Unit CSA–L30cc133
CONSTRUCT COMPLEX MASONRY STRUCTURES

LEARNING OUTCOMES
LO1/2: Know how to and be able to prepare for the construction of complex masonry structures
LO3/4: Know how to and be able to set out and construct axed arches to the given specifications
LO5/6: Know how to and be able to set out and construct curved brickwork
LO7/8: Know how to and be able to set out and construct obtuse and acute angle quoins
INTRODUCTION

The aims of this chapter are to:

- help you to select materials, components, tools and equipment
- help you to construct complex masonry structures.

PREPARING FOR THE CONSTRUCTION OF COMPLEX MASONRY STRUCTURES

Preparing for the construction of complex masonry structures requires much the same considerations as preparation for any other type of building. This includes consideration of:

- potential hazards
- types of drawings and specifications and how to interpret and extract accurate information from them
- risk assessments
- PPE
- protecting materials, completed work and the environment.

Health and safety and hazards

In Chapter 1 we examined the importance of identifying potential hazards and the ways in which risk assessments and method statements can help to avoid possible health and safety hazards. It is also important to make sure that manufacturers’ instructions are followed. All of these precautions help to ensure that you follow health and safety legislation and keep yourself safe.

In Chapter 1 there is also information about Work at Height Regulations and how to ensure that any equipment and safety measures you use will protect you. You should always try to avoid working at height if possible. Always use the proper equipment and put measures in place to prevent falls if this cannot be avoided. There will always be a risk, even if the proper equipment and safety measures are taken. As there is always a risk, measures need to be put in place to minimise the distance and consequences of a fall.
Checking drawings and specifications

Each type of drawing has a specific purpose and together they should provide you with the full picture of exactly what is required.

The purpose of drawings is to assist construction. They are organised in a logical sequence, which should follow the flow of the actual construction work. Scales should be clear and show the details of the structure.

Drawings and their purpose are covered in detail in Chapter 2.

It is important to ensure that all documents used are accurate and that each matches the other.

All drawings must follow the requirements of BS 1192:2007. This means that the drawings will have a common format and symbols. Building drawings use what is known as first angle orthographic projection. Drawings in this form will have a special symbol.

Interpreting measurements

In Chapter 2 we detailed the types of symbols and hatchings used on drawings and specifications. These are industry-standard and they help you to interpret the materials required for the job in hand.

Reporting inaccuracies

If, at the outset of a job, it becomes obvious that there have been some inaccuracies in the documents prepared for the construction work, it is vital that this is reported immediately. It may be necessary to report any inaccuracies to the site manager or, if appropriate, to an architect or designer.

A bricklayer is unlikely to be responsible for either surveying or setting out the project. However, a supervisor does have the responsibility to check to ensure that the work follows what has been outlined in the drawings. It means knowing if something has gone wrong or could go wrong.

Once the setting out has been carried out it is good practice to double check. Additional checks should be carried out before important new stages of construction get underway. In any case of a discrepancy the drawing needs to be checked to ensure it is correct. This means almost certainly talking to the architect or designer to clear up any misunderstandings and avoid potential problems.
Potential hazards

Typical construction potential hazards can include:
- falls from scaffolding, ladders and roofs
- electrocution
- injury from faulty machinery
- power tool accidents
- being hit by construction debris
- falling through holes in flooring
- fires and explosions
- burns, including those from chemicals
- slips, trips and falls.

PPE

PPE should include the following:
- Safety goggles or safety glasses – these are always necessary if there is a risk of eye injury.
- Gloves – these are especially useful if you are working in cold conditions or regularly using cement, solvents or other potentially harmful chemicals.
- Safety footwear – in case of sharp objects, uneven ground and poor weather conditions.
- Hard hat – to protect your head from objects falling from above and from bashing it on structures.
- High visibility clothing (hi-vis) – these may be waistcoats, jackets, overalls, or clothing with reflective pads, to ensure you can be easily seen on site.

Resources

The specification will tell you what types of materials are to be used. They will also tell you the joint finish required.

Using the plans you can work out the materials you will need for the job. You will also need a range of brickworking tools and PPE. Before you get underway you need to check that your materials and your equipment are ready for use. You should always ask yourself the following questions:
Interviews are about Preparation, Presentation, and Personality.

Do some research about the companies or organisations you’re applying to work for.

Turn up smartly dressed.

Talk about things that interest you and why you’re passionate about becoming a bricklayer.

- Do I have the right materials and are there enough of them?
- Are the materials in good condition or are they damaged?
- Do I have all the tools that I will need for the work and are they in a good state of repair?
- Do I have the necessary PPE and has it been maintained properly?

Calculations and formulae for quantities

In order to work out the amount of materials required for a particular walling job, you need to know the area of the wall. This is the surface that it covers. This is simply achieved by multiplying the length by the width. This gives the area of the walling.

For some jobs it can be more complicated, as there may be separate walls of different shapes. In this case you need to work out the area for each shape and then add them all together.

Working drawings will usually show lengths and widths in millimetres, so these need to be converted into square metres. It is often a good idea to convert from millimetres to metres before you start making any calculations. See Chapter 2 for more on drawings and working out areas.

The next stage is to work out how many bricks you will need for each square metre of walling. As a general rule of thumb, there are 60 bricks per square metre of half-brick walling. Once you know the total area of the wall that you will be constructing you multiply the number of square metres by 60.

Protecting the work and the surrounding area from damage

Newly built brickwork can be vulnerable to cold temperatures and rain. The brickwork should be encouraged to dry out, which may mean putting a covering material over the face of a wall. Hessian is also used as an insulating layer.

Waste is unavoidable but strict environmental legislation determines how you handle and dispose of waste. The waste that is produced will cause some environmental damage and this must be minimised by:

- reusing broken bricks and blocks as hardcore
- sweeping fine debris into heaps and sprinkling water on it to minimise the dust
- not returning unused mortar to be remixed as this is bad practice
- not burning waste
keeping all material bins shut or locked when not being used

bagging up any waste, or at least covering it up.

**SETTING OUT AND CONSTRUCTING AXED ARCHES**

A more ornamental way of bridging openings is by the use of arches, which are made up of bricks bonded together around a curve or series of curves. Arches need no additional reinforcement, unlike brick lintels, because the shape of the arch distributes the load sideways and around the arch. The higher the load placed on the arch, the tighter it will become.

Arches are generally classified into three main groups according to their use or method of cutting and preparation:

- **Rough arches** – where the joints, and not the bricks, are wedge-shaped. Such arches are generally used on work which does not require a high standard of finish, or work which is to be plastered over. Little or no cutting is needed for this type of arch.

- **Axed arches** – are used on fine work, and the wedge-shaped bricks called voussoirs are all cut to the same shape and size and have a pleasing appearance when finished. They may be cut from the same bricks as the general face work, or sometimes bricks which have contrasting colour are used to the effect of the arch standing out from the general walling.

- **Gauged arches** – which are very ornamental and expensive and are generally only used on higher quality buildings as the bricks require a lot of preparatory work before they can be built in the arch. They are prepared and bedded with a very fine white joint. Building this type of arch requires a sound knowledge of geometry.
### Axed arches terminology

There are a number of terms related to arches that you need to be familiar with. The following table identifies the most commonly used terminology.

<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voussoirs</td>
<td>The individual wedge-shaped bricks in an arch.</td>
</tr>
<tr>
<td>Span</td>
<td>The distance between the jambs or reveals of the opening over which the arch is bridged.</td>
</tr>
<tr>
<td>Soffit</td>
<td>The surface of the underside of the arch.</td>
</tr>
<tr>
<td>Springing points</td>
<td>The lowest points of the arch from where the curve begins.</td>
</tr>
<tr>
<td>Springing line</td>
<td>A horizontal line drawn through the springing points.</td>
</tr>
<tr>
<td>Rise</td>
<td>The vertical distance between the springing line and the highest point of the soffit.</td>
</tr>
<tr>
<td>Key brick</td>
<td>The highest or central brick. It is usually the last brick to be laid in the arch.</td>
</tr>
<tr>
<td>Crown</td>
<td>The highest part of the arch, where the key brick is laid.</td>
</tr>
<tr>
<td>Intrados</td>
<td>The underside of an arch when viewed in elevation.</td>
</tr>
<tr>
<td>Extrados</td>
<td>The upper side of the arch when viewed in elevation.</td>
</tr>
<tr>
<td>Haunch</td>
<td>The lower third of the arch, from the springing line to midway to the crown.</td>
</tr>
<tr>
<td>Bed joints</td>
<td>The joints between the voussoirs.</td>
</tr>
<tr>
<td>Face joints</td>
<td>The cross joints between the voussoirs.</td>
</tr>
<tr>
<td>Skewback</td>
<td>The sloping abutment from which an arch springs (see Fig 6.2).</td>
</tr>
<tr>
<td>Template</td>
<td>This piece of material is marked out from the drawing of the arch and cut to the shape of the voussoirs. The bricks are cut to match the shape of the template.</td>
</tr>
<tr>
<td>Striking point</td>
<td>This is the centre point from which the curve of the arch is drawn. The voussoirs should radiate to the striking point.</td>
</tr>
<tr>
<td>Turning piece</td>
<td>A solid piece of wood in the shape of the arch. It is used as a support.</td>
</tr>
<tr>
<td>Arch centre</td>
<td>This is another method of support while the arch is being constructed. (We look in more detail at providing temporary support a little later in this section.)</td>
</tr>
</tbody>
</table>

**Figure 6.1** Semi-circular arch

**Figure 6.2** Skewback

**Table 6.1** Terms related to arches
There are several different types of common arch. These are explained in the following table.

<table>
<thead>
<tr>
<th>Type of arch</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-circular</td>
<td>If the brickwork is not going to be seen, the arch is made using standard bricks and the mortar joints are v-shaped joints. If the brickwork will be visible then a central key brick is used with an equal number of specially shaped voussoirs either side.</td>
</tr>
<tr>
<td>Segmental</td>
<td>This is called a segmental arch because only part of a full circle is actually constructed. All of the voussoirs are the same. Usually these arches will have a low rise and a large span. This means that standard bricks can be used, which are held in place with v-shaped joints. To make the arch more visually appealing, particularly if it is a smaller span arch, tapered voussoirs are used. There is always an odd number of voussoirs and the central one is the key brick.</td>
</tr>
<tr>
<td>Soldier</td>
<td>This looks like an arch with a straight top. It is non-structural and built by fixing bricks on their ends, which in turn are supported by a steel lintel. It looks like an arch but the bricks do not actually perform any supporting function.</td>
</tr>
<tr>
<td>Flat or skewback</td>
<td>The voussoirs in this type of arch are either bought to order or are cut on site from a template. Each of the voussoirs has a unique shape. The arch is flat at the top and the ends slope (skewback). Effectively this creates a wedge that supports the structure.</td>
</tr>
</tbody>
</table>

**Table 6.2 Different types of common arch**

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**Setting out axed arches and providing templates**

The following is an outline of the general procedure for preparing the voussoirs for an axed arch. This procedure may be slightly varied to suit the different types of arches but the basic principles remain the same.

1. An outline of the arch should be set out full size on a setting-out board.

2. Mark out the voussoirs on the extrados of the arch. The voussoirs are set out by marking out the key brick first then dividing the extrados into a number of equal divisions. The marked divisions should not be greater than the width of the bricks being used plus the thickness of one bed joint. If the arch is to be bonded on face there must be an even number of voussoirs on each side of the key brick, as seen in Fig 6.3. This will ensure that the springing brick corresponds to the key brick.

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Be careful of coming across as too confident or cocky, or you may not get the help that you need from your team members who might let you go ahead and make mistakes on your own. Remember, some of your workmates will have been in the trade a lot longer than you.

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Figure 6.3  There must be equal numbers of voussoirs either side of the key brick
3. When the correct size of the voussoirs has been determined, the shape of the arch can be completed. This is done by drawing the joint lines between the extrados and the intrados so that they radiate to the striking point of the curve. This ensures that the bricks are normal to the curve (square to the tangent at the point on the curve it passes through), as can be seen in Fig 6.4.

You can now cut out a template. This can be made from plywood or hardboard and is cut to the shape of the voussoirs on the full size drawing. One method of marking the template is to extend any two lines of the arch voussoirs, laying the plywood or hardboard between and transferring the lines to the upper surface by means of a straight edge. The template should be considerably longer than the depth of the arch and should extend at the narrow end of the template, as can be seen in Fig 6.5.

Check the accuracy of the template shape against other voussoirs in the full size drawing.

After the shape is checked the joint can be determined by laying a straight edge along one edge of the voussoirs on the drawing and placing the template against it so that it fully covers the voussoir. Then move the template along the straight edge until the required thickness of bed joint is visible on the drawing. Mark on each side of the template the cutting mark for the bricks. It is useful to nail a strip to the template at the cutting mark, as can be seen in Fig 6.6.

Mark the bricks by placing the template on the face of the brick, as shown in Fig 6.7. Mark the soffit with the aid of a square, as shown in Fig 6.8.
Providing temporary support

When construction is taking place it is necessary to provide some form of support to the brickwork over the opening. As we have already seen, no permanent reinforcement is required so any support will be carefully removed once the arch has been built. Two common methods of temporary support are the turning piece and the arch centre.

Turning piece

A turning piece is formed from solid pieces of wood into the actual shape of the arch. Turning pieces are generally used for segmental arches which have only a small span and rise. It is more economical to build up a centre from a small piece of timber when arches of dimensions are greater than 1 m span and 75 mm rise are to be formed.

Arch centre

An arch centre is made up of a number of small section timber pieces formed into the shape required.

Arch centres can be conveniently used over quite large spans. The timber members of a centre include the following:

- Ribs – these are the shaped members which are formed to suit the required arch shape.
- Ties – these are placed across the lower part of the centre to prevent it from spreading out when it is carrying the weight of the arch.
- Laggings – these are small pieces of timber that are fixed across the ribs to carry the voussoirs. Centres may be open or close-lagged, although open lagging is an inferior method because of the difficulty in marking the position of the voussoirs on the centre before building the arch. An alternative method is to use resin-bonded plywood nailed on to the ribs instead of the small timber lagging. This provides a smooth surface on which to work and is the most efficient method (see Fig 6.11).
Bearers – these are the timbers which are fixed underneath the ties to prevent the ribs from spreading apart. They also carry the weight of the centre and arch.

Struts – these are used in larger centres to support the ribs off the centre and go between the props (see Fig 6.10).

Props – these are the main supports to keep the centre at its correct height.

Folding wedges – these are placed between the props and the bearers to provide any slight adjustment that may be necessary to the height of the centre before beginning to set the arch in position.

Construction methods and procedures for arches

Once the template has been made, and the temporary supports have been placed, then the construction of the arch can begin. The procedure for construction is given below:

- Cut the bricks using a hammer and bolster.
- Secure the centre of each voussoir carefully in position. You can make any adjustments required using the folding wedges.
- Accurately mark the position of the voussoirs on the intrados and the width of the joints.
- Drive a nail at the striking point(s) and attach a length of line so that the radiation of the bricks to the striking point can be checked for accuracy and that they are normal to the curve of the arch.
- Check the arch for straightness along its face. This can be done by building up the brickwork each side of the arch and stretching a line in between (see Fig 6.12). Alternatively a line can be stretched between two temporary one-brick piers that have been erected on

Figure 6.11  A typical arch centre
each side of the opening. These temporary piers are known as dead men (see Fig 6.13).

- Build up the arch evenly on each side, meeting it at the middle or key brick.
- Check each voussoir for its correct position on the centre and correct alignment by means of the line from the striking point.
Constructing a semi-circular and a segmental arch

The method of constructing these two different arches is very similar.

- The opening needs to have a tolerance of around 5mm.
- The centre of the arch needs to be identified.
- The abutments should be built up to the springing line. The centre is supported by timber props and wedges. At all times they should be checked for being level.
- The corners should be built up to 4 or 5 courses.
- For segmental arches, the skewback angle is marked on the supported bricks. These are then cut and bedded in as each course of bricks is laid. This continues until you reach the top of the skewback angle.
- A line is pulled through the corners and the face of the voussoirs is laid to the line.
- Each voussoir is levelled as it is laid. It is important to check that they are laid square.
- Voussoirs on each side of the arch are laid carefully, with full joints; otherwise the arch will be weak.
- Brickwork is then laid in courses around the arch, making any necessary cuts to cope with the shape.
- As the brickwork around the arch is built up the key brick is then laid, with well-filled joints.
- When the arch is complete the joints should be allowed to contract as they set. Do this by gently easing the wedges to allow the arch to settle. Any supports are removed after the joints have set and the soffit of the arch is jointed.

Safely removing the support

Providing the arch has been allowed to set, the temporary supports can now be removed. The folding wedges can then be removed completely. Then the centre can be taken out.
1. CONSTRUCT A SEMI-CIRCULAR AXED ARCH

OBJECTIVE
To construct a semi-circular axed arch, using an arch former and a voussoir template.

In an axed arch, the bricks are shaped so that the bricks are consistent and regular. This creates a neater finish than a rough arch, where the joints dictate the way that the arch is formed. To achieve this, the arch has to be set out accurately and each brick marked and dressed as identical units.

This model is for a semi-circular arch, with the main body of the wall constructed in two stretcher bond walls built adjacent to each other so that you can concentrate on the arch itself.

TOOLS AND EQUIPMENT
- Walling trowel
- Lump hammer
- Bolster chisel
- Spirit level
- Block/pins and line
- Straight edge
- Jointing iron
- Steel tape measure
- Compass dividers

PPE
Ensure you select PPE appropriate to the job and site where you are working. Refer to the PPE section of Chapter 1.

PRACTICAL TASK

STEP 1 Mark a straight line on the floor and dry bond the wall 890 mm long at each side of the arch centre.

STEP 2 Dry bond the bricks either side in order to build up the corners and build the piers up to the springing point of the arch.

STEP 3 To set out the arch, draw the span on a piece of board then place the piece of board on the face of the arch to mark the voussoirs on. Then bisect the span in order to find the centre point.

PRACTICAL TIP
Make sure that the bond will work throughout the length so that the correct bond is maintained when the brickwork runs above the arch.
**STEP 4** Mark the intrados and extrados on the board with a trammel, so that the voussoirs can be marked.

**PRACTICAL TIP**
Start with the dividers set at the width of a brick (65 mm) and adjust by reducing until the spacing around the extrados divides equally.

**STEP 5** Take a pair of dividers so that the width of the voussoirs can be established, and mark on the board.

**PRACTICAL TIP**
Scribe the cuts with a sharp steel point rather than a pencil. Use a set square to transfer the lines on the face to the edge of the brick.

**STEP 6** To make the voussoir template:
- Radiate the lines to the centre point and extend them to above the extrados.
- Transfer the lines onto the hardboard template and cut out.
- Place the template on one voussoir and position straight edge along one edge.
- Slide the template along the straight edge until the right sized joint is achieved.
- Mark the position and fix a small batten to fix the size of the cuts to be made.

**STEP 7** Cut the bricks and lay flat on the board, ready to be laid to the arch.

**STEP 8** Place the arch centre. Ensure that it is plumb and does not project beyond the face of any further brickwork.

**STEP 9** Build the corners up as far as possible so that the alignment of the arch can be maintained as its constructed.

**STEP 10** Start building the voussoirs over the former with a constant joint and maintain alignment with the string line. The position of the voussoirs can be checked with a line attached to the springing point. Work from either end to the centre.

**STEP 11** Complete the arch and run the full width courses over the arch.

**STEP 12** Finish the model with a half round joint and brush it.
2. CONSTRUCT A SEGMENTAL AXED ARCH

OBJECTIVE
To construct a segmental axed arch, using an arch former and a voussoir template.

This model is for a segmental arch with the main body of the wall constructed in two stretcher bond walls built adjacent to each other.

Figure 6.17 Elevation of a segmental axed arch

TOOLS AND EQUIPMENT

- Walling trowel
- Lump hammer
- Bolster chisel
- Spirit level
- Block/pins and line
- Straight edge
- Jointing iron
- Steel tape measure
- Compass dividers
- Adjustable bevel

PPE
Ensure you select PPE appropriate to the job and site where you are working. Refer to the PPE section of Chapter 1.

STEP 1 Follow Steps 1 and 2 from Construct a semi-circular arch, above.

STEP 2 After you have marked the voussoirs, establish the span and bisect it. Then bisect the line from the rise to the springing point.

STEP 3 Establish the intrados, extrados and skewback and mark on the board.

STEP 4 Take a pair of dividers so that the width of the voussoirs can be established, and mark on the board.

PRACTICAL TIP
Start with the dividers set at the width of a brick (65mm) and adjust by reducing until the spacing around the extrados divides equally.

STEP 5 Follow Steps 6 to 8 from Construct a semi-circular arch, above.
Step 6: Construct the skewback ready to take the voussoirs over the former.

Step 7: Build the corners up as far as possible so that the alignment of the arch can be maintained as it is constructed.

Step 8: Start building the voussoirs over the centre with a constant joint and maintain alignment with the string line. The position of the voussoirs can be checked with a line attached to the springing point. Work from either end to the centre.

PRACTICAL TIP
Don’t be tempted to build the arch above the height of the corners. Build a section of arch and infill with brickwork and then repeat the process until over the arch.

Step 9: Complete the arch and run the full width courses over the arch.

Step 10: Finish the model with a half round joint and brush to finish.
SETTING OUT AND CONSTRUCTING CURVED BRICKWORK

Many modern buildings incorporate curved walling or brickwork features, including bay windows and garden walling. Curved brickwork, like an arch, will have a striking point, or centre, from which all of the brickwork will radiate. Vertical plumbing and horizontally levelling are very important when building curved brickwork. It is not possible to use lines and pins for curved walling.

Setting out curved brickwork on plan

This involves the use of one of three methods:

- Wooden templates – commonly used on bay windows, they give the line of the main wall and the curve of the bay. They are used when the curve of the bay has a small radius.

- Templates and plumbing points – when the radius of the curve is larger, the template is used to lay only the first course of brickwork. Plumbing points are then marked around the curve. As each course of brickwork is started a brick is laid at each of the plumbing points. These bricks are bedded in bond and levelled horizontally from the main wall and plumbed vertically from the first course of bricks.

- Trammels – these are pieces of steel rod or conduit that are fixed into position and plumbed. A batten is drilled so that it fits easily over the rod and is cut to the length of the radius. The batten is threaded over the rod and the wall can be built to the batten.

Construction methods and procedures

When the radius of the curved work is large enough the bricks can be laid around the curve with ‘V’ joints between them so that no cutting is necessary on the front 112 mm of the facing course of a one-brick wall. A certain amount of cutting will, however, be required on the inside of the curve because of the reduced radius (see Fig 6.25). The face work may be built using any of the principal bonds.

Figure 6.25  Building a curved wall using ‘V’ joints
If the face work is on the concave face (see Fig 6.26) it may be difficult to do the bonding on the convex side of the wall. If both sides of the wall should be neat work it is essential to be extremely careful and it is normally better to use purpose-made bricks. These may be supplied as headers or stretchers and will allow a good face to be obtained on both sides of a 225 mm (one-brick) wall, for example.

Another method of building curved work, particularly when the radius is small, is to use all heading bond on the face side of the wall. If the radius is very small, bats will have to be introduced (see Fig 6.27).

**Figure 6.26** Walls curved on plan

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**Serpentine walling**

This type of walling curves in and out along its length (see Fig 6.28).

Its use is normally confined to boundary walling and gives a pleasant non-monotonous effect. It also may be seen on some large housing estates where the roads have been deliberately constructed with curves in them to control the speed of the traffic. Low serpentine boundary walls are then constructed parallel to these roads.

**Figure 6.28** Serpentine walling
When building walls which are curved on plan, it is most important to set out the plumbing points at the base and to maintain these points all the way up the wall. The work in between the plumbing points should be checked by the use of a template cut to the shape of the curve, out of plywood or hardboard (see Fig 6.29).

Another method for checking accuracy is to use a trammel, as can be seen in the following diagram.
3. BUILD A SERPENTINE WALL

OBJECTIVE
To practise the skills of building a serpentine wall as well as those for the features that are constructed within the pier.

One of the unusual aspects of this model is the skill required to plumb a wall along an irregular length, as a line cannot be utilised. Different techniques for maintaining regularity can be used, but careful checking is essential.

TOOLS AND EQUIPMENT
- Walling trowel
- Lump hammer
- Bolster chisel
- Spirit level
- Jointing iron
- Scutch hammer
- Steel tape measure
- Gun template
- Boat level
- Steel or timber trammel

PRACTICAL TIP
Place some support under what will become the feature, preferably with a piece of timber directly under it so that the arc can be calculated and marked as a reference.

PRACTICAL TASK

Figure 6.31 Plan of a serpentine wall

STEP 1 Mark the position of the model on the floor, starting at the pier end.

STEP 2 The regularity of the serpentine wall can be maintained by fixing a pin at a certain point and using a line or trammel to set the arc. This can then be checked by the use of the template.

STEP 3 Build the pier section, making sure to leave the recess for the feature on the piers to be built in as work progresses.

PPE
Ensure you select PPE appropriate to the job and site where you are working. Refer to the PPE section of Chapter 1.
Step 4 Install the soldiers in the arc, using a boat level to check for plumb and a template to maintain the arc correctly.

Step 5 Rack out the bricks into the serpentine wall enough to be able to reach the height of the pier.

Step 6 Build in the second feature by supporting the projecting brickwork and repeating the process that was undertaken with the first.

Step 7 Finish the pier to height but leave off the main capping on the wall until the remainder of the wall has been built.

Step 8 Mark six equally spaced plumbing points on the floor, along the face of the serpentine wall.

Step 9 Lay the first course of the serpentine wall using the spirit level to check the wall for level along the width and length of the wall. Check for alignment with the template.

Step 10 Continue running out each course using the spirit level along with the plumbing marks as reference points and the template to check the accuracy of the radius.

Step 11 Run the brick-on-edge capping on the pier section. All the bricks can be laid in order, or the full bricks can be laid first and the cut bricks bedded in after these have been completed. Each method is down to individual preference.

Step 12 Run the brick-on-edge capping in using the same method as for the body of the serpentine wall.

Step 13 Finish the main wall with a half round joint and a flush joint to the brick on edge cappings.

Practical Tip
Running the upper level of copings in first will help prevent the lower section becoming marked.

Practical Tip
A straight edge can be used in conjunction with the spirit level to check the entire course once it has been laid.
Time and experience count for a lot

Marcus Chadwick, a bricklayer at Laing O’Rourke talks about building complex structures.

‘At college, you probably only get to do one project on complex structures, so you only really start learning on the job. You’ve got to take notice of the people who are teaching you. Not only your tutors – although they’re giving you an insight – but you only really start learning once you’re on site, where you’ve got your old boys who’ve been doing it for decades. Especially when you consider that they didn’t have as much mechanical help like forklifts – it was more hands on, whereas we’re very mechanically orientated now. So it’s by paying attention to those more experienced people that you learn about things like building arches. It’s a dying part of the trade. If I hadn’t paid attention to it, I wouldn’t have known how to do it and I wouldn’t have been able to pass it on.

The basis of your arch is the timber arch-former (centre), and it’s about knowing exactly where to place those bricks so that it’ll work out when you get to the top and you put your keystone in. That keystone, once that arch-former comes out, that’s what’s holding that arch together – and gravity and mortar of course. Remember, some of these arches have been up for hundreds of years – so the old masons must have known what they were doing!

I like doing that sort of more complex work, it’s satisfying. But don’t get me wrong, I love coming to work with a nice long stretch of brickwork to do. I feel really good if I can put down 500 or 600 bricks in a day. And you do end up counting your bricks!

I used to work with this old bricklayer who was 72 – we were taking the mickey out of the young lads because between us we were doing over a thousand bricks a day and the young lads were doing like 400 to 500 between two of them. Pretty impressive when you consider that my mate’s 72. But you develop speed with time and experience – it’s no good going out on a site and trying to keep up with bricklayers, because you’ll just end up taking your work down. And once that’s happened, it’s a bit embarrassing, so it’ll only ever happen the once!’
A quoin is a corner brick. They can provide strength for walling, or can be used as a feature of a corner. Brick quoins may protrude from the facing brickwork on a building to give the appearance of blocks.

**Setting out and constructing obtuse and acute angles**

Not all sites are square on plan, particularly in town or city areas and, therefore, it is often necessary for walls to be built out of square with one another. Walls that are set at an angle of less than 90°, or a right angle, form an acute angle.

There will be little difficulty in cutting the shapes of the bricks at the angle if a mechanical brick-cutting saw is available. It is unlikely that this work would be cut by hand because of the costs involved in hours.

If an acute angle is formed in an exposed position it is liable to become damaged. In such cases it is usual to cut the angle short and to form two obtuse angles, as can be seen in the following diagram.

![Diagram showing the construction of obtuse and acute angles](image)

*Figure 6.32 Bonding acute angles in English bond*
When obtuse angles are being formed, it is possible to use purpose-made bricks. These are generally used for standard angles, such as $135^\circ$ or $120^\circ$. For other angles the bricks would have to be purpose-made if a sufficient number were required. If only a small number were needed they would be cut on a mechanical brick-cutting saw.

It is important to remember that a closer should always be placed next to a squint brick to form the bond in the brickwork, as shown in Fig 6.35.

An alternative method of building an obtuse angle is to overlap ordinary square bricks at the angle, called a birdssmouth. Figs 6.36 and 6.37 show this method being used in both English and Flemish bond.

The use of this technique for forming an obtuse angle saves the cost of the squint bricks, but great care is required to ensure accuracy in plumbing.
When the walling is built to form an internal obtuse angle, dogleg bricks are generally used to form the bonding at the angle, as can be seen in Fig 6.38.

![Diagram of internal obtuse angles in English and Flemish bond](image)

This method is much stronger than with ordinary square bricks cut at the angle to form the bond, as it is then very difficult to ensure an adequate lap. Any poor lapping is likely to create a weakness and allow cracking to take place in the angle, should there be any slight movement in the structure.

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**PRACTICAL TASK**

### 4. BUILD AN ACUTE (SQUINT) RETURN CORNER

**OBJECTIVE**

To practise building walls at angles other than 90°.

Squint quoins are special bricks which allow corners other than 90° to be formed and, as such, require different setting out methods. They can often be found on areas such as bay windows on houses.

This model uses 30 and 60° squint quoins to form the acute angled returns.

**TOOLS AND EQUIPMENT**

- Walling trowel
- Jointing iron
- Lump hammer
- Scutch hammer
- Bolster chisel
- Steel tape measure
- Spirit level
- Straight edge

**PPE**

Ensure you select PPE appropriate to the job and site where you are working. Refer to the PPE section of Chapter 1.
**PRACTICAL TIP**

The length of the whole bricks along the face will be 1,340 mm long and the extra for the added squints and angle marks can then be allowed for.

**STEP 1** Mark a line long enough to locate the front line of the model as well as calculate the angles for the returns.

**STEP 2** On the 60° angled return, mark a length of line a set distance, e.g. 400 mm. Then with a compass or trammel scribe lines from either end to a point where they intersect and form an equilateral triangle. The flank of this corner will be 60°.

**PRACTICAL TIP**

The calculation is based on the knowledge that all the internal angles in a triangle add up to 180°. Therefore, as all the angles are equal, when divided by three, the 60° angle will be formed when measured against the initial base line.

**STEP 3** On the 30° angle, follow the same procedure as for the 60° angle. Once formed, mark a line half way alongside and draw a line through this and the corner opposite. This will bisect the 60° angle equally giving the 30° angle required.

**STEP 4** Dry bond the first course making sure that all the angles and bonds are correct. The 60° return is constructed in English bond and the 30° in Flemish bond.

**STEP 5** When you are satisfied with the setting out, lay the first course using level and straight edge to give a good base from which the rest of the model can be constructed.

**STEP 6** Build up the corners on either end to the full height of six courses.

**PRACTICAL TIP**

Form the stop ends completely while forming returns as this is easier than racking them back and constructing after full height has been reached.

**STEP 7** Run in the remaining brickwork on the face of the model.

**STEP 8** Finish the model with a half round joint to the face and a flush joint to the rear.

**Figure 6.40** The finished model
TEST YOURSELF

1. Approximately how many standard size bricks will be required for a square metre of walling?
   a. 50
   b. 40
   c. 60
   d. 70

2. In rough arches, which part of the structure is wedge-shaped?
   a. Joints
   b. Bricks
   c. Plaster work
   d. Metal reinforcement

3. Which type of arch is non-structural and not in the shape of a circle?
   a. Flat
   b. Soldier
   c. Segmental
   d. Semi-circular

4. What material is usually used to make a turning piece?
   a. Concrete
   b. Metal
   c. Wood
   d. Polystyrene

5. Laggings can be fixed across the ribs of arch centres to carry the voussoirs. Normally these are small pieces of timber, but what is an alternative method?
   a. To use quick-drying cement
   b. To use metal rib reinforcement
   c. To use resin-bonded plywood
   d. There is no alternative

6. When building the corners of an arch, how many courses of bricks should be completed at any one time?
   a. 1 to 2
   b. 2 to 3
   c. 3 to 4
   d. 4 to 5

7. When building a semi-circular arch, which of the following is the last task?
   a. Remove supports and joint the soffit
   b. Allow the joints to contract as they set
   c. Lay the key brick
   d. Support the arch with props

8. What is a trammel?
   a. A type of brick course
   b. A wooden template
   c. A batten
   d. A piece of steel rod

9. Where are you likely to find a quoin?
   a. Under a wall opening
   b. At the corner of a wall
   c. As part of an arch
   d. As part of a chimney stack

10. Walls that are set at an angle of less than 90° are said to form which of the following?
    a. A right angle
    b. An acute angle
    c. A wide angle
    d. An obtuse angle