



Manual 14



Brickwork in Landscape

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Manufacturer: Austral Bricks
Brick collection: La Paloma
Builder: Melbourne Homes of Distinction
Contractor: Homestead Bricklaying
Photography credit: Peter Clarke Photography

The brick pattern in this courtyard captivates and mesmerises, bringing outdoor light and shadow into the home. Inspired by dappled shadows created by trees and structures, floor and wall pattern were meticulously detailed. The subtle play of colours and forms unifies flooring and fence, planters and seats, blurring the boundaries between inside and outside.

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Contents

1	Introduction	4
2	Brickwork Basics	5
3	Walls and fences	8
4	Paving	12
5	Architectural furniture	20
6	Trees, Creepers and Brickwork	28

1. Introduction

Brickwork can play an important role in creating a harmonious and aesthetically pleasing environment while at the same time providing practical low-maintenance solutions to a wide range of landscape problems.

Brickwork possesses a versatility that facilitates visual continuity, while its impact can range from discreet to dramatic. In addition to the innumerable construction possibilities there is a wide range of colour, texture and size options available. Brick has an underlying ability to harmonise with natural elements and materials and is particularly useful in the landscape setting.

Most garden and landscape structures will be subjected to extremes of exposure and therefore the materials and workmanship should be of high quality. This is particularly necessary in instances where the structural integrity must be maintained indefinitely as is the case with earth retaining walls and fences. In landscape applications it is desirable to use only hard fired bricks with a reputation for resistance to salt attack. While second hand bricks may give a rustic effect to a landscape not all bricks are resistant to salt attack and may not be suitable for use in landscaping.

The need for good materials, workmanship and planning notwithstanding, there will be many instances in which the user may not be unduly concerned to produce structures that are impervious to the passage of time. Moderately imperfect surfaces and the growth of creepers can soften brickwork and provide an antique appearance that can be most attractive.

This technical note draws attention to some of the essential aspects of brickwork, many of which are frequently overlooked, but it has been assumed that the reader is familiar with the handling of bricks and mortar. For those who are not it is recommended that you attend a course in bricklaying or paving before attempting projects of any magnitude.

2. Brickwork Basics

2.1 Preparation and Planning

Time spent on preparation and planning is an investment that will pay during the construction stage and in the outcome of the project. Particular attention should be given to the characteristics of the foundation soil, the degree of exposure to wind, sun and rain, and the natural drainage of the site. Many otherwise good brick structures have been spoiled by a lack of attention to such considerations, particularly the adequacy of the footings. (If a qualified tradesman is not carrying out the construction of footings and brickwork it is recommended to seek advice from a qualified person regarding the design of the footing.)

The problems associated with footings usually result from heave or shrinkage caused by moisture reactive soils or the activity of tree roots. Soils that produce cracking in brickwork are the “dry” clay types which exist in nature in a condition of moisture deficiency. When they gain or lose water they change their volume and fairly predictable seasonal changes can be observed. Trees that draw large quantities of moisture can cause localised downward foundation movement and it is therefore advisable to determine the relevant characteristics of their root activity if trees are to be in the proximity of brickwork.

2.2 Setting out footings and brickwork

The footings and brickwork should not be constructed without careful preparation. The use of profile boards and string lines is a simple method of controlling the accuracy of the structure and is well suited to those with a limited experience in bricklaying.

Profile boards consist of stakes driven into the ground with crossbars fixed to them at a known height. Nails are driven into the top surface of the crossbars representing the faces of the brickwork and footings. String is stretched between the nails and a spirit level is then employed to locate the position and height of the structural elements. The base of footings should be set at a depth removed from seasonal moisture changes, generally not less than 450 mm below natural grade level.

Once the required finished height of the brickwork has been decided, the height of the top surface of the footing can be calculated allowing for full courses of brickwork. If the foundation slopes, the footing can be stepped. Each step should be equal to a full number of brick courses. All excavations should be clean and contain no loose earth or free water and steel reinforcement should be securely fixed prior to pouring of concrete and have a minimum cover of 65 mm.

2.3 Mortar and bricklaying

Care should be taken when mixing mortar to ensure that the correct proportions are achieved and that foreign matter does not contaminate the mix. The cement and lime should be kept in good condition under cover and not in contact with the ground.

The sand should be carefully selected to be free from excessive clay (maximum 10% -75 micron), earthy matter and the presence of soluble salts. The mortar ingredients should be measured by volume in a convenient container like a bucket and if mixing is to be done manually, they should be thoroughly mixed prior to the addition of water. The mortar should be used in a condition as plastic as is practicable.

Most modern bricks are low in suction and need not be wetted before laying. Where brick suction is unusually high, as will be indicated by the mortar stiffening too quickly for easy bricklaying, pre-wetting of the bricks can be helpful. As the bricks are laid the excess mortar should be struck from both sides of the brickwork throughout the bricklaying process.

Never move a brick after it has been in position for more than a few seconds as this will destroy the bond. New brickwork should be protected from the rain and sun until it is 24 hours old.

2.4 Basic footing construction and bricklaying procedure

Step 1 Allow sufficient space between the profile board and the trench for room to work. With concrete footings it is useful to drive a peg into the bottom of the trench to fix the level of the top of the footing. Steel reinforcing bars should be placed prior to the pouring of concrete and be supported at the required height by bar chairs.

Step 2 Spread a layer of mortar about 12 mm thick at each end (or corner) of the footing and place the first brick in position using the spirit level to ensure that it is exactly below the crossing of the string lines.

Step 3 Wherever possible the brick structure should fit brick dimensions and be laid to the nearest half brick in length, width and thickness. Lay out the second and subsequent bricks using a gauging rod to check that the bond is maintained.

Figure 1. Set out

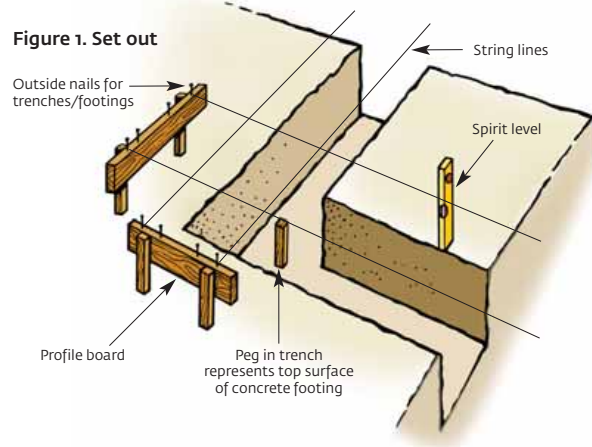


Figure 2. Footing

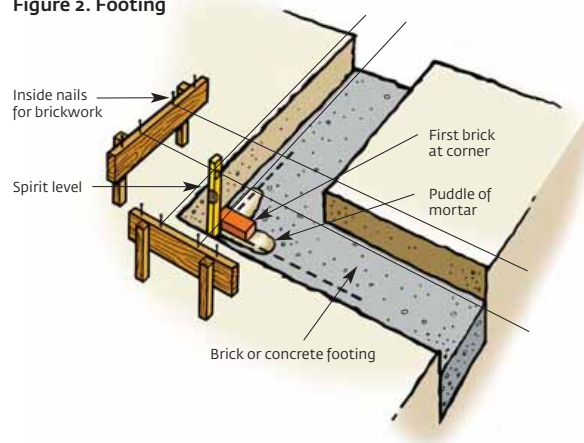
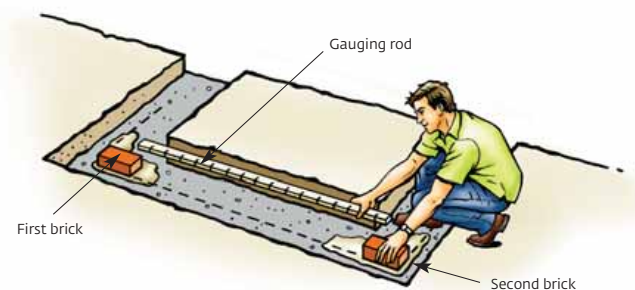


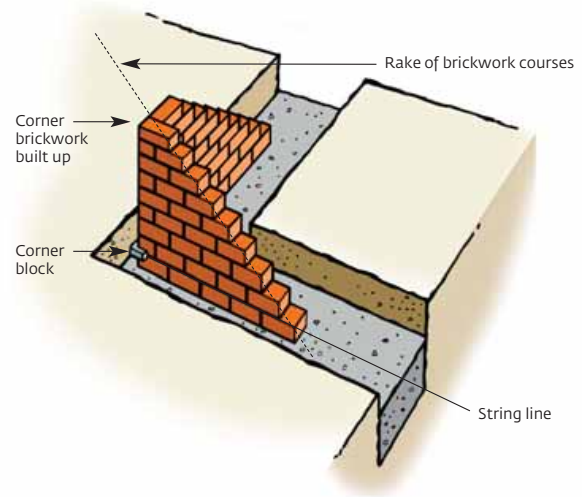
Figure 3. Gauging first course brickwork



Step 4 Build up the corners first by laying five bricks at each wall end. Level them and check the perpend for distance. Build the bricks up in courses, each course being racked back as illustrated.

Continually check the perpend, the rake and the plumb of the brickwork. When the ends are found to be true, stretch the string line between the corners using corner blocks and complete a full course at a time. The string should not be too long or slack otherwise it will sag. An intermediate section can be built up to which can be attached a plate to support the line (called a tingle plate). The operation is repeated until the required height is reached.

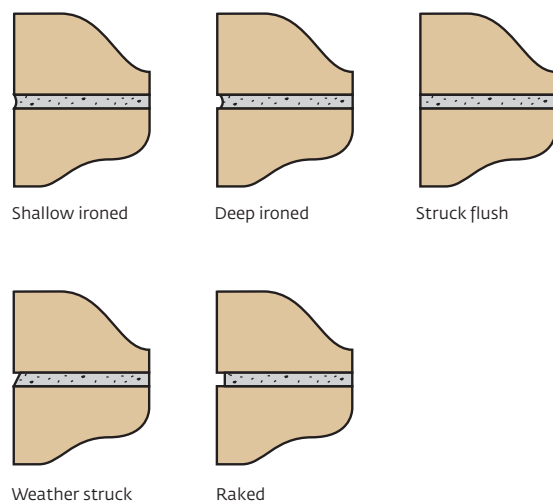
Figure 4. Building up corner brickwork



Joint finishes

The type of jointing employed in brickwork can play a considerable part in determining its finished appearance. It is advisable to study as many built examples as possible as there are many combinations of brick and joint colour, size, pattern and texture, and not all of the results are readily foreseen. For example, the shadows of recessed joints are not only much more obvious with light coloured bricks but are also much stronger on rain-washed mortar while the horizontal joints become dirty. Jointing will also exaggerate or diminish the precision with which bricks are made. The use of recessed joints plus mortar of similar colour as the bricks will disguise slight irregularities while flush joints in light mortar will emphasise them. Light colour mortars generally reduce the apparent size and the effect of the texture of the brick. Dark mortars tend to emphasise these qualities.

Figure 5. Common mortar joint finishes



3. Walls and Fences

3.1 Unreinforced brick fences

To comply with the relevant codes unreinforced pier and panel construction becomes inadequate in most circumstances. This is because the piers only effectively resist wind loads applied to the opposing wall face. Reinforced piers are an economical solution to this problem but a simple alternative is the “staggered” wall.

In this context it is worth noting that the twin leaf staggered walls occupy relatively little space and use less materials than conventional pier and panel walls.

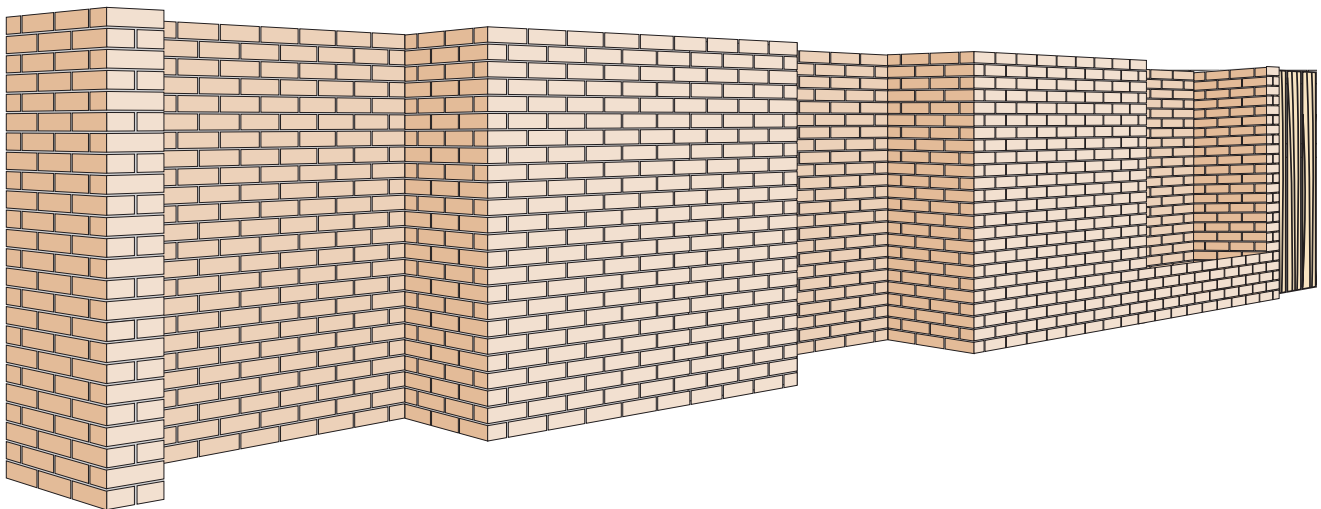
Twin leaf walls have an advantage over single leaf

walls in that they are better proportioned and can provide perfect faces on both sides. This is often difficult to achieve with single leaf walls.

Table 2 gives the required layout and dimensions of staggered walls of various thickness up to 2000 mm in height. These wall designs are suitable for exposure to winds of up to N1 wind class.

At the free ends, the wall panel should either be half the normal length, or it will require a substantial buttress (Table 2), protruding the same depth as the return.

Figure 6. Typical single-leaf staggered brick fence



1. The coping unit should shed rainwater clear of the wall by at least 12 mm.

2. A damp-proof course should be provided beneath the coping unit or last course of brickwork.

3. Twin leaf walls must be bonded through the wall at least one course in six or alternatively be tied together with metal wall ties with a cross sectional area of not less than 30 mm at 600 mm centres horizontally by every third course vertically.

Mortar throughout the wall should not be weaker than 1:1:6 cement:lime:sand.

Only bricks with a low level of permanent moisture expansion (less than 1.2 mm/m) are suitable for use in staggered walls. The designer must ascertain the 15-year permanent expansion value (e_m) of the brick to be used and provide control gaps in accordance with Table 1.

4. The control gaps must be located exactly mid span between the returns (stagger) in the panels and allow for a closing movement of 15 mm with a final width of at least 5 mm. In other words the constructed width should be 20 to 25 mm.

5. A mortar DPC not weaker than 1:3 cement:sand should be provided at about 150 mm above finished grade.

6. Footings should be level and include steps if the ground slopes.

Figure 7. Design and construction considerations for staggered brick fence

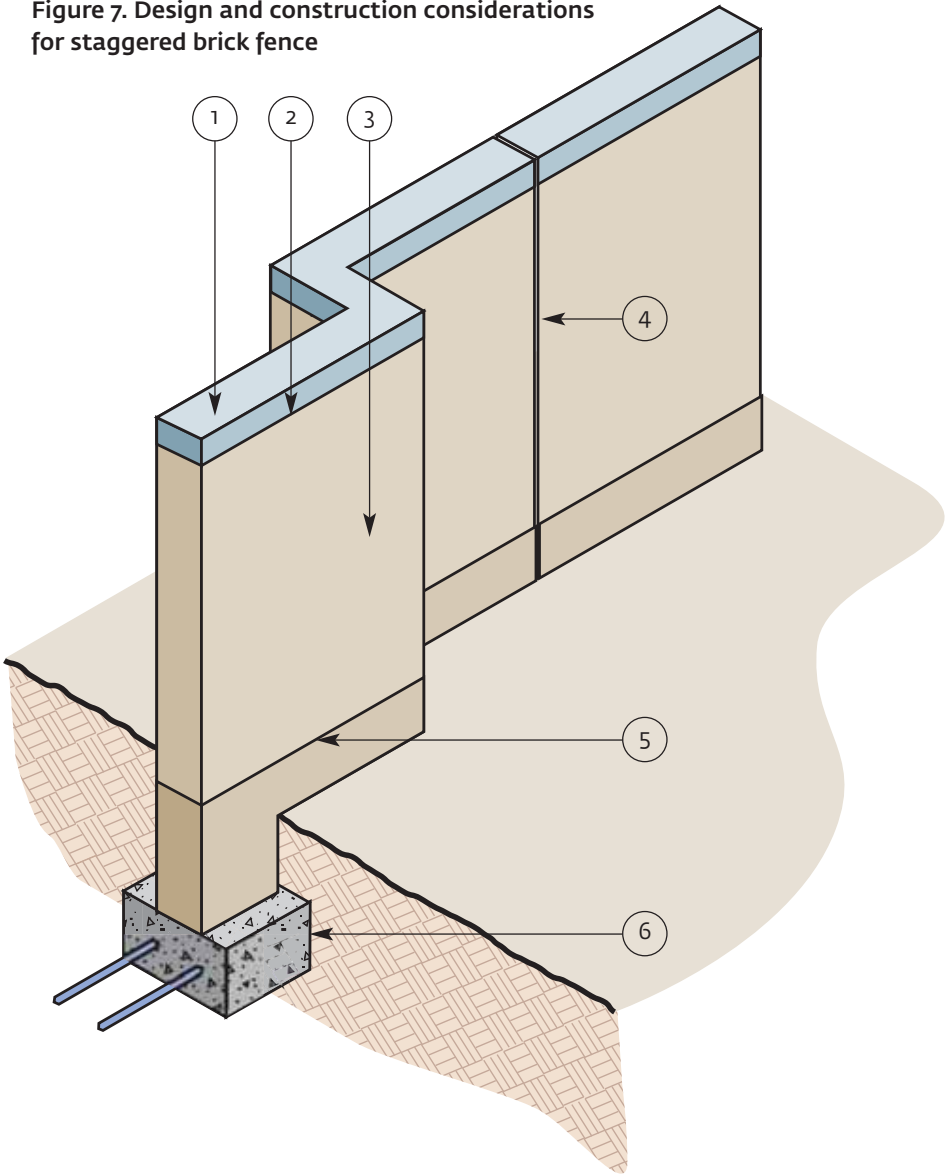
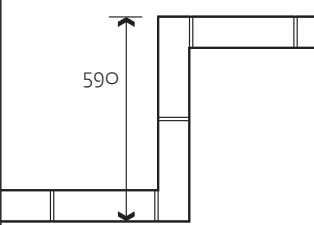
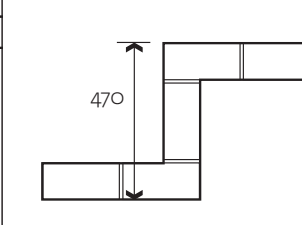
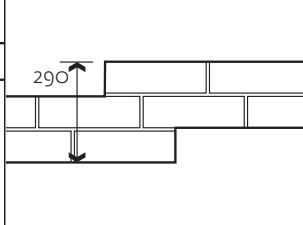
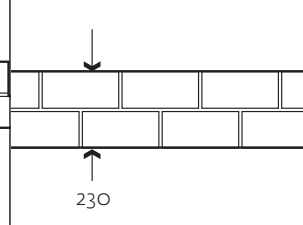
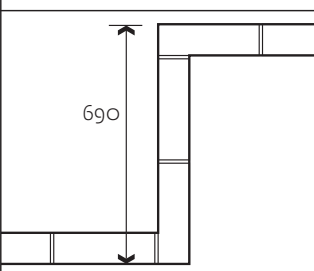
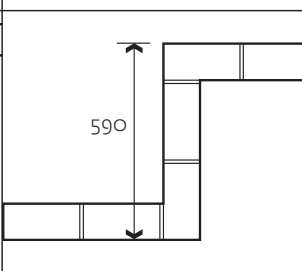
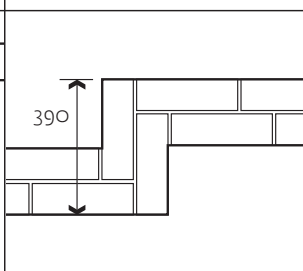
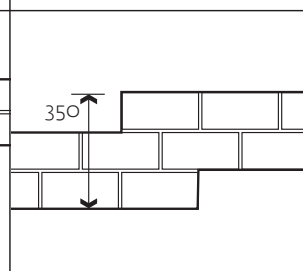
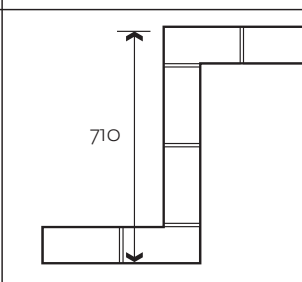
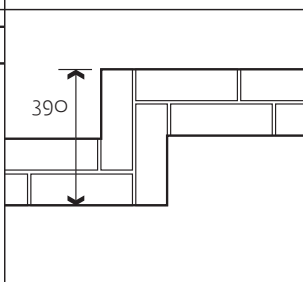
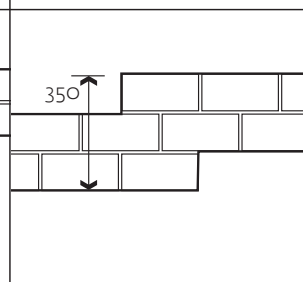
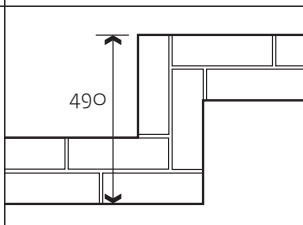
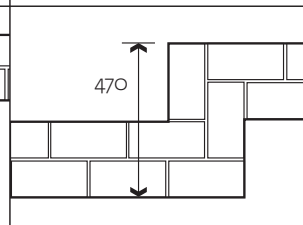
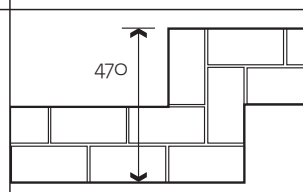
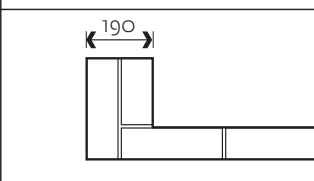
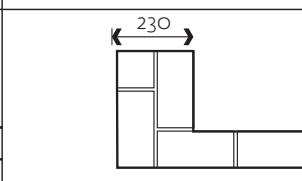
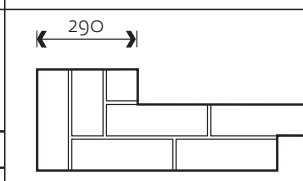
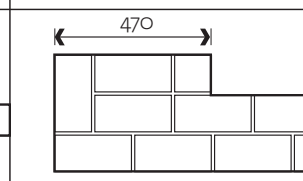


Table 1. Spacing of control gaps in staggered walls

e _m 15 year permanent expansion (mm/m)	Depth of return	
	Not greater than wall thickness (m)	Greater than wall thickness (m)
0.4	23.0	11.5
0.8	16.0	8.0
1.2	12.0	6.0

Table 2. Specification of staggered walls

Spacing of returns (mm)	2200	2700	4700	5700
Thickness of wall (mm)	90	110	190	230
Wall height 900 mm				
Wall height 1200 mm				
Wall height 1500 mm	N.A.			
Wall height 1800 mm	N.A.	N.A.		
Wall height 2100 mm	N.A.	N.A.	N.A.	
Thickness of buttress at wall end (mm)				

3.2 Low earth retaining walls

3.2.1 Introduction

Low earth retaining walls are a common requirement in landscape architecture. They are used to form the edges to paved areas, retain earth at driveways, to form terraces and maintain cuttings. All retaining walls over 600 mm in height should be designed by a qualified engineer.

3.2.2 Introduction

In general, small retaining walls should be designed and constructed on the following basis.

- i. The surface of the back fill is horizontal.
- ii. The soils retained are non-cohesive and not of the moisture reactive type.
- iii. Brickwork and reinforcement complies with AS3700-2018, The Masonry Code.
- iv. The back of the wall must be rendered or covered with moisture penetration barrier, weep holes should be provided at approximately 1200 mm centres at the base of the wall.
- v. The back of the wall must be lined with a minimum thickness of 300 mm of porous backfill.
- vi. Only bricks classified Exposure Grade that are resistant to salt attack should be used, together with an M4 mortar.

3.2.3 Construction

The base of the footing must be at a depth free from seasonal moisture changes and must provide a firm foundation with a minimum bearing capacity of 75 kPa. All excavations should be clean and contain no loose earth or free water.

Unless otherwise specified by the designer, the reinforcing mesh should have a minimum cover of 65 mm in the footings and 20 mm from the internal face of the brickwork. It should be accurately positioned, straight and be free of rust or other contamination that may reduce the bond of the concrete or grout.

The brickwork must be accurately laid using a string line and be plumbed level with all mortar joints completely filled. Joints should not be greater than 13 mm in thickness.

The cavity must be kept clear of mortar droppings and mortar squeezed out into the inside should be cut off flush and removed as the brickwork proceeds.

The wall should be provided with a coping unit beneath which a damp proof course is placed. The coping unit (or the damp proof course) should shed rainwater clear of the wall face by not less than 12 mm.

The earth in front of the base of the wall should be protected to prevent water accumulating there and softening the foundations.

4. Paving

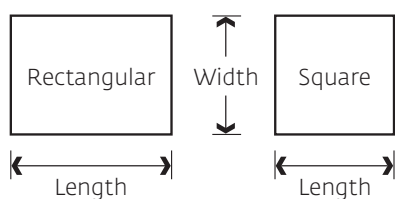
4.1 Calculating areas for paving

4.1.1 Introduction

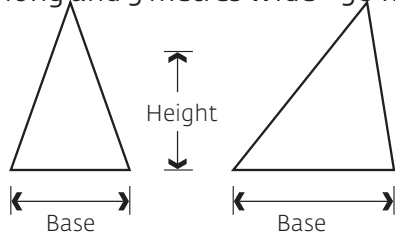
Clay paving around the house is increasingly popular with do-it-yourselfers. Unlike house bricks which are generally sold by the thousand, clay pavers are generally sold by the square metre (usually shortened to m²). This section will enable you to accurately calculate the areas to be paved.

4.1.2 Back to basics

Most areas are one or another (or a combination) of three basic shapes: rectangles (including squares), triangles and circles.

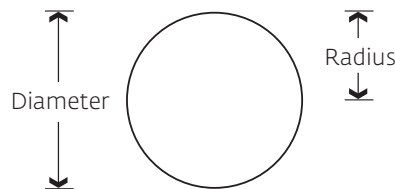


The area of a rectangle (or a square) = length x width. For example: an area of 10 metres long and 5 metres wide = 50 m².



The area of a triangle = half the width of the base x height. For example: a triangle with a base 10 metres wide and a height of 8 metres = 5 x 8 metres = 40 m².

Circle



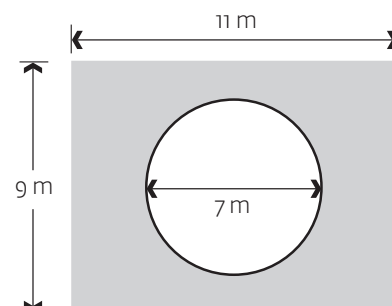
The area of a circle = πr^2 or multiply the circle radius by itself and multiply the result by 3.14 (the radius is half the diameter). For example: a circle with a diameter of 5 metres (and therefore a radius of 2.5 metres) = $2.5 \times 2.5 \times 3.14 = 19.6 \text{ m}^2$.

4.1.3 Putting the theory into practice

Always order a few more pavers to allow for the occasional breakage and for those which need to be cut. Allow more cuts if the area to be paved is irregularly shaped. After the pavers have been laid store a few spares to allow for future replacements.

The staff at your local clay brick and paver display centre will be able to help in estimating the number of extras you are likely to need.

Example 1: A rectangular area with round pool



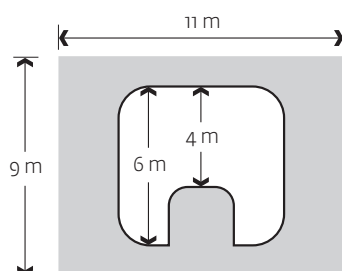
This is simply a rectangle with a circle missing. Measure the length and width of the area to be paved and the diameter of the pool. Use these to make two calculations.

Total area (including pool) = length x width = $9 \times 11 = 99 \text{ m}^2$

Area of pool = radius x radius x 3.14 = $3.5 \times 3.5 \times 3.14 = 38.5 \text{ m}^2$

Area to be paved = Total area – area of pool = $99 - 38.5 = 60.5 \text{ m}^2$

Example 2: A rectangle area with an irregular pool



Measure the length and width of the area to be paved. Measure the length of the pool and the two widths shown.

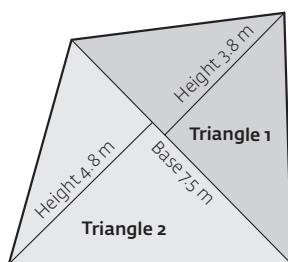
Average width of pool = (widest + narrowest) divided by 2 = $(6 + 4) \div 2 = 10 \div 2 = 5$ metres.

Approximate area of pool = length x average width = $9 \times 5 = 45 \text{ m}^2$

Area to be paved = Total area =
Area pool = $99 - 45 = 54 \text{ m}^2$

Note this calculation is only approximate – allow extra pavers.

Example 3: An irregular area, treated as two triangles

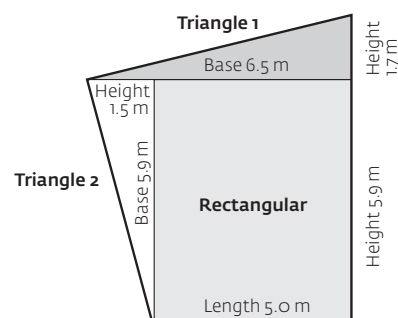


Area of triangle 1 = (half width of the base) x height = $(7.5 \div 2) \times 3.8 = 3.75 \times 3.8 = 14.3 \text{ m}^2$

Area of triangle 2 = $(7.5 \div 2) \times 4.8 = 3.75 \times 4.8 = 18.0 \text{ m}^2$

Area to be paved = $14.3 + 18.0 = 32.3 \text{ m}^2$

Example 4: An irregular area, treated as a rectangle and two triangles



Area of rectangle = length x width = $5.0 \times 5.9 = 29.5 \text{ m}^2$

Area of triangle 1 = (half width of the base) x height = $(6.5 \div 2) \times 1.7 = 3.25 \times 1.7 = 5.5 \text{ m}^2$

Area of triangle 2 = (half width of the base) x height = $(5.9 \div 2) \times 1.5 = 2.95 \times 1.5 = 4.4 \text{ m}^2$

Area to be paved = rectangle + triangle 1 + triangle 2 = $29.5 + 5.5 + 4.4 = 39.4 \text{ m}^2$

4.2 Laying clay pavers

4.2.1 Introduction

The method described here is suitable for clay brick paving around the house, such as paths, patios and driveways on a gentle slope. However it may not be suitable for driveways on a steep slope or for commercial paving.

4.2.2 Tools and equipment

You will need these tools:

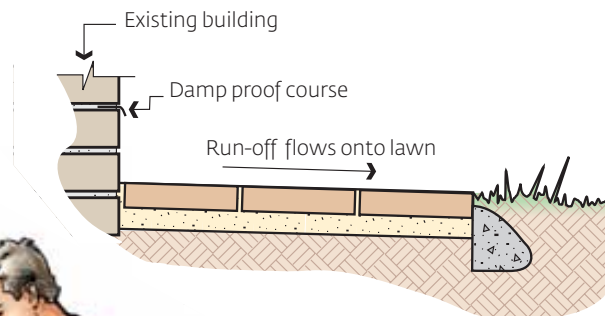
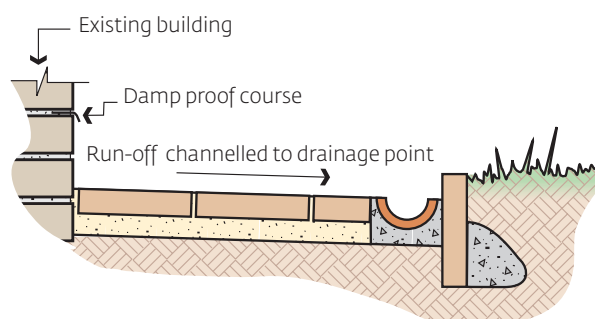
- tape measure
- barrow
- spade
- garden rake with metal prongs
- ball of string
- line level
- screeding bar, about 3 m long
- two screeding rails (metal strips, each about 2 mm x 50 mm x 3 m. Alternatively, use rails of straight timber, water pipe, electrical conduit etc
- yard broom
- garden hose
- rubber mallet
- length of hardwood, about 50 mm x 100 mm x 1.8 m

You will probably need to hire a vibrating plate compactor for a couple of days. Compacting the bedding sand and roadbase (where used) is the key to a strong pavement. Alternatively make a hand compactor using a 75 x 50 mm hardwood handle and head no bigger than 300 x 150 x 50 mm.

4.2.3 Drainage is important

Rain water must flow off the finished pavement and away from buildings. For this reason, the pavement must not be perfectly flat, but should slope a little (about 15 mm per metre). If the pavement is against the side of the house, the pavers must be below the damp-proof course. Never bridge damp-proof courses or air vents.

Figure 8. Typical drainage details



4.2.4 Base construction

Figure 10 illustrates the cross-section of a finished pavement subject to vehicular traffic, high rainfall or poorly drained soil.

Excavate the soil to a reasonably constant depth. Completely remove all weeds and grasses. For pedestrian traffic on well drained soil the bedding sand will be about 30 mm thick after being compacted.

Compacting is the process of packing the loose layers of the pavement. This gives a firm base which will support heavy loads. Failure to properly compact the bedding sand and roadbase (where used) may cause the pavement to subside.

The roadbase may need to be compacted in layers as most compactors are not powerful enough to compact the full thickness.

For small areas make a hand compactor as discussed previously. Keep the head small to ensure maximum impact and overlap to compact the area thoroughly.

The next step is to level the bedding surface. This is called screeding. It is advisable to compact the sand using a vibrating plate compactor prior to laying. Set up a stringline along one edge. Place a line

level on the string-line to ensure it slopes in the desired direction. Bed pavers to the correct finished surface level at intervals along the string-line. Remove the pavers to reveal the correct level of the bedding sand.

Repeat this process to create 'stepping stones' (or reference levels) over the area.

Use the screeding bar to level between the 'stepping stones' and create parallel tracks. Place screeding rails in two tracks and screed between the tracks. Repeat this over the whole area. If you are using timber or water pipe for screeding rails, don't forget to fill in the ruts in the sand left by the screeding rails.

Figure 9. Typical cross-section for pedestrian pavement on well-drained soil

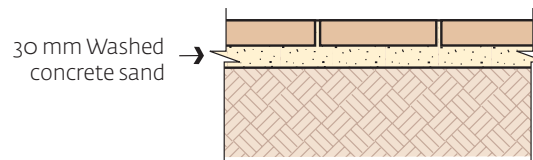


Figure 10. Typical cross-section for vehicular pavement in high rainfall area or poorly drained soil

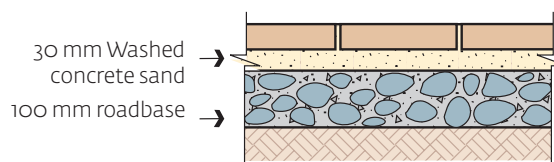


Figure 11. Use of stringlines

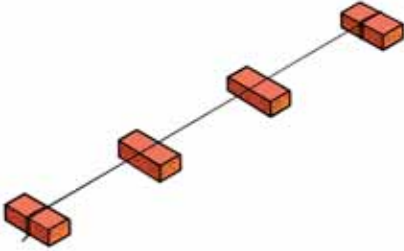


Figure 12. Use of reference levels

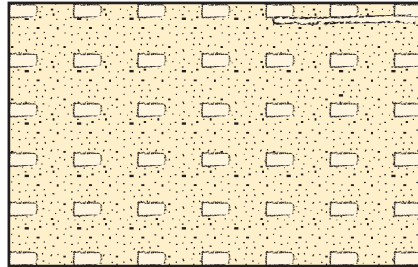
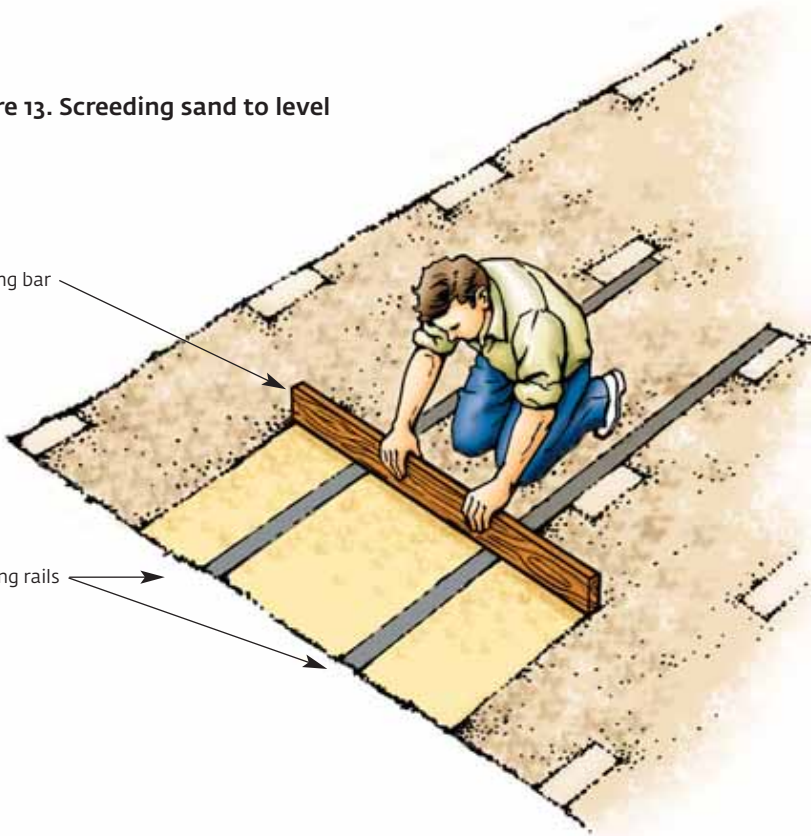


Figure 13. Screeding sand to level

Screeding bar

Screeding rails



4.2.5 Laying pavers

Clay pavers, being made from natural minerals, vary slightly in size.

If you do not allow for this size variation, the pattern of the pavement may not stay in line. The best way to regulate the pattern is to use a grid of stringlines spaced at exact intervals. It sounds complicated, but it's really very simple and will save work in the long run.

First, you need to determine the average width of your pavers. Select 20 pavers at random, place them tightly, side by side and measure their overall width.

Divide this figure by 20 to get an average width

Add 2.5 mm to this average width (to allow for the joint between the pavers) and multiply that figure by eight (for eight pavers). This is the spacing for the grid of stringlines.

For example, if the average paver width was 112.5 mm, the grid spacing would be 920 mm ($112.5 \text{ mm} + 2.5 \text{ mm} \times 8 = 920 \text{ mm}$).

Place pavers between key pavers leaving a gap of two to three mm. Pavers must not touch.

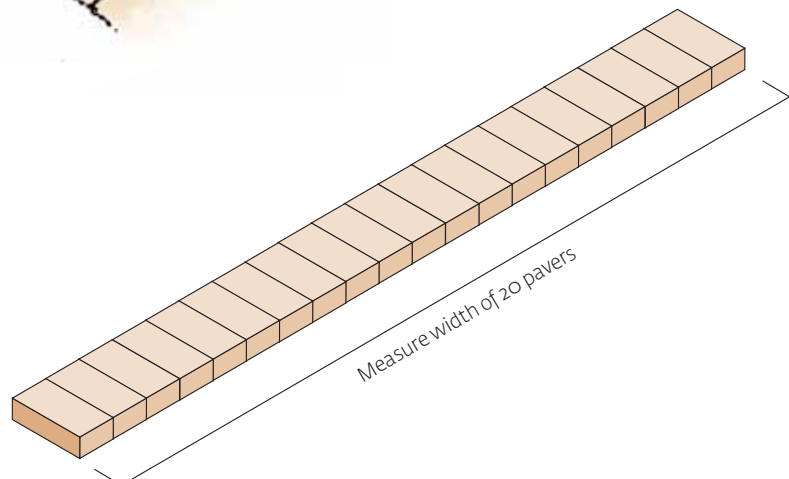
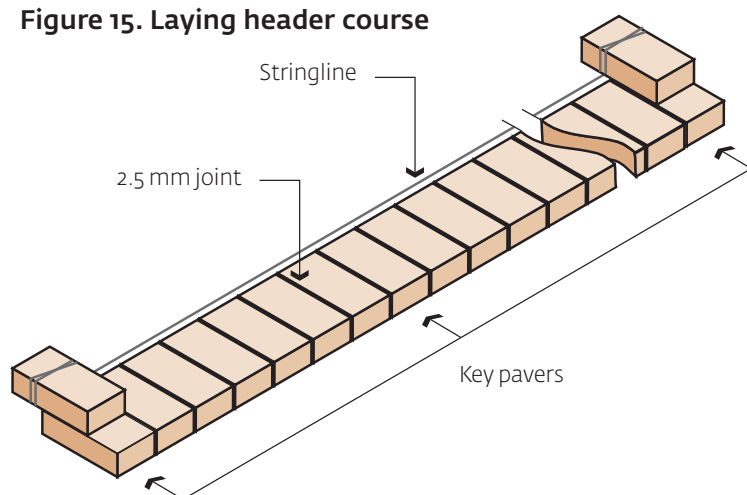


Figure 15. Laying header course



The header course is the row of pavers along the edge of the pavement. They give it a strong, neat edge. The first header course may be placed along an existing straight edge such as a concrete path or the wall of the building.

If there is no straight edge, set up a stringline where the first header course is to be located.

Place a tape measure along this edge and place 'key pavers' at the grid spacing calculated in the previous section.

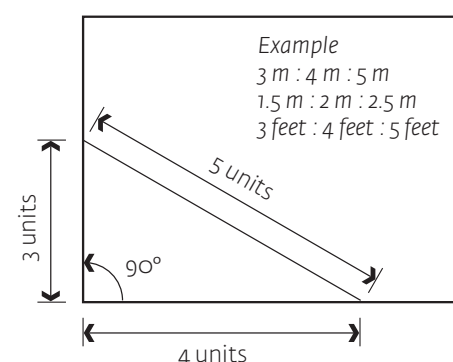
Now you can set out the other header courses. Depending on the area being paved, it may not be necessary to have a header course on all sides.

As appropriate, position other stringlines around the perimeter. Use the ratio of 3:4:5 to determine squareness.

Set out key pavers on other edges at grid spacing intervals as calculated from average paver dimensions.

Place pavers between key pavers. Again, leave a gap of about 2.5 mm and ensure pavers do not touch.

Figure 16. Determining squareness

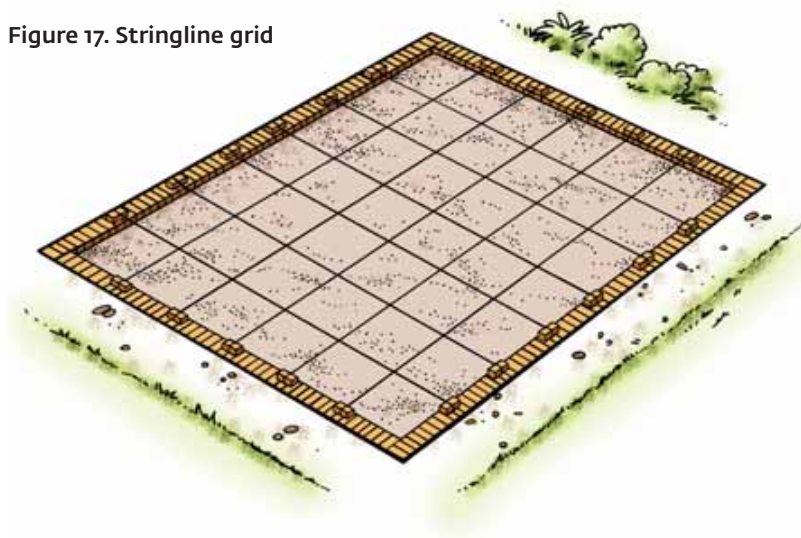


Position the stringline from opposing key pavers (that is every eighth paver). Repeat this over the whole area.

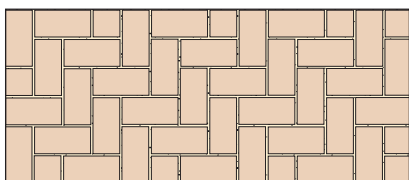
Figure 17 shows how the finished grid should look:

Clay pavers can be laid in many different patterns (called 'bonds'). Unlike shaped pavers, the only limit is your imagination. Figure 18 shows some popular bonds: Figure 18. Popular paving patterns 90° Herringbone is very attractive and strong and looks more complicated than it really is.

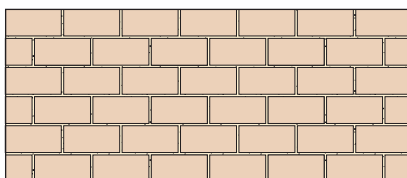
Figure 17. Stringline grid



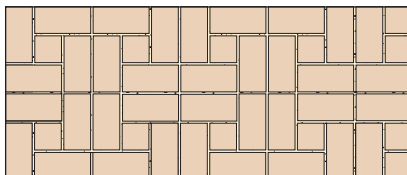
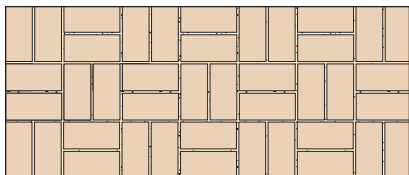
Stretcher is very good for paths.



Basketweave is simple to lay and usually needs less cutting.



Tracery is attractive and easy to lay but requires more cutting.

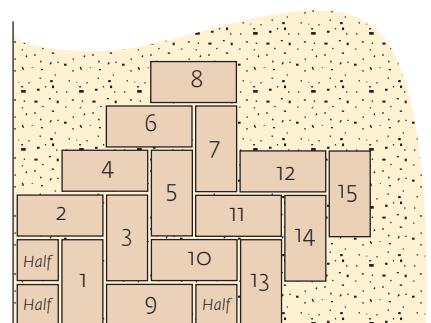


Laying clay pavers is a matter of developing a routine and working between the string lines. Start from one corner so you don't walk on the prepared sand bed.

Work to the stringlines. If the paver does not line up with the stringline go back to the previous line and relay the pavers.

Develop a system for laying the pavers. Shown here is a simple way to lay a herringbone pattern.

Figure 19. Laying herringbone paving pattern



4.2.6 Cutting, sanding and edge restraints

Most paving patterns require some cutting. Most clay pavers are very hard and can only be cut cleanly with a diamond saw.

You can hire a diamond saw by the day (wear protective equipment and be very careful when using it!) But the easiest method is to mark the pavers you want cut and take them to a brick-cutting service. (Check the Yellow Pages or the trades directory in your local newspaper). Cut pavers should be no smaller than one-third of the paver if the cut is cross-ways or one-quarter if the cut is on an angle. If the section to be filled is smaller than this, cut a neighbouring paver to allow for a larger area.

Now that they are all in place, check that the lines of pavers are straight. Use the tip of the trowel or screwdriver to adjust any pavers not in line.

Spread jointing sand carefully over the pavers and sweep it into the joints until they are full of sand.

Edge with a timber support or lay a concrete haunch at 45degrees along any unsupported edges. Compact the pavers into their final position using a rubber mallet and a length of timber.

Once the area is compacted it may be necessary to sweep extra jointing sand into the joints working it in with a broom, then lightly hose the area to finish.

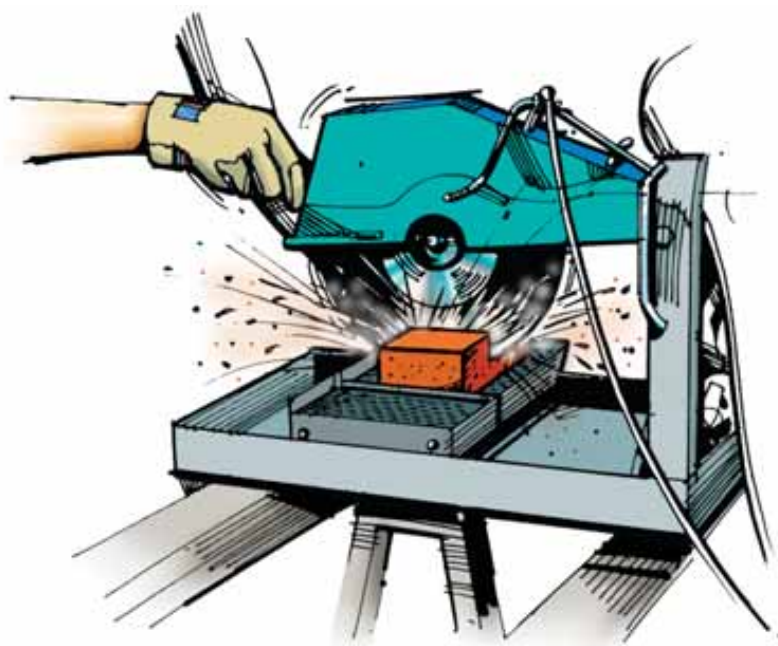
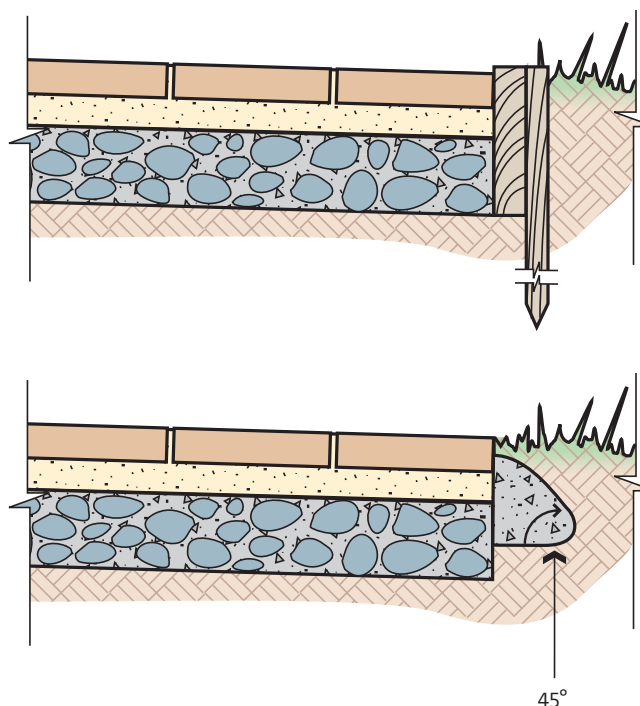


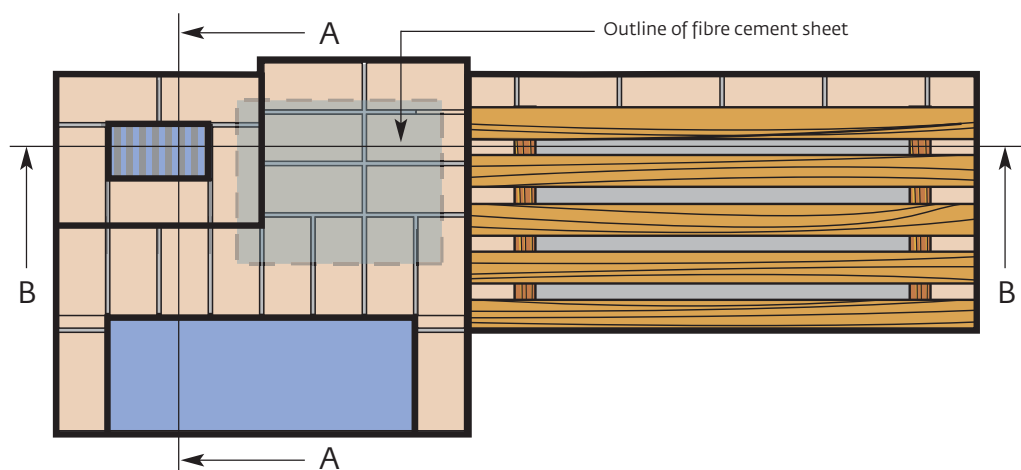
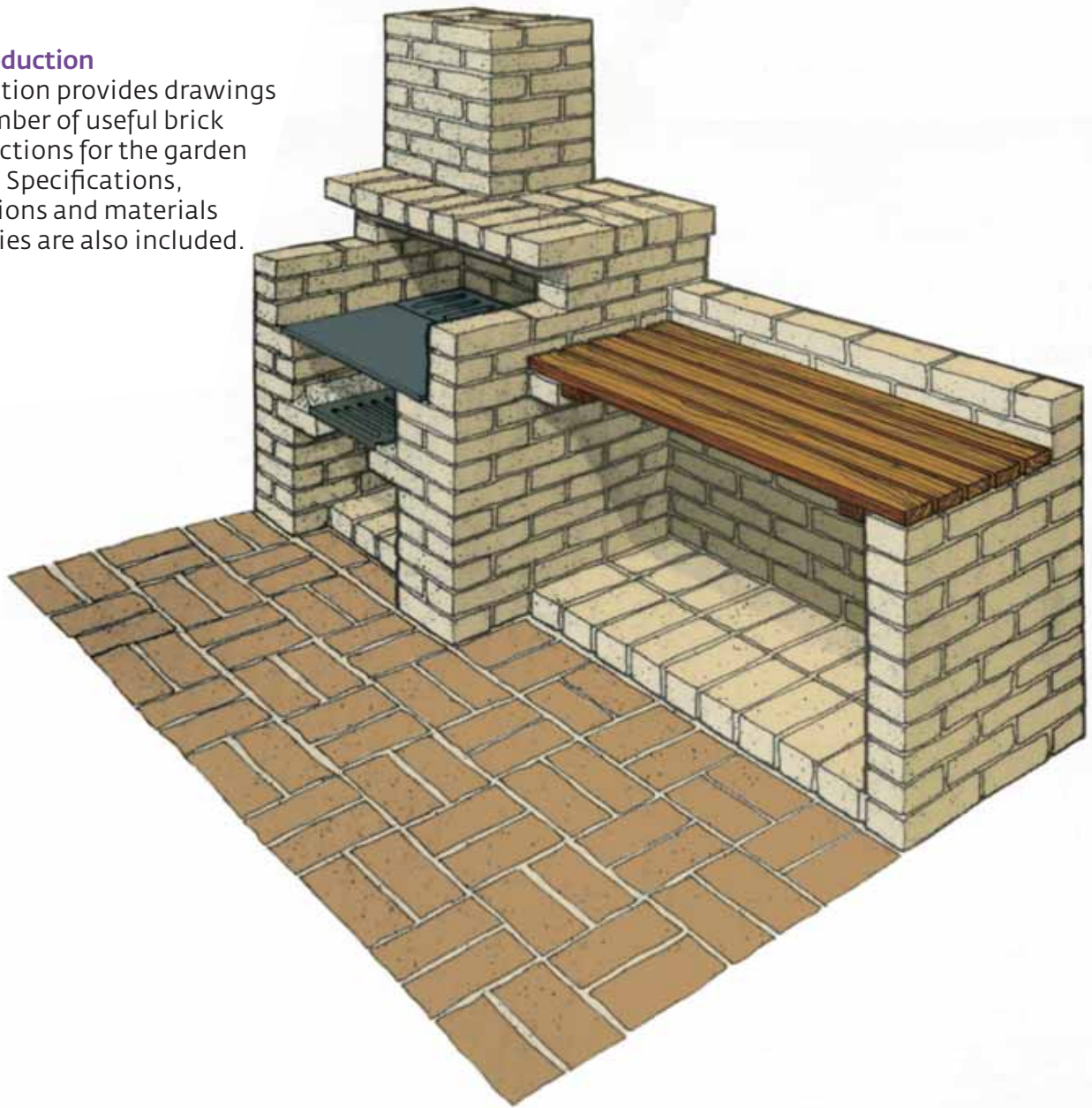
Figure 20. Typical edge restraints



5. Architectural furniture

5.1 Introduction

This section provides drawings of a number of useful brick constructions for the garden setting. Specifications, dimensions and materials quantities are also included.



5.2 Brick barbecue

The drawings should be followed as closely as possible to keep the number of cut bricks to a minimum. Please note:

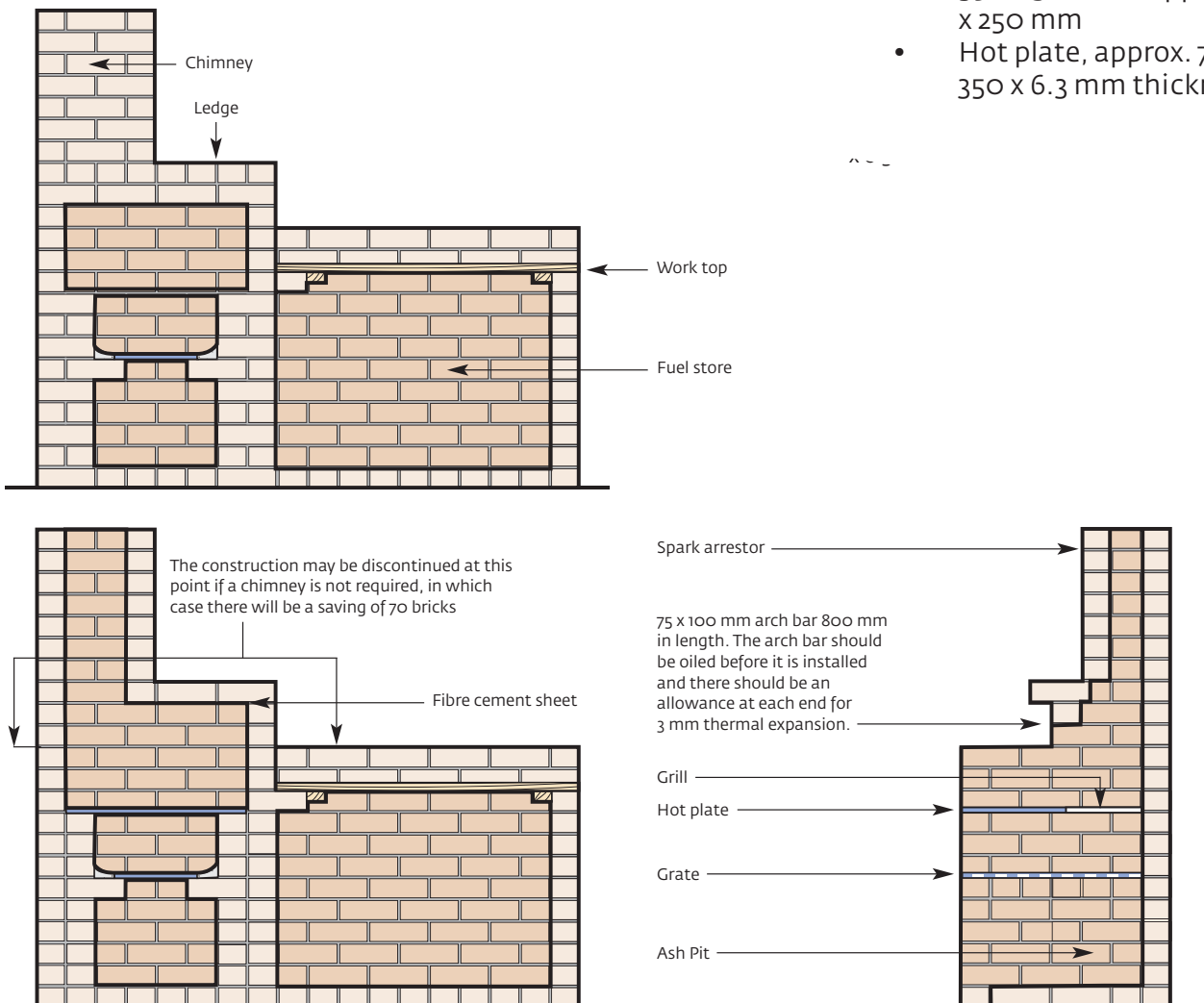
- 1) It is advisable to use solid bricks or pavers in the fire box and chimney.
- 2) Some clearance should be provided around iron members to allow for thermal expansion.
- 3) Timber should be western red cedar, preserved pine, jarrah or other durable timber.

Quantities

Bricks:

- Brickwork above ground as shown
- One course below ground plus brick-on-edge footings (not shown)
- Brick paving as shown
- Mortar (1:1:6) for 550 bricks:
- Sand: 0.26m³ — say 1/3 m³
- Cement and lime: two bags each
- Grate and hot plate:
- Cast iron grates (2) approx. 590 x 300 mm approx. 700 x 250 mm
- Hot plate, approx. 700 x 350 x 6.3 mm thickness

Figure 21. Typical brick barbecue, plan, front and side elevations



5.3 Fly-proof compost bin

Compost is formed from decayed vegetable matter and is of considerable benefit to the garden.

Unfortunately it is in decaying matter that flies breed and therefore every gardener should have a fly proof method for the disposing of biodegradable waste. Lawn cuttings in particular are a major source of flies.

The compost bin illustrated is not only fly-proof, but is designed to facilitate the composting process and to provide permanent utility. The holes at the base of the bin give access to the finished compost.

The front section not only accommodates the soil required in the composting process but prohibits flies from gaining access. The floor of the bin is bare earth to provide access for worms to the contents, thus enhancing the process considerably.

Notes:

- i. Good fertile soils contain soluble salts and a permanent encrustation of efflorescence is likely to occur. It is important to use hard fired bricks for compost bin construction.
- ii. Mortar specification, 1:0.5:4.5 cement:lime:sand.
- iii. It is good practice to render the inside of the bin with a 1 cement: 3 sand plaster.
- iv. Always ensure that the lid is replaced after use and that there is adequate soil in the front section to keep flies out of the bin interior.

A 12 mm layer of 1:3 cement:sand mortar should be placed on the internal ledge and be covered with a plastic film. The fibre cement sheet can then be pressed into position to form a good seal.

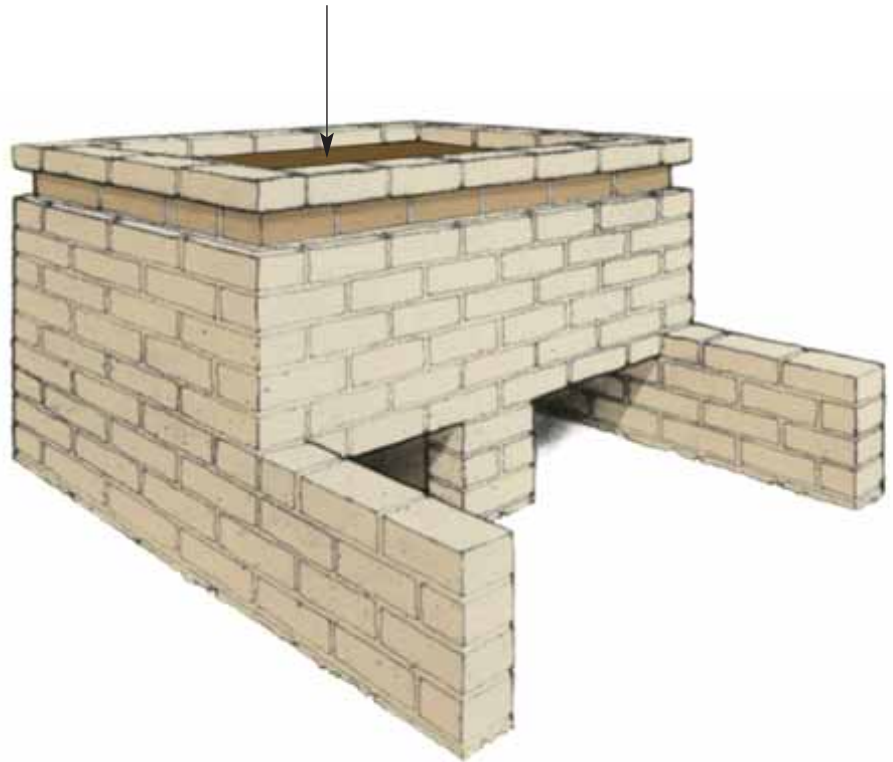
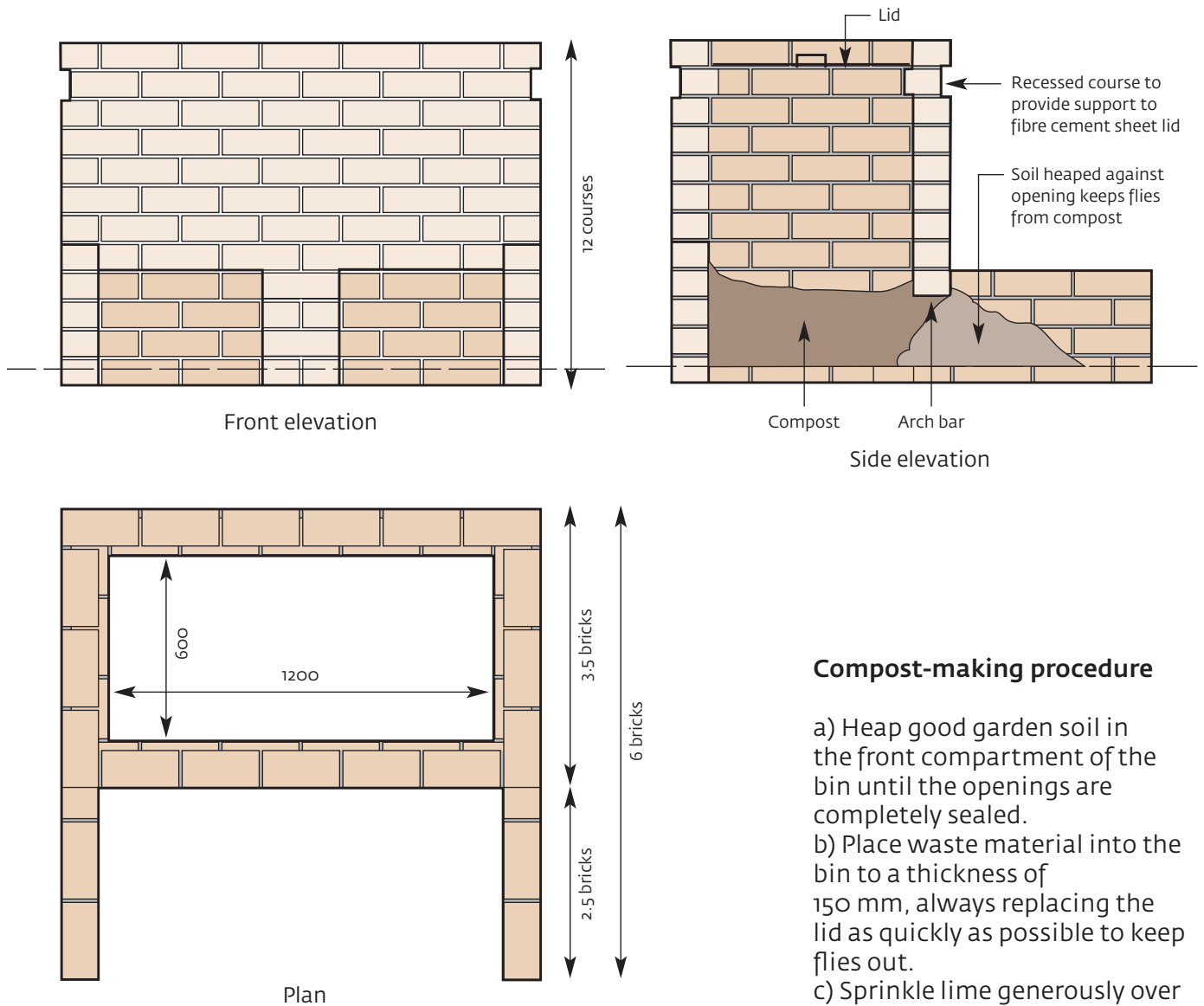


Figure 22. Plan and elevation of typical brick compost bin



Compost-making procedure

- Heap good garden soil in the front compartment of the bin until the openings are completely sealed.
- Place waste material into the bin to a thickness of 150 mm, always replacing the lid as quickly as possible to keep flies out.
- Sprinkle lime generously over the 150 mm layer of waste and add a layer of animal manure 25 to 50 mm in thickness. A nitrogenous fertilizer can be substituted for the animal manure.
- Cover the contents of the bin with 25 to 50 mm of soil and repeat the process continuously. Finished compost can be removed from the bottom access of the bin after about two to three months.

5.4 Garden Steps

5.4.1 Design considerations

Changes in ground level occur in most gardens and steps can be used to answer both functional needs and also to provide dramatic emphasis. Steps that are easy to use have a mathematical relationship between the riser (tread height) and the going (tread depth). Shallow risers should be accompanied by a deep going and large risers should have a short going.

The formula used to determine the steps in Figure 23 is: twice the riser (height) + the going (width) = 680mm. The gradients of Designs 1 to 4 are:

1. 1 in 5.5 (10°)
2. 1 in 3.7 (15°)
3. 1 in 2.0 (25°)
4. 1 in 1.3 (37°)

Steps that are much steeper than 37 degrees are difficult to climb. Long straight flights of steps should be avoided and consideration should be given as to whether or not a handrail is required.

5.4.2 Construction

Step 1 Roughly cut the foundations to the profile of riser and going with the cut moved along and down by one complete step. The steps should not be built upon loam or fine non-cohesive soils or where water is expected to collect. In these instances the steps should be built upon a continuous reinforced concrete base to eliminate the risk of slippage.

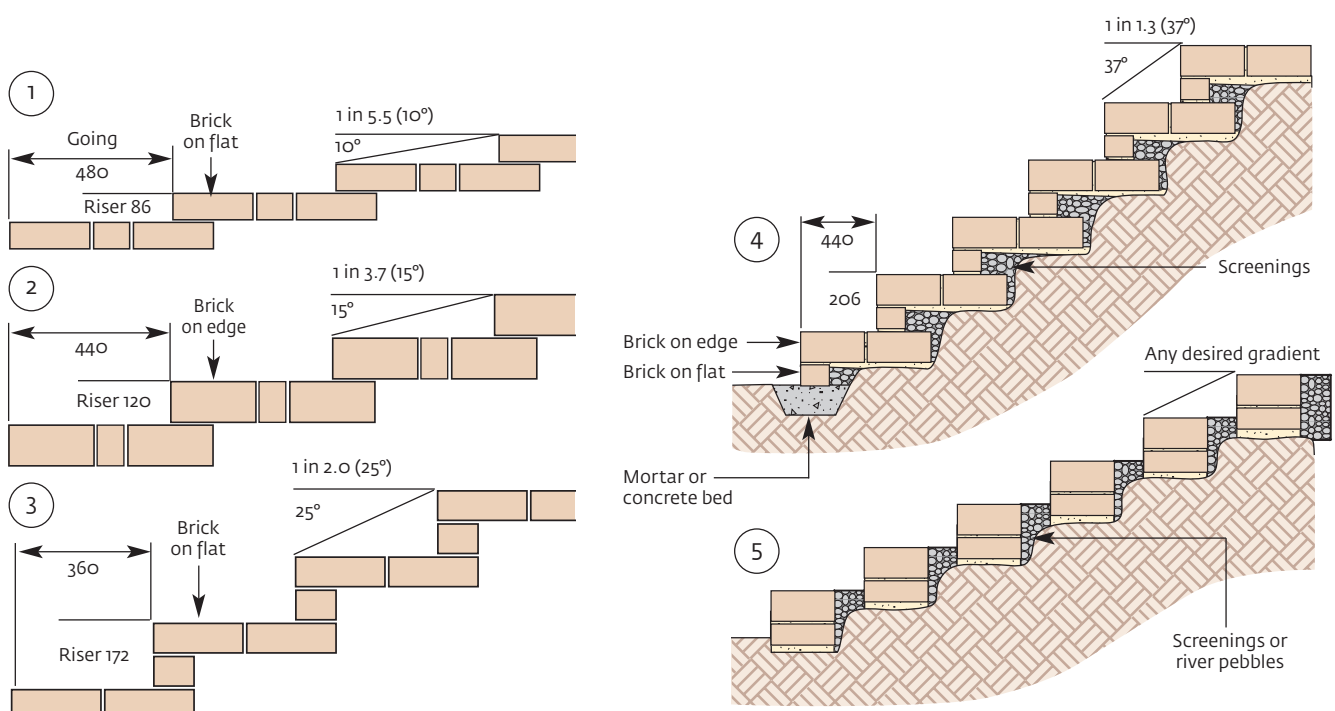
Step 2 The lowest step is begun first and should be used as a datum point. Place the first row of bricks on a bed of mortar and tap it into position ensuring that it is at the required height. Position the corresponding brick of the last step next and stretch a string line between the two to help in achieving an even gradient. Complete all of the first courses of bricks before proceeding to the next course.

Step 3 Accurately place the first and last row of "riser" bricks in position checking that they are

true and level. Use the string level to complete the risers of the remaining steps as in step 2, repeating the procedure where there are two bricks to the riser. The spaces behind the risers should be filled with screening to support the goings, but the going-bricks should be laid upon a bed of mortar. Use a mortar not weaker than 1:0.5:4.5 cement:lime: sand, and ensure that all of the joints are filled and tooled to a smooth finish. The going should slope forward slightly (about 1 mm in 100 mm) to prevent rainwater collecting there.

Note: The method shown in Design 5 is suitable in many situations where an informal effect is required of only a minor gradient. This technique is suited to curved step arrangements. The space behind the riser bricks should be filled with screenings or river pebbles.

Figure 23. Five typical step designs



5.5 Seat and planter box

Figure 24. Plan view of typical planter box

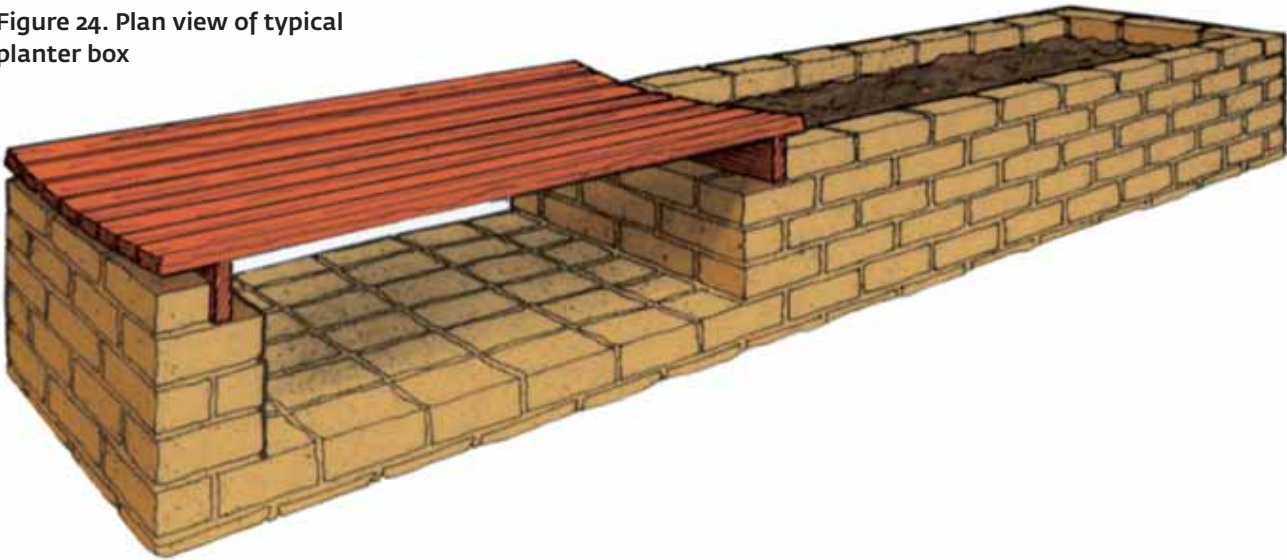
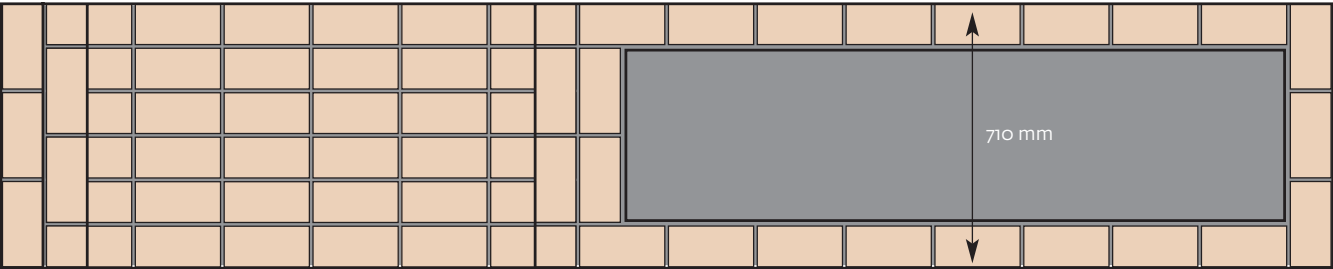
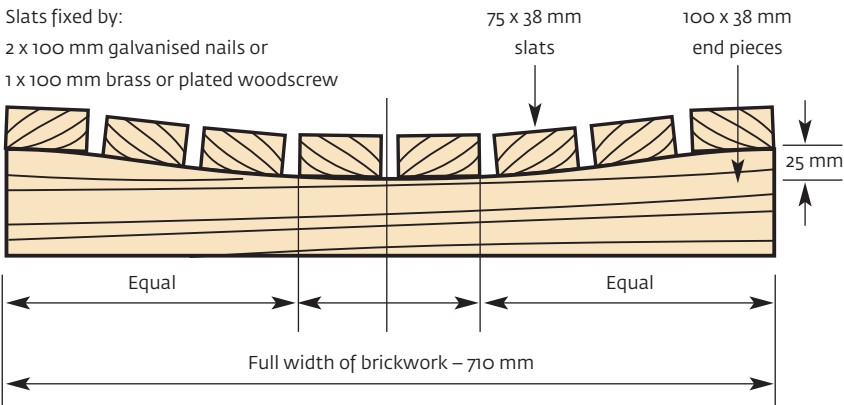
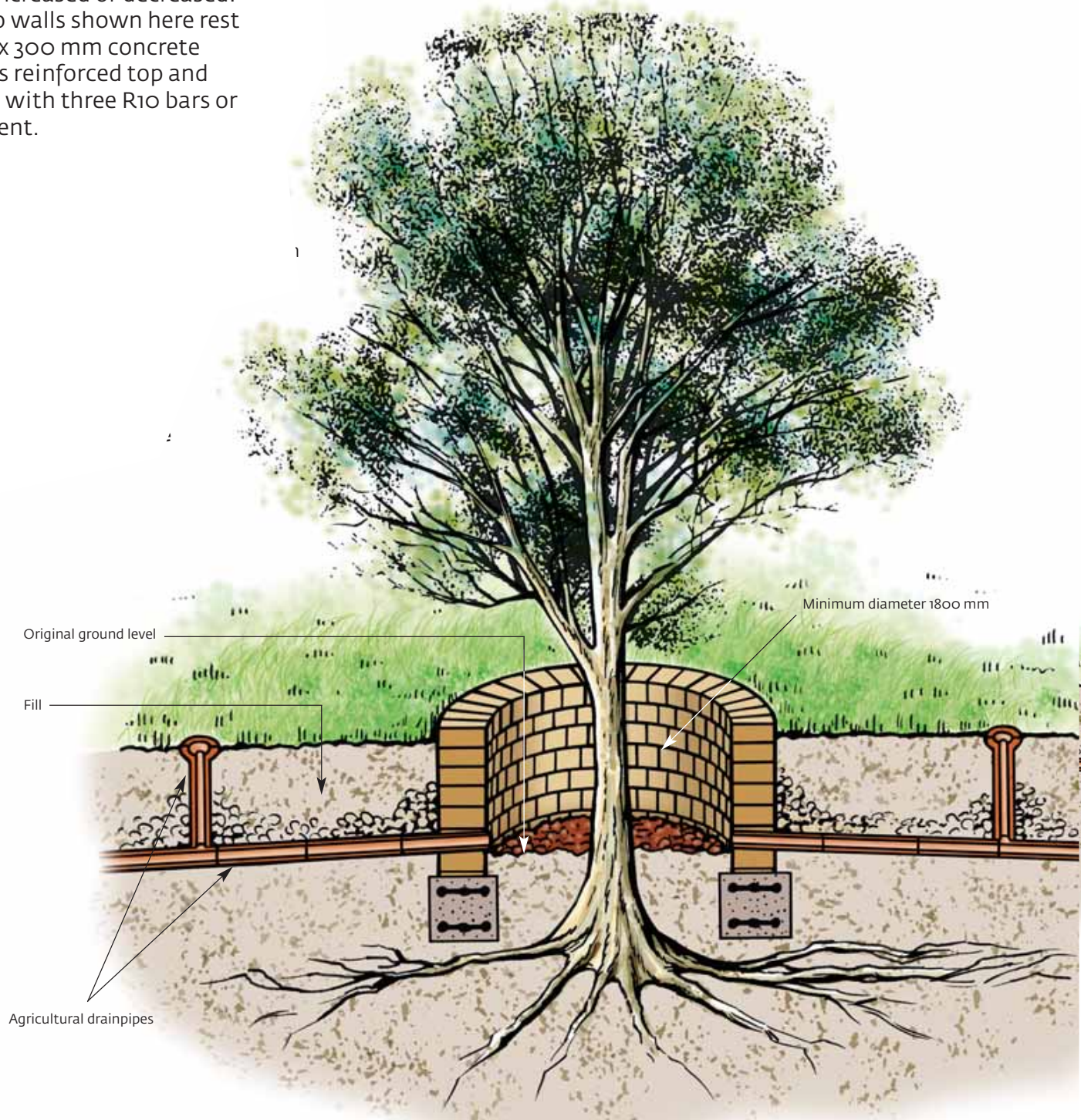


Figure 25. Detail through timber seat



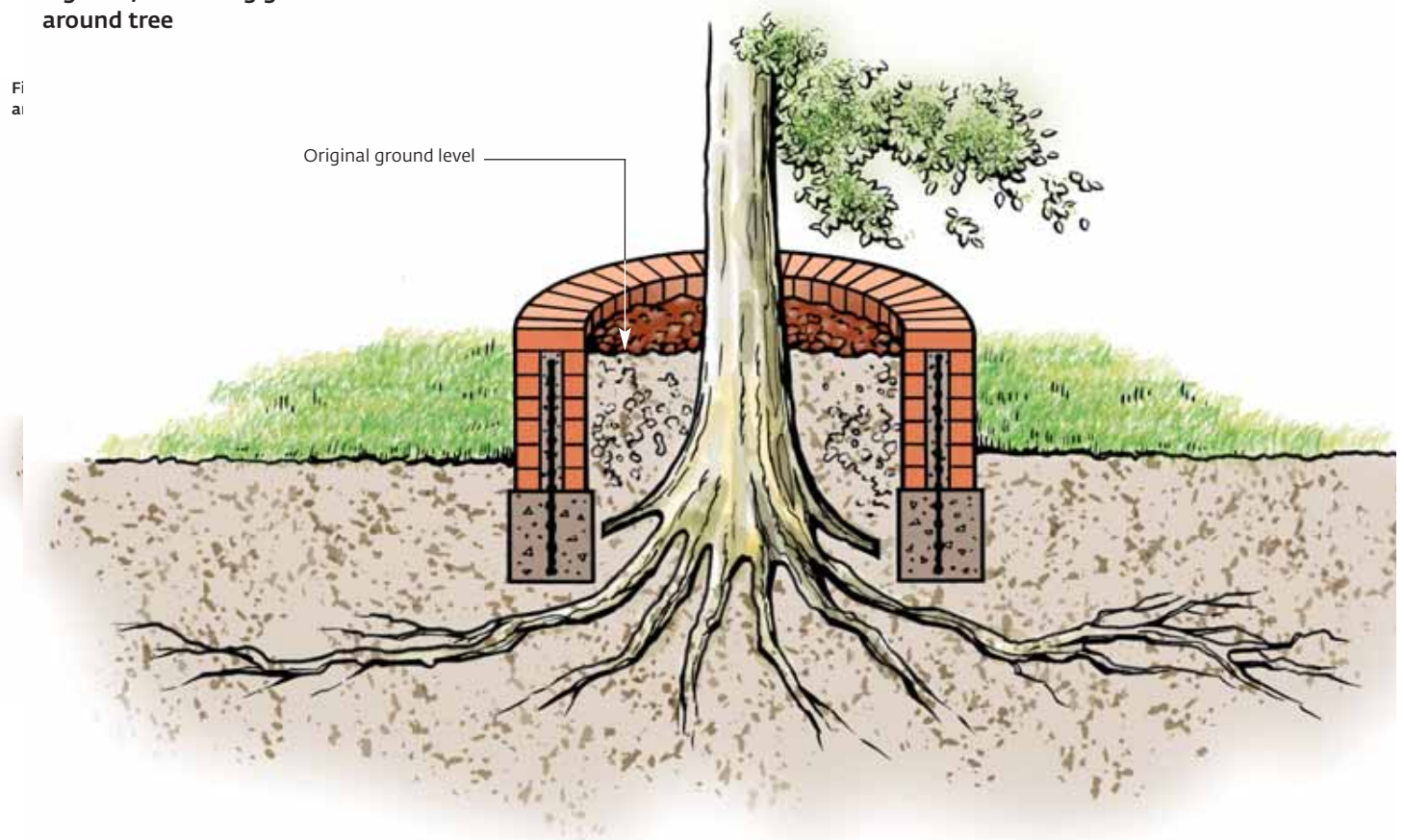
5.6 Changing ground levels around trees

Tree roots require air, water and minerals and it is necessary to maintain their supply when the depth of soil over these roots is either increased or decreased. The two walls shown here rest on 300 x 300 mm concrete footings reinforced top and bottom with three R10 bars or equivalent.



In Figure 26, earth is retained by a circular twin leaf wall. The well is drained by 100 mm diameter agricultural pipes (three to six, depending upon rainfall). Vertical pipes are provided beneath the edge of the tree growth for additional air and water supply. In Figure 27 earth is retained by a circular reinforced grout filled cavity wall 300 mm in thickness using F62 mesh.

Figure 27. Lowering ground level around tree



6. Trees, creepers and brickwork

6.1 Effects of tree roots on brickwork

An important consideration in the suitability of trees when they are planted close to brickwork is the possibility that their root systems might cause structural damage. This problem has been highlighted in recent years as the younger generations moving into the older inner city suburbs have tended to plant rapid growing native trees too close to walls and buildings.

Damage occurs in structures built on clay soil when during times of drought the rapid growing trees extract moisture from the clay on which the structure's footings rest. When the clay dries out it shrinks causing localized downward movements, and cracks may appear in the brickwork and internal linings (see section 2.1). The phenomenon of trees causing damage to brickwork is not limited to old buildings or native trees.

Sandy loam soils hold little moisture in their upper levels and hence tree roots need to penetrate deeply to obtain sufficient moisture. Footings for structures are usually quite close to the surface and are not often affected by moisture removed from deeper levels.

In clay soils the trees tend to be shallow rooted because moisture rests at a higher level and because root penetration is impeded by the dense nature of the clay. In a drought period many trees have the ability to rapidly send out lateral roots in search of moisture, and these can intrude upon the foundations of building structures.

Some of the more common trees that have caused trouble include blue gums, mahogany gums, lemon-scented gums, poplars, elms and willows. All of these trees are rapid growers, gross feeders and extract a lot of moisture from the soil.

To prevent damage occurring in the future, any trees that are planted should be carefully chosen, bearing in mind the nature of the soil, the type and strength of footing and the distance between the relevant trees and the structure. In clay areas the rapid growing and gross feeding trees such as the Tasmanian blue gum (*Eucalyptus globulus*) should be well separated from structures. Far more suitable would be the smaller species of eucalypts such as the swamp mallee (*Eucalyptus spathulata*). This type of tree has a low transpiration rate due to the tree's small size and light foliage. As an approximate rule-of-thumb, trees planted on clay soil should be no closer to a building structure than half of the tree's mature (ultimate) height.

6.2 Remedial action

If cracks have developed in brickwork at the end of summer and there are large or fast growing trees nearby, then it is probable that the trees are contributing to the damage and should therefore be removed. The damage should be left unpatched for 12 months to allow the soil to stabilize and the cracks to close up. Too early action may cause cracking to occur elsewhere.

If the cracking is only minor and the trees are mature or the drought has been unusually severe, then constant watering of the trees may prevent the damage from worsening. Excessive watering should be avoided as this could weaken the soil or cause it to swell.

If the walls are badly cracked and have moved out of the vertical, underpinning may be required.

6.3 Creepers and brickwork

Climbing plants attach themselves to supports in a variety of ways. The types that are most suitable in conjunction with brickwork are the ‘self-clinging’ types that use suckers or hooked prickles to adhere to a surface.

Certain virulent creepers such as *Wistaria sinensis* should be avoided as they can cause serious damage. *Clematis*, on the other hand, attaches itself by the same principle but given adequate support from light wires or mesh it is unlikely to harm the brickwork. The following table lists self-clinging climbers suitable for use on brickwork.

Table 3. Self-clinging climbers for use on brickwork

Botanical name	Common name
<i>Bignonia capreolata</i>	cross-vine
<i>Doxantha unguis-cati</i>	cat’s claw creeper
<i>Ficus pumila</i>	climbing fig
<i>Hedera helix</i>	english ivy
<i>Metrosideros diffusa</i>	small rata vine
<i>Parthenocissus quinquefolia</i>	virginia creeper
<i>Phaedranthus buccinatorius</i>	mexican blood-trumpet

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