Cihan University Sulaymaniya
Faculty of Engineering
Architectural Engineering Department

Building Materials

Chapter Four
(Masonry Work)
(2-Brick Work)

1st Grade- Fall Semester 2022-2023

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Chapter Four
Masonry Materials

Masonry Materials:

A mason is one who builds with bricks, stones, and blocks. Masonry is the part of a building or structure that is made from combining the masonry units: stone, block or brick, and mortar.

Types of Masonry Units:

1- Bricks

2- Blocks

3- Stones

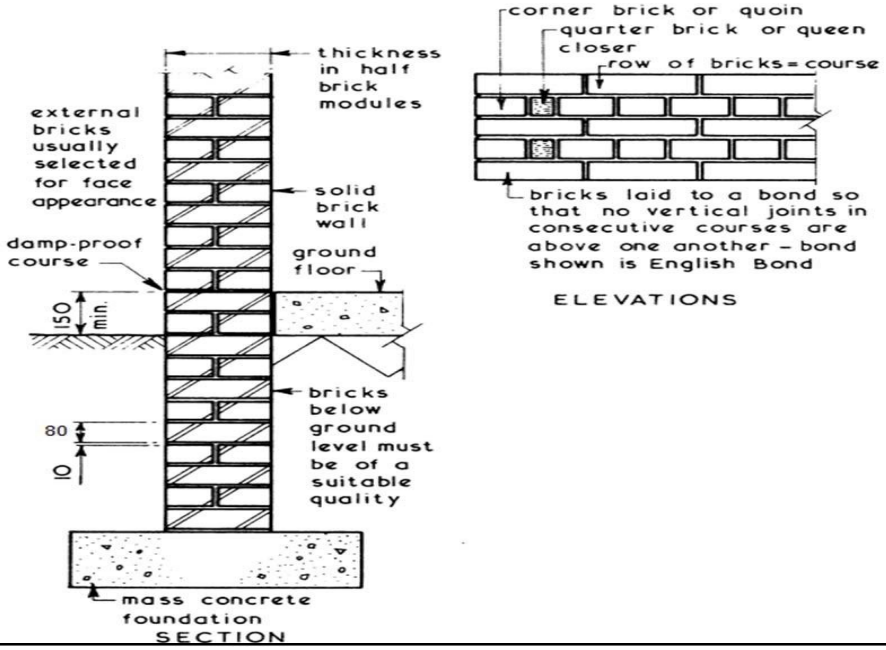
Brick work

The systematic arrangement of laying bricks and bonding together with mortar to form a unified mass which can transmit the superimposed load without failure is termed as brick masonry.

Since bricks are: Light in weight, uniform in size and easier in handling; they are very convenient construction material for the structure.

Bricks: these are walling units within a length of 375 mm, a width of 225 mm and a height of 112.5 mm. The usual size of bricks in common use is length 230 mm, width 115 mm and height 80 mm. like blocks they must be laid in a definite pattern or bond if they are to form a structural wall. Bricks are usually made from **clay** or from **sand** and **lime** and are available in a wide variety of strengths, types, textures, colors and special shaped bricks.

Brick work



Brick work

Types of brick according to material:

1- clay brick

1.1- Adobe bricks
1.2- Stabilizer soil bricks
1.3- Refractory bricks
1.4- Glazed bricks
1.5- Usual sun-baked bricks

Brick Manufacturing:

a- soft mud process Clay mixed with (20-30 percent water)
b- stiff mud process Clay mixed with (12 to 15 percent water)
c- dry-press process Clay mixed with (up to 10 percent water)

After molding by any of these three processes, the bricks are dried for 1 or 2 days in a low-temperature dryer kiln. They are then ready for transformation into their final form by a process known as firing or burning.

Brick work

Manufacturing of Bricks:

Brick work

Engineering properties, and specification:-

a- shape, dimensions and type of product:

Common dimension (230x115x80) accuracy for each dimension %3

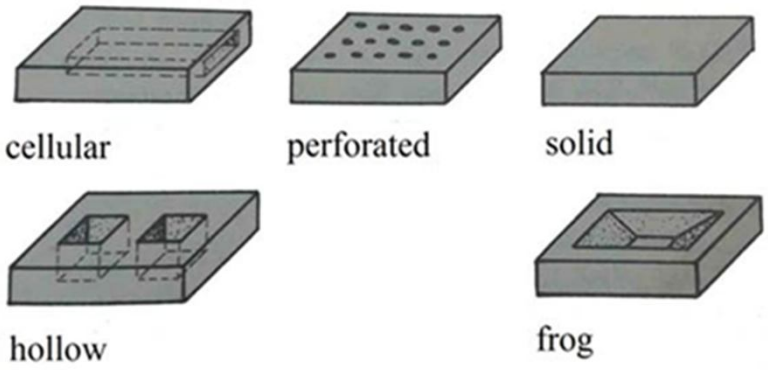


Fig.1. Type of brick according to shape

Brick work

b- porosity: by increasing porosity (density is decreasing , compressive strength is decreasing, absorption is increasing and thermal insulation is increasing)

c- compressive strength

Minimum compressive strength (MPa)		
Brick class	Degree	Average of compressive strength for ten brick
A	1 2	20 16
B	1 2	13 11
C	1 2	9 7

Brick work

A: it uses for load bearing wall, and foundation, and exposure for corrosion by environmental factors

B: it uses for load bearing wall, and non-exposure for corrosion by environmental factors

C: it uses for non-load bearing wall (partitions), and non-exposure for corrosion by environmental factors

d- water absorption: by increasing water absorption(compressive strength is damage the finishing layers, and paint, and by freezing reduce the durability of brick work).

Maximum water absorption equal to %17 for class A , %22 for class B and %25 for class C e- efflorescence

f- thermal insulation

g- fire resistance

Brick work

2- Sand-lime brick

3- Concrete brick

4- Glass brick

To join the individual bricks together to produce a compact mass, a binding material is required. Mortars are used as binding materials in brick-works. Following are the commonly used mortars:

(1) Mud Mortar,

(2) Lime Mortar,

(3) Cement Mortar,

(4) Lime-Cement Mortar,

(5) Cement-Lime Mortar,

Brick work

The selection of mortar depends upon the:

1- Type of finish desired,
2- The superimposed load,
3- The weathering agencies ,
4- The importance of the structure.

For the construction of temporary buildings or structures, mud mortar is used and for important structures of permanent nature, the cement mortar is preferred.

Definitions

(1) Course: A complete layer of bricks laid on the same bed is known as course and its thickness is equal to the thickness of a brick Plus the thickness of one mortar joint.

Brick work

(2) Frogs: These are depressions provided in the face of the bricks; there are two reasons for the provision of frogs:

(a) To form a key with mortar to prevent sliding of bricks on their beds.

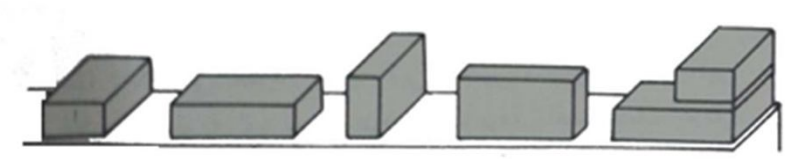
(b) To reduce the weight of the brick and hence economy in the cost of transport.

(3) Bed: The bottom surface of the brick when it is laid flat is known as bed (115 x240 mm.).

(4) Stretcher: The side surface of a brick visible in elevation when the brick is laid flat is known as stretcher (80x 240 mm).

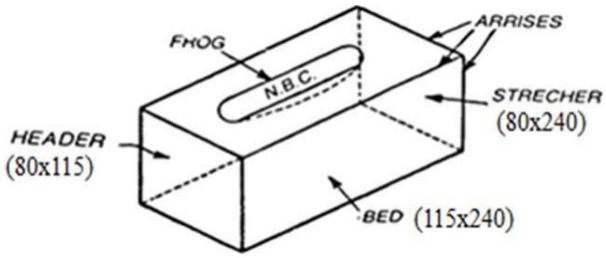
(5) Header: The end surface of the brick when it is laid flat is known as header (80 x 115 mm)

Brick work



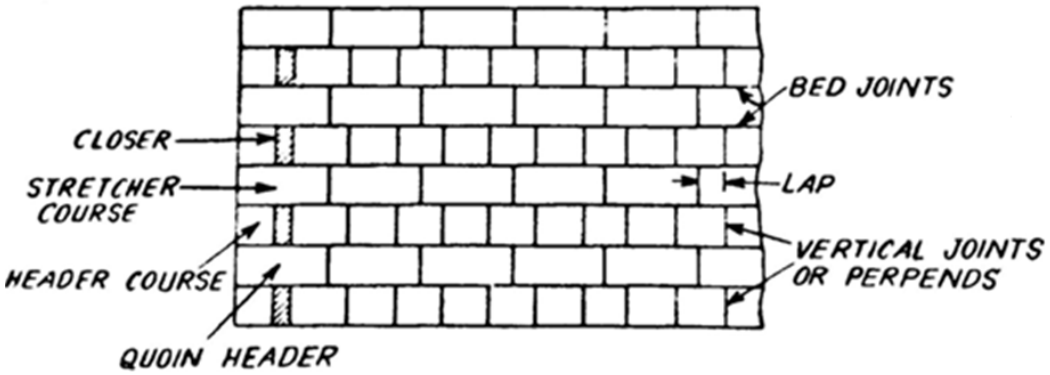
Header stretcher bull header bull stretcher corner

(6) Arrises: The edges formed by the intersection of plane surfaces of a brick are known as arrises and in good quality bricks they are straight and sharp.



Brick work

(7) Perpends: These are vertical joints between bricks either in longitudinal or cross directions. They are also known as cross joints.

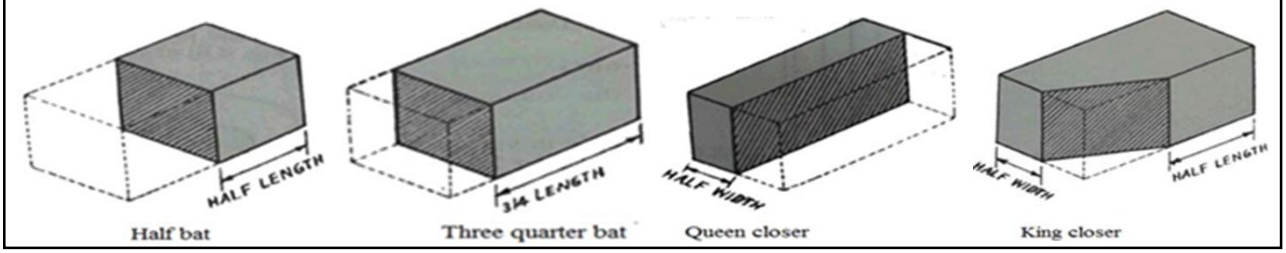


(8) Bed joints: The horizontal mortar joints between two successive courses are known as bed Joints.

Brick work

(9) Bat and closers: Standard bricks may be arranged in various ways to form walls, but in certain cases these bricks require to be reduced in size and altered in shape; this is achieved with the use of cutting tools. When a brick is cut to a reduced size it is known either as a "bat" or a "closer" according to its shape show the various "bats" and "closers".

It may be observed that in the case of a bat the cut extends across the width of the standard brick while a closer generally has the cut extending from one header face to the other except in the "King closer" when it runs from a header face to a stretcher face



Half bat | Three quarter bat | Queen closer | King closer

Brick work

(10) Quoin: The external corner or angle or a wall surface is known as quoin.

(11) Facing, Backing and Hearting: The exposed surface of a wall or structure is known as facing; the internal surface of the wall or structure is known as backing and the portion in between the backing and facing is called as hearting or filling.

(12) Lap: The horizontal distance between two perpends in two successive courses is known as lap.

Types of wall

1- Solid wall

1.1- Load bearing wall

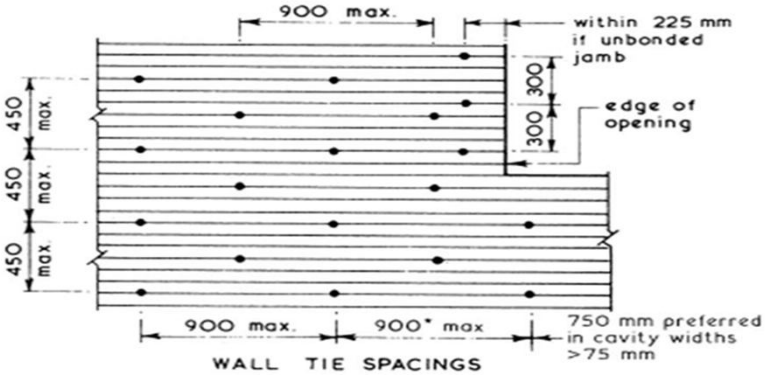
1.2 - Non-load bearing wall (partition)

Brick work

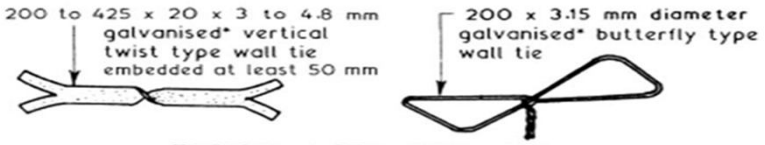
2- cavity wall

- These consist of an outer brick or block leaf or skin separated from an inner brick or block leaf or skin by an air space called a cavity.
- These walls have better thermal insulation and weather resistance properties than a comparable solid brick or block wall and therefore are in general use for the enclosing walls of domestic buildings.
- The two leaves of a cavity wall are tied together with wall ties at not less than the spacings given as (below).
- The width of the cavity should be between 50 and 75mm unless vertical twist type ties are used at not more than the centers given as below when the cavity width

Brick work



WALL TIE SPACINGS



TYPICAL METAL WALL TIES

Ref: BS EN 845-1: Specification for ancillary components for masonry. Ties, tension straps, hangers and brackets.

* Note: Stainless steel or non-ferrous ties are now preferred.

Brick work

Wall must be:

1- Good appearance

2- durable

3- Properly built (good alignment horizontally and vertically, all joint filled,...etc.)

The strength of brick work depends upon the:

1- Type of brick: its strength, material, size, shape, etc....

2- Type of mortar: its strength, material, thickness, etc...

3- Type of bond

Brick work

Brick bonding

Purposes of Brick Bonding:

1- Obtain maximum strength while distributing the loads to be carried throughout the wall, column or pier.

2- Ensure lateral stability and resistance to side thrusts.

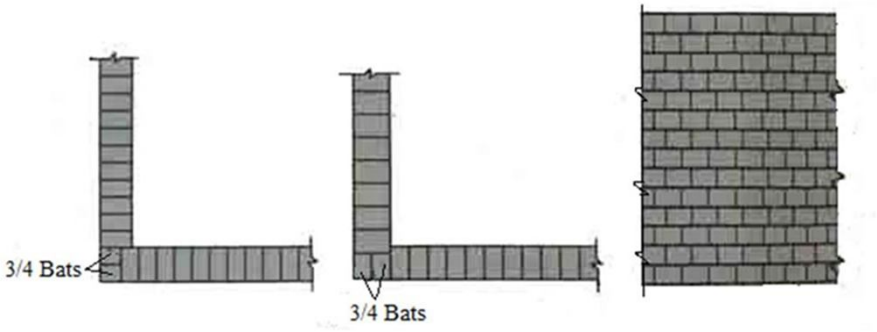
3- Create an acceptable appearance.

Type of bond:

1- Heading bond

In this type of bond, all the brick are laid as headers towards the face of wall. This is suitable for one-brick thick walls and also used for construction of curved wall. It may be used for footing in foundations for better transverse load distribution.

Brick work

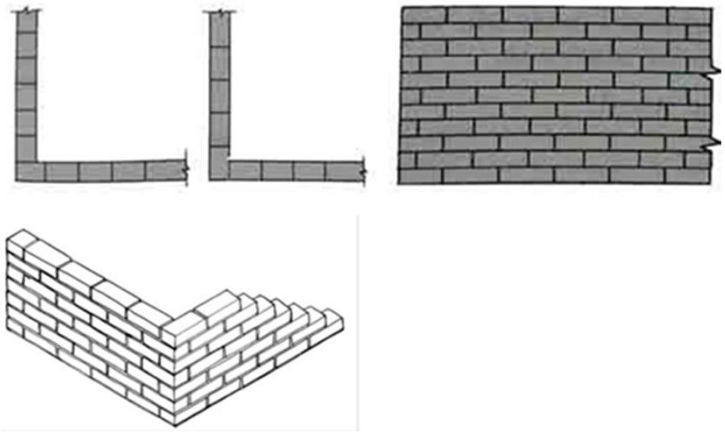


2- Stretching bond

In such type of bond, all the bricks are laid with their lengths in the longitudinal direction of the wall. As only stretchers are visible in elevation, this is known as stretcher bond.

This bond is only useful for half brick thick partition walls, some cavity wall, parapet, and fence.

Brick work



3-English bond

In this type of bond, alternate course of stretchers and headers are laid. A queen closer is successive courses. This type of bond is very commonly used in all types of construction and it is very strong.

Brick work

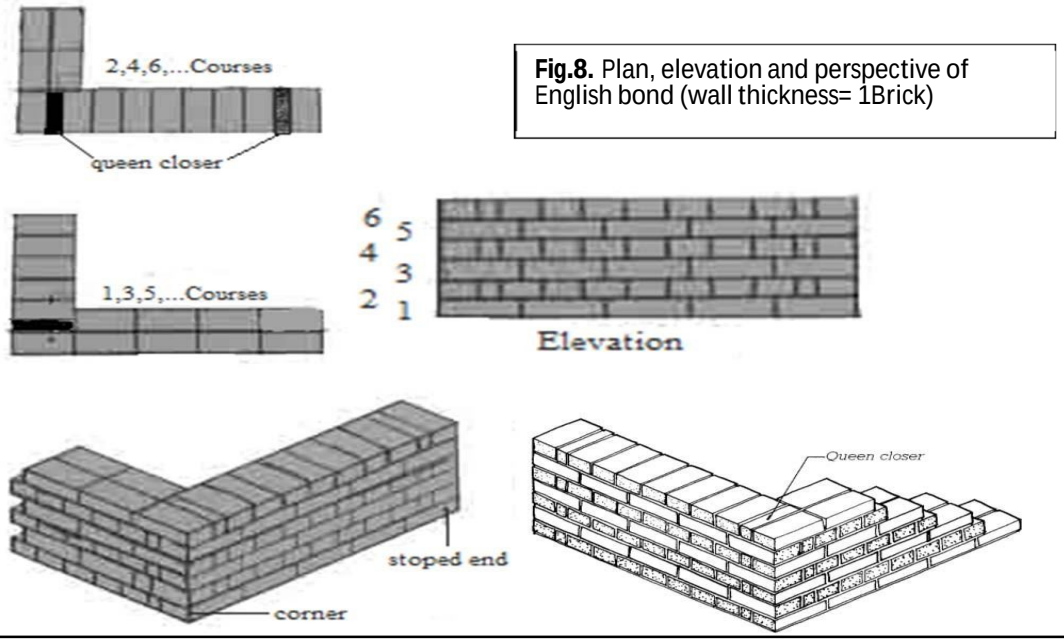


Fig.8. Plan, elevation and perspective of English bond (wall thickness= 1Brick)

Brick work

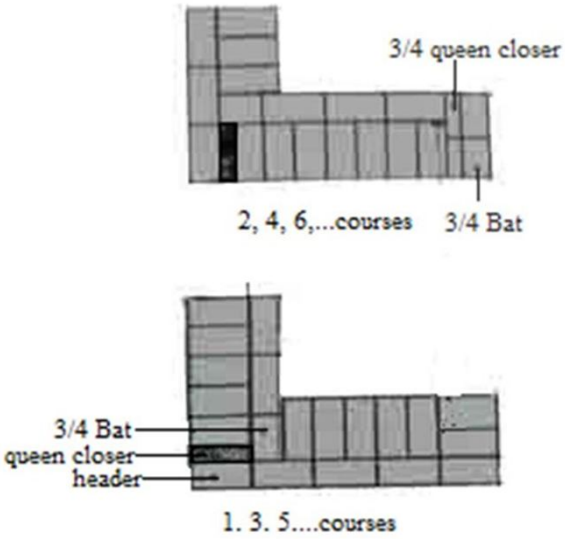


Fig.9. Plan of English bond (Wall thickness=1 ½ Brick)

Brick work

4 - Flemish bond

When alternately stretchers and header are laid in each course, the arrangement is known as Flemish bond (i.e: all courses the same appearance).Appearance of this bond is better than the English bond.

4.1 -Double Flemish bond

This type of bond presents the Flemish bond appearance both in the facing and backing.

Brick work

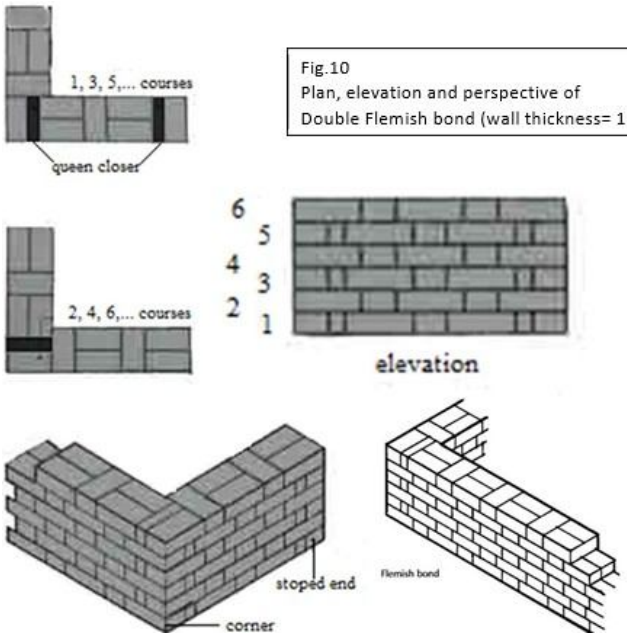


Fig.10
Plan, elevation and perspective of
Double Flemish bond (wall thickness= 1Brick)

Brick work

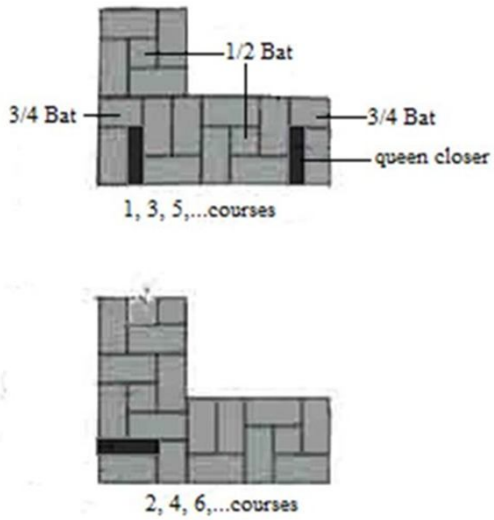


Fig.11. Plan of Double Flemish bond (wall thickness= 1 ½ Brick)

Brick work

Relative Merits and Demerits of English Bond and Double Flemish Bond:

(1) English bond is more compact and stronger than Double Flemish bond for the walls having thickness greater than 1 ½ bricks.

(2) Double Flemish bond presents pleasing and better appearance in the facing.

(3) In the construction of Double Flemish bond good workmanship and careful supervision is required.

(4) Double Flemish bond is economical than English bond as a number of bats are.

Brick work

4.2 - Single Flemish bond

- This bond has the advantages of both the types of the bond, i.e., English bond as well as Double Flemish bond.
- In this type of bond, the facing of the wall consists of Flemish bond and the filling as well as backing consist of English bond in each course.
- The minimum thickness of the wall for this bond is 1 ½ bricks.

Brick work

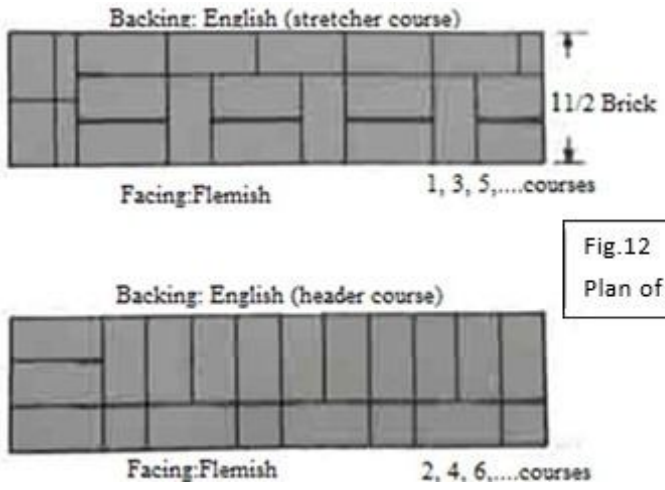


Fig.12
Plan of Single Flemish bond (wall thickness= 1 1/2Brick

Brick work

The following are the advantages of Single Flemish bond:

(a) The strength of English bond and appearance of Double Flemish bond are partly achieved.

(b) Good quality bricks can be used for facing in Double Flemish bond and cheaper bricks can be used as filling and backing in English bond.

The following are the disadvantages of this bond:

(a) This bond cannot be employed for walls having thickness less than 1 ½ bricks.

(b) A long continuous vertical joint is formed which renders the wall weaker.

Brick work

5 - Hollow bond

This type of bond used in

1. Cavity wall.
2. Isolator
3. Light weight

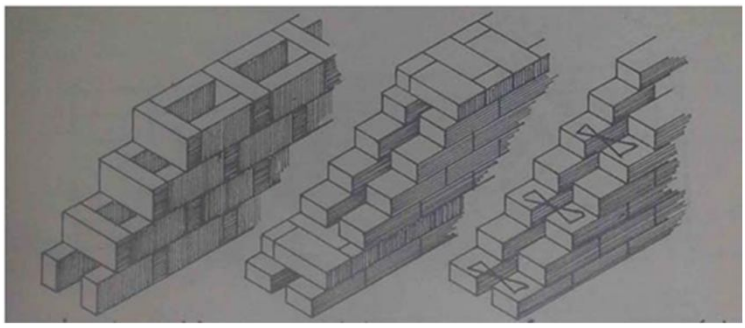
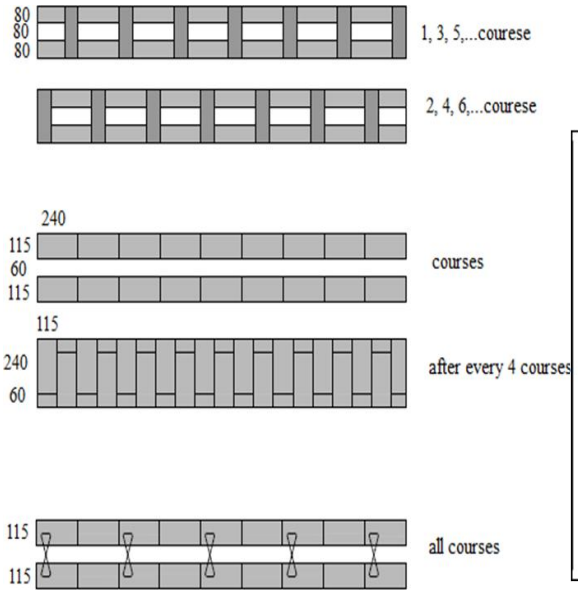
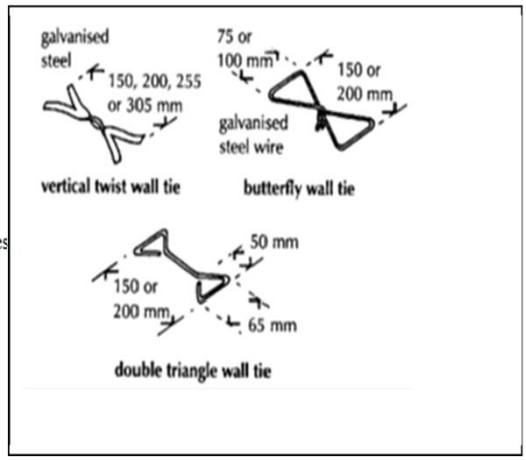


Fig.13. Plan of three type of hollow bond And tie detail

Brick work





Brick work

6 - Garden wall bond

This type of bond is useful for construction of garden walls, compound walls, boundary walls, etc. It is possible to construct one brick thick wall with uniform faces with economy, when this bond is employed.

There are two types of garden wall bond:

6.1 English garden wall bond

Brick work

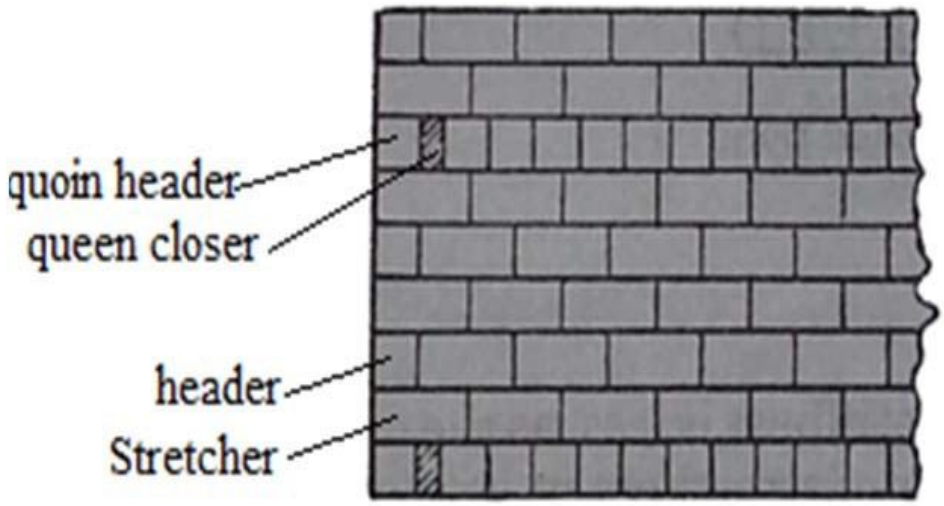
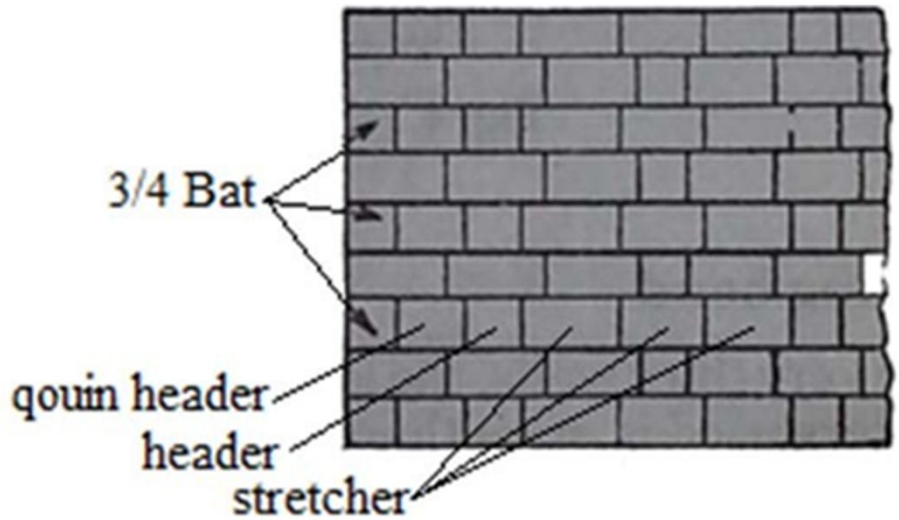


Fig.14. Elevation of English garden wall bond

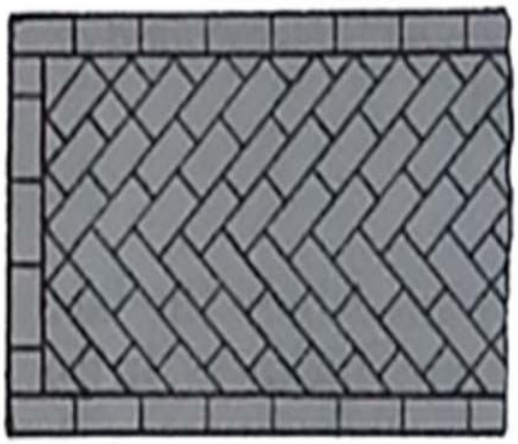
Brick work

6.2 Flemish garden wall bond



Brick work

7 - Pattern bond



Herring bone bond

Diagonal bond

Brick work

Bond at Junction

Junction is formed when two walls meet or intersect each other the wall must be bonded together.

Piers attached to wall

Piers attached to wall for:

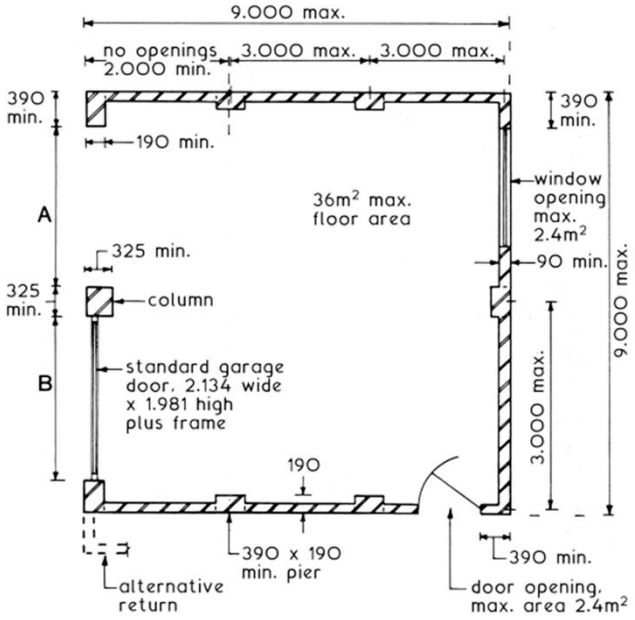
1- Increasing the stability of walls.

2- Improving architectural beauty of plain walls.

3- Provide a large bearing area for giving support to roof.

They may be constructed in English bond or double Flemish bond.

Brick work



Brick work

Completing and connecting the wall

1 - Toothing

2 - Racking

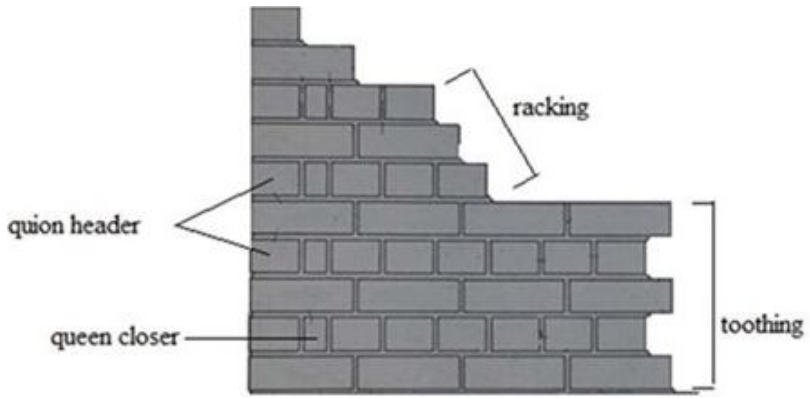
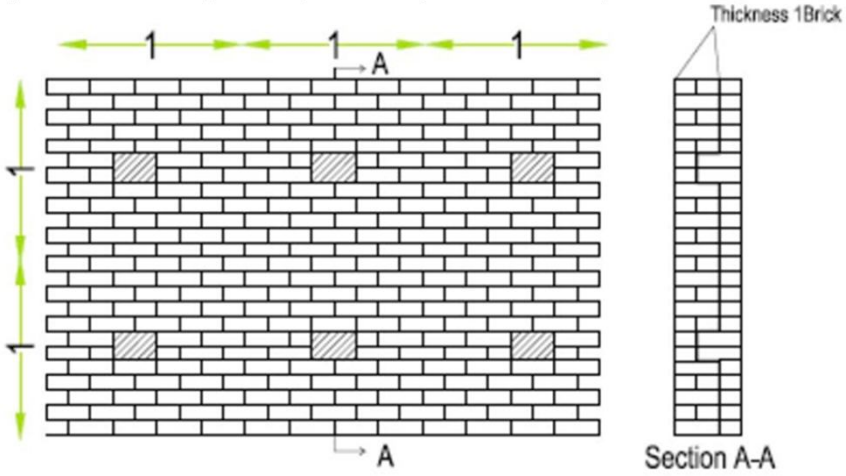


Fig.16. Elevation show the method of completing by racking and toothing

Brick work

3 - Thickening

Increase the thickness of wall in away excavate the hole on the surface of wall by dimension (2x2x1/2 Brick) for each square meter.



Brick work

Reinforced Brick Masonry

Reinforced brick masonry (RBM) is analogous to reinforced concrete construction. The same deformed steel reinforcing bars used in concrete are placed in thickened collar joints to strengthen a brick wall or lintel.

Reinforced is provided for:

1- RBM walls are much stronger against vertical loads.

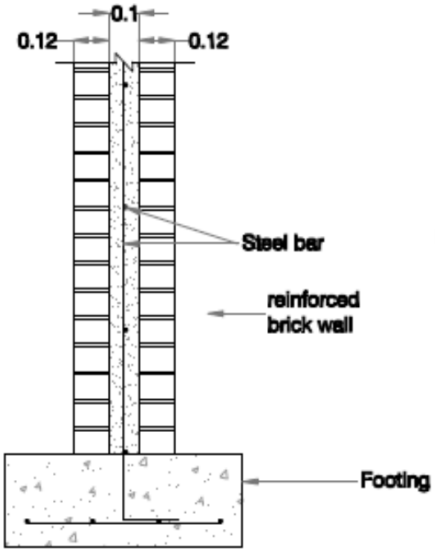
2- To carry loads from wind or earth pressure, and shear loads.

3- To provide continuity of the structure.

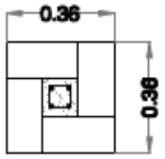
RBM is also used for brick piers, which are analogous to concrete columns, and, less commonly, for structural lintels, beams, slabs, and retaining walls.

Reinforced brickwork may also be created at a smaller scale by inserting reinforcing bars and grout into the cores of hollow bricks. This technique is especially useful for single family residential construction.

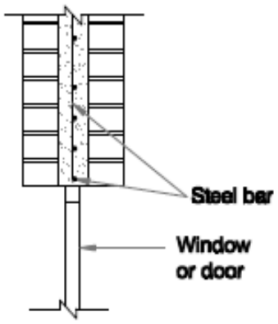
Brick work



Cross section of reinforced brick wall



Cross section of reinforced brick column



Cross section of reinforced brick lintel

Brick work

Determine the thickness of wall according to the structural and nonstructural requirements such as:

1-carry load safely

2-Resistance to damp penetration

3-Thermal insulator

4-Sound insulator

5-Fire resistance

Brick work

The main factors governing the loadbearing capacity of brick walls and columns are:-

1. Thickness of wall.
2. Strength of bricks used.
3. Type of mortar used.
4. Slenderness ratio of wall or column.
5. Eccentricity of applied load.

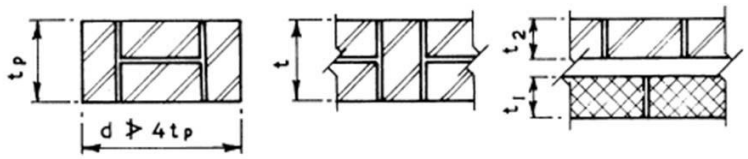
Brick work

Thickness of wall: this must always be sufficient throughout its entire body to carry the design loads and induced stresses. Other design requirements such as thermal and sound insulation properties must also be taken into account when determining the actual wall thickness to be used.

Effective Thickness: this is the assumed thickness of the wall or column used for the purpose of calculating its slenderness ratio …

Brick work

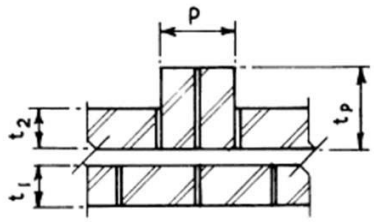
Typical Examples ~



COLUMN OR ISOLATED PIER
effective thickness = t_p

SOLID WALL
eff. th. = t

CAVITY WALL
eff. th. = $^2/_3(t_1 + t_2)$



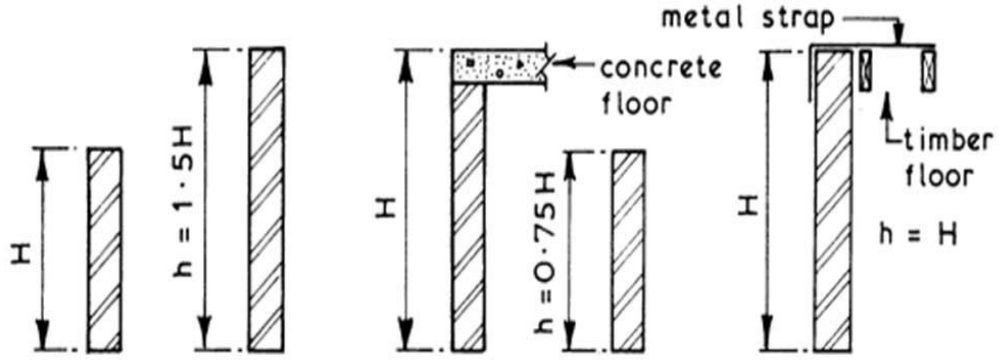
CAVITY WALL STIFFENED BY PIER

effective thickness
= $^2/_3$ (t_1 + effective thickness t_2)
effective thickness of t_2 can be ascertained by multiplying t_2 by a stiffening coefficient obtained from BS 5628

Brick work

Effective Height ~ this is the dimension taken to calculate the slenderness ratio as opposed to the actual height.

Typical Examples- actual height = H effective height = h



NO LATERAL SUPPORT AT TOP

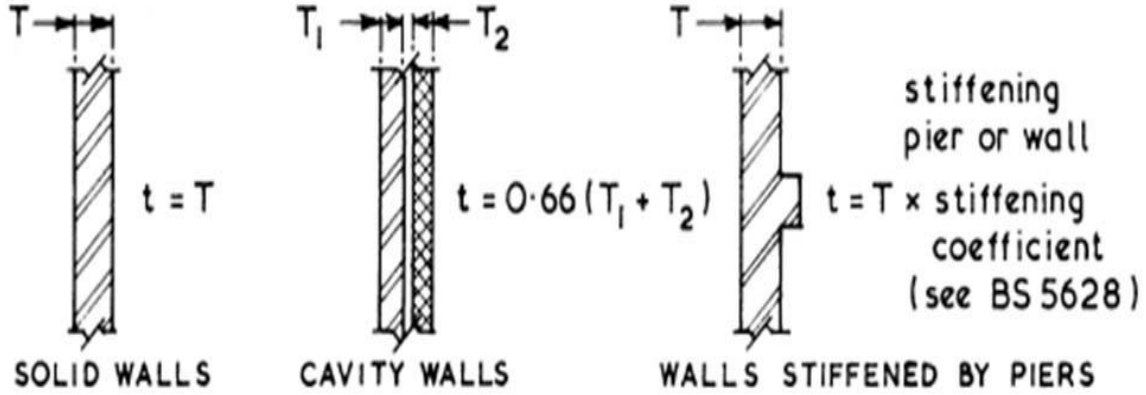
CONCRETE FLOOR BEARING ON WALL

FLOOR EFFECTIVELY TIED TO WALL

Brick work

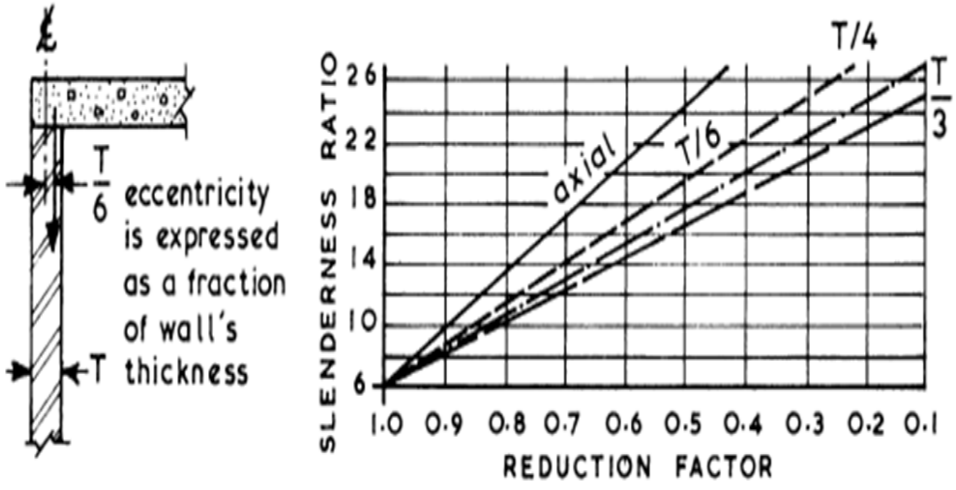
Effective Thickness ~ this is the dimension taken to calculate the slenderness ratio as

Typical Examples – actual thickness = T effective thickness = t



Brick work

Stress Reduction ~ the permissible stress for a wall is based on the basic stress multiplied by a reduction factor related to the slenderness factor and the eccentricity of the load:-



Thank You