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11. BRICKWORK

11.1 SCOPE

All brick masonry required to be constructed under these specifications for masonry buildings, structures, piers, abutments, and perforated as directed by the Engineer-in-Charge, shall consist of the materials herein specified and cement sand mortar shall be proportioned, mixed, and bricks placed in accordance with the requirements stated herein. The requirements set forth herein shall apply to all brickwork, except when such requirements are specifically modified by the Engineer-in-Charge for any particular item of work.

11.2 APPROVAL OF SUPPLY SOURCE

All products supplied under this section must be obtained from an approved source with respect to strength and quality. The contractor will not be permitted to change the source of supply without the permission of the Engineer-in-Charge.

11.3 CLAY MASONRY UNITS (BRICKS)

The clay bricks shall be manufactured from good firm loam with a clay content ranging from 10 to 20 percent as per BS 6669, which will give plasticity index of 7. The earth shall be free from objectionable quantities of lime, gravel, coarse sand and roots or other organic matter. Salts and calcium silicates in the earth shall not exceed 0.5% and 2.0% respectively as given in BS 187.

The common burnt clay bricks shall be hand moulded or machine moulded. They shall be free from nodules of free lime, visible cracks, flaws warp age and organic matter, have a frog 100 mm in length 40 mm in width and 10 mm to 20 mm deep on one of its flat sides as per BS 4729. Bricks made by extrusion process and brick tiles may not be provided with frogs. Each brick shall be marked (in the frog where provided) with the manufacturer's identification mark or initials.

11.3.1 DIMENSIONS

Nominal size of bricks/tiles shall be as follows as per BS 4729:

Bricks	9 inches x 4-1/2 inches x 3 inches (225x113x75mm)
Tiles	12 x 6 x 2 inches (300x150x50mm)
	12 x 6 x 1-1/4 inches
	9 x 4-1/2 x 2 inches, as specified

The bricks shall have smooth rectangular faces with sharp corners and shall be uniform in colour and emit clear ringing sound when struck. Bricks required for construction works usually measure 225x113x75 mm as nominal size. However, Bricks/Tiles used for special works shall measure according to the special needs.

11.4 CLASSIFICATIONS

Bricks as they come from the kiln are stored and stacked in stacks of one or two thousands separately, accordingly as they are First Class, Second Class, Third Class (under burnt or 'pilla' Fourth Class (over-burnt or 'Jhama') and Fifth Class (Sundried) Bricks.

11.4.1 FIRST CLASS BRICKS

The size of bricks shall be as specified. They shall be well burnt without being vitrified. They shall be of uniform colour, regular in shape and size, with sharp and square corners and

parallel faces. They must be homogeneous in texture and emit a clear ringing sound when struck. They shall be free from flaws and cracks. They shall not absorb more than 1/6th of their weight of water after being soaked for one hour at a temperature of 24 to 26°C, and shall show no signs of efflorescence on subsequent drying. The average compressive strength of five representative bricks shall not be less than 2000 pounds per square inch. The average weight of ten bricks shall not be less than 5.5 lbs. (2.5 kgs).

11.4.2 SECOND CLASS BRICKS

Second class bricks shall be as well burnt as first class, or slightly over-burnt but not vitrified in any part and must give a clear ringing sound when struck. In this class of bricks slight irregularities in size, shape, or colour will be accepted but not such as to give irregular or uneven courses when used. Second class bricks may have slight chips or flaws. They shall not absorb more than 1/4th their weight of water after one hour's immersion in water of 24 to 26°C. Their compressive strength shall not be less than 1500 pounds per square inch. The average weight of bricks shall not be less than 5.5 lbs. (2.5 kgs).

11.4.3 THIRD CLASS BRICKS OR UNDER-BURNT OR PILLA BRICKS

These bricks are not as fully burnt as first or second class bricks. Any defects in uniformity or shape must not be such as to cause difficulty in obtaining uniform courses with their use. Their compressive strength shall not be less than 1000 lbs. per square inch. The use of third class bricks is prohibited except as substitutes for sundried bricks.

11.4.4 FOURTH CLASS JHAMA BRICKS

Jhama bricks are bricks so over-burnt as to get vitrified or distorted and are useless for exact work. Their compressive strength shall not be less than 725 lbs. per square inch. They may be broken up for ballast provided the vitrified mass has not become porous or spongy in the process of being over-burnt.

11.4.5 FIFTH CLASS OR SUNDRIED BRICKS

Sundried bricks shall be un-burnt bricks. Any defects in uniformity or shape must not be such as to cause difficulty in obtaining uniform courses with their use. Their compressive strength shall not be less than 500 lbs. per square inch.

11.4.6 GENERAL PHYSICAL CHARACTERISTICS

A good clay brick should have a fine, compact and uniform texture. It should be sound, hard and well burnt, and should give a metallic tinkle when struck with a hammer or another brick. It should be of uniform colour and free from cracks, fissures, holes, air bubbles, lumps, pebbles and stones and particles of lime, etc. It should not contain soluble salts in excess of 0.5%.

11.5 COMPRESSIVE STRENGTH

Bricks/Brick tiles shall be classified on the basis of their minimum compressive strength specified and summarised here below:

Designation	Average compressive strength (lbs/Sq.inch)
First Class	2000
Second Class	1500
Third Class	1000
Fourth Class	725

11.6 SAMPLING AND TESTS

Samples of bricks shall be subjected to the following tests:

- (a) Dimensional tolerance.
- (b) Water absorption.
- (c) Efflorescence.
- (d) Compressive strength.

11.6.1 SAMPLING

For carrying out compressive strength, water absorption, efflorescence and dimensional tests, the samples of bricks shall be taken by one of the methods given below:-

Sampling Bricks or Tiles from a motion:

Whenever practicable samples shall be taken whilst the bricks or tiles are being moved; for example, during loading or unloading. In this case the bricks or tiles shall be taken at random from each of a number of convenient portions of the consignment or batch. The portion chosen should be small enough in relation to the whole to provide the minimum number of samples specified below.

Sampling Bricks or Tiles from a stack:

Samples shall be taken each at random from a stack of bricks or tiles. The number of bricks required for the tests shall be taken from across the top of the stack, the sides accessible and from the interior of the stack by opening the trenches from the top.

Whichever method is employed a sample of 50 bricks/tiles shall be taken at random from every consignment of 50,000 bricks/tiles or part thereof.

The samples thus taken shall be stored in a dry place not in contact with the ground until the tests are made. The bricks for tests shall be taken at random from the sample.

11.6.2 TESTING OF SAMPLES

11.6.2.1 VISUAL & DIMENSIONAL CHARACTERISTICS

The Visual & Dimensional Characteristics of bricks/tiles as specified under 11.4.1, 11.4.2 & 11.4.6 shall be checked on a sample of 20 first class & 2nd class bricks.

11.6.3 COMPRESSIVE STRENGTH

The average compressive strength of five representative bricks, when tested according to ASTM Designation C-67 shall have a minimum average compressive strength for various classes as given in Sub-Section 11.5. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%.

11.6.4 WATER ABSORPTION

The average water absorption of first class & second class bricks for a sample of five bricks when tested shall be not more than as specified in Clause 11.4.1 and 11.4.2.

11.6.5 EFFLORESCENCE

The bricks checked for water absorption as per Clause 11.6.4 shall show no signs of efflorescence in drying.

11.6.6 CRITERIA OF ACCEPTANCE

If more than 10% bricks in the stacks do not conform with any of the specification requirements, than the whole consignment shall be rejected.

11.7 BRICK WORK

11.7.1 CLASSIFICATION

The brick work shall be classified according to the class designation of bricks used. The specifications stated hereof are for First class brick masonry in cement sand mortar except specified otherwise.

11.7.2 MORTAR

The mortar cement sand for the brick work shall be as specified. For sundried brick mud mortar shall be used.

A. Mud Mortar

1. Composition

Mud mortar for brickwork and masonry shall be prepared from good earth and water, Sand or shopped straw shall be added to the earth that is too clayey. Mud mortar for plastering shall be prepared from earth, water and chopped "bhoosa".

2. Materials

a) Earth

Earth shall be good firm loam with clay content ranging from 10% to 20% will give plasticity index of 7. The earth shall be free from objectionable quantities of lime, gravel, coarse sand and roots of other organic matter. Salts and calcium contents shall not exceed 0.5% and 2% respectively; i.e. it shall be good brick earth or selected clay obtained from approved sources. Clay containing more than 0.5% soluble salts, more than 0.2% sulphates and 4% organic content or efflorescent salts or taken from a locality where there are white ants shall not be used. In case of brick earth it shall be reduced into fine powder & free from stones, grass, kankar, roots and other matter.

b) Water

Only fresh and clean water free from earth, vegetations, organic impurities and any other substances likely to cause efflorescence or otherwise prove harmful to the work shall be used. Water containing injurious amounts of oils, acids, alkalis, Salts, sulphides, chlorides, carbon dioxide shall not be used. The pH Value of water shall range between 6 & 8.

Broadly speaking water which does not show an intensive odour or brackish taste shall be acceptable.

3. Preparation

Earth / Clay shall be mixed with water on a plane ground surface especially cleared for the purpose and tempered for at least two days. During this period it shall be worked up at intervals with men's feet and "phowrahs". Sand or chopped straw shall be added, as desired, to the earth that is too clayey. Mud mortar for plastering shall be prepared as specified above and 1.8 kg of chopped "bhoosa" shall be thoroughly mixed with 0.03 cum of mortar.

4. **Consistency**

The consistency of mud mortar shall be of a type that it shall readily slide off the face of trowel, but the mortar shall not be so wet that it parts into large drops in falling. No water shall be added to the mortar after it is delivered to job.

5. **Pits**

Unless otherwise specified or directed by the Engineer, the contractor shall make his own arrangements for obtaining the necessary earth / clay for the mortar. When permitted by the Engineer to take earth from the site of work, the contractor shall fill all pits with good earth and dress them off properly on the completion of work.

6. **Restriction of Use**

Mud mortar shall not be used for any masonry or brickwork likely to remain under water at any time or likely to bear pressure other than directly vertical.

B. **Cement Mortar**

Composition

Cement mortar shall consist of one part Portland cement to specified number of parts of dry loose sand (Fine aggregate) by volume and sufficient water to produce proper consistency for intended use. Waterproofing agent not exceeding 25% by volume of dry cement shall be added when specially required or directed by the Engineer-in-Charge.

1. **Materials**

a) **Portland Cement**

Portland Land cement shall conform to ASTM C 150-94 Type I or B.S.S.12.

b) **Sand**

Sand shall be such that it passes through a No.16 sieve and not more than 30 percent, passes through a sieve of 100x100 meshes to the square inch. The sand used or supplied shall be clean sand, gritty to the touch and free from any admixture of clay, loam, salts, organic matter or other impurities. The sand shall be of such cleanness that when a handful of it is shaken in a glass with clean water and allowed to stand for one hour the precipitation of mud (or flour in the case of screenings) on the sand shall not exceed 10%. If more than this precipitate is found, the sand shall be washed.

The source of the sand is subject to the approval of the Engineer-in-Charge from the designated sources.

c) **Water**

Water shall conform with specifications for water for mud mortar clause 11.7.2.

2. **Mix**

Unless otherwise specified or directed by the Engineer-in-Charge, the ingredients for cement mortar shall be proportioned by volume.

3. **Preparation**

- a) Methods and equipment used for mixing mortar ingredients – including their mixing in dry state – shall be such as will accurately determine and control the amount of each separate ingredient entering into the mortar and shall be subject to the approval of the Engineer-in-Charge. Normally cement and sand is thoroughly mixed in a dry state on a pucca platform or in troughs as directed by the Engineer-in-Charge. It shall be gauged with a quantity of water sufficient to make the mortar workable.

Water shall be added with a fine rose. Only such quantity of mortar shall be prepared as can be used before the initial setting time.

- b) If a mixer is used, it shall be of the approved design. The mixing time after all the ingredients are in the mixer, except for the full amount of water, shall be not less than two minutes. Water shall be added at a uniform rate during the mixing time.
- c) Mortar shall be mixed only in sufficient quantities for immediate use and all mortar not used within thirty (30) minutes after addition of the water to the mix shall be wasted. Re-tempering of mortar will not be allowed. Mixing troughs and pans shall be thoroughly cleaned and washed at the end of each day's work. When colour for face work is specified to be mixed in it shall be of approved quality and brand and shall be added in such quantity to obtain the required shade, water proofing material shall be added only when specifically directed.

C. Lime Mortar

a) Composition

Lime mortars, as specified herein, shall consist of one of the following combinations mixed in specified proportions and water sufficient to produce proper consistency for the use of mortar;

- 1. Stone lime and Surkhi
- 2. Kankar Lime and Sand
- 3. Slaked Kankar or Stone Lime & Cinder

b) Materials

1. Lime

Lime for lime mortars shall be obtained from suitable calcinations of naturally occurring forms of Calcium Carbonates (Lime stone or Kankar).

2. Surkhi

Surkhi used as substitute for sand shall be made by grinding fully burnt first class bricks, brick bats or burnt clay to powder. On no consideration surkhi shall be obtained from over burnt or under burnt bricks and bats or from kiln lining. Surkhi shall pass through a screen of 12x12 meshes to 6.45 square cms and in case, it is required for works to remain under water, the size of mesh shall be 8x8. It shall in no case pass one of 50x50 meshes to the 6.45 square cms.

3. Cinder

Cinder shall be obtained from an approved source. It shall be free from admixtures of clay, dust, vegetation or foreign matter. Only clean surface clinker coal i.e. residue from furnaces of steam boilers using coal fuel only shall form the parent material. After having been ground in mill and screened, the whole of it shall pass through a screen of 12x12 meshes to the 6.45 square cms but does not pass through a mesh of 50x50 mesh shall be used.

4. Sand

Sand shall conform to specifications, requirements and stipulations specified for sand para 11.7.2 (ii) (2) (b) of cement mortar.

5. Water

Water shall conform to Specifications described under para 11.7.2 (ii) (c), "cement mortar".

c) Mix

Unless otherwise specified or directed by the Engineer-in-Charge, the ingredients for lime mortar shall be proportioned by volume.

1. Mortar for Masonry and Brickwork

Thoroughly slaked and screened stone lime/kankar lime and surkhi/sand shall be measured in boxes and mixes on a pucca platform or in a mixing trough as specified. The troughs, if used, shall be capable of being washed and drained. These ingredients shall be mixed twice in a dry state and then ground in a grinding mill with a quantity of water sufficient to produce a mortar of specified consistency.

2. Mortar for Plastering and Pointing

Unless otherwise specified one part of lime mixed with two parts of surkhi by volume shall be kept under water for at least 12 hours and then made to pass through a screen of 12x12 meshes per 6.45 sq. cms. Requisite coloring material shall be added to it and the mortar applied as fresh as possible.

11.7.3 SOAKING OF BRICKS

Bricks shall be soaked in water before use for a period for the water to just penetrate the whole depth of the bricks. The soaking of bricks would be for 2 to 3 hrs. Alternatively bricks may be adequately soaked in stacks by profusely spraying with clean water at regular intervals for a period not less than six hours. The bricks required for masonry work using mud mortar shall not be soaked. When the bricks are soaked they shall be removed from the tank sufficiently early so that at the time of laying they are skin-dry. Such soaked bricks shall be stacked on a clean place where they are not again spoiled by dirt earth etc.

Note I:

The period of soaking may be easily found at site by a field test in which the bricks are soaked in water for different periods and then broken to find the extent of water penetration. The least period that corresponds to complete soaking will be the one to be allowed for in construction work.

Note II:

If the bricks are soaked for the required time in water that is frequently changed the soluble salt in the bricks will be leached out, and subsequently efflorescence will be reduced.

11.7.4 BRICK MASONRY CONSTRUCTION

11.7.4.1 DURABILITY

There are four main causes which impair the durability of brickwork: frost action, crystallization of soluble salts, chemical action and moisture movement. Since it is the presence of water in brickwork which is responsible for bringing these causes into action the first safeguard is to protect the work by avoiding unnecessary exposure and providing damp-proof courses, where practicable.

Frost can affect both the bricks and the mortar, and its effects are fairly straightforward. The affected part spalls or crumbles with the action of ice-forming in its saturated pores. Crystallisation of salts and chemical action depend on the presence of soluble salts which may originate in the bricks or the mortar or both. The movement of salts to the surface of the wall is influenced by pore structure of its elements, so that some of the salts from the brick may come out at joints and vice versa. It is possible to control to some extent the incidence of efflorescence and crystallization by ensuring that the parts at which these actions would be least harmful are most porous. In the case of chemical action, an important type of failure occurs when clay bricks containing a dangerous proportion of calcium sulphate are bonded in mortar containing cement or covered with a rendering containing cement. In certain damp conditions the sulphate can combine with cement and cause general expansion and failure of work

11.7.4.2 BONDS

Bond is the name given to any arrangement of bricks in which no vertical joint of a course is exactly over a vertical joint in another course immediately above or below it, and has the greatest possible amount of lap, which is usually one-fourth the length of a brick.

To ensure good bond the following rules should be rigidly adhered to:

- a) Bricks must be arranged in a uniform manner.
- b) Fewest possible bats are employed.
- c) Vertical joints in every other course must be perpendicularly in line on the internal as well as the external face.
- d) Stretchers are to be used only on the faces of the wall; the interior should consist of headers only, as also the footings and corbels.
- e) When bedded the length of a brick should equal twice the width, plus one mortar joint.
- f) Lateral lap between perpend is $\frac{1}{4}$ of brick length.

Common types of bonds used in brickwork are described as follows:-

a) **ENGLISH BOND:**

It consists of one course of headers and one course of stretchers alternately. In this bond, bricks are laid as stretchers only on the boundaries of courses, thus showing on the face of the wall. The joints in a course running through from back to front of a wall must not be broken. The course which consists of stretchers on the face is known as a stretching course. The courses above or below should consist of headers with the exception of the closer brick, which is always placed next to the quoin header to complete the bond. These courses are called as heading courses.

It may be noticed that in walls the thickness of which is a multiple of a whole brick the same course will show

Either

- a) Stretchers in front elevation and stretchers in back elevation.

Or

- b) Headers in front elevation and headers in back elevation.
But in walls whose thickness is an odd number of half brick, the same course will show

Either

- a) Stretchers in front elevation and headers in back elevation.

Or

- b) Headers in front elevation and stretchers in back elevation.

In setting out the plan of a course to any width, the quoin or corner brick should be drawn: then next to the face (which in front elevation shows headers) closers should be to the required thickness of wall; after which all the front headers should be set out and, if the thickness is a multiple of a whole brick, headers in rear should be set out. The intervening space, if any, should always be filled in with headers.

b) **DOUBLE FLEMISH BOND**

This bond has headers and stretchers alternatively in the same course, both in front and back elevation. It is weaker than the English Bond because of the greater number of bats and stretchers, but is considered by some to look better on the face. It is also economical, since a

greater number of bats may be used in it and thus bricks broken in transit may be utilized. By using the Double Flemish Bond for walls one brick in thickness, it is easier to obtain a better appearance on both sides than with the English Bond.

c) SINGLE FLEMISH BOND

It consists in arranging the bricks as Flemish Bond on the face, and English Bond as backing. This is often done on the presumption that it attains the strength of the English Bond and the external appearance of the Double Flemish. It is generally used where expensive bricks are specified for facing. The thinnest wall where this method can be introduced is 1-1/2 brick thick.

d) STRETCHING BOND

Stretching bond is used for walls half-brick thick such as partition walls, brick nogging in partitions. All bricks are laid as stretchers upon the face.

e) HEADING BOND

All bricks in this bond show as header on face. It is used chiefly for rounding curves, for footings, corbels and cornices.

f) RACKING BOND

Walls as they increase in thickness increase in transverse strength but proportionally weaker in longitudinal direction, owing to the fact that stretchers are not placed in the interior of walls. This defect is remedied by using racking courses at regular intervals of four to eight courses in the height of a wall. The joints of bricks laid in this position cannot coincide with the joints of ordinary courses directly above or below, the inclination to the face usually being determined by making the longitudinal distance between the opposite corners equal to the length of brick. It is not advisable to use one racking course directly above another, since there is always a weakness at the junction of the racking with the face bricks.

Racking bonds are most effective when placed in the stretching courses in walls of even an even number of half bricks in thickness. In this way they are effective over a greater area than if they were placed in the heading course.

The alternate courses of racking bonds should be laid in different directions in order to make the tie as perfect as possible. There are two varieties of racking bonds, viz. Herring bond and diagonal.

11.7.4.3 LAYING

(a) General

The brick laying shall be carried out complete with all embedment and installations for completion of the construction as shown on drawings and directed by the Engineer-in-Charge.

Bricks shall be laid in English Bond unless otherwise specified. For brick work in half brick wall, bricks shall be laid in stretcher bond. Half or cut bricks shall not be used except as closers where necessary to complete the bond. Closers in such cases, shall be cut to the required size and used near the ends of the wall. Header bond shall be used preferably in all courses in curved plan for ensuring better alignment.

Note:

Header bond shall also be used in foundation footings unless thickness of walls (width of footing) makes the use of headers impracticable. Where thickness of footing is uniform for a number of courses, the top course of footing shall be headers.

All loose materials, dirt and set lumps of mortar which may be lying over the surface on which brick work is to be freshly started, shall be removed with a wire brush and surface wetted. Bricks shall be laid on a full bed of mortar, when laying, each brick shall be properly bedded and set in position by gently pressing with the handle of a trowel. Its inside face shall be buttered with mortar before the next brick is laid and pressed against it. Joints shall be fully filled and packed with mortar such that no hollow spaces are left inside the joints.

(b) Bedding of Bricks

While bedding bricks, both the bed and side joints must be thoroughly flushed or filled up with mortar.

(c) Levelling

While bedding bricks, great care should be taken to keep all courses perfectly level. To do this, the footing and the starting course should be carefully levelled, using a spirit level with a stack at least 10 feet long.

11.7.4.4 CONSTRUCTION OF WALLS

a) The walls shall be taken up truly in plumb or true to the required batter where specified. All courses shall be laid truly horizontal and all vertical joints shall be truly vertical. Vertical joints in the alternate course shall come directly one over the other. Quoin, Jamb and other angles shall be properly plumbed as the work proceeds. Care shall be taken to keep the perpend properly aligned within following maximum permissible tolerances:

- (i) Deviation from vertical within a storey shall not exceed 6 mm per 3 m height.
- (ii) Deviation in verticality in total height of any wall of building more than one storey in height shall not exceed 12.5 mm.
- (iii) Deviation from position shown on plan of any brick work shall not exceed 12.5 mm.
- (iv) Relative displacement between load bearing wall in adjacent storeys intended to be vertical alignments shall not exceed 6 mm.
- (v) A set of tools comprising of wooden straight edge, Masonic spirit levels, square, 1 metre rule line and plumb shall be kept on the site of work for every 3 masons for proper check during the progress of work.

All quoins shall be accurately constructed and the height of brick courses shall be kept uniform. This will be checked using graduated wooden straight edge or storey rod indicating height of each course including thickness of joints. The position of damp proof course, window sills, bottom of lintels, top of the wall etc. along the height of the wall shall be marked on the graduated straight edge or storey rod. Acute and obtuse quoins shall be bonded, where practicable in the same way as square quoins. Obtuse quoins shall be formed with squint showing three quarters brick on one face and quarter brick on the other.

b) Raking

The brick work shall be built in uniform layers. No part of the wall during its construction shall rise more than one metre above the general construction level. Parts of wall left at different levels shall be raked back at an angle of 45 degrees or less with the horizontal by setting back 2-1/2 inches at each course, with a maximum of twelve courses, to reduce the possibility and the unsightliness of defects caused by any settlement that may take place in the most recently built portion of the wall. Tothing shall not be permitted as an alternative to racking back. For half brick partition to be keyed into main walls, indents shall be left in the main walls.

c) Other Factors

All pipe fittings and specials, spouts, hold fasts and other fixtures which are required to be built into the walls shall be embedded, as specified, in their correct position as the work proceeds unless otherwise directed by the Engineer-in-Charge.

Top courses of all plinths, parapets, steps and top of walls below floor and roof slabs shall be laid with brick on edge, unless specified otherwise. Brick on edge laid in the top courses at corner of walls shall be properly radiated and keyed into position to form cut (marrow) corners as shown in Where bricks cannot be cut to the required shape to form cut (marrow) corners, cement concrete 1:2:4 (1 cement :2 coarse sand : 4 graded stone aggregate 20 mm nominal size) equal to thickness of course shall be provided in lieu of cut bricks.

Bricks shall be laid with frog (where provided) up. However, when top course is exposed, bricks shall be laid with frog down. For the bricks to be laid with frog down, the frog shall be filled with mortar before placing the brick in position.

In case of walls one brick thick and under, one face shall be kept even and in proper plane, while the other face may be slightly rough. In case of walls more than one brick thick, both the faces shall be kept even and in proper plane.

To facilitate taking service lines later without excessive cutting of completed work, sleeves shall be provided, where specified, while raising the brick work. Such sleeves in external walls shall be sloped down outward so as to avoid passage of water inside.

Top of the brickwork in coping and sills in external walls shall be slightly tilted. Where brick coping and sills are projecting beyond the face of the wall, drip course/throating shall be provided where indicated.

Care shall be taken during construction that edges of jambs, sills and projections are not damaged in case of rain. New built work shall be covered with gunny bags or tarpaulin so as to prevent the mortar from being washed away. Damage, if any, shall be made good to the satisfaction of the Engineer-in-Charge.

(d) Stability

The stability of brickwork is affected in three general ways:

1. By loading a given area of ground beyond its ultimate resistance, by an irregular concentration of great pressures on a soft sub-soil, by the tendency of the sub-stratum to slid or by eccentric loadings, the walls are thrown out of the upright, crack or disintegrate.
2. By bad bonding, resulting in disintegration.
3. By side thrusts which may be distributed or concentrated, and their tendency is to overturn the walls; they are provided for by designing the walls of a sufficient thickness, or by placing buttresses at regular intervals.

11.7.5 JOINTS

The horizontal joints shall be parallel whereas vertical joints in alternative courses shall be directly over one another. The thickness of the vertical joints shall be approximately 6 millimetres and the thickness of horizontal joints shall be 10 millimetres.

Finishing of Joints:

The face of brick work may be finished flush or by pointing. In flush finishing either the face joints of the mortar shall be worked out while still green to give a finished surface flush with the face of the brick work or the joints shall be squarely raked out to a depth of 1 cm while the mortar is still green for subsequently plastering. The faces of brick work shall be

cleaned with wire brush so as to remove any splashes of mortar during the course of raising the brick work. In pointing, the joints shall be squarely raked out to a depth of 1.5 cm while the mortar is still green and raked joints shall be brushed to remove dust and loose particles and well wetted, and shall be later refilled with mortar to give ruled finish. Some such finishes are 'flush', 'weathered', ruled, etc.

11.7.6 CURING

The brick work shall be constantly kept moist on all faces for a minimum period of seven days. Brick work done during the day shall be suitably marked indicating the date on which the work is done so as to keep a watch on the curing period.

11.7.7 SCAFFOLDING

Scaffolding shall be strong to withstand all dead, live and impact loads which are likely to come on them. Scaffolding shall be provided to allow easy approach to every part of the work and safe working

11.7.8 SINGLE SCAFFOLDING

Where plastering, pointing or any other finishing has been indicated for brick work, single scaffolding may be provided, unless otherwise specified. In single scaffolding, one end of the put-logs/pole shall rest in the hole provided in the header course of brick masonry. Not more than one header for each put-log/pole shall be left out. Such holes shall not be allowed in the case of pillars, brick work less than one metre in length between the openings or near the skew backs of arches or immediately under or near the structural member supported by the walls. The holes for putlogs/poles shall be made good with brick work and wall finishing as specified.

11.7.9 DOUBLE SCAFFOLDING

The brick work or tile work is to be exposed and not to be finished with plastering etc. double scaffolding having two independent supports, clear of the work, shall be provided.

11.7.10 BRICK LAYING IN FREEZING WEATHER

a) PROTECTION OF BRICKS:

All bricks delivered for use in freezing weather shall be fully protected immediately upon delivery by a weather-tight covering that will prevent the accumulation of water, snow or ice on the bricks; loose board covering shall not be permitted.

b) HEATING OF SAND:

All sand shall be heated in such a manner as will remove all frost, ice or excess moisture but will prevent the burning or scorching of the sand.

c) HEATING OF BRICKS:

All frosted bricks shall be defrosted by heating them to a temperature of approximately 180° F.

d) HEATING OF WATER

All water used shall be heated to a temperature of approximately 180°F.

e) SLAKING OR SOAKING OF LIME:

All slaking of quick lime or soaking of hydrated lime shall be done at a temperature of at least 60° F, and this temperature shall be maintained until lime is incorporated into the mortar.

f) **PROTECTION OF MORTAR AGAINST FREEZING:**

After the mortar has been mixed it shall be maintained at such temperature as will prevent its freezing at all times and if necessary the contractor shall use metal mortar board equipped with oil torches. No anti-freeze liquid, salt or other substance shall be used in mortar, except when specified or permitted by the Engineer-in-Charge.

g) **ENCLOSURES AND ARTIFICIAL HEAT:**

All work under construction shall be protected from freezing for a period of 48 hours by means of enclosures, artificial heat or by other suitable methods duly approved by the Engineer-in-Charge.

11.8 BRICK WORK IN ARCHES

The detailed specifications for brick work mentioned in 11.7 shall apply, in so far as these are applicable. Arch work shall include masonry for both gauged as well as plain arches. In gauged arches, cut or moulded bricks shall be used. In plain arches, uncut bricks shall be used.

Brick forming skew-backs shall be dressed or cut so as to give proper radial bearing to the end voussoirs. Defects in dressing of bricks shall not be covered by extravagant use of mortar, nor shall the use of chips or bats etc. be permitted. The bricks of the spandrel wall at their junctions with extrudes of the arch shall be cut to fit the curvature of the arch.

11.8.1 CIRCULAR ARCHES

These shall be either (a) plain arches, and shall be built in half brick concentric rings with break joints, or (b) gauged arches built with bricks cut or moulded to proper shape. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The bricks shall be flush with mortar and well pressed into their positions so as to squeeze out a part of their mortar and leave the joints thin and compact. All joints shall be full of mortar and thickness of joints shall not be less than 5 mm nor more than 15 mm.

After the arch is completed, the haunches shall be loaded by filling up the spandrels upto the crown level of the arch. Care shall be taken to load the haunches on two sides of the spandrels.

When the arch face is to be pointed (and not plastered), the face bricks shall be cut to proper shape or moulded, so as to have the joints not more than 5 mm thick. These shall be laid with radial joints to the full depth of the arch. The voussoirs shall break joints to the full depth of the arch.

11.8.2 FLAT ARCHES

These shall be gauged arches of brick cut or moulded to proper shape. The extrados shall be kept horizontal and the intrados shall be given slight camber of 1 in 100 of the span. The centre of the arch from which joints shall radiate, shall be determined by the point of the inter-section of the two lines drawn from the ends of the arch at the springing level and at 60° to horizontal.

In flat arches, bricks shall be laid with radial joints to the full depth of arch and voussoirs breaking joints with each other. The arch work shall be carried up from both ends simultaneously and keyed in the centre. The thickness of the joints shall not exceed 5 mm. Flat arches may be used for the sake of appearance but for purpose of carrying loads of the wall above, these shall be used in conjunction with relieving arches, lintels placed below.

11.8.3 CENTRING AND SHUTTERING

The centring and shuttering for the arch shall be got approved by the Engineer-in-Charge before the arch work is started. It shall be strong enough to bear the dead load of the arch and the live loads that are likely to come upon it during construction, without any appreciable deflections.

The shuttering shall be tightened with hard wood wedged or sand boxes, so that the same could be eased without jerks being transmitted to the arch. The sequence of easing the shuttering shall be got approved from the Engineer-in-Charge. The shuttering shall be struck within 48 hours of the completion of the arch but not before 24 hours. This shall be done after the spandrel has been filled in and the arch loaded.

11.9 BRICK TILE WORK

The work shall be done in the same manner as described in Sub-section 11.7 except that brick tile shall be used instead of bricks.

11.10 HONEY COMB BRICK WORK/PERFORATED BRICK MASONRY

The honeycomb brick work shall be done with specified class of brick, laid in specified mortar. All joints and edges shall be struck flush to give an even surface.

The thickness of the brick honeycomb work shall be half-brick only, unless otherwise specified. Openings shall be equal and alternate with half brick laid with a bearing of 2 cm on either side.

11.11 JOINING OLD BRICK WORK WITH NEW BRICK WORK

In case the height of the bricks of old as well as new work is same, the old work shall be toothed to the full width of the new wall and to the depth of a quarter of brick in alternate courses. In case the height of the bricks is unequal, then the height of each course of new work shall be made equal to the height of the old work by adjusting thickness of horizontal mortar joints in the new wall. Where necessary, adjustment shall be made equal to thickness of old wall by adjusting the thickness of vertical joints. For joining new cross wall to old main walls, a number of rectangular recesses of width equal to the thickness of cross wall, three courses in height and half a brick in depth shall be cut in the main walls. A space of the three courses shall be left between two consecutive recesses. The new cross wall shall be bonded into the recesses to avoid any settlement. Joining of old brick work with the new brick work shall be done in such a way that there shall not be any hump or projection at the joint.

11.12 MOULDING AND CORNICES

The specifications described under 11.7 shall apply in so far these are applicable. Mouldings and cornices shall be made with bricks as specified for brick work. The bricks shall be cut and dressed to the required shape as shown in the architectural drawings.

Cornices shall not ordinarily project by more than 15 cm to 20 cm and this projection shall be obtained by projecting each brick course by more than one fourth of the length. For cornices projecting more than 20 cm and requiring more than quarter bricks projection, metal cramps shall be used and paid for separately. Corbelling shall be brought roughly to shape by plastering with the specified mortar. When the mortar is still green, the mouldings shall be finished straight and true with the help of metal templates.

11.12.1 CURING AND PROTECTION

The mouldings and cornices shall be cured for at least seven days. These shall be protected from the effects of sun and rain by suitable covering and also from damage during the execution of the work.

11.13 EXPOSED BRICK WORK

11.13.1 FACING BRICKS

The facing bricks made from suitable soils shall be free from cracks, flaws, nodules of free lime warp age and organic matter. These shall be thoroughly burnt and shall have plane rectangular faces with parallel sides and sharp straight right angled edges. Facing bricks shall have uniform colour and even texture. Unless otherwise specified, facing bricks shall be machine moulded only. As far as possible, total requirement of facing bricks for a work shall be arranged from the same kiln. Bricks with chipped edges and broken corners shall not be used.

Facing bricks shall be of 1st class unless otherwise specified, water absorption shall not exceed 20 per cent by weight and efflorescence rating shall be nil. Mortar, Soaking of Bricks and laying shall be as specified in Para 11.7.2, 11.7.3 and 11.7.4 respectively.

Joints in the exposed brick work shall be truly horizontal and vertical and kept uniform with the help of wooden or steel strips. The thickness of joints shall be as per 11.7.5. Curing and scaffolding shall be as specified in 11.7.6 and 11.7.7 respectively.

11.13.2 FURTHER REQUIREMENTS

All face work shall be finished with neatly drawn joints and pointed if it has not to be plastered. If it has to be plastered, the joints shall be raked out before any plaster is laid on. The raking shall be done with a hook to a depth of 13mm before the mortar sets each day. Where pointing or plastering to the face work is not provided as a separate item, the joints in the face work shall be struck. For face work, the bricks shall be of true edges, uniform colour and correct dimensions. If specially required, face work shall be laid up with pressed bricks. All brick courses shall be so proportioned that they will work out evenly with the height of the windows and doors. Backing of the pressed brickwork shall be done as per specifications for brickwork, or as specifically directed by the Engineer-in-Charge.

- a) Steel reinforcement and steel ties, if any, shall be provided and installed as indicated on the Drawings or directed by the Engineer-in-Charge.
- b) Openings or chases shall be provided in the brickwork as shown on the Drawings or required by the Engineer-in-Charge.
- c) If, after the completion of any brickwork, brick is out of alignment or level, or does not conform to the lines and grades shown on the Drawings, or shows a defective surface, it shall be removed and replaced by the Contractor at his expense unless the Engineer-in-Charge grants permission, in writing, to patch or replace the defective area.

11.14 CAVITY WALL

11.14.1 GENERAL

It is a wall comprising of two leaves, each leaf being built of masonry units and separated by a cavity so as to provide an air space within the wall and tied together with metal ties or bonding units to ensure that two leaves act as one structural unit. The width of the cavity shall not be less than 50 mm and not more than 115 mm. Each leaf of the cavity wall shall not be less than 75 mm. The space between the leaves being either left as cavity or filled with non-load bearing insulating and water proofing material.

11.14.2 MATERIALS

The bricks shall be first class bricks specified in this Section. The mortar shall be cement sand mortar as specified in accordance with the provisions of Sub-section 11.7.2 (ii).

The laying of bricks masonry for cavity walls shall comply with provisions of Sub-sections 11.7.3 & 11.7.4. Curing and scaffolding shall be as per Sections 11.7.6 & 11.7.7.

11.14.3 METAL TIES

These may be of galvanised iron, wrought iron, gun metal, brass, copper, stainless steel or any such corrosion resistant metal, made of flats 20 x 5 mm cranked or twisted at their mid-point with ends split and fish tailed. The ties shall be built into horizontal bed joints during erection, placed sloping towards the exterior side to prevent water from flowing along it from outer to inner leaf side.

11.14.4 BONDING UNITS

Length of the Bonding units will be sum of thickness of both leaves plus width of cavity if the leaves are 75 mm or 115 mm. If the leaves are more than 115 mm thick, then the length of a unit will be $[(2 \times 115) + \text{width of cavity}]$.

Cement concrete used in the bonding units shall not be leaner than 1:3:6 (1 cement : 3 sand : 6 aggregate 20 mm nominal size).

11.14.5 SPACING

Metal ties/bonding units shall be spaced not more than 90 cm apart horizontally and 45 cm vertically and staggered in each course. Additional ties shall be used near openings.

11.14.6 RESTRICTIONS

Cavity walls shall not normally be built more than 7.5 metres in height and 9 metres in length. Where large lengths and heights are desired, the wall shall be divided into panels with strengthening measures such as pillars etc. Cavity shall be covered at the top with at least two courses of masonry unit and/or a coping over it.

Adoption of cavity walls is not recommended when heavy concentrated load from beam etc. are to be supported by walls

11.15 REINFORCED BRICK MASONRY

11.15.1 GENERAL

Reinforced brick masonry shall be constructed as specified and shown on drawings.

11.15.2 BRICKWORK

Brickwork shall be as specified and conform with the provision for construction of brickwork of this section. The mortar shall be cement sand mortar as specified and shall conform with the provision of Clause 11.7.2(ii).

11.15.3 REINFORCEMENT

The reinforcement for brick masonry could be 18 gauge hoop irons or mild steel bars as specified. The hoop iron shall be of best quality as approved by the Engineer-in-Charge. Mild steel reinforcement shall comply with the provisions of Section 5 – Plain & Reinforced Concrete. Unless otherwise specified in drawings or schedule of quantities, the reinforcement for normal structures shall be as follows;

Wall Thickness (Inches)	Horizontal Bars (9-5/8") C/C	Vertical Bars (24") C/C
7 – ½	3/8" dia	3/8" dia
9	3/8" dia	½"
11	½"	½"
12	½"	½"

Refer to the drawings for others wall thickness and special details

- a) Vertical reinforcement at jambs of opening and at ends of walls shall be doubled. Horizontal reinforcement above and below all openings shall also be doubled.
- b) Reinforcement shall be continuous. Bars may be furnished in any convenient length. All splices shall be lapped at least 14" for 3/8" diameter bars and at least 18" for ½" diameter bars and horizontal reinforcement shall be bent around corners.

11.15.4 SCAFFOLDING & CURING

The scaffolding & curing shall conform with applicable provisions of this Section.

11.16 BRICK EDGING

The edging shall be of bricks of class specified in the item. The specifications of bricks shall be as described in 11.4. Trenches of required depth and width shall first be made along the edge of the plinth protection to receive the bricks for edging. The bed of trenches shall be compacted to a firm and even surface. The brick shall be laid true to line in cement mortar 1:4 (1 cement: 4 fine sand) with length parallel and butting the plinth protection. The top face of the brick edging shall be in one level to conform to the finished level of the plinth protection adjacent to the edging. After the concreting is done, no portion of the brick edging shall project above the adjacent concrete surface. Cement mortar shall conform to the specification described in Sub-section 11.7.2 (ii).

11.17 BRICKWORK IN COPING

11.17.1 SCOPE

While in all respects it shall conform to the requirements for Brick Construction specified hereof, following special requirements shall also be met with, except when it is specially modified by the Engineer-in-Charge.

The top course of all plinth, parapets, steps etc. shall be built in brick on edge. In case of parapet walls the outside half brick shall be weathered and throated. The corners shall be made by cutting fine bricks or by special bricks of 9 inches x 9 inches x 4-1/2 inches (225mm x 225mm x 110mm) size to give a radiated and keyed joints.

11.18 SUN-DRIED BRICK WORK IN MUD MORTAR

11.18.1 SCOPE

In this case, sun-dried bricks i.e. unburned bricks shall be used. Any defect in uniformity and shape shall not be such as to cause difficulty in obtaining uniform courses with their use. For all other purposes, stipulations and requirements for laying brick work shall be relied.

11.19 BRICK MASONRY WITH FIRE CLAY BRICKS AND ALUMINA CEMENT (VITRIFIED MORTAR)

11.19.1 SCOPE

All brickwork required to be constructed under these specifications and for all related purposes or as may be required by the Engineer-in-Charge shall consist of following special materials instead of those prescribed under these specifications. However, other materials, methods of their proportioning, mixing, forming and placing as well as the stipulations and other requirements shall conform to specifications given under sub-sections 11.7.4 except when any stipulations and requirements are specially modified by the Engineer-in-Charge for any particular occasion. In case, fire clay brickwork is required in arches they shall also conform to specifications 11.8 "Brick Work in Arches".

11.19.2 MATERIALS

a) Bricks

Only fire clay bricks of specified sizes of approved specifications/approved brands shall be used. These shall also meet the tests specified for them.

b) Cement

Special alumina cement shall conform to BS 915.

c) Sand

Sand required for the mortar shall be produced from crushed fire bricks graded as sand in conformity with Specifications laid down for sand in the sub-section 11.7.2.

11.20 GHILAFI BRICKWORK

11.20.1 SCOPE

The ghilafi brickwork shall consist of first class brickwork laid in mud mortar at the outer face and the balance work shall be executed in sun dried bricks laid on mud mortar on the inner side conforming to provisions of Sub-section 11.18.

11.21 KACHA WALL/PISE WALLING

11.21.1 SCOPE

Kacha wall shall either be of mud walling or Pise walling type as specified.

11.21.2 BUILDING OF KACHA WALLS/PISE WALLING

- a) Mud walling shall be constructed from the fifth class clay bricks conforming to Sub-Section 11.4.
- b) Pise walling shall be made by laying mud in 8 Cms. to 15 Cms (3"- 6") thick layers and tightly rammed between two parallel boards which form the front and back face of the wall. As soon as the space between boards is completely filling the same shall be moved to the next length and so on till the whole is complete.

11.22 PARTITION WALLS

11.22.1 GENERAL

Brick masonry partition walls shall be one brick thick either flat or on edge

11.22.2 HOOP IRON

In case the partition walls are to be reinforced, it shall be done with 1" wide, 18" gauge hoop iron placed in course not more than 12" apart and continued for 9" into the main wall on which the partition wall abuts. In case the length of the wall exceed 20 feet or the height

exceed 15 feet hoop iron shall be introduced at course not more than 6" apart. M.S bars may also be provided in place of hoop iron as specified.

11.22.3 BRICKS

Bricks used for construction of partition walls shall confirm to the specifications under sub-section 11.4 to 11.6.

11.22.4 MORTAR

The partition walls shall be set in cement mortar not less than 1:3 proportions unless otherwise specified.

11.22.5 SOAKING OF BRICKS

Soaking of bricks shall confirm to the specification under sub-section 11.7.3

11.22.6 WORKMANSHIP

Workmanship in the partition walls is to be the best quality as due to the small thickness of walls great care is to be taken. The total height of the wall in one day shall not exceed 4 feet.

11.22.7 CURING

Curing shall be carried out in the manner as detailed in sub-section 11.7.6

11.22.8 METHOD OF BONDING WITH RCC FRAME

All brick masonry walls shall be bonded with the column of the R.C.C frame by providing ¼" dia. Reinforcement protruding out of the column at every 12". The length of the bonding bars shall not be less than 12" with a hook of 1" dia. at the end and allowed to extend out through the holes provided in the form works for the column.

11.23 MEASUREMENT AND PAYMENT

11.23.1 COMPOSITE RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to the applicable CSR items as provided in Contract Agreement and shall constitute full compensation, for procurement, transportation, performance in all respects and completion of work as specified including the site clearance as approved by the Engineer-in-Charge.

11.23.2 LABOUR RATE

The measurement and payment for the items of the work of Brickwork hereof shall be made corresponding to applicable CSR item as provided in Contract Agreement and shall constitute full compensation for procurement transportation, performance in all respects and completion of work as specified including site clearance, as approved by the Engineer-in-Charge except the cost of materials to be provided by Department at designated location as defined in the Contract Agreement.

11.23.3 QUANTIFICATION

The unit of measurement shall be measured as mentioned below in accordance with corresponding CSR items.

1. For Volumetric items, the unit of measurement shall be cubic meter or cubic foot. Following items of CSR are measured in the above mentioned criteria;
Item No.: 11-1 to 11-33, 11-42 to 11-54, 11-56 to 11-58, 11-61 to 11-62 and 11-67

2. For linear items, the quantity of work shall be measured linearly along centre line of structure. The unit of measurement shall be running meter or running foot. Following item of CSR is measured according to this criteria;
Item No.: 11-65
3. For bulk items, the quantity of work shall be measured in units of weight i.e. Tonne or Tons. Following items of CSR are measured according to this criteria;
Item No.: 11-35, 11-38, 11-68
4. The following Items of CSR shall be measured as Weight units i.e. Kilogram or Pound;
Item No.: 11-34,11-36, 11-37 and 11-39 to 11-41
5. The following items shall be measured as %age Nos.;;
Item No.: 11-55, 11-59, 11-60
6. The following items shall be measured as Each;
Item No.: 11-63, 11-64, 11-66