सत्यमेव जयते
Ministry of Rural Development
Government of India

Training rural masons

Learning unit 3

Masonry works

International Labour Organization

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Learning Unit 3

Masonry works

3.0 Introduction

The purpose of this Learning Unit is to: *enable a rural mason to build various masonry structures using brick, block or stone and fix ready-to-install doors, windows and ventilators.*

By the end of this Learning Unit the rural mason should be able to:

(i) Manage excavation works for foundations,
(ii) Construct foundations for rural houses,
(iii) Perform brick masonry for construction of foundations, footings, load bearing and non-load bearing walls, columns, and including plinths and DPC,
(iv) Perform rubble stone masonry for construction of foundation walls, including plinths and DPC,
(v) Fix ready-to-install doors, windows, lintels and ventilators,
(vi) Carry out pointing and plastering of wall surfaces, and
(vii) Lay IPS floor slabs.

Good quality masonry works is indispensable for house building and is a skilled craft developed over centuries. It is a craft that demands attention to detail, precision and great care. The work of a rural mason is there for everybody to see and admire for a long time when carried out in the best tradition of the trade.

For rural houses, stone, brick and block masonry is relatively simple, although the principles of quality norms and skills required are the same as for any other masonry work.

This Learning Unit provides the necessary information on how to build masonry structures for rural houses. It covers the masonry works for foundations, plinths, walls and simple pillars.

3.1 Excavating and backfilling for foundations

This section attempts to develop the following skills for rural masons:

For excavation works:

- Check and ensure that excavation is carried out to the required dimension using appropriate tools.
- Check and ensure that the desired slope of earth is maintained during digging activity and, if necessary, support the vertical sides of the excavation to avoid that soil collapses.
- Ensure earth is disposed from the excavated pit by using suitable tools and equipment such as spade, wheel barrows, pans etc.
- Check for loose material, soil lumps, pebbles on achieving the desired earth level.
- Ensure surface dressing work is carried out by disposing loose material, gravels, plant roots, sludge, muck or debris as per requirement to the appropriate locations.
- Ensure compaction of base by ramming.

For backfilling works

- Check and remove gravels, oversized aggregate, organic matter from the soil prior to be used in backfilling as per site conditions.
- Ensure that soils are placed and spread maintaining uniform layers of 10 cm thickness.
- Ensure water is sprinkled uniformly over the layer to be compacted as and when required as per site conditions.
- Check and ensure that the compaction of the soil is carried out as per site conditions.

- Check and ensure re-filling and compaction of excavated trenches, pits surrounding the structures or at necessary location as per soil site conditions.

Summary

It is said that a house is only as good as its foundation. It is therefore essential that great care be taken when excavating the foundation trenches. The trenches have to be precisely marked out and excavated to the correct depth and width. Where the soil stability is low, the sides have to be supported so that they do not cave in. The bottom of the foundation trench should be level and well compacted.

Once the foundation is built, backfilling can take place with the excavated material. The backfill material should be free from debris and organic matter, such as tree branches, roots, leaves, etc. The fill material is placed in layers and properly compacted using earth rammers.

3.1.1 Excavating and preparing foundations

Foundations for houses should be placed on firm ground that can carry the load of the building. Surface soils are usually unsuitable for supporting the foundation and therefore trenches are excavated to a depth where suitable firm soil is reached. The trenches should be wide enough to accommodate the foundation and to provide sufficient working space. Trenches may be dug with vertical faces or with sloping faces depending on the depth and quality of the soil. Care should be taken to ensure that the trench walls do not collapse.

Worksheet M1 describes in detail how to excavate the trenches.

Tips for the facilitation of Worksheet M1: *Excavating foundation trenches*

The following approach is recommended when facilitating the work process described in this worksheet:

- Display the poster of Worksheet M1 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M1' and refer to it throughout the lesson.
- Also link your explanation to the respective training posters.
- Start explaining the worksheet by giving a general introduction to the purpose of the described work. Link your explanation to actual physical work undertaken during this training course (building a house).
- Explain the basic purpose of foundations and why foundation trenches are necessary.
- Explain the basic concept of 'soil conditions' and 'bearing capacity' and what that this means when excavating a foundation trench. Instruct the trainees to study and test the soil at hand (for their house project) and define the general quality of the in-situ soil.
- Mark out the trench to be excavated together with the trainees. Decide on the appropriate width and shape of the trench depending on the soil condition assessment. Demonstrate first how to mark out the trench and then let them practice it themselves → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- After having marked out the trench lines, assign each of the trainees to a section for excavation to the shape, width and depth required for the entire house. Make sure each trainee has the correct tools and uses them in the right way → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- It is particularly important to achieve a uniform, firm and level bottom of the foundation trench. Ensure that the trainees check the level using a water tube level.
- When the trainees have finished their tasks, let them assess each other's work and comment on the achieved quality.
- Recapitulate the completed work together. Use the training poster to review the 'Remember List'.

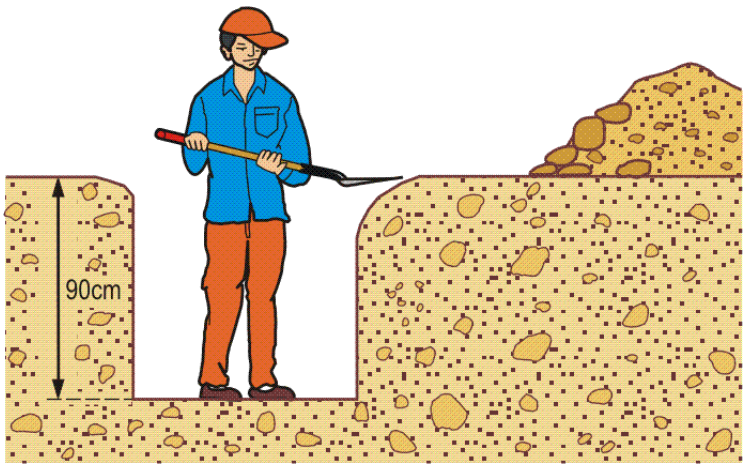
Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Excavating foundation trenches

M1

Work method:

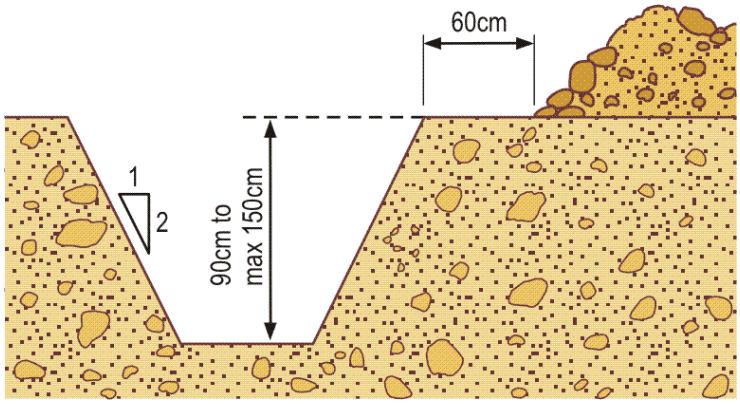
1. Set out the trenches to be excavated with pegs (width of the foundations plus working space of minimum 30cm on both sides), using the already established fixed reference points (refer to Worksheet S2 for details).
2. Assess the quality of the soil to determine whether the excavation can be done with vertical walls or whether safe slopes are required. You may have to dig a test hole to determine the soil quality.
3. First remove the topsoil and any debris plus organic matter, and deposit away from the construction site.
4. Excavate the trench and deposit the material neatly at least 60cm away from the trench. The same material is later used for backfilling.



Take the necessary preventive measures to avoid the trench walls from caving in. With firm soil and where the trench is less than 90cm deep, the walls can be kept vertical. In less firm or wet soils where the trench is deeper, the walls should be sloped. The slope angle depends on the soil quality but should not be less than 2:1.

Vertical walls or placing the excavated material too close to the trench can cause caving in of the trench walls. In shallow trenches this just creates additional work.

In deep trenches, this must be avoided by all means as it can severely harm the workers. In trenches deeper than 150cm, it may be necessary to support the walls from caving in.



Labour:	**Tools:**	**Material:**
• Rural mason for marking out and supervision • Labourers for excavation	• Thread lines with plumb bob • Water tube and spirit levels • Tape measure • Shovels and hoes • Crow bar and pickaxe for hard soil	None

Quality checkpoints:
- Check the exact width and depth of the foundation trench.
- Confirm level and horizontality of the bottom using the water tube level.
- Check the evenness using a straight edge and a spirit level.

3.1.2 Backfilling foundations

The trenches can be backfilled once the foundations have been constructed (for construction of foundations refer to Section 3.2.). Backfilling of foundations is explained in Worksheet M2.

Tips for the facilitation of Worksheet M2: *Backfilling foundations*

When facilitating the work process described in this worksheet the following approach is recommended:

- Display the poster of Worksheet M2 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M2' and refer to it throughout the lesson.
- Also link your explanation to the respective training posters.
- Start explaining the worksheet by giving a general introduction to the purpose of the described work. Link your explanation to actual physical work you are undertaking during this training course (building a house).
- Explain the basic purpose of backfilling and why it has to be done in layers and with proper compaction.
- Demonstrate first how to fill material and spread it to a uniform layer of not more than 10cm thickness. Also demonstrate how to compact it using an earth rammer. After demonstration let them practise it themselves → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have finished their tasks, let them assess each others work and comment on the achieved quality.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

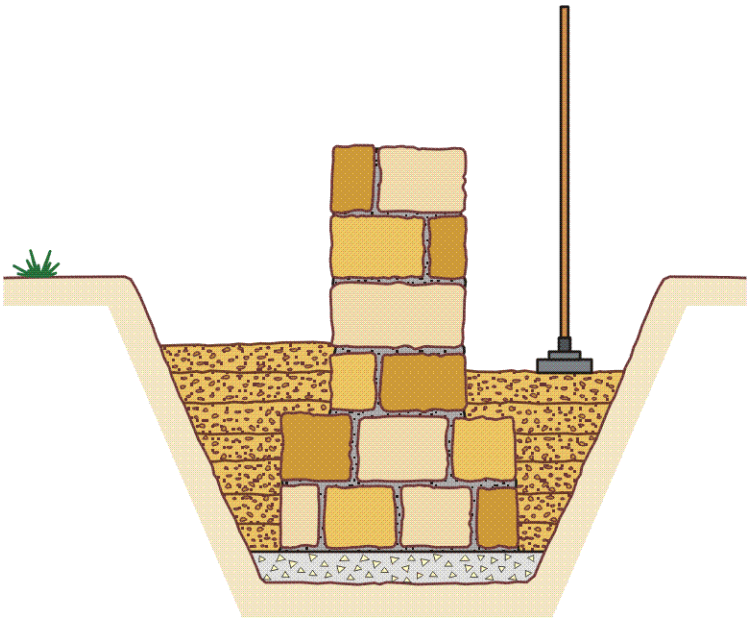
Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Backfilling foundations

M2

Work method:

1. Carefully fill deposited excavation material on both sides of the foundation in layers not exceeding 10cm. Use a rake to level the loose material to form a uniform layer.
2. Moisten the backfilling soil if it is dry by sprinkling it with water.
3. Compact each layer with an earth rammer until properly compacted. Take care not to damage the foundation.
4. Continue layer by layer equally on both sides until reaching the desired level – usually slightly higher than the level of the surrounding terrain.
5. Dispose of excess excavation material at a safe location away from the work site.



Labour:	**Tools:**	**Material:**
• Rural mason for supervision • Labourers for backfilling and compaction	• Shovel • Rake • Earth rammer	• Excavated material of good quality for backfilling • Water to moisten the soil, if too dry.

Quality checkpoints:

- Check and approve the material to be used for backfilling. Check its moisture content. If the soil is too dry, sprinkle water on each layer before compacting.
- Continuously check the thickness of the layers.
- Continuously check achieved compaction degree before placing the next layer.

3.2 Building foundations

The purpose of this section is to explain how a rural mason can:

- ✓ *Determine the size of the strip foundation, and*
- ✓ *Perform all strip foundation works.*

Summary

After excavating the trenches the actual foundations can be constructed. For rural houses these are mostly strip foundations. Depending on the bearing capacity of the ground, the size (width and height) of the foundations is decided. An engineer may approve the size of the foundation.

In most cases, the house foundation can be constructed using bricks, cement blocks or rubble stone depending on the availability of such materials. However, it is important to use only good quality bricks, blocks or stone as the case may be.

3.2.1 Defining the size and type of foundations

Types of soil in foundations

The entire house rests on the foundation. Hence the foundation needs to reach a depth where a layer of firm ground is found. The minimum depth of a foundation for a rural house should be 60 cm - even where soils are very hard.

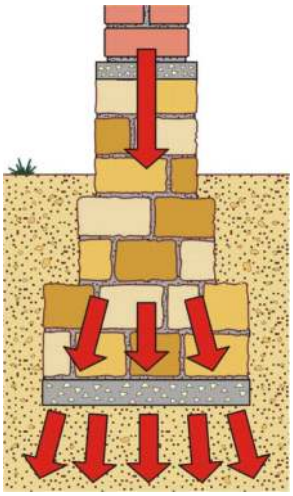
The ground upon which the house stands has a defined bearing capacity, which depends on the nature of the ground. When the soil is wet the bearing capacity is reduced significantly. Therefore, foundations on wet ground do not fulfil the requirements for houses.

The following are the most common material on which foundations are built:

- *Rock* is the best foundation bed. It is usually sufficient to cut the rock into a level bed and wash it before the foundation is cast. Instead of cutting the rock to a level bed it can be levelled using lean concrete.
- *Gravel* is the next best foundation material. It has a high load bearing capacity.
- *Sand* is usually not recommended as a foundation bed. It requires a complicated and expensive foundation that should be avoided.
- *Sand, silt and clay*: The combination of these materials can provide a reasonable foundation bed. However, it is most important to keep water away from this material. The presence of water strongly reduces its bearing capacity. Foundations placed onto this material have to be carefully planned and constructed.

Size of the foundation

The size of the foundation is designed according to the bearing capacity of the ground on which the foundation rests. The load to be applied is the weight of the house, which the foundation needs to transfer to the ground. This can be relatively easy to estimate for simple rural houses while for larger buildings engineering calculations are required.



The engineer or building site technician needs to carefully study the best location for the foundations and their design, taking into consideration any presence of ground water (the water table), old backfills or soft or muddy soils that can make the construction unstable.

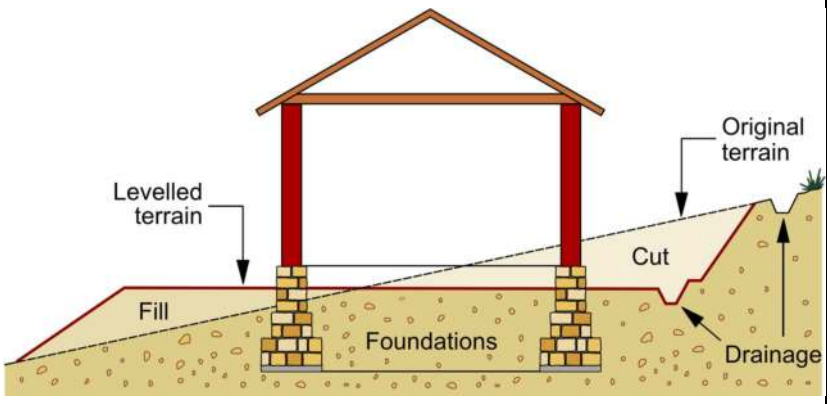
Strip foundations are the easiest and most common foundations used in house construction. The width of a strip foundation depends on the bearing capacity of the ground, and the thickness of the wall.

Foundations are generally twice as wide as the wall they are meant to support in order to distribute the load of the wall over as large a surface as possible within the ground. As a minimum, the height of the strip foundation should be larger than the thickness of the wall.

Foundations on sloping ground

Foundations always need to be level. Therefore, if the house plot is located in sloping terrain, the ground first needs to be levelled to secure the necessary space. This implies that part of the plot will need to be excavated, using the excavated soils as a fill. Since the original soils (in-situ soils) are usually more stable and already well compacted, avoid placing any part of the foundation on the fill. It is important that the foundations reach down to undisturbed firm ground on all sides of the house. Fills have a tendency to continue consolidating even if properly compacted.

It is also necessary to drain water away from the house to prevent it running down into the foundations.



3.2.2 General rules for the construction of foundations

- ✓ The soil of the foundation bed should be uniform. If this is not the case, it is better to shift the building to a location where the ground is uniform.
- ✓ The foundation bed should be horizontal and level. In many places the house is built on sloping ground. Before excavating the trenches, it is common practice to first establish a level surface on which the house is built. Excavated soils may be used as fills to extend the level area. Foundations, however, need to reach down to firm ground below the depth of any landfill.
- ✓ The depth of the foundation below the ground depends on the nature of the soils available. Topsoil including vegetative matter should be removed.
- ✓ Erosion of the foundation has to be carefully considered. Precautionary measures have to be taken to drain the rainwater around the structure so that it cannot expose the foundation and affect it.
- ✓ In cold climates, the foundation needs to be deep enough to avoid that the foundation bed does not freeze. Freezing causes the expansion of the soil, which creates a strong force that can lift up the structure and cause cracks in the foundation and walls.
- ✓ Ensure that the foundation trench is clear from any loose material or debris.
- ✓ When the excavation is complete, the foundation should be built as quickly as possible, especially during the rainy season (to prevent swelling of the ground due to rainwater or caving in of the trench walls).

Tips for the facilitation of Worksheet M3: *Building foundations*

When facilitating the work process described in this worksheet the following approach is recommended:

- Display the poster of Worksheet M3 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M3' and refer to it throughout the lesson.
- Start explaining the worksheet by giving a general introduction to the purpose of the described work. Link your explanation to actual physical work being undertaken during this training course (building a house).
- Also link your explanation to the respective training posters and to Worksheets M5, M6 and M7 for brick masonry or M8 for stone masonry.
- Explain the basic purpose and process of building a foundation.
- Split the class into work groups of three trainees. Each group carries out all the required activities.
- Ensure every work step is fully exercised by the trainees. Demonstrate, observe, correct, encourage and refer to the worksheets.
- When the trainees have completed their tasks, let them assess each other's work and comment on the achieved quality.
- Recapitulate the work done. Use the training poster to review the 'Remember List'.
- In places where stone is not available for foundation work, bricks or cement blocks can be used instead. The worksheet should then be revised accordingly.

Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Building the foundation up to plinth level

M3

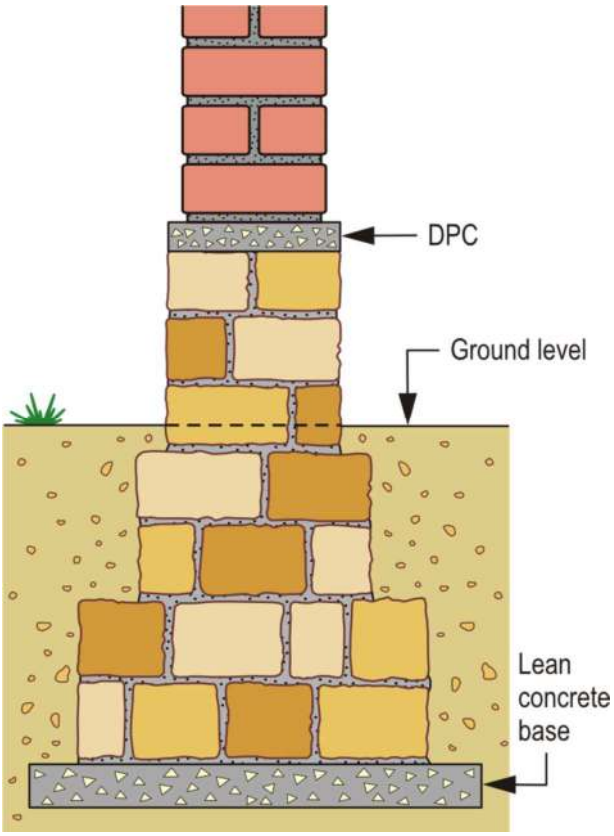
Work method:

For excavation of foundation trenches, refer to worksheet M1.

1. Ensure that the bottom of the foundation trench is clean, level and to the correct depth. Compact any soft spots with an earth rammer.
2. Check the levels again using a tube level. Mark the level in the trench corners as a benchmark for (i) the lean concrete base and (ii) levels for each course of bricks or stone. Use a mason's line as a guide for each course of stone.
3. At the bottom of the trench place a 5 cm thick layer of lean concrete (1:5:10).
4. Start laying the first course of stone, bricks or blocks. Make sure all joints are fully filled with mortar before adding the next layer.
5. Complete sufficient courses to reach up to ground level using a mortar mix of 1:6.

Refer to Worksheets M4, M5, M6 and M7 for details on mixing mortar and masonry works.

6. Add two more courses up to plinth level, reaching some 50 cm above ground level.
7. Place a Damp Proof Course (DPC) of 5 cm. This needs to be watertight. The mix proportion should be 1:2:4 with 12 mm stone, using an aqua-proof compound in the rate of 1 kg per bag of cement.
8. Ensure proper curing of the foundation and plinth wall. Cover the works with moist gunny bags and sprinkle regularly.



For backfilling refer to worksheet M2.

Masonry works for foundations need to be performed with great care, skill and patience to ensure that the foundation is able to support the house and protect the walls from moisture from the ground.

Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist with preparing material	• Shovel and rake • Earth rammer • Straight edge and spirit level • Complete masonry tool set	• Lean concrete for base, 1:5:10 • Random rubble stone for foundation • Dressed stones for plinth • Cement, sand and aggregate • Aqua-proof compound

Quality checkpoints:

- Make sure level of the foundation bed is correct and that the soils are firm and compact.
- Ensure all stones are of good quality and contain no cracks.
- Check that the mortar has a correct mix of cement and sand plus water content.
- Verify that the position of the first foundation layer is correct, at the right level and width.
- Continuously check levels and position (vertical and horizontal) of each layer.
- The DPC layer should be level, smooth and cover the entire crown of the foundation/plinth.

3.3 Brick and block masonry works

The objective of this section is to describe the work methods used to:

- Determine types of bond for masonry works,
- Carry out the required preparatory activities for brick and block masonry works,
- Identify and check the material to be used for brick and block masonry works,
- Lay bricks for construction of foundation footings, walls and columns,
- Carry out pointing in brick masonry.

Brick masonry is the core activity of a rural mason. The mason has to be able to determine the required wall and bond type in accordance with the drawings. The preparatory activities have to be carried out in a planned manner to secure the right tools, materials and labour. Building brick structures requires adequate skills to achieve good quality workmanship.

Most brick walls for rural houses are not plastered (exposed brickwork) and are therefore seen by everybody. These walls are therefore the 'business card' of the rural mason.

3.3.1 Wall and bond types

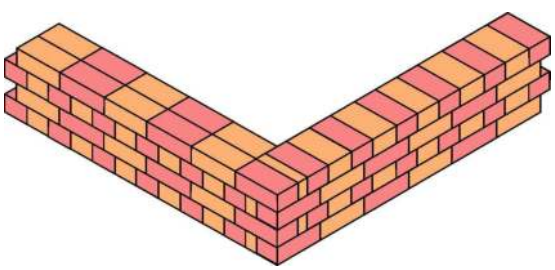
In rural housing works brick masonry is used for building:

- *Load bearing walls* are walls that carry the weight of the roof.
- *Non-load bearing walls* do not carry any load but are merely there to separate rooms.
- *Columns* used in rural houses if walls are long and therefore require intermediate strengthening or in verandas.
- *Footings in foundations and plinths:* These are the vertical extension of the foundations up to the level of the floor of the house.

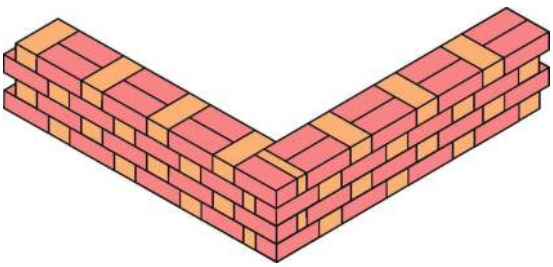
Brick and block walls can be built using different bonds, depending on the design of the house. The thickness of a wall is determined by its function, for example whether it is a load bearing wall or a non-load bearing wall. Also the length and height can influence the thickness of the wall and therefore the type of bond required. The drawings of the building prescribe which type of wall needs to be constructed.

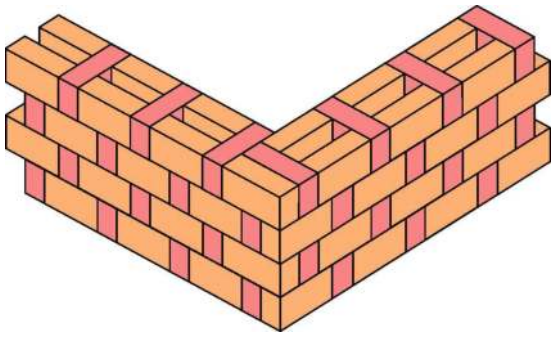
Bonds generally used in rural housing programmes include the English bond, Flemish bond and the rat-trap bond. Each of these bond types has different positioning of the bricks. The following sketches show how the bricks are assembled in each type of bond.

English bond



Flemish bond





Rat-Trap bond

The rat-trap bond is a cost effective masonry pattern. In rat-trap walls the bricks are placed on edge, thereby leaving a cavity between the inner and outer walls. The bricks are placed with alternating headers and stretchers as in a Flemish bond. Rat-trap masonry reduces cost by minimizing the consumption of bricks and cement mortar.

Where to use rat-trap bond brick masonry?

Where good quality bricks are available. Bricks used in rat-trap masonry need a minimum compressive strength of more than 35 kg per square centimetres.

Advantages:

- Compared to a 9" thick solid brick wall, the consumption of brick is reduced by 25%.
- Due to the reduction in the number of bricks, the consumption of cement mortar is also reduced.
- The stability of the wall is not affected as the excess material is eliminated from around the centre line.
- Acts as a good thermal insulator due to the cavities in the wall.
- Plastering the outside face is not necessary as well as inside plaster is minimized since both surfaces are fair faced.

3.3.2 Preparatory activities for brick masonry works

Before starting the masonry works, it is necessary to prepare the work. For this some planning is required on a daily basis.

1. *Estimate the amount of material required for the job at hand:*
   a. Number of bricks or blocks depends on the size of the wall, the type of bond and size of bricks / blocks. Also add 10% for wastage.
   b. The amount of sand and cement depends on the size of the wall, type of masonry and mortar mixture required.
   c. Water for mixing mortar and wetting the bricks or blocks.
2. *Assemble tools and protective equipment for the job at hand:*
   a. Standard mason's tool set.
   b. Measuring tools: tape measure, water tube level, straight edge with spirit level, mason's square, plumb bob, string (mason's line) with pegs or clamps.
   c. Protective equipment: helmet, facemask, goggles, good boots and gloves.
3. *Set out the walls to be built:*
   a. Re-establish the wall corners and lines according to the site plan (drawing) using thread lines and a mason's square. Mark the external side of the walls on top of the foundation.
   b. Measure and mark where the openings (doors and windows) will be located.

c. Countercheck the levels, e.g. the top of the Damp Proof Course, DPC. This layer must be horizontal. If necessary make the first corrections to ensure the walls start with horizontal and uniform courses.

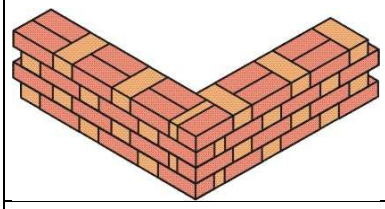
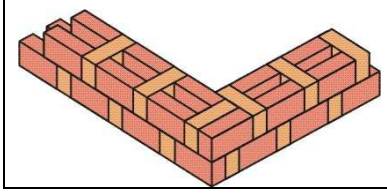
3.3.3 Materials for brick masonry works

Materials for masonry are bricks or blocks and mortar.

Material quantities:

Refer to Learning Unit 1, Basic knowledge for further information on materials for brick masonry.

The table below shows the approximate quantities of materials required for each cubic metre of brick walls:

Type	Width of joints	Material requirements for 1 m^3 finished wall
 Brick masonry in English and Flemish bond with mortar 1:6. Brick size = 22.5 x 10.5 x 7.5 cm	1.2 to 1.5 cm	Bricks = No. 512 Cement = 48 Kg (1 bag) Sand = 0.2 m^3
 Brick masonry in rat-trap bond with mortar 1:6. Brick size = 22.5 x 10.5 x 7.5 cm	1.2 to 1.5 cm	Bricks = No. 385 Cement = 36 Kg Sand = 0.15 m^3

Cement mortar

Mortar consists of sand and cement, which forms a pliable mass after mixing with water. Mortar hardens (cures) gradually.

Good mortar used for masonry consists of cement, sand and water in the correct proportions. The sand needs to be clean and of a certain grain size, small enough to pass through a 2.36mm sieve. It is important to separate debris and organic matter from the sand by sieving it. Best is to use river sand.

When mixing mortar, a uniform mixture of sand and cement (turned at least 3 times) is first prepared before adding water. Mortar mixed with water must be used within one hour, after which the mortar hardens and can no longer be used.

Water should be added sparingly to avoid the mortar becoming too fluid. If too much water is added, the mortar not only looses its strength but also spills out when the bricks are positioned.

The specification of cement mortar is defined in terms of the proportions of cement and sand. For example, the ratio of 1:6 implies that the mortar consists of one part of cement and six parts of sand.

Tips for the facilitation of Worksheet M4: *Mixing mortar*

When facilitating the work process described in this worksheet the following approach is recommended:

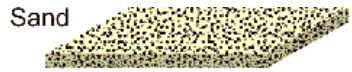
- Display the poster of Worksheet M4 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M4' and refer to it throughout the lesson.
- Start explaining the worksheet by giving a general introduction to the purpose of the described work. Link your explanation to actual physical work undertaken during this training course (building a house).
- Explain the principles of mixing mortar as per Worksheet M4. Give particular attention to the correct proportion of cement and sand plus the amount of water to be added to obtain good quality mortar.
- Split the class into work groups of three trainees. Each group first mixes dry sand with cement until the mix is uniform. Then mixing continues by adding the correct amount of water.
- Ensure that all trainees practices every work step → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have completed their tasks, let them assess each other's work and comment on the achieved quality.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

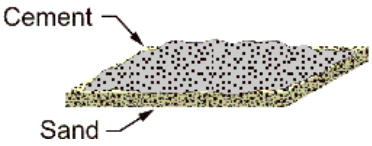
Worksheet
Activity: Mixing mortar

M4

Work method:



1. Place and spread six parts of sand on a clean platform or hard surface.
2. Add one part of cement on top of the sand.



3. Thoroughly mix the sand and cement until a uniform grey mixture is achieved. The general rule is that sand and cement is mixed dry together at least three times before adding water. It is important to achieve a consistently uniform mix.

4. Rake the mix together and dig a well in the centre of the heap and carefully add water. Add the water in portions to avoid ending up with a too wet mix.
5. Carefully shovel the dry mix into the water in the middle of the heap and continue mixing until the mortar has a uniform mass with the preferred consistency.

Caution:

- Always use fresh and lump free cement.
- First mix the dry ingredients (sand and cement) before adding water.
- Protect the mortar-mixing place from wind, rain and sunshine.
- Since the mortar sets relatively quickly, it should never be mixed in larger quantities than what can be used during the next hour. Do not use mortar that has already hardened.

Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Clean platform for mixing • Shovels • An appropriate size box or measured buckets for batching • Water buckets	• Cleaned and sieved sand • Cement • Clean water (no salt water) • Canvas to protect mixed mortar from sunshine

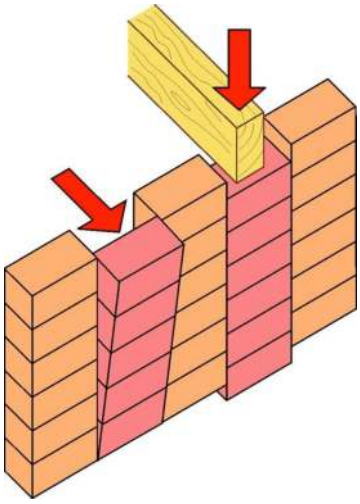
Quality checkpoints:

- ✓ Check that the cement has not expired and does not contain any lumps.
- ✓ Check that the sand is clean and with correct grain size.
- ✓ Ensure that the water is clean - no salt water.
- ✓ Check that batching is done correctly, to an appropriate amount and with the desired mix ratio.
- ✓ Continuously check consistency when mixing and avoiding a too wet or too dry mix.
- ✓ Ensure that the mortar used is fresh.

3.3.4 Bricklaying

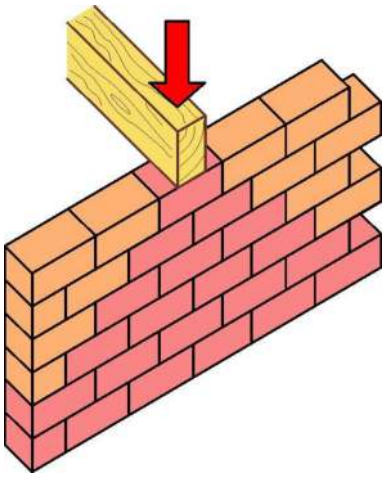
The art of masonry is the accurate laying of bricks or blocks by ensuring:

- ✓ correct measurements as per the drawings,
- ✓ accurate vertical lines (plumb),
- ✓ accurate horizontal lines,
- ✓ accurate levels.



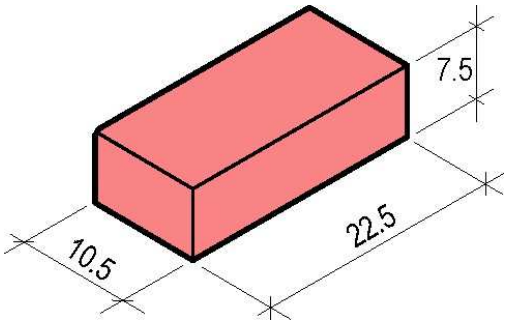
The building procedure for bricks or blocks is the same. Joints between bricks should never be in line with the joints of bricks in the course below. Good bonding between courses ensures that the forces applied to the wall are effectively distributed. The structure remains stable and strong and functions as one unit.

Unbounded or insufficient bonding results in vertical joints with the accompanying risk of failure as shown in the adjacent figure.



The term bonding means the arrangements of bricks in which no vertical joint of one course is exactly above the one below. That means the bricks are laid in such a way that they overlap and breaks the joint below. The amount of overlay is generally half the length of a brick. The minimum lap is 1/4 of the length of a brick.

The courses of bricks are placed with staggering joints. The bonds produce a stronger wall allowing loads to be transferred effectively.



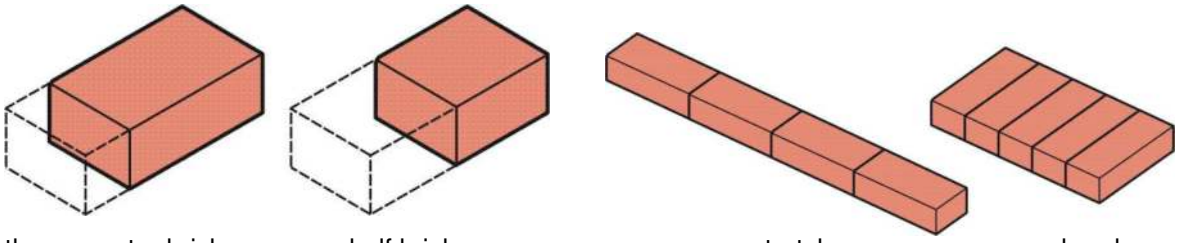
Clay bricks with the dimensions 22.5 x 10.5 x 7.5cm are handy to work with and suitable for all kinds of bonding.

For horizontal joints (mortar bed) the thickness of 12mm is recommended for brickwork to ensure:

- levelling of the mortar bed,
- placing of bricks completely in mortar, and
- no uneven or incomplete support of the bricks due to stones in the mortar.

Too thick horizontal joints (more than 12mm) is a waste of costly mortar (cement), and weakens the structure. The joints are the weakest part of the masonry structure. For the vertical joints (buttering) a thickness of 10mm is recommended for brickwork for the same reasons. The reduction of 2mm compared to the horizontal joints is possible because the contact area is much smaller at the side than at the bottom.

In order to obtain a good bond it is necessary to insert “bats” (parts of bricks). Some of the commonly used brick terms are:



three-quarter brick half brick stretchers headers

Bricks can be laid in a variety of bonding arrangements. To prevent the crushing of bricks, use bonding of as many full bricks as possible, using three quarter and half bricks.

Tips for the facilitation of Worksheet M5: *Brick and block masonry – general application*

When facilitating the work process described in this worksheet that the following approach is recommended:

- Display the poster of Worksheet M5 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M5' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to masonry work in general. Link your explanation to actual physical work undertaken during this training course (building a house) and emphasise that masonry is the core of their work as rural masons.
- Also link the explanation to the respective training posters.
- Discuss each point of the described work method in Worksheets M5, M6, M7 and M8. Always relate to actual on-going work. Make examples or even better demonstrate the real process.
- Split the class into work groups of three trainees. Each group carries out all the required activities in a 'dry-run' exercise.
- Ensure that all the trainees get to practice every work step → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have finished their tasks, let them assess each other's achievements and comment on the quality. If necessary, let them repeat the exercise until they have acquired the minimum required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

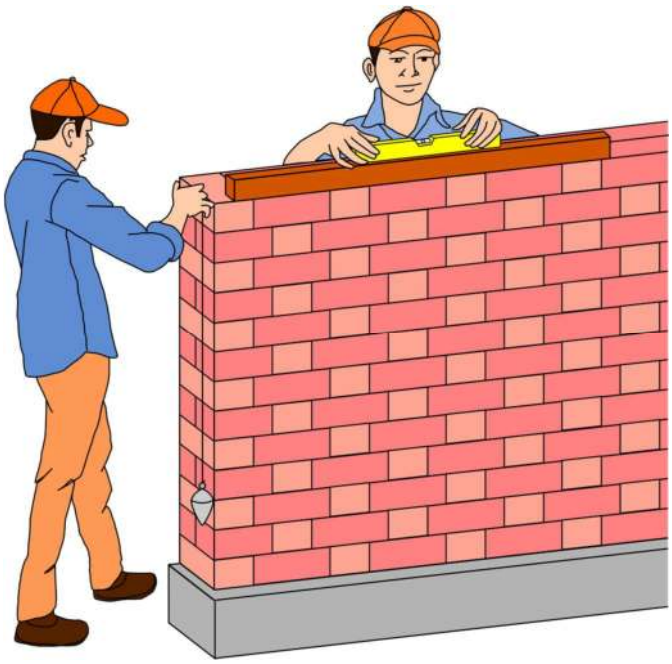
Worksheet
Activity: Brick and block masonry – general application

M5

General work method to construct masonry walls:

1. Lay out exactly the proposed structure by marking the external side of the walls on the plinth.
2. Clean the foundation with a steel brush and wet it properly.
3. Lay the first two courses without mortar to check that the correct bond is achieved. Always start at two ends or corners.
4. Cement blocks are cleaned and sprinkled with water. Burnt bricks are soaked in water for one minute before use. This is to avoid that water in the mortar is absorbed by the bricks or blocks, which may reduce the quality and strength of the mortar.

   If the bricks are not clean, the mortar does not bond properly, which in turn may produce cracks caused by swelling and shrinking.
5. Check the quality of every brick by performing a sound test before using it for construction.



6. Lay the corners exactly with bricks and mortar and stretch a line from one corner to the other. Thereafter build the first course in between these marked lines.
7. Fix a mason's line properly using a string to ensure that all courses are straight and level. Make sure the string is always tightly pulled to avoid any sagging.
8. Build the corners four to five courses high and then lay the complete courses following the mason's line.

Caution:

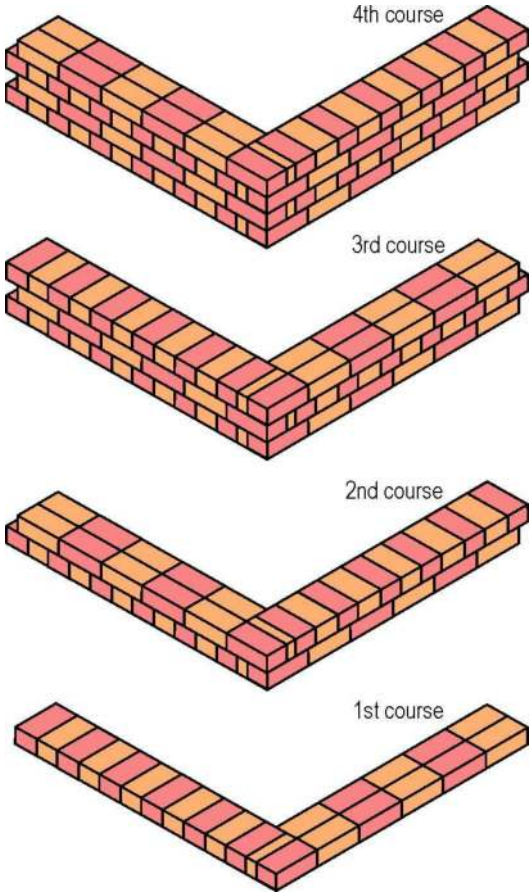
- Quarter bricks should never be used at the end of a wall. Use as many full bricks as possible.
- Use the same bond throughout the job.
- Leftover mortar after each course should be cleaned from the bricks as well as from the ground. If it is clean, the mortar can be used for the next course.
- The maximum brick wall height built per day should not exceed 10 layers.

Worksheet
Activity: Brick masonry – English bond

M6

Work method:

1. Set out the exact position of the structure (wall) by marking the external side of the walls on the plinth.
2. Lay the first two courses using 'dry' bricks – without mortar. This allows you to arrange proper bonding, identify where bricks need to be cut and to check the thickness of the vertical joints.
3. Always begin a wall with a stretcher course. Start work at a corner by first laying the corner bricks. Use a spirit level to check that the corner bricks are horizontal in both directions and vertical at the corner line.
4. Continue with the following bricks off the corner in both directions. In one direction it will be a stretcher course and in the other direction a header course. In the header course you have to place as the second brick a half-size brick to ensure the bonding becomes correct.
5. Start with the second course again in the corner, but now place the corner bricks in the opposite direction from the corner bricks in the first course. Again check horizontal and vertical directions and ensure the correct thickness of the joints (not more than 15mm).
6. The third course is exactly the same as the first course and the fourth course is identical to the second course.



7. Build all walls simultaneously for better bonding. The maximum brick wall height per day should not exceed 10 layers.

Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Standard masonry tool set • Shovel • Buckets with water to soak bricks / blocks • Mortar pans for carrying and keeping mortar • Gunny bags to cover wall from direct sunshine	• Bricks ready next to the mason • Mortar ready next to the mason • Water for wetting stones

Quality checkpoints:

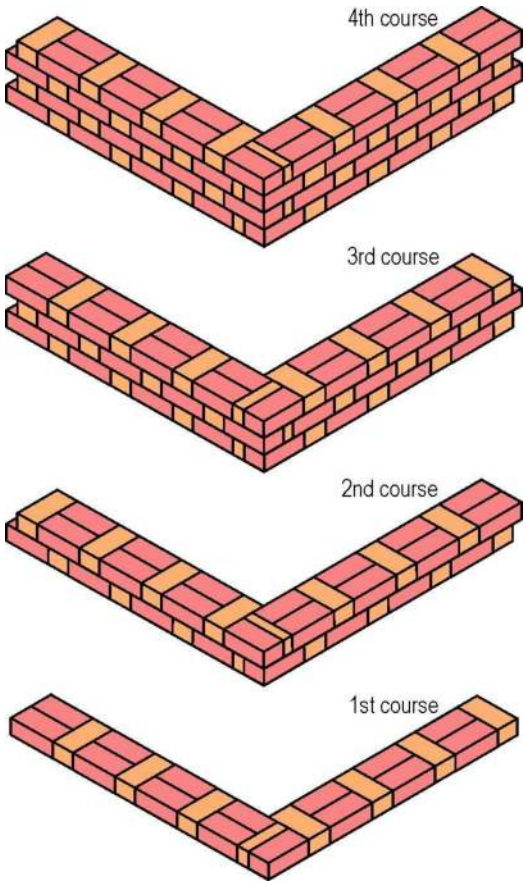
- Check that all corners remain vertical at all times.
- Check that the level of each course is correct (height of courses = one brick plus one joint)
- Ensure the mason's line is tightly pulled to avoid any sagging.
- Make sure that the joints are not less than 10mm and not more than 15mm.
- All joints should be fully filled with mortar.
- Use a plumb bob to check that every wall is vertical.
- Immediately remove excess mortar protruding from the joints.
- In hot weather, cover the completed wall with wet gunny bags at the end of the day.

Worksheet
Activity: Brick masonry – Flemish bond

M7

Work method:

1. Lay out exactly the proposed structure (wall) by marking the external side of the walls on the foundation
2. Lay the first two courses using 'dry' bricks – without mortar. This allows you to arrange proper bonding, identify where bricks need to be cut and to check the thickness of the vertical joints.
3. Start work at a corner by first laying the corner bricks. Check with a spirit level that the corner bricks are horizontal in both directions and vertical at the corner line.
4. Continue with the following bricks off the corner in both directions by alternating stretchers with headers.
5. Start with the second course again in the corner, but now place the corner bricks in the opposite direction from the corner bricks in the first course. Again check horizontal and vertical directions and ensure the correct thickness of the joints (not more than 15mm).
6. The third course is exactly the same as the first course and the fourth course is the same as the second course.



Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Standard masonry tool set • Shovel • Buckets with water to soak bricks or blocks • Mortar pans for carrying and keeping mortar • Gunny bags to cover wall from direct sunshine	• Bricks ready next to the mason • Mortar ready next to the mason • Water for wetting stones

Quality checkpoints:

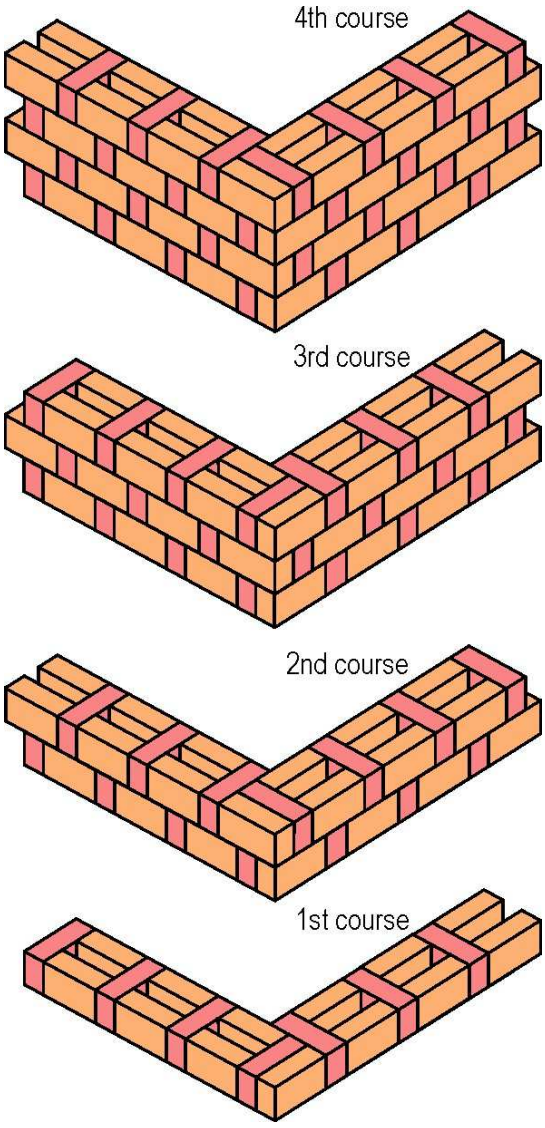
- Check that all corners remain vertical at all times.
- Check that the level of each course is correct (height of courses = one brick plus one joint)
- Ensure the mason's line is tightly pulled to avoid any sagging.
- Make sure that the joints are not less than 10mm and not more than 15mm.
- All joints should be fully filled with mortar.
- Use a plumb bob to check that every wall is vertical.
- Immediately remove excess mortar protruding from the joints.
- In hot weather, ensure that completed works are covered with wet gunny bags.

Worksheet
Activity: Brick masonry – Rat-trap bond

M8a

Work method:

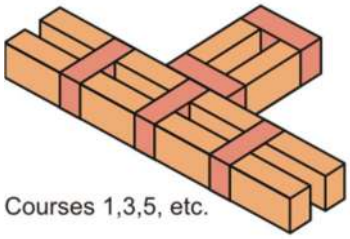
1. Lay out exactly the proposed structure (wall) by marking the external side of the walls on top of the foundation.
2. Lay the first two courses using 'dry' bricks without mortar. This allows you to arrange proper bonding, identify where bricks need to be cut and to check the thickness of the vertical joints.
3. Note: For the Rat-Trap bond all bricks are laid on their narrower side – vertically.
4. Start work at a corner by setting the two corner bricks. Check with the spirit level that the corner bricks are horizontal in both directions and vertical at the corner line.
5. Continue laying bricks in both directions from the corner by alternating stretchers with headers and leaving a cavity in the middle. Do not fill the cavity with mortar or with any other material.
6. Start with the second course again in the corner, but now place the two corner bricks in the opposite direction from the corner brick in the first course. Again, check horizontal and vertical directions and ensure correct thickness of the joints (not more than 15mm).
7. The third course is exactly the same as the first course and the fourth course is the same as the second course.

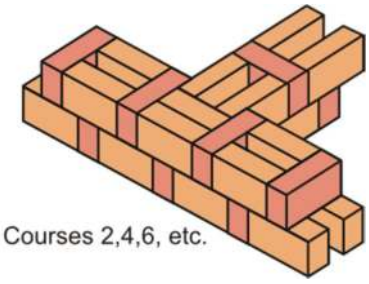


Worksheet
Activity: Brick masonry – Rat-trap bond

M8b

8. Special bonding arrangements are required for T-junctions:





Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Standard masonry tool set • Shovel • Buckets with water to soak bricks • Mortar pans for carrying and keeping mortar • Gunny bags to cover wall from sunshine	• Bricks ready next to the mason • Mortar ready next to the mason • Water for wetting stones

Quality checkpoints:

- Check that all corners remain vertical at all times.
- Check that the level of each course is correct (height of courses = one brick plus one joint).
- Ensure the mason's line is tightly pulled to avoid any sagging.
- Make sure that the joints are not less than 10mm and not more than 15mm.
- All joints should be fully filled with mortar.
- Use a plumb bob to check that every wall is vertical.
- Immediately remove excess mortar protruding from the joints.
- In hot weather, cover the completed wall with wet gunny bags at the end of the day.

3.3.5 Pointing for brick masonry

The main reasons for pointing the surface of block or brickwork joints are to increase its weather resistance and to provide a neat and good-looking finish to the wall.

Pointing can be carried out as a part of construction of the brickwork using ordinary mortar in which the bricks are bedded.

Another method is to finish the masonry works first and then carry out the pointing with a 1:2 cement mortar later. The joints are then be raked out, brushed, washed and filled with fresh mortar. Ideally to save cement and mason-days it is better to take up pointing simultaneously with the actual brick laying.

Tips for the facilitation of Worksheet M9: *Pointing brick masonry*

When facilitating the work process described in this worksheet the following approach is recommended:

- Display the poster of Worksheet M9 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M9' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to the different pointing techniques, their advantages and disadvantages. Link your explanation to actual physical work undertaken during this training course (building a house).
- Discuss each work step of the described work method in the worksheet. Always relate to actual on-going work and demonstrate the real work process.
- Let each trainee carry out all the required activities.
- Ensure that each trainee practices every work step → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have finished, let them assess each other's work and comment on the achieved quality. If necessary, repeat the exercise until they have acquired the minimal required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

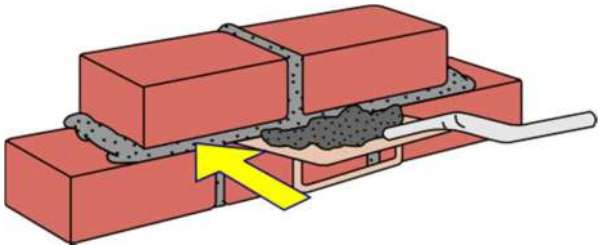
Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Pointing brick masonry

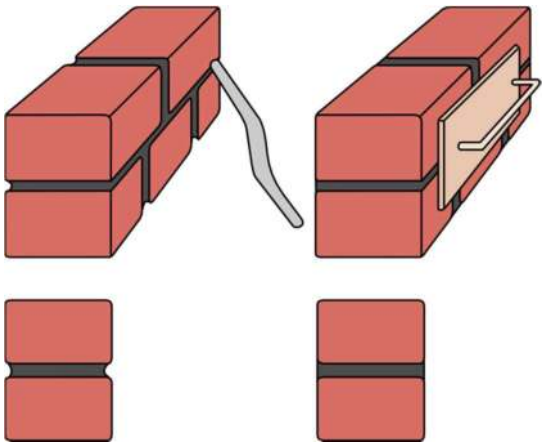
M9

Work method:

1. Rake out the joints to a depth of about 1 to 1.5 cm. This is best to do not later than one day after the wall has been built while the mortar is still soft.
2. Brush and clean the joints so they are free from dust and mortar debris.
3. Wet the joints and fill with cement mortar 1:2. Pointing: flush or keyed.
4. Brush all bricks clean until there are no remaining mortar stains.



Filling the joints with mortar 1:2



Recessed joints flush joints

Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Standard masonry tool set • Mortar pan to carry mortar • Buckets with water to wet the joints • Brush / broom for cleaning joints and wall • Gunny bags to cover wall from direct sunshine	• Mortar ready next to the mason • Water for wetting joints

Quality checkpoints:

- Ensure all joints are properly raked and cleaned out.
- Ensure all joints are properly filled and nicely keyed.
- Ensure wall is clean and leftover mortar on the ground is removed.
- Protect the wall from sun and rain

3.4 Stone masonry

This section aims to enable the rural mason to:

- ✓ Determine wall and bond types in stone masonry works,
- ✓ Carry out all the required preparatory activities for stone masonry works,
- ✓ Identify and check the material to be used,
- ✓ Carry out stone masonry for construction of foundations, footings, load bearing and non-load bearing walls, and columns,
- ✓ Carry out pointing in stone masonry.

Good stone masonry requires advanced skills. The rural mason has to be able to determine the required wall and bond type in accordance with the drawings. The preparatory activities need to be carried out in a planned manner to ensure that the right material, tools and labour are available.

Stonewalls are usually not plastered and are therefore seen by everybody. The quality of these walls is therefore the 'business card' of the mason.

3.4.1 Wall and masonry types

In rural housing works, stone masonry can be applied for:

- *Load bearing walls* are walls that support a load, such as a roof.
- *Non-load bearing walls* are walls that do not support any load but are merely there to separate rooms.
- *Columns* are used in rural houses if the walls are long and therefore require intermediate support or to carry roof trusses.
- *Footings*, are also called 'plinths', and are the vertical extension of the foundations up to the level of the floor inside the house.

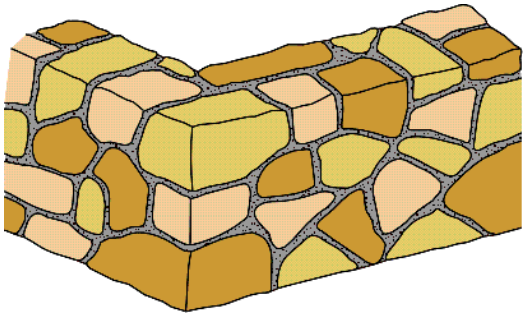
Stone masonry may be classified in various ways, as for instance, according to the kind of stones used, surface finishing, bonding, etc.

Rubble masonry is composed of stones with any shape. They are found in quarries or found in the open field. The quarried variety is preferable because they are stronger and usually of a more rectangular shape, which is better for masonry works. Their faces are sharper and form a better hold for the mortar than the weather worn and smoother surfaces of field stones. However, in some areas, non-round field stones are also used for house construction.

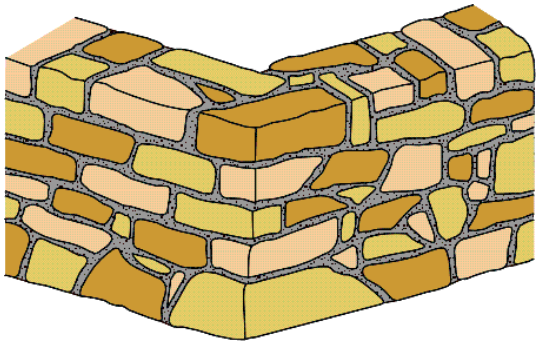
There are three kinds of rubble masonry, known as:

Undressed rubble

This kind of masonry covers all kinds and sizes of stones in which faces, joints and beds are randomly shaped. No special attention is given to the level of the courses. With good attention to the surface finish (joint finish, flush joints) an attractive wall will result.



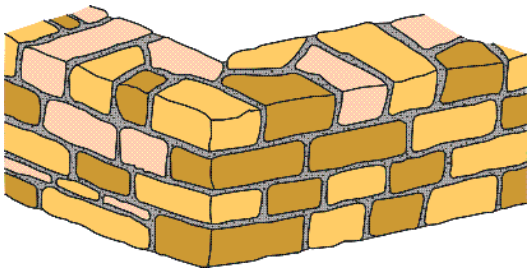
Random dressed rubble



In this kind of rubble masonry all the stones have well shaped faces. In laying the stones special attention is given to bringing each course to as near level as possible.

The difference between undressed and random dressed rubble can be seen in the surface finish. In random dressed rubble smaller stones are used than in undressed rubble.

Dressed rubble



With dressed rubble particular attention is given to shaping the stones. The faces are close to rectangular and the height of all the stones should be nearly the same. When laying the stones, special attention is given to the bond stones, the height of each course and a proper alignment.

In all the above types of masonry, bond stones should be used (long stones across the entire width of the wall) at the rate of 120cm intervals to ensure proper bonding.

3.4.2 Preparatory activities for stone masonry works

Before commencing the masonry work, there are several important preparatory activities. For this, some planning is required on a daily basis.

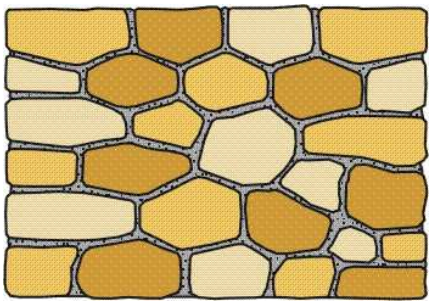
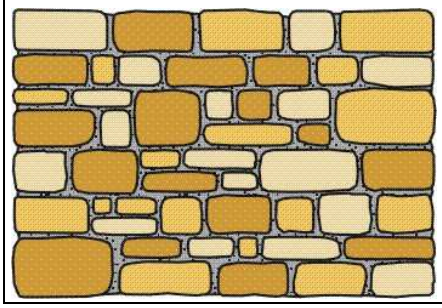
1. *Estimate the amount of material required for the job at hand:*
   a. Estimate the quantity of rubble stone based on the size of the wall and size of stones, the type of bond and shape of rubble stones (un-dressed, random dressed or dressed). Also add 30% for wastage for un-coursed rubble and about 20% for random or coursed rubble.
   b. Calculate the amount of sand and cement, depending on the size of the wall, type of masonry and mortar mixture required.
   c. Make water available on site for mixing mortar and wetting the stones.
2. *Assemble the necessary tools and protective equipment:*
   a. Special tools required for quarrying and dressing the stones, like crowbars, sledge hammer, chisels and club hammers.
   b. Standard mason's tool set.
   c. Measuring tools: tape measure, water tube level, straight edge with spirit level, mason's square, plumb bob, string line with pegs or clamps.
   d. Protective equipment: helmet, facemask, goggles, good boots and gloves.
3. *Setting out the walls:*
   a. Re-establish the wall corners and lines according to the site plan, using a string line. Mark the *external* side of the walls on top of the foundation.
   b. Measure and mark where the openings (doors and windows) will be located.
   c. Countercheck the levels, e.g. the bottom of trenches and top of DPC. These surfaces should be horizontal. If necessary first make corrections to ensure the walls start with horizontal and uniform courses.

3.4.3 Material for stone masonry works

Materials for the masonry work consist of rubble stone and mortar.

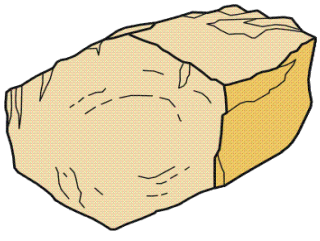
Refer to Learning Unit 1, Basic knowledge for detailed information on materials for stone masonry.

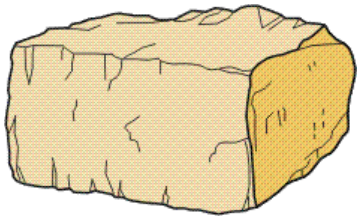
The table below shows the approximate quantities of material required for each cubic metre of stonewalls:

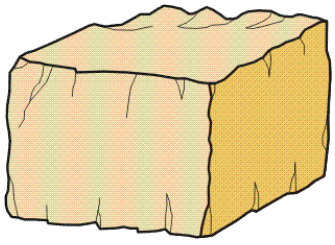
Type		Width of joints	Material requirements for 1 m^3 finished wall
	Undressed rubble stone masonry: The stones are not specifically cut or shaped. To build a wall with proper bonding using undressed rubble stone requires well-developed skills from a mason.	1 cm to 4 cm	Stones: approx. 1.3 to 1.5 m^3 (includes waste) Mortar 1:6 Cement = 85 kg Sand = 0.35 m^3
	Random dressed and dressed rubble stone masonry: The stones are dressed to a rectangular shape. Using these stones it is easier to produce a wall with proper bonding and a uniform surface.	1 cm to 2.5 cm	Stones: approx. 1.2 m^3 (includes waste) Mortar 1 : 6 Cement = 75 kg Sand = 0.32 m^3

Preparing the stone

Shaping (dressing) stones takes time and patience. It is the task of the rural mason to prepare the stones to the required size and shape. In some instances workers who are trained and supervised locally can assist in the stone shaping. The following shapes of stones are used for construction:







Line stones

Stones built between corner stones are called line stones. They should have (but not necessarily) a flat and even surface. The combination of flat surfaces at the corners and rough hammer dressed line stones give the stone masonry an attractive appearance.

Corner stones

Two faces should be squared and shaped with a chisel and a club hammer to a flat surface, or at least hammer dressed to allow for accurate plumbing.

Cement mortar

Cement mortar is commonly used for rubble stone masonry.

Refer to Worksheet M4 for detailed information on how to prepare mortar.

Tips for the facilitation of Worksheet M10: *Shaping stones*

When facilitating the work process described in this worksheet the following approach is recommended:

- Display the poster of Worksheet M10 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M10' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to the reasons for shaping stones. Link your explanation to the actual physical work undertaken during this training course (building a house).
- Discuss each step of the described work method in the worksheet. Always relate to actual on-going work and demonstrate the real work process. Give particular attention to the use of protective equipment.
- Demonstrate how to shape stones correctly and then let each trainee exercise shaping.
- Ensure that all trainees have practiced every work step → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have finished their tasks, let them assess each other's work and comment on the achieved quality. If necessary, let them repeat the exercise until they have acquired the minimal required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

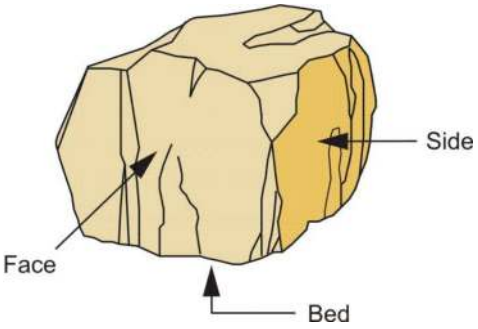
Worksheet
Activity: Shaping stones (random dressed and dressed stones)

M10

Work method:

1. Prepare the work ground, tools and safety equipment.
2. Clean the stone to be dressed, e.g. using a brush and water.
3. Cut it roughly on all sides, to the extent possible utilising its natural shape. Stones should be of size and weight that can be carried by one person.
4. Dress the face straight and check it with a straight edge.
5. Select the stones that could be used as corners and shape the reverse face.
6. Make sure all dressed stones are completely clean and stockpile them neatly.
7. Clean the work area from debris. Stone chips may be used as backfilling material for foundations or plinths.

Make sure that all safety equipment is in use.



The surfaces of the stones that may need to be shaped are:
- Face (the surface of the wall),
- Bed (the side on which the stone rests), and
- Side.

Labour:	**Tools:**	**Material:**
• Rural mason and/or trained chiseller	• Measuring tape (3m) • Mason's square (90°) • Sledge hammer • Chisel hammer • Long chisel tipped • Chisel flat / tipped (various sizes) • Shovel and broom (to remove waste)	• Good quality rubble stone

Quality checkpoints:

- Check that all stone is clean with no cracks and that they have the desired size and shape (random dressed or dressed).
- Check that the dressed stone faces are smooth.

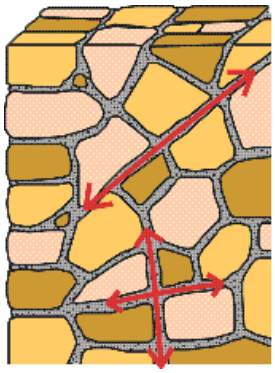
3.4.4 Laying stone

The art of stone masonry is the accurate laying of rubble stone by ensuring:

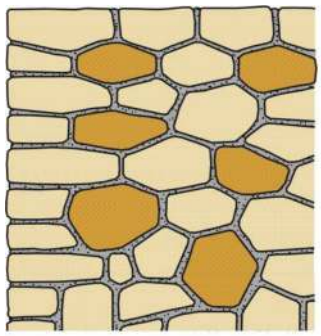
- correct measurements as per plan,
- accurate vertical lines (plumbness),
- horizontal levels,
- accurate levels, and
- good bonding.

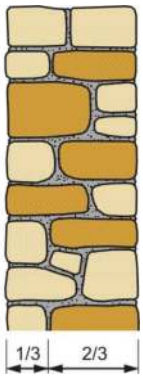
Proper bonding is very important in stone masonry. The following rules should be strictly observed:

- ✓ Headers should extend not less than 2/3 the thickness of the wall.
- ✓ Bond stones should be used (long stones across the entire width of the wall) at 120cm intervals to ensure proper bonding.
- ✓ The vertical joints of each course should break with the joints of the course below.
- ✓ The largest stones should be used for the lowest courses.
- ✓ Stratified stones should be laid on their natural beds (sandstones).



Poor bonding

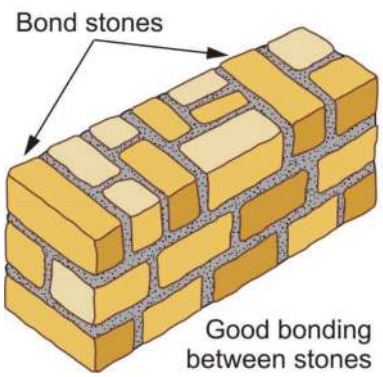


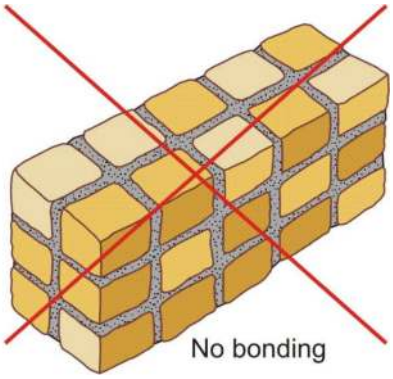


Incorrect

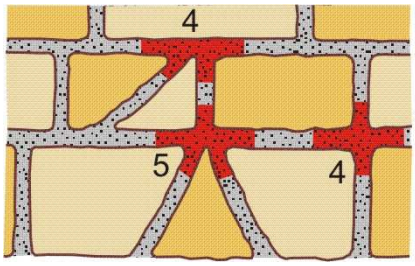
Correct

Place bond stones at frequent intervals thereby increasing the cohesive strength of the wall.





The joints should be in staggered rows, thereby ensuring that stones in overlaying layers produce good overlap above joints in the underlying course. The ideal is to allow for a maximum of three intersecting joints. More intersecting joints will result in poor bonding and reduce the strength of the wall.



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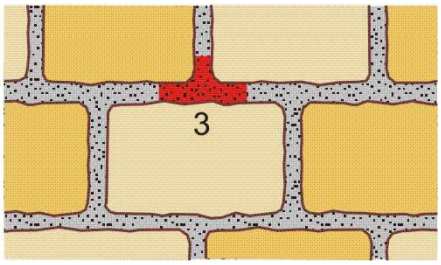
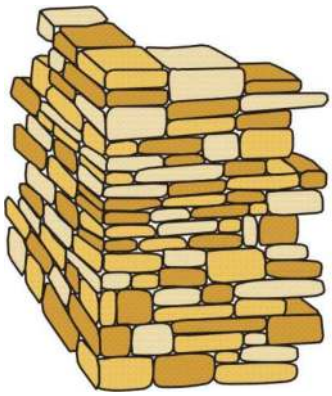
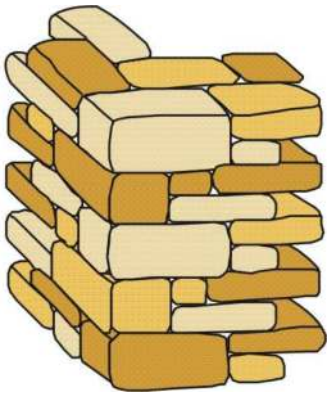


Correct

Reinforcing the corners

Corners are more vulnerable. Place the largest stone in the corners and try to obtain good bonding between the corner stones and the adjacent wall stones.


Incorrect


Correct

The work methods for ensuring level and straight courses of stone and vertical walls are the same as for brick masonry. It is advisable to have one string for the inner wall and a second for the outer side, and to work with two masons at the same time.

While one mason builds on the outside, the other mason builds the inside of the wall.

Tips for the facilitation of Worksheet 11: *Stone masonry*

When facilitating the work process described in this Worksheet M11, the following approach is recommended:

- Display the poster of Worksheet M11 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M11' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to the basic features of the stone masonry. Link your explanation to actual physical work to be undertaken during this training course (building a house). Give particular attention to explaining the importance of proper bonding arrangements.
- Also link your explanation to the respective training posters.
- Discuss each work step of the described work method in the worksheet. Always relate to actual on-going work and demonstrate the real work process.
- Split the class into work groups of three trainees. Each group carries out all the required activities as a 'dry-run' exercise.
- Once satisfied with the outcome of the 'dry-run', move to the actual work.
- Ensure that the trainees practice every work step → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have finished their tasks, let them assess each other's work and comment on the achieved quality. If necessary, let them repeat the exercise until they have acquired the required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Stone masonry

M11

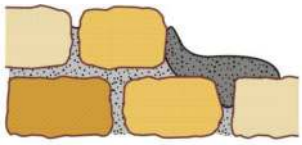
Work method:

1. Preparation

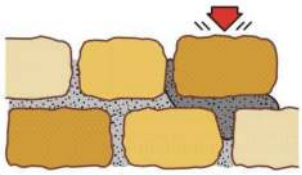
- Set out exactly the proposed structure by marking the sides of the walls on the foundation or the trench bed.
- Clean the foundation with a steel brush, wet it properly and if necessary rough it by chiselling.
- Two masons should work at the same time on a wall, one inside and one outside.
- Use crack-free and washed stone.
- A stiff mortar should be used. Never fill the inside of the wall with slurry mortar because this will reduce the strength.

2. Construction

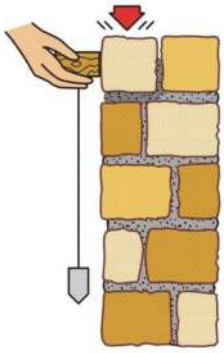
- Use the largest and straightest stones on the ground and as corner stones.
- Use two-faced shaped and squared stone for corners as well as for the top of the wall.
- The stones are laid on a mortar bed and then tapped gently into the mortar with a hammer.
- Build the corner stones inside and outside, then stretch a string on each side and build in between these lines.
- Leftover mortar from each course should be cleaned from the stones as well as from the ground and can be used in the next course.
- The overlap of the stones should be minimum 10cm.
- The face and the inner part of the wall should be built at the same time.
- The joints should not be thicker than 2.0-2.5 cm but never less than 1.0 cm, depending also on the size of the stone.
- Small pieces of stone are used for better seating of the shaped stone but they should not be visible at the outside of the wall. These stone chips needs to be well embedded in mortar.



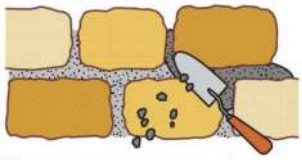
Apply a 3 cm thick layer of mortar



Place the stone in position



Check that the wall is vertical with a plumb bob or spirit level



Remove any excess mortar

Labour:	**Tools:**	**Material:**
• 2 rural masons • Labourers to assist	• Standard masonry tool set • Shovel • Buckets with water to soak stones • Gunny bags	• Stone at hand next to the mason • Mortar ready next to the mason • Water for wetting stones

Quality checkpoints:

- Ensure proper bonding of the stone.
- Use a plumb bob to check that all walls remain vertical.
- Ensure all joints are fully filled with mortar and all stones are fully embedded in mortar.
- Immediately remove excess mortar protruding from the joints.
- In hot weather, cover the completed works with wet gunny bags.

3.4.5 Pointing for stone masonry

The main reasons for pointing the surface of stone masonry joints are to increase its weather resistance and to give a neat and good-looking finish to the work.

Pointing can be carried out when stone masonry work takes place, using ordinary mortar in which the stone is embedded.

Another method is to first finish the masonry work and later carry out the pointing work with a 1:2 cement mortar. The joints are then raked out, brushed, washed and filled with fresh cement mortar.

Tips for the facilitation of Worksheet M12: *Pointing stone masonry*

When facilitating the work process described in this worksheet the following approach is recommended:

- Display the poster of Worksheet M12 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M12' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to the different pointing technics, their advantages and disadvantages. Link the explanation to actual physical work undertaken during this training course (building a house).
- Discuss each work step described in the worksheet. Always relate to actual on-going work and demonstrate the real work process.
- Let each trainee carry out all the required activities → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have finished their tasks, let them assess each other's work and comment on the achieved quality. If necessary, let them repeat until they have acquired the required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Pointing stone masonry

M12

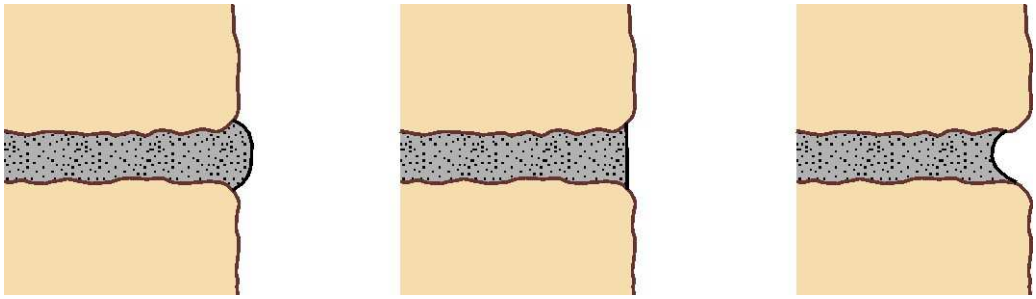
Purpose:

Pointing the joints protect the wall from wind and moisture entering into or though the wall. Well-pointed masonry foundations in wet soils will resist water from entering the wall.

Work method:

1. Rake out the joints to a depth of about 3 to 4 cm. This is best to do not later than one day after the wall has been built, while the mortar is still relatively soft.
2. Brush out and clean the joints so they are free from dust and mortar debris.
3. Wet the joints and fill with cement mortar with a mix of 1:2, using fine sand.
4. The pointing of the joints can be projecting, flush or keyed.
5. Smooth the joints with the pointing trowel.
6. Brush all stones clean so there is no remaining mortar stains.

There are three types of joints:



Projecting joint | Flush joint | Keyed joint

The flush joint is the recommended pointing for masonry walls in rural house construction.

Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Standard masonry tool set • Buckets with water to wet the joints • Canvas to cover the walls from direct sunshine or rain	• Mortar ready next to the mason • Water for wetting joints

Quality checkpoints:

- Ensure that all joints are properly raked and cleaned out.
- Check that the joints are properly filled and nicely keyed.
- Ensure that the walls are clean and that any leftover mortar on the ground is removed.
- Protect the pointed joints allowing the mortar to cure properly and avoiding that the mortar is dried out from sunshine or washed out by rain.

3.5 Installing doors, windows, lintels and ventilators

This section attempts to provide the rural mason with the necessary skills to:

- ✓ Setting out the location of doors, windows and ventilators,
- ✓ Install frames for doors and windows,
- ✓ Construct lintels,
- ✓ Install ventilators.

3.5.1 Installing frames for doors and windows

Doors and windows are fixed into wooden or sometimes metal frames. Frames are installed together with the on-going masonry work to ensure they are properly fixed into the wall and that they fit exactly into the opening.

Great care should be taken to ensure that the frames are fixed without being twisted. The doors and windows should fit exactly into the frame.

Tips for the facilitation of Worksheet M13: *Install door and window frames*

When facilitating the work process described in this worksheet, the following approach is recommended:

- Display the poster of Worksheet M13 so that all trainees can easily see it.
- Instruct the trainees to open their reference Handbook at 'Worksheet M13' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to installing frames for doors and windows. Give particular attention to maintaining correct levels and how to fix the frames securely into the wall. Link your explanation to actual physical work undertaken during this training course (building a house).
- Also link the explanation to the respective training posters.
- Discuss each work step described in the worksheet. Always relate to actual on-going work and demonstrate the real work process.
- Split the trainees into groups of three and let them carry out the installation of a door and a window frame under your guidance.
- Ensure all trainees get to practice every work step → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have completed their tasks, let them assess each other's work and comment on the achieved quality. If necessary, let them repeat the exercise until they have acquired the required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

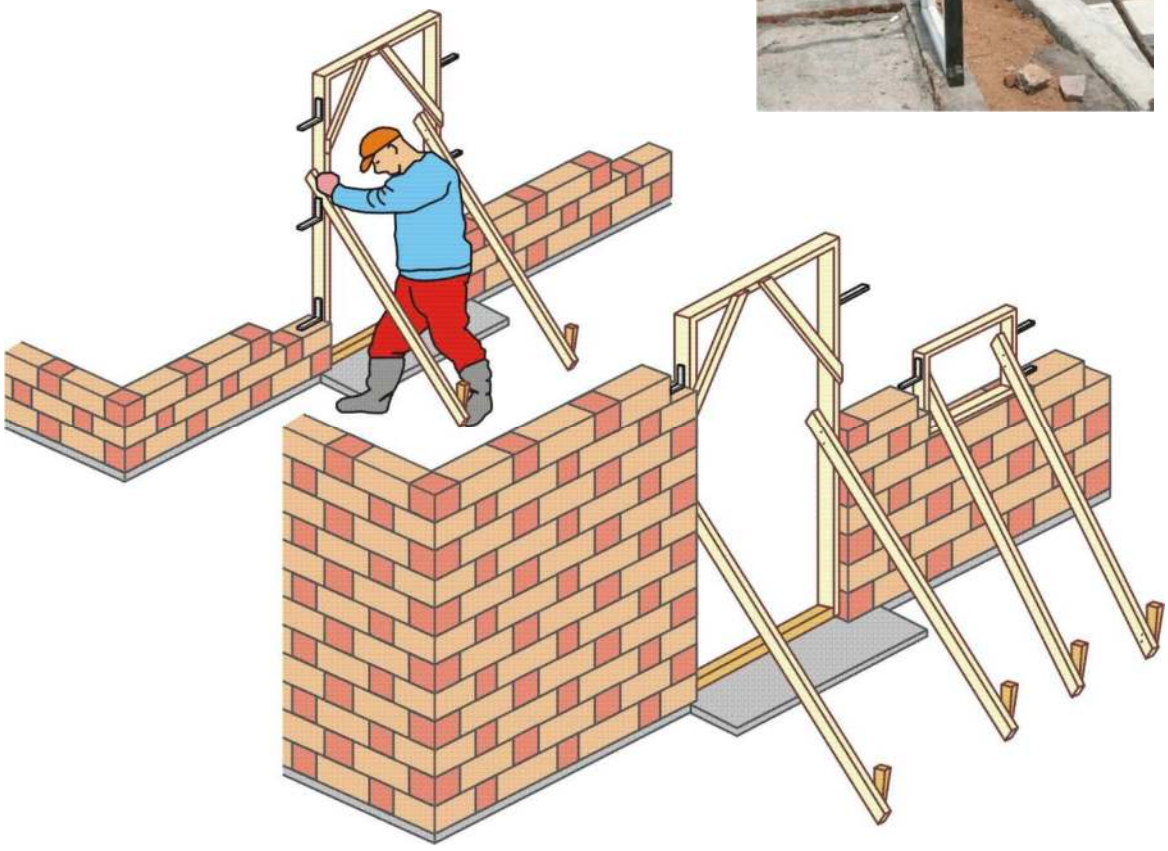
Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Installing door and window frames

M13

Work method:

1. Mark the exact location of the doors and windows to be fixed. Combine this with setting out the walls before commencing the masonry work.
2. Place the frame at marked locations and hold it upright with temporary support. These are usually timber supports, which are firmly fixed into the ground.
3. Construct the masonry walls next to the frames
4. Grout between the frame and wall, filling all gaps with mortar.



Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Standard masonry tool set • Mortar for grouting • Saw and hammer to fix support battens	• Door and window frames • Timber boards / battens • Nails • Mortar for grouting

Quality checkpoints:

- Check that the frames are in the correct position.
- Ensure no deformation of the frames takes place.

3.5.2 Constructing lintels and sunshades

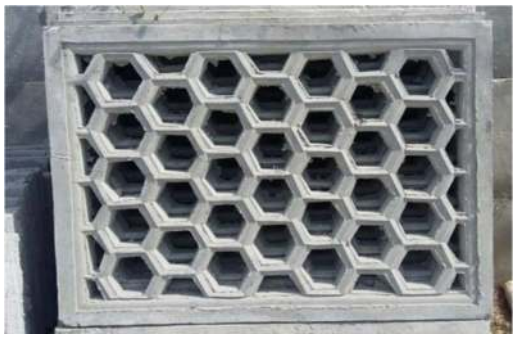
Lintels are the small beams constructed above openings for doors, windows and terraces. The lintels are built into the walls once the masonry reaches the top level of the door and/or window frames.

Sunshades are extensions of lintels, creating small cantilever slabs kept above windows and doors in rural houses basically to provide shade and to prevent rain sprinkling into the room. The thickness of the lintel varies from 15 cm to 30 cm depending on the size of the opening. In some places sunshades are not taken up to reduce costs.

The lintel is supported by the wall on both sides of the door, window or other opening. Therefore the masonry work up to the level of the lintel needs to be completed before starting the installation of the lintel.

3.5.3 Installation of ventilators

Ventilators are prefabricated elements that are integrated into the wall right below the roof. Commonly, there are two different types:



They are usually prefabricated concrete blocks with integrated ventilation holes. Ready-made ventilators are usually available from local suppliers.

Jallys can also be made of steel. These are also easily integrated into the wall.

When constructing the walls, these ventilators are normally positioned just below the roof slab.

The exact position of these ventilators is shown in the construction drawings.

Tips for the facilitation of Worksheet M14: *Constructing lintels*

When facilitating the work process described in this worksheet the following approach is recommended:

Note: The construction of lintels requires skills in reinforced concrete works including shuttering, preparing and fixing reinforcement bars, erecting scaffolding, concrete mixing, pouring concrete and curing. These issues are described in Learning Unit 4, Concrete Works, and in detail in Worksheets C1, C2, C6, C7 and C8.

- Display the poster of Worksheet M14 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M14' and refer to it throughout the lesson.
- Start explaining the work sheet by giving an introduction to constructing lintels. Give particular attention to maintaining the correct levels and how to ensure proper bearing space on the wall. Also make sure your refer to concrete works and the basic requirements to ensure proper:
  - shuttering with props and braces,
  - preparation and fixing of reinforcement bars,
  - mixing and pouring concrete,
  - curing and finishing.
- Link your explanation to actual physical work undertaken during this training course (building a house).
- Also link the explanation to the respective training posters.
- Discuss each work step described in Worksheet M14. Always relate to actual on-going work and demonstrate the real work process.
- Split the trainees into groups of three and first let them do the preparation works, step by step for 1. Shuttering, 2. Preparation and 3. Fixing reinforcement.
- Split the trainees into groups of three and assign them with the actual concrete activities: 1. Mixing, 2. Pouring and compacting, 3. Curing.
- Ensure that all trainees practice all work steps → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- When the trainees have completed their tasks, let them assess each other's work and comment on the achieved quality. If necessary, let them repeat the exercise until they have acquired the required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

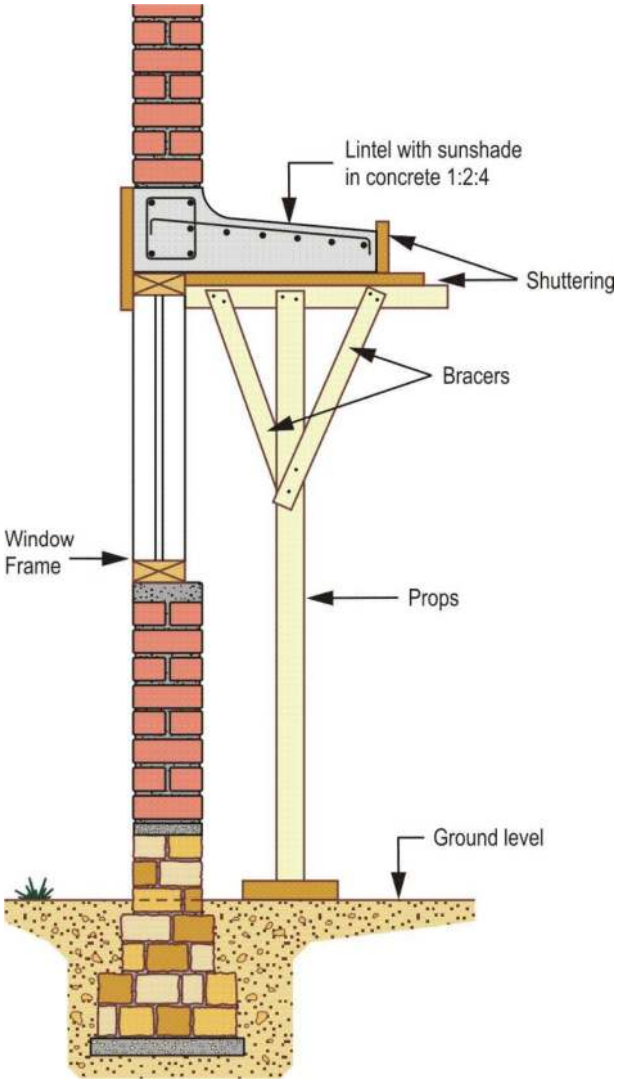
Throughout the training process refer to the required safety at work. Always display Training Poster No. 1: Safety at work.

Worksheet
Activity: Constructing lintels and sunshades

M14

Work method:

1. Remove bricks in the wall for 15 cm width for sufficient support for the lintel on either side of the opening and so that the lintel can be placed in its correct position in the wall.
2. Cut, bend and assemble reinforcement bars according to the plan or instructions from the engineer.
   Refer to worksheets C1 and C2.
3. Cut shuttering boards, support and props to the correct sizes and assemble the formworks to the correct shape and position.
4. Install the reinforcement steel in the correct position in the formworks.
   Refer to worksheet C3.
5. Mix 1:2:4 concrete on a hard and clean surface. Pour concrete into formworks and compact.
   Refer to worksheet C7.
6. Cure the concrete for a minimum of 14 days. Ideally, the curing should be given 21 days for all beams, lintels and sunshades. Cover the concrete with wet gunny bags to facilitate the curing and protect it from sunshine.
7. The shuttering on the vertical sides can be removed after 14 days – but leave the support in place.
8. Once the shutters are removed, check for honeycombs. Remove any loose aggregate and fill the voids with cement mortar 1:4.



Labour:	Tools:	Material:
• Rural mason • Labourers to assist with shuttering works, mixing and pouring concrete	• Standard masonry tool set • Mortar pans • Saw and hammer • Gunny bags for curing	• Timber boards, props and struts • Nails • Reinforcement bars, wire • Cement, sand and aggregate

Quality checkpoints:

- Check that the formwork is in the correct position, that it is straight and at correct levels.
- Check that the reinforcement bars are in the correct position and properly fixed.
- Secure sufficient support on both sides of the wall.
- Ensure that the concrete is mixed to correct proportions.
- Ensure continuous curing for 14 days, keeping the concrete moist and protected from the sun.
- Do not remove the props before 14 days.

3.6 Plastering

This section describes the following activities that a rural mason needs to master:

- ✓ Carry out all the required preparatory activities for plastering work, and
- ✓ Plaster masonry walls.

Finishing work may include the plastering of walls, although this is not always required. Plastering is an additional and special skill that masons need to master. In order not to waste material and to achieve good quality plaster the careful establishment of wall lines is required before starting the actual plastering activity. Careful and skilled finishing is required to assure a uniform, smooth and good-looking surface.

Walls are plastered to obtain a smooth finish to the surfaces. Plastering the exterior walls also preserves and protects from weather by acting as a protective layer. Plastering on a building's interiors conceals poor workmanship of brickwork and masonry joints, if any. It also covers walls and ceilings with fine mortar, which acts as the base that is essential for painting or whitewashing.

The tools used in plastering are floats, gauging trowel, plumb bob and other tools like brushes, straight edge and a scratching tool.

As plastering makes a surface smooth, durable and prepares it for further finishing through painting, it is important to treat and improve the surface so that the quality of plastering is durable and at its best. In this session the rural masons will learn how to prepare the surface for plastering.

Generally, masonry walls are constructed to perfect plumbs on the interior side of the wall. As the quality of the brick may not be perfect in rural areas, the *outside wall* is generally not to perfect plumb. Hence the outside is plastered in two coats:

- first layer of 16 mm thickness using a cement mortar with ratio of 1:6
- second layer of 4 mm thickness using cement mortar with ratio of 1:4

The *interior side of the wall* requires

- only one layer of 12 mm thickness, using cement mortar with ratio 1:5 or 1:4

However, the specifications for interior and exterior plastering given by the administration should be followed.

Materials required for plastering a 10 m^2 wall			
Plaster type	Mortar ratio	Cement	Sand
Single coat 12 mm	1:5	43.2 kg	0.15 m^3
Two coats 20 mm	First coat 1:6 (16 mm) Second coat 1:4 (4 mm)	43.2 kg 14.4 kg (Total: 57.6 kg)	0.22 m^3
Single coat 20 mm	1:5	60.48 kg	0.21 m^3

Tips for the facilitation of Worksheet M15: *Plastering walls*

When facilitating the work process described in this worksheet, the following approach is recommended:

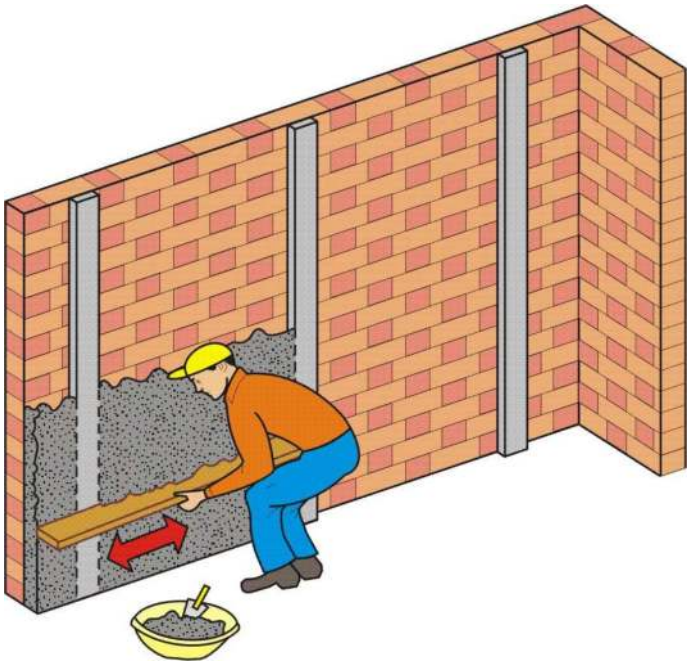
- Display the poster of Worksheet M15 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M15' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to the standards and work process of plastering. Give particular attention to stressing the required quality of mortar and workmanship to ensure good quality finishing.
- Link your explanation to actual physical work undertaken during this training course (building a house).
- Discuss each work step of the described work method in the worksheet. Always relate to the actual on-going work and demonstrate the real work process.
- Split the trainees into groups of three and allocate one full room wall to each group. Ask them to check the walls to be plastered: requirements for preparations, checking lines and levels in all directions → demonstrate → observe → correct → encourage → refer to the worksheet all the time
- As a second activity, each group plasters the guide strips as prescribed in the worksheet.
- After completion of every work step, explain the following step and proceed as described above.
- When the trainees have finished their tasks, let them assess each other's work and comment on the achieved quality. If necessary, let them repeat the exercise until they master the required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

Worksheet
Activity: Plastering walls

M15

Work method:

The main steps to follow when preparing a surface and plastering are:



1. Use a brush to clean the surface and joints.
2. Rake the joints to remove any loose or protruding mortar and knock any projections off the surface. Fill any holes and cavities with mortar.
3. Water the entire surface before starting plastering. The surface should be evenly wetted.
4. Check that the wall is uniformly lined using a string line and a straight edge with a spirit level.
5. If the surface is uniform across the entire wall, place guide strips of mortar of 12 mm thickness and with a width of 10 cm to 15 cm.

   The first and last strips should be about 15cm from the room corner. Intermediate strips are added to give a spacing of 100 to 120cm, depending on the length of the straight edge at hand.
6. After one day, fill the space between the guide strips with cement mortar 1:6 using a trowel. Make sure there is full contact between the mortar and the underlying surface. The plaster should be slightly thicker than the guide strips.
7. Using a straight edge, screed the mortar to the same thickness as the strips. Use a float for the final smoothening as soon as a section has been plastered and levelled.
8. Plaster the entire wall from one corner to other corner on the same day.
9. Cure the wall for at least 14 days by keeping it moist.

Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to prepare mortar	• Complete masonry tool set • Shovel • Straight edge and spirit level • Mason's string	• Cement • Sand • Water

Quality checkpoints:

- All cavities or holes should be filled and levelled.
- The surface should be plane and free from projections but not smooth.
- Check that all lines (horizontal, vertical and diagonal) are level and uniform.
- Ensure that the final surface is uniform and smooth.

3.7 IPS flooring

IPS flooring stands for Indian patent stone flooring. It is a basic type of flooring which provides good wearing properties. It is laid using concrete in two distinct layers on a well-compacted gravel base.

This section explains how to:

- ✓ Mark out levels for IPS flooring, and
- ✓ Carry out all activities to build an IPS floor.

Preparation and laying IPS flooring

IPS flooring is part of the finishing works. Therefore it is done after completing the roof slab and plastering the walls.

Before the concrete works, a firm base needs to be produced by filling gravel to the correct level and compacting it well.

The IPS floor is constructed in two distinct layers on top of the compacted gravel base:

- The base layer with a thickness of 7.5 cm consists of lean concrete with a 1:5:10 mix.
- The top layer with a thickness of 4.0 cm is laid with a mix of concrete 1:2:4
- The surface of the top layer is finished with cement slurry with a 1:2 mix to achieve a smooth finish. Sometimes, red oxide is used in the cement slurry to colour it for good looks.

Tips for the facilitation of Worksheet M16: *IPS flooring*

When facilitating the work process described in this worksheet, the following approach is recommended:

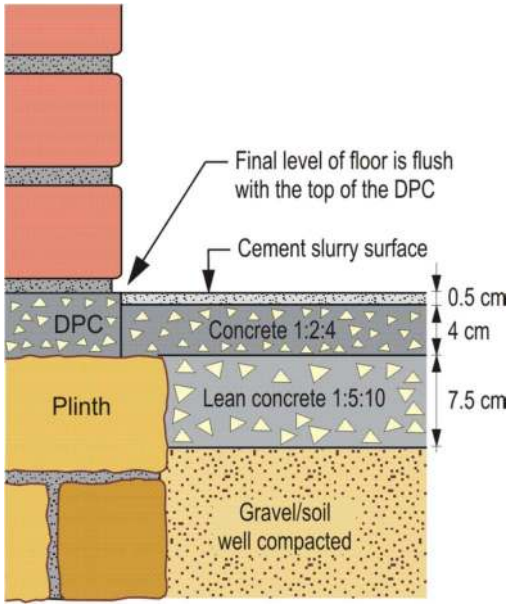
- Display the poster of Worksheet M16 so that all trainees can easily see it.
- Instruct the trainees to open their reference handbook at 'Worksheet M16' and refer to it throughout the lesson.
- Start explaining the worksheet by giving an introduction to the work process of IPS flooring with particular emphasis on the layers and their required quality. Link the explanation to actual physical work undertaken during this training course (building a house).
- Also link your explanation to the respective training posters.
- Discuss each work step described in the worksheet. Always relate to actual on-going work and demonstrate the real work process.
- Split the trainees into groups of three or four and let them carry out all activities involved in IPS flooring.
- Ensure that the trainees practice every work step → demonstrate → observe → correct → encourage → refer to the worksheet all the time.
- After completion of every work step, explain the steps followed.
- When the trainees have completed their tasks, let them assess each other's work and comment on the achieved quality. If necessary, let them repeat the exercise until they have acquired the minimum required skills.
- Recapitulate together the work done. Use the training poster to review the 'Remember List'.

Worksheet
Activity: Concrete flooring

M16

Work method:

1. Place and level the gravel layer, sprinkle it with water and compact well.
2. Ensure that the level of the finished floor will be flush with the top of the DPC in the walls. Therefore the surface of the levelled and compacted soils should be 12 cm lower than the DPC top.
3. Mix lean concrete 1:5:10 using 40mm stone.
4. Pour the lean concrete on the prepared, well compacted gravel/soil surface with a thickness of 7.5cm. Level it out and compact well.
5. Mix concrete 1:2:4 using 20mm stone.
6. Lay the concrete on top of the base layer with a thickness of 4 cm. Level it out using a wooden straight edge and compact well.



7. Finally apply a fine cement slurry 1:2 (use fine sand), 'wet-in-wet' with a thickness of 4 to 6mm. Red oxide powder may be added on top of the wet slurry and troweled off using a float.
8. While the slurry is still fresh, grid lines should be drawn using a thread line. The small groves formed as grid lines help to accommodate minor cracks if any develop in the floor.
9. The floor should be cured for a minimum of 21 days by spreading used gunny bags over the surface and keeping them continuously wet.

Labour:	**Tools:**	**Material:**
• Rural mason • Labourers to assist	• Standard masonry tool set • Shovel, space for mixing concrete • Earth rammer • Thread line • Straight edge	• Cement and sand • Aggregate 40mm and 20mm • Water • Red oxide powder • Gunny bags

Quality checkpoints:

- ✓ Check the level of compacted gravel surface.
- ✓ Make sure the concrete has the correct mixtures. Control the water content.
- ✓ Ensure that each layers is well compacted and levelled.
- ✓ Ensure a smooth and good-looking slurry surface.