INSTITUTE OF AERONAUTICAL ENGINEERING

(AUTONOMOUS)

Dundigal – 500 043, Hyderabad

B.Tech IV semester

Regulation:R16

BUILDING MATERIALS CONSTRUCTION AND PLANNING

Course code: (ACE007)

Department of Civil Engineering

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UNIT 1
STONES, BRICKS AND AGGREGATES

- NATURALLY AVAILABLE MATERIALS
- INDISTRIAL MATERIALS
- STONE
- BRICK
- LIME
- CEMENT
- METEL
- CERAMICS

INTRODUCTION

- TIMBER
- SAND
- AGGREGATES
- MORTAR

Naturally Available Materials

- Clay / Earth / Soil
- Wood / Timber
- Sand / Fine Aggregate
- Rock

Artificial Or Industrial Materials

- Cement
- Bricks
- Steel
- Tiles
- Ceramic
- Paints and Varnishes
- Glass
- Plastic
- Stone
- Lime

STONE

Requirements of Stone

- Structure
- Appearance-Colour Texture
- Weight
- Fineness of Grains
- Durability
- Strength
- Hardness
- Facility of Working and Dressing

Types of Stone

- Igneous Rocks, Sedimentary Rocks, Metamorphic Rocks.
- Stratified, Unstratified, Foliated.
- Siliceous, Argillaceous, Calcarious.

Uses of Stone:

- They are used in hydraulic structures like dams and bridges.
- They are used in retaining wall masonry to retain soil.
- They are used as road metal in road construction.
- They are used as ballast for permanent way in railways.
- They are used to make concrete in the form of coarse aggregate.

Properties of Stone:

- Silicious rocks are hard and durable. They are not easily affected by weathering actions.
- Argillaceous rocks may be dense and compact or they may be soft.
- The Durability of calareous rocks will depend upon the constituents present in surrounding atmosphere.
- Marble and quartzite have compact crystalline structure.

Solid vs. With Holes:

- Solid brick used where holes may be unsightly (steps or window sills)
- Holes in Brick:
  - Help units fire properly
  - Promote bonding with mortar
  - Reduce overall weight
  - Make units easier to handle

Classes of Brick:

- Adobe – sun-dried clays and a binder
- Kiln-burned – natural sand and clay or shale (most widely used)
- Sand-lime – pearl-grey in color, dolomite lime is mixed with clean sand, pressed, and allowed to harden in closed vessels under steam pressure
- Concrete – portland cement and suitable aggregate, formed in molds

Brick Kilns:

- Burning of brick is done in 4 stages
  - Water smoking: 400 °F
  - Dehydration: 300 -1800 °F
  - Oxidation: 1000 – 1800 °F
  - Vitrification: 1600 – 2400 °F
- Flashing (oxygen reduction)– produces different colors or color shading
- Cooling down – done in 2-3 days; rate of cooling will affect cracking, and color

Brick Types/Sizes:

- Common (now called Building)
  - Most widely used
  - Dark orange to deep red color
  - Many finishes & sizes available
- Meets ASTM C62 grading criteria:
  - SW – severe weathering for exposure to heavy rainfall & freezing
  - MW – moderate weathering for avg. moisture and minor freezing
  - NW – Negligible weathering for exposure to moisture & freezing

Face Brick

- Made from clay, shale, fire clay, or a mixture, under controlled conditions
- Meets ASTM C216 standard
- Appearance types:
  - FBS- general use in exposed & interior walls where wide color ranges & variation in sizes are permitted
  - FBX- used in exterior & interior walls where a high degree of mechanical perfection, narrow color range & little variation of size is required
  - FBA- nonconformity in size, color, & texture

Glazed Face Brick

- Bricks sprayed with a ceramic glaze and fired at high temperature to fuse glaze to the brick
- Finishes may appear dull, satin, or glossy

Fire Brick

- Made of clays with a large amount of alumina, silica, flint, and feldspar
- These bricks are used in fireplaces, chimney stacks, incinerators, and many industrial settings

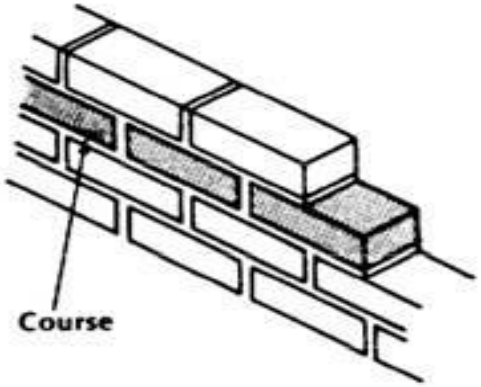
NOMINAL VS. ACTUAL SIZE

Unit	**Nominal Dimension (in.) W x H x D**	**Actual Dimension (in.) ** W x H x D**
Modular	4 x 2 2/3 x 8	3 5/8 x 2 ¼ x 7 5/8
Utility	4 x 4 x 12	3 5/8 x 3 5/8 x 11 5/8

** Note: actual dimensions may vary among manufacturers of brick – dimensions noted from *Graphics Standards* 2000 publication

Brick Bond

- Bond – the arrangement of bricks in rows (courses).
- Bonds are designed for:
  - Appearance
  - To tie together a structural or outer wall (wythe) to an inner wall
- *Wythe – a vertical section of wall one brick thick*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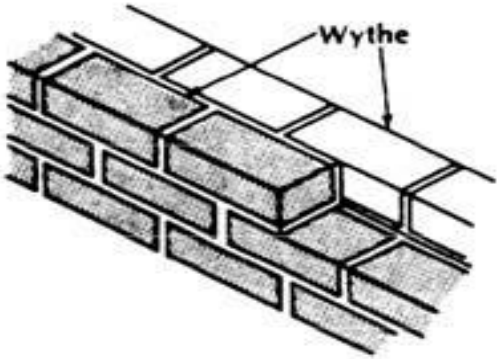
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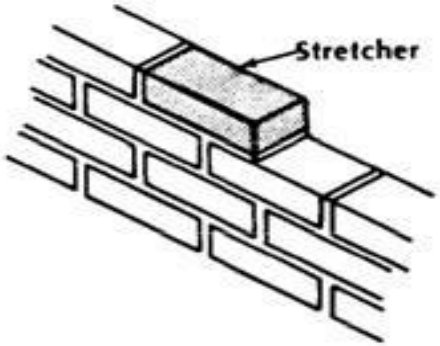
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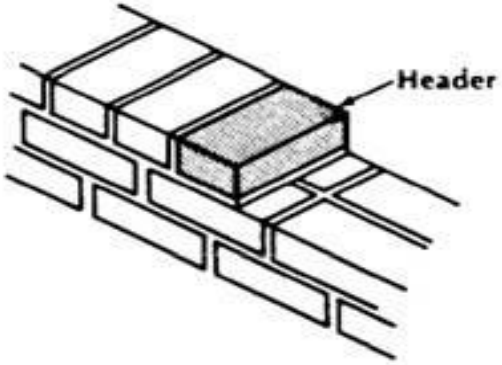
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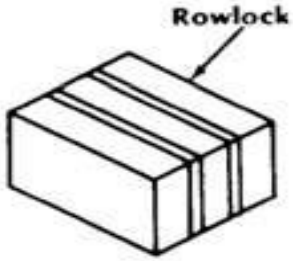
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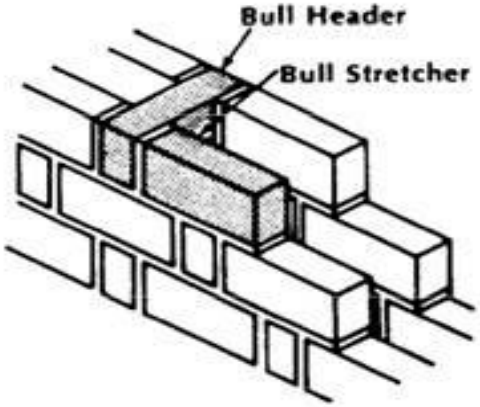
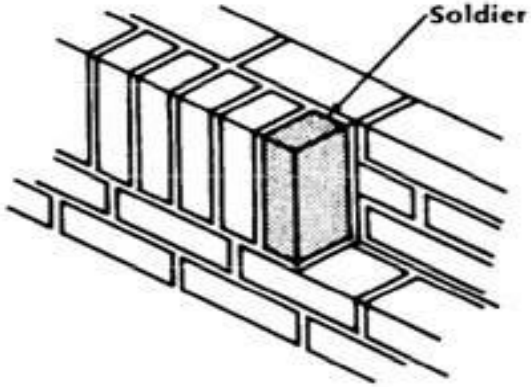

Bull Header
Bull Stretcher


Soldier

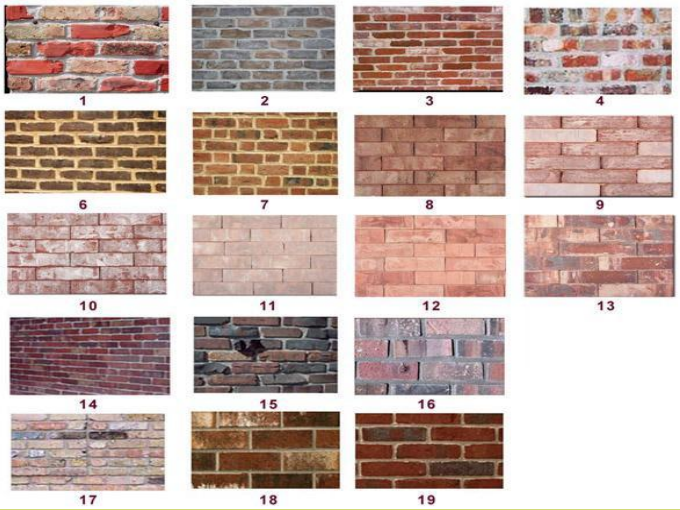
BRICK

Requirements of Bricks

- The colour of the brick should be red or copper and uniform.
- It should be well burnt in kilns.
- The surface should be even and free from cracks.
- The edges should be sharp.

Types of Bricks

- Conventional / Traditional bricks :
  Size 23 cm x 11.4 cm x 7.6 cm
- Standard / Modular : Size : 19 cm x 9 cm x 9 cm



USES OF BRICK

- Bricks are used in wall masonry construction of building
- Used in brick lintal construction
  - Bats of brick are used in concrete in foundation work

Properties of bricks

- They are durable.
- They are low cost material.
- They possess good strength.
- They are easily available.
- Brick are light in compared to stones.

TYPES OF AGGREGATES

- sand
- crushed stone
- Gravel
- Limestone/marl
- River stone
- Shale

Aggregates are classified according to roundness and size.

AGGREGATES

- Fine aggregates are those which will pass through a standard 5mm sieve and coarse aggregates are those which are retained on a standard 5mm sieve. The aggregates must be free from clay, mud, silt and other materials that might weaken the mix

CHARACTERISTICS OF AGGREGATES

- Clean
- Sound
- Well-graded
- Angular shaped
- Strong

Sand

Requirements of sand

- It should be clean.
- It should be well graded.
- Maximum permissible clay content is 3 to 4% in sand.
- It should contain sharp, angular grains.
- It should not contain salts which attract moisture from the atmosphere.

TYPES OF SAND

- Natural

  natural sand is obtained from pits, river beds and sea beds.

- Artificial

  artificial sand is formed by decomposition of sandstone due to various weathering effects.

USES

- Sand is useful in various construction activities like masonry work, plaster work, flooring and concrete work.
- Sand is used in cement mortar, plan cement concrete , reinforced cement concrete and prestressed concrete as key ingradient in building construction.

Properties of sand

- It is naturally available material
- It is durable
- It mix with binding material easily
- It has shiny luster
- It is of whitish brown colour.

AGGREGATES

Requirements of Aggregates

- Aggregates should be sufficiently strong.
- Aggregate surface should be rough and free form cracks.
- Aggregate should have good soundness.
- Aggregate should have good adhering with binding material.

TYPES

- Fine aggregates

  size of aggregate is 4.75 mm or less is termed as fine aggregates.

- Coarse aggregates

  size of aggregates 80mm to 4.75 mm is known as course.

USES

- Fine aggregates are used to prepare cement mortar, lime mortar and cement concrete.
- Course aggregates are used to prepare cement concrete bituminous pavement, rigid pavement etc.
- They are used in construction of beams, columns, slab, lintel etc.

PROPERTIES OF AGGREGATES

- They are insoluble in water.
- They are of moderate weight.
- They are strong and durable.
- They have resistance to scratches.
- They have resistance to corrosion and decay.

MORTAR

Requirements of mortar

- It should have good adhesion with bricks, stones.
- It should resist penetration of rain water.
- It should be cheap, durable, and workable.
- It should be set quickly.
- The joints formed by mortar should not develop crecks.

Types

- As per type of binding material like cement, lime, gauged, gypsum, surkhi.
- As per nature of application.
- As per density of the mortar.
- Spicial morter.

USES

- To bind the bricks or stones firmly in wall construction work.
- They are used in plaster work as finishing material to provide weather resistance joints of masonry work are covered by plaster work. White wash and colour are applied on plastered surface easily.
- **Properties of mortar**
- Mobility.
- Place ability.
- Water retention

UNIT- 2
Cement and Admixtures

CEMENT

PROCESS OF MANUFACTURING PORTLAND CEMENT

Portland cement is produced from limestone. To be effective, it must have the proper amounts of four ingredients:

- Alumina **(Al_2O_3)**,
- Iron Oxide **($Fe_2 O_3$),**
- Lime **(CaO)**, and
- Silica **(SiO_2)**.

To produce a portland cement, limestone is first dug from a quarry. It is then crushed and ground to a powder. Once ground, the other additives may be mixed with the product in proper proportion. It is then heated to about 2900° F, driving off all remaining water. Calcium sulphate is then added to the mix once it is cooled rapidly to prevent it from re-absorbing moisture.

- The calcium sulfate ($CaSO_4$) is added to control the rate at which the cement will set up. Without it, the cement would set up too fast to be of use. This product is then sifted and packaged into one-cubic-foot bags.

TYPES OF CEMENT

- Ordinary portland cement(opc)
- Rapid hardening portland cement
- Quick setting cement
- Pozzuolana portland cement
- Low heat cement
- Blast furnace cement
- White cement
- Sulphate resisting cement
- Coloured cement

USES OF CEMENT

- It is used in making joints for drains ,pipes.
- It is used to prepare RCC structures of building by using reinforcement with cement concrete.
- it is used in construction of buildings, bridges, tanks, domes, flyovers, dockyard etc.
- It is used to prepare cement mortar for building construction works like masonry, plaster, painting, flooring etc.
- It is used to prepare cement concrete for various construction works.

PROPERTIES OF CEMENT

- Physical properties of cement
- Mechanical properties of cement
- Chemical composition
- Fineness
- Soundness
- Setting of cement

What Are They?

- Ingredients other than:
  - Cement
  - Water
  - Aggregates

- Added before or during mixing.

Why Are They Used?

- To modify properties of fresh & hardened concrete
- To ensure the quality of concrete during mixing, transporting, placing & curing
- To overcome certain unexpected emergencies during concrete operations (ie, set retarders)

How Applied?

- Most admixtures are supplied in a ready-to-use form and added at plant or jobsite.
- Pigments and pumping aids are batched by hand in VERY small amounts

Effectiveness

- Factors effecting results of use:
  - Type & amount of cement:
    - Chemistry effects due to portland components
  - Water content & Slump
    - Flowability will effect how well admixtures are activated due to
      internal agitation actitivity
  - Mixing time
    - Effects of admixtures are dependent on time allowed to react.

CONCRETE

- Concrete is a mixture of cement/lime, sand, crushed rock,water.
- Preparation of concrete

<1>Ingredient of concrete

<2>Methods of mixing of concrete

*TYPES OF CONCRETE

<1>Plain cement concrete

<2>Reinforced cement conceret

<3> Precast concrete

<4>prestressed concerte

PROPERTIES OF CONCRETE

- Workability
- Strength
- Durability
- Dimensional stability

USES

- Foundation to slabe in building
- Coating materil for water proofing

Typical Functions of Admixtures:

- Air entraining
- Water-reducing
- Retarders
- Set Accelerators
- Plasticizers (super plasticizers)
- Some other “specialty” types exist: Color, corrosion inhibitors, etc.

Air Entrainment

- Developed in 1930s
- Today, recommended for all concretes exposed to freeze/thaw cycles
- Imposes microscopic air cells that relieve internal pressure of freezing water
- Typical target air values are 5%-8%
- Will also increase slump (workability)

Master Builders Micro Air

- Performance:
  - Improved air void system
  - Improved workability & plasticity
  - Reduced permeability

- Dosage 1/8 to 1-1/2 oz per cwt of cement
  - Trial batch required to target air.

Water Reducers

- Internal lubricant
- Allows for reduction of water/cement ratio while maintaining workability (increased strength)
- Can reduce water requirement at least 5-10%
- Obtain higher slump without adding water
- *Mid-range* water reducers result in at least 8%
  - *Mid-range* water reducers provide more consistent setting times than standard water reducers.

Water Reducer: Pozzolith

- Performance:
  - Improves workability at low w/c ratio
  - Normal to retarded set times
  - Helps eliminate “cold joints”
- Dosage:
  - 4-10 oz per cwt of cement

Set Retarders

- Slows curing rate
- Used to counteract hot weather conditions that cause increased rate of hardening.
  - This makes placing and finishing difficult
- Pozzolith 961
  - Performance & dosage (see handout)

Set Accelerators

- Increase curing rate for achievement of high early strength
- Speeds up start of finishing operations
- Used for speeding curing rate in cold weather concreting
- Pozzolith 122
  - Performance & Dosage (see handout)

Master Builders Pozzolith

- Performance:
  - High early strength
  - Accelerated setting time characteristics

- Dosage: 16-64 fl oz/cwt (100 wt) cement
- Higher dosages increase acceleration rate

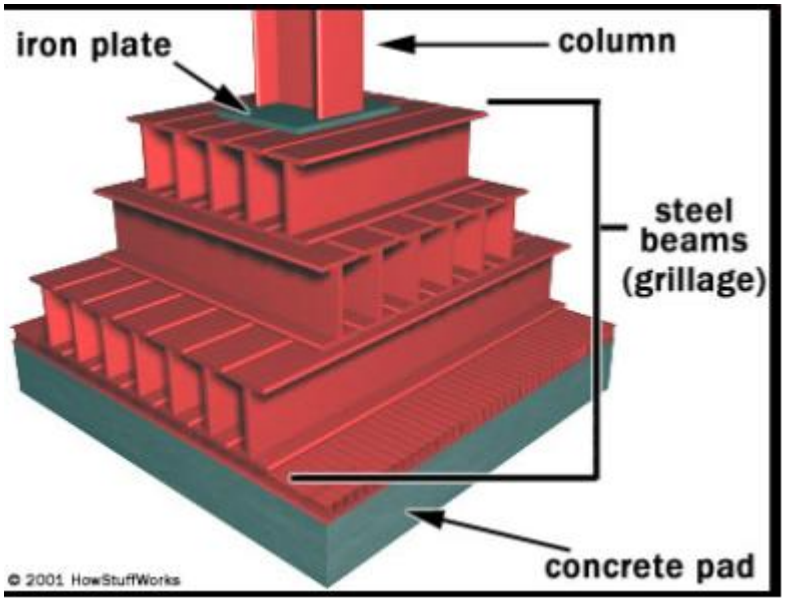
SUPERPLASTICIZERS

- Also known as *high-range* water reducers (HRWR)
- Reduce water requirement by 12-30%
- Can make low slump concrete flow like high-slump mix
- Makes mix highly fluid and can be placed with little or no vibration or compaction
- Effect lasts only 30-60 minutes and is followed by rapid loss of workability
- Usually added at jobsite

UNIT 3
BUILDING COMPONENTS AND FOUNDATION

FOUNDATION…

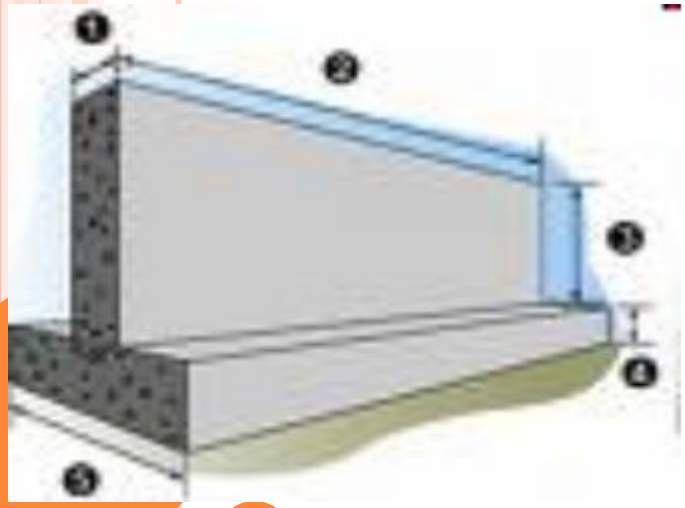
- Isolated footing (single footing, column footing)…



FOUNDATION…

- Isolated footing (single footing, column footing)…

wall footing



FOUNDATION…

- Combined footing:
- This type of footing is adopted when the space between two columns is so small that the foundation for individual columns will overlap.
- Combined footings are proportioned in such a way that the centre of gravity of the loads coincides with the centre of gravity of the foundation. Hence these footings have either a trapezoidal or a rectangular shape.

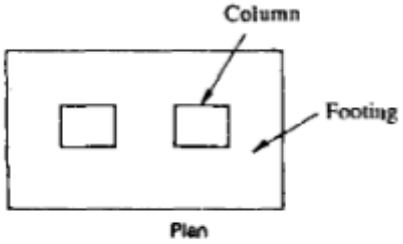


Fig. 2.2 *Combined footing*

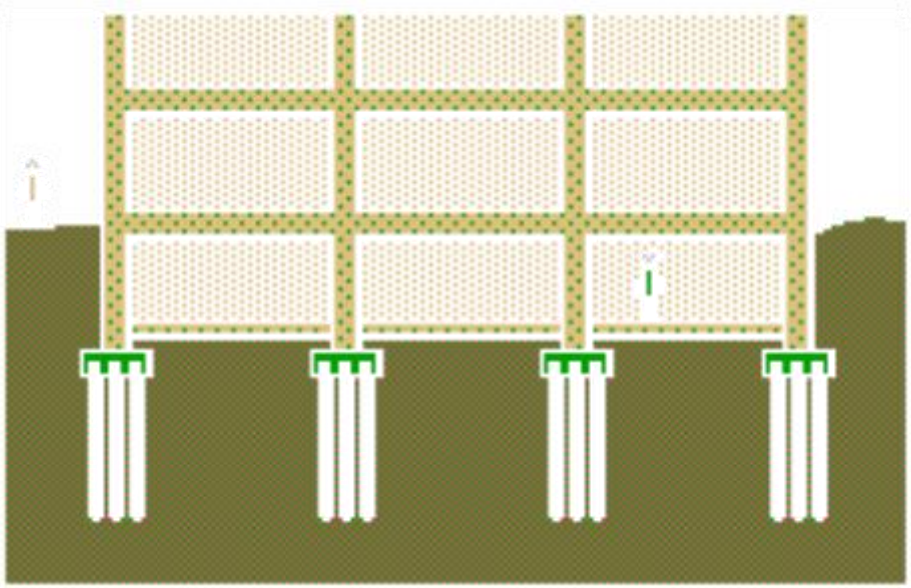
Footing :

Footings are structural members used to support columns and walls and to transmit and distribute their loads to the soil in such a way that the load bearing capacity of the soil is not exceeded. Also excessive settlement, differential settlement or rotation are prevented and adequate safety against overturning or sliding is maintained.

FOUNDATION…

- **Pile :**

- A slender, structural member **consisting steel or concrete or timber.**
- It is installed in the ground to transfer the structural loads to soils at some significant depth below the base of the structure.



VENTILATIONS

- The process of supplying fresh air and removing contaminated air by natural / mechanical process is termed as Ventilation.
- To provide excellent conditions to live and Work Air movement, temperature, Humidity conditions etc are important. The simultaneous control of temperature, humidity, air motion and air purity is known as air- conditioning.

SYSTEMS OF VENTILLATION

- A good ventilating system should fulfill the following requirements:
  - It should admit required amount of fresh air in the room.
  - All the corners of the room should get proper ventilation.
  - Desired humidity should be maintained.
  - Effective temperature should be maintained.
  - The ventilating air should be free from impurities such as dust, odour etc

- The systems of ventilation may be divided into two categories:
  - NATURAL VENTILATION
  - MECHANICAL VENTILATION

UNIT 4
WOOD, ALUMINIUM AND GLASS

Major Topics

- History
- Mortar
- Grout
- Brick
  - Types
  - Bond
  - Joints
- Structural Clay Tile
- Concrete Block (CMU)

TOPICS CON'T

- Masonry Panels
- Gypsum Block
- Glass Block
- Stone
- Stone Masonry

History

- One of the oldest manufactured building materials
- Sun-baked brick was found in the remains of structures in the Tigres-Euphrates basin as early as 6000 B.C.
- Romans also used thin bricks in thick mortar made of volcanic materials and lime.
- 1633 – 1st brick buildings erected in Manhattan Island (imported from Holland & England)

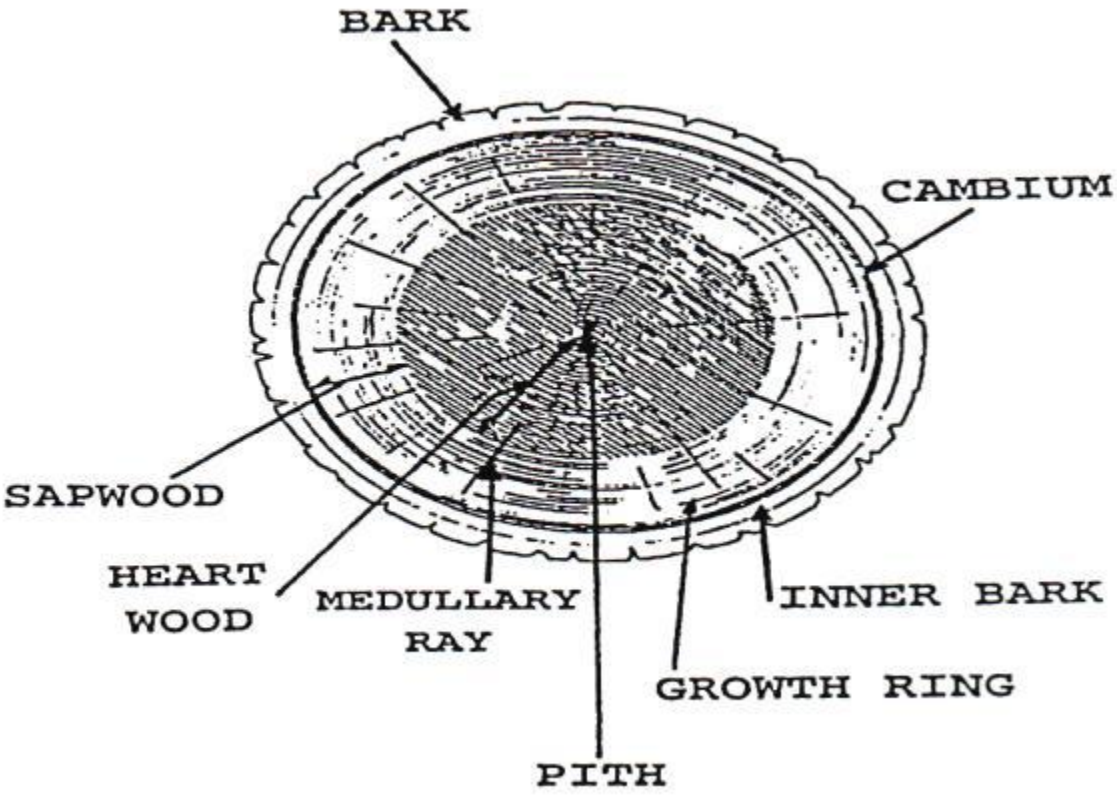
Masonry Defined

An assembly or combination of small building units made of clay, shale, concrete, glass, gypsum, or stone that are set in mortar.

Masonry consists entirely or partially of hollow or solid units laid contiguously in mortar.

TIMBER AND TIMBER PRODUCTS

CROSS-SECTION OF A TREE



TIMBER

Requirements of timber

- It should be dense.
- It should have uniform texture.
- It should have dark uniform colour.
- It should be workable, good machinability.
- The medullary rays should be compact.

TYPES

- Natural timber

  babul, oak, pine, mango, sal, teak, neem, palms, chir.

- Industrial timber

  veneers, plywoods, fiberboards, impreg timber, compreg timber.

Uses

- Railway sleepers, bridges, pipes.
- Furniture, decorative pieces, doors.
- Packing material, piles, cart wheels.
- Poles, pen, rafter.
- Roofs, partition walls, boats etc.

- ***Annual or growth rings*** **-** *in temperate climates there are two distinctive growth seasons*, spring and summer - the spring growth is rapid and is shown as a broad band whereas the hotter, dryer summer growth shows up narrow. In tropical countries the growth rings are more even and difficult to distinguish.
- ***Bark*** - *the outer layer, corklike and provides protection to the tree from knocks and other*

  damage.

- ***Cambium*** *- layer of living cells between the bast and the sapwood.*
- ***Heartwood*** *- mature timber, no longer carries sap, the heart of the tree, provides the* strength of the tree. Usually a distinctive darker colour than the sapwood.
- ***Medulla ray*** *- (rays) food storage cells radiating from the medulla - provides a decorative* feature found in quarter cut timber.

- ***Pith or medulla*** - *the centre of the tree, soft and pithy especially in the branches.*
- ***Sapwood*** - *new growth carries the raw sap up to the leaves. Usually lighter in colour than* the heartwood, especially in softwoods.
- ***Bast*** - *the inner bark carries enriched sap from the leaves to the cells where growth takes* place.

DISTINCTION BETWEEN HARDWOOD & SOFTWOOD

- ***Softwoods*** *(gymnosperms). Softwoods are coniferous trees and the timber is not necessarily 'soft'. They* are 'evergreen'. (The *larch is an exception)*
- *Their general characteristics are:*

• Straight, round but slender, tapering trunk.

• The crown is narrow and rises to a point.

- It has needle like or scale-like shaped leaves and it's fruit, i.e. it's seeds are carried in cones.

• The bark is course and thick and softwoods are evergreen and as such do not shed their leaves in autumn.

- **E.g.** pine, bitter wood, redwood, cypress, red cedar, douglas fir, cedar damsel, yew, eucalyptus, sitka spruce, juniper, ginkgo

- ***Hardwoods*** *(angiosperms). Hardwood trees are broadleaf and generally deciduous. They shed their leaves in the autumn. Their timber is not* necessarily hard. For instance, balsa (the timber used for making model planes) is a hardwood.
- The general characteristics are:

• Stout base that scarcely tapers but divides into branches to form a wide, round crown.

- The leaves are broad and may have single or multi lobes.

• The bark may be smooth or course and varies in thickness and colours.

• Its fruit may be: nuts, winged fruits, pods, berries, or fleshy fruits.

E.g. lignum vitae, oak, sycamore, teak, ash, bullet wood, cotton, tamarind, white cedar, mahoganies, satin wood, mahoe, poplar

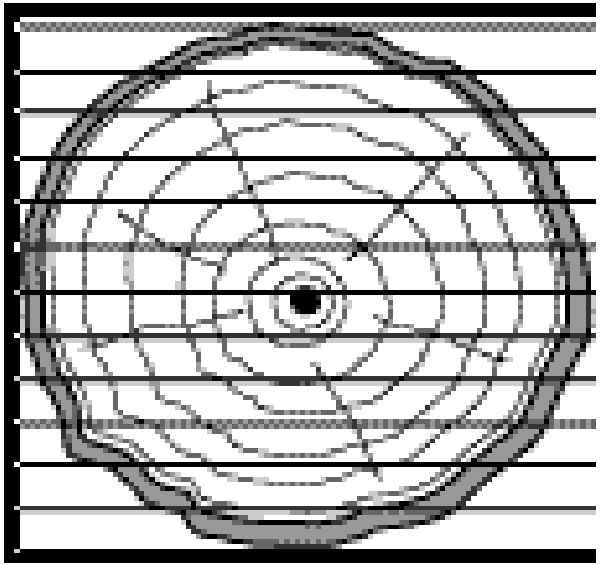
LUMBER CONVERSION

Conversion is the cutting of log into marketable timber for commercial use.

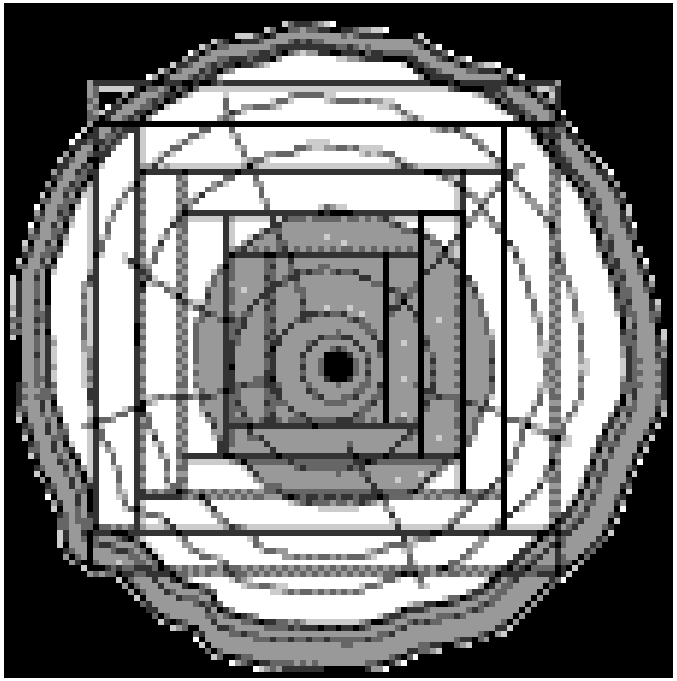
- There are two *main methods of converting timber:*
- *Through and through (or Plain or Crown sawn), which produces tangential boards and*
- Quarter Sawn, which produces radial boards.

- **Quarter sawn** (radial, figured) is far more expensive because of the need to double (or more) handle the log. There is also more wastage. It is however more decorative and less prone to cup or distort. Such timber is expensive due to the multiple cuts required to convert this board. Annual growth rings form an angle greater than 45 degrees.

- **Through and through** produces mostly tangentially sawn timber and some quarter sawn stuff. Tangential timber is the most economical to produce because of the relatively less repetitive production methods. It is used extensively in the building industry



- **Tangential boards** (crown, plain or flat sawn) are used extensively for beams and joists. They are stronger when placed correctly edge up with the load in the tangential axis. These type of boards suffer from 'cupping' if not carefully converted, seasoned, and stored properly. Annual growth rings form an angle less than 45 degrees.



- **Rift sawn** is the cut which falls between crown and true quarter sawn. Quality floor boards are prepared from *rift sawn* timber because it wears well and shrinks less. Annual growth rings form an angle between 30 and 60 degrees.

SEASONING

- **Seasoning** is the controlled process of reducing the moisture content (MC) of the timber so that it is suitable for the environment and intended use.
- *For construction grade timber the timber must be below 20% MC*
- *For framing and outside finish 15% MC*
- *For Cabinet and furniture 7 to 10% MC*

METHODS OF SEASONING

- Air/Natural drying

Air-drying is the drying of timber by exposing it to the air. The technique of air-drying consists mainly of making a stack of sawn timber (with the layers of boards separated by stickers) on raised foundations, in a clean, cool, dry and shady place. Rate of drying largely depends on climatic conditions, and on the air movement (exposure to the wind). Coating the ends of logs with oil or thick paint, improves their quality upon drying.

- Kiln drying

The process of kiln drying consists basically of introducing heat. This may be directly, using natural gas and/or electricity or indirectly, through steam-heated heat exchangers. In the process, deliberate control of temperature, relative humidity and air circulation is provided to give conditions at various stages of drying the timber to achieve effective drying.

- For this purpose, the timber is stacked in chambers, called wood drying kilns, which are fitted with equipment for manipulation and control of the temperature and the relative humidity of the drying air and its circulation rate through the timber stack

MOISTURE CONTENT IN LUMBER

- **Moisture Content** A measure of the amount of water in a piece of lumber.
- *The % MC is obtained by the formulae*

  Wet weight – dry weight / dry weight X 100 = %MC *(this is a standard scientific formulae for determining wood %MC)*

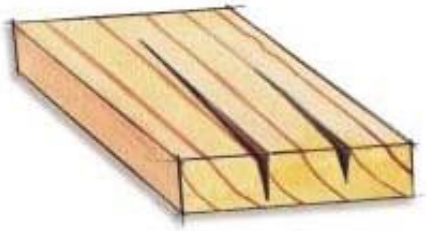
DEFECTS IN WOOD

- A defect is any irregularity occurring in or on wood which reduces is strength, durability and usefulness. It may improve or reduces its appearance

Man Made Defects

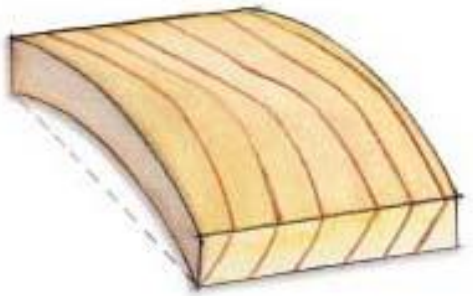
Bow: A curve along the face of a board that usually runs from end to end.

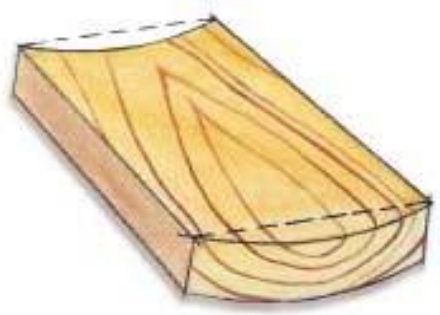
Check: A crack in the woo ce, usually running lengthwise. Checks are usually restricted to the end of a board and do not penetrate as far as the opposite side of a piece of sawn timber.



Crook: Warping along the edge from one end to the other. This is most common in wood that was cut from the centre of the tree near the pith.

Cup: Warping along the face width of the board. This defect is most common of

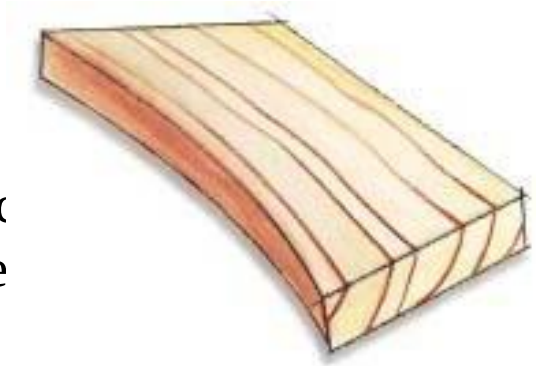




Shake: Separation of grain between the growth rings, often extending along the board's face and sometimes below its surface.

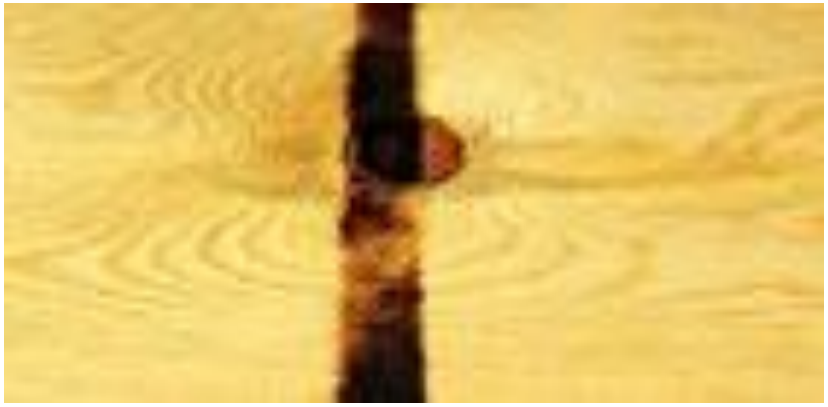
Split: A longitudin  /hich extends to the opposite face of a piece of sav

Twist: Warping in lumber where the ends twist in opposite directions.



Wane: The presenc ɔod on corners or along the length of a piece

Machine Burn: Discoloration of the wood due to overheating caused by friction, and either scorching the wood or the resins within it. Machine burn is caused by stopping or not feeding the wood across the blades at the correct rate of speed. machine burn can almost always be prevented by using sharp blades and correct feed rates.



Blue Stain: A discoloration that penetrates the wood fibre. It can be any colour other than the natural colour of the piece in which it is found. It is classed as light, medium or heavy and is generally blue or brown.

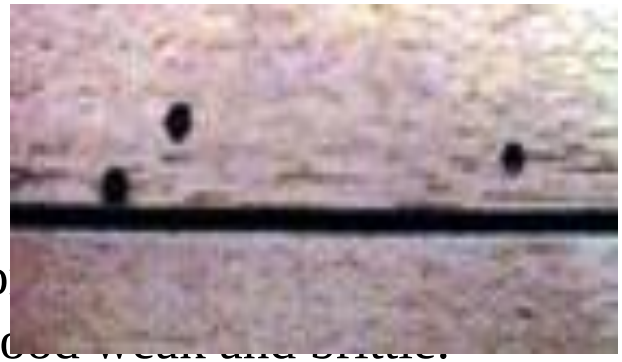
Pitch: An accumulation of resinous material on the surface or in pockets below the surface of wood. Also called gum or sap.

Loose /Dead Knot: A [illegible] to remain in place in the piece. Caused by a dead branch that was not fully integrated into the tree before it was cut down.

Tight/Live Knot: A knot fixed by growth or position in the wood structure so that it firmly retains its place in the surrounding wood.

Spalt: Typically found ...orm of wood discoloration caused by fungi.

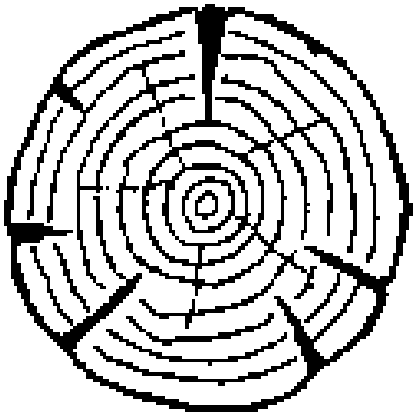
Wormhole: Small holes in the wood caused by insects and beetles.



Dry rot is a conditio breaks down wood fibers and renders the wo

Heart shake: Wood tissue separates due to uneven stress forming a crack.

Star shake: This occu  l shakes radiate from the centre region.



Ring or cup shake: This type of shake follows the line of the growth ring. The split occurs between two growth ring and is the result of uncontrolled seasoning.

Resin pockets: Resin pockets do not affect the overall strength of the timber. They are more of a problem when it comes to machining and finishing the timber surface. The resin sticks to machine blades, eventually blunting them.

COMMON METHODS OF WOOD PRESERVATION

- Spraying or brushing with wood preservative
- Pressure treatment
- Dipping

PROPERTIES OF TIMBER

- It has low heat conductivity.
- It has small bulk density.
- It is relatively high strength.
- It is susceptible to decay.
- It is susceptible to flame.

EXPLANATIONS

- **Pressure treatments** force preservative into wood under higher than atmospheric pressures. Properly pressure treated wood is recommended for use in situations of high decay hazard (ground line contact).

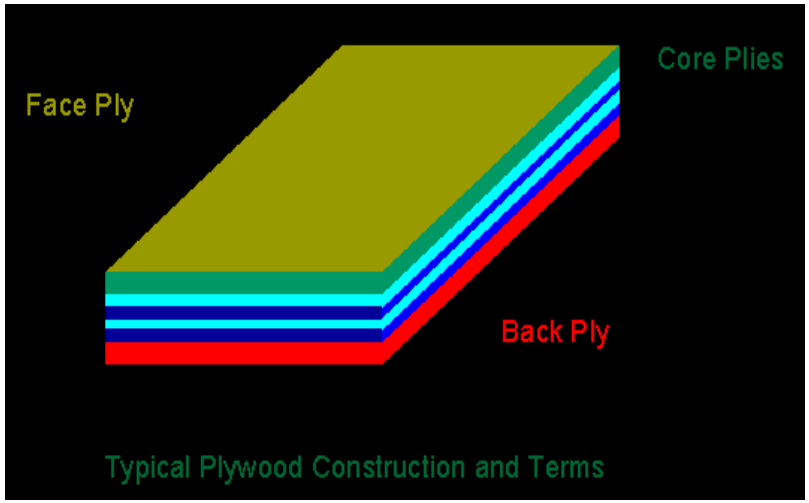
- **vacuum process:** wood is placed in a sealed container and as much air is pumped out as is possible, creating lower than atmospheric pressure in the wood cells. Preservative is flooded into the tank and the seal is broken creating a partial vacuum which sucks preservative into the wood.

- **thermal process or hot-cold bath** involves placing wood in a tank of hot preservative oil followed by immersion in cold preservatives. The hot bath heats and expands the air within the wood, forcing some of the air out. The wood is then immersed in the cold bath and the heated air contracts pulling preservative in with it. The thermal process is frequently used in treating utility poles

- **Cold soaking** in solutions of creosote or penta has been moderately effective in treating round stock of species with thick, easily treated sapwood, such as that of many pines. Cold soaking should not be used when heartwood is exposed. Normal soaking times vary from 24 to 48 hours and there is little control over retention and penetration.

MANUFACTURED BOARDS

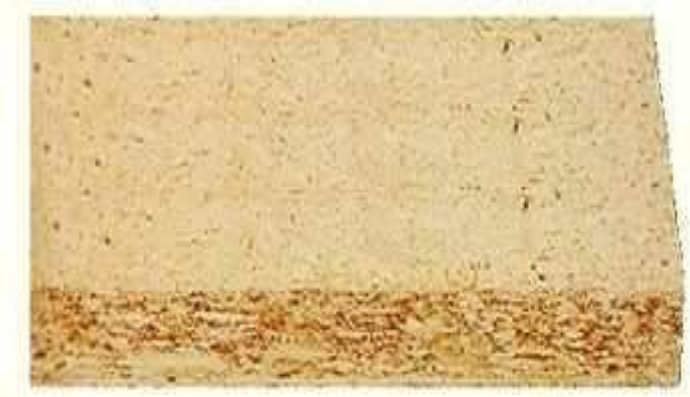
- **Manufactured or man made boards** - are made from wood products and have new/different properties to the wood they were made from. Board sizes are 8ft x 4 ft (2440 x 1220 mm).



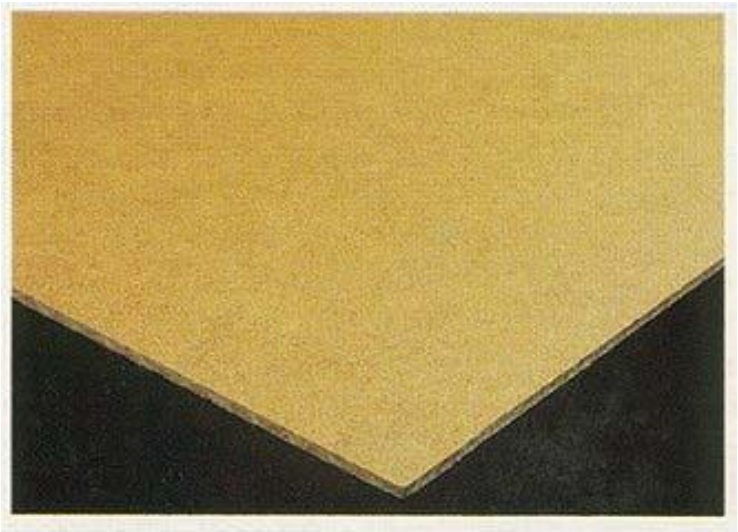
- **MDF (medium density fibreboard)** made by a process which glues wood fibres together using heat and pressure. The boards are smooth and strong. They are resistant to warping. MDF is used industrially for the production of furniture (especially shelves and cupboards),display cabinets, wall-panels and storage units.
- MDF is available in a range of thicknesses, 3mm, 6mm, 9mm, 12mm, 15mm, and 18mm.

- **Plywood** is made from layers of thin wood glued together at 90 degrees to each other. There is always an odd number of veneers and the direction of the grain runs alternately to give the material strength
- **Sizes**: -Plywood is sold in 2440 x 1220mm and 1525 x 1525mm sheets. The most common thicknesses are 4, 6, 9 and 12 mm.
- **Uses**: -It may be used for wall panelling, flooring, furniture making, strong structural panelling board used in building construction. Some grades used for boat building and exterior work.

- **Chipboard** is made by bonding together wood particles with an adhesive under heat and pressure to form a rigid board with a relatively smooth surface. Used for kitchen and bedroom furniture, kitchen worktops and carcases (cupboard shells). normally available in 2440 x 1220 sheets. Thicknesses range from 12 to 25 mm.



- **Hardboard (particle board)**
  Hardboard is made from wood fibre is extracted from chips and pulped wood waste. In the production process the pulp is exploded under pressure. Heat and steam is applies to leave a fine, fluffy brown fibres. These fibres are transformed into mats, which are held together with lignum and other glues. The mats are than pressed between steam-heated metal plates to give grainless sheets with one smooth, glossy surface and one textured surface. **Used** for furniture backs, covering curved structures, door panels.



- **Blockboard** is composed of a core of softwood strips (up to about 25mm wide) placed edge to edge and sandwiched between veneers of hardwood, the 'sandwich' is then bonded under high pressure. Used where heavier structures are needed. Common for shelving and worktops.
- Blockboard is normally available in 2440 x 1220 sheets (or subdivisions), thicknesses tend to be limited to around 30mm.

- **laminated board**
- At first sight, edge laminated softwood board can look like one piece of timber, but it is actually made up of narrow (25 to 100 cm) strips of softwood glued edge to edge. This board is ideal for making furniture where the natural gain can be left exposed.

Bagasse is the fibrous matter that remains after sugarcane or sorghum stalks are crushed to extract their juice. **Bagasse board** Made from sugar cane.

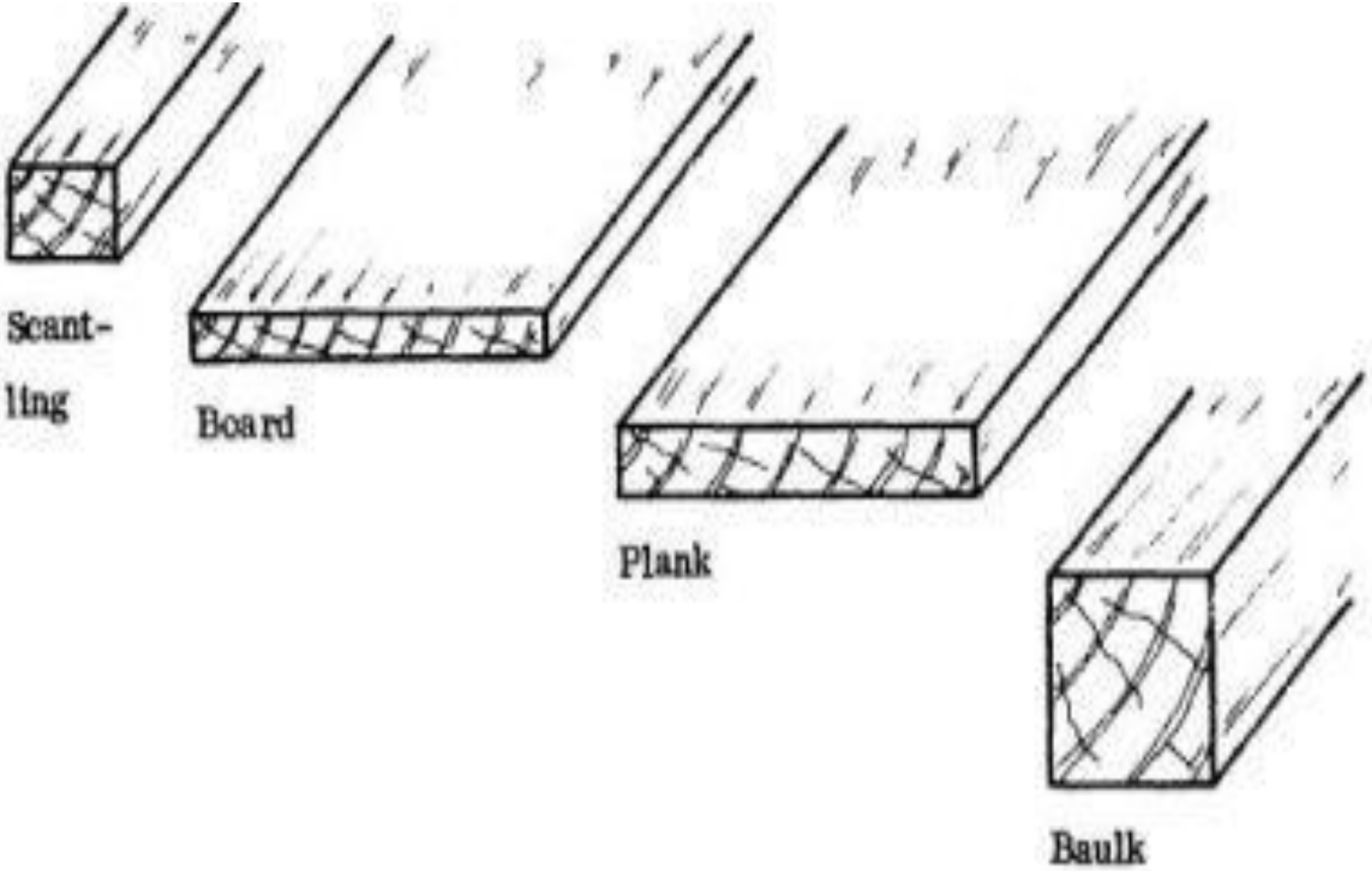
PROPERTISE OF MANUFACTURED BOARDS

- Large sizes
- Uniform texture
- Smooth surfaces
- Standard dimension
- predictable quality
- Less warp

PIECES OF TIMBER IDENTIFICATION

- **Baulk:** square shaped pieces, about 100 mm wide and 50 mm or more thick.
- **Planks**: above 200 mm wide and between 38 and 100 mm thick.
- **Flitches**: 100mm x 300mm; not less
- **Deals**: 50mm x 100mm x 225-300mm maximum
- **Battens**: 50mm -100mm x 125mm - 200mm
- **Slating and tiling**: 16mm – 32mm x 25mm – 100mm

- **Panels**: thin board slices
- **Scantling**: pieces about 75 mm wide by 50 mm thick.
- **Strips Fillets**: under 50mm, less than 100mm
- **Quartering**: square 50mm x 50mm, 150mm x 150mm, etc.
- **Boards**:more than 150 mm wide and less than 50 mm thick.


Scant-
ling
Board
Plank
Baulk

LUMBER CALCULATIONS

- Metric size lumber gives thickness and width in millimeters (mm) and length in meters (m). Metric lumber lengths start at 1.8m (about 6”) and increase in steps of 300mm to 6.3m (little more than 20’) metric lumber is sold by the **cubic meter (m^3)**
- Formula
- a}$\frac{T(mm) \times W(mm) \times L(m)}{1000 \times 1000 \times 1}$ b}$\frac{T(mm) \times W(mm) \times L(mm)}{1000 \times 1000 \times 1000}$

- Another unit of measure for lumber is the **Board Footage (bd. Ft.).** When the size contains a mixed fraction, such as 1¼, change it to an improper fraction (5/8) and place the numerator above the formula line and the denominator below.

- *Formula:*

a) $\frac{T(in) \times W(in) \times L(ft)}{12}$

b) $\frac{T(in) \times W(in) \times L(ft)}{144}$

CAVEAT

- **Nominal Size** - Refers to the size of a piece of lumber before it is dressed and seasoned. It is used to designate a particular size piece of lumber, such as 2x4, 2x6, etc.

  Actual Size - Refers to minimum acceptable size after it has been dressed and seasoned. A nominal 2x4 can have a minimum actual size of 1.5 in. x 3.5 in. When referring to a specific piece of lumber, the nominal size is used. Length is not reduced by processing from the buyer.

IMPORTANCE OF INSULATION

- **Insulation helps to:**

i. Hold down energy cost

ii. Control the temperature of the building

iii. Keep heat from entering the building

- **Insulation** in construction involves materials that do not readily transmit energy in the form of heat, electricity or sound. *Insulators are made from many materials, including cellulose, rock wool, a glassy lava called perlite, gypsum, certain plastics, fiberglass, asbestos, foam, insulating concrete, loose fills, quilt, insulating plasters, mica and refractory materials.*

FIRE RETARDANTS

A **fire retardant** is a material or substance other than water that reduces flammability of fuels or delays their combustion (burn slowly) .

- Gypsum
- CO_2Paints
- Fibre wall boards
- rock wool
- asbestos cement
- perlite boards
- calcium silicate boards

- Sufficient quantity of water is provided to the building for the needs such as drinking, bathing, washing of cloths and washing of floors. More quantity of water is used through sanitary fittings like water closets, washbasins, sinks, bath rooms etc..

- In addition, telephone services and electric fittings are also come under the preview of building services.

GLASS

- Glass is an amorphuos,inorganic,homogeneous,transparent or translucent material.

TYPES OF GLASS

- Soda lime glass
- Potash lime glass
- Potash lead glass

PROPERTIES OF GLASS

- It can not deform.
- It is hard.
- It has resistance to scratches.
- It is brittle.
- It is affected by alkalies.
- It is transparent or translucent.
- It is no effect of air & water.

Requirements of metal

- They should provide sufficient strength to bear the loads coming on them
- They should provide resistance to corrosion and weather actions
- They should provided resistance to heat and fire.
- They should have good adhesion with cement concrete.

Types of metal

- Ferrous metals
  1)pig iron
  2)cast iron
  3)wrought iron
  4)steel
- Non ferrous metals
  1) Aluminium
  2) copper
  3) Magnesium
  4) Nickel

PLASTIC

- The plastic is an organic substance and it consists of natural or synthetic binders or resins with or eithout moulding components.

TYPES OF PLASTIC

<1>THERMO PLASTIC

<2>THERMOSETTING PLASTIC

PROPERTIES OF PLASTIC

- It is light in weight.
- Specific gravity of plastic is 1.40.
- They are low electrical conductivity.
- They are low thermal conductivity
- They can absorb shocks.
- USES
- To make waterproof doors,bags.
- To make furniture .
- To make optical lenses, frameas.

Mortar

- Must conform to ASTM C270
- 4 basic types of mortar used: M, S, N, O
- Composed of: portland cement, hydrated lime, sand, and water
- Key to forming a strong and durable bond with masonry units

Mortar Types

Type	Avg Compressive Strength	Use
M	2500 psi	Masonry below grade and in contact with earth
S	1800 psi	Where maximum flexural strength is required (winds >80 mph)
N	750 psi	General use in exposed masonry above grade; parapets, chimneys, and ext. walls subjected to severe weathering
O	350 psi	Solid unit load-bearing walls Where compressive strength < 100 psi

Mortar Properties/Function:

- Have a tendency to shrink very little
- Have a high degree of resistance to moisture penetration
- Possess adequate strength to resist the forces applied to it
- Provide aesthetic qualities to the structure through the use of color and type of joint

Mortar Basics:

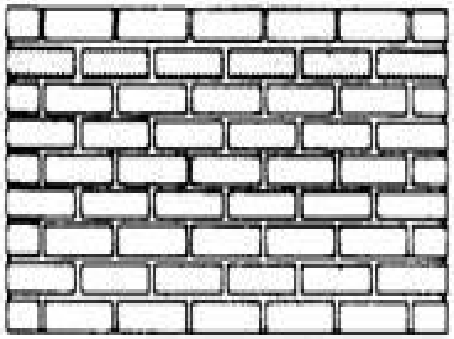
- Brick masonry mortar made of portland cement, hydrated lime, and sand (stone masonry uses white portland cement [nonstaining].
- *Retempering – adding water to the mortar mix to maintain consistency*
- Mortar mix should be used within 2 – 2 ½ hours after initial mix is prepared
- *Efflorescence – the soft white powder appearing on the face of brick; caused by salts in the brick or mortar brought to the surface*

Mortar Joints:

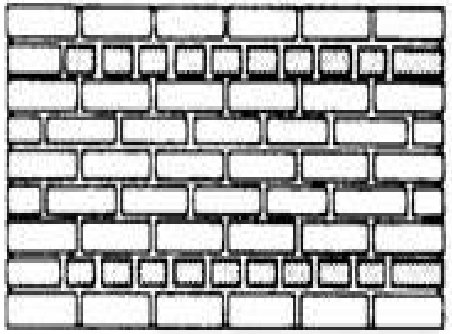
- Joint sizes vary
  - Facing brick – 3/8” to ½”
  - Building brick – ½”
  - Glazed brick – 1/4 “
- Although many types of joints exist (see Fig. 4-3, pg 82), the most weatherproof & recommended are: *V-shaped, Weathered, & Concave*
- Joints may be formed by using a trowel, steel rod, or specialized tools

Grout

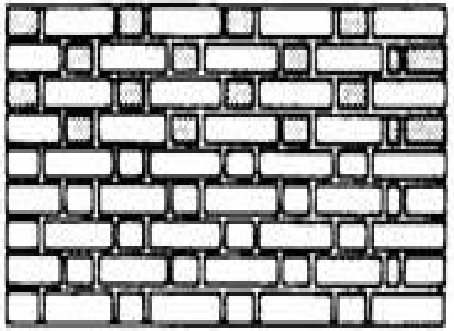
- The water/cement ratio is less critical in grout than in mortar or concrete
- It is intended to be very “fluid” in order to function in it’s “binding” capacity (slump of 8-11 inches)
- May be used to fill cavities between masonry walls (often around vertical reinforcement)



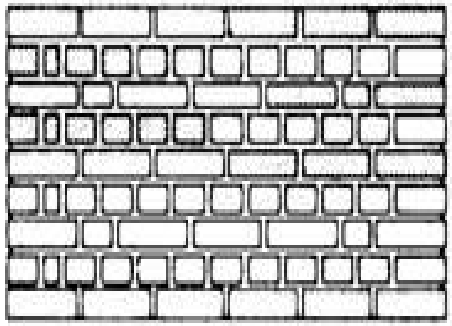
RUNNING



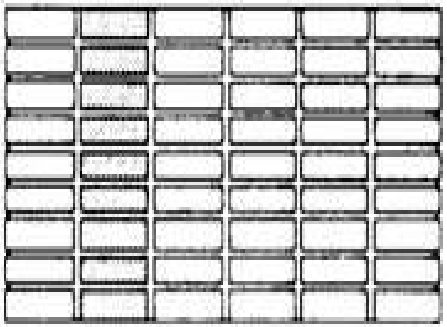
COMMON OR AMERICAN



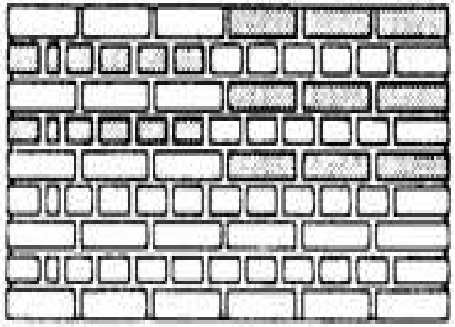
FLEMISH



ENGLISH

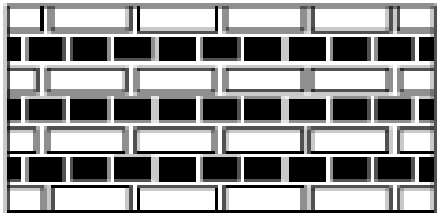


STACK

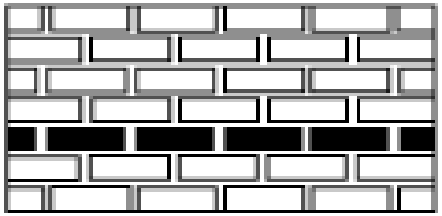


ENGLISH CROSS OR DUTCH

143

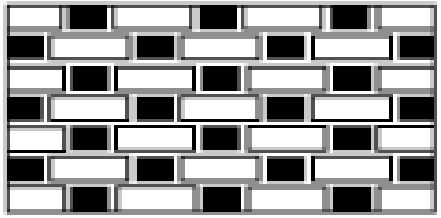


ENGLISH BOND

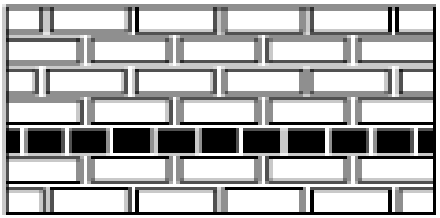


STRETCHER BOND

STRETCHER

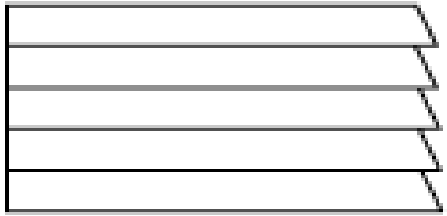


FLEMISH BOND

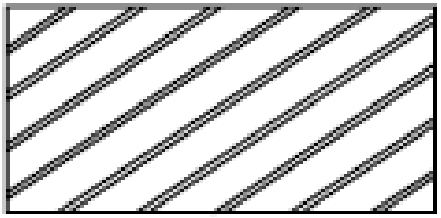


COMMON BOND

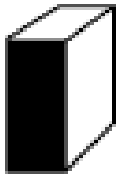
HEADER



CLAPBOARD
OR WEATHERBOARD



DIAGONAL SIDING



SOLDIER

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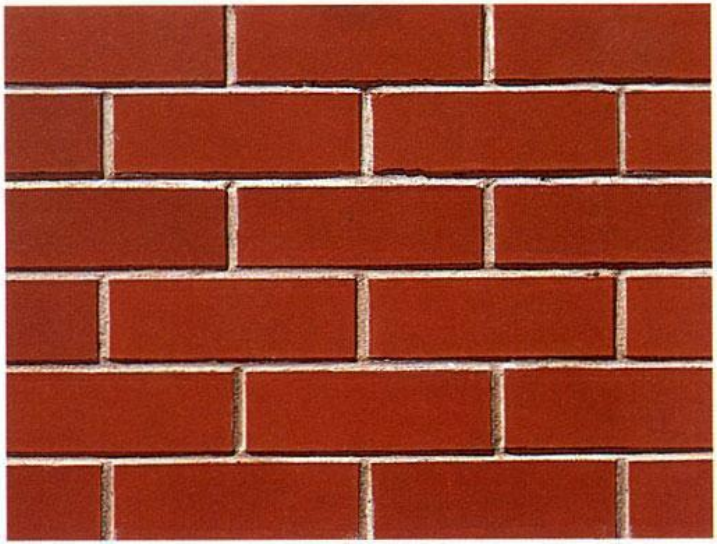
FLAME RED



IVORY SANDSTOCK with cream mortar

Brick Walls

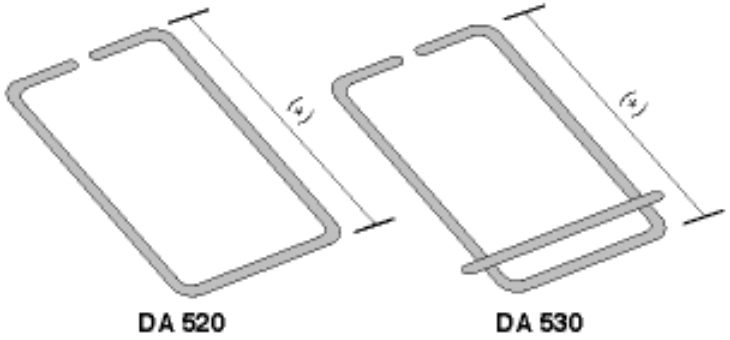
- May be bearing (supports any vertical load) or non-bearing
  - Solid walls- 2 or more wythes bonded together by ties, headers
  - Cavity walls – 2 walls spaced 2 in. apart by metal ties; may fill cavity with insulating material; *Weep holes must be in outer wall in order for moisture to escape* ; not allowed in earthquake zones

Brick Walls con't

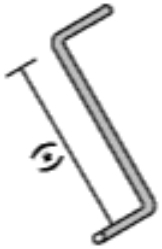
- Faced walls – brick masonry units bonded to a backup wall of another material (common brick, hollow structural clay tile, or CMU)
- Veneered walls – facing material is securely tied to a structural wall but NOT bonded to it (common residential wood- frame construction)
- Reinforced brick masonry – steel reinforcement is placed vertically & horizontally and often grout surrounds it (spacing governed by local code requirements)

Ties

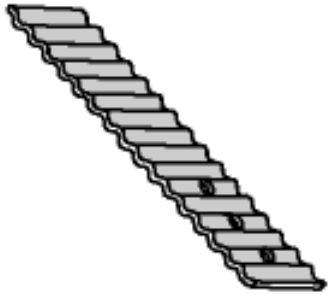
- May be standard unit ties or adjustable
- Number and placement of ties depends on application and building code requirements



"Adjustable Box Anchor" – designed to tie multi-wythe walls



"Z" tie – multi- wythe walls when fully grouted



"Corrugated" wall tie – veneer walls

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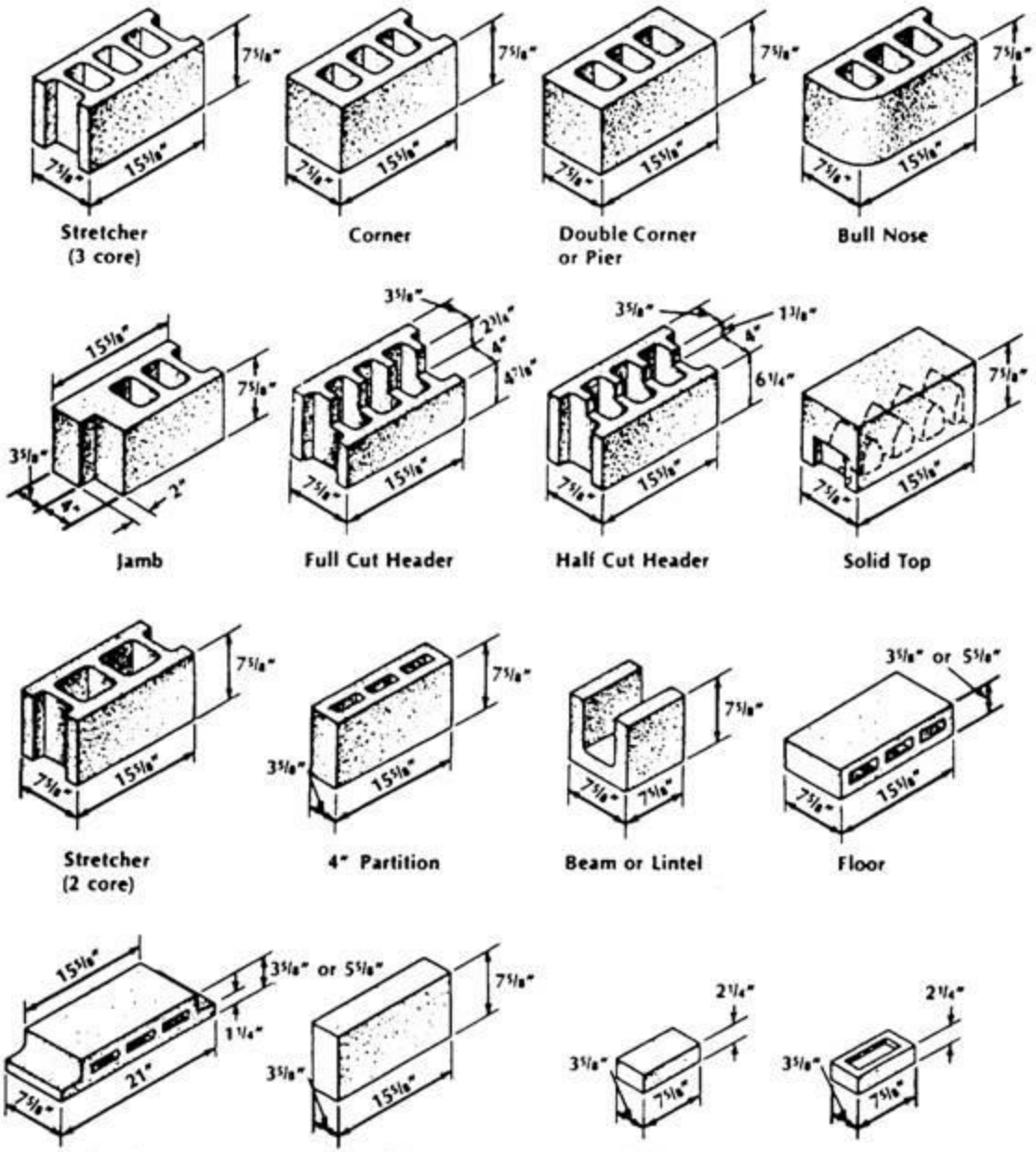
Concrete Masonry Unit (CMU)

- Hollow (or solid) masonry units used for interior/exterior bearing or non-bearing walls, partitions, and backing.
- The aggregate used to make the units will determine the weight (25-50 lb. for 8” x 8” x16” stretcher unit)
- Nominal sizes include: widths- 4”,6”,8”,10”,12”; lengths- 6”,8”,12”, 16”, 24”
- Have good fire-rating, thermal storage capability, good resistance to sound transmission, and are economical.

CMU Types


Stretcher (3 core)
Corner
Double Corner or Pier
Bull Nose
Jamb
Full Cut Header
Half Cut Header
Solid Top
Stretcher (2 core)
4" Partition
Beam or Lintel
Floor

CMU Screen Units

- Used to form a wall (screen) for privacy (walls in carports), separation of spaces, and architectural details (cast shadows).
- Sizes and geometric shapes (patterns) are varied. Sizes may include 4” –12” squares.

Surface Bonding (BlockBond)

- CMU is laid dry with vertical steel grouted in place.
- 2 coats of BlockBond is sprayed on inside and outside of walls
- Surface may be textured and requires no paint
- Colors include white, beige, and gray

Gypsum Block

- Lightweight, used in non-load bearing applications, fire-resistant, interior locations
- Concern: never use in areas in which moisture exposure could occur

Glass Block

- Often used for their decorative effect but also:
  - Provide controlled light transmission
  - Good insulation
  - Condensation protection
  - Good sound reduction

Glass Block con't

- The blocks are formed of 2 cast glass shells that are fused together to form a hollow unit containing a partial vacuum. The vacuum decreases heat transmission and surface condensation.
- Faces can be:
  - Smooth – provides vision through the block
  - Textured – provide only light transmission
  - Opaque – fired with a ceramic finish

Glass Block con't

- Common sizes are 6", 8", 12" sq. by 4 " thick
- Mortar joints typically ¼ "
- Usually laid in a stack bond (can only support their own weight)
- Concern: glass block expands 1.5 to 2 times more than a brick wall & therefore, must have expansion joints

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Stone Classification

- Igneous – formed by the solidification of molten rock such as volcanic activity (Granite)
- Sedimentary – formed from silt, marine life, and rocks that have been deposited by running water (Limestone, Sandstone, & Travertine)
- Metamorphic – igneous or sedimentary rock that have been changed by pressure, heat, or moisture (Marble, Slate)

Stone- General Information

- The removal method (quarrying), sizes, shapes (smooth round, angular), thickness, textures, finish, and application & installation vary for each type.
- There are natural stones as well as cultured (man- made) stones used in building materials.

Stones & Uses

Stone	Color	Major Use	Minor Use
Granite	Wide Range	Ext. & Int. wall facing	Paving, Flooring
Limestone	Buff, Gray	Exterior wall facing	Copings, Sills, Interior wall facing
Marble	Wide Range	Ext. & Int. wall facing, flooring	Countertops
Sandstone	Yellow, Brown, Reds, Tan	Exterior wall facing	Paving
Slate	Blue, Gray, Green, Red, Black	Paving, Roof Shingles	Wall facing
Travertine	Tan, Buff, Gray	Ext. & Int. wall facing	Flooring, Paving

Examples of Stone

Stone

- Walls classified in 3 categories (based on shape & surface finish)
  - Rubble – stones as they are collected (fieldstone) or as they come from quarry
  - Ashlar – constructed of squared stones set in random or uniform courses
  - Cut stone (dimension)- fabricated and finished at the mill ready to set in place per the specifications

Fieldstone (rubble)

Ashlar (squared)

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Masonry Restoration

- 4 causes of deterioration
  - Freeze/Thaw Cycle – causes fractures
  - Wet/Dry Cycle – capillary action produces force that is stronger than the masonry
  - Thermal Expansion/Contraction – entire structure expands/contracts with change in temperature
  - Salt Crystallization – if on surface of masonry will cause efflorescence; if under surface may lead to crumbling

Masonry Cleaning

- Water Mist – will remove surface deposits; problem is entrapment of moisture
- Chemical – may damage masonry if not suitable for that particular type
- Muratic Acid Solution – may etch surface, change color of masonry
- Abrasive – (sandblasting & pressure washing) may damage surface; remove mortar

Unit 5
Stairs and Building Planning

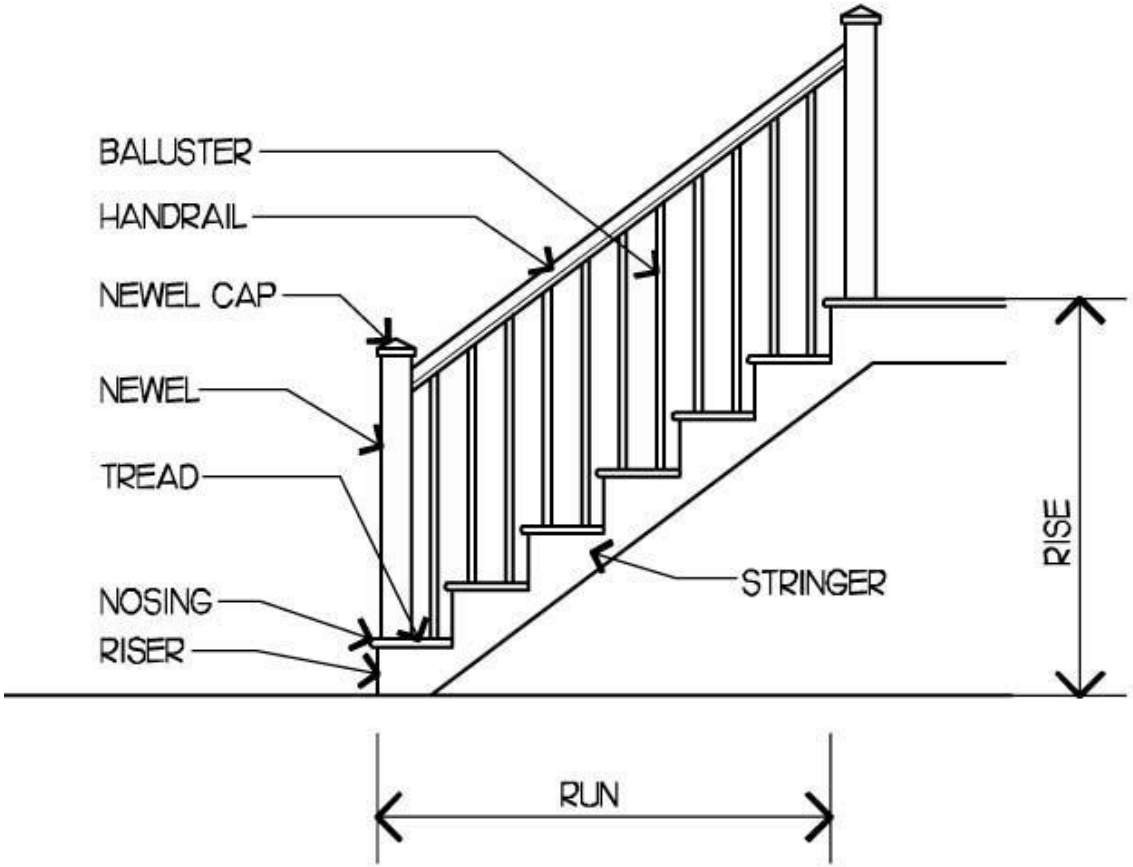
STAIRS

"A set of steps leading from surface of a building to another surface, typically inside the building is termed as Stairs."

WHY DO WE NEED STAIRS ?

To protect people from injury and to facilitate access during movement from one level to another in a building.

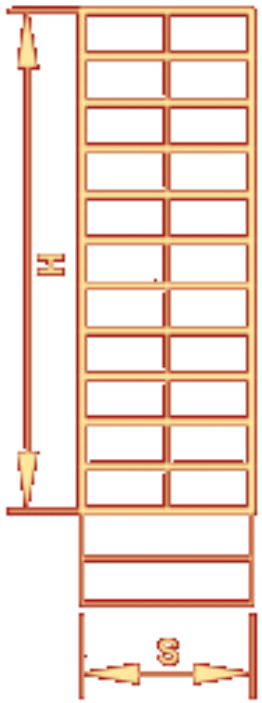
Main Parts of Stairs :



Classification of Stairs :

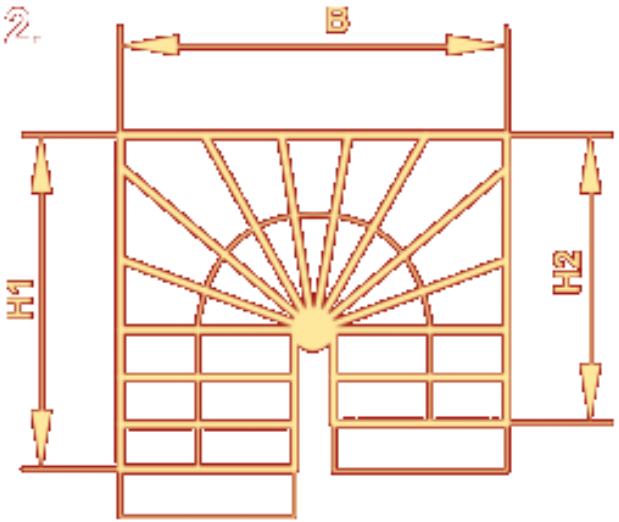
Based on shape of Plan:

1.



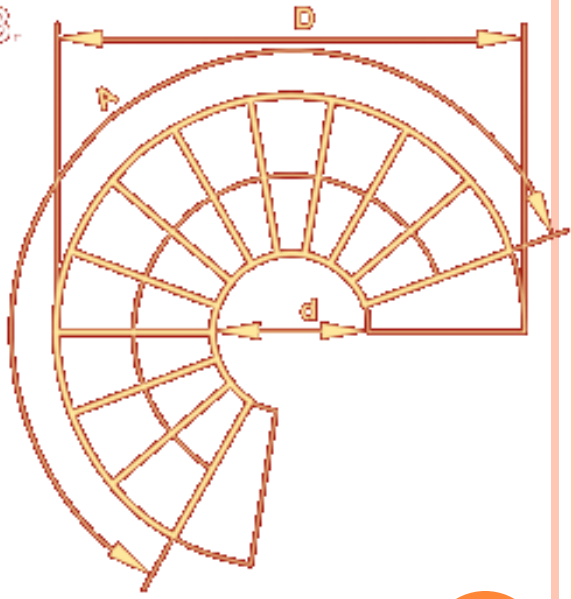
Straight staircase

2.

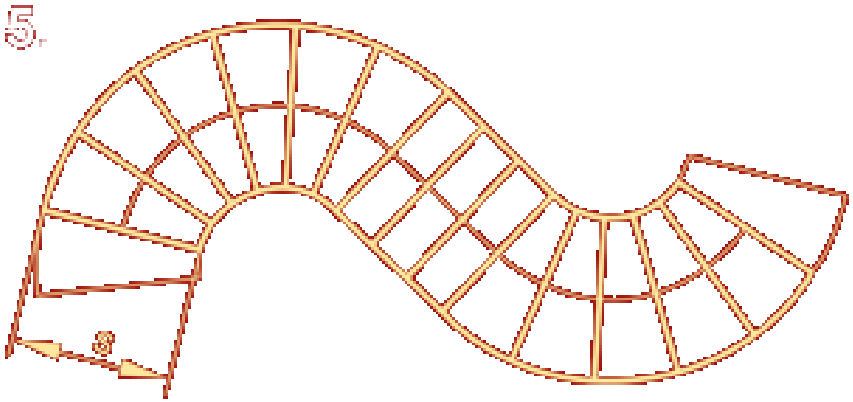


“U” staircase

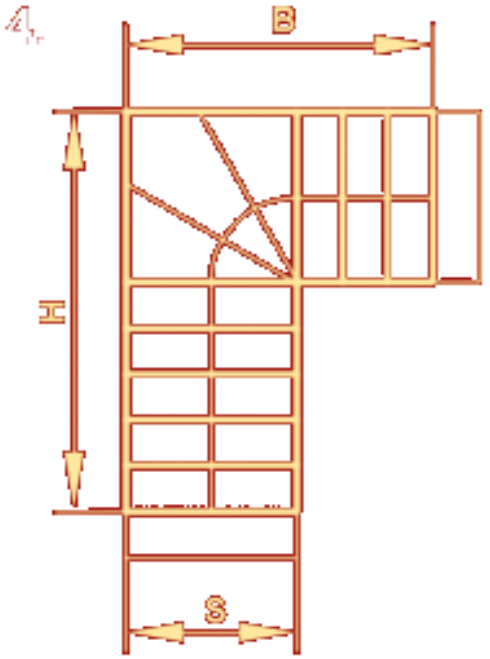
3.



“C” Staircase



Adjustable Staircase



"L" Staircase

Stair Plans

Based on type of Material :

1. Wooden Stair
2. Stone Stair
3. Steel Stair
4. Reinforced Concrete Stair
5. Brick stair

1. Wooden Stair

2. Stone Stair

3. Steel Stair

4. Reinforced Concrete Stair

5. Brick Stair

6. Glass Stair

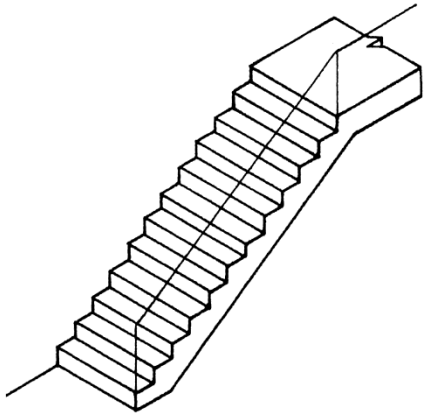
Types of Stairs :

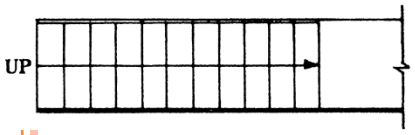
1. Straight Stair
2. Dog legged Stair
3. Quarter turn Stair
4. Open newel Stair
5. Three quarter turn Stair
6. Bifurcated Stair
7. Geometrical Stair
8. Circular Stair

1. Straight Stair :

- These are the stairs along which there is no change in direction on any flight.

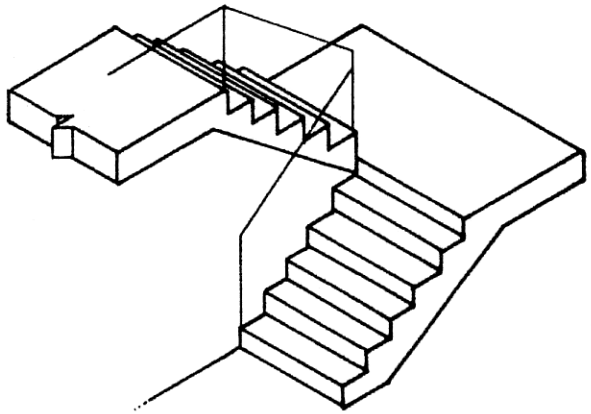
- It is used where stair case hall is long and narrow



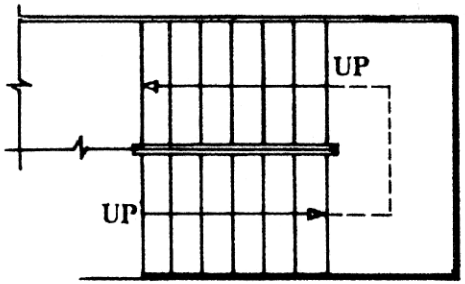


2. Dog legged Stair :

- It consists of two straight flights of steps with abrupt turn between them. A level landing is placed across the two flights at the change of direction.



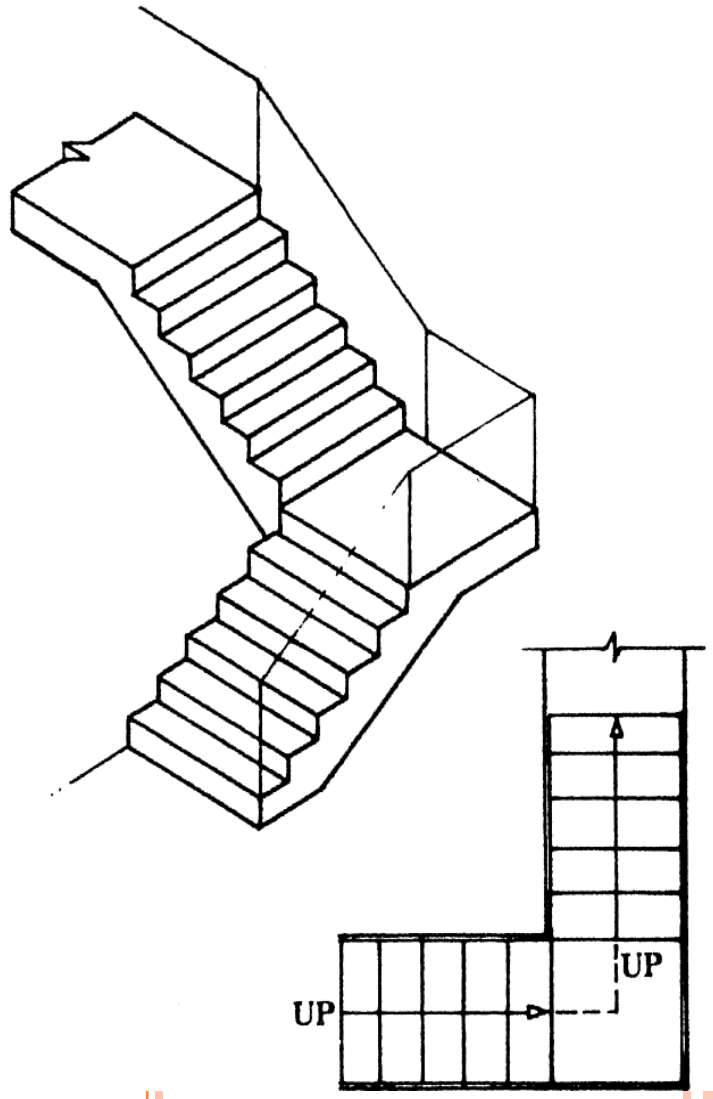
- This type of stair is useful where the width of the staircase hall is just sufficient to accommodate two width of stair.



3. Quarter turn Stair :

- A stair turning through one right angle is known as quarter turn stair.

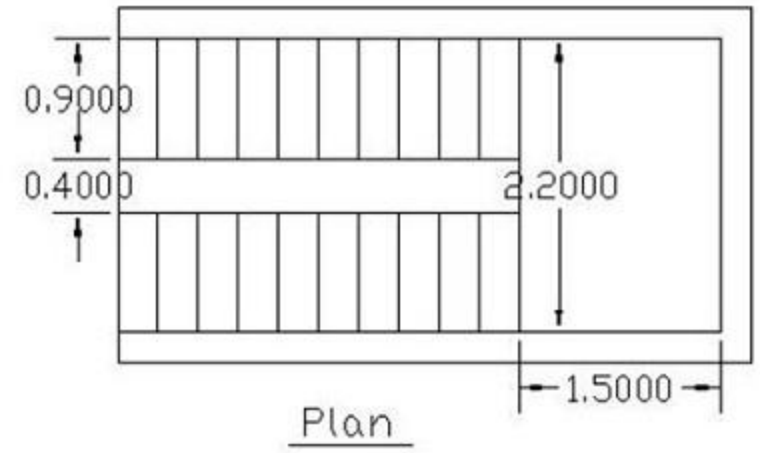
- The change in direction can be affected by either introducing a landing or by providing winders.



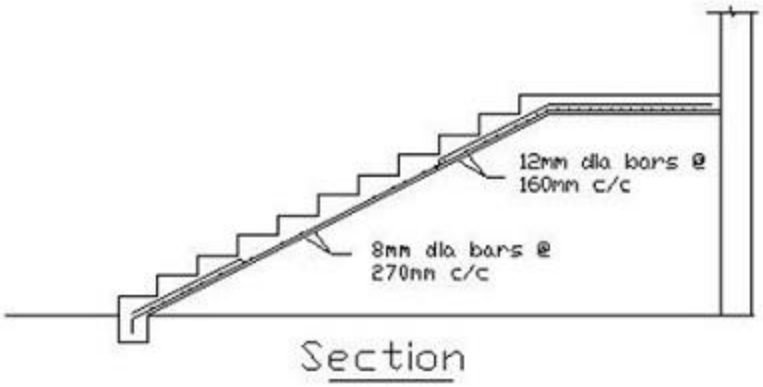
4. Open Newel Stair :

- In these type of stair there is a well or opening between the flights in plan.

- This well may be rectangular or of any geometrical shape and it can be used for fixing lift.



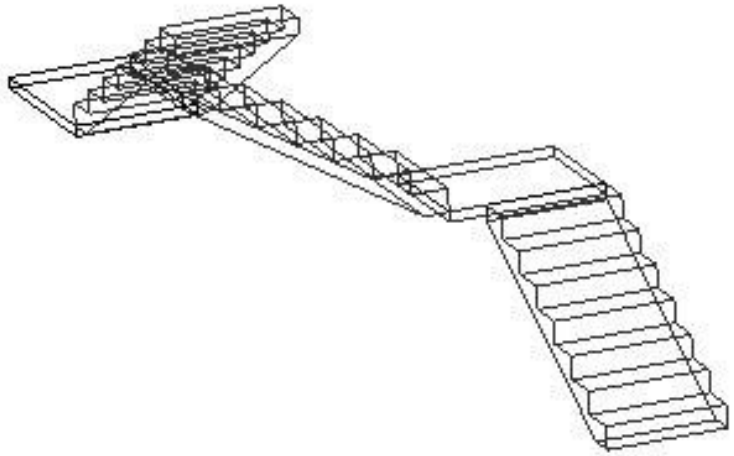
Plan



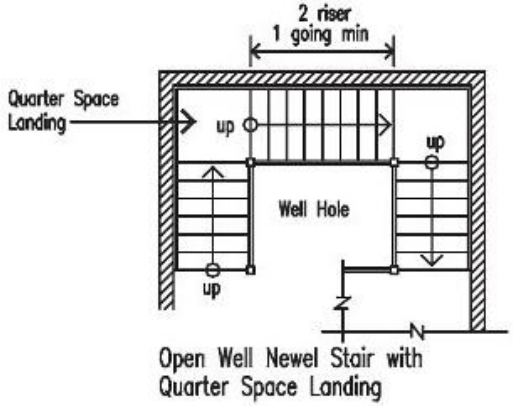
Section

5. Three Quarter Turn Stair :

- A stair turning through right angles (270 degree) is known as three quarter turn stair.



- In this case an open well is formed.



Open Well Newel Stair with Quarter Space Landing

6. BIFURCATED STAIR :

- These stair are so arranged that there is a wide flight at the start which is further sub-divided into two narrow flights at the mid-landing.

- The two narrow flight starts from either side of the mid-landing.

- These stairs are suitable for modern sub building.

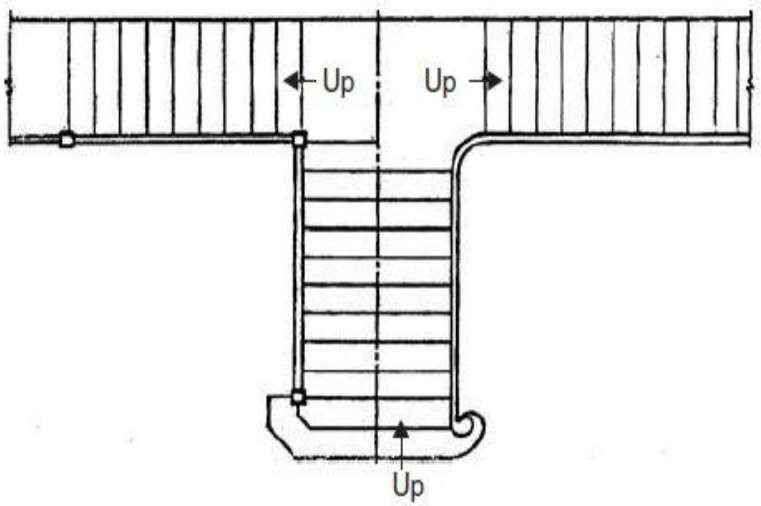


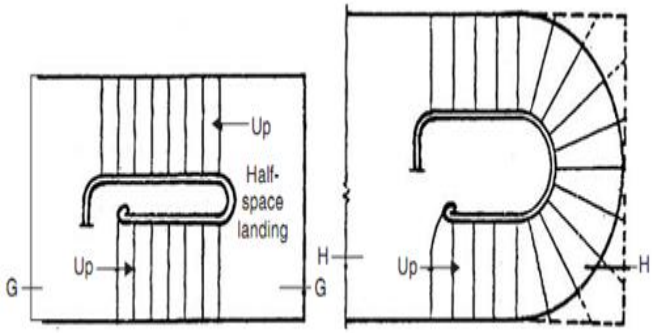
Fig. 8.40. Bifurcated stairs

7. Geometrical Stair :

- These stairs have no newel post and are of any geometrical shape.

- The change in direction is achieved through winders.

- The stairs require more skill for its construction and are weaker than open newel stair.



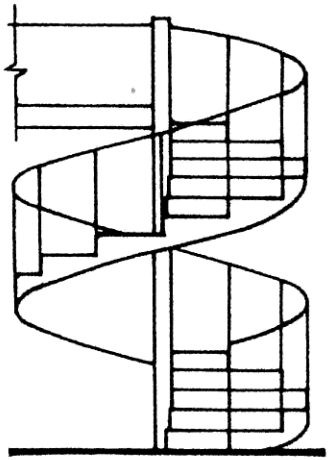
8. Spiral or Circular Stair :

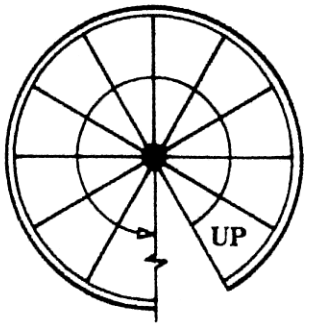
It is known as spiral stair.

When viewed from top it appears to follow a circle with a single centre of curvature.

The spiral stairs are provided where space available is limited and traffic is low.

These stairs can be constructed in R.C.C., Steel or Stone





WHY PLAN?

- A plan helps you focus on the goal
  - "Begin with the end in mind.[1]"
- A plan let's you estimate job completion
- A plan helps you track progress
- A plan gives you milestones that provide a sense of accomplishment along the way
- A plan helps you identify problems early
- A plan establishes commitments for the team and each individual on it

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What is a Plan?

- An agreement by the team on the cost and schedule for a specified job
- A structure for organizing the work
- A framework for obtaining the required resources (people, funds, etc.)
- A record of what was initially assumed and committed
- It's a CONTRACT!

Components of a Plan

- A Lifecycle Planning Model: The Master Plan for the Project
  - Order and criteria for key events
  - Correct model for the job?
- Work Estimate
  - How big is the job (size and effort)?
  - How long will it take, when will we finish?
- Schedule and Work Breakdown
  - When do we expect to have things done?
  - What are we committing to?

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Characteristics of a Good Requirement

- Verifiable: stated in a way that allows for independent verification that the system meets or exceeds the stated requirement.
- Justifiable: necessary, rather than simply desirable
- Unambiguous: stated such that multiple interpretations are precluded

Characteristics of a Good Requirement

- Consistent: no conflict with any other requirement
- Modifiable: should be stated in a way that allows for change based on technical/business considerations.
- Hierarchically Traceable: should define a single
- attribute, traceable back to a higher level requirement.

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Tips for Successful Requirement Determination

- Start by establishing what the team thinks the features/functions of the system should be
  - Brainstorm as team and write everything down
  - Keep a simple list (such as the requirements worksheet on the website)
- Meet with your sponsor to review/modify your list and discuss alternatives
  - Add any features/functions that the sponsor believes are required

Tips for Successful Requirement

- Consider and add ancillary requirements
  - E.g., performance, packaging, look and feel
- Discuss and add as necessary any "non-functional" requirements
  - E.g., standards that you must adhere to, maintenance and support, safety
- Discuss and analyze the feasibility of meeting or exceeding each requirement within the budget, time and skills allowed.

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What is building Bye-Laws

- It is the strict rules which must be obeyed by everyone.
- If everyone makes buildings without obeying any rules then there will be problems of

1. Irregular and narrow roads
2. Frequent traffic
3. Problem of parking
4. Health problems due to pollution

What is building Bye-Laws

5. Poor light and ventilation
6. No proper planning of gardens, play grounds, etc.
7. Problems regarding services like water supply, drainage, telephone, gas, electricity etc.
8. Noise nuisance in education, hospitals, court etc.

Purpose of Bye-Laws

- Provide suitable areas for selected activities
- Avoid problem of traffic
- Develop town in systematic manner
- Provide safety against diseases
- Provide well lighted and ventilated houses
- Provide safety against diseases
- Assure basic services like water supply, drainage, electricity, gas, telephone lines, etc

WHO PREPARES THE BYE-LAWS?

- Consider the local situations and the actual requirements of local people the local authority prepares certain rules for the buildings and for the development of the town
- These rules are submitted to the government for approval.
- This rules after the approval of the government becomes bye laws.

Characteristic of Bye-Laws

- The rules must be specific, clear and the language of rules should be grammatically correct.
- Terms used should be defined clearly so that there must be one and only one meaning of the term.
- Due to some special conditions and requirements, some bye-laws differ from the bye-laws of other places.
- Even though in a single town Bye-law of single town is not applicable at the other area.
- It can be modified by government if required.

Zones

- “Town/City is divided into different areas is called zones”.
- Location of a zone depends upon the suitability for specific activities
- Local authority decides number and types of zones considering the necessity of town.

Zones

- Following are the some of zones

1. Residential: Residential buildings, gardens, play grounds, schools, offices are allowed

   Industries, hospitals, whole-sale markets are not allowed

2. Commercial: Cinema, retail shops, town-halls, restaurants, bank, offices, shopping centers are allowed

   Hospitals and Industries are not allowed

Zones

3. Industrial Ordinary: Light industries, Workshops, printing press, small factories are allowed

   Heavy, Obnoxious and hazardous industries are not allowed

4. Hazardous Industrial: All types of industries allowed

   Residential buildings are totally not allowed

5. Educational: School, collages, sports complex allowed

   Other than education activities are not allowed

Built-Up Area

"Area of all floors above or below the ground"

Details to be included	Details not to be included
Basement	Steps
Building Structure	Otta
Ramps	Kundi
Swimming pool	Soakpit
Reservoir	Fountain
Chimney	Manhole
Water purification plant	Water tank
Humidity plant	Frame
Duct for humidity	Swing

Carpet Area

“Net usable area within building”

To calculate carpet area deduct following areas from plinth area.

- Verandah,
- Passage
- Corridor,
- Porch
- Lift
- W/c bath
- Thickness of wall
- Vertical shaft for drainage

Floor Area

“Usable area on each floor”

It includes the following things

- Porch
- Each flat area in single floor for apartment
- Stairs
- Corridor
- door swing place

Plinth Area

"Area of each floor covered by roof"

Area to be included in plinth area	**Area not to be included in plinth area**
Area of walls at floor level excluding plinth offset, external area of projecting cladding.	Additional floor to accommodate seats in theatre, assembly hall, or auditorium
Cover of stair	Balcony
Barsati	Curvature provided to improve appearance
Machine room	Platform without cover terrace above floor
Porch without cantilever	Dome, tower at terrace, spiral stairs

Basement

"Lower storey of a building having minimum half the clear floor area height of the basement of cellar below average ground floor."

- Basement is not permitted in margins
- Area of basement < 2 × Area of plinth or plot
  whichever is less
- Use of wood as structural member is not permitted.

Basement

- Proper ventilation should be provided in the basement.
- It should not be connected with water or drainage lines.
- Depth of basement should not exceed 1.5m below ground level.
- permission can be granted for other basement below for parking purpose but total depth should not exceed 6m.

Use of Basement

Basement can be used as

- Domestic store
- Safe deposit vault
- Air conditioning machine place
- Parking
- Other service equipments

Types of Building

1. Apartments: Building with more than one storey and combined construction
2. Assembly building: Buildings where group of people gather for amusement, social, religions, recreation, patriotic, civil, travel or similar purposes
3. Business building: Building used for transaction of record, offices, banks etc.
4. Chawl : Building prepared for rental purpose, each tenant will have two rooms & bathrooms and toilets are combined

Types of Building

5. Educational Building: Exclusively used for schools and collages
6. Mercantile Building: Building used as shops, stores market for display
7. Row houses: Building having residential units provided in row with same plans
8. Storage building: Building used for storage or shelter of goods, ware house, cold storage

Types of Building

9. High rise building: Building having height more than 15m but less than 30m
10. Low rise building: Building having height less than 15m
11. Industrial building: Building in which products or materials are fabricated, assembled or processed
12. Institutional Building: Building constructed for public activities like medical, education, etc.

Building Unit

“it is one or more than one plots approved by the competent authority for width of plot less than 10.5m”

Plot width less than 3m and area less than 18m2 is not considered as building unit

“Line up to which the plinth of a building adjoining a street may be law-fully extended is called building line.”

Common plot for residential and commercial buildings

- Open space or the purpose of entertainment shall have to be kept when the area of layout exceeds 0.3 hectors
- Common plot should be located at one place only however pockets may be permitted.
- Minimum area should not be less than

  (i) 15% of the area of layout

  (ii) 0.3 to 0.4 hector/1000 persons

  (iii) 0.3/1000 persons for low income group housing

Common plot for industrial zone

- For industrial unit having area more than 0.8 hectors, & 5% area shall be reserved for amenities, such area can be used for general parking.
- If this area is more than 1500 m^2 buildings for bank, canteen, welfare centers can be made in this additional area
- For industries having area > 1000 m^2 then 10% space reserved for amenities
- This amenities area should be maximum 2500 m^2.

Margins for special buildings

Width of Proposed Road	Road side margin in meter
9m or less	3
9 to 12m	4.5
12 to 18m	6
18 to 30m	7.5
30 to 60m	9
More than 60m	12

Margins on sides other than road side

Area of plot m^2	margins
18 to 25	1
25 to 50	1.5
50 to 90	2
90 to 150	2.5
150 to 250	2.5 (rear side) 1.5(other side)
More than 250	3

Margins for industrial use

- Maximum permissible built up area on any floor including ground floor shall be 50% of plot area.
- Maximum side margins along perimeters of plot

(i) plot with area more than 1000m^2 should be 6m

(ii) plot with area up to 1000m^2 should be 4.5m

- Minimum clear distance between two detached structures should be 6m and 4.5m as suggested above.

Margins high rise building

- High rise buildings shall be permitted on roads more than 12m wide.
- Side margins should be 6m or 0.2 × Height which ever is more.
- Road side margins for roads

  Up to 30m = 0.3 × Height **or** 9m whichever is more

  More than 30m = 0.3 × Height **or** 9m whichever is more

Mezzamine floor

“It is an additional floor provided between two consecutive floors.”

- Its area < 1/3 of plinth area
- Height < 2.2m
- It should not be used as kitchen and it should not be divided.
- It should be properly ventilated and its area should not be less than 9.5m^2 if it is proposed to be used as a habitable room.

COMPOUND WALL

"This is the wall made around the building which cover up the whole building"

- Height of compound wall abutting road should not be more than 1.5m.
- Height of compound walls on other sides should be less than 1.8m.
- If opening in the portion above 0.9m are provided the height can be 2.4m.

Compound wall

- Gate is not permitted on the curvature at the junction of roads.
- Gate should be 15m away from junction.
- Shutter of compound wall gate should not open outside on road side.
- Height of compound wall should not be more than 0.75m above crown of road.
- Local authority permits 2.4m height of compound wall for public buildings like industries, hospitals, etc.

Other Building Units

Use of Building Units	Minimum area m^2
Primary & High School	1000
Educational institutions, Community Hall, marriage hall, Town Hall, Assembly hall, Cinema theatre	2000
Petrol pump without service station	1000
Petrol pump with service station	2000
Religious places(temples, masjids, church)	500(Built up area<20% of plot area)
Industries	More than 300(width>15m)

Habitable Room

"A room occupied or designed for occupancy by one or more persons for study, living, sleeping, eating, kitchen if it is used as living room."

Rooms like water closets, bathroom, store, pantries, laundries, cellars, etc. are not generally considered into habitable rooms.

Habitable Room

Height of habitable room > 2.75m for regular

> 2.4m for air conditioned

> 2.6m for row houses

Every side must be greater than 2.4m in length

minimum area for first room > 9.5m^2

Other rooms > 7.5m^2

Head Room

“Clear height from top of floor to the bottom of ceiling.”

Minimum head rooms for different types of building

1) Residential & commercial – 2.75m
2) Educational – 3.6m & 3m(for cold area)
3) Industrial – 3.6m & 3m (for A/C)

Height of Building

"Maximum Height of building will depend upon the width of street on which the building is abutting"

Width of road	Permissible height of building up to
6 to 9m	10m
9 to 12m	13m
More than 12m	As per high rise building

Lift

- Lift shall be provided when the height of the building exceeds 15m.
- Two lift is required when height of building exceeds 21m.
- For residential apartments there should be one lift for 20 flats
- For non-residential buildings lifts should be at the rate of one lift on one lift per 1000 m^2.
- Generator is advisable with the lift for the safety purpose where electricity cuts more often.

Lift capacity

For high rise,

residential building – 8 persons

other building – 12 persons

For low rise,

residential building – 4 persons

other building – 8 persons

Lift dimensions of lift should be as per NBC.

Loft

- Head room below loft should not be less than 2.2m
- Height of loft should not be more than 1.5m
- Area of loft should not exceed ¼ area of room
- Bath and Water closet can be fully covered by loft.

Minimum Stair width

Type of Building	Width of stair in meter
Residential	1
Hotels	1.5
Assembly type buildings like cinema theatres auditoriums etc.	1.5
Educational institutions up to 24m height more than 24m height	 1.5 2
Hospital up to 10beds more than 10 beds	1.5 2
Other Buildings	1.5

Parking

- Separate provisions for cars, scooters, visitors should be made
- Common plot must not be used for parking
- Head room for the road leading to parking should not be less than 2.1m
- For a car – 14m^2 area required
- For a motor cycle – 1.25 m^2 area required
- For a cycle – 0.8 to 1 m^2 area required

Parking area for different buildings

Types of Building	Suggested parking Area
Residential	15% of total built up area of all floor
Cinema & Assembly hall	1m^2 per seat
Shops, offices, institutes, hospitals, etc.	30% of total built up area of all floors
Community hall, recreation club, party plot	50% of area
Collages	70 m^2 per 100 students
i) Secondary & higher secondary schools ii) Primary schools	50 m^2 per 100 students 20 m^2 per 100 students
Grain, timber agriculture, whole sale markets	30% of total built up area of all floors

Set back

"Some distance kept between road line and a plinth of building parallel to road line."

- This land though remains in possession of the owner of the plot.
- Can be utilized for widening of road in future
- 1.5m set back for roads up to 12m.
- 2m set back for the road wider than 12m.

Advantages of Set back

- Availability of sufficient light & ventilation.
- Availability of land for widening of roads in future.
- Availability of sufficient sight distance at road crossings.
- Availability of space for parking.
- Availability of necessary privacy.
- Reduction of unwanted noise.

Road width for residential building

Length of road in meter	Width of road in meter
75	6
150	7.5
250	9
400	12
1000 and more than that	24

Road width for other buildings

Length of road in meter	Width of road in meter
200	12
400	15
600	18
1000 and more than that	24

Unsafe Building

- It is considered as dangerous from public safety point and must be repaired properly or demolished
- Authority will arrange to examine such building and keep record.
- Owner or occupier shall be given written legal notice starting defects of the building.
- Owner or occupier shall arrange for the stated repairs or demolition to the satisfaction of the authority within the period stated in the notice.

Unsafe Building

- In case any person is not vacating the building the authority may take police action against him.
- If a person fails to comply with the requirements of the notice, authority will repair or demolish the structure.
- The cost incurred for the repairs or removal of structure shall be charged to the owner of the premises.

Ventilation

- For habitable room, the area of clear total opening excluding frames should not be less than 1/10 the floor area of room.
- Windows or ventilators provided for ventilation should abut exterior open space, or open verandah or gallery.
- For factory or go-downs clear area of windows and ventilators should not be less than 1/7 floor area.

Ventilation

- The width of the open space on which the ventilators should not be less than 1/3 height of building.
- Relaxation in the above recommendations may be made when artificial ventilation is provided.
- For stair room the ventilation per floor should not be less than $1m^2$.

Color code for drawing plans

Items	Site plan ammonia print
Boundary	Thick black
Existing Street	Green
Proposed road	Green dotted
Permissible building lines	Thick dotted black
Open spaces	No color
Existing work	Blue
Work proposed to be demolished	Yellow hatched
Proposed work	red
Drainage & sewage work	Red dotted
Water supply work	Black dotted thin

Thank you