire.

e. Granites have thecapacitytotakeveryfine and glassypolish.

f. Quantityoffelspardecidesthe colourofgranite.

Uses

a. Finegrainedgranite issuitable forornamentalcolumn,plinth,etc.asittakesveryfine polish and exhibits glassy appearance.

b. High values ofstrength, hardness, specific gravity and durability make it suitable for construction ofsea walls, light houses and bridge piers, etc.

c. Large pieces are used as building blocks for masonrystructures, smaller ones as road metals or railway ballast and the chippings for manufacture ofconcrete.

Basalt: It isa volcanictype igneousrock.The mainconstituentsaresilica,aluminaand felspar.

Characteristics

a. Itsspecific gravityisabout2.96.

b. Itisveryheavyandstrongandisheavierthangranite.

c. Itscrushingstrengthvariesfrom70to80MN/m^2.

d. It hasgreenishgreytodarkgreycolour.

Uses

a. Basaltissuitablefor pavingsetsandasaroadmetal.

b. Itisusedasaggregateinconcrete.

c. Itisalsousedformanufactureofartificialstones.

Limestone: Limestone is a sedimentary rock of calcareous variety and of organic origin.In its purest form, it contains mainly $CaCO_3$, although some varieties may contain $MgCO_3$ and small amount of silica and alumina.

Characteristics

a. Itsspecificgravityis 2.6.

b. Itscrushing strength isabout 52 MN/m^2.

c. The colour of limestone depends on its composition, especially the type of finely dispersed impurities present throughout the carbonate matrix. However, they are available inthree main colours viz., brown, yellow and dark greycolours.

Uses

a. Limestonesarenotveryusefulas buildingstonebecauseoftheirpoorstrengthvalues. However, dense, compact and massive varieties are used for stone masonryin walls.

b. Itisusedasroadmetalwhenbettermaterials like basaltandgranitearenotavailable.

c. Itisusedinblastfurnaces,bleaching,tanningandother industries.

Marble: It is metamorphic rock of calcareous variety. It is formed fromthe metamorphosis of limestone. Its main constituent is recrystallised hard and compact $CaCO_3$.

Characteristics

a. Itsspecific gravityisabout2.72.

b. Crushingstrengthofmarblevariesfrom50to60MN/m^2.

c. Itisveryhardandtakesafine polish.

d. It is available ina varietyofcolours suchas white, yellow, grey, green, red, blue and black colours.

e. It iseasytoworkwithmarble.

Uses

a. Itis forcarvinganddecorationwork.

b. Itisalsousedfor steps,walllinings,columns,electricalswitchboardsandtabletops.

Sandstone: It isasedimentaryrockofsiliceousvariety. It containssandorquartzcemented by lime, mica, magnesium, alumina, iron oxide.

Characteristics

a. Itsspecificgravityis 2.25.

b. Itsstructureshowssandygrains.

c. Crushingstrengthofsandstone variesfrom35 to40MN/m2.

d. Sandstonesoccurinmanycoloursviz., white,grey, pink,red, maroonanddark.

e. Fine grained sandstones withsiliceous cementing materialare strong and durable and are excellent building materials.

f. Sandstonesofdifferenthuesareavailablee.g.,white,grey,brown, pink, etc.

Slate: It isa metamorphicrockofargillaceousvariety. It hasadistinct foliatedstructure. Itis composed ofalumina mixed with sand or carbonate of lime.

Characteristics

a. Itsspecificgravityis 2.8.

b. Agoodslateishard,toughandfine grained.

c. Crushingstrengthofslate variesfrom60 to70MN/m^2.

d. Ithasgreyordarkblue colour.

e. Itcanbesplitintothinsheets.

f. Itisnon-absorbentanddurable.

g. Itproducesasharpmetallicsoundonhammering.

Uses

a. Thin-layeredslateshavinggoodcompressivestrengthareusedas sillsand for pavements inside and outside palatial building.

b. Slateispracticallyimperviousand hence verysuitable forroofingstoneandurinal partitions.

Laterite: Itissedimentaryrockcomposedmostlyofoxidesofaluminiumwithvarying amounts of oxides of iron.

Characteristics

Itsspecificgravityvariesfrom2to2.2.

Ithasapoorcompressivestrength,whichvariesfrom20to30MN/m^2. It is

light to dark red in colour.

Ithasaporousandspongyorcellularstructure.

Uses

a. Laterite isused asabuildingmaterialonly inordinaryconstruction.

b. Itismostlyused asroadmetals.

Gneiss: It is a metamorphic rock. It is formedby the metamorphosis of granite and has thesame constituents as granite. It is siliceous incomposition and foliated instructure.

Characteristics

a. Gneissesarecoarselycrystalline rocks.

b. Itcanbefreelysplitintoslabs.

c. Gneissismore easytoworkwiththangranite.

d. Itisavailableindifferentcolours.

Uses

a. Coarselycrystalline anduniformlytexturedgneissesareasgoodbuilding materialsas granites.

b. Itisusedforornamentalanddecorative purpose.

Quartzite: It iscomposedofsilica. It isdense, hardandglassyinstructure.Somevarietiesof quartzite are very hard and strong and are considered to be very good as building stone. It is strong and durable and used as road metalor railwayballast. it is alsoused inconcrete.

CHAPTER2

BRICKS

I. DEFINITION

Bricks are structuralunits ofrectangular shape and convenient size, and are made ofsuitable clay by the process of moulding, drying and burning.

Since long, bricks are believed to have been used by the people of ancient civilization. This has been established beyond doubt from the excavation of prehistoric sites like Indus Valley civilization at Mohen-jo-daro and Harrappa. Bricks are the most favouredstructural units used for construction in the modern day world around the globe. This is on account of the following reasons in favour of bricks.

1. Easyavailabilityofclay
2. Knowhowofconstruction methods
3. Ready-to-usesize,shapeandhandling
4. Cost

All the above factors combined together go in favour of bricks to make them a very convenient building material.

II. COMPOSITIONANDSELECTIONOFBRICK EARTH

Earths of specific characteristics are used for manufacturing good bricks. A good brick earth should have the following components to give desired characteristics to the bricks manufactured fromthem. Asuitable brick earthshould have the following composition inthe desired proportion.

Alumina

Agood brick earth should have 20 to 30% ofalumina. It gives required plasticityto the brick earth in the moulding stage (wet condition). Alumina content in brick earth should not be more than 30% because it makes the earth more plastic. Bricks made of such earth shrink on drying and cracks may appear on moulded bricks. However, if percentage of alumina is less than 20%, moulding ofbricks to proper shape would become difficult.

Silica

The percentage of silica in good brick earth should be 50 to 60. Silica in brick earth may be presentas a constituent of clay minerals or as free silicain the form of sand or quartz. Desired percentage of silica in clay imparts hardness and strength to the brick. Silica gives resistance against shrinkage and durability of brick to weather. However, if percentage of silica are higher in silica, moulding becomes difficult. Such bricks arefound to be quite brittle and porous.

IronOxide

A small amount of iron oxide (4 to 6%) reduces the softening temperature and makes the fusion of various constituents of clay possible at lower temperature. It alsogives characteristic red colourtothe bricks. However, excessofironoxide makesthe brick too soft during burning which causes deformation of shape and size of the brick. The colour also becomes darker and hence not appealing.

Lime

Presence of lime makes burning and hardening quicker. Lime, if any, should be present in finelypowdered formand thoroughlydispersed. Slaking or disintegration maytake place due to presence of lime in the formofnodules or lumps.

Undesirableorharmfulcomponents

Thebrickearthshouldideallyfreefromthefollowingharmfulcomponents.

1. Limenodules
2. Organicmatterandvegetableroots
3. Sulphidesandsulphates
4. Alkalisalts
5. Pebblesofstoneandgravel

III. BRICKMAKING

Brickmakingorbrickmanufacturinginvolvesthefollowingsteps.

1. Preparationofbrickearth
2. Mouldingofbricks
3. Dryingofbricks
4. Burningofbricks

1. Preparationofbrickearth

The site withsoilsuitable for manufactureofbricks is selected. After selectionofsite, thetop 15 to 20 cm layer overburden is removed to clear off harmfulundesirable ingredients such as vegetation, pebbles and other organic matter. The earth below is then dug out and spread on the ground and exposed to the atmosphere for a period of about two weeks. Sometimes, additional amount of sand, lime etc. are also mixed with the dug soil depending upon the requirement if any. This process is known as **weathering**.

After weathering, the earth is then ground thoroughly to break the lumps if any present in it. The weathered earth is thoroughly mixed with the sand, lime added to it. The process is known as **blending**.

The blended earth is then spread out on a platform and desired amount of water is added tothe mixture and the mixture is then **kneaded** thoroughly so as to form a homogeneous and plastic mix. Thisprocess isknownastempering. Generally25to 30%ofwater issufficientto make the mixture plastic enough for moulding. The amount of water added depends on the type of moulding.

For large scale manufacture of bricks, **pug mill** is used for kneading of clay. It consists of a conical upright steel cylinder covered at the top and with a hole at the bottom. Figure 2.1 shows a typical pug mill. It is 2 to 3 m in height, a part of which is buried under the ground. The top diameter is slightly more than the bottom diameter. A central rotating vertical shaft pivoted at the base, which can be rotated with the help of long arm driven mechanically or manually. The centralshaftis attached with horizontal blades carrying knives.

Seasoned clay and water are added from the opening at the top. The rotation of the shaft and its churning effect on the clay-water mixture produce mud of required plasticity. The mud is then taken out fromthe hole at the base for moulding.

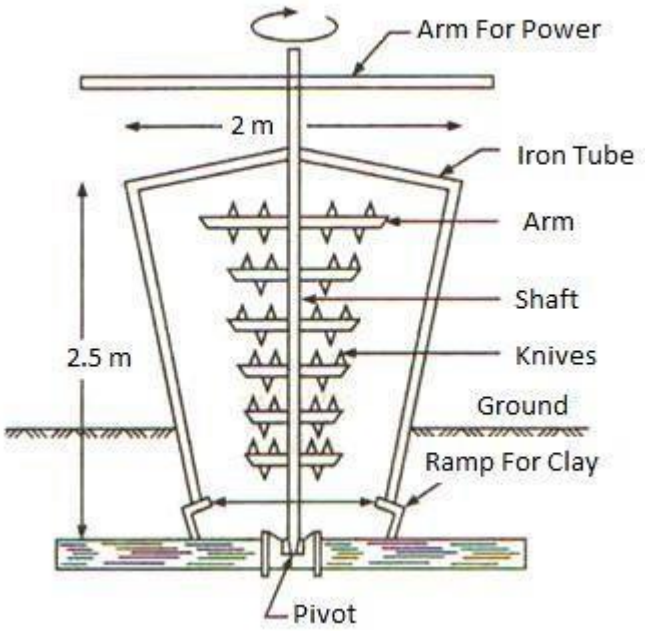


Figure2.1PugMill

2. Preparationofbrickearth

The process of making green bricks of proper shape and sizefrom the tempered clay is known as moulding. Moulding of brick is carried out with the help of a mould. A mould is made of either wood or steel. A wooden mould is fitted with iron plates at edges to make it strong. The inside dimensions of a mould are generally 8 to 10% larger than the size of the bricks. This is to allow shrinkage of bricks during drying.

Therearetwomethodsofmoulding the bricks.

a. Handmoulding

b. Machinemoulding

The tools essential in hand moulding process include brick mould, cutting edge or wire, wooden plates and stock board (Figure 2.2).

a. Handmoulding

In this method, moulding of bricks from tempered clay is done by using skilled manpower. The clayis invariablykept soft sothat it canbe givendesired shape. The watercontentofthe mud is generally 18 to 25% than those used for machine moulding. This method is further divided intotwotypesdependingonthe fact thatwhetherthe moulding isdoneontheground or on a specially designed table. They are

i. Groundmoulding

ii. Tablemoulding

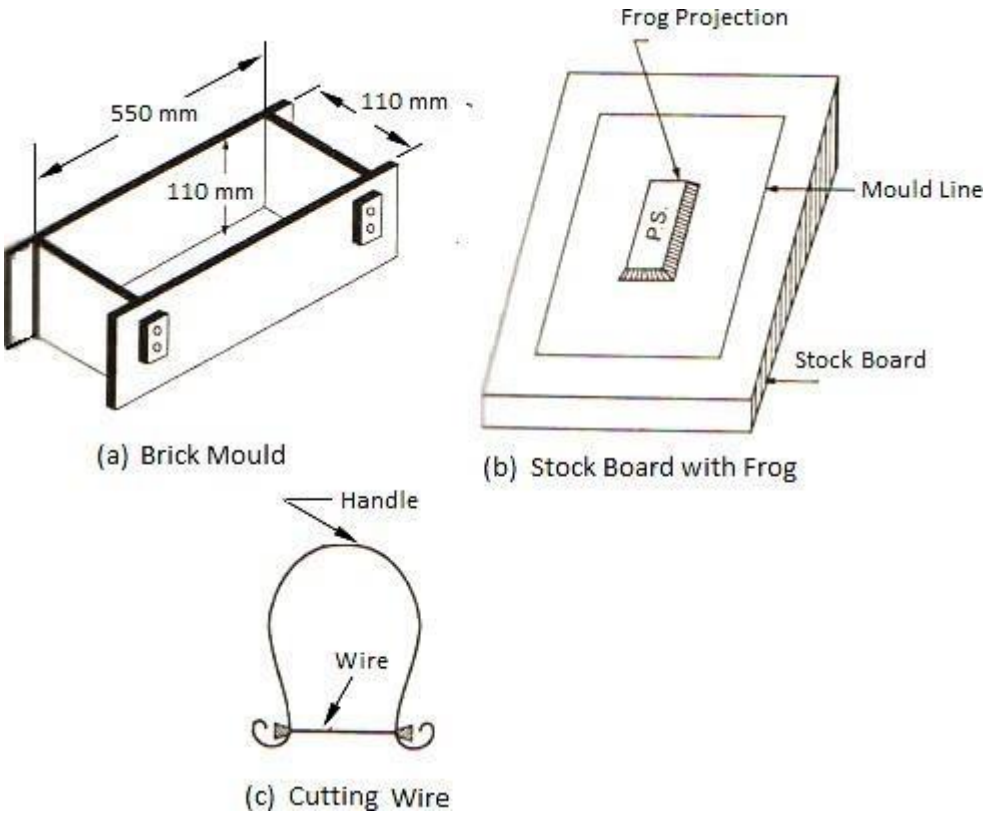


Figure2.2Tools inHand Moulding

i. Groundmoulding

The process of moulding bricks on the ground by skilled manpower is known as ground moulding. In ground moulding, moulding is done on a levelled and rammed ground. Sand is sprinkled over the ground to avoid the sticking of moulded brick with the ground. The moulding process is started from one end of the ground and continued to the other end. The moulded bricks are laid onthe levelled ground for drying.

Groundmouldingiscarriedoutinthefollowingsteps.

The mould is dipped in water or sprinkled with sand in order to avoid sticking of the green mud to the inner side of the mould. A lump of is carefullydashed into the mould by hand. It should be ensured that the clayreaches to the sides and corners ofthe mould. Surplus mud if any is removed withthe help ofstrike or cutting edge. The mould is then lifted witha sudden jerk leaving behind the moulded brick on the ground sprinkled with sand.

ii. Tablemoulding

In this process all the moulding operations are carried out by skilled worker on a specially designed table as shown in the Figure 2.3. The moulded bricks are transported to the drying place with the help of pallet boards. This process is similar to the pallet moulding on the ground. The mould is place over the stock board and some sand is sprinkled on the inside surface of the mould. A lump of mud is then carefully pushed into the mould, pressed thoroughly and skilfully such that the mud reaches to the sides and corners of the mould. The surplus mud is then cut away with the strike or cutting edge. A pallet is placed over the mould and the moulded brick is transferred to the pallet by turning the mould over it. The brick is transported to the drying yard.

Good quality bricks are produced in table moulding. However, the operation process is slow and hence the cost of production is slightly higher in table moulding. The table is large enough to accommodate all the accessories required for moulding.

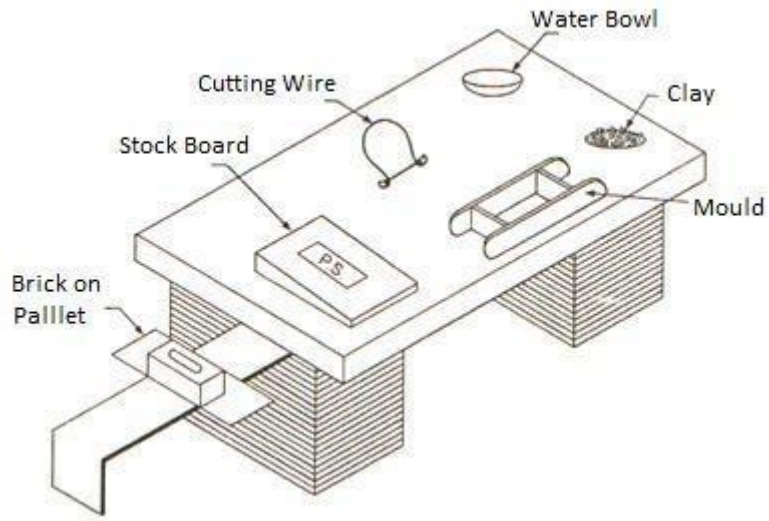


Figure2.3TableMoulding

b. Machine moulding

Machine moulding is useful for large scale manufacturing of bricks. About 2000 bricks can be moulded by a machine per day. It gives bricks of uniform quality andis cheaperin the long run. Depending on the water content of clay, two methods of machine moulding are in use.

i. Stiffmudprocess
ii. Dryprocess

i. Stiffmudprocess

In this method, the very stiff or plastic clay is used for moulding. Only a small quantity i.e., about 8 to 12% of water is added during tempering in the pug mill. The clay is made to pass under pressure through a moulding machine. The pressed mud comes out through the orifice which gives the mud a continuous ribbon shape of given height and depth. This is cut into desired length by means of cutting wires. The cut bricks are then taken away for drying. A brief description of a typical worm gear typemoulding machine as shownin Figure 2.4 is give below.

WormGearTypeMoulding Machine

Awormgeartypemouldingmachinecomprisesofthefollowing parts

i. Feedingchamberprovidedwithwormgeartoapplypressure

ii. Hoppertoreceive claymixfrompugmill
iii. Fixedorificeprovidedinthenarrowfrontend
iv. Conveyorbeltonsetofrollers
v. Cutting wire device adjusted in front oftheorifice to cut the moulded brick to give it third dimension

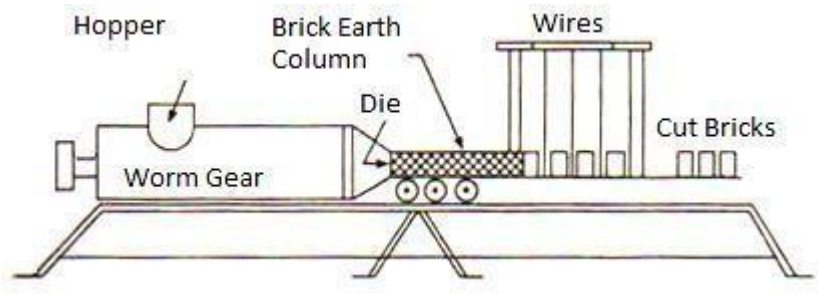


Figure2.5WormGear TypeMachineMoulding

ii. Dryprocess

In this type of moulding, very small quantity of water, a maximum of 10% of water is added during tempering so that the mix is almost dry. The clay is then fed through the hoppers into the mould and is compressed by a plunger with a pressure of about 50-150 kg/cm^2. Such a pressure is sufficient enoughto convert the loosedamp clay mass into a dense, verycompact brick unit, which is then removed from the mould. The metal mould is heated during the moulding process to avoid sticking of clay. Bricks from such moulding machines can be directlytaken for burning. The bricks, thus manufactured, have perfect shapes and sizes.

3. Drying

Mouldedbricksneedtobedriedbeforeburning.Dryingisessentialduetofollowingreasons.

i. tomakethegreenbrick strongenoughsothattheycanbehandled duringstacking
ii. to allow lossofmoisture content at aslow ratebecause ifthe bricksare straight away burnt, they may disintegrate due to rapid loss of moisture
iii. thefuelrequirement issignificantlyreducedwithreductionofmoisturecontent

There are two methods of drying

a. Naturaldrying

b. Artificialdrying

a. Naturaldrying

In this method, bricks are dried in the sun in open after moulding.Bricks are laid flat side wise for 2to 3 days for drying. Whenthe bricks are dryenoughto be handled safely, theyare carried to the specially prepared drying yards for stacking. Drying yards are situated at a higher elevation for draining off rain water. The bricks are stacked in the drying yards by keeping them at their edges. 8-10 bricks are kept in each rowof a stack. Enough space is left betweenthe rows andthe layers ina stackfor freecirculationofair around eachbrick. Bricks are protected from direct exposure to sun. And sometimes roofs are also made over drying yard to protect them fromheavyrains. Figure ddd shows a typical stack.

b. Artificialdrying

Artificial method of drying is used in mechanized brick manufacturing units where bricks in largescalearerequiredto bedriedat averyrapidrateandthroughoutthe year independent of weather conditions. Artificial drying is carried out in specially designed chambers or tunnels which receive heat fromspecial furnaces builtfor the purpose.

4. Burning

Aftermouldinganddrying,bricks areburnteitherin the clampor in the kiln.Burningnot onlyimparts strength and hardness to the brick but also increases its density.

Clamps

Clamps or Pazwas are temporary working arrangements made for burning bricks. In this method dried bricks and locally available ordinary fuel are stacked together in alternative layers upto a desired height on a properly prepared ground to form a clamp.The clamp isthen plastered with mud from outside for its protection.It is ignited from the base and allowed to burn for about a month and then allowed to cool for another month.

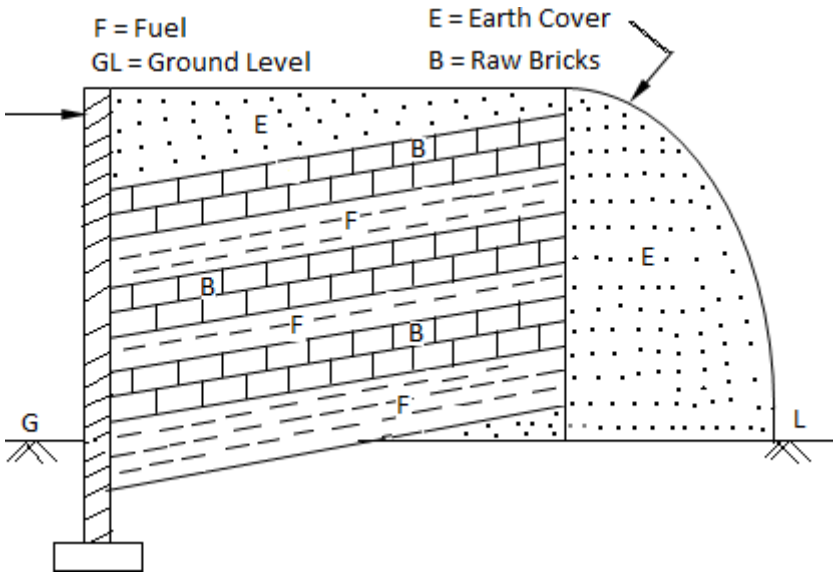


Figure2.6 Clamp

A characteristic clamp is shown in the Figure 2.6. In this, a sloping ground of trapezoidal shapeand slopeangleofabout 15^0 isprepared. Thenarrowend ofthetrapeziumisdug below the ground leveland the wider end is raised by filling with the earth so dug. Over the ground so prepared,the first layer oflocallyavailable fuel suchasstraw, wood,leaves, branches, etc. is laid up to a height of about 1 m. Three to fivelayers of sun dried bricks are properly stacked over such fuel layer leaving sufficient open spaces between the bricklayers. Over this, another layer of fuel of slightly smaller heightis laid.The arrangement of alternate layers of fuel and bricks is repeated till the required height is achieved. The clamp is then plastered with mud fromoutside and the clamp is ignited fromthe narrowend at the base. It is allowed to burn for a month and then allowed tocool for a month.

Kilns

Unlike clamps, kilns are permanent structure used for burning bricks. Kilns are mainly divided into two broad categories based on their principle of their construction. They are: **intermittent kilns**, and the **continuous kiln**. An intermittent kiln is one, which produces bricks after a definite intervaloftime. On the other hand, a continuous kiln is the one, which produces bricks continuously. Continuous kiln consists ofa number ofchambers. Burning in

a continuous kiln involves five stages of operations such as loading, burning, preheating, cooling and unloading. The operations in the chambers are so controlled that at a given time, different chambers perform different functions. For example, when one chamber is in the loading process, another chamber may be in the burning stage, the third chamber is in the preheating stage, the fourth chamber in the cooling stage and the fifth chamber in the unloadingor supplystage. Theoperationsareshifted fromchamber to chamber insuchaway that at anytime one chamber is available for unloading.

Intermittentkiln

Allahabad kiln is a common type of intermittent kiln and is widely used. It is generally rectangular inshape and has four permanent walls. It maybe constructedtotallyunderground or partly underground and partly over ground. The longer walls are raised perpendicular tothe directions of prevailing winds. The kilns are provided with a number of openings called flues, exactly opposite to each other with a view of charging fuels and controlling air. These openings are provided with dampers or door sheets, which can be raised or lowered.

The shorter walls are provided with doors for loading and unloading the bricks. The floors provided with narrow and deep grooves in the transverse direction running fromone opening to the other in the long walls. The place between any two grooves makes a raised platformof about 1 m width. This is called rouse.

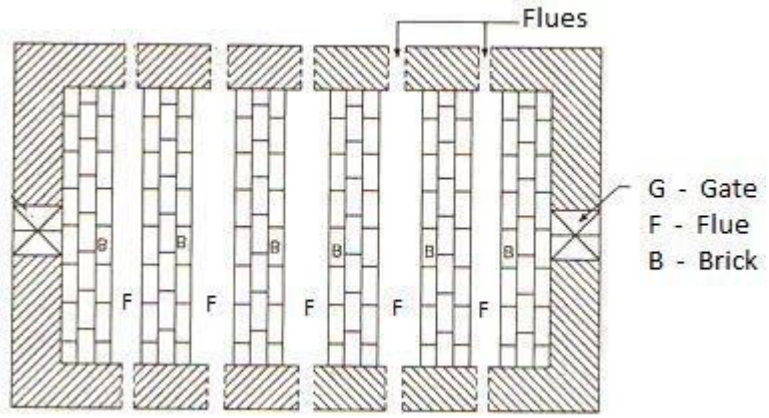


Figure2.7Intermittentkiln(AllahabadKiln)

IV. CLASSIFICATIONOFBRICKS

According to the IS: 1077 , 1971 ofBureau ofIndian Standard bricks are classifiedinto the following classes.

Class of brick	Characteristics	Uses
Firstclass	1. It is well burnt having smooth and even surface with perfectly rectangular shape and uniform reddish colour. 2. Its surface is smooth, clean and freefromcracks. 3. When two bricks are stuck against each other a ringing sound is produced. 4. Itscompressivestrengthshall not be less than 140 kg/cm2. 5. It should not absorb more than 20% of water by weight when immersed inwater for 24 hours. 6. When scratched by finger nail, there should be no mark left on it. 7. When broken into two pieces, it should show uniform compact structure. 8. Showonlyslightefflorescence.	1. Excellent in all types of construction in exterior walls 2. UsedinR.Bwork 3. Used as ballast for R.C work 4. Used for flooring and walling purposes
SecondClass	1. It iswellburnt orslightlyover burnt, not perfectly rectangular shape, havingroughsurface and doesnot have uniform reddish colour. 2. Metallicringingsoundisproducedwhen two bricks are stuck against each other. 3. Compressive strength shall not be less than 70 kg/cm^2. 4. It should not absorb more than 20% of waterwhen immersedinwaterfor24	1. These are used in internal walls not exposed to atmosphere. 2. Should be plastered, if used in facing work. 3. Thesearenotusedin R.B work. 4.Thesebricksmaybelaid in mud and lime mortar.

	hours. 5. Showsonlyslightefflorescence. 6. Itisnot freefromlumpsandcracks.	
Thirdclass	1. Thesebricksarenotburntinkilnandare slightly under or over burnt. 2. Thesearesoftandcanbeeasilybroken. 3. They are light in colour with yellowish tinge. 4. When struck against each other, they do not produce ringing sound. 5. It should not absorb more than 25% of water by weight when immersed in water. 6. Efflorescenceis moderate. 7. Compressive strength is between 35 to 50 kg/cm2.	1. It is used in inferior construction work andat placesoflessrainfall.
Jhama or over burnt brick	1. Due to over burning, these bricks loose shape and get twisted. 2. Theyare darkincolour. 3. These are quite strong in compressive strength and have compressive strength more than150kg/cm^2. 4. Thesebrickshavelowporosityand waterabsorption.	1. These bricks are not used in building construction. 2. They may be used as road metals, and in foundation and floor soling.

V. QUALITIESOFGOODBUILDINGBRICKS

1. Itshouldhaveperfectlyrectangularshape,regularsurfaceandredcolouredappearance.
2. Itshouldconfirmtothespecifiedsizei.e., 19x9x9cmfor modular bricks.
3. It should be perfectly burnt. To confirm proper burning, two bricks are struck against each other. A metallic ringing sound confirms proper burning where as a dull thug indicates improper burning.

4. A good building brick should not absorb water more than 20% of its dry weight when immersed inwater for 24 hours. Inno case, it should be morethan25%.
5. The compressive strengthofa building brick inno case be less35 kg/cm2. Aroughtest for the strength of brick is to drop the brick from a height of 1 m on a hard surface. Upon falling, it should not break.
6. It should leave no mark when scratched by fingernail. This showsthat the brick is hard enough for building construction.
7. A good brick has a uniform colour and structure throughout. To check this, a brick is taken from the lot and broken into two halves. The broken surfaces in both halves should have same appearance and structure.
8. Efflorescenceshould beminimum.It showsthatthesaltsofalkalineareless.
9. A good brick should be able to resist the effects of weathering agents like temperature variation, rain, frost action, etc.
10. A good brick should have adequate resistance to fire. Ordinary bricks can resist temperature upto 12000 C.

VI. USESOFBRICKBATSANDSURKHIS

VII. USESOFHOLLOWBRICKS

Hollow bricks are also known as cavity bricks or cellularbricks. They have a few well defined sets of holes of specified dimensions made in their body. Hollow bricks are made of special type of brick earth having higher percentage of clay. Net weight o f a hollow brick is about one-third to one-half ofthe solid brick ofsame dimension.Ahollow brick differs from a perforatedone in the sense the bodyof the brick. Hollow bricks have following advantages in their favour. Atypical hollow brick is depicted in the Figure 2.8.

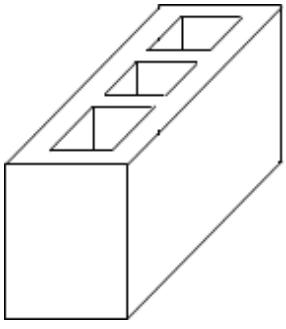


Figure2.8HollowBricks

Advantages

i. Itislightinweightandcanbemoreconvenientlyhandled.
ii. Itoffersbetterinsulationagainstheat,soundanddampnessofthe building.

Uses

They are used for construction of load bearing walls, partition walls or panel walls in multi-storeyed building. Theyare also used in building forbetter insulationagainst heat, sound and dampness.

CHAPTER-3

CLAYPRODUCTSANDREFRACTORYMATERIALS

=>Theproductswhichare preparedfromclayare knownasclayproduct.

=>Theclaywhenmadewet withwaterit possessplastic innatureandthisplasticclaycan be moulded in any shape, then dried and burnt.

Theclayproductswhichareemployed intheconstructionofbuildingsaretile, terra cotta, porcelain, glazing etc.

TILE:-

->Itmaybedefinedasthethinslabofbrickwhichare burntinkiln.

->The manufacturingprocessoftileisjustsimilartobricki.e

(i) Preparationofclay.

(ii) Moulding

(iii) Drying

(iv) Burning

->Thetilecanbeclassified astwotypes

(i) Common tile

(ii) Encoustictile

COMMONTILE:-

->Thesetileshavedifferentshapeandsizeandmainlyusedinpavingandflooring.

ENCOUSTICTILE

->Thesetilesareusedfordecorativepurpose,i.einfloors, walls, ceiling etc.

->Thesetilesare manufacturedfromcarefullypreparedclay,colouring materialsandother ingredients.

=>Thecostofthese tilesaremorethancommontiles.

=>Thesetilesprovideuniformappearance.

TYPES OFCOMMONTILE

Dependinguponitheusethereare3differenttypesoftile.

*Draintile

*Floor tile

*Rooftile

DRAINTILES

->Thetileswhichareusedfordrainspurposesareknownasdraintiles.

->Generallythese areusedinwater loggedareas.

=>Thesetilesmaybecircular orsemicircularinshape.

=>ThesetilesarealsousedinIrrigationstructures.

FLOORTILES

->Thetileswhichareused for flooringpurposesareknownasfloortiles.

->Thesetilesmaybeofsquareorhexagonalin shape.

->These tilesare hard.

=>thesetilesareavailableindifferentcolours.

=>Thesetilesdo notrequirepolishing&the floorisreadyto usefromthenext dayof laying.

ROOFTILES

->Thetileswhichareusedforroofing purposesareknownasRoofTiles.

->Thesetilesareheatproof.

=>Thevarioustileswhichareavailable inthe market areFlemishtiles, pottiles, corrugated tiles etc.

CHARACTERISTICS OFAGOOD TILE

Agoodtileshould havethefollowingcharacteristics.

* Itshouldberegularinshapeandsize.

* Itshouldbehard.

* It shouldwell burnt.

*Itshouldbefreefromanycracks.

TERRACOTTA:-

->Terracottamean bakedearth.

->ItisatypeofclayproductwhichisglazedwithGalena.

=>Itisasoftmaterial.

=>Themanufacturing process ofterracottaisalsosimilartothat ofbrick.

Properties

->Itislightinweight.

->Itisfireproof.

->Itcanbeeasilyclean.

=>Itcanbeeasilymouldedindesired shape.

=>Itcannotbeaffected byatmosphericagents.

USESOFTERRA COTTA:-

->Itisadoptedforalltypesofornamentalwork.

->Itisusedasadecorativematerialinpillars, columnsetc.

TYPESOFTERRA COTTA:-

Thereare2types ofterracotta.

1. Porousterracotta.
2. Polishterracotta.

POROUSTERRACOTTA:-

->Toprepareporousterracottathe sawdustareaddedinclaybeforethe stageofmoulding.

->Whenthearticles fromsuchclayare burnt inakiln, theorganicparticlesareburnt andthey leave pores in the articles.

=>Thisterracottaisfire proof.

=>Itisverylightinweight&structurallyweak.

POLISHTERRA-COTA

->This isalsoknownasfineterra-cotta.

->To preparethistypeofterra-cottathearticlesare burnt inthekilnat atemperatureabout 650°c.

=>Thenthearticles areremovedfromthekiln&areallowedtocooldown.

=>Theyarethencoatedwithglazingcompounds&burnt againinthekilnat atemperature about 1200°c.

=>Itisunaffectedbytheadverseatmosphericconditions.

EARTHENWIRE:-

->Theearthenwire isuseto indicatethearticlespreparedfromclaywhichisburnt at low temperature & cooled down slowly.

->Thisclayismixed withrequiredquantityofsand,crushedpotteryetc.

=>Theadditionofsuchmaterialspreventscracking duringburning.

=>Theearthwireswithbased materialbecome imperviousto water&theyarenotaffected by atmospheric action.

=>Theseareusedfororordinarydrainpipes,partitionblocksetc.

STONEWIRE:-

->Thetermstonewire isusedto indicatetothearticlespreparedfromclaywhichare mixed with stones and crushed pottery.

->Thismixeristhenburntatahightemperatureandcooleddownslowly.

=>Thestonewiresarestrong, durable &fireresistant.

=>Theyareusedasjarstostorechemicals,washbasinsetc.

PORCELAIN:-

Thetermporcelain isusedtoindicatetheearthenwirewhichiswhite, thinand semitransparent.

->Asthecolourofporcelainiswhiteitalsoknownaswhitewire.

->Itishardandnon-porousmaterial.

=>Itishard&nonporous.

->Theseareusedinvariouspurposes likesanitaryfittings,insulatingboardsetc.

->Theseare oftwotypes

*Lowvoltageporcelain

*Highvoltageporcelain

Lowvoltageporcelain:-

- ⇨ Itispreparedbydryprocess&atlowvoltage.
- ⇨ Ifsome lowquantityofalumina isaddedthenit canresist high temperaturetoa certain extent.
- ⇨ Thesearemainlyusedfor switchboards,insulatingtubesetc.

Highvoltageporcelain:-

- ⇨ Itispreparedbywetprocessathightemperature.
- ⇨ Itcanresisthightemp. &voltage.
- ⇨ Theseareusedintheconstructionofatomicreactors,plugsetc.

GLAZING:

->Aglaze isaglassycoatthicknessabout 0.1to 0.2mmappliedonthesurfaceoftheclay products.

->Theglazing isdoneforfollowingpurposes

*Toimprovetheappearance

*Tomakethearticlemoredurable

*Toprotectthearticlesfromweatheringaction.

TYPESOFGLAZING

*Transparentglazing

*Opaqueglazing

TARNSPARANTGLAZING

->Whenaglazing materialfromtransparent colourisprovided inthesurfaceofclayproduct it is called as transparent glazing.

->Theappearanceofthisglazingislikeglass.

->It giveslessstrength.

=>Thisglazingisrarelyused asitprovideslesssafetytothearticles.

OPAQUEGLAZING

->Thistypeofglazing isadoptedto givebutterappearancethanthat givenbythe burnt material.

->Theclayisfinelypowderanddried. Thenthesufficient quantityofwaterisaddedto clay to make a plastic substance.

->Thearticleswhicharetobeglazedaredipped inthissubstancebeforeburningandthen heated.

=>Theburning ofarticlesgivestheflowofclayparticle &anopaqueglazeisformed.

=>Forobtainingcolouredglazes,aspecialcolourpigment isadded like ironoxide,which gives red colour, copper oxide, which gives green colour etc.

REFRACTORYMATERIAL

->Thematerialswhichareabletoresisthightemparatureareknownasrefractorymaterial.

->Therefractorymaterialcanposessthefollowingpropaties.

*It'smeltingpoint shouldbehigh.

* Itshouldbestronganddurable.

* Itmustpossessresistancetoweatheringaction.

USES:-

->Theseareusedinblastfurnaces.

CLASIFICATIONOFREFLACTORYMATERIAL :-

->Theseareclassifiedintofollowingtwoways.

*Accordingtochemicalproperties

*Accordingtoresistancetotemparature.

ACCORDINGTOCHEMICALPROPERTIES :-

->Theseare3 types.

*Acidicmaterial–e.gSilica,quartzaite.

*Basic–e.gmagnesiaDolamite.

*Neutralmaterial– e.gCarbon,chromite,boxite.

ACCORDINGTORESISTANCETO TEMPARAATURE

->Thesearedevidedinto2types

*Lowqualityrefractorymaterial

*Highqualityrefractorymaterial

Lowqualityrefractory material:-

- ⇨ Thematerialwhosemeltingpoint ismorethan1580°cisknownaslowquality refractory material.
- ⇨ Thismaterialisusedformanufacturingflyashbrick&alsousedforelectricboards.

Highqualityrefractorymaterial:-

- ⇨ Thematerialwhose meltingpoint isabout 1600°cisknownas highqualityrefractory material.
- ⇨ Thesematerialsareusedfortheconstructionofrockets,jetsetc .
- ⇨ Thistypeofmaterialisalsousedinthemanufacturing ofvehicles.

CHAPTER-4

CEMENT

Compositionofcement :-

Thecementconsistsofthefollowingchemicals

°Lime -CaO-62%

°Silica–SiO_2-22%

°Alumina-Al_2O_3-5%

°Calciumsulphate-$CaSo_4$-4%

°IronOxaide-Fe_2O_3-3%

°Magnesia-MgO-2%

°Sulphur-S-1%

°Alcalineandother material-1%

Typesof cement:-

Accordingtothecreationofthecementitisclassifiedintotwotype.

* Naturalcement

* Artificalcement

NaturalCement :-

Thenaturalcement isobtainedbyburingandcrushingthestonescontainingclay carbonates of lime and some amount of carbonates of magnesia.

* Thequantityofclayinnaturalcementis 20-40%.

*Thecolorofthiscementisbrown.

*Thiscementsetsrepidlywhenmixedwithwater.

* Thecost ofthistypeofcementisveryhigh.

* ThistypeofcementisrarelyusedinIndia.

Artificialcement:-

->Thistypeofcementispreparedindifferentverities.

->Themanufacturing ofthistypesofcementincludesthefollowingprocess.

* Mixingofrawmaterials.

* Burning.

* Crushing.

* Grinding.

Typesofartificialcement:-

:-Acidresistantcement.

:-Blastfornesscement.

:-Colouredcement.

:-Expanding cement.

:-Highaluminacement.

:-Hydyophobiccement.

:-Lowhitcement.ral

:-Pozzuolanacement.

:-Quicksettingcement.

:-Rapid hardeningcement.

:-Sulphateresistingcement.

:-Whitecement.

Acidresistingcement:-

Anacidresistingcementiscomposedofthefollowingingradients.

i. Acidresistingaggregate.

ii. Additiveslikesodiumfluosilicate.

iii. Aquessolutionofsodiumsilicate.

Theadditionoffluosilicateacceleratesthehardeningprocessofsodiumsilicate&it also increases the resistance of cement to acid & water.

Blastfranacecement:-

->Forthiscementtheslagwhichisobtainedfromblastfurnaceisused.

->Theslagisawasteproductinthemanufacturingprocessofiron.

=>The clinkerofcementismixed with60– 65%ofslag.

=>Thestrengthofthiscementis less&itrequireslonger quiringperiod.

Colouredcement:-

->Thecement ofdesiredcolourisobtained bymixingthe mineralpigmentswithordinary cement.

->Theamountofcolouringmaterialisbetween5-10%.

=>Thecolouredcementiswidelyusedforfinishingoffloors, externalsurfacesetc.

=>Thechromiumoxidegivesgreencolour,cobaltgivesbluecolour &ironoxidegives brown red or yellow colour in different proportions.

Expandingcement:-

->Thistypeofcement isproducedbyaddingtheexpanding materialoringradients likes sulpher alluminate to ordinary cement.

=>Thistypeofcement isused fortheconstructionofwaterretaining structures&for repairing the damaged concrete structures.

HydrophobicCement:-

- Thistypeofcement containstheadmixtureswhichdecreaseswettingabilityof cement grains.
- Usuallytheadmixturesareoxides,petroliumsetc.
- Thesesubstancesformathinlayerarroundcementgrains.
- Whenthiscementisused ,thewaterresistanceofconcreteisincreased.

Highaluminacement:-

- Thiscement isproducedbygraindingtheclinkersfromed bycalciningbauxiteand lime.
- ThiscementisrarelyusedinIndia.

Low heatcement:-

- Inthiscementaconsiderableheatisproducedduringthesettingaction.
- Itcontainshigher%age ofdicalciumsilicate&lower%ageoftricalciumaluminate.
- Thiscementpossesslesscompressivestrength.

Pozzuolonacement:-

- ⇨ Itcanbeproducedbysurkhiwhichispreparedbyburning bricks made fromordinary soils.
- ⇨ Thiscementisusedfor concreteworkunder water.
- ⇨ The%ageofpozzuolanamaterialshouldbebetween10to30.
- ⇨ Itischeap.

Quicksettingcement:-

- ⇨ Thiscementisproduced byadding smallpercentageofaluminiumsulphateand by finely grinding the cement.
- ⇨ Thewsettingactionofthiscementstartswithin5minutes.
- ⇨ Thiscementisusedtolayconcreteunder staticwater&running water.

Rapid hardening cement:-

- ⇨ Itisjustsimilartoordinarycementbutisgives morestrengththanordinarycement.
- ⇨ Itisnotdamagedeasily.
- ⇨ It containshighpercentages oftricalcIiumsilicate.
- ⇨ Thestructureswithheavyloadareconstructedwiththiscement.
- ⇨ Thiscementiscostlierthanordinarycement&isverylight.

Sulphateregisting cement:-

- ⇨ Theordinarycementismixedwithcalsiumhydroxideandfinallygrinded.
- ⇨ Thecement isused forthestructrewhicharetobedamaged byalkalineconditions such as canal linings, culverts , siphons etc.
- ⇨ Thecementisusedinmarineconstruction.

Whitecement:-

- ⇨ Thiscement ispreparedfromtherawmaterialswhicharepracticallyfree from colouring oxides of iron,manganese or chromium.
- ⇨ Itisusedforplasteringwork,floorfinishingetc.
- ⇨ Itisalsocostlythanordinarycement.

Propertiesofcement:-

Followingaretheproperties ofcement.

1. Itiseasilyworkable.
2. Itgivesstrengthtothemasonarywork.
3. Itisanexcellentbindingmaterial.
4. Itoffersgoodresistancetothe moisture.
5. Itpossessgoodplasticity.
6. Itstiffensorhardensearly.

Testingofqualityofcement :-Fortestingthequalityofacement,the followingtestsare carried out in the laboratory :-

(i) Fineness
(ii) Consistency
(iii) Compressivestrength
(iv)Settingtimes(Initial&Final)
(v)Soundness

CHAPTER-5

SANDGRAVEL,MORRUMANDFLYASH

Sand:-

->Generallysandisformedbythedecompositionofstonedueto variouseffectsofweather.

->Thesandparticlescontainssmallgrainsofsilica(SiO_2).

->Thereare3 catagoriesofsand accordingtothenaturalsourcesfromwhichitisobtained :

*Pitsand

*Riversand

*seesand

PITSAND

->Theseareobtainedbyformingpits.

->Thepitisexcavatedfroma depthof1-2mfromtheground.

->Thesepitsandconsistsofsharp, angular grains,whicharefreefromsalt.

->theseareexcellentmaterialformortarofconcretework.

->Thesepitsandisrarelyusednowadays.

RIVERSAND

->Thissandisobtainedfromriverbeds.

->Thissand consists offinerounded grains duetotheactionofwatercurrent.

->The colourofriversandiswhite.

->Thissandiscommonlyusedincleanedcondition, soitisusedfor allpurposes.

SEESAND

->Thissandisobtainedfromseeshores.

->Thesesandisalsoconsist offineroundedgrains.

->Thecolourofthissandislightbrown.

->Thissand retardsthesetting actionofcement.

CLASSIFICATIONSANDACCORDINGTOTHESIZEOFGRAIN

Accordingtothegrainsizeofsandparticles itisclasifiedto3type.

*Finesand

*course sand

*Gravellysand

=>Thesandpassingthroughascreenofopeningof1.5 mmiscalledas finesand.Theseare mainly used in plastering purpose.

=>Thesandpassingthroughascreenofclear openingof3.71mmiscalledascoursesand. It is mainly used for masonry work.

=>Thesandpassingthroughacscreenofclear openingof7.61 mmiscalled Gravellysand. These are commonly used for floorings, paving of road surfaces etc.

BULKINGOFSAND:-

The presence of moisture in sand particles increases the volume ofsand.It is due to the fact that the moisture causes a thin layerof water arround the particles which results increase in volumeofsand.Foramoisturecontentofabout5to 8percent,this increase involume may be as muchas20 to 40 percent ,depending upon the grading ofsand. The finer the material, the more will be the increase in volume for a given moisture content . This phenomenon is known as the bulking of sand.

Qualitiesofsandforplaster&forMasonrywork:-

- Thesandshouldbeclean&coarse.Itshould be free fromanyorganicorvegetable matter.
- Itshouldcontainsharp, angular, coarse&durablegrains.
- Itshouldnotcontainsaltswhichattractmoisturefromatmosphere.
- It should be well graded i.e, should contain particles of various sizes in suitable proportions.It shouldpassBISNo.480meshsieve&should notpassBISNo.15 sieve. The fineness modulus ofsand should be between 2 & 3.

Gradingofsandforplaster&forMasonrywork:-

- Inordertoobtainedtheconcreteofgoodqualities, thesandshould beproperly graded.
- Forincreasing thestrengthofconcretestructure,thegradationshouldberequired.
- Thegradingofsand isexpressed intermsofBIStest seiveNo.480,240,120,60,30, 15.
- Thegradingofsand hasa markedeffect bontheuniformity,workability&finishing qualities of concrete.

GRADING TABLE

BISsieveNo.	%ageofwtpassingthroughthesieve

No480	95-100
No240	70-95
No120	45-85
No60	25-60
No30	5-30
No15	0-10

USEOFGRAVEL:-

->There are6typeofgravel

*1crushedgravels:-Theseareusedinredimixedconcrete.

*1roundgravel:-Theseareusedinroofing,decorating purposesetc.

*2crushedgravel:-Theseareusedformanufacturingofbasementmaterials indrains.

*2roundgravel:-Theseareusedforroofing,decorating purposes.

*3crushedgravel:- Theseareusedforbasementmaterialinroads.

*3roundgravel:-Theseareusedfor decorating purposesinplaygrounds.

USEOFMORRUM:-

->Itisusedaspavingmaterialintheconstructionofroad.

->Itisusedasbasementmaterialindrains.

->Itisusedforfillingundergroundtanks.

->Itisusedfor under layingsurfaceoffoundation.

->Itisusedforflooringpurposesinbuildings.

USEOFFLY ASH

->Itisusedasanadmixtureinconcrete.

->Italsoimprovesthestrengthofconcrere.

->It improvesthewatertightness ofconcrete.

->Itpermitstheeasierplacing&finishingofconcrete.

->Itisusedformanufacturingthebuildingbricks.

CHAPTER-6

MORTARANDCONCRETE

Definition&Composition

Mortar is a mechanical mixture of cement and sand having different proportionpreparedbyaddingrequiredquantityofwater.It isalso knownasbinding material like cement or lime.

Mortarisusedasabinding materialforbrick masonryandstone masonry,asacovering materialto walls inthe formofplaster to provide a smooth, hard and decorative.

Propertiesofgood buildingMortar

Followingarethepropertiesofgoodbuildingmortarrequired

1. Itshouldbeeasilyworkable.
2. Itshoulddevelopadequatestrengthintension,compressionand bond fortheworkfor which itis used.
3. Itshouldsetquicklysothat thespeedofconstructionisensured.
4. Itshould bedurableandnotaffect thedurabilityofothermaterials.
5. Itshould bindthestoneandbricktogiveatight jointthroughwhichwatercannot penetrate.
6. Itshould becapableofdevelopingthedesignedstressed.
7. Itshouldbecheap.

Usesof Mortar

Thefollowing aretheusesofmortar

1. Itisusedto fillupthespacesbetweenbricksandstones formakingwallweather tight.
2. Itisusedtobindtogetherthebricksinbrickmasonry.
3. It isusedinconcrete asa matrix.
4. Itisusedtoformjointsofpipes.
5. Itisusedtoimprovegeneralappearanceofstructure.
6. Itisusedtohideopenjointsofabrickworkandstonework.
7. Itisusedtoserveasamatrixorcavitytoholdcoarseaggregates.
8. Itisusedtobindthebuildingunitssuchasbricks,stones,etc.intoasolidmass.
9. Itisusedtofillupcracksdetectedinthestructureduringmaintenanceprocess.

INGREDIENTSOFMORTAR

Theingredientsofvarious mortarsusedfordifferentengineeringpurposeareas follows

1. Bindingmaterials(Cement,Lime)
2. Fineaggregates(Sand,Surkhi,Ashes,Cinder)

Bindingmaterials

Cement mortar:

In this type of mortar, cement is used as a binding material. Depending upon the strengthrequiredand importanceofwork,theproportionofcementto sandbyvolume varies todifferent proportions.Thesurkhiandcindercannotbeused incement mortarbecausethey are not chemically inert substances.

Function:Incementmortar,cementperformsthefollowingfunctions:

- Itmakesthemortarimpermeablebyfillingupthevoidsexistinginthefineaggregate.
- It impartsstrengthtothemortaronsetting andhardening.

Limemortar:

Itisalso usedasabinding materialinpreparingthe mortarsforvariouspurposesbut itsstrengthis lessthanthatofcement mortar.Thesurkhiisusedasthe fineaggregateinthis case.

FineAggregates(SAND)

Sandisthemost important fineaggregatewhichisusedincement mortar.Thesand forms an important ingredient of mortar.

ClassificationofSand:

Accordingtothesizeofgrains, the sandisclassified asfineandcoarseandgravelly.

1. Thesandpassingthroughascreenwithclear openingsof1.5875mmisknownasthe fine sand. It is mainly used for plastering.
2. Thesandpassing throughascreenwithopeningof3.175mmisknownasthecoarse sand. It is generally used for masonry work.
3. Thesandpassingthroughascreenwithopeningof7.62mmisknownasthegravelly sand. It is used for concrete work.

PropertiesofgoodSand

Following arethe properties ofgoodsand

1. Itshould bechemicallyinert.
2. Itshouldbecleanandcoarse.
3. Itshouldbefreefromanyorganicor vegetablematter.
4. Usually3to4%clayis permitted.
5. Itshouldcontainsharp,angular, coarseanddurablegrains.
6. Itshouldnotcontainsalt.

FunctionofsandinMortar:

Thesandisusedinmortarforfollowing purposes:

1. **Bulk:**Itdoesnot increasethestrengthofmortar.But it actsasadulterant.Hencethe volume of mortar is increased which results in reduction in cost.
2. **Setting:**Ifbuilding materialisfat lime,thecarbondioxide isabsorbedthroughthe voids of sand and setting of fat lime occurs effectively.
3. Strength: it helps intheadjustmentofstrengthofmortar byvariationofitsproportion with cement or lime. It also increases the resistance of mortar.
4. **Surfacearea:** It subdividesthepasteofthebindingmaterialinto athinfilmandthus more surface area is offered for its spreading.
5. **Shrinkage:**It preventsexcessiveshrinkageofthemortarinthecourseofdryingand hence the cracking of mortar during setting is avoided.

PERCAUTIONSINUSINGMORTAR:

Followingaretheprecautionsaretobetakenwhilemakinguseofmortar:

1. **Consumptionofmortar:**afterpreparation,the mortarshould beasearlyaspossible. The lime mortar should be consumed within 36 hours after its preparation and it should be kept wet or damp. The cement mortar should be consumed within 30 minutes.
2. **Frost action:** Thesettingactionofmortar isaffectedbythepresenceoffrost. Itis thereforeadvisable to stopthe workin frostyweather orto executeit withcement mortar.
3. **Workability:** Themortarshouldnot containexcesswaterand it shouldbeselected or recommended.

CONCRETE

Definition

Thecementconcreteisamixtureofcement, fine aggregate(sand),coarse aggregate(crushedrock)andwater,whicharewellproportionedand mixproperly.Itbecome hard like a stone after proper curing.

CHARACTERISTICSOFGOODCONCRETE

Agoodconcreteshouldhavefollowingcharacteristics:

1. Itshouldbehighcompressivestrength.Thecompressivestrengthshouldnotbeless than 15.5 N/mm^2.
2. Onhardening, itshouldexhibitminimumshrinkage.
3. Itshouldbeeconomicalfor thedesiredstrength.
4. Itshouldhaveminimumthermalexpansionsoastoprovidegoodresistanceto fire.

5. Itmustbeadequatelydense.The densityofgoodconcrete shouldbeabout24kN/m^3.
6. Itshouldsufficientlyhardandprovideenoughresistancetoabrasion.
7. Thispropertyisofparamount importancewhenconcreteisto beusedformaking steps of stairs and road pavements.
8. Itmustbeadequatelydurabletoresisttheeffectsofweatheringagents.
9. Itshouldhaveprovidedtherequiredfinishtotheconcretestructure.
10. Itshould minimumcreep.
11. It isproved to be more economicalthansteel. This isdue tothe fact that sand and aggregates,formingthebulkofcement concrete,totheextent ofabout80to90%.

ADVANTAGES OFCONCRETE:

Followingaretheadvantagesofconcrete

1. Ithashighcompressivestrength.
2. Ascomparedtoother materials,concreteiseconomicalinlongrun.
3. Itisdurableandfireresistantandrequiresverylittlemaintenance.
4. Thegreenconcretecanbeeasilyhandledand moulded into anyshapeorsize according to specifications.
5. Theconcretecanbepumpedandhenceitcanbelaidinthedifficultpositionsalso.
6. Concretecanevenbesprayedonand filled intothecracksforrepairsbythegrading process.
7. Beingstoredincompression, it hasunlimitedstructuralapplicationsinincombination with steel reinforcement.

DIS-ADVANTAGESOFCONCRETE:

Followingarethedisadvantages ofconcrete

1. Concreteistobereinforcedwithsteelbarsormeshessince it haslowtensilestrength and hence cracks easily developed.
2. Provisionforconstructionjointshasto bemadetoavoidthedevelopment ofcracks due to drying shrinkage and moisture movement in fresh concrete.
3. Inorderto avoidtheformationofcracksduetothermalmovement ,expansionjoints have to be provided.
4. Concreteisliabletodisintegrate byalkaliand sulphateattack.
5. Concreteasamateriallacks inductilityandthis factorprovidesdisadvantageouswith respect to earthquake resistance.

USESOFCONCRETE:

Followingareusesofconcrete

- Foundation
- Building
- Road
- Artificial
- Airfield
- Waterretainingstructures
- Dock andharbour
- Dams
- Bridges
- Bunkers

GRADINGOFAGGREGATES:

In order to obtain concrete of denser quality, the fine and coarse aggregates are properlygraded. Thegradingoffineaggregateisexpressed intermsofBIStest sievesnos. 480, 240, 120, 60, 30 and 15.

GRADINGLIMITSFORFINEAGGREGATES

BISsieve	Percentagebyweightthroughseive	
	Naturalorcrushedgravelsand	Crushedstonesand
No.480	95-100	90-100
No.240	70-95	60-90
No.120	45-85	40-80
No.60	25-60	20-50
No.30	5-30	5-30
No.15	0-10	0-15

WATER-CEMENTRATIO:

1. Itistheratio ofwaterto cement and isexpressedasratiooftheweightorvolumeof water to the weight or volume of cementin concrete mixture.
2. Generallyitisexpressedassomanylitresofwater percementbag(50kg).
3. Itis foundtheoreticallythatwaterrequiredforthesetwofunctionsisabout0.50to 0.60timestheweightofcement.
4. Thequantityofwater required inlitresper bagofcement as1litreofwaterweighs1 kg. For instance, ifwater required for 1 bagofcement is30 litres, the water-cement ratioisequalto $\frac{30}{50}$ **= 0.60**

REINFORCEDCEMENTCONCRETE(R.C.C.)

Concrete is good in resisting compression but is very weak in resisting tension. Hence reinforcement is provided in the concrete wherever tensile stress is expected. The best reinforcement is steel, since tensile strength of steel is quite high and the bond between steel and concrete is good. As the elastic modulus of steel is high, for the same extension the force resisted by steel is high compared to concrete. However in tensile zone, hair cracksin concrete are unavoidable.Reinforcements are usually in theformof

mild steel or ribbed steel bars of 6 mm to 32 mm diameter. A cage of reinforcements is prepared as per the design requirements, kept in a form work and then green concrete is poured. Afterthe concrete hardens, the formwork is removed. The composite materialof steeland concrete now called R.C.C. acts as a structural member and can resist tensile as well as compressive stresses very well.

DEFINITIONOFPRESTRESS:

Prestress is defined as a method of applying pre-compression to control the stresses resulting due toexternal loads below the neutral axis of the beam tension developed due to external load which is more than the permissible limits of the plain concrete. The pre-compression applied (may be axialor eccentric) will induce the compressive stress below the neutralaxis or as a whole ofthe beamc/s. Resulting either no tensionor compression.

BasicConcept

Prestressed concrete is basically concrete in which internal stresses of a suitable magnitude and distribution are introduced so that the stresses resulting from the external loads are counteracted to a desired degree.

CHAPTER-7

TIMBER

Definition:

Thewordtimber isderived fromanold Englishwordtimbrianwhich meansto build. The timber denotes wood which is suitable for building or carpentry on various engineering purpose and it is applied to the trees measuring not less than 600mm in the circumference of the trunk.

CharacteristicsofgoodTimber:

Following arethe characteristicsofgoodtimber

1. Itshouldbeheavyanduniformcolour.
2. Itshouldhaveregularannularrings.
3. Afreshlycutsurfaceshould giveasweetsmell.
4. Itshouldhavestraight andclose fiber.
5. Itshouldbesonorouswhenstruck.
6. Itshouldbe heavyinweight.
7. Itshouldbefreefromshacks,flaws,dead, knotsofanykind.
8. Thecellulartissueofthemedullaryraysshouldbehardandcompact.
9. Whenplaned,itssurfaceshouldpresentafirmbrightappearancewithasilkylustre.
10. Agoodtimber shouldbestrong for workingasstructuralmember suchas joints, beams, rafters, etc. it should be capable oftaking loads slowlyor suddenly.

AdvantagesofTimber:

Followingaretheadvantages oftimber

1. Itislightinweightyetstrong.

2. Itiseasilyavailable andcanbequicklytransportedbysimplemeans.
3. The floor joints in an average dwelling weighs less than rolled-steel beams of equalstrength.
4. Boardsmaybecutrapidlybyasawandfastenedfirmlytogether withnails.
5. It isagoodinsulatorofheatandsound.
6. When properly protected timber structures may be give good servicefor hundred of years.
7. Itstandsshocksandbumps,agooddealbetterthanironand concrete.
8. Repairs,additionsandalterationstotimberconstructionareeasy.
9. Onaccountofitslightweight,timberisgenerally preferredforbuildingworksin earthquake region.
10. It isconsideredto be an idealmaterialofconstruction insea waterormarine worksas it can resist corrosion.

Dis-AdvantagesofTimber:

Followingarethedis-advantagesoftimber

1. Thegreatestdisadvantage isitsreadycombustibility,whichcanbediminished but not eliminated even by expensive treatment.
2. Framebuildings builtcloselytogetherpresentaseriousconflagrationhazard.
3. Timberswellsandundergoesshrinkagewithchangingatmospherichumidity.

UsesofTimber:

Followingaretheusesoftimber

1. It is generally usedin theform of piles,posts, beams,lintels,door-window frames, and leaves, roof members, etc.
2. Itisemployedforflooring,ceiling,paneling,andconstructionofpartitionwalls.

3. Itisusedforformworkforconcrete,forthe timberingtrenches,centeringforarch work, scaffolding, transmission poles and fencing.
4. Itisusedinwagonsandcoachbuilding,marineinstallations bridges.

CLASSIFICATIONANDSTRUCTUREOFTIMBER:

Fortheengineeringpurposes,thetreesareclassifiedinto**two** categories.

i.e-1.EexogenusTree 2.Endogenous Tree

ExogenousTree:

1. Thesetrees aregrow outwards andincreaseinbulkby theformation of successive annular rings on the outside under the bark.
2. Inthese trees,eachannualringrepresentslayerofwood,deposited everyyear.
3. Example:-Deodar,Chir,Sal,Kail,Shishum,Teak.
4. TheExogenoustreesmaybefurtherclassifiedintotwocategories:
    1. ConifersTree 2.Deciduousorbroad-leafstrees

EndogenousTree:

1. Thesetreesaregrowsinwardsorendwards.
2. Thesteamsofthesetreesaretooflexibleandthustheyarenotmuchsuitablefor engineering works.

StructureofTree:

A tree basically consists of three parts namely :- trunk, crown, and roots.

Fromthevisibilityaspect,thestructurefatreecanbedivided intotwo categories:

I. Macrostructure
II. Microstructure

Macrostructure:

Followingarethedifferentcomponents

1. **Pith:-** The innermost center personor coreofthetree is called the pith or medullar. It varies in size and shape for different types of trees, it consistentirely of cellular tissuesand it nourishesthe plant in its young age whenthe plant becomesold the pith dies up.

2. **Heart wood:-** The inner annual rings surrounding the pith constitute the heart wood.It is usually dark in colour it indicate dead portion f tree. But it provides strong and durable timber for various engineering purpose.

3. **Sap wood:-** The outer annualrings between heart wood and cambium layer is known as the sap wood. It is usually light in colour and weight. It indicates recent growthof sap woods are less sharply defined then those of heart wood.

4. **Cambium layer:-** Thethinlayerofsap betweensapwoodand innerbark isknownas cambium layer. Ifthe bark is removed for anyreasonthe cambium layer gets exposed and the cells are cease to be active resulting in the death oftree.

5. **Inner bark:-** The inner skin or layer covering the cambium layer is known as the inner bark. It gives protection to the cambium layer fromany injury.

6. **Outer bark:-** The outer skin or cover of the tree is known as the outer bark. It is the outer most protective layer and it sometimes contains cracks. It is also known as the Cortex.

7. **Medullary ray:-** The thin radial fibers extending from pith to cambium layer are known as the medullar rays. Thefunctions of these rays are to hold together the annual rings ofheart wood and sap wood. These rays are sometimes broken.

Microstructure:

The structureofwood apparent onlyat great magnification is called the microstructure.It isstudiedundera micro scopeinwhichlivinganddeadcellsarepresent.

Alivingcellconsistsofthefollowing4parts:

I. Membrane

II. Protoplasm

III. Sap

IV. Core

Thedead cellconsistsoffollowing 3 parts:

I. Conductivecell

II. Mechanicalcell

III. Storagecell

DefectsinTimber:

Thedefectsoccursintimberaregroupedintofollowingfive categories

1. Defects duetoconversion
2. Defectsduetofungi
3. Defects duetoinsects
4. Defects duetonaturalforces
5. Defectsduetoseasoning

(1) Defectsduetoconversion: Inthiscase,thefollowingdefectsmayoccurs:

I. Chipmark

II. Diagonalgrain

III. Torngrain

IV. Wane

(2) Defectsduetofungi: Thefungiareminutemicroscopicplantorganism.Theyattack timber only when the following two conditions are satisfied.

I. Themoisturecontentftimberisabove20%.

II. Therearepresencesofairandwarmth forthegrowthoffungi.

Following defectsareoccursinthetimberbyfungi:

I. Bluestain

II. Brownrot

III. Dryrot

IV. Heartrot

V. Saprot

VI. Wet rot

VII. Whiterot

(3) Defectsduetoinsects: Followingaretheinsectswhich areusually responsibleforthe decay in timber;

I. Beetles

II. Marineborers

III. Termites

(4) Defects due to naturalforces: The main naturalforcesresponsible for causing defects in timber. Following are the defects are caused bythese forces:

I. Burls

II. Callus

III. Chemical Stain

IV. CoarseGrain

V. DeadWood

VI. Druxiness

VII. Foxiness

VIII. Knots

IX. RindGalls

X. Shakes

XI. TwistedFiber

XII. Upsets

XIII. WaterStain

XIV. WindCrack

(5) Defectsdue to seasoning: Followingarethe defectsoccursduetoseasoning:

I. Bow

II. Case-hardening

III. Check

IV. Collapse

V. Cup

VI. Honey-combing

VII. RadialShakes

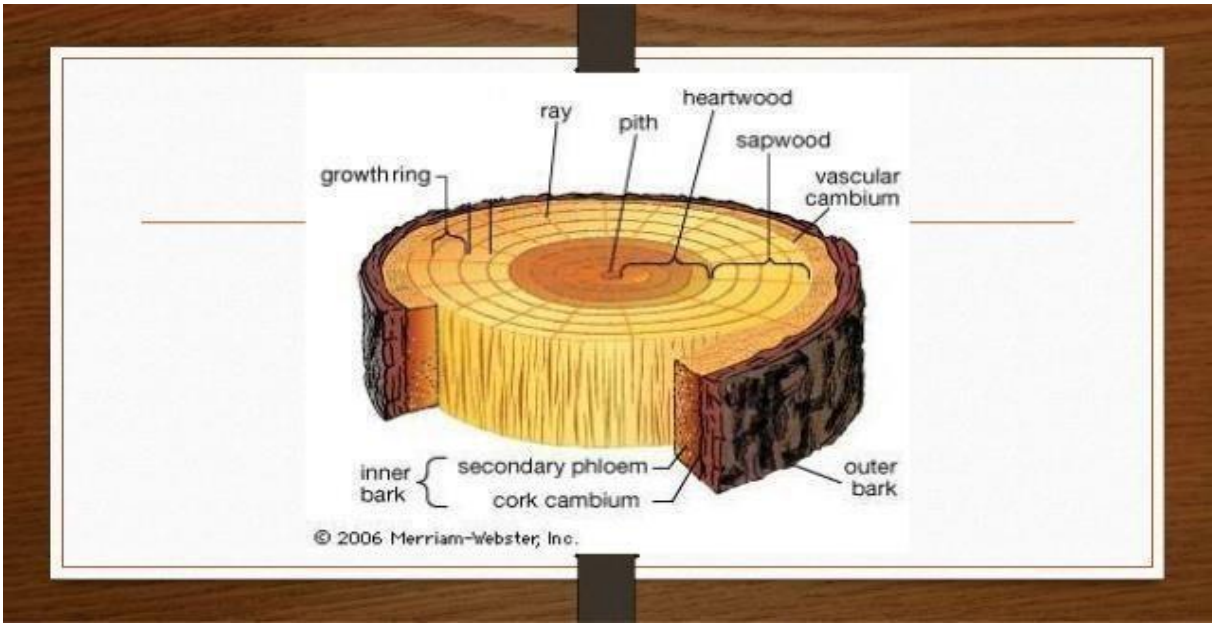
VIII. Twist

IX. Warp

Rindgall:

Adefect intimbercausedbyabruise inthe barkwhichproducesacallusonthewood over which later layers grow without consolidating. Or

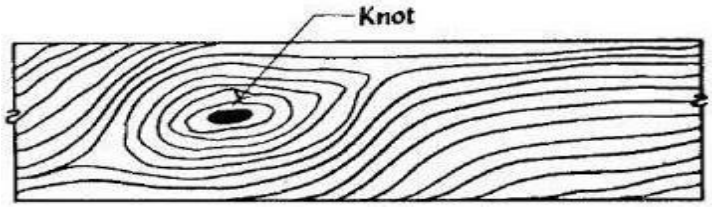
Adefect intimbercausedbyabruise inthe barkwhich producesacallusuponthe woodoverwhichthe later layersgrowwithout consolidating. Laslett, TimberandTimber Trees.



Knots

Knots are cut or broken off limbs or sprout branches, green or dead, protruding, flush, or depressed, but with exposed sound or rotten wood. If the exposed wood is sound, the knot is "sound"; if rotten, it is "unsound".

Knots are common blemishes in trees, often causinglumps or holes within the trunk of the tree itself. In most cases knots are caused by the natural growth of the tree, though the specific circumstances under which they form determines how they will appear. Some knots are formed by fungal infections, however, and can spread to other trees on your property as well.



Qualityofgood Timber:

Ingeneral,thequalityofgodtimberdependsuponthefollowingfactors

1. Environmentalconditionofthelocality.
2. Maturityofthetree.
3. Methodofseasoning.
4. Natureofsoil.
5. Processofpreservation.
6. Timeoffelling.

DecayofTimber:

Thetimberissaidtobedecayedwhenitissodeteriorated thatitlossesits value as an engineering material.

Followingarethe variouscauseswhichfavoredthe earlydecayofthe timber:

1. Alternatedryandwetcondition.
2. Badstorageorstackingoftimber.
3. Improper seasoning.
4. Keepingtimberincontactwithdampness.
5. Useoftimberwithouttaking sapwoodfromitsstructure.
6. Usingunseasonedtimberwithoutapplyingsuitablepreservativeonitssurface.

PreservationofTimber:

Thepreservationoftimberiscarriedouttoachievethefollowingthree objectives:

1. Toincreasethelifeoftimber structures.
2. Tomakethetimberstructuresdurable.
3. Toprotectthetimberstructuresfromthe attackofdestroyingagents.

Requirementsofa goodPreservation;

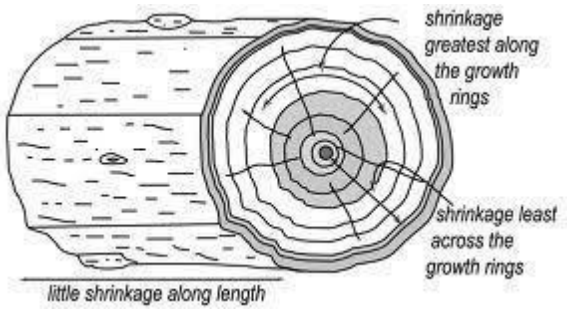
Followingarethe requirementsofa goodpreservation:

1. Itshouldbecapableofcovering alargeareawithsmallquantity.
2. Itshouldbe free fromunpleasantsmell.
3. Itshould benon-inflammable.
4. Itshouldbequitefficientinkillingfungi,insectsetc.
5. Itshouldnotaffectthestrengthcharacteristicoftimber.

Seasoningoftimber:

1. Seasoningoftimberistheprocessofdryingtimberorremovingmoistureorsap, present in a freshly felled timber, under more or less controlled conditions.

2. Freshly felled timber contains a large quantityofmoisture roughlyfrom100 to 200% based on dry weight of timber.



Objectivesofseasoning

Followingaretheobjectivesofseasoning

1. Tominimize thetendencyoftimbertoshrink.
2. Toincreasethestrength.
3. Tomakethetimber safeagainstfungiandinsects.
4. Tomakethetimber easilyworkableinanyshape.
5. Tomakethetimbersuitableforgluing.

No.	Typeoftimber	Thickness inmm			
		12	25	38	50
1	Non-refractory	6Days	8Days	12 Days	17 Days
2	Moderatelyrefractory	7Days	10 Days	14 Days	18 Days
3	Highlyrefractory	9Days	12 Days	17 Days	22 Days

DiseasesofTimber:

Thecommondiseasesofthetimberare

I. Dryrot

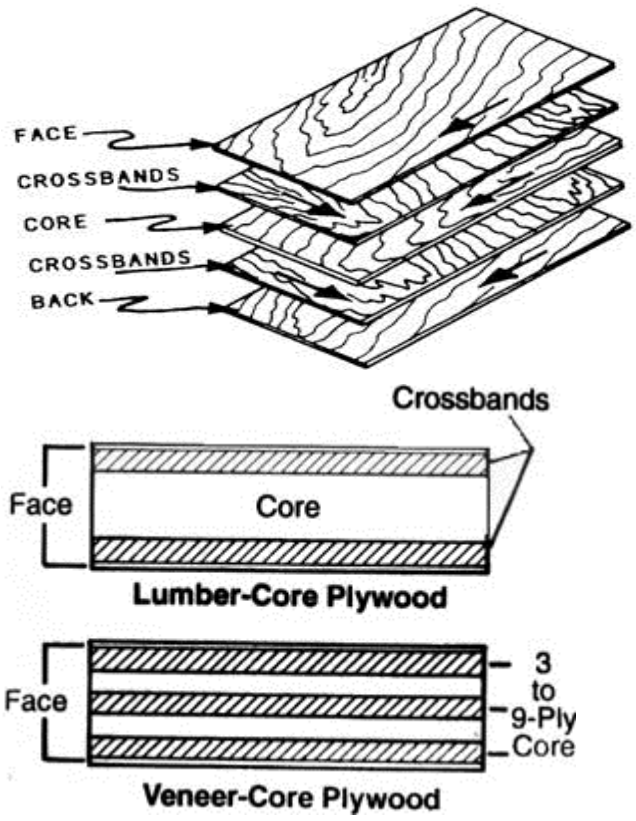
II. Wet rot

Timbersaresuitableforvarioususes:

Sl.No.	Application/Uses	Timber
1	Sportsgoodsandbaskets.	Ash,Oak,Mulberry. Pine,
2	Match industry.	Simul.
3	Bulkcarts.	Babul.
4	Musicalinstruments.	Jack.
5	Railway sleepers.	Deodar,Kail,Sal,Ash.
6	Wellcurbs.	Mango, Jack, Simul.
7	DoorsandWindows.	Sal, Deodar.
8	Scaffolding	Bamboo,Sal.
9	Agriculturaltools	Babu, Ash, Mulberry.
10	Highclass journeyandfurniture	Teak,Shishum,Walnut.

Plywood:

Plywoodis made bycementing together several layers ofwoodwhich maybe thin veneers or thicker boards.



Theadvantages ofplywoodare

1. Better appearance.
2. Easilyworkableandcapableofbeingshared tonumerousdesign.
3. Uniformtensilestrengthinalldirection.
4. Lightinweightandgreaterstrength.

CHAPTER-8

PAINTS,VARNISHESANDDISTEMPERS

Thepaints arecoatingsoffluidmaterials andthe areapplied overthe surfaces of timberandmetals. Thevarnishes aretransparent ornearly transparent solutions ofresinous materials andtheyareapplied overthepainted surfaces. The distempers areappliedoverthe plastered Surface.

PurposeofPaintingasurface:

Following arethe objectsofpainting asurface:

(i) Itprotects the surface from weathering effects ofthe atmosphere and actions byother liquids, fumes and gases.

(ii) Itprevents decay ofwood and corrosion inmetal.

(iii) Itisused togivegood appearance tothesurface. The decorative effects Maybecreated bypaintingandthesurface becomeshygienicallygoodclean, colourful and attractive.

(iv) Itprovides asmooth surface foreasy cleaning.

CHARACTERISTICS OFANIDEALPAINT

Followingare the characteristics ofanideal paint:

(i) It should possess agood spreading power i.e. maximum area Of the surface should becovered byminimum quantity ofthe paint.

(ii) The paint should befairlycheapandeconomical.

(iii) Thepaint shouldbesuchthatit canbeeasilyandfreelyappliedonthe surface.

(iv) Thepaint shouldbesuchthatit dries inreasonabletimeandnottoo rapidly.

(v) The paint should besuch that itscolour ismaintained foralong time.

(vi) The paint should form ahard and durable surface.

(vii) The paint should not affect health ofworkers during its application.

(viii) The paint should notbeaffected byweathering actions ofthe atmosphere.

(ix) The paint shouldpossess attractive andpleasing appearance.

(x) Thesurface coated withpaint should notshowcrackswhen thepaint dries.

(xi) When applied on the surface, thepaint should formathinfilmof uniform nature.

INGREDIENTSOFANidealPAINT

AnOilpaint essentially consists ofthe following ingredients:

(1) abase,
(2) avehicle orcarrier,
(3) adrier,
(4) acoloring pigment, and
(5) asolvent.

(1) Bases: A baseis asolid substance in afinestateof division and itforms the bulk of a paint. Itdetermines the character of the paintand imparts durability to the surface which ispainted. It reduces shrinkage cracks formed ondrying and italsoformsanopaquelayer to obscurethesurfaceofmaterialto be painted

BASES FORPAINTS

1. White lead
   i. This isacarbonate oflead and itforms the baseoflead paints. It possesses good bulk and isthemost widely used base.
2. Red lead
   i. Thisisanoxide ofleadanditforms thebaseoflead paints.
   ii. It isquite suitable forpainting iron surfaces andfor providing apriming coat tothewood surfaces.
3. Oxide ofzincorzincwhite
   i. This isanoxide ofzincand itforms thebase ofallzinc paints.
   ii. Itissmooth, transparentandnonpoisonous.
4. Oxide ofiron
   i. This isanoxideofiron and itforms thebase ofall ironpaints.
5. Titanium white
   i. This material possesses intense opacity
6. Antimony white
   i. This isnearly similar tothe titaniumwhite.
7. Aluminium powder
   i. This forms thebulk ofaluminium paints.

(2) Vehicles

Thevehiclesaretheliquidsubstances whichholdtheingredientsofapaint in liquidsuspension.Theyarerequired mainly fortworeasons:

(i) tomakeitpossible tospread thepaint evenly anduniformly onthe surfacein the formofathin layer; and

(ii) to provide abinder fortheingredientsofapaint sothattheymaystick or adhere tothesurface

VEHICLESFORPAINTS

1 Linseed oil

(i) This isthemost common material used asvehicle of a paint. Itisextracted from flax seeds. The linseed oil prepared from fine full-grown ripe seeds is clear transparent, pale , sweet tothe taste and practically odourless. Itisused invarious grades.

2 nutoil

(i) This oilisextracted from ordinary walnuts. It is nearly colourlessanddriesrapidly Itdoesnotprovide adurable finish and isused forordinary work asit ischeap.

(3) Driers:

Thesesubstancesacceleratetheprocessofdrying. Adrier absorbsoxygenfromtheair and transfers it tothe linseed oil, which in turn, gets hardended .
The various patented driers are available in the market. They may be either in the formof soluble driers or paste driers.The former driers are compounds of metals such as cobalt,lead,manganese, etc.dissolvedinlinseedoilorsomeothervolatile liquid. The latterdriers arecompoundsofthe same metal.

The litharge, red lead and sulphate of manganesecan also be used as driers. The litharge is the most commonlyused drier ,the proportionbeing1.25Nto 5litresofoil. the red lead is lesseffective than lithargeand it isto beusedwhenitsadditiondoesnotinterferewith the tintofthe paint. The sulphateofmanganese isused withzinc paintsso asto eliminate the risk of discolouration of a lead drier.

(4) Colouringpigments:

whenit isdesiredto haveadifferent colourthanthebaseofapaint, acolouring pigment is to be added.Thepigmentsareavailable in the formof fine powders in various colours and qualities.

(5) Solvents:

Thefunctionofasolvent istomakethepaintthinso that icanbeeasilyapplied on the surface. It also helps the paint inpenetratingthroughtheporoussurfaces. The mostcommonly used solvent is the spirit of turpentine.
Theturpentine isinflammable, evaporates rapidly and dries the oil consequently. Theuseofathinner inpaint reducestheprotectivevalueofthe coating, flattens Coloursand lessens the gloss of the linseed oil as the spirits evaporateleavingan excessofcolournot mixedwith the oil.

THEPROCESS OFPAINTING

Brushes: Itisnecessary tohave good brushesforpainting.Thebrushesshouldbe composed of bristles and not of horse hairs. The bristle brushes are elasticand possess goodpaint-holding capacity. The bristlesare splits atendsand in thisrespectthey can be distinguishedfrom horse hairs.

Paints: The readymixed Paints of different make and various brand are available in the market. Theyare available in different tints and can be applied in the same formas received. Thereadypaintsarenormallyexpensiveandtheyareto beusedsoonafteropeningthesealed container because of the fat that volatisation of the vehicle and solvent will take place when exposed to the atmospheric oxygen . Ifthe ready mix paint is kept expose to air for a long duration, the solidification of the base and the pigment occurs.

Knotting: Theterm knotting isused toindicate thecovering orkillingofall knots inwoodwork with asubstance throughwhichtheresin cannot exude or come out . There are three methods ofknottingasmentioned below:

(i) Ordinaryor size knotting:Thisisappliedintwo coats. Forthefirstcoat, the redlead ground inwater andmixed with Strong glue size is used in hot condition. Thiscoat dries inabout tenminutes andthen second coat is applied.The second coat consists ofredleadgroundinoilanditisthinned by boiled oiland turpentine.

(ii) Patent knotting: Thisisapplied intwo coats.Forboththecoats,thevarnish prepared bydissolving shellacinmethylated spirits ofwine is used.

(iii) Limeknotting:The knot is covered by hot lime and itisleft for 24 hours.The surfacethenscrappedoffand then ordinary knotting is carried out.

Stopping: Thetermstoppingisusedtoindicatetherubbingdownofthe surface afterthe first coat ofpaint is applied. The rubbing is donebymeansofpumice-stoneor glass-paperorboth. Beforerubbingiscommenced, theholes, cracks, etc.onthe surface arefilled with ordinary putty made fromwhitingand linseedoil.The puttybecomes hard when it dries.

Thetermhardstoppingisusedwheninsteadofordinaryputty,anadmixture of one-third white lead and two-third ordinary putty, is filled in holes, cracks, etc. It is adoptedfor superior work .

Coats: Thepaintisusuallyappliedinthreeorfourcoats.The first coat known astile primingcoat, the secondoneasunder coatandtheremaining asfinishingcoats. Theprimingcoatcreatesalayerorfilmwhich provides adhesion of thepaint with thesurface.Italso protectsthesurfacefromweathering actions. The suitable materialforpriming-coatshouldbeused,dependingonthenatureofsurfaceto bepainted.The undercoatservestoprovidefoundationorsupporttothefinishing coat.

Thesurfaceismadeevenandallirregularitiesofthesurfaceareremovedby thiscoat. ,

The finishing coat orcoats arethenappliedasperrequirement.

VERNISHING : Thetermvarnish isusedto indicatethesolutionofresinsorresinous substances preparedeitherinalcohol,oilorturpentine.

Followingarethemainobjects ofapplyingvarnishonawoodensurface:

(i) Itbrightens the appearance ofthegrain inwood.

(ii) Itrenders brilliancy tothepainted surface.

(iii) Itprotectsthepaintedsurfacefromatmosphericactions.

(iv) Itprotectstheunpainted woodensurfaces ofdoors,windows,rooftrusses, floors, etc., from the actions ofatmospheric agencies .

CHARACTERISTICSOFANIDEALVARNISH:

Followingarethecharacteristicsofanideal varnish:

(i) Itshould render the surface glossy .

(ii) Itshoulddryrapidlyandpresent afinishedsurfacewhichisuniforminnature and pleasing inappearance.

(iii) Thecolourofvarnishshould notfadeawaywhenthesurfaceisexposedto the atmospheric actions.

(iv) Theprotectingfilmdevelopedbyvarnishshouldbetough,hardanddurable.

(v) Itshouldnotshrinkorshowcracksafterdrying.

INGREDIENTSOFAVARNISH:

Following are the ingredientsofavarnish:

(1) Resins orresinous substances

(2) Driers

(3) Solvents.

(1) **Resins or resinous substances:**The commonly used resins arecopal, lac or shellac androsin. Thecopal isahard substance andisavailablefrom theearth atplaceswhere pine trees existed inpast.Itisavailableinvarietyofforms. Thelacorshellacisobtainedbyexudationofsometypes of insectsin India. Therosin isobtainedfrompinetrees.Otherresins areamber, mastic, gum dammar, etc.

(2) **Driers:** Thefunctionofadrier invarnishistoacceleratetheprocessofdrying. Thecommondriersused invarnishesarelitharge, whitecopperand lead acetate.

(3) **Solvents:**Dependinguponthenature ofresin,thetypeofsolventisdecided.

SOLVENTS FOR RESINS

No.	Solvent	Resins
1.	Boiled linseed oil	Amber, Copal
2.	Methylated spirits of wine	Lacor shellac
3.	Turpentine	Mastic, Gum dammar, Rosin
4.	Wood naphtha	Cheap varieties ofresins

PROCESSOFVARNISHING:

Theapplicationofvarnishonthewoodworkiscarriedoutinthefollowingway:

(1) **Preparation ofsurface:**The woodworkisthoroughlyrubbeddownbymeansof sandpaper orpumicestone.The surface isthen madesmoothand clean.

(2) **Knotting:**Theprocessofknottingisthencarriedoutasincaseofpainting.

(3) **Stopping:** Thesurfaceofwoodworkisthenstopped.This isdoneby meansof hotweak gluesize. Itwillfilluptheporesonthesurface.OneNofgluewill formaboutonelitreofgluesize.Alternatively,theboiledlinseedoilcanbeapplied intwocoats. Whenthesurface becomes dry, it shouldbeonceagain rubbeddown withsandpaper.

(4) **Coats ofvarnish:**Thevarnish isthenapplied onthesurfaceinthincoats. Thenext coat is applied after the previousonehasthoroughlydriedup. The varnishing should not be done with ordinary paint brushes . But fine haired varnishing brushes should be used .

DISTEMPERING:

PURPOSEOFDISTEMPERING:

Themainobjectofapplyingdistempertotheplasteredsurfacesistocreateasmoothsurface.
Thedistempersareavailable inthemarketunderdifferenttrade names.
Theyarecheaperthanpaintsandvarnishesandtheypresenta neat appearance.
they areavailableinavarietyofcolours.

PROPERTIESOFDISTEMPERS:

Followingarethepropertiesofdistempers:
(i) Ondrying,thefilmofdistemper shrinks.Henceitleadstocrackingandflaking, ifthe surface to receive distemper is weak.
(ii) The coatingsofdistemper areusuallythick and theyare morebrittlethan othertypesofwater paints.
(iii) Thefilmdevelopedbydistemper isporousincharacter anditallowswater vapourtopassthroughit.Henceitpermitsnewwallstodryoutwithoutdamagingthe distemper film.
(iv) Theyaregenerallylightincolourandtheyprovideagoodreflectivecoating.
(v) They arelessdurablethanoilpaints.
(vi) Theyaretreated aswater paints andtheyareeasytoapply.
(vii) Theycanbeapplied onbrickwork,cement plasteredsurface,limeplastered surface, insulating boards, etc.
(viii) Theyexhibitpoorworkability.
(ix) Theyprovetobeunsatisfactoryindamplocationssuchaskitchen,bathroom,etc
.

INGREDIENTSOFADISTEMPER:

Adistemper iscomposed ofbase, carrier,colouring pigmentsandsize.For base, the whitingorchalkisusedandforcarrier,thewaterisused.Thusitis more or lessapaint inwhich whiting orchalk isused asbase instead of white leadand thewaterisusedascarrierinsteadoflinseedoil.
The distempersare available in powder formorpasteform.Theyareto be mixed with hot water before use. The oil-bounddistempersareavarietyofan oil paint inwhichthe dryingoilissotreatedthatitmixeswithwater.The emulsifyingagentwhich iscommonlyusedisglueorcasein. Asthewater dries, theoilmakes a hard surface which is washable.
It shouldbe rememberedthat most of the manufacturers of ready madedistemper supplycompletedirectionsforuseoftheirproducts. These directions are to be strictly followedtoachievegoodresults.

PROCESSOFDISTEMPER:

Theapplication ofdistemper iscarried out inthe following way:
(1) **Preparationofsurface:** Thesurfacetoreceivethedistemper isthoroughly rubbedand cleaned. The important factsto be kept in mind are:
(i) Thenewplastered surfacesshould bekept exposedforaperiodoftwo monthsor sotodryoutbefore distemper is applied on them. The presence of dampnessonthesurface results infailure ofdistemper coating.

(ii) The surfacetoreceive distempershouldbefreefromany efflorescencepatches. These aretobe wipedoutbycleancloth.

(iii) Theirregularitiessuchascracks, holes,etc.ofthesurfacearetobefill bylime putty orgypsumandallowedtobecomehardbefore distemperis applied onthe surface.

(iv) Ifdistemperistobeappliedontheexistingdistemperedsurfaces,theold distemper should be removed by profuse watering.

(2) **Primingcoat:** Afterpreparing thesurface toreceive thecoatsofdistemper aprimingcoatisappliedanditisallowedtobecomedry.Forreadymade distempers, the priming coat should be composed of materials as recommended bythe makersofdistempers.

Forlocalmadedistempers, themilk is usedfor priming coat. Onelitreofmilkwillcoverabout $10m^2$ofthe surface.

(3) **Coatsofdistemper:** Thefirstcoatofdistemperisthenappliedonthesurface. It should beofalight tintandappliedwithgreatcare. Thesecondcoat of distemperisappliedafter thefirstcoathasdriedandbecomehard. Following facts are to be remembered:

(i) Thedistempering should bedoneindryweathertoachievebetter results.

(ii) Theoil-bound distemper orwashabledistemperadhereswelltooil-painted walls, wood,corrugated iron, etc. Butaprimingcoatofpuremilkshould be appliedbefore distempering is doneonsuchsurfaces.

(iii) The applicationofdistemper byaspraying pistolissuperiortothat by brushes. The spraying affordssmoothand durable filmofdistemper.

APPLICATIONOFWHITEWASHING:

The fresh lime isslaked atsiteofwork and mixed thoroughlywith sufficientquantity ofwaterinatub.Itisthenscreenedthroughacleancloth. Theclean gumdissolvedinhot water isthen addedattherateof20Nper m^3 oflime. The rice maybe used in place ofgum.

The surface tobewhitewashed shouldbecleanedbeforetheworkisstarted. Forwhitewashing wallswhicharewhitewashed before,theoldloosewhitewash is to befirst removed and repairing totheplasteriscarried out, ifnecessary.

The whitewashisappliedwithjutebrushandthebrushis soworkedthatasurfacewithuniformcolour isobtained. Thethree coatsaregenerallyapplied, each afterthepreviouscoat has completelydried.

Thelime istoxicforgerms. It reflectslight andthusit increasesthebrightnessofthe surface. The white washing therefore is extensivelyused for interior wallsurface.

Theprocessof whitewashingissometimesusedforexteriorwallsurfaces also.Asatisfactoryworkgivesanopaquesmoothsurfacewithuniformwhite colour and does notreadilycome offonthehand, whenrubbed.

APPLICATIONOFCOLOURWASHING:

This isprepared byaddingthecolouringpigmenttothescreenedwhitewash. It should beseenthatthecolouringpigment is notaffectedbythepresenceoflime. Ordinarily, theyellow earthispopularforcolourwashing.Generally, thewallsare

colour washedandceilingsarewhitewashed.The mixture istobekeptconstantly stirred during use.

Thecolourwash isapplied inthesamefashion asthewhitewash. Asatisfactoryworkdoesnotgiveoutpowderwhen thefinished surfaceis rubbed withthe fingers.

The process ofcolourwashingimpartscleanlinessandpleasantappearanceofthe surfaces which aretreated .

REPAINTINGOFOLDSURFACE:

Repaintingoldwoodwork:Ifthepaint ontheoldwoodwork hascrackedorhas developed blisters,itistoberemoved.Ifthe surface has become greasy. it shouldbecleanedbyrubbingdownsand-paperorfinepumicestone.Theold paintcanalsoberemovedbyapplyinganyoneofthefollowingthree paint solvents .

(i) A solutioncontaining2 N of causticsodato alitreofwaterispreparedand usedto washthesurface. The paint dissolvesandthesurfacebecomes clean.

(ii) Amixtureconsisting ofone part ofsoftsoap and twopartsofpotashis preparedandone part of quicklimeisthenaddedafterwards. Thismixtureis appliedonthesurfacein a hot stateandallowedtostay for about 24hours. Thesurfaceisthen washed with hot water.

(iii) Amixtureconsistingofequalpartsofwashingsodaandquicklimeis broughttoa paste form by addingrequiredquantityofwater.Itis applied on thesurfaceand keptforaboutanhour.The surface isthenwashedwithwater.

After removing old paint from the surface, the woodwork ispainted as in
case ofpainting onnew woodwork.

Repaintingoldironworkand steelwork: The oldsurfaceshouldbe thoroughly cleaned bythe application of soap-water and ifgreaseispresent,it shouldbe removedbywashing thesurfacewithlimeandwater. Ifitisnecessarytoremove oldpaint, thesurfaceshouldbeburnt, usuallybya blowlampandthenoldpaint shouldbescrapedoffordissolvedand removedbyusinganypaint solvent, After thesurface isthus prepared, the painting is carried out as in case of new ironworkor steelwork.

CHAPTER-9

CASTIRON:

Thecast ironis manufactured byre-meltingpig-ironwithcokeand limestone.Thisre- melting is done in a furnace known as the cupola furnace .

USESOFCASTIRON:

Followingaretheimportantusesofcast-iron:

(i) Formakingcisterns,waterpipes,gaspipesandsewers,manholecoversandsanitary fittings .
(ii) For makingornamentalcastingssuchasbrackets, gates, lampposts,spiral staircases, etc.
(iii) Formakingparts ofmachinerywhicharenotsubjecttoheavyshocks.
(iv) For manufacturingcompressionmemberslikecolumnsinbuildings,basesof columns, etc.
(v) Forpreparing agricultural implements.
(vi) Forpreparingrailchairs,carriagewheels,etc.

WROUGHTIRON:
Thewroughtironisalmost pureironand it hardlycontainscarbonmorethan0.15 percentor so . But the process of its manufacture is laborious and tedious .

USEOFWROUGHT-IRON :

The wrought-ironisreplacedatpresenttoaverygreatextentbymildsteel. It istherefore producedtoavery smallextent at present. It is used where a tough material is required .

The wrought-iron,atpresent, isusedforrivets, chains, ornamentaliron work, railwaycouplings, waterandsteam pipes,raw material formanufacturingsteel, bolts and nuts, horseshoebars,handrails,strapsfortimber roof trusses,boiler tubes, roofing sheets, armatures, electro-magnets , etc .

STEEL:

Depending upon thecarbon content,the steelisdesignatedasthe mild steelor mediumcarbonsteelor highcarbonsteel.Thevarioususesofsteelaregovernedby the amount of carbon contained in it.
Thecarbon content ofmild steel is about 0.10 to 0.25 per cent. When carbon content islessthan0.10percent, itisknownasthedeadsteelorverylow carbon steel.
The carboncontentofmediumcarbonsteel isabout 0.25 to0.60percent. Thehigh carbonsteelisalsoknown asthe hard steel and its carbon content variesfrom 0.60 to 1.10percent orso.

USESOF STEEL:

Nameofsteel	**Carboncontent**	**Uses**
Mild steel	Up to0.10%	Motorbody,Sheetmetal,tin plate, etc.
Mediumcarbon Steel	Up to 0.25%	Boilerplates,structuralsteel,etc.
	Upto0.45%	Rails,tyres,etc.
	Upto0.60%	Hammers,largestampingand pressingdiesetc.
High carbon steel	Up to 0.75%	Sledgeshammers,springs, stamping dies ,etc.
Orhard steel	Upto0.90%	Miner'sdrills,smith'stools,stone mason'stoolsetc.
	Up to 1.00%	Chisels,hammers,saws,wood working tools,etc.
	Up to 1.10%	Axes,Cutlery,drills,knives,picks,punches,etc.

Itisobserved that the steel isrequired forthe existence oftheheavy a lightengineering industries,forshipbuilding, railways androlling stock, automobiles sheet metal industries, power generation and electrical industries, etc. Itshouldalsobenoted thattheentire range ofelectrical engineering industry depends upontheproperty ofmagnetism ofsteel.

PROPERTIESOFMILDSTEEL

Followingarethepropertiesofmildsteel:

(i) Itcanbemagnetisedpermanently.
(ii) Itcanbereadilyforgedandwelded.
(iii) Itcannotbeeasilyhardened andtempered.
(iv) Ithasfibrousstructure.
(v) Itismalleable andductile.
(vi) Itisnoteasilyattacked bysaltwater.
(vii) Itistougher andmoreelasticthanwrought-iron.
(viii) Itisusedforalltypesofstructural work.
(ix) Itrustseasilyandrapidly.
(x) Itsmelting pointisabout 1400°C.
(xi) Itsspecificgravity is 7.80.

(xii) Itsultimate compressivestrength isabout80to120kNpercm^2
(xiii) Itsultimate tensileandshearstrengths areabout60to'80kNpercm^2

PROPERTIESOFWROUGHTSTEEL

Following aretheproperties ofhardsteel:
(i) Itcanbeeasilyhardened andtempered.
(ii) Itcanbemagnetisedpermanently.
(iii) Itcannotbereadilyforgedandwelded.
(iv) Ithasgranular structure.

CAST IRON:

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Nameofsteel	**Carboncontent**	**Uses**
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CHAPTER-

10BITUMINOUSMATERIA

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INTRODUCTION

Bituminous materials or asphalts are extensively used for roadway construction, primarily because oftheir excellent binding characteristics and water proofing properties and relatively low cost. Bituminous materials consists of bitumen which is a black or dark coloured solid or viscous cementitious substances consists chief high molecular weight hydrocarbons derived from distillation of petroleum or natural asphalt, has adhesive properties, and is soluble in carbon disulphide. Tars are residues from the destructive distillation of organic substances such as coal, wood, or petroleum and are temperature sensitive than bitumen. Bitumen will be dissolved in petroleum oils where unlike tar.

TYPESOFBITUMINOUSMATERIALS

Normallythreetypesofbituminousmaterialsareextensivelyused incivilengineering works. They are as follows.

Bitumen → It is the heavy end (i.e. higher molecular weight) residue from thefractionationof crude oil. It is a thick sticky black liquid obtained after extraction of things like fuels, fuel oils, lubricating oils and waxes fromthe crude oil.

Tar → It is similar to bitumen but is not extracted from crude oil. It is obtained from destructive distillation of organic materials like coal, wood etc.

Asphalt → It is a mixture of bitumen and aggregates (inorganic heavy fillers, sands, grit, stones) of various kinds used for construction of road surfaces.

Tarisnolonger usedfor highwayconstructionasitisconsideredtobeahealthhazard

COMPARISONBETWEENBITUMEN, TAR&ASPHALT

Sl No	Property	Bitumen	Tar	Asphalt
1	Colour	Darkwithslight reddish tinge	DeepDark	Blackishbrown
2	CarbonContent	Moderate	High	Low
3	State	Solid	ViscousLiquid	SolidorSemi-solid
4	Effecton Heating	Melts	Becomesmorefluid	Burnswithasmoke flame&becomes plastic
5	SettingTime	Less	More	Less
6	AdhesivePower	More	More	Less

7	Resistanceto Acid	More	Less	More
8	Uses	AsDamp Proof	Forpreserving	Asdampproof
		Course&Roofing felt	Timber	course,forpaints,as roofing felt & for road works

TYPESOFTARANDTHEIRUSE

Birch tarorbirch pitchisa substance (liquid when heated) derived fromthe drydistillation of the bark of the birch tree.
Birch tar was used widely as an adhesive as earlyas the late Paleolithic or early Mesolithic era. It has also beenused as a disinfectant, in leather dressing, and in medicine.

Coal tar is a brown or black liquid of extremely high viscosity. Coal tar is among the by-products when coal is carbonized to make coke or gasified to make coal gas. Coal tars are complex and variable mixtures of phenols,polycyclic aromatic hydrocarbons (PAHs), and heterocyclic compounds.
Coal tar is sometimes used for heating or to fire boilers as it is flammable. Coal tar was a component of the first sealed roads. Coal tar is also used to manufacture paints, synthetic dyes, and photographic materials.

Pine tar is a sticky material produced by the high temperature carbonization of pine wood in anoxic conditions (dry distillation or destructive distillation). The wood is rapidly decomposed by applying heat and pressure in a closed container; the primary resulting products are charcoal and pine tar.
Pine tar is now mainly used as a softening solvent in the rubber industry, andfor construction material and special paints. Pine tar can be used for preserving wooden boats (and other wood which will be exposed to the elements) by using a mixture of pine tar, gum turpentine and boiled linseed oil

TYPESOFASPHALTANDTHEIRUSE

Asphalt concrete pavement material is commonly composed of 5% asphalt/bitumen cement and 95% aggregates (stone, sand, and gravel). Due to its highly viscous nature, asphalt/bitumen cement must be heated so it can be mixed with the aggregates at the asphalt mixing plant.

Asphalt concrete paving is widely used in airports around the world. Due to the sturdiness and ability to be repaired quickly, it is widely used for runways dedicated to aircraft landing and taking off.

Mastic asphaltis a type of asphalt which differs from dense graded asphalt(asphaltconcrete) in thatit has a higher asphalt/bitumen (binder) content, usually around 7–10% of the whole aggregate mix, as opposed to rolled asphalt concrete, which has only around 5% added asphalt/bitumen.

Mastic asphaltbeing thermoplastic substance is widely used in the building industry for waterproofing flat roofs and tanking underground. Mastic asphaltis heated to a temperature

of210 °C (410 °F) and is spread in layers to forman impervious barrier about 20millimeters (0.79 inches) thick.

Asphalt emulsion contain up to 70% asphalt/bitumen and typically less than 1.5% chemical additives. There are two main types of emulsions with different affinity for aggregates, cationic and anionic.

Asphalt emulsions are used ina wide varietyofapplications. Chipseal involves spraying the road surface with asphalt emulsion followed by a layer of crushed rock, gravel or crushed slag. Slurry seal involves the creation of a mixture of asphalt emulsion and fine crushed aggregate that is spread on the surface of a road. Cold-mixed asphalt can also be made from asphalt emulsion to create pavements similar to hot-mixedasphalt, several inches in depth and asphalt emulsions are also blended into recycled hot-mix asphalt to create low-cost pavements.

OtherusesofAsphalt

Asphalt/bitumen is used to make Japan black, a lacquerknown especially for its use on iron and steel. Asphalt/bitumen also is used in paint and marker inks by some graffiti supply companies (primarily Molotow) to increase the weather resistance and permanence of the paint and/or ink, and to make the color much darker. Asphalt/bitumen is also used to seal some alkaline batteries during the manufacturing process.

CHAPTER-11

PLASTICS,HEATPROOFINGANDACOUSTICMATERIALS

Plastic is the generic name for a family of synthetic materials derived from petrochemicals. It is often product of two or more components.

There are manyfamilies ofplastics and polymers being used in construction industry. Examples of plastics used in building are: Acrylic, Composites,Expanded Polystyrene,Polycarbonate, Polyethylene,Polypropylene,Polyvinyl Chloride

UsesofPlastic asBuildingMaterials

SomeoftheexamplesbelowareProductsofPlasticsintheConstruction industry:

- Pipes : ElectricalConduits, Rain Water &Sewage pipes, Plumbing, Gas Distributions.
- Cables:PVCInsulationoncables,InsulationTapes.
- Floorings:Flooringtiles&Rolls.
- Domes/skylights: Opaqueaswellas transparent.
- Roofing:ColouredorDoubleskinnedfor insulation.
- Windows&doors:Extrudedsectionsfor Door andwindowsand panels.
- Storagetanks :Storagetanks.
- Hardwareaccessories:Washers,Nutbolts,Sleeves,Anchoringwires.
- Temporarystructures:Guardcabins,tents
- Insulationmaterials:PVCsheets,insulating membranes.

Fireproofing or Heat proofing is rendering something (structures, materials, etc.) proof against fire, or incombustible; or material for use in making anything fire-proof. Itis apassive fire protectionmeasure.

CharacteristicsofFireFighting/ResistantMaterials

- The materialused inbuildingshould beofsuchnaturethat it doesnotdisintegrate under the effect of heat produced during fire.
- The materialshouldnot expanddueto heatalso andshouldensurestabilityof structure.
- Thenatureofmaterialused inbuildingshould have minimumcontractiondueto sudden cooling with water after the material is heated at high temperature.
- Thenatureofmaterialused inthebuildingshouldbesuchthat it doesnot catchfire easily.

FireResistant PropertiesofBuildingMaterials

Stone:

It is a bad conductor of heat. Sand stone with fine grains can moderate fire successfully without having serious cracks. Granite is disintegrated when it receives heat from fire. Lime stone is easily crumbled by ordinary fire. Most of stones are disintegrated into small pieces when heated during fire and cooled afterwards.

Brick:

Bricks are bad conductor of heat. They have no serious effect of heat until the temperature during fire rises above 1200 degrees to 1300 degrees. At the time of construction if good quality mortar is used and brick work constructed by skilled mason, brick masonry offers good resistance to fire.

Clayorshaletile:

Hollowclayor shaletileshall be laid inTypeM, S, N,Oorgypsummortar. Clayor shaletile used innonbearing partitionsand for fire resistance shallmeet the requirementsofcode.Clay or shale tile used in exterior walls and in all load bearing walls shall comply with the requirements of code.

Gypsum:

Pouredgypsumusedforfireresistanceandfloorandroofconstructionshallcontain notmore than12 1/2percentofwoodchips,shavingsorfiber,measuredinadrycondition,asa percentage by weight of the dry mix. Gypsum mortar shall be composed of one part gypsum and not more than three parts clean, sharp, well-graded sand, by weight. Fibered plaster may be used where unsanded or neat gypsumplaster is prescribed.

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Acoustics (also known as room acousticsand **building acoustics**) is the science and engineering of achieving a good sound within a building and is a branch of acousticalengineering. Architectural acoustics can be about achieving good speech intelligibility in a theatre, restaurant or railway station, enhancing the quality of music in a concert hall or recording studio, or suppressing noise to make offices and homes more productive and pleasant places to work and live in. Architectural acoustic design is usually done by acoustic consultants

TheAcousticNatureofMaterials

Concrete, stone, and other masonry materials:

Masonry materials are great for sound isolation, especially when used in floors and walls where the masonry material is quite thick. A solid concrete wall 1 ft. thick will rarely cause clients to complain about sound isolation, for two reasons. One is the material's *rigidity*, meaningthat it willnot flexandcreatesound wavesonthequiet sideofthewall. Theother is concrete's*mass*.Nothingstopssoundwavesquitelike massive materials,andtheyare

especially capable of stopping the critical low frequencies that are so hard to stop with less massive materials. Stone and brick are very similar to concrete in mass, andconcretemasonry units, although they are lighter, can do a very good job when they are fully filled with concrete, instead of just filling the cells that contain the rebar.

Concrete slabs also do a good job of isolating sound between floors – something that is very difficult to do any other way.

Wood,andwoodproducts:

Wood is much lessdensethan masonry, and provides much less inthewayofsound isolation for that reason. Wood products like MDF, on the other hand, are somewhat moremassive, and are sometimes usedin interior walls toadd mass. OSB is less dense than MDF, butcan be useful as well, as part of an integrated system. Plywood comes in varying densities, and again can contribute something to the equation in a multi-layer wall.

Wood's real beauty lies in its ability to reflect sound in a pleasing way, meaning that it is a useful material for sound treatment. Since wood resonates easily, it has a way of absorbing some of the sound energy as it vibrates, letting some of the sound pass through to the other side, and reflecting some of the sound back from whence it came. This genteel quality of wood is one reason it is widely used in the making of musical instruments, and wood has a major role to playas an interior finish material in good sounding rooms.

Steel:

Steelis a quite dense material, but because ofits expense it is rarelyused as a sound isolation material. Steel's density actually becomes a liability in structural uses where its dense nature causes it to carry sound vibrations for long distances. If you strike an I-beam with a hammer and place your ear to the other end –let's say 24 ft. away, you'll see that the sound carries quite well through the steel. This type of sound transfer is called *structure-borne vibration*, where sound is carried through some material other than airfor a time. The othermaintype of sound transfer is *air-borne vibration*.

Steel studs can actually transmitless structure-borne vibration than wood, even though steelis more prone to this problem simply because flimsy steel studs have much less cross- sectional area to carrythe vibrations between the two wall surfaces.

Drywallandplaster:

Drywall is the poor man's masonry, and for interior walls can provide a lot of mass for the money. But one ½" layer doesn't do allthat much. Multiple layers are used in sound studios and broadcast facilities where high mass walls are needed.

Roofing:

Asphalt shingles are fairly massive, as you know if you hauled them up to the roof, but they arealso thin. Installationwitha largeoverlap, heavyfelt, andevendouble layer sheathing can

help quite abit. Ceramic and claytilesare more massive thanwoodshakes byfar, and cando a reasonable job in residential applications. Metal roofing has mass but is thin, and requires that the underlying structure be fairly massive.

Glassandothertransparentmaterials:

Glass is quite massive – about three times as massive as drywall. So in a sound wall withthree 5/8" layers of drywall on one side, one layer of 5/8" glass maybe inserted to create a window *on that side*, provided that itis properly sealed.A corresponding piece of glass would be required onthe other side ofthe wall, at the appropriate thickness.

A relatively recent development is the invention of absorptive glass-like products that offer pretty good transparency while absorbing enough sound to reduce the harsh reflectivity usually associated with glass. These products are made from Plexiglas or thin transparent foils, perforated withtiny holes. Their use is mainlyconfined to professional sound studios.

Insulatingmaterials(fiberglass,foam,rockwool, etc.):

Insulating materials have little mass, so they have limited uses for sound isolation. However, fiberglass has good sound *absorption* characteristics, and is very useful as a sound treatment material for sound room interiors. Fiberglass and rock wool, which has similar acoustic properties, absorbsound byslowing the *velocity*ofthe air particles carrying the wave. Wood, on the other hand, absorbs sound best when in the *pressure zone* of a sound wave. Sound waves are at highest pressure when at lowest velocity, so care must be taken toplace materials appropriately. Waves are generally at highest pressure at room boundaries, particularly multiple boundaries like dihedral and trihedralcorners.

PlasticsandRubber(vinyl,neoprene):

Plastics are sometimes used in the manufacture of low-cost acoustical devices, but have limited usefulness. Rubber, particularlyneoprenerubber isverygoodasa mechanicalisolator
-- for floating glass and preventing the diaphragmatic vibrations of the glassfrom transmitting into the wall, for instance.

Mass loaded vinylcan be used inside wallcavities to increase sound isolation, and is hung in a limp, as opposed to stretched, fashion.

Mechanicalandplumbingmaterials(ductwork,metalandplasticpipes):

Metaland plastic pipes are oftentransmittersof structure borne vibration, and can be isolated or deadened with rubber materials. Refrigerant lines are especially bad for transmitting high-pitched whining noises through buildings, so you want to locate them carefully, and de-couple them from the structure.

Ductwork should be heavy sheet metal, lined with at least 1" of acoustic liner. Flex duct is virtually acoustically transparent, and should be avoided when you are picky about crosstalk between the ducts in attics and other mechanical spaces.

Fabricsand othersoftmaterials:

Fabrics, carpets, and other soft materials can be useful for sound treatment. Heavystage type curtains are much more effective than thin fabrics. Carpets, although sometimes better than nothing, can soak up too much mid and high frequency sound while leaving boomy lower frequencies untreated. As part of an overallplan, carpet can be put to good use, but area rugs are much more versatile and adjustable.

Specialtyacousticalproducts:

Specialtyproductsgenerallyfallinto twocategories:thoseusedforsoundisolation, andthose used for acousticaltreatment. Those used for sound isolation include various shock absorbers used to isolate air handlers and ductwork, and even to float concrete slabs, aswell as neoprene isolators used for floating drywall off of studs (in conjunction with metal furring channel). Specialized door seals also utilize neoprene,and the best ones are adjustable,so that the installer can tweak any gaps between the door and the neoprene. Neoprene is also used under floor plates to isolate walls from floors. When specifying neoprene, care must be takento get the proper *durometer*, or firmness, ofneoprene, so that it doesn't bottomout and cease to work as a shock absorber. Sound deadening board can be used between layers of drywall, or between the drywall and the studs, to reduce structure borne vibration while also deadening resonances.