MINISTRY OF EDUCATION

Building Construction & Woodwork Technology

(Applied Technology)

for Senior High Schools

TEACHER MANUAL

YEAR 2

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

MINISTRY OF EDUCATION

REPUBLIC OF GHANA

Building Construction & Woodwork Technology

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TEACHER MANUAL

Year Two

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

BUILDING CONSTRUCTION & WOODWORK TECHNOLOGY TEACHER MANUAL

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Introduction

The National Council for Curriculum and Assessment (NaCCA) has developed a new Senior High School (SHS) curriculum which aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, competencies, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, further their education and enter the world of work.

This is the first time that Ghana has developed an SHS Curriculum which focuses on national values, attempting to educate a generation of Ghanaian youth who are proud of our country and can contribute effectively to its development.

This Teacher Manual for Building Construction and Woodwork Technology (Applied Technology) is a single reference document which covers all aspects of the content, pedagogy, teaching and learning resources and assessment required to effectively teach Year Two of the new curriculum. It contains information for all 24 weeks of Year Two including the nine key assessments required for the Student Transcript Portal (STP).

Thank you for your continued efforts in teaching our children to become responsible citizens.

It is our belief that, if implemented effectively, this new curriculum will go a long way to transforming our Senior High Schools and developing Ghana so that we become a proud, prosperous and values-driven nation where our people are our greatest national asset.

Acknowledgements

Special thanks to Professor Samuel Ofori Bekoe, Director-General of the National Council for Curriculum and Assessment (NaCCA) and all who contributed to the successful writing of the Teacher Manuals for the new Senior High School (SHS) curriculum.

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SECTION 1: WOODWORK HAND TOOLS, SUBSTRUCTURES AND SETTING OUT

The section covers the following unit (strands); woodwork technology and building construction technology.

In this section, learners will acquire knowledge and understanding of hand tools, select the right tool for a specific woodwork operation and care and maintain for them. In the building construction technology unit, learners are expected to gain the knowledge and understanding of substructure of a building and setting out. All the above are treated from unit 1 to unit 4.

UNIT 1

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Tools and Machines in Woodwork Industry

Learning Outcome: *Demonstrate knowledge and understanding of hand tools and machines to select the right tool and machine for a specific woodwork operation.*

Content Standard: *Demonstrate the ability to use woodwork hand tools and machines in the woodwork shops.*

HINT

- ***Assign Portfolio Assessment** for the academic year by Week 3. Portfolio should be submitted by Week 23. **See Appendix A** of this Section and Teacher Assessment Manual and Toolkit pages 22-25 for more information on how to organise a portfolio assessment.*
- *The Recommended Mode of Assessment for Week 2 is **Project Work (group).** The outline indicating a detailed scope and rubrics for learners to focus on in their research has been provided in the **Appendix B**.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to select and use appropriate hand tools for a specific woodwork operation. Woodworking hand tools are non-powered tools used for various tasks like cutting,

shaping, assembling, and marking wood. They offer a sense of control, precision, and require less setup compared to power tools. These tools allow for a variety of woodworking projects, and with practice, learners can create beautiful and functional pieces.

The unit covers only week 1: ***Select and use appropriate hand tool for a specific woodwork operation.***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in selecting and explaining the uses of appropriate hand tool for a specific woodwork operation. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts in this unit require learners to demonstrate conceptual understanding, including their real-life applications. The assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Teachers should also administer assessments such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the various uses of appropriate hand tool for a specific woodwork operation and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 1

Learning Indicator: *Select and use appropriate hand tools for a specific woodwork operation*

FOCAL AREA 1: WOODWORK HAND TOOLS

1. Geometrical Tools (*measuring tools, marking tools and setting out tools)*

Before starting to make any piece of work, it is necessary to measure it and mark it out. The following are the **Geometrical Tools** to use:

a. Pencil: This is used for general marking out where a temporary line is required. It should be HB or softer grade.

b. Rule: The rule is made of either steel, wood or plastic. The edges are straight, parallel and graduated in inches and millimetres or centimetres. It is used for measuring distances, testing for flat surfaces and testing for straight edges. The square end can be used for measuring up to an edge.

c. Tape measure: A flexible spring steel tape in a metal or plastic container. It is used for measuring longer lengths, typically up to three meters.

Figure 1.1: *Tape measure*

d. Marking knife: This tool has a hardened steel cutting edge, sharpened on one side, which allows a mark to be made alongside a straight edge. The tool is used for marking lines across the grain of wood. The cutting-edge cuts through the fibres of the wood.

Figure 1.2: *Marking Knife*

e. Try square/Mitre square: A wooden **stock** (normally rose wood for resilience) with a brass face attached at right angles to a hardened steel blade. It enables lines to be marked 90° to a prepared edge. It can also be used to check if two edges are square to each other. The mitre face has the stock and blade set at 45° at the top corner joint of the stock to blade. It enables accurate lines to be marked at an angle of 45° to an edge

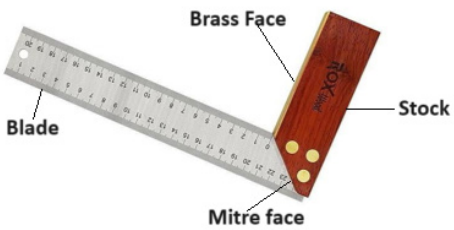


Figure 1.3: *Try square/Mitre square*

f. Sliding bevel: The sliding bevel has an adjustable blade. The blade is slotted and held in the stock by a screw. When the screw is loosened, the blade can be set to any angle. When a line is required at any other angle than 90° or 45°, the adjustable blade of this tool can be used. It can also be used to transfer angles from one place to another.

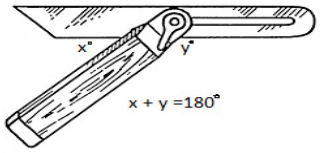


Figure 1.4: *Sliding bevel*

g. Wing compasses: The wing compass has two hardened points, a wing and thumb screw. The wing and thumbscrew allow radii to be set and replicated. The wing compass is used for marking circles and arcs on a piece of wood. It is also used to step off equal distances and transfer distances on a piece of wood.

Figure 1.5: *Wing compass*

h. Marking gauge: The marking gauge consists of a stem, fence, spur and a thumb screw used for tightening. The wooden fence can be moved along the wooden stem by releasing the thumbscrew. It is used for marking a line parallel to a prepared edge or along the grain of wood. It is also used to mark the width and thickness of wood.

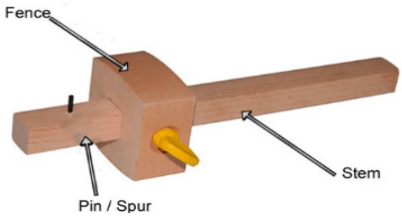


Figure 1.6: *Marking gauge*

i. Cutting gauge: The cutting gauge is similar to a marking gauge, except that it is made of cutting blade instead of a spur. The cutting blade is used to gauge lines across the grain of wood parallel to an edge, and for cutting veneers and strips for inlaying.

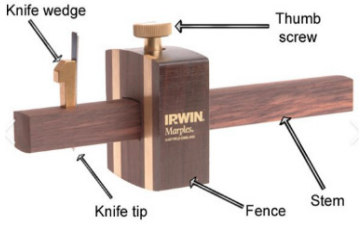


Figure 1.7: *Cutting gauge*

j. Mortise gauge: The mortise gauge is similar to the marking gauge but has two spurs. One spur is fixed and the other is movable by means of an adjustable screw. It is used to mark two parallel lines in cutting a mortise joint, tenon joint and bridle joints.

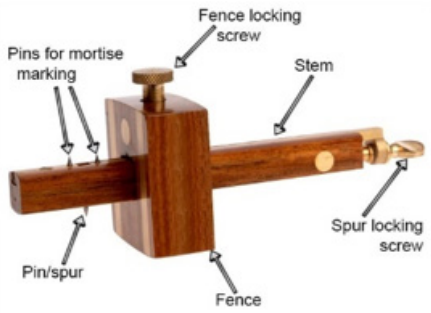


Figure 1.8: *Mortise gauge*

2. Abrading cutting tools

There are various types of saws used in the woodwork industry. The difference is in size and shape of the teeth and also the uses.

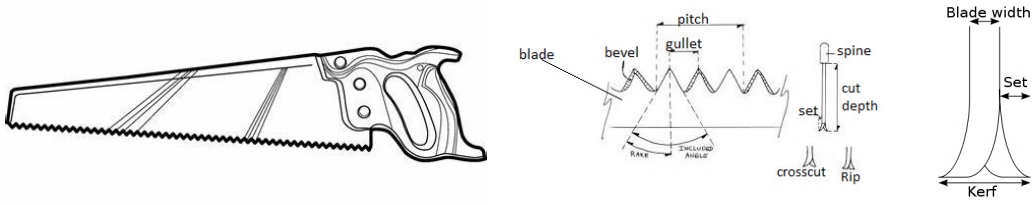


Figure 1.9: *Hand saw*

a. Crosscut saw: This is used for cutting across the grain of the wood. It has between five and eight teeth per 25 mm. The teeth angle ranges from 75° - 80°.

Figure 1.10: *Crosscut saw*

b. Rip saw: This is used for cutting along the grain of wood. It has between three and four teeth per 25 mm. The teeth angle ranges from 90°.

Figure 1.11: *Rip saw*

c. Tenon saw: This type of saw is known as a 'backed' saw because of the steel or brass re-enforcement along the back of the blade. The strip is there to keep the relatively thin blade straight and to help with cutting straight line. Although the saw's name suggests it is used for cutting tenon, this is not its only use. It can be used for all general small crosscutting jobs.

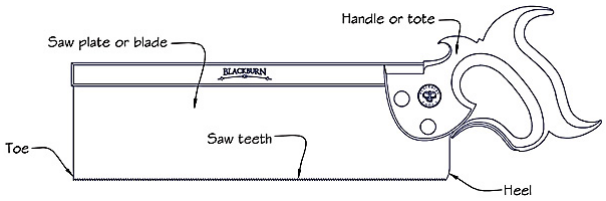


Figure 1.12: *Tenon saw*

d. Dovetail saw: This is a smaller version of the tenon saw and, as the name suggests, it is used for cutting dovetails and other fine work. It has between sixteen and twenty teeth per 25 mm.

Figure 1.13: *Dovetail saw*

e. Coping saw: This is a saw used for cutting curved lines and, in common with all saws for this purpose, it has a narrow blade. The blade should be fitted in the frame with the teeth facing the handle and the cutting done with a pulling action.

Figure 1.14: *Coping saw*

f. Bow saw: With this saw, the blade is tensioned by tightening a cord on the opposite side of the frame from the blade. As with the coping saw, the blade of bow saw can also be turned in the frame to allow access to awkward places.

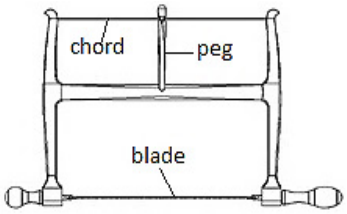


Figure 1.15: *Bow saw*

g. Fret saw: This is a curve cutting saw. The deeper frame on this saw allows work to be carried out further away from the edge of a board.

Figure 1.16: *Fret saw*

h. Pad saw: In order that it is possible to make cut-outs well away from the edge of a piece of material (wood), this saw is used. To cut a hole in the middle of a board, you need to first drill a hole at each corner of the cut-out, then saw between the holes.

Figure 1.17: *Pad saw*

3. Paring and shaving cutting tools

After the material has been cut out, it needs to be smoothened and brought down to its correct size. The following planes, which may have either a wooden or metal body, are used to do this.

a. Jack plane: This plane has a **sole length** of around 350 mm and is a general-purpose plane for reducing timber to size, squaring up or smoothing.

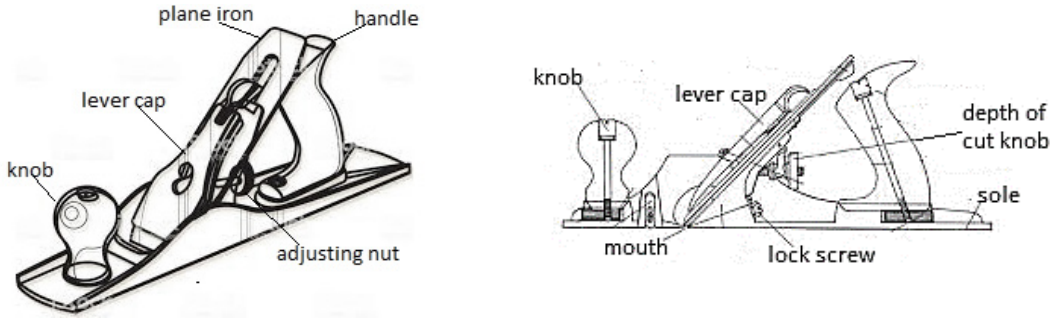


Figure 1.18: *Jack plane*

b. Smoothing plane: A shorter version of the jack plane, with a sole length of between 200 and 250 mm. Its main purpose is to give a smooth surface to wood that has already been planed to size. The adjustment is like that of the jack plane.

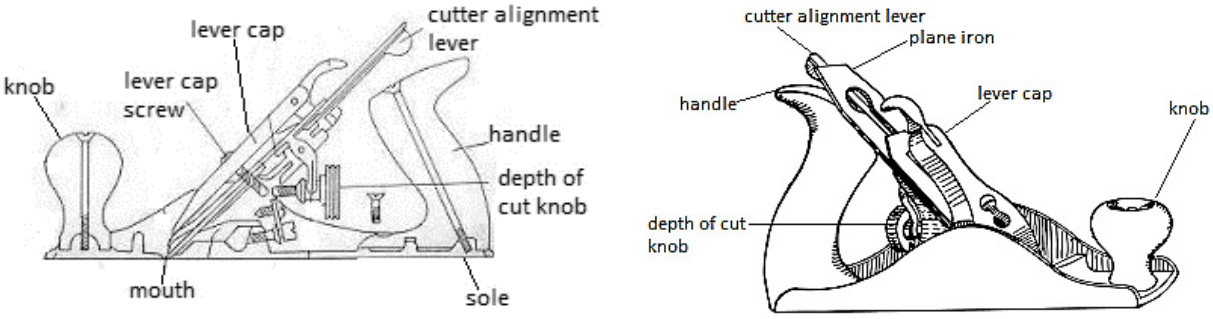


Figure 1.19: *Smoothing plane*

4. Spokeshaves

a. Flat spokeshave: This is used for cutting and smoothing all convex edges, narrow surfaces and stopped chamfers. It has two adjusting screws on top of the blade for setting both the depth and squareness of the blade.

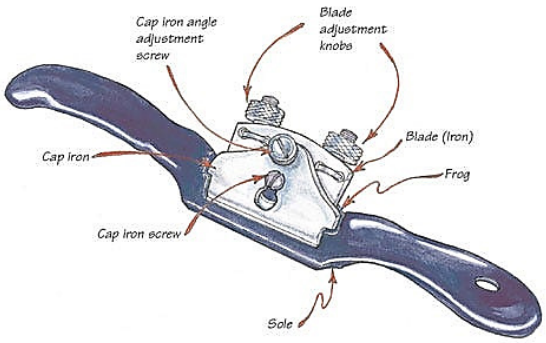


Figure 1.20: *Flat spokeshaves*

b. Raised faced spokeshave: This is like the flat spoke shave but with a round sole. The round sole enables it to be used on concave surfaces.

Figure 1.21: *Raised faced spokeshave*

5. Chisels and files

These are cutting tools for removing waste from recesses. There are three different types, i.e. firmer chisel, paring chisel and mortise chisel. They consist of hardened steel blades which have soft tangs at their ends, onto which are fixed, the wooden handles. Their handles are fitted with brass ferrules to stop them splitting when hit. The size of a chisel is determined by the width of its blade.

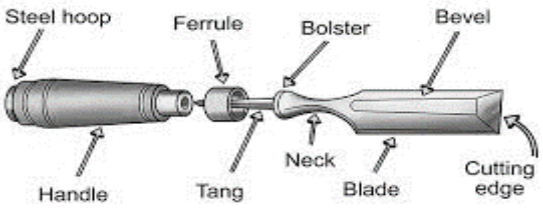


Figure 1.22: *Chisel*

a. Firmer chisel: This has a rectangular section blade which makes it stronger than bevel-edged chisel. It is used to remove waste from joint and used for cutting outside curves of small radius

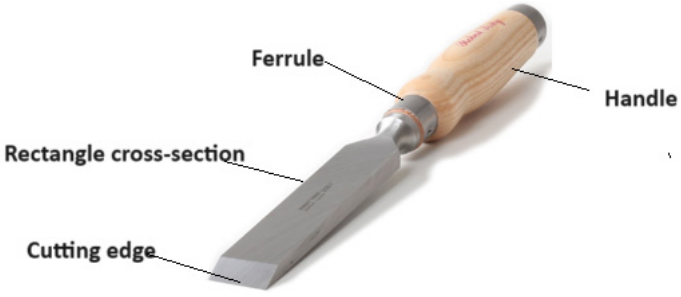


Figure 1.23: *Firmer chisel*

b. Bevel-edge firmer chisel: It is similar to the firmer chisel except that it is bevelled along both edges. The bevel-edge firmer chisel has the advantage of being able to work into corners less than 90°.

Figure 1.24: *Bevel-edge firmer chisel*

c. Mortise chisel: Has an almost square cross- section blade. The handle may also be fitted with a metal band to stop it splitting and a leather washer is fitted between the handle and blade to absorb any shock. This chisel has extra strength to withstand the blow of a mallet. It is used for cutting deep holes in wood.

Figure 1.25: *Mortise chisel*

d. Firmer gouge: This has the blade sharpened on the outside and is used for grooving and general carving purposes.

Figure 1.26: *Firmer gouge*

e. Scribing gouge: This has the blade sharpened on the inside and is used for trimming curved surfaces.

Figure 1.27: *Scribing gouge*

f. Files: A file consists of a hardened steel blade with a tang at one end onto which a wooden handle must be fitted. For safety reasons a file should never be used without a handle. The blade has a series of cuts (teeth) and the coarseness of the file is determined by the number of cuts per 25 mm. To specify which file you require it is necessary to state its length, cut and cross-sectional shape, e.g. 150mm, **second cut,** round file.

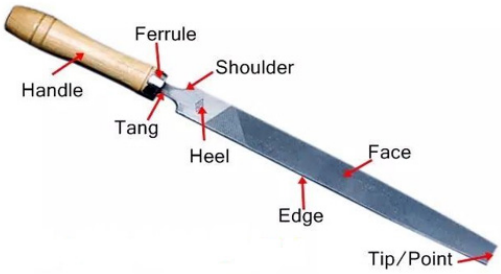


Figure 1.28: *File*

g. Rasps: These are a much more common tool to use on wood. They are very similar to files but have individual triangular teeth on the surface of the blade and are usually half round in cross section.

Figure 1.29: *Rasp*

h. Scraper: This is a rectangular flat piece of tool steel about 125 mm ×75 mm. The cutting edges are found by **burring** over the long edges. It is used to produce a very smooth surface and to remove plane marks before glass papering or sanding.

6. Boring cutting tools (brace & bits)

This is normally fitted with a chuck which will take up to 8 mm bits. The **chuck** is rotated by turning that small handle.

a. Ratchet brace: This is the traditional tool for producing larger diameter holes. It consists of a crank with a handle at one end and a chuck at the other. The chuck may be fitted with alligator jaws, which only accept **square shank** drill bits, or with universal jaws which also accept **parallel shank** bits.

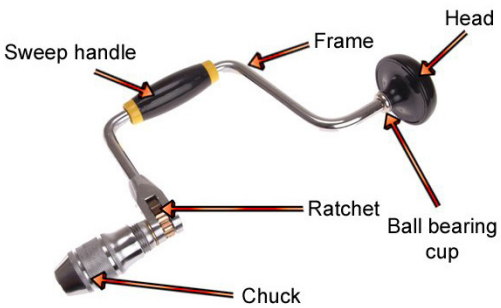


Figure 1.30: *Ratchet brace*

b. Wheel brace: A wheel brace functions similarly to the ratchet brace. It can be fitted with drills, bits, or twist drills, making the task of boring holes easier. It allows many holes to be bored without exhaustion.

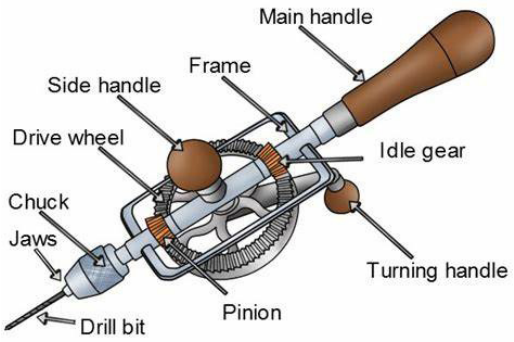


Figure 1.31: *Wheel brace*

c. Woodwork bits: These are tools designed for boring holes under special conditions. Bits have a square tapered shank or tang to fit the jaws of a hand brace which is used for turning the bit into the wood. They are of different sizes, from 6 mm to 50 mm. There are many varieties of bits; the following are some examples;

i. Twist drills (hand drill): These are drill bits most commonly used for holes up to 12 mm wide. They have a straight shank to go into plain chucks and spiral flutes to clear the waste away from the cutting edges.

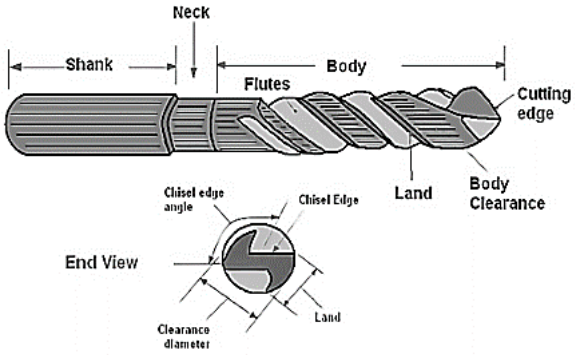


Figure 1.32: *Twist drills (hand drill)*

ii. Auger bits: These are twist bits with long shanks. They have a screw point to position the drill centrally and pull the drill through.

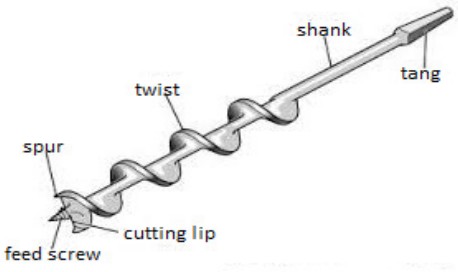


Figure 1.33: *Auger bit*

iii. Countersink bit: For countersunk screws to be flush with the surface of the workpiece, a **countersink hole** needs to be produced with the countersunk bit.

Figure 1.34: *Countersink bit*

iv. The following bits and tool can also be used for various types of holes boring in wood:

- Centre bit
- Forstner bit
- Expansion bit
- Gimlet
- Bradawl

7. Impelling and precaution tools (driving tools)

They are also called **Striking tools**; they are used for driving chisels and nails into wood and for assembly work. Driving tools are also used for moving objects into woodwork pieces through hammering, punching, or screw-driving.

a. Screwdrivers: A screwdriver is a tool used for driving screws into pieces of wood. There are several different types of screwdrivers but the two main types used with the wood screws are:

i. Cabinet pattern screwdriver: This has a circular cross section blade which is flattened where it enters the wooden handle. The handle is very comfortable and useful when driving in many screws. They are sold in different sizes with either flat or star end.

Figure 1.35: *Cabinet pattern screwdriver*

ii. London pattern screwdriver: This has a flat blade which is designed to give a greater turning potential. The wooden handle is normally flattened on two sides.

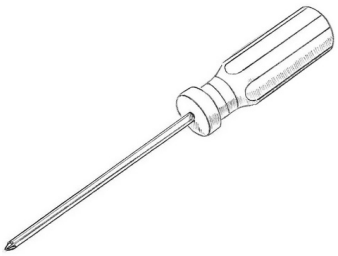


Figure 1.36: *London pattern screwdriver*

b. Hammers: Most hammers consist of a cast metal head and an ash hickory wooden handle. The handle is normally held in place with metal wedges. There are two main types of hammers used by the woodworker. These are: -

i. Claw hammer: This is a heavy-duty hammer used mainly on structural work and building. It is used for driving in and removing nails.

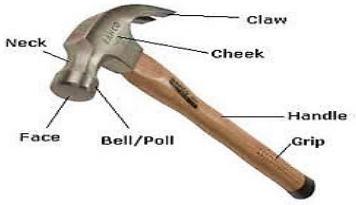


Figure 1.37: *Claw hammer*

ii. Warrington hammer: This is the joiner's hammer and is also known as a **cross pein hammer.** The cross pein is used for starting small nails or for hammering into awkward corners.

Figure 2.38: *Warrington hammer*

c. Pincers: These are used for removing nails. The jaws grip the nail and by pulling back, the nail is easily pulled out.

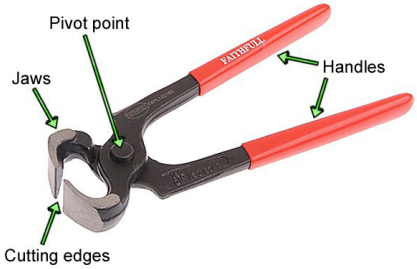


Figure 1.39: *Pincers*

d. Nail punch: When nails are driven home with a hammer, they finish up flush to the surface. To ensure a smooth surface they need to be punched below the surface of the work. The nail punch has recessed end to keep it on the nail.

Figure 1.40: *Nail punch*

e. Mallet: This is made from beech and consists of a head and a tapered handle. It is used for driving tools with wooden handles.

Figure 1.41: *Mallet*

8. Holding and supporting tools (Vices and Cramps)

In order that tools can be used effectively, it is necessary to hold firmly the material that is being worked on. The devices for holding the work firmly are vices and cramps.

a. Bench vice: This consists of two cast metal jaws which are moved along two guide rods by a **leadscrew.** The vice must be fitted with **wooden cheeks** to make sure the material being worked on does not get damaged.

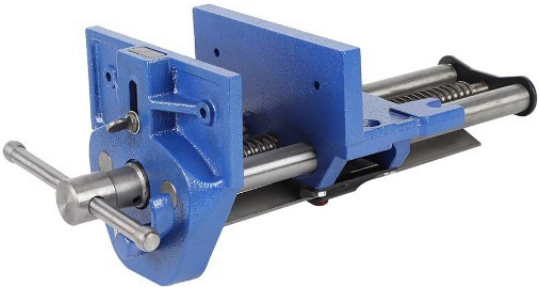


Figure 1.42: *Bench Vice*

b. G-cramp: This consists of a G-shape steel frame and a threaded shaft which has a loose fitted shoe on one end and a **tommy bar** at the other.

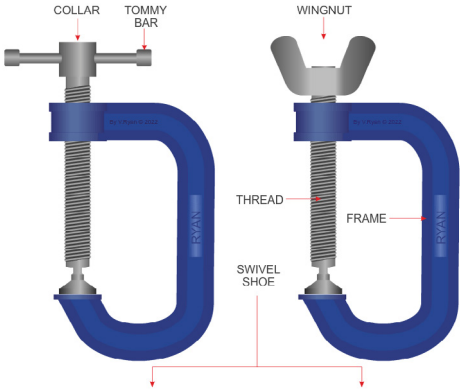


Figure 1.43: *G-Cramp*

c. Sash cramp: This is used for clamping over a longer distance. It has two shoes for holding the job or work piece. One is moveable by means of a leadscrew and the other can be fixed in position on the main bar means of a metal peg.

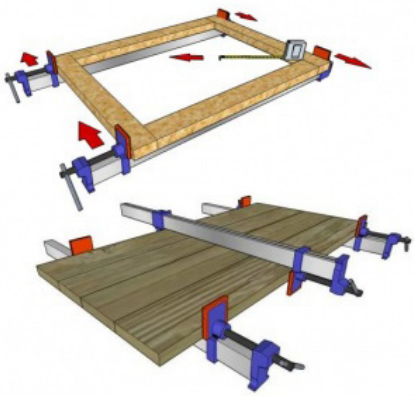


Figure 1.44: *Sash cramp*

Learning Tasks

1. Identify at least three hand tools use in the woodwork shop.
2. Explain at least three uses of the various woodwork hand tools.
3. Demonstrate how to use a rip saw to rip a piece of wood.

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners through a video demonstration of the types of woodwork hand tools, and brainstorm on the identification of types of woodwork hand tools. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and review explanations from them.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to discuss the uses of the classification of various woodwork hand tools. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
3. **Experiential Learning:** Guide learners in mixed ability groups to co-operatively select the appropriate hand tool and use it properly taking into skills level and safety aspects. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

KEY ASSESSMENT

1. **Level 1:** Which tools would one use for the following jobs:
   - **a.** Marking a line at 90° to the edge of a piece of wood.
   - **b.** Marking a line across the grain of a piece of wood.
   - **c.** Marking a line at an angle other than 45° or 90° to the edge of a piece of wood.

2. **Level 2:** Explain at least one setting or adjustment that should be made before using a jack plane
3. **Level 3:** How is a large hole cut in the middle of a sheet of plywood?

HINT

*The recommended mode of assessment for week 1 is **class exercise**. You may use the level 2 question as a sample question.*

UNIT 1 REVIEW

Unit 1 of week 1 introduced learners to the selection and the uses of appropriate hand tool for a specific woodwork operation. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies will enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real object (woodwork hand tool)

Reflection: Are learners able to select and explain the uses of appropriate hand tools for a specific woodwork operation.

UNIT 2

STRAND: CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Categories and describe foundations used under various soil conditions*

Content Standard: *Demonstrate knowledge and understanding of sub-structure of buildings*

INTRODUCTION AND UNIT SUMMARY

This unit introduces learners to substructure, components of the substructure, and functions of the various components of the substructure. Learners after having covered substructure and its components, will learn the functional roles of the various components. Components of the substructure are load-bearing members which are located below the ground level and serve as an anchor for the building.

The unit covers only week 2: ***Explain substructure of a building***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in Critical thinking and Talk for Learning Approaches. Guide learners to brainstorm the meaning of substructure of a building. Conduct experiential learning by organising field trips to construction sites where learners will observe the substructure and its components. Organise learners into mixed ability groups and help explain the substructure of a building, outline its components and discuss their functions. Help learners to develop a deeper understanding of the concept of substructure. Learners will all engage in critical thinking. The collaborative environment made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will capture the diverse knowledge they have.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative and this should include quizzes, oral and written presentations and home assignments. Teachers must keep track of the performance of each learner given the different levels of performance of the learner in class and provide the relevant motivation or support to enhance understanding of the concept. The assessment will also serve as a tool to evaluate levels 1, 2 and 3 of the DoK amongst learners. In this way the pedagogical differentiation strategies adopted will also be complemented under the assessment. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 2

Learning Indicator: *Explain substructure of buildings*

FOCAL AREA 1: SUBSTRUCTURE

The substructure of a building is largely a hidden section of the building. It is the part of the building that is below the ground level. Built from the foundations to the ground floor level it is sometimes referred to as under building construction. The parts of the substructure include:

1. **Foundation:** These are load-bearing components located below the ground level. It is the base on which the building rests, it has direct contact with the ground and serves as an anchor to the building**.**

Figure 1.45

Figure 1.46

Component of the substructure called foundation concrete.

2. **Footings**: These are also an important part of the substructure construction and are load bearing components. They are two or more blocks or bricks laid immediately after the foundation concrete and the purpose is to support and distribute the weight of the building evenly across the entire structure.

Figure 1.47: *Foundation footing of a building*

3. **Oversite concrete floor slab:** These are structural features, usually of constant thickness, that can be used as floors to prevent the ground beneath from being disturbed. They also block out moisture and air from the ground beneath to provide a solid, hard, and level surface.

Figure 1.48: *Oversite concrete floor slab for substructure*

Learning Tasks

1. Explain the substructure of a building.
2. Outline the various components of the substructure.
3. Discuss the functions of the substructure of a building.

PEDAGOGICAL EXEMPLARS

Teachers should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners to brainstorm the meaning of substructure in building.
2. **Group Work/Collaborative Learning**: Organise learners into mixed ability groups and assist them to outline the various components in the substructure of a building.
3. **Group Work/Collaborative Learning**: Discuss the functions of a substructure of a building.

KEY ASSESSMENT DOK

1. **Level 1:** Outline the various components of the substructure.
2. **Level 2:** Explain the substructure of a building.
3. **Level 3:** Discuss two functions of a substructure for buildings.

HINT

*The recommended mode of assessment for week 2 is **discussion**. You may use the level 3 question as a sample question.*

UNIT 2 REVIEW

This unit presents the learners with a deeper understanding of the concept of substructure of a building. The pedagogical exemplars used in this section include group work/collaborative learning, role-play, digital learning and experiential learning which help to meet varied needs of all learners. These strategies will enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities are structured to cater for all varied activities of learning. These assessments are classified under the DoK level 1, 2 and 3.

UNIT 3

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Tools and Machines in Woodwork Industry

Learning Outcome: *Demonstrate the knowledge and understanding of hand tools and machines to select the right tool and machine for a specific woodwork operation.*

Content Standard: *Demonstrate the ability to use woodwork hand tools, joints and machines in woodwork shops.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to care for and maintain hand tools used in the woodwork shop. The term "care and maintenance of tools" refers to the practices involved in keeping tools in good condition. This includes regular cleaning, proper storage and performing necessary repairs or adjustments. The proper care and maintenance ensure that tools remain functional and safe to use, which can also increase their lifespan.

The unit covers only week 3: ***Explain how to care for and maintain hand tools***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in explaining and discussing the appropriate method to care for and maintain hand tools in the woodwork shop.

The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Teachers should also administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the various uses of appropriate hand tool for a specific woodwork operation and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 3

Learning Indicator: *Explain how to care for and maintain hand tools.*

FOCAL AREA: CARE AND MAINTENANCE OF HAND TOOLS

General Maintenance

a. Check each tool in turn to see that it does not have any piece of dried glue or any other workshop waste on it.

b. If there is any sign of rust, remove it immediately, using wire wool and a light oil.

c. Ensure that all tool handles are in good condition and firmly fixed to the tool.

d. Any sign of movement needs to be thoroughly checked and, if necessary, repaired or replaced.

e. Remove all plane blades and check that the escapement is free from any dust or shavings.

f. Check all saw blades for straightness. Any bent blades need to be straightened.

g. With power tools, carefully check for damage to the power cable. If damaged, the whole cable should be replaced to avoid danger of electrocution.

Saw Sharpening

The teeth of a saw, like any other cutting edge, require regular maintenance or reconditioning to ensure satisfactory performance. The stage of reconditioning is as follows:

a. **Topping or jointing:** This process becomes necessary when the height of the teeth has become uneven. To level up the tip or tops of the teeth, a flat file is used to file along the tips until the whole teeth are levelled. The file is held square to the saw blade.

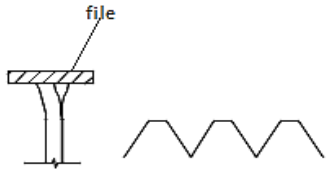


Figure 1.49: *Topping*

b. **Re-shaping:** This process is carried out when the teeth have become irregular because of numerous sharpenings or when some of the teeth have become flattened after topping. The saw is held in a vice with the gullets about 3 mm above the vice. Using a suitable size of triangular file, the affected gullets are filed straight across, holding the file at right to the saw and inclined to the front edges of the teeth at an angle of 70° to 80° to the line of the teeth.

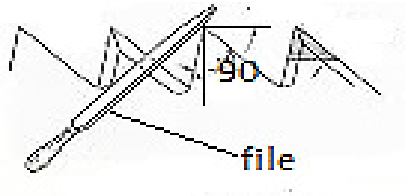


Figure 1.50: *Re-shaping*

c. **Setting:** Setting is the process of bending adjacent teeth to opposite sides to provide a slightly wide kerf; to prevent the saw from jamming. A plier saw-set or a special saw-setting hammer is used. The setting is done to only 1/3 to 1/2 of the top part of the teeth. Irregularities are corrected by slightly filing along each side of the teeth.

d. **Sharpening:** This is a process of filing the teeth to form a pointed and knife-edge. The saw is held in the vice with reasonable projection of the teeth, about 3 mm above the vice jaws. Beginning from the toe of the saw, file each gullet across while holding the file at the correct angle to the side of the blade. The sharpening angle for a cross-cut saw for general purpose is 45°, but those purposely used for cutting hardwood are sharpened at 60° to give the teeth greater strength. For a ripsaw the best sharpening angle is 90°.

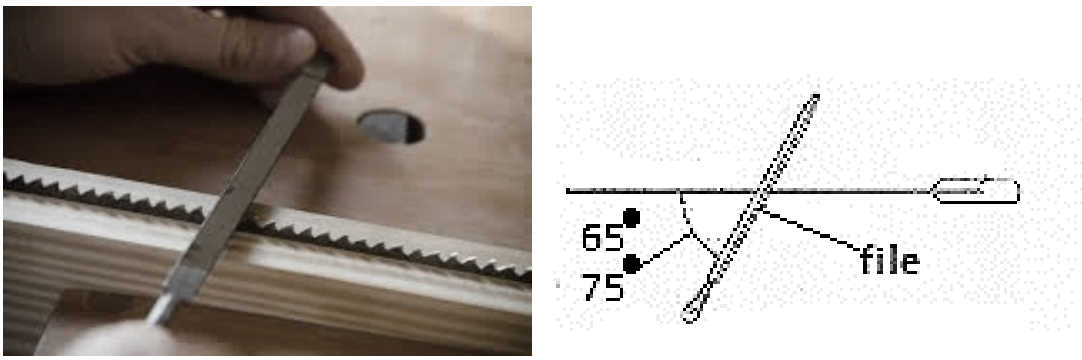


Figure 1.51: *Various sharpening angles*

Sharpening of Plane Blade and Chisels

To sharpen a tool requires the use of the following:

a. **Grinding stone:** A **sandstone wheel** is usually set on a horizontal axle and rests in a water bath. This bath ensures a constant supply of coolant to both stone and tool and cleans the stone whilst it is in use. The edge of the wheel is used for the grinding process.

b. **Grinding wheel:** A carborundum wheel, usually set on an axle so that the edge of the circular wheel is used. To prevent overheating of the tool, it is necessary to dip the grinding edge into a coolant.

c. **Oilstones:** These fall into two categories; **natural** and **artificial**. The best-known **natural stone** is the **Arkansas,** which is available in the following grades: medium, fine, extra fine and combination. The **artificial stones** are **India and carborundum**. These are available in coarse, medium, fine or combination grades. The stones should be housed in a solid wooden box, with a lid, for use in the workshop. A supply of lubricating oil should always be at hand because if the stones are not lubricated, they will become clogged and no longer suitable for sharpening.

d. **Sharpening angles:** Most woodworking tools should be ground to an angle of between 20° and 25° and then sharpened to an angle of between 25° and 30°.

Learning Tasks

1. State at least two general ways to care for and maintain hand tools in the woodwork shop.
2. Explain at least three important methods of caring for and maintaining hand tools in the woodwork shop.
3. Demonstrate how to care for and maintain any three hand tools in the woodwork shop.

Pedagogical Exemplars

The teacher should consider the following activities:

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners in pairs to watch a video on care and maintenance of hand tools and state the ways of caring for and maintaining hand tools in the woodwork shop. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to explain the importance of caring for and maintaining hand tools in the woodwork shop.

   The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
3. **Experiential learning:** Guide learners in mixed ability groups to select a hand tool and demonstrate how to care for and maintain the hand tool. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

Key Assessment (DoK)

Level 1

1. State any two general ways to care for and maintain hand tools in the workshop
2. How will you prevent the blade of a saw from rusting?

Level 2: Explain the importance of Topping, Re-shaping, Setting and Sharpening as applied in care and maintenance of saws in the workshop

Level 3

1. How will you sharpen the following hand tools?
   - **a.** A blunt rip saw
   - **b.** Blade of a jack plane
   - **c.** A firmer chisel

2. Importance of topping, re-shaping, setting and sharpening as applied in care and maintenance of saws in the workshop.

Scenario

Carpenter Bingo tried cutting "odum" board with rusty saw: In 2 ways, how can this saw be made to work efficiently?

HINT

The recommended mode of assessment for week 3 is **case study**. *Use the level 3 question 2 as a sample question.*

UNIT 3 REVIEW

Unit 3 of week 3 introduced learners in how to care for and maintain hand tools. The pedagogical exemplars used in this section included talk for learning, group work/ collaborative learning, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies will enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real object (woodwork hand tools)

Reflection: Are learners able to care for and maintain hand tools

UNIT 4

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Categorise and describe foundations used under various soil conditions*

Content Standard: *Demonstrate knowledge and understanding of sub-structure of buildings*

INTRODUCTION AND UNIT SUMMARY

Setting out of the building, which is also referred to as staking out or laying out, involves using surveying techniques to physically mark out design points on the ground and ensure that all elements are of the right size, position, and level on the ground are the same as on the working drawing. As an initial activity to be performed it can be described as a vital activity which ensures the success and sustainability of the construction work.

The unit covers only week 4: ***Explain setting out***

SUMMARY OF PEDAGOGICAL EXEMPLARS

The Experiential Learning strategy will be used through the organisation of Field Trips to construction sites, where setting out is in progress to observe and interact with surveyors as they set out buildings. This strategy will help bring about learning through visual and practical experience. Research on the internet as well as other materials are recommended to help deepen the learner's understanding of setting out. Collaboration, brainstorming and critical thinking are strategies the whole class comprising the approaching proficiency, the Proficient and Highly proficient would engage in when placed in mixed-ability groupings. The ability to explain the meaning and reasons for setting out will be covered. To outline the tools and materials required for setting out, discuss methods used for setting out and analyse the critical methods that can be used to check accuracy of the setting out will be enhanced through the field trip experiences and research works. For successful outcomes GESI, SEL and National Values are to be incorporated to enhance the performing environment for the collaboration, brainstorming and critical thinking sessions.

ASSESSMENT SUMMARY

The assessments used to monitor learning progress during instruction should be formative, including quizzes and short oral and written responses to questions. Teachers must keep track of performance of each learner given his or her unique level as Approaching Proficiency, the Proficient and Highly Proficient and provide the relevant motivation or support to enhance the

understanding of setting out of a building. The assessment will also serve as a tool to evaluate depth of knowledge amongst learners approaching proficiency, the Proficient and Highly Proficient. In this way, the pedagogical differentiation strategies adopted shall be mirrored under assessment. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 4

Learning Indicator: *Explain what setting out is.*

FOCAL AREA: SETTING OUT

Setting out which is also referred to as staking out or laying out involves using surveying techniques to physically mark out design points on the actual ground and ensure that all elements are of the right size, position, and level on the actual ground same as on the working drawing. It can also be described as a process of marking the positions of structural elements accurately on the ground before starting the actual constructional works. The activity is also described as establishing the exact location and measurements of the structure to be built.

The main reasons for setting out include the following

a. To guide the workers as they begin construction.

b. To ensure that the construction works remain within the legal boundary such that no disputes arise regarding property boundaries and rights of access.

c. Setting out ensures compliance to regulatory requirements, building codes, and safety standards.

d. Setting out ensures accuracy by causing construction work to be done with precision according to design so as to minimising errors and discrepancies.

The tools, equipment and other requirements used for setting out include the following

a. The working drawings.

b. A modern theodolite mounted on a tripod and fitted with an EDM (Electric Distance Meter). It uses a movable telescope to measure both vertical and horizontal planes. A total station will use electronic transit theodolites with a distance meter to read slope distance. It measures distance accurately and can also be used with mapping software to provide a database of reference points.

c. Mallet to drive pegs into the ground.

d. Hammer and nails.

e. A builder's square.

f. A 30-metre steel measuring tape. A measuring tape is used in smaller construction projects where a builder may not need to contact a surveyor to set out.

g. Nylon strings to demarcate distances and boundaries within the development itself. This will be strung between pegs hammered into the ground at pivotal points and levelled using a spirit level.

h. Spirit level

i. Sharp Pegs measuring 75mm x 75mm x 300 mm.

j. White lime powder to mark out foundation walling and other excavation points. The setter out will use white lime powder, as it is insoluble in water and therefore won't wash away even in bad weather.

Figure 1.52: *Theodolite mounted on a tripod and fitted with an EDM*

Some Known Methods Of Setting Out

Table 1.1 **Methods of setting out**

Methods	Descriptions, comments and uses
The 3-4-5 method	This method is based on the principle of the Pythagorean theorem. By creating a triangle with sides of 3 units, 4 units, and 5 units, right angles can be easily established. This method is commonly used to ensure that corners are square and perpendicular or used to set out a right angle from a certain point on the base line.
The rope method	Used to set out a line perpendicular to the base line, starting from a point which is not on the base line.
Pegging and Stringing	This method involves driving pegs into the ground at specific points and then stretching string lines between them to establish the layout of walls, columns, and other structural elements.
Tape Measure and Offset Method	This technique uses a tape measure to measure distances and offsets from existing reference points such as walls or columns. It is handy when setting out features that are not aligned with the reference points. In this method, measurements are taken from established reference points such as property lines or existing structures. These measurements are then used to mark the positions of structural elements by creating offsets perpendicular to the reference points.
Grid Method	The grid method divides the construction site into a series of squares or rectangles, with each square representing a specific unit of measurement. This method helps ensure accurate positioning of building elements.
Optical Levelling	Optical levelling involves using a surveyor's level and a levelling staff to establish accurate height measurements. This method is crucial for setting out levels, especially when constructing multi-level buildings.

Total Station	A total station combines electronic distance measurement and angular measurement to determine precise positions and distances. It is often used for setting out complex building structures and establishing accurate coordinates.

Table 1.2: How to set out a building using the offset method

Step	Activity
1	Clear the ground of any debris, vegetation and other obstruction.
2	Measure the distance from the existing boundary wall/fence to the desired location of the new building's exterior wall. Let's say this distance is 5 metres.
3	Mark this 5metre offset distance at regular intervals along the boundary wall/fence, such as every 2-3 metres. You can use pegs or spray paint to mark these offset points.
4	Run a string line between the offset points to create a parallel line that represents the outer face of the new building's wall.
5	Repeat this process for the other sides of the building, using the existing boundaries or other fixed reference points to establish the offsets.
6	Once you have the offset lines marked for all sides, you can then use these as guidelines to excavate the foundation or erect the formwork for the building's walls.

Table 1.3: How to set out an outline of a building on the ground using fixed lines and profiles

Step	Activity
1	Clear the ground of any debris, vegetation and other obstruction.
2	Find out the distance from the site boundary to the building line on the working drawing. Use the tape measure to measure the same distance from the site boundary to the building line on the ground. Select a corner on the ground to be corner AA.
3	Place a peg in the ground at corner A and hammer a nail into the top of the peg.
4	Repeat these steps to place a peg in the ground for corner BB.
5	Tie the string between pegs A and B. Measure the distance between AA and BB. Check that the distance on the ground is the same measurement as the distance on the drawing.
6	Repeat these steps for corners CC and DD.
7	Measure the diagonals AA-DD and BB-CC. The two diagonals should be equal.
8	Use the Builder's square to check that the corners are at right angles.

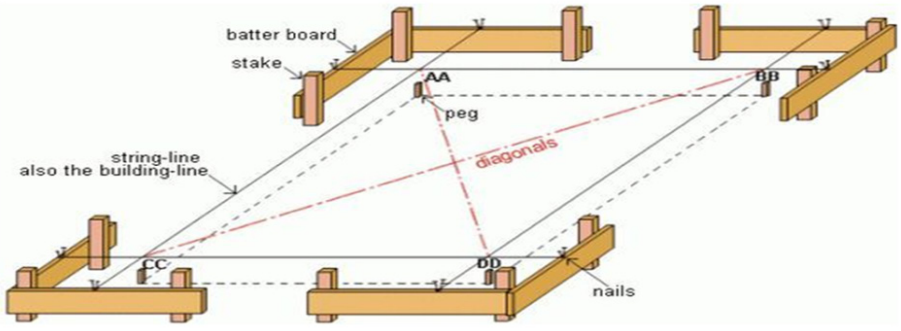


Figure 1.53: *Using Equal Diagonals as a check in the Setting Out*

Making Right Angles

The walls of a square or rectangular must form a right angle of 90°. The traditional method for making right angle is to use a 3-4-5 triangle.

Table 1.4: Checking for a right-angle corner or joint using the 3-4-5 method

Step	Activity
1	Nail 3 pieces of timber together which you cut to these lengths to make a frame 750mm 1000mm 1250mm A frame with a right-angled corner is called a square.
2	Place the right angle of the square against the line between the corners. If the corners are not at right angles, then move the corner pegs until they make right angles.
3	Measure the diagonals to check that they are the same length.

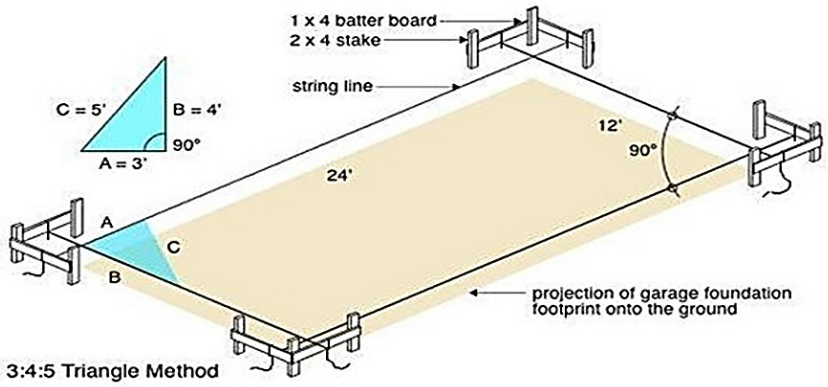


Figure 1.54: ***Setting out the corners of a building***

Making And Using Profiles

Table 1.5 **:**Making and using profiles

Step	Activity
1	Attach horizontal board to two timber posts and sharpen the posts at one end to stick in the ground.
2	Mark the top of the board with nails to show the width of the walls and foundations at the corners.
3	Place a pair of profiles in the ground beside the pegs used for setting out and check that the angles are still 90^0.
4	Stretch lines between the profiles at the corners of the building. Use nails to locate the position of the walls and foundations.

Setting Out Columns And Piers

Columns and piers which are upright supports should be set out on two lines that pass through the Centre of the column or pier at right angles to each other.

Table 1.6: Setting out columns and piers

Step	Activity
1	Locate the positions of the columns and piers on the working drawings.
2	Measure the positions on the ground and place pegs to mark the Centre of the columns and piers.
3	Check that the lines are at right angles to the proposed wall positions.
4	Run lines from the Centre of the pegs in both directions to the opposite wall positions or profiles.
5	Remove the pegs as the building work progresses.

Setting Up Site Datum for Vertical Levels

Site datum is a fixed point from which all vertical measurements can be taken. This can be a wooden peg. The following depths or levels are obtained using the Datum.

Table 1.7: Setting up site datum for vertical levels

Step	Activity
1	The depth of foundation trenches.
2	The height of the concrete strip foundation.
3	The depth of the excavation under the hardcore bed.
4	The height of the hardcore bed.
5	The height of oversight concrete.

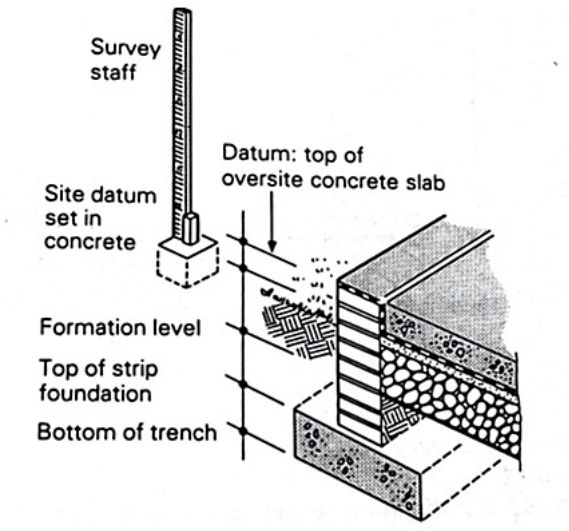


Figure 1.55: *Detail of a datum in relation to the foundations*

Learning Tasks

1. Explain the meaning of and reasons for setting out a building.
2. Outline the various tools, plant and equipment available for setting out and categorise them according to the different methods adopted for setting out a building.
3. Discuss the activities performed during the setting out process which serve as check and balance on the builders' work. Explain how these checks and balances impact on the building being set out.

PEDAGOGICAL EXEMPLARS

1. **Conduct Experiential Learning** by organising Field Trips to construction sites, where setting out is taking place for learners to observe and learn about the activity as they interact with the professionals.
2. Encourage research by using the internet to help learners acquire understanding of setting out as practiced abroad to compare to what happens in the Ghanaian building construction industry.
3. Place learners in mixed-ability groups where the different needs of learners approaching proficiency, the proficient and highly proficient will be met. They will all be encouraged to engage in critical thinking and brainstorming about setting out as well as understanding check and balance methods used to sustain the integrity of the setting out exercise.

KEY ASSESSMENT

1. **Level 1:** Outline the popular methods used in setting out a building.
2. **Level 2:** Categorise the various approaches to setting out into simple and complex methods. Associate with these categories the tools, plant and equipment that can be used.
3. **Level 3** Discuss the major activities undertaken from start to the end of a setting out exercise including those steps that serve as check and balances on the setting out exercise.

UNIT 4 REVIEW

This unit is the review of the lesson taught in week 4. This unit provides learners with a deeper understanding of setting out of buildings at the construction site. The pedagogical exemplars used in this section include experiential learning and putting learners in mixed-ability groups to engage in critical thinking and brainstorming about setting out. These strategies will enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group are structured to cater for all varied activities of learning. These assessments are classified under the DoK level 1, 2 and 3.

APPENDIX A: SAMPLE PORTFOLIO ASSESSMENT

Task: Compile and submit a comprehensive portfolio that represents your work for the entire academic year. The portfolio should include a selection of **design portfolio**, exercises/ assignments, project work, and both mid-semester and end of semester examination papers.

STRUCTURE AND ORGANISATION OF THE PORTFOLIO

As part of the structure of the portfolio assessment, make sure the following information has been provided:

1. **Cover Page with**
    - **a.** *learner's name*
    - **b.** *class*
    - **c.** *subject*
    - **d.** *period/date, etc.*
2. Table of Contents which has the list of items included with page numbers.
3. Brief description/background of items such as background information for each included artefact, etc**.**

LEARNERS' WORKS TO BE INCLUDED IN THE PORTFOLIO

1. Design portfolio project
2. Class Exercises/Assignments
3. Project works
4. Reflective Pieces
5. Mini-research work
6. Mid-semester examination papers
7. End of semester examination papers, etc.

MODE OF ADMINISTRATION FOR PORTFOLIOS

1. Clearly explain the purpose of the portfolio and its various components to the learners. Provide examples and templates for each section to guide them in their work.
2. Set up regular review sessions, every 4 weeks, to monitor learners' progress. During these checkpoints, they offer feedback and guidance to help them improve their portfolios.
3. Share the scoring rubrics with the learners and thoroughly explain how their work will be evaluated.

Set the final due date for portfolio submission in Week 22 of the academic calendar. Offer a grace period for learners to make revisions based on the final feedback they receive.

MODE OF SUBMISSION/PRESENTATION

1. Clearly inform all learners of the final deadline for portfolio submission to ensure that all work is completed and submitted on time.
2. Learners should organise their portfolios in a clear and logical manner, with each section clearly labelled and easy to access.
3. Learners may submit their portfolios either in physical form or via the school's online submission system.
4. For digital submissions, learners should upload their portfolios either as a single file or in well-organised folders within the online platform.
5. Ensure the portfolio contains all required components: assignments, projects, quizzes, tests, reflective pieces, mini-research work, as well as mid-semester and end of semester examination papers.

FEEDBACK STRATEGY

1. Schedule regular meetings to review learners' progress, set new goals, and make any necessary adjustments to their learning strategies.
2. Provide helpful comments throughout the learning process to support learners' development. Ensure that learners clearly understand how to use this feedback to continually improve their work and achieve better results.

AN EXAMPLE OF A SCORING RUBRIC/ MARKING SCHEME

Learner's pieces of work	Items	Marks per Item	Total Marks
Design Portfolio	11	1 mark each	11 marks
Assignments/Exercises	2	1 mark each	2 marks
Project work (Group)	1	1 mark	1 mark
Project work (Individual)	1	2 marks	2 marks
Mid-semester Examination Papers	2	1 mark each	2 marks
End of semester Examination Paper	2	1 mark each	2 marks
Total Marks			***20 marks***

APPENDIX B: GROUP PROJECT

Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)
Heading (Caption of the Project)	Heading includes 4 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.	Heading includes 3 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.	Heading includes 2 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.	Heading includes 1 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.
Project Design Brief	Brief is based on 4 of the following: has project specification, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords	Brief is based on 3 of the following: written, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords	Brief is based on 2 of the following: written, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords	Brief is based on 1 of the following: written, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords
Team work	Exhibit 4 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility	Exhibit 3 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility	Exhibit 2 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility	Exhibit 1 of these Contributing to the group. Respecting the views of others Tolerating others Resolving conflicts Taking responsibility
Technical Specification	Final work shows 4 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.	Final work shows 3 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.	Final work shows 2 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.	Final work shows 1 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.

SECTION 2: WOODWORK MACHINES, EXCAVATION AND FOUNDATIONS

The section covers woodwork technology and building construction technology unit (strands).

In this section, learners will acquire knowledge and understanding of machines to select and use the appropriate machine for a specific woodwork operation and care and maintain it. In the building construction technology unit learners are expected to gain the knowledge and understanding of the processes involved in excavation and the various types of foundation used given the soil type. All the above are treated from unit 5 to unit 8.

UNIT 5

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Tools and Machines in the Woodwork Industry

Learning Outcome: *Demonstrate the knowledge and understanding of hand tools and machines to select the right tool and machine for a specific woodwork operation.*

Content Standard: *Demonstrate the ability to use woodwork hand tools, joints and machines in the woodwork shops.*

HINT

Mid-semester examination is in week 6. Refer to Appendix C at the end of the section for sample tasks and Table of Specifications for help support you to conduct the mid-semester assessment.

INTRODUCTION AND UNIT SUMMARY

This unit will help learners select and use the appropriate machine for a specific woodwork operation. Woodworking machines are machines that are used to process wood in the woodwork industry. These machines are usually powered by electric motors and are used extensively in woodworking to shape, cut, carve and create complex designs on wood materials. There are various types of woodworking machines. These machines are grouped into two main categories: handheld power machines and stationery machines. These machines allow for a variety of

woodworking projects to be carried out, and with practice, can create beautiful and functional pieces.

The unit covers only week 5: ***Select and use the appropriate machine for a specific woodwork operation***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in selecting and explaining the uses of appropriate machine for a specific woodwork operation. The teacher will employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies will be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. The assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers will employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Teachers will administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the various uses of appropriate machine for a specific woodwork operation and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 5

Learning Indicator: *Select and use appropriate machine for a specific woodwork operation.*

FOCAL AREA: WOODWORK MACHINES

Woodworking machines are machines that are used to process wood in the woodwork industry. These machines are usually powered by electric motors and are used extensively in woodworking to shape, cut, carve and create intricate designs on wood materials.

a. **Crosscut Saw:** The main use of the cross-cutting saw is to cut the timber (across) to the required lengths. It is also very useful for **angular cross-cutting**. When fitted with special cutters, the machine can also be used for **trenching**, **tenoning** and **ploughing**.

Figure 2.1: *Crosscut saw machine*

b. **Circular Saw:** The main purpose of the saw is to cut the timber along the grain to obtain the required width and thickness. It is used for ripping the timber to obtain the required width, termed **flatting**, and ripping it to the required thickness, known as **Deeping**. The machine has a sturdy base which is either cast iron or fabricated steel sheet, with a table. The whole saw assembly can be raised or lowered by means of a handwheel.

Figure 2.2: *Circular saw bench main parts*

c. Dimension saw bench: A general-purpose bench saw which can perform a large variety of cutting operations to very accurate dimensions.

The major operations which can be carried out on the machine are: cross-cutting, ripping, beveling, cutting compound bevels, grooving, mitering, rebating.

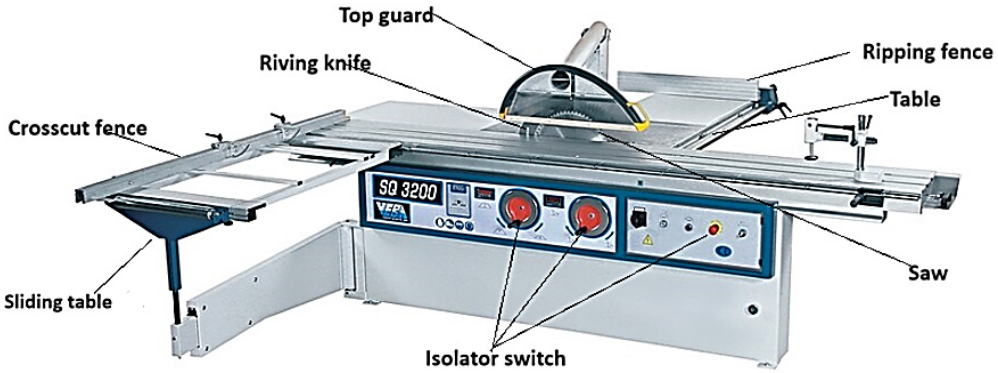


Figure 2.3: *Dimension saw main parts*

d. Saw blades: Saw blades have several types of teeth, the shapes of which are determined by the work done by the saw blade. ***Figures 2.4 – 2.7*** show a section and part elevation of different saw blades.

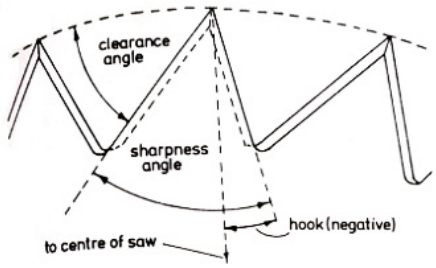


Figure 2.4: Ripsaw teeth

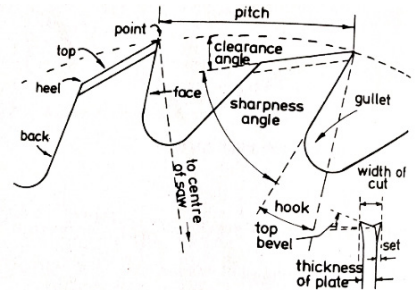


Figure 2.5: *Crosscutting saw*

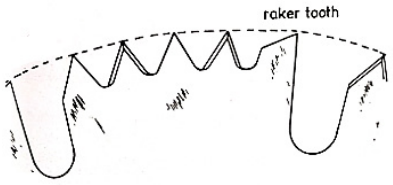


Figure 2.6: *Novelty type teeth*

Figure 2.7: *Carbide tipped teeth*

e. Packing Saw Blades: Some circular saws are provided with a recess on each side of the saw where it enters the table. These recesses are to receive packings and a mouthpiece. Packings are made of thick felt, which assists in keeping the saw cutting in a straight line. The mouthpiece is made of hardwood and is inserted to prevent breaking out (spelching) on the underside of the timber at the point of exit of the teeth.

f. Push-Stick: A suitable push-stick must be made available for use at the bench of every circular saw which is fed by hand. A Push-stick should be used for the last 300mm of the timber which is being cut and are also used for removing **offcuts** from the table around the saw blade.

g. Narrow Bandsaw: The bandsaw is used mainly for cutting curved work, though straight cutting is also carried out on the machine. The saw runs through a wooden mouthpiece

which fits into a slot in the centre of the work table. The table can be set at any angle up to 45°. This enables splayed or bevelled work to be carried out. Various widths of bandsaw blades are available. Small curves require a narrow saw blade. Straight cuts and large sweeping curves require the widest blades.

Figure 2.8: *Narrow bandsaw main parts*

The various parts of the machine are

i. **Top pulley guard**: encloses the top pulley and part of the saw blade above the saw blade front guard.

ii. **Tracking device**: enables the saw blade to run or track central round the pulley rims.

iii. **Saw tensioning wheel**: controls the correct tension for the width of blade in use.

iv. **Saw blade guard:** encloses the saw blade between the work piece and the top pulley guard.

v. **Fence:** is fitted to the blade when using the bandsaw for a flat or deep cutting.

vi. **Table**: the saw blade runs through a slot in it and the timber to be cut is placed on it. It can cant up to an angle of 45o to the right and up to the angle of 5o to the left.

vii. **Bottom pulley guard**: encloses the bottom pulley and part of the saw blade below the worktable.

h. **Surface Planer:** After sawing the timber to the required size on the circular saw, the next operation is planning. This is done on the surface planer. The main function of the surface planer is to produce one surface of the timber straight, flat and smooth and one edge straight and at an angle of 900 to the flat surface. These are termed **surfacing** and **edging.** Rebating**,** bevelled work and tapering can also be done on the machine.

Figure 2.9: *Surface planer main parts*

These are the parts of the surface planer

i. **Back table**: the table at the back of the cutter block.

ii. **Top or bridge guard:** guards the cutter block.

iii. **Fence:** the face-side of the timber being 'edged' is pressed against it. It can be adjusted to any required position across the table and can also cant up to 450.

iv. **Front table:** the table in front of the cutter block. It can be adjusted to vary the cutting depth (to vary the amount of timber which is to be planed off).

v. **Hand wheel:** for adjusting the height of the table.

vi. **Isolator switch:** for cutting off the power supply to the machine.

i. **Thicknesser Machine:** The main function of the machine is to plane to the required thickness of timber which has previously been surfaced and edged. The table of the machine occupies a position below the cutter block and can be adjusted vertically to be the required dimension of the finished thickness of the timber. The timber is fed through the machine by two power-driven feed rollers and anti-friction rollers.

Figure 2.10: *Thicknesser machine main parts*

The parts of the machine indicated are:

i. **Rise and fall table:** the trued surface of the timber is placed on it.

ii. **'On/off' switch:** for cutting off the power supply to the machine.

iii. **Thickness scale:** enables the table to be set to the required thickness of the timber being planned.

iv. **Control board:** to control the rise and fall of the table for a specific thickness to be plane.

j. **Combined surfacing and thicknesser machine:** This is a useful machine serving the purpose of the surfacing machine and the thicknesser. The cutter block of the machine is used for both operations. The machine has two tables; one above the cutters is of two parts used for surfacing and edging. The one below the cutters, mounted on vertical slides, is used for thicknessing. This machine can only be used for one operation at a time.

These are the parts of combined thicknessing and surfacing machine:

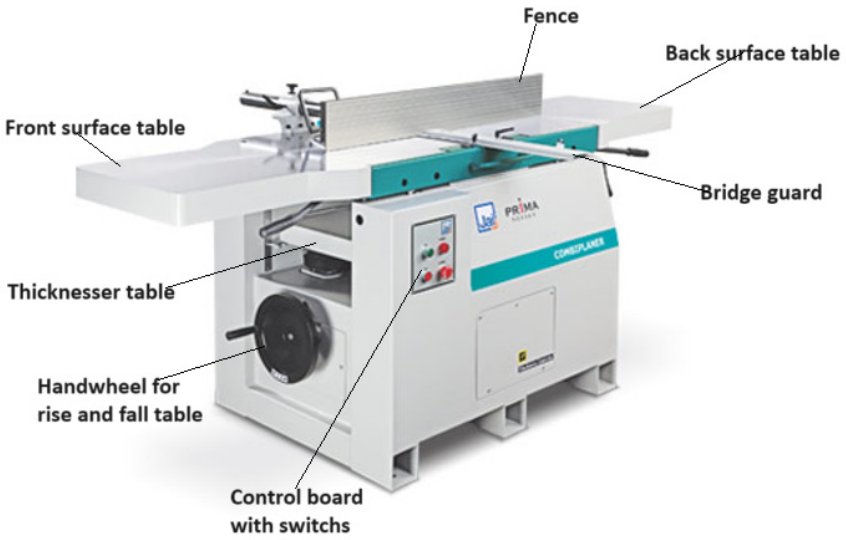
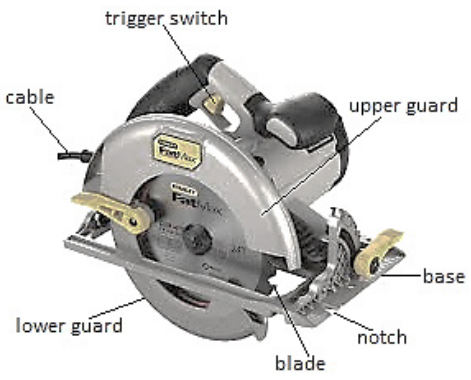


Figure 2.11: *Combined Thicknesser and surface machine*

Portable Power Hand Machine

The use of portable power hand machine in the workshop and on the site is ever-increasing. It is, therefore, necessary for the woodworker to have a wide range of these tools at his disposal to enable him to increase of workmanship.

Table 2.1: Portable Power Machines

Nº	Item	Machine
1	**Portable Power Circular Handsaw:** The saw is used extensively on the building site. It is useful for straight and cross-cutting, bevelled and splayed cuts, rebating and grooving. Special saw blades and abrasive wheels can be fitted to the tool, which enables it to cut metal, asbestos, manufactured boards, synthetics, etc.	

2	**Portable Power Jig Saw:** The portable power jig saw is an ideal portable tool for use in cabinet shops, furniture factories and on site. A stroke is a straight up-and-down motion of the blade. The blade cuts only on the return stroke. Some jig saws are equipped with the guide to aid straight ripping and cross-cutting.	
3	**Power plane:** When using the plane, it is pushed along the grain of the timber in the manner of a hand plane. The plane can be used for removing rough surfaces of a timber, shooting doors into frames, cleaning up large items or any planning work that cannot be done on either the surface or the Thicknesser.	

Introduction to Computer Numerically Controlled Machinery (CNC)

Woodworkers use computer numerically controlled machinery to make precise measurements, cuts, and designs. This advanced technology requires intense training and courses since the equipment is expensive for initial purchase, maintenance, and part replacement. The CNC works on the Cartesian coordinate system (X, Y, Z) for 3D motion control.

The following are some types of computer numerically controlled machinery (CNC):

Table 2.2: Types of CNC Machines

№	Item	Machine
1	CNC Crosscut saw machine	
2	CNC Circular/Panel saw machine	

3	CNC Band saw machine	
4	CNC four sided planer machine	

Learning Tasks

1. Identify at least two machines used in the woodwork shop.
2. Explain at least two uses of the various woodwork machines.
3. Demonstrate how to use the machines to perform a specific operation.

Pedagogical Exemplars

The teacher should consider the following activities:

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners through a video demonstration on the types of woodwork machines, and brainstorm on the identification of types of woodwork machines. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group Work/Collaborative Learning /Digital Literacy Learning:** Place learners into small mixed-ability groups. Ask learners to discuss the uses of the various woodwork machines. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
3. **Experiential learning:** Guide learners in mixed ability groups to select an appropriate machine and use it properly taking into account skill levels and safety rules. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

KEY ASSESSMENT

Level 1

1. Which machine would you use for the following operations in the workshop
   a. Ripping the timber to obtain the required width and thickness?
   b. Cutting curved work in a workpiece?
   c. Producing one surface of the timber straight, flat and smooth and one edge straight and at an angle of 900 to the flat surface?

Level 2: Explain why the table of the narrow bandsaw is set at any angle up to 450 before sawing a workpiece.

Level 4

1. Given pieces A, B, C and D, produce the following cuts from the given pieces of wood in the workshop
   a. Curved cut
   b. Pattern cut
   c. Groove cut
   d. Rebate cut
2. Research, select and demonstrate the use of appropriate woodworking machines for specific tasks.

HINT

*The recommended mode of assessment for week 5 is **research**. Use the level 4 question 2 as a sample question.*

UNIT 5 REVIEW

Unit 5 of week 5 introduced learners to the selection and the uses of appropriate machines for a specific woodwork operation. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet the varied needs of all learners. These strategies will enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments are classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real objects (woodwork machines)

Reflection: Are learners able to select and use the appropriate machine for a specific woodwork operation?

UNIT 6

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Content Standard: *Demonstrate knowledge and understanding of sub-structure of buildings*

Learning Outcome: *Categorise and describe foundations used under various soil conditions*

INTRODUCTION AND UNIT SUMMARY

Excavation is defined as any man-made cut, cavity, trench, or depression in the Earth's surface followed by earth removal. A trench is a long, narrow and deep excavation (in relation to its length) made below the ground's surface. The main reasons for excavating trenches and precautions taken before, during, and after excavation have been reviewed in this unit. Detail discussions with the help of various tables and illustrations have been presented on the most common excavation methods as well as tools, plants and equipment used for excavation of trenches.

The unit covers only week 6: ***Discuss processes involved in excavation.***

SUMMARY OF PEDAGOGICAL EXEMPLARS

21st century skills of collaboration and communication shall be employed as teaching strategies to help learners in mixed ability groups to brainstorm or carry out critical thinking in explaining the excavation of trenches as well as discussing tools, plant and equipment normally used in connection with various methods of excavation. For successful outcomes GESI, SEL and National Values are to be incorporated to enhance the performing environment for the strategies mentioned.

ASSESSMENT SUMMARY

The assessments used to monitor learning progress during instruction should be formative, including quizzes and short oral and written responses to questions. Teachers must keep track of the performance of each learner given his or her unique level as approaching proficiency, the proficient and highly proficient. Teachers will provide the relevant motivation or support to enhance the understanding of excavation of foundation trenches, the tools, plant and equipment to be used in connection with the various methods of excavation. The assessment will also serve as a tool to evaluate depth of knowledge amongst learners approaching proficiency, the proficient and highly proficient. In this way, the pedagogical differentiation strategies adopted shall be used under assessment too.

WEEK 6

Learning Indicator: *Discuss methods of excavating foundation trenches*

FOCAL AREA 1: PROCESSES INVOLVED IN EXCAVATING FOUNDATION TRENCHES

Excavation is defined as any man-made cut, cavity, trench, or depression in the Earth's surface followed by earth removal. A trench is a long, narrow and deep excavation (in relation to its length) made below the ground's surface.

There are certain steps and precautions that must be taken before, during and after a trench has been excavated.

Table 2.3: Precautions and steps to take before, during and after excavation

Item	Precautions and steps to take before, during and after a trench has been excavated.
1	**Plan for excavation:** decision as to what set of tools and heavy equipment to use, the route to use that will not damage any valuable property, making the type of soil to dig is known since different soils require different equipment.
2	**Check for Major Pipelines:** check with the local government/utility for location of underground services pipes so as not to damage them while excavating.
3	**Procurement of appropriate equipment:** hand tools could be rented. Leasing a mini excavator could be resorted to if the intention is to save a lot of time and the finance is available.
4	**Removal and re-use of Vegetation:** If desirable for re-use existing vegetation can be kept alive after safe removal and replanted after the job is done.
5	**Removal of Topsoil:** removal of the topsoil to a depth of about 10–20 cms can be done. Storage of the topsoil away from the site to avoid contamination is recommended. To avoid compaction, the heap of topsoil must not exceed 1 – 1.5m in height.
6	**Digging of ditch:** plan for excavation is to be carried out in terms of desired depth, width and route.
7	**Getting rid of bad soil:** getting rid of poor or contaminated soil is to ensure that it does not encumber the processes while reinstalling the utilities or other works the trenches have been dug for.
8	**Protecting workers:** removing water out of trench and supporting sides of trench.
9	**Use of laser to check depth of trenches:** the depth of the trench must be checked to ascertain if all areas have been dug equally to the exact level or measurement according to the initial plan.
10	**Casting of concrete**: casting of foundation concrete that the trench has been dug for.
11	**Backfill of trench**: filling back soil and compacting as specified.

Working Safely in Excavation Trenches

Trench timbering is a typical method for preventing the collapse of a trench due to the reasons covered in table below.

Table 2.4: Safety issues to consider while excavating in a trench

Item	Conditions		
1	Is the soil firm or loose?		
2	How long will the excavation remain open?		
3	Is the rainfall excessive?		
4	Are the temperatures very high? High temperatures can dry the soil very fast.		
5	How deep is the excavation? Deep trenches need more support at the sides.		
6	Are there heavy loads or vehicles near the edges?		
7	Is there any vibration from any equipment nearby?		

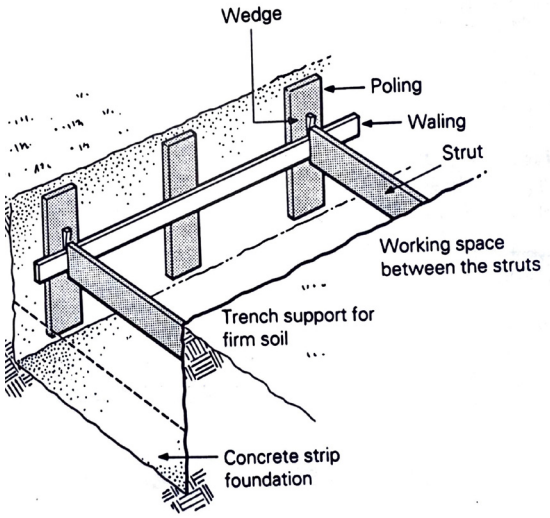


Figure 2.13: *Trench support for firm soil*

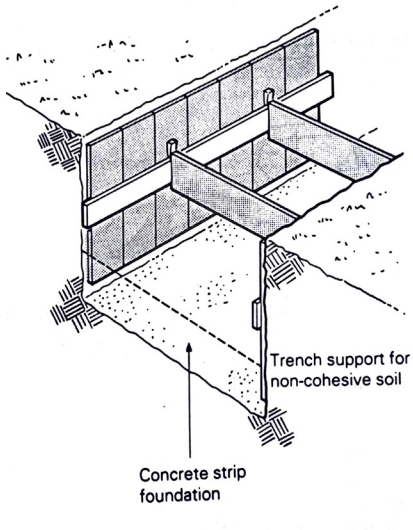


Fig. 2.14: *Trench support for non-cohesive soil*

Digging out for a basement floor at the sloping side of a plot of land

Table 2.5: How to excavate a sloping side of land to create a basement floor

Step	Activity
1	Take spot heights on the land to determine the lower level of the land, which will accommodate the basement floor.

2	Provide working drawings to show upper floor and lower basement floor in the sections of the working drawing.
3	Set out building according to block plan and set the datum as indicated on the sections.
4	Part of land to be excavated to accommodate basement and retaining wall(s) can be read from the working drawings with room height dimensions of the basement indicated.
5	Depending on the soil type use hand tools or plant to excavate in order to reduce the level of the ground at the space indicated to accommodate the basement floor.
6	The retaining wall on sectional drawing on Figure 2.15 indicates where soil pressure builds up and where ground water is likely to come from into the interior basement space. Apart from providing reinforced concrete wall to deal with the pressure, the retaining basement wall must receive tanking, and damp-proof course as well as membrane for the basement floor.

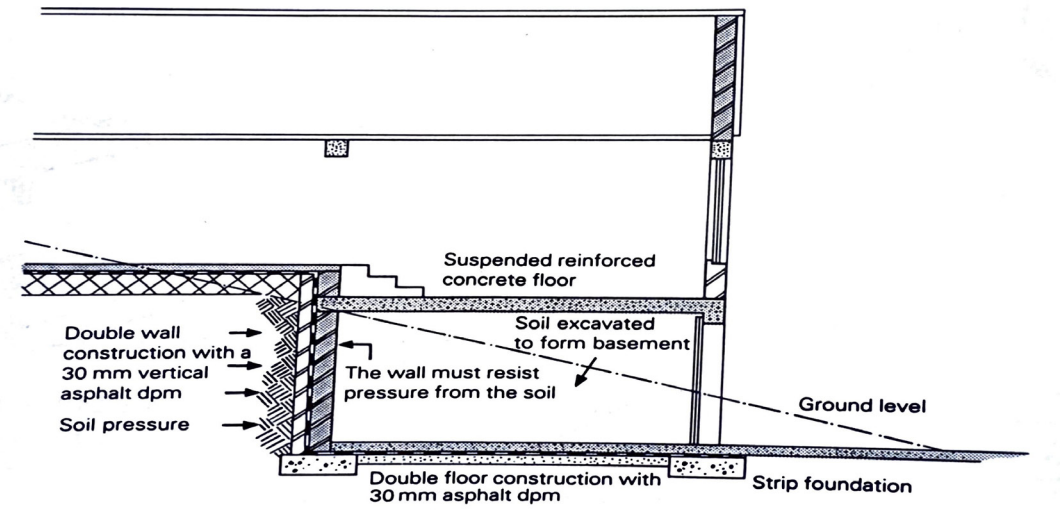


Figure 2.15: *Excavation to create a basement at the lower level of a plot of land.*

Excavating Pits for Piers or Columns

Table 2.6: Excavation for a pier or a column which is usually square

Step	Activity
1	Calculate the depth from the top of the profile to the desired level of excavation using the working drawing at site.
2	Make a measuring staff called boning rod which is the same length as the distance between the top of the profile and the bottom of the trench (Figure 2.16).
3	Place the boning rod in the trench.
4	Dig down the trench until the top of the "T" top of the boning rod lines up with the top of the profiles.

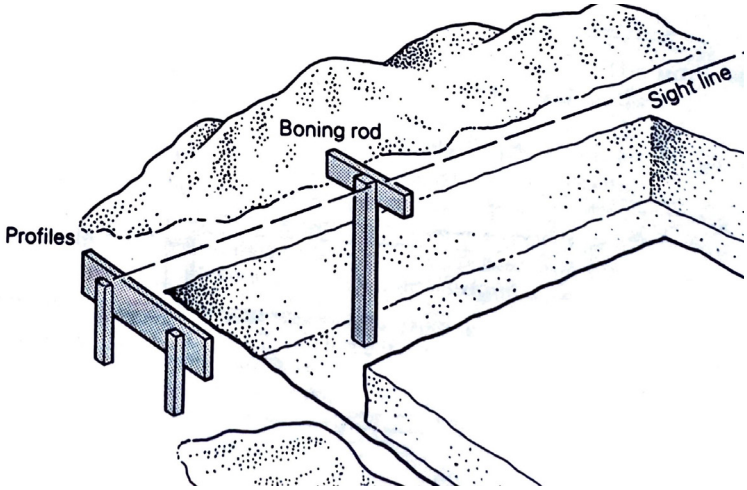
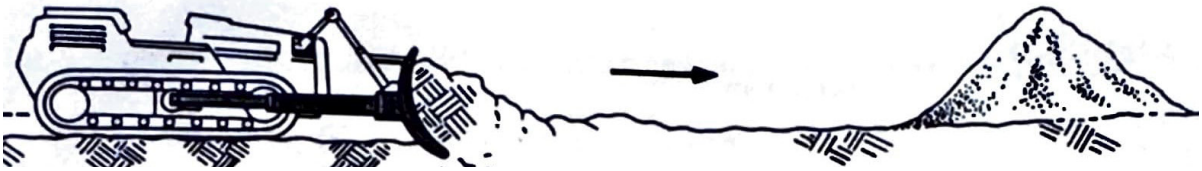


Figure 2.16: *Excavating a Pit for a pier or a column*

Excavating for Strip foundations

- **Strip foundations (or strip footings)** are a type of shallow foundation that are used to provide a continuous and level (or sometimes stepped) strip of support to a linear structure, such as a wall or closely-spaced rows of columns built centrally above them.
- **Deep strip foundations** may be necessary where soil with a suitable bearing capacity is deeper. Wide strip foundations may be required where the soil is soft or of a low bearing
- capacity to spread the load over a larger area. Wide strip foundations will typically require reinforcement.
- **Bulldozers:** Bulldozers are used for **shallow digging and ditching**; short-range transportation of material; spreading soil dumped from trucks; rough grading; removing trees, stumps, and boulders; and cleaning and leveling around loading equipment.



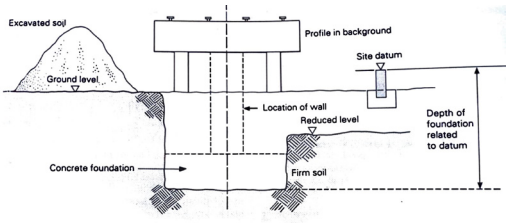


Figure 7.3 Excavating a trench for a strip foundation.

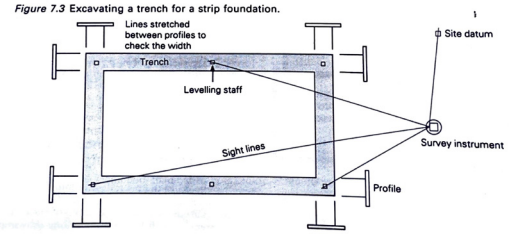


Figure 2.17: *Excavated trench for strip foundation*

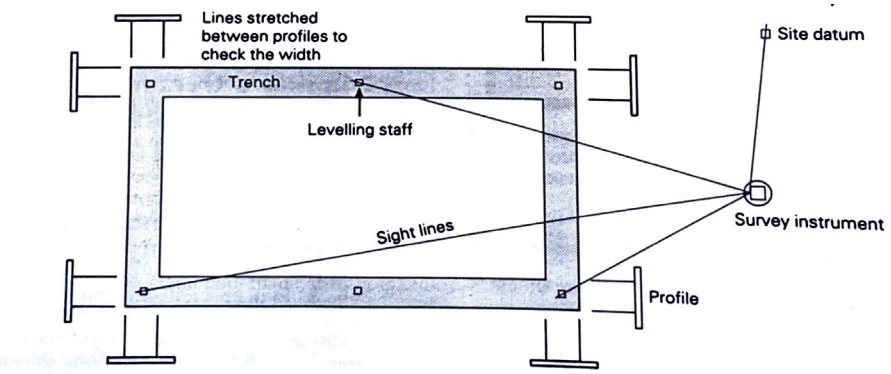


Figure 2.18: *Excavated trench for strip foundation using survey instrument to determine levels for excavation*

Types of Excavation Plants and Their Functions

1. **Mechanical Shovel**: Power shovels are used principally for excavation **and removal of debris**. Mechanical cable-operated shovels apply engine power to the base and attachment through clutches, gears, shafts, winch drums, and cable.

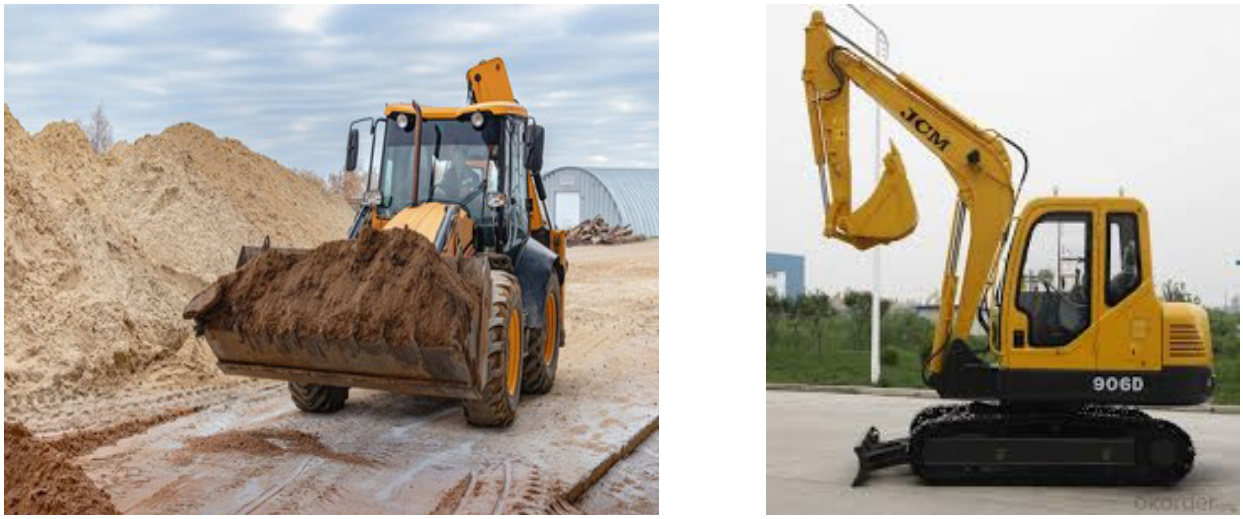


Figure 2.19: *Mechanical Shovel*

2. **Backhoe:** A backhoe, also sometimes called a rear actor or back actor, is a piece of construction equipment useful for **agricultural, landscaping, and paving projects**. A backhoe's front-end loader and rear bucket make the machine extremely versatile, allowing it to dig, backfill, load, and trench.

Figure 2.20: *The backhoe*

3. **Drilling Pile:** Piling is the process of driving or boring pile foundations into the ground beneath a building that is under construction. These piles **transfer loads from the structure to the ground, helping to support it**. Pile foundations are often used where the ground is too weak to underpin the structure.

Figure 2.21: *Drilling Pile*

4. **Drilling Rock:** A hand-held pneumatic drill will drill into solid rock. The drill is connected by a hose to a compressor that provides the power for the work.

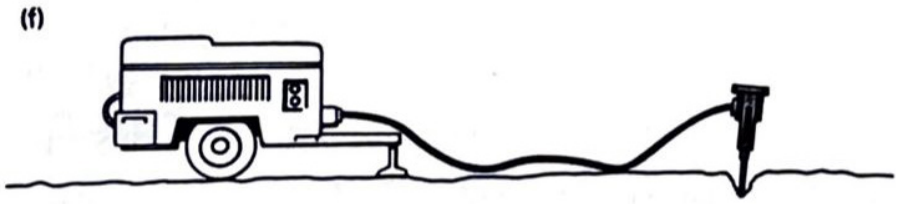


Figure 2.22: *Drilling Rock*

5. **Dump truck:** Dump trucks are used to transport loose materials like sand, dirt, and gravel for construction projects. They have several key components, including a dump box, wheels, a cab, and an engine compartment.

Figure 2.23: *Dump truck*

Learning Tasks

1. Explain the meaning of and reasons for excavating foundation trenches.
2. Discuss the various tools, plants and equipment used for excavating trenches and categories them according to the different methods adopted for excavating trenches.
3. Discuss methods of excavation alongside safety precautions and the impact the precautions can have on the project.

Pedagogical Exemplars

1. Place learners in mixed-ability groups where the different needs of learners approaching proficiency, the proficient and highly proficient will be met and where they will communicate on definitions and reasons for excavating trenches.
2. In mixed-ability groups where the different needs of learners will be met engage learners to discuss tools, plant and equipment usage associated with excavation of trenches.
3. In mixed-ability groups where the different needs of learners will be met a engage learners to discuss methods and safety precautions involved in excavation of trenches.

Key Assessment

1. **Level 1:** Explain excavation and outline the reasons why excavations of trenches are done.
2. **Level 2:** Categorise the various approaches to excavation into simple and complex methods. Associate with these categories the tools, plant and equipment that can be used.
3. **Level 3:** Discuss the major methods of excavating trenches and the impacts of any safety precautions that go with the project's processes.

HINT

*The recommended mode of assessment for week 6 is **Mid-Semester Examination**. Refer to the Appendix C at the end of the section for more sample task and the Table of Specification.*

UNIT 6 REVIEW

This review is for the lesson taught in week 6. Learners were provided with an understanding of excavation of trenches at the construction site. The pedagogical exemplars used in this section include collaboration and communication as learners are put in mixed-ability groups to engage in critical thinking and brainstorming about the meaning and reasons for excavation of trenches at the construction site. Using similar strategies learners are to discuss tools, plant and equipment as well as methods of excavation. Safety precautions are discussed using the same strategies of communication and collaboration. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities are structured to cater for various activities of learning. These assessments are classified under the DoK level 1, 2 and 3.

UNIT 7

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Tools and Machines in the Woodwork Industry

Learning Outcome: *Demonstrate knowledge and understanding of hand tools and machines to select the right tool and machine for a specific woodwork operation.*

Content Standard: *Demonstrate the ability to use woodwork hand tools, joints and machines in the woodwork shops.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to care for and maintain machines used in the woodwork shop. The term "care and maintenance of machines" refers to the practices of providing maintenance to machinery to guarantee its continuous operation. Cleaning surfaces, lubricating gears, and inspecting parts like belts for wear and tear are examples of normal maintenance that might be included. It can also occur before any kind of breakage or damage. Inspecting equipment for any indications of impending problems, such as altered vibration patterns, elevated temperature, or increased energy usage, can also be part of it. The actions taken when a machine breaks down, such as evaluating damage and changing parts, are also included in machine maintenance. Proper care and maintenance ensure that machines remain functional and safe to use, which can also increase their lifespan.

The unit covers only week 7: ***Explain how to care for and maintain machines***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in discussing the appropriate methods to care for and maintain machines in the woodwork shop. The teacher will employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies will be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities will be encouraged to participate fully in investigations as well as presentation of findings. The teacher will implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. The assessments will largely cover levels 1, 2 and 3 of the DoK. Teachers will employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress

and give prompt feedback. Teachers will administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on care and maintenance of machines in the woodwork shop and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 7

Learning Indicator: *Explain how to care for and maintain machines*

FOCAL AREA: CARE AND MAINTENANCE OF MACHINES

Woodworking machines can be **dangerous** if not properly used. It is, therefore, very important that students should be fully instructed in the use of the machines and be fully conversant with all matters of safety before being allowed to use the machines. No machine may be used by a student unless permission has been sought from a teacher.

Factories Ordinance 1952 governs the use of woodworking machines in Ghana and anybody using the machines must have a thorough knowledge of the regulations.

Safety: The following general rules must be observed when using any machinery:

1. Allow cutters in the machine to reach the maximum speed before feeding the machine.
2. Adjustments should not be made to a machine while the cutter is moving.
3. The cutter of a machine should stop moving before leaving the machine.
4. Do not allow yourself to become distracted while operating a machine.
5. Make sensible use of guards and safety devices.
6. Always isolate the machine and clean it down after use.

General Maintenance of Machines

a. **Regular cleaning:** Keep machines free from dirt, dust, and debris to prevent damage and clogging.

b. **Lubrication:** Apply the appropriate lubricants to moving parts to reduce friction and wear.

c. **Inspections**: Regularly check machines for signs of wear, damage, or malfunction.

d. **Scheduled maintenance:** Follow manufacturer guidelines for maintenance schedules and procedures.

e. **Training:** Ensure operators are properly trained to use machines correctly and safely.

f. **Repair and replacement**: Address issues promptly and replace worn or damaged parts to prevent further damage.

g. **Storage:** Correctly store machines and equipment when not in use to protect them from environmental factors.

h. **Upgrades**: Consider upgrading machines to improve performance, efficiency, and safety.

i. **Record keeping:** Maintain accurate records of maintenance, repairs, and inspections to track machine history.

j. **Safety protocols:** Establish and enforce safety protocols for machine operation and maintenance.

Maintenance of Machines

1. **Maintenance of floors:** The floor surroundings of every woodworking machine shall be maintained in good and level condition, and as far as practicable free from chips or other loose material and shall not be allowed to become slippery.
2. **Fencing of circular saws:** Every circular shall be fenced in the following manner:
   - **a.** The part of the saw below the bench table shall be protected by two plates of metal or other suitable material, one on each side of the saw. The plates shall not be more than 150mm apart except where the part below the bench is completely enclosed and shall extend from the axis of the saw outwards to a distance of not less than 50mm beyond the teeth of the saw. Metal plates, if not beaded, shall be of a thickness at least equal to 14 gauge, or, if beaded, be of a thickness at least equal to 20 gauge.
   - **b.** Behind and in direct line with the saw there shall be a riving knife, which shall have a smooth surface, shall be strong, rigid, and easily adjustable, and shall also conform to the following conditions:
   - **c.** The edge of the knife nearer the saw shall form an arc of a circle having a radius not exceeding the radius of the largest saw used on the bench.
   - **d.** For a saw of a diameter of less than 600mm, the knife shall extend upwards from the bench table to within 24mm of the top saw, and for a saw of a diameter of 600mm or over shall extend upwards from the bench table to a height of at least 225mm.
   - **e.** The top of the saw shall be covered by a strong and easily adjustable guard, with a flange that shall extend below the roots of the teeth of the saw. The guard shall extend from the top of the riving knife to a point as low as practicable at the cutting edge of the saw.
3. **Push-stick to be kept available at the bench of every circular saw:** A suitable push-stick shall be kept available for use at the bench of every circular saw which is fed by hand, to enable the work to be carried on without unnecessary risk.
4. **Fencing of plain band saw:** Every plain band saw shall be fenced as follows:
   - **a.** Both sides of the bottom pulley shall be completely encased by sheet metal or other suitable material.
   - **b.** The front of the top pulley shall be covered with sheet metal or other suitable metal.
   - **c.** All portions of the blade shall be enclosed or otherwise securely guarded except the portions of the blade between the bench table and the top guide.
5. **Overhead planing machine:** Every planing machine used for overhead planing shall be provided with a 'bridge' guard capable of covering the full length and breadth of cutting slot in the bench, and so on constructed as to be easily adjusted both in a vertical and horizontal direction.
6. **Feed roller or planing machine used for thicknessing:** The feed roller of every planing machine used for thicknessing, the combined machine for overhead planing and thicknessing, be provided with an efficient guard.

7. **Cylindrical cutter block:** No planing machine, which is not mechanically fed, shall be used for overhead planing unless it is fitted with a cylindrical cutter block.
8. **Fencing of the cutter of vertical spindle moulding machine:** The cutter of every vertical spindle moulding machine shall be provided with the most efficient guard where practicable, having regard to the nature of the work which is being performed.
9. **Use of jig:** For work that cannot be performed with an efficient guard for the cutter, the wood being moulded at every vertical spindle moulding machine, shall if practicable, be held in a jig or holder of such construction as to reduce as far as possible the risk of accident to the worker.
10. **Provision of a '*spike*':** A suitable 'spike' or push-stick shall be kept available for use at the bench of every vertical spindle moulding machine.
11. **Chain mortising machine:** The chain of every chain mortising machine shall be provided with a guard which shall enclose the cutters as far as practicable.
12. **Maintenance and adjustment of guards, and other appliances:** The guard and other appliances required by these Regulations shall be maintained in an efficient state and shall be constantly kept in position while the machine is in motion, except when, owing to the nature of the work being done, the use of the guards or appliances it rendered impracticable. The guards shall be so adjusted as to enable the work to be carried on without unnecessary risk.
13. **Exceptions to regulations:** Regulations 4, 6, 7 and 8 of these Regulations shall not apply to any woodworking machine in respect of which it can be shown to the satisfaction of a Factory Inspector that other safeguards are provided and maintained which render the machine equally safe as it would be if guarded in the manner prescribed by these Regulations.

Duties Of Persons Employed

Every person employed on a woodworking machine shall

- **a.** Use and maintain the guards provided in accordance with these Regulations.
- **b.** Use the 'spikes' or push-sticks and holders provided in accordance with Regulations 5, 11 and 12, except when, owing to the nature of the work being done, the use of the guards or appliance is rendered impracticable.

Learning Tasks

1. Outline how to care for and maintain machines in the workshop.
2. Explain the importance of caring for and maintaining machines in the workshop.
3. Demonstrate how to care for and maintain any three machines in the woodwork shop.

Pedagogical Exemplars

The teacher should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners through a video demonstration on the care and maintenance of machines, and brainstorm on the different ways of caring and maintaining machines with open-mindedness. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to discuss and explain the importance of caring for and maintaining machines in the woodwork shop. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
3. **Experiential learning:** Guide learners in mixed ability groups to select the appropriate machine and demonstrate how to care for and maintain the selected machine taking into consideration skill level and safety rules. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

Key Assessment

Level 1: State when the following regular maintenance is carried out on machines in the workshop

1. Cleaning surfaces
2. Lubricating gears
3. Checking for wear and tear

Level 2

1. Explain how to care for 2 hand tools
2. Explain the consequences of neglecting machine maintenance in the workshop.

Level 3: To optimise machine performance and efficiency in the workshop, how will you specifically care for and maintain each of the following machines?

1. Band saw
2. Thicknesser machine
3. Circular saw

UNIT 7 REVIEW

Unit 7 of week 7 introduced learners to how to care for and maintain machines. The pedagogical exemplars used in this section include talk for learning, group work/collaborative learning, digital learning and experiential learning which help to meet the varied needs of all learners. These strategies will enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentations, class exercises, homework, and practical group activities are structured to cater for all the varied activities of learning. These assessments are classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real objects (woodwork machines)

Reflection: Are learners able to care for and maintain machines in the workshop?

UNIT 8

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Categorise and describe foundations used under various soil conditions*

Content Standard: *Demonstrate knowledge and understanding of sub-structure of buildings*

INTRODUCTION AND SECTION SUMMARY

This unit introduces learners to foundation, various types of foundation and categories of foundations used under various soil conditions. Major foundation types include Strip, Pad, Raft or Mat, Pile and Buoyancy Foundations. Learners after having understood foundation and types of foundation, will understand that these are load-bearing components located below the ground level. and that they serve as anchor for the building. Foundations belong to that part of the building called the substructure which is below the ground level.

The unit covers only week 8: ***Discuss the various types of foundation used given the soil type***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be relevant, learners must fully participate in Critical thinking and Talk for Learning Approaches. Guide learners to brainstorm the meaning of foundation. Conduct experiential learning by organising field trips to construction sites where learners will observe foundations being prepared. Organise learners into mixed ability groups and assist them to explain foundation of buildings, discuss types of foundation and factors affecting the choice of foundation. Help learners develop a deeper understanding of the concept of foundation. Learners will all be encouraged as they engage in critical thinking. The collaborative environment made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will capture the diverse knowledge that the groups have.

ASSESSMENT SUMMARY

The assessments used to monitor progress of learning during instruction should be formative, including quizzes, oral and written presentation and home assignments. Teachers must keep track of performance of each learner given the different levels of performance of the learner in class and provide the relevant motivation or scaffolds to enhance understanding of the concept. The assessment will also serve as a tool to evaluate levels 1, 2 and 3 of the DoK amongst learners. In this way the pedagogical differentiation strategies adopted will also be complemented under the assessment. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 8

Learning Indicator: *Discuss the various types of foundation used given the soil condition.*

FOCAL AREA 1: FOUNDATIONS

The foundation of a building is the element that connects the building to the ground. They are located at the very bottom of the building that is underneath the ground, are load-bearing components of the building and serve as anchor for the building. Foundations belong to that part of the building called substructure which is below the ground level and it is sometimes referred to as under building construction. The requirements of a foundation include:

a. Ability to intercept load from the building and spread evenly over the required bearing capacity.

b. Having the strength to prevent downward vertical loads shearing through them.

c. Ability to accommodate movement due to shrinkage and swelling of earth or earthquakes.

Figure 2.24: *Foundation concrete having direct contact with the ground*

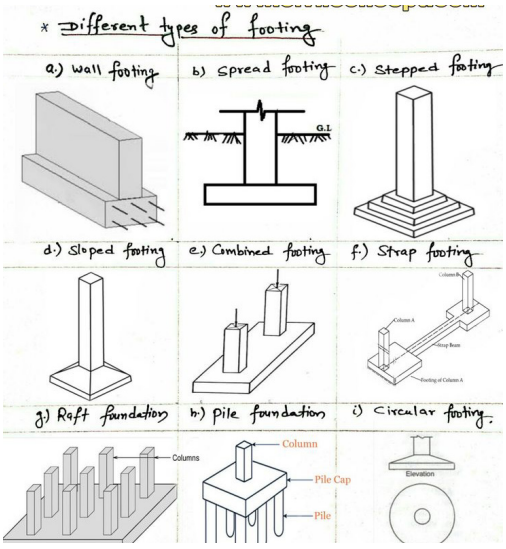


Figure 2.25: *Types of foundation and categories of foundations used under various soil conditions*

Learning Tasks

1. Explain what is meant by a foundation for a building.
2. Outline two requirements of foundation concrete used for building.
3. Discuss different foundation concrete types for building.
4. Discuss the factors that affect the choice of a foundation type for building.

PEDAGOGICAL EXEMPLARS

1. **Critical thinking and Talk for Learning Approaches:** Guide learners to brainstorm the meaning of foundation.
2. **Group work/Collaborative Learning**: Organise learners into mixed ability groups and assist them to discuss types of foundation for building and outline the requirements of foundation concrete for buildings.
3. **Group work/Collaborative Learning**: Organise learners into mixed ability groups and assist them to discuss the factor that affects the choice of a foundation concrete for building.

KEY ASSESSMENT

Level 1: Outline two requirements of a foundation concrete.

Level 2: Explain the foundation for a building.

Level 3

1. Discuss the types of foundation concrete used for building.
2. Discuss the factors that affect the choice of a foundation type for building.
3. Create a concept map to illustrate the key components and functions of a building foundation.

HINT

*The recommended mode of assessment for week 8 is **concept mapping**. Use the level 3 question 3 as a sample question. Refer to Appendix D for a sample rubric to score learners work.*

UNIT 8 REVIEW

This unit presents the learners with a deeper understanding of the concept of foundation of a building. The pedagogical exemplars used in this section included group work/collaborative learning, role-play, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies will enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities are structured to cater for all varied activities of learning. These assessments are classified under the DoK level 1, 2 and 3.

APPENDIX C: STRUCTURE OF EXAMINATION

15 Multiple Choice Questions (MCQ) to be answered individually within 20 minutes, questions should be selected from DoK level 1 to 3.

RESOURCES

Scannable sheets or A4 papers

SAMPLE QUESTIONS

Multiple Choice - *20 mins*

1. *One of the reasons for excavation of trenches in Building Construction projects is, to ……...*

- **a.** *cast foundation.*
- **b.** *fill hardcore.*
- **c.** *plaster walls.*
- **d.** *screed floor.*

MARKING SCHEME

Multiple Choice - ***15 questions at 1 mark each.***

1. *One of the reasons for excavation of trenches in Building Construction projects is, to ……...*

- **a.** ***cast foundation.***
- **b.** *fill hardcore.*
- **c.** *plaster walls.*
- **d.** *screed floor.*

TABLE OF SPECIFICATION FOR MID SEMESTER 1

WKS	LEARNING INDICATORS	DoK level				TOTAL
		1	2	3	4	
1	Select and use appropriate hand tool for a specific woodwork operation.	1	1	1		3
2	Explain substructure	1	1	1		3
3	Explain how to care for and maintain hand tools.	1	1	1		3
4	Explain what setting out is.	1	2			3
5	Select and use appropriate machine for a specific woodwork operation.		2	1		3
	TOTAL	4	7	4		15

APPENDIX D: RUBRIC FOR EVALUATING CONCEPT MAPPING (FOUNDATIONS AND SOIL TYPES)

Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)
Types of Foundations	The concept map shows 4 of the following; describes shallow type foundation, deep foundations, where deep foundations are applicable and where shallow foundations are applicable.	The concept map shows 3 of the following; describes shallow type foundation, deep foundations, where deep foundations are applicable and where shallow foundations are applicable.	The concept map shows 2 of the following; describes shallow type foundation, deep foundations, where deep foundations are applicable and where shallow foundations are applicable.	The concept map shows 1 of the following; describes shallow type foundation, deep foundations, where deep foundations are applicable and where shallow foundations are applicable.
Purpose of Foundations	The purpose includes 4 of the following; load distribution, stability, protection, with an example.	The purpose includes 3 of the following; load distribution, stability, protection, with an example.	The purpose includes 2 of the following; load distribution, stability, protection, with an example.	The purpose includes 1 of the following; load distribution, stability, protection, with an example.
Types of Soil	Indicates 4 of the following; describes clay soil describes sand soil, describes silt soil and an impact on foundation.	Indicates 3 of the following; describes clay soil describes sand soil, describes silt soil and an impact on foundation.	Indicates 2 of the following; describes clay soil describes sand soil, describes silt soil and an impact on foundation.	Indicates 1 of the following; describes clay soil describes sand soil, describes silt soil and an impact on foundation.

SECTION 3: ARTEFACTS DESIGN WITH CAD, FOUNDATION AND FORMWORK

The section covers the following unit (strands); woodwork technology and building construction technology.

In this section learners will acquire knowledge and understanding of applying Computer Aided Design [CAD] in designing and making artefacts as well as how design thinking draws on logic. In the building construction technology unit, learners are expected to gain the knowledge and understanding of foundations used under various soil conditions and formworks. All the above are treated from unit 9 to unit 12.

UNIT 9

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and artefact production in Woodwork Industry

Learning Outcome: *Apply knowledge and understanding in design and making of artefacts, translate the ideas into drawings using CAD and produce working drawings from the final solution and generate a model.*

Content Standard: *Apply knowledge of design and making in artefacts production.*

HINT

End of semester examination is in Week 12. Refer to Appendix E at the end of the section for the structure and sample Table of Specifications for conduction the exam.

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to apply Computer Aided Design [CAD] in designing and making artefacts. Design thinking draws on logic, imagination, intuition and systemic reasoning to explore the possibilities of what could be, and to create desired outcomes that benefit the end user (the customer). A design mind-set is not problem-focused, it's solution-focused, and action-oriented. It involves both analysis and imagination. Design thinking is linked to an improved future and seeks to build ideas up. Drawing is the normal way in which suggestions for practical

work are expressed, and this may be in the form of freehand sketching and mechanical drawing with CAD.

*The unit covers only week 1****: Apply Computer Aided Design [CAD] in designing and making of artefacts.***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in applying Computer Aided Design [CAD] in designing and making artefacts. Design thinking draws on logic. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Precisely, teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on Computer Aided Design [CAD] in designing and making of artefacts and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 9

Learning Indicator: *Apply Computer Aided Design [CAD] in designing and making of artefacts*

FOCAL AREA 1: COMPUTER AIDED DESIGN [CAD] IN DESIGNING AND MAKING OF ARTEFACTS

What is Design?

Design is the practical expression of purposeful action to bring about change in man-made things. Wood design is the intentional planning or inventing and making of wooden artefacts for a particular use. Design refers to the artefact itself and the planning of its construction, operation and appearance. It may be made **by hand** or **machine** and is influenced by the materials, shape, structure, use and appearance.

Designing

Designing involves the following: an examination of situation or identifying problem, investigating about the situation, generating possible solutions; selecting and developing possible solutions; generating final solution, realising final solution, testing or evaluating of final solution.

The problem-solving route can be interpreted in a diagrammatic from thus:

a. **Situation:** The term situation is the description of the problem (need statement). In other words, it is a statement describing the problem. There are many ways of finding situations, such as an examination of activities undertaken in the home and school, equipment and furniture for use in the lounge, bedroom, kitchen, school, etc. The way other people live and work may also provide situations where needs may be identified.

b. **Brief:** A brief is a short statement describing what the designer intends to design and make. For example, 'Design and make a unit that would help toddlers to walk".

c. **Investigation:** Investigation means finding out more information about a design problem. It involves examining the situation with thoughts and judgments (analysis). The most

effective method of examining a situation is through a series of questions which faces the designer. The analysis can be done by asking questions like why, how, where, who, and what about the problem. This helps make suggestions for solving the problem and decides what and how it must be done. One of the first steps in an investigation will be to ask yourself. 'What is the function of the artefact?'

d. **Solutions:** This encompasses possible solutions and the final solution. By getting to know the problem, you will begin to think of possible solutions, and then develop the selected possible idea/solution to get the final solution.

e. **Realisation (Construction):** Realising a design final solution means making the artefact that has been designed. Careful planning is needed to complete the artefact on time.

f. **Testing/Evaluation:** Testing is carried out to see how well an artefact performs or how well it meets the need or solves the problem outlined in the design brief. To find out how well your artefact does the job it was intended to do you must first be clear about what the job is. What function is the artefact meant to perform?

Freehand Sketching

Freehand drawing refers to the ability to draw something without using any tool or mechanical instruments like grids, rulers, or compasses to assist in drawing. Free hand sketching is the quickest and most convenient way of drawing objects. All the three kinds of pictorial drawing can be done either by freehand sketch or CAD Sketch, where the materials are the pencil (HB) and paper, or by using AutoCAD. When designing, ideas must be recorded and presented fast. Freehand sketching, which is a fast method for graphical representation, is therefore used during the formulation and developmental stages of the design process.

Introduction to AutoCAD

Welcome to the world of CAD. CAD simply means Computer-Aided Design, or Computer-Assisted Design, or Computer-Aided Drafting, or Computer-Assisted Drafting. There are other related terms in the system because of their functions and these are Computer-Aided Design and Drafting (CADD) and Computer-Aided Mapping and Computer-Aided Cartography. We designed the material so that the instructions on the commands should work on almost any version of CAD. The use of CAD will help acquire skills to develop 2D & 3D drawings and print them out to scale.

The Structure of AutoCAD

The user must be very familiar with the interface and know where to locate all the commands needed before using AutoCAD effectively and efficiently. The AutoCAD interface has been designed to present as much information as possible to the user and provide access to many commands with as few mouse clicks as possible.

The following should be known before beginning actual drawing with CAD:

a. Launching AutoCAD

b. Exploring the AutoCAD interface. These include:

a. World coordinate system

b. Crosshair cursor

c. Start tap: Setting of sheets (e.g., acad, acadiso, architecture etc.)

d. Draw/ Graphic area

e. Ribbon: consist of various command/tools for modelling artefact (e.g., layers, draw, modify, modelling, solid editing, mesh, views, etc.)

f. Command window/line

g. Status bar: there are settings which consist of grid mode, snap mode, ortho mode, polar tracking, object snaping, workspace switching, line weight etc.

h. Menu bar: consist of home, solid, surface, mesh, visualise, parametric, insect, view, manage, etc.

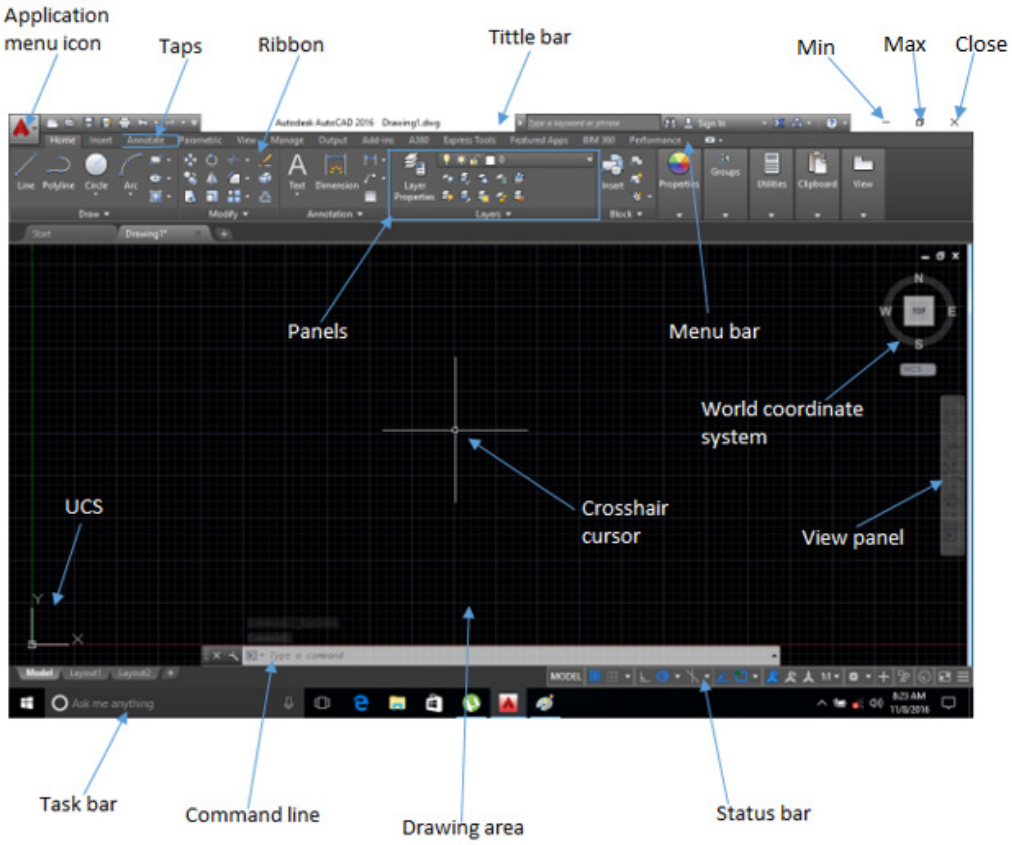


Figure 3.1: *Method of drawing in isometric*

Factors That Affect Solution to Situations/Problems

When designing solutions for situations or problems, several factors can impact the effectiveness of the solution. Some these factors include:

a. **Functionality:** Customer satisfaction is extraordinarily high when the factors affecting the design of a product fulfill the purpose for which it is developed.

b. **Materials:** It is essential to have adequate knowledge of all the materials before designing a product. The designer must be updated and well renewed with all the new materials & technologies existing in the market.

c. **Durability:** Product protection is essential in designing solutions to problems. This should be environment-specific protection.

d. **User requirements:** Understanding the requirements, goals, and behaviours of the target user is crucial.

e. **Cultures:** If a product is for a certain market with its own individual culture, then this factor must be kept in mind during the design of the product. A product which is acceptable in one culture would end up being unpleasant or unwelcome in another one. It is also significant to consider the environmental factors as well for its long-lasting capabilities

f. **Regulatory requirements:** Compliance with laws, regulations, and industry standards must be considered.

g. **Sustainability**: Consider environmental and social impact, as well as long-term maintenance and support.

h. **Technological advancements:** Stay up-to-date with emerging technologies and trends that may impact the solution.

Learning Tasks

1. Identify the parts of the AutoCAD interface.
2. Pose one problem identified at the headmaster's office, which contains only a table and a plastic chair. Write its corresponding brief.
3. Demonstrate how to sketch at least two possible solutions with annotated notes.

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Assist learners through a video demonstration of the AutoCAD interface, and brainstorm on the identification of the parts of the AutoCAD interface with open-mindedness. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should pull all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to discuss how to write a situation and design brief. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
3. **Experiential learning:** Guide learners in mixed ability groups to co-operatively sketch two possible solutions with annotated notes with freehand or CAD, taking into consideration skill levels and safety rules. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

Key Assessment

Level 1: Identify and explain any three parts of the AutoCAD interface.

Level 2

1. Pose one problem identified at the headmaster's office, which contains only a table and a plastic chair. Write its corresponding brief.
2. Explain any three parts of the AutoCAD interface.

Level 3: Sketch two possible solutions with annotated notes of the identified problem.

UNIT 9 REVIEW

Unit 9 of week 9 exposed learners to the application of Computer Aided Design [CAD] in designing and making of artefacts. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real object (computers, laptops, tablet)

Reflection: Are learners able to apply Computer Aided Design [CAD] in designing and making artefacts.

UNIT 10

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Categorise and describe foundations used under various soil conditions*

Content Standard: *Demonstrate Knowledge and understanding of sub-structure of buildings*

INTRODUCTION AND SECTION SUMMARY

This unit introduces learners to foundation footing, elements used for footings, and functions of footing. Two or more blocks or bricks laid after casting foundation concrete is referred to as foundation footing. The teacher will guide learners to understand the key concepts of foundation footings to buildings. Having understood foundation footing, learners will appreciate footings for buildings, explain and outline the elements used for footings. Literally they serve as anchor for the building. Foundation footings belong to that part of the building called substructure which is below the ground level.

*The unit covers only week 10****: Categorise and describe foundations used under various soil conditions***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in Critical thinking and Talk for Learning Approaches. Guide learners to brainstorm the meaning of foundation footing. Conducting experiential learning by organising field trips to construction sites where learners will observe foundation footings. Organise learners into mixed ability groups and assist them to explain foundation footings of a building and discuss the elements of foundation footings. Help learners to develop a deeper understanding of the concept of foundation footing through Critical thinking. Learners will all be involved as they engage in critical thinking without any form of inhibition. The collaborative environment made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will capture the diverse knowledge that the groups have.

ASSESSMENT SUMMARY

The assessments used to monitor learning progress during instruction should be formative, including quizzes, oral and written presentations using flip charts and home assignments. Teachers must keep track of the performance of each learner given the different levels of performance of the learner in class and provide the relevant motivation or scaffolds to enhance

understanding of the concept. The assessment will also serve as a tool to evaluate levels 1, 2 and 3 of the DoK amongst learners. In this way the pedagogical differentiation strategies adopted will also be complemented under the assessment. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA2023) on how to use the assessment strategies effectively

WEEK 10

Learning Indicator: *Explain foundation Footing*

FOCAL AREA 1: FOUNDATION FOOTING

The foundation footing of a building is the element that connects the building to the foundation concrete. It is located within the substructure of the building that is underneath the ground and is the load-bearing component of the building. It serves as anchor for the building and is sometimes referred to as under building construction.

Figure **3.2:** *Concrete footings*

Figure **3.3:** *Block footings*

Learning Tasks

1. Outline the elements of footings.
2. Explain the meaning of foundation footings.
3. Discuss the functions and importance of foundation footings of buildings.

PEDAGOGICAL EXEMPLARS

1. **Critical thinking and Talk for Learning Approaches:** Guide learners to brainstorm the meaning of foundation footings, elements of foundation footings and functions of foundation footing.
2. **Group work/Collaborative Learning**: Organise learners into mixed ability groups and assist them to discuss and outline the elements used for foundation footings.
3. **Group work/Collaborative Learning**: Organise learners into mixed ability groups and assist them to discuss functions of foundation footings.

KEY ASSESSMENT (DOK)

Level 1: Outline the various elements used for foundation footings.

Level 2: Explain the foundation footings of a building.

Level 3

1. Discuss the functions and importance of foundation footings.
2. Create and exhibit a model showcasing the schematic diagrams of at least two different elements used for setting out a building foundation.

HINT

*The recommended mode of assessment for week 10 is **display and exhibition**. Use the level 3 question 2 as a sample question. Refer to Appendix F for a sample rubric to score learners work.*

UNIT 10 REVIEW

This unit provided the learner with a deeper understanding of the concept of foundation footing of a building. The pedagogical exemplars used in this section included group work/collaborative learning, role-play, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

UNIT 11

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and Artefact Production in Woodwork Industry

Learning Outcome: *Apply knowledge and understanding in design and making of artefacts, translate the ideas into drawings using CAD and produce working drawings from the final solution and generate a model.*

Content Standard: *Apply knowledge of design and making in artefacts production.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to produce working drawings from the final solution of a design problem. In a design process, after the idea has been formulated and developed by means of freehand sketching/CAD, there is a need to show more accurately the sizes and proportions of the various component parts and how they are related to each other. To accomplish this, standard drawing instruments or AutoCAD are used. This process of communicating ideas through a picture or a drawing is often called graphic communication. A drawing is therefore a graphic symbol which represents the real artefact. There are two main types of drawing which are used by the designer. These are pictorial drawing and orthographic drawing. The main difference between them is that a pictorial drawing shows the front, top and end views of the artefact all at the same time, while, in orthographic drawing, these views are drawn separately at different positions.

The unit covers only week 11: ***Produce working drawings from the final solution***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in producing working drawings from the final solution of a design problem. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 2 and 3 and 4 of the DoK. Teachers should employ a variety of formative assessment strategies such

as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Precisely, teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on producing the working drawings from the final solution of a design problem and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 11

Learning Indicator: *Produce working drawings from the final solution*

FOCAL AREA (S): WORKING DRAWING

A working drawing in the woodwork industry is a detailed, precise, and dimensioned drawing or plan that provides a clear understanding of how to construct a woodwork project. It serves as a guide for craftsmen, woodworkers, and manufacturers to produce a specific woodwork piece, such as furniture, cabinet, architectural model, or decorative item.

Pictorial Drawing

There are three main methods for drawing objects or artefacts in a pictorial form: isometric drawing, oblique drawing and perspective drawing. All these methods enable the three basic dimensions of the object, i.e., the length, width and height, to be seen. It is for this reason that they are referred to as three-dimensional drawings (3D).

a. **Isometric Drawing**: In isometric drawing, all lines representing the height are drawn vertically (perpendicular to the horizontal) and those representing the length and the width are drawn at an angle of 300 to the horizontal line. All the lines are also parallel to each other.

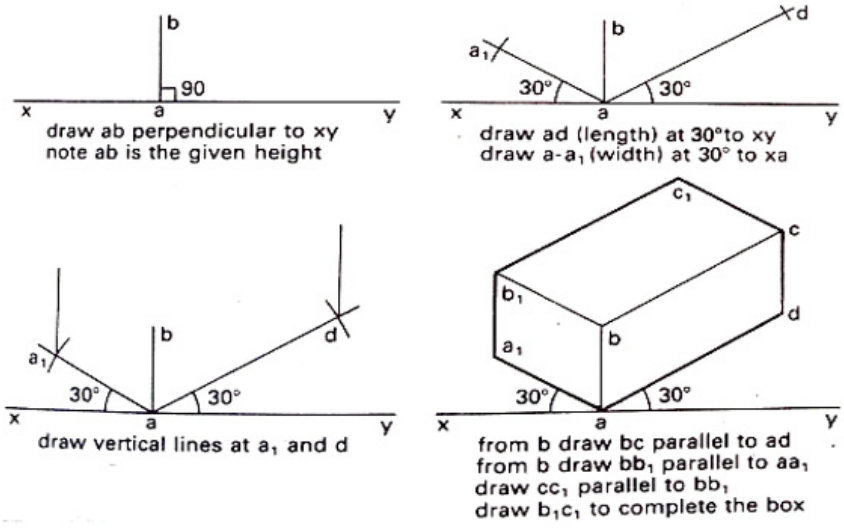


Figure 3.4: *Method of drawing in isometric*

b. **Oblique Drawing**: In oblique projection, one of the views of the object is drawn when looking at it at right angles and the lines representing the side are drawn or projected at an angle of 450 to the horizontal line. All the lines are parallel to each other. It is worth noting that objects drawn in oblique appear to be distorted. When drawn to full length, it is called cavalier. Even the cabinet does not look as real as the isometric and perspective drawings.

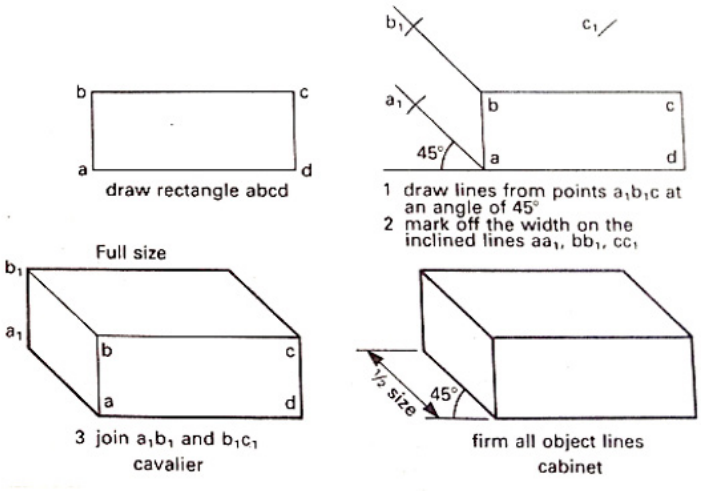


Figure 3.5: *Method of drawing in isometric*

c. **Perspective Drawing**: Perspective drawing has all lines representing height drawn vertical and parallel. The lines which represent the length and the width converge to a vanishing point. Objects drawn in perspective are more real than those drawn in isometric or oblique. Because of this, designers mostly use perspective drawing to present their ideas.

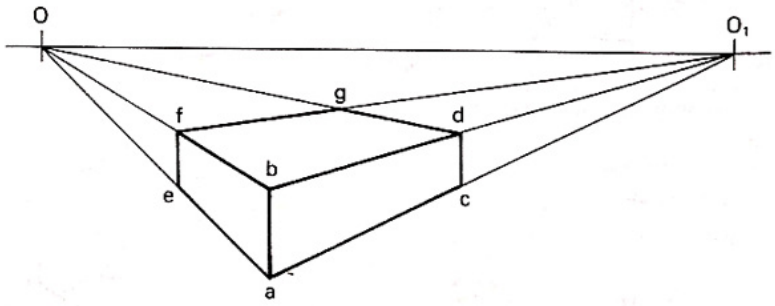


Figure 3.6: *Two-Point Perspective Drawing*

Orthographic Projection

Orthographic Projection is a technique for representing three-dimensional objects in two dimensions. These two-dimensional drawings of views of an object are projected at right angles (i.e., perpendicular) to the planes of projection. The principal views are the front elevation, the plan and the end elevation. There are two kinds of projection used in orthographic projection. These are the first angle projection, also called European (British) projection and the third angle projection, referred to as the American projection. Both projections are currently in use and students should know both. The first angle projection was taught at the Junior Secondary School level. Examples of third-angle projection have been given in this text to enable students to understand the principle.

a. **Planes of Projection:** There are two principal planes onto which the views are projected. As seen in ***Figure 3.7,*** they are arranged to intersect at right angles, forming four right angles called quadrants. As the name implies, the projection takes place in the third angle or the third quadrant. From the directions of views, as indicated in the diagram, the projection planes are in the front of the object and to enable the object to be seen, the planes are always made of a transparent material.

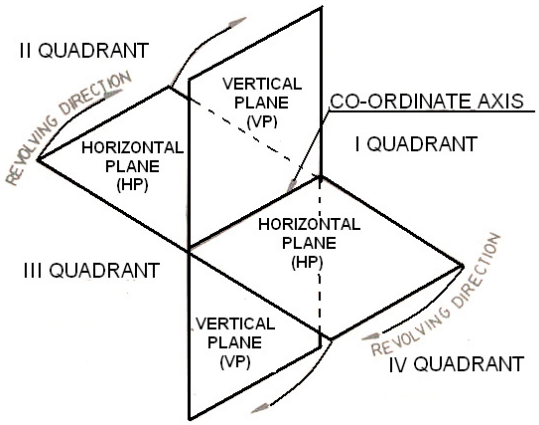


Figure 3.7: *Planes of Projection*

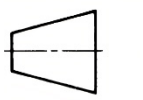
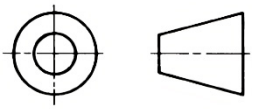
Projection	Symbol
First angle	
Third angle	

Figure 3.8: *Symbols of Orthographic Projection*

b. Principles of Projection: Note that the projection box is made of transparent material. The object is assumed to be suspended in the projection box.

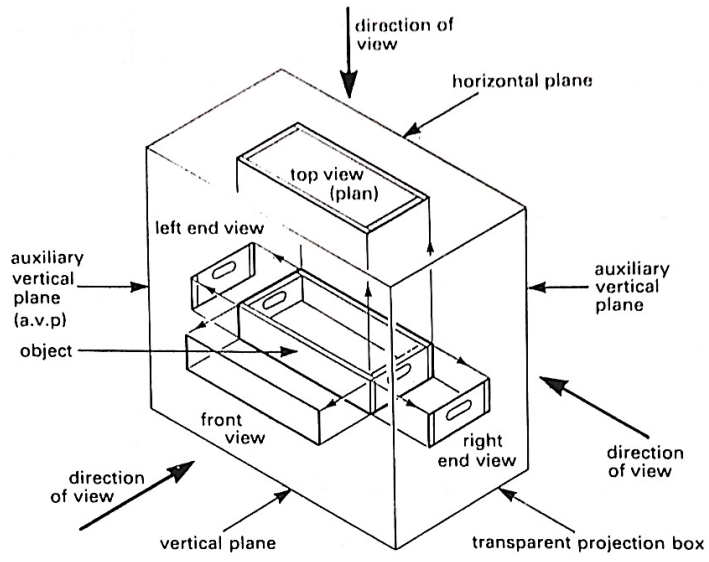


Figure 3.9: *Principles of 3rd angle projection*

i. **Front elevation**: The front view is taken at angles to the object through the ***principal vertical plane (VP)***. The seen elevation is projected back onto the ***principal vertical plane***.

ii. **Plan (Top view):** The view is taken at right angles through the horizontal plane. The seen view is projected back onto the horizontal plane.

iii. **Right End elevation**: The view is taken at right angles through the right auxiliary vertical plane. The seen view is projected back onto the same plane.

iv. **Left End elevation**: The view is taken at left angles through the left auxiliary vertical plane. The seen view is projected back onto the same plane.

Exploded Drawing

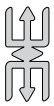
Very often, it is not easy to have a clear idea of how parts of an artefact are put or secured together. To explain how the artefact is constructed, how the various parts are fitted together, and how each part is related to the other, an exploded isometric drawing is used. It gives a dismantled view of the artefact and it serves as a constructional guide to the beginner.

Rendering

Rendering is the technique of making the surface of a unit/artefact pleasing to the eye or to look more realistic. Rendering can be done using freehand or AutoCAD. The techniques used in freehand sketching include hatching, cross-hatching, stippling, blending, thick and thin line shading and texture shading. The techniques used in AutoCAD rendering include shading, realistic, conceptual, sketchy, x-ray etc. which can be assessed through a visual style manager.

Drawing Instruments/AutoCAD application in designing of artefact (Table)

Use any version of AutoCAD software to produce the following working drawings of a table; isometric view or pictorial view, orthographic projections, exploded, and rendered with materials.



Note

Drawing instruments can also be used to produce the following working drawings of a table; isometric view or pictorial view, orthographic projections, exploded, and rendered with materials.

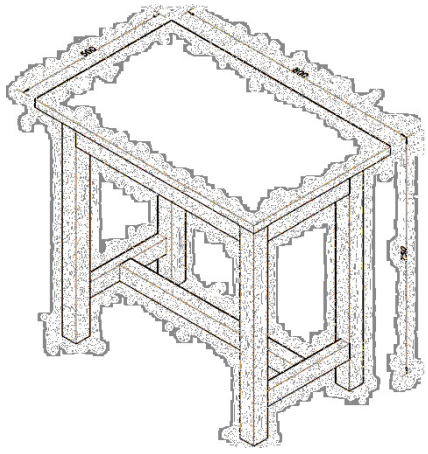


Figure 3.10: *Table in isometric drawing*

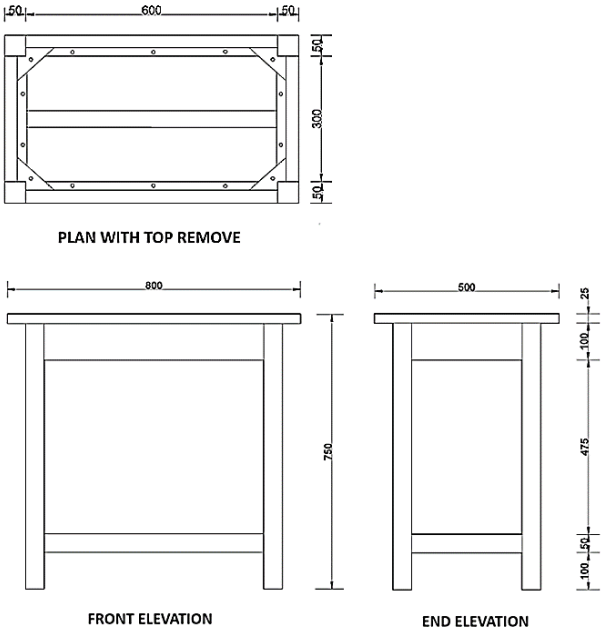


Figure 3.11: *Third Angle Projection*

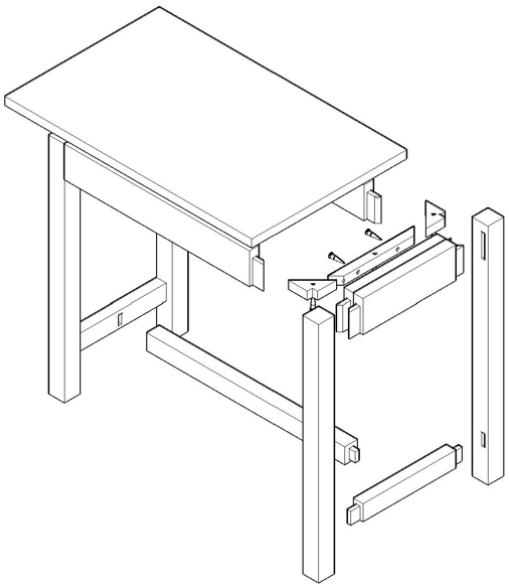


Figure 3.12: *Exploded View*

Figure 3.13: *Rendered table with AutoCAD.*

Freehand Drawing Of Artefact (Table)

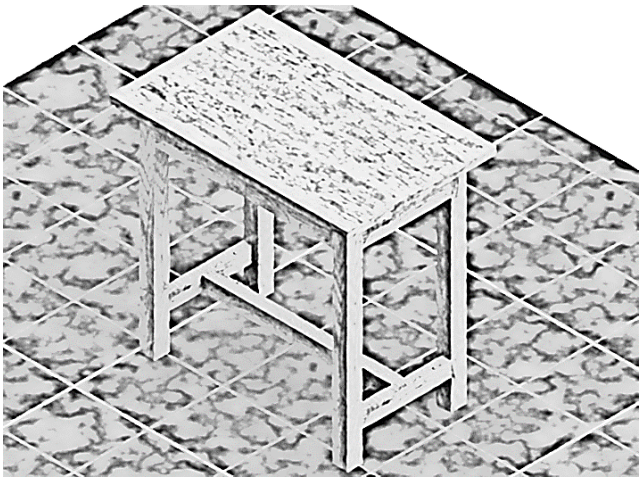


Figure 3.14: *Rendered table with freehand.*

Learning Tasks

With the use of drawing instruments or AutoCAD design a table with the given dimension 800mm × 500mm × 750mm.

1. Explain how to draw in two-point perspective.
2. Draw the isometric view of the table cabinet.
3. Draw in third angle orthographic projection the following views of the table.
   a. *Front elevation*
   b. *Plan with top remove*
   c. *End elevation*

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities

1. **Experiential Learning/Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to use drawing instruments or AutoCAD to draw the isometric view of a table with the given dimension. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
2. **Experiential Learning:** Guide learners in mixed ability groups to co-operatively use drawing instruments or AutoCAD to produce the various orthographic projections of the table taking into consideration skill levels. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

KEY ASSESSMENT (DOK)

Level 2

1. Explain how to draw a given block in two-point perspective.
2. With the use of drawing instruments or AutoCAD design a bedside cabinet with the given dimension of 400mm × 400mm × 500mm.

Level 3: Draw the isometric view of the bedside cabinet.

Level 4

1. Draw in third angle orthographic projection the following views of the bedside cabinet.
   a. Front elevation
   b. Plan
   c. Sectional end elevation across the centre of the table.
2. Demonstrate the process of drawing an isometric view of a table cabinet.

HINT

The recommended mode of assessment for week 11 is demonstration. Use the level 4 question 2 as a sample question.

UNIT 11 REVIEW

Unit 11 of week 11 exposed learners to how to produce working drawings from the final solution. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet the varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentations, class exercises, homework, and practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 2, 3 and 4.

Resources: Pictures, videos, real objects (set squares, pencils, drawing boards, computer, laptop, tablet)

Reflection: Are learners able to produce working drawings from the final solution?

UNIT 12

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Categorise and describe foundations used under various soil conditions*

Content Standard: *Demonstrate Knowledge and understanding of sub-structure of buildings*

INTRODUCTION AND SECTION SUMMARY

This unit introduces learners to formworks, materials used for formworks and functions of formworks. A temporary structure, or encasement is used to mold and contain fresh concrete at its position, in the desired shape until it gains enough strength to be self-supporting is referred to formwork. The teacher will guide learners to understand the key concepts of formwork during construction of buildings. Learners having understood formworks, will appreciate the importance of formworks, explain and outline the materials used. Generally, formworks are prepared by using timber, steel, and plastic or fibreglass.

*The unit covers only week 12****: Explain formworks, materials and functions***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in Critical thinking and Talk for Learning Approaches. Guide learners to brainstorm the meaning of formworks. Conducting experiential learning by organising field trips to construction sites where learners will observe the construction of formworks. Organise learners into mixed ability groups and assist them to explain formworks and discuss the materials used in preparing formworks. Help learners to develop a deeper understanding of the concept of using formworks during the construction of buildings. Learners will all be capacitated as they engage in critical thinking without any form of inhibition. The collaborative environment made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will capture the diverse knowledge of all learners.

ASSESSMENT SUMMARY

The assessments used to monitor progress of learning during instruction should be formative, including class exercise, oral and written presentations using flip charts and home assignments. Teachers must keep track of the performance of each learner given the different levels of performance of the learner in class and provide the relevant motivation or scaffolds to enhance understanding of the concept. The assessment will also serve as a tool to evaluate levels 1, 2

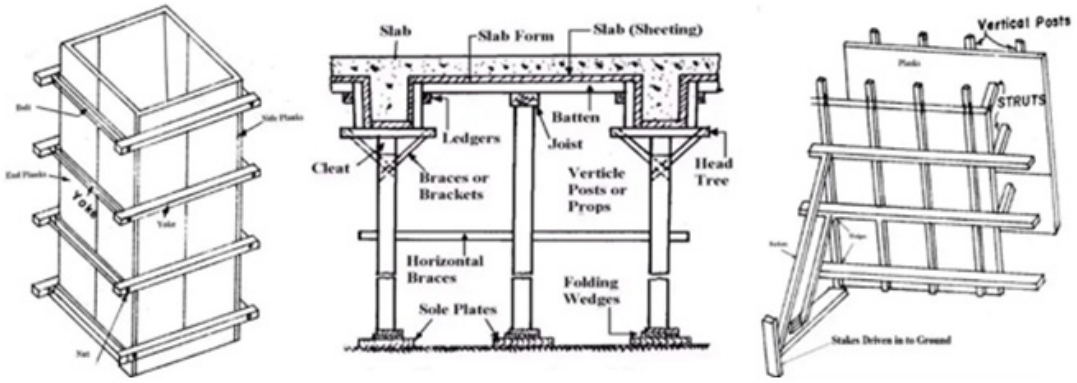
and 3 of the DoK amongst learners. In this way the pedagogical differentiation strategies adopted will also be complemented under the assessment. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively

WEEK 12

Learning Indicator: *Discuss formwork.*

FOCAL AREA 1: FORMWORK

Formworks are temporary structures, or encasements used to mold and contain fresh concrete, in the desired shape until it gains enough strength to be self-supporting. They are temporary structures which are prepared during the construction of buildings and the materials used are timber, steel, and plastic or fibreglass.



Column formwork *Beams formwork* *Open drain formwork*

Figure 3.15: *Formworks*

Learning Tasks

1. Explain what formworks are.
2. Outline the materials used for formworks.
3. Discuss types and functions of formwork.

PEDAGOGICAL EXEMPLARS

1. **Critical thinking and Talk for Learning Approaches:** Guide learners to brainstorm and explain formworks.
2. **Group work/Collaborative Learning**: Organise learners into mixed ability groups and assist them to discuss types of formworks, outline the materials used and functions of formworks.

KEY ASSESSMENT

1. **Level 1:** Distinguish between column formworks and beam formworks.
2. **Level 2:** Outline the various materials used for formworks during construction.
3. **Level 3:** Discuss the various types and functions of formworks.

HINT

*The recommended mode of assessment for Week 12 is **End of Semester Examination**. Refer to the **Appendix E**.*

UNIT 12 REVIEW

This unit provides the learners with a deeper understanding of the concept of formworks. The pedagogical exemplars used in this section included group work/ collaborative learning, role-play, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

APPENDIX E: STRUCTURE OF EXAMINATION

30 Multiple Choice Questions (MCQ) Questions covering DoK levels 1 to 3

6 essay type questions covering DoK levels 1 to 3

DURATION

- Section A 45 minutes
- Section B 1hr 15 mins

RESOURCES

Scannable sheets, A4 paper, answer booklets, class list, etc.

SAMPLE QUESTIONS

1. Which of the following scenarios **best** illustrates the importance of workplace safety protocols? An employee……..

a. *attends team meeting regularly.*

b. *follows the dress code policy.*

c. *reports a minor injury to their supervisor.*

d. *uses (PPE) while handling hazardous materials.*

ESSAY TYPE

State and explain ***2 importance*** of foundation for building structures.

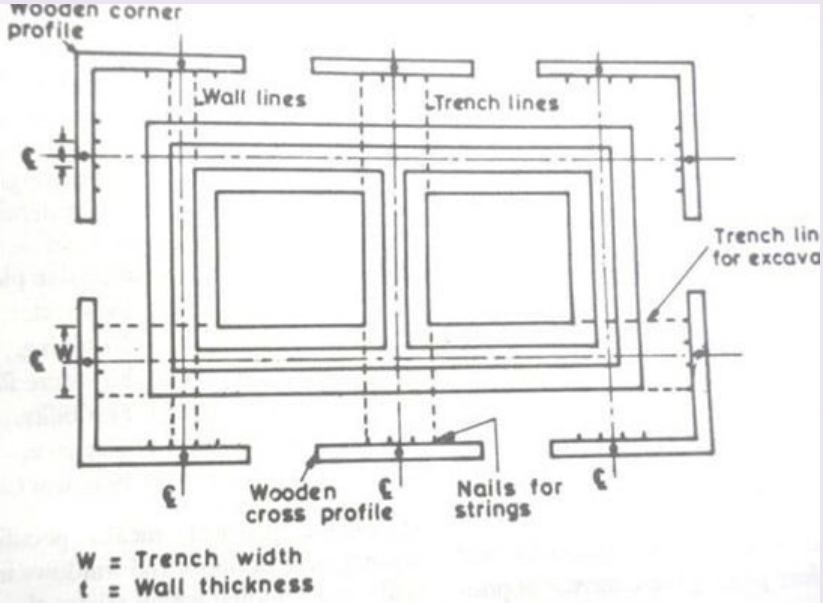
TABLE OF SPECIFICATIONS FOR MCQS

WKS	LEARNING INDICATORS		DoK Levels				TOTAL
			1	2	3	4	
1	Select and use appropriate hand tool for a specific woodwork operation.	MCQ	1	1	1		3
		Essay		1			1
2	Explain substructure	MCQ	1	1	1		3
		Essay		1			1
3	Explain how to care for and maintain hand tools.	MCQ	1	1	1		3
4	Explain what setting out is.	MCQ	1	1	1		3
		Essay			1		1
5	Select and use appropriate machine for a specific woodwork operation.		1	1	1		3

6	Discuss the processes involved in excavation.		1	1	1		3
7	Explain how to care for and maintain hand tools and machines.	**MCQ**	1	1	1		3
		Essay		1			1
8	Discuss the various types of foundation used given the soil type.		–	1	1		2
9	Apply Computer Aided Design [CAD] in designing and making of artefacts.	**MCQ**	1	1			2
10	Explain foundation Footing.	**MCQ**	1	1	–		2
		Essay			1		1
11	Produce working drawings from the final solution.	**MCQ**	1	1	–		2
12	Discuss floor Construction	**MCQ**		1			1
		Essay		1	–		1
	TOTAL		**10**	**16**	**10**		**36**

MCQs	30 questions
Essay	6 questions

APPENDIX F: MARKING SCHEME FOR SCORING DISPLAY AND EXHIBITION



Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)
Model to be display	Model exhibits 4 of the following, tools used, layout diagram, type of building and type of foundation.	Model exhibits 3 of the following, tools used, layout diagram, type of building and type of foundation.	Model exhibits 2 of the following, tools used, layout diagram, type of building and type of foundation.	Model exhibits 1 of the following, tools used, layout diagram, type of building and type of foundation.
Design and creativity	Display shows creativity and organisation of any 4 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow.	Display shows creativity and organisation of any 3 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow. .	Display shows creativity and organisation of any 2 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow.	Display shows creativity and organisation of any 1 of these: layout that draws attention to key points. Visuals are eye-catching, relevant, and enhance understanding of the content. Text and images are balanced and easy to follow.

SECTION 4: WOODWORK MODELLING WITH MATERIALS AND FLOOR, WALL CONSTRUCTION

The section covers woodwork technology and building construction technology unit (strands).

In this section learners will acquire knowledge and understanding of selecting appropriate materials suitable for producing the final solution and modelling from working drawings. In the building construction technology unit learners are expected to gain the knowledge and understanding of floor construction and load bearing and non-load bearing members of the superstructure. All the above are treated from unit 13 to unit 16.

UNIT 13

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and Artefact Production in the Woodwork Industry

Learning Outcome: *Apply knowledge and understanding in design and making of artefacts, translate the ideas into drawings using CAD and produce working drawings from the final solution and generate a model.*

Content Standard: *Apply knowledge of design and making in artefact production.*

HINT

Assign Individual project work in Week 16. Refer to Appendix G at the end of the section for a guide.

INTRODUCTION AND UNIT SUMMARY

This unit will help learners select appropriate materials suitable for producing the final solution. Materials selection involves choosing the appropriate material to suit the requirements of a particular application. This can include design requirements for setting manufacturing processes, material attributes such as the chemical, electrical, physical and mechanical properties of the material, and the material's cost.

The unit covers only week 13: ***Select appropriate materials suitable for producing the final solution.***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in selecting appropriate materials suitable for producing the final solution. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Precisely, teachers should administer assessments such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on selecting appropriate materials suitable for producing the final solution and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 13

Learning Indicator: *Select appropriate materials suitable for producing the final solution.*

FOCAL AREA: MATERIALS SELECTION

The durability of the materials used in artefact production is an important consideration, especially for furniture that will be used frequently or in high-traffic areas. Materials such as timber (solid wood), manufactured boards, metal, plastics, leather, fabrics, foams or high-quality synthetic materials can be more durable and long-lasting. Below are the popular materials used to produce artefacts:

1. **Timber:** (West African hardwood timbers): This includes
   - **a.** Mahogany
   - **b.** Sapele
   - **c.** Iroko (Odum)
   - **d.** Wawa (obeche)
   - **e.** Teak
   - **f.** Mansonia (oprono)

Figure 4.1: *Wood materials*

2. **Bamboo:** Bamboo can be used for bamboo furniture. That includes chairs and tables to shelves and bed frames. Bamboo is an excellent choice for creating stylish and eco-friendly furniture pieces. It can also be used as a building material for flooring, bench tops, fences and screens.

Figure 4.2: *Bamboo*

3. **Plastic**
    a. **Thermo-setting plastic**
        i. Phenol formaldehyde
        ii. Urea-formaldehyde
        iii. Polyester resin
        iv. Epoxy resin
        v. Polyurethane
    b. **Thermoplastics**
        i. Polymethyl methacrylate
        ii. Polytetrafluoroethylene
        iii. Polystyrene
        iv. High impact polystyrene
        v. Acrylonitrile butadiene styrene (ABS)
        vi. Polyethylene
        vii. Polyvinyl chloride
4. **Glass:** This material is produced by mixing **soda ash**, **limestone, sand** and a quantity of **cullet** (recycled glass). Glass is used for glazed doors and windows, louvre blades, picture frames, sliding doors of cabinets and showcases.
5. **Leather:** To produce leather, hair and wool are removed from animal skin. The skin is then treated. This treatment produces different types of leather. Goat skin makes very supple leather. Leather from pig skin is very hardwearing. The thickest and strongest leather is obtained from horse skin. Leather is mostly used as covering material for upholstery work such as lounge seats, chair seats/tops and backs, padded tabletops, etc.
6. **Fabrics**: A textile fabric is a material either woven or non-woven (knitted, tufted, knotted, or bonded). Textile fabrics can be made from natural fibres, meaning they are plant-based or animal-based, or synthetic fibres, meaning humans manufactured them. Synthetic fabrics are also known as artificial fabrics. It is used to add a decorative touch to furniture in upholstery.
7. **Manufactured boards**
    a. **Plywood**
        i. Birch plywood (e.g., furniture, cabinets)
        ii. Oak plywood (e.g., furniture, construction)
        iii. Marine plywood (e.g., boat building, outdoor furniture)
    b. **Medium-Density Fibreboard (MDF)**
        i. Furniture (e.g., cabinets, shelves)
        ii. Architectural elements (e.g., moldings, trim)

c. Oriented Strand Board (OSB)

i. Construction (e.g., sheathing, flooring)

ii. Furniture (e.g., cabinets, shelving)

d. Solid Surface Materials

i. Corian (e.g., countertops, sinks)

ii. Hi-Macs (e.g., countertops, bathroom fixtures)

e. Engineered Wood Products

i. Glulam (e.g., beams, columns)

ii. Laminated Veneer Lumber (LVL) (e.g., beams, headers)

f. Wood Composites

i. Wood-Plastic Composites (WPCs) (e.g., decking, fencing)

ii. Wood-Fibre Composites (WFCs) (e.g., panels, boards)

(*Refer to year one manual for more details on manufactured boards)*

8. Metals: ferrous and non-ferrous *(Refer to year one Teacher manual for details on metals)*

Learning Tasks

1. Identify materials suitable for the production of artefacts.
2. Explain reasons for the selection of a particular material to produce an artefact.
3. Determine how to ensure the sustainability of artefact's materials.

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners through a video demonstration on selection of materials, and brainstorm on the types of materials for artefact production with open-mindedness. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group Work/Collaborative Learning /Digital Literacy Learning:** Place learners into small mixed-ability groups. Ask learners to discuss the reasons for selecting a particular material for an artefact. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
3. **Experiential learning:** Guide learners in mixed ability groups to co-operatively determine how to ensure the sustainability of artefact materials taking into consideration skill levels. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

KEY ASSESSMENT (DOK)

Level 1: Identify three materials suitable for the production of final solution.

Level 2: Explain three reasons why you would select a non-wood material for the production of your artefact.

Level 3

1. How you will ensure the sustainability of your artefact's materials.
2. Draw and label a rip saw.

HINT

*The recommended mode of assessment for week 13 is **chart or diagrams**. Use the level 3 question 2 as a sample question.*

UNIT 13 REVIEW

Unit 13 of week 13 introduced learners to the selection of appropriate materials suitable for producing final solution. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet the varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real objects (Mahogany, Sapele, Odum, Wawa, Teak, Thermo-setting plastics, Thermoplastics, bamboo)

Reflection: Are learners able to select and use the appropriate materials for the production of final solution?

UNIT 14

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Categorise and describe foundations used under various soil conditions*

Content Standard: *Demonstrate Knowledge and understanding of sub-structure of buildings*

INTRODUCTION AND UNIT SUMMARY

Floors are horizontal structural elements of a building providing support to the occupants, furniture and equipment. The different floors that exist include ground and upper floors. The unit reviews the types, functions and composition of these floors as well as discussing safety precautions normally observed in the course of constructing the floors to ensure their sustainability. Detail tables and illustrations have been presented on the most common floor constructions.

*The unit covers only week 14****: Discuss floor Construction***

SUMMARY OF PEDAGOGICAL EXEMPLARS

21st century skills of collaboration and communication shall be employed as teaching strategies to help learners in mixed ability groups to brainstorm or do critical thinking pursuant of explaining floor construction. For successful outcomes GESI, SEL and National Values are to be infused to enhance the performing environment for the strategies mentioned.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative and this will include quizzes and short oral and written responses to questions. Teachers must keep track of performance of each learner given his or her unique level as approaching proficiency, the proficient and highly proficient as well as provide the relevant motivation or scaffolds to enhance the understanding of floor construction. The assessment shall also serve as a tool to evaluate depth of knowledge amongst learners approaching proficiency, the proficient and highly proficient. In this way, the pedagogical differentiation strategies adopted shall be used under assessment too. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 14

Learning Indicator: *Discuss floor Construction*

FOCAL AREA 1: FLOOR CONSTRUCTION

Definitions and Types Of Floors

Floors are horizontal structural elements of a building providing support to the occupants, furniture, equipment and finishes. Floors also divide buildings into different levels, one above the other to create more accommodation. Floors are generally classified into Ground and Upper Floors.

Functions of floors

1. **Structural Support:** To provide a level surface capable of supporting people, furniture, equipment and internal partitions. The floor should safely support its own weight (dead load) and any superimposed load.
2. **Environmental Control:** The most important function in this respect is the exclusion of water from the interior of the building. One can achieve this with two methods: by providing an air-gap (cavity) or a ventilated space under the floor; by providing an impervious barrier in form of a damp-proof membrane in or under the floor or beneath the screed, and a damp-proof course in the external wall at floor level. Other functions of the floor, as part of environmental control, include reduction of noise transmission and provision of sufficient thermal insulation. Noise transmission is usually a problem in raised and upper floors. In air-conditioned areas floors and walls should be insulated against heat gain from non-air-conditioned rooms below or above.
3. **Durability:** Another important function of all floors is that they must be durable. Their life expectancy should be that of the whole structure of the building. Surface wear however depends on the quality and behaviour of the floor finishes, that is the selected coverings.

Construction of Ground Floor Types

The classification referred to as ground floors include **basement, solid and suspended or raised floors.**

1. **Basement Floors:** The part of a building that is entirely or partly below ground level is referred to as the basement. Recessing a building into the ground creates many difficulties including challenges with water exclusion. However, when the site turns out to have a very steep slope or when the construction of a multi-floor structure is being contemplated construction of basements becomes inevitable. Basements generally are useful for storage, services installations or for parking cars. The average basement floor is made of reinforced concrete to ensure stability and avoid ingress of water into the interior.
2. **Solid Concrete Floors:** Solid floors are supported by the ground itself. These are used when the ground is predominantly flat. At ground level, this transmits load directly and

evenly to the supporting ground. The thickness of the slab is decided by the engineer after the necessary soil investigations

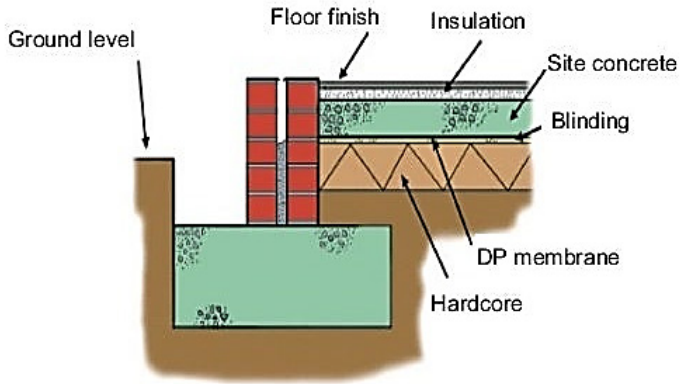


Figure 4.3: *Section through Solid Ground Floor*

Figure 4.4: *Solid Ground Floor slab with mesh reinforcement*

Table 4.1: Steps in casting of basement and solid floors

Item	Steps to take prior and during Casting of Basement and Solid Floors.
1	A minimum of 150mm thick base course of laterite (hardcore) must be put in place to determine the level of the concrete.
2	The base course must be watered and well rammed (in layers of 600mm maximum) by a power compacter to achieve efficient compaction.
3	Prior to placing concrete, the base course must receive blinding of fine sand.
4	Base course or hardcore filling must be void of any organic matter and sulphate.
5	PVC sheeting or 3mm thick layer of hot bitumen may be laid as DPM where rising damp is likely to be realised underneath concrete slab or above it and beneath screed.
6	Floors can be cast to 100- or 150-mm thickness.

7	Concrete may be cast in the ratio of 1:3:6 or 1:2:4
8	The floor slabs are usually reinforced with mild steel square mesh.
9	The floors can be cast in-situ in 3 to 5m square bays all in one go.

3. **Suspended Floors:** These are supported by the foundation components such as foundation footings, columns, walls, slipper walls, ground beams etc. If elevated well above the ground level, the space below can be utilised for facilities such as services duct, storage area etc. No differential settlement arises but the floor slabs are usually reinforced with mild steel.

   a. **Suspended timber floors:** To build a timber suspended floor, the following are needed:

      i. Honeycomb sleeper walls

      ii. Air bricks

      iii. A damp-proof course

      iv. Wall plates

      v. Floor joists

      vi. Floor boarding.

Table 4.2: Steps involved in preparing suspended timber floor

Item	Steps involved in preparing suspended timber floor
1	A concrete oversite slab to be cast and adequate space to be provided between the concrete surface and the suspended floor of timber to ensure ventilation.
2	Honeycomb sleeper walls are to be built over the oversite slab in such a way that some bricks would be omitted to create openings for air to circulate underneath the suspended floor.
3	Lay airbricks in openings left in the external walls. Airbricks have openings in them to allow air into the interior for circulation hence ventilation. Provide the airbricks with mesh to keep insects away.
4	Damp-proof course (Dpc) is normally laid on the sleeper walls to prevent dampness reaching the wall plates.
5	Wall plates are timber pieces 75x100mm that are used as bases for fixing floor joists. They are laid on the (Dpc) along the length of the sleeper walls.
6	Floor joists are timber members that span between the wall plates and support the floorboards. Size of joists depends on the spacing of the sleeper walls. The joists are laid 400mm apart. To avoid moisture joists are not built into external walls.
7	For flooring, timber boarding such as softwood boards, plywood and blockboard can be laid.

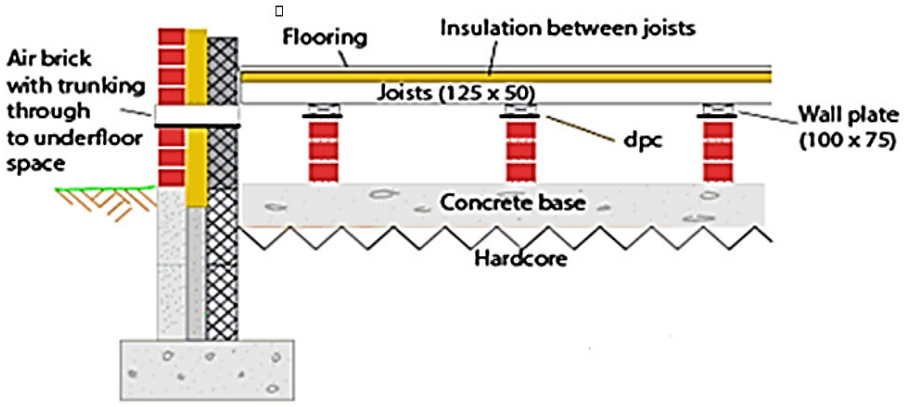


Figure 4.5: *Suspended Floors*

b. The choice to have suspended floors or solid floors depends on:

i. The desired ground floor level in relation to the existing

ii. Site level;

iii. The load bearing capacity of the ground;

iv. The foundation design;

v. The anticipated superimposed loads on the floor;

vi. The availability and cost of suitable back fill.

If the site is flat and the bearing capacity of the ground good, a solid floor with only a nominal (normally 150mm thick) layer of well rolled laterite or hardcore (where this is available) is cheaper than a suspended floor. In areas with a poor load bearing capacity of the soil, a suspended floor is the obvious choice, as it is also for piled foundations. In moist areas with heavy rainfall the ground floor level should be about 300mm to 400mm above the existing site level. The required infill in such cases would be rather expensive. In this case, which will most probably apply to many areas of tropical developing countries, a suspended floor should be chosen.

4. Base course and fill or hardcore filling: All solid concrete floors are laid on a base course of well rolled laterite or hardcore (where this is available). The thickness of the base course should not be less than 150mm or the amount of surface soil which has been excavated to remove all organic growth.

a. The base course fulfils the following functions:

i. It provides the correct surface and required level for the structural floor;

ii. It acts together with the structural floor in spreading point loads over a greater area;

iii. It restricts or reduces capillary movement of water from the ground upwards;

iv. It provides additional insulation.

The base course and fill material must be free of organic matter and of sulphates; it should be thoroughly compacted (with a smooth-wheeled roller, hand or power rammers).

The top of the fill or base course can be blinded with a final layer of finer material e.g., sand.

5. **Damp-proof barrier:** A damp-proof membrane, known as a DPM, is a material that prevents moisture from penetrating the internal walls and floors of a building. It offers protection against a variety of problems associated with moisture ingress ranging from visible damp patches on walls and floors to salt damage, rot and mold.

   In moist conditions this should be incorporated in solid floors to prevent rising damp from affecting the floor finish and entering the building. There are two ways of fixing this barrier:

   As Damp-proof Membranes (D.P.M.): from polythene, light-gauge P.V.C. sheeting or a 3mm thick hot bitumen layer under or between the floor slab or under the screed.

6. **Concrete floor:** A concrete floor is typically one in which a flat slab is formed of concrete, which is either poured in-situ or precast in a factory. Rebar, also known as reinforcement steel and reinforcing steel, is a steel bar or mesh of steel wires often used to reinforce concrete. Concrete is made up of several different components including aggregate, sand, cement, water, and admixtures.

Upper Floors

Upper Floors are subsequent floors above the ground floor (or a floor above a basement floor which can be called upper ground floor). These are reinforced concrete slabs spanning between supporting structures such as the beams which in turn take support from the columns and load bearing walls. The upper floors have monolithic bonding with the entire building since its reinforcements are linked up with those of the beams and columns and the concrete cover for all the components jointly cast.

Table 4.3: Steps to take prior to, during and after Casting Upper Floors

Item	Steps to take prior, during and after Casting Upper Floors.
1	Put in place the formworks.
2	Provide spacer blocks 20mm thick to ensure adequate cover which will prevent exposure of reinforcement bars after casting concrete and striking formwork.
3	Lay all service pipes.
4	Batch up cement, sand and coarse aggregate to the ratio specified by the engineer and mix well in a concrete mixer.
5	Place concrete on to the formwork and vibrate using poker vibrator to eliminate air bubbles when concrete has yet to set.
6	Take concrete samples for testing.
7	Cure concrete by covering it with plastic sheeting and sprinkling it over with water for 3 to 14 days to ensure that the slab does not lose moisture so rapidly.
8	Strike side of formworks.
9	Finally remove props supporting slabs by 28 days as Concrete must have achieved initial strength to support self-weight and imposed loads.

Learning Tasks

1. Explain the meaning of floors and outline various types you know.
2. Discuss the functions of floors.
3. Discuss composition of various floors and how they are put together.

PEDAGOGICAL EXEMPLARS

1. Deliberately place Learners in mixed-ability groups where the different needs of learners Approaching Proficiency, the Proficient and Highly Proficient will be met and where they will communicate on definitions and types of floors that can be used in the construction of a building given various circumstances.
2. In mixed-ability groups where the different needs of learners will be met and where they will collaborate engage learners to discuss functions of floors.
3. In mixed-ability groups where the different needs of learners will be met and where they will collaborate engage learners to discuss safety measures usually observed during construction to prevent upper floors from failing.

KEY ASSESSMENT (DOK)

Level 1

1. State at least 3 functions of floors.
2. Explain floors and outline the various types used in building construction.

Level 2: Distinguish Upper Floors from Ground Floors.

Level 3: Discuss how safety precautions observed during construction of Upper Floors will help prevent them from failing.

UNIT 14 REVIEW

This review is for the lesson taught in week 14. Learners were provided with understanding of Floors in terms of floor types, functions and compositions. The pedagogical exemplars used in this section included collaboration and communication as Learners were put in mixed-ability groupings to engage in critical thinking and brainstorming about the meaning, types and composition of various floors. Using similar strategies of communication and collaboration Learners were to discuss Safety precautions observed when constructing floors. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for various activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

UNIT 15

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and Artefact Production in Woodwork Industry

Learning Outcome: *Apply knowledge and understanding in design and making of artefacts, translate the ideas into drawings using CAD and produce working drawings from the final solution and generate a model.*

Content Standard: *Apply Knowledge of Design and Making in Artefacts Production.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to produce a model from their working drawings. In a design and realisation process, after the work has been done by means of manual drawing/CAD, there is the need to produce a model from the working drawings. A model refers to an initial or prototype version of the final artefact. It is a solid representation of the design concept, created to test, refine, and validate the design before proceeding with full-scale production. A model serves several purposes such as: proof of concept, testing and refinement, visual representation, quality control and design iteration among others. Models in artefact production can be: Prototype - This is a functional, preliminary version of the final product; Mock-up - A non-functional, visual representation of the final product; Scale model - A reduced-scale version of the final product. Pilot model - A small-scale, functional version of the final product. By creating a model, designers and producers can ensure that the final artefact meets the desired quality, functionality, and aesthetic standards, reducing the risk of errors and costly rework.

The unit covers only week 15: ***Produce a model from your working drawings***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in producing a model from their working drawings. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 3 and

4 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/ written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on producing a model from their working drawings and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 15

Learning Indicator: *Produce a model from your working drawings.*

FOCAL AREA: MODEL FROM WORKING DRAWINGS

In woodwork, a model from working drawings refers to a prototype or a sample piece created from a set of detailed drawings or plans. These drawings, known as working drawings, provide precise instructions and measurements for constructing the model. A model from working drawings in woodwork serves several purposes: ***Proof of concept:*** (verifies that the design is feasible and works as intended), ***Testing and refinement:*** (allows for testing and refinement of the design, materials, and construction methods), ***Visual representation:*** (provides a tangible representation of the final product, helping to communicate the design to clients, stakeholders, or colleagues), ***Quality control:*** (enables the identification and correction of errors or defects before proceeding with full-scale production), ***Design iteration:*** (facilitates the iteration and refinement of the design, ensuring that the final product meets the desired quality and functionality standards) and ***Training and education:*** (serves as a teaching tool for apprentices or students to learn woodworking techniques and best practice).

Some common woodwork models produced from working drawings include:

1. **Furniture**
   - **a.** Chairs (e.g., dining, lounge, rocking)
   - **b.** Tables (e.g., coffee, dining, desk)
   - **c.** Cabinets (e.g., kitchen, bathroom, storage)
   - **d.** Beds (e.g., frame, headboard, dresser)
2. **Wood Carvings**
   - **a.** Sculptures (e.g., figurines, abstract shapes)
   - **b.** Decorative figurines (e.g., animals, humans)
   - **c.** Wooden signs (e.g., nameplates, directional signs)
3. **Architectural Models**
   - **a.** Buildings (e.g., houses, bridges, skyscrapers)
   - **b.** Bridges
   - **c.** Historical landmarks (e.g., monuments, temples)
4. **Decorative Items**
   - **a.** Picture frames
   - **b.** Mirror frames
   - **c.** Wooden boxes (e.g., jewellery, treasure)

By following the working drawing carefully and using various woodwork techniques, craftsmen can create precise and complicated models that showcase their skills and attention to detail. The working drawing serves as a guide throughout this process, ensuring that the final model meets the design specifications and requirements.

Procedures in Making a Model from a Working Drawing

In woodwork, producing a model from a working drawing involves several steps:

a. **Interpretation**: Carefully study the working drawing to understand the design, dimensions, and requirements.

b. **Material selection**: Choose the appropriate type and quantity of wood, considering factors like grain direction, texture, and durability.

c. **Workpiece preparation**: Prepare the workpieces by measuring, marking out or setting out, etc. (Tape measure, pencil, Jack plane, saw, etc.)

d. **Cutting:** Cut the workpieces into the required sizes using various cutting tools (e.g., saws, jigsaws, or CNC machines) to cut the wood into the required shapes and sizes. Use the correct methods, observe safety precautions and minimise waste.

e. **Marking of joints**: Marking out of the joints using the appropriate marking out tools (e.g., try square, marking gauge, mortise gauge, pencil, etc.)

f. **Cutting of joints**: Cut the various joints using the appropriate cutting tools (e.g., saws, chisels, etc.)

g. **Assembly:** Trial assembly of the various parts of the work. Use joinery techniques to trial assemble of parts and then to final assembly of the cut components into the final model.

h. **Shaping and sanding:** Use hand tools (e.g., chisels, planes, or sandpaper) to refine the model's shape, smooth out surfaces, and remove any imperfections.

i. **Finishing:** Apply a finish (e.g., lacquer, stain, varnish, or paint) to protect the wood and enhance its appearance.

j. **Quality control:** Inspect the model for accuracy, precision, and overall quality, making any necessary adjustments.

Examples of Models

Figure 4.6: *Cantilevered Shelves*

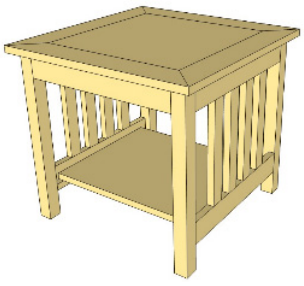


Figure 4.7: *Basic Framed End Table*

Figure 4.8 Bamboo Chair

Figure 4.9: *Bamboo Stool*

Learning Tasks

1. Describe the procedures for producing a model from a working drawing.
2. Produce a model from working drawing using a suitable material.

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners through a video demonstration on producing model from working drawings with open-mindedness. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to discuss the procedures for producing models from working drawings. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.
3. **Experiential learning:** Guide learners to individually produce a model from their working drawings taking into consideration skill levels and safety rules. Highly Proficient learners can be assigned to assist groups in discussions with the teacher.

KEY ASSESSMENT (DOK)

Level 3: Considering your working drawing, describe the procedures you will follow for producing your model

Level 4

1. Produce a model from your working drawing using two or more suitable materials.
2. Analyse the step-by-step procedures required to produce a model based on a working drawing.

HINT

*The recommended mode of assessment for week 15 is **task analysis**. Use the level 4 question 2 as a sample question. Refer to Appendix H for a sample rubric.*

UNIT 15 REVIEW

Unit 15 of week 15 exposed learners to producing a model from working drawings. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet the varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 3 and 4.

Resources: Pictures, videos, real objects (furniture, wood carvings, architectural models, decorative items)

Reflection: Are learners able to produce a model from their working drawings?

UNIT 16

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Be able to differentiate load bearing from non-load bearing components and their functions in the superstructure.*

Content Standard: *Demonstrate knowledge and understanding of load bearing and non-Load bearing components of the superstructure.*

INTRODUCTION AND UNIT SUMMARY

The manual for week 16 explains load-bearing components such as columns and beams as those that support the weight of the building and non-load-bearing components such as timber frames as those that do not support the weight of the building and can be disposed of without any serious consequence to the structural stability of the building. The manual explains and categorises the major components into load-bearing and non-load bearing classifications. The relevant care given the various classifications of the components by project managers is also explained. Detail illustrations are presented on the most common situations of load- bearing and non-load bearing components of buildings.

*The unit covers only week 16****: Explain load bearing and non-load bearing members of the superstructure***

SUMMARY OF PEDAGOGICAL EXEMPLARS

21st century skills of collaboration and communication shall be employed as teaching strategies to help learners in mixed ability groups to brainstorm or do critical thinking pursuant of explaining load bearing and non-load bearing members of the superstructure as well as distinguishing one from the other. For successful learning outcomes, GESI, SEL and National Values are to be infused to enhance the performing environment for the strategies mentioned.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative. This shall include quizzes and short oral and written responses to the questions. Teachers must keep track of performance of each learner given his or her unique level as approaching proficiency, proficient and highly proficient as well as provide the relevant motivation or scaffolds to enhance understanding of the concept of load bearing and non-load bearing components as related to performance of building components of the superstructure. The assessment shall also serve as a tool to evaluate depth of knowledge amongst learners

approaching proficiency, proficient and highly proficient. In this way, the pedagogical differentiation strategies adopted shall be used under assessment too. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 16

Learning Indicator: *Explain load bearing and non-load bearing members of the superstructure.*

FOCAL AREA 1: LOAD BEARING AND NON-LOAD BEARING MEMBERS OF THE SUPERSTRUCTURE

Explanation of Load Bearing and Non-Load Bearing Components In The Super-Structure

- ***Load-bearing members*** of the superstructure act to support the building and they cannot be taken down in renovations. The weight that load-bearing components support is distributed from the roof and presses down through to foundation for even distribution to the sub soil.
- ***Load bearing components*** such as beams, columns and external walls are key structural elements within a building. Their primary functions are to support the weight above them, help maintain the structure's balance, and ensure its safety and stability. Without these components, structures would easily collapse under pressure and weight. A non-load bearing component doesn't support loads above it. It is not a part of the structural frame system. Most of the time, they are interior fixtures built with lighter materials to reduce the dead load of the structure.
- ***A non-load-bearing wall***, also known as a ***partition wall*** for instance, is a building component that does not carry any significant vertical load. Apart from its own weight it doesn't support floor or roof loads above them. It is not a part of the structural frame system. Most of the time, they are interior walls whose purpose is to divide the floor area into a number of rooms. They are built with lighter materials to reduce the deadload of the structure.

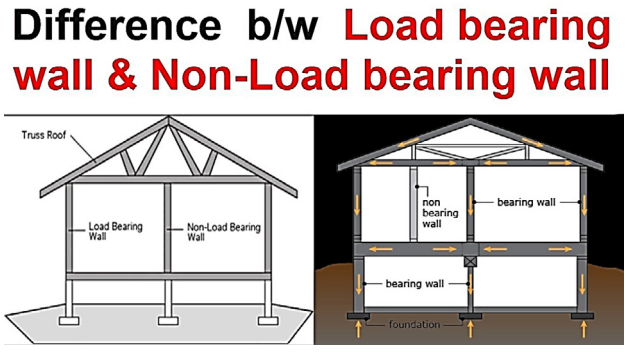


Figure 4.10: *Load-bearing and non-load-bearing Walls in the Superstructure*

Load-bearing walls are mostly external walls which support the building. They differ from other types of walls which are called partition walls whose function is to separate spaces. Load-bearing walls cannot be taken down in renovations because they bear weight and their removal would cause the collapse of the building.

Some structural terminologies associated with load bearing components of the superstructure.

a. **Load:** Load directly means the weight that is exerted on the structure. It is broadly divided into two parts, the dead loads and the live or super imposed loads.

b. **Dead Load:** It is the weight of the structure itself that is putting pressure on the foundation. Dead Loads are the materials used in putting up the building and they remain permanent.

c. **Live or super imposed Loads:** These are created by the weights of the people and the movable fittings such as furniture. Wind pressure is also a live load.

d. **Compression Loading:** One of the functions of the structure of the building is to transfer loads safely to the foundation and the sub-soil. Solid walls are subjected to vertical compression loads hence the reason why they are regularly subjected to compression tests. Concrete is said to be an excellent material that can withstand compression but weak in tension. Hence the introduction of reinforcement into concrete members. With an arch in place compressive loads can be transferred to the sides till they become vertical loads at the bottom.

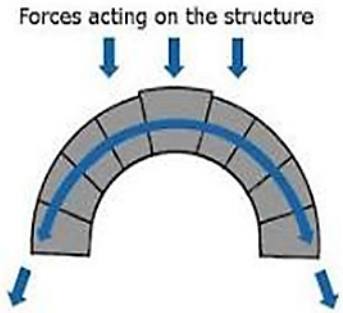


Figure 4.11: *Transfer of compressive loads*

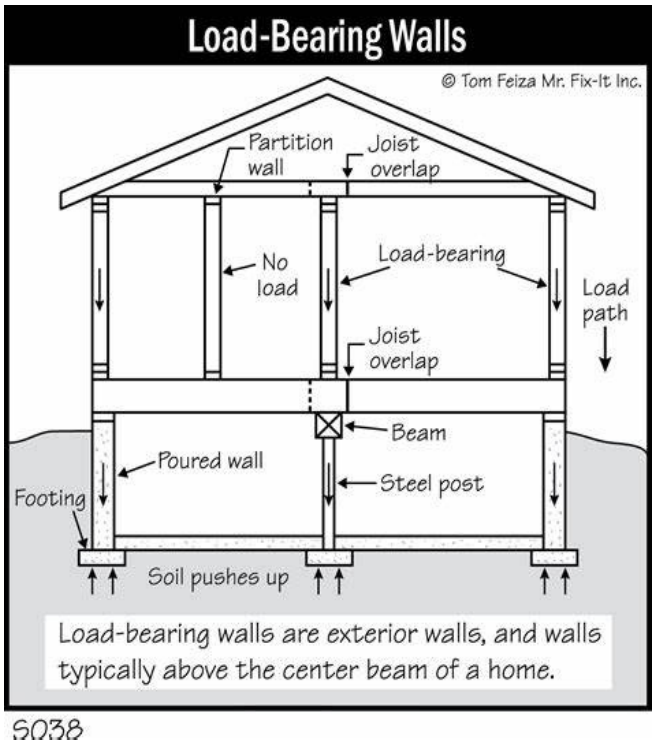


Figure 4.12: *Non-Loadbearing Components of the Superstructure*

e. **Reinforced Concrete:** Concrete consists of a solid and chemically inert particulate substance, called aggregate (usually sand and stone), bonded together by cement and water facilitating the workability. Reinforced concrete is a composite material. This is made up of different constituent materials with very different properties that complement each other. In the case of reinforced concrete, the component materials are almost always concrete and steel. The steel is the reinforcement.

Reinforced concrete is typically used in the construction of columns, floors, roof slabs and beams in buildings. The benefits of using reinforced concrete in construction include: ability to resist high-stress, fire and weather resistance, limitless range of shapes that it can assume, low maintenance costs and requirement of less labour owing to the availability of many plants and equipment to handle concrete works.

To reinforce a concrete slab for instance, rebar rods are positioned across the entire slab at regular intervals, both lengthways and width ways. The rods should be tied together with suitable reinforcement ties, and the entire rebar structure should be supported from below, using appropriate positioning tools. Reinforced concrete, is concrete in which steel is embedded in such a manner that the two materials act together in resisting forces. The reinforcing steel—rods, bars, or mesh—absorbs the tensile, shear, and sometimes the compressive stresses in a concrete structure.

f. **Lintels:** Another method of transferring a load sideways, to bridge an opening, a lintel or a beam is used. When the lintel or beam bends slightly under pressure this is called deflection. A beam or a lintel is a horizontal member which transfers loads to the supports at each end. Examples of beams are floor joists, rafters or staircase strings. They can bend slightly and the deflection or bend should not be more than 1/360th of the span of the beam.

g. **Beams:** One of the main load-bearing elements of construction is a beam, which can be composed of metal, concrete, or wood. The main structural component used to support the weight of the structure is the beam. The depth and breadth of the beam element determine the strength and ability of a load-bearing structure to resist a load. As there are many internal and external pressures acting on the beam, it is susceptible to greater shear and compression forces.

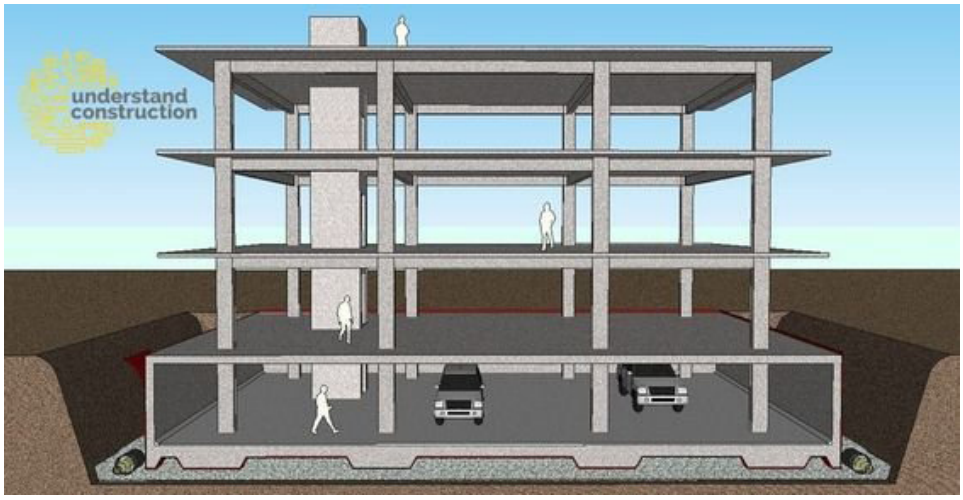


Figure 4.13: *Load- Bearing structure*

h. **Columns:** The transmission of dead and live loads from the building structure to the foundation is one of the critical functions of columns, and it is one of the key structural components of a structure.

i. **Braces**: The load-bearing structural system uses braces as one of its structural components. These load-bearing components significantly stiffen the structure.

j. **Trusses:** The load-bearing components known as trusses support the roof components of a building. The trusses receive the weight from the roof in a consistent or even manner. Both tension and compression forces are applied to the trusses. There are no moments that the trusses are exposed to.

Outline of The Major Load-Bearing and Non-Loadbearing Components of The Superstructure

The major load-bearing components acting within the superstructure of a building can be identified as the beam, lintel, column, floor slab, roof truss, load-bearing wall etc. These components may be designed by the engineer using reinforced concrete, steel or timber. The non-load bearing members include partition walls, door and window frames, finishes to floors, internal walls, ceilings, ducts, furniture fixed and unfixed among others.

Attitudes of Project Managers Towards Load-Bearing and Non-Loadbearing Components

Components considered to be load-bearing tend to receive high levels of care due to the direct effects they can have on the structural integrity and safety of the building. When it comes to programming the load-bearing components are on the critical path and therefore given urgency. They are considered to be sequential in construction and a beam becomes capable only if the supporting column is in place. Load-bearing components are usually constructed in situ with some urgency and inconvenience to project managers while non-load bearing components can be prefabricated without much urgency and installed into the building at convenient times. For quality assurance and safety purposes load-bearing components are constantly subjected to testing.

Learning Tasks

1. Explain what load-bearing members in the building are.
2. Distinguish load-bearing members from non-load bearing members of a building.
3. Discuss the characteristics that are associated with those building components. acknowledged to be load bearing members of the superstructure.

PEDAGOGICAL EXEMPLARS

1. Place learners in mixed-ability groups where the different needs of learners approaching proficiency, the proficient and highly proficient will be met and where they will communicate and explain load-bearing and non-load-bearing members of the superstructure.

2. In mixed-ability groups where the different needs of learners will be met and where they will collaborate, engage learners to categories load-bearing and non-load-bearing members of the superstructure.
3. In mixed-ability groups where the different needs of learners will be met and where they will collaborate engage learners to discuss how load imposed from upper part of the building is managed safely till it is distributed to the foundations.

KEY ASSESSMENT (DOK)

Level 1: Explain load bearing and non-load bearing members of the superstructure.

Level 2: Distinguish between load bearing and non-load bearing members of the superstructure.

Level 3

1. Outline the different loads incident on the building and discuss how load bearing takes place safely in the building with the relevant components or members of the superstructure relied upon to manage the load-bearing.
2. Run simulation using AutoCAD on load bearing and non-load bearing members of superstructure.

HINT

*The recommended mode of assessment for week 16 is **simulation**. Use the level 3 question 2 as a sample question.*

UNIT 16 REVIEW

This review is for the lesson taught in week 16. Learners were provided with understanding of Load bearing in the superstructure. The pedagogical exemplars used in this section included collaboration and communication as learners were put in mixed-ability groups to engage in critical thinking and brainstorming about the meaning of load-bearing in a building as well as the outline of members that bear the load and those that don't bear the weight of the building. Using similar strategies of communication and collaboration learners were to discuss how the weights of the building are managed. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for various activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

APPENDIX E: INDIVIDUAL PROJECT

Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)
Heading (Caption of the Project)	Heading includes 4 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.	Heading includes 3 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.	Heading includes 2 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.	Heading includes 1 of the following; clear, concise, accurately reflects the project's content and follow syntax rule.
Project Design Brief	Brief is based on 4 of the following: has project specification, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords	Brief is based on 3 of the following: written, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords	Brief is based on 2 of the following: written, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords	Brief is based on 1 of the following: written, (50-60 words), provides comprehensive overview of the project and correct spelling of keywords
Technical Specification	Final work shows 4 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.	Final work shows 3 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.	Final work shows 2 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.	Final work shows 1 of the following: test meets specifications, accurately documented, all parts functional and ecofriendly.

APPENDIX H: MARKING SCHEME FOR THE TASK ANALYSIS ASSESSMENT

Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)
Analyses of model based on a working drawing.	Analysis indicates 4 of the following; sequential steps that are easy to follow, model replicate the working drawing, documentation on sequential steps and safety precautions followed.	Analysis indicates 3 of the following; sequential steps that are easy to follow, model replicate the working drawing, documentation on sequential steps and safety precautions followed	Analysis indicates 2 of the following; sequential steps that are easy to follow, model replicate the working drawing, documentation on sequential steps and safety precautions followed.	Analysis indicates 1 of the following; sequential steps that are easy to follow, model replicate the working drawing, documentation on sequential steps and safety precautions followed.
Communication skill	Showing 4 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture	Showing 3 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture	Showing 2 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture	Showing 1 of the skills e.g. Audible voice, Keeping eye contact Pay attention to audience Engaging the audience with interaction Use of gesture

SECTION 5: WOODWORK JOINT, ADHESIVES AND WALL, DOOR, WINDOW, FRAME CONSTRUCTION

The section covers the following unit (strands); woodwork technology and building construction technology.

In this section learners will acquire knowledge and understanding of woodwork joint, select and use appropriate joints for a specific woodwork as well as uses of different types of adhesives. In the building construction technology unit, learners are expected to gain the knowledge and understanding of types walls and their functions as well as doors and windows. All the above are treated from unit 17 to unit 20.

UNIT 17

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and Artefact Production in Woodwork Industry in Ghana

Learning Outcome: *Demonstrate knowledge and understanding of hand tools, joint and machines to select the right tool, joint and machine for a specific woodwork operation*

Content Standard: *Demonstrate the ability to use woodwork hand tools, Joints, and Machines in the woodwork shops.*

HINT

Mid-semester examination is in week 18. Refer to ***Appendix I*** *at the end of the section for the structure and the Table of Specifications to guide the construction and conducting of the exam.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners select and use appropriate joints for a specific woodwork. When joining two or more pieces of wood together it is necessary to choose the correct joint for the purpose. This will ensure that the joint made will provide the most effective use of material

being jointed. Although there are a considerable number of different woodwork joints, many are simply variations of a few basic types.

*The unit covers only week 17****: Select and use appropriate joints for a specific woodwork***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in the selecting and the uses of appropriate joints for a specific woodwork project. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Precisely, teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the uses of appropriate joints for a specific woodwork project and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 17

Learning Indicator: *Select and use appropriate joints for a specific woodwork*

FOCAL AREA: WOODWORK JOINT

Joints in woodwork are the connections between two or more members/parts to form a single unit. When joining two or more pieces of wood together it is necessary to choose the correct joint for the purpose.

Types of Joints

There are different types of joints used in woodwork. The common ones are:

Angle Joint

Angle joints are used to join box-like constructions where members meet at right angles. The following are examples angle joints.

1. **Dovetail joint:** This is a very strong joint which can be used at the corner of boxes or carcasses. It consists of two parts; one has the dovetails and the other has the pins. You can see that the arrangement of the pins is such that there is a pin at each end of the joint. When marking out the joint it is important to take this into account. The joint is made by first marking out and cutting the dovetails, and then marking the pins from these to ensure a good fit.

   a. The **through dovetail** has the problem that it can be seen from both sides of the corner.

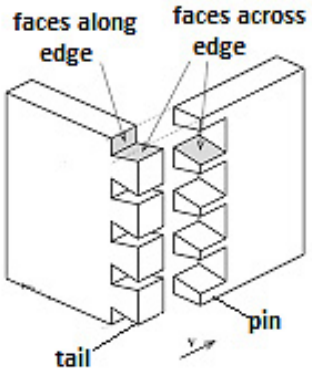


Figure 5.1: *Through Dovetail joint*

   b. To overcome through dovetail of showing end grains at both sides the **lapped dovetail** can be used.

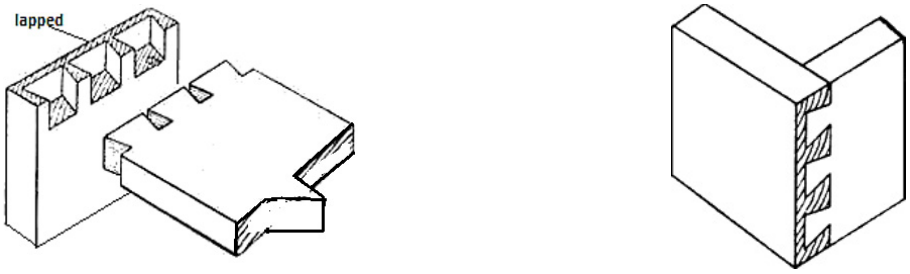


Figure 5.2: *Lapped dovetail*

2. **Housing joint:** When fitting shelves into a cabinet it is necessary to let them into the side to improve the strength. To do this a **housing joint** is used. A groove is cut into the side of the cabinet for the shelf to fit in.

   a. Through housing joint

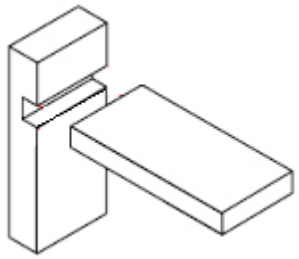


Figure 5.3: *Housing joint*

   b. To improve the appearance at the front of the shelf, a **stopped housing** can be used.

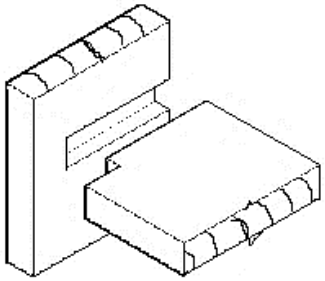


Figure 5.4: *Stopped housing*

   c. The strength of the joint can be increased by using the dovetail housing.

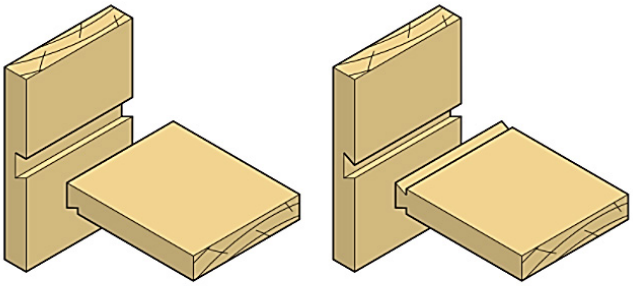


Figure 5.5: *Double dovetail housing*

3. **Rebate joint:** This joint can be used in place of a lapped dovetail, the main advantage being that it is considerably easier to make. It does, however, have many disadvantages, the main ones being the fact that it is not strong and requires both gluing and nailing.

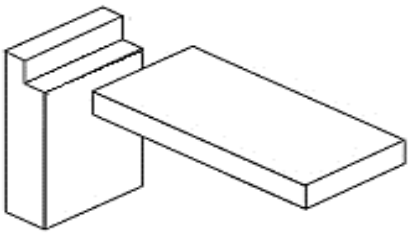


Figure 5.6: *Rebate joint*

4. **Barefaced tongue and groove joint:** A slightly stronger version of the joint, because of the greater surface area in contact, is the **bare faced tongue and groove**, but this has the disadvantage of the short piece of end grain being weak.

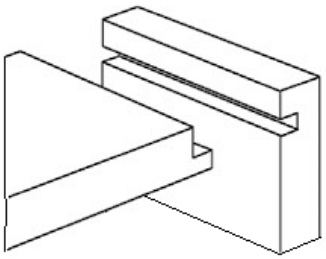


Figure 5.7: *Barefaced Tongue and groove joint*

5. **Butt joint:** When two pieces of material are simply together to form a joint it is called a **butt joint**. The advantage of this type of joint is its simplicity. The disadvantages are its lack of mechanical joining as well as it only presenting the minimum amount of surface area in contact. It will also require some form of glue, screw or nail to hold it together.

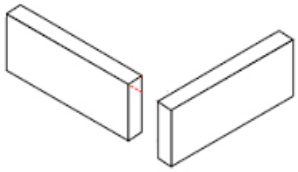


Figure 5.8: *Butt joint*

6. **Box/Pin joint** is a woodworking joint made by cutting a set of complementary, interlocking profiles in two pieces of wood, which are then joined (usually) at right angles, usually glued.

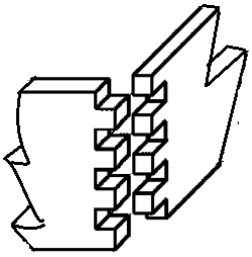


Figure 5.9: *Box/pin joint*

Framing Joint

Framing joints are useful for frame-like constructions where pieces meet at right angles.

1. **Halving joint:** In order that there is no increase in the thickness, when overlapping two pieces of material, a halving joint is used.

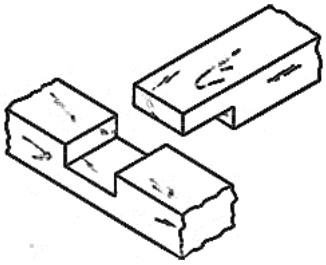


Figure 5.10: *Halving joint*

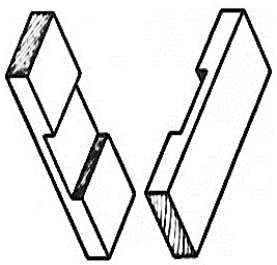


Figure 5.11: *Cross halving joint*

In this joint, half the thickness of each piece of material is removed so that the surfaces remain flush when assembled. Variation of the joint include the **dovetail halving** and the **skew halving.**

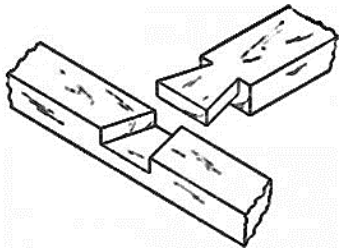


Figure 5.12: *Dovetail halving joint*

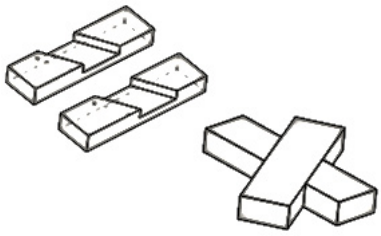


Figure 5.13: *Skew halving*

2. **Dowel joint:** A simple way of improving the strength of butt joint is to include some dowels.

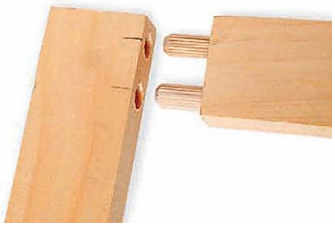


Figure 5.14: *Dowel joint*

3. **Mortise and tenon joint:** It is the most common joint used when making a frame. It consists of a hole (mortise) in one piece of material and a reduced section piece (tenon) on the other. The thickness of the tenon should be one third of the thickness of the material. The joint is made by first cutting the mortise using a mortise chisel. The bulk of the material can be removed by drilling first, as this helps to avoid splitting. The tenon is then made to fit the mortise.

   a. Through Mortise and tenon joint:

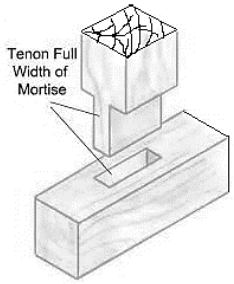


Figure **5.15:** *Through mortise and Tenon joint*

   b. If the joint is to be made more stronger, **square haunch** or a **secret haunch** may be used at the top corner of the frame.

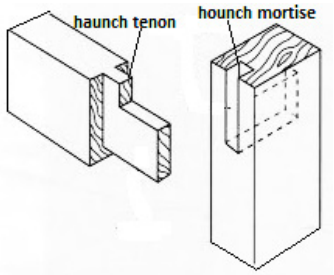


Figure 5.16: *Square haunch M&T*

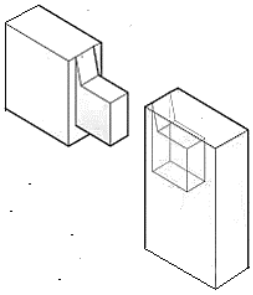


Figure 5.17: *Secret haunch M&T*

c. If the piece of material containing the mortise is not of the same thickness as the piece with the tenon a barefaced tenon is used.

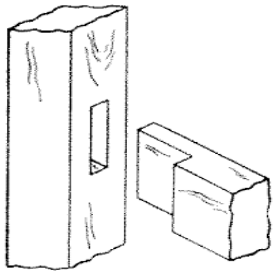
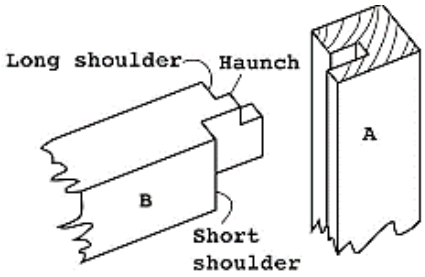


Figure 5.18: *Barefaced Mortise & tenon*

d. For more strength and for frame construction which requires the rebate recess to receive glass or plywood panel long and short shoulder mortise and tenon is used.



Long and short shoulder mortise and tenon

Figure 5.19: *Long and short shoulder mortise and tenon*

4. Bridle joint: This is a variation of a mortise and tenon joint and can be used at a corner or some distance from a corner.

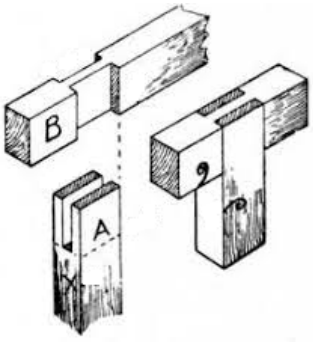


Figure 5.20: *Plain bridle joint*

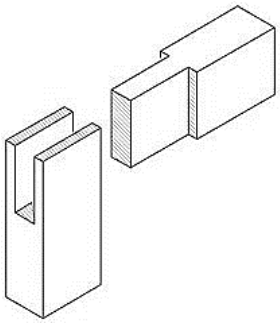


Figure 5.21: *Angle bridle joint*

5. Mitres: When two pieces of material are to be jointed together at right angles to each other a mitre joint can be very useful to tidy up the appearance of the joint. The mitre is normally at 45o.

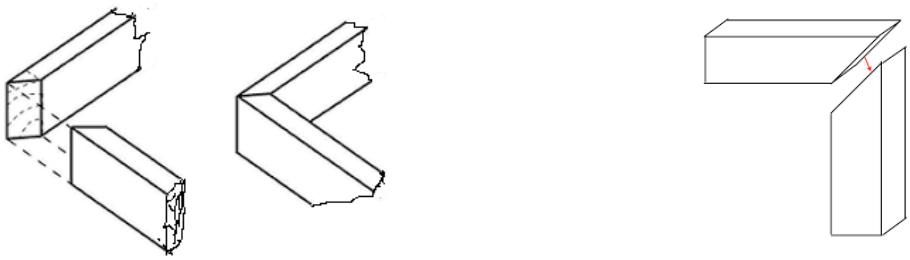


Figure 5.22: *Mitre joint*

Widening and Lengthening Joint

1. **Dowel joint:** A simple way of improving the strength of butt joint is to include some dowels. All that is needed is to drill some equally spaced holes of the correct diameter. A dowel of the appropriate length is then inserted. The dowel should have a groove cut into is length to allow excess glue to escape

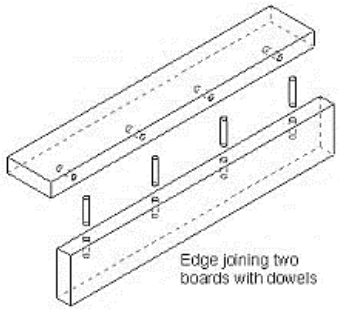


Figure 5.23: *Dowel joint*

2. **Tongue and groove joint:** To make a wide board from narrow pieces of timber, this joint helps in two ways. It locates the two pieces of material level and it increases the surface area in contact. To further increase the surface area for gluing, a grove can be cut in the edge of each piece and a loose tongue of thin plywood can be introduced.

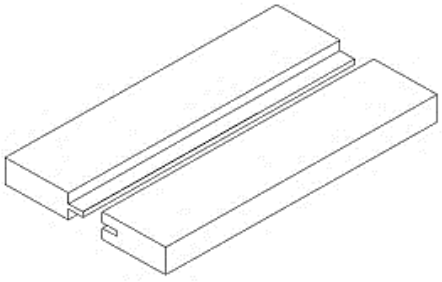


Figure 5.24: *Tongue and groove*

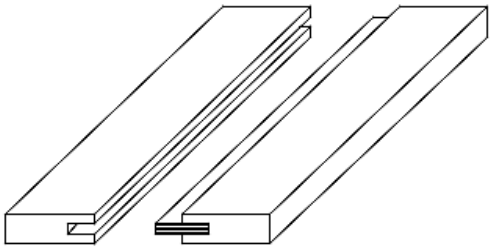
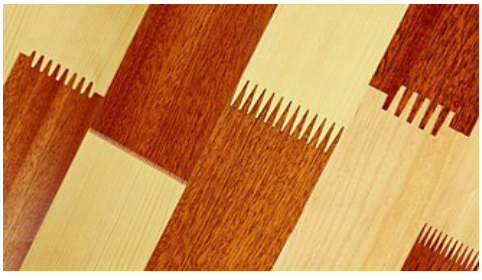


Figure 5.25: *Loose Tongue and groove*

3. **Finger joint**, also known as a **comb joint**, is a woodworking joint made by cutting a set of complementary, interlocking profiles in two pieces of wood, which are then glued. The cross-section of the joint resembles the interlocking of fingers between two hands, hence the name "finger joint"



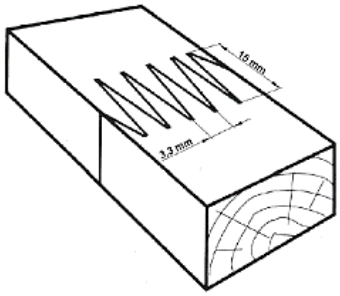


Figure 5.26: *Finger joint*

Purpose of Joints In The Construction Of Artefacts

The following are some purposes of joints in the construction of artefacts;

1. **Connect pieces**: Join multiple wood pieces together to form a single, cohesive unit.
2. **Provision of strength**: Add stability and rigidity to the artefact, making it more durable and resistant to stress.
3. **Improve appearance:** Create a visually appealing and professional-looking finish by hiding gaps and seams.
4. **Distribution of loads:** Share weight and pressure evenly across the joints, preventing damage or collapse.
5. **Facilitate assembly:** Enable easy assembly and disassembly of components, making transportation and storage more convenient.
6. **Generate functionality:** Allow for the creation of moving parts, such as drawers, doors, and lids.
7. **Enhance flexibility:** Permit woodworkers to create complex shapes and designs that would be difficult or impossible to achieve with a single piece of wood.

Learning Tasks

1. Identify the types of joints used in the construction of artefacts.
2. Discuss the purpose of joints in the construction of artefacts.
3. Sketch examples of joints under the following types of joints:
   a. *Angle joint*
   b. *Framing joint*
   c. *and lengthening joint*

Pedagogical Exemplars

The teacher should consider the following activities.

1. **Critical Thinking and Talk for Learning Approaches:** Assist learners through a video demonstration of types of joints in woodwork, and identify the types of joints with open-mindedness. To push thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should pull all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to discuss the purpose of joints in the construction of artefacts. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.
3. **Experiential learning:** Guide learners in mixed ability groups to co-operatively sketch examples of joints under; Angle joint, Framing joint and Widening and lengthening joint.

Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

KEY ASSESSMENT (DOK)

Level 1: Outline at least two types of joints used in the construction of artefacts.

Level 2: Explain why joints are used in the construction of artefacts.

Level 3: Sketch any three examples of joints each under the following types of joints;

1. Angle joint
2. Framing joint
3. Widening and lengthening joint

HINT

*The recommended mode of assessment for week 17 is **checklist**. Use the level 1 question as a sample question.*

UNIT 17 REVIEW

Unit 17 of week 17 exposed learners to the selection and uses of appropriate joints for a specific woodwork. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real object (Samples of joints)

Reflection: Are learners able to select and demonstrate the uses of appropriate joints for a specific woodwork?

UNIT 18

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Be able to differentiate load bearing from non-load bearing components and their functions in the superstructure.*

Content Standard: *Demonstrate knowledge and understanding of load bearing and non-load bearing components of the superstructure*

INTRODUCTION AND SECTION SUMMARY

This unit introduces learners to walls, types and their function. A **wall** is a structure and a surface that defines an area; carries a load; provides security, shelter, or soundproofing; or, is decorative. There are many kinds of walls that will be discussed in this unit which includes; Solid walls, Cavity walls, Curtain walls, Load or Mullion walls, non-load or partition walls, Retaining walls, Boundary walls etc. The teacher will guide learners to understand the key concepts of walls in construction. Learners will appreciate the importance of walls, explain and outline types and functions of walls. Generally, walls are constructed by using blocks, bricks, stones, concrete, glass, plasterboard etc.

The unit covers only week 18: ***Be able to explain walls, outline types and discuss their functions***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in Critical thinking and Talk for Learning Approaches. Guide learners to brainstorm the meaning of walls. Conducting experiential learning by organising field trips to construction sites where learners will observe the construction of different types of walls. Organise learners into mixed ability groups and assist them to discuss the various types of walls. Help learners to develop a deeper understanding through critical thinking of the concept of using walls in construction. The collaborative environment which will be made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will in turn capture the diverse knowledge of all learners.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative and this should include class exercise, oral and written presentations using flip charts and home assignments. Teachers must keep track of performance of each learner given the

different levels of performance of the learner in class and provide the relevant motivation or scaffolds to enhance understanding of the concept. The assessment will also serve as a tool to evaluate levels 1, 2 and 3 of the DoK amongst learners. In this way the pedagogical differentiation strategies adopted will also be complemented under the assessment. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively

WEEK 18

Learning Indicator: *Discuss wall construction*

FOCAL AREA: WALLS

A **wall** is a vertical structure and a surface that defines an area and carries a load. The purposes of walls in buildings are to support roofs, floors and ceilings; to enclose a space as part of the building envelope along with a roof to give buildings form; and to provide shelter and security. In addition, the wall may house various types of utilities such as electrical wiring or plumbing. Wall construction falls into two basic categories: framed walls or mass-walls. In framed walls the load is transferred to the foundation through posts, columns or studs. A mass wall is a structural element made of dense materials such as concrete, masonry, or earth. It is designed to resist lateral forces and provide stability and support to a building. Mass walls store energy during the day and release it at night, contributing to energy efficiency or encasement. Walls are classified as, Solid walls, Cavity walls, Curtain walls, Load or Mullion walls, non-load or partition walls, Retaining walls, Boundary walls etc.

TYPES OF WALLS

a. **Solid walls:** They are walls constructed as a single series of bricks or stone, with no cavity, and therefore no room for insulation inside the wall. They are external walls of a building that have no cavities or gaps.

Figure 5.27: *Solid wall*

b. **Cavity walls:** A cavity wall is a type of wall construction that consists of two parallel masonry walls separated by a gap or cavity The walls are usually made of brick, concrete blocks, or other masonry materials. The cavity provides insulation and helps prevent moisture intrusion.

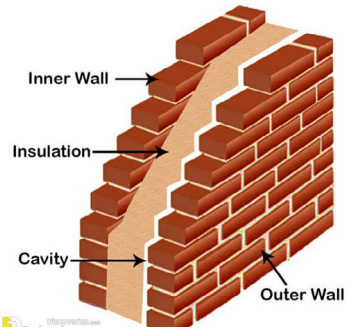


Figure 5.28: *Cavity wall*

c. **Curtain walls:** Curtain wall refers to a building facade that is not load-bearing but provides decoration, finish, front, face, or historical preservation. They are an exterior covering of a building in which the outer walls are non-structural, instead serving to protect the interior of the building from the elements. Because the curtain wall façade carries no structural load beyond its own dead load weight, it can be made of lightweight materials.

Figure 5.29: *Curtain wall*

d. **Load or Mullion walls:** A mullion or load-bearing wall is a wall that is an active structural element of a building, which holds the weight of the elements above it, by conducting its weight to a foundation structure below it. A wall is a structural system in which the load of the floor slab is taken by prefabricated panels around the perimeter**.**

Figure 5.30: *Load or Mullion wall*

e. **Non-load or partition walls**: They are structural elements within a building that do not carry any significant vertical load apart from their own weight and the weight of non-structural elements. Examples are partition walls, curtain walls, pony walls etc. Key features of the wall include:

i. It doesn't support floor or roof loads above.

ii. It relies on load-bearing walls and structural elements for support.

iii. It is typically made from lightweight materials.

iv. Its main function is division and decoration within a building.

Figure 5.31: *non-load bearing wall.*

f. **Retaining walls:** They are built to resist movement of earth, stone, or water. They are relatively rigid walls used for supporting soil laterally so that it can be retained at different levels on the two sides. Retaining walls are structures designed to restrain soil to a slope that it would not naturally keep to (typically a steep, near-vertical or vertical slope). They are used to bound soils between two different elevations often in areas of inconveniently steep terrain in areas where the landscape needs to be shaped severely and engineered for more specific purposes like hillside farming or roadway overpasses. A retaining wall that retains soil on the backside and water on the frontside is called a seawall or a bulkhead.

Figure 5.32: *Retaining wall*

g. **Boundary walls**; A boundary wall**,** also known as a compound wall, is a structure constructed around a building area or property to enclose and secure its boundaries. It serves the purpose of carrying its own load while providing security, privacy walls, boundary-marking walls on property, and town walls. These intergrade into fences. The conventional differentiation is that a fence is of minimal thickness and often open in nature, while a boundary wall is usually more than a nominal thickness and is completely closed.

Figure 5.33: *Boundary wall*

Learning Tasks

1. Explain what is meant by walls.
2. Outline types of walls.
3. Discuss types and functions of walls.

PEDAGOGICAL EXEMPLARS

1. **Critical thinking and Talk for Learning Approaches:** Guide learners to brainstorm and explain walls and outline the various types.
2. **Group work/Collaborative Learning**: Organise learners into mixed ability groups and assist them to discuss the various types of walls and their functions.

KEY ASSESSMENT

1. **Level 1:** Explain walls in construction.
2. **Level 2:** Outline the various types of walls in construction.
3. **Level 3:** Discuss the various types of walls and their functions in construction.

HINT

*The recommended mode of assessment for week 18 is **mid-semester examination**. Refer to the Appendix I at the end of the section for the structure and a Table of Specification.*

UNIT 18 REVIEW

This unit produces the learners with a deeper understanding of concept of walls. The pedagogical exemplars used in this section included group work/collaborative learning, role-play, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

UNIT 19

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and Artefact Production in Woodwork Industry in Ghana

Learning Outcome: *Demonstrate knowledge and understanding of finishes and finishing to select and apply the appropriate finishes to an artefact.*

Content Standard: *Apply knowledge of finishing to artefacts.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners demonstrate the uses of different types of adhesives. Adhesive is a bonding agent used for gluing pieces of wood surfaces together. They play a crucial role in ensuring the structural integrity, durability, and aesthetic quality of wooden products. Adhesives in woodworking can be classified based on their composition, curing methods, and application techniques. As adhesives continue to evolve with advancements in materials science, they offer new possibilities for innovation and creativity in woodworking.

The unit covers only week 19: ***Explain the uses of different types of adhesives***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in demonstrate the uses of different types of adhesives. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Precisely, teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the uses of different types of adhesives and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 19

Learning Indicator: *Explain the uses of different types of adhesives*

FOCAL AREA: TYPES OF ADHESIVES

Types of Adhesives

An adhesive is a substance used to bond two or more surfaces together. There are several types, however, the common ones used for woodwork are discussed here.

1. **Protein Adhesives/ Natural Adhesives:** Among the commonly used protein adhesive used for woodwork are the animal glue and the casein glue.
2. **Animal glue (scotch):** Animal glue is a good all-purpose glue but it has a low resistance to damp and is therefore not good for use on items that are going to be used outside. It needs to be used hot and needs a special glue pot for its preparation. It is obtained in the form of **pearls** or **cakes** which are put into the pot and covered with water and then left overnight to soak. The pot and its contents are heated and the hot glue stirred to the right consistency, ready for use.

Figure 5.34: *Animal glue*

3. **Casein glue:** This type of glue has a good resistance to damp and can be used on items for outdoor use. It is obtained in powder form; the powder being mixed with water to make the glue.
4. **Synthetic Resin Adhesives:** There are many types of synthetic resin adhesives. Those used for bonding wood include:
5. **Polyvinyl Acetate (PVA)/White Glue:** Polyvinyl acetate adhesive is supplied as a white liquid ready for immediate use. It is a good all-round glue, but has a low resistance to damp.
6. **Contact Glue/Impact adhesive:** This is the most common type used, for fixing plastic laminates, veneer and other materials to wood. It is applied to both parts to be joined and then left for ten to fifteen minutes. The two parts are brought together carefully, as the glue sticks immediately and movement of the two parts is not always possible.
7. **Epoxy Resin:** This is a two-part glue used mainly for joining metal to wood. The two parts are mixed thoroughly in equal quantity and the glue is applied to both parts and the parts

brought together and left for 24 hours. The application of moderate heat speeds up the curing process.

8. **Urea Formaldehyde Resin:** These types of adhesives are available in three forms and they are all applied cold. They all have high resistance to damp. The first type consists of a viscous syrup resin and a powder or liquid hardener, it has a shelf-life span of three to six months. The second type has a white powder resin and a powder or liquid hardener with a shelf-life span of one to two years. The third one consists of a powder resin and a powder hardener already mixed together which have one to two years shelf-life span. When powders are used, they are mixed with water. It is important that when mixing, the right proportions of resin and hardener are used according to the maker's instructions.

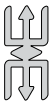
There are two ways of applying the glue.

1. The resin and the hardener may be mixed as one liquid and spread on both parts of the work. The parts are then assembled and clamped before the glue gels.
2. The resin liquid may be applied to one part of the work and the liquid hardener applied to the other. The parts are then assembled and clamped while each part is still moist.

Factors to Consider In Selecting An Adhesive

There are a number of factors that have to be taken into account when selecting an adhesive:

1. **Resistance to damp:** Is the finished object going to be kept or used outside? If so, an adhesive that can resist damp needs to be used, if not, a cheaper adhesive that has less resistance to damp can be used.
2. **Setting time:** The setting time for each adhesive is different and must be taken into account when choosing the glue. You will need longer time if you need to assemble and clamp a joint.
3. **Application of pressure:** Some adhesives require the application of pressure to the joint until the adhesive cures. Others do not require the application of any pressure at all. It is important that you understand the requirements of each adhesive and how those requirements affect the job being done.



Note

Other factors to consider in selecting adhesive include: strength required, ease of use, curing time, compatibility with wooden surfaces, durability of the adhesive, shelf life, heat resistance, etc.

Terms Used in Adhesives

Below are some common terms used in adhesives.

1. **Shelf life:** It is the length of time an adhesive can be stored between manufacture and mixing for use. In other words, it is the period of time that an adhesive will remain suitable for use.

2. **Pot life:** This is the length of time an adhesive remains usable after mixing or the period of time allowed for use after either mixing or preparing the adhesive.
3. **Assembly time:** The time allowed between applying an adhesive and the fitting of the members of the work together.
4. **Setting time:** This is the time a glued work reaches its maximum strength after clamping.
5. **Open assembly:** It is the time allowed between applying the glue and fitting of the members of the job together
6. **Closed assembly:** This is the period during which adjustments are possible such as squaring and aligning members before final tightening of clamps.
7. **Clamping time:** Is the time the job should be left in the claps before they can be safely removed
8. **Curing or setting time:** Is the period it takes the glue to reach maximum strength after being applied to the work piece.

Learning Tasks

1. Identify the types of adhesives used to bond surfaces together in woodwork
2. Discuss the factors to consider when choosing an adhesive for an artefact
3, Demonstrate how to apply an adhesive for effective adhesion

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Assist learners through a video demonstration of types of adhesives, and identify the types of adhesives. To push thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to discuss the factors to consider when choosing an adhesive for an artefact. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.
3. **Experiential learning:** Guide learners in mixed ability groups to co-operatively demonstrate how to apply an adhesive for effective adhesion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

KEY ASSESSMENT

1. **Level 1**: Identify the at least two types of adhesives commonly used to bond surfaces together in woodwork.

2. **Level 2**: Explain at least three factors to consider when choosing an adhesive for the construction of an artefact.
3. **Level 3**: In the construction of your designed artefact, how will you apply a chosen adhesive for effective adhesion?

HINT

*The recommended mode of assessment for week 19 is **gamification**. Use the level 2 question as a sample question.*

UNIT 19 REVIEW

Unit 19 of week 19 exposed learners to the uses of different types of adhesives. The pedagogical exemplars used in this unit included talk for learning, group work/ collaborative learning, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real object (PVA, Contact adhesive, etc.)

Reflection: Are learners able to use different types of adhesives?

UNIT 20

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Be able to differentiate load bearing from non-load bearing components and their functions in the superstructure*

Content Standard: *Demonstrate knowledge and understanding of load bearing and non-Load bearing components of the superstructure*

INTRODUCTION AND SECTION SUMMARY

This unit introduces learners to doors, windows and frames. Doors are movable barriers to an opening in walls which are fixed to an assembly of horizontal and vertical members forming an enclosure called door frame. A window is an opening formed in a wall or roof primarily to admit daylight through transparent or translucent materials which are fixed in structural supports that holds the window glass in position. It surrounds and supports the window pane affecting both aesthetic energy efficiency. There are many kinds of doors and windows that will be discussed in this unit which includes; (Doors) pocket door, sliding door, Rolling shutter door, panel door, Ledged and braced door and Flush door. (Windows) Single-hung window, double-hung window Casement window and Sliding window. The teacher will guide learners to understand the key concepts of doors and windows. Learners having understood doors and windows will appreciate the importance of them, explain and outline types and functions of doors and windows. Generally, doors and windows are constructed by using vinyl, wood**,** aluminium**,** and fibreglass.

The unit covers only week 20: ***Discuss doors and windows***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be achieved, learners must fully participate in Critical thinking and Talk for Learning Approaches. Guide learners to brainstorm the meaning of doors and windows. Conducting experiential learning by organising field trips to construction sites where learners will observe different types of doors and windows. Organise learners into mixed ability groups and assist them to discuss the various types of doors and windows. Help learners to develop a deeper understanding of the concept of doors and windows in buildings. Learners will all be capacitated as they engage in critical thinking without any form of inhibition. The collaborative environment which will be made tolerant of GESI, SEL and National Values is expected to enhance the brainstorming sessions which will in turn capture the diverse knowledge of all learners.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction should be formative and this should include class exercise, oral and written presentations using flip charts and home assignments. Teachers must keep track of performance of each learner given the different levels of performance of the learner in class and provide the relevant motivation or scaffolds to enhance understanding of the concept. The assessment will also serve as a tool to evaluate levels 1, 2 and 3 of the DoK amongst learners. In this way the pedagogical differentiation strategies adopted will also be complemented under the assessment. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 20

Learning Indicator: *Discuss doors, windows and their frames*

FOCAL AREA: DOORS AND WINDOWS

Doors

A door is a hinged or otherwise movable barrier that allows ingress (entry) into and egress (exit) from an enclosure. The created opening in the wall is a doorway or portal. A door's essential and primary purpose is to provide security by controlling access to the doorway (portal). Doors are generally made of a material suited to the door›s task and are commonly attached by hinges, but can move by other means, such as slides or counterbalancing. Many doors incorporate locking mechanisms to ensure that only some people can open them (such as with a key). Doors may have devices such as knockers or doorbells by which people outside announce their presence. Apart from providing access into and out of a space, doors may have the secondary functions of ensuring privacy by preventing unwanted attention from outsiders, of separating areas with different functions. Doors can have aesthetic, symbolic ritualistic purposes. Doors are classified as pocket door, sliding door, Rolling shutter door, panel door, Ledged and braced door and Flush door.

1. **Pocket door:** A pocket door is a sliding door that, when fully open, disappears into a compartment in the adjacent wall. Pocket doors are used for architectural effect, or when there is no room for the swing of a hinged door. They can travel on rollers suspended from an overhead track or tracks or guides along the floor. Single- and double-door versions are used, depending on how wide an entry is desired.

Benefits of pocket doors include

a. **Space-saving:** They maximise floor space as they do not require swing clearance.

b. Versatility: They can be used in various spaces, including bathrooms, closets, and living areas.

c. **Seamless aesthetics:** When open, pocket doors create a continuous flow between rooms.

d. **Sound insulation:** They help keep out sound and light from other parts of your home.

e. **Modern appeal:** Pocket doors enhance functionality, appearance, and add value to your home.

Disadvantages of pocket doors include

a. Hard to install and maintain.

b. Do not block noise and odours well.

c. Need a lot of interior wall space.

d. Can be noisy.

May not seal as tightly as conventional doors, allowing noise, smells, and light to be transferred from one space to the other.

Figure 5.35: *Pocket door*

2. **Sliding door:** A sliding door is a type of door which opens horizontally by sliding, usually parallel to (and sometimes within) a wall. Sliding doors can be mounted either on top of a track below or be suspended from a track above. Some types slide into a space in the parallel wall in the direction of travel, rather than the door sliding along the outside of the parallel wall. Sliding doors are commonly used as shower doors, glass doors, screen doors, and wardrobe doors.

Sliding doors offer several advantages some of which are:

a. Better ease of movement when used as door options.

b. Better air and sun in the inside, leading to better ventilation.

c. Space savers in small sitting areas.

d. Minimal maintenance.

e. Durability.

Disadvantages of sliding doors include

a. **Limited insulation and soundproofing:** Sliding doors may be less efficient at insulating against noise and weather compared to hinged doors.

b. **Potential for misalignment and maintenance issues:** Tracks need regular cleaning, and large glass panes can be challenging to maintain.

c. **Limited visibility:** One side of a sliding wardrobe door is always covered, so you can't view the entire contents at once.

d. **Need for gentle handling:** Rough handling can compromise the panels and alignment of the doors.

Figure 5.36: *Sliding door*

3. **Rolling shutter door:** A roller shutter door is a type of door or window shutter consisting of many horizontal slats hinged together. The door is raised to open it and lowered to close it. On large doors, the action may be motorised Roller shutters are commonly used as a door to provide a high level of security for all types of properties. The door is usually constructed from aluminium or steel slats.

Advantages of roller shutter doors include

a. **Enhanced security:** Roller shutter doors act as a robust barrier against unauthorised access, vandalism, and break-ins.

b. **Weather protection:** These doors offer excellent resistance to rain, wind, and dust.

c. **Fire protection:** They can provide fire resistance.

d. **Easy to operate:** Roller shutter doors are easy to open and close.

e. **Insulation:** They provide thermal insulation.

Disadvantages of roller shutter doors include

a. **Cost:** Roller shutter doors can be expensive to purchase.

b. **Maintenance requirements:** Deep cleaning and fixing roller shutters can be time-consuming and complicated.

c. **Noise impact:** Roller shutters may be noisy when operating.

d. **Space requirements:** They may require additional space inside and outside the door.

e. **Aesthetic considerations:** Some people may not find roller shutters traditional or aesthetically pleasing.

Figure 5.37: *Rolling shutter door*

4. **Panel door:** A panel door is a type of door that has a textured surface created by recessed or raised panels**.** These panels can vary in number, shape, and overall style. Panel doors are usually made up of two to eight rectangular or square panels. They are crafted by fitting together these panels to create the finished door. In modern terms, a panel door has square or rectangular sections that are thinner than the rest of the door, giving it a traditional look.

Panel doors have several advantages some of which are

a. **Durability:** Panel doors are extremely durable and unlikely to break or crack.

b. **Elegance and natural beauty:** They have a classic and natural appearance.

c. **Customisable:** Panel doors can be made to any design as required by architects.

d. **Soundproofing:** They provide increased insulation and soundproofing.

Disadvantages of panel doors include

a. Costly, especially when made from wood.

b. Require more daily cleaning due to dust retention.

c. Joints in wood require good workmanship and skill.

d. Glass panel doors are easily broken.

e. Limited expansion and contraction.

Figure 5.38: *Panel door*

5. **Ledged and braced door:** is a classic design that has been used in households for centuries due to its simple construction. It typically consists of several vertical planks of equal length, held together by horizontal "ledges." Running diagonally across the door are the "braces." These doors are commonly found in rustic or cottage-style settings. Exterior versions may have slight variations, but they all share this basic structure. For interior use, ledge and brace doors are mainly available in oak or pine. These doors often feature vertical lining panels on both sides and offer improved soundproofing and stability.

   Ledged and braced doors offer several advantages, making them a popular choice for both exterior and interior use. Here are some benefits:

   a. **Durability:** Ledged and braced doors are robust and sturdy. The combination of horizontal ledges and diagonal braces provides stability, ensuring the door's longevity.

   b. **Weatherproofing:** These doors are more weather-resistant than traditional doors. The design helps prevent warping or dropping over time, making them suitable for external use.

   c. **Insulation:** The solid wood construction acts as a natural barrier, reducing heat transfer and noise transmission. This insulation property contributes to energy savings and creates a quieter atmosphere, making them ideal for bedrooms or home offices.

   d. **Timeless Charm:** Ledged and braced doors have a rustic, timeless charm. They work well in properties with country or rustic aesthetics, adding character and warmth.

e. **Custom Fit:** Framed ledge and brace doors are available in various sizes, ensuring a custom fit for any layout or aesthetic. They can add value and vintage appeal to any home, especially those with country charm.

Disadvantages of ledged and braced doors include

a. **Quick Oxidation:** The exposed timber in these doors can be susceptible to oxidation, especially if the wood quality is poor.

b. **Water Stains:** If not properly sealed or maintained, water stains can mar the appearance of the wood over time.

6. **Twisting and Warping:** External ledged and braced doors (with one side internal and one side external) may twist and warp due to differences in temperature and weather conditions on each side. Framed ledged and braced doors are a better option in such cases.

Figure 5.39: *Ledged and braced door*

7. **Flush door:** A flush door is a simple and contemporary type of door that is characterized by its smooth and flat surface. It is constructed with a frame and infill material, and the facing on both sides gives it a uniform appearance. Flush doors are widely used in both residential and commercial buildings due to their versatility and modern aesthetic. There are several types of flush doors, each designed to meet specific requirements.

Advantages of flush doors which are as follows

a. The designs of flush doors are very simple so they are inexpensive in cost and easily found.

b. These doors are stiff, impact-resistant, and contain high strength.

c. These doors never twist with time, as they are prepared of rectangular softwood blocks on the inner.

d. Are attractive, traditional, and rich in appearance.

e. These doors are not weighty in weight as regular plywood doors and can be effortlessly fitted and used every day.

f. These doors can be utilised in both areas inner and outer as well.

g. These **doors** are weatherproof by applying varnish and decay-proof.

h. Because of chemical treatment these doors are termite and fungi-free.

i. The material price in preparing these doors is very low and hence, these doors are cheaper.

Disadvantages of flush doors which are as follows

a. Factory-prepared and hence the desired or perfect size of the door opening must be provided, as the following alternations are very hard.

b. The plywood-covered flush door cannot be utilized where they will be opened to rain and the sun.

c. This door is heavyweight. So, it is very difficult to carry, transport, handle and fit in a building.

d. They are hard to repair on the top veneer or laminate or **plywood** starts dividing into layers due to temperature, moisture, etc. effects.

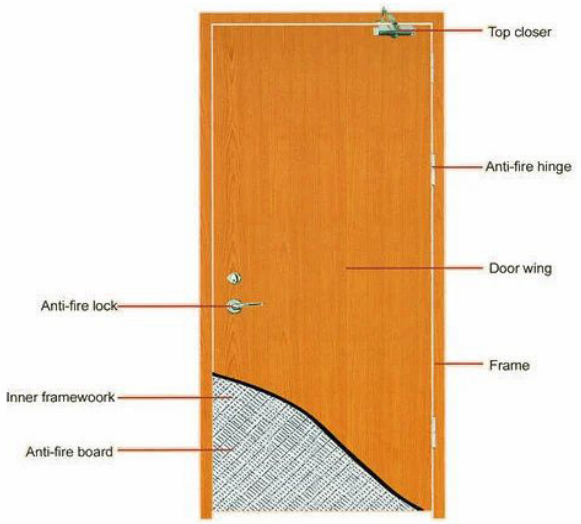


Figure 5.40: *Flush door*

Windows

Windows are vented barriers fixed in the walls of buildings for ventilation purposes. They allow people to gaze at outside views effortlessly and directly. Windows serve the purposes of admitting natural light, air, or gazing; they also help elevate the beauty of buildings. Windows are classified as Single-hung window, double-hung window, Casement window and Sliding window.

1. Single-hung window: A single-hung window is a type of window that consists of two sashes. The top sash is stationary**,** while the bottom sash can be opened and closed vertically. These windows are commonly seen in traditional and colonial-style homes.

Advantages of single hung windows include

a. Affordability: Single-hung windows are typically more affordable than double-hung windows.

b. Easy Maintenance: Only the lower sash moves, making cleaning and maintenance straightforward.

c. **Space Efficiency:** They don't protrude when opened, making them ideal for rooms with limited space.

d. **Energy Efficiency:** Designed to insulate, they can help reduce heating and cooling costs.

e. **Traditional Appeal:** Their simple design and limited moving parts make them a popular choice.

Disadvantages of Single Hung Windows

a. **Limited Ventilation:** Single hung windows only open from the bottom, which limits the amount of ventilation that can enter a room.

b. **Cleaning and Maintenance Challenges:** Single hung windows can be more difficult to clean and maintain than other window styles.

c. **Safety and Escape Concerns:** Single hung windows can present safety and escape concerns in the event of an emergency.

d. **Reduced Variety of Sizes and Styles**.

Figure 5.41: *Single-hung window*

2. **Double-hung window:** Double hung windows are named as such because they have two sashes that can be opened or closed independently. This versatile design allows homeowners to take advantage of different ventilation options by adjusting the sashes to allow air in from either the top or the bottom.

Double-hung windows offer several advantages

a. They add more natural light to your home.

b. They improve energy efficiency.

c. They increase ventilation.

d. They are much easier to clean compared to other window styles.

e. They are versatile, durable and easy to customise.

Disadvantages of double-hung windows include

a. Air leakage

b. Limited ventilation

c. Increased energy consumption

d. Thermal comfort

e. Cost

Figure 5.42: *Double hung window*

3. **Casement window:** A casement window is a window that is attached to its frame by one or more hinges at the side. They are used singly or in pairs within a common frame, in which case they are hinged on the outside. Casement windows are often held open using a casement stay. Windows hinged at the top are referred to as awning windows, and ones hinged at the bottom are called hoppers.

Advantages of casement windows include

a. Increased security.

b. Excellent ventilation.

c. Easy to open and close.

d. Variety of design features.

e. Energy efficient.

Some of the disadvantages of casement windows are

a. They can be more expensive than other types of windows.

b. They can be easier to break into, especially if the hinges are rusty or faulty.

c. They can be difficult to install, repair, and use.

d. They have more mechanical components that can malfunction or wear out.

e. They have size limitations and cannot accommodate large areas.

Figure 5.43: *Casement window*

4. **Sliding window:** A slider window is a type of window that you open horizontally. If you tilt your head to one side they almost look like double-hung windows. They're one of the simplest replacement windows designs available.

Advantages of sliding windows include

a. Ventilation and cooling sliders are great for warmer climates.

b. Easy installation and maintenance especially if you don't want a door-like opening.

c. Easy to open and close with minimal effort.

d. Nice view of the outside while still maintaining privacy.

e. Space-saving design energy-efficient and easy to use and maintain.

Disadvantages of sliding windows include

a. Lack of privacy sliding windows reveal nearly everything inside your home to anyone standing outside.

b. Lack of security sliding windows and doors can be opened either way, making them less secure than other types of doors and windows.

c. Poor thermal protection sliding windows may not provide as good thermal insulation as other types of windows.

d. Difficult to clean while it's easy to clean the inside of slider windows, it's difficult to clean the outside.

e. Roller maintenance if your sliders have rollers, you might need to replace them after a few years.

Figure 5.44: *Sliding window*

Learning Tasks

1. Outline types of doors and windows.
2. Explain various doors and windows.
3. Discuss the function as well as advantages and disadvantages of doors and windows.

PEDAGOGICAL EXEMPLARS

1. **Critical thinking and Talk for Learning Approaches:** Guide learners in small mixed-ability groups to brainstorm and outline types doors and windows and also assigned highly Proficient learner to the group as a leader to assist the members of the group to explain of doors and windows used in buildings.
2. **Group work/Collaborative Learning**: Organise learners into small mixed ability groups and assist them to discuss the functions of doors and windows. Assist learners to discuss the advantages and disadvantages of doors and windows in buildings.

KEY ASSESSMENT

Level 1: Explain the doors and windows that are used in buildings.

Level 2

1. Outline the various types of doors and windows used in buildings.
2. Outline the various materials used in the production of doors and windows.

Level 3

1. Discuss the function of doors and windows as used in buildings.
2. Discuss the advantages and disadvantages of doors and windows

UNIT 20 REVIEW

This unit produces the learners with a deeper understanding of concept of doors and windows. The pedagogical exemplars used in this section included group work/ collaborative learning, role-play, digital learning and experiential learning which helped to meet varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for all varied activities of learning. These assessments were classified under the DoK level 1,2 and 3.

APPENDIX I: STRUCTURE OF EXAMINATION

15 Multiple Choice Questions (MCQ) all to be answered within 20 minutes. Questions cover DoK level 1 to 3

Resources

Scannable sheets, A4 sheets, class list, etc.

Sample Question

Multiple Choice

1. One of the reasons for excavation of trenches in Building Construction projects is, to ……...

a. *cast foundation.*

b. *fill hardcore.*

c. *plaster walls.*

d. *screed floor.*

Marking Scheme

1. One of the reasons for excavation of trenches in Building Construction projects is, to ……...

a. *cast foundation.*

b. *fill hardcore.*

c. *plaster walls.*

d. *screed floor.*

TABLE OF SPECIFICATION FOR MID SEMESTER TWO EXAMINATION

WKS	LEARNING INDICATORS	DoK level				TOTAL
		1	2	3	4	
13	Select appropriate materials suitable for producing the final solution.	1	2			3
14	Explain load bearing and non- load bearing members of the Superstructure.	1	1	1		3
15	Produce a model from your working drawings.	1	1	1		3
16	Discuss wall construction.	1	1	1		3
17	Select and use appropriate joints for a specific woodwork operation.		2	1		3
	TOTAL	4	7	4		15

SECTION 6: FASTENERS, FITTINGS, FINISHES AND ROOF, CEILING CONSTRUCTION

The section covers woodwork technology and building construction technology unit (strands).

In this section learners will acquire knowledge and understanding of fasteners and fittings to select and use the appropriate fasteners and fittings for a specific woodwork artefact as well as the uses of different types of finishes. In the building construction technology unit learners are expected to gain the knowledge and understanding of roof construction and ceilings. All the above are treated from unit 21 to unit 24.

UNIT 21

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and Artefact Production in Woodwork Industry in Ghana

Learning Outcome: *Demonstrate knowledge and understanding of finishes and finishing to select and apply the appropriate finishes to an artefact.*

Content Standard: *Apply knowledge of finishing to artefacts.*

HINT

End of semester examination is in Week 24. Refer to Appendix J at the end of the section for the structure and the Table of Specifications.

INTRODUCTION AND UNIT SUMMARY

This unit will help learners select and use appropriate fasteners and fittings for a specific woodwork artefact. Woodwork fasteners and fittings are essential components in the construction and assembly of wooden structures and furniture. They provide the necessary strength, stability, and functionality to woodworking projects, ensuring that pieces are securely joined and can withstand various stresses and loads. Understanding the different types of fasteners and fittings, along with their appropriate uses, is crucial for anyone involved in woodworking, from hobbyists to professional carpenters.

The unit covers only week 21: ***Select and use appropriate fasteners and fittings for a specific woodwork artefact***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in selecting and using appropriate fasteners and fittings for a specific woodwork artefact. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2 and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Precisely, teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the uses of appropriate fasteners and fittings for a specific woodwork artefact and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 21

Learning Indicator: *Select and use appropriate fasteners and fittings for a specific woodwork artefact.*

FOCAL AREA: FASTENERS AND FITTINGS

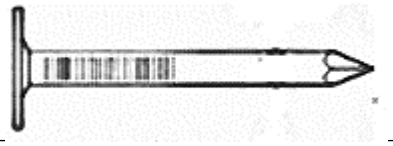
Fasteners and fittings: These are hardware used in woodwork to join or assemble wood pieces together. It is often necessary to use hardware to perform particular functions in construction of artefacts. These pieces of hardware are most often made of metal and are introduced when the use of wood would be inappropriate. The metal used can be either steel or brass. Steel is cheaper, but not as resistant to corrosion as brass. They are device that closes or secures something. Some common types of fasteners and fittings used in woodwork include:

1. **Nails:** There is a wide range of different nails available, therefore it is important to choose the correct one of use. Although nails are very useful and are easy to use, they do have some disadvantages, the main ones being the tendency to split the wood and the need to use glue if a permanent joint is required.

Types of Nails

Table 6.1: Types of Nails

No	Nail Type	Image
1	**Common nail (Wire nail/Framing nail):** They are used for general construction, framing, and other structural work where the appearance of the head on the surface of the job is of secondary importance.	
2	**Finishing nail/ (lost head nail):** When the nail is hit fully home, the head is below the surface and a filler is used to cover the resulting hole in woodwork and work well for molding.	
3	**Oval wire nail:** This has an oval cross section and, as with the lost head, the head of the nail ends up below the surface of wood.	
4	**Panel pin:** A much smaller nail for light work, such as holding **mouldings** in place. After insertion, the head of the pin should be punched below the surface.	
5	**Tack nail:** This is used mainly in **upholstery,** where the large head grips the fabric and so reduce the tendency to tear and also used to fix carpets to floors	

6	**Clout:** This nail is also used in upholstery for holding **webbing**. It's more common use, however, it for **holding roofing felt**, where its large head prevents tearing.	
7	**Cut floor brad:** This heavy-duty nail is used for holding down floor boards; its wedge shape gives good gripping qualities and the blunt end tears the fibres of the wood, so preventing splitting.	
8	**Roofing nail:** A roofing nail is a small nail with a large flat head and a barbed shank that is used to secure roofing sheet to a roofing board. Sometimes, these types of nails are also slightly bent to increase the holding power.	

2. **Screws:** The woodworker sometimes needs a method of joining that is not permanent and yet has maximum holding power. Screws fit this role perfectly, as they have much better holding power than nails and can be removed easily. They have a tapered body which has a sharp twist or helix thread; this screw itself into the wood fibres and can only be removed by unscrewing. Many types of screw are available - made from mild steel or brass – and may be coated for protection or decoration, for example, black japanned or galvanized. The head shapes vary, as does the method of turning the screw. The screw size is determined by its shank diameter or gauge. Its length is from the head rim to thread tip. Gauge numbers (4, 6, 8, 10, etc.) stay the same, whatever the length.

   The common screws are:

   a. **Countersunk head screw:** A general-purpose screw that is used when a flush surface finish is required. The work to be joined does required a countersunk hole for the screw to sit flush, which can weaken thin material. Common sizes range from 6.5 to 150mm.

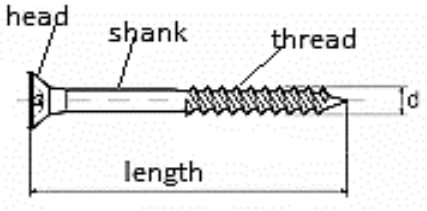


Figure 6.1: *Countersink screw*

   b. **Roundhead screw:** This is mainly used for fixing other fittings to wood, such as metal strip or plastic. It has the advantage of not weakening the material by countersinking, but will not give the flush finish. Quite often roundhead screws are black japanned for protection when they are used out of doors. Common sizes are from 6.5 to 87mm.

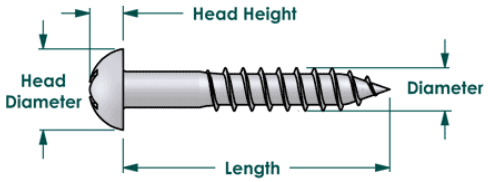


Figure 6.2: *Roundhead screw*

c. Raised head screw: A decorative screw that holds like a countersunk, but gives the round head finish. It is used for holding such things a door handles, cupboard catches and letter plates. For this reason, they are coated to match the fitting, for example chromium or nickel. Common sizes are from 8 to 50mm.

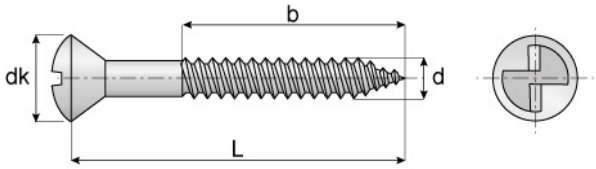


Figure 6.3: *Raised head screw*

d. Coach screw: This is the largest of all the screws and has to be turned with spanner. It is used for heavy constructions and frames. Common sizes are from 25 406 mm.

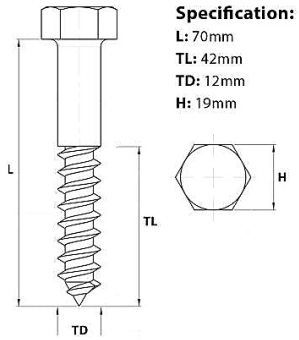


Figure 6.4: *Coach screw*

Fitting of screws: Before screws can be fitted, the work has to be drilled. A hole is first made the same sizes as the screw shank. This is called a **clearance hole**. It may be countersunk if needed. The work is now positioned together and a **pilot hole**, about half the size of the clearance hole, is drilled into the holding place. The length of the screw should be 2½ to 3 times longer than the thickness of the object to be held.

Stages For Drilling A Countersunk Woodscrew

a. Drill a hole slightly smaller than the diameter of the shank.

b. In hardwoods, drill a pilot hole less than the diameter of the thread core.

c. Countersink the hole to a diameter equal to the diameter of the head.

d. Label 4a and 4b shows the options of **'counterboring'** and inserting a wooden plug, or using a screw cup.

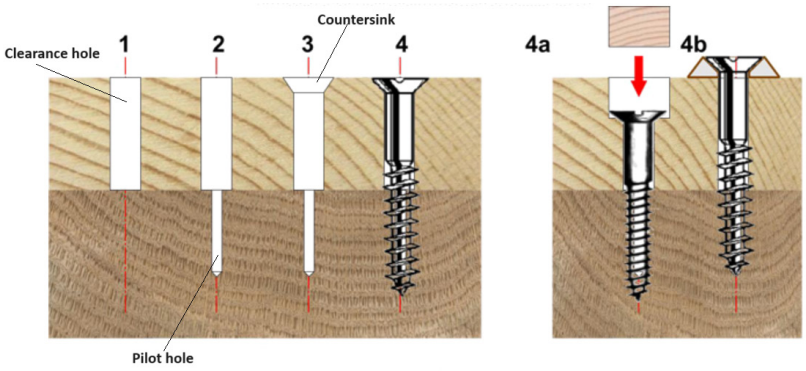


Figure 6.5: *Fitting of screw*

Points to remember: When screwing into end grain manufactured board the screw fails to grip well. To overcome this, two simple methods can be used.

a. **Plastic wall plug:** In place of the pilot hole, a hole is drilled for a plastic wall plug which matches the screw to be used. The plug is inserted and the screw is fitted. The plug expands and grips the side of the hole.

Figure 6.6: *Plastic wall plug*

b. **Dowel:** If the wood or board is not too wide, a hole can be drilled at right angles to the direction of the screws. Into this can be glued a wooden dowel. This provides side grain for the screw to grip into. When using wood screws, always screw the thinner piece of wood to the thicker piece.

3. **Locks:** These are used to ensure that anyone without the correct key cannot gain access into the items to which the lock is fixed. They often serve a dual purpose, i.e. as a **lock**. The latch allows a door or box to be kept closed without actually locking it. The following locks are used for house doors:

a. **Mortise lock:** This type of lock requires a mortise to be cut into the edge of the door and a striking plate fixed to the edge of the door-post. It has the added security advantage of being completely hidden and therefore impossible to remove when the door is closed.

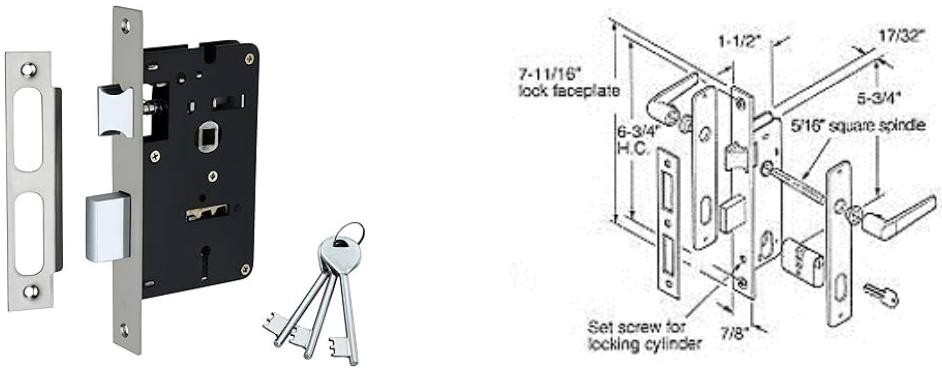


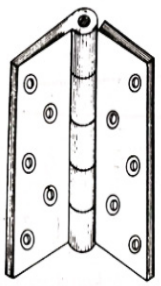
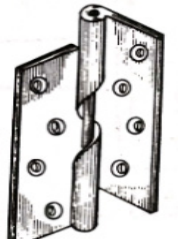
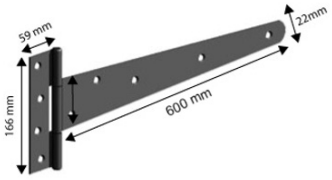
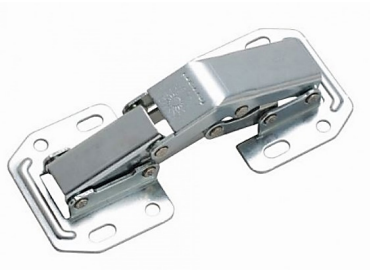
Figure 6.7: *Mortise lock*

b. **Drawer lock:** This lock also requires to the cupboard lock and are requires letting-in.

Figure 6.8: *Drawer lock*

4. **Hinges:** A hinge is a piece of ironmongery which is used in woodwork to allow one part of a construction to move relative to another. It usually consists of two parts which are loosely joined with a **pin**. Hinges are normally available in two materials, i.e. steel and brass.

Table 6.2: Types of Hinges

N°		Image
1	**Butt hinge:** This is available in a wide range of sizes, from small model-makers' hinges up to hinges used on large doors and is available in both brass or steel. It consists of two **leaves** which are let into the two sides of the pieces of the hinged.	
2	**Rising butt hinge:** This type of hinge is used on internal doors where the door has no open over a piece of raised flooring such as a carpet. It has the advantage that, once the door has risen up the slop of the hinge, the door will close by itself when released.	
3	Tee hinge: This hinge is a cheap hinge and is used almost exclusively outside for hinge gates and shed doors. It is normally obtained either with a black japanned or galvanized finish as a form of weather protection.	
4	Cabinet/Spring hinge: Often equipped with a spring mechanism that manually or automatically closes the door after opening, ensuring that doors remain closed when not in use. Various furniture pieces, such as wardrobes, dressers, and cupboards, use cabinet hinges for door attachment and functionality.	
5	Hidden spring hinge: Often equipped with a spring mechanism that manually or automatically closes the door after opening, ensuring that doors remain closed when not in use. Various furniture pieces, such as wardrobes, dressers, and cupboards, use cabinet hinges for door attachment and functionality.	

5. **Drawer runner:** A drawer runner, also known as a drawer slide or drawer guide, is a hardware component used to facilitate the smooth opening and closing of drawers or slide in and out of its enclosure with ease. They come in various designs and mechanisms, tailored to different types of drawers and specific needs.

a. **Side-mounted drawer runners**: These are attached to the sides of the drawer and the interior sides of the cabinet. They are visible when the drawer is open and are commonly used for their durability and ease of installation.

Figure 6.9: *Side-mounted drawer lock*

b. **Center Mounted (Undermount) Drawer Runners**: These runners are mounted under the drawer and are hidden from view when the drawer is open. They are often used in high-end cabinetry because they provide a cleaner look and are less likely to accumulate dust and debris.

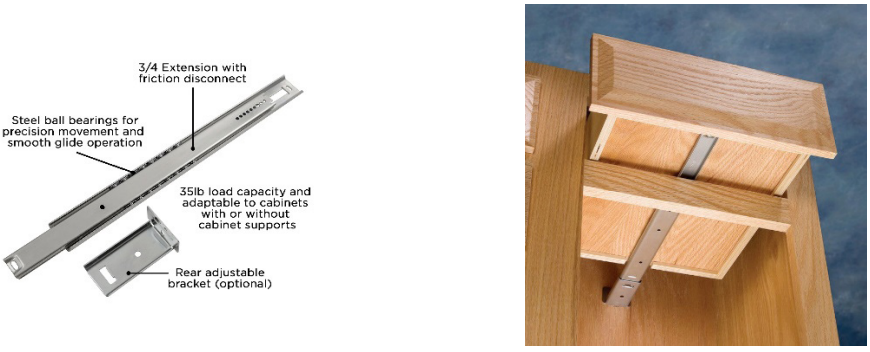


Figure 6.10: *Center mounted (undermount) drawer lock*

c. **Roller Runners**: These runners use a system of rollers to allow the drawer to slide in and out. They are typically more affordable than ball bearing runners but may not handle heavy loads as well.

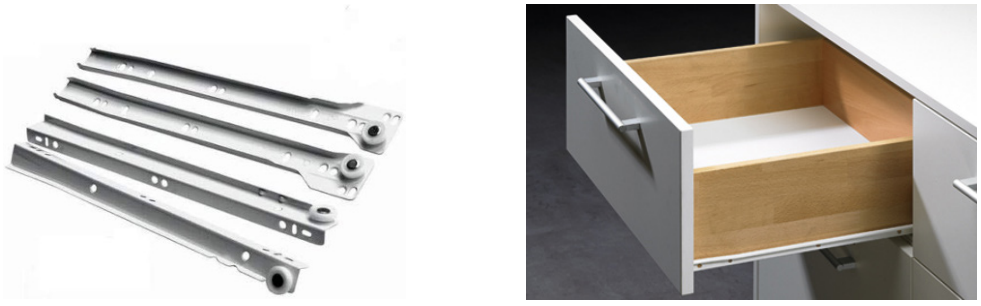


Figure 6.11: *Drawer lock*

6. **Barrel bolts:** The most important use for this item is to hold doors closed. The bolt will give an element of security, whereas the catch will only hold the door in places. They consist of pieces of round, rectangular or square **bars** which are contained in **barrels.** The bar is moved by a handle.

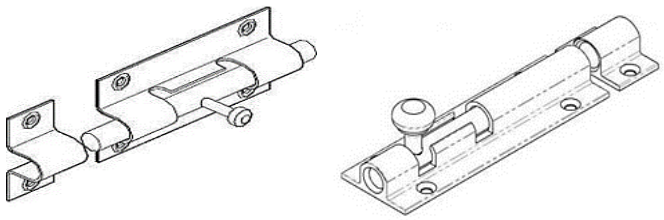


Figure 6.12: *Barrel bolt*

7. Ball catch: This type of a spring-loaded ball in a barrel which is fixed into the door and a catch plate will normally have a **ramp** which should be positioned so that the ball runs smoothly up it and into a hole in the catch plate.

Figure 6.13: *Ball catch*

8. **Magnetic catch:** This type of catch has a magnet which holds the door in position when closed.

Figure 6.14: *Magnetic catch*

9. **Castors (screw and plate):** It is often necessary in a design to allow for a piece of furniture to be easily moved around. This is most successful achieved with the use of castors, which are small wheels that can be fitted to the under-side of the construction.

Figure 6.15: *Castors (screw and plate)*

10. **Stays:** When it is necessary to restrain the movement of a door or flap, a stay is needed.
    a. **Rule joint stay:** This consists of a metal strip hinged in the middle. The ends of the strip are attached to the box and the flap so that the strip straighten when the flap is

fully open. Care needs to be taken in the positioning of the stay to ensure that there is room inside the box for the stay to fold.

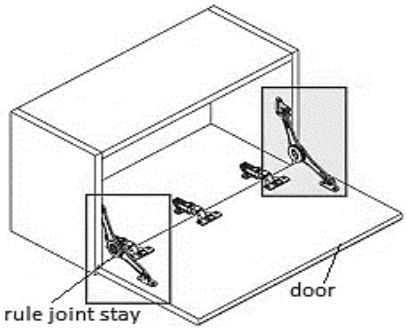


Figure 6.16: *Rule joint stay*

b. Sliding stay: This consists of a strip with a slot cut along its length. This strip is hinged and fitted to the flap. A pin on the box slides in the slot as the flap closes. Once again, it is necessary to take care that there is room inside the box for the strip when the flap is closed.

Figure 6.17: *Bureau Sliding door stay*

Woodwork Knockdown Fittings

Knockdown fittings are specialised hardware items used in woodworking to allow furniture and other structures to be easily assembled and disassembled. These fittings are particularly popular in flat-pack furniture, such as those from IKEA, due to their convenience for transportation and storage. Here is an overview of common types of knockdown fittings and their uses:

Common Types Of Knockdown Fittings

Cam lock connectors

- **Description**: Consist of a cam and a dowel. The cam locks into a pre-drilled hole in one piece of wood, while the dowel fits into a corresponding hole in the adjoining piece.
- **Uses**: Common in flat-pack furniture, providing strong and secure joints that are easy to assemble and disassemble.

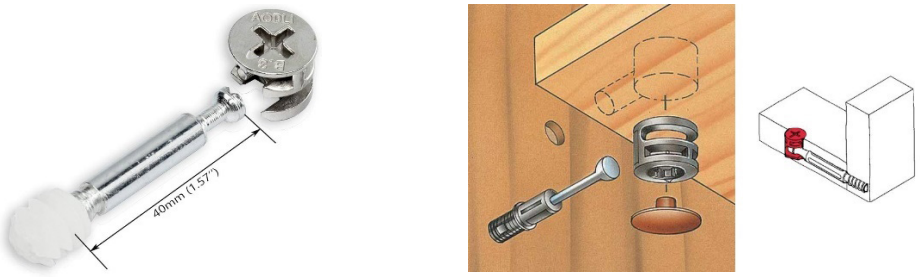


Figure 6.18: *Cam lock connector*

Cross Dowel and Bolt

- **Description**: A bolt is inserted through a pre-drilled hole in one piece of wood and into a cross dowel fitted into a perpendicular hole in the adjoining piece.
- **Uses**: Provides a very strong joint, commonly used in bed frames and other furniture where high strength is required.

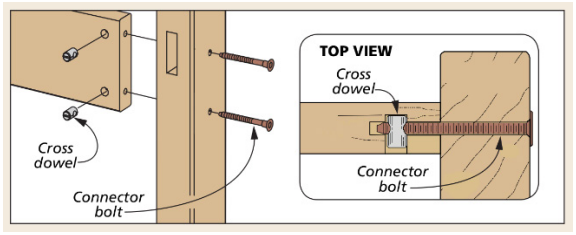


Figure 6.19: *Cross dowel and bolt*

Plastic corner blocks (knockdown blocks)

- **Description**: Plastic blocks with screws that secure the joints between two pieces of wood at right angles.
- **Uses**: Often used in furniture like kitchen cabinets, offering a simple and effective way to join panels.

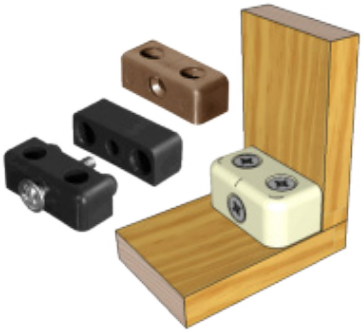


Figure 6.20: *Plastic corner blocks*

Rafix Connectors

- **Description**: A two-part connector with a dowel and a locking mechanism that fits into corresponding holes.
- **Uses**: Common in flat-pack furniture, allowing quick and easy assembly.

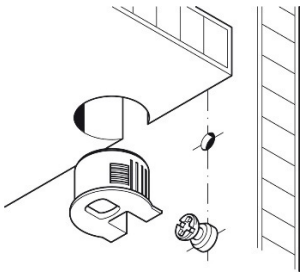


Figure 6.21: *Rafix connector*

Advantages of knockdown fittings

a. **Ease of assembly and disassembly**: Knockdown fittings are designed to make it easy to put furniture together and take it apart, which is ideal for moving or reconfiguring furniture.

b. **Transportability**: Furniture with knockdown fittings can be flat-packed, making it easier and cheaper to transport.

c. **Versatility**: These fittings allow for modular furniture designs that can be adapted or expanded over time.

d. **Damage reduction**: Since the fittings are designed for repeated assembly and disassembly, they help prevent damage to the wood.

Considerations when using knockdown fittings

a. **Precision in Drilling**: Accurate drilling of holes is essential for the proper alignment and fit of knockdown fittings.

b. **Material Compatibility**: Ensure that the fittings are suitable for the type of wood or composite material being used.

c. **Load Capacity**: Select fittings that can handle the expected load and stress to avoid joint failure.

d. **Aesthetics**: Some knockdown fittings may be visible after assembly, so consider the appearance if this is a concern.

Learning Tasks

1. Identify the types of nails and screws used in woodwork.
2. Discuss the applications of the various types of fasteners and fittings in woodwork.
3. Demonstrate how to fix fasteners and fittings used in woodwork.

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities:

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners through a video demonstration on the types of nails and screws, and identify the types of nails and screws To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should pull all learners back in for whole-class feedback and collect relevant explanations from learners.
2. **Group work/Collaborative Learning /Digital Literacy learning:** Place learners into small mixed-ability groups. Ask learners to discuss the applications of the various types of fasteners and fittings in woodwork. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

3. **Experiential learning:** Guide learners in mixed ability groups to co-operatively demonstrate how to fix fasteners and fittings used in woodwork. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

KEY ASSESSMENT (DOK)

Level 1: Identify at least three types of nails and screws each used in joining wood pieces together.

Level 2: What are the applications of the following types of fasteners and fittings used in woodwork?

- **a.** Hinges
- **b.** Stays
- **c.** Locks
- **d.** Magnetic catch
- **e.** Castors

Level 4:

1. In the realisation of your designed artefact, how will you fix the following fasteners and fittings to your artefact?
   - **a.** Screws
   - **b.** Hinges
   - **c.** locks
2. Make a poster of 4 types of fasteners used in woodwork and label your pictures appropriately.

HINT

*The recommended mode of assessment for week 21 is **poster presentation**. Use the level 4 question 2 as a sample question.*

UNIT 21 REVIEW

Unit 21 of week 21 exposed learners to the selection and uses of appropriate fasteners and fittings for a specific woodwork artefact. The pedagogical exemplars used in this section included talk for learning, group work/collaborative learning, digital learning and experiential learning which helped to meet the varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentation, class exercises, homework, practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real objects (Nails, Screws, Hinges, Locks, Castors, etc.)

Reflection: Are learners able to select and use the appropriate fasteners and fittings for a specific woodwork artefact?

UNIT 22

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Be able to differentiate load bearing from non-load bearing components and their functions in the superstructure*

Content Standard: *Demonstrate knowledge and understanding of load bearing and non-Load bearing components of the superstructure*

INTRODUCTION AND UNIT SUMMARY

The manual of the 22nd week explains the roof as a component of the superstructure by defining it and describing it either as flat or pitched. The components of a pitched roof, the roof framing system, roof types and functions of the roof as well as roofing materials were all discussed.

Illustrations are presented on most of the issues discussed above.

The unit covers only week 22: ***Discuss roof construction***

SUMMARY OF PEDAGOGICAL EXEMPLARS

21st century skills of collaboration and communication shall be employed as teaching strategies to help learners in mixed ability groups to brainstorm or do critical thinking pursuant of explaining roof, functions of the roof as a building component and outline types and materials used in roof construction. For successful outcomes GESI, SEL and National Values are to be infused to enhance the performing environment for the strategies mentioned.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction would be formative and this shall include quizzes and short oral and written responses to questions. Teachers would do well to keep track of performance of each learner given his or her unique level as approaching proficiency, proficient or highly proficient. Teachers would also have to provide the relevant motivation or scaffolds in order to enhance understanding of what a roof is as a building component, its functions, major existing types and the different materials used for constructing the component of the superstructure. The assessment shall also serve as a tool to evaluate depth of knowledge amongst learners **approaching proficiency, the proficient and highly proficient**. In this way the pedagogical differentiation strategies adopted during teaching and learning would have been adopted under assessment as well.

WEEK 22

Learning Indicator: *Discuss roofs*

FOCAL AREA 1: ROOF CONSTRUCTION

The Roof as a Component of the Superstructure

Introduction: A roof is the combination of a top covering or material and the structural framing system or what is referred to as the roof carcass which is anchored to the building. A roof as part of the building envelope provides protection against rain, sunlight, extreme temperature and act as a load bearing component which withstands wind loads acting against the building.

Pitched and Flat Roofs

Residential roofs are either pitched or flat. Under some circumstances the two approaches are adopted for the same house given the architectural design. Even though they are called flat, flat roofs are constructed to have some minimal slopes so as to enhance drainage. Flat roofs are prone to ponding or accumulation of water at the top which can threaten the structural integrity of the building. Pitched roofs, depending on the slope, easily and quickly drain off rain water and other forms of precipitation from the roof top. some important components of the pitched roof can be identified and related to the pitched roof when one considers its functioning.

The two main types of roofs are

a. **Flat roofs:** These have historically been widely used in the Middle East, the American Southwest, and anywhere else where the climate is arid and the drainage of water off the roof is thus of secondary importance.

b. **Pitched or Sloping roofs**: These are the most common type of roof. They are designed to allow water to run off the roof and into gutters or other drainage systems.

A flat roof is a roof that is almost level**,** with a slope of up to approximately 10°. It is commonly used in arid climates and allows the roof space to be used as a living area or a living roof. While it is called a flat roof, it should never be completely flat to allow for proper water drainage. A flat roof is a nearly horizontal roof, while it's not entirely flat, it has a slight incline to allow water runoff.

Figure 6.22: *Aluminium corrugated sheet Flat roof.*

Figure 6.23: *Concrete flat roof*

Some Components of the Pitched Roof

a. **Collar tie:** A collar tie is a board that creates a horizontal line between two rafters. It can be structural but also may frame a ceiling.

b. **Eaves:** The bottom end of the roof where it meets the walls.

c. **Fall:** The slope required on flat roofs for water to run-off.

d. **Pitch:** The angle formed by the slope of the roof.

e. **Span:** The horizontal distance between two structural supports such as walls

f. **Rafters:** A rafter is usually a timber beam that extends from the ridge to the eaves of a roof. It supports various sections of the roofing system.

g. **Jack Rafter:** A short rafter that spans the hip and eaves or valley and ridge of the roof. It is also used to secure and support the roof at its eaves especially where the roofing frame is that of the purlin system.

h. **Ridge board:** A ridge board is a structural timber member that sits at the peak of gable walls and thereby, in that position, obtaining support from the gable walls for the Rafters to lie on.

i. **Tail:** The tail is the rafter's end that hangs over both the exterior wall and part of the eaves. It directs water away from the structure's walls, foundation, and entryways.

j. **Roof Deck:** A roof deck is a wooden board underneath the shingles and other exterior parts. This is a structural component that supports the frame. It's where a builder attaches the shingles, and it offers protection against severe weather. Roof decking comes in various types, including the Sheet decking which is one large board made of plywood among other materials.

k. **Underlayment:** The roof underlayment is a layer placed between the deck and shingles. It's an extra moisture barrier that protects roof decking from water that can find itself under the shingles. The underlayment sometimes comes as Felt which is a heavy mat made of organic matter that has been dipped in asphalt to help it resist water. Roofers often use felt when installing tile shingles.

l. **Flashing:** Roof flashing is a metallic material used to stop water from entering through vulnerable spots such as the **Valley of a roof where** two parts of the roof meet to form a V-shape.

m. **Roof Vents:** Roof vents allow heat and moisture to escape from the attic or crawl space. Some types of vents to be found on a roof include the ones housed in the gable wall in the form of jalousie windows to allow heat to flow out from the attic or the crawl space.

n. **Wall Plate:** The timber member fixed to the top of a wall to secure a rafter or a trussed member onto the building.

o. **Hip: The point where two inclined roof surfaces meet over an external angle.**

p. **Soffit:** The underside of the eave or overhang of the roof having been fitted with a ceiling is referred to as the soffit. The soffit has some portions fitted with vents to let out heat. If the soffit didn't release heat, shingles could break down and make the roof vulnerable to leakage.

Fascia: This is a timber board fixed to the end of rafters to cover access into the roof as well as hold any roof gutters that would be fixed. Fascia boards can be made of aluminum, vinyl, or wood.

Gutters and Downspouts

Gutters are attached to the fascia boards to collect water that runs down the pitch or valleys of the roof. Once water enters the gutter, it travels to the downspout, which is a vertical gutter that runs along the side of the building. Both the gutter and downspout block water from entering the home by draining it and releasing the water elsewhere.

Roof Framing System

A roof's framing system or carcass serves as its core support. The system provides structure and shape to the roof. The most common framing systems prevailing in the Ghanaian industry include the following.

a. **The Trussed Rafter-Purlin system** which is used for medium to large buildings. The light trusses are anchored to the walls at 1.8-to-2.4- meter centers. The dimensions of the purlins and spacing are determined by the span and weight of the roofing materials and these are all specified by the architect or the engineer. The purlins provide the convenient spacing to accommodate directly the roofing material while the trusses combine to carry the entire weight of the materials.

b. **The Unsupported rafter system** which is used only for short span buildings due to limitations in the lengths of sawn timber. A span of 6.5 meters will have to incorporate a tie in the rafter system and for any further span more than the 6.5m a trussed system will have to be considered.

c. **The Simple Purlin Roofing system** uses sawn timber purlins spanning between walls that are not more than 4.8m apart. Unlike what prevails in other frames the purlins here serve as load bearers.

Outline of common roof types in use:

a. Single Pitch roof

b. Broken Pitch roof

c. Double Pitch roof

d. Double Pitch roof with Hipped ends

e. Flat roof

f. Self-Supporting Aluminum arches or Barrel roof.

Figure 6.24: *Double Pitch or Gable roof building*

Figure 6.25: *Hipped Roof*

Functions of The Roof

a. To drain off rain water so as to avoid leakage. The steeper the slope of roof the easier and quicker the drainage.

b. To shade windows and external walls especially those on the East or West facades.

c. To provide the interior spaces insulation against the sun's radiation with the help of the ceiling.

d. To act as load-bearing member of the superstructure in withstanding loads imposed by the wind.

e. To span efficiently and be properly anchored to structural supports on the exterior.

f. Plywood and other lining materials underneath roof finishes are to reduce noise or drumming effect in times of rainfall.

Some Roof Styles And Preferred Framing Systems

a. **The Single Pitch roof** usually has in place Simple Rafter roof system. It may use the purlins when cross walls act like rafters. It is also referred to as a Lean-To roof where there is a load bearing wall it is leaning to.

b. **The Double Pitch roof** has gable ends and for that matter uses Trussed Rafter-Purlin system, the Rafter system or Purlins depending on slope and span of building.

c. **The Double Pitch roof with Hipped ends** may use the Trussed Rafter-Purlin system at the double pitch area and the Simple Rafter arrangement at the hipped ends.

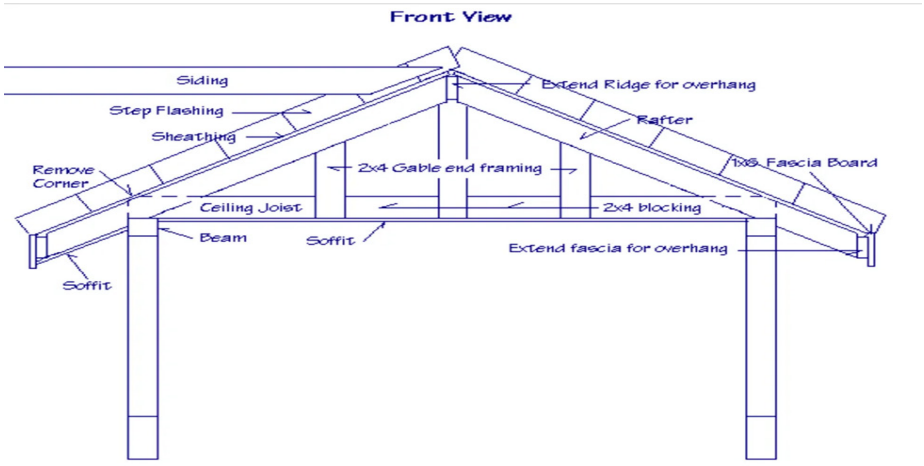


Figure 6.26: *Rafter-Purlin system*

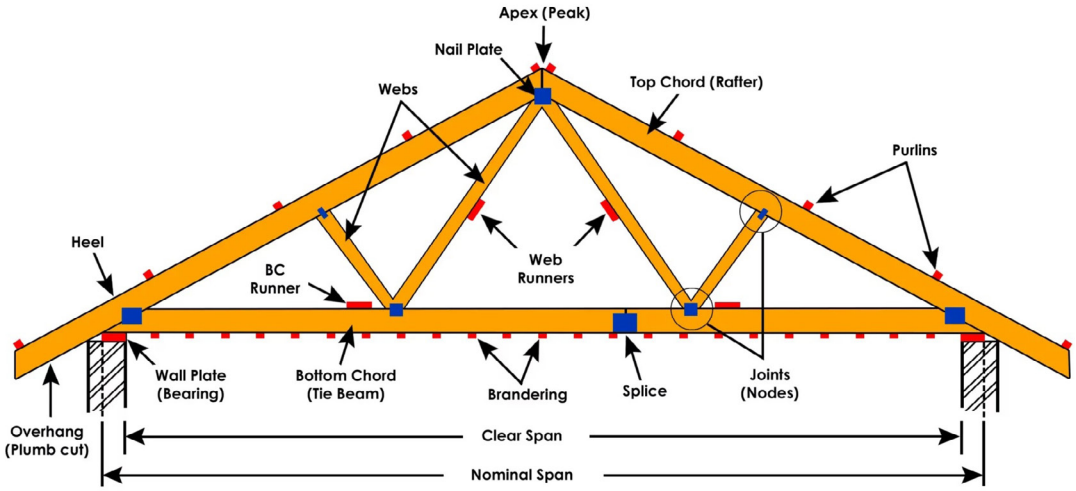


Figure 6.27: *The Trussed Rafter-Purlin system*

Roofing Materials

a. **Shingles:** If properly laid, usually at a pitch of 25° to 35°, the material is described to be a very durable and long-lasting roofing material. Wood of the Red Cedar tree is used. A number of tropical hardwoods such as Emeri *(Terminalia tvorensis) and* Kokrodua *(Pericopsis Excelse),* are also suitable for use as shingles. These timber species are durable and do not need to be treated with preservatives.

b. **Burnt Clay Tiles and Concrete Tiles:** These are laid at the pitch of pitch 30°. There are many different types and sizes of tiles from both materials, produced as interlocking

flat pan tiles to be supported on timber battens which in turn are fixed to rafters. Concrete tiles are produced from Portland cement and sand which has a high quartzite content. Both roof finishes are very durable if laid properly, they need little maintenance.

c. **Corrugated Galvanized Steel Sheets:** These are laid at the pitch of pitch 20°. Popularly known as "iron sheets", corrugated galvanized steel sheets were the most commonly used roofing material before the advent of aluminium and before the introduction of an aluminium manufacturing industry in Ghana. They are made from galvanized mild steel sheets in gauges from 16 to 26 with corrugations of 76mm pitch. If the galvanized steel sheets are used in areas which are exposed to sea air or acid vapour, they should be covered with a zinc coating or be painted with any oxide paint.

d. **Corrugated Aluminium Sheets:** These are laid at the pitch of pitch 20°. (or self-supporting arches): If well insulated and ventilated, this is an economic, light and durable roofing material in countries which have aluminium sheet pressing factories. Aluminium corrugated sheets are produced in an increasingly wide range of profiles and gauges which are used in residential, public, institutional, industrial and agricultural buildings with different accessories.

e. **Concrete:** These are laid at the pitch of 10 in 100 to 10 in 600. Concrete roofs are not particularly suitable in tropical conditions unless they have a suspended ceiling with a ventilated space below the concrete slab. A built-up concrete roof requires first class workmanship to make sure it is impermeable. Concrete roofs should not be completely flat. They should be laid to fall to: - 1 in 60 for a concrete slab with solar slabs, thermotiles or a promenade roof; - 10 in 300. for a concrete slab with high tensile roofing felt and light-reflective chippings; - 10 in 100 for a concrete slab with high tensile, metal faced or mineral surfaced roofing felt. There are a number of different plastic liquids and membranes which can be brush- or spray-applied or fixed in the form of sheeting with liquid finish to concrete roofs or to concrete gutters. All of these are to prevent leakage or lag the material against solar heat transfer into the interior spaces.

f. **Thatch:** Thatch as a finishing material is laid between 45° and 50° pitch. Thatch from different materials has been and still is a very common roofing material in tropical countries. The materials are a large variety of grasses including leaves from the raphia palm *(Raphia Hooken),* coconut palm *(Cocos Nucifera) and* reeds *(Phragmites Vulgaris).* A thatched roof needs regular maintenance and renewal every two to three years. Palm leaf thatch which is produced in Ghana in tiles ready for laying lasts about five years. Reed is the heaviest thatching material. A grass thatch roof needs a light substructure of timber or bamboo for support. Thatch is a cheap but a very combustible material. It is prone to rot and weathering and can harbour insects. An application of fire-retardant chemicals which are all water-soluble, has to be repeated practically every year.

Learning Tasks

1. Explain the roof as a component of the superstructure of a building.
2. Distinguish between the Trussed Rafter–Purlin system of roofing from the Purlin system of roofing.

3. Discuss the functions of the roof as a component of the superstructure of a building.

PEDAGOGICAL EXEMPLARS

1. Place learners in mixed-ability groups where the different needs of learners approaching proficiency, the proficient and highly proficient will be met and where they will communicate and explain the roof as a component of the superstructure of a building.
2. In mixed-ability groups where the different needs of learners will be met and where they will collaborate, engage learners to categorise the different roof styles in terms of the structural systems supporting them.
3. In mixed-ability groups where the different needs of learners will be met and where they will collaborate engage learners to discuss the factors that limit the use of roofing materials as well as systems of roofing that can be specified by architects or structural engineers.

KEY ASSESSMENT

Level 1: Explain the roof as a component of the superstructure of a building.

Level 2: Distinguish the Trussed Rafter-Purlin system from the Purlin system and outline the main limitations each has.

Level 3

1. Outline the different categories of roofing materials available in the Ghanaian building Industry and discuss the major limitations one may encounter in using them.
2. Write field trip report on roof as component of the superstructure of a building.

HINT

*The recommended mode of assessment for week 22 is **field trip report**. Use the level 3 question 2 as a sample question.*

UNIT 22 REVIEW

This review is for the lesson taught in week 22. Learners were provided with understanding of the roof. The pedagogical exemplars used in this section included collaboration and communication as Learners were put in mixed-ability groups to engage in critical thinking and brainstorming about what a roof is, outline of roof types, outline functions of the roof and discuss materials used to roof the building. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for various activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

UNIT 23

STRAND: WOODWORK TECHNOLOGY

Sub-Strand: Materials and Artefact Production in Woodwork Industry in Ghana

Learning Outcome: *Demonstrate knowledge and understanding of finishes and finishing to select and apply the appropriate finishes to an artefact*

Content Standard: *Apply knowledge of finishing to artefacts.*

INTRODUCTION AND UNIT SUMMARY

This unit will help learners to demonstrate the uses of different types of finishes. When pieces of timber have been prepared as part of a construction, whether by simply shaping them or cutting joints in them, it is necessary, prior to assembly, to ensure they are correctly finished. This can be done in a number of ways. Often, the finish left after preparing the surface with a well-sharpened and well-set plane will be sufficient for the subsequent application of the appropriate surface finish. This is most often the case where the part is a simple flat piece of material. With more complex shaped piece of material, the use of the **scraper**, either fixed into a scraper plane or used in the hand, can produce a good finish. The most common finishing technique used is glasspaper. It is used with a glasspaper block for flat surfaces and in the hand for curved ones, for a good consistent finish. As long as you work carefully down through the grades, making sure that you achieved a consistent finish with each one, the end result will be a perfectly smooth surface.

The unit covers only week 23: ***Explain the uses of different types of finishes***

SUMMARY OF PEDAGOGICAL EXEMPLARS

For this unit to be accomplished, learners must participate in the demonstration of the uses of different types of finishes. The teacher should employ pedagogies such as critical thinking and talk for learning, group work/collaborative learning and experiential learning. These strategies should be used in mixed-ability and mixed-gender groupings, in pairs and individual learning. All learners, irrespective of their learning abilities should be encouraged to participate fully in investigations as well as presentation of findings. The teacher should implement differentiation strategies to accommodate diverse learning needs.

ASSESSMENT SUMMARY

The concepts under this unit require learners to demonstrate conceptual understanding, including their real-life applications. Hence, the assessments should largely cover levels 1, 2

and 3 of the DoK. Teachers should employ a variety of formative assessment strategies such as oral/written presentations, pair-tasks, reports, home tasks, etc. to collect information about learners' progress and give prompt feedback. Precisely, teachers should administer assessment such as class exercises (including individual worksheets) after each lesson, homework, scores on practical group activities on the uses of different types of finishes and document learners' results in continuous assessment records. Teacher can consult Teacher Assessment Manual and Toolkit (TAMTK) (NaCCA 2023) on how to use the assessment strategies effectively.

WEEK 23

Learning Indicator: *Explain the uses and application of different types of finishes.*

FOCAL AREA: USES AND APPLICATION OF FINISHES

Surface Preparing for Finishing

Before the surface of an artefact can be finished, there is the need for the surface to be prepared with an abrasive to receive the finish.

Abrasives

After completing the construction of an artefact, it is necessary to improve the smoothness of the surface of the members. To accomplish this, an **abrasive** is used. This consists of grades of abrasive materials, i.e., sand, glass, silicon, carbides, etc., on paper. The standard sheet size for abrasive paper is about 280mm x 230mm.

Using abrasive paper

In order that a smooth surface is produced when using the paper, it is normal to use a **sanding block** or **cork rubber.** This is a block of cork that the paper is wrapped around. Sanding always takes place in the direction of the grain of the wood so that it does not scratch the surface, as these scratches are difficult to remove Always start with the coarsest grade of paper and work through the grades to the smoothest. When choosing which grades to use it is usually sufficient to have three different grades for a particular job, but the grades chosen should not be spaced too far apart.

Types of Abrasive Paper

a. **Glasspaper:** This is the cheapest, most common form of abrasive paper and, as the name suggest, the grit is glass. It is produced in a range of nine grades, the finest being 00 and the coarsest being 3. 00 (floor paper) – 0 – 1 – 1½ - F2 – M2 – S2 – 2½ - 3, 60, 180, 120, 50, 20.

b. **Garnet paper:** This paper uses crushed semi-precious stones instead of glass as sits grit. This means that it stays **sharp** longer and is less likely to clog. It is, however, more expensive than glass paper. It is available in the following grades, the finest being 8/0 and the coarsest being 2. 8/0 – 6/0 – 5/0 – 4/0 – 3/0 – 2/0 – 2/0 – ½ - 1 – 1½ - 2.

Steps in Surface Preparation

a. Use a coarse grade of glass paper (abrasive) to remove small faults or marks from the surface.

b. Use medium grade of glass paper to increase the smoothness of the surface.

c. Use a fine grade of glass paper to produce extra smooth surface ready to receive a finish

d. Dusting off the surface to receive the finish

Finishes

Wood finishes are used to protect and enhance the appearance of wood surfaces. A number of different finishes can be applied, to both protect the material as well as enhancing the appearance. These finishes should only be applied after the correct finishing process has been completed.

Types of Finishes

The common types of wood finishes include:

a. **Lacquer:** This finish has some advantages over the more popular varnishing. It has a much thinner consistency which means that it can be applied using a spray method. It also dries much more quickly. Care should be taken to ensure that it is applied in a well-ventilated area as the fumes given off are rather unpleasant. If it is to be applied with a brush, it is important that a very soft brush is used to that no streaks are left behind. After the application of lacquer requires the use of a special cellulose thinner to clean the brush.

b. **Varnish:** This is a mixture of resins in oil or spirit. The work to be vanished should be sized first with a mixture of glue and water or by the application of a coat of well thinned varnish. This sizing will ensure that the pores of the wood are sealed and subsequent layers of varnish are not completely absorbed into the wood. It has the disadvantage of not being heat, stain or water resistant. For this reason, nowadays, it has been replaced by **polyurethane varnish**, which has a degree of resistance to all of these things, as well as being much tougher and able to withstand a great deal more abrasion.

c. **Oil paint:** This is a mixture of a **base** (white lead), a **binder** (linseed oil), a **thinner** (white spirit) and a drier. It is available in a range of colours, which has been prepared by being filled with a suitable filler, then undercoated. The second coat of paint can be applied the following day, after rubbing down.

d. **Shellac:** This is made from a natural yellow-brown resin which is secreted by the lac insect, found in parts of India and Thailand. The resin is purified and then made into flakes. To use the shellac, the flakes are dissolved in methylated spirit. It is clear and transparent, but colours may be added. It provides a good preparation for polished surfaces as it forms a thin seal on the surface, so preventing polished surfaces as it forms a thin seal on the surface, so preventing subsequent applications from soaking in. it has good adhesion to the wood and it is quickly and easily applied. It can be applied with a brush as long as a good quality **squirrel or camel hair** one is used.

Reasons for Using Finishes

The following are some reasons for finishing the surface of an artefact.

a. Protect/ preserve it

b. Makes it more hygienic

c. Makes it easy to clean

d. Makes it more beautiful

Factors to consider in selection of finish

The choice of finish for an artefact depends on the following factors:

- **a.** The type of material to be finished
- **a.** The use of the artefact (whether for exterior or interior)
- **b.** The degree of gloss or lustre required
- **c.** The method of application (i.e., spraying or brushing)
- **d.** The durability of the finish (i.e., the resistance to heat, rain, moisture, chemicals, stain, etc.)

Application of Finishes

Below are some common tools/equipment for finishing

- *a.* Brushes
- **b.** Spraying gun and equipment
- **c.** Rubbing pads
- **d.** Paint rollers

Application of finishes with spray gun

Spray gun: A device consisting of a container from which paint or other liquid is sprayed through a nozzle by air pressure from a pump. The trigger is obviously the most important part of the sprayer gun. It functions simply by pulling this part. It is connected with the plunger rod, nozzle, needle, and valves in order to maintain a proper working function. The needles allow for the liquid (paint) to flow through the nozzle.

Fluid Inlet: This is the area where the spraying materials will enter into the gun. Then, they will be pushed through the spray gun onto the object to be sprayed. The amount of liquid flowing through the gun will depend upon the air pressure and the intensity with which the trigger is pulled.

Figure 6.28: *Spray gun*

Learning Tasks

1. Identify the types of finishes used in woodwork
2. Discuss the factors to consider when choosing a finish for an artefact

3. Demonstrate how to apply a chosen finish to an artefact

PEDAGOGICAL EXEMPLARS

The teacher should consider the following activities

1. **Critical Thinking and Talk for Learning Approaches:** Guide learners through a video demonstration on the types of finishes used in woodwork, and identify the various types of finishes. To move thinking on, the teacher should target questions to learners as they discuss with one another. The teacher should bring all learners back in for whole-class feedback and collect m relevant explanations from learners.
2. **Group Work/Collaborative Learning /Digital Literacy Learning:** Place learners into small mixed-ability groups. Ask learners to discuss the factors to consider when choosing a finish for an artefact. The teacher should circulate the classroom ensuring all learners are supported and participating in the discussion. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.
3. **Experiential Learning:** Guide learners in mixed ability groups to co-operatively demonstrate how to apply a chosen finish to an artefact. Highly Proficient learners can be assigned to assist groups in discussions in addition to the teacher.

KEY ASSESSMENT

1. **Level 1:** Identify at least three types of finishes used in woodwork.
2. **Level 2:** Explain at least three factors to consider when choosing a finish for an artefact.
3. **Level 3:** In the finishing process of your constructed artefact, how will you apply a chosen finish to your artefact?

UNIT 23 REVIEW

Unit 23 of week 23 exposed learners to the uses of different types of finishes. The pedagogical exemplars used in this section included talk for learning, group work/ collaborative learning, digital learning and experiential learning which helped to meet the varied needs of all learners. These strategies enable learners to develop communication, collaboration, critical thinking and problem-solving skills. Various assessment strategies such as oral/written presentations, class exercises, homework, and practical group activities are structured to cater for all the varied activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

Resources: Pictures, videos, real objects (brush, paint roller, spray gun, air compressor)

Reflection: Are learners able to demonstrate the applications of different types of finishes in the workshop?

UNIT 24

STRAND: BUILDING CONSTRUCTION TECHNOLOGY

Sub-Strand: Substructure and Superstructure

Learning Outcome: *Be able to differentiate load bearing from non-load bearing members and their components of the superstructure*

Content Standard: *Demonstrate knowledge and understanding of load bearing and non-load bearing components of the superstructure*

INTRODUCTION AND UNIT SUMMARY

The manual of the 24th week explains the ceiling as a component of the superstructure and outlined its functions as well as materials used to provide the ceilings. The reasons for selecting a type of ceiling and its method of installation will be discussed. Illustrations are presented on most of the issues discussed above.

The unit covers only week 24: ***Discuss Ceilings***

SUMMARY OF PEDAGOGICAL EXEMPLARS

21st century skills of collaboration and communication shall be employed as teaching strategies to help learners in mixed ability groups to brainstorm or do critical thinking pursuant of explaining ceiling, its functions in the superstructure of the building as well as outlining the traditional materials used in providing it. For successful outcomes GESI, SEL and National Values are to be infused to enhance the performing environment for the strategies mentioned to be achieved.

ASSESSMENT SUMMARY

The assessments to be used to monitor progress of learning during instruction would be formative and this shall include quizzes and short oral and written responses to questions. Teachers would do well to keep tract of performance of each learner given his or her unique level as approaching proficiency, proficient or highly proficient. Teachers would also have to provide the relevant motivation or scaffolds in order to enhance understanding of what a ceiling is as a building component, its functions, and the different materials used for constructing it. The assessment shall also serve as a tool to evaluate depth of knowledge amongst learners **approaching proficiency, the proficient and highly proficient**. In this way the pedagogical differentiation strategies adopted during teaching and learning would have been adopted under assessment as well.

WEEK 24

Learning Indicator: *Discuss Ceilings*

FOCAL AREA 1: CEILING CONSTRUCTION

The Ceiling as A Component of The Superstructure

Introduction: A ceiling is an overhead interior roof that covers the upper limits of a room. It is not generally considered a structural element, but a finished surface concealing the underside of the roof structure or the floor of a story above. Ceilings can be decorated to taste, and there are many examples of artworks on ceilings of buildings.

For the purposes of the performance of ceiling linings within buildings, a ceiling includes:

a. the underside of a gallery; and

b. the underside of a roof exposed to the room below.

Types of Ceiling

a. **Tightly attached ceilings:** Ceilings made of gypsum, plasterboard, tongued and grooved timber and so on, may be attached tightly to timber joists or rafters, steel joists or concrete slabs. Careful detailing is required where beams or other obstructions protrude through the plane of the ceiling, such as vents, conduits, pipes, sprinkler heads and so on.

Figure 6.29: *Tightly attached ceiling*

b. **Suspended ceilings:** Suspended ceilings are secondary ceilings suspended from the structural floor slab above and thereby creating a void between the underside of the floor slab and the top of the suspended ceiling. The gap between a suspended ceiling and the structural floor slab above is often between 3 to 8 inches (75mm to 200mm) and that is why they are sometimes referred to as dropped ceilings or false ceilings. The ceilings provide space for concealing wires, air-conditioning, speakers, light fittings and other services pipes and gadgets that might look unsightly from within.

c. **Strip ceilings:** These are from hardwood, metal or plastic strips with their own fixing systems. Hardwood strips are normally fixed tongued and grooved to ceiling joists. There are a large number of decorative tropical hardwoods which make a very attractive ceiling. Aluminium strip ceilings are functional and durable. The suspended ceilings

have strips which are finished with baked enamel paint in various colours. A metal strip suspended ceiling can lower the ceiling height of rooms. The strips are simply clipped over aluminium carrier profiles. These suspended ceilings are suitable in schools, libraries, hotels, hospitals, shops.

The selection of suspended ceilings may depend on

a. Aesthetic considerations.

b. The requirement to incorporate fittings necessary for building services.

c. Requirements for acoustic attenuation and absorption.

d. The need to provide fire separation.

e. Cleaning requirements.

f. Thermal insulation.

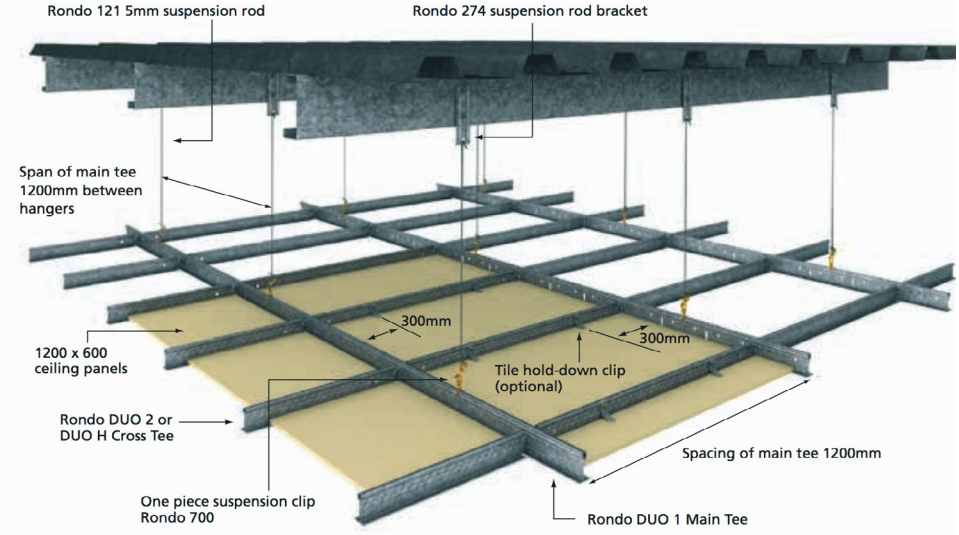


Figure 6.30: *Suspended or (Drop) Ceiling*

Interstitial Space : Interstitial space, which is also referred to as interstitial ceiling allows for a larger space to be located between regular-use floors. They generally include an access walkway, and have a low room-height. They are commonly used in buildings such as hospitals and laboratories that have complex services which may include:

a. Air-conditioning ducts

b. Water and waste pipework

c. Electrical and communications wiring

d. Compressed air lines

e. Oxygen

f. Chilled water

g. Vacuum pipework

As ducts and pipework can occupy a significant amount of space, often require continual maintenance and are subject to frequent change, interstitial ceilings can allow for maintenance

and updating work to be carried out without interruption of activities in the spaces above and below.

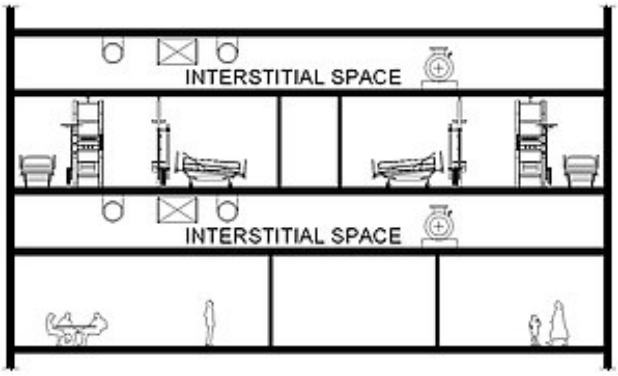


Figure 6.31: *Interstitial space or ceiling*

Acoustical ceilings: Acoustic ceilings tend to be made from fibrous materials that absorb sound energy, unlike plaster and gypsum ceilings. They do not necessarily reduce the transmission of sound between spaces, rather they reduce the amount that reflects back into the space and so can be used to tailor the acoustic character of a space. The sound absorption performance of a ceiling material is expressed in terms of its noise reduction coefficient (NRC). An NRC of 0.85 means that a ceiling material absorbs 85% of the sound that reaches it, and reflects 15% back into the room. NRCs for most acoustical ceilings range from 0.5 to 0.9, compared to values below 0.10 for plaster and gypsum ceiling board materials. Where acoustic privacy is required, heavier ceiling materials such as plaster or gypsum board are more effective.

Figure 6.32: *Acoustical ceilings*

Functions of the Ceiling

a. Ceilings serve as insulative barrier against solar heat penetration through the roof structure.

b. Ceilings help to create enclosure of space or separation between spaces.

c. Ceilings help to control the diffusion of light and sound around a room.

d. Ceilings serve as sound barriers between different rooms.

e. Ceilings have fire resistant properties and prevent the spread of fire outbreak.

f. Ceilings serve as accommodation for building services such as vents, lighting etc.

g. Ceilings help to conceal other services such as ducts, pipes and wiring.

h. Suspended ceilings provide space for concealing unsightly wires and installations that otherwise would alter the interior appearance of the building.

i. The space gained through installing a suspended ceiling is useful for distribution of air conditioning, plumbing and wiring services, as well as providing a platform for the installation of speakers, light fittings, wireless antenna, CCTV, fire and smoke detectors, motion detectors, sprinklers and so on.

OUTLINE OF SOME COMMON CEILING MATERIALS

a. Tiles manufactured from materials such as mineral fibre and laminates. Tiles may be manufactured from materials such as mineral fibre, metal, plasterboard and laminates and are often perforated to provide specific levels of acoustic absorption.

b. Tongued and grooved timber

c. Plywood

d. Plastered metal lathing

e. Perforated acoustic cards

f. Metal panels for suspended ceilings

g. Plasterboard

h. Aluminium suspended ceilings

i. Decorative metal ceilings

j. Hat channel

k. Gypsum

l. Self-stretching fibre glass reinforced P.V.C. sheeting

m. Hardwood, metal or plastic strips

n. Aluminium strips

Learning Tasks

1. Explain the ceiling as a component of the superstructure of a building.
2. Distinguish between the suspended ceiling and the tightly attached ceiling.
3. Discuss the functions of the ceiling as a component of the superstructure.

PEDAGOGICAL EXEMPLARS

1. **Group work/Collaborative Learning:** Deliberately place Learners in small mixed-ability groups where different needs of learners will be met. Guide all learners in the groups to communicate and explain the ceiling as a component of the superstructure of buildings.

In mixed-ability groups different needs of learners will be met through collaborative and critical thinking and engage learners to differentiate between suspended ceiling and the tightly attached ceiling.

2. **Critical thinking and Talk for Learning Approaches:** Guide learners to discuss the functions of the ceiling as a component of the superstructure.

KEY ASSESSMENT

1. **Level 1:** Explain the ceiling as a component of the superstructure of a building.
2. **Level 2:** Distinguish between the suspended ceiling and the tightly attached ceiling.
3. **Level 3:** Discuss how ceilings can improve comfort levels of users of the facilities.

HINT

The recommended mode of assessment for week 24 is End of Semester Examination. Refer to the Appendix K at the end of the section for more sample task and the Table of Specification.

UNIT 24 REVIEW

This review is for the lesson taught in week 24. Learners were provided with understanding of the ceiling. The pedagogical exemplars used in this section included collaboration and communication as learners were put in mixed-ability groupings to engage in critical thinking and brainstorming about what a ceiling is, outline what types of ceilings there are and discuss in general functions of the ceiling in the building. Various assessment strategies such as oral/written presentation, class exercise, homework, practical group activities were structured to cater for various activities of learning. These assessments were classified under the DoK level 1, 2 and 3.

APPENDIX J: STRUCTURE OF EXAMINATION

1. ***30 Multiple Choice Questions (MCQ)*** all should be answered within 45 minutes. Questions cover DoK level 1 to 3.
2. ***10 essay type questions, 7*** to be answered within 2 hours. Questions cover DoK level 1 to 3.

RESOURCES

Scannable sheets, A4 paper, answer booklets, class list, etc.

SAMPLE QUESTIONS

Multiple Choice

1. How should a company respond to a safety incident to prevent future occurrences**?**
   - **a.** *Blame employee involved and issue a warning.*
   - **b.** *Ignore incident if no one was seriously injured.*
   - **c.** *Increase the workload to make up for lost time.*
   - **d.** *Investigate and implement corrective actions.*

Essay

- List 2 importance of roofing as part of the superstructure, etc.

TABLE OF SPECIFICATION FOR END OF SMESTER TWO EXAMINATION

WKS	LEARNING INDICATORS	TYPE	DoK LEVEL				TOTAL
			1	2	3	4	
13	Select appropriate materials suitable for producing the final solution.	MCQ	1	1	1		3
14	Explain load bearing and non-load bearing members of the Superstructure.	MCQ	1	1	1		3
		Essay		1			1
15	Produce a model from your working drawings.	MCQ	1	1	1		3
16	Discuss wall construction.	MCQ	1	1	1		3
		Essay			1		1
17	Select and use appropriate joints for a specific woodwork operation.	MCQ	1	1	1		3
		Essay	1				1
18	Discuss wall construction.	MCQ	1	1	1		3
		Essay		1			1

19	Explain the uses of different types of adhesives.	MCQ	1	1	–		2
		Essay		1			1
20	Discuss doors and windows.	MCQ	–	1	1		2
		Essay	1				1
21	Select and use appropriate fasteners and fittings for a specific woodwork artefact.	MCQ	–	1	1		2
		Essay	1				1
22	Discuss roof construction.	MCQ	1	1	–		2
		Essay			1		1
23	Explain the uses of different types of finishes.	MCQ	1	1	–		2
		Essay			1		1
24	Discuss Ceiling.	MCQ	–	1	1		2
		Essay		1			1
	TOTAL		**12**	**16**	**12**		**40**

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ONLINE IMAGES

No	Name of Image	Reference (link)
1	Tape measure	*amazon.com/dp/B00DT3T5GU?tag=aim-wds-001730-20*
2	Marking Knife	*axminstertools.com/crown-112-marking-knife-ax21839*
3	Try square/Mitre square	*walmart.com*
4	Sliding bevel	*upload.wikimedia.org/wikipedia/commons/2/24/Sliding_T_bevel_(PSF).png*
5	Wing compass	*www.indiamart.com/proddetail/wing-compass-20538598391.html*
6	Marking gauge	*wonkeedonkeetools.co.uk/media/wysiwyg/MOG-Marking-Out-Gauges-Amy/4MOG/08MOG-4-2.jpg*
7	Cutting gauge	*wonkeedonkeetools.co.uk/media/wysiwyg/MOG-Marking-Out-Gauges-Amy/9MOG/MOG-9-1.jpg*
8	Mortise gauge	*wonkeedonkeetools.co.uk*
9	Hand saw	*pinterest.com*
10	Crosscut saw	*https://th.bing.com/th/id/R.ba9e67b65cfa7c5f6cf950f78c78f106?rik=zssl%2b-WHCsdhFyw&pid=ImgRaw&r=0*
11	Rip saw	*https://thumbs.dreamstime.com/b/saw-isolated-white-background-50523272.jpg*
12	Tenon saw	*pinterest.com*
13	Dovetail saw	*www.lie-nielsen.com/products/tdscherry*
14	Coping saw	*www.faithfulltools.com/images/xxlarge/FAICS.jpg*
15	Bow saw	*https://toolsforworkingwood.com/store/more/bowsawdesign.html*
16	Fret saw	*axminstertools.com*
17	Pad saw	*www.shorthillstudio.com/storeimages/SA568b_lg.JPG*
18	Jack plane	*www.alamy.com/stock-photo/jack-plane.html?sortBy=relevant*
19	Smoothing plane	*commons.wikimedia.org/wiki/File:Smoothing_plane_drawing.png*
20	Flat spokeshaves	*www.beatsons.co.uk/images/faithfull-spokeshave-round-p8180-31199_medium.jpg*
21	Raised faced spokeshave	*oldtools.co.uk*
22	Chisel	*wonkeedonkeetools.co.uk*
23	Firmer chisel	*https://www.mhg-tools.de/images/600/P7000.XX.jpg* *toolsandtimber.co.uk*
24	Scribing gouge	*taytools.com*
25	Bevel-edge firmer chisel	*toolnut.co.uk*
26	Mortise chisel	*https://www.stepbystep.com/wp-content/uploads/2013/08/Mortise-Chisel.jpg*

27	Firmer gouge	*https://assets.leevalley.com/Size4/10119/10S1226-26mm-narex-firmer-gouge-f-7283.jpg*
28	File	*pinterest.com*
29	Rasp	*https://www.forge-de-saint-juery.com/the-hog-roughing-rasp---half-round/*
30	Ratchet brace	*www.wonkeedonkeetools.co.uk/hand-drills-and-braces/what-are-the-parts-of-a-brace*
31	Wheel brace	*wonkeedonkeetools.co.uk*
32	Twist drills (hand drill)	*blogspot.com*
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40	Nail punch	*https://www.ebay.com/itm/226207378385*
41	Mallet	*hardwareireland.ie*
42	Bench Vice	*www.amazon.co.uk/TOPWAY-Heavy-Duty-Wood-Clamp/dp/B08P2DMCX8*
43	G-Cramp	*https://technologystudent.com/equip1/cramp1.htm*
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48	Plier saw-set	*https://workshopheaven.com/spear-and-jackson-saw-setting-pliers/*
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50	Theodolite mounted on a tripod and fitted with an ED	*https://thumbs.dreamstime.com/z/setting-out-construction-si-1959213.jpg?ct=jpeg*
51	Using Equal Diagonals as a check in the Setting Out	*https://i.pinimg.com/564x/1d/b9/77/1db97700c9137d8810d72c801cb8bdf5.jpg*
52	Setting out the corners of a building	*https://www.pinterest.com/pin/3166662231528819/*
53	Crosscut machine	*https://www.daltonswadkin.com/process/manual-crosscut-saw/*
54	Circular saw machine	*quizlet.com*
55	Dimension/panel saw machine	*https://en.wikipedia.org/wiki/Panel_saw*
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60	CNC Crosscut saw machine	*bottene.it*
61	CNC Circular/ Panel saw machine	*keepital.com*
62	CNC Band saw machine	*easwonmachinery.com*
63	CNC four-sided planer machine	*3059dcdc1e5fc08e.en.made-in-china.com*
64	Functions of the mechanical shovel	*https://www.google.com/url?sa=t&source=web&rct=-j&opi=89978449&url=https://www.shutterstock.com/search/mechanical-shovel&ved=2ahUKEwieiYLTq_eGAxWpcKQEHUEODCUQ1bUFegQIRRAA&usg=AOvVaw0dJlaQT4QNUTmfBjZCmYGg*
65	Functions of the back hoe	*https://www.google.com/imgres?q=back%20actor&imgurl=https%3A%2F%2Fi.pinimg.com%2Foriginals%2F44%2F96%2F0e%2F44960ea9e-d5a3c3606567f9b7d7d884c.jpg&imgrefurl=https%3A%2F%2Fwww.pinterest.com%2Fpin%2F566257353140699138%2F&docid=8Atj_zOm-JQSEVM&tbnid=EX86Ywg2f7ZdnM&vet=12ahUKEwiIteT5rPeGAxVP-cKQEHWd1BhUQM3oECBkQAA..i&w=400&h=331&hcb=2&ved=2ahUKEwi-IteT5rPeGAxVPcKQEHWd1BhUQM3oECBkQAA*

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67	Dump truck	*https://www.deere.com/en/articulated-dump-trucks/310-p-adt/.*
68	Concrete footings	*https://marketingplatform.vivial.net/sites/default/files/inline_images/iowa-city-excavating.jpg*
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70	Formworks	*https://civilunlimited.com/wp-content/uploads/2022/12/Formwork-and-types-of-formwork.jpg*
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77	Bamboo	*https://www.freepik.com/free-photos-vectors/oriental-bamboo/4*
78	Section through solid ground floor	*https://civilunlimited.com/wp-content/uploads/2022/12/Formwork-and-types-of-formwork.jpg*
79	Solid ground floor slab with mesh reinforcement	*https://concreteplussiouxcity.com/wp-content/uploads/2015/10/finishing-concrete-work.png*
80	Suspended Floors	*https://www.practicaldiy.com/general-building/flooring/floor-ground-2.gif*
81	Cantilevered Shelves	*https://www.daniellacey.com/sites/default/files/furniture/cantilevered-shelving.jpg*
82	Basic Framed End Table	*https://i.pinimg.com/originals/dd/a5/da/dda5da10e89c4add7aea1f33b3452b8d.png*
83	Bamboo Chair	*https://livingbamboo.com/uploads/products/20140323222101.jpeg*
84	Bamboo Stool	*https://cabanahome.com/wp-content/uploads/2016/09/IMG_6455-1016x1014.jpg*
85	Load-bearing and non-load-bearing Walls in the Superstructure	*https://i.ytimg.com/vi/vxQLYt86X5Y/maxresdefault.jpg*
86	Transfer of compressive loads	*https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcR-eJmsocH5gFm6JBm8RfRw0SbwTi4FvfhZY6k3EnPsQA&s*

87	Non-Loadbearing Components of the Superstructure	*https://th.bing.com/th/id/OIP.D-wWrDTiVA8n7CShI80gfwAAAA?rs=1&pid=ImgDetMain*
88	Load- Bearing Structure	*https://housing.com/news/wp-content/uploads/2022/12/1-5.jpg*
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90	Dowel joint	*1.https://canadianwoodworking.com/techniques_and_tips/dowels/* *2. http://www.builderbill-diy-help.com/dowel-joint.html*
91	Finger joint	*https://en.wikipedia.org/wiki/Finger_joint#/media/File:Keilzinkenprofile.jpg*
92	Solid wall	*https://th.bing.com/th/id/OIP.MdJ71Rxp4onxnh5HnD7iLAHaD4?w=291&h=180&c=7&r=0&o=5&pid=1.7*
93	Cavity wall	*https://th.bing.com/th?id=OIP.s5q7FTBytyJuqO1zA2QZ6gHaHa&w=250&h=250&c=8&rs=1&qlt=90&o=6&pid=3.1&rm=2*
94	Curtain wall	*https://www.loewen.com/wp-content/uploads/2020/08/Curtain-Wall-Exterior_02-1280x1024.jpg*
95	Load or Mullion wall	*https://www.loewen.com/wp-content/uploads/2020/08/Curtain-Wall-Exterior_02-1280x1024.jpg*
96	Non-Load Bearing wall	*https://th.bing.com/th/id/OIP.y3CvDPMojJ0HAnEedar3swHaEK?rs=1&pid=ImgDetMain*
97	Retaining wall	*https://th.bing.com/th/id/R.03e51cf324d46341c4e1c35fd062da75?rik=4A3MzYVgH98gMA&pid=ImgRaw&r=0*
98	Boundary wall	*https://res.cloudinary.com/jerrick/image/upload/c_scale,f_jpg,q_auto/63356a4f2df116002083889b.jpg*
99	Animal glue	*http://www.gluehistory.com/glue-origin/history-of-animal-glue/#google_vignette*
100	Pocket door.	*https://i.pinimg.com/originals/a3/6d/50/a36d50cc3f79a28a292be7927dbc703f.jpg*
101	Sliding door	*https://images.door-commerce.co.uk/external-sliding-doors/WHIUPVCSLI3600FSSF-1.jpg*
102	Rolling shutter door	*https://www.ngfindustrialdoors.co.uk/wp-content/uploads/2018/01/roller-shutters_commercial_7.jpg*
103	Panel door	*https://s3.amazonaws.com/cdn02.prod.aws.reeb.com/content/interior-wood-stile-and-rail/popular-designs/F5_O66.jpg*
104	Ledged and braced door	*https://i.pinimg.com/originals/19/e8/02/19e802a2cb048002f43a7fa7f6e0f9c9.jpg*
105	Flush door	*https://5.imimg.com/data5/JG/UY/MY-263597/wooden-fire-door-500x500.jpg*
106	Single-hung window	*https://image.made-in-china.com/2f0j00rkwoZjcApEby/Single-Double-Hung-Windows-Double-Hung-Window.jpg*
107	Double hung window	*https://www.windowworld.com/uploads/images/product/EC-Double-Hung4.jpg*

108	Casement window	*https://www.anglianhome.co.uk/-/media/ahi/product-catalogue/windows/products/upvc-fully-reversable/ventilators-on-fully-reversible-window_.jpg?h=400&cw=400&c=1*
109	Sliding window	*https://platinumvinylwindows.com/wp-content/uploads/2015/02/Teal-Slider-Window.jpg*
110	Common nails	*https://www.indiamart.com/proddetail/wire-nails-chennai-2853499574588.html*
111	Finishing nail	*https://www.bradfords.co.uk/product-rlh050-timco-bright-round-lost-head-nail-50mm-x-3-0mm-1kg-bag*
112	Oval wire nail	*https://www.travisperkins.co.uk/roundwire-nails/4trade-losthead-wire-nail-50mm-bright-12kg-box-of-6/p/347247*
113	Panel pin	*www.tfmsuperstore.co.uk/products/panel-pin-1-60-x-25mm-500g/*
114	Roofing nail	*https://www.qunkunmetal.com/wire-and-nails/roofing-nails.html*
115	Roundhead screw	*https://boltdepot.com/Product-Details?product=11593*
116	Raised head screw	*https://www.nfgab.com/sortiment/p/1866-slotted-raised-countersunk-head-wood-screw-one-way*
117	Coach screw	*https://www.fusionfixings.co.uk/products/m12-x-70mm-coach-screw-a4-stainless-steel-din-571*
118	Fitting of screw	*https://bshopen.stevelyonsfund.org/category?name=counter%20sink%20screws*
119	Plastic wall plug	*1. https://www.beaconinternational.co.uk/product/fischer-contract-plastic-wallplug/* *2.https://www.hilti.co.uk/c/CLS_FASTENER_7135/CLS_MECHANICAL_ANCHORS_7135/r637*
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121	Drawer lock	*1. https://www.amazon.in/Automatic-Drawers-Counter-Showcase-Cabinet/dp/B0CH7512XT* *2. https://www.etsy.com/listing/1405230916/rare-original-wren-0501-brass-drawer*
122	Tee hinge	*https://www.ironmongerydirect.co.uk/product/suffolk-thumb-latch-black-galvanised-205709*
123	Cabinet/Spring hinge	*https://www.osculati.com/en/11330-m-042215/spring-hinges-for-soft-close-cabinet-doors*
124	Hidden spring hinge	*https://www.daro.com/sprung-lay-on-hinge-900-nickel-es01g-2576356*
125	Side-mounted drawer lock	*1. https://www.amazon.com/Gobrico-Mounting-Brackets-Closing-Extension/dp/B01KLR8CTW* *2. https://www.maxavegroup.com/side-mount-drawer-slides/*
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127	Roller runner	*1. https://www.ebay.co.uk/itm/173910617219* *2. https://web.hettich.com/en-us/products/runner-systems/roller-runners-fr*

128	Ball catch	*1. https://www.ubuy.co.in/product/4E71JG5WI-closet-door-ball-catch-cabinet-tension-latches-spring-loaded-closer-solid-brass-furniture-hardware-strong-closures-strength-adjustable-2-pack* *2. richelieu.com*
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132	Cross dowel and bolt	*1. https://www.amazon.com/Rockler-Cross-Dowels-8-pack/dp/B001DSXTJ2* *2. https://www.woodsmith.com/article/our-favorite-knock-down-fasteners/*
133	Plastic corner blocks	*https://wiki.dtonline.org/index.php/Knock_Down_Fittings,_Brackets_and_Plates*
134	Rafix connector	*1. https://closetmanufacturer.com/seamless-panel-connectivity-with-cm-rafix-connectors/* *2. https://www.hafele.com.de/en/product/connector-housing-rafix-20-system-zinc-alloy/P-00861351/*
135	Aluminum flat roof	*https://www.permaroof.co.uk/wp-content/uploads/2020/03/Flat-Roofing-scaled.jpg*
136	Concrete flat roof	*https://i.ytimg.com/vi/d8cSI8aVXIM/maxresdefault.jpg*
137	Double Pitch or Gable roof building	*https://thearchitectsdiary.com/wp-content/uploads/2023/12/Gable-Roof-Design-Image-03-1024x677.webp*
138	Hipped Roof	*https://www.shutterstock.com/shutterstock/photos/481596103/display_1500/stock-photo-stone-stucco-house-with-slate-roof-481596103.jpg*
139	The Rafter–Purlin system	*https://myroofhub.com/wp-content/uploads/2016/08/gable-roof-structural-architecture.png*
140	The Trussed Rafter–Purlin system	*https://as2.ftcdn.net/v2/jpg/03/61/89/77/1000_F_361897781_dFdkUnxw7JVzRAke2l3Qh4nCM0CInGUH.jpg*
141	Spray gun	*1. https://freeworxmk.shop/product_details/46610791.html* *2. https://www.toolsource.com/conventional-guns-c-34_63_65/siphon-feed-paint-spray-gun-18mm-p-99132.html* *3. https://www.paintsprayersplus.com/Fuji-Spray-7002G-M-Gravity-HVLP-Turbine-Spray-Gun-p/fj7002g.htm*
142	Tightly attached ceilings	*https://www.armstrongceilings.com/content/dam/armstrongceilings/residential/images/installation/easy_up_step_3.jpg/_jcr_content/renditions/resimagecaptionlarge.1220.826.jpg*

143	Suspended or (Drop) Ceiling	*https://i.pinimg.com/originals/a9/71/37/a97137386d2e21518ce8fb03170f0b54.png*
144	Interstitial space or ceiling	*https://handwiki.org/wiki/images/thumb/5/5f/Interstitial_space.jpg/300px-Interstitial_space.jpg*
145	Acoustical ceilings	*https://acousticalsolutions.com/wp-content/uploads/2015/01/sonex-contour-acoustic-ceiling-tile-application-dining-01.jpg*
146	Pile Drill	*https://www.keller.co.uk/projects/crendon-industrial-estate*