# CE6401 CONSTRUCTION MATERIALS

**BOOKS :**

1. Varghese.P.C, "Building Materials", PHI Learning Pvt. Ltd, New Delhi, 2012.
2. Rajput. R.K., "Engineering Materials", S. Chand and Company Ltd., 2008.

# VISION AND MISSION OF THE INSTITUTE

**VISION**

• To emerge and sustain as a center of excellence for technical and managerial education upholding social values

**MISSION**

Our aspirants are

• Imparted with comprehensive, innovative and value - based education

• Exposed to technical, managerial and soft skill resources with emphasis on research, And professionalism

• Inculcated with the need for a disciplined, happy, married and peaceful life

# VISION MISSION DEPARTMENT OF CIVIL ENGINEERING

**VISION**

Our Vision is to

• To inspire and mould Civil Engineering aspirants as competent and dynamic infrastructure developers.

**MISSION**

Our Mission is to

1. Integrate high quality Civil Engineering education and research.
2. Keep updating students with the state of the art theory and practice
3. Create a supportive environment to meet professional challenges.

# OVERVIEW

- UNIT I STONES – BRICKS – CONCRETE BLOCKS
- UNIT II LIME – CEMENT – AGGREGATES – MORTAR
- UNIT III CONCRETE
- UNIT IV TIMBER AND OTHER MATERIALS
- UNIT V MODERN MATERIALS

# OBJECTIVE

**On completion of this course you will be able to**

- Compare the properties of most common and advanced building materials.
- Understand the typical and potential applications of these materials
- Understand the relationship between material properties and structural form
- Understand the importance of experimental verification of material properties.

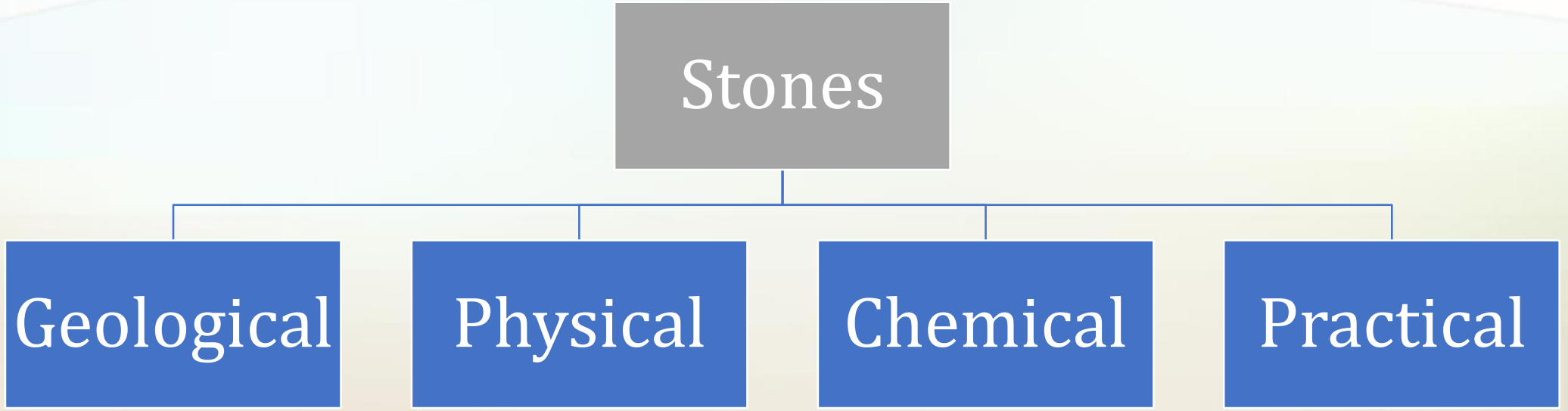
# UNIT I STONES – BRICKS – CONCRETE BLOCKS

- Stone as building material – Criteria for selection – Tests on stones – Deterioration and Preservation of stone work – Bricks – Classification – Manufacturing of clay bricks – Tests on bricks – Compressive Strength – Water Absorption – Efflorescence – Bricks for special use – Refractory bricks – Cement, Concrete blocks – Light weight concrete blocks.

# STONES

- Stone is one of the oldest building material.
- Our ancient people used to live in small homes or caves made of stones.
- Researches from Archaeologists shows that stone is used as building material in India starting from 3200 BC.
- Many ancient monuments like Ajantha temple, Taj Mahal etc., were completely made of stone.
- Many ancient civilizations like Indus valley civilization, Mesopotamian civilization used stone as building material
- Stones are derived from rocks which form the earth's crust and have no definite shape or chemical composition but are mixture of two or more minerals.

# CLASSIFICATION OF STONE



# GEOLOGICAL CLASSIFICATION

## a)Igneous rocks

- Formed by cooling the molten lava on or inside the earth's surface during the volcanic eruption.
- The portion of lava which comes outside the surface, cools quickly and forms the rock of non crystalline nature such as **Trap or Basalt.**
- The portion which remains inside the earth undergoes cooling at slow rate and results information of crystalline variety known as **granite.**

## b)Sedimentary rocks

- Formed by gradual deposition of disintegrated rocks, vegetable matter and clay at the bottom of rivers, lakes or sea.
- Eg: Limestone, Sandstone.

## c)Metamorphic rocks

- When sedimentary rocks or igneous rocks are subjected to great heat and pressure inside the earth, a new variety of rock is formed known as metamorphic rocks.
- The change of structure is called metamorphism.
- Eg: Limestone changes to marble, Slate changes to gneiss etc.,

## IGNEOUS ROCKS

GRANITE

DIORITE

FELSITE

BASALT

OBSIDIAN

## SEDIMENTARY ROCKS

CONGLOMERATE

SANDSTONE

SHALE

LIMESTONE

DOLOMITE

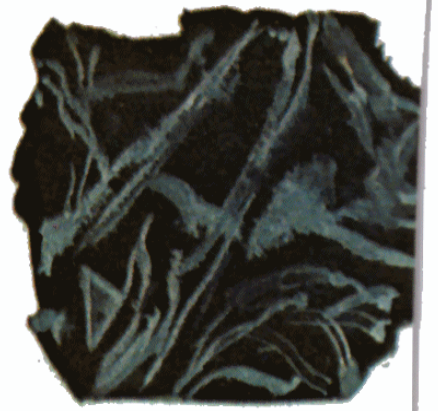
## METAMORPHIC ROCKS

SLATE

SCHIST

SERPENTINE

QUARTZITE



MARBLE

# PHYSICAL CLASSIFICATION

**a)Stratified rocks(layer)**

- Exhibit distinct layers which can be separated.
- Plane along which separation can be carried is called cleavage plane.
- Eg: limestone, slate, sandstone.
- **“Cleavage** is the tendency of a mineral to break along smooth **planes** parallel to zones of weak bonding”

- **b)Unstratified rock(uncountable)**
  - Do not show any sign of strata and cannot be easily split in to slabs.
  - Eg: Granite, trap.

# CHEMICAL CLASSIFICATION

**a)Silicious rocks –** Contains silica ($SiO_2$) as the principal constituent

- Eg: Sandstone, Quartzite

**b)Argillaceous rocks-** Containing silt- or clay-sized particles that are less than 0.0625 mm

- Eg: Slate, laterite, kaolin

**c)Calcarious rocks -** Contains a high proportion of, calcium carbonate

- Eg: Limestone and marble

# PRACTICAL CLASSIFICATION

Classified based on usage

- Stones have been classified as granite, marble, slate, limestone etc.,

# CRITERIA FOR SELECTION OF STONE

## Appearance and Colour

- Uniform and appealing colour if used for decoration.
- Free from flaws and clay holes.
- Stones with high iron content should not be used since it will disfigure and brings detoriation to stones.
- Able to receive good polish.

## Weight

- Weight should be high as heavier stones can resist high force.
- Heavy stone possesses more compactness and less porosity.

## Porosity and absorption

- If porosity is high the stone is unsuitable for construction because during rain water will seep in to pores and destroy the stone.
- When climate is cold, water entering pores may freeze and split the stone.

## Fineness of grain

- Fine grained stones are suitable for moulding works.
- Non-crystalline stones will disintegrate under the action of natural agencies.

## Compactness

- Stones durability is decided by their compactness or density of compaction.
- Compact stone can withstand the effects of external agencies effective

## Resistance to fire

- For resistance against fire, the stone
- i)should have homogeneous composition and
- ii)should be free from calcium carbonate or oxide of iron.

## Electrical resistance

- The electrical resistance of a stone decreases when it gets wet.
- Stone must be non-absorbent to have steady and high electrical resistance.

## Hardness and toughness

- Stone must be hard and tough to resist wear and tear.
- Hardness is tested by scratching with a pen knife.
- Toughness is tested by subjecting it to hammering action.

## Strength

- Stones used in buildings are subjected to compression.
- Hence they should have sufficient strength to meet the requirements.

## Durability

- A stone is more durable if it is
  - i)compact
  - ii)homogeneous
  - iii)free from any material affected by HCL and $H_2So_4$.
- It should have negligible water absorption.

## Dressing

- The art of shaping a stone is known as dressing.
- Stones should possess uniform texture and softness for easily dressing.
- If it is hard , finish will be poor and uneconomical

**Cost**

- Cost is an important factor for selecting building stone.
- The cost of stone depends upon the ease with which it can be quarried out, proximity of quarry to place of use and transportation facilities available.
- Dressing cost should also be low.

**Seasoning**

- Good stone must be free from quarry sap.
- Stones after quarrying and dressing should be left for a period of 6 to 12 months for proper seasoning before use in construction work.

# USES OF STONES AND THEIR SELECTION

| USE | NAME OF STONE | REASON |
|---|---|---|
| ➢ Construction of building exposed to high wind particles | ✓ Granite and sand stone | ✓ Hardness due to presence of silica |
| ➢ General building work (i.e walls, foundation and super structure) | ✓ Sand stone | ✓ Hard and durable |
| ➢ Heavy engineering works (docks, bridges and light houses) | ✓ Granite | ✓ Strong, durable, capable of resisting thrust |
| ➢ Building exposed to fire | ✓ Compact sand stone | ✓ Fire resisting property |
| ➢ Building in industrial town | ✓ Granite and Sand stone | ✓ Acids and smoke proof |
| ➢ Road metal and railway ballast | ✓ Granite and basalt | ✓ Hard, tough and abrasion resistance |
| ➢ Electrical switch boards | ✓ Slate of marble | ✓ Electric resistance |

# Why should we test and which tests are appropriate?

- Failure mode effect analysis
- What can go wrong?
- What can we test for this?
- How can we manage the risk?
- Is it safe?
- Will it last?
- Is it strong enough?

# TESTS ON STONES

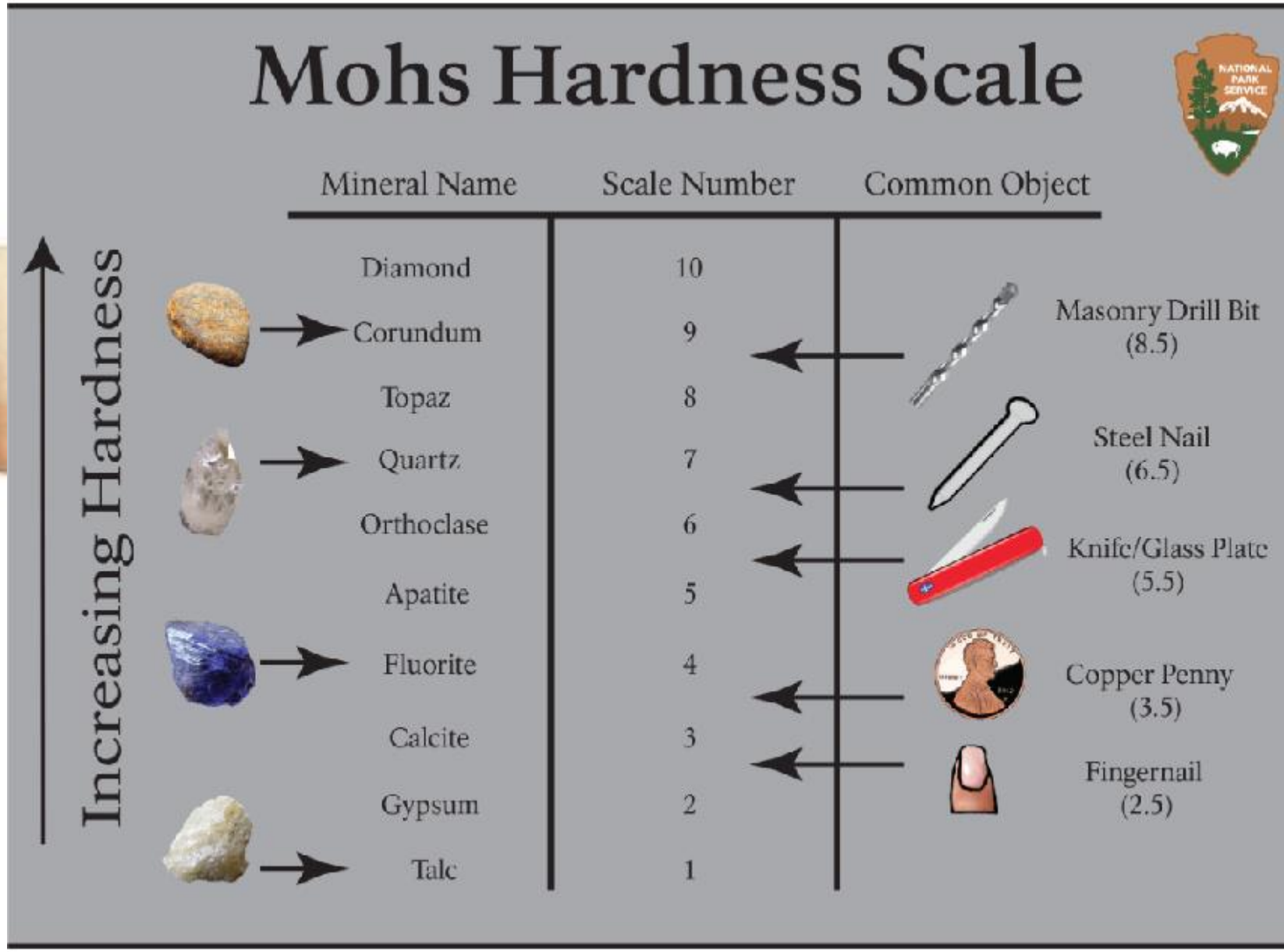
## 1. Hardness Test:

- Tested by a pen knife.
- Determined with aid of Mohr's scale of hardness.
- If a pocket knife makes a mark on fresh surface of limestone, the hardness of it may be taken as H = 3.
- Hard silicious rock has a hardness of H=7 since it cannot be scratched easily with knife.
- Coefficient of hardness is found as follows
  - i)A cylinder of dia 25mm and height 25mm is taken and
  - filled with stone to be tested.
  - ii)It is then weighed.

- Placed in Dorry's testing machine and pressed with a load of 1250 g
- Annular disc of the machine is rotated at a speed of 28 r.p.m.
- During rotation, coarse sand of standard specification is sprinkled on top of disc.
- After 1000 revolutions, the specimen is taken out and weighed.
- Coefficient of hardness = 20 – (loss in weight in $gm/m^3$)

## DORRY'S APPARATUS

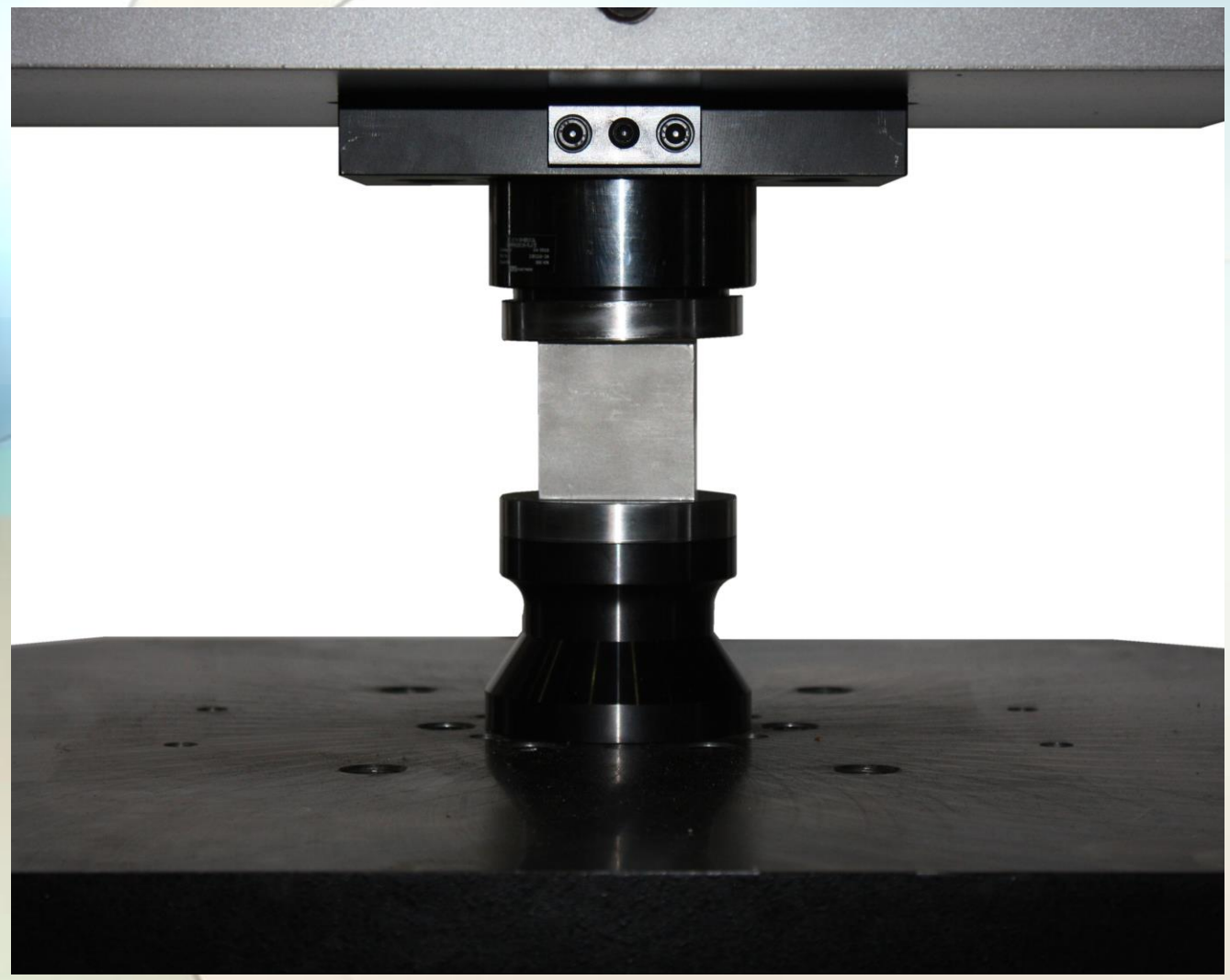

## MOHS SCALE



## 2. Crushing Test

- Tested to find out compressive strength of stone.
- Needed for stones used at bottom of heavy structure.
- The test is carried out as follows
  - Stone is cut in to cubes of size 40mmX40mmX40mm and sides of cube are finely dresses and finished.
  - Specimen are placed in water for 72 hours prior to test and tested in saturated condition.
  - Load bearing surface is covered with plywood and load is applied axially on the cube at the rate of 13.7 N/mm2 per minute with crushing testing machine.
  - Crushing strength per unit area is maximum load at which sample crushes divided by area of bearing face of specimen.

# COMPACTION MACHINE

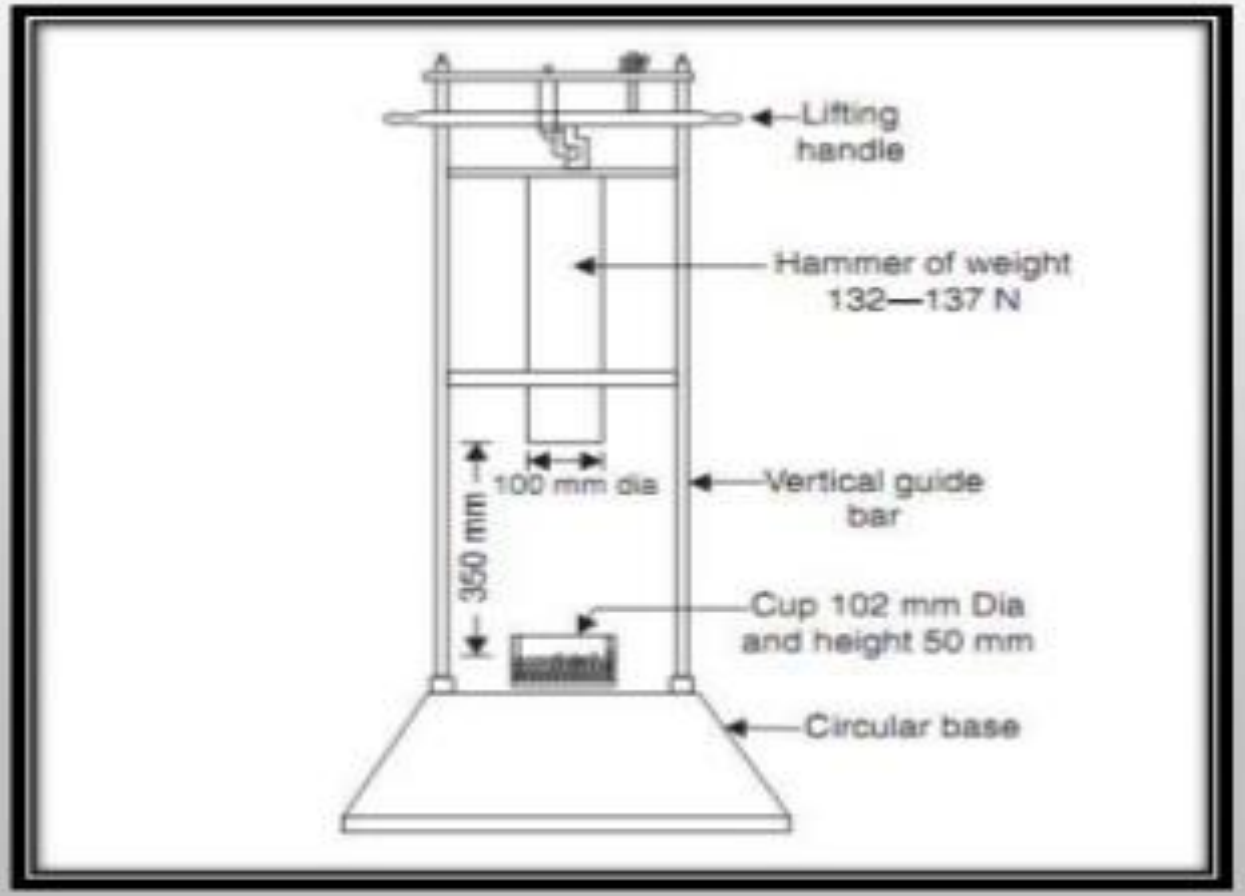


| Name | Compressive strength($N/mm^2$) |
|---|---|
| Laterite | 2 to 3 |
| sandstone | 70 |
| Granite | 70 to 130 |
| Trap | 300 to 400 |

### 3. Impact test:

- Carried out in an impact testing machine.
- The test is carried out as follows
  - Cylinder of dia 25mm and height 25mm is taken and filled with sample stone.
  - Sample is placed on the machine.
  - A steel hammer of 20N is allowed to fall axially in vertical direction.
  - Height of first blow is 1cm, that of second blow is 2cm and so on.
  - The blow at which specimen breaks is noted. If it is $n^{th}$ blow, n represents the **toughness index** of the stone.

# IMPACT TEST


Lifting handle
Hammer of weight 132—137 N
350 mm
100 mm dia
Vertical guide bar
Cup 102 mm Dia and height 50 mm
Circular base

## 4. Fire resistance test

- Stone which is free from calcium carbonate can resist fire.
- Presence of calcium carbonate in the stone can be detected by dropping few drops of dilute sulphuric acid which will produce bubbles.
- Or kept under direct exposure to flame causes deteriorations in stones

## 5. Attrition test

- To determine the rate of wear of stones employed for construction of road.
- Carried out in Deval's attrition testing machine.
- Test is carried out as follows
  - Sample of stone is broken in to pieces of 60mm size.
  - Samples are taken in cylinders of dia 200mm and length 340mm respectively.

- Cylinders are rotated about the horizontal axis for 5 hours at the rate of 30 r.p.m.
- Contents are taken out from the cylinder and passed through a size of 1.5mm mesh.
- Retained material is weighed.
- % wear = (loss in wt/initial wt)X100.

## 6. Acid Test

- Stone is kept for one week in the solution of sulphuric acid and hydrochloric acid.
- Corners of stones will turn roundish and loose particles will get deposited on surface if alkaline content is high.
- Stone having less alkaline content will be resistant to weathering conditions

## ATTRITION TEST

## FIRE RESISTANT TEST

***7. Water absorption test:***

- The water absorption test is carried out to determine the quality of stone.
- The stones is immersed in a water bath for 24 hours.
- Initial weight M1 and Final weight after 24 hours M2 is measured
- Absorption percentage is calculate by the following formula
- *% Absorption= [(M2- M1)/M1] x 100*

## *8. Microscopic examination:*

- This is basically a geologists test. Thin sections of stone are taken and placed under a microscope to study the following properties:
  - Average grain size
  - Texture of the stone
  - Mineral constituents
  - Type of cementing material
  - Presence of pores, fissures, veins, shakes etc.
  - Presence of harmful constituents
  - Condition of fractured surfaces.

**Brad's test:**

- This test is conducted for frost resistance.

**Smith's test:**

- This test is conducted to find out the presence of water soluble matter present in
- the stone. It is only a qualitative test.

**Specific gravity test:**

- This procedure is adopted for determination of specific gravity of stone, as
- per IS : 1121-1974

$$Gt=(M2-M1)/((M4-M2)-M3-M2)$$

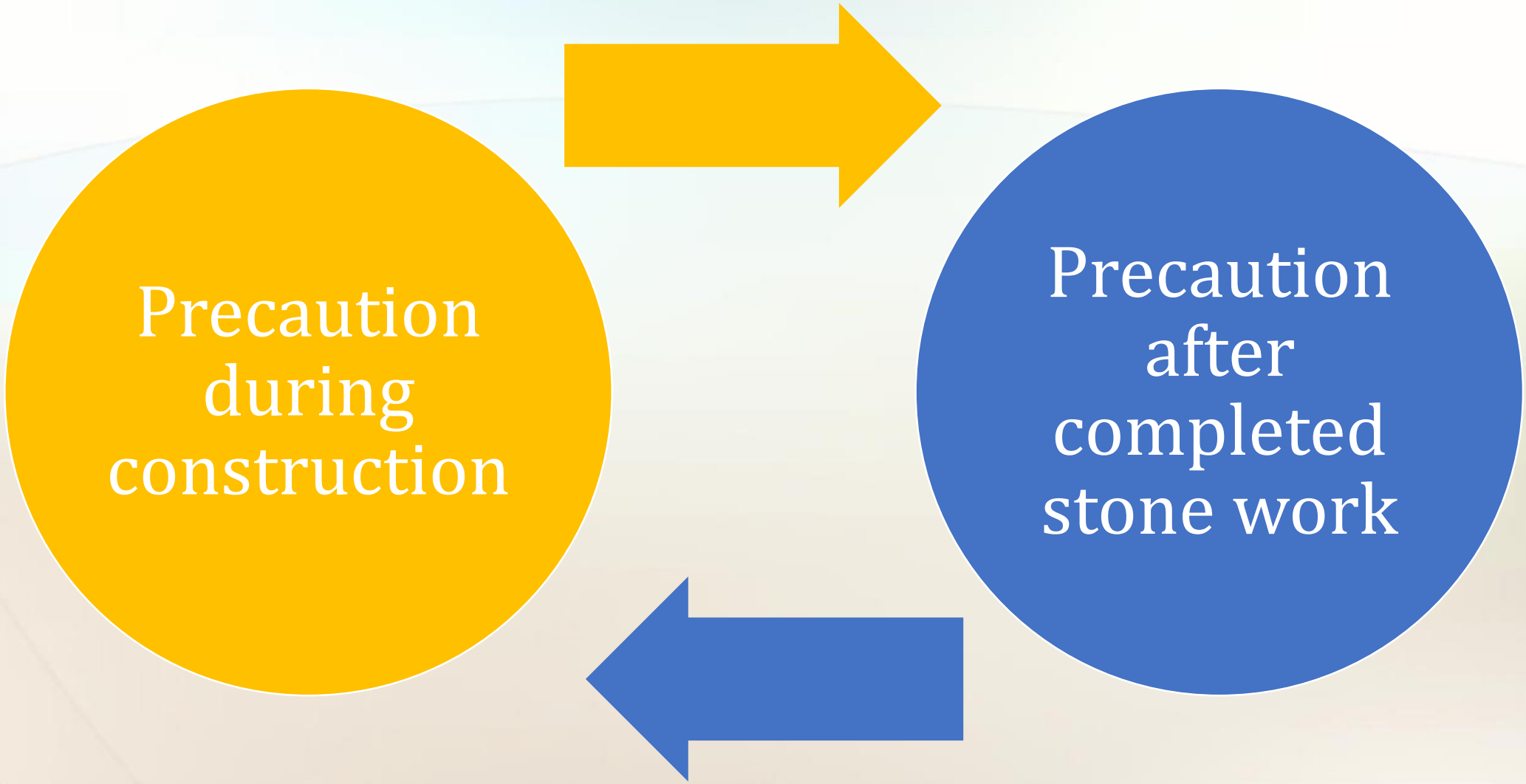
**Durability test:**

- The durability (soundness) test is performed to find out the capacity of stone to resist disintegration and decomposition.
- Durability value= change in the mass= (M1- M2)*100

# DETERIORATION OF STONES

- Alternate wetting and drying
- Alternate freezing and thawing
- Deleterious substance presence in the air such as in the atmosphere near the seashore and industrial areas
- Living organisms, growth of vegetation and living bacteria that live in the stone may cause decay
- Movement of chemicals between minerals
- Nature of mortar
- Temperature variations
- Waterfalls and rainfalls
- Wind

# PRESERVATION OF STONES



# PRECAUTION DURING CONSTRUCTION

- Type and size of stones should be good
- Only compact and durable stones should be selected for construction
- The size of the stones should be large as far as possible to avoid minimizing the number of joints
- The stones should be well seasoned and washed clean before they are used
- The stones should be placed on their natural beds and the joints completely filled with mortar so that there is no cavity

# PRECAUTION AFTER COMPLETED STONE WORK

- **Linseed oil**
  - Raw oil is light in colour while boiled becomes dark
  - Dis-colours the stones
- **Alum and soap**
  - 40:60 proportions , acts as protective coat
- **Barium hydroxide (Baryta)**
  - Effective treatment against decay caused by $CaSo_4$
  - $Ba(OH)_2 + CaSo_4 \rightarrow BaSo_4 + Ca(OH)_2$
- **Paraffin**
- **Paint**

# BRICKS

- Brick is one of the oldest building material.
- Extensively used in present time as a leading building material because of its durability, strength, reliability, low cost and easy availability.
- Great wall of china was built with both burnt and dried bricks.
- Bricks and mortar is one of the essential components of brick masonry.

# ACTUAL DEFINITION

- The artificial material of construction in the form of clay bricks of uniform size of shape are known as bricks.

**Size of brick**

1) Traditional brick :- 23cm X11.4 cm X 7.6 cm

2) Modular Brick :- 19 cm X 9 cm X 9 cm

# PRINCIPAL INGREDIENT

- **Alumina**: Should contain 20 to 30 % ,
  - Imparts plasticity
  - if present in excess raw bricks shrink and deforms during drying and burning and becomes very hard on burning.
- **Silica:** Should contain 50 to 60 % ,
  - Imparts uniform shape to the bricks
  - prevents Cracking, shrinking, and deform of raw bricks.
  - Excess destroys the cohesion between particles and brick becomes brittle
- **Lime:** Should not exceed 5%
  - Prevents shrinkage of raw bricks.
  - Excess Causes bricks to melt and hence the shape is lost.
- **Oxide Of Iron:** Desirable Quantity about 5 to 6 percent
  - Imparts Red Color to the Brick.
  - Excess makes brick dark blue or blackish and lesser quantity makes it yellowish
- **Magnesia:** imparts yellow tint and decreases shrinkage.
  - Excess leads to the decay of bricks.

# HARMFUL INGREDIENTS IN BRICKS

- **Lime-** excess causes bricks to melt and shape is lost
- **Iron pyrites-** bricks are crystallized and disintegrated during burning because of the oxidation of iron pirates.
- **Alkalis –** mainly found in the form of soda potash. Acts as a flux in the kiln during burning and they cause brick to fuse, twist and deform.
- **Pebbles -** it will not allow the clay to be mixed uniformly and thoroughly which will result into weak and porous bricks.
- **Vegetation and organic matters –** if doesn't get burnt completely causes pores in the brick

# CHACTERISTICS OF A GOOD BRICK

- Brick should have sharp edges.
- Brick shall not break in to pieces when dropped from height about 1 meter.
- Brick shall have low thermal conductivity.
- Brick shall be sound proof.
- Brick when broken shall show a homogeneous and uniform compact structure, free from voids.
- When soaked in water for 24 hour, brick shall not show deposit of white salt when allow to dry.
- Brick shall not have crushing strength less than 55kg/cm2.

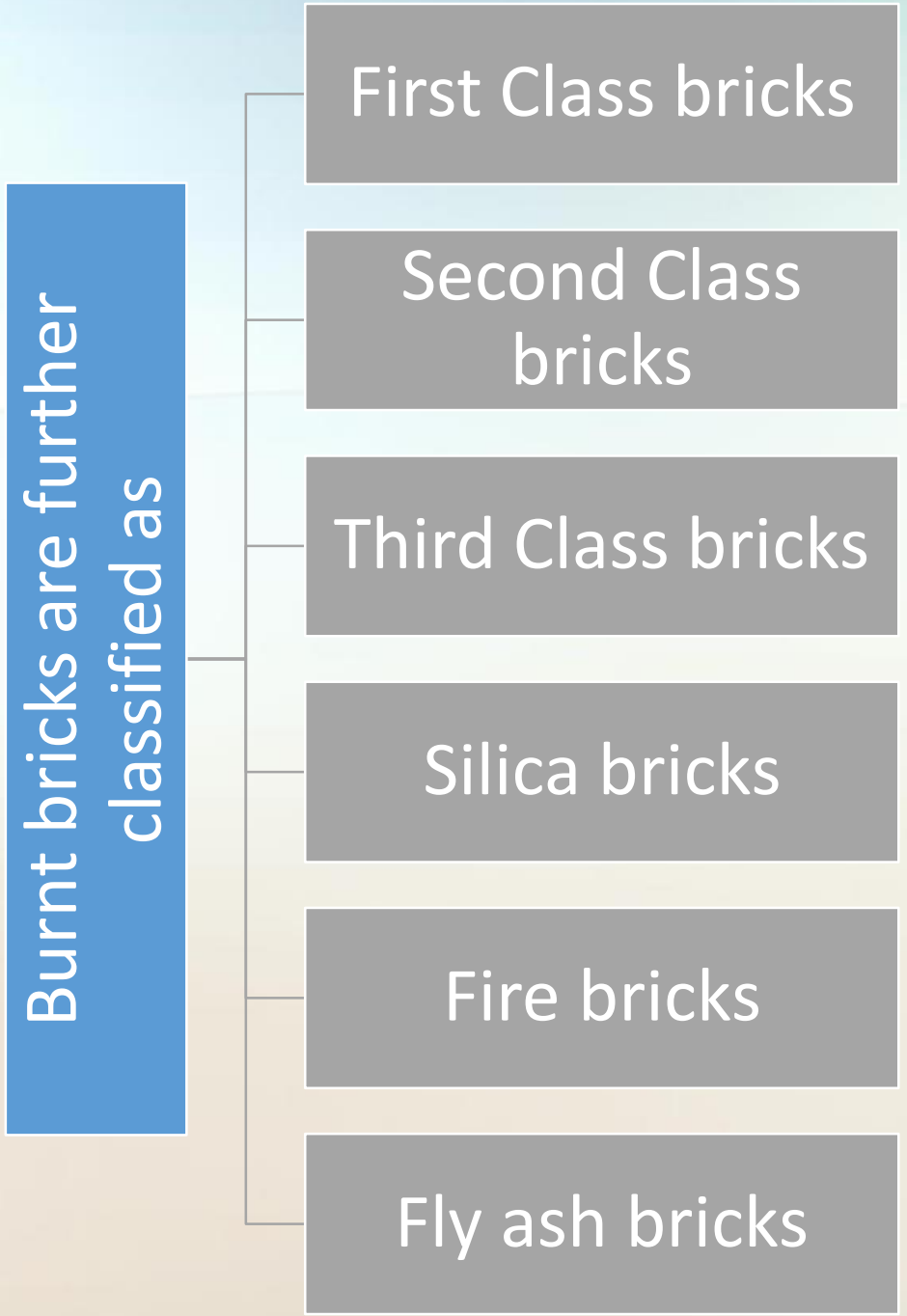
# CLASSIFICATION OF BRICKS

## 1. Unburnt Bricks:

- These bricks are dried through sun light. It is also called Sun-dried Bricks. They have very low strength as compared to other types of bricks. It is believed that first-time bricks were used, in sun-dried form (unburnt Bricks), in Egypt some 6000 years ago.

## 2. Burnt Bricks:

- The bricks which are used commonly in today's age are burnt bricks. They are prepared and burnt in a kiln. They have high strength as compared to unburnt bricks.


Burnt bricks are further classified as
First Class bricks
Second Class bricks
Third Class bricks
Silica bricks
Fire bricks
Fly ash bricks

## i. First Class Bricks:

- These are 19 x 9 x 9 cm in size. They are made from good earth, free from saline deposits. They should be thoroughly burnt. They should be of good color. They should be of regular shape with square edges and parallel faces.
- These bricks are free from flaws, cracks, chips, stones, etc. They should give a ringing sound when two bricks are struck together.
- Its compressive strength shall not be less than 140 $kg/cm^2$. And they shall not absorb more than 20% of water when immersed in water for 24 hours.
- **USE:** Excellent for all types of construction in the exterior walls. they are also suitable for flooring.

## ii. Second Class Bricks:

- These are also fully burnt and give a clear ringing sound when struck together. Slightly irregularities in shape, size or color are accepted.
- Its compressive strength shall not be less than 70 $kg/cm^2$ and absorption value should not be greater than 22 percent when soaked for 24 hours in water.
- Slight difference in the structure on fractured surfaces is admissible.
- **Use:** For exterior work when plastering is to be done. And can also be used for interior works but they may not be used for flooring.

## iii. Third Class Bricks:

- These are not burnt so fully as in previous two cases but are generally of uniform reddish yellow color. Defects in uniformity or shape are tolerated. On striking together, they produce a dull thud sound.
- Its compressive strength lies between 35 – 70 $kg/cm^2$ and absorption between 22 – 25 percent.
- **Use:** They are used mostly in the ordinary type of construction and in dry situations.

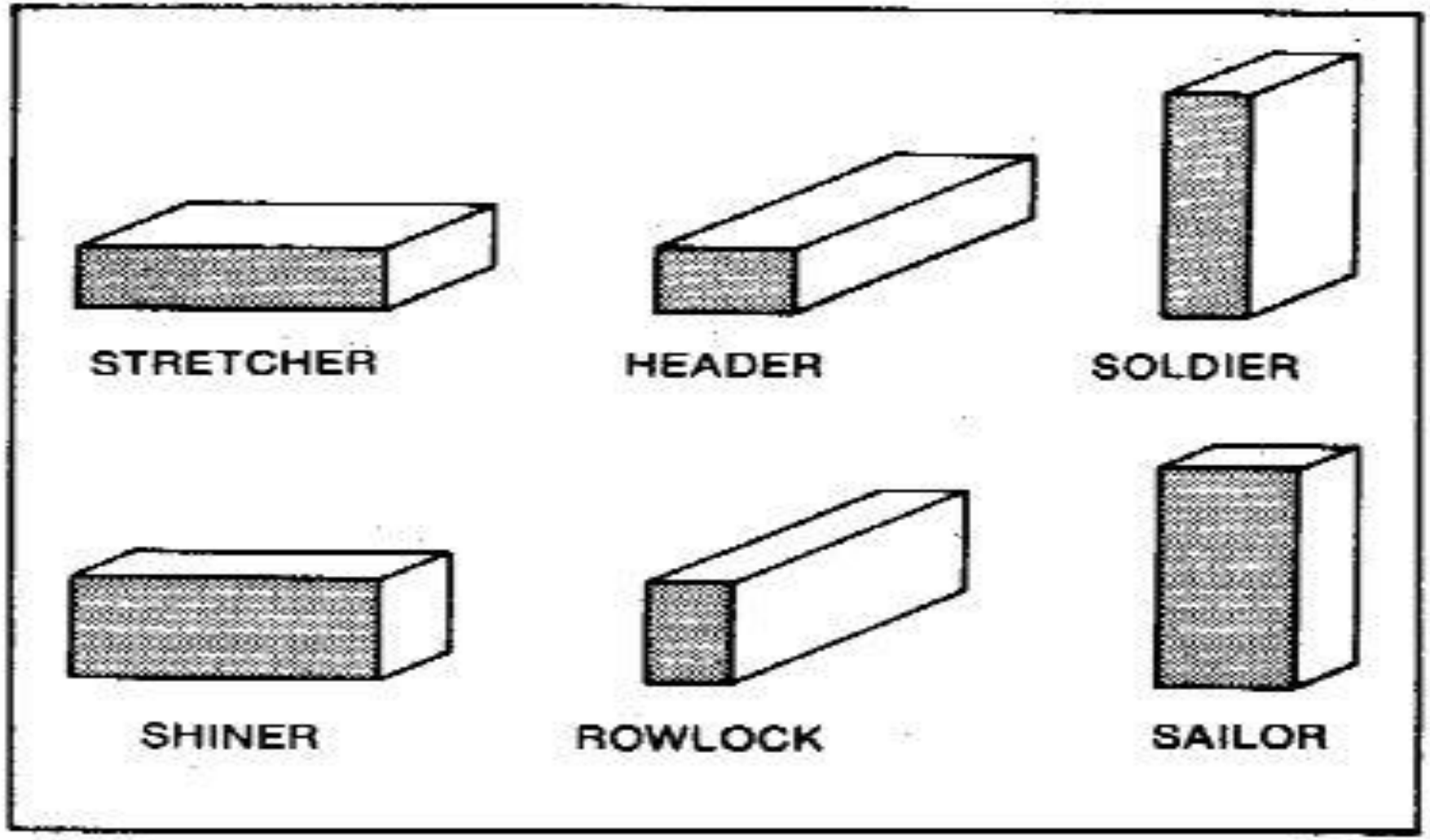
## iv. Fourth Class Bricks:

- These types of bricks are irregular in shape and dark in color which is due to over burning. They are quite strong in compressive strength, generally above 150 $kg/cm^2$ and low in porosity and absorption.
- **Use:** Despite their high strength, these types of bricks are unfit for use in building construction. This is because of their distorted shape and irregular size.

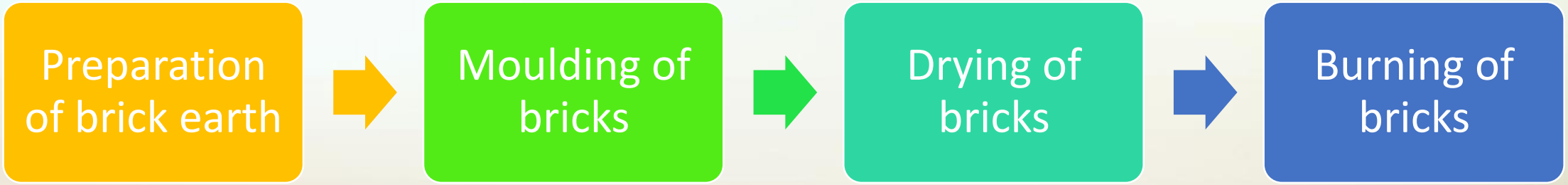
- **Special Types of Bricks:**
- Ordinary building bricks are typically rectangular in shape, solid in Structure and made from a Suitable type of brick-clays.
- In building construction, however, bricks of modified Shapes, porous or hollow structure and also made from materials other than clay are also sometimes used.
- A familiarity with this Special classification of bricks is quite important for a construction engineer.

# *Brick Positions*

- Stretcher
- Header
- Soldier
- Shiner
- Rowlock
- Sailor



# MANUFACTURING OF BRICKS



# PREPARATION OF BRICK EARTH

***Removal of loose soil***

- The top layer of the loose soil about 30 cm depth contains a lot of impurities like organic matter and hence it should be taken out and thrown away.

***Digging, spreading and cleaning***

- The earth is then dug out from the ground. This earth is spread into heaps about 50 to 150 cm height.

***Weathering***

- The earth is then exposed to atmosphere for softening. The period may be Of few weeks to a season.

***Blending and tempering***

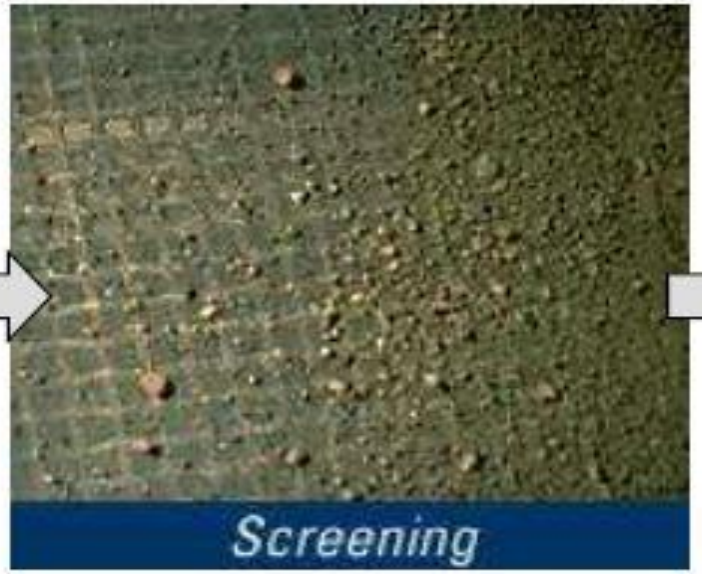
- The clay is then mixed with suitable ingredients. It is carried out by taking a small portion of clay every time and by turning it up and down in vertical direction

Gathering raw materials

Storage of raw materials

Crushing

Grinding



Screening

Pug mill

# MATERIAL PREPARATION

# MOULDING

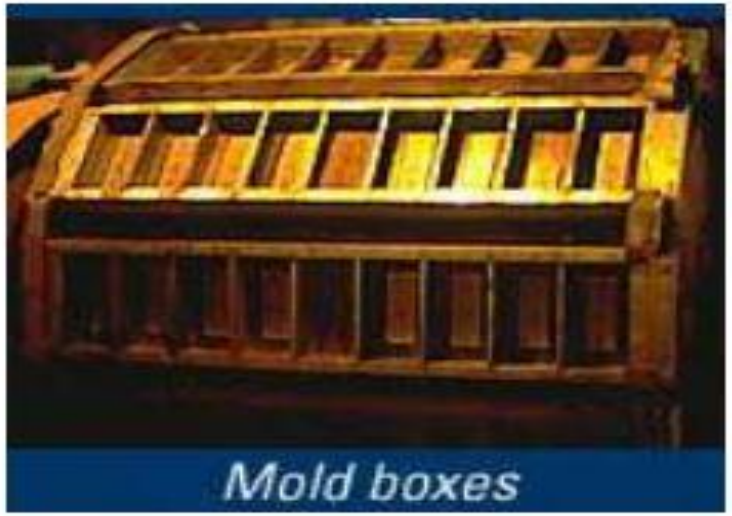
***Hand moulding***

- When moulding is done with hand it is called hand moulding.
- A wooden rectangular mould made in the shape of a brick is normally used for this purpose.

***Machine moulding***

- The clay is placed in the machine, it comes out through the opening under pressure.
- It is cut to bricks by steel wires fixed into frames.
- These bricks are also called wire cut bricks.


HAND
Moulding



Mold boxes

Throwing brick

Squeegee

Dumping mold box

Hand setting

**Manufacturing**

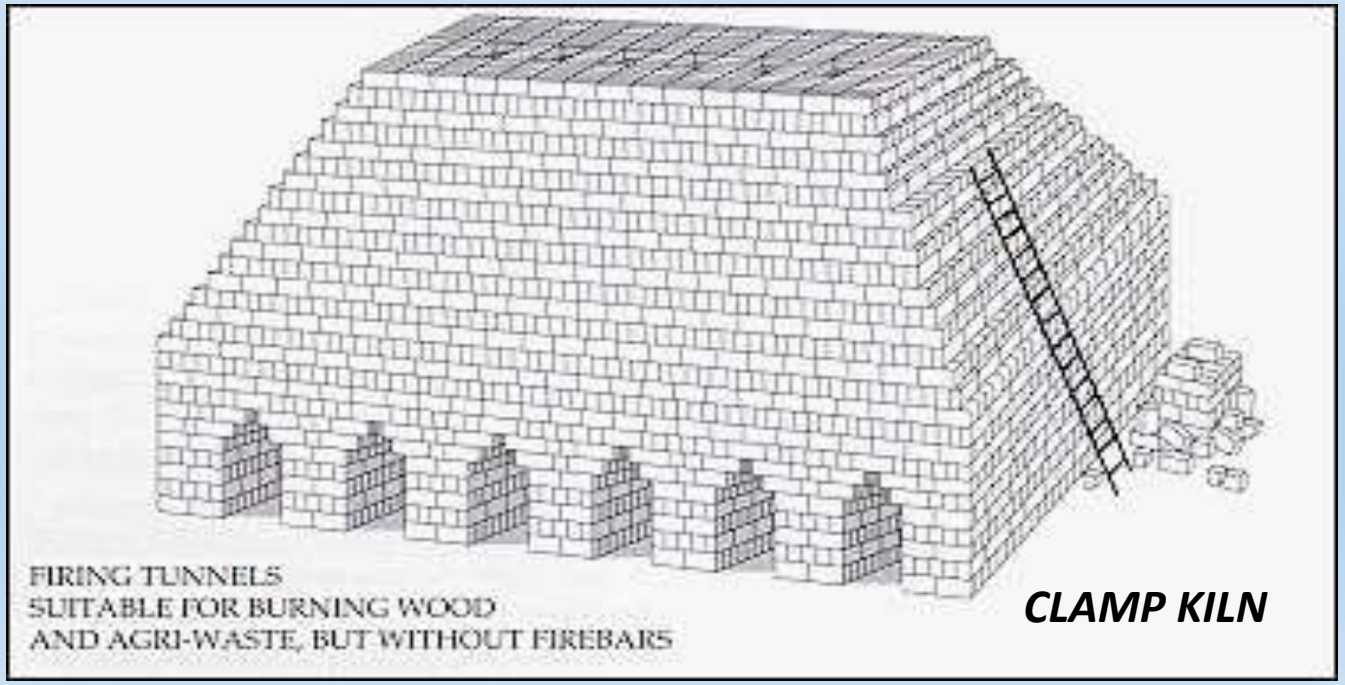
**( MACHINE MOULDING)**

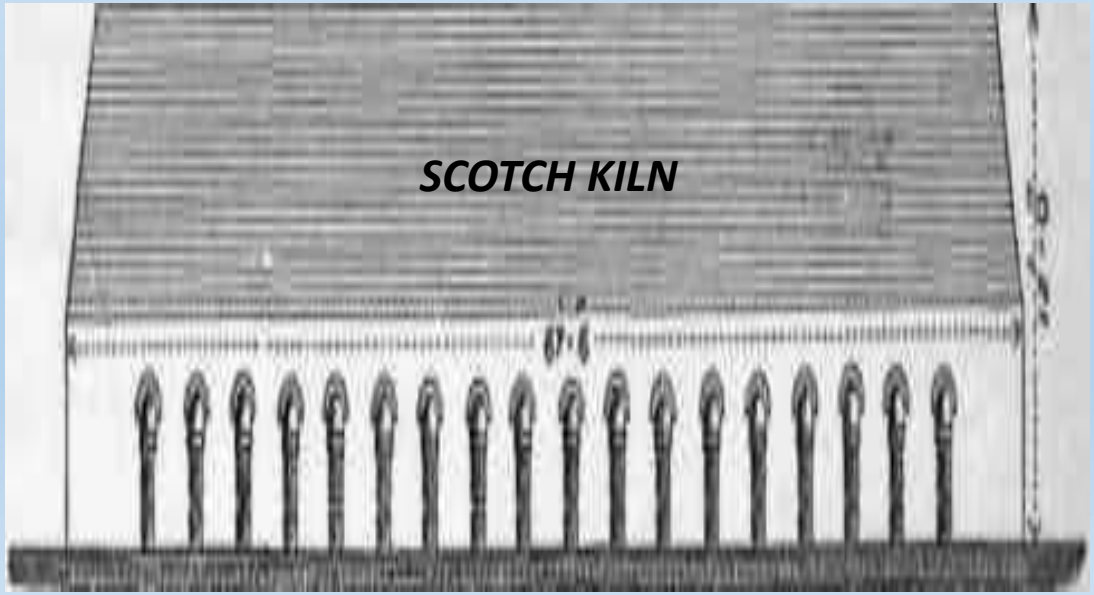
# DRYING OF BRICKS

- Wet brick from molding or cutting machines contain 7 to 30 percent moisture, depending upon the forming method.
- Before the firing process begins, most of this water is evaporated in dryer chambers at temperatures ranging from about 100 ºF to 400 ºF (38 ºC to 204 ºC).
- The extent of drying time, which varies with different clays, usually is between 24 to 48 hours.
- Heat and humidity must be carefully regulated to avoid cracking in the brick.

# BURNING OF BRICKS

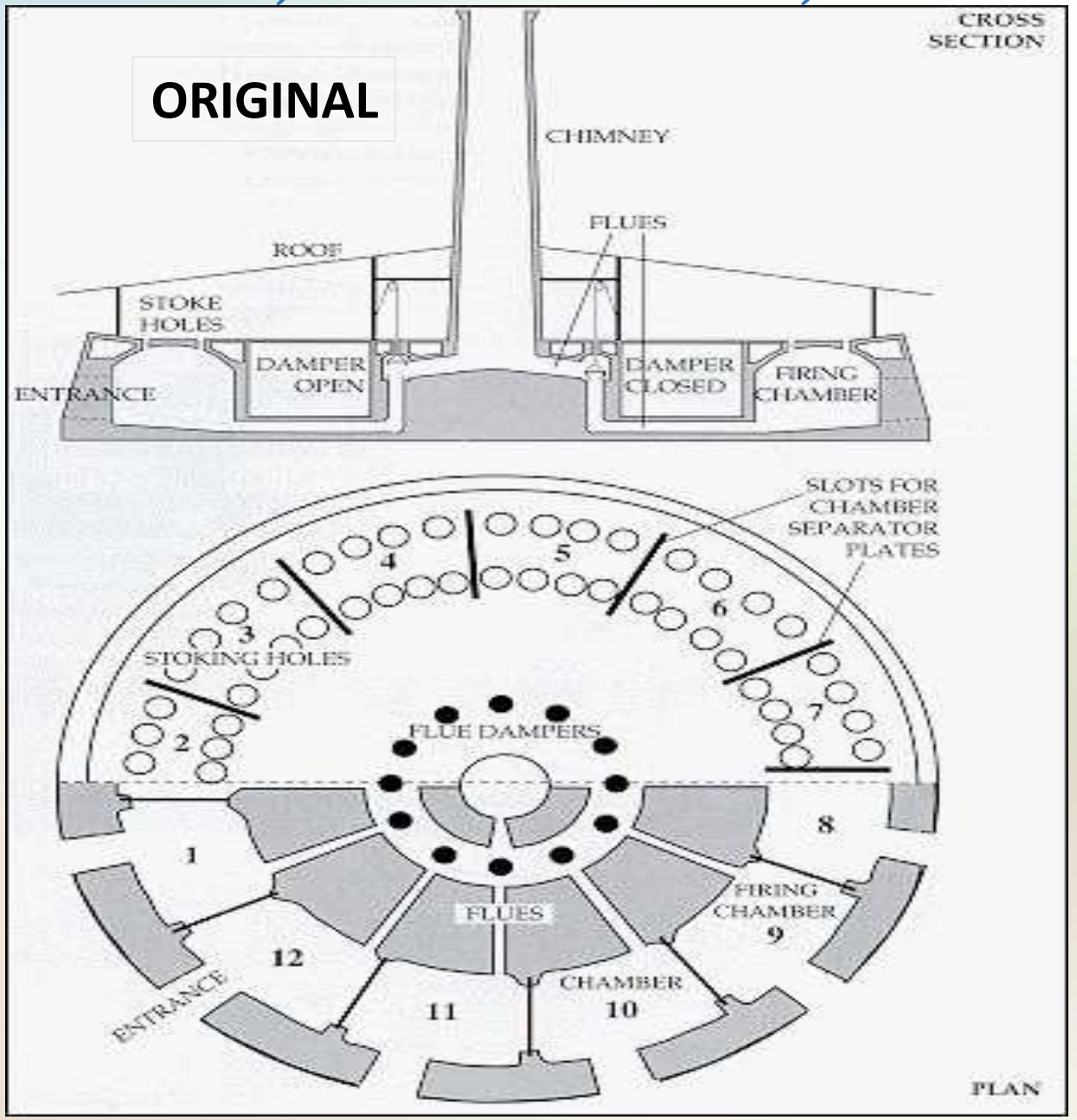
- ***INTERMITTENT KILN -*** *CLAMP , SCOVE & SCOTCH*
- Highly inefficient & labor-intensive.
- Use coal + scavenged fuels
- Most common, most primitive, most polluting
- Used for temporary Structures

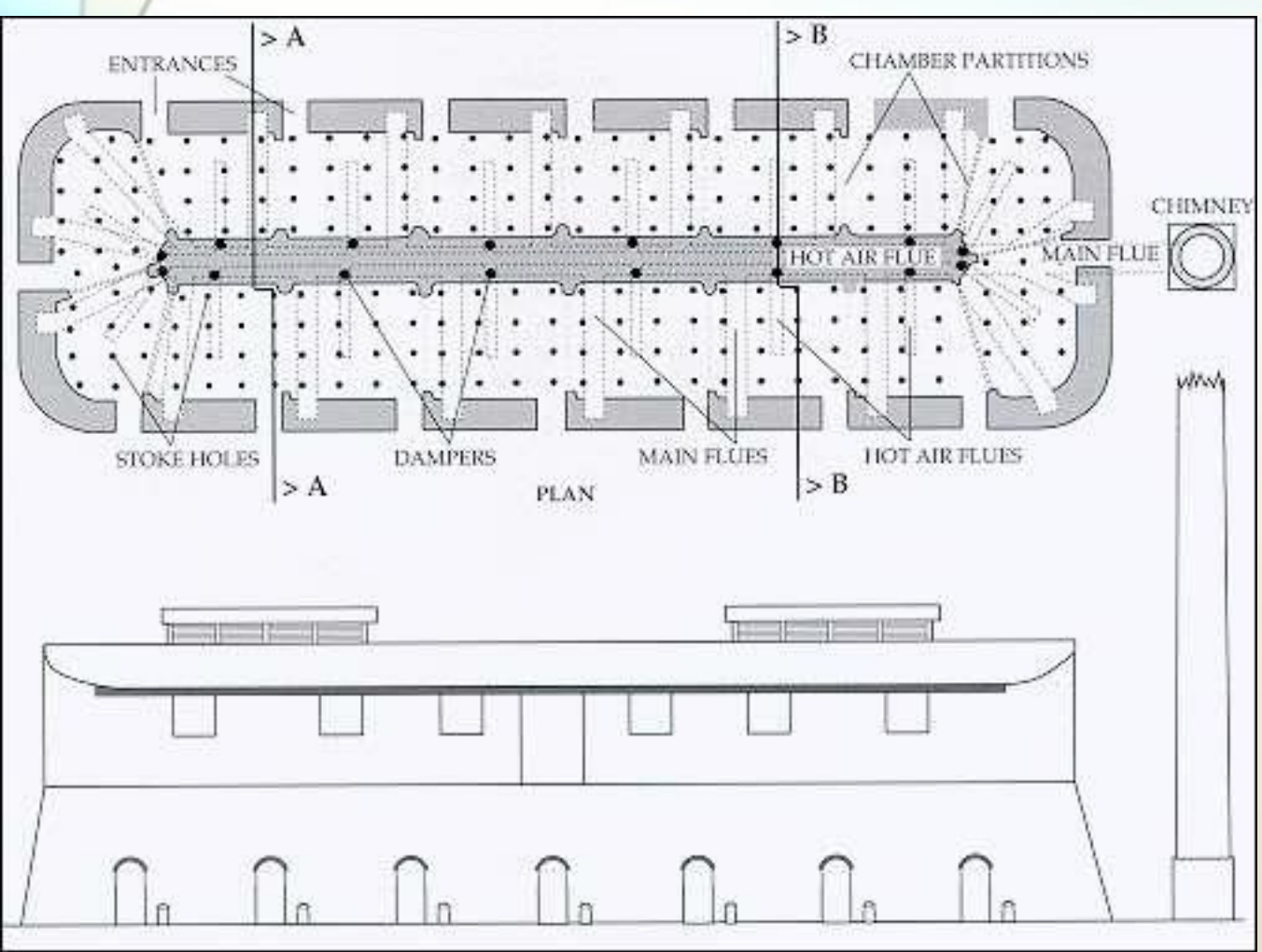
# *CONTINOUS KILN BURNING – HOFFMAN, BULL'S TRENCH, VERTICAL SHAFT & HABLA*

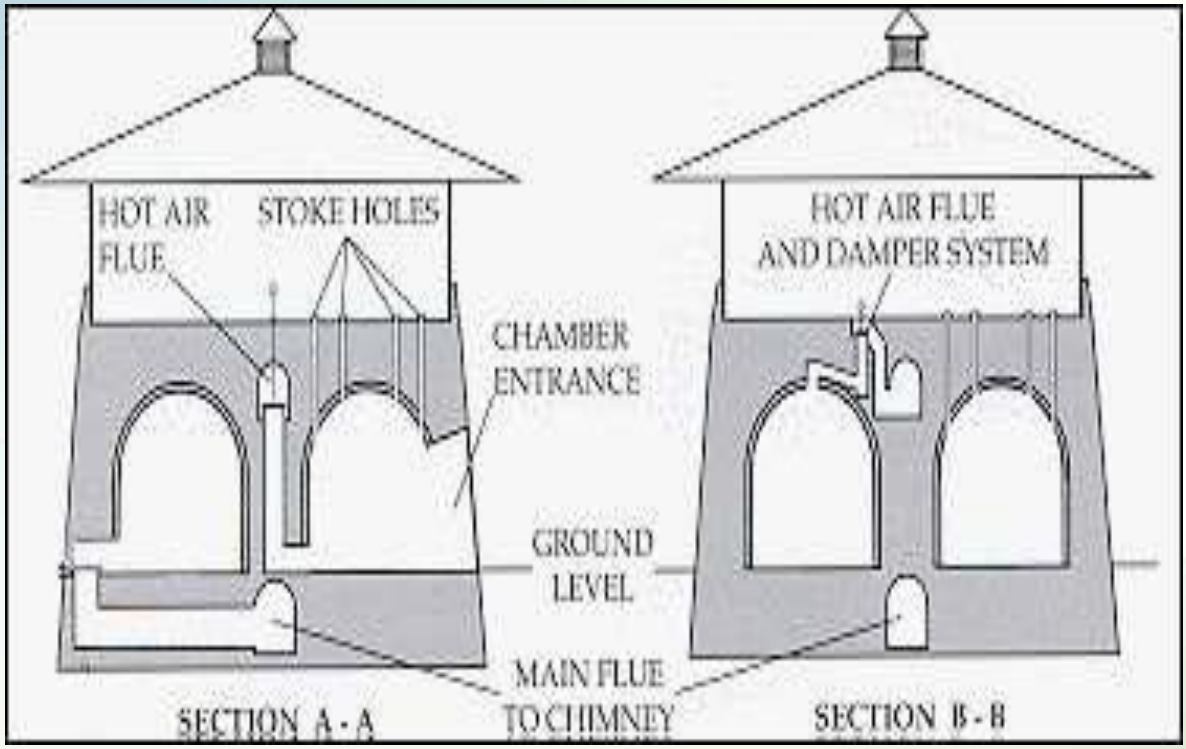
- These are permanent structures.
- Burning is done continuously in kilns.
- Bricks from kilns are of correct size, perfect shape and good quality.
- Rate of burning is also high in kilns.
- But initial investment for kiln is very high.
- Efficient and potentially clean –
  - Hybrid Hoffman
  - VSBK
  - Habla
  - Tunnel (modern – several variations)

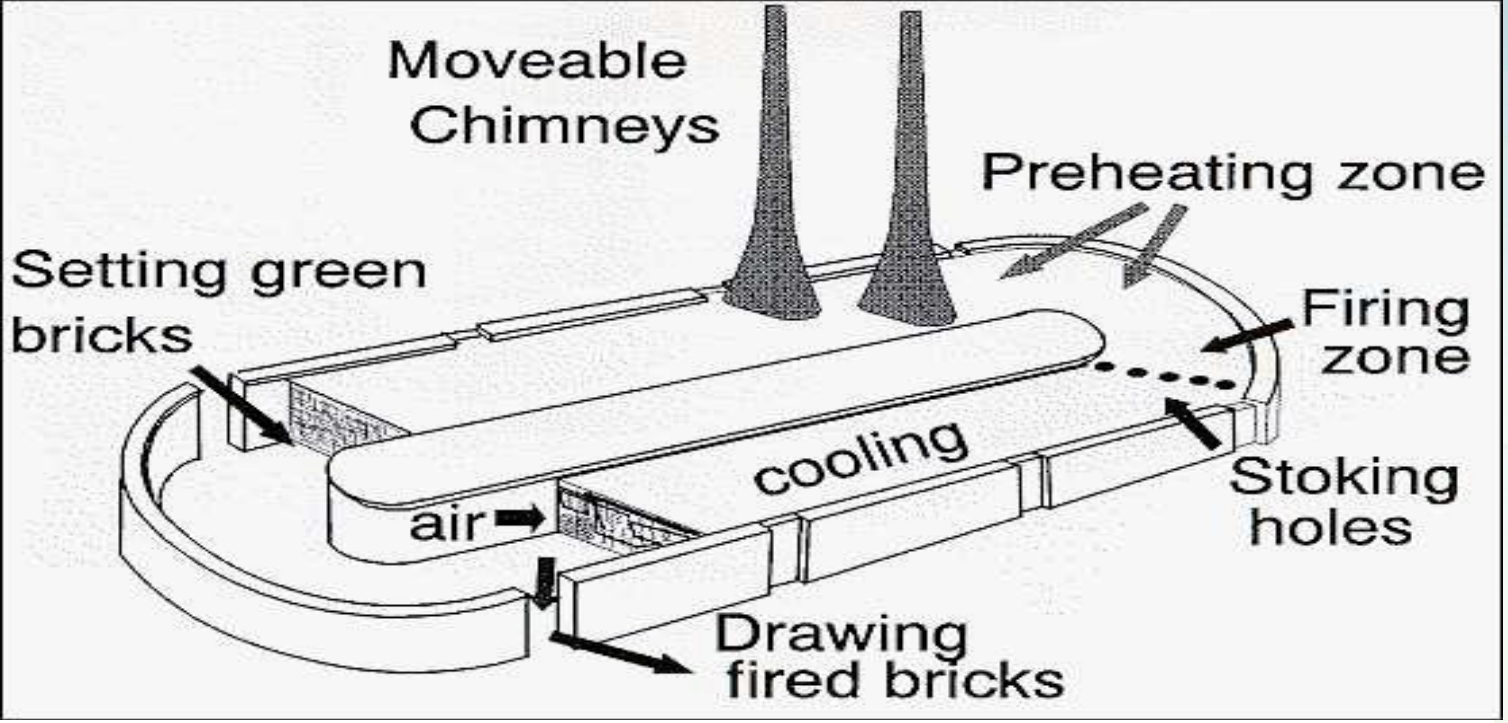


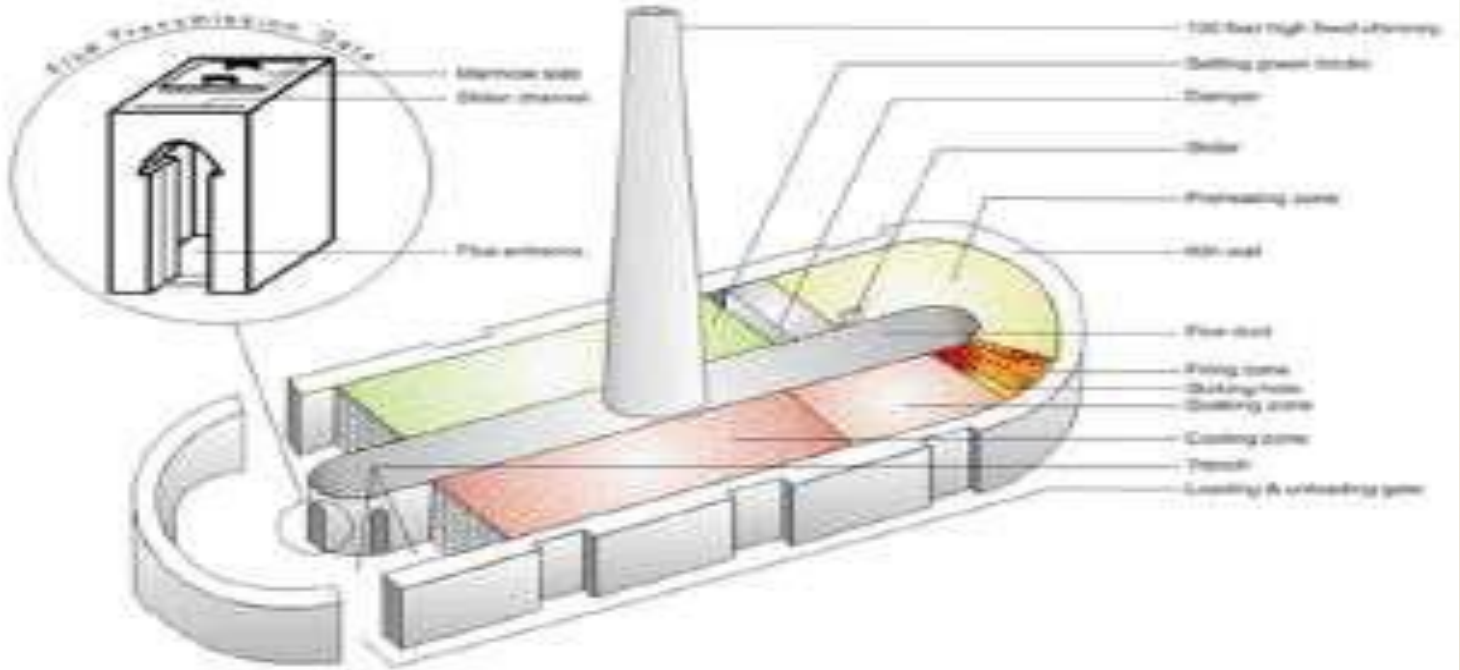
# Hybrid Hoffman

- Widely used in China = 90% of bricks
- Can use coal or natural gas

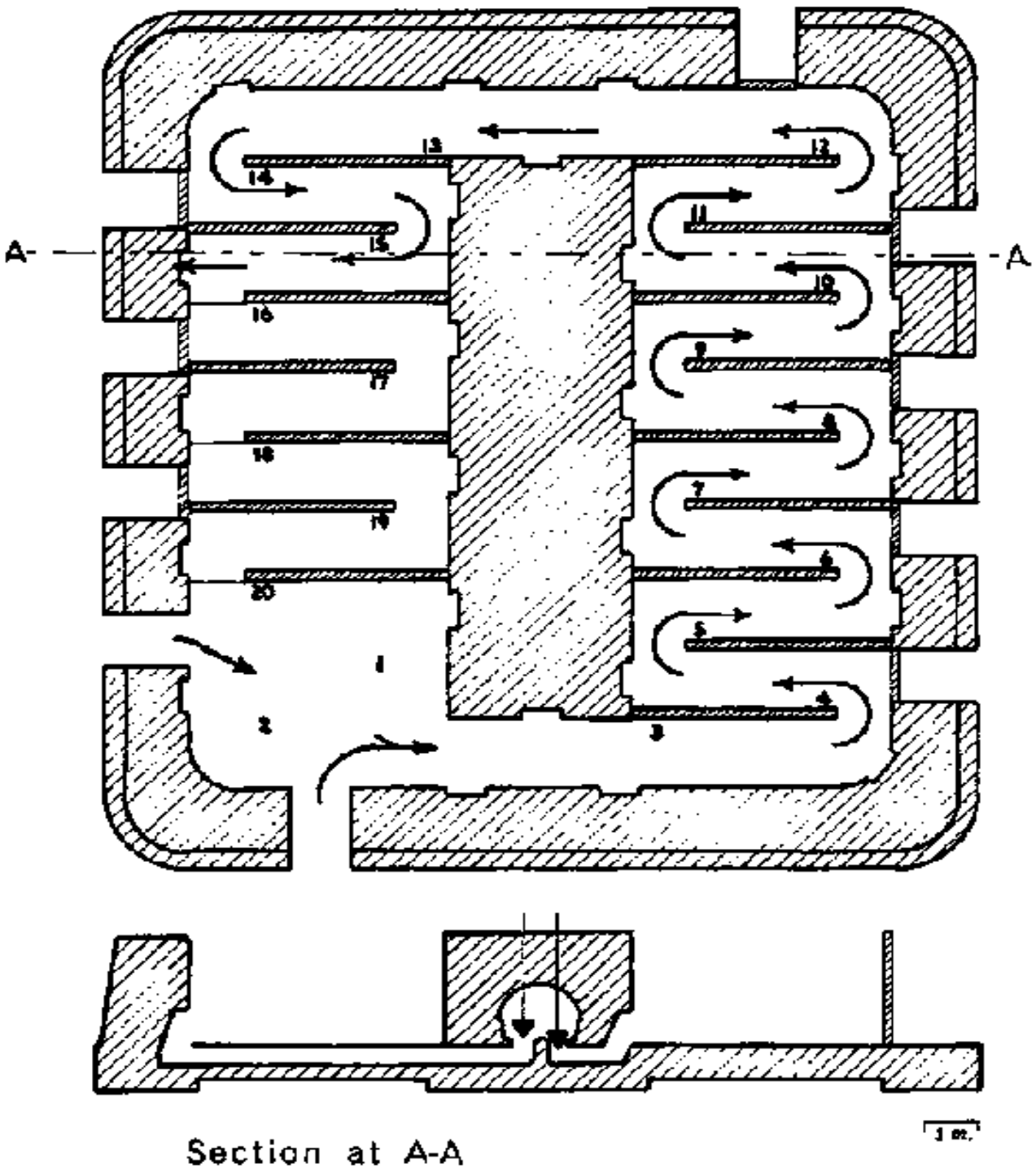


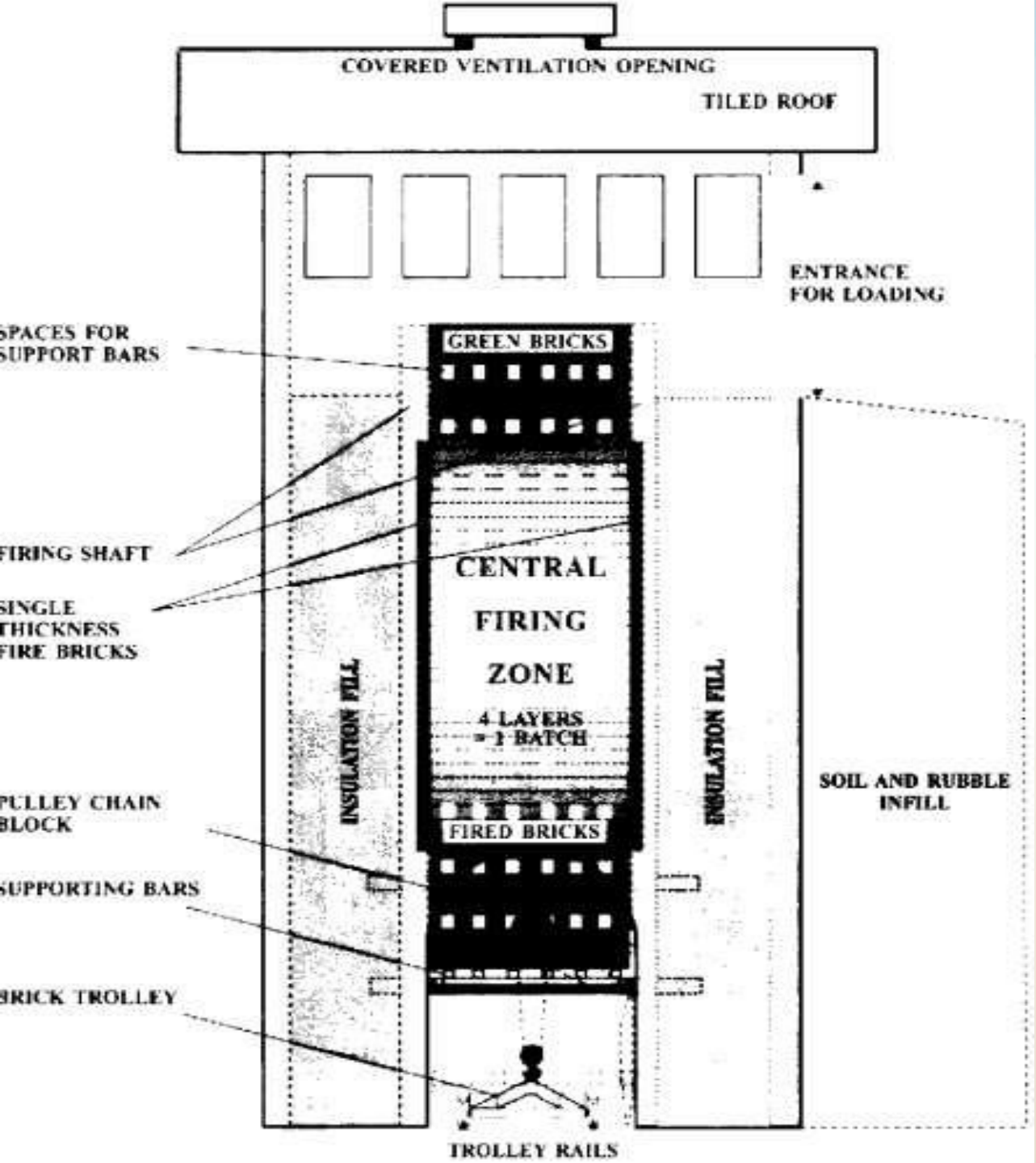



- ***BULL'S TRENCH KILN***
- Used in India, Pakistan, Nepal, Bangladesh
- Uses coal and scavenged fuels
- "Movable chimney" (MC) and "Fixed" Fixed (FC)
- MCBTK banned (but still used) in India, parts of
- Nepal & Pakistan due to very high emissions




## *HABLA ZIGZAG KILN*

- Effective tunnel length of Hoffmann increased with “zigzags” made of green bricks Larger capacity and more efficient than other kilns
- Needs fan to draw air through = needs source of electricity




# VERTICAL SHAFT BRICK KILN (VSBK)

- Loaded at top, bricks removed from bottom
- High efficiency, low emissions
- Kiln of choice for aid agencies
- India, Nepal, Pakistan, Vietnam

# TYPES OF TESTS ON BRICKS FOR CONSTRUCTION PURPOSE

- Following tests are conducted on bricks to determine its suitability for construction work.
  - Absorption test
  - Crushing strength test
  - Hardness test
  - Shape and size
  - Color test
  - Soundness test
  - Structure of brick
  - Presence of soluble salts (Efflorescence Test)

## Absorption Test on Bricks

- Absorption test is conducted on brick to find out the amount of moisture content absorbed by brick under extreme conditions.
- In this test, sample dry bricks are taken and weighed. After weighing these bricks are placed in water with full immersing for a period of 24 hours.
- Then weigh the wet brick and note down its value. The difference between dry and wet brick weights will give the amount of water absorption.
- For a good quality brick the amount of water absorption should not exceed 20% of weight of dry brick.

## Crushing Strength or Compressive Strength Test on Bricks

- Crushing strength of bricks is determined by placing brick in compression testing machine.
- After placing the brick in compression testing machine, apply load on it until brick breaks.
- Note down the value of failure load and find out the crushing strength value of brick.
- Minimum crushing strength of brick is 3.50N/$mm^2$.
- If it is less than 3.50 N/$mm^2$, then it is not useful for construction purpose.

**Hardness Test on Bricks**

- A good brick should resist scratches against sharp things. So, for this test a sharp tool or finger nail is used to make scratch on brick. If there is no scratch impression on brick then it is said to be hard brick.

**Shape and Size Test on Bricks**

- Shape and size of bricks are very important consideration. All bricks used for construction should be of same size.
- The shape of bricks should be purely rectangular with sharp edges.
- Standard brick size consists length x breadth x height as 19cm x 9cm x 9cm.
- To perform this test, select 20 bricks randomly from brick group and stack them along its length , breadth and height and compare. So, if all bricks similar size then they are qualified for construction work.

**Color Test of Bricks**

- A good brick should possess bright and uniform color throughout its body.

**Soundness Test of Bricks**

- Soundness test of bricks shows the nature of bricks against sudden impact. In this test, 2 bricks are chosen randomly and struck with one another. Then sound produced should be clear bell ringing sound and brick should not break. Then it is said to be good brick.

**Structure of Bricks**

- To know the structure of brick, pick one brick randomly from the group and break it. Observe the inner portion of brick clearly. It should be free from lumps and homogeneous.

## Efflorescence Test on Bricks

- A good quality brick should not contain any soluble salts in it.
- If soluble salts are there, then it will cause efflorescence on brick surfaces.
- To know the presence of soluble salts in a brick, placed it in a water bath for 24 hours and dry it in shade.
- After drying, observe the brick surface thoroughly.
- If there is any white or grey color deposits, then it contains soluble salts and not useful for construction.

# SPECIAL BRICKS

- Specially shaped
- Burnt clay
- Heavy duty
- Perforated
- Burnt clay hollow
- Sand lime
- Sewer bricks
- Acid resistant bricks

# REFRACTORY BRICKS

- REFRACTORIES – all materials used for the construction of heat resisting containers
- Principle = thermal insulation and conduction
- A good refractory brick should withstand
  - High temperature
  - Sudden alternating heating and cooling(thermal shock)
  - Abrasion and rough usage
  - Contraction and expansion
  - Corrosive actions of gases
  - Impermeable to liquid and gases
  - Have low electrical conductivity

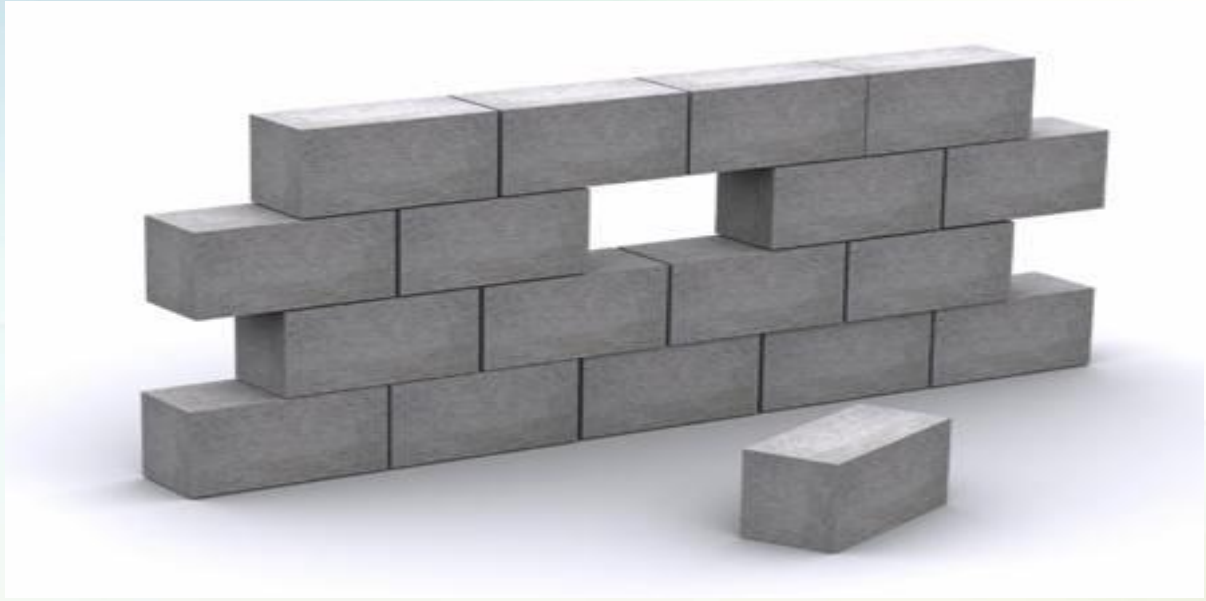
# TYPES OF REFRACTORY BRICKS

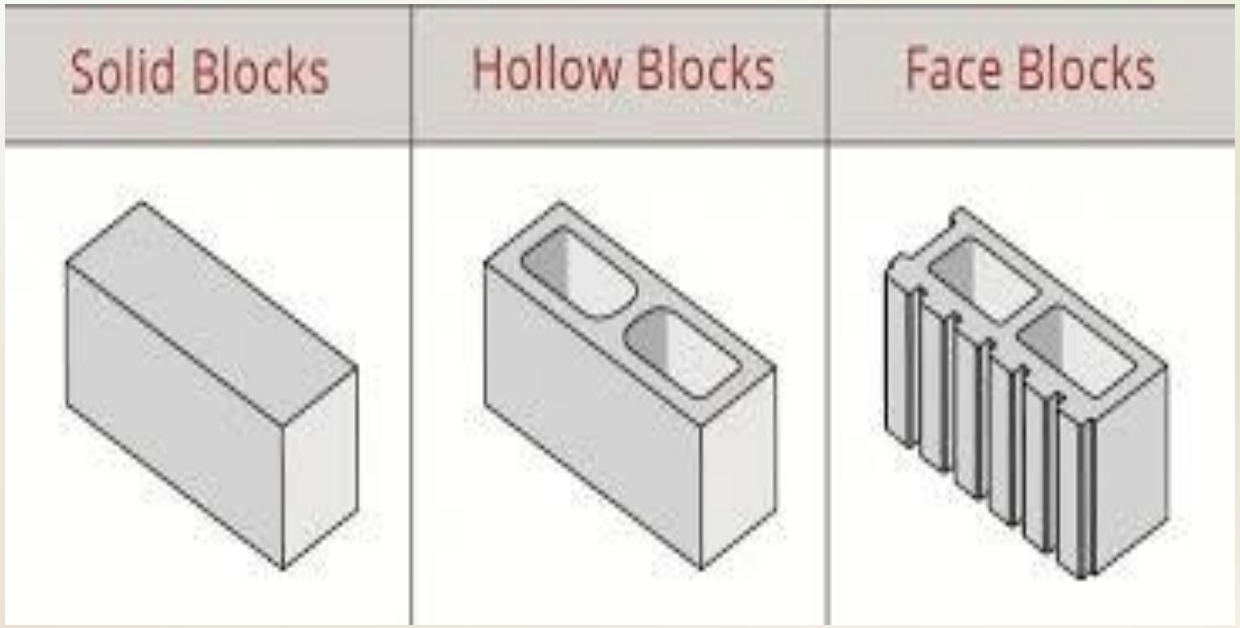
- Acid bricks
  - Fire bricks
  - Silica bricks
- Basic bricks
  - Magnesite bricks
  - Dolomite bricks
  - Bauxite bricks
- Neutral brick
  - Chrome bricks
  - Chrome-magnesite bricks
  - Spinel
  - Forsterite bricks

# CEMENT CONCRETE BLOCKS

- Nowadays widely used for construction because of
  - Their large size
  - Uniformity in design
  - Easy handling and placing
  - Attractive appearance
- Types
  - Regular
  - Light weight

- **LWCB**
  - Common finished surface
  - Glazed finish
- Common sizes
  - 39 x 19 x 30 cm
  - 39 x 19 x 20 cm
  - 39 x 19 x 10 cm





# MANUFACTURING PROCESS

- **Selection and proportion of Ingredients**: The main criteria for the selection of the ingredients are the desired strength of the block. The greater the proportion of coarse aggregate, the greater will be the strength of the quantity of cement used.
- **Mixing of ingredients:** The blending of aggregates, cement and water should be done very carefully. The mixing should preferably take place in a mechanical mixer. For hand mixing, extreme care should be taken to see that the cement and aggregates are first mixed thoroughly in dry state and the water is then added gradually.
- **Placing and vibration:** The mixed concrete material is fed into the mould box upto the top level and it is ensured that the box is evenly filled. The vibration of concrete is done till it has uniformly settled in the mould box.
- **Curing:** The block is watered after about one day of casting and it is continued for a minimum of 7 days and preferably till 28 days. The longer the curing period, the better will be the block.

# FACTORS TO BE CONSIDERED

- Aggregates should be properly graded
  - 60% fine and 40% (6 to 12 mm) coarse to be used
  - Fineness modulus 2.9 to 3.6
- Concrete mix = 1:6
- Should be kept in undisturbed platform for 24 hours
- Should be cured under shade for minimum 24 hours
- Then immersed in water for 7 days
- Dried for about 1 month after curing
- Minimum strength 30 kg per sq.m