

MASONRY

-SURABHI (A.P. CE)

BUILDING PLANNING AND CONSTRUCTION (CE-404)

DEPT. OF CE

JNGEC SUNDERNAGAR



MATERIALS USED IN MASONRY



Bricks



Stone



Concrete Block

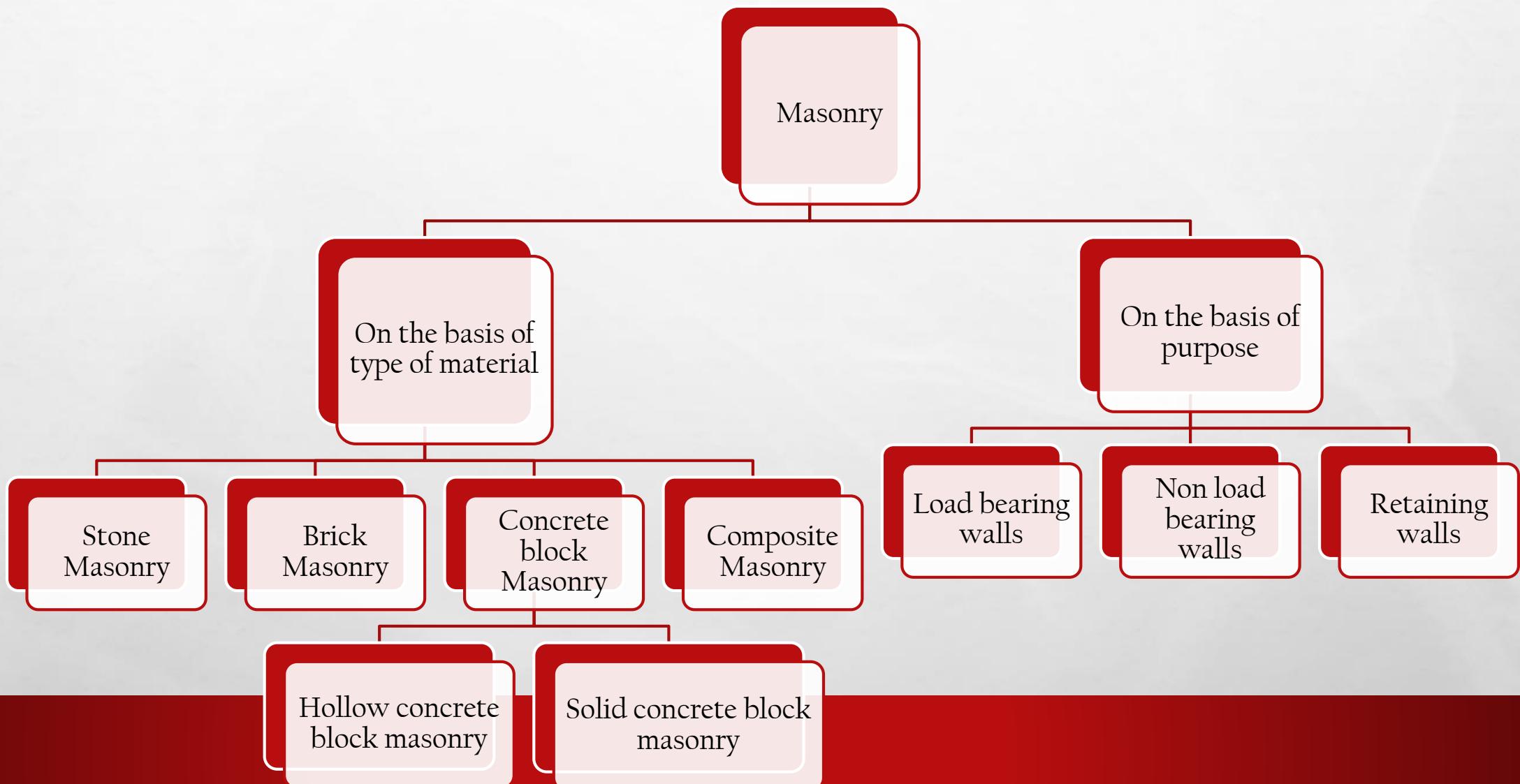


Mortar

MASONRY

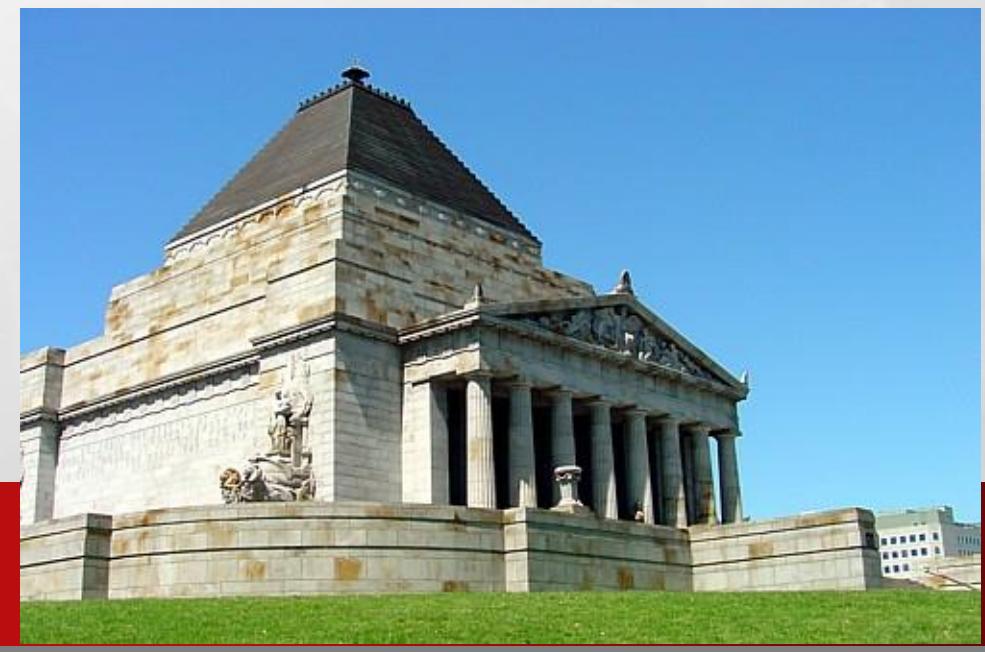
- MASONRY IS A UNIT CONSTRUCTION BY BONDING EITHER BRICKS, STONES OR CONCRETE BLOCKS TOGETHER WITH THE HELP OF MORTAR**

CLASSIFICATION OF MASONRY

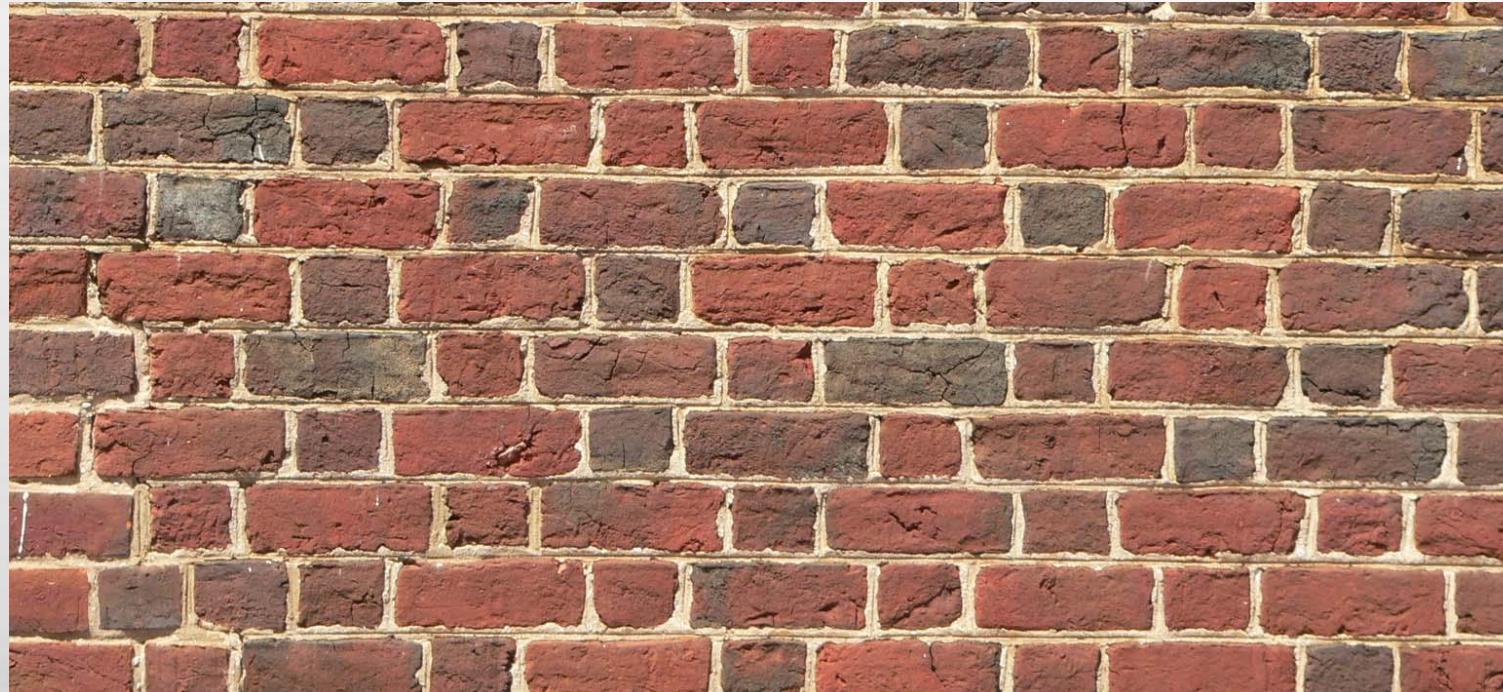


STONE MASONRY





BRICK MASONRY





SOLID CONCRETE BLOCK MASONRY

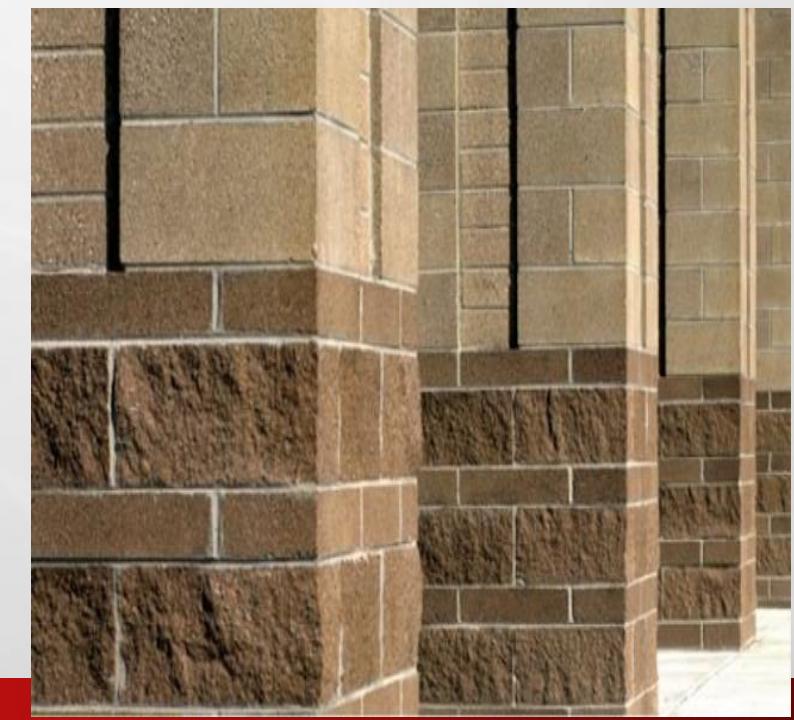
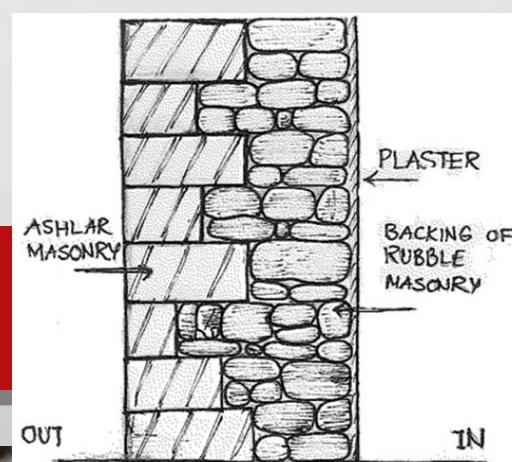
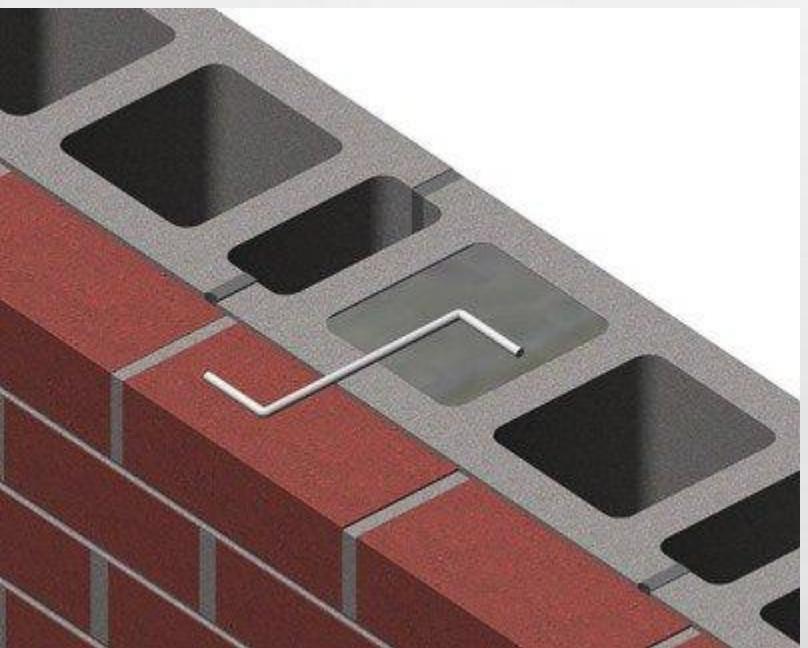


HOLLOW CONCRETE BLOCK MASONRY



COMPOSITE MASONRY

Composite masonry is defined as the walls constructed from two or more building materials are termed as composite walls. The combination may be stone slab in the face work and brick masonry at the backing, or superior stones in the facing with rubble stone masonry at the backing so on



LOAD BEARING WALLS

- Walls which carry the load of the structure and are strong enough to bear the imposed load
- A load-bearing wall or bearing wall is a wall that is an active structural element of a building, that is, it bears the weight of the elements above said wall, resting upon it by conducting its weight to a foundation structure
- Stone, solid concrete blocks or thick brick masonry used to construct these

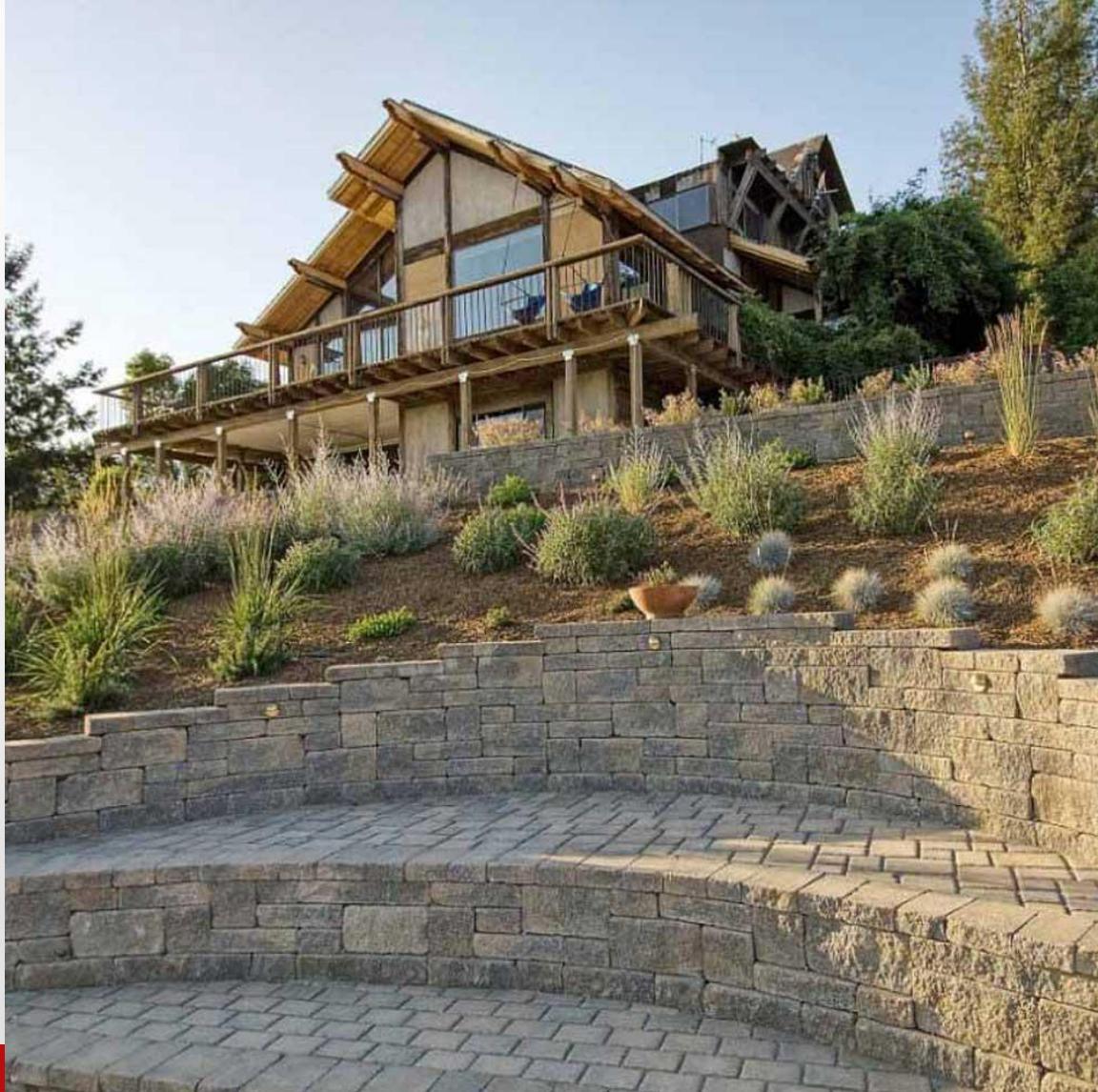
NON-LOAD BEARING WALLS

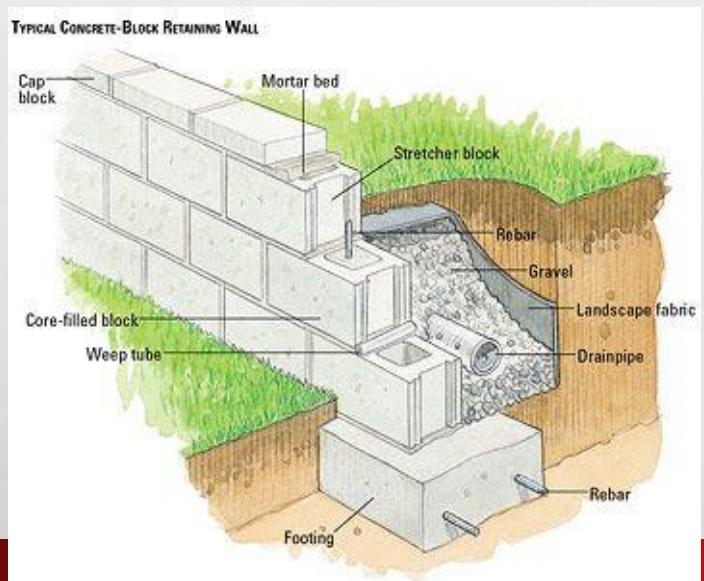
(Partition or curtain walls)

- Walls constructed in framed structures.
- In framed structures structural load is carried by beams and columns.
- Purpose of these walls is to provide enclosure or partition.
- Don't require much strength
- Thin brick, hollow concrete block masonry used

RETAINING WALLS

- Purpose is to retain the backfill
- Ordinary type of masonry used





TERMS RELATED TO MASONRY

- **STRETCHER**

- Lengthy face of brick

- **HEADER**

- Face of the brick showing its width

- **BED**

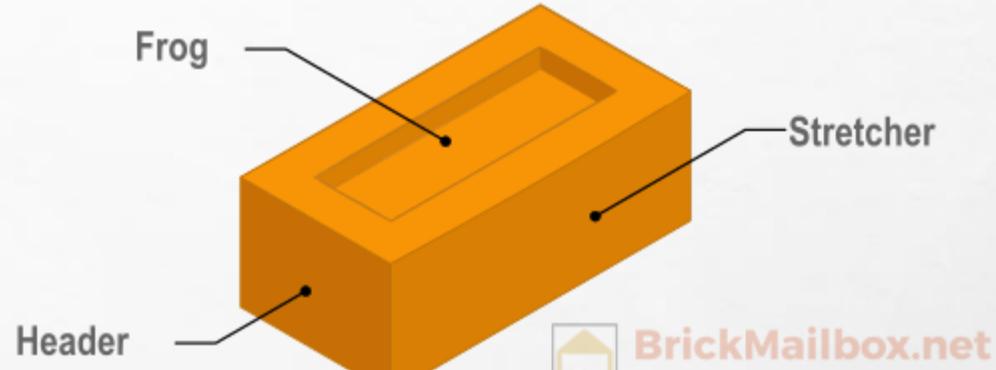
- Lower surface of a course on which brick rests

- **BACK**

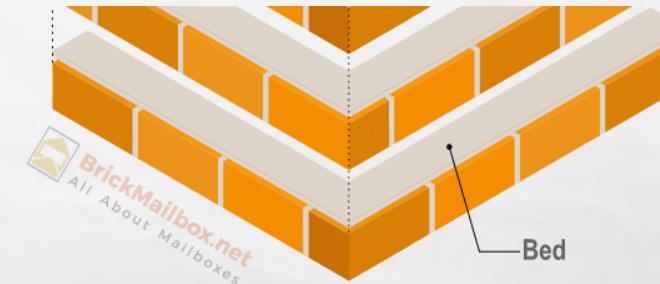
- Internal surface of masonry not exposed to weather

- **QUOINS**

- External corners of walls



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• HEARTING

- Portion of wall between face and back

• JOINTS

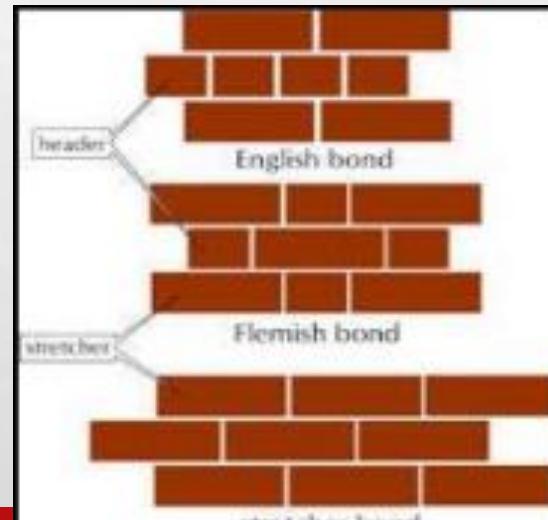
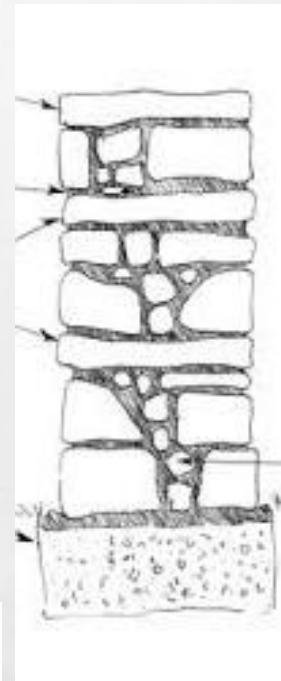
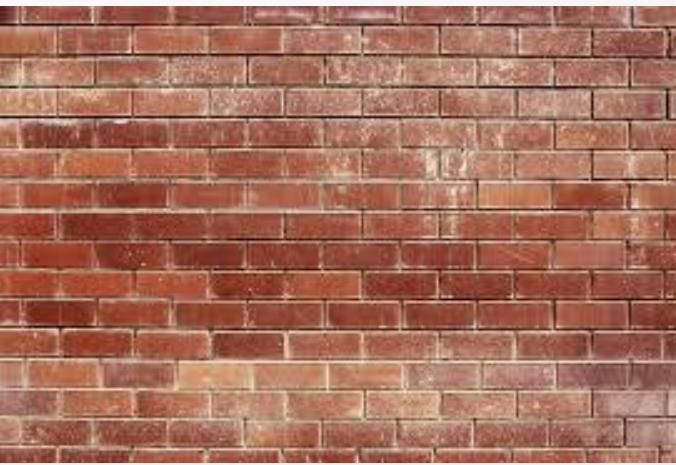
- Junction of two or more bricks or stone
- Vertical joints separating bricks is called perpends

• COURSE

- Horizontal layer of bricks or stones
- Thickness = 10 cm in brick masonry and 40-70 cm in stone masonry

• BOND

- Arrangement of courses of bricks by which vertical joints are avoided in successive courses is called bond



• KING CLOSER

- Part of brick obtained by cutting triangular corner portion from middle points of width and length of a brick

• QUEEN CLOSER

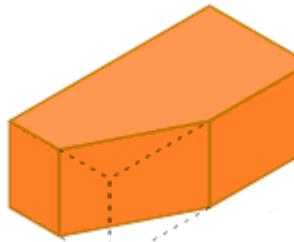
- Part of brick obtained by cutting a brick longitudinally into two equal parts.

• BEVELLED CLOSER

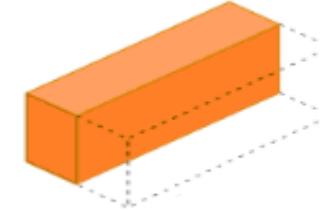
- Similar to king closer obtained by cutting triangular portion of the brick half width and full length
- It has queen closer face at one end and full header face at other end

• MITRED CLOSER

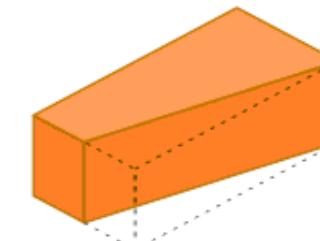
- Obtained by cutting one full width of header at 45° to 60°



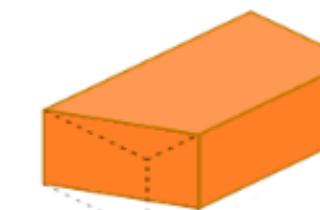
KING CLOSER



Queen Closer



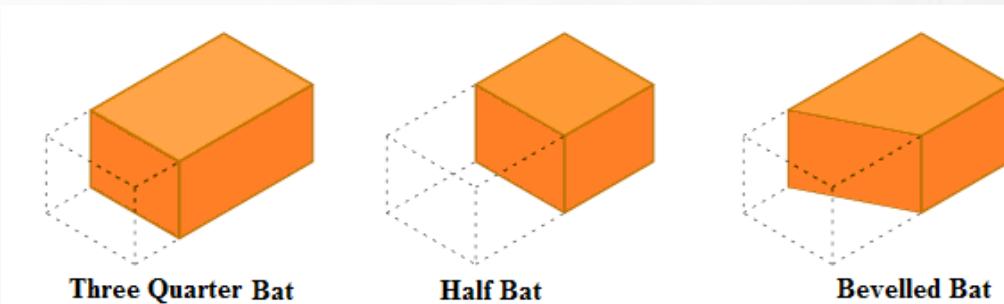
BEVELLED CLOSER



Mitred Closer

- **BAT**

- Piece of brick obtained by cutting along the length
- Brick half to its length is called “Half Bat”
- Brick $\frac{3}{4}$ th of its length is called “Three quarter Bat”
- Brick half to its length and bevelled at header is “Bevelled Bat”



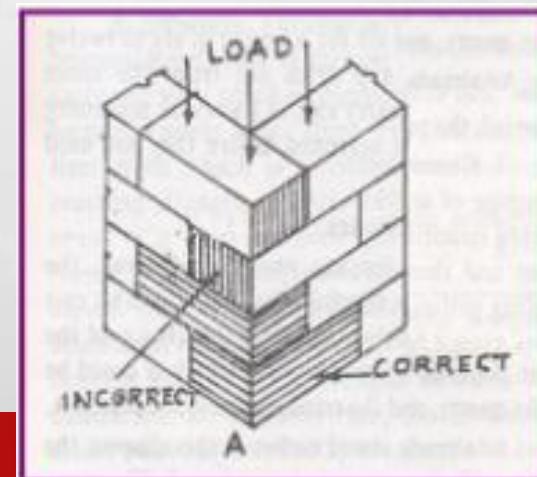
- **FROG**

- A triangular, square or rectangular depression made on top surface of brick. Frog kept on upper side of each course



- **Natural bed in Stone masonry**

- Original layers of stones along which they have formed
- It can be easily split along this plane
- Each stone is laid such that natural bed is perpendicular to direction of load



• THROUGH STONE

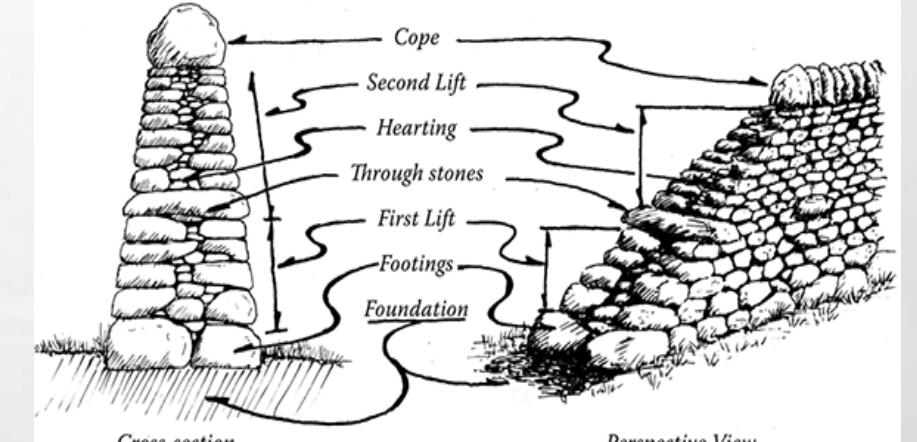
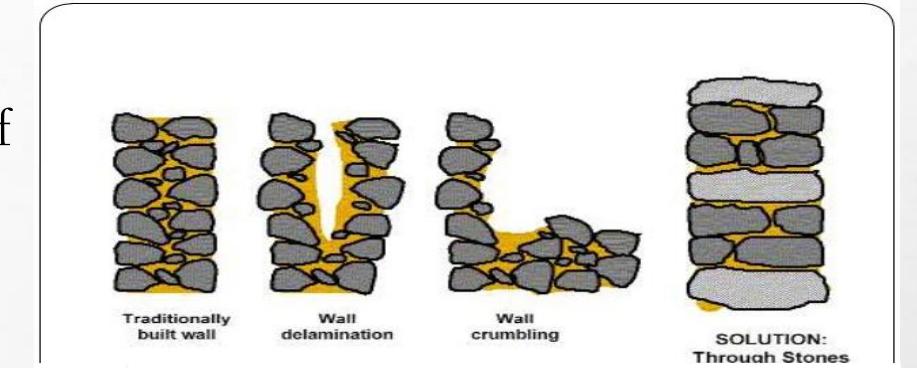
- Single stone fixed at regular intervals joining face and back of masonry wall
- Provided for good bond between face and back of stone wall
- If stone wall is too thick two through stones must be provided

• SPALLS

- Pieces of stones used to fill cavities in the hearting of stone masonry

• PLINTH

- Projecting course of stone or brick masonry at ground floor level
- It indicates height of building ground floor level from natural ground level.
- Varies from 20-60 cm



• DAMP PROOF COURSE

- Impervious course laid at plinth level to prevent rise of water from foundations to superstructure

• SILL

- Horizontal bottom course at a window or door opening to support vertical members of frame

• JAMBS

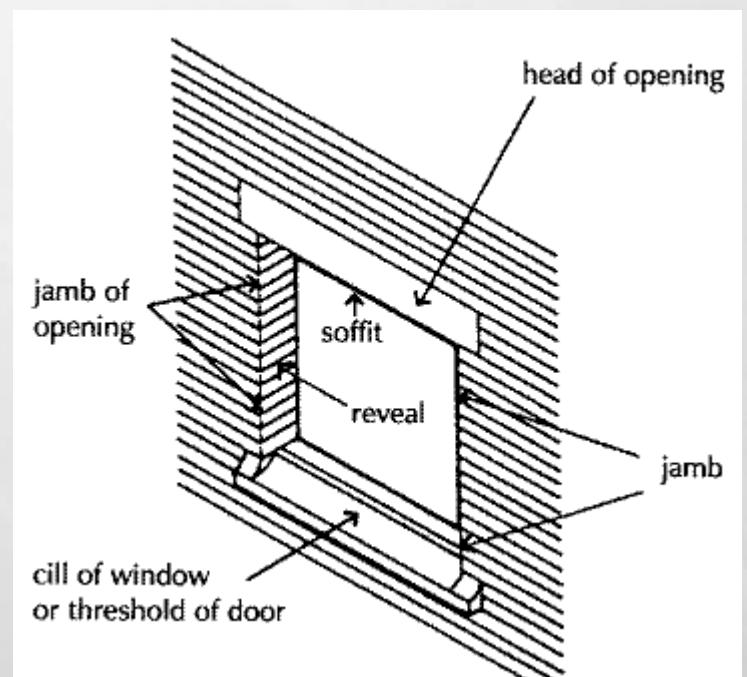
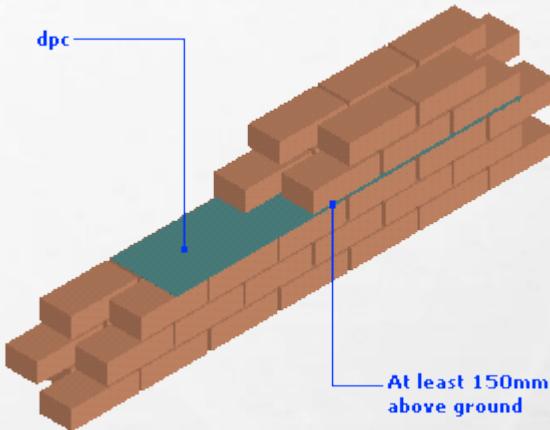
- Inner vertical sides of a finished surface of a door or window openings

• REVEALS

- Outer vertical sides of a finished surface of a door or window opening

• LINTEL

- Horizontal member of stone, brick, wood, steel or RCC provided to support masonry above opening



- **ARCH**

- Curved lintel



- **PARAPET**

- A low wall constructed around open terrace



- **GABLE END**

- Triangular shaped wall at end of a sloped roof

- **PIER**

- Thickened section of masonry placed at intervals along a wall to increase stiffness of wall



- **BUTTRESS**

- A pier of masonry built as an integral part of wall and projecting from either or both surfaces decreasing in cross section area from base to top



- **BUTTRESS**

- A pier of masonry built as an integral part of wall and projecting from either or both surfaces decreasing in cross section area from base to top



- **THRESHOLD**

- Arrangement of steps provided from ground level to reach plinth level at external doors and entrances like verandahs



STONE MASONRY

**It is a unit of construction made by bonding stones together
by means of some binding agent.**

CLASSIFICATION OF STONE MASONRY

STONE MASONRY
(ON THE BASIS OF QUANTUM OF SURFACE DRESSING)



A. RUBBLE MASONRY

- **STONES RECEIVED FROM QUARRY ARE USED WITHOUT DRESSING**
- **ONLY EXCESS PROJECTIONS REMOVED BY HAMMER**
- **INFERIOR TYPE OF MASONRY**
- **GIVES LESS STRENGTH**
- **IRREGULAR SHAPED STONES**

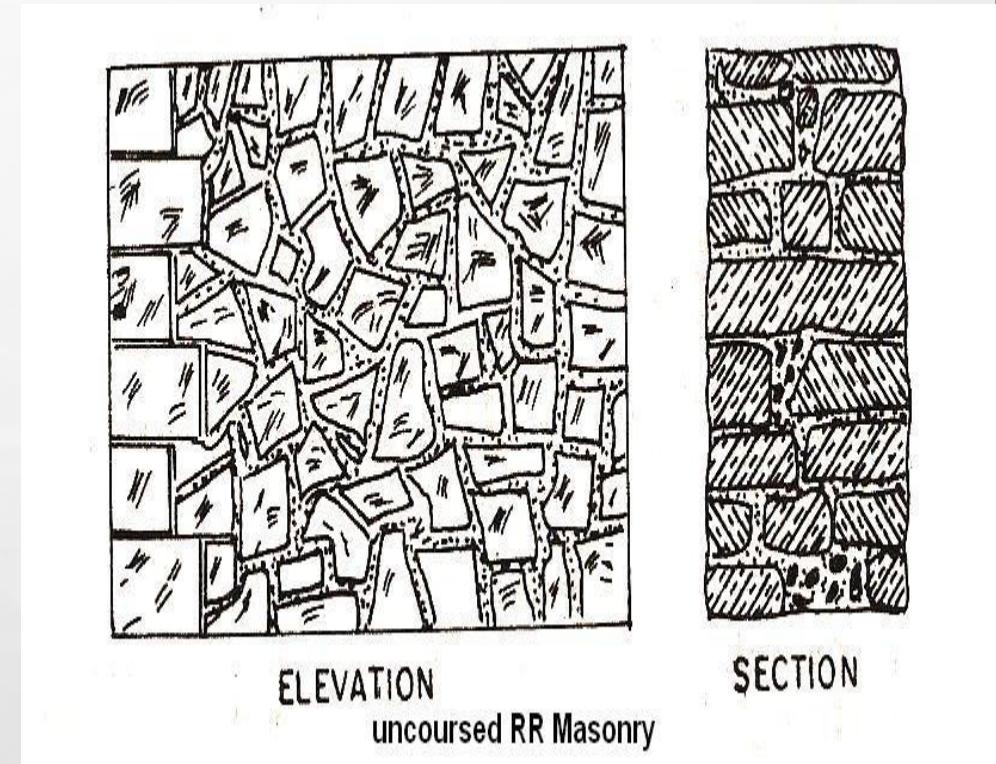
- Points to be considered for rubble masonry:

- Good quality mortar to be used
- Stones should be roughly dressed
- Through stones to be used at regular intervals for good bond between face and back



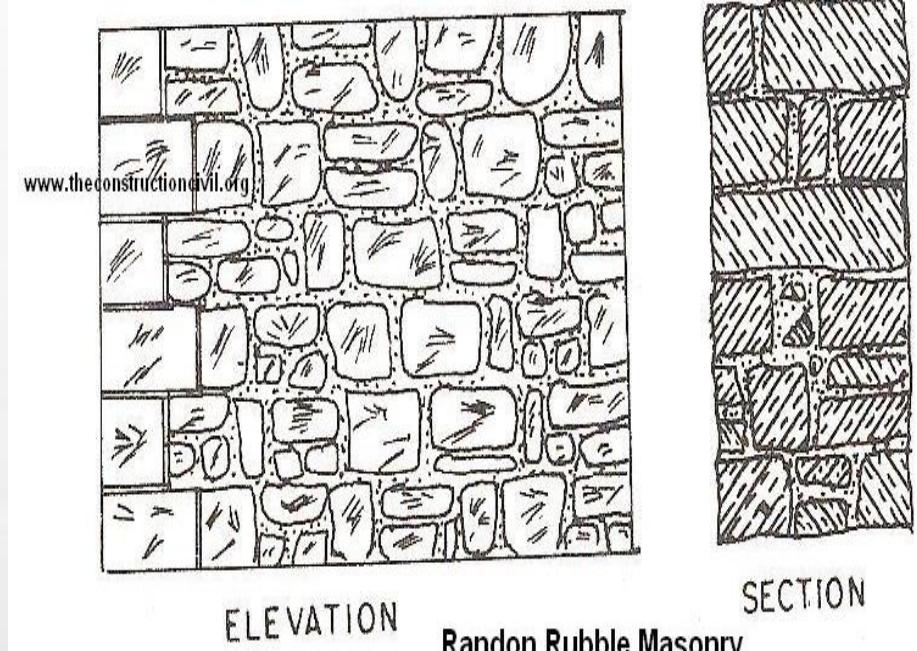
A1. UNCOURSED RUBBLE MASONRY

- Cheapest and weak type of rubble masonry
- Stones received from quarry used as it is with just knocking off weak corners
- No proper course
- Through stones used
- Roughly dressed stones used as quoins
- Alternate header and stretcher used at quoins
- Cavities filled with spalls and mortar
- Thickness of mortar shall not exceed 12 mm
- Used for ordinary work such as compound walls, low cost housing etc.



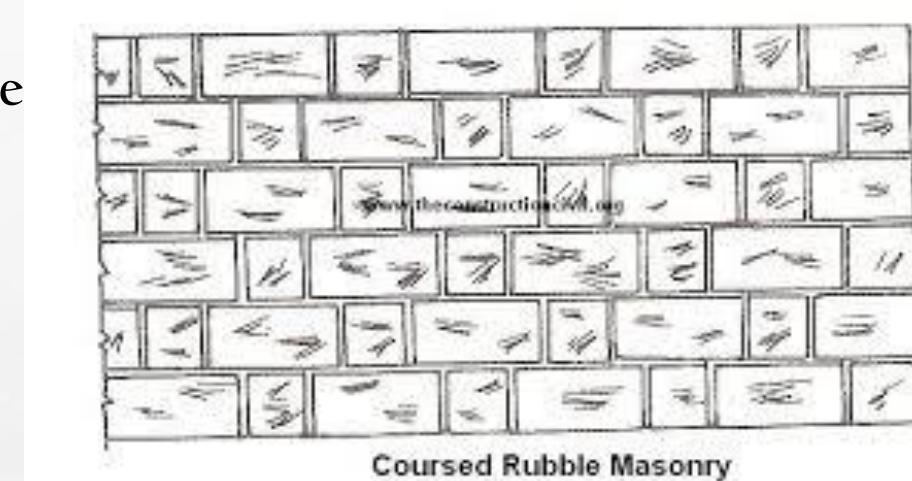
A2. RANDOM RUBBLE MASONRY

- Slightly superior than uncoursed
- Stones roughly dressed by chisel and hammer removing sharp arises and weak corners
- Course height is more or less uniform. Sizes of stones not uniform
- Through stones provided
- Quoins consist of alternate courses of header and stretcher
- Used in Low cost housing



A3. COURSED RUBBLE MASONRY

- Superior type of masonry
- Stones dressed properly . Bed and sides of stones dressed with chisel and hammer and all sharp arises removed.
- 1st , 2nd, 3rd class coursed rubble masonry depending upon quality of dressing
- Uniform height of course. Uniform thickness of joints (does not exceed 10 mm)
- All stones are so arranged that they are uniform in size and color.
- Through stones provided usually 1.5 m to 1.8 m c/c intervals
- Atleast 30% of face stones tail back into the hearing to a length equal to twice their height.
- Construction of residential and public buildings



A4. DRY RUBBLE MASONRY

- Same as coursed or random masonry
- No mortar is used to bond the stones together
- Used in temporary retaining walls, compound walls, etc

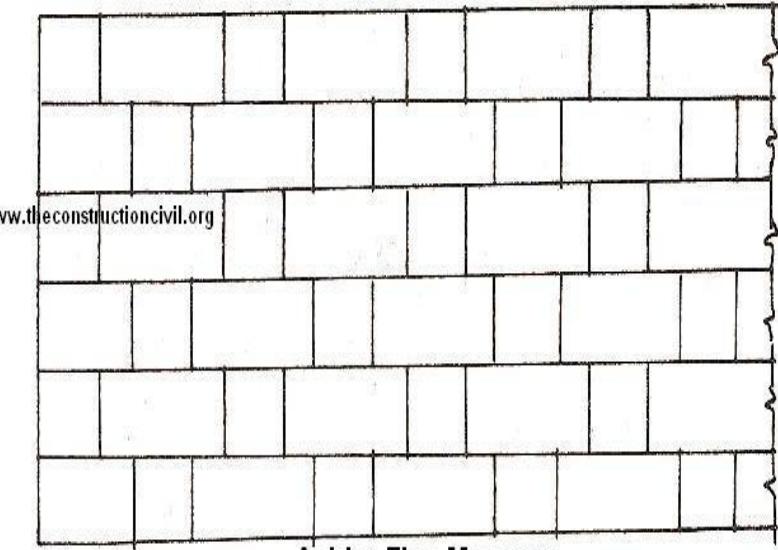


B. ASHLAR MASONRY

- **STONES NEATLY DRESSED TO SIZE AND SHAPE**
- **COSTLIER AND REQUIRES SKILLED WORKMANSHIP**

B1. ASHLAR FINE MASONRY

- Stones dressed true and square on all sides
- Equal height courses and height of each course is never less than 30 cm
- Joints are very fine, never exceed 3 mm in thickness
- Proper bond maintained and stones arranged in alternate header and stretcher pattern
- Height of stones never less than their breadth and length never less than twice their height
- Bond/through stones provided at every 1.5 m intervals. For walls above 75 cm thickness, overlapping bond stones used in alternate courses



Ashlar Fine Masonry

B2. ASHLAR ROUGH TOOLED MASONRY

- Stones dressed true and square on all sides.
- Edges of exposed surfaces are finely dressed with chisels. Portion inside edges of these face stones remain rough tooled.
- Size of stones, courses, bond same as Ashlar fine masonry
- Thickness of joint not more than 6 mm



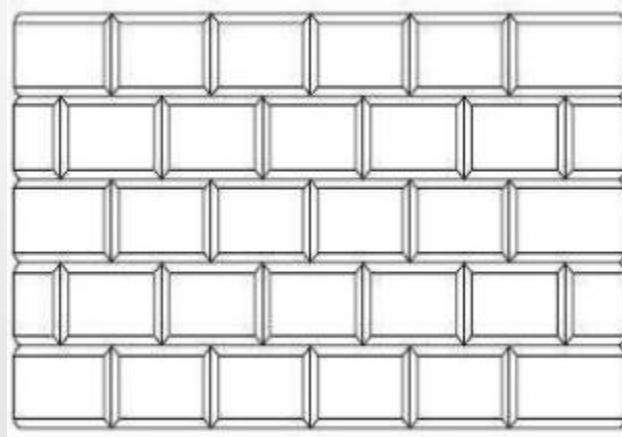
B3. ASHLAR ROCK, RUSTIC OR QUARRY FACED MASONRY

- Stones dressed true and square
- A strip 25 mm wide is made by chisel provided around the perimeter of every stone. But remaining portion of face is left rough as received from quarry.
- Sharp arises beyond 8 mm are removed and face is left rough.
- Size of stones, bond, course same as Ashlar fine masonry



B4. ASHLAR CHAMFERED MASONRY

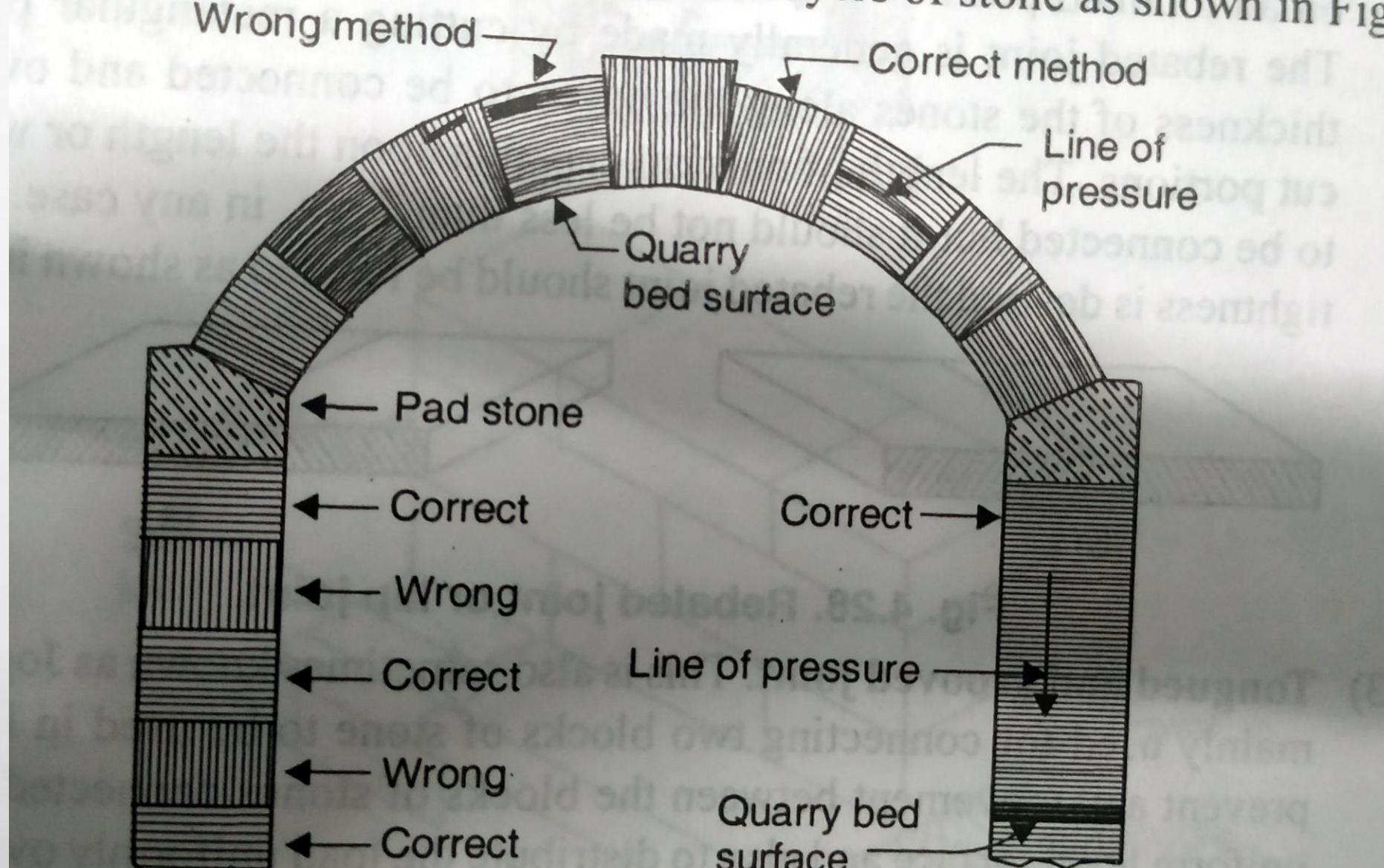
- Stones chamfered at 45° on the exposed surface to a width of 25 mm.
- A fine chisel drafting of 10-12 mm width is also made inside chamfered edges on exposed face and enclosed space between these chisel drafting is left rough



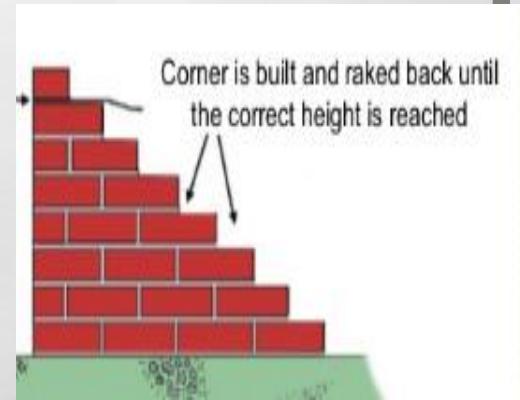
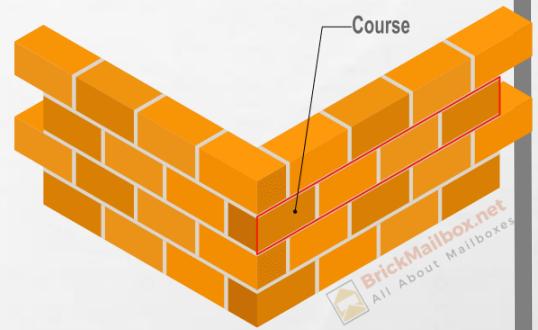
REQUIREMENTS IN STONE MASONRY

- Homogeneous nature stones should be used
- Stones should be strong, hard, tough and should have uniform texture
- Stones should be well watered beforehand so that they do not absorb moisture from mortar instantaneously. This can lead to weakening of mortar as loss of water effects hardening process
- Stones should be free from defects, flaws, cavities and cracks.
- Cement mortar, lime mortar, cement and lime mortar may be used as binding agents.
- Mortar should have adequate workability
- Thin joints
- Stones should be used in their natural bed surface

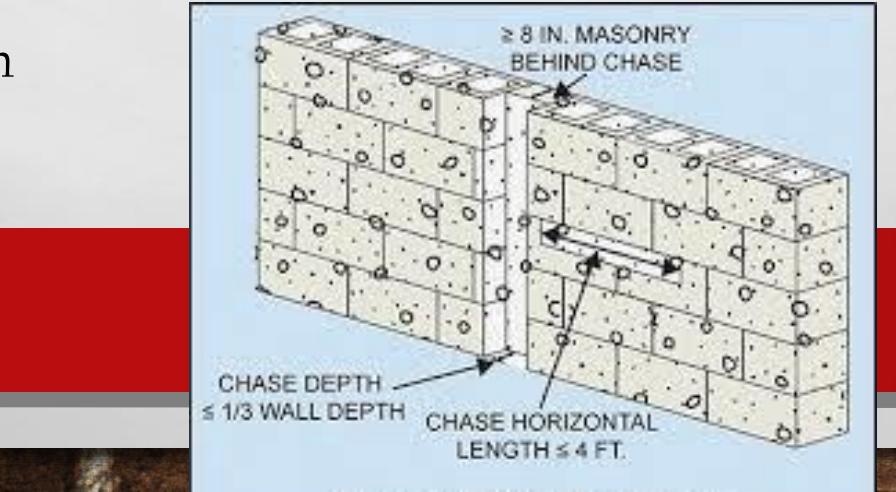
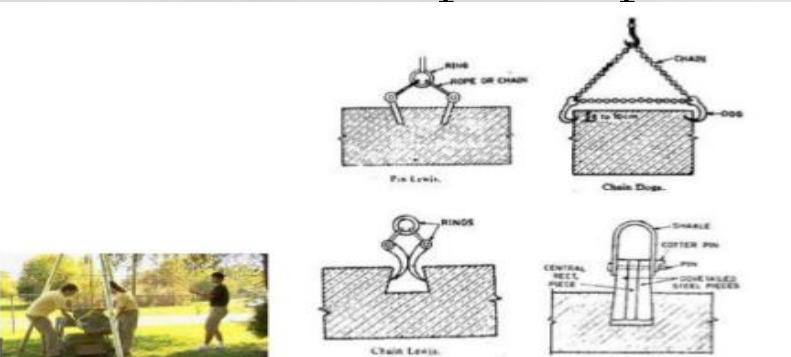
Line of stone as shown in Fig.



- Proper bond should be maintained between stones
- Continuous vertical joints should be avoided
- Face and back of stone masonry must be well bonded by use of through stones at intervals of 1.5 m
- Whole masonry work should be raised uniformly so that unequal loading doesn't occur. But if it is required to break the uniformity, raking is done at an angle of 45° so as to get good bond between old and new work
- Length and breadth of quoins should be at least 2 or 1.5 times their depth
- All the cavities in the masonry should be filled with spalls and mortar mixture



- At every 1 m height the verticality of wall should be checked by use of plumb bob.
- Pointing should be done in the exposed joints. Pointing in masonry construction is the finishing of mortar joints in brick or stone masonry
- Curing should be done for a period of 10 days
- Bed joints should be uniform and thoroughly filled up
- Stones should have level surface at bottom so that no hollow is left in the bed joints
- Before construction of new masonry over old one, old masonry should be cleaned with wire brush and watered sufficiently
- Chases must be left for fixtures
- Suitable lifting devices should be used for large stones
- Good workmanship and supervision



BRICK MASONRY

It is a unit of construction made by bonding bricks together by means of some binding agent like cement or lime or mud mortar

FACTORS AFFECTING STRENGTH AND DURABILITY OF BRICK MASONRY

**Quality of
bricks used**

Mortar used

**Type of Bond
adopted**

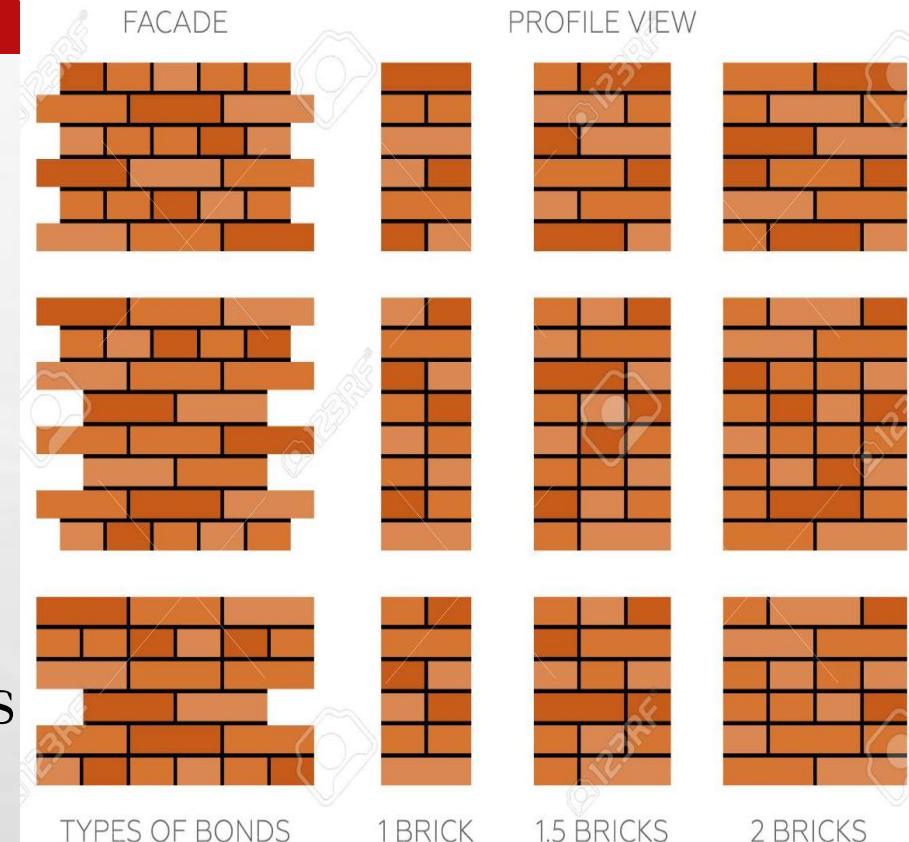
**Labour and
workmanship**

COMPARISON OF BRICK AND STONE MASONRY

Parameter	STONE MASONRY	BRICK MASONRY
Strength	Excellent	Moderate
Durability	Long lasting	Moderate
Weather Resistance	Excellent	Moderate
Crushing strength	Excellent	Moderate
Appearance	Good (depends on finishing and dressing)	Average (require plastering)
Damp Resistance	High	Moderate
Chemical Resistance	Good	Poor
Fire Resistance	Moderate	High
Workmanship	Skilled workers required	Needs less skilled labour
Handling and ease of working	Difficult	Easy
Progress of work	Poor	Quick
Cost	High	Moderate

BONDS IN BRICK MASONRY

- Bricks should be so arranged such that continuous vertical joints are avoided
- Proper arrangement of bricks leads to more strength and better load transfer
- Arrangement of bricks in different fashions is known as **BOND**



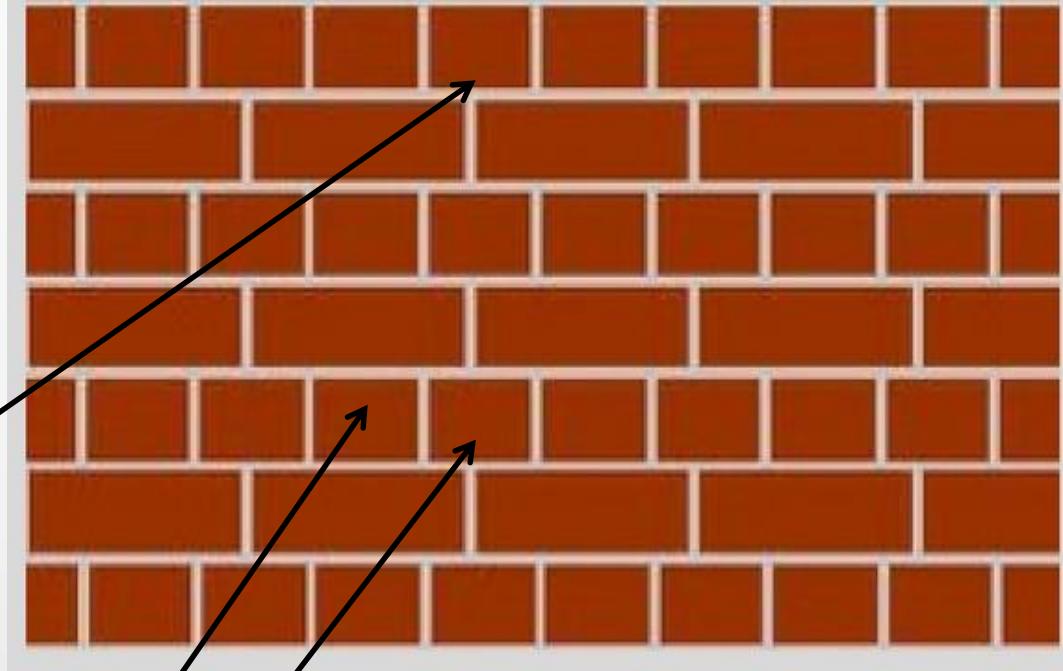
CLASSIFICATION OF BONDS IN BRICK MASONRY

BRICK MASONRY
(ON THE BASIS OF TYPE OF BONDS)

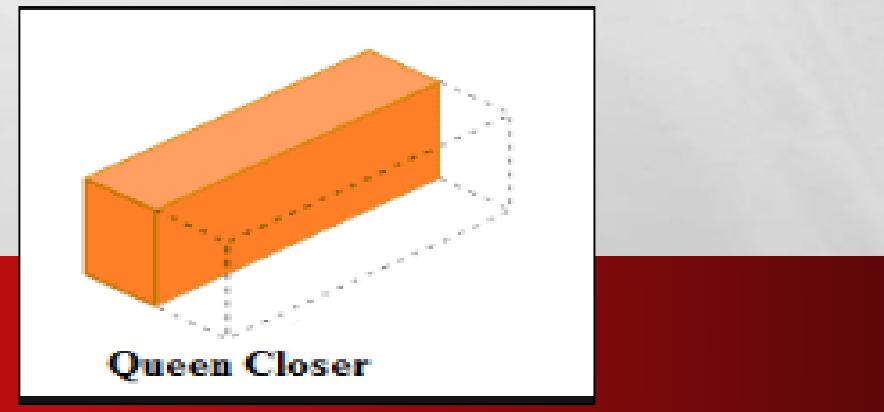
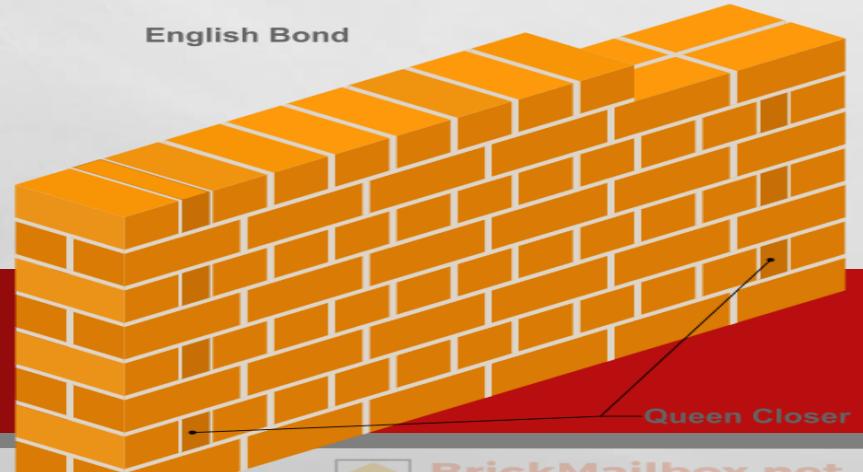
- ENGLISH BOND
- FLEMISH BOND : SINGLE AND DOUBLE
- HEADER BOND
- STRETCHER BOND
- FACING BOND
- BRICK ON EDGE BOND
- SILVER LOCK BOND
- RAKING BOND
- ENGLISH CROSS BOND
- DUTCH BOND
- GARDEN WALL BOND

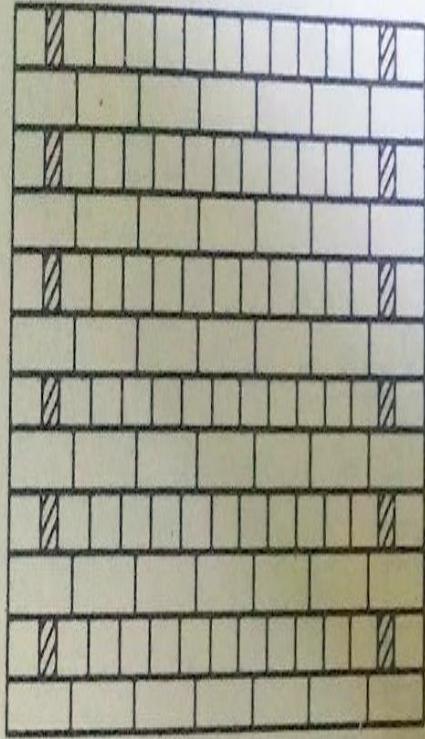
ENGLISH BOND

- Alternate courses of header and stretcher
- Stretchers will overlap upto $1/4^{\text{th}}$ of their length over header course so that vertical joints in stretcher course will come exactly at centre over alternate headers
- Joints should be made thinner in header course as no. of joints are more in header course
- All headers are centrally placed over stretchers and joints in stretcher course alternatively.



- For walls of thickness equal to an whole number of bricks (one brick, two brick, three brick....)they show same appearance on both front and back. E.g. a course consisting of headers in face of wall will show headers in the back of wall also.
- For walls of thickness equal to not an whole number of bricks (one and half brick, two and a half brick etc...) , the same course will show headers on one face and stretchers on the back.
- For thick walls, hearting must be filled with headers to prevent formation of vertical joints in the body of wall
- In each header course, a queen closer is placed next to quoin header to break continuity of vertical joints.

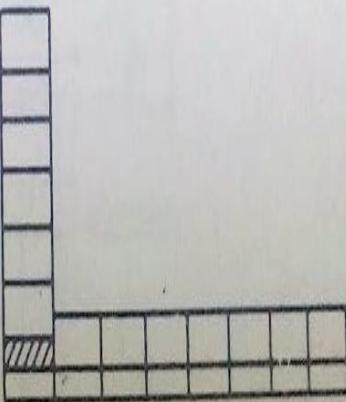




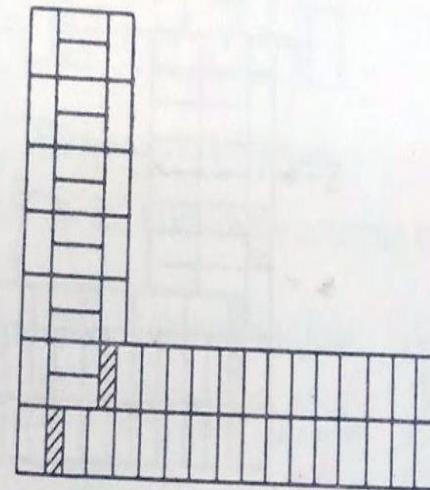
Elevation

Plan for 2,4,6 course

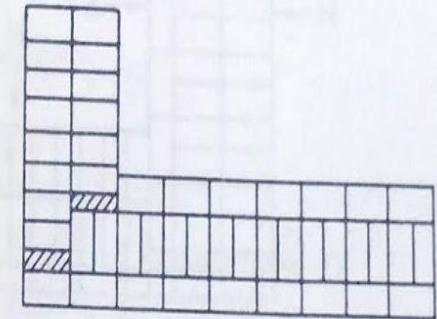
One-brick wall English bond



Plan for 1,3,5 course

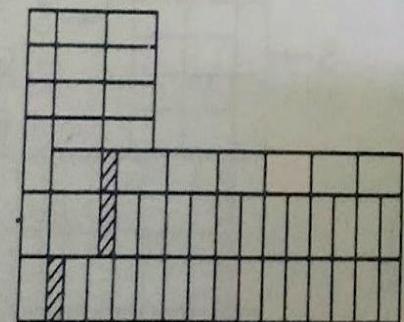


Plan for 1,3,5 course

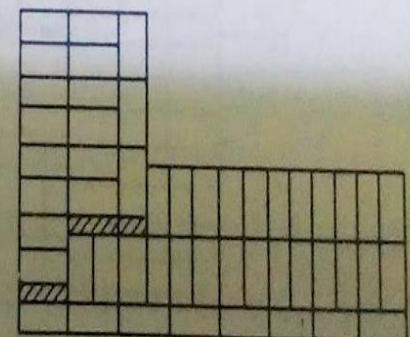


Plan for 2,4,6 course

Two-bricks wall English bond

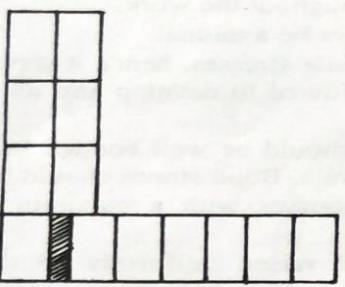


Plan for 1,3,5 course



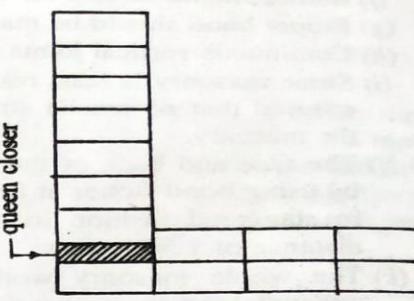
Plan for 2,4,6 course

Two-and-a-half-bricks wall English bond

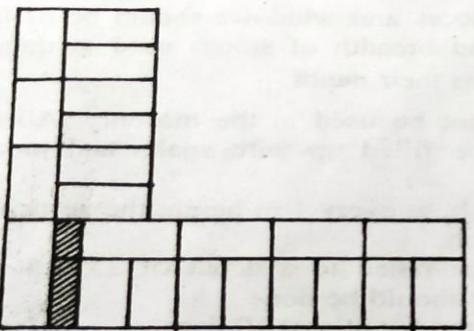


1, 3, 5, courses

one brick wall

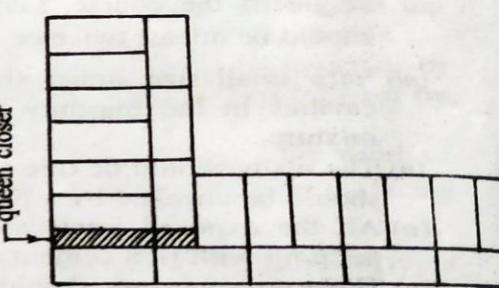


2, 4, 6, courses

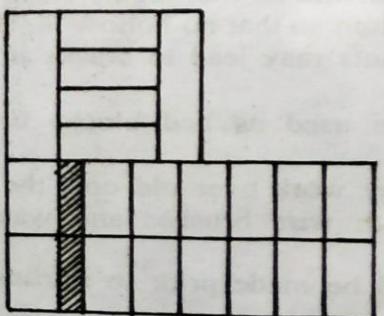


1, 3, 5, courses

one and half brick wall



2, 4, 6, courses



1, 3, 5, courses

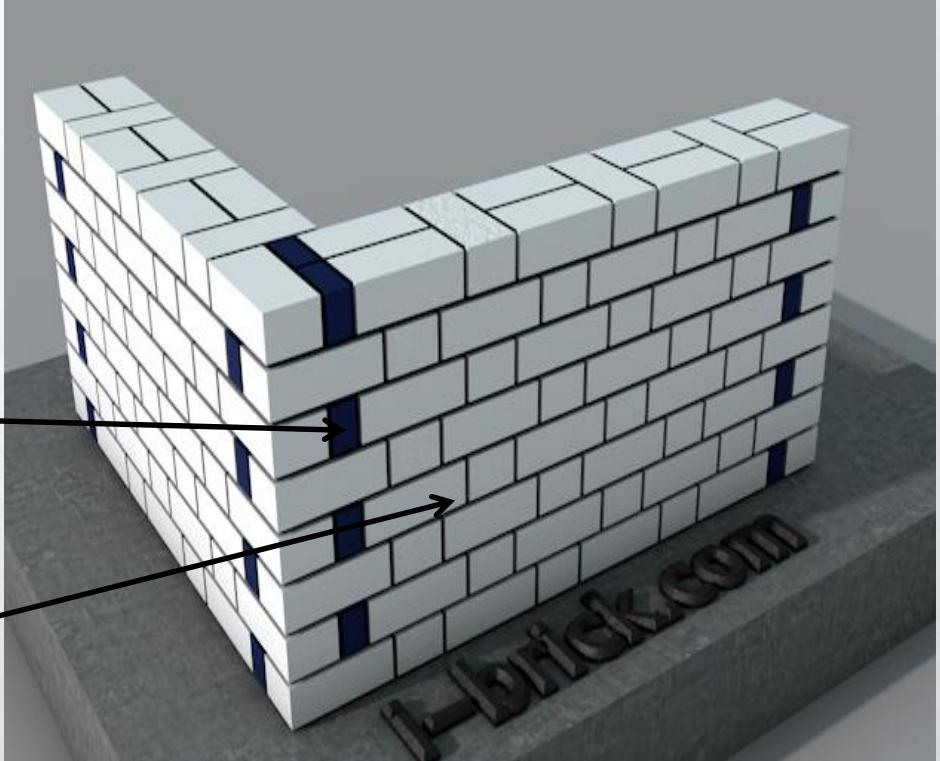
two brick wall

2, 4, 6, courses

Fig. 3.5. Arrangement of Bricks in English bond

FLEMISH BOND

- Each course of wall consists of header and stretcher alternatively
- Every alternate course starts with a header and queen closer is inserted next to quoin header to break the continuity of vertical joints.
- Every header is placed centrally over the stretcher above it
- Brick bats are used for walls of thickness equal to an odd number of half bricks.

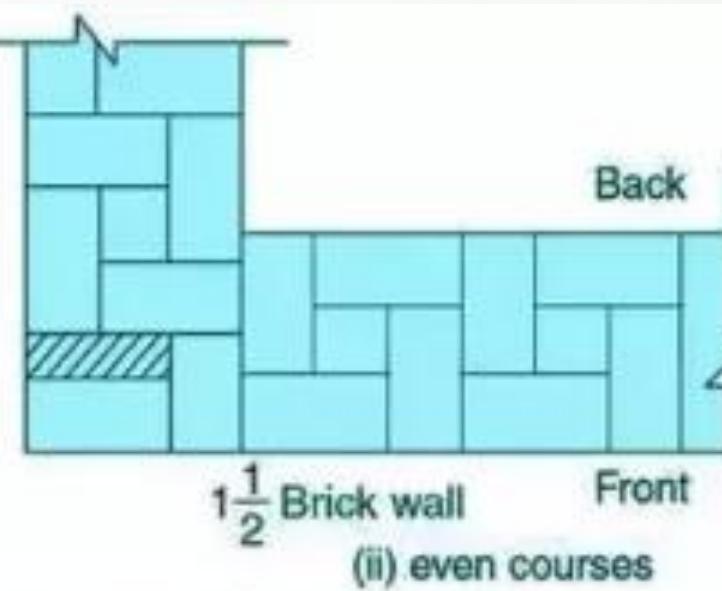
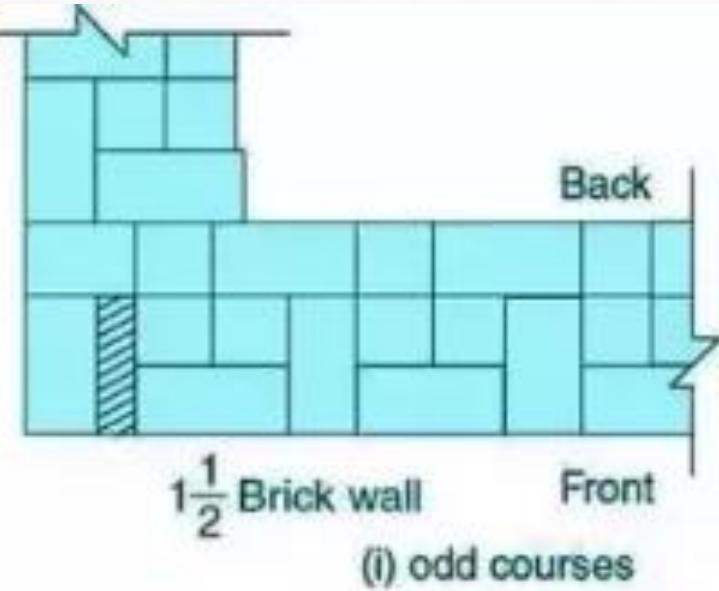


SINGLE FLEMISH BOND

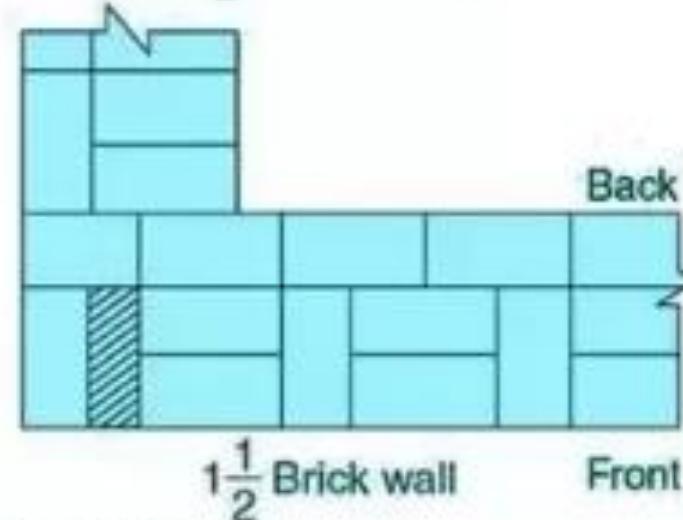
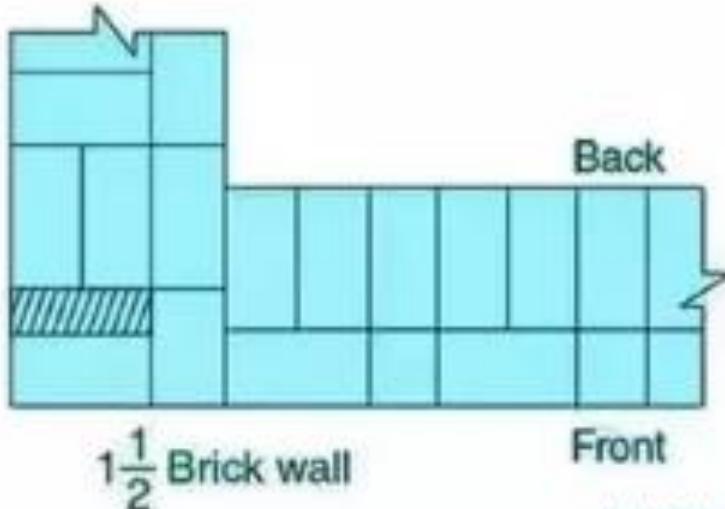
- Combination of English and Flemish bond
- Facing is Flemish bond, hearting and back reflects English bond
- Quarter and half brick bats are used in this

DOUBLE FLEMISH BOND

- Same appearance in face and back
- Not much strong as English bond



(a) Double flemish bond ($1 \frac{1}{2}$ brick thick)



(b) Single flemish bond

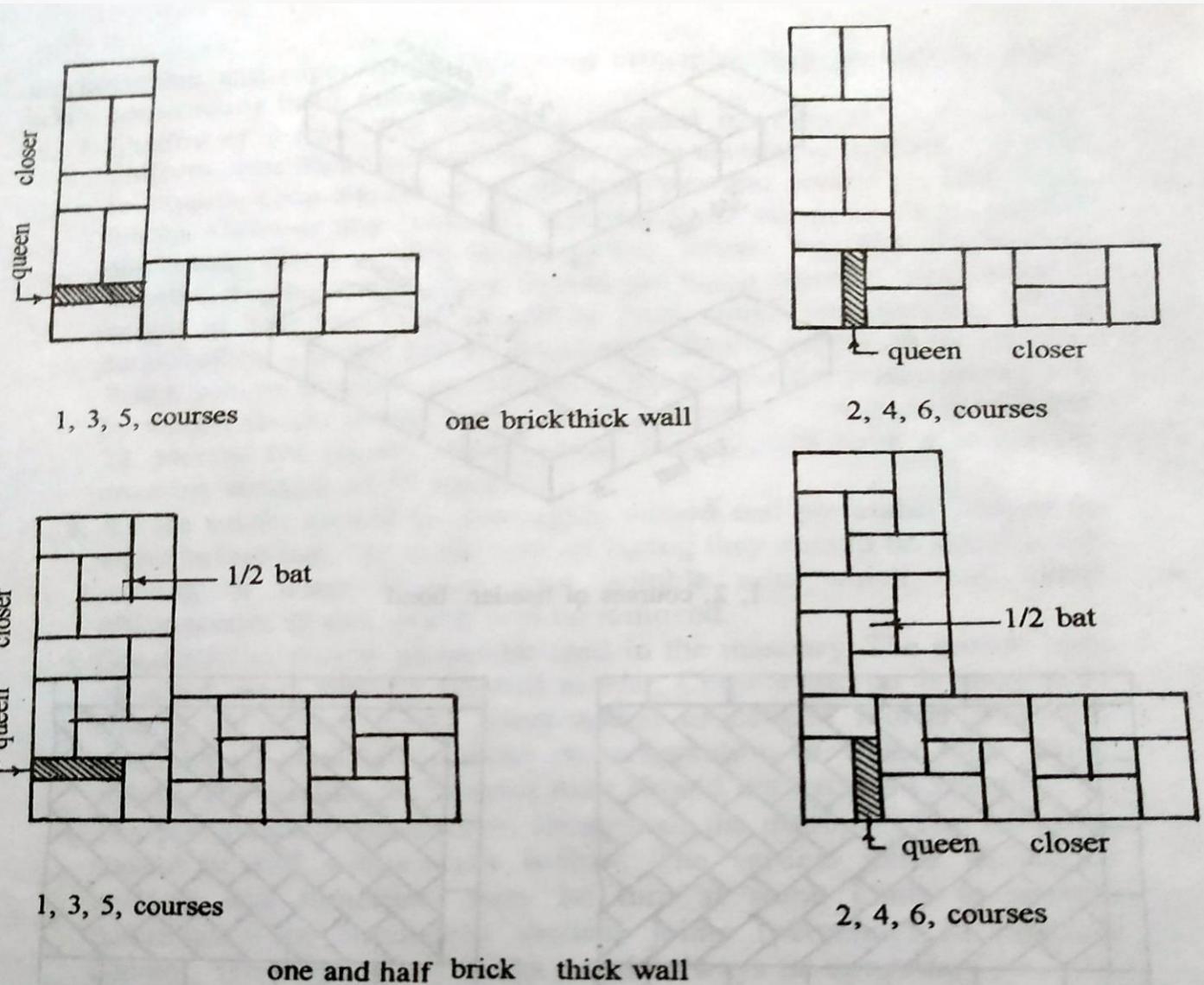
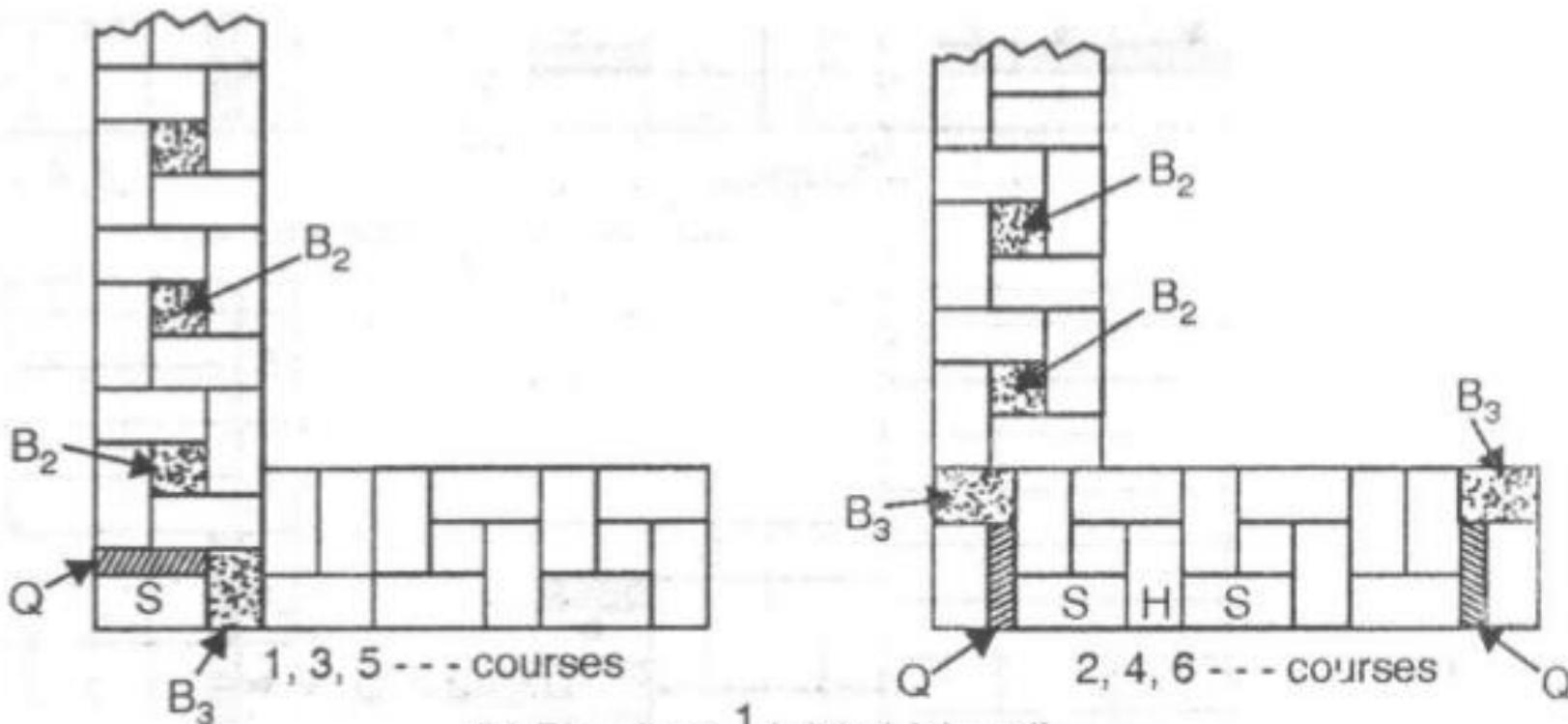


Fig. 3.6. Alternate Courses of Brick walls in Double Flemish bond



(b) Plan for $1\frac{1}{2}$ brick thick wall

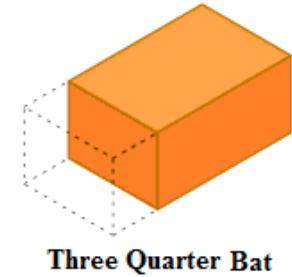
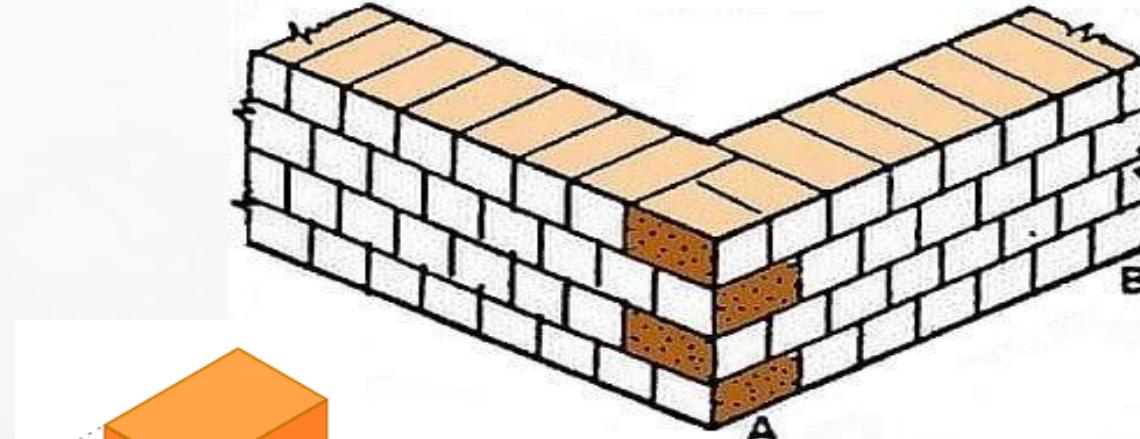
S = STRETCHER ; H = HEADER ; Q = QUEENS CLOSER ;

B₂ = HALF BAT ; B₃ = $\frac{3}{4}$ BRICK ; B₁ = QUARTER BAT

DOUBLE FLEMISH BOND.

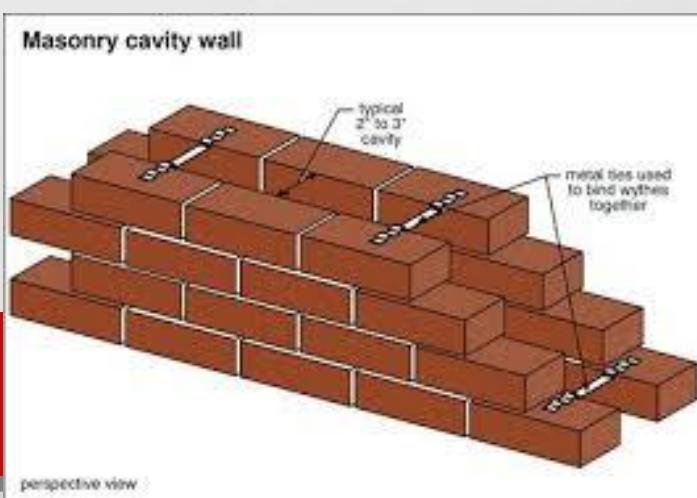
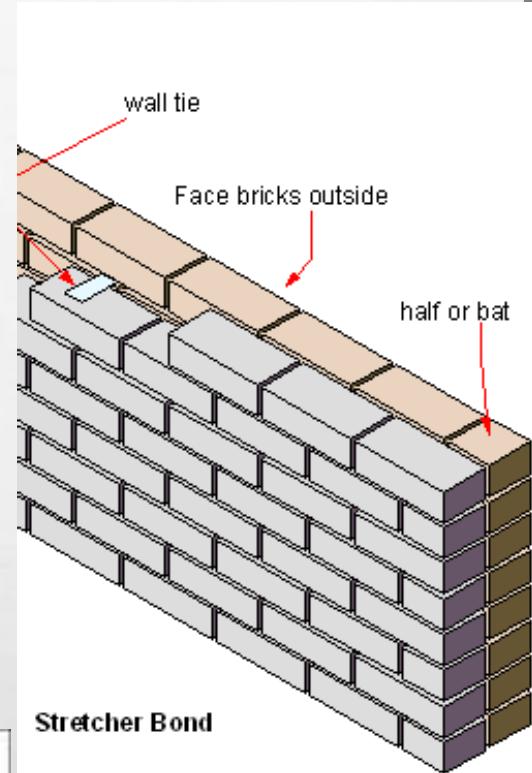
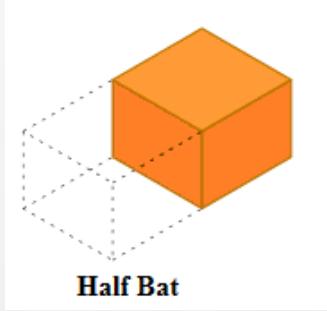
HEADER BOND

- All courses show headers on face
- A three quarter bat is used at quoins at alternate courses for overlap
- Bond is most useful for walls curved in plan



STRETCHER BOND

- All courses show stretchers on face
- A half brick thick bat is used at quoin to get the overlap
- Used for construction for cavity and partition walls
- Reinforcement can be provided at intervals to increase strength



FACING BOND

- A header course is provided after several stretcher courses
- Weak bond
- No uniform load distribution

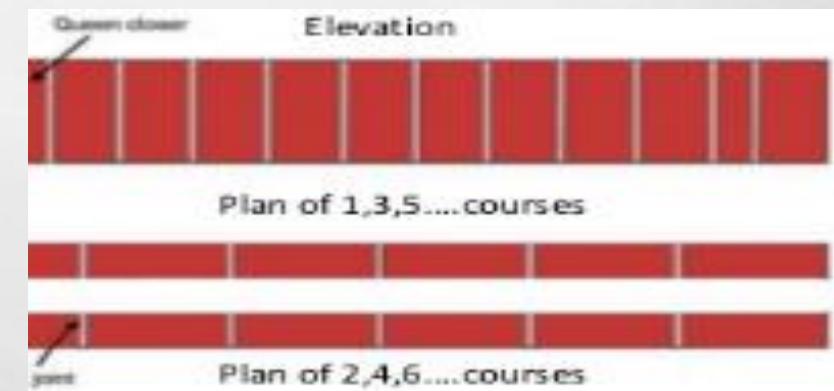
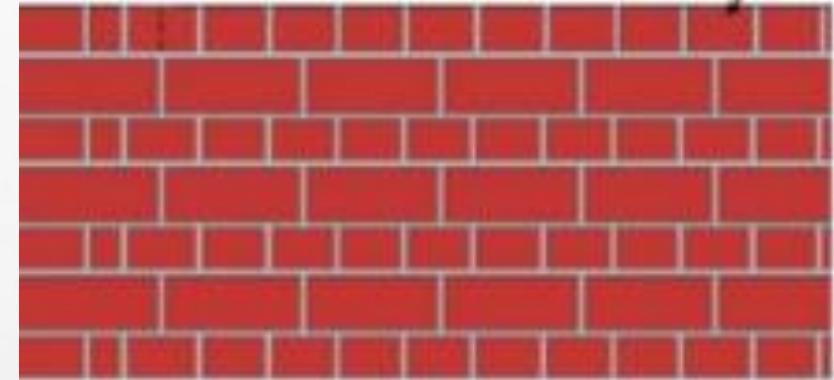


BRICK ON EDGE BOND

- All the bricks are laid on their edge instead of their bed
- Thin walls, poor in strength
- Used in walls of low height , non-load bearing walls, compound walls etc.

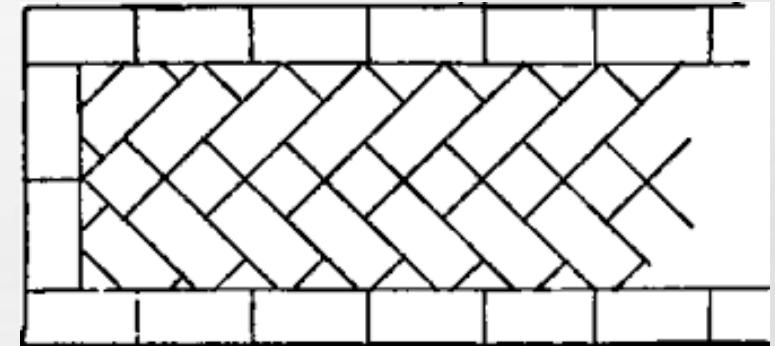
SILVER LOCK BOND

- Alternate courses of headers and stretchers
- Stretchers are laid on edge and contain cavity in between face and back
- Used in garden walls, partitions etc.

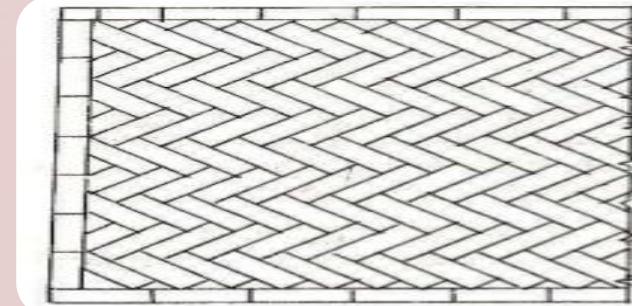
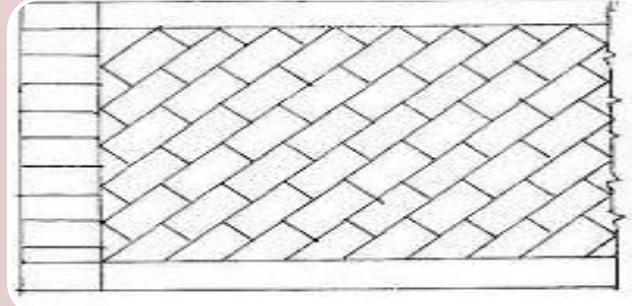
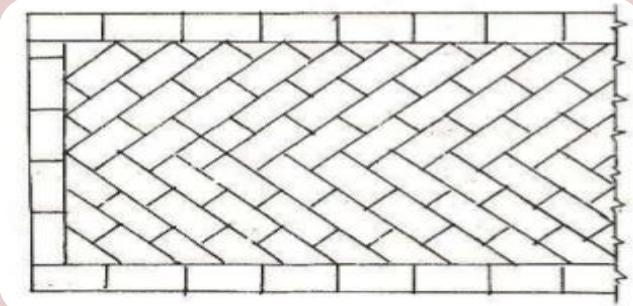


RAKING BOND

- Used for walls more than 4 bricks in thickness
- Hearting is filled with inclined bricks in different patterns (30° - 70°)
- Face and back show alternate header and stretcher courses usually



Depending on the fashion of laying of bricks in hearting, raking bond is further classified as below:



Herring Bone Bond:

Bricks laid at 45° from centre of wall in plan

Diagonal Bond:

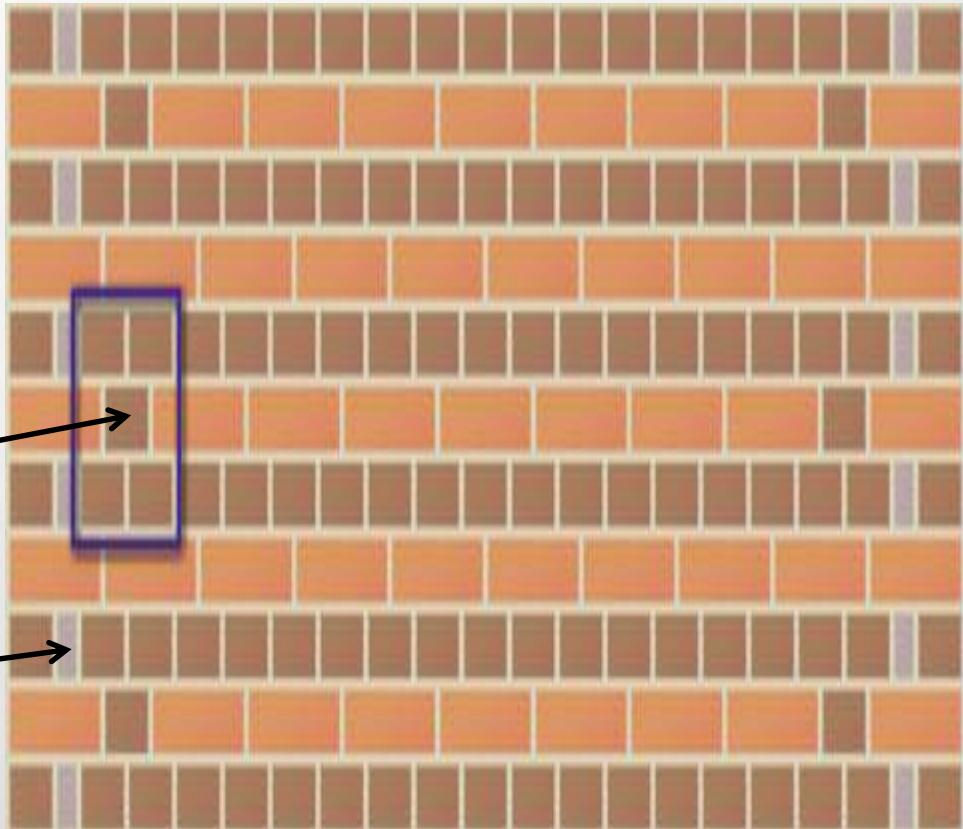
Bricks are inclined in one direction at an angle 45° to 60°

Zig-Zag Bond:

Hearting is filled with bricks laid in zig-zag fashion

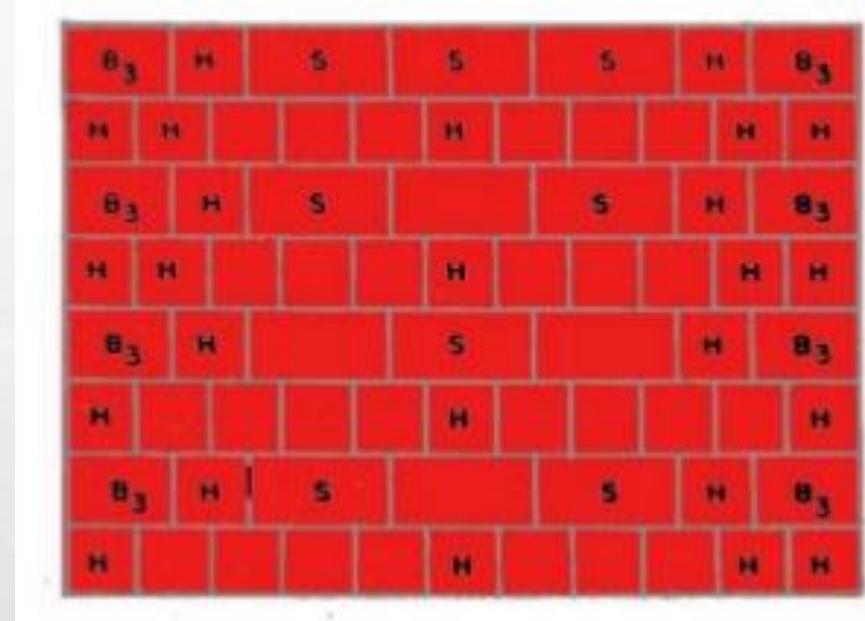
ENGLISH CROSS BOND

- Alternate courses of header and stretchers same as English bond but with the difference that header is placed next to quoin stretcher at alternate stretcher courser.
- Queen closer is placed next to quoin header in every header course



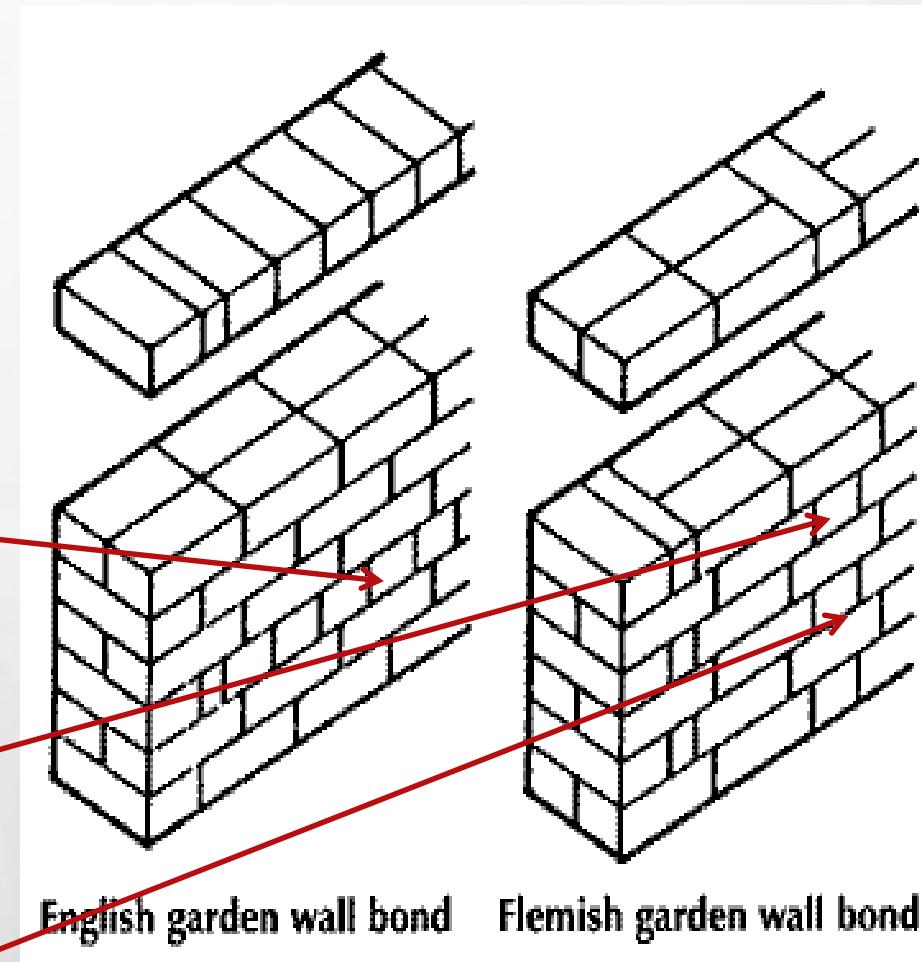
DUTCH BOND

- Alternate courses of header and stretchers same as English bond but with the difference that each stretcher course starts with a three quarter bat at quoins.
- A header is placed next to the three quarter bat at quoins in alternate stretcher course



GARDEN WALL BOND

- Used for construction of one-brick thick garden, compound walls.
- Two types:
 - English Garden Wall Bond: Same as English Bond but header course is laid after 3 or 5 stretcher courses. Header course consists of queen closer next to quoin header.
 - Flemish Garden Wall Bond/Scott Bond: Each course has headers and stretchers. Headers provided after 3 or 5 stretchers in each course. Alternate course consists of a three quarter bat next to quoin header. Central stretcher always has a header over its middle.



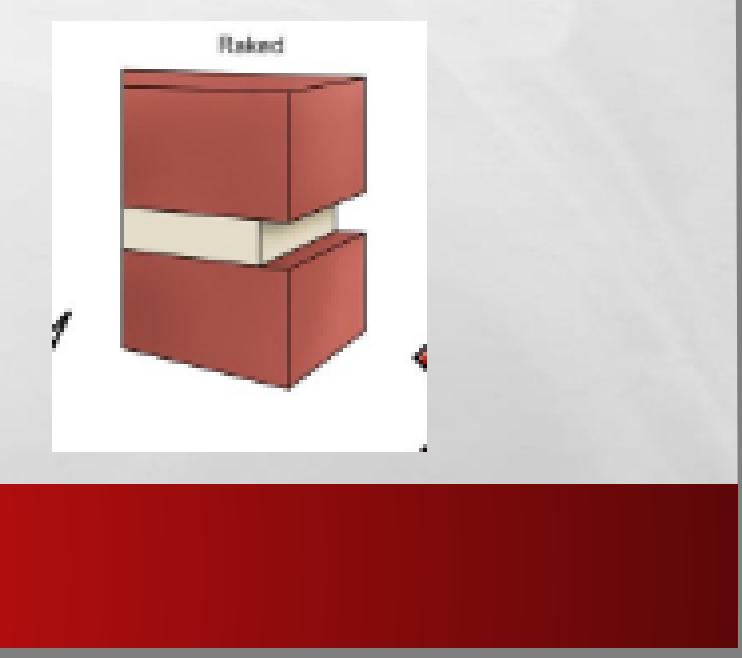
REQUIREMENTS IN BRICK MASONRY

- Bricks should have uniform size, shape and color.
- Bricks should be free from cracks, flaws etc.
- Bricks should not break when dropped from a height of 120 cm
- Percentage water absorption should not be more than 20% for 1st class and 22% for 2nd class bricks after 24 hours
- All bricks must be thoroughly wetted and soaked before use to remove dirt, dust, salts etc.. But at the time of laying they should be dry.
- Good quality mortar should be used (cement, lime or mud). Thickness of mortar should not exceed 13 mm

- Joints should be uniform . Bed joint should be full and without holes. Vertical joints should be uniform or sometimes thin to prevent continuation of vertical joints
- Frog of bricks must face upwards.
- Bricks should always be flat and pressed gently. They can be laid edge in some cases (brick on edge bond)
- Masonry work should be vertical and checked by plumb bob.
- Fixtures such as holdfasts of doors, windows, conduit pipes to be inserted in brick walls should be encased un rich cement mortar or cement concrete.
- Masonry work should be raised uniformly. When it is unavoidable wall should raked back at 45° angle.
- Long and high walls must be strengthened by providing buttresses or counterforts.



- When cross walls are to be connected to main walls in future, recesses known as “toothings” should be left in alternate courses so that new work can be bonded well with the old work. Good interlocking.
- To provide good key for plastering, face joints should be raked to a depth of 10 to 15 mm when mortar is still fresh
- Masonry work should be cures for atleast 7 days. Plastering done after 28 days of completion of masonry work.
- Long brick walls should be provided with expansion joint (as per IS 3414, expansion joint of 18 mm provided for every 30 m length of wall)



- Half brick walls should be reinforced with either hoop iron straps or exmet at every 4th or 5th course
- Brick surface must be protected from weather by plastering

