Improvement Test

Building materials and construction- 17CV36- Solution

1. Characteristics of good mortar

The chief properties of hardened mortar are strength, development of good bond with building units, resistance to weathering and those of green mortar mixes are mobility, placeability and water retention. In addition, the mortar should be cheap and durable and should not affect the durability of building units in contact. The joints made with mortar should not develop cracks.

a. Strength

The strength of masonry depends upon both the mortar and the building unit (brick, stone or block). A very strong mortar with weak building units will be of little use. It is also important to consider whether full strength is gained within a short time. In cold weather, when the strength of lime or cement mixes develops slowly, this is likely to affect the choice of mix.

Strong cement mortars are most likely to lead to shrinkage cracks, and should, therefore be avoided except where high strength is an essential requirement. On the other hand the use of much weaker mortar say, 1:10 cement mortar is not satisfactory since reduction in cement content leads to less workability, less cohesion and will produce porous joints of low frost resistance. Strength of hardened mortar depends on the activity of binding materials, the water-cement ratio, consumption of binding material and the quality of sand. It has been found that

the density and strength of mortars made of the same class of aggregate decrease as the proportion of fine aggregate is increased.

It requires about twice as much cement to produce a mortar of given strength when fine sand is used as it does with coarse sand.

When the percentage of mixing water is increased beyond that required to form a placeable mix, the density and strength of mortar reduces. The proportionate effect is greatest at the early ages.

Even small percentage of mica if present considerably lowers the tensile strength and adversely affects the compressive strength. There is a loss of compressive strength by the replacement of less than 25 per cent of cement by hydrated lime. Cement lime mortars are helpful in autogenous healing of cracks.

b. Resistance to penetration of rain

The mortar for plastering should protect the masonry joints and units by forming an impermeable sheet. A satisfactory bond between the building units, mortar and plaster should be ensured.

c. Mobility & placeability

The term mobility is used to indicate the consistency of mortar. The placeability is the ease with which the mortar mix can be applied with a minimum cost in a thin and uniform layer on the surface. Depending on its composition a mortar may have a consistency ranging from stiff to fluid. Mortars for masonry finishes and other works are made sufficiently mobile. The mobility of mortar mix determines its placeability. Mortars prepared from portland cement alone are frequently deficient in cement paste, stiff and non-placeable and often plasticizers are added.

d. Water retention

It is characterized by the ability of mortar not to stratify during transportation and to retain adequate humidity in a thin layer spread over a porous bed. A mortar mix of low water retention will show the defects after hardening. Mortar may lose so much water that the amount left may be insufficient for its hardening and required strength. Mineral and organic plasticizing agents may be added to enhance water retention.

2.a. Tests on bricks

To know the quality of bricks following 7 tests can be performed. In these tests some are performed in laboratory and the rest are on field.

- Compressive strength test
- Water absorption test
- Efflorescence test
- Hardness test
- Size, shape and colour test
- Soundness test
- Structure test

Compressive strength test: This test is done to know the compressive strength of brick. It is also called crushing strength of brick. Generally 5 specimens of bricks are taken to laboratory for testing and tested one by one. In this test a brick specimen is put on crushing machine and applied pressure till it breaks. The ultimate pressure at which brick is crushed is taken into account. All five brick specimens are tested one by one and average result is taken as brick's compressive/crushing strength.

Water absorption test: In this test bricks are weighed in dry condition and let them immersed in fresh water for 24 hours. After 24 hours of immersion those are taken out from water and wipe out with cloth. Then brick is weighed in wet condition. The difference between weights is the water absorbed by brick. The percentage of water absorption is then calculated. Good quality brick doesn't absorb more than 20% water of its own weight.

Efflorescence test: The presence of alkalies in bricks is harmful and they form a grey or white layer on brick surface by absorbing moisture. To find out the presence of alkalis in bricks this test is performed. In this test a brick is immersed in fresh water for 24 hours and then it's taken out from water and allowed to dry in shade. If the whitish layer is not visible on surface it proofs that absence of alkalis in brick. If the whitish layer visible about 10% of brick surface then the presence of alkalis is in acceptable range. If that is about 50% of surface then it is moderate. If the alkali present is over 50% then the brick is severely affected by alkalies.

Hardness test: In this test a scratch is made on brick surface with a hard thing. If that doesn't leave any impression on brick then that is good quality brick.

Size, shape and colour test: In this test randomly collected 20 bricks are staked along lengthwise, width wise and height wise and then those are measured to know the variation of sizes as per standard. Bricks are closely viewed to check if its edges are sharp and straight

And uniform in shape. A good quality brick should have bright and uniform colour throughout. Soundness test: In this test two bricks are held by both hands and struck with one another. If the bricks give clear metallic ringing sound and don't break then those are good quality bricks. Structure test: In this test a brick is broken or a broken brick is collected and closely observed. If there are any flows, cracks or holes present on that broken face then that isn't good quality brick.

2.b. Aggregate impact value test

It is a measure of resistance of aggregate against impact or sudden loads.

Test procedure

- The test sample consists of aggregate which passes a 12.5 mm sieve and is retained on a 10 mm sieve.
- The aggregate comprising the test sample is dried in an oven for a period of four hours at temperature of 100-110°c and cooled.
- It is filled in three layers with 25 strokes and the surplus aggregate is struck off, using the tamping rod as a straight-edge.
- The net weight of aggregate in the measure is determined to the nearest gram (weight A).

• A steel cup, 102 mm internal diameter and 50 mm deep, is fixed firmly in position on the base of the machine and the whole of the sample is placed in it and compacted by a single tamping of 25 strokes of the tamping rod.
• The hammer (14kg) is raised until its lower face is 380 mm above the upper surface of the aggregate in the cup, and allowed to fall freely.
• The test sample is subjected to 15 blows each being given at an interval of not less than one second.
• The crushed aggregate is then removed from the cup and the whole of it is sieved on 2.36 mm is sieve.
• The fraction passing the sieve is weighed (weight A).

Aggregate impact value = B/A x100

This value should not be more than 30% for concrete used in runways, roads etc and 45% for aggregate used in concrete.
Aggregate abrasion value test
Using los angles machine
Abrasive charge – It consist of cast iron spheres or steel spheres approximately 48 mm in diameter and each weighing between 390 and 445 g. They are taken according to the grade of aggregate eg – grade A – 12 spheres , grade B –11 .
The test sample consists of dry coarse aggregate made up of percentages of the various sizes conforming to one of the grading. For example grade A and grade B is given below.
• The test sample and the abrasive charge is placed in the los angeles abrasion testing machine and the machine is rotated at a speed of 20 to 33 rev/min.
• For gradings A, B, C and D, the machine is rotated for 500 revolutions; for gradings E, F and G, it is rotated for 1000 revolutions.
• At the completion of the test, the material is discharged from the machine and a preliminary separation of the sample made on a sieve coarser than the 1.70 mm. The finer portion is then sieved on a 1.70 mm sieve.
• The material coarser than the 1.70 mm sieve is washed, dried in an oven at 105 -110°c and weighed.
• The difference between the original and the final weights of the test sample expressed as a percentage of the original weight of the test sample gives the percentage of wear.

3. Objectives of plastering

- Give decorative effect
- Protect surface against vermin
- Conceal inferior materials
- Protect external surface against penetration of rain water and other atmospheric agencies.

Requirements of good plaster

- Hard and durable
- Good workability
- Cheap
- Possible to apply it during all weather conditions
- Should adhere to the background and should remain during all variations in seasons and other atmospheric conditions.
- Should effectively check penetration of moisture.

4. Method of damp proofing:

Following methods of damp proofing is generally used in practice. Besides, some special damp proofing is done at some places and in some important buildings which are not discussed here. Only commonly used damp proofing methods are discussed.
a. Use of damp proofing course (D.P.C)
b. Integral damp proofing
c. Surface treatment
d. Cavity wall construction
e. Guniting
f. Pressure grouting
Use of D.P.C:
D.P.C which is other wise called as damp proof course is a water repellant membrane or damp proofing course between the source of dampness and the part of building adjacent to it. The mechanism covers a wide range of materials which may consist of flexible materials like bitumen, mastic asphalt, bituminous felts, plastic or polythene sheets, cement concrete etc. D.P.C course may be provided either horizontally or vertically in floors and walls etc. Or in both direction as per requirement. Some principles are kept in mind while providing the D.P.C course. They are as follows:
i. The D.P.C course should cover the full thickness of the walls though it excludes rendering coat.
ii. The mortar bed on which damp proof course is laid should be leveled and even with out any projections so as not to damage the D.P.C provided.
iii. A continuous projection is provided with the laying of D.P.C, besides the damp proof course should have continuation in the junctions and corners of walls horizontally and if vertical D.P.C is provided, it should have same nature too.
iv. When a horizontal D.P.C is continued to a vertical face, a cement concrete fillet of 7.5 cm radius should be provided at the junction.
v. D.P.C should not be kept exposed to prevent it from getting damaged during finishing work.
Integral damp proofing:
This consists of integrating certain water proofing compound or water repellant compound to the concrete mix, so that the concrete itself becomes water resistive. These water proofing compounds may be in 3 forms:
i. Compounds of void filling material made from chalks, talc, fullers earth etc. which fills the voids of concrete under the mechanical action principle making it highly impermeable to water due to presence of lesser voids.
ii.Compounds like alkaline silicate, aluminium sulphate, calcium chlorides etc. react with concrete to produce water proof concrete. Also compounds like soap, petroleum, oils, fatty acids like stearates of calcium, sodium, ammonia etc. work on water repulsion principle. So when these are mixed with concrete, the concrete becomes water repellant. However all these materials after addition should be able to resist the super imposed load as well as should maintain the bond between the concrete materials.
iii.Commercial publo, permo, silka etc are available as water repellant materials.
Surface treatment:
In this method, application of water repellant layer by using some special compounds on the surface of floors through which water enters in the form of moisture is done to protect it from getting damped. Various water proofing agents are used in practice out of which calcium and aluminum stearates which are called metallic soaps are much effective against rain water penetration. Pointing and plastering of exposed surfaces must be done carefully, using water proofing agents like sodium and potassium silicates and

aluminum and zinc sulphate and barium hydroxide and manganese sulphate etc. This treatment gets effective against the moisture and normal water, but not against water under pressure.

Cavity wall construction:

This is effective method of not only damp prevention but also sound insulation and temperature protection. The main wall of the building is shielded by an outer skin wall and there exists a cavity left in between them. Cavity wall is highly essential in swampy areas and notably there is no reduction of load carrying capacity due to cavity.

Guniting:

This is a special type of surface treatment in which dampness caused by water under pressure is checked effectively. In this process, deposition of the impervious layer under pressure is done which is rich in cement and the ratio of cement and sand is 1:3. The nozzle of the gun is kept at a distance of 75 to 90 cm from the wall surface. After getting the impervious layer, the surface should be cured at least for 10 days. This is done particularly over pipes and cisterns and outer walls.

Pressure grouting:

In this process, forcing of cement mortar into the cracks and voids under pressure which are present in the structural components of the building is done. The defects may be in structure or inside the ground i.e. near foundation. Thus the structural components and the foundations which are liable to the water penetration and moisture penetration are thus made water resistant. This method is quite effective in checking the seepage of water into the ground through the foundations and the sub structures of the buildings. This is also an effective method in counteracting differential settlement and in shrinking and expansive soil where there occurs shrinkage in summer.

5. Defects in paint work

The defects which are commonly found in paint work are as follow.

A. Blistering

Formation of bubbles like shapes on the painted surface is known as blistering. The primary cause of this defect is water vapour. When water vapour trapped under the paint layer, it creates bubbles under the film of paint.

B. Blooming

Formation of dull patches on the painted surface is known as blooming. The primary cause of this defect is poor quality of paint and improper ventilation.

C. Fading

When there is a gradual loss of colour from the pained surface, it is known as fading. The main cause of this defect is the reaction of sunlight on pigments of paint.

D. Flaking

In this type of defect, some portion of the paint film is not sticked properly with the surface; resulting flaking off of the paint layer. This is cause due to poor adhesion between paint and the surface to be painted.

E. Flashing

Presence of glossy patches on the painted surface is known as flashing. The cause of this defect is mainly due to poor workmanship, cheap paint or weather actions.

F. Grinning

If the thickness of the final coat of paint becomes very thin, the background can be seen clearly. This is known as grinning. Poor workmanship is the main cause of this defect.

G. Running

This type of defect is seen when the surface to be painted is very smooth. In case of smooth surface the paint runs back and leaves small areas of surface uncovered.

H. Sagging

This type of defect is more prominent when a thick layer of paint is applied on a vertical or inclined surface.

I. Saponification

Formation of soap patches on the painted surface is termed as saponification. Chemical action of alkalis is the cause of this defect.

Constituents of paint

- Base
- Carrier or vehicle
- Drier
- Colouring pigment
- Solvent or thinner

i.Base
Base is a solid substance in the form of fine powder generally metallic oxide. The type of base determines the character of paint and imparts durability to the surface painted. Various bases are white lead, red lead , oxide powder , oxide of iron . It hides the surface to be painted.

ii.Carrier
Carrier is a liquid substance which holds the different ingredients of paint in liquid suspension. eg – linseed oils, nut oil, poppy oil. Raw linseed oil is thin, but it takes a long time to dry.

iii. Drier
They are used to accelerate the process of drying and hardening by extracting oxygen from the atmosphere and transferring to vehicle. It reduces the elasticity of paint; they should not be used in the final coat. Liquid driers are finely ground compounds of metals such as cobalt, lead, manganese dissolved in a volatile liquid whereas paste driers consist of above metals mixed with large percentage of inert fillers such as barytes , whiting etc and then ground in linseed oil.

iv. Colouring pigment
It is a white or colored pigment, mixed with a paint to get desired color of the paint.
v.Thinner
It is a liquid which thins the consistency of the paint and evaporates after the paint film has been applied.eg – spirit of turpentine, naphtha, benzine alcohol, methyl amyl acetate.

6. Dampness is the presence of hygroscopic and gravitational water in the structural elements. It endangers the structural safety as well as gives rise to the unhygienic conditions along with that it supports the pathogenic and fungal colonies. Basically moistures travelling through the walls, roofs and floors are stuck there and gives rise to dampness. Therefore damp prevention is very much essential and it should be done through provision of damp proof course or through proper structural design.

Causes of dampness:

There are many causes of dampness. They are described one by one as below.

Moisture rising up the wall from the ground:

All structures are found on the soil and sub structures are constructed in to it. If the soil is pervious then moisture constantly travels through it and in case of impervious soil, due to rain water or frost, there may be accumulation of water at the base of the structure due to poor drainage. Due to capillary action as studied in the fluid mechanics, this moisture tends to rise up into the walls and floors. As we know that normal concrete is highly porous, the ground water table if get rose and stays in that condition for a long time, it possesses threat of dampness to the foundations and even the concrete structures.

Rain beating against external walls:

During a heavy shower of rain in the rainy season, rain drops beat against the external faces of walls and if the walls are not properly plastered or treated with water proof agents, then moisture will enter into the wall, causing dampness. If balcony and chajja protections do not have outward slope or when the protection falls sort in protecting the complete wall, water will accumulate on these and at the base of the wall and ultimately enter into the joints causing dampness. This moisture will completely deface the interior decoration and patches will come in side.

Rain water travel from wall tops:

In case of improperly protected/treated wall tops, rain water will enter the wall and travel down. Leaking roofs also permit the same which causes serious threat to the stability as well as load carrying capacity of the structures. Also due to dampness, the swelling of walls and bond between mortar is reduced.

Condensation:

Condensation is the process of accumulation of atmospheric water in the joints of walls, floors etc. Due to this condensation of atmospheric moisture, dampness occurs, mostly in the wall joints. This dampness may occur on the walls, ceilings and floors etc. Which come in contact with atmospheric moisture directly. This type of dampness occurs due to variation of temperature in atmosphere.

Miscellaneous other causes:

i.Poor drainage at the building site, from which the leaking water continuously and persistently keeps the foundation base damp.

ii.Reduced air flow is another cause of dampness as water does not get evaporated.

iii.Low temperature also causes dampness due to no evaporation of water but in winter season, as there is very lesser humidity, hence despite of low temperature, water get evaporated. But where the humidity is at normal level, and temperature is low, dampness occurs.

iv.Imperfect orientation of buildings is another cause of the dampness where the dampness occurs only due to less or zero illumination of the building through sun light. The darkness existing due to absence of sun light makes the rooms swampy in all most all the seasons and the humidity of the building is genuinely higher than other such buildings.

v.Imperfect roof slope also causes dampness and it’s mainly seen in case of flat roofs.

vi.Imperfect joints in walls and roofs and defective throating etc. like defective constructions

causes dampness. Also due to improper compaction of the concrete during construction, it not only gives rise to weak structures, but also there is always a chance of water penetration due to the voids present in the structures.
vii.Defective cavity wall construction.
viii.Defective rain water pipe as well as basin pipe of kitchens causes water leakage or absorption and that's why causes dampness. This type of dampness is the common type of dampness in residential as well as public buildings.
ix.Less use or absence of damp proof course in the buildings causes dampness. It's the major cause of dampness related problems in the old masonry buildings and forts.
x.Underground seepage is also a cause of dampness in the structures present near water reservoirs or at bank of rivers. Also presence of any water reservoir like ponds and wells etc. cause dampness to the buildings.

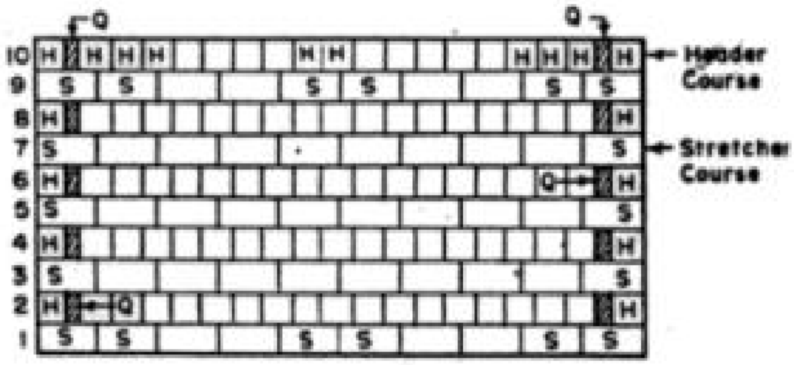
7. English bond

a. It is most commonly used type of bonds.

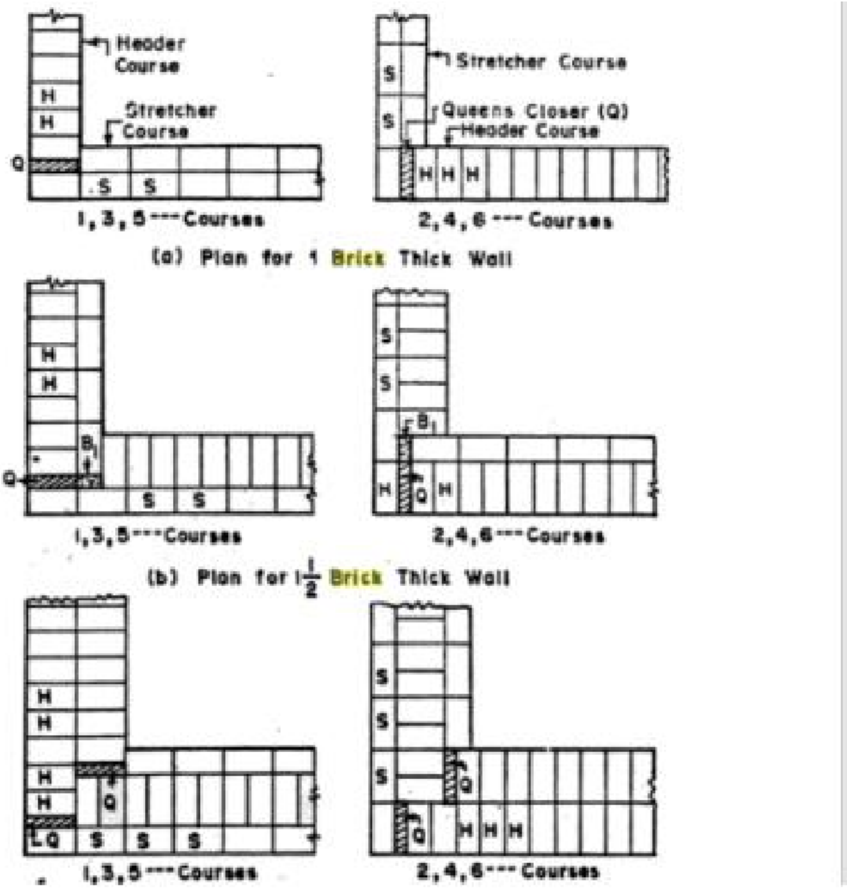
b.It consists of alternate courses of headers and stretchers and it is strongest bond. Vertical joints of header courses come over each other.
c.Similarly vertical joints of stretcher courses come over each other.

d.It is essential to place quoin closer after a quoin header in every alternate course.
e.Every header comes centrally over the joint between two stretchers in course below.
f.In stretcher course there should be a minimum overlap of 1/4 their length over headers.
g.A header should never start with the queen closer as there are more chances of displacement.
h.Since joints in the header course are more than joints in the stretchers, joints in the header courses are made thinner.
i.Walls of even multiple of half bricks show same appearance on both faces.
(1, 2 brick thick wall)

j.Walls of odd multiple of half bricks show stretcher on face and header on other face.
(1 ½ , 2½ brick thick wall)



S = STRETCHER ; H = HEADER ; Q = QUEEN CLOSER
FIG. 6.6. ENGLISH BOND.



1. Flemish bond

a) Double flemish bond

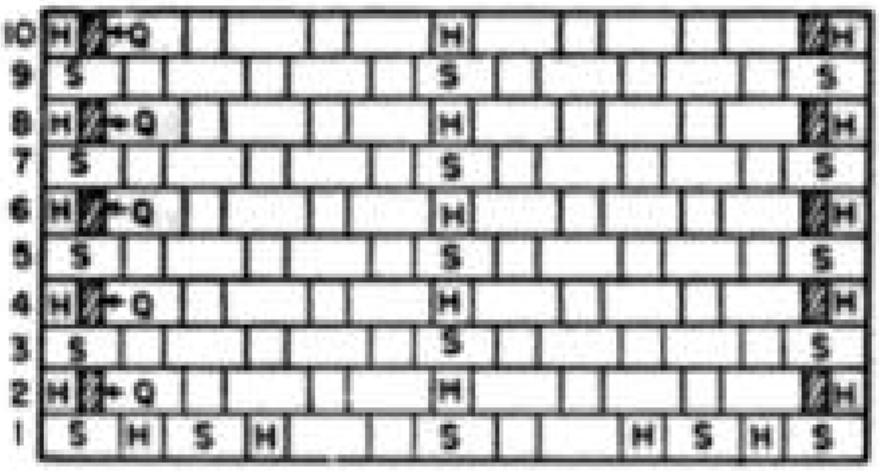


FIG. 6.9. FLEMISH BOND (ELEVATION).

a.Every course consists of alternate header and stretcher in the same course.

b.The facing and backing has same appearance

c.Quion closers are kept next to quoin headers

d.For walls having even multiples of half bricks no bat are used

e.For walls having odd multiples of half bricks, half bats and three fourth bats are used

B.Single flemish bond

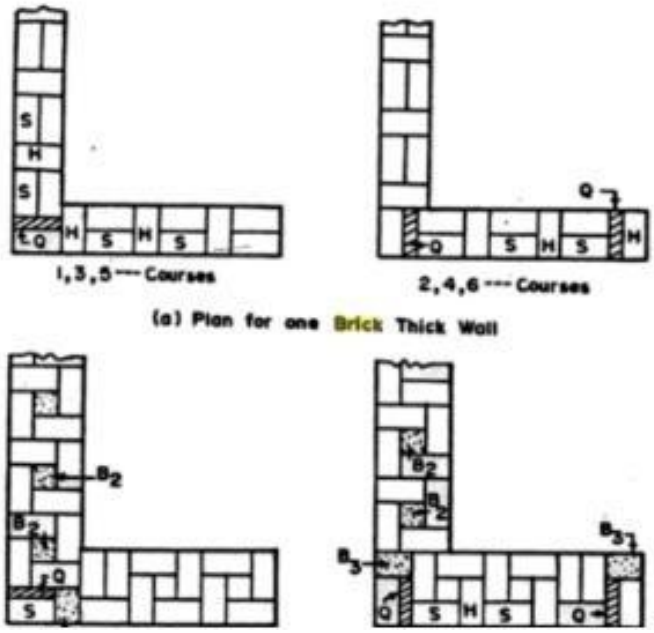
a.It is composed of double flemish bond facing and english bond backing and hearting in each course.

b.This bond uses appearance of flemish and strength of english bond.

c.Construction is done using good quality expensive bricks.

d.Cheaper bricks can be used for backing and hearting.

e.It can be used for 1 ½ brick brick thick wall.



S = STRETCHER ; H = HEADER ; Q = QUEENS CLOSER ;
B_2 = HALF BAT ; B_3 = $\frac{3}{4}$ BRICK ; B_1 = QUARTER BAT

FIG. 6.10. DOUBLE FLEMISH BOND.

8. A structure essentially consists of two parts, namely the super structure, which is above the ground level, and the substructure that is below the ground level. Substructure is known as the foundation and this forms the base for any structure. Footing may be defined as portion of foundation that is in contact with the soil.

Objectives (functions) of a foundation:

• Reduction of load intensity

To distribute the total load coming on the structure on a larger area so that intensity of load at its base does not exceed safe bearing capacity of subsoil.

• Even distribution of load

It distributes the non uniform load of superstructure evenly to the subsoil.

• Lateral stability

To give enough lateral stability to the structures against various disturbing forces, such as wind and rain.

• Provision of level surface

Provide a level and hard surface over which the superstructure can be built.

• Protection against soil movements

To prevent or minimize cracks due to moisture movement because of expansion and contraction of subsoil.

• Safety against undermining

To provide structural safety against undermining or scouring due to animals, flood water etc

Essential requirements of a good foundation:

• It should be rigid enough to bring down differential settlement.

• It should be located so that its performance may not be affected due to any unexpected future influence.

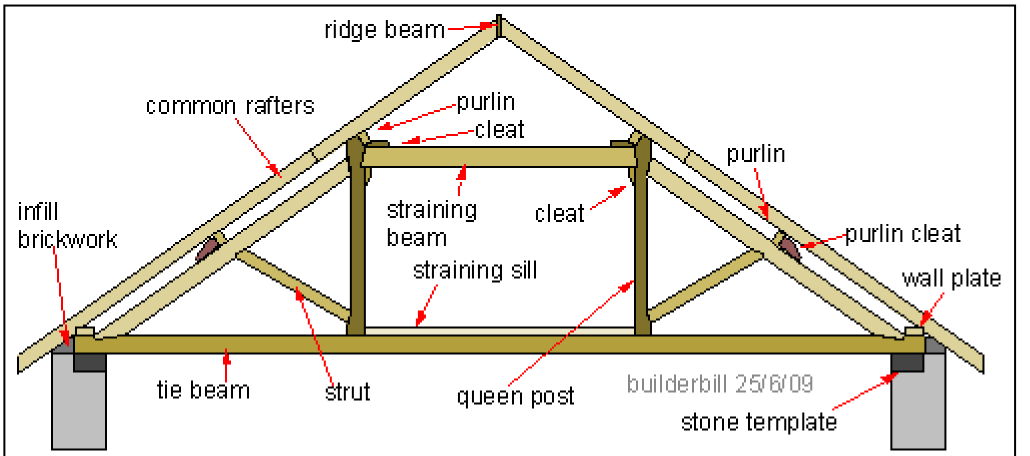
• Located at a sufficient depth so as to check failure due to swelling, sliding and overturning of soil.

• It should sustain the dead and imposed loads and transmit these to subsoil in a such a way that pressure on it will not cause settlement.

Safe bearing capacity: Maximum pressure which the soil can carry safely without the risk of shear failure

9. Queen post truss

If the span is in between, 8 to 12 meter then queen post trusses are used. Two vertical posts are provided in two sides at a distance that are termed as queen posts. The vertical posts are connected by a horizontal piece called straining beam. The queen posts are tension members. The tops of the posts are connected by a horizontal piece called straining beam. Two struts are provided to join the feet of each queen post to the principal rafters. The straining beams receive the thrust from the principal rafter and keep the junction in stable position. A straining sill is introduced on the tie beam between the queen posts to counteract the thrust from the inclined struts that are in compression. In the absence of the straining sill, the thrust from the strut would tend to force the foot of the queen post inwards. Purlins with cleats are provided as in king post truss.



Traditional Queen Post Roof Truss

The head of the queen post is wider and the head of the principal rafter and the end of straining beam are tenoned into it. The joint is further strengthened by fixing a 3way strap of wrought iron or steel on each face.

10. Deterioration of stone works

The stones with exposed faces are acted upon by various atmospheric agencies such as rain, heat, etc. and chemicals deteriorate the stones with time. Following are the causes of decay of stones:

a. Rain water - Rain water acts both physically and chemically on stones. The physical action is due to the alternate wetting and drying causes disintegration and the chemical action due to the rain water descents through atmosphere absorbs co2, h2s and other gases present in the atmosphere and affect the stones.

b.Wind – It carries fine particles of dust, when it blows at high speed particles will strike against the stone surface and thus stone will be decayed. The wind allows rain water to enter pores of stones with force. Such water on freezing, expands and splits the stones.

c.Vegetable growth – The creepers and certain trees develop on the stone surfaces with their roots penetrating in stones joints. Such roots attract moisture and keep the surface damp. At the same time, they may try to expand also, resulting in stone decay.

d.Alternate wetness and drying – Stones are made wet by various agencies such as rain, frost, dew etc. It is found that stones subjected to such alternate wetness and drying wear out quickly.

e.Living organisms – Some living organisms like worms and bacteria act upon stones and deteriorate them.

f.Nature of mortar – The nature of mortar used as a binding material may react chemically with any one of the constituents of stones and thus lead to disintegration of stones.

Preservation of stones

Preservation of stone is essential to prevent its decay. Different types of stones require different treatments.

Preservatives, which are commonly adopted to preserve the stones, are

- Coal tar – If it is applied on stone surface, it preserves stone. But colour produces objectionable appearance and absorbs heat of sun. Hence it is not adopted generally since it spoils beauty of stones.
- Linseed oil – It is used as raw or boiled linseed oil. Raw linseed oil does not disturb original shade, but requires frequent renewal whereas boiled oil makes stone surface dark.
- Paint – It preserves the stone but changes original colour.
- Paraffin – It may be used alone or along with dissolved naptha and then applied on stone surface.
- Solution of alum and soap- They are mixed in one litre of water in 40:60 proportions.

11. Requirements of good stones

a. Appearance- It should have fine, compact texture
b. Structure - It should have a uniform texture, free from cavities, cracks and patches.
c. Strength – It should be strong enough to withstand the disintegrating action of weather.
d. Seasoning – Stones should be well seasoned.
e. Weathering – Resistance of the stones against wear and tear due to atmospheric agencies should be high.
f. Specific gravity – It should be between 2.3 to 2.5.
g. Toughness - Tough stones are used where vibratory loads are expected.
h. Hardness - It is an important for floors, pavements and aprons of bridges.
i. Porosity and water absorption – Porosity of the stone depends on mineral constituents, cooling time and structural formation. A porous stone disintegrates as it absorbs rain water, freezes, expands and causes cracking.
j. Workability – Stones should be such that cutting, dressing and bringing it to shape and size should be economical.