**9 Parapet**

It is the wall built around a flat roof which acts as a protective wall for the users of the terrace. In case of pitched roof, the parapet wall is used to conceal to gutter at coves level.

**10 Coping**

The coping is covering of bricks or stones which is placed on the exposed top of on external wall to prevent seepage of water through joints of top most course in a wall.

**Parts of a building (Fig 1)**

**Buildings:** Building is not only a "SHELTER" but:

1 Energy saving

2 Efficiency improving

3 Environment friendly

4 Users friendly

5 Building can be defined as the three dimensional shape or form in the space, resting on the earth, secured to the earth by foundation for stability.

**Different stages in the life of building**

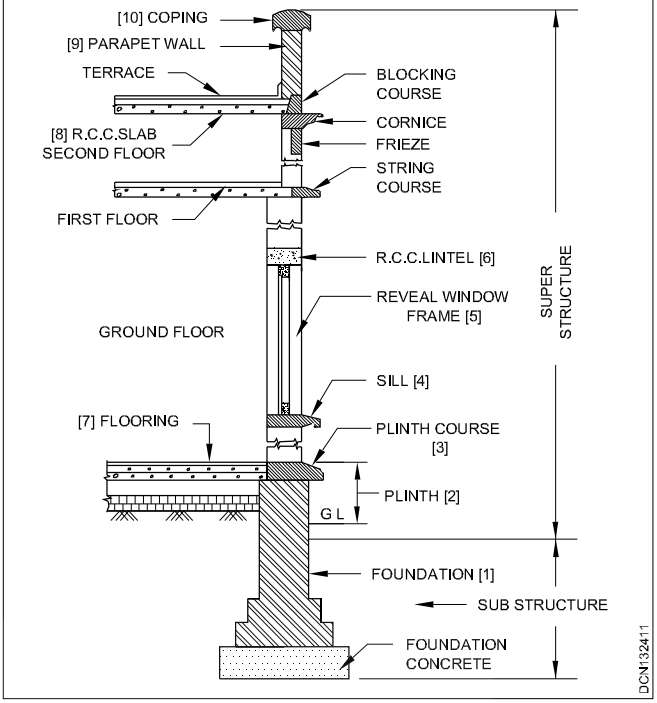
**Planning:** Decides the initial form

**Designing:** Decides the final form

**Drawing:** Tool to convert requirements into reality.

**Construction:** Conversion of two dimensional drawing into three dimensional structure. It is engineering in action, hence needs Construction Management.

Fig 1




**Occupation:** Environment Design Evaluation is essential after occupation to assess achievements in Planning, Designing and Construction by observing behavior of user and by obtaining user's views.

**Maintenance and preservation:** Preparation of maintenance programme to maintain livability throughout the life of the building by observing effect of Sun, Rain, Wind, and Human Behavior on building materials and construction.

# Masonry

**Objectives:** At the end of this lesson you shall be able to
- **define masonry**
- **identify the components of masonry**
- **explain the materials required for masonry**
- **list out the classification of masonry.**

**INTRODUCTION**

The term masonry is used to indicate the art of building the structures either in stone or brick or combination of materials such as stones, bricks, tiles, concrete block etc. Even though new principles of construction and new materials are adopted in the construction process, masonry has got highest importance in the building industry. Masonry is normally used for the construction of foundation, walls, pillars and other structural components of buildings.

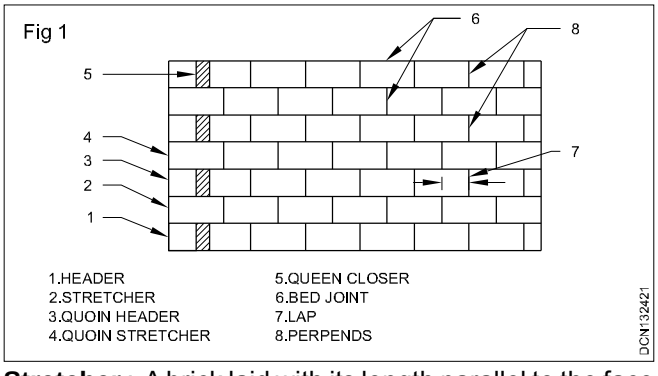
**MASONRY**

Masonry is the art of binding building blocks (stone, brick, or other building blocks) with binding material or an assemblage of masonry units properly bonded together with mortar.

**COMPONENTS OF MASONRY**

**Technical Terms:**

Fig 1




**Stretcher** : A brick laid with its length parallel to the face of the wall

**Header** : A brick laid with its breadth or width parallel to the face of wall

**Bed** : The lower surface of the brick when laid flat

**Bed joint** : The horizontal layer of mortar up on which the bricks are laid

**Perpends** : The vertical joints separating the bricks in either length or cross direction.

**Lap** : The horizontal distance between the vertical joints in successive course.

**Closer** : A piece of brick which is used to close up the bond at the end of brick courses.

**Queen closer** : Cutting the brick longitudinally in two equal parts

**MATERIALS REQUIRED FOR A MASONRY**

**MASONRY UNITS**

Masonry units shall confirm to accepted standards. Masonry units may be of the following types :

a Common burnt clay bricks

b Stones ( in regular sized units)

c Sand lime bricks and

d Concrete blocks

**MORTAR**

Where specified for normal masonry and in all cases for load bearing masonry walls, mortar shall be sampled and tested for flow and water retention .

**CLASSIFICTION OF MASONRY**

The masonry is generally classified as follows.

1 Stone masonry

2 Brick masonry

3 Hollow block concrete masonry

4 Reinforced masonry and

5 Composite masonry

## Stone Masonry

**Objectives:** At the end of this lesson you shall be able to
- **define stone masonry**
- **state the general principles of construction of stone masonry**
- **describe the five types of ashlar masonry**
- **explain types of stone masonry joints.**

**Introduction**

In ancient times most of the building construction was done in stone masonry. Stones are available in large quantity but not in all parts of India. Stones are used for the construction of walls ,pillars, lintels, arches footings etc.' of the building. Most common types of stones available in India for stone masonry are granite, sand stone, limestone, marbles, slates etc., Usually lime and cement mortar are used in the stone masonry.

**Definition**

The art of building the structures with stone is called stone masonry.

**General princiles of contruction of stone masonry**

- Stones shall be hard, tough, compact and durable.
- Stone should be laid on their natural bed.
- Proper bond should be maintained.
- Masonry should be raised uniformly otherwise too things or recesses or steps should be provided.
- The hearting of masonry should be properly filled with stones and spalls or snicks with mortar.
- Vertical faces should be checked with plumb rule.
- The masonry should not be subjected to tensile stress.
- When construction is to be done over old surface it should be well cleaned and wetted before starting the work.
- The stones should be wetted before used to avoid absorption of water from mortar.
- The exposed joints should be pointed.
- The entire masonry should cure for two weeks.
- Through stones should be used at every 1.5m height.

**Materials required for stone masonry**

1 Stone

2 Mortar

**1 Stone:** Stones should be hard, durable, tough and free from any defect. **Eg** : Basalt, Granite, Laterite, Marble, Quartzite Sandstone, Slate.

**2 Mortar:** Mortar is used to keep the stones in position. Selection of mortar depends on strength required load coming and resistance desired for weathering agencies. **Eg**: Lime mortar, Cement mortar, Lime cement mortar, Cement lime mortar.

**Rubble Masonry**

In the rubble masonry the blocks of stones used are either undressed or rough dressed. The strength obtained from

1 Quality of mortar

2 Using of through stone in certain intervals

3 Filling up mortar thoroughly between the facing.

**Ashlar Masonry**

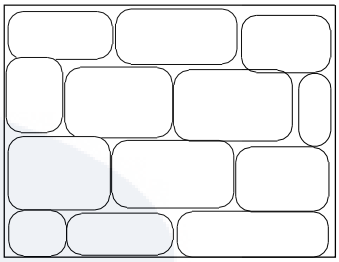
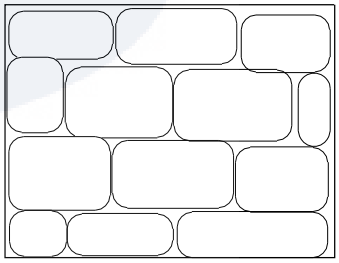
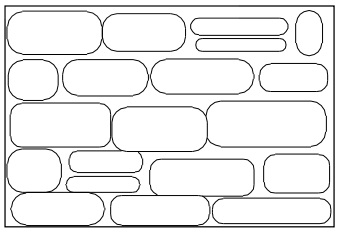
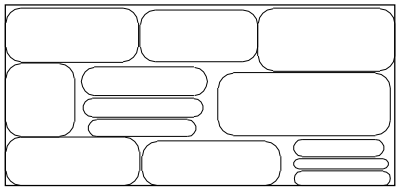
In ashlar masonry regular stones of square or rectangular shape with accurate bed joints are used.

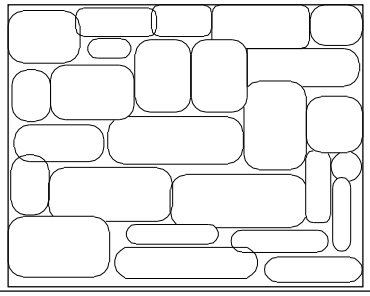
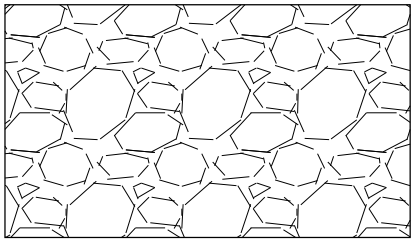
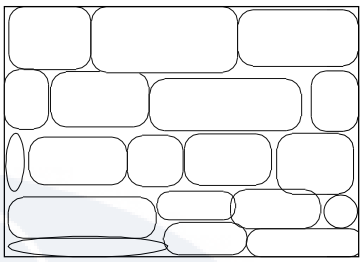
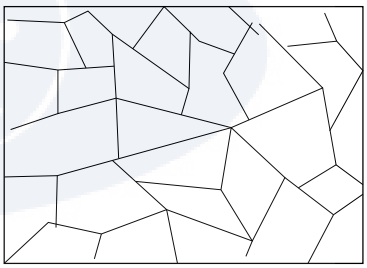
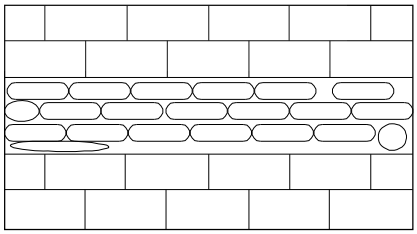
## CLASSIFICATION OF STONE MASONRY

**Stone Masonry**

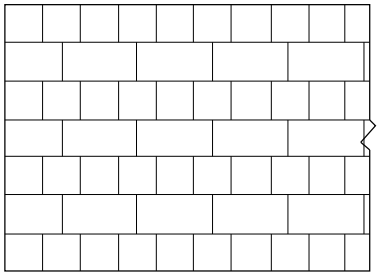
- **Rubble Masonry**
  1. Coursed Rubble
  2. Uncoursed Rubble
  3. Random Rubble
  4. Dry Rubble
  5. Polygonal Rubble
  6. Flint Rubble Course
- **Ashlar Masonry**
  1. Ashlar Fine
  2. Ashlar Rough Tooled
  3. Ashlar Rock or Quarry Faced
  4. Ashlar Chamfered
  5. Ashlar Block in course masonry

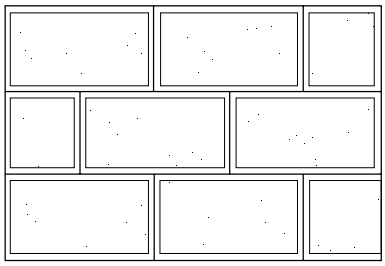
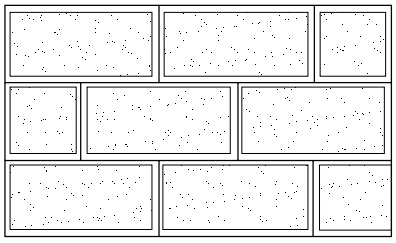
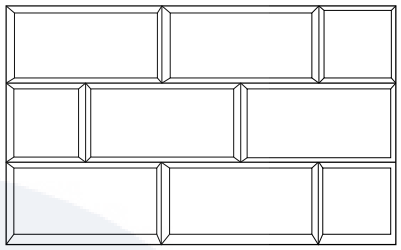
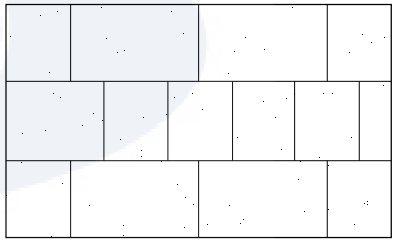
## RUBBLE MASONRY

| Sl No | Name of masonry | Description | Figure |
|---|---|---|---|
| 1 | Coursed rubble masonry | Heights of stones vary from 50mm to 200mm. Stones inparticular course are of equal heights. Used for public buildings, residential buildings etc., |  |
| 1a | Coursed rubble ( 1st sort) | Face stones are hammer dressed, bushings do not project more than 40mm, mortar joint does not exceed 10mm. |  |
| 1b | Coursed rubble (2nd sort) | Stones are of different heights, two stones are to be used to make up the height of one course mortar joint 12mm. |  |
| 1c | Coursed rubble (3rd sort) | Minimum height 50mm,only three stones are to be used to make up the height of one course, mortar joint is 16mm. |  |

| Sl No | Name of masonry | Description | Figure |
|---|---|---|---|
| 2 | Un coursed rubble masonry | Stones are used as they are available from the quarry, course is not regularly, and the thickness of mortar joint is 12mm. This masonry is used in compound wall, go downs, garages etc., |  |
| 3 | Random rubble masonry | The stones are irregular size and shape but arranged so as to have good appearance, so more skill is required. Mortar joint does not exceed 6mm. Used for residential building, compound wall etc., |  |
| 4 | Dry rubble masonry | Similar in construction to the coursed rubble masonry3rd sort except that no mortar is used. It require more skill in construction Used for compound wall ,pitching on bridge approaches ,retaining wall etc. |  |
| 5 | Polygonal Rubble Masonry | Stones are hammer dressed. Stones are selected for face work are dressed in a irregular polygonal shape. More skill required for the construction. Used for face work. |  |
| 6 | Flint Rubble Masonry | Stones used are flint which is irregularly shaped nodules of silica. Face arrangements may be coursed or uncoursed. Strength is increased by introducing lacing course.Used at place where flints are available readily |  |

**ASHLAR MASONRY**

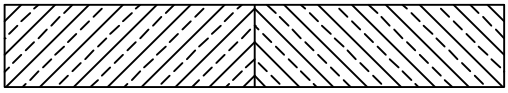
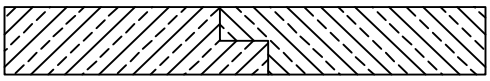
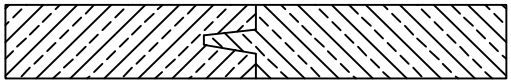
| Sl no | Name of masonry | Description | Figure |
|---|---|---|---|
| 1 | Ashlar Fine | The beds, sides ,and faces are finely chisel dressed. The stones are arranged in proper bond. Thickness of mortar joints does not exceed 3mm.It gives smooth appearance ,but it is very costly. Used for superior work. |  |

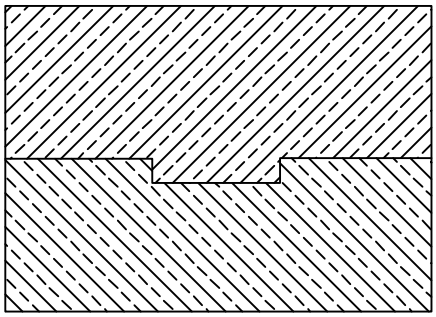
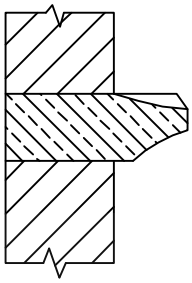
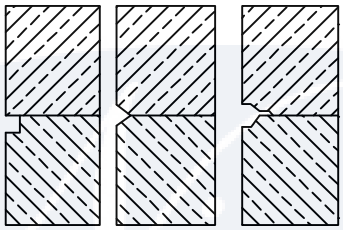
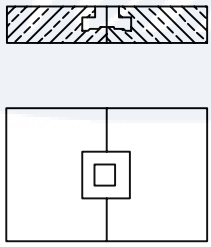
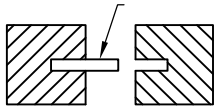
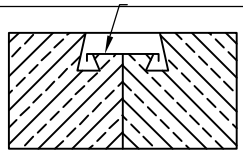
| Sl no | Name of masonry | Description | Figure |
|---|---|---|---|
| 2 | Ashlar rough tooled (Bastard ashlar) | Beds and sides are finely chisel dressed. Faces made rough.Thickness of mortar joints does not exceed 6mm. A strip is provided around the perimeter. Used only for exposed surface. |  |
| 3 | Ashlar rock or quarry faced | All the faces and sides except exposed face is left as received from quarry. Only bushings are removed. A strip is provided around the perimeter. |  |
| 4 | Ashlar chamferred | A strip is provided 25mm wide, it is chamfered or beveled at an angle of 45° using chisel . Another strip 12mm wide remaining exposed face of the stone. Remaining part just like received from quarry. It gives neat appearance. |  |
| 5 | Ashlar block in course masonry | It occupies a position between the rubble masonry and ashlar masonry. Faces are hammer dressed. Thickness mortar joint does not exceed 6mm. It is used for retaining walls, sea walls, railway stations, temples bridges etc., |  |

**JOINTS IN STONE MASONRY**

In order to increase the length, breadth, thickness of stone in masonry or to secure the stones firmly with each other, joints are required.

**TYPES OF JOINTS IN STONE MASONRY**

| NO | TYPE OF JOINTS | FIGURE | USES |
|---|---|---|---|
| 1 | Butt joint |  | Most common joint used in ordinary works . |
| 2 | Rebated joint or Lapped joint |  | Used arch work, coping of gable tops. |
| 3 | Tongued and grooved joint or joggled joint |  | Joint require more labour make expensive . Used only in some portions of ashlar masonry. |

| NO | TYPE OF JOINTS | FIGURE | USES |
|---|---|---|---|
| 4 | Tabled joint |  | This joint prevent lateral movement. Used in structures like sea wall where lateral pressure is more. |
| 5 | Saddled or rusticated joint |  | Used to protect the joint of cornice. |
| 6 | Rusticated joint |  | These joints are used for plinth, quoin, outer wall of lower storey. |
| 7 | Plugged joint |  | This used for coping cornice etc. |
| 8 | Dowelled joint |  | In some end portions of ashlar masonry at places where joggled joint is needed we can use this joint. |
| 9 | Cramped joint |  | It prevent the tendency of stone joint to pull apart. This joint is used instead of dowel joint |

# Brick masonry

**objectives :** At the end of this lesson you shall be able to,

- **define brick masonry & bond**
- **state the general principles of bonding in brick masonry**
- **explain special bricks used in brick masonry**
- **explain the types of bonds used in brick masonry**
- **describe types of brick masonry**
- **points to be observed while supervising the brickwork**
- **differentiate brick masonry & stone masonry**

### Introduction

The techniques of laying various types of bricks, together with the different kinds of mortar used in the construction of thick walls, all require a different craft operation.

In dry weather all bricks must be well soaked in water before use and the top of old wall should be wetted before the comencement of work. The soaking and wetting is done to remove dust and prevent the bricks absorbing too much water from the mortar.

### Definition

An art of builidng which the structure with bricks bonded with mortar is called brick masnory. A bond is an arrangement of bricks in layers by which no continuous vertical joints.

### Principles of Bonding

1 The amount of lap should be minimum of ¼ th brick along the length of the wall and ½ brick across the thickness of wall.(Ref. components of masonry)

2 The brick should be uniform size to get uniform lap

3 The structure should be used in facing

4 Hearting should carry out with headers only.

5 Use of brickbats should avoid as far as possible.

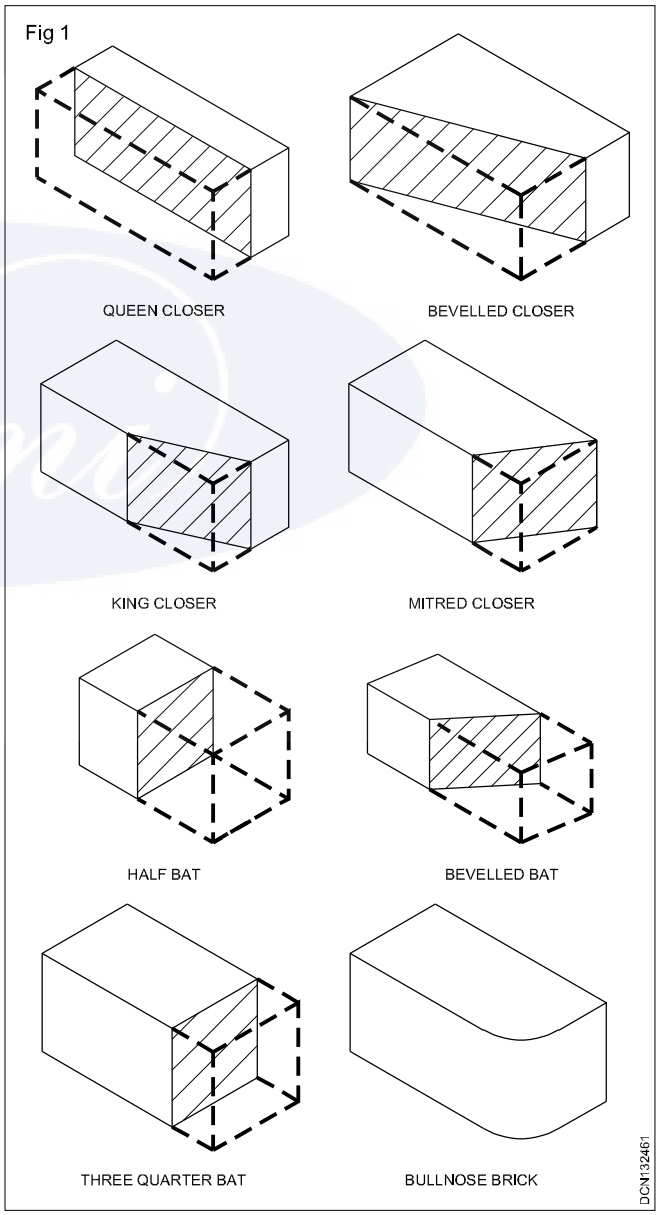
6 The vertical joints in alternate courses should be along it perpend.

### Special bricks

**Closer** - A piece of brick which is used to close up the bond at the end of brick courses.

- **Queen closer** : Cutting the brick longitudinally in two equal parts(Fia 1a).
- **King closer**: Cutting a triangular portion of the brick such that half a header and half a stretcher are ob tained on the adjoining cut face (Fia 1b).
- **Bevelled closer:** Cutting a triangular portion of half the width but of full length(Fia 1c).
- **Mitred closer**:- Cutting a triangular portion of the brick through its width an angle of 45° to 60° with the length of the brick(Fia 1d).
- **Half Bat** : The portion made by cutting the standard brick across their length,i.e,quarter bat,half bat, three quarter bat (Fig 1 e).
- **Bullnose** :A brick moulded with a rounded angle (Fia f).
- **Cow nose**: A brick moulded with a double bull nose on end.
- **Bevelled Bat :**The portion cut 3/4 of length of brick one side and 1/2 of the length on other side.(Fig 1g)

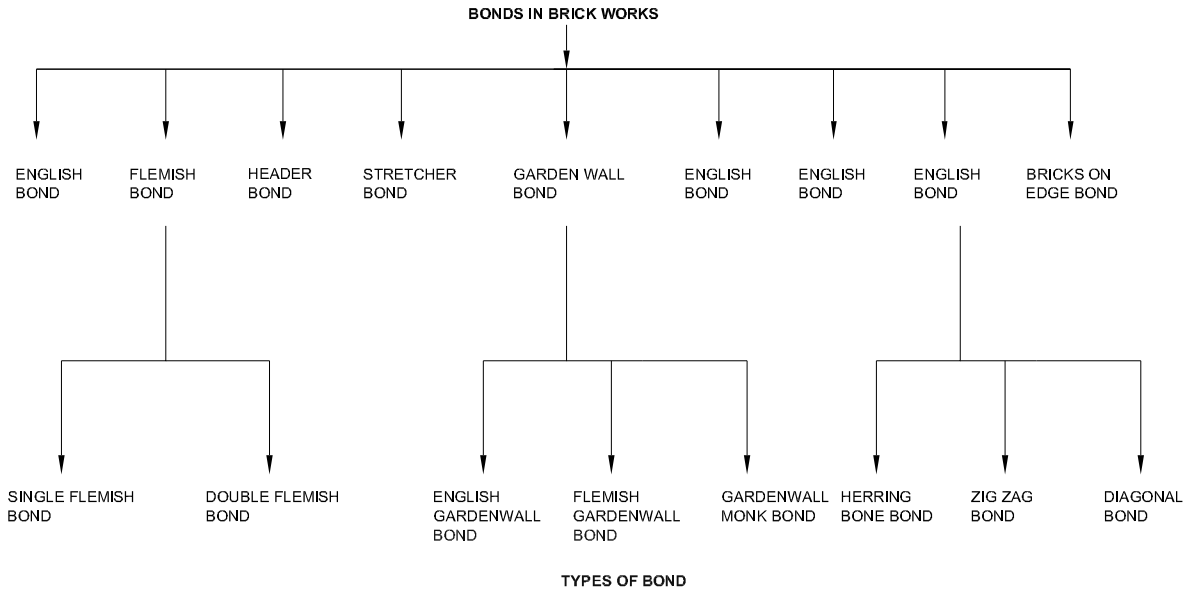
Fig 1

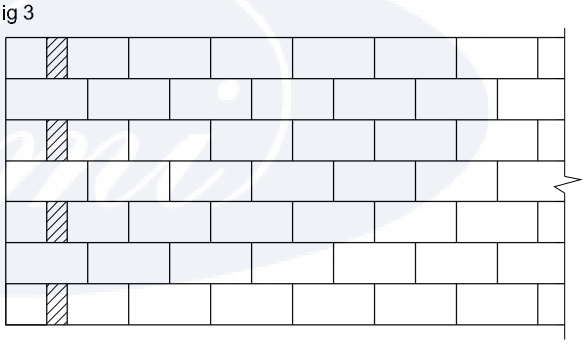
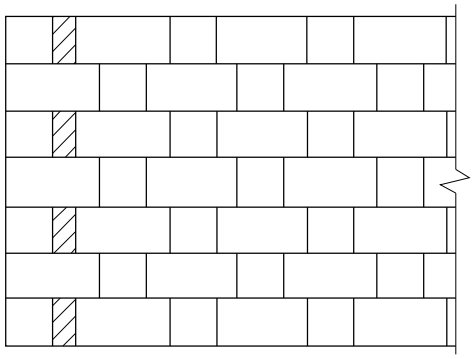


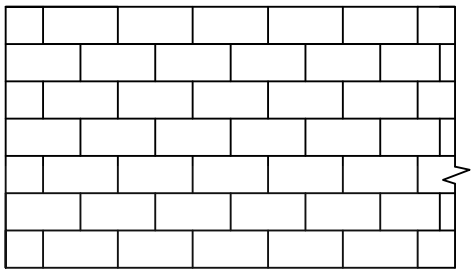
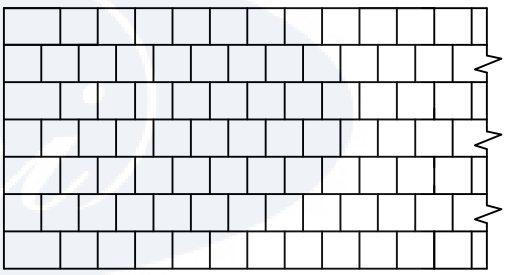
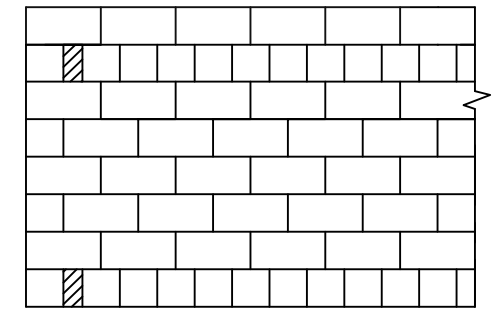
## Types of Bond

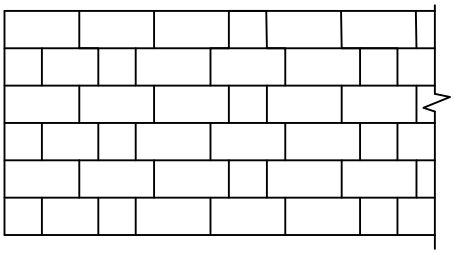
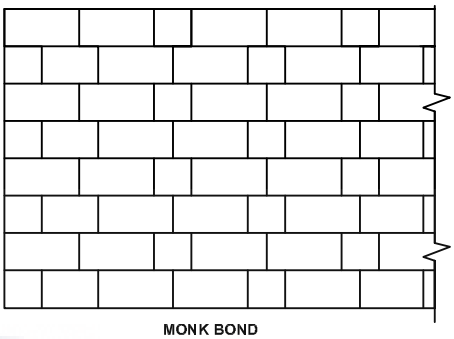
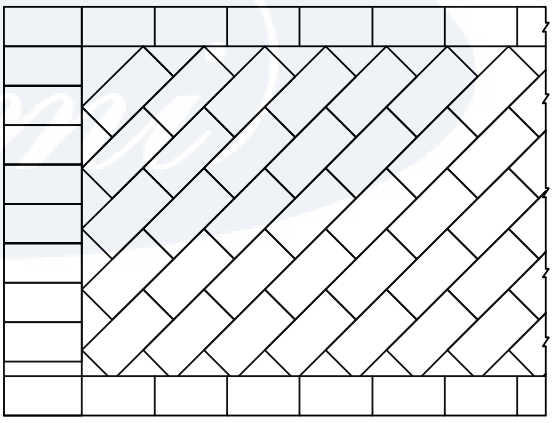
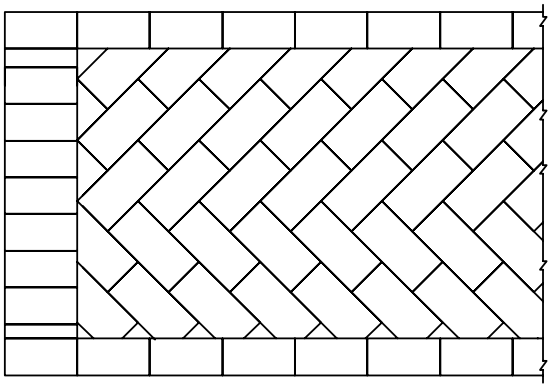
## Bonds in brick works

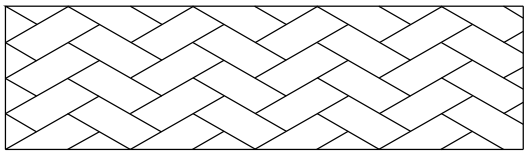
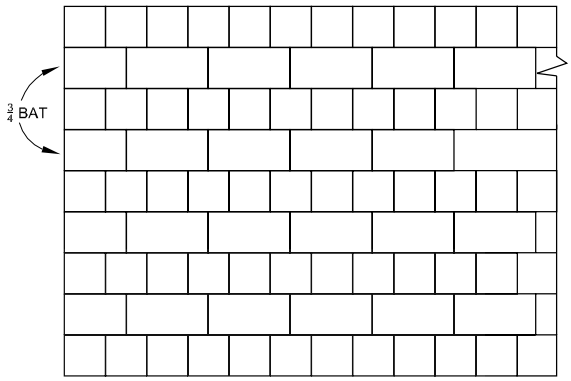
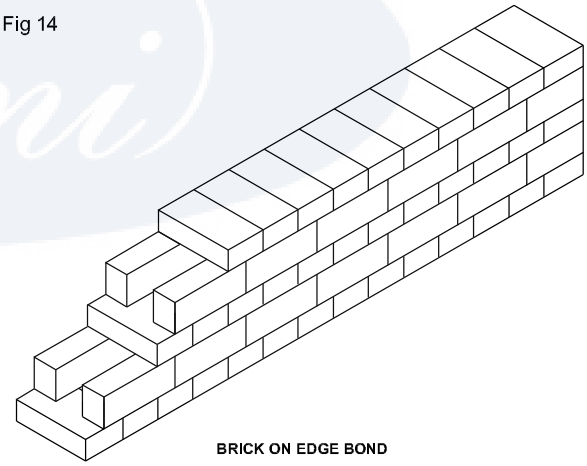
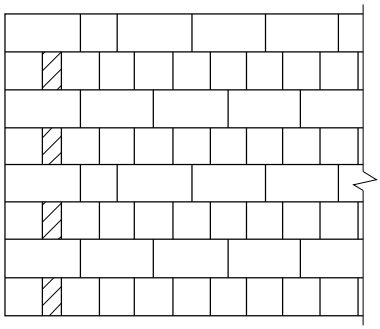
Fig 2

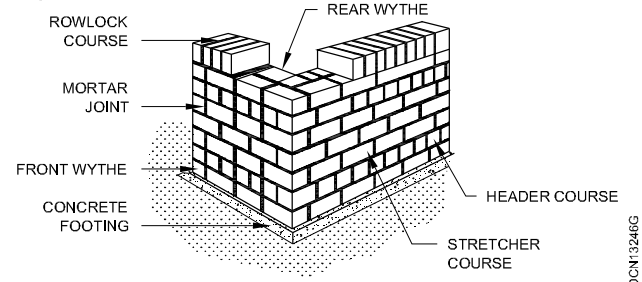
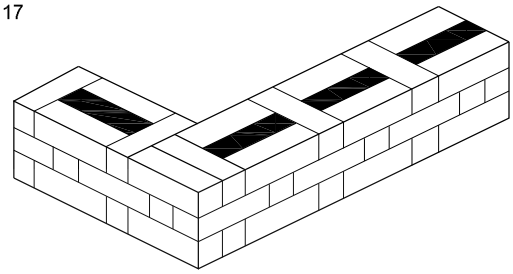



| Name of bond | Features and uses | Figure |
|---|---|---|
| English bond | Alternate courses consists of headers and stretchers (Fig 3).<br>Queen closer put next to the quoin header to get lap.<br>Each alternate headers centrally<br>supported on stretchers.<br>Continuous vertical joints are not formed excepted stopped ends.<br>Header course should never start with a queen closer.<br>Queen closers are not required in tretcher course.<br>Minimum lap should be ¼ th brick.<br>1,2,3...thick wall same look on both faces Multiple of half thick wall not in same look in facing and backing. | Fig 3<br>  <br>ENGLISH BOND<br>DCN132463 |
| Flemish bond | In every course headers and stretchers are placed alternatively.(Fig 4)<br>A queen closer is put next to the quoin header.<br>Every header is centrally supported over a stretcher below it.<br>In thin board short continuous vertical joints are formed.<br>Brickbats are to be used in the un even multiple of half brick. | Fig 4<br>  <br>FLEMISH BOND<br>DCN132464 |

| Name of bond | Features and uses | Figure |
|---|---|---|
| a) Single flemish bond<br>b) Double flemish bond | a) The facing elevation is Flemish bond but backing and hearting are of English bond<br>b) The headers and stretchers are placed alternatively in facing as well as backing.<br>Uses:-<br>1. For structural work or load bearing walls<br>2. Having pleasing appearance. | |
| Stretcher bond | 1. All the bricks are arranged in stretcher course. (Fig 5)<br>2. It does not develop proper internal bond | Fig 5<br>  <br>STRETCHER BOND<br>DCN132465 |
| Header bond | 1. All the bricks are arranged in header course. (Fig 6)<br>2. Overlap is kept equal to half brick width achieved by using ¾ bats.<br>Uses : For circular wall<br>For circular manhole | Fig 6<br>  <br>HEADER BOND<br>DCN132466 |
| Garden wall<br>a) English garden wall bond | 1. One header course is provide to two or five stretcher course.<br>2.Quoin headers are placed in alternate bond course and queen closer is placed next to the quoin header in header course to develop lap<br>3. The wall is one brick wall thick and the bond height is 2m (Fig 7).<br>4. It may be constructed in English or Flemish bond.<br>Uses:-The bond is used for Garden walls and compound wall. | Fig 7<br>  <br>GARDEN-WALL ENGLISH BOND<br>DCN132467 |

| Name of bond | Features and uses | Figure |
|---|---|---|
| b) Flemish garden wall bond | 1. Each course contain one header to three or five stretcher<br>2. A ¾ th bat is placed next to the quoin header. | Fig 8<br>  <br>GARDEN-WALL FLEMISH BOND<br>DCN1:32468 |
| c) monk bond | 3. A header is placed centrally over each middle stretcher.<br>1. Each course contain one header to two stretchers<br>2. The header rest on the joint between two headers.<br>3. A 3/4$^{Th}$ bat is placed next to the quoin header. | Fig 9<br>  <br>MONK BOND<br>DCN1:32469 |
| 6. Raking bond<br>a) Diagonal bond | 1. Courses are inclined<br>2. Inclination should be in opposite direction in alternate courses.<br>3. Brick are laid at 45°<br>Bricks are laid longitudinally, Usefull for 2-4 brick thick.(Fig 10) | Fig 10<br>  <br>PLAN SHOWING ARRANGEMENT OF BRICK IN DIAGONAL BOND<br>DCN1:3246A |
| b) Herring bone bond | Brick are laid at 45° from the centre in both the direction, Useful for ornamental finish.(Fig 11) | Fig 11<br>  <br>HERRING BONE BOND<br>DCN1:3246B |

| Name of bond | Features and uses | Figure |
|---|---|---|
| c) Zig-zag bond | Bricks are laid at 45° in zig-zag fashion and used for flooring (Fig 12) | Fig 12  ZIG-ZAG BOND DCN13246C |
| Dutch bond | 1. Alternate courses of headers and stretchers. (Fig 13)<br>2.The quoin of stretcher course is ¾ bat.<br>3. A header is introduced next to the ¾ bat in every alternate stretcher course.<br>Uses:- Corner of wall can be strengthened. | Fig 13   DUTCH BOND DCN13246D |
| Brick on edge bond | 1. Bricks are laid as headers and stretchers in alternate courses.(Fig 14)<br>2. Headers are laid on bed and stretchers are laid on edge.<br>3. Continuous cavity is formed.<br>Uses:- Used for garden wall, compound wall, partition wallet. | Fig 14  BRICK ON EDGE BOND DCN13246E |
| English cross bond | 1.Alternate courses are of headers and stretchers. (Fig 15)<br>2. The queen closers are placed next to the quoin header.<br>3. A header is introduced next to the quoin stretcher.<br>Uses:- This bond adds the beauty of wall | Fig 15  ENGLISH CROSS BOND DCN13246F |

| Name of bond | Features and uses | Figure |
|---|---|---|
| Facing bond | 1. A header course is placed after several stretcher course.(Fig 16)<br>Uses:- Used when facing and backing brick are varying size. | Fig 16<br>  |
| Rat trap bond | 1. Locally made bricks having thick ness less than 10cm are used. (Fig 17)<br>2. all the bricks are laid on edge.<br>3. Alternate headers and stretchers are used in same course.<br>4. A cavity is formed inside the course.<br>5. It is strong ,sound and heat proof. | Fig 17<br>  |

**Comparision of English bond with Flemish bond**

| Features | English Bond | Flemish Bond |
|---|---|---|
| Arrangement of brick | a. Headers and stretchers are laid in alternate courses<br>b. Each alternate header is centrally supported over a stetcher | a. Headers and stretchers are laid alternatively in each course.<br>b. Every header is centrally supported over a stetcherbelow it. |
| Strenth | Strongest type of bond | Weakest bond for all walls |
| Appearance | Provides rough appearance | Provides good appearance |
| Skill | Requires less skill | Requires more skill |
| Material cost | Costly, brick bats are not used | Economical, as brick bats are used. |
| Mortar | More mortar required | More mortar required for additional joints. |

**Bonds at connections**

The walls in different directions are united together at certain places, which are called connections.

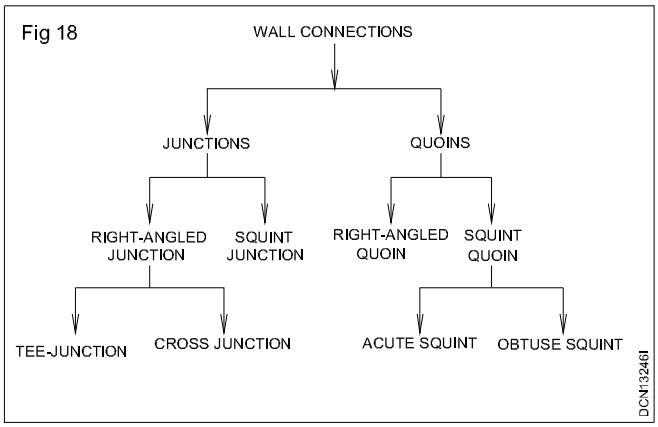
Requirements to be satisfied by bond at connections are:-

1 Vertical joints should not be continuous.

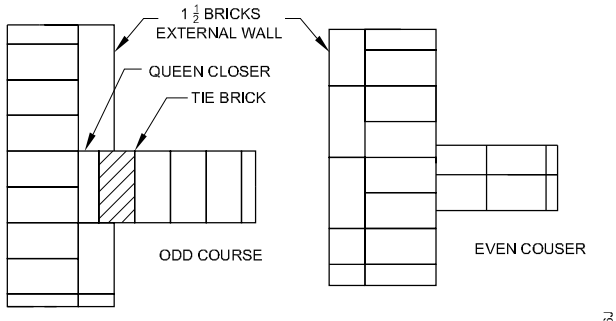
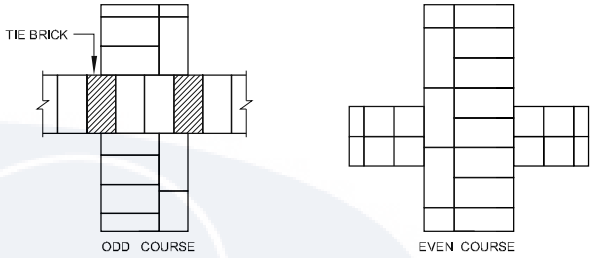
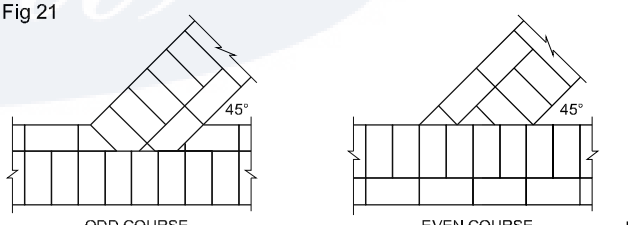
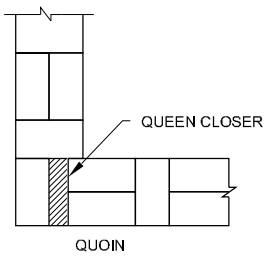
2 Broken bricks to be used minimum.

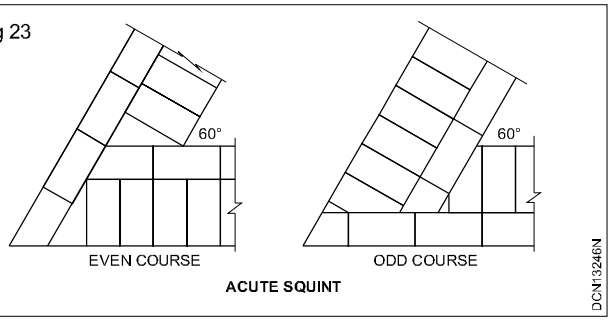
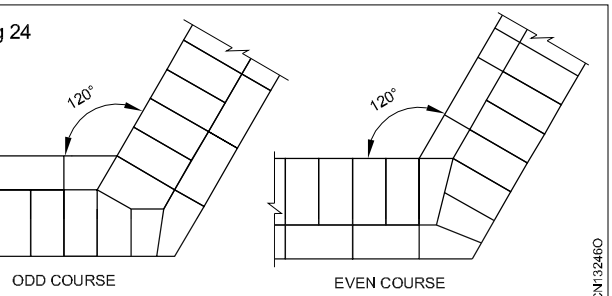
3 Connection should be strong enough to resist differential settlement.

Fig 18



## Forms of connections

| Forms of connections | Features | Figure |
|---|---|---|
| **1. Junction**<br>a) Right angled junction | Two walls meet each other at right angles (Fig 19) | Fig 19<br>  <br>PLANS OF ALTERNATE COURSES T - JUNCTION<br>DCN13246J |
| a.i) Tee Junction | Forms the shape of letter 'T'. Header courses of courses of cross wall enters the stretcher course of main wall. Alternate courses simply abutting the main wall. | |
| a.ii) Cross junction | Two walls cross each other. Alternate courses simply abutting the main wall. Other alternate courses are provided with the bricks in the form of key headers to create necessary lap. (Fig 20) | Fig 20<br>  <br>CROSS JUNCTION<br>DCN13246K |
| b) Squint junction | Two walls meet each, other then a right angle. Not common in use (Fig 21) | Fig 21<br>  <br>SQUINT JUNCTION<br>DCN13246L |
| 2 Quoins | Connection formed when a wall takes turn (Fig 22) | Fig 22<br>  <br>ONE BRICK WALL<br>DCN13246M |

| Forms of connections | Features | Figure |
|---|---|---|
| 2.a) Right angled quoin<br><br>2. b) Squnit quoin | Wall take a turn and makes a right quoin (square quoin) angle. No vertical continuous joints are formed. (Fig 23)<br><br>Walls takes a turn and make other than a right angle.<br><br>Enclosed angle on the side of the | Fig 23<br>  |
| 2. b i) Acute squint quoin<br><br>2. bii) Obtuse squint quoin | Wall is less than a right angle<br><br>Enclosed angle on the side of the wall should between $90^0$ to $180^0$ (Fig 24) | Fig 24<br>  |

**Defects in brick masonry**

Following are the causes of defects in a brick masonry work.

1 Corrosion of embedded fixtures.

2 Crystallization of salts from bricks

3 Shrinkage on drying

4 Sulphate attack

5 Freezing of water

**Types of brick masonry**

The brickwork is classified according to the quality of mortar, quality of brick, and thickness of mortar joint are as follows.

| Types of brickwork | Pecularities |
|---|---|
| 1. Brickwork in mud mortar | a. Intimately mixed sand and clay -mud- is used to fill joints.<br>b. Mortar thickness 12mm<br>c. Used for cheapest construction of height up to 4m |
| 2. Brickwork in CM or LM I class | a. Cement mortar or lime mortar is used .<br>b. Bricks are table moulded of standard shape<br>c. The surface and edges are sharp, square and straight.<br>d. Mortar joint doesn't exceed 10mm |
| 3. Brickwork in CM or LM II class | a. Cement mortar or lime mortar is used.<br>b. Bricks are ground moulded of standard shape and burnt in kilns.<br>c. Thickness of mortar joint is 12mm |
| 4. Brickwork in CM or LM III class | a. Cement mortar or lime mortar is used.<br>b. Bricks are ground moulded of standard shape and burnt in clamps.<br>c. Thickness of mortar joint is 12mm |

**Points to be observed while supervising the brick work**

Following points are to be carefully attended to while supervising the brickwork:

1 The bricks to be used should confirm with the requirements of the specification of the work.

2 The bricks should be saturated with water so as to prevent absorption of moisture from the mortar. This is effectively done by providing a tank at the site of work and by immersing the bricks for a period of at least 2 hours before the bricks are actually placed in position.

3 The bricks should be properly laid on their beds. The mortar should completely cover the bed as well as the sides of bricks. The bricks should be laid with the frog uppermost.

4 The brickwork should be carried out in proper bond.

5 The brickwork should complete with the requirements of the specifications for the work.

6 The mortar to be used for the work should be of quality and of proportion as specified.

7 As far as possible, the brickwork should be raised uniformly. But when this is not possible or when a cross wall is intended to be inserted after sometime, the steps or toothings should be provided.

8 In the brickwork, the brickbats should not be used except as closers. All the brickbats of size less than half- brick should be rejected and not allowed to be used in the construction.

9 The single scaffolding should be adopted to carry out the brickwork at a higher level. The required headers are taken out to create supports for the scaffolding and they should be inserted when the scaffolding is removed.

10 The brickwork should be carried out as per line and level. The vertical faces should be checked by means of a plumb bob and the inclined surfaces, if any should be checked by means of wooden templates.

11 After construction, if cement martor is used the brick work should be cured for a period of about two to three weeks, if lime mortar is used and for a period of about one to two weeks.

**Difference between stone masonry and brick masonry**

| Stone Masonry | Brick Masonry |
|---|---|
| 1. Stones are natural material obtained from quarries. | 1. Bricks are artificial material. |
| 2. Dressing of stone is important. | 2. Dressing not required only rectangular blocks using |
| 3. Bonding is fair but strength is more | 3. Bonding is good. But strength is less. |
| 4. Required skill labour. | 4. Less skilled labour |
| 5. Lifting and laying is heavy | 5. convenient in lifting and laying. |
| 6. More quantity of mortar need | 6. Less quantity of mortar need. |
| 7. Mortar joints are irregular | 7. Mortar joints are uniform. |
| 8. Plastering is not required | 8. Plastering is required. |
| 9. Fire resistance less | 9. Fire resistance more. |
| 10. Wall thickness more than 300 mm | 10. 100 mm, 200 mm wall easily constructed. |
| 11. Ornamental work costly | 11. Cheap and easy construct ornamental works. |

## Reinforced masonry

**Objectives :** At the end of this lesson you shall be able to,
- **explain reinforced masonry**
- **describe the features of reinforced masonry walls & columns**
- **explain reinforced masonry lintel & slabs**
- **prepare freehand sketches of reinforced masonry for walls & columns.**

### Introduction

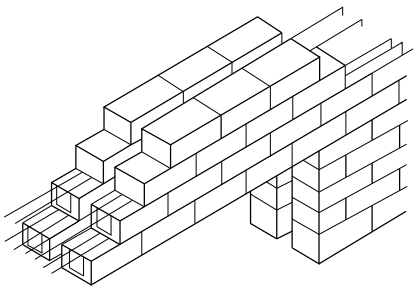
Brickwork strengthened by expanded metal, steel-wire mesh, hoop iron, or thin rods embedded in the bed joints .Reinforced masonry is also essentially a wall material. Of course, beams and slabs have been built in reinforced masonry, but with the exception of deep wall beams, it is hard to justify them in comparison with reinforced concrete ones. Reinforced masonry does not require shuttering and expensive element of concrete. The real advantage of reinforced masonry lies in walls subject to bending perpendicular to the wall plane. It combines flexibility of form with good finish and frequently a large cost saving compared with reinforced concrete. Reinforced masonry is thus a cheap, durable, fireproof, easy to construct and in most cases it results in the increase of floor space due to adoption of brickwork of lesser thickness. The reinforced masonry has been used with advantage under the following circumstances.

1 Retaining walls up to 6 m height can be constructed using various types of brick walls and filled hollow blocks, with a drained granular fill. (fig.1)

2 Reinforced masonry can be used for cantilevering vertically in boundary walls or tall sheds where the walls cannot be restrained at the top.

3 It can also be used in horizontally spanning cladding where it is not possible to prove stability in wind due to arching.

Fig 1



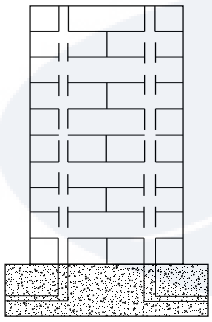
DCN132471

**Reinforced masonry walls: (Fig 2)**

Iron bars or expanded metal mesh is generally provided at every third or fourth course. Before starting the next course the steel fabric is spread flat on the cement mortar and pressed evenly.

Flat bars of section about 25mmX2mm may be used as hoop iron reinforcement for walls. They are hooked at corners and junctions and usually dipped in tar and sanded immediately so as to increase their resistance against rusting. Generally, one strip is provided for every thickness of half brick. Reinforcement in vertical directions may be provided by using special bricks or blocks. Mild steel bars (6 mm diameter) can also be used as longitudinal reinforcement in walls.

Fig 2

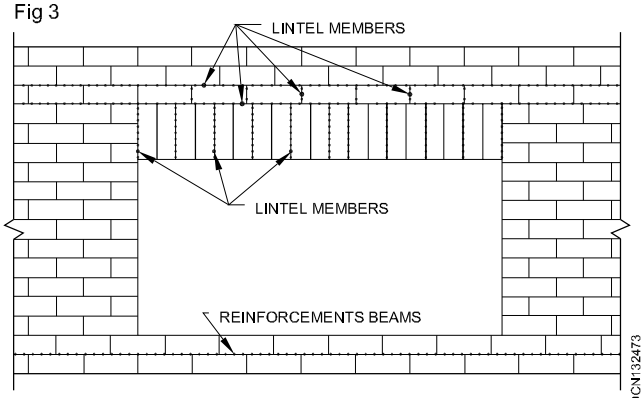


DCN132472

**Masonry units used in reinforced masonry (Fig 3)**

The properties of masonry units used for reinforced masonry work should complete with the requirements of relevant European standards (EN 771-1-6). Masonry units are classified into the following types: solid, perforated unit, hollow unit, cellular unit, horizontally perforated unit.

Fig 3




DCN132473

**Masonry reinforced columns (Fig 4)**

The reinforced columns are provided with steel plates of about 6 mm thickness at every fourth course. Vertically reinforcement bars are placed between special type of blocks used for the columns. The steel bars are fixed in the foundation concrete block.

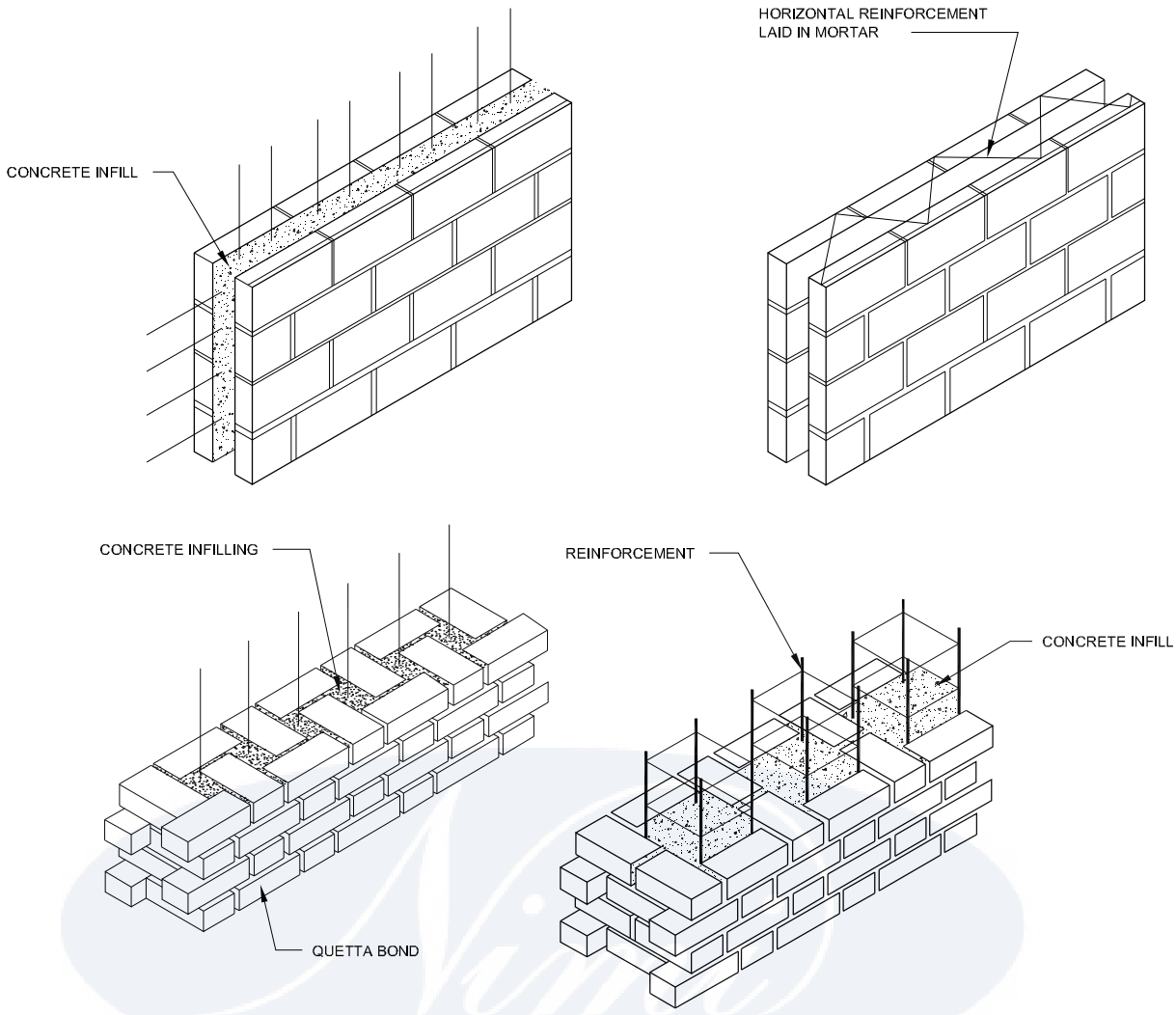
**Reinforced masonry lintes: (Fig 5)**

In case of brick lintels reinforcement in the form of 6 to12 mm diameter bars is provided longitudinally in between in between the vertical joints. Vertical stirrups of 6 mm diameter are provided at every third vertical joint to take up the vertical shear.

**Reinforced masonry slab**

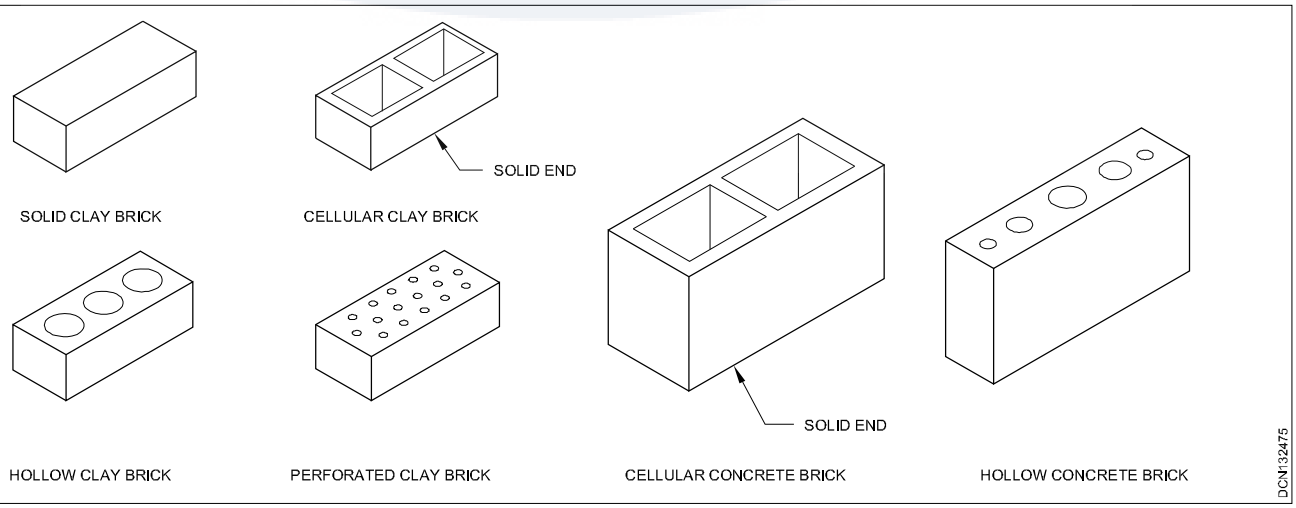
For the construction of masonry slab, the centering in the form of a platform of wooden planks supported on beams is erected at the required level. The centering is covered with well-beaten earth and fine sand is sprinkled over it. Reinforcement is placed in positions and the bricks are laid in one or two courses. Reinforcement should be properly embedded in mortar. Joints should be properly filled with mortar. The slab is kept wet for a period of two to four weeks for proper curing. After 28 days the centering is removed and top and bottom surfaces of slab are suitable finished

Fig 4




**REINFORCED MASONARY WALLS**

Fig 5



# Composite masonry

**Objectives :** At the end of this lesson you shall be able to,
- **explain composite masonry**
- **list out the measures adopted for composite masonry**
- **explain usual combinations to obtain composite masonry.**

### Introduction

When facing and backing of walls are constructed using different types of materials, the construction so obtained is known as composite masonry. The composite masonry reduces the overall cost of construction. This also makes the structure more durable by providing materials of better quality and good workmanship in the facing so as to minimize the effects of atmospheric influcences on the wall.

### Measures adopted for composite masonry

This type of construction results in a large number of mortar joints in the inside than at the outside of the wall. This may lead to unequal settlement. The following measures must be adopted to prevent the unequal settlement.

1 Use large number of tough stones.

2 Provide metal cramps, dowels, lead plugs, etc, between facing and backing of the wall.

3 Provide the hearting portions in rich cement mortar.

4 Carry up the facing and backing portions of the wall simultaneously

### The usual combinations adopted to obtain composite masonry can be listed as below:

Facing of ashlars and backing of rubble masonry or brickwork figure.

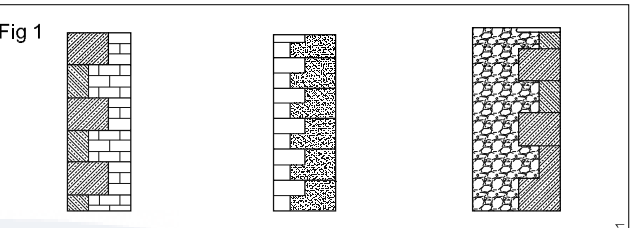
1 Facing of stone slabs and backing of concrete.

2 Facing of brickwork and backing of ashlar masonry.

3 Facing of brickwork and backing of concrete, and

4 Facing of brickwork and backing of hollow concrete blocks.

Fig 1

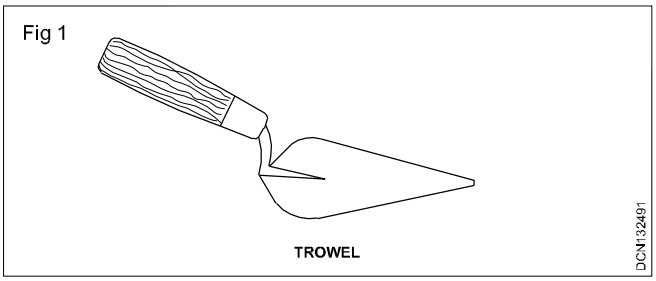



# Tools and equipments used in brick masonry

**Objectives:** At the end of this lesson you shall be able to
- **state the various tools and equipment used in brick work.**

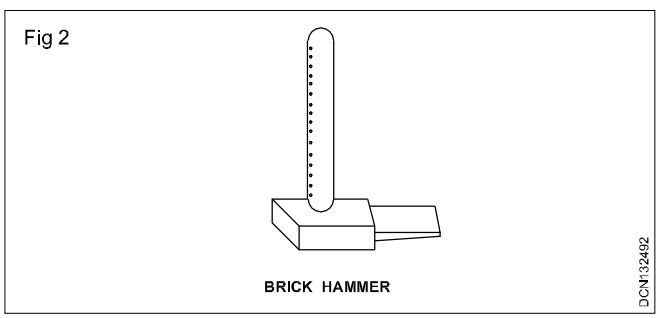
1 Trowel : It consists of a blade and shank in to which a wood handle is fixed. It is used for lifting and spreading mortar on to a wall cutting the brick and forming joints (Fig 1)

Fig 1



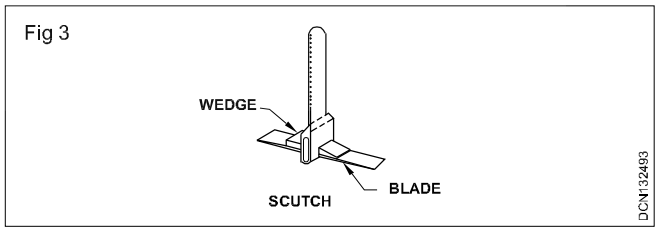

2 Brick hammer : This hammer is used for cutting the bricks to the required shape. One edge of hammer is sharp and the other is square. (Fig 2)

Fig 2



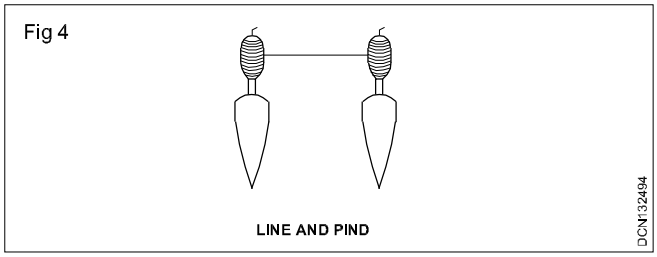

3 Scutch : It is used for cutting soft bricks and dressing the surface of the brick (Fig 3)

Fig 3




4 Line and pin : The line is wood round two pins. It is used to maintain the correct alignment of courses. (Fig 4)

Fig 4




5 Spirit level : Sprit level for getting horizontal surfaces. (Fig 5)

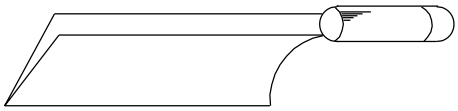
Fig 5

SPIRIT LEVEL

DCN132495

6 Brick axe : It is purpose is similar to brick hammer. (Fig 6)

Fig 6

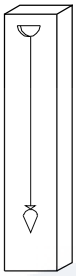


BRICK AXE

DCN132496

7 Plumb rule : Plumb rule is used to clock verticality of brick work or stone wall. (Fig 7)

Fig 7

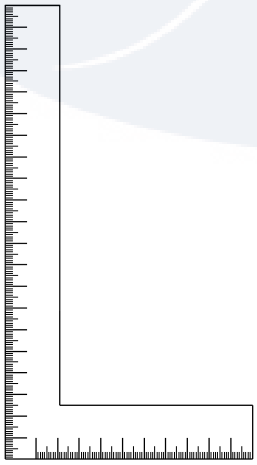


PLUMB RULE

DCN132497

8 Manson's square : It is made of steel or wood is used for checking right angle of the wall. (Fig 8)

Fig 8

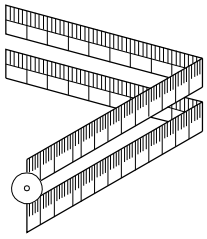


MASON'S SQUARE

DCN132498

9 Four folded foot rule : It is used for taking measurements (Fig 9)

Fig 9

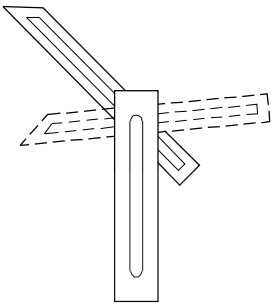


1-METER 4-FOLD RULE

DCN132499

10 Bevel : It is used for setting out angles (Fig 10)

Fig 10



BEVEL

DCN13249A

## Strength of walls

**Objectives:** At the end of this lesson you shall be able to

- **explain strength and stability of walls**
- **state the related posts by category.**

### Strength and stability - walls

The strength of the materials used in wall construction is determined by the strength of a material in resisting compressive and tensile stress and the way in which the materials are put together. The usual method of determing the compressive and tensile strength of a material is to subject samples of the material to tests to assess the ultimate compressive and tensile stress the material fails in compression and in tension.

From these tests the safe working strengths of materials in compression and in tension are set. The safe working strength of a material is considerably less than the ultimate

strength, to provide a safety factor against variations in the strength of materials and theri behaviour under stress. The characteristic working strengths of materials, to an extent, determine their use in the construction of buildings.

The traditional building materials timber, brick and stone have been in use since man first built permanent settlements, because of the ready availability of these natural materials and their particular strength characteristics. The moderate compressive and tensile strength of timber members has long been used to construct a frame of walls, floors and roofs for houses.

The compressive strength of well burned brick combined with the durability, fire resistance and appearance of the material commends it as a walling material for the more permanent buildings.

The sense of solidity and permanence and compressive strength of sound building stone made it the traditional walling material for many larger buildings.

Steel and concrete, which have been used in building since the industrial revolution, are used principally for their very considerable strength as the structural frame members of large buildings where the compressive strength of concrete, separately or in combination with steel, is used for both columns and beams.

In the majority of small buildings, such as houses, the compressive strength of brick and stone in rarely fully utilized because the functional requirements of stability and exclusion of weather dictate a thickness of wall in excess of that required for strength alone. To support the very must loads on the walls of small buildings the thinnest brick or stone wall would be quite adequate.

**Related posts by category**

**Walls**

- Rubble walling and random rubble - wall
- Dowels, Cramps - walls- stones.
- Weathering to cornices, cement joggle-stones-walls.
- Conice and parapet walls, saddle joint-walls-stones.
- Openings to stone walls - lintels.
- Stone masonry walls.
- Vapour barrier, vapour check, external insulation, resistance to the passage of sound.
- Solid walls, mechanical fixing, internal finish.
- Solid walls, adhesive fixing.
- Solid walls: Thermal insulation, internal insulation.
- Brick lintels - walls.
- Prestressed concrete lintels and composite and non-composite lintels - walls.
- Reinforcing rods and casting lintels - walls.
- Head of opening in solid walls and timber lintels.
- Bonding of bricks at rebated jambs - walls.
- Jambs of openings and rebated jambs - walls.
- Openings in solid walls.
- State and tile hanging - walls.
- External weathering to wall of brick and block and rendering.
- Resistance to weather - solid wall of brick.
- Solid walls.
- Cavity wall insulation : Partial fill, insulation materials, insulation thickness, total fill, thermal bridge.
- Resistance to the passage of heat - walls.
- Concrete lintels walls.

## Strength of masonry

**Objectives:** At the end of this lesson you shall be able to
- **explain compressive strength of masonry**
- **explain application - advantages- disadvantages structural limitations of masonry**
- **describe veneer and dry set masonry.**

**Verifying compressive strength of masonry**

For masonry under construction, we need to determine compliance with the specified compressive strength of masonry. We have two options for accomplishing this. One is the unit strength method and the other is testing masonry prisms for compressive strength.

The unit strength method verifies the compressive strength of the individual materials and then uses tables to determine compressive strength of the assembly from that information. The MSJC specification in section 1.4B, compressive strength determination, is one source of tables for the unit strength method and the international building Code (IBC) is another. They are set up similarly. They have one table for clay masonry and one for concrete masonry and each give the compressive strength of the assembly based on the strength of the unit and the type of mortar. If the wall is grouted, then the grout simply has to comply with ASTM C476, specification for grout for masonry, or be the same strength as the specified strength of masonry, but not less than a minimum of 2,000 pounds per square inch (psi).

If you do not use tables, you need to know about constructing prisms to verify compliance with design compressive strength. These specimens are built at the job site. Methods for ths are outlined in ASTM C 1314, Standard test method for compressive strength of masonry prisms, which entails constructing the prisms, including grouting if applicable, and bag curing them.

Masonry prisms for compressive strength testing are constructed and then cured in plastic bags. Following initial curing, they are shipped to the lab in a rig to prevent damage during movement. (IMG15865)

Fig 1

The construction will be deemed acceptable or not acceptable based on the prism test results, so it's important to do the job right. Prisms are fabricated in moisture-tight-bags. Large black polyethylene bags, like heavy-duty trash bags, are common. units are mortared together, and the resulting prisms are left to cure for 24 to 48 hours. If the construction is to be solidly grouted, the prisms are grouted at this time. Following grouting, the bags are resealed and cured for an additional 48 hours or longer. Prisms are then strapped or clamped together to prevent damage during transport to the testing laboratory. Then they are further cured, removed from the bags two days prior to compressive strength testing, and tested in compression at an age of 28 days or another designated test age. This produced values for strength of masonry to determine whether or not the as-constructed wall meets the design requirements.

**Resources**

Standard test method for compressive strength of masonry prims, ASTM C1314-12.

**Masonry**

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Masonry is the building of structures from individual units, which are often laid in and bound together by mortar; the term masonry can also refer to the units themselves. The common materials of masonry construction are brick, building stone such as marble, granite, travertine, and lime stone, cast stone, concrete block, glass block, and cob. Masonry is generally a highly durable form of construction. However, the materials used, the quality of the mortar and workmanship, and the pattern in which the units are assembled can substaintially affect the durability of the overall masonry construction. A person who constructs masonry is called a mason or brick layer.

Fig 2

A mason laying mortar on top of a finished course of blocks, prior to placing the next course



**Applications**

Masonry is commonly used for walls and buildings. Brick and concrete block are the most common types of masonry in use in industrialized nations and may be either weight- bearing or a veneer. Concrete blocks, especially those with hollow cores, offer various possibilities in masonry construction. They generally provide great compressive strength, and are best suited to structures with light transverse loading when the cores remain unfilled. Filling some or all of the cores with concrete or concrete with steel reinforcement (typically rebar) offers much

greater tensile and laterial strength to structures.

Advantages

The use of material such as brick and stones can increase the thermal mass of a building and can protect the building from fire.

Masonry is non - combustible product.

Masonry walls are more resistant to projectiles, such as debris from hurricanes or tornadoes.

**Disadvantages**

Extreme weather, under certain circumstances, can degradation of masonry due to expansion and contractions forces associated with freeze - thaw cycles.

Masonry tends to be heavy and must be built upon a strong foundation, such as reinforced concrete, to avoid setting and cracking.

Other than concrete, masonry construction does not lend itself well to mechanization, and requires more skilled labor then stick-framing.

Masonry consists of loose components and has a low tolerance to oscillation as compared to other materials such as reinforced concrete, plastics, wood, or metals.

**Structural limitations**

Masonry has high compressive strength under vertical loads but has low tensile strength (against twisting or stretching ) unless reinforced. The tensile strength of masonry walls can be increased by thickening the wall, or by building masonry piers (vertical columns or ribs) at intervals. Where practical, steel reinforcements such as windposts can be added.

**Veneer masonry**

A masonry veneer wall consists of masonry units, usually clay- based bricks, installed on one or both sides of a structurally independent wall usually constructed of wood or masonry. In this context the brick masonry is primarily decorative, not structural. The brick veneer is generally connected to the structural wall by brick ties (metal strips that are attached to the structural wall, as well as the mortar joints of the brick veneer). There is typically an air gap between the brick veneer and the structural wall. As clay- based brick is usually not completely water proof, the structural wall will often have a water- resistant surface (usually tar paper) and weep holes can be left at the base of the brick veneer to drain moisture that accumulates inside the air gap. Concrete blocks, real and cultured stones and veneer adobe are sometimes used in a very similar veneer fashion.

Most insulated buildings that utilize concrete block, brick, adope, stone, veneers or some combination there of feature interior insulation in the form of fiberglass batts between wooden wall studs or in the form of rigid insulation boards covered with plaster or drywall. In most climates this insulation in much more effective on the exterior of the wall, allowing the building interior to take advantage of the aforementioned thermal mass of the masonry. This technique does, however, require some sort of weather - resistant exterior surface over the insulation and consequently, is generally more expensive.

**Dry set masonry**

Fig 3

Dry set masonry supports a rusticlog bridge, where it provides a well - drained support for the log (which will increase its service life)

**Dry stone**

The strength of a masonry wall is not entirely dependent on the bond between the building material and the mortar; the friction between the interlocking blocks of masonry is often strong enough to provide a great deal of strength on its own. The blocks someties have grooves or other surface features added to enhance this interlocking, and some dry set masonry structures forgo mortar altogether.

**Compressive strength of brick masonry**

A wall or column carrying a compressive load behaves like any other strut, and its load bearing capacity depends on the compressive strength of the materials, the cross-sectional area and the geometrical properties as expressed by the slenderness ratio.

Fig 4

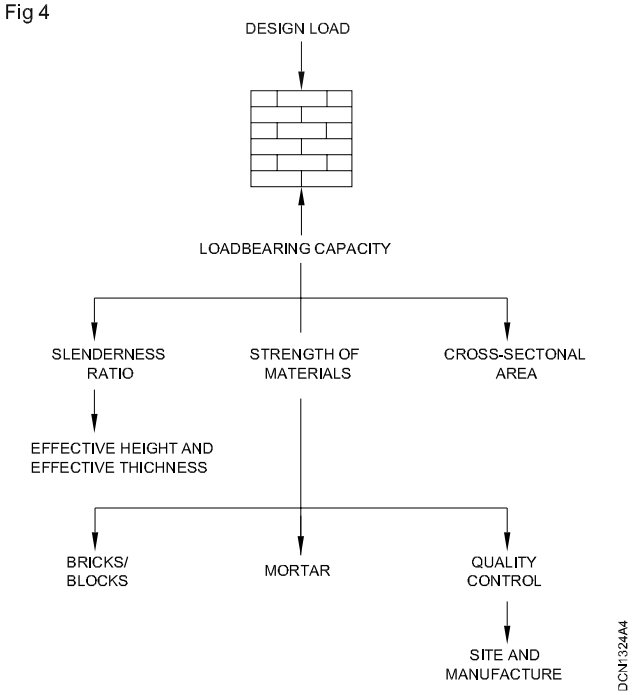
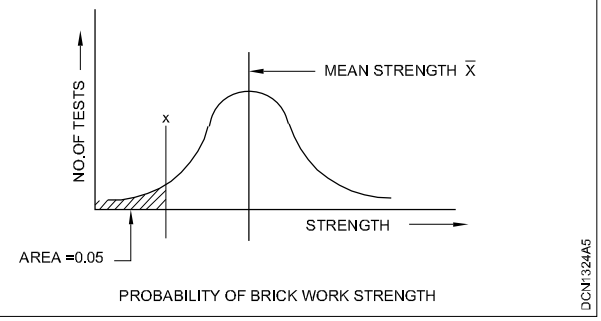


Fig 5




PROBABILITY OF BRICK WORK STRENGTH

The compressive strength of a wall depends on the strength of the units used, the bricks or blocks, and the mortar. The assessment of the combined strength of these elements will also be affected by the degree of quality control exercised in manufacture and construction. The slenderness ratio, in turn, depends upon the effective height (or length) and the effective thickness of the wall or column.

Fig 6

COMPRESSIVE STRENGTH OF UNIT (N/mm $^2$)

| BRICKS | BLOCKS |
|---|---|
| 5.0 | 2.8 |
| 10.0 | 3.5 |
| 15.0 | 5.0 |
| 20.0 | 7.0 |
| 27.0 | 10.0 |
| 35.0 | 15.0 |
| 50.0 | 20.0 |
| 70.0 | 35.0 |
| 100.0 | |

TYPICALLY AVAILABLE VALUES

TYPICAL STRUCTURAL UNITS

BLOCKS OF THESE STRENGTHS MAY NOT BE READILY AVAILABLE

DCN1324A6