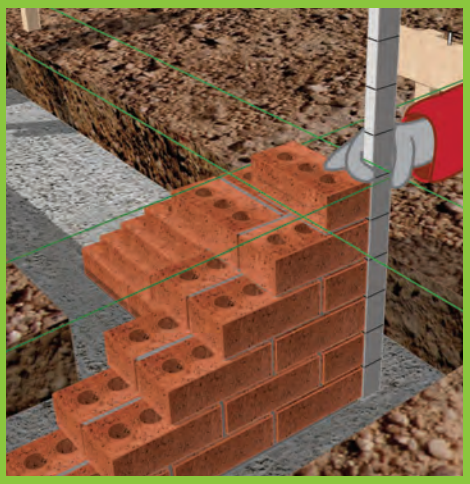
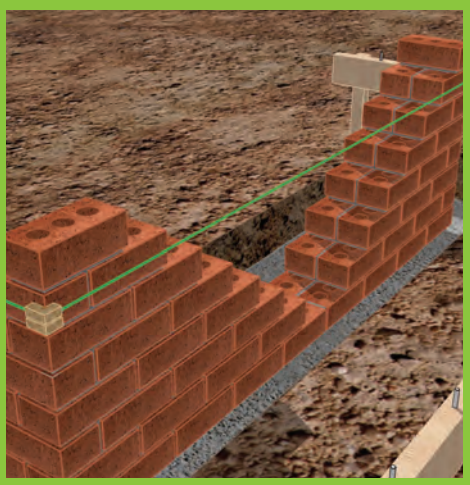
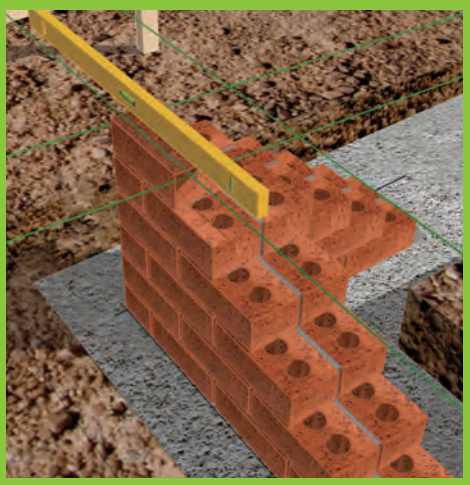
CLAY BRICKLAYING MADE EASY

A Guide to Better Bricklaying





Environmentally Friendly

CLAYBRICK for good

CLAY BRICKLAYING MADE EASY

4th Edition

The Clay Brick Association of South Africa

Environmentally Friendly

CLAY BRICK LAYING MADE EASY

ISBN: 978-0-9922328-3-2

Published: The Clay Brick Association of South Africa

1st Edition: 1973
2nd Edition: 1982
2nd Edition: 1983 Reprinted
2nd Edition: 1984 Reprinted
2nd Edition: 1985 Reprinted
2nd Edition: 1987 Revised
2nd Edition: 1988 Reprinted
3rd Edition: 2003

Illustrations: Buildaid Communications

Design and layout: Buildaid Communications

Printed: ABC Press

ACKNOWLEDGEMENTS

Frik Kraukamp
South African Bureau of Standards
Cement & Concrete Institute

The Clay Brick Association of South Africa

Reg. No. 63/009511/09

www.claybrick.org.za

FOREWORD

Many of mankind's traditional crafts and skills are fast disappearing from a machine-age world in which sophisticated technology has become the watchword. It is particularly gratifying therefore when one such craft defies all attempts to reproduce mechanically that which can still be best accomplished by human hands - i.e. the craft of the bricklayer. Throughout the centuries the basic skill of bricklaying has remained virtually unchanged because it is simple, efficient and not too difficult to acquire.

For the professional bricklayer it is a skill, which no machine can out-perform; for the amateur bricklayer it is a hobby which few can equal for its sense of accomplishment in building with one's own hands projects that will last for many decades.

For the hobbyist there is also the added benefit of building whatever is involved at no greater cost than that of the required bricks and mortar. Indeed, there could hardly be a more timeous occasion to introduce this completely revised and updated edition of "Bricklaying is Easy" than in today's high labour-cost climate.

The new edition contains considerably more information than the previous book and makes greater use of step-by-step photographs to illustrate to the reader the procedures to be followed in acquiring a lifetime skill.

May it serve as your foundation for many rewarding bricklaying ventures in the future.

A. R. KEMP

Chairman: Brick Development Association of SA Ltd. (Clay Brick Association)

CONTENTS

CHAPTER 1

Introduction

CHAPTER 1

Introduction

Certain tools and materials are necessary for building. Knowledge of the names of these tools and materials, and how they should be used is a basic requirement for the amateur builder. In addition, you should know some builder's terms and certain proven methods of construction. We therefore start with these requirements of construction and then proceed to a description of the various steps in building, with suitable illustrations and photographs.

Important Notes

- Before starting, make sure you understand the plans and know what the house or structure will look like.If someone else has already built a house or structure to the plan you have chosen, have a good look at it.
- Compile a list of the building materials you will need for the job. Make sure they are all readily available and what it is going to cost you.
- See that you have all the tools you need and know how to use them. (See Chapter 2)
- Cement, timber for the roof, doors and windows and any other material made of wood must be kept under cover.
- Once you have started to build, complete the structure as soon as possible. Walls without a protective roof can be spoilt. Too much rain on the walls may cause white patches (efflorescence) to appear, which have to be removed before plastering. It is best to build in the dry season.

The Three Golden Rules

If you want your structure to be neat and well built, there are three rules you must remember. These rules are Square, Level and Plumb.

Rule One – Square

"Square" means that all the corners are at right angles. When you set out your house it is fairly easy to get the right measurements, but the most difficult / and most important thing is to get it "square". If you study Chapter 5 carefully, you should be able to get your house square.

Rule Two – Level

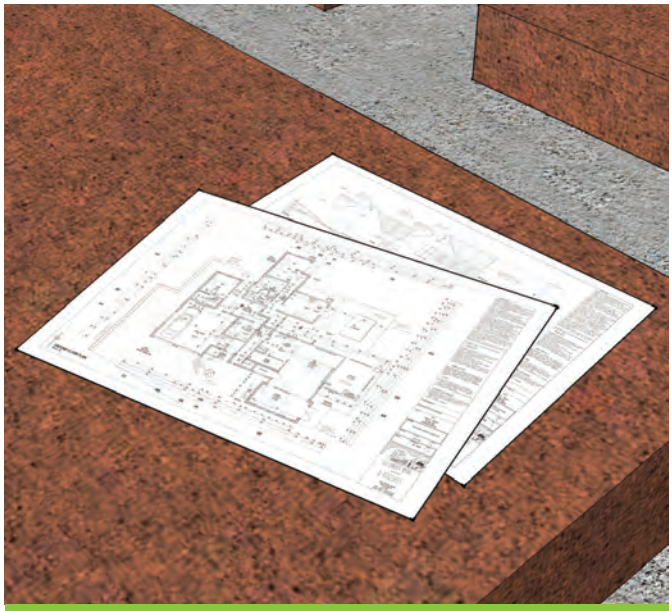
"Level" means that a surface has no slope and is horizontal. The surface of standing water is level. It is important to keep the walls level. If the foundations are completely horizontal, it will be easier to keep the walls level.

Rule Three – Plumb

"Plumb" means that a surface is vertical, i.e. standing straight up and not leaning over. If the walls, doors and windows are not plumb, the structure will be spoilt. To keep a house level and plumb a spirit level is used. When building the corners of the walls level and plumb every course. Also level and plumb the door and window frames. If the spirit level is too short to reach both points to be levelled, use a straight edge with the spirit level. (See Figure 5.14)

Municipal Building Plan Approvals

All building plans must receive approval from the local Municipality prior to commencing any building work on site. In many cases the Architectural Professional who draw up your plans is able to carry out this important step.



1.1 - Study the plans carefully

NOTE:

A projects success is derived from the quality of drawings produced by the Architectural Professional. Ensure all the information required to embark on the project is present. If any information is missing, insist the the missing information be provided to avoid any mishaps.

THE LANGUAGE OF CLAY BRICKS

FBX	**Face Brick Extra**	Clay bricks that are selected or produced for their **durability** and **high degree** of	**uniformity** of **size, shape** and **colour**.
FBS	**Face Brick Standard**	Clay bricks that are selected or produced for their **durability** and **uniformity** of **size** and **shape**.	
FBA	**Face Brick Aesthetic**	Clay bricks that are selected or produced for their **durability** and **aesthetic** effect deriving from	non-uniformity of **size, shape and colour**.
NFX	**Non-Facing Extra**	Clay bricks suitable for use, **plastered** or **unplastered**, for **general building work below damp-proof course** or under	**damp conditions** or **below** ground level where **durability** rather than aesthetics is the criteria for selection.
NFP	**Non-Facing Plastered**	Clay bricks suitable for **general building work** that is to be **plastered.**	
E	**Engineering Units**	Any class masonry unit produced for structural or load-bearing purposes in face or non-face work, where the manufacturer supplies	clay bricks to an agreed compressive strength. An engineering unit is designed by the addition of the letter E followed by a number equal to the nominal compressive strength in megapascals, e.g. FBSE21
PA	**PA Clay Pavers**	Clay pavers that are selected or produced for their durability and for a high degree of uniformity in size and shape, and that have	dimensions such that the ratio of work size length to work size width is approximately 1:1, 2:1 or 3:1.
PB	**PB Clay Pavers**	Clay pavers that are selected or produced for their durability and for their uniformity in size and shape.	

NOTES

CHAPTER 2

Bricklaying Tools

BRICKLAYING TOOLS

Four Basic Groups

Before beginning to build a house, it is necessary to learn something about the tools to be used. These are divided into four basic groups, namely:

Setting-out tools (Fig. 2.1)

- Tape (steel)
- One metre folding rule
- Steel square
- Line
- Wooden or steel pegs
- Straight-edge

Bricklaying tools (Fig. 2.2)

- Brick trowel
- Line pins and line
- Line blocks
- Level
- Tingle
- Gauge rod

Brick cutting tools (Fig. 2.3)

- Brick hammer
- Bolster
- Club hammer or 2kg hammer
- Cold chisels

Jointing tools (Fig. 2.4)

- Long jointer
- Short jointer
- Pointing trowel

SETTING OUT TOOLS

Tape

A good tape is needed for setting out a house

Folding rule

A folding rule of one metre in length is always needed on the job.

Steel Square

The large mason's square is used to layout guidelines and to check inside and outside corners during building. As it is made of steel, it will rust. Keep it lightly oiled.

Building line

Building line is sold in rolls and is obtainable from any hardware shop.

Steel or wooden pegs

These are short lengths of steel (wooden pegs can also be used) which are hammered into the ground to mark a point or to gauge the concrete when levelling a foundation.

Straight-edge

This is a length of aluminium or wood with straight square edges, which is used to level off concrete or to transfer a level from one point to another.

Bricklaying Tools

Brick Trowel

This is the most important tool as it is always in use when mortar is spread and bricks are laid. It is only by practice that one learns to use it well. The trowel should always be cleaned and oiled after use. Do not wet the handle of the trowel too much, as it will crack and become loose.

Line Pins and Line

The brick courses are laid to the height of the line, which is strung taut between outside corners using the pins or line blocks.

Line Blocks

Line blocks are used instead of line pins when the corners are built up. They are made of wood and normally cannot be purchased. Builders therefore usually make their own blocks.

Spirit Level

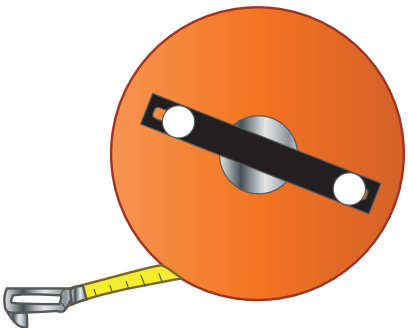
The plumbing and levelling spirit level is used to ensure that the vertical faces of the work are true and that the structure is level. This tool must be handled with care, as the bubble tube (vial) is made of glass and can very easily break. The spirit-level should not be dipped or cleaned in water, as water may penetrate and stain the outer glass cover. Clean the level by wiping it with a piece of sacking.

Tingle

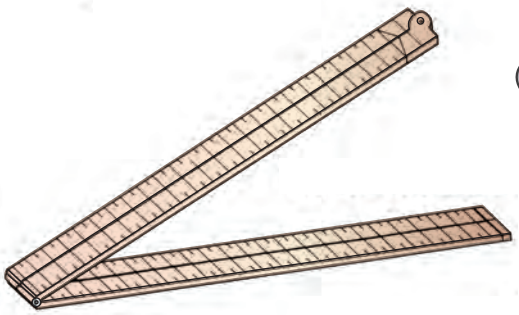
As the weight of the line between the line pins tends to make it sag, tingles are used to lift it and keep it straight. A tingle can be cut out of a piece of flat iron.

Gauge Rod

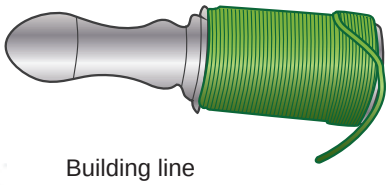
This is a long straight edge, marked at intervals equal to the thickness of one brick, plus the thickness of the mortar joint. The distances between the marks vary according to the type of brick used. The gauge rod is used for checking and keeping the brick courses at even multiples of bricks, plus mortar joint thicknesses, when working on different sections of the building. This ensures that all the corners of a particular structure will be of equal height upon completion



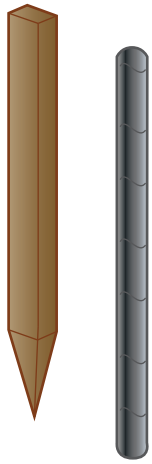
Measuring Tape (30m reccomended)



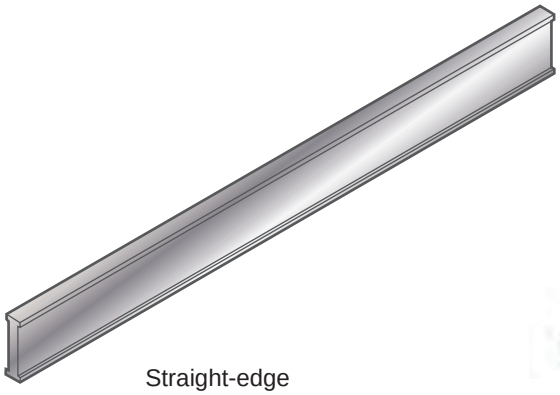
Folding rule



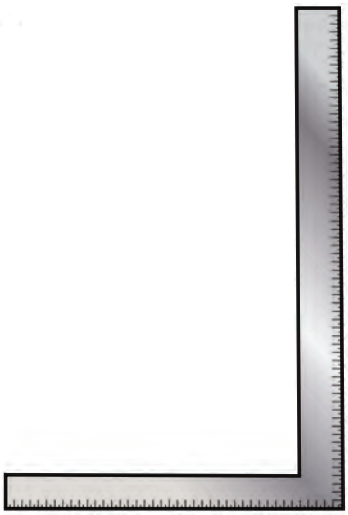
Building line



Steel or wooden pegs

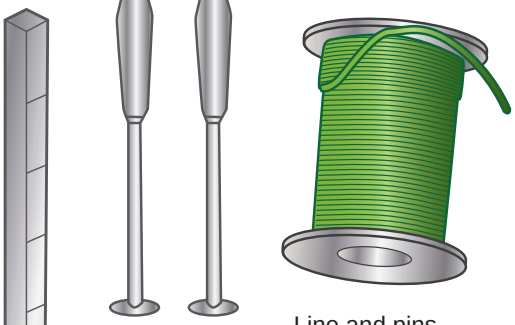


Straight-edge

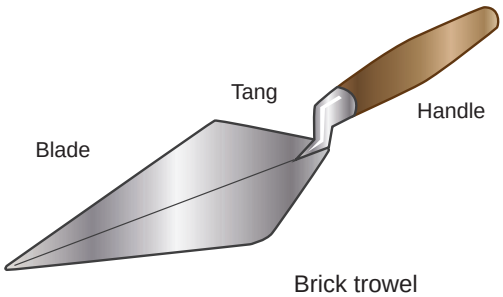


Steel Square

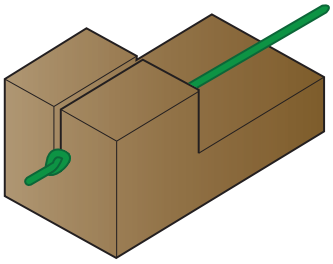
2.1 - Setting out tools



Line and pins

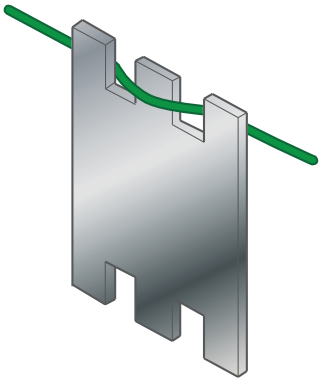


Brick trowel

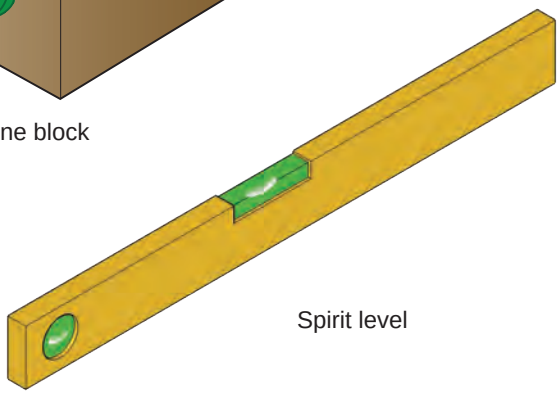


Line block

Gauge rod



Tingle



Spirit level

2.2 - Bricklaying tools

Brick Cutting Tools

Brick Hammer

This tool can be used for any hammering that needs to be done by the bricklayer, and the chisel side for cutting stock bricks.

Bolster

This is a broad chisel used together with a hammer for cutting bricks or cutting chases in brickwork.

Club Hammer

This is used with most brick-cutting tools, such as the bolster and cold chisels.

Cold Chisel

The cold chisel is used for chasing the walls for pipes or for cutting holes in brickwork where needed.

Comb/Scutch Hammer

Used like a brick hammer. In place of the chisel end, a slot is cut to hold a comb, which can be replaced when worn. The comb is used for chasing and trimming brick where necessary.

Jointing Tools

Long Jointer

The long jointer as shown is used to make the horizontal hollow key joint on face brickwork. A tool similar to the round jointer is the square jointer. Before the joint is finished off with the square jointer it is racked out with a scraper. (See page 37).

Short Jointer

The short jointer is used to finish off the short, perpendicular or vertical joints on facebrick.

Pointing Trowel

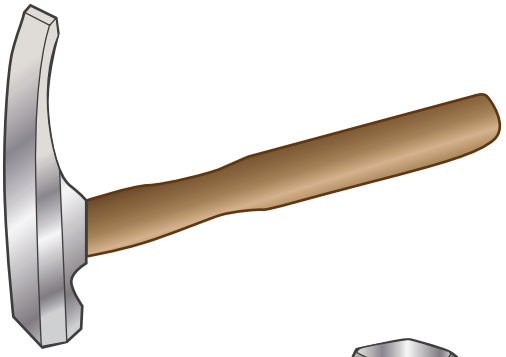
This is a small trowel that looks like the bricklaying trowel. It is used for filling in small holes with mortar.

Mastic Trowel

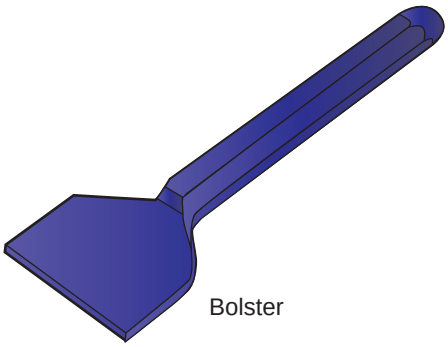
The Mastic Trowel has a long narrow blade and is used when pointing brickwork.

Scraper

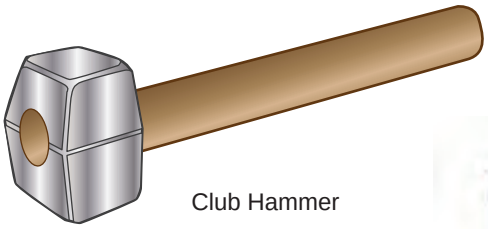
A scraper can be made of steel or made on site with a block wood and a nail. It used to scrape excess mortar from the joints before jointing takes place.



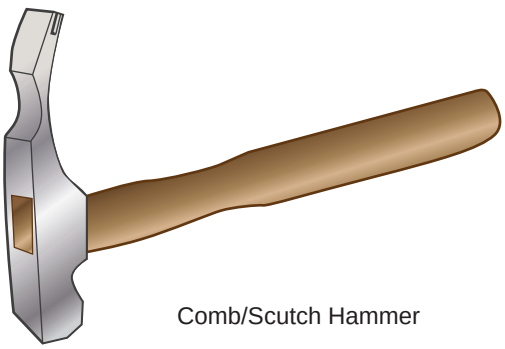
Brick Hammer



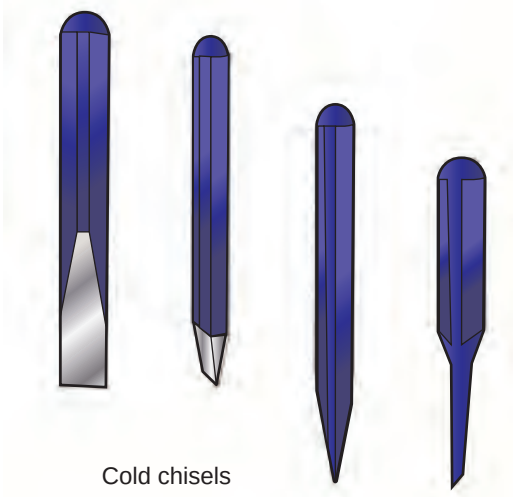
Bolster



Club Hammer

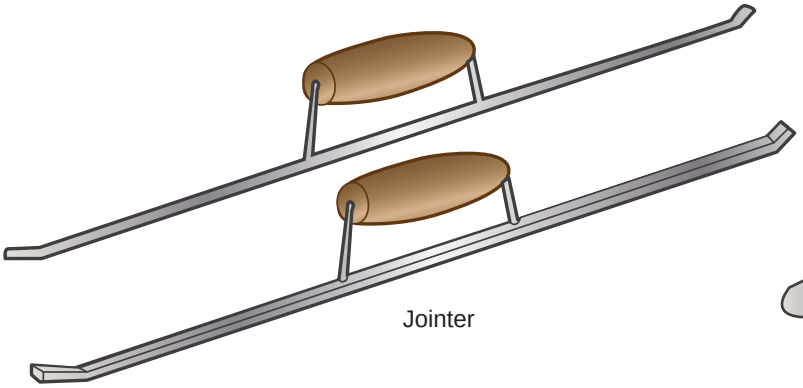


Comb/Scutch Hammer

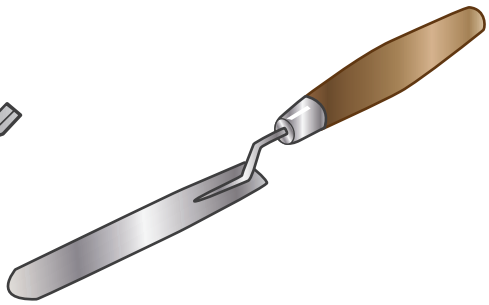


Cold chisels

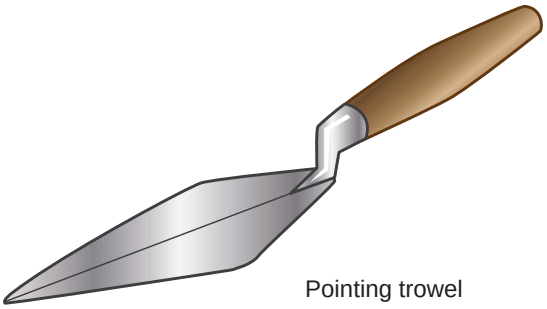
2.3 - Brick-cutting tools



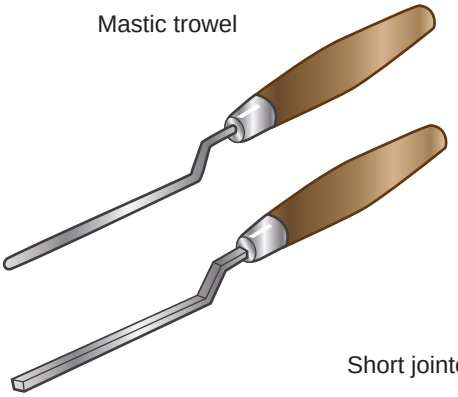
Jointer



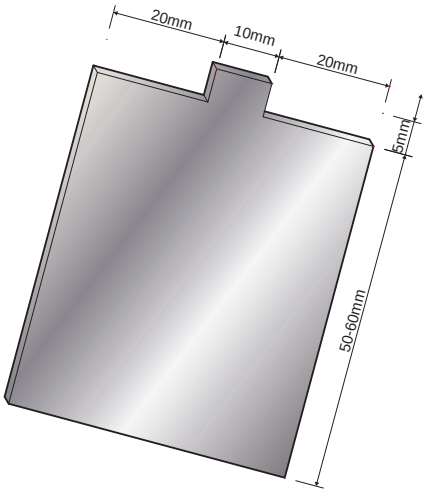
Mastic trowel



Pointing trowel



Short jointer



Scraper

DID YOU KNOW?

A notable person who used to enjoy brickaying as a hobby was Sir Winston Churchill.

NOTES

CHAPTER 3

Terms used in Brickwork

CHAPTER 3

Terms used in Brickwork

TERMS USED IN BRICKWORK

ARCH

An arrangement of bricks over an opening.

ARRIS

The edge of a brick.

BAT

Portion of a brick a quarter or larger (Figure 3.2)

BED JOINT

The horizontal joint.

BOND

An arrangement of bricks in a particular manner (See page 26).

BUTTERING

Means applying mortar to the end or side of a brick when laying bricks.

CENTRE

(Turning piece). The board (temporary support), which is placed across an opening to support the brickwork above when crossing an opening.

CHASING

Cutting grooves into brickwork for electrical or plumbing pipes.

CLOSER

A brick cut in two lengthways (See page 28)

CONCRETE

A mixture of stone, sand, cement and water.

COURSE

A complete row of bricks (brick plus mortar joint).

DAMP PROOF COURSE (D.P.C)

A layer of material, such as PVC, at least 150mm above ground level to prevent moisture rising up the wall.

EXCAVATION

The trench which is dug in the ground for the foundation.

FOUNDATION

The brickwork and concrete below the D.P.C. (See chapter 8).

HEADER

The head or short side of a brick.

JOINTING

The process of finishing off brickwork by means of jointers.

LAP

The distance the bricks of one course, overlaps with the bricks of another course. (Figure 3.1)

LINTEL

A pre-stressed concrete plank above an opening. It could also be comprised of brickwork for aesthetic reasons.

LUGS

Strips of metal (fixed onto the sides of metal doors and window frames) to secure frames to the brickwork.

MORTAR

A mixture of sand, lime, cement and water.

PERPENDS

The perpendicular joints.

PLANS

Special drawings used by a builder when building a house.

QUOIN

Corner brick - the first brick of each course at the corner. (Figure 3.3)

RACKING BACK

The steps left in the brickwork back when pulling up corners (Figure 3.3)

REINFORCING

Metal that is built into brickwork, e.g. reinforcing bars, brickforce or expanded metal.

REVEAL

The vertical sides of an opening.

ROOF TIES

Lengths of hoop-iron or strands of wire built into the wall to secure the roof to the walls.

SILL

The part of the brickwork directly below a window.

SOFFIT

The top part of an opening or the underside of an arch

STRETCHER

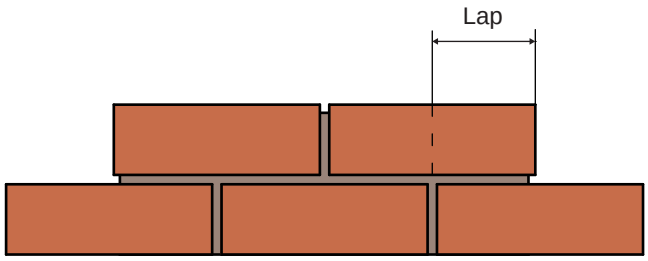
The long face of a brick.

SUPERSTRUCTURE

The brickwork from the floor slab (D.P.C) upwards.

THRESHOLD

The section of the floor at the doorway.



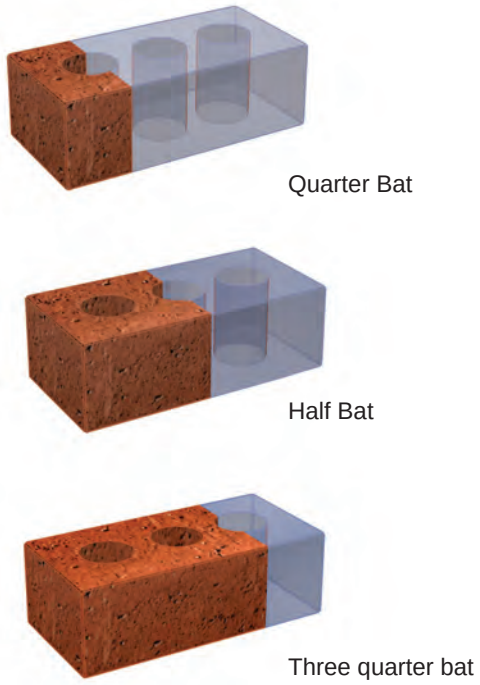
3.1 - Lap

TOOTHING

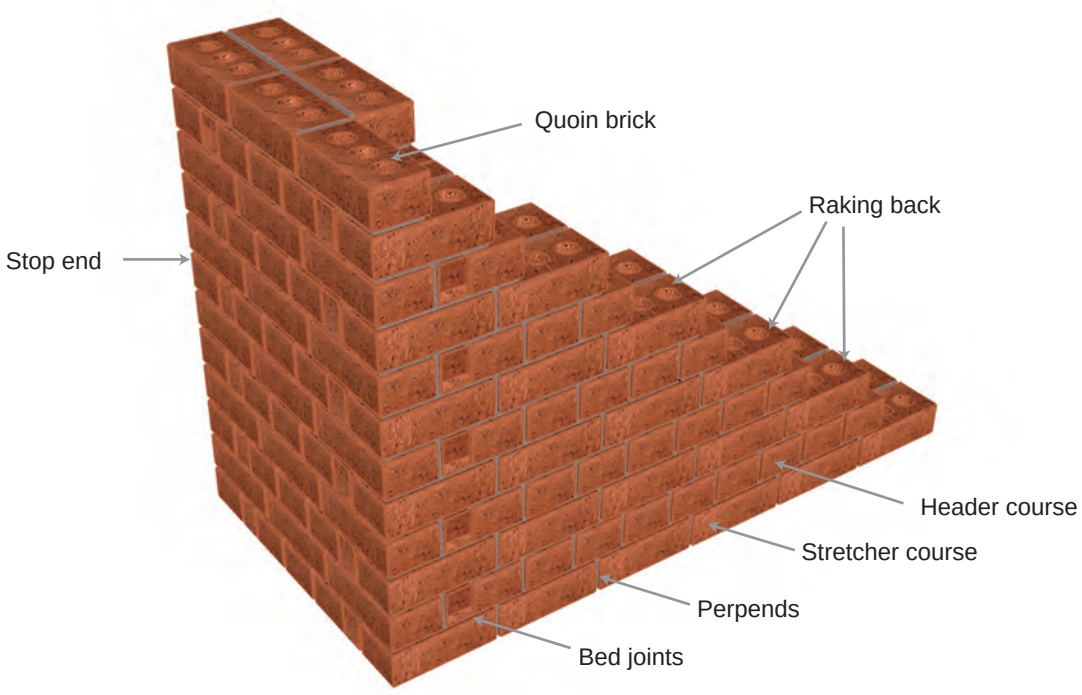
Leaving indents in the wall. This means removing every second brick when adding new brickwork to existing. (See Chapter 13: Additions)

WALL TIES

Short pieces of wire built into the brickwork to keep the two wall skins together.



3.1 - Bats



3.1 - Bats

NOTES

CHAPTER 4

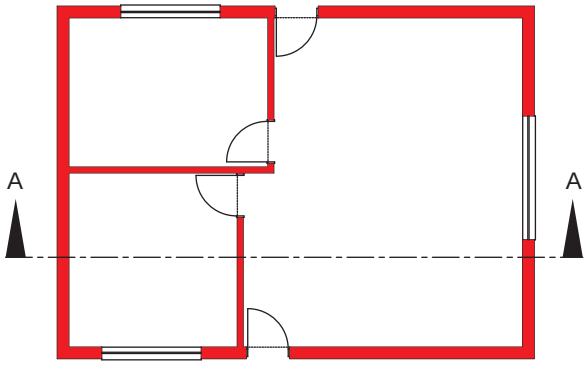
Working Drawings

WORKING DRAWINGS (PLANS)

The owner, or person who wants to build the house, decides how he wants it built. He makes rough sketches from which special drawings (plans) are made. These plans show the exact position and size of each room. The material needed and the cost of the house is also worked out from these plans before building operations are started.

The Plan - Fig 4.1

The word 'plan', besides including all the drawings of a house, also means a special part of a drawing. It shows the house as it would look from above but without roof.



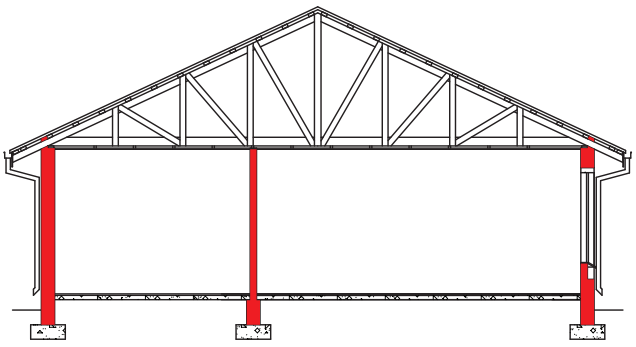
4.1 - Plan of a house

A-Section - Fig 4.2

If one could take a big saw and cut right through a building, starting at the roof and cutting through vertically to the foundation, and then removing the portion that has been cut off, the portion that remains would represent a section of the house. This section will indicate:

- How high the doors, windows and walls should be
- What happens to the walls under the floor
- The size of the foundations
- How the roof should be constructed

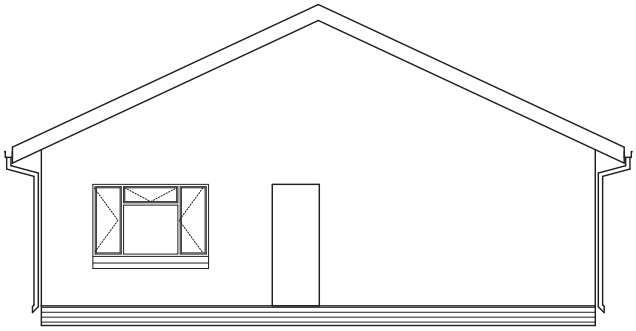
Marks like those in Figure 8 appearing on a plan, indicate where the section has been cut. They also indicatethe angle from which the section should be viewed.



4.2 - Section

Elevation - Fig. 4.3

This is a drawing of one side of a house. A house usually has four sides; thus, there are four elevations which can be shown on the plans - the front, back and end elevations. This is usually enough to show what the building will look like.



4.3 - Elevation

Scale

The plan, section and elevations of a house can obviously not be drawn to full size, so they are made very much smaller. This means that every metre length of the real building is represented by a proportionately shorter length on the drawing. The drawing is then said to be 'drawn to scale.

Dimensions of the house.

Any dimensions required when building the house can be taken off the drawing with a scale rule. This method is not recommended, as the measurements may not be exact. In order to eliminate any errors, all the important dimensions are written on the plan. One need only read the dimensions correctly.

IMPORTANT NOTE:

All building plans by law need to drawn up by a registered architectural professional. Architectural professionals need to be registered by SACAP (South African Council of Architectural Professionals)

CHAPTER 5

Site Work

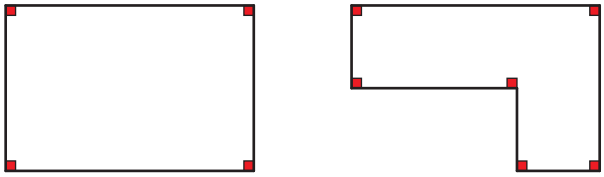
SITE WORK

Setting Out

Before beginning the setting out operations, study the working drawings (plans), especially the site plan. This is done to ensure the house is positioned correctly in relation to the stand.

Certain by-laws come into play at this early stage, e.g. distance from street (curb), and distance from the two adjoining stands (boundaries). Remember, houses in South Africa normally face North.

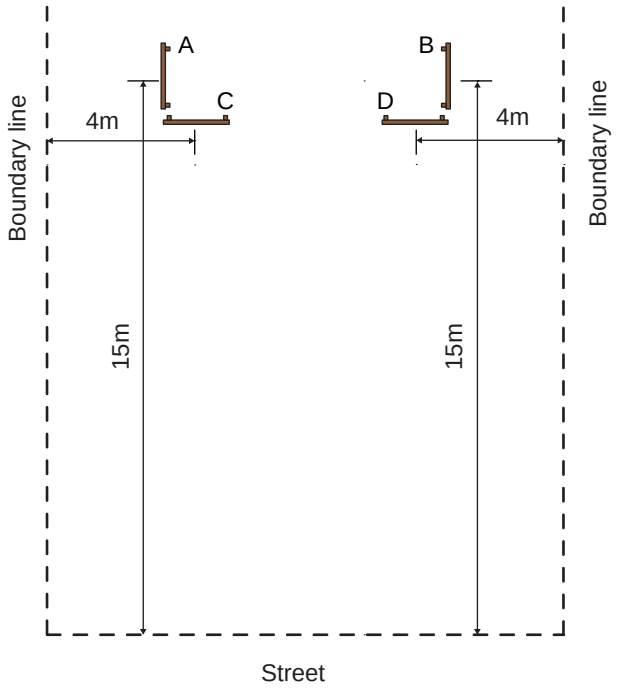
Establish the four corner pegs of the proposed structure. In the case of a non-rectangular structure, it will be necessary to locate all the outside corner pegs, as shown below:



5.1 - Corner Pegs

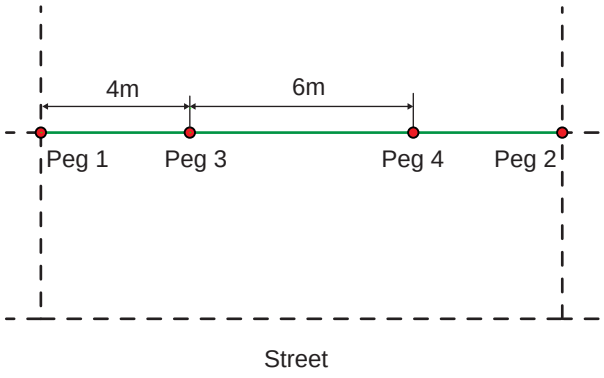
Example:

Say the distance from the outside of the building to the street is 15m and 4m on both sides from side boundaries as shown. Put in two pegs.



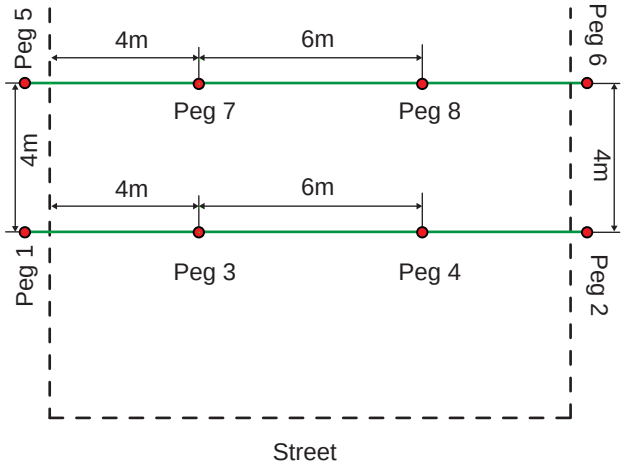
5.2.1

String a line between the two pegs. Pull taut. Say the house is 6m long and it must be 4m from the one boundary line, measure 4m along peg. These are the two front corners of the house.



5.2.2

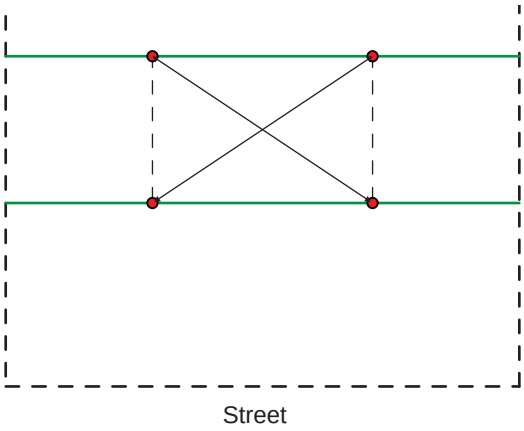
Say the width of the house is 4m. Measure back along the boundary 4m. Put in two pegs. String a line between these pegs. Measure the first 4m, put in a peg, and then 6m, put in another peg, as shown in Fig. 5.2.3. These are the back corners of the house.



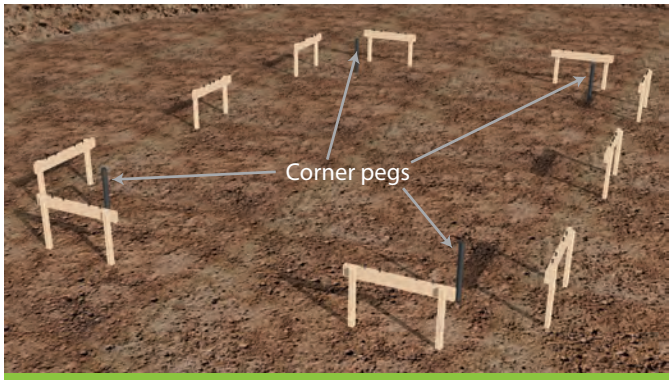
5.2.1

Measure across (diagonally) from each front corner to the back corner on the other side. The distance must be the same. If not, move the pegs back until the two distances across are the same.

See Fig. 5.2.4

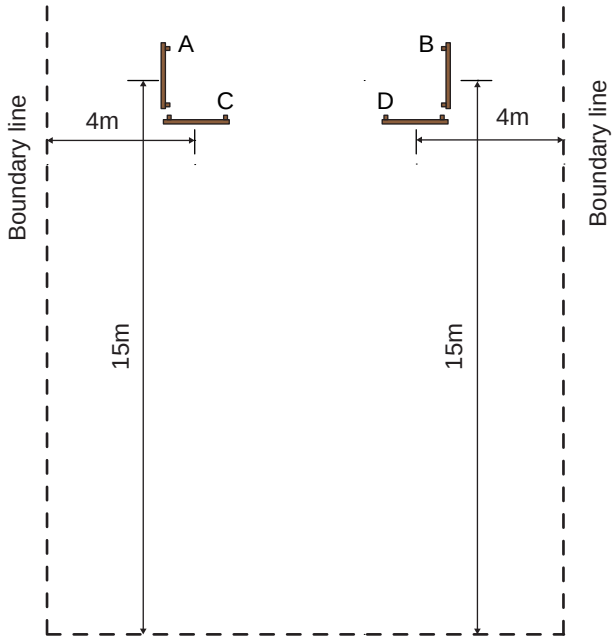


5.2.1



5.3 - This picture illustrates the four corner pegs established and with the profiles in position.

Keep the profiles about one metre away from the temporary located outside corner pegs. This will allow enough room for people and wheelbarrows to pass between the edge of the trenches and the profile, which must remain in position until after the foundation walling has been set out on top of the concrete footings.



5.4 - Boundary lines

When setting out, there should be one fixed line which must not be moved and from which the rest of the measurements are taken.

Let us assume that the building has to be set back 15m from the street and 4m from the boundary on both sides. Take a tape and measure 15m from the edge of the street or pavement to profile A. Make a pencil mark on the profile. Measure 15m from the street to profile B and make a pencil mark. Small nails may be knocked in on the marks.

Measure 4m from the side boundaries to profiles C and D as shown. Make clear pencil marks. Knock in small nails on the four pencil marks. Tie the end of a ball of line to the nail in profile A. Pull the line taut and tie it to the nail in profile B. This line between profiles A and B represents the fixed line from which the rest of the building will be set out. All the other lines may be moved after this to get the building square, but the line between profiles A and B must remain fixed.

Bring the line round and tie it to the nail in profile C, and then let a second person hold it taut across profile E.

The next step is to check whether the angle made by the two lines is a right angle. Use the 3.4.5. Method as follows:

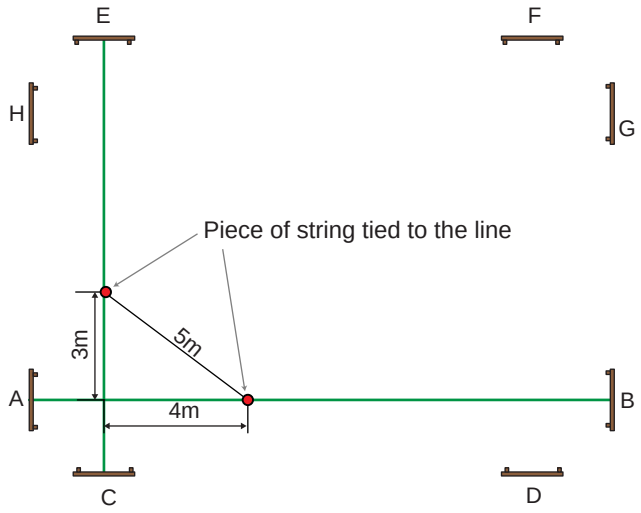
Measure 3m from intersection 1 towards profile E. Mark this point by tying a short piece of string on the line.

Next, measure 4m along the fixed line, again from intersection Mark this point with a short piece of string tied to the line. (see Fig. 5.5)

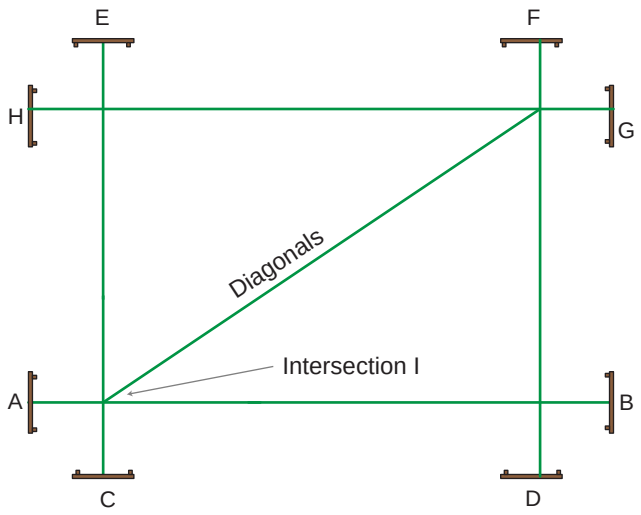
Take a tape and pull it out until you find the 5m mark. Let another person hold the end of the tape on the 4m mark while you hold the 5m mark over the 3m mark on the line.

If the 5m mark on the tape is not directly above the 3m mark, the line stretched across profile E must be moved either to the left or to the right by the person holding it, until these two marks are over each other.

When the 5m mark is directly above the 3m mark, the angle formed by the two lines is a perfect right angle. Knock in a nail next to the line in profile E and tie the line to the nail.

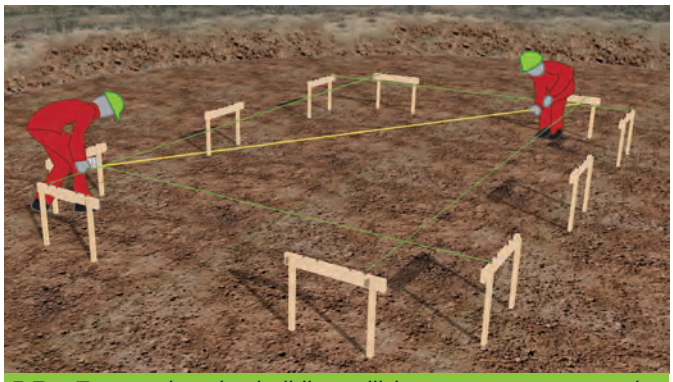


5.5 - 3,4,5 Method



5.6

- From the nail on profile B, measure the required length of the side of the building to profile G. Put in the nail.
- Bring the line across from profile H to the nail on profile G. Unroll the line and stretch it taut across profile H.
- Let somebody hold the line taut while two other people use the 3.4.5. Method to check and make sure that the angle between the lines is a right angle. Put in a nail next to the line on profile G and tie the line to it.
- Three sides of the building have now been set out.
- From the nail on profile C, measure the length of the building to profile D. Do the same from profile E to F. Put in a nail on profile F.
- Bring the line around from profile G to the nail on profile F. Unroll it, and pull it taut while tying it to the nail on profile D.
- The four sides of the building have now been set out. The four lines will appear as shown in figure 5.6.



5.7 - Ensure that the building will be square -measure the diagonals.

The lines represent the four sides of the building.

Although, we have checked each corner by means of the 3.4.5 Method, the building may still not be perfectly square. To make quite sure, we must measure diagonally across from corner to corner, as follows:

Let somebody hold the end of the tape above the point where the lines cross at profiles A and C.

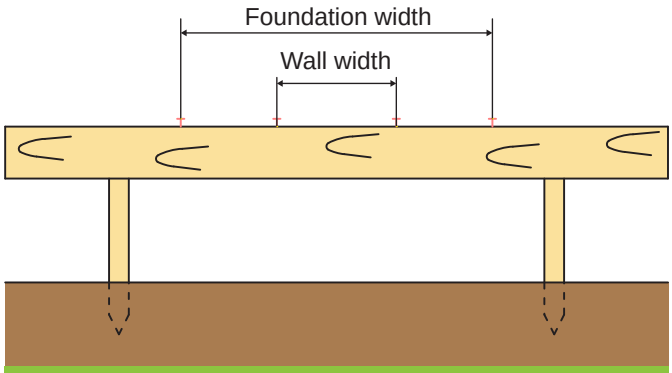
Pull the tape taut towards profiles F and G. Read off the figures appearing on the tape at this point, or hold your finger on the mark. Let the person holding the tape walk over to profiles E and H while you walk to profiles D and B.

Check the distance, as shown. If the two diagonals are the same, the lines are rectangular and the building is square. (See Fig. 5.7).

To mark out the width of the foundations on the profile, the thickness of the walls must first be marked off as follows:

On profile A, from the nail, measure with a tape, the thickness of the outside wall and make a pencil mark. This measurement must be in the direction of profile H. In other words, the rectangle formed by a line between these nails, will be the internal line of the external wall of the house.

After putting in the nails representing the inside of the walls, the nails representing the foundation can be driven into the profiles.



5.8 - Profile board

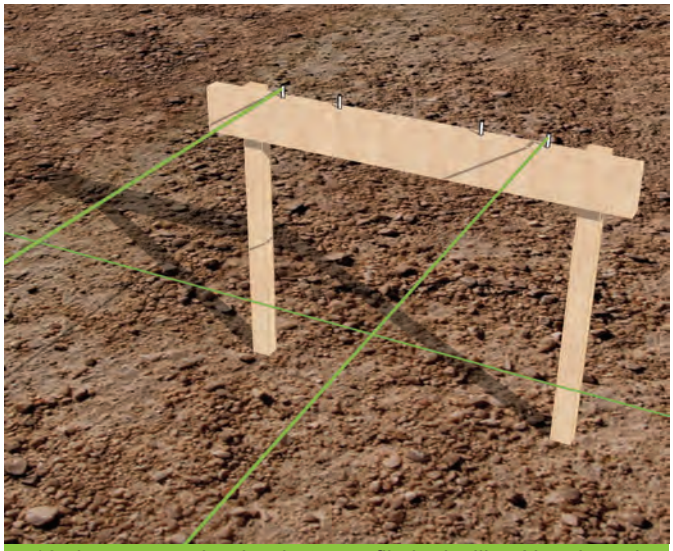
Let us suppose the foundations must extend for 15 mm on each side of the wall. Measure, 150rnm on each side of the two nails on each profile. Put in the extra nails. These nails represent the width of the foundation. The profile will now appear as shown on the illustration. (Fig. 5.8)

Untie the line on the inside nail and fix it to the outside nails, starting from one side. After completing this step, eight lines should be stretched across the site, representing the internal and external lines of the foundations.

Study pictures 3 to 5, following the description, and you will see what the building site looks like with the lines strung across to represent the foundations. Transfer these lines onto the round by using a pick or other sharp object, as shown in the pictures.

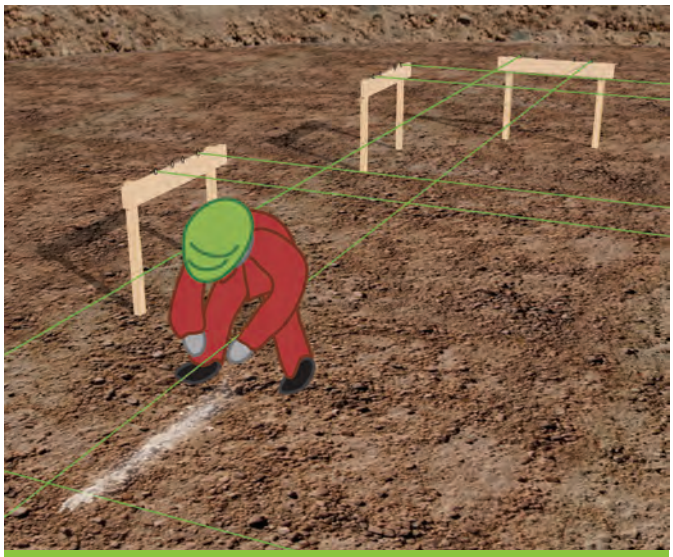
Start digging the trenches.

5.9 - The first step in setting out the foundation is to erect timber profile right round the proposed building using scaffolding planks, bluegum poles or any other similar straight timber. All foundations and wall dimensions are then marked out on these profiles by means of nails driven into the wood. The figure shows the builder's line for marking out the foundations.



5.10 shows very clearly what a profile looks like. Note how the width of the wall as well as the foundation is marked off. The profiles are also kept well back from the corners.

5.11 - The foundation measurements may be transferred to the ground by using a pick as shown



5.12 -The foundation measurements can also be transferred down by pouring lime or sand on the ground below foundation lines.

The bottom of the trench should be level and the sides' plumb, as shown in the figures. Where big stones or tree roots have been taken out, the holes in the trench must be filled in with soil that is well rammed before the concrete foundations are laid.

When the ground slopes, trench bottoms must be stepped so that the foundation itself does not slope. The steps should be equal to one or more courses of brickwork, as shown in Figure 5.15.

To ensure that the foundation itself will be level and of uniform depth, level pegs must be hammered in along the trenches. The length of peg left to protrude from the ground should be equal to the thickness that the concrete will eventually have.

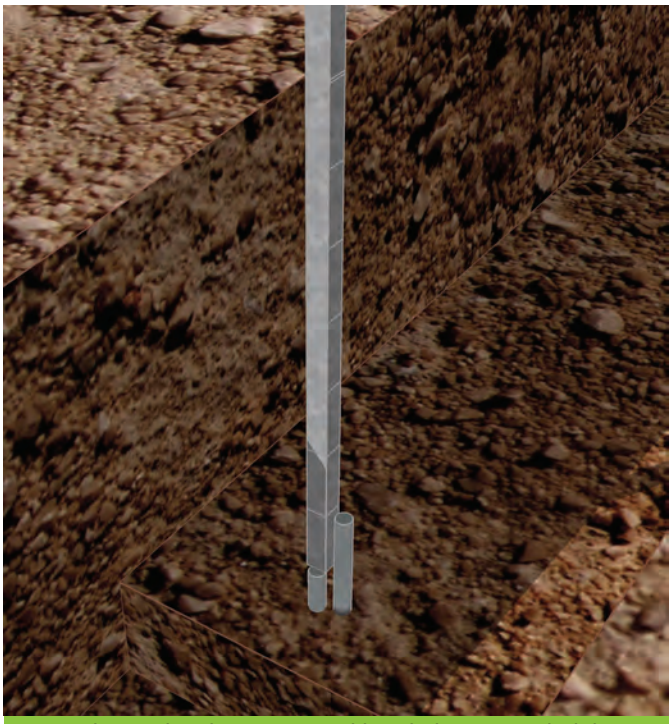
For the purpose of this example, assume a concrete thickness of 225mm.

Set the first peg in the ground at the lowest point in the foundation trench, allowing it to protrude 225mm above the bottom of the trench. Place one end of a 2 metre straight-edge on the first peg. Drive in another peg near the end of the straight-edge. Check to see whether the two pegs are level by placing a level on top of the straight-edge. Hammer in the second peg until the two pegs are dead level. (Refer to Figure 5.12.)

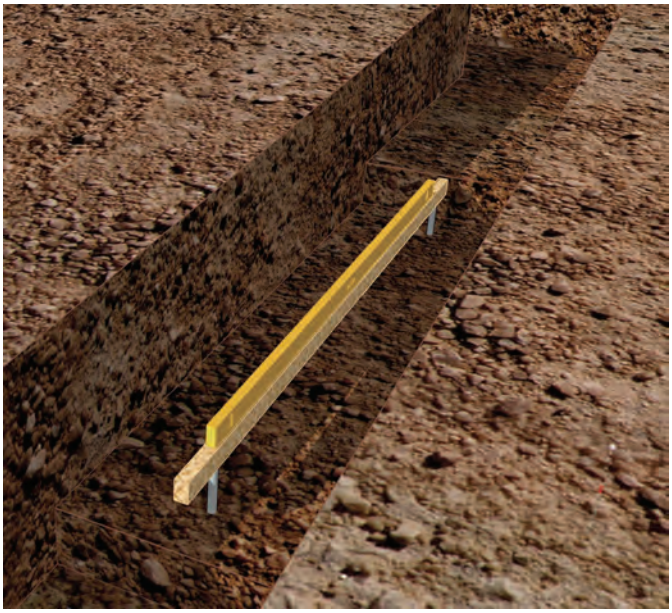
NOTE

Foundation trenches can be 'shored' in wetter conditions to prevent the trenches from collapsing. Timber boards are placed against the edges and braced in place using a wooden plank.

5.13 - Foundation trenches should be dug to a depth of not less than 400mm below the surface all round, following the contours of the ground. The width of the trench is usually twice the thickness of the wall plus 150mm, with a minimum width of 450mm for internal walls. The figure shows how the sides of the trench must be trimmed neatly and square.



5.15 –Figure showing gauge rod in relation to peg height

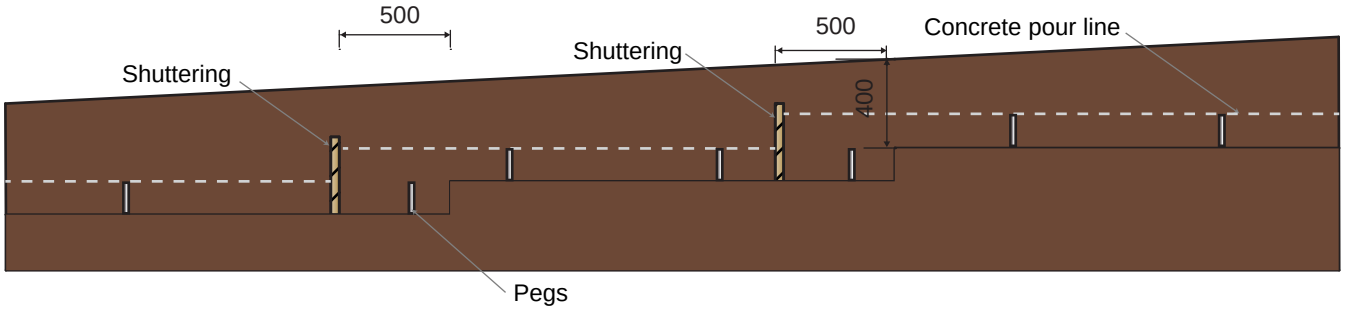


5.14 - Level pegs are then driven into the bottom of the trench starting at the lowest point and allowing the first peg to protrude 225 mm above the bottom of the trench. Use a 2 m straight-edge and drive in the next peg slightly less than the length of the straight-edge away from the first peg. The top of the second peg is levelled with the top of the first, using the straight-edge and spirit level. This process is continued along the trench until the last peg to be driven in level protrudes less than 150 mm above the bottom of the trench. At this point another peg is driven in next to the last peg, but with its top about 90 mm higher. At this point the foundation will later be stepped.

IMPORTANT NOTE:

Steps in foundation should be equal to marks on the gauge rod (courses). Remember that the distance between the marks on the gauge rod is equal to the thickness of a brick plus a mortar joint.

5.16 Level pegs in position.

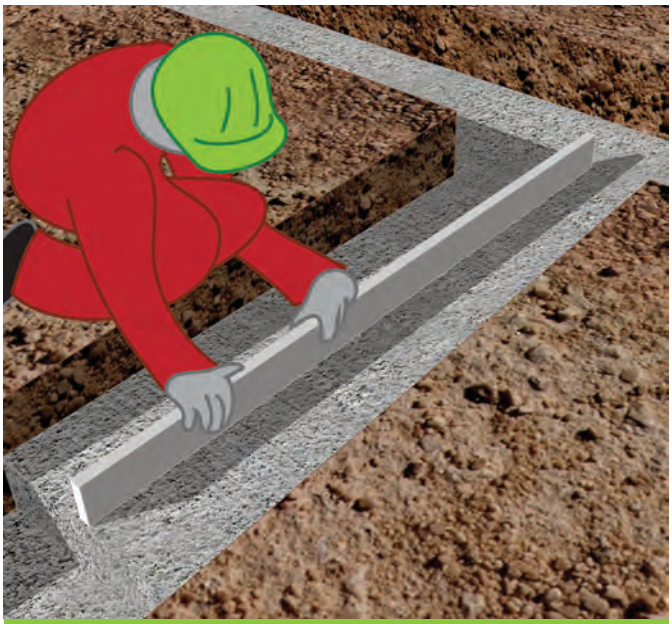


5.17 - Section through stepped foundation

Carry on inserting the pegs level along the trench bottom until you reach a stage where the peg no longer protrudes more than 150mm above the ground. A step must now be made in the trench. Finish putting in all the pegs on a level before starting on the next level.

Assuming that the second level is two courses above the first, start this level by putting in a peg next to the last peg on the previous level, as shown in the figures.

The top of the new peg should be two courses higher than the top of the adjacent peg on the previous level. When all the pegs have been set out on the different levels, start on one side and remove all surplus sill so that all the pegs protrude 225mm. This will ensure that you have a 225mm thick concrete foundation all round.



5.18 - Level the foundation concrete using a straight-edge to the top of the concrete thickness pegs.

5.19 - Showing completed foundations with steps.

NOTES

CHAPTER 6

Materials

MATERIALS

Aggregate

Aggregates can be defined as any granular material used as the main constituent of concrete, mortar, or plaster. Aggregate is described by its size - as course, fine; or all-in; or its source.

19mm stone and riversand are the most commonly used aggregates in manufacturing normal concrete.

Aggregates are used to reduce the cost per cubic metre of concrete and reduce shrinkage and other deformations.

Aggregate in concrete may be classified in two groups:

Dense – Sand and stone, and
Low density – vermiculite (light weight concrete)

Shape of aggregate

In order to get strong concrete, the aggregate should be well placed and packed closely together to avoid any voids 'honeycomb'. The shape of the crushed aggregates ranges from rounded; angular; flaky; and elongated. Flaky and elongated aggregates should be avoided in concrete mixes.

Types of aggregate

Coarse aggregate (Stone)

Coarse aggregate is used in concrete for bulk and because it is cheaper than cement, making the mix more economical. If the stone size is increased, less water is needed to give the required slump, therefore less cement is necessary to maintain the same water:cement ratio and strength.

There are a number of different sizes of stone, the four commonly used nominal sizes are; 26.5mm; 19mm, 13.2mm and 9.5mm. Stone is sorted by using a sieve or screens with the relevant size holes in order that the stone to be sized.

Fine aggregate (Sand)

Fine aggregate is used as a void filler. It fills up spaces between the stone and cement. It also affects the amount of water needed in the mix and as described above the shape of the particles is also important as it affects the amount of water required and the slump. Sand also reduces the paste content and makes the concrete more stable.

Sands lacking fine fractions (fines) – passing through a 300µm sieve -produce harsh concrete that bleeds and has a tendency to segregate.

An essential requirement is that sand should be free of organic matter such as roots, twigs, humus, clay etc.

Cement

Cementitious materials for concrete are fine mineral powders. When these materials are mixed with water, they react chemically to form a strong rigid mass that binds aggregate particles together to make concrete.

For the purpose of this publication, we deal with ordinary Portland cement only. It has a medium setting period and is obtainable from your local hardware store or building supply merchants.

When sealed in airtight drums, cement remains the same in strength for up to 3 years.

When packed in sacks, even under good conditions, deterioration in the strength of the cement will occur, with a prolonged shelf life, for example:

20% loss after 3 months
30% loss after 6 months
40% loss after 1 year
50% loss after 2 years

The arrangements for storing or stocking cement should be such that batches are used in the same order in which they were received. First in - first out.

IMPORTANT NOTE:

It is illegal to sell cement in South Africa if it does not have the SABS mark indicating its compliance with the requirements of the standard. Portland cement extenders

- SANS 1491: Part 1 - Ground granulated blast- furnace slag
- SANS 1491: Part 2 - Fly ash
- SANS 1491: Part 3 - Silica fume

Lime

The addition of lime to mortars is recommended but is no longer common practice.

CHAPTER 7

Concrete

CONCRETE

Concrete is the name given to a mixture of Portland cement and an aggregate of sand and gravel, or sand and small stones, together with water, which when allowed to set and harden takes the shape of the mould into which it has been placed. After 28 days the full strength of concrete has been achieved.

After mixing these materials together, a plastic mass is formed, which when set, becomes as hard as stone.

Concrete hardens with age, hence its usefulness as a building material.

The strength of concrete is dependent on such factors as the quantity of water used the grading of the aggregates used, the ratio of the materials used, the thoroughness of the mixing of the materials and the curing of the concrete after it has been cast.

Plain Concrete

This consists solely of cement powder, water and graded coarse and fine aggregates. No reinforcement is used. It can be manufactured on site, or can be purchased from a ready mixed concrete company.

Uses include simple foundations, garden paths and driveways; paving slabs, kerbs and channels; protection of drainage pipes, etc.

Reinforced Concrete

This consists of plain concrete reinforced with metal, usually steel bars or fabric mesh. It is stronger than plain concrete in both tension and compression, and it can be manufactured either on site or under factory conditions away from the site.

Uses include foundations, walls, columns, lintels and beams; floors, roofs, etc.

Pre-cast Concrete

Usually in the form of some kind of unit which can be manufactured either on or away from the site. The unit is made in some other place than that which it is to permanently occupy. It can be plain, reinforced or pre-stressed.

Uses include bricks, blocks, cladding panels, pad stones, copings, window sills, canopies, chimney caps, flue liners and all types of structural units.

NOTE

When the concrete is placed on site in the position where it is to remain permanently, it is termed in-situ concrete.

Composition of concrete mix

The composition of a good quality concrete mix consists of cement, sand, stone, and water as a lubricant, proportioned together to produce concrete which will satisfy the specific performance requirements (workability, compressive strength, and durability) as well as to give the correct yield or blend.

Classification and uses

A concrete mix ratio as well as the size of the course aggregate determines the strength of the concrete for a specific concrete element or component.

Various recommended concrete strengths for various uses are however provided as guidelines in the table below:

Concrete strength at 28 days MPa	Use
10	Mass filling
15	Foundations for houses and unreinforced concrete
20	Floors on the ground (surface beds) for houses
25	Reinforced concrete Home driveways
30	Reinforced concrete Floors on the ground for heavy duty – e.g. factories
35	Floors on the ground for heavy duty – e.g. factories Precast concrete
40	Precast concrete

Mix proportions and quantities

The materials in concrete, i.e. cement, course and fine aggregate, water and admixture (if required), should be proportioned to give the required properties in the fresh and hardened state.

As described above, mix requirements for a given strength of concrete can be specified in one of two ways. Proportions or quantities of each material to be used may be stated in terms of either volume or mass. Alternatively a strength requirement may be given.

Mix proportions in the following table are based on the assumption that a CEM II/A 32.5 cement will be used.

Concrete strength at 28 days, MPa	Mass or volume	9,5 or 13,2mm stone			19,0 or 26,5mm stone		
		Cement	Sand	Stone	Cement	Sand	Stone
10	Mass/bag	50 kg	238kg	128kg	50kg	230kg	196kg
	Volume/bag	**1 bag**	**0,175 m³**	**0,095 m³**	**1 bag**	**0,170 m³**	**0,145 m³**
	Mass/m³	250 kg	1 190 kg	640 kg	225 kg	1 030 kg	890 kg
	Volume/m³	5,0 bag	0,88 m³	0,47 m³	4,5 bag	0,76 m³	0,66 m³
15	Mass/bag	50 kg	175kg	106kg	50kg	170kg	164kg
	Volume/bag	**1 bag**	**0,130 m³**	**0,080 m³**	**1 bag**	**0,125 m³**	**0,120 m³**
	Mass/m³	315 kg	1 100 kg	670 kg	280 kg	950 kg	920 kg
	Volume/m³	6,3 bag	0,82 m³	0,50 m³	5,6 bag	0,70 m³	0,68 m³
20	Mass/bag	50 kg	138kg	92kg	50kg	130kg	138kg
	Volume/bag	**1 bag**	**0,100 m³**	**0,070 m³**	**1 bag**	**0,095 m³**	**0,100 m³**
	Mass/m³	375 kg	1 030 kg	690 kg	340 kg	880 kg	940 kg
	Volume/m³	7,5 bag	0,76 m³	0,51 m³	6,8 bag	0,65 m³	0,70 m³
25	Mass/bag	50 kg	114kg	84kg	50kg	106kg	125kg
	Volume/bag	**1 bag**	**0,085 m³**	**0,060 m³**	**1 bag**	**0,080 m³**	**0,090 m³**
	Mass/m³	425 kg	970 kg	710 kg	385 kg	820 kg	960 kg
	Volume/m³	8,5 bag	0,72 m³	0,53 m³	7,7 bag	0,61 m³	0,71 m³
30	Mass/bag	50 kg	95kg	78kg	50kg	90kg	114kg
	Volume/bag	**1 bag**	**0,070 m³**	**0,055 m³**	**1 bag**	**0,065 m³**	**0,085 m³**
	Mass/m³	475 kg	910 kg	730 kg	430 kg	770 kg	980 kg
	Volume/m³	9,5 bag	0,67 m³	0,54 m³	8,6 bag	0,57 m³	0,73 m³
35	Mass/bag	50 kg	80kg	72kg	50kg	75kg	105kg
	Volume/bag	**1 bag**	**0,060 m³**	**0,055 m³**	**1 bag**	**0,055 m³**	**0,080 m³**
	Mass/m³	525 kg	850 kg	750 kg	475 kg	710 kg	1000 kg
	Volume/m³	10,5 bag	0,63 m³	0,56 m³	9,5 bag	0,53 m³	0,74 m³
40	Mass/bag	50 kg	68kg	68kg	50kg	64kg	98kg
	Volume/bag	**1 bag**	**0,050 m³**	**0,050 m³**	**1 bag**	**0,045 m³**	**0,075 m³**
	Mass/m³	575 kg	780 kg	770 kg	520 kg	650 kg	1020 kg
	Volume/m³	11,5 bag	0,58 m³	0,57 m³	10,4 bag	0,49 m³	0,76 m³

Information courtesy of the Concrete Institute - www.cnci.org.za

Example:

1.3 m3 of 20 MPA concrete using 9.5 or 13.5mm stone is needed. The amount of each material required is:

Cement	8.0	x 1.3	= 10.4 bags
Sand	0.76 m3	x 1.3	= 0.988 m3
Stone	0.51 m3	x 1.3	= 0.663 m3

Allow for a little waste and order 11 or 12 sacks of cement, 1.2 m3 of sand and about 1 m3 stone.

Water requirements

Only clean fresh water, free from vegetable or organic matter, earth, clay acid or alkaline substances in either suspension or solution should be used.

Depending on the size of stone used in the mix, the amount of water required per m³ can be estimated in the following way:

Water requirement of concrete mixes for average-quality sand. [(a)]

Nominal size of stone (mm)	Water requirement of concrete (ℓ/m³)
9.5	235
13.2	225
19.0	210
26.5	200
[(a)] The volume of water is based on a 75mm slump	

Example:

If you are using a 19mm stone, the water required in the mix would be about 210ℓ for every cubic metre.

Mixing

Site Mixing

Site mixing should only be done on small work. It may also be necessary in the event that the mixer breaks down. It should never be done on the ground but on a light wooden platform, a metal tray, a concrete floor or a small area packed with bricks. If done on a porous surface, this may interfere with the mix design as the surface may absorb water.

The procedure of mixing is important.

The stone should be spread out first in a rather flat heap (not a high, conical heap, as the larger stones will roll down the sides and separate.)

Next, the sand should be spread evenly over the heap, followed by the cement - also spread evenly and not dumped in one spot.

The dry materials should be mixed at least three times by shovelling from the centre and again to the side. The materials should not be dumped from one place to another; each shovelful should be turned over by twisting the wrist and spading into the pile. About half to three-quarters of the total quantity of water required should be poured into the centre of the ring; the materials mixed into it, and then back into the ring.

The remainder of the water can now be added slowly as the materials are mixed into it, stopping the addition of water when the right workability has been obtained. Adding all the water at once will result in some running away and taking cement with it.

Ten per cent more cement than specified for machine mixing should be allowed for possible loss. Mixing must be done until the colour is uniform and the consistency the same throughout the pile.

Machine Mixing

The stone should be placed in the skip first, then the sand and cement, so that the stone is the last material to enter the drum of the mixer. With very small mixers, where materials are placed directly into the drum, the stone should not be added too quickly, otherwise 'balling' of the cement is likely to occur.

After all the material and the water have been added, mixing should continue for at least one minute, though one and a half minutes is preferable and should be sufficient for all but very dry mixes, for which two minutes would be better. The mixing time should never exceed twenty minutes.

The drum should be completely emptied of a batch before refilling, otherwise it is impossible to control the water for each batch accurately. At the end of concreting, the drum should be washed out thoroughly. Concrete must never be allowed to harden in the drum.

Placing

Before the concrete is placed in position, whether in forms or foundation trenches, the place into which the concrete is poured must be wetted thoroughly. Whatever method is used for transporting the concrete - whether by wheelbarrow, skip, hoist or chute - segregation of the materials must not occur.

The period between discharge from the mixer and placing in position should never exceed 30minutes. All equipment must be thoroughly clean. The filling of the foundation trenches or forms should be completed in one operation if possible, to prevent joints. If construction joints are unavoidable, the old surface must be clean, rough, wet and concrete, otherwise a bond will not be obtained and a crack will result.

As the foundation trenches and forms are filled, puddle the mixture well with a stick or heavy iron rod, especially in the corners, to eliminate the trapped air and to obtain a dense, uniform concrete.

Puddling, or working the concrete with a spade or trowel, will always bring the lighter mortar to the surface so that the face of the structure will have a thin film of mortar on the surface without holes and stones. It should not be carried too far, however, as segregation of the materials could result, leaving the interior short of mortar.

Curing

Concrete will gain in strength for several years after the initial set provided enough water is present. In hot weather rapid withdrawal of moisture from the mix may result in shrinkage of the concrete and cracks appearing. An effective remedy is to keep the concrete moist by spraying daily with a garden hose or you can keep the concrete covered. In general, the longer the period of curing the better will be the quality of the concrete.

Hints on Concrete

In this chapter, we have discussed the different ways of mixing concrete.

For the do-it-yourselves, mixing small quantities of concrete by hand is by far the most economical way. The next best is, to hire a small mixer which adds to the cost of the concrete, but the speed at which different batches can be mixed, makes up for the additional cost. Pre-packed sacks of concrete material obtainable from most hardware shops is an easy way of obtaining the material you require for small jobs.

This method is certainly recommended if you need up to, say, one quarter cubic metre of concrete. For jobs requiring more concrete, it is advisable to order the materials in small quantities from your hardware shop. Merchants deliver small quantities.

If the quantity of the material that you need is say 4m^3, it is often cheaper to buy a whole load, as you will be required to pay a full load cartage rate.

Ready-mixed concrete

Ready-mixed concrete, albeit more expensive than the other methods, has the advantage that the concrete can be of the same consistency, well mixed and strength of the concrete of different loads is the same.

When ordering ready-mixed concrete for foundations and surface beds, a suitable workable mix should be asked for. Further, a minimum concrete strength of 15MPa should be specified for foundations and 20MPa for surface beds. This concrete should be placed, consolidated and levelled as soon as possible. A delay will result in a stiffening of the mix and badly consolidated and honeycombed concrete.

Where ready-mixed concrete is used and the strength of the concrete can be accurately specified and obtained, a slightly lower strength for the footings than for the surface beds is acceptable 15MPa as against 20 MPa. This can be explained as follows:

- The footings have a shape that minimises drying out and the concrete therefore goes on curing (and gaining strength) over a prolonged period.
- The footings do not have a wearing surface.
- The weaker the mix, the more susceptible it is to bleeding, which is less serious for footings than it is for surface beds, which are exposed to wear.

IMPORTANT NOTE:

It is illegal to sell cement in South Africa if it does not have the SABS mark indicating its compliance with the requirements of the standard. Portland cement extenders

- SANS 1491: Part 1 - Ground granulated blast- furnace slag
- SANS 1491: Part 2 - Fly ash
- SANS 1491: Part 3 - Silica fume

NOTES

CHAPTER 8

Concrete Work

CHAPTER 8

Concrete Work

CONCRETE WORK

Foundations for walls and piers

All loadbearing walls and piers are required to stand on a concrete foundation, which must be able to receive and pass-on the load placed upon it to the natural foundations.

Natural Foundations

The subsoil (bottom of excavation) on which the concrete foundation rests is termed the natural foundations. This could be rock, clay, gravel, sand or even waterlogged and reclaimed ground. Where clay, loose sand or waterlogged soil is present, the advice of a geotechnical or soils engineer should be sought to avoid repairs arising from possible settlement of the foundations.

Purpose of Foundations

- To spread the load
- To prevent walls leaning over as a result of undue settlement.
- To bridge over any soft spots that may occur in the natural foundations.
- To form a level base on which to build.

Types of Foundations

- Pad foundations
- Raft or slab foundations
- Pile foundations
- Strip foundations
- Stepped strip foundations

In this publication the emphasis will be on strip and stepped strip foundations.

Pad Foundations

Pad foundations are isolated blocks of concrete supporting brick piers or concrete columns.

Raft Foundations

Raft foundations consist of concrete slabs formed at ground level, and covers the entire area to be enclosed by the eventual structure.

Pile Foundations

In cases where the natural foundation may subside (sink), when the weight of the building is applied, pile foundations are used. Pile foundations entail the drilling of a number of holes of various depths,and filling these with reinforced concrete. These concrete piers (piles) support the eventual structure.

Strip Foundations

This type of foundation is a continuous strip of concrete with a minimum thickness of 200mm. The depth and width are determined by SANS 10400 and illustrated in the following figures.

Stepped Strip Foundations

On sloping sites where the natural foundations run parallel with the ground surface, it is good building practice to construct a stepped foundation. This method reduces the depth and quantity of excavations.

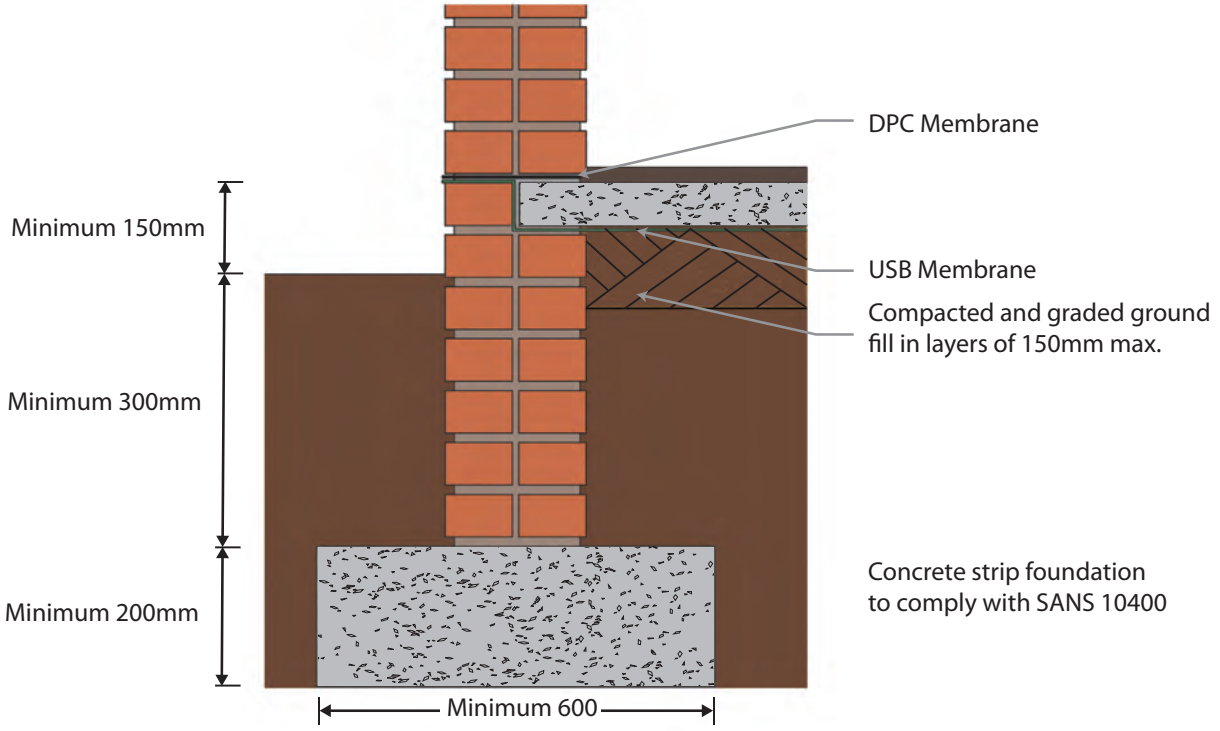
Where a foundation is laid at more than one level, the higher foundation is to be extended over the lower level at a distance equating to the vertical thickness of the higher foundation, or alternatively the difference between adjacent levels, whichever is the greater. (See Figure 5.17)

Overlap

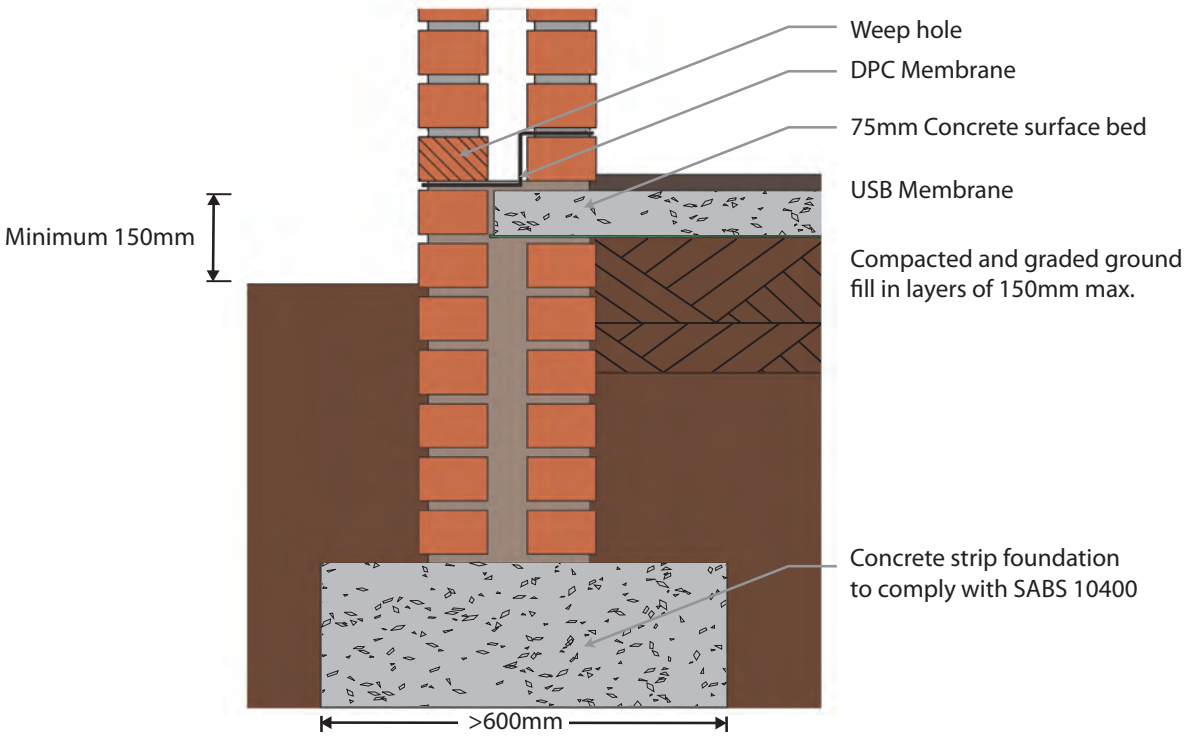
The minimum overlap is not less than 400mm (See Figure 5.17) and no less than 200mm thick.

IMPORTANT NOTE:

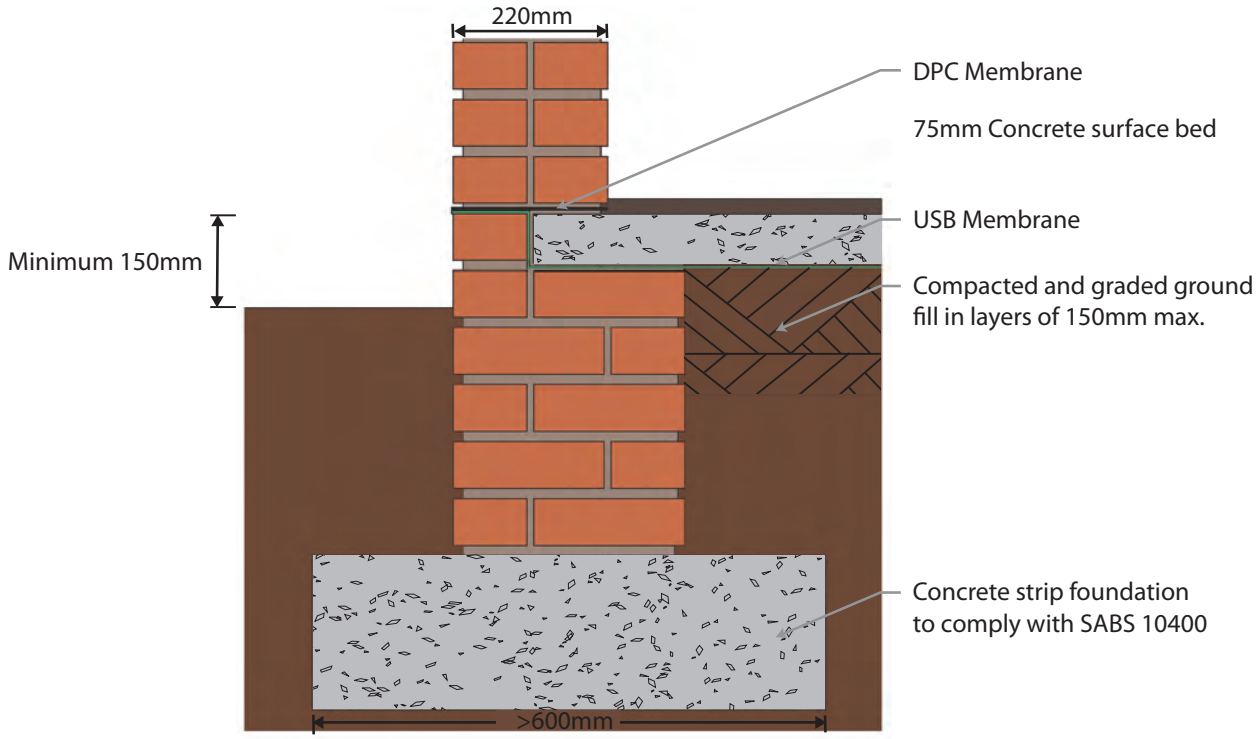
SANS 10400 specifies a minimum foundation width of 600 mm and a minimum foundation depth of 200 mm.



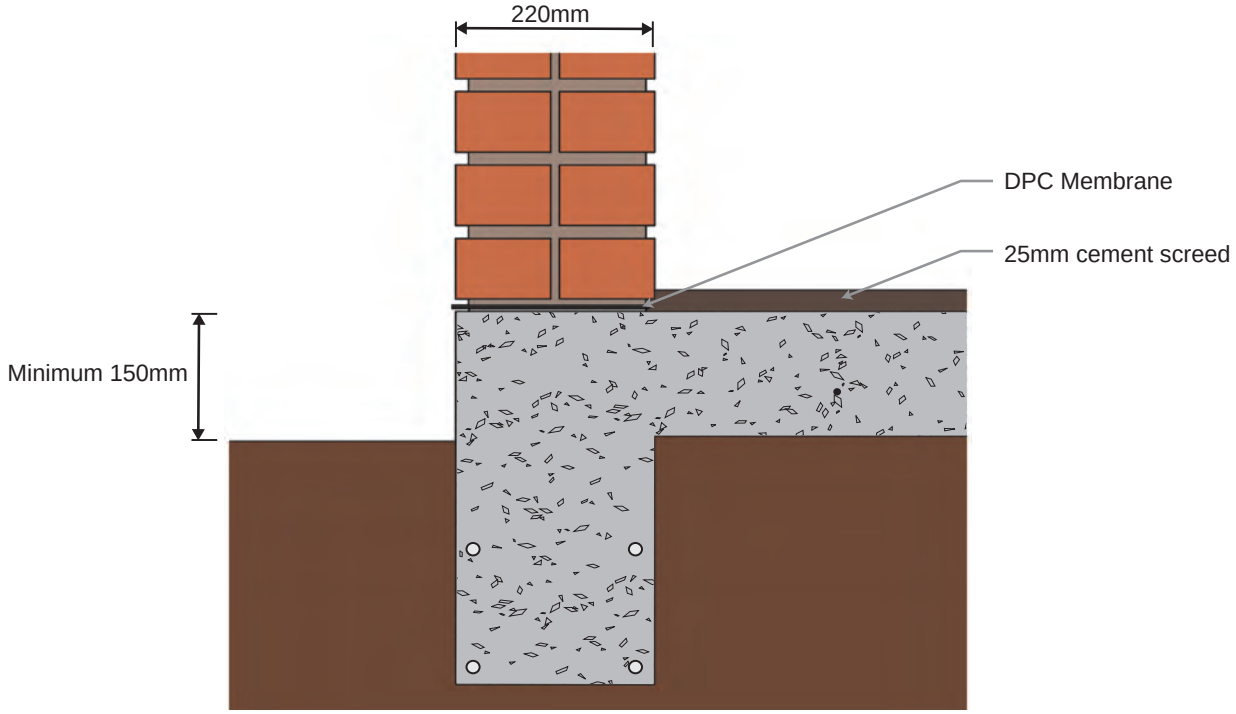
8.1.1 - One brick wall foundation



8.1.2 - Cavity wall foundation



8.1.3 - One and half brick wall foundation



8.1.4 - Raft foundation

Surface Beds

In normal domestic construction, the surface bed (floor slab) shall not be less than 75mm thick. The filling under the slab must be level and well compacted.

The filling required to bring the level of the ground up to the required underside of the slab level shall consist of broken bricks or well compacted inert fill material, and must be applied in layers not exceeding 150mm in thickness.

The use of ash is to be avoided, as the salts present in the ash will lead to excessive efflorescence on the foundation brickwork with possible deterioration of the brickwork or plaster.

Lintels

The simplest method of bridging an opening is to use one of the many types of lintels available, e.g. timber, steel, concrete and brick. As timber and steel are not generally used for lintels, we will consider only concrete and brick lintels.

Concrete Lintels

These may be either pre-cast or boxed and poured in position (in-situ).

Pre-Cast Lintels

These are cast away from the job and can be raised and placed into position when required without any holdup for the bricklayer. They are readily available from your local hardware store or any building supplier merchants.

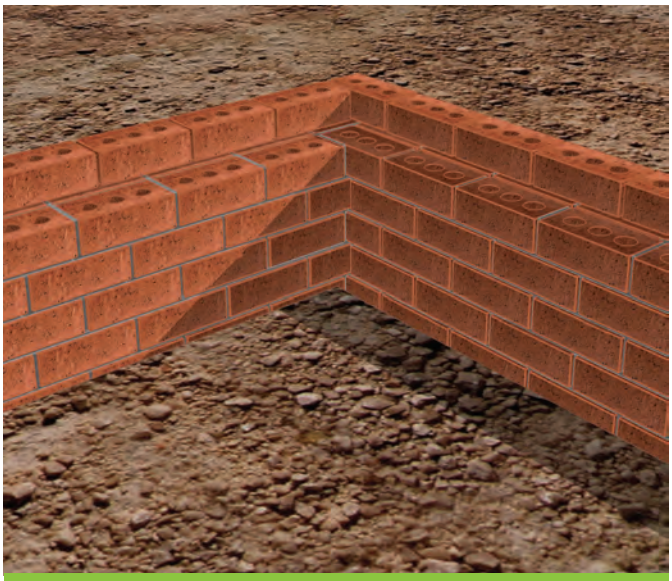
Description	Nominal size (w x h) mm
Standard 'one brick' lintel	110 x 75
6" (150mm) Lintel	150 x 75
Maxi brick lintel	90 x 110
Maxi brick/block lintel	140 x 110
Standard lengths	
900mm to 6000mm in 300mm increments	
900mm · 1300mm · 1900mm 2400mm · 3000mm	

Pre-stressed lintels require a minimum of 100mm of bearing on each side (See figure 8.6)

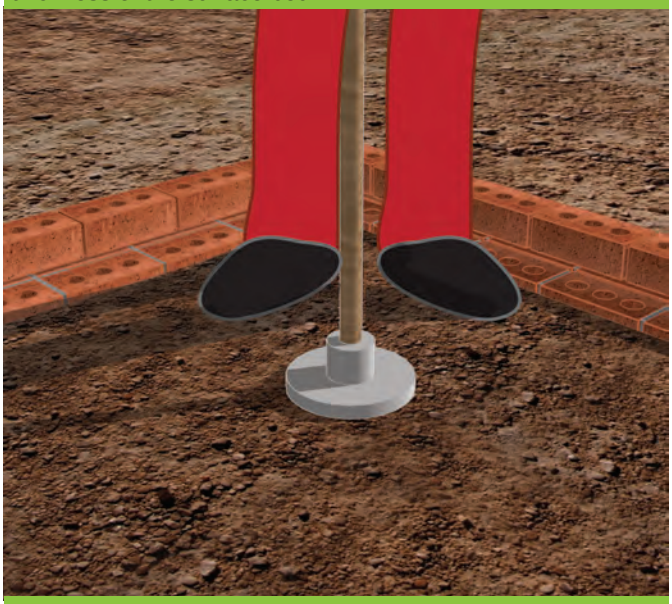
In cases where the outside of the construction is built of face brick, i.e. not plastered, the practice is to use a brick lintel on the face side, backed by a cast in-situ concrete lintel. When pre-cast lintels are not readily available, we use the in-situ concrete lintel method.

In-situ Concrete Lintel

The bricklayer builds the wall to the top of the lintel, leaving the required bearing at each end, as indicated in Figure 8.6.

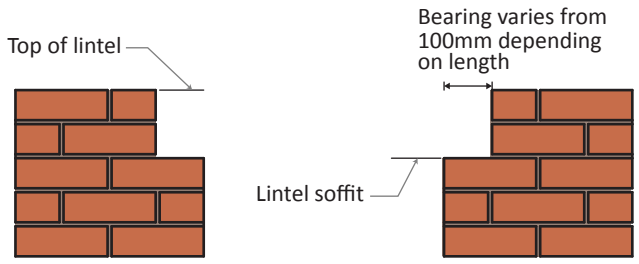


8.3 - Showing the complete foundation walling. Note the outer course is built one course higher to define the edge and thickness of the surface bed.



8.4 - The inside cavity between foundation walls is filled with rubble in layers not exceeding 150mm thick, which are well compacted.

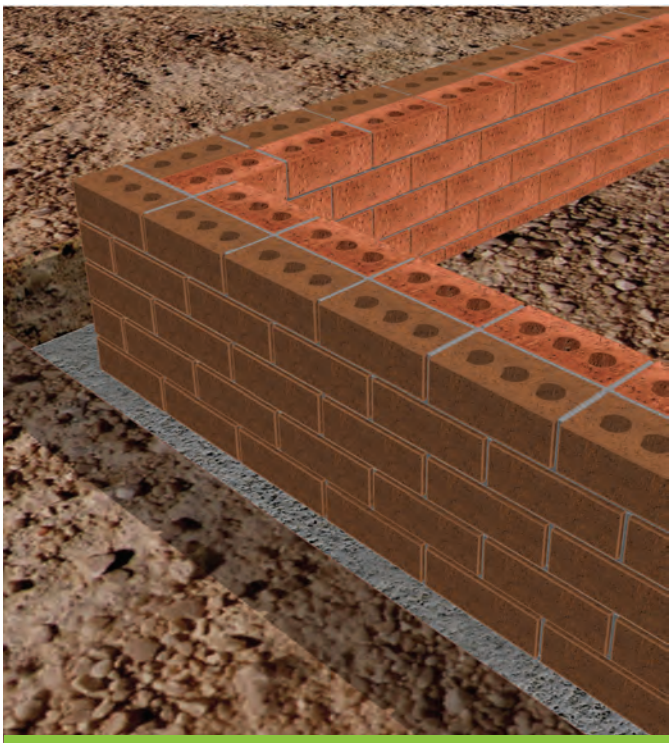
8.5 - Final layer is fully compacted. This layer needs to be poisoned by a specialist contractor. This prevents any infestations below the surface bed.



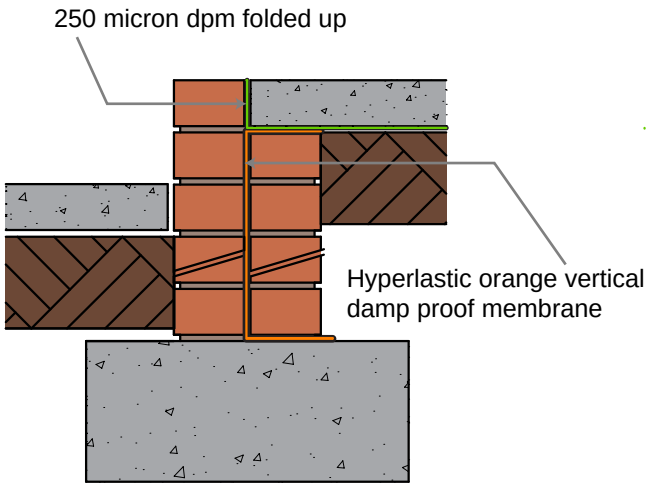
8.6 - Bearing

The form work (wooden box) as shown below consists of several upright supports, two sides and a bottom board which is fixed firmly in position.

8.7 - Cast in-situ concrete lintel



8.8 - Face bricks are used only where they are exposed in the finished structure



8.9 - Tanking of a split level foundation

PHOTO STILL REQUIRED FROM CBA

Pre-cast lintels in position, air vent positioning, centre supports in large openings and wirea roof ties.

A simple method to determine the size of the in-situ lintel and reinforcement required is shown below:

Length	Depth	Bar Diameter
Up to 1200mm	2 courses	12mm
Up to 1600mm	3 courses	16 mm
Up to 2000mm	3 courses	20mm
Up to 2500mm	3 courses	20mm

One reinforcing bar is used per half brick thickness of walling, e.g.

½ brick wall = 1 bar
1 brick wall = 2 bars

Before casting the concrete, ensure that the reinforcement is raised off the bottom of the box.

Advantages of in-situ Lintel

- They can be cast to any shape or size.
- They are useful for providing support for a brick lintel. (See Figure 8.7

Disadvantages of in-situ Lintel

- The bricklayer must wait until the lintel is formed.
- Getting the wet concrete into the box can be difficult.

NOTE

The above is only a guideline, the reccomendations of a structural engineer are reccommended.

Brick lintels

This type of lintel is simply a flat arch and because of the nature of its structure, it is a weak form of construction. Brick lintels can be built in anyone of the following ways:

- Stretcher course
- Brick-on-edge
- Brick-on-end (Soldier course) (See figure 8.10)

Method

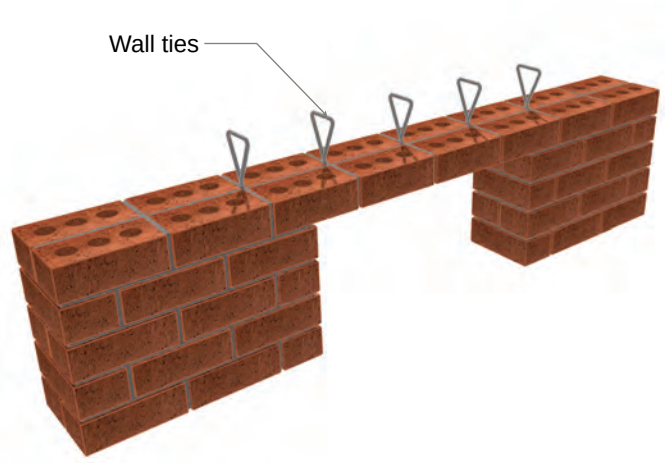
- Before an opening can be bridged with a brick lintel, a wooden support must be installed.
- Nail short lengths of timber (cleats) to the two sides of the opening (reveals).
- Cut another piece of timber equal to the span of the opening.
- Rest this piece of timber on the two side cleats. This turning piece must be level with the top of the window frame as brick lintels rest directly on the frame. (See figure 8.11)

Stretcher course lintel

This method is employed for small spans, e.g. bathroom or toilet windows, and where the walls are going to be plastered. Raise the line at the corners and build the stretcher course across the turning piece.

Precautions

- Add a small amount of neat cement to the mortar on the mortar board closest to the opening. This richer mix will add to the strength of the brickwork above the opening.
- Build in brick reinforcement in at least 3 courses above the brick lintel.
- Prepare butterfly wall ties and build these into the vertical joints as shown in Figure 8.10



8.10 - Stretcher course lintel. Butterfly wall ties built into vertical joint of the stretcher course lintel. This method is not recommended. Rather use a header brick-on-edge or precast lintel

Brick-on-edge lintel

This method is recommended if the opening exceeds 1 metre in length. If the outside of the building is of facebrick, then all the openings will be bridged by using either brick-on-edge or brick-on-end lintels. Prepare and bring on a turning piece (supports) for the brick lintels as described before.

Precautions

- Prepare a slightly richer mix for the brick lintel.
- Wall ties must be built in at every vertical joint.
- Brick reinforcement must be installed in at least 3 courses above the brick lintel.
- Bring on gauge marks to ensure full bricks across the opening.

Brick-on-end (soldier course) lintel

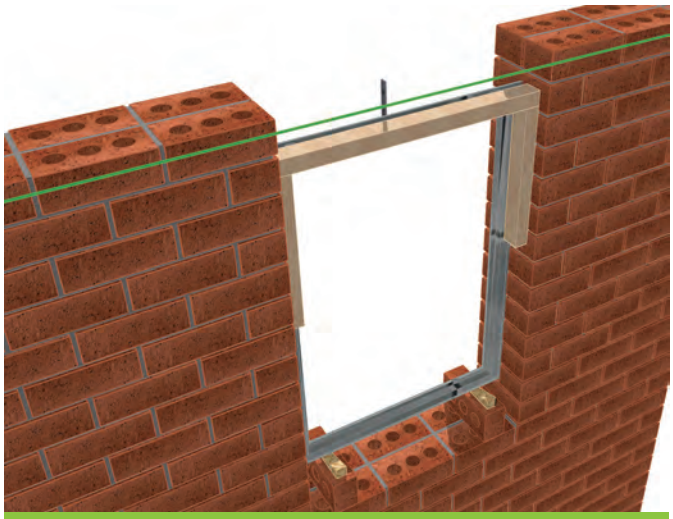
This method, like brick-on-edge is used mainly as an attractive feature in facebrick work. To increase the span of the brick lintel, wall ties are built in at every joint and left projecting behind. An in-situ reinforced concrete lintel is then cast in behind. (See figure 8.12).

Method

Bring on temporary supports. Gauge off the bricks to ensure full bricks. Build the brick-on-edge course using a slightly richer mix. Do not forget the wall ties. At the completion of the brick lintel, bring on the framework as described under cast-in-situ concrete lintels. Install the required number of reinforcing bars and cast the concrete.

IMPORTANT NOTE:

If the span exceeds 1 metre in length, centre upright supports under the turning piece must be installed to avoid undue sagging during building operations.



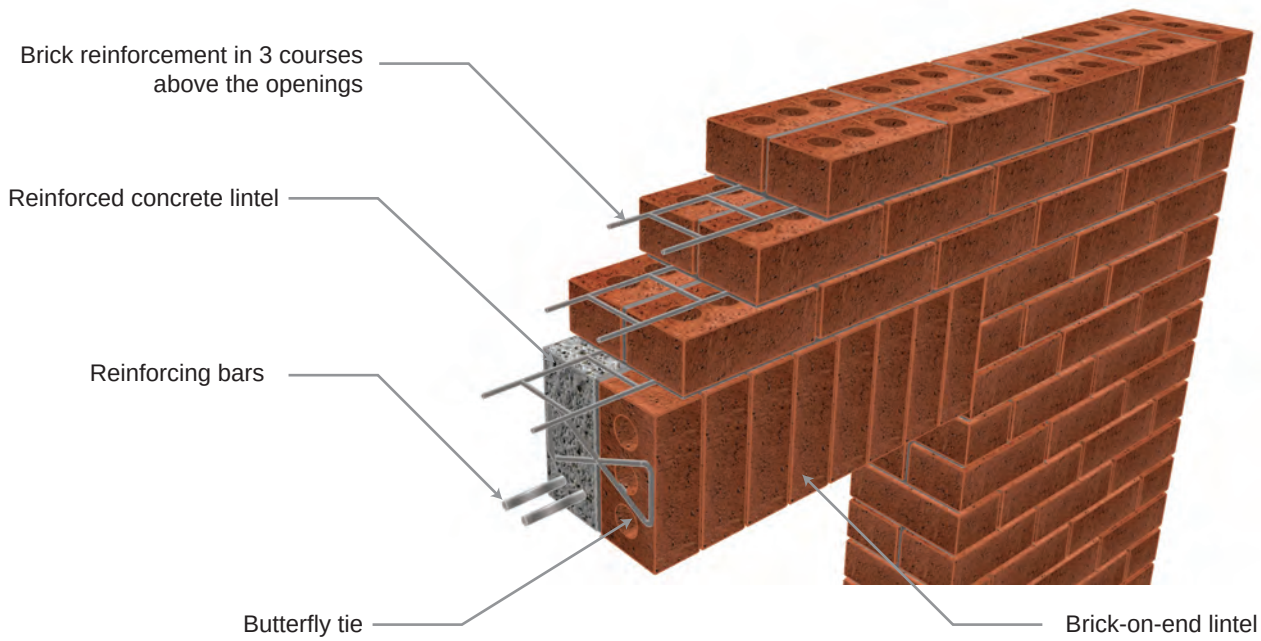
8.11 Showing wooden form work in position.

Brick reinforcement

There are various materials that can be used for brick reinforcement, e.g.

- Mild steel reinforcing rods
- Brickforce - 2 strands of mild steel wire with short pieces welded across
- Exempt (expanded metal).

These products and others suitable as brick reinforcement are obtainable in rolls of varying lengths and widths, from your local hardware shop or buildersupplies merchants.



8.12 - Brick-on-end lintel with reinforced concrete backing.

CHAPTER 9

Mortars

MORTARS

Mix proportions

The proportion of each material in the mix should suit the type of work being done. Strength requirements and mix proportions, recommended by the Cement and Concrete Institute, are given in table below.

Mortar must not be used after it has started to set, which usually occurs about two hours after it has been mixed. One man – particularly if he is a weekend builder – can probably lay a little more than 60 bricks an hour. If you are working on your own or with one assistant, it is better to mix a number of small batches as they are required than to mix a one-bag batch. Do not use too thick a layer of mortar between bricks or blocks; this is wasteful and may lead to cracking.

Mortar class

In general terms the classes of mortar may be used as follows:

Class I

Highly stressed masonry incorporating high-strength structural units such as might be used in multi-storey load-bearing buildings; reinforced masonry.

Class II

Normal loadbearing applications, as well as parapets, balustrades, retaining structures, and freestanding and garden walls, and other walls exposed to possible severe dampness.

In practice, Class II mortars are used for most applications.

Although SABS 0249:1993 refers to a Class III mortar, it is so seldom used that it has been omitted from the table below.

Other proportions may be used if these can be shown by test to be satisfactory.

Use of building limes

The use of limes added to cement mortars is recommended as the improved workability and water retentively will lead to superior brick to mortar adhesion, with improved resistance of the brickwork to rain penetration.

Mortar Strength Requirements and Mix proportions

Mortar class	Minimum required compressive strength at 28 days, MPa		Quantity of sand[1] per 50kg bag of cement,ℓ		Quantities of materials required per m³ of mortar (not including wastage)			
	Preliminary laboratory tests	Works tests	Common[2] cement 32,5 · 42,5	Masonry[3] cement 22,5X	Common[2] Cement, bags 32,5 · 42,5	Sand m³	Masonry[3] Cement, bags 22,5X	Sand m³
I	14,5	10	130ℓ	100ℓ	9,0	1,15	10,5	1,1
II	7	5	200ℓ	170ℓ	6,5	1,25	7,25	1,22

[1] Sand is estimated at a 5% moisture content.
[2] Common cement complying with SANS 50197-1: Strength class 32,5 or 42,5.[a]
[3] Masonry cement complying with SANS 50413-1: Strength class 22,5X. [b]
[a] The addition of lime to common cements is optional - For class I mortar use between 0-10 litres and for class II mortar use between 0-40 litres. (Lime shall not be used to replace a portion of the cement mix)
[b] The addition of lime to masonry cements is not permitted

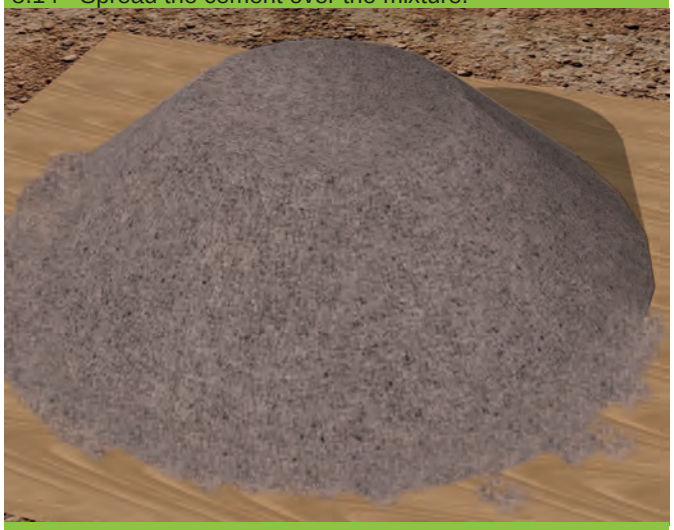
Example:

Class II Mortar (1:6) =

+

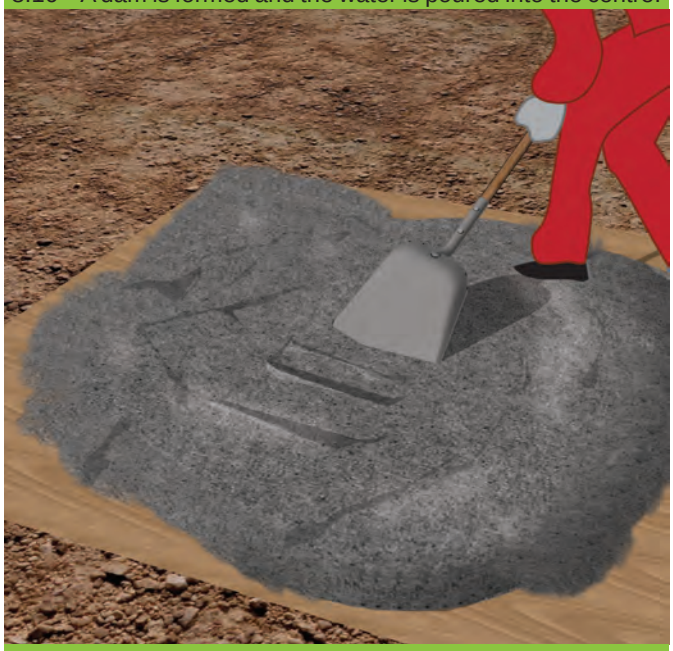
8.13 - The bucket of cement is emptied on top of the six buckets of sand and the bucket of lime.

8.14 - Spread the cement over the mixture.



8.15 The cement is thoroughly mixed with the pit sand until the whole lot takes on the grey colour of cement before water is added.

8.16 - A dam is formed and the water is poured into the centre.



8.17 The dry mix is mixed with the water and worked through with a shovel to the right consistency.

NOTES

CHAPTER 10

BONDS IN BRICKWORK

BONDS IN BRICKWORK

Reasons for Bonding

Bonding brickwork means the arrangement in brickwork so that the units are tied together to form a solid mass. The load is then evenly distributed along the length of the wall.

These drawings show what happens to a wall that is not bonded and one that is bonded.

There are two methods of lapping:

i. The half brick lap
ii. The quarter-brick lap, also known as the half bond and the quarter bond.

If bricks are so placed that no lap occurs, the cross joints or perpends are directly over each other, and we have what is known as 'straight joints', which should be avoided wherever possible.

The rules of bonding are:

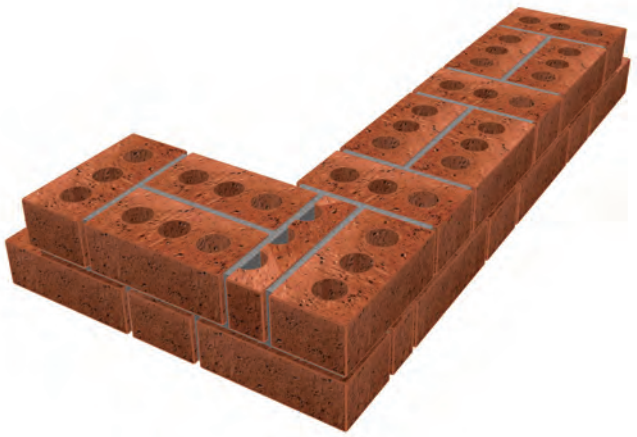
3. Use half or quarter bond, and avoid straight joints.
4. Use the same bond throughout the job.

Bonding

There are basically three types of bonds used in South African construction and examples of all three can be seen in all towns and cities, viz: Flemish Bond, English Bond and Stretcher

Flemish Bond

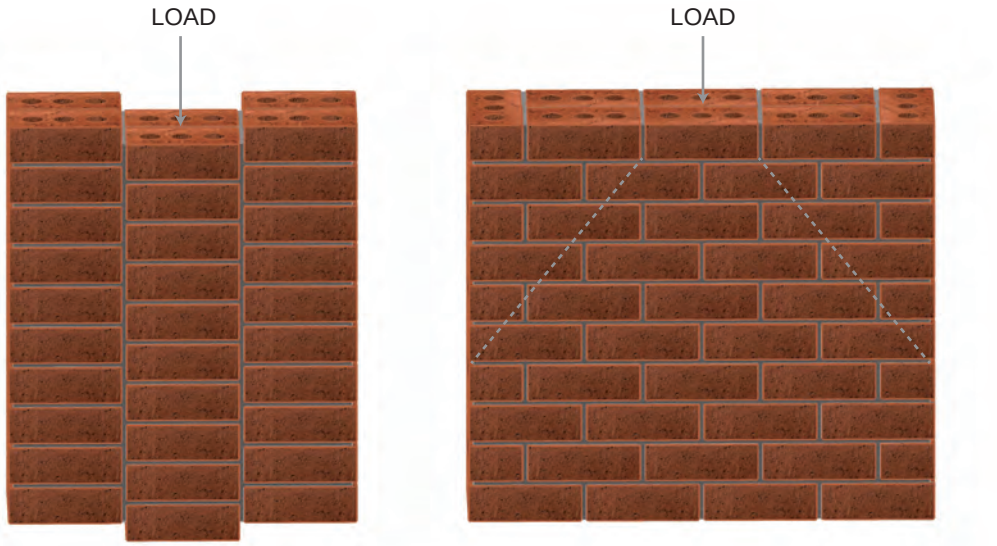
Consists of headers and stretchers in the same course.



10.2 - Flemish Bond

Flemish Garden Wall Bond

Consists of a header followed by two or three stretchers in the same course.



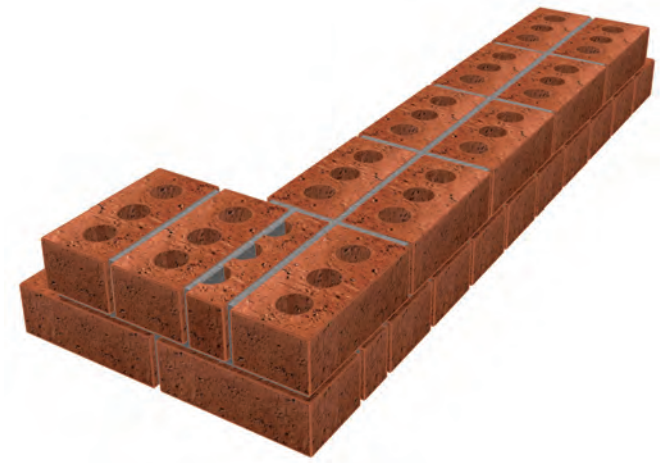
Unbonded Brick Wall
INCORRECT

Bonded Brick Wall
CORRECT

10.1 - Difference between a bonded and unbonded brick wall

English Bond

Consists of alternate courses of headers and stretchers. This bond is believed to be the strongest bond because of the header across bonding. It is usually employed in foundation walling behind the half-brick outer skin, and for retaining walls.



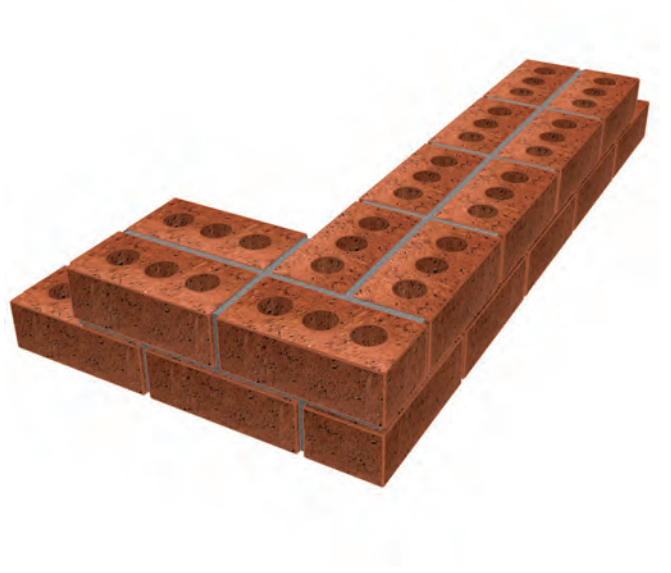
10.3 - English Bond

English Garden Wall Bond

There is a variation sometimes used on an English bond, where the header course is followed by as many as three to five stretcher courses. This bond is referred to as English garden wall bond.

Stretcher Bond

Consists of bricks laid lengthways along the line. This is by far the most commonly used bond in South Africa. In cavity wall construction this is the most economical bond to employ.



10.3 - English Bond

DID YOU KNOW?

Bricks are one of the oldest known building materials dating back to 7000BC where they were first found in Southern Turkey and Jericho.

NOTES

CHAPTER 11

Bricklaying

BRICKLAYING

Preparing a Gauge Rod

Before any bricklaying can be done it is necessary to prepare a gauge rod. This bricklayer's aid, when used, ensures that all the corners of a structure are of equal height on completion.

A gauge rod comprises of a planed piece of timber equal in height to the height of a single storey wall, e.g. 2.7m, onto which marks of equal spacing are brought on. The dimensions between the marks represent the average thickness of a brick, plus the thickness of a mortar joint.

Method

Take a random sample of, say, 6 bricks from the bricks on the building site. Measure the thickness of each brick and write it down. Determine the average thickness by dividing the sum of the thicknesses of the bricks by six. Add to this the thickness of a mortar joint.

Example:

Say bricks measured come to -

71 mm	
72 mm	
73 mm	
71 mm	
74 mm	
72 mm	
433 mm	divided by 6
= 72 mm	average thickness
+ 15 mm	joint thickness
87 mm	

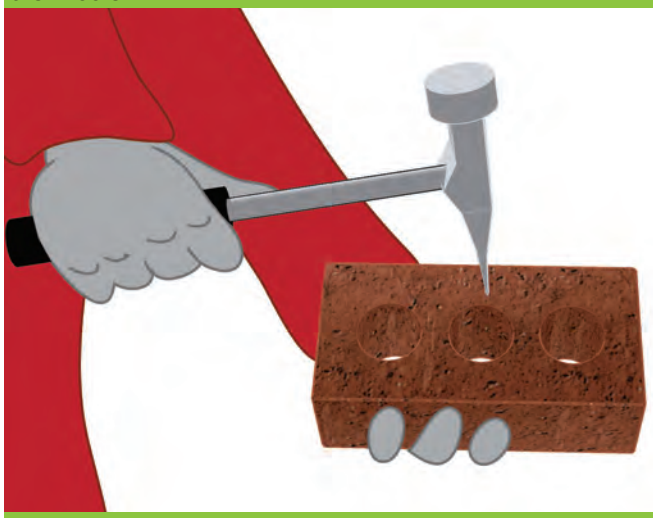
Mark off gauge rod at 87mm intervals.

Guide to Mortar joint size

- Generally for face brickwork a 12 mm joint thickness is the usual practice.
- Adjust the joint thickness of the backing plaster brickwork to match the same coursing height set out on the gauge rod.

Cutting the bricks

11.1- Queen closers may be cut by tapping the brick lightly all round with the sharp edge of a brick hammer. A final sharp blow on the header side will usually result in a clean split down the middle.



11.2 - Cutting a half brick with a brick-hammer.

11.3 - Cutting a three-quarter brick is done by tapping the brick in the required spot all round with the sharp edge (chisel point) of the brick hammer until it breaks.

11.4 - When cutting face-bricks greater accuracy is generally required than with the stock bricks (as the latter is normally plastered over). A bolster is used to ensure that the brick breaks at the desired point.

Buttering

11.5 - Mortar for the bed is picked up with a sideways motion of the trowel. The trowel should be filled with mortar then lifted and the mortar deposited firmly in position.

11.6 - Showing mortar bed slightly furrowed to make the placing of the brick easier to lay.

11.7 - Lifting enough mortar to butter a brick.

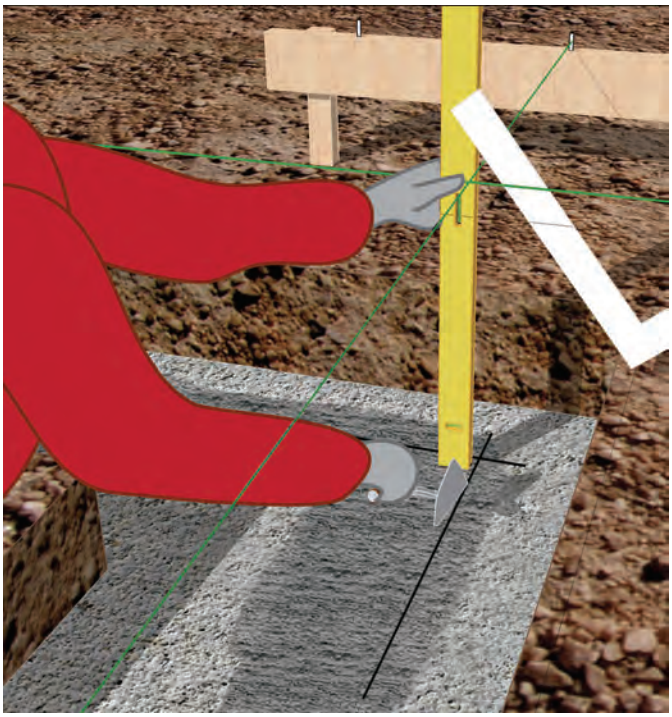
11.8 - Cover the ends completely with mortar to provide an adequate seal against rain penetration.

11.9 - A suggested method of carrying a number of bricks.

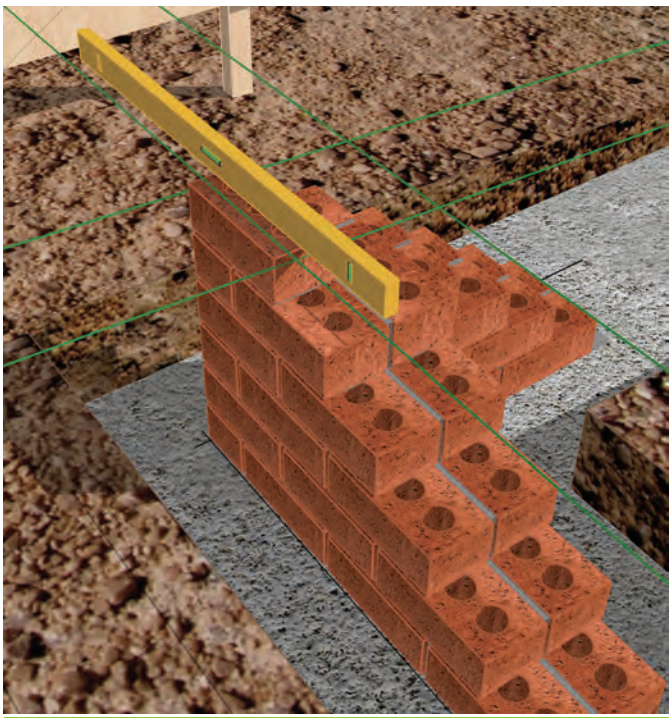
11.11 - After a second line is transferred down a little further along, the lines are joined using a level or straight edge.

Laying the bricks

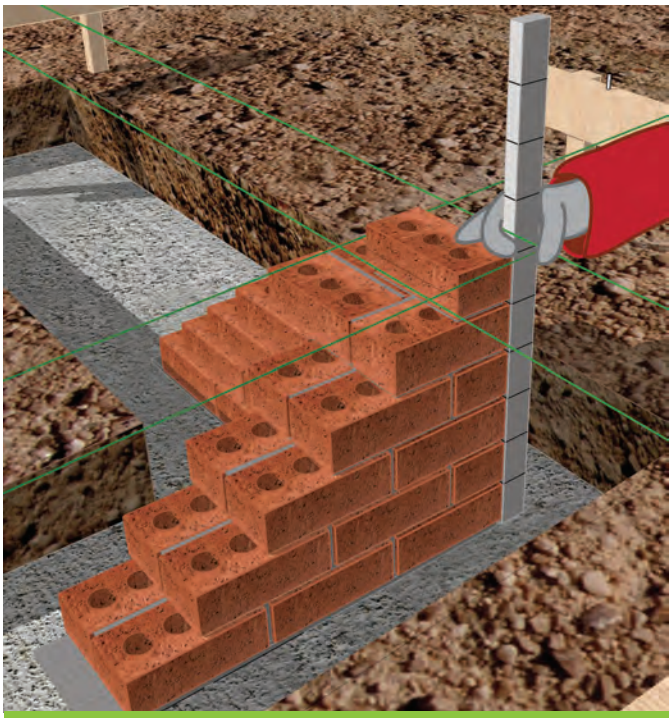
Leave the foundation concrete overnight before starting to build on it.



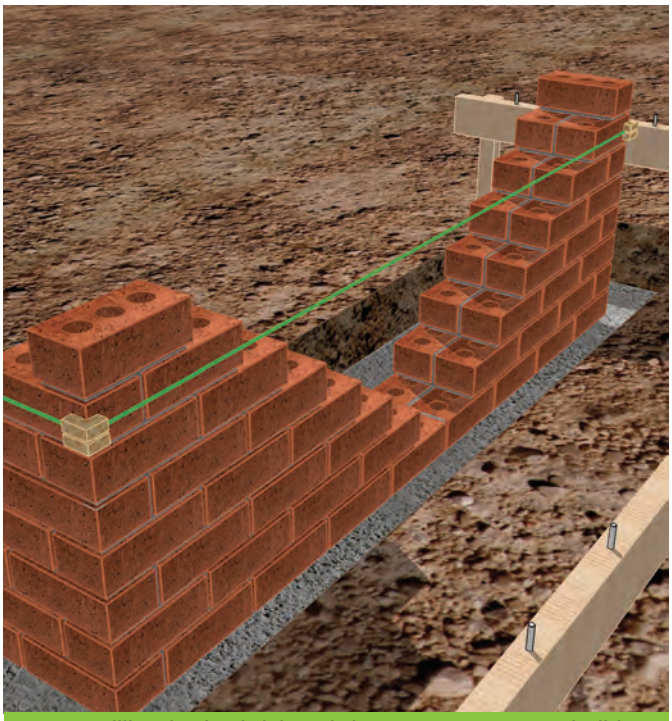
11.10 - Spread a thin layer of mortar on top of the foundation concrete and transfer the building line down as shown. Steady the level with the square.



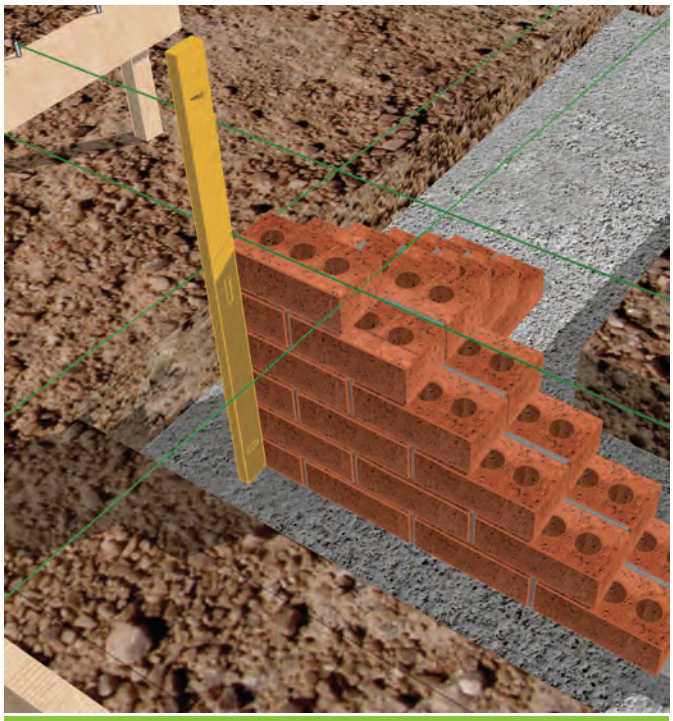
11.12 - When building a corner, the brick is pressed into position and levelled at-the same time. Excess mortar is cut off with the trowel held at an acute angle away from the face of the brick to prevent smearing the mortar and soiling the brick.



11.13 - Shows the gauge-rod being used to ensure that the top of the last brick placed in position lines up with the mark on the rod.



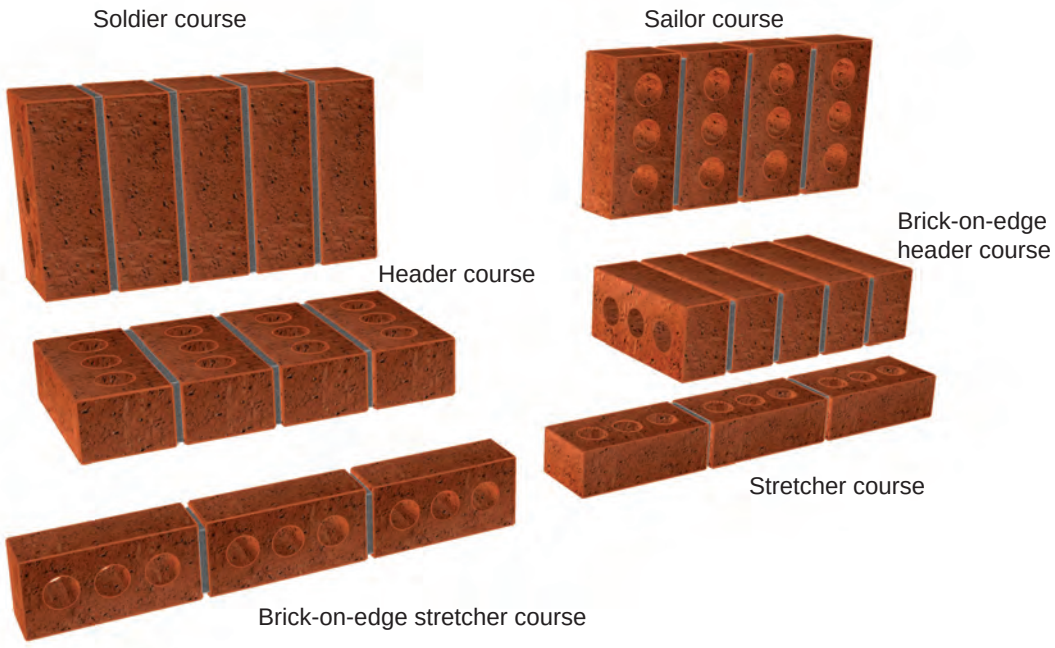
11.15 - Filling in the brickwork between corners, a builder's line and line-blocks or line-pins are used to ensure that each course is laid straight.



11.14 - Each corner brick is laid plumb. The brick must also be levelled crossways. When the corner is complete, all the bricks should touch the level as shown.

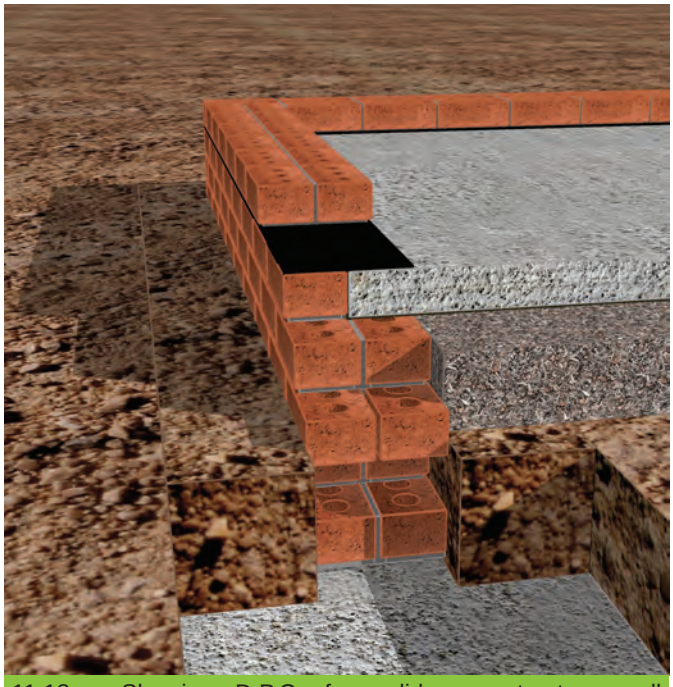
11.16 - Bricks are laid next to, but not touching the line, otherwise the line may be pushed out of position and the wall will not be built straight.

Different ways a brick can be laid

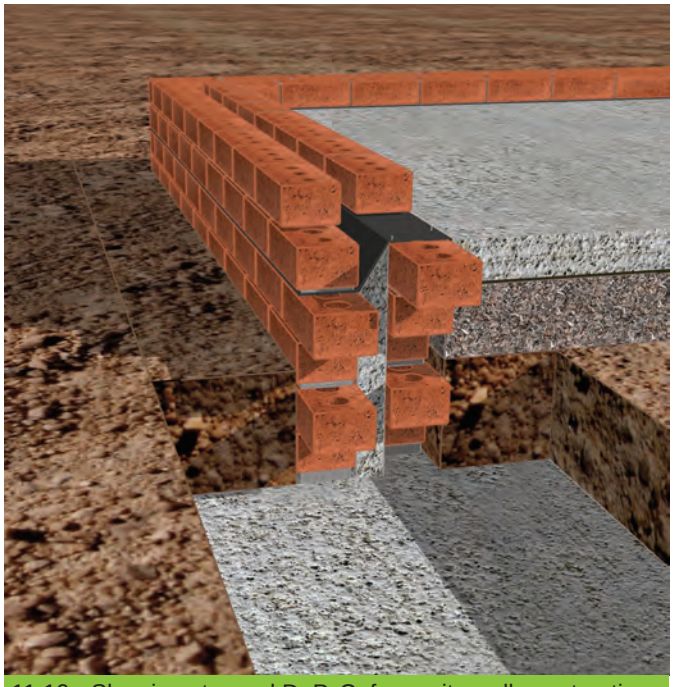


11.17 - Course terms

Damp-proofing of buildings



11.18 - Showing D.P.C. for solid superstructure wall construction.



11.19 - Showing stepped D. P. C. for cavity wall construction.

IMPORTANT NOTE:

Good building practice is to sandwich the DPC between two half thickness's of bedding mortar to ensure water tightness at this junction.

Damp proof courses

Damp proof courses (DPC) need to be installed to prevent moisture and water seepage through walls etc. DPC is a sheeting of impervious material; Mastic asphalt, bitumen polymer and fibre felt or embossed polyethylene pre-manufactured in rolls, to suit the different widths of brickwork, also available in different thicknesses known as microns (µm) with the most common being 375 µm.

The three basic methods of protection in which DPC courses are used, are:

i. To prevent moisture penetration from below (rising damp)
ii. To prevent moisture penetration from above
iii. To prevent moisture penetration from the side (horizontal entry)

Extracts from SANS 10400 part K on damp-proofing

Any wall or sleeper pier of a building shall be provided with damp proofing and vapour barrier installations in such positions and to an extent that will reliably protect the wall against rising damp and the interior of the building against ingress of moisture from abutting ground.

Any material used as a damp-proof course shall comply with the relevant requirements contained in SANS 248, SANS 298, or SANS 952, or be the subject of an Agrément certificate.

In a masonry wall, a damp-proof course shall be installed:

a. at the level of the top of a concrete floor slab resting on the ground; or
b. Where applicable, below any ground floor timber beam or joist.

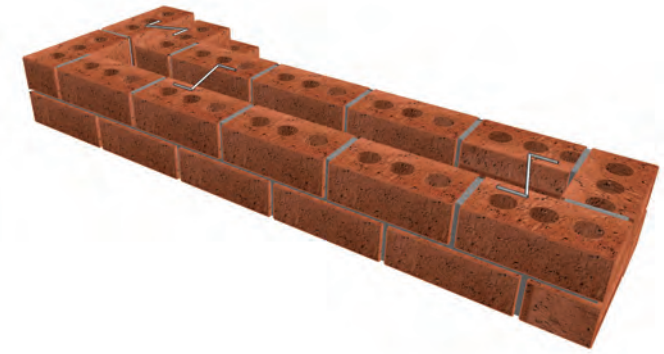
In the case of any masonry cavity wall

a. each leaf of such wall shall be provided with its own damp-proof course which shall extend over the full thickness of such leaf, in which case the cavity shall extend 150 mm below the damp-proof course; or
b. each leaf of such wall shall be covered by a membrane which extends across the cavity provided that the position of the membrane at the inner leaf is higher than its position at the outer leaf; and
c. Where necessary, weepholes to prevent build-up of water in the cavity shall be provided in the external leaf of every cavity wall, spaced not more than 1 m apart, in the masonry unit course immediately below the damp-proof course contemplated in (a) or in the masonry unit course immediately above the membrane contemplated in (b)

NOTE

A damp-proof course should not be installed in any freestanding wall. Where moisture is likely to be encountered from ground water, high-density masonry units with a water absorption not exceeding 7% should be used up to 150 mm above ground level in order to prevent rising damp.

Cavity Wall Construction



11.20 - Cavity wall

In certain parts of the country, like the high rainfall area along our coasts, it is advisable, if not mandatory through local building bylaws to install cavity walls on all external walls of a dwelling, that is, two skins or leaves of brickwork are built with a cavity between the leaves.

The width of the cavity is usually 50mm. The advantages of this type of construction are:

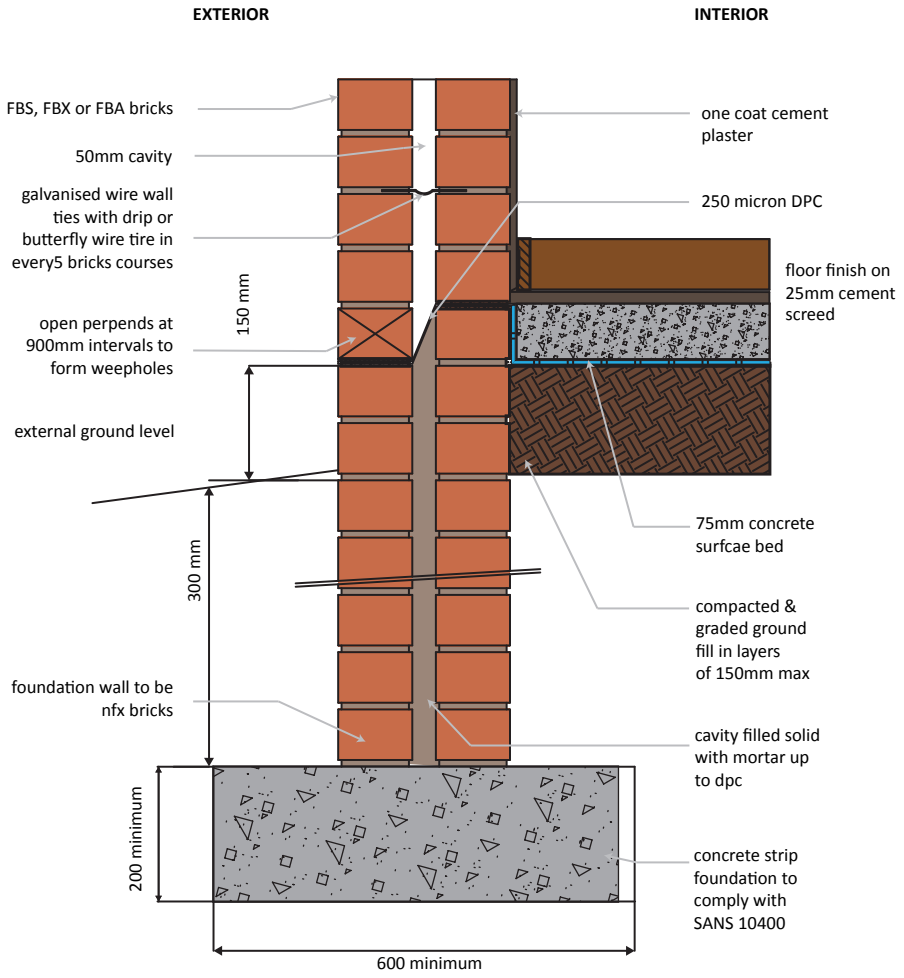
1. A dry interior is ensured - water cannot cross the cavity into the inner skin.
2. The enclosed airspace acts as insulation and ensures a more even temperature inside.
3. The inner leaf can be built with a different type of material.

There are also slight disadvantages:

i. A cavity wall occupies more space on the floor area - 50 mm is lost all round.
ii. Vermin and other insects may enter the cavity.
iii. Sealing of the cavity demands more labour and increases the cost.

Wall ties

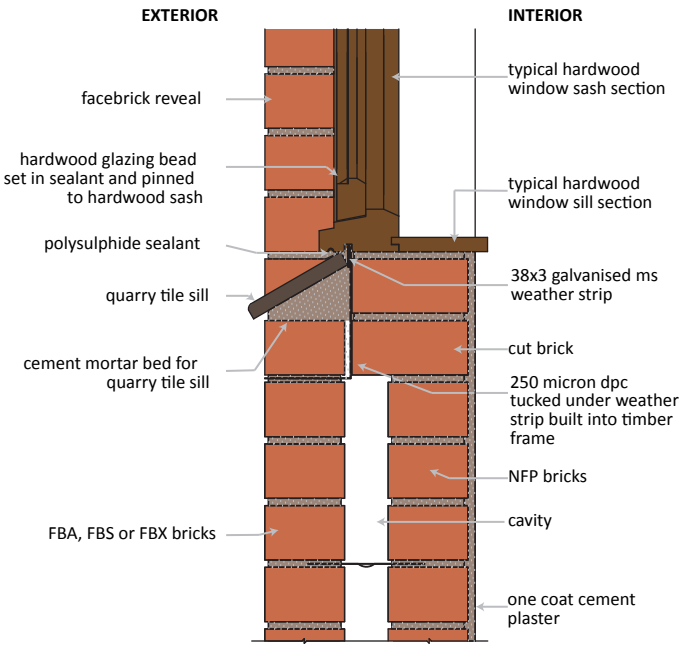
The National Building Regulations states that wall ties be installed in, and evenly distributed at 450 maximum at vertical centres and 600mm maximum horizontal centres.



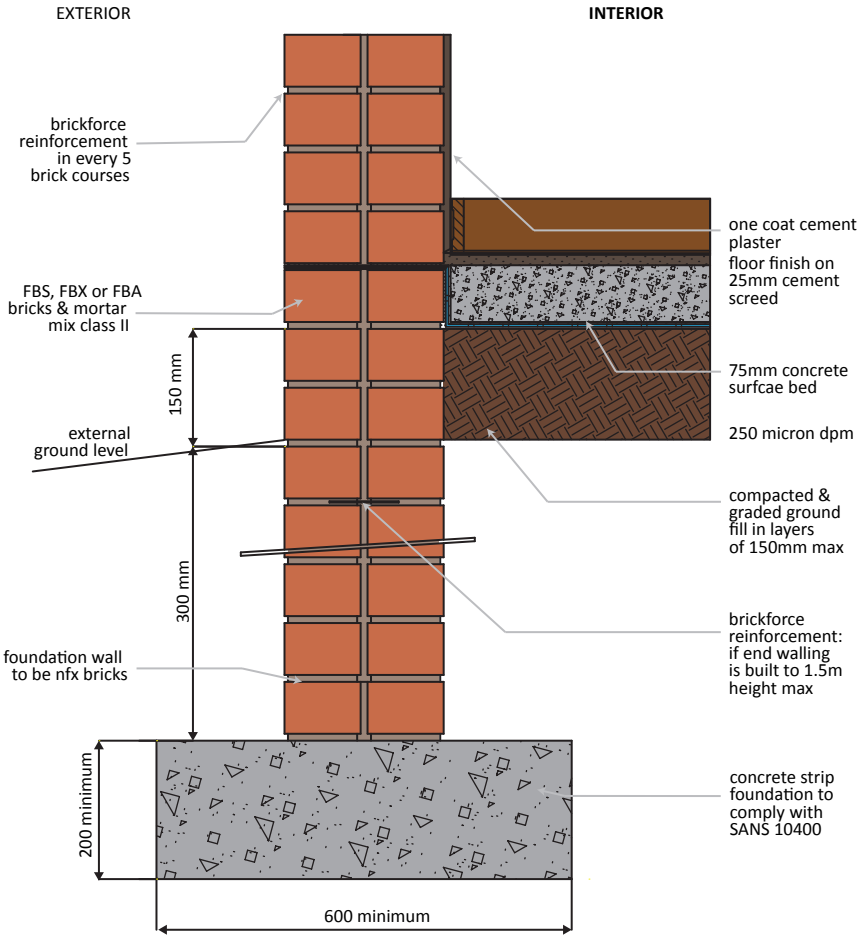
Wall Ties

- *Galvanised wall ties with drip or butterfly wall ties in accordance with SANS 28 to be used in cavity construction.*
- *In sea spray zones wall ties must be made from 816 stainless steel.*
- *Wall ties fixed at not more than 600 mm horizontal spacing and not more than 450 mm vertical spacing, approximates to 4 wall ties per m^2.*

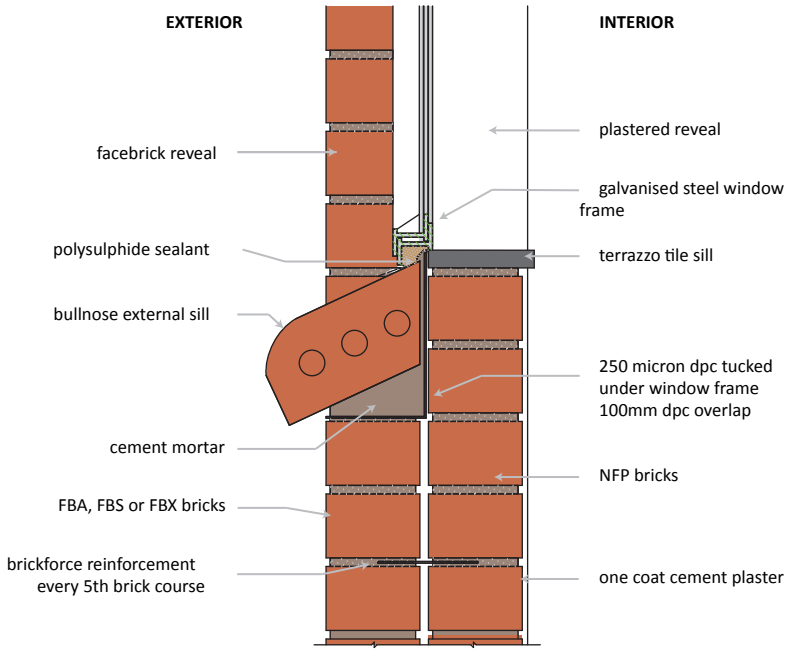
11.21- External brick cavtiy wall and surface bed junction



11.22 - Facebrick externally with timber window frame and quarry tile sill for cavity wall



11.23 - External brick wall and surface bed junction

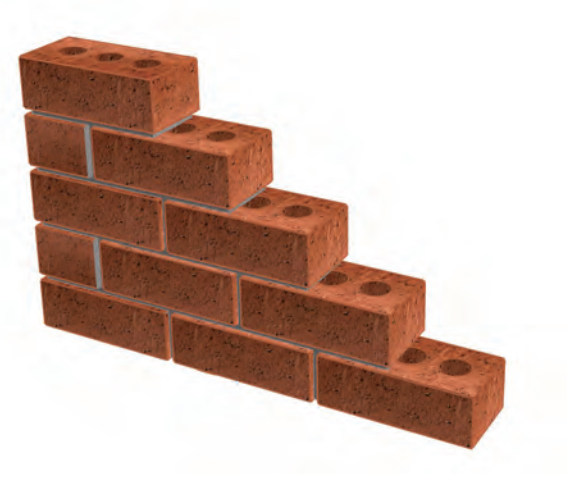


11.24 - Facebrick with sill externally for brick wall (steel window)

Cleaning the Cavity

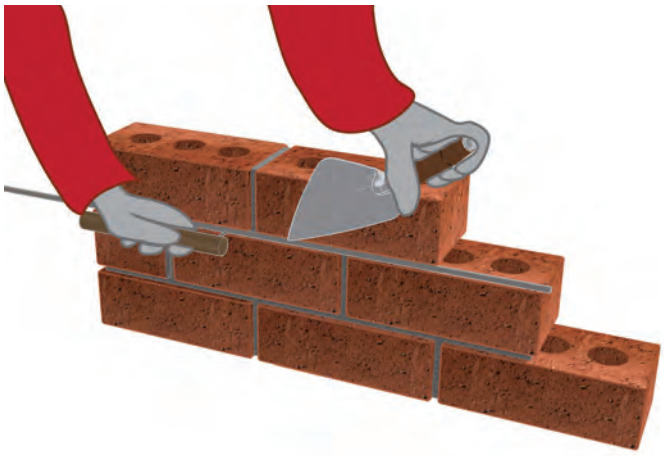
To safeguard against water penetration, certain precautions are necessary during the actual building of the cavity wall:

1. All openings must be sealed off.
2. D.P.C. must be stepped down to divert any water that may have penetrated the outer leaf to the outside.
3. The cavity must be kept clean of mortar droppings. The normal method of preventing mortar droppings from falling to the base of the cavity is to use a cloth-wrapped batten (38 x 38 mm). This batten is placed on the wall ties while building the wall. The batten is then raised by means of wire tied to its ends before the next row of wall ties is positioned.

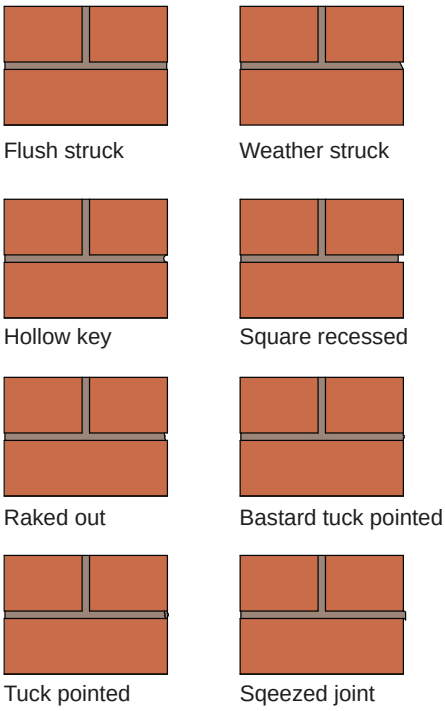


11.28 - Using a short key jointer to finish off the vertical joints.

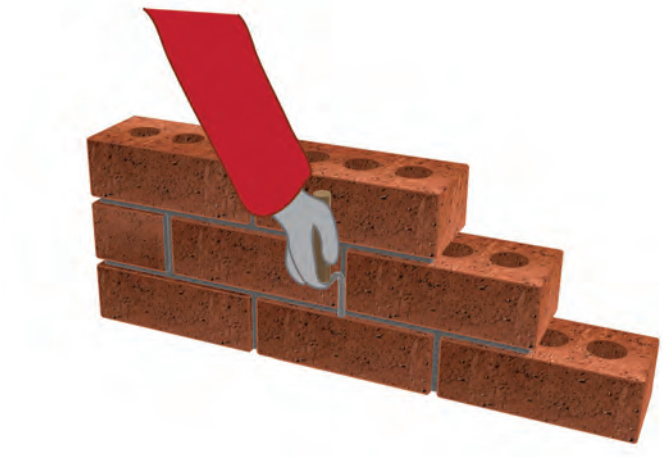
Jointing



11.26 - Jointing the bed in a corner with a key-jointer and at the same time using a trowel to clean off and polish the upper edge of the bed.



11.23 - Different ways to joint brickwork



11.27 - Using a short key jointer to finish off the vertical joints.

NOTE

For external face brickwork, particularly in coastal and high rainfall inland regions, a well polished hollow key horizontal and perpendicular joint profile is highly recommended.

NOTE

When jointing the bed joint, use the top edge of the bottom course to get a straight horizontal joint.

CHAPTER 12

Windows, Doors & Window Sills

CLAYBRICK for good

Environmentally Friendly

WINDOWS, DOORS & WINDOW SILLS

Notes on setting up a window.

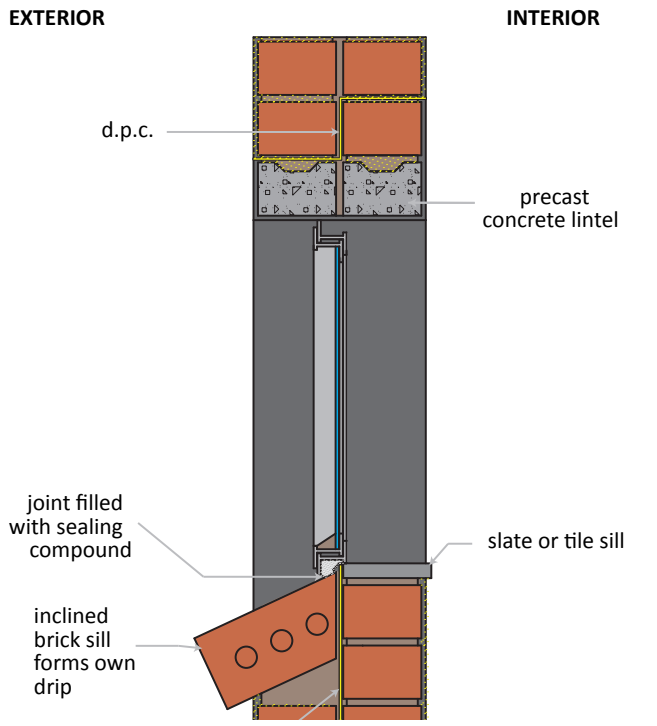
Points to consider before setting up the window frame:

Method employed to span the window opening in the wall:

Plastered finish	: Pre-cast lintels can be used.
Unplastered finish	: Brick lintels
Brick flat	: Stretcher course
Brick on edge	
Brick on end	

The height of the windows

Normally the tops of all doors and windows are on the same level, unless otherwise indicated on the plan.



12.1 - Solid wall construction (Detail suitable for Highveld)

Stand the gauge rod next to a positioned door frame and transfer this height onto the gauge rod.

The actual position of the window in the wall

Generally the window frames are positioned in the centre of each room on the outside wall, unless otherwise indicated on plan.

If a number of similar size windows are to be built in

For example a hall or large room, and the outside finish is an unplastered finish (face-brick), the arrangement of the bonding must be looked at on the first course of the super-structure to ensure whole bricks in the small brick panels between the windows.

Welsh Arch:

A brick cut wedge-shaped like a key brick, and usually supported by two projecting stretchers. It is used for small openings only (See photo 65).

Damp-proofing

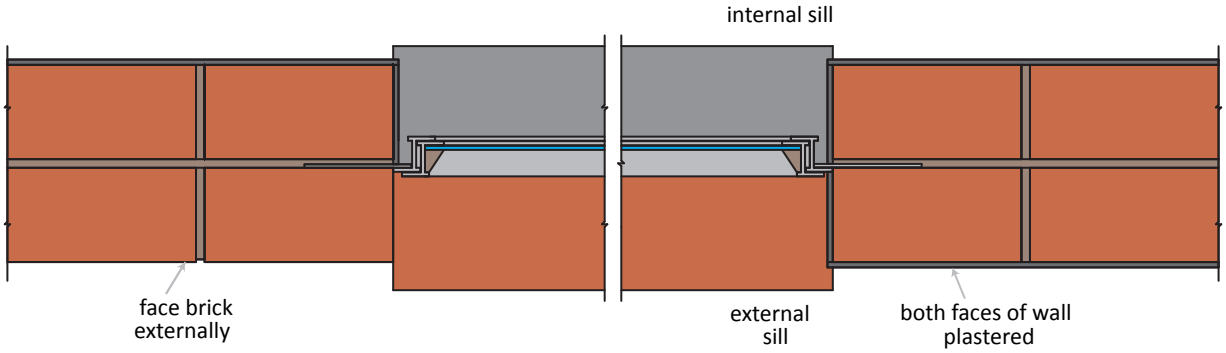
A damp-proof course (D.P.C.) is placed on the floor slab wherever exterior and interior walls will be built. A damp-proof course must also be installed underneath the external sill. (See Figure 12.1 and Figure 11.23). In solid wall construction, vertical D.P.C. in the reveals is necessary to prevent water migration from the outside face of the wall through to the inside (See Figure 12.2)

Positioning

- Ensure that the parts that open on the frame (sashes), open outwards.
- Build up the wall.
- Place two bricks flat across the wall. The window frame will be placed on top of these bricks.
- The window is generally positioned in the centre of the panel.

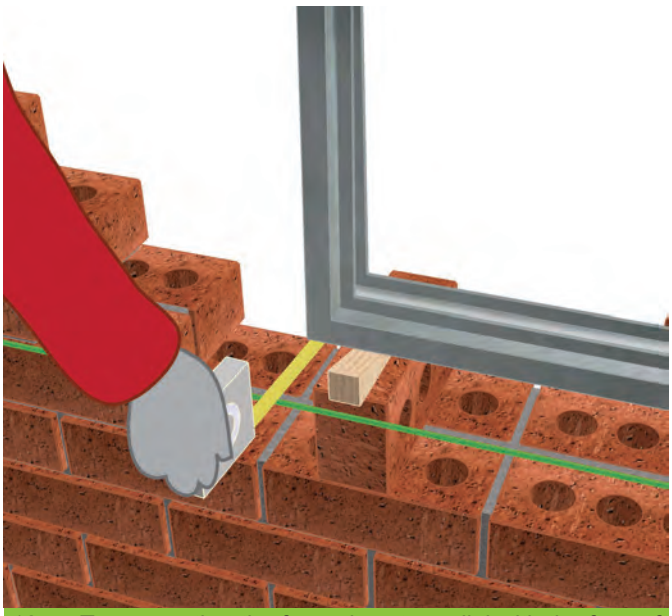
DID YOU KNOW?

In the 18th and 19th centuries Window Tax was a property tax based on the number of windows were in a house. To avoid the tax some houses from the period can be seen to have bricked-up window spaces ready to be glazed at a later date.



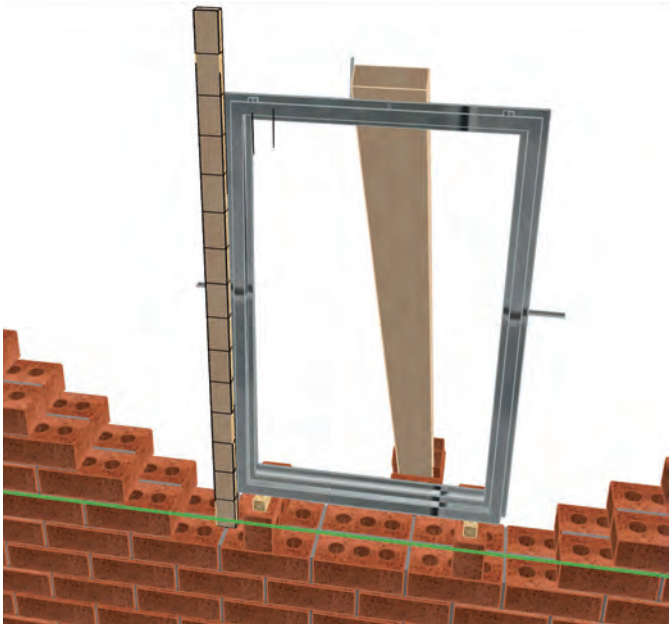
12.2 - Solid wall construction (Detail suitable for Highveld)

12.3 - Securing window frame in position. Large frames will need two supports one at each end. Supports comprise of a scaffold with a nail driven in the centre, which is hooked over the frame to act as a firm support whilst building in. Secure the base of the board with bricks.

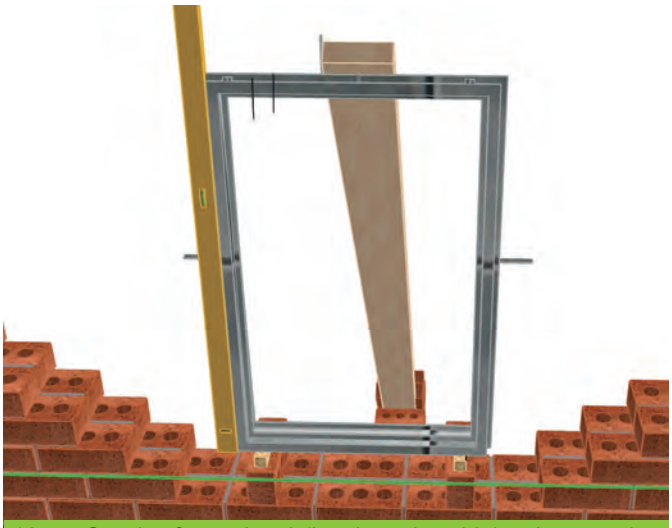


12.5 - To ensure that the frame is set parallel with the face of the wall measure back from the line to the frame on both ends of the frame.

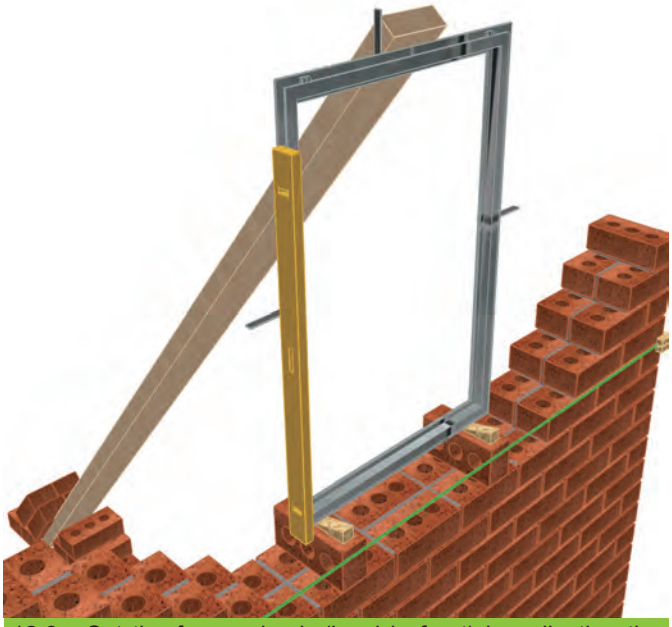
12.4 - Bring on a line on the face side of the brickwork.



12.6 - Use your gauge rod and set up the window to the correct height. NOTE: The top of the frame is the thickness of a mortar joint higher than the corresponding mark on the gauge rod. (Stretcher course Lintel.)



12.7 - Set the frame level (level on the side) using wooden wedges

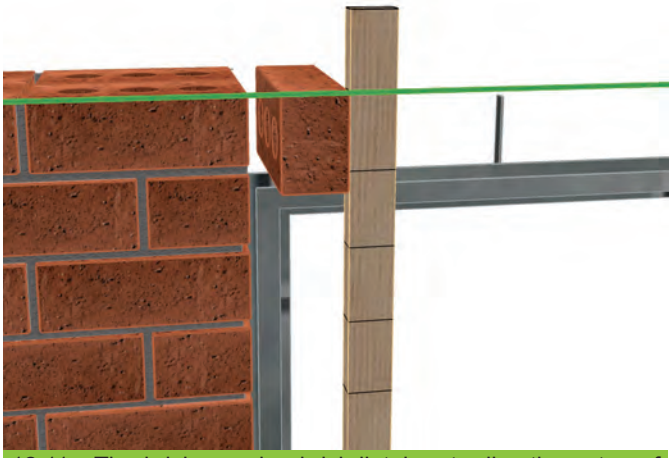


12.8 - Set the frame plumb (level in front) by adjusting the support.

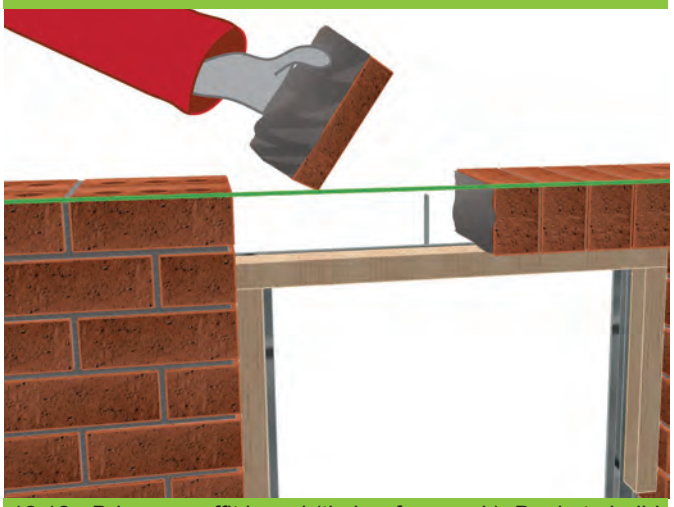
12.9 - Build in the lugs. Check to ensure that the window frame is still level and plumb.

12.10 - The built in window frame projects above the brickwork by a joint thickness.

Brick-on-Edge Lintel

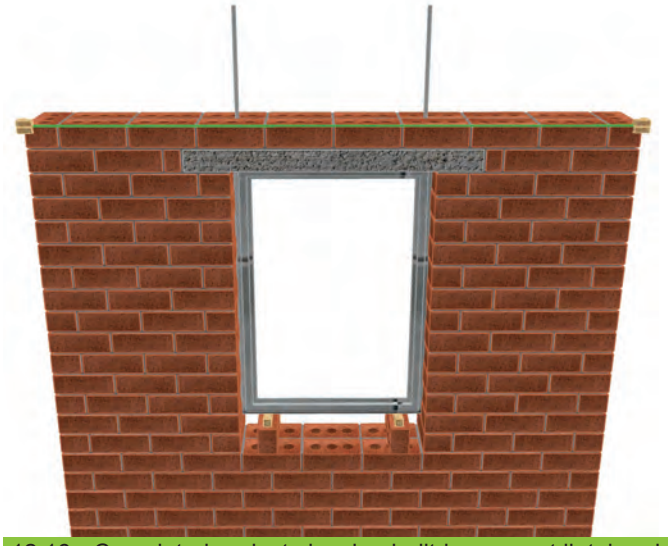


12.11 - The brick-on-edge brick lintel rests directly on top of the window frame and corresponds with the brick courses on the side.

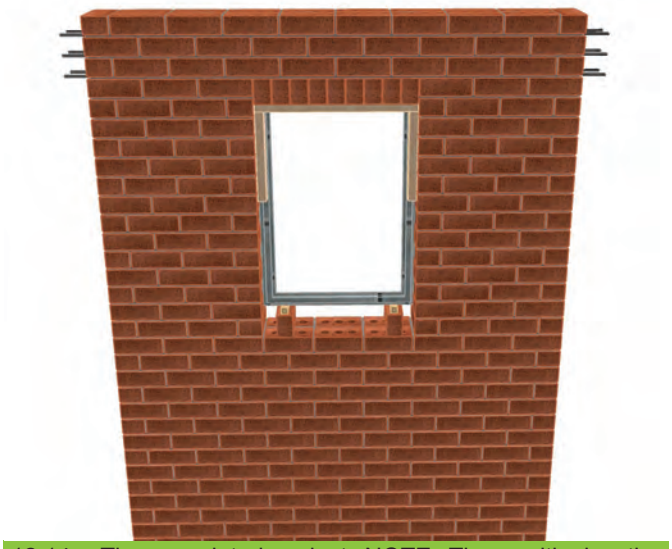


12.12 - Bring on soffit board (timber formwork). Begin to build the brick-on-edge lintel. NOTE: The joint between bricks must be well filled and the top building-in lug bent upright.

12.13 - Brick reinforcement is built-in in the next three courses.



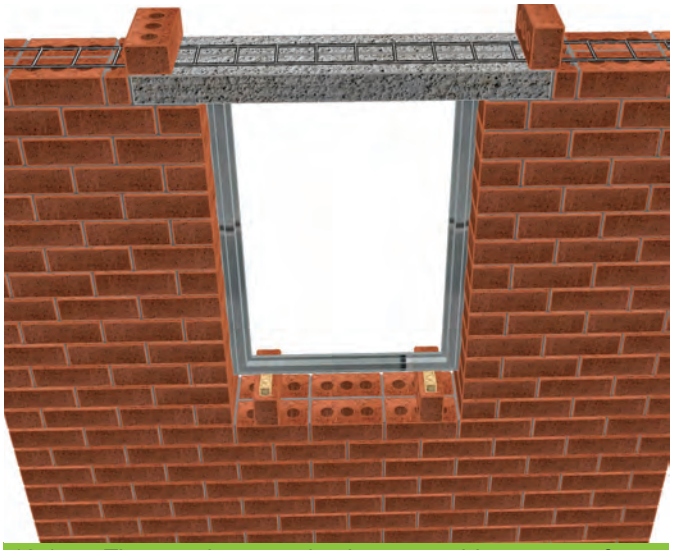
12.16 - Completed project showing built-in pre-cast lintel and roof wire ties.



12.14 - The completed project. NOTE: The positioning the arch (Welsh Arch) over the window opening.

Building in Sills

12.17 - Pre-cast concrete external sill laid sloping. NOTE: The undersill D.P. C.



12.15 - The opening can also be crossed by means of pre-cast lintel.

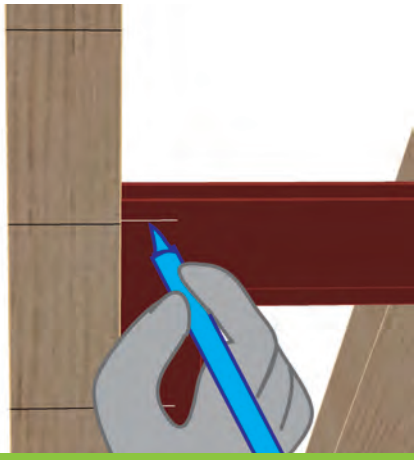
12.18 - Brick-an-edge external sill. The slope of the sill is measured to ensure an equal slope on all the external sills of a particular building. NOTE: The placing of the undersill D. P. C.

12.19 - Install the internal sill level.

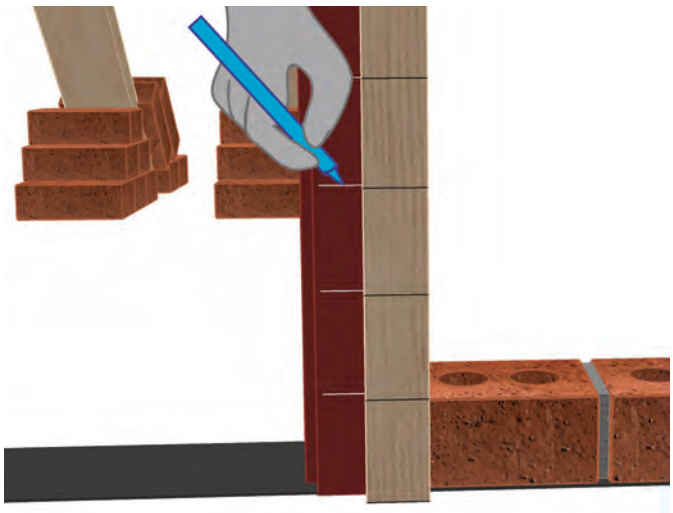
Building in Doors

12.20 - Doorframe set upright in position on top of the D. P. C. As with window frames the door frame is secured in position with temporary supports.

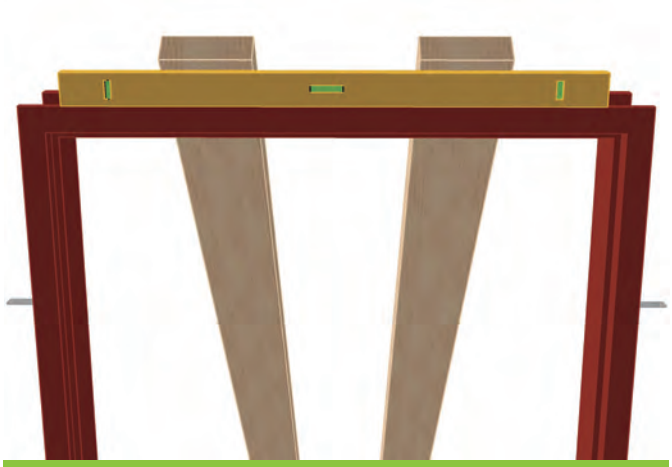
12.21 - Front view of the door frame. NOTE: The lugs and the centre strut (dwang) that is installed to prevent the frame from bulging in during building-in operations.



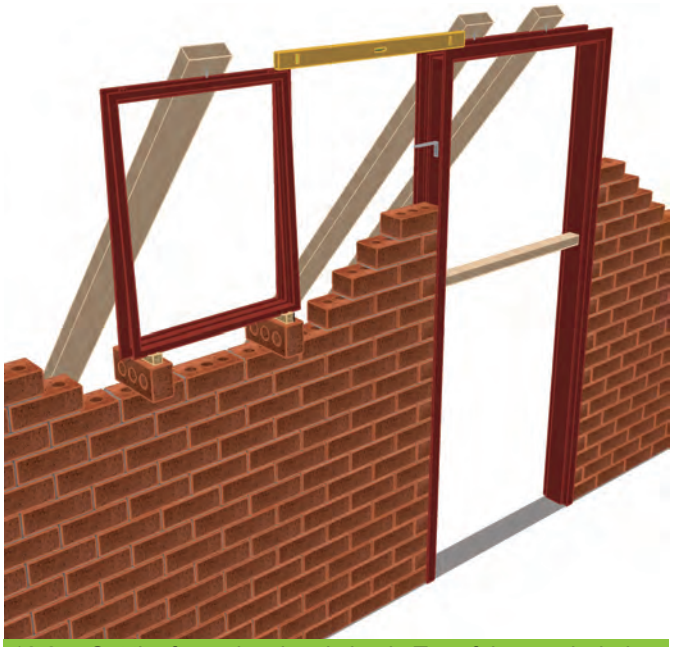
12.22 - Transfer course heights from the gauge rod to the door frame starting at the top. Adjust by means of wedges.



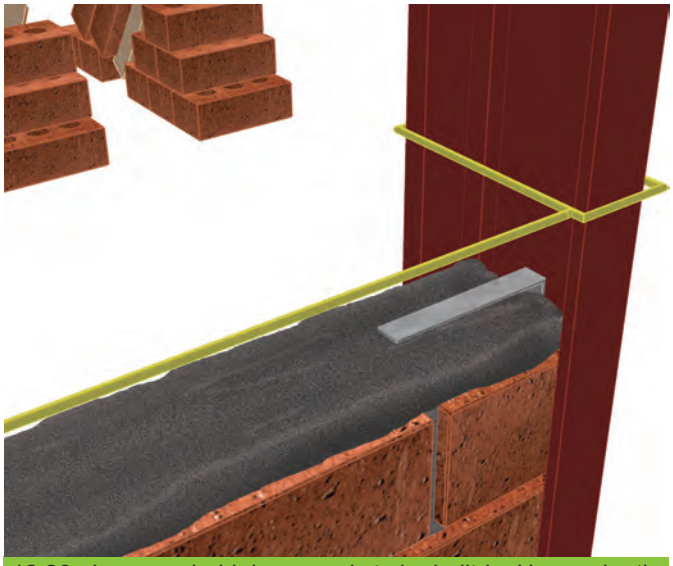
12.23 - Repeat on the other side of frame.



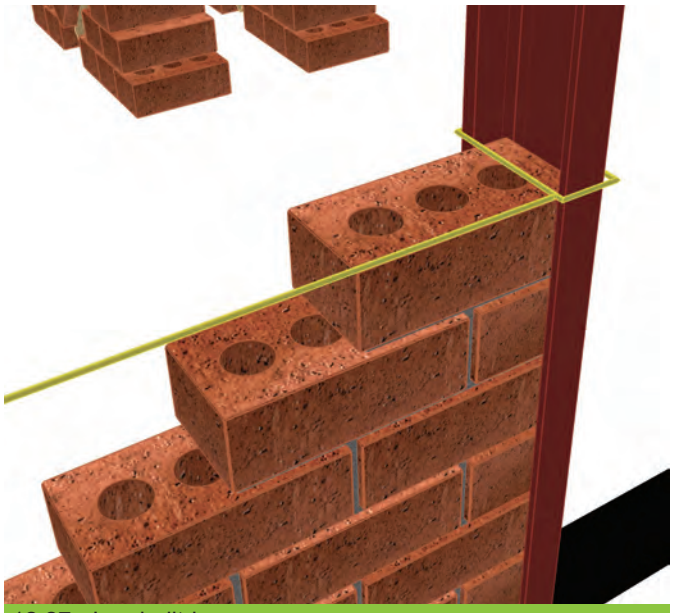
12.24 - Set the frame level and plumb.



12.25 - Set the frame level and plumb. Top of door and window frames are on the same level.



12.26 - Lugs are held down ready to be built-in. Use a wire tie to secure your line to the door frame during building in operations.



12.27 - Lug built-in.

NOTES

NOTES

CHAPTER 13

Construction of Walls

CONSTRUCTION OF WALLS

The correct method of building is to erect corners using a gauge rod. The corner bricks should be perfectly perpendicular and also level. After the erection of the two corners, the area between is filled in, laying each course carefully to a line strung taut between the corners.

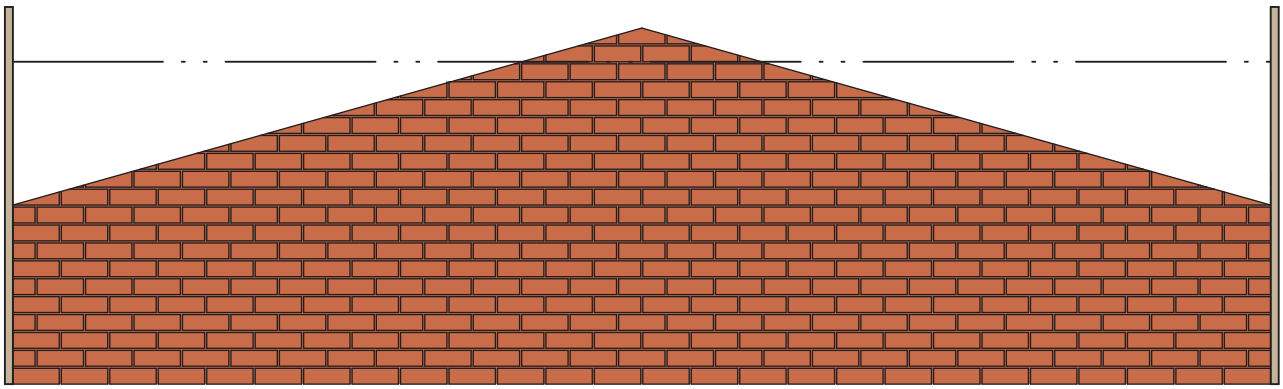
Use of aids

To provide temporary corners along the length of the wall and instead of building up corners, profiles are erected. The profiles comprise of a vertical section equal in height to a storey (wall height) and one or more stays.

The vertical section can be either a straight piece of timber, 50 x 75mm in size, or a length of hollow, square tubing. The latter is most suitable as it does not get damaged easily by the handling on site. The stays can also be of the same material as the upright or scaffold boards.

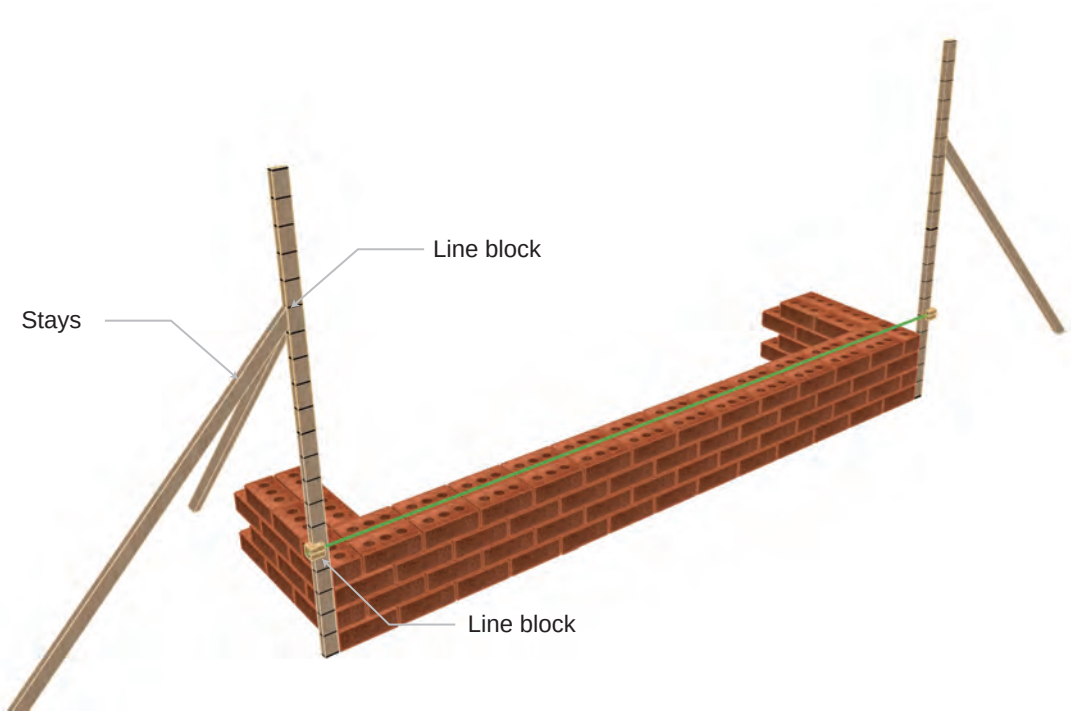
When building the triangular brickwork at gable ends, it is necessary to erect two profiles at each corner, as shown in the illustration below.

Employing profiles will make the building-up of the brickwork relatively easy.



Gable End

13.1a - Profile method.



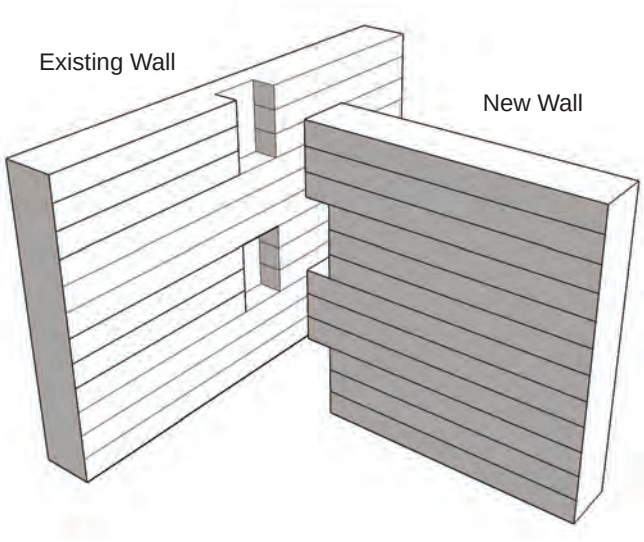
13.1b - Profile method.

Additions

There are basically two bonds which can be used when joining new additions onto existing brickwork, i.e. block bonding and toothing.

Block Bonding

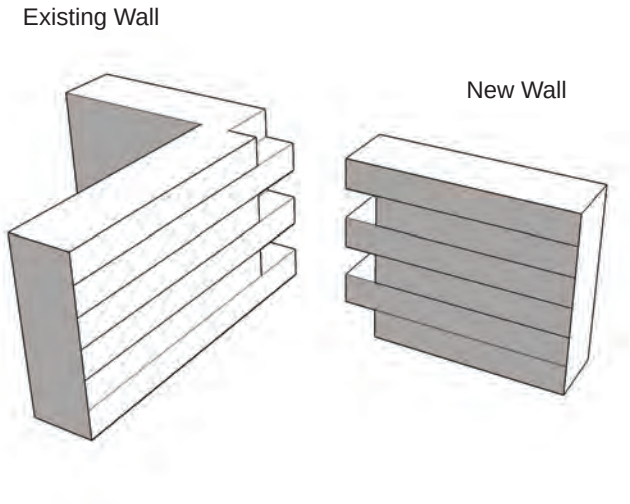
Block bonding means cutting out three or more courses and leaving an equal number. The new wall fits into the old as shown below. This method is recommended.



13.2 - Block bond

Toothing

Toothing means cutting out a brick in every alternative course. When joining face brickwork onto existing, this method is used as it is very necessary to maintain the bond. The joints must however be filled properly, especially the upper joints of each indent.



13.3 - Toothing

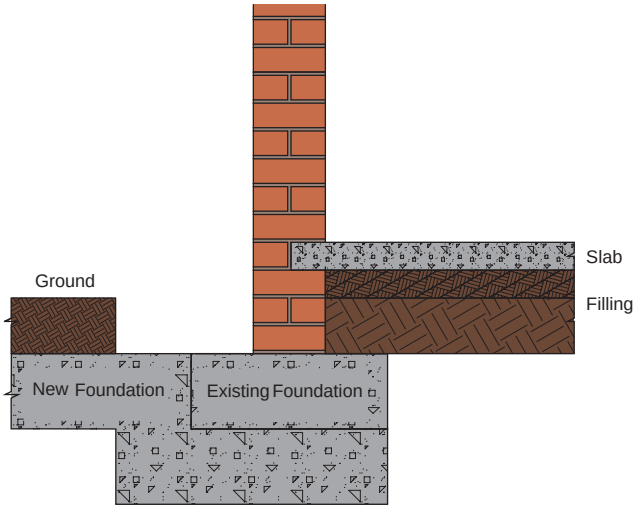
Underpinning

To ensure a proper bond without a vertical crack when joining new walls to old, it is advisable to underpin the existing concrete foundation.

Underpinning means to strengthen the existing foundation. The illustration below shows how the foundation continues underneath the existing concrete foundation.

The concrete underneath adds to the strength of this very weak point where new work is added onto old brickwork that has settled properly over the years.

The underpinning, as illustrated, is accomplished by excavating a cavity below the existing foundation approximately equal to the width and depth of the trench of the new foundation, and filling properly with concrete, as shown.



13.4 - Underpinning

Gable ends

Most domestic buildings today have one or more gable ends. When the gable ends are built-up, certain bylaws apply, e.g. precast lintels over the openings.

See photos overleaf

PHOTOS REQUIRED - CBA

A gable end with a window and then above it a precast lintel.

PHOTOS REQUIRED - CBA

A gable end over a double garage door. Here, it is very easy to see why it is necessary to insert a precast lintel. The weight of the brickwork above may have collapsed the arches below.

CHAPTER 14

Brick Reinforcement and Roof Ties

BRICK REINFORCEMENT AND ROOF TIES

In domestic housing, the brickwork of unreinforced walls are capable of carrying the downward load (compression) of the roof or upper storey. Walls are therefore strong in compression but weak in tension and shear. In other words, walls can bear the vertical load quite easily but are weak when supporting, for instance, a heavy gate or when having to withstand heavy pressures such as filling or strong winds.

Areas where brick reinforcement should be used:

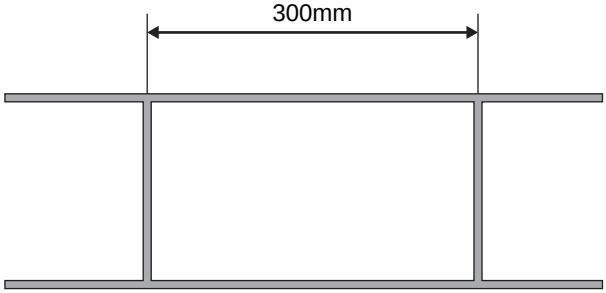
1. Lintels
2. Retaining walls
3. Decorative face brick panels where straight joints cannot be avoided. The most commonly used types of reinforcement are: expanded metal strips, brickforce, reinforcing rods, wire and hoop-iron.

Expanded metal strips

This is a diamond mesh available in a variety of sizes. This type of reinforcement is used in walls and partitions to resist both horizontal and vertical pressures, but is not commonly used in comparison to brickforce.

Brickforce

This consists of two strands of wire joined together by spot-welded cross wires at approximately 300mm intervals. Brickforce, obtainable in 15m rolls is available in widths of 76, 152 and 228mm.



14.1 - Brickforce

Reinforcing rods

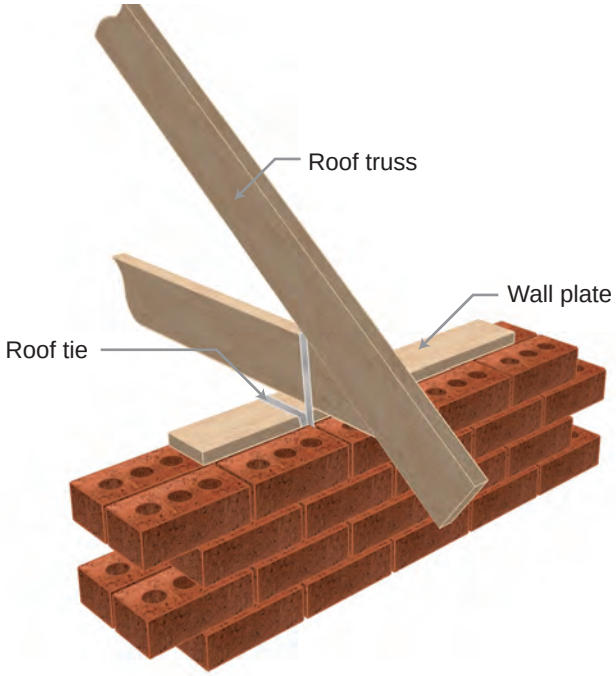
If available, mild steel rods can be used for reinforcing brickwork but may be more expensive than other types, but this is not common practice. The most common use of mild steel rods is for vertical reinforcement where the other types of reinforcing available do not perform satisfactorily.

Areas where vertical reinforcement is required :

1. Gate pillars
2. Retaining walls
3. Walls where the natural foundation is suspect
4. In houses located close to busy railway lines to counteract vibrations

Wire and Hoop-iron

Galvanised wire obtainable in rolls from building merchants is commonly used in South African construction to secure the roof to the superstructure. A double strand is built in 8 courses from the top (at intervals equal to the spacing of the roof trusses) and fastened around the bottom end of the trusses.



14.2 – Truss secured via roof ties

Galvanised hoop-iron

This used to be the traditional material for horizontal reinforcement, and for anchoring the roof to the superstructure. This method of securing the roof to the walls has fallen into disuse, but is still highly recommended.

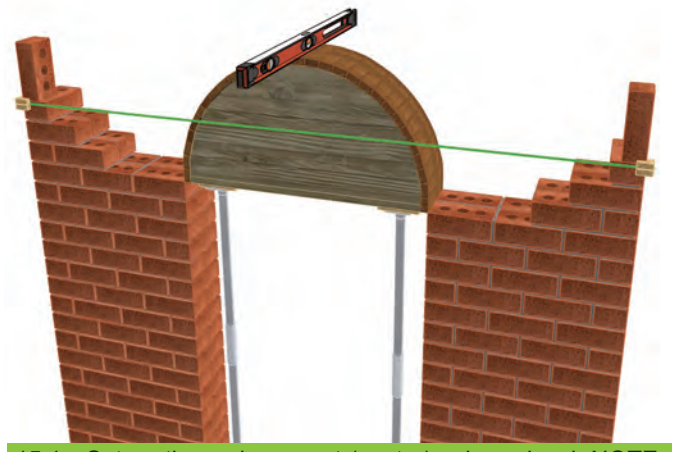
CHAPTER 15

Arches

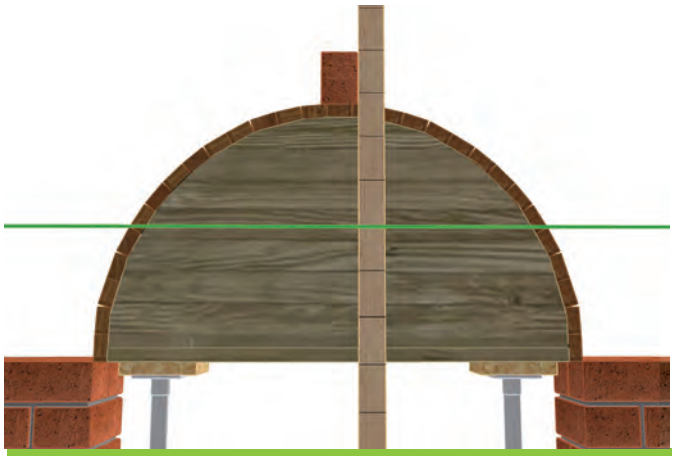
ARCHES

Setting up the centre (Formwork)

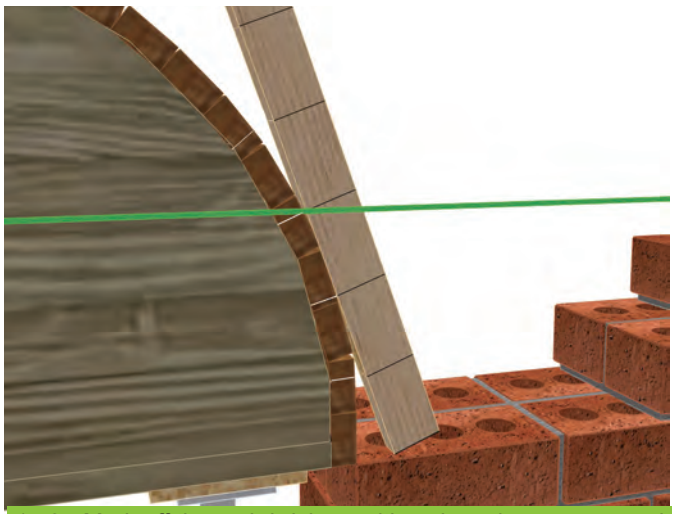
The following figures illustrate how to build an arch over an opening.



15.1 - Set up the arch support (centre) using a level. NOTE: The centre is set to the face of the wall by raising the line.



15.2 - Ensure that the top of the brick arch corresponds with the top of a brick course.

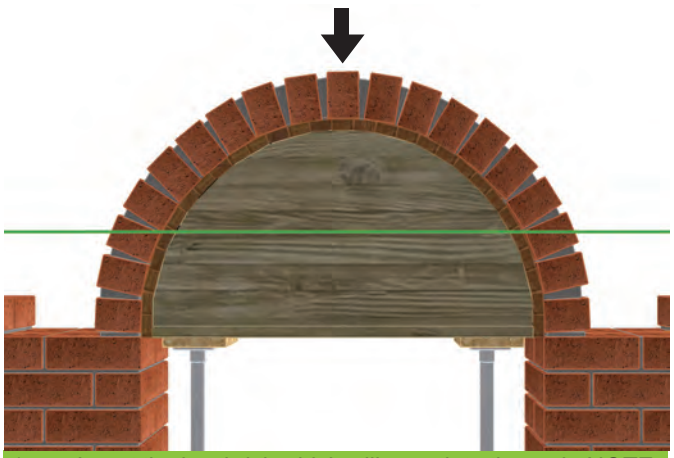


15.3 - Mark off the arch bricks positions by using a gauge rod to avoid unnecessary cutting of bricks.

15.4 - Build two courses on each side.

15.5 - Build up evenly on each side to prevent the arch centre from being pushed out of position.

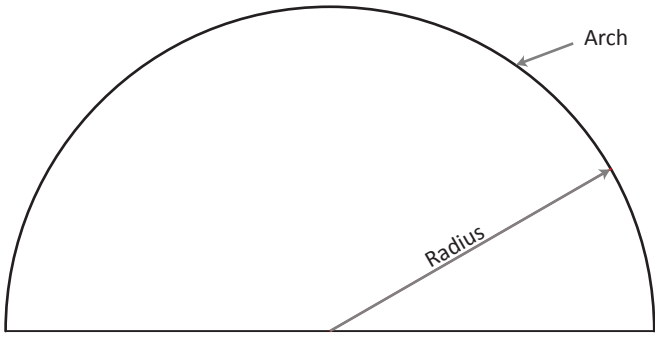
15.6 - Check the face of the arch with a level or a straight edge.



15.7 - Insert the key brick which will complete the arch. NOTE: The key brick is the top most brick of an arch.

15.8 - Begin to build up the brickwork on either side of the arch. NOTE: The neat cutting in on the sides.

15.9 - The wooden support is removed and a portion of the uncompleted brickwork on the one side is shown.

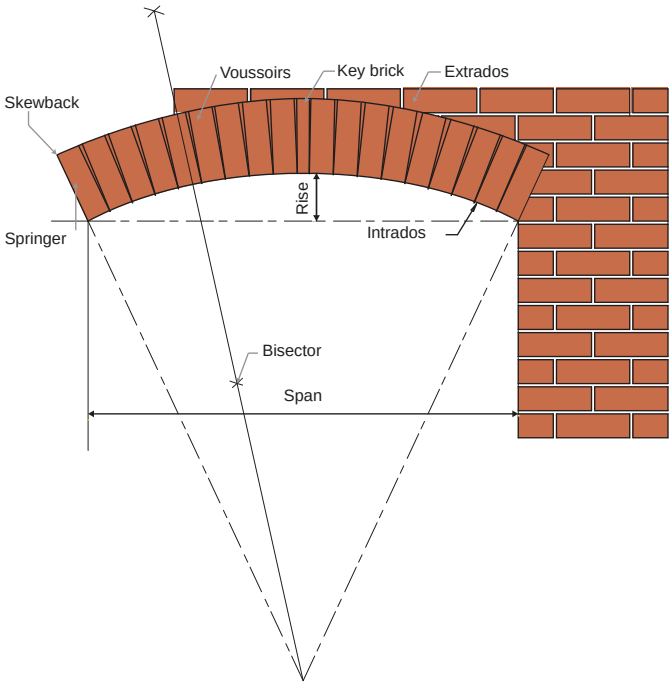


15.10 - Semi-circle as used in a semi-circular arch

The setting out of a semi-circular arch is simple. Half the span is the rise.

Segmental arches

ROUGH segmental arches are built of standard bricks and the mortar between each brick is wedge-shaped. These arches are normally executed in stock bricks because the arch is used internally as a relieving arch. Before we can set out the arch we must know the rise. The rise to any segmental arch is normally one-sixth of the span.

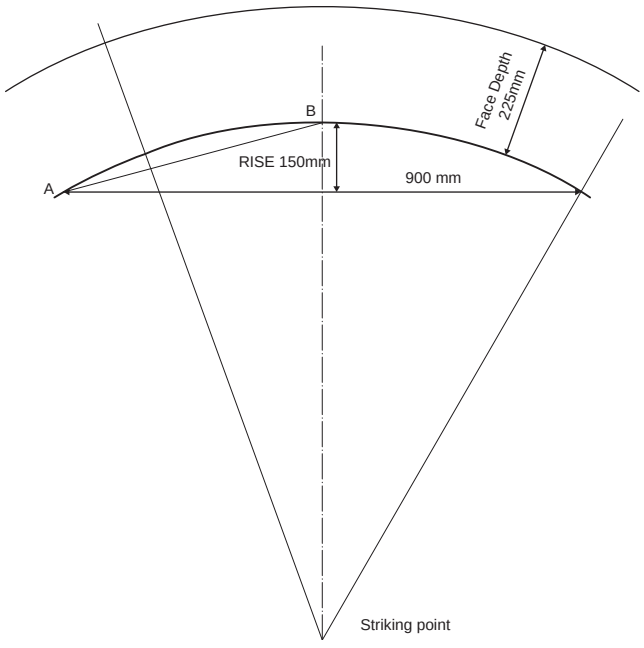


15.10 - Semi-circle as used in a semi-circular arch

Illustrated above is an arch built with a one- brick-on-end-ring. Notice the wedge-shaped mortar joints.

To set out the Arch

a. Draw the span, assuming it to be 900mm.
b. Draw a perpendicular bisector.
c. Mark off rise 150mm.
d. Join (a) and (b) and bisect.
e. Where the bisector intersects the centre line, point (c) is the striking point of the required arch.



15.12 - Geometrical setting out of a segmental arch

NOTES

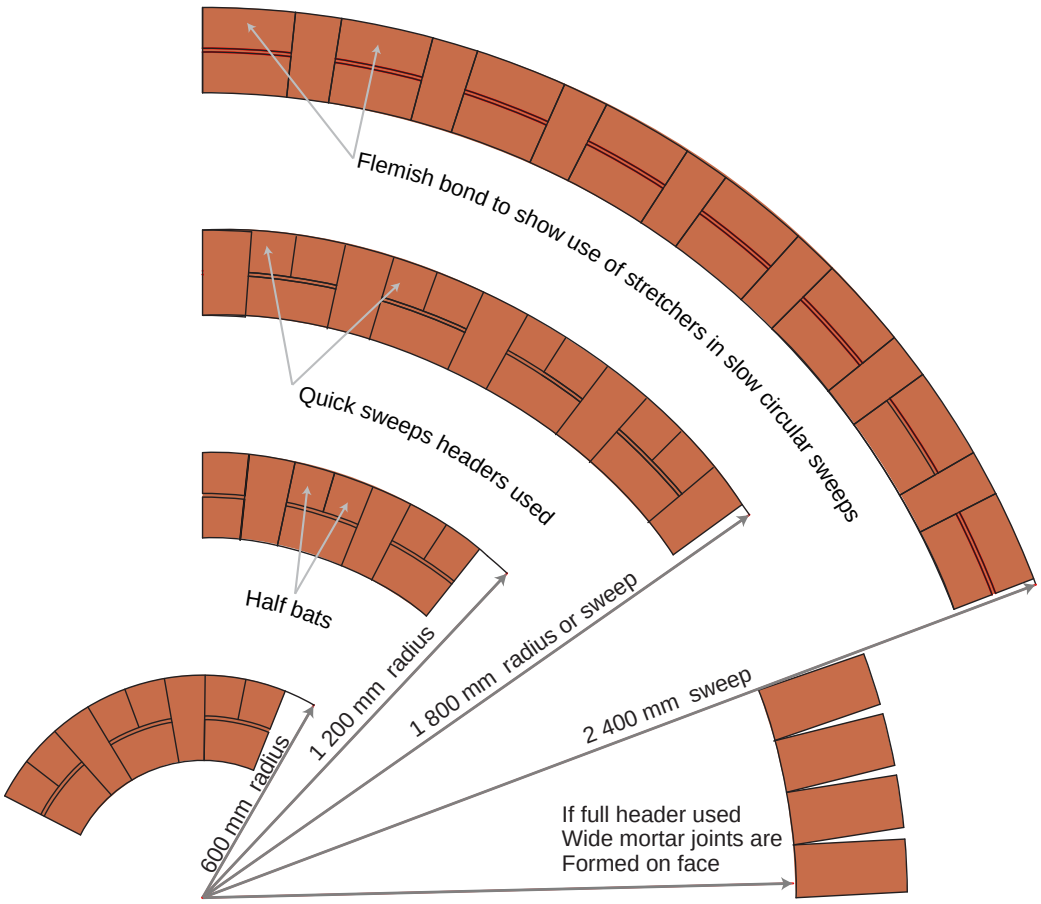
CHAPTER 16

Circular or Curved Walls

CIRCULAR OR CURVED WALLS

Circular walls can create interesting features inside a house and in gardens, such as around trees or retaining flower bed walls or garden seats. The recommended method of building a curved wall is the line or trammels method. Note that some of the bricks on the inner curve may have to be cut to avoid excessively wide joints.

A half brick wall will have a less complicated bond.



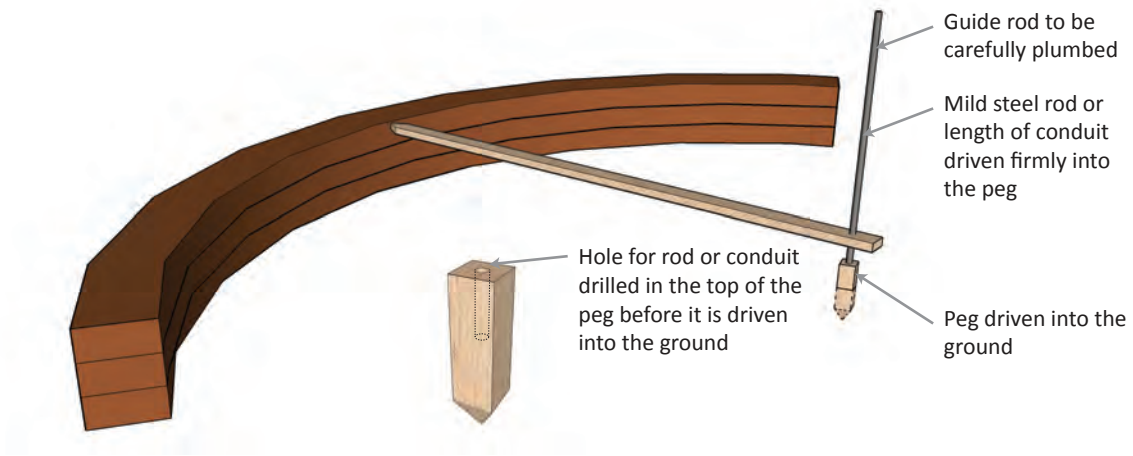
16.1 - Plans of 1 brick circular walls

Trammel Method

1. Drive a hole down the centre of a short length of batten as illustrated.
2. Insert a mild steel rod into the hole. Note: The rod must be truly plumb.
3. Decide on the circle diameter, find the radius and cut a length of wood (trammel) equal to radius.
4. Drill a hole the size of the rod at one end of the trammel.
5. Lower trammel onto rod.
6. Scribe an arch.

Another rough method of scribing an arch is to tie a loop on a piece of string equal to the radius. Hook loop over rod and scribe the required arch.

This method has a disadvantage to the trammel method, in that it is not always possible to keep the string equally taut. This results in an irregular curve. The trammel method is therefore recommended.



16.2 - Trammel method

To mark out excavations

1. Fix a nail to the trammel and scribe a line on the ground. This line represents the face of the wall.
2. Measure back from the line a distance equal to the width of the wall. Scribe a line.
3. Measure 150mm on outside of the two lines
4. Now excavate 400mm deep between the outer lines.
5. Level trench
6. Insert level depth pegs so that they protrude 300mm above trench bottom.
7. Cast in concrete to the tops of the depth pegs.
8. When the concrete is dry use trammel to scribe a line indicating wall face (line).
9. Proceed to build the curved wall using one of the methods illustrated.

During building the trammel must be used constantly to ensure, firstly, that the wall follows the correct curve and, secondly, to make the wall plumb. A level must still be used across the top of each course as a line cannot be used in this curved construction.

NOTES

NOTES

CHAPTER 17

Garden Walls

GARDEN WALLS

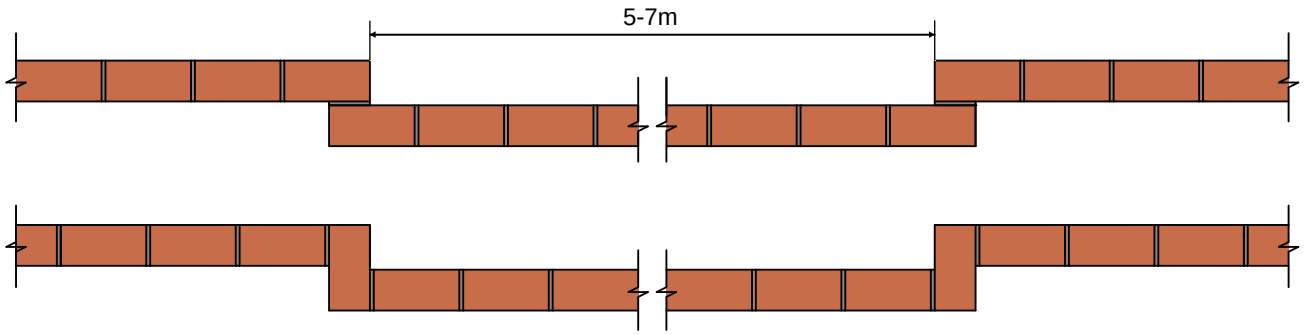
Garden and boundary walls have become a South African way of life. The walls ensure security and privacy to your home, including the entertainment, garden and pool areas, and included roaming animals and intruders to enter your property. In many cases, the application of boundary walls are required as municipal by-laws.

A well-constructed clay brick boundary wall not only enhances the appearance and value of your property. Its enduring low maintenance qualities will require minimal upkeep and prove to be economical in the long term, compared to other types of walling, like precast, hedges and aluminium that require ongoing upkeep.

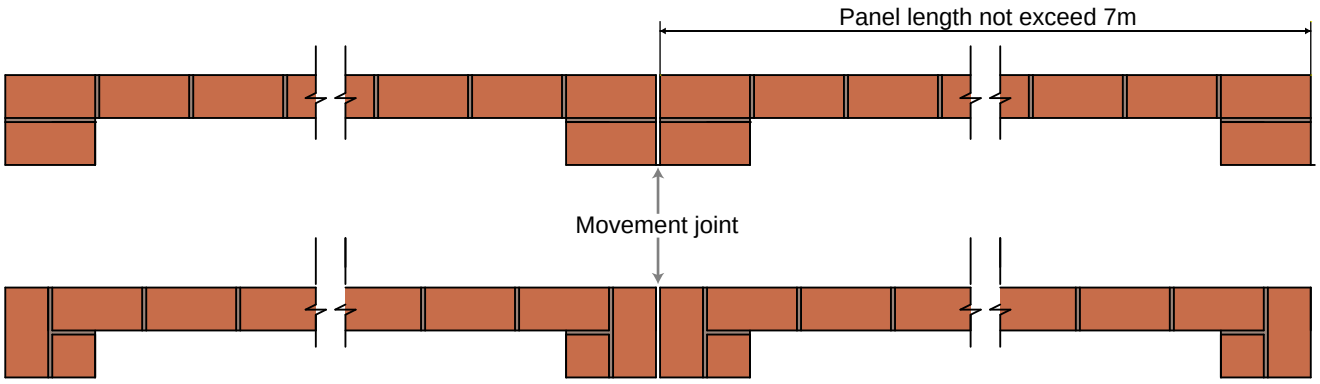
This chapter deals with three possible Ways that a clay brick boundary wall can be constructed.

NOTE

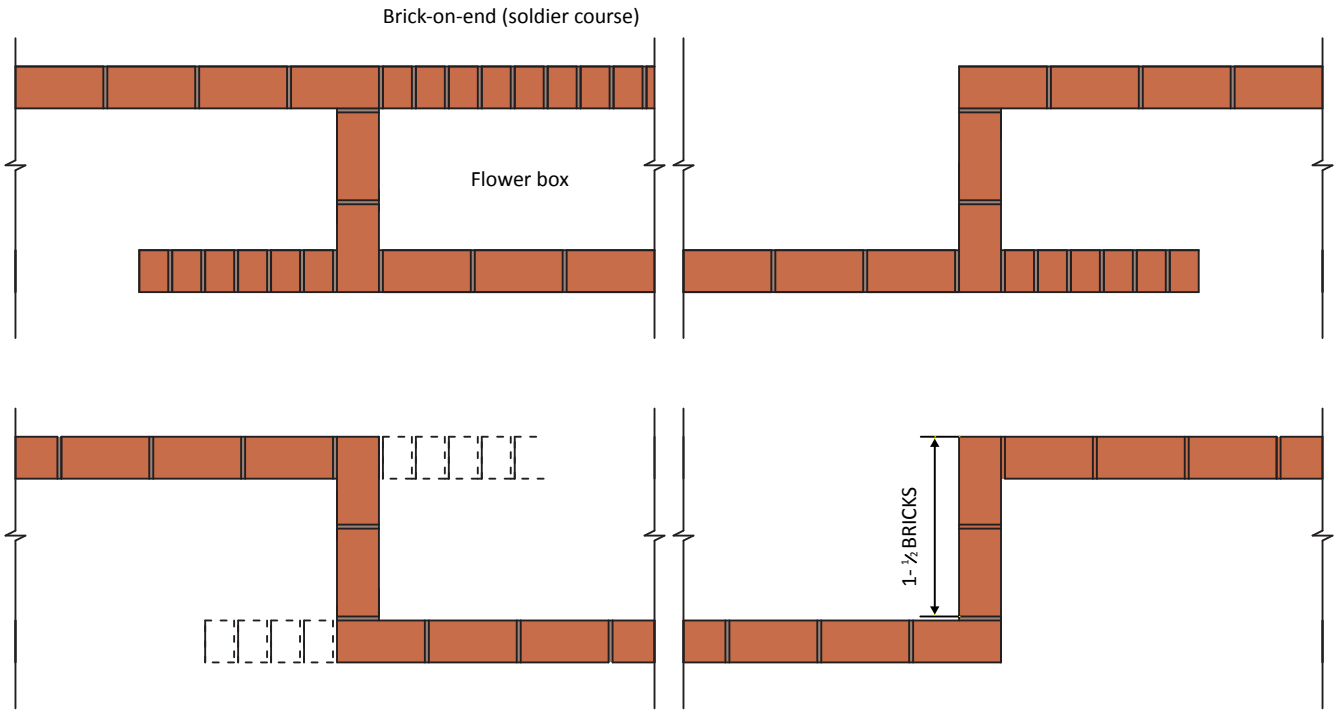
Any free standing wall, such as a garden or boundary wall, should receive some type of finish on top, such as a coping. A finish such as a brick on- edge or brick-on-end is normally used for this purpose. (See page Chapter 11 - Figure 11.18 - Different ways a brick can be laid.)



17.1 - Shows Plan view of first and second courses Instead of attached piers the wall can be recessed. This wall is generally built as a boundary wall between stands.



17.2 - Shows a wall with movement joints. These joints should be kept open free of mortar.



17.3 - Shows that if the recess depth is increased it can serve as a flower box or planter. The brick-on-end wall forms the flower box area. The height of the planter can be built to any desired height.

Points to consider:

1. The wall thickness in garden walls is generally only a half brick in thickness, with supporting piers at intervals not exceeding 7m in length.
2. Free standing walls require frequent movement joints at 5-7 m intervals.
3. Retaining walls should have a thickness no less than 220mm (one brick thick). Local bylaws may also require that special bonding patterns, such as , English bond is used to build the wall.
4. Walls up to 1.8m are usually not governed by local bylaws. It is however good practice to consult with the local building inspector regarding wall heights, foundation widths and depth, as there are certain factors which may affect the planning of the wall i.e. in some municipalities the concrete foundations may not go beyond the building line.
5. 10-12 mm Movement joints to be filled with a suitable compressible bitumastic filler.

In other words, the actual outside line of the finished wall must be set back 100mm or more from the building line, a loss of 100mm all round the boundary.

NOTES

CHAPTER 18

Manholes

MANHOLES

National Building Regulations : Manholes / Inspection Chambers (I.C)

D25: Drains passing through or under walls or under buildings

1. Where any drain passes under a wall, other than a freestanding wall, such drains shall be of cast-iron pipes and completely encased in concrete no less than 100mm thick.
2. Where any drain passes through a building, that part which is within the building shall –

    a. Be adequately supported throughout its length without restricting thermal movement, with any fitting giving such support being securely attached to the building; and
    b. Be so placed that all junctions, bends and access eyes are readily accessible.

D.26: Means of access to drain

1. Every drain shall have such means of access as may be necessary for inspection and cleansing and without prejudice to the generality of the foregoing:

    a. There shall be an inspection chamber or manhole:

        i. At each point where there is a change of direction or gradient;
        ii. On drains within 12m from any junction, and between the drain and any other drains unless there is an inspection chamber or manhole situated at such junction;
        iii. Within 1.5 m of the point of junction between a drain and a connecting sewer unless there is an inspection chamber or manhole situated at such junction;
        iv. At the highest point of a drain unless there is an access eye at that point; and

    b. No part of a drain shall be at a distance of more than 25m (measured along the line of the drain) from an inspection chamber, manhole or other access point situated on the same drain.

2. Every inspection chamber or manhole shall;

    a. Be so designed and constructed of brickwork, concrete, precast concrete sections or other suitable and durable material, so as to:

        i. Sustain the load which may be imposed upon it and
        ii. Be watertight

    b. Be of such size and form as to permit ready access to the drain for inspection, cleansing and rodding;
    c. Have a removable and non-ventilating cover of adequate strength, constructed of suitable and durable material;
    d. Where the depth of a manhole so requires, an approved means of access as to provide a safe approach to the level of the drain; and
    e. Where the part of the drainage system within the inspection chamber or manhole is constructed of open channels, and provided with benching of a smooth impervious finish, and so formed as to guide the flow of sewage towards the pipe into which the main channel discharges and provide a safe foothold.

3. Any inspection chamber or manhole within a building, other than an inspection chamber or manhole giving access to part of a drain which is constructed with inspection fittings having watertight covers shall be:

    a. So constructed in conjunction with its frame and cover as to be watertight when subjected to the maximum internal pressure which could be caused by blockage of the drainage system at any point below the inspection chamber of manhole; and
    b. Fitted with a removable and non-ventilating cover of adequate strength constructed of suitable and durable material which is:

        i. Fitted in a frame with an airtight seal and
        ii. Secured to the frame by removable bolts made of corrosion-resistant material.

D27:Junctions

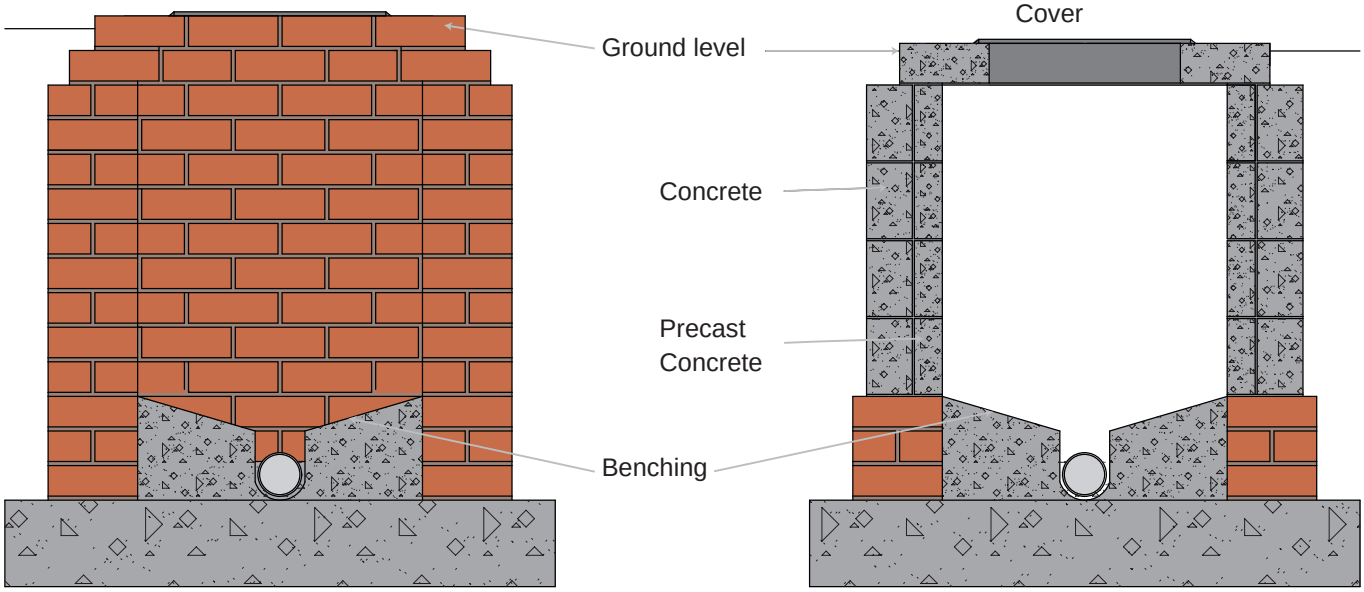
1. Any connection at a junction between:

    i. A ranch drain and any other drain; or
    ii. A drain and connecting sewer where such drain and connecting sewer are not in line shall be so made that the tributary drain discharges its contents into the other drain or connecting sewer obliquely in the direction of flow in that other drain or connection sewer.

2. Any connection between a drain and connecting sewer shall be so made that the connection will remain watertight and otherwise satisfactory under all working conditions. Note this connection is usually done by the local authority.

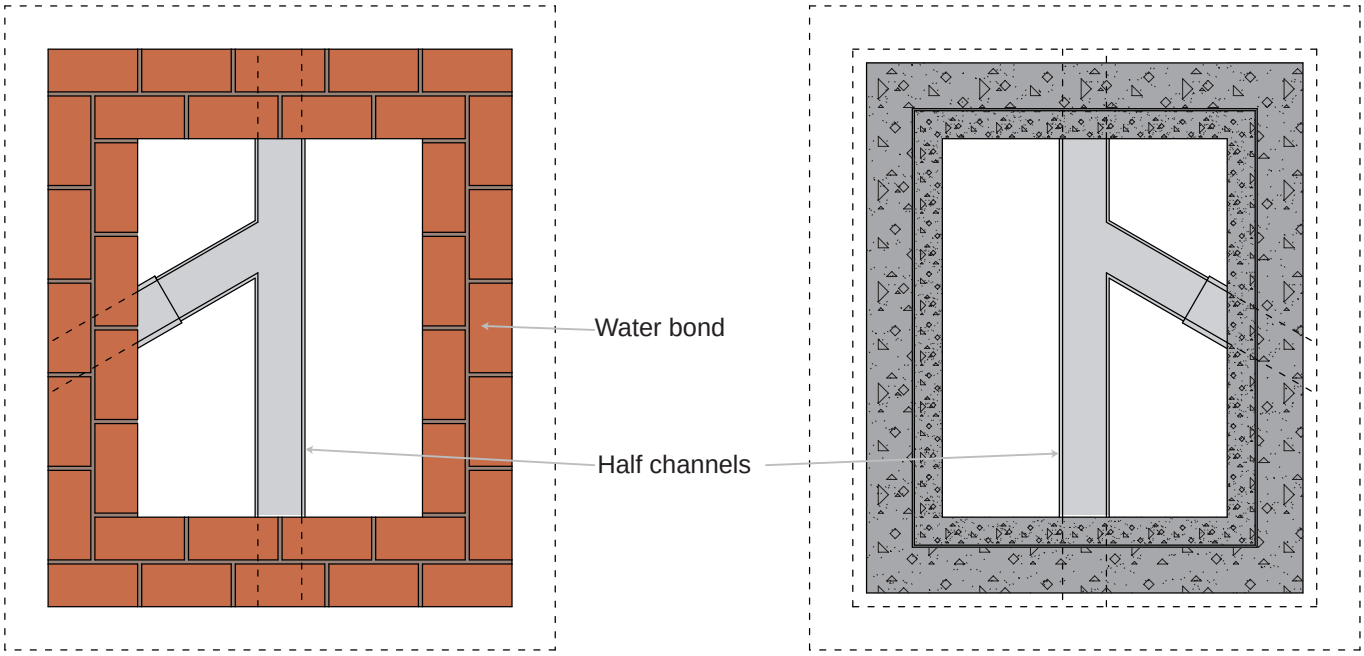
D28:Test for drains

Every drain laid in terms of these regulations shall be tested in accordance with the test contained in prescribed manuals by the local authority.



Section (a)

Section (c)



Plan (b)

Section (d)

NOTES

CHAPTER 19

Paving

PAVING

There are many ways in which a property owner can improve on the appearance of an estate. Modifications, such as paving outdoor surface areas can increase the value of the property significantly.

To pave a Clay Brick driveway, the following steps are recommended:

Decide on the type of Clay Paver to be used

The choice of paver is largely determined by the building design, as well as the colour, style and finish to be achieved. It is highly recommended to seek the expert advice of a Clay Brick supplier, who will gladly assist in selecting the most suitable brick for the required application.

Decide on a suitable pattern

Clay Pavers are available in an array of earthy colours, textures and natural hues, allowing for creativity in design and layout that naturally compliments the environment.

Some of the most commonly used paving patterns are illustrated below. (See Fig.19.1 and 19.2)

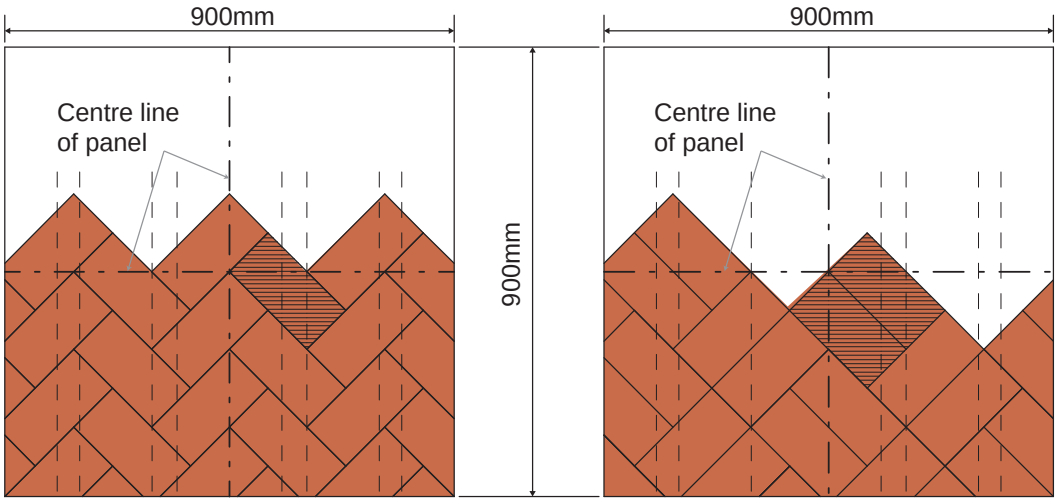
Setting Out

Provision is to be made for openings where flowers, shrubs or trees are to be planted on completion of the paving. It is best to demarcate at the initial planning stage.

Preparation of the surface

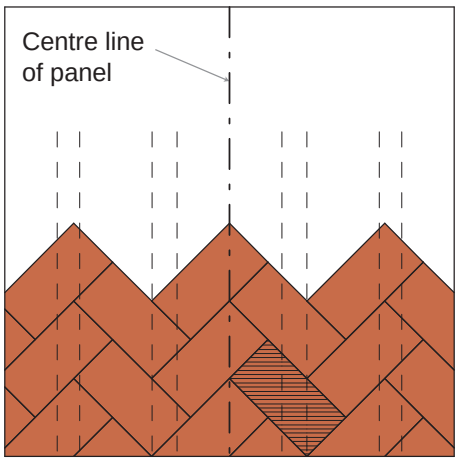
Under all circumstances provision must be made for water drainage. Always slope the surface to be paved away from the house and/or garage.

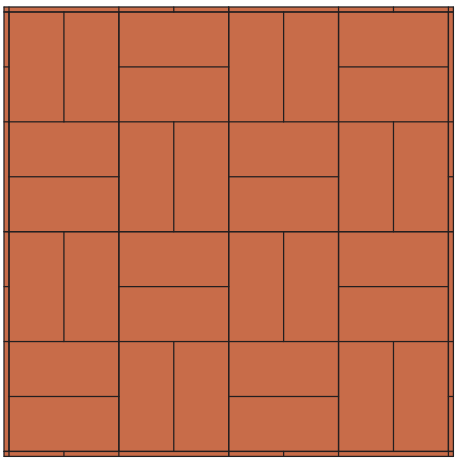
If the driveway slopes towards the house, direct the water away by raising one side of the paving slightly. This precaution is vital to keep the garage dry, and also water out of the home. If an enclosed courtyard is paved, the water is generally drained in the direction of the entrance gate.



Single Herringbone Bond

Double Herringbone Bond

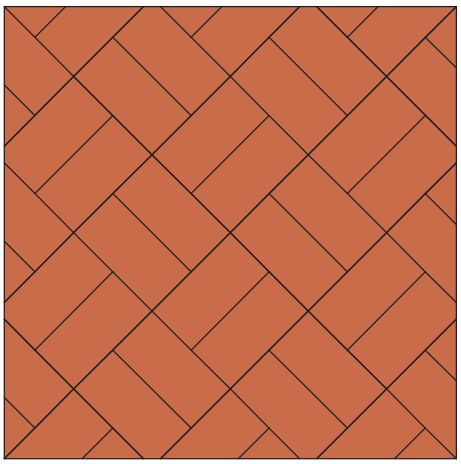




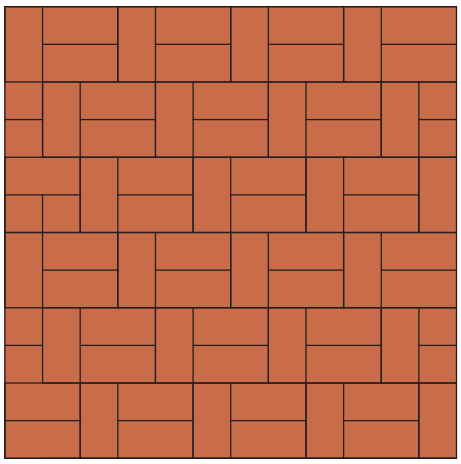
Setting out from bottom of panel

Basketweave bond

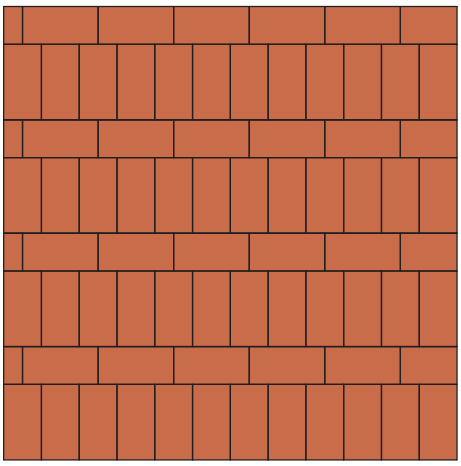
19.1 - Paving patterns



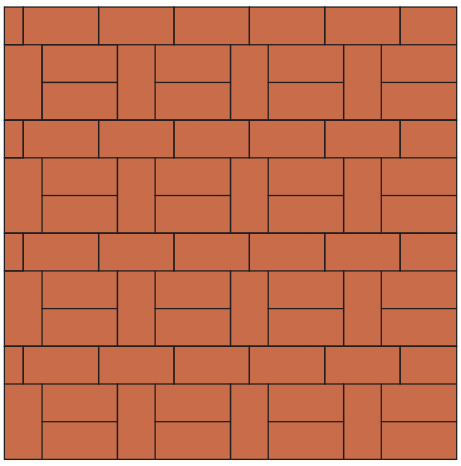
Diagonal Basketweave



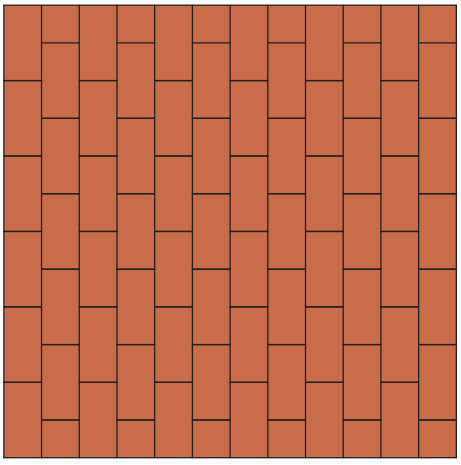
Staggered Basketweave



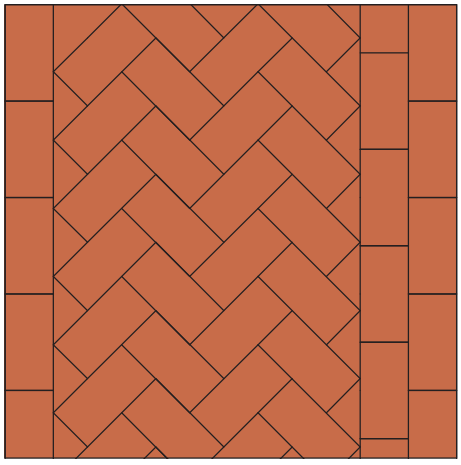
Bordered Grid



Stretcher Basketwave Pattern



Stretcher Bond Pattern



Bordered Herringbone Pattern

19.2 - Paving patterns continued

The surface to be paved must be loosened by picking. In other words, dig up the whole area to a depth of 70-80 mm. Use a long, straight board to level off the area. When you are satisfied that the area is perfectly level (no hollows or bumps) and that the water will be diverted in the required direction, the entire area must be consolidated.

The consolidation of the soil is best achieved by using a vibrator roller or a plate compactor. These items can be hired on a daily basis from plant hire firms.

The soil compaction is vitally important if problems are to be avoided later. To prevent weeds from growing through the paving it is necessary to spread a patent weed killer, which is obtainable from the garden nursery, across the area to be paved.

Laying of Paving

Follow the soil compaction, by laying the Clay Pavers to the pattern of your choice, on a thin layer, ± 20mm thick, of mine sand which has been levelled over the compacted area.

To make the actual placing of the bricks easier, a line or a prepared metal grid can be used.

The grid consists of reinforcing bars welded together to form the required pattern. Prepare the grid so that the bricks fit easily between the bars. The grid's total size should be approximately one square metre. This grid is placed alongside a line, filled with bricks and lifted and repositioned.

Bricks can be laid with an opening between (joints) which must be filled (grouted) later or abutting touching). Once the entire area has been laid out with bricks, and if the bricks are laid abutting, simply sweep the crevices full between the bricks with a dry mixture of one part cement and four parts sand (concrete or river sand).

If using the metal grid, a cement grout must be prepared to fill the joints. For grouting there is a choice of two methods, in that you can sweep the joints full with a dry or with a wet mortar mix.

Mix four parts sand with one part cement dry and sweep all the joints full.

Next, with a fine spray of water, wet the entire area. At the same time the bricks must be sprayed clean. All the loose cement must be washed off. Use a wet sponge to clean off the upper surface of the completed paving.

The same mix can also be wetted and then swept in.

An important fact to remember is that the cement must be washed off the paving bricks, with a strong water spray, before it has time to dry. This will result in some of the grout between the bricks being washed out. Do not try and avoid this, it is quite normal. Also, do not spray directly onto a joint.

Leave the brickwork for a couple of hours to settle, then wipe the surface with a wet sponge to ensure all the cement stains are removed.

IMPORTANT NOTE:

When preparing the area to be paved, make sure that the top surface of the paving is below the D.P.C. level of buildings adjoining the paving.

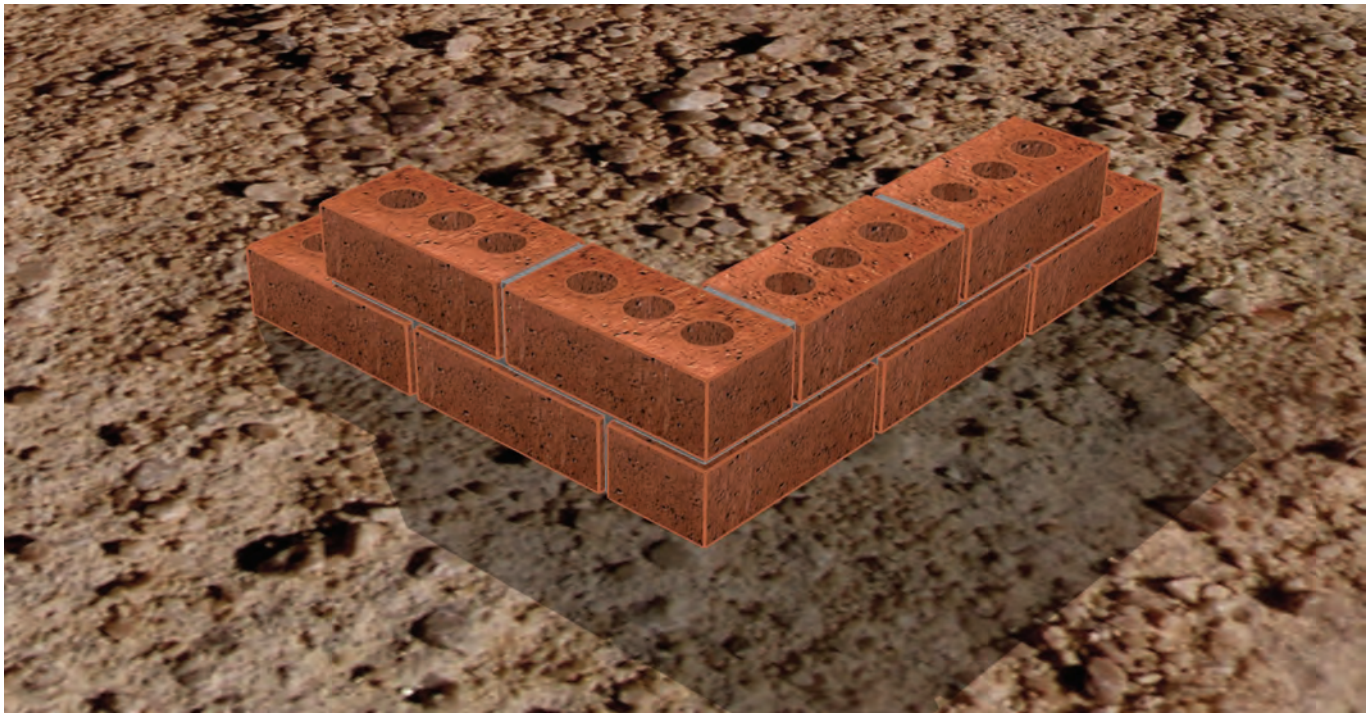
NOTES

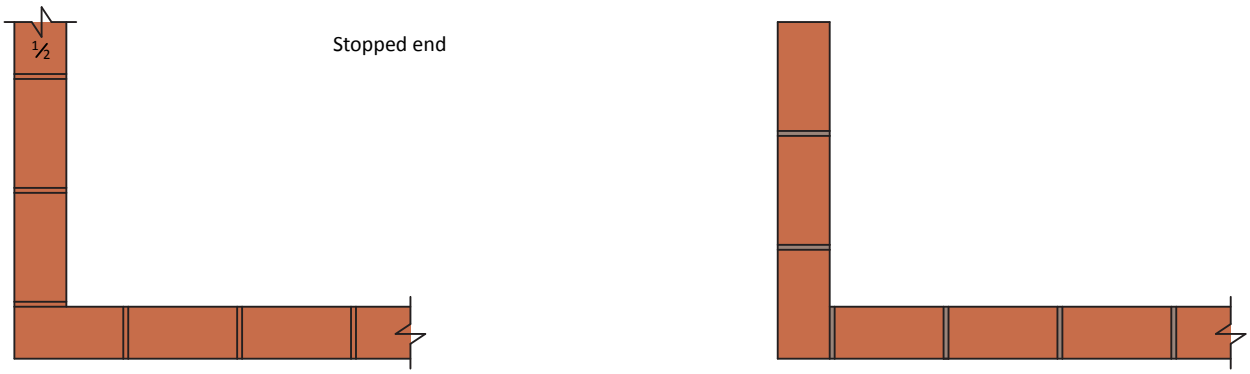
CHAPTER 20

Practical Projects

PRACTICAL PROJECTS

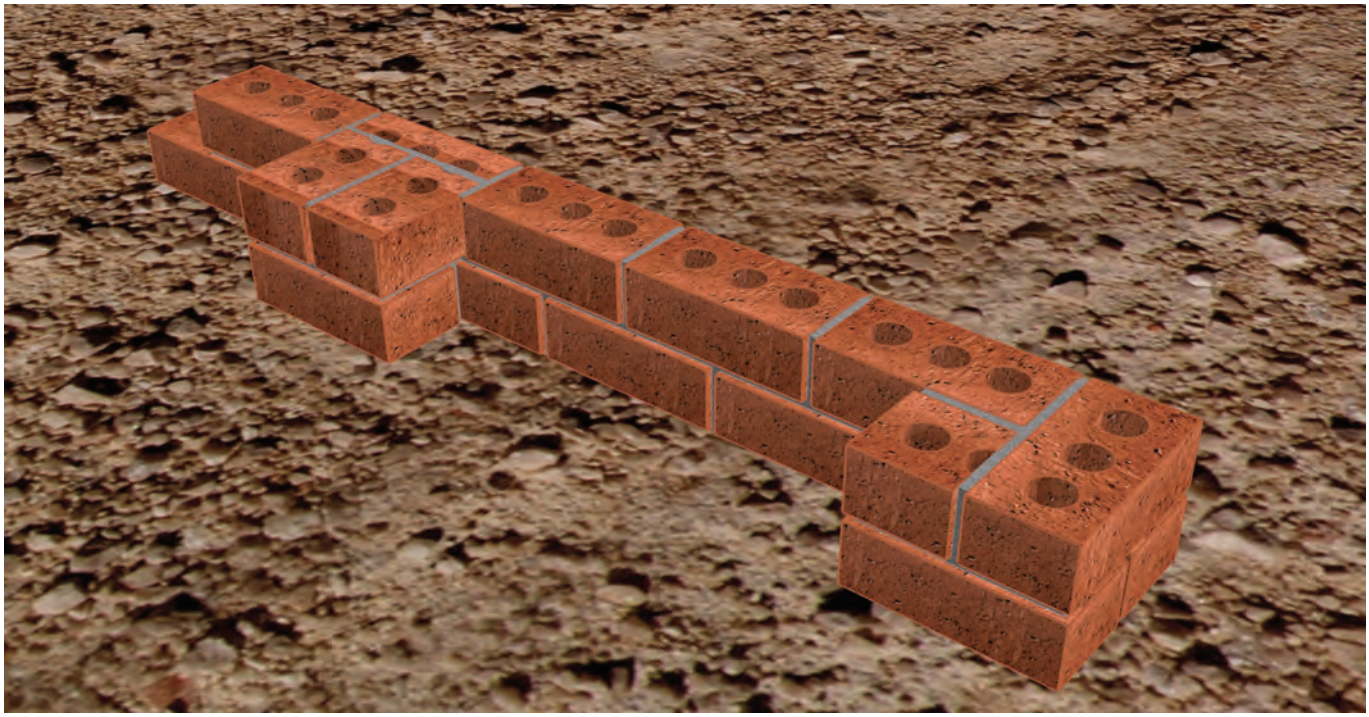
Project 1: 1/2 Brick stretcher bond quoin

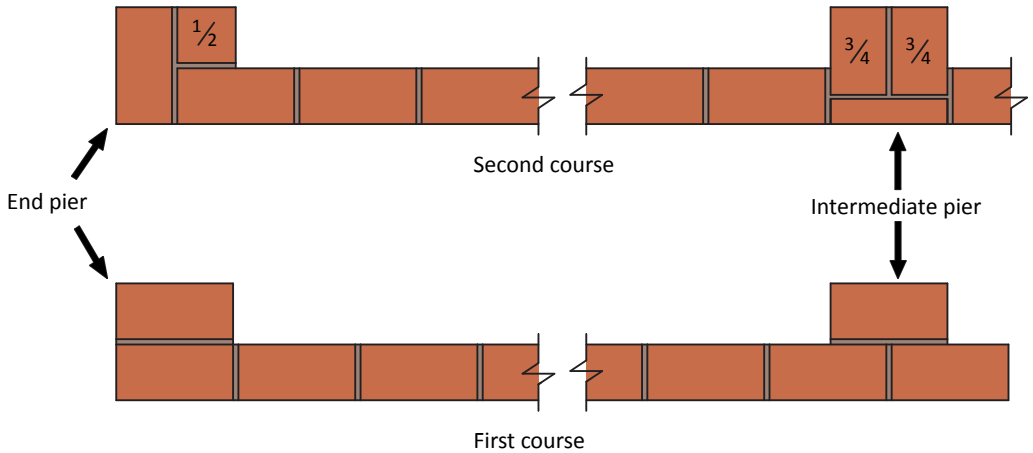




Alternate plan courses

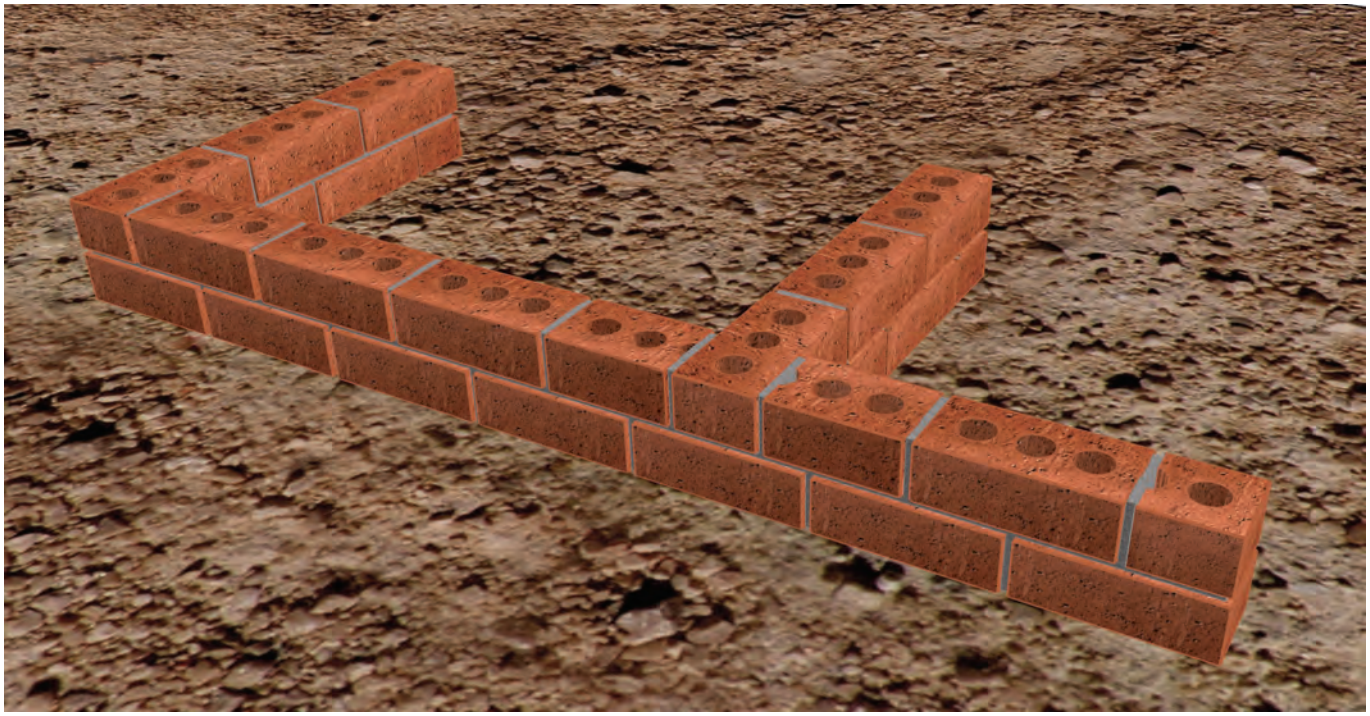
Project 2 : 1/2 Brick stretcher bond wall with attached piers

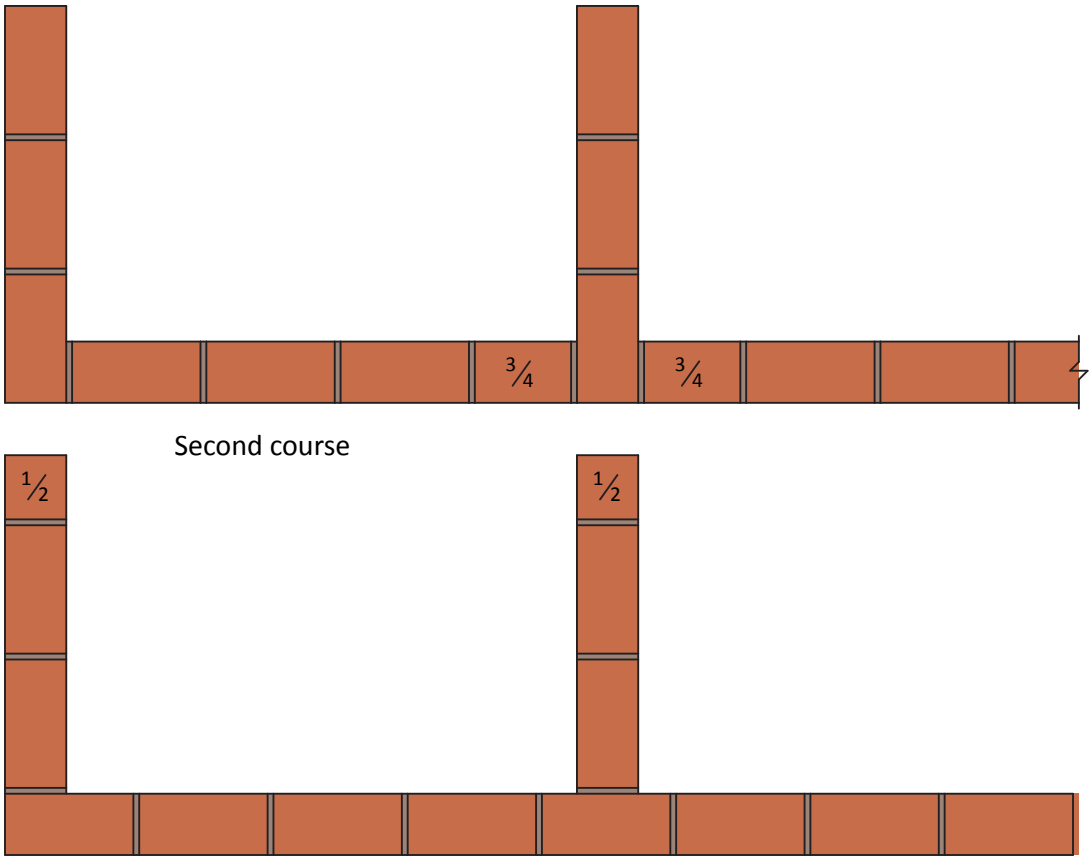




Alternate plan course

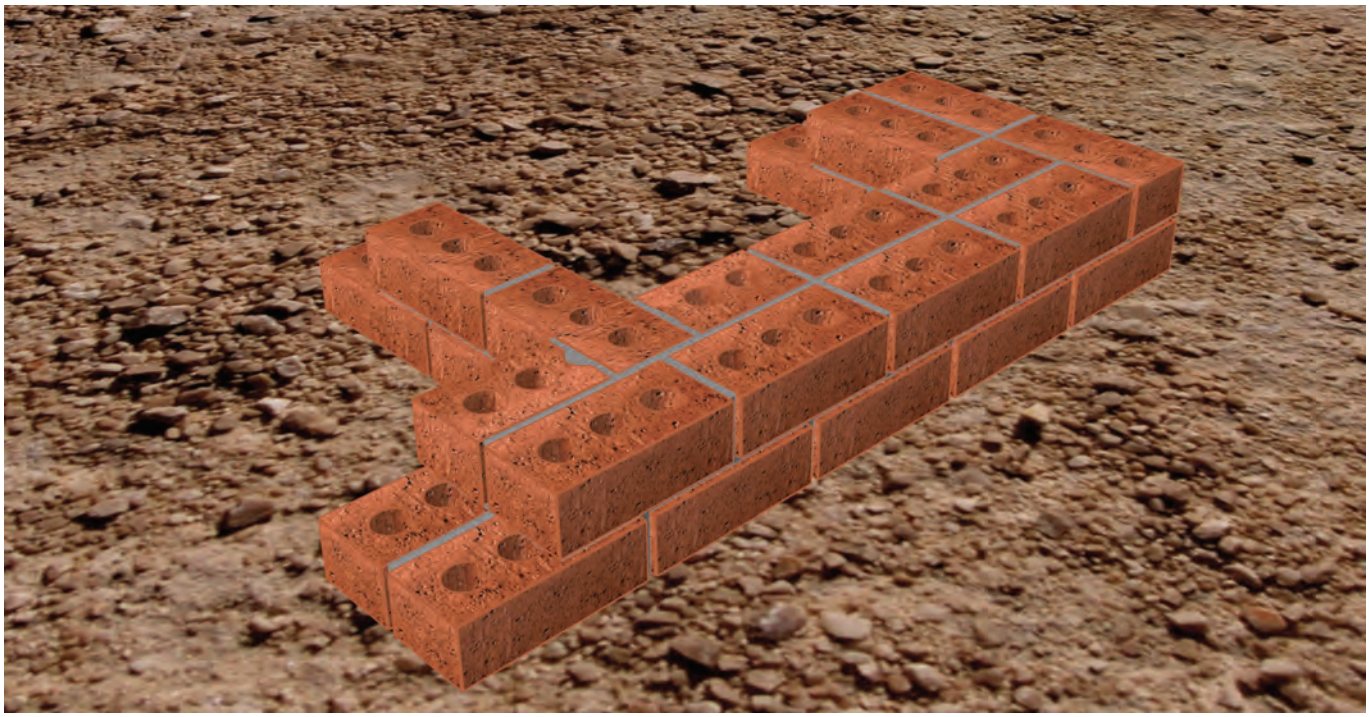
Project 3 : T-Junction built-in stretcher bond

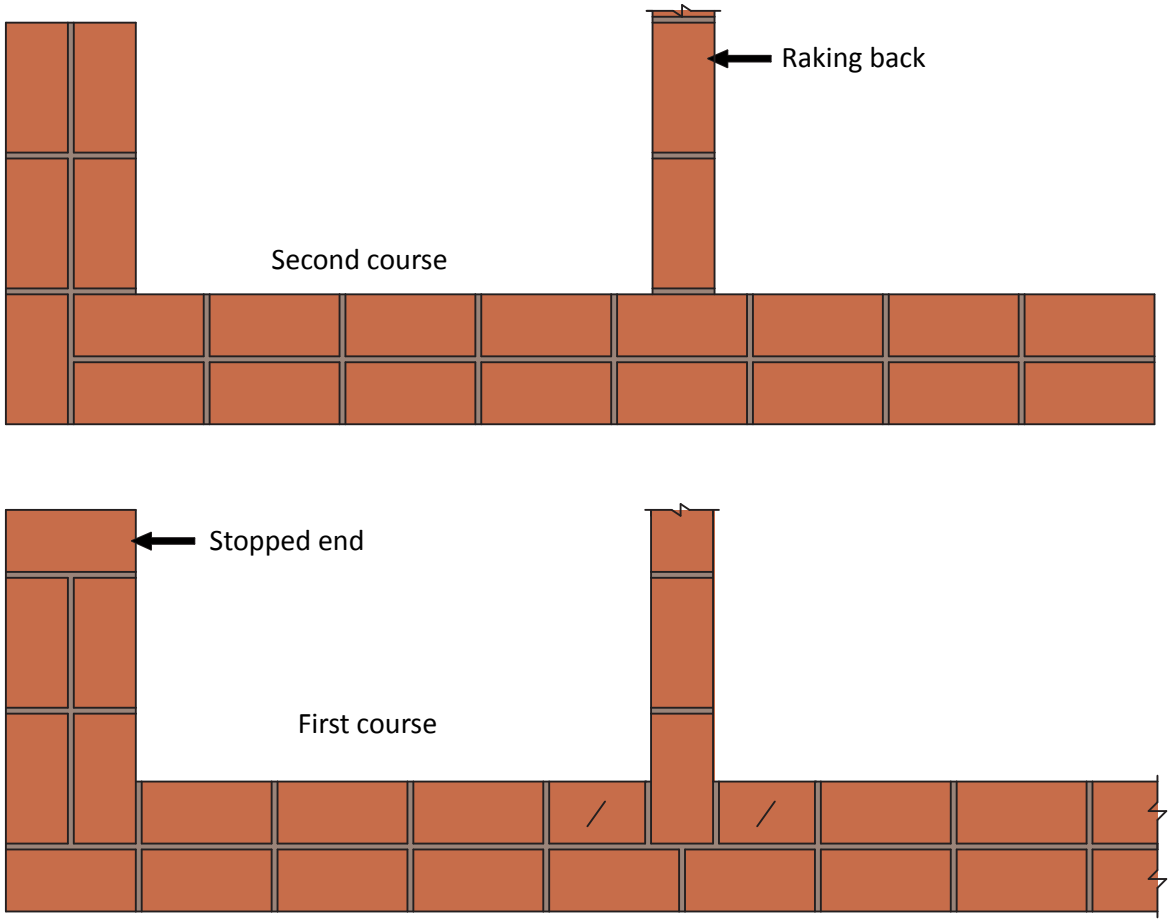




Alternate plan course

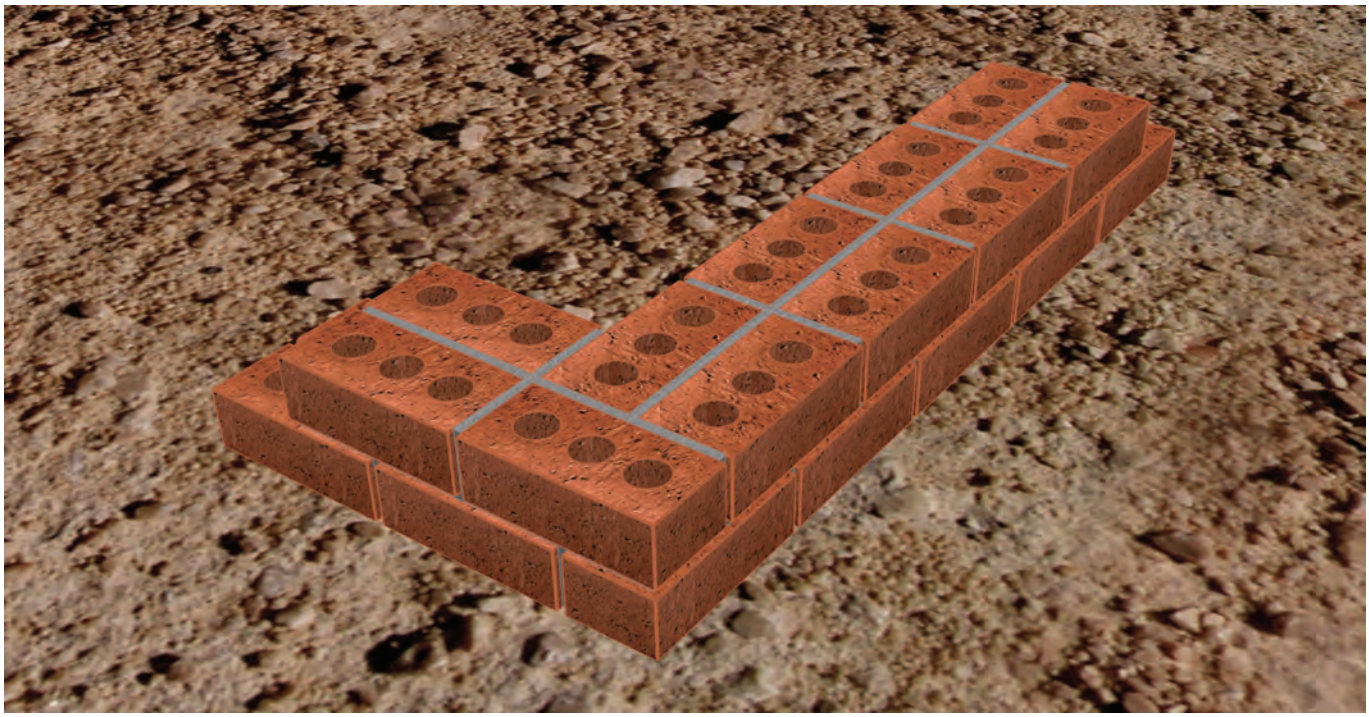
Project 4 : One brick stretcher bond wall with a 1/2 brick T-Junction

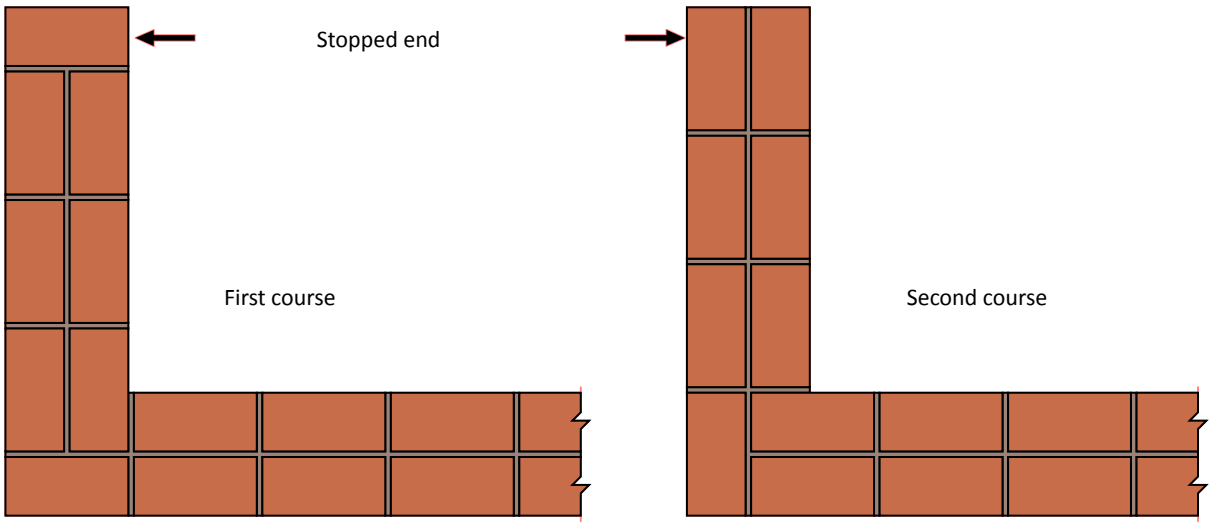




Alternate plan course

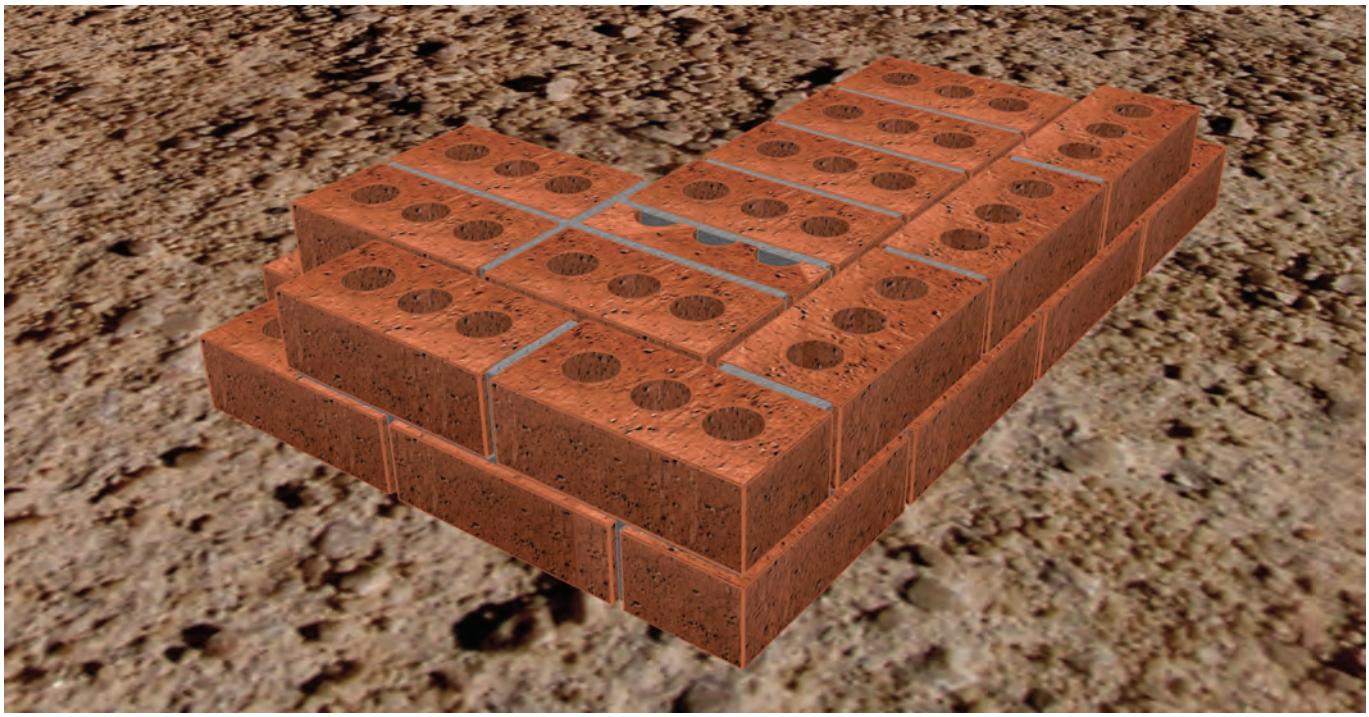
Project 5 : Stretcher bond quoin

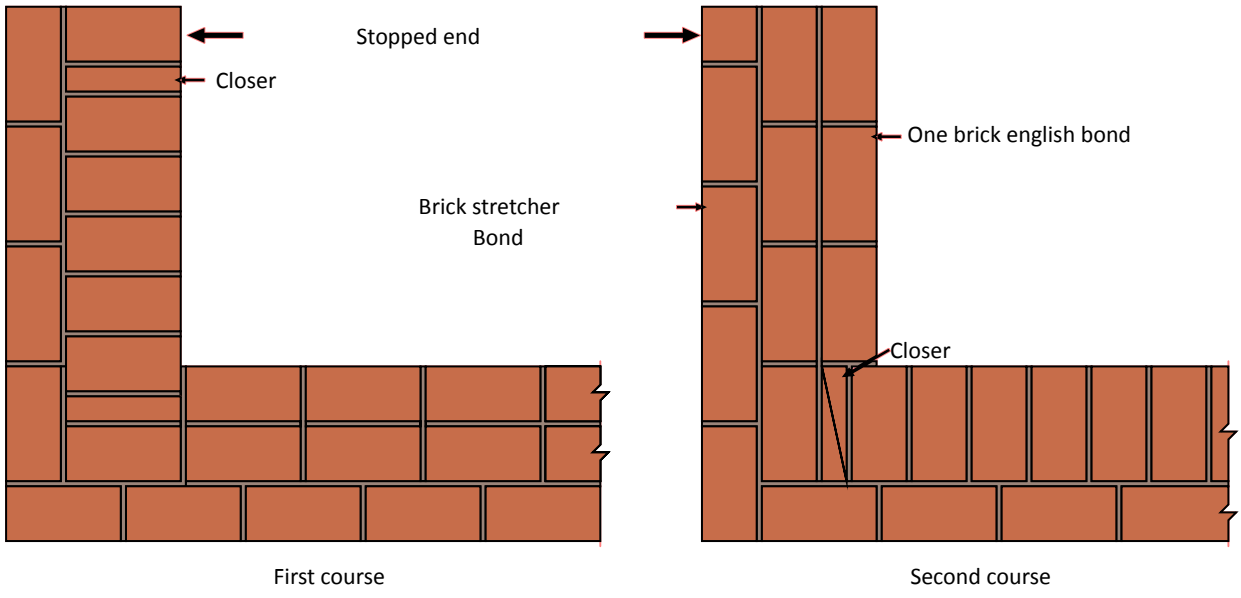




Alternate plan course

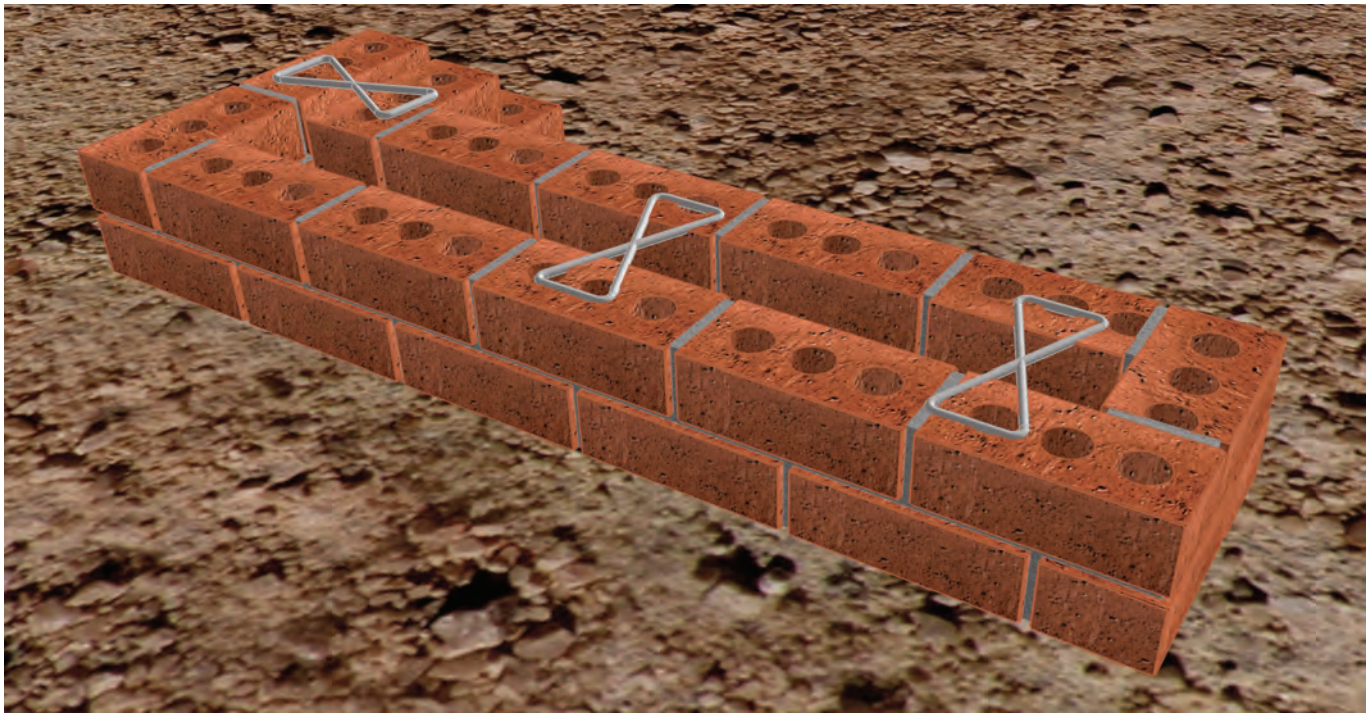
*** NO DESCRIPTION *** please advise

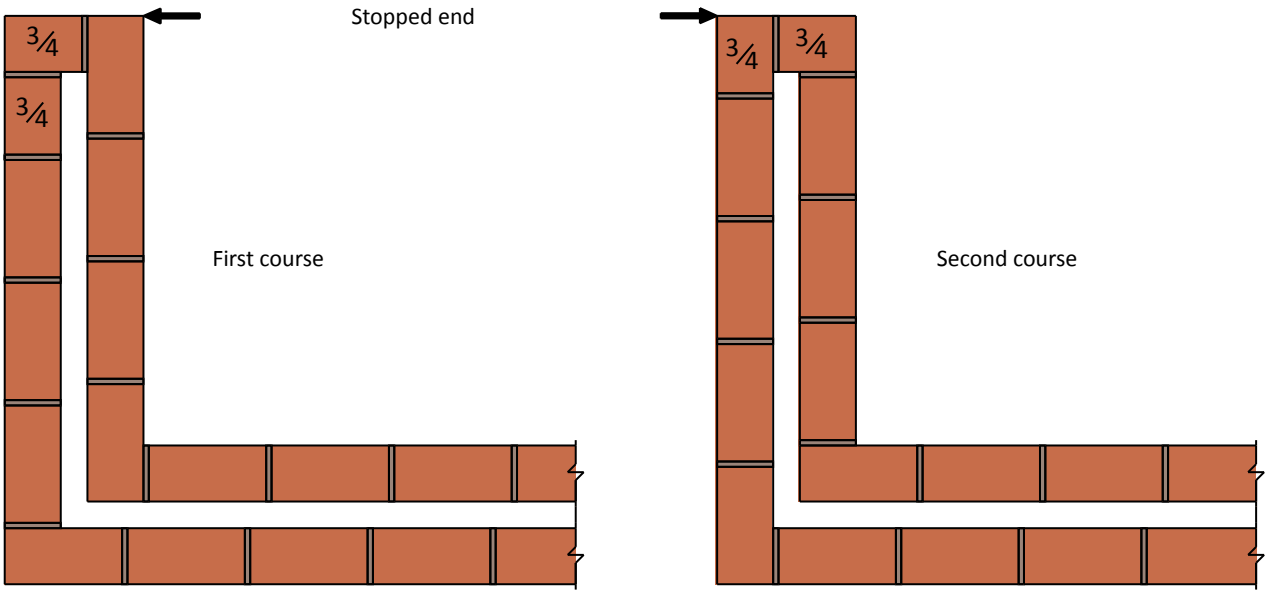




Alternate plan course

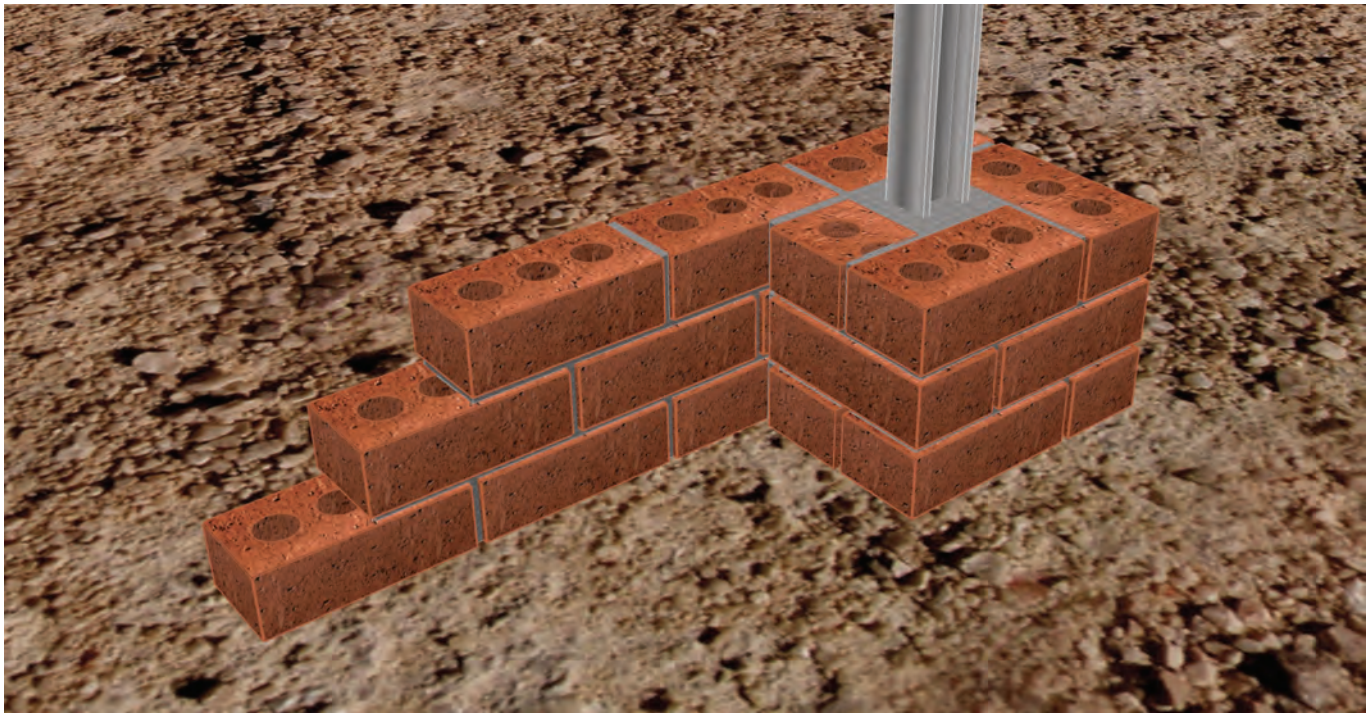
Project 7 : Cavity wall

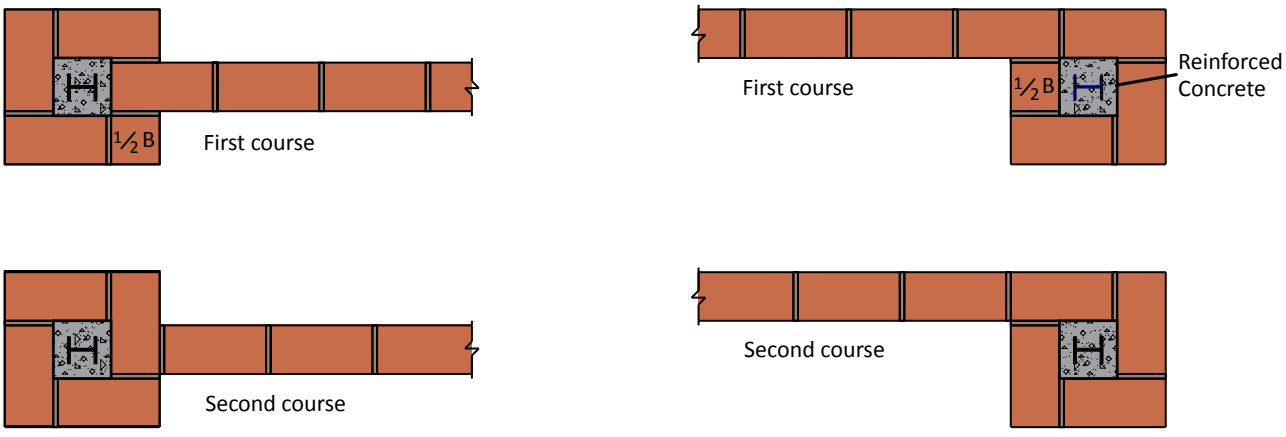




Alternate plan course

Project 8 : Reinforced garden wall pier
One and a half brick square reinforced pier attached to a 1/2 brick garden wall

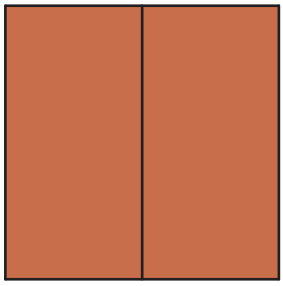




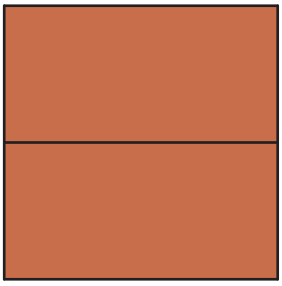
Alternate plan course

Project 9 : Isolated piers

Alternate plan courses

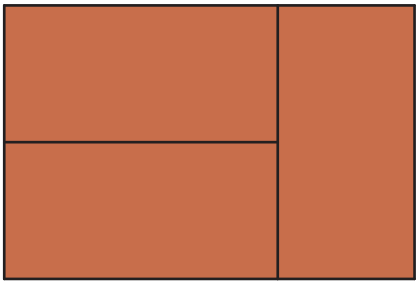


First Course

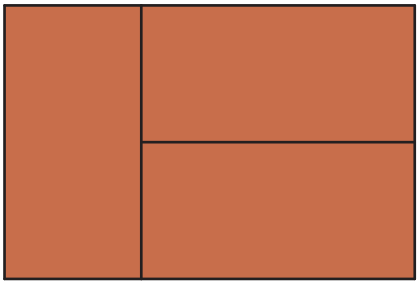


Second Course

One Brick Square

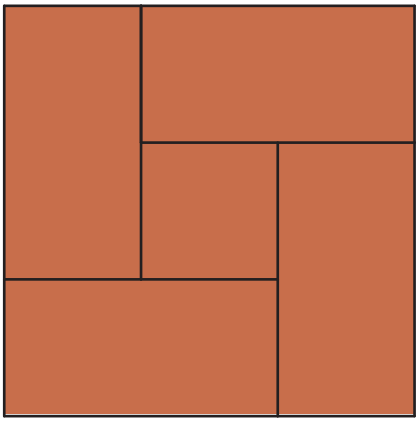


First Course

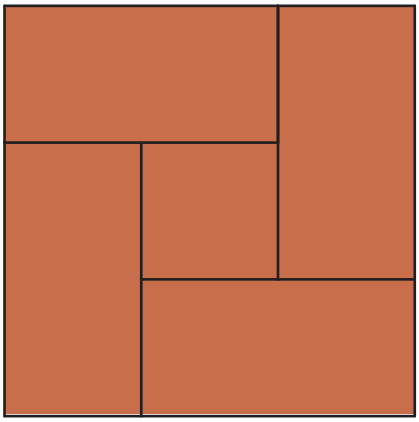


Second Course

One Brick x One and a Half Brick



First Course



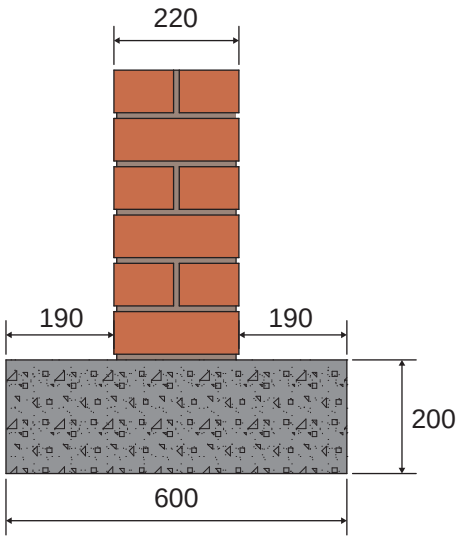
Second Course

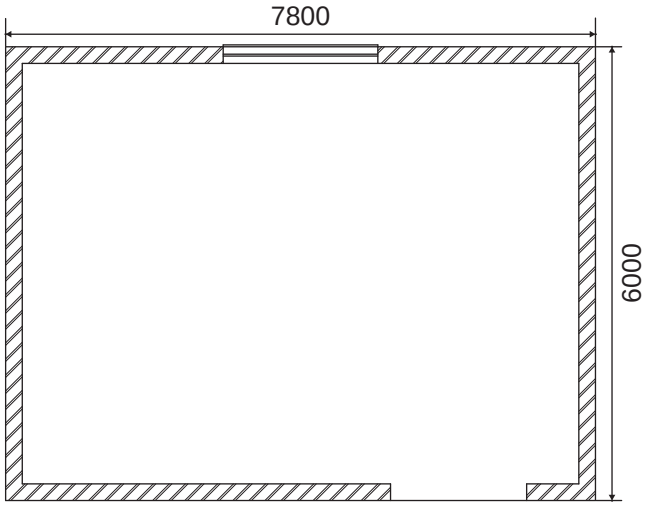
One Brick x One and a Half Pier

CHAPTER 21

How to Calculate Material Requirements

HOW TO CALCULATE MATERIAL REQUIREMENTS





Examples on how to Calculate Material Quantities:

Wall Height : 2.4m

Calculate:

1. Volume of concrete - foundation slab
2. Number of bricks required
3. Material required for topping
4. Material required for plaster internally and externally

1. Concrete Footing (Strip Foundation)

To calculate the volume of concrete required, the overall dimensions of the concrete strip foundations need to be determined. Also, refer to guidelines of cement manufacturer.

Overall length + outside wall dimension + 380

Therefore	:	7800 + 380 = 8180m
		6000 + 380 = 6380m
Volume	=	L x B x H (thickness)
	=	2(8180) + 2(6380) x 600 x 200
	=	(16360 + 12760) x 600 x 200
	=	29.120 x 600 x 200
	=	3.49m^3

Requirements: Low Strength Concrete

To produce 1m^3 of concrete you will need:

5.5	bags cement
0.7m^3	riversand
0.75m^3	stone

To produce 3.49m^3 of concrete as per the calculation, the following is required:

3.49 x 5.5	=	19.195 bags cement (round off to 20 bags)
3.49 x 0.75	=	2.6175m^3 riversand (round off to 3m^3)
3.49 x 0.75	=	2.6175m^3 stone (round off to 3m^3)

2. Floor Slab

To calculate the volume of concrete required, refer to the Internal dimensions of the room. Also, refer to guidelines of cement manufacturer.

Therefore:		7800mm - (220 + 220) = 7800 - 440 = 7360
		6000mm - (220 + 220) = 6000 - 440 = 5560
Volume	=	Length x Width x Thickness
	=	7.360m x 5.560m x 0.075m
	=	3.069m^3

Requirements: Medium Strength Concrete

To produce medium strength concrete as per the calculation, the following is required:

3.069 x 7 =	21.483 bags of cement (round off to 22)
3.069 x 0.70 =	2.1483 (round off to 2.2m^3 riversand sand)
3.069 x 0.70 =	2.1483 (round off to 2.2m^3 stone)

3. Clay Brick Walls

To calculate the number of Clay Bricks required for the construction of walls, the following formula is applied. Also, contact your local Clay Brick supplier should you need assistance.

External Walls : 220mm or two leaf walls
For every 1m^2 of walling : 110 bricks are required

Formula	=	Area

	=	Length x Height
	=	(2X7800 + 2X6000) x 2.4
	=	15.600 + 12.000 x 2.4
	=	27.600 x 2.4
	=	66.24m^2 walling

Number of Clay Bricks	=	66.24m^2 x 110
	=	7286 Clay Bricks

Number of Clay Bricks required in foundation walling

Assume 500mm height	=	Wall Length x Height
	=	27.600 x 500
	=	13.80m^2
	=	13.80 x 110
	=	1518 Clay Bricks

Total Required	:	7286 + 1518
	=	8804 Clay Bricks

NOTE

Clay Bricks are delivered on pallets or packages. Please check with your supplier to order economical loads.

4. Topping (Screed)

To produce 100m^2 of screed, that is 25mm thick you will need:

23	bags of cement
3.0m^3	riversand sand

The formula to calculate the volume of screed required is as follows. Consult with your local materials supplier should you need assistance.

Floor Area	=	7.360m x 5.560m
	=	40.92 (41m^2)

0.41 x 23	=	9.43 (10) pockets cement
0.41 x 3	=	1.23m^3 sand

5. Plaster

The formula to calculate 15mm thick plaster is as follows.

Internal

Formula	=	Length x Height
	=	(14.72 + 11.12) x 2.4
	=	25.84 x 2.4
	=	62.016m^2

For every 100m^2 of plaster 15mm thick, the following is required. Consult with your local materials supplier should you need assistance.

10	bags of cement
2.0m^3	plaster sand

62 x 0.10	=	6.2 bags of cement (round off to 7)
62 x 0.02	=	1.24m^3 plaster sand

External

Area	=	Length x Height
	=	(2X7800 + 2X6000) x 2.4
	=	(15.60 + 12.00) x 2.4
	=	27.60m x 2.4m
	=	66.24m^2
	=	0.6624 x 10
	=	6.624 bags of cement (round off to 7)
	=	0.6624 x 2
	=	1.32m^3 sand

NOTES