MINISTRY OF EDUCATION
TECHNICAL TEACHERS
ASSOCIATION OF GHANA

# Building Construction & Woodwork Technology

## (Applied Technology)

### for Senior High Schools

Year 2


Michael Korblah Tsorgali
Isaac Buckman
Frank Fabian Aidoo

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Ghana Education Service (GES)

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# FOREWORD

Ghana's new Senior High School Curriculum aims to ensure that all learners achieve their potential by equipping them with 21st Century skills, knowledge, character qualities and shared Ghanaian values. This will prepare learners to live a responsible adult life, progress to further studies and enter the world of work. This is the first time that Ghana has developed a Senior High School 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.

The Ministry of Education is proud to have overseen the production of these Learner Materials which can be used in class and for self-study and revision. These materials have been developed through a partnership between the Ghana Education Service, teacher unions (Ghana National Association of Teachers-GNAT, National Association of Graduate Teacher -NAGRAT and the Coalition of Concerned Teachers- CCT) and National Subject Associations. These materials are informative and of high quality because they have been written by teachers for teachers with the expert backing of each subject association.

I believe that, if used appropriately, these materials 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.

**Haruna Iddrisu MP**
*Minister for Education*

SECTION

# 1

# WOODWORK HAND TOOLS, SUBSTRUCTURES AND SETTING OUT

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# UNIT 1

# WOODWORK TECHNOLOGY

## Tools and Machines in the Woodwork Industry

## Introduction

Woodworking hand tools are non-powered tools used for tasks like cutting, shaping, assembling, and marking wood. They give you control and precision, making them easier to use with less setup than power tools. Knowing how to select and use the right tool for a specific woodwork operation is important because it helps you work faster, more accurately, and safely. These tools are essential for different woodwork projects, helping you build your skills, and confidence and empowering you to work responsibly.

**KEY IDEAS**

- Always choose tools that are designed for the specific job and make sure they are in good condition.
- Select and use the correct hand tools for woodwork, the task you are doing and know which tool to use to make your work easier and safer.

## WOODWORK HAND TOOLS

Woodwork hand tools are non-powered tools essential for various tasks in woodworking. They can be classified into different categories based on their functions. These are:

1. **Geometrical tools**

   These tools are essential for measuring, marking out, setting out, and testing a job at various stages. Common tools include a pencil, ruler, tape measure, marking knife, wing compasses, try square/Mitre square, sliding bevel, marking gauge, mortise gauge, and cutting gauge. They help ensure accurate measurements and layouts.

2. **Abrading cutting tools**

   These remove material by scraping or grinding, creating small particles. This category includes saws, files, rasps, and honing tools. Saws cut wood, generating sawdust.

- **Hand Saw & Crosscut Saw:** Used for cutting wood across the grain.
- **Rip Saw:** Cuts along the grain of the wood.
- **Tenon & Dovetail Saw:** Ideal for precise joinery.
- **Coping, Bow, Fret, & Pad Saws:** Suitable for curves and intricate shapes.

3. **Paring and Shaving Cutting Tools**

Paring and shaving tools are used to shape and smooth wood by removing excess material. Paring involves using a chisel, typically without a mallet, to remove waste wood, while shaving tools are designed to refine wood to a specific size or shape. Common tools in this category include:

- **Jack Plane:** For rough shaping by removing large amounts of wood.
- **Smoothing Plane:** For achieving a fine, smooth finish on surfaces.
- **Spokeshaves:** Used for detailed shaping, particularly on curved surfaces; flat spokeshaves are for general work, while raised face spokeshaves are for more precise tasks.

4. **Chisels and Files**

Chisels and files are essential tools for removing wood waste and refining surfaces.

- **Chisels:** Used to cut and shape wood, chisels come in various types like firmer, bevel-edge, paring, and mortise chisels. Each has a hardened steel blade and a durable wooden handle. Chisels vary in size based on blade width, with reinforced handles to prevent splitting during heavy use.
- **Files and Rasps:** After initial shaping, files, rasps, and scrapers smooth and refine wood surfaces, essential for detailed finishing work.

5. **Boring Cutting Tools**

Boring cutting tools are designed to create holes in wood for joining and assembly. They are essential in woodworking for drilling holes of various sizes and depths and include:

a. **Braces (Ratchet and wheel):** Used with auger bits and other drills to drill larger holes.

b. **Twist Drills:** General-purpose, precise holes.

c. **Countersunk Bit:** For screw heads to sit flush.

d. **Forstner Bit:** Drills flat-bottom holes.

e. **Expansion Bit:** Adjustable for different hole sizes.

f. **Gimlet & Bradawl:** Small starter holes for nails or screws.

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### 6. Impelling and Percussion Tools (Driving Tools)

Impelling and percussion tools are essential for forcing or striking materials into position in woodworking.

a. **Impelling Tools:** Used to apply force for driving materials into wood. Screwdrivers, with alloy steel tips and hardwood or plastic handles, drive screws, while nail punches set nails below the wood surface.

b. **Percussion Tools:** These tools, like hammers (claw and Warrington) and mallets, strike other tools (chisels and gouges) or fasteners, aiding in securing, shaping, and assembling materials.

### 7. Holding and Supporting Tools (Vices and Cramps)

These tools are essential for securing wood firmly during work for stability, safety and precision. Key types include:

a. **Bench Vice:** A fixed vice on a workbench to hold the wood firmly.

b. **G-Cramp:** A small clamp for stabilising wood during cutting or chiselling.

c. **Sash Cramp:** A longer clamp for holding larger projects like frames.

**Table 1.1.1:** The table below summarises the classification, name and sketches of various tools, descriptions and their uses

| Classification | Name and sketch of the tool | Description | Uses |
|---|---|---|---|
| **Geometrical tools (measuring, marking and setting-out tools)** | **Pencil**  | A pencil is a simple tool with a graphite core encased in wood or plastic. | A pencil helps mark precise lines for cutting or shaping in woodworking. |
| | **Rule**  | A rule is a straight-edged measuring tool, often made of metal, wood, or plastic, marked with units like inches or centimetres. | A rule is used to measure distances or dimensions accurately in woodworking and other tasks. |
| | **Tape measure**  | A tape measure is a flexible ruler, typically made of metal or fibreglass, that can extend and retract, with markings in both inches and centimetres. | A tape measure is used to measure long distances or curved surfaces in woodworking. |

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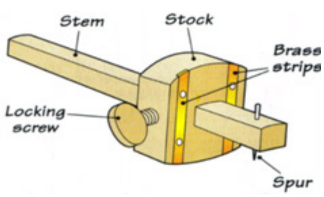
| | **Marking knife**<br> | A marking Knife is a sharp-edged tool with a pointed blade, typically made of steel, used to scribe fine, precise lines on timber. | A marking knife creates clean, accurate lines for cutting and fitting joints like dovetails and mortise and tenons. It provides a guide for saw or chisel work. |
| | **Try square**<br> | A try square is a tool with a steel blade fixed at a 90-degree angle to a metal or wooden stock. | A try square is used for checking and marking right angles.<br>It helps to draw straight, perpendicular lines on timber for accurate cutting and assembly. |
| | **Mitre square**<br> | A mitre square has a blade fixed at a 45° angle to its stock, similar to a try square. | A mitre square is used for testing and marking 45° angles. |
| | **Sliding bevel**<br> | A sliding bevel (bevel gauge) is an adjustable tool with a handle (stock) and a movable blade that can be set at any angle. | It is used to measure, mark, or transfer angles other than 90 degrees.<br>Again, it allows woodworkers to replicate complex angles for joints or cuts. |
| | **Wing compasses**<br> | Wing compasses are precision tools with two hinged legs and a locking screw. One leg has a point, and the other holds a pencil or scribe. | Wing compasses are used for marking out accurate circles or arcs on timber.<br>It helps measure and transfer specific distances directly onto the workpiece. |
| | **Marking gauge**<br> | A marking gauge consists of wooden stock and a sharp steel point termed a spur which scribes a line into the surface of the timber. The marking gauge makes a thin accurate mark. | A marking gauge is used to mark a line parallel to a straight edge of the timber. |

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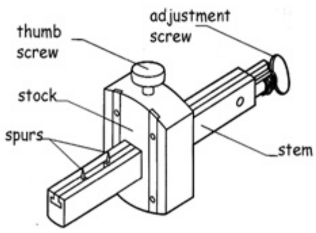
| | **Cutting gauge**<br> | A cutting gauge is a marking tool with a sharp blade or pin instead of a point, mounted on a sliding fence. It scores lines parallel to the edge of a workpiece. | It is used to score accurate lines on wood, especially across the grain, for clean and precise cuts.<br><br>It is ideal for slicing thin materials like veneers to size. |
| | **Mortise gauge**<br><br> | A mortise gauge is a marking tool with two adjustable pins mounted on a stem, used to mark two parallel lines simultaneously. It has a sliding fence for adjusting the distance between the pins. | It is used to scribe two parallel lines for mortise and tenon joints.<br><br>It helps ensure precision when marking wood for joinery, particularly in creating slots or grooves. |
| **Abrading Cutting Tools** | **Hand saw**<br> | Hand saws are used for straight cuts and come in types such as cross-cut, rip, and panel saws. They have two main parts: a blade made of cast steel and a wooden handle, typically beech. The saw length refers to the blade only, excluding the handle. Cross-cut saws, a type of hand saw, are around 600–650 mm long and have 8–10 teeth per 25 mm. | Hand saws are versatile for both ripping (cutting along the grain) and cross-cutting (cutting across the grain), depending on the tooth design. They are ideal for making straight cuts and trimming timber accurately. The knife-like teeth in cross-cut saws cut wood fibres smoothly, removing waste material and leaving a clean, precise kerf. This functionality makes them essential for general woodworking and carpentry tasks where precise shaping or trimming is required. |

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| | **Crosscut saw**<br> | A cross-cut saw features pointed, knife-like teeth with edges angled between 70° and 80°, allowing for efficient slicing through wood fibres. The saw ranges from 550 mm to 700 mm in length, with 5 to 9 points per 25 mm, creating a slightly wider cut, or kerf (the path of the cut made by a saw), than the blade width due to its tooth set. | It is exactly used for cutting thick boards across the grain, it can also cut thin boards along the grain if needed. Its sharp, angled teeth are ideal for clean cross-cuts on wood panels or large boards. |
| | **Rip saw**<br> | A rip saw is similar in appearance to a cross-cut saw but has distinct chisel-like teeth that are set at an angle of 90°. It is usually between 620 mm and 700 mm in length, with a tooth pitch of 3-6 points per 25 mm, designed to cut along the grain of thick boards. | It is primarily used for ripping, or cutting wood along the grain, making it ideal for breaking down larger boards into strips or custom sizes for carpentry and joinery. |
| | **Tenon saw**<br> | A tenon saw is a type of backed saw, reinforced with a steel or brass strip along the back of its blade. This reinforcement helps keep the thin blade straight, ensuring precise cuts and stability when cutting along straight lines. | The tenon saw is used to cut tenons. It can also be used for a variety of small, precise crosscutting tasks, making it versatile for general woodworking projects that require accuracy. |
| | **Dovetail saw**<br> | A dovetail saw is a smaller version of the tenon saw, with 12 to 28 teeth per 25 mm, and a length ranging from 200 to 350 mm. It has a fine-toothed blade designed for delicate, precise work. | It is primarily used where high accuracy is needed, such as in making dovetail joints and other fine joinery. The saw is ideal for clean, detailed cuts that require a smooth finish. |

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| | **Coping saw**<br> | The coping saw has a flexible steel frame with a wooden handle. A narrow blade (about 3 mm wide and 170 mm long) is held by pegs between two studs, allowing blade rotation to any angle.<br><br>The handle tightens the blade, adding tension when turned. | The coping saw is mostly used for cutting sharp curves in thin boards near edges and for trimming waste from dovetail joints.<br><br>To prevent buckling or breaking, it is best to install the blade with the teeth facing the handle so it cuts on the backward stroke. |
| | **Bow saw**<br> | The bow saw has a wooden frame shaped like a bow and a thin blade, which is about 6 mm wide.<br><br>The blade has a length of about 300 mm, which is tensioned with a cord and toggle at the top of the frame. | The bow saw is largely used for cutting external and internal curves in thicker boards, making it suitable for curved woodworking cuts in larger pieces. |
| | **Fret saw**<br> | The fret saw features a longer rectangular frame, measuring between 300 mm and 500 mm, and has a very fine blade that is 125 mm to 150 mm long.<br><br>The blade is tensioned using a wing nut opposite the handle. | The fret saw is used for cutting curves in thin boards. Its long frame allows cutting further from the edge, and to avoid breakage, the blade should be installed with teeth facing the handle for backward strokes. |
| | **Pad saw**<br> | This is the smallest saw, with a blade around 250mm long. | It is used for cutting small, precise holes, like keyholes, or for starting interior cuts where access is limited. |

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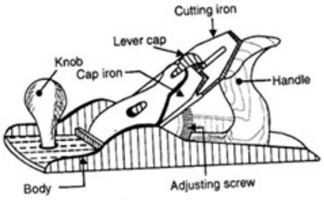
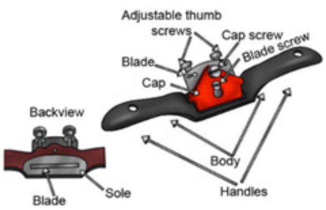
| **Paring and Shaving Cutting Tools** | **Jack plane**   | The jack plane resembles a roughing plane but has a longer stock, about 350 mm, with a fixed handle located behind the cutting iron. It features a cap iron that adds tension to the cutting edge, minimizing vibration and breaking shavings. The cutting iron is 50 mm to 56 mm wide and set at a 45° angle, with a slightly curved edge for removing thicker shavings easily. Key components include a striking button for removing the cutting iron, a wedge for securing the cutting iron, and an escapement that allows shavings to escape. | The Jack plane is predominantly used for planing rough surfaces of sawn timber to size, squaring up edges, and smoothing surfaces. |
| | **Smoothing plane**  | The smoothing plane can be made of wood or metal. The wooden version is designed for one-handed use and has no handle, with a cutting iron width ranging from 31 mm to 56 mm and slightly rounded corners to prevent digging. The metal version typically measures about 230 mm long with a blade width of 50 mm or more. | Both types of smoothing planes are used for dressing surfaces and edges of workpieces, levelling assembled joints, and preparing jobs for glass papering. Their small size allows for precise work in tight or cross-grained areas. |
| | **Flat spokeshave**   | The flat spokeshave has a flat sole and a cutting iron held securely in a wood or metal frame, with sizes varying by the width or length of the iron. | It is ideal for shaping and smoothing flat or convex surfaces. It is commonly used for refining edges and levelling narrow areas. |

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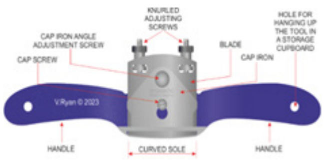
| | **Raised faced spokeshave**<br><br> | A raised-faced spokeshave has a rounded sole to shape concave curves, with a cutting iron fixed in the frame. | A raised-faced spokeshave is used mainly for shaping and smoothing concave surfaces. It is excellent for refining inner curves and planing stopped chamfers. |
| **Chisels and files** | **Firmer chisel**<br> | The firmer chisel has a rectangular-section blade, which gives it more strength compared to a bevel-edged chisel. It comes in widths ranging from 3 mm to 50 mm. | This chisel is ideal for general woodwork tasks, such as removing waste from joints and cutting outside curves with a small radius. |
| | **Bevel-edge firmer chisel**<br> | The bevel-edge chisel is a lighter version of the firmer chisel, with bevels along the front edges of the blade. This design allows it to fit into tight corners that are less than 90°, such as in dovetail joints. It comes in widths from 3 mm to 50 mm. | Its bevelled edges make it ideal for working in confined spaces, like cutting dovetails or chiseling corners at angles smaller than 90°. |
| | **Paring chisel**<br> | The paring chisel is a longer, lighter version of the bevel-edged chisel, with lengths ranging from 225 mm to 500 mm. It is designed for handwork only and should not be struck with a mallet. | It is used for fine shaping and smoothing wood surfaces, allowing for precise control during both vertical and horizontal paring. |
| | **Mortise chisel**<br> | The mortise chisel has a thicker, almost square cross-section blade, designed to endure heavy hammering. It is stronger than firmer chisels and is available in widths from 6 mm to 25 mm. The handle may include a metal band to prevent splitting and a leather washer to absorb shock. | It is specifically used for cutting deep mortises or holes in wood, where it can withstand the force of a mallet during heavy-duty tasks like chopping mortises. |

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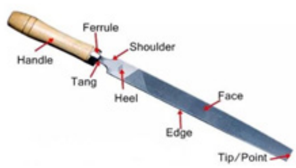
| | **Firmer gouge**  | A firmer gouge (out cannel) has an outwardly sharpened blade, ideal for heavy-duty work. Its robust, curved edge is suited for following convex shapes, providing strong control while carving. | The firmer gouge is used for grooving, carving, and hollowing convex surfaces. Its design allows precise control in shaping rounded surfaces and removing wood smoothly for general carving tasks. |
| | **Scribing gouge**  | A scribing gouge (in cannel) has an inside-sharpened, curved blade, designed to pare and shape concave surfaces with precision. This inward bevel provides control when following tight, curved lines. | The scribing gouge is used for trimming and paring concave surfaces and is particularly helpful in detailed, curved woodwork where accuracy is needed for a smooth, accurate finish. |
| | **Rasps**  | A rasp is a metal tool with a half-round shape and sharp, raised teeth made by punching triangular points into the surface. Rasp teeth vary from fine to rough grades. | In woodworking, rasps smooth curved or irregular edges where other tools are less effective. They work quickly but leave a rough finish, requiring further smoothing with a file or glasspaper. |
| | **Files**  | Files are tools used in woodwork for smoothing edges and shapes where other cutting tools may struggle. They feature a series of cuts across their face, creating varying grades of teeth from fine to rough. Common shapes include round files for concave curves, square files for slots, half-round files for smoothing edges, and triangular files for sharp corners and grooves. The triangular file is also known as the saw file due to its use in sharpening hand saws. | Files are used to smooth edges and shapes, enlarge holes, produce slots, and sharpen hand saws. Each file shape serves a specific purpose in woodwork, such as the round file for concave curves and the triangular file for creating grooves. |

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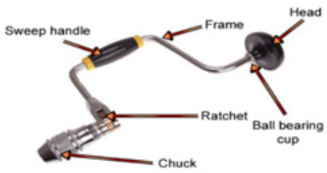
| | **Scraper**  | This tool is a flat rectangular piece of steel, approximately 125 mm by 75 mm in size. Its cutting edges are formed by slightly bending over the long edges. | It is used to create a very smooth finish on wood surfaces and to remove plane marks before final sanding or glass papering. |
| **Boring Cutting Tools** | **Ratchet brace**   | A ratchet brace is a hand tool used primarily for drilling, consisting of a head, crank, chuck, and ratchet mechanism. The hardwood head fits comfortably in the palm and rotates smoothly on ball bearings.<br><br>The steel crank provides leverage and sweep, while the chuck holds bits securely. The ratchet mechanism allows the user to turn the brace in one direction for effective drilling in tight spaces. | The ratchet brace is used to hold and drive auger bits into wood, making it ideal for boring precise holes in woodwork projects, even in restricted areas. |
| | **Wheel brace**   | A wheel brace is a hand tool for drilling holes, featuring a handle for grip, a crank for rotation, gears to amplify motion, and a chuck and jaws to hold various drill bits.<br><br>This design makes it easier to bore multiple holes without tiring, ensuring steady, controlled pressure. | The wheel brace is used to hold various drill bits for drilling holes, creating pilot holes in dense wood preventing splitting when screws are inserted and countersinking in wood. |

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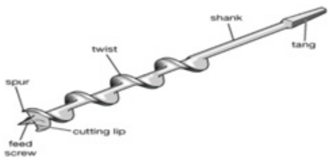
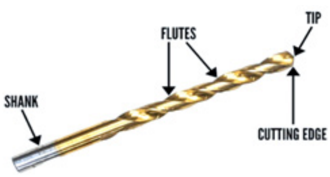
| | **Auger bits**<br><br> | Auger bits are a type of twist bit, often with a spiral body known as the Jennings pattern. This spiral design stabilises the bit, guiding it to create deep, straight holes while providing an efficient channel for wood chips to exit.<br><br>A threaded centre point on the bit helps it pull into the wood, keeping it steady and centred. Some auger bits also include spurs on the outer edge of the cutting end, which help cut wood fibres cleanly before the main cutter engages. | Auger bits are primarily used for boring straight, deep holes in both hardwood and softwood, with sizes typically ranging from 6 mm to 30 mm. They are especially useful for woodworking tasks requiring accuracy and depth.<br><br>To avoid splitting the wood when boring through it, reverse and finish from the opposite side as the bit's point begins to show. |
| | **Twist drill (hand drill)**<br><br> | A twist drill (hand drill) is a versatile tool used for creating small to medium-sized holes in materials such as wood, metal, or plastic.<br>A twist drill is designed with a cylindrical body featuring deep helical grooves, known as flutes, which allow the removal of debris during drilling.<br><br>The drill consists of three main parts: the shank (which fits into the chuck), the body (where the grooves are), and the drill point (which initiates the cut). Twist drills typically come in sizes up to 12 mm in diameter and are made for general-purpose drilling tasks. | Twist drills are mostly used to bore holes in wood, metal, or plastic. Their spiral design ensures smooth cutting and efficient waste removal during drilling. They are ideal for precision work, making clean, accurate holes, especially in woodwork projects requiring various hole sizes. |

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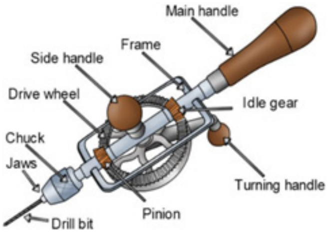
| | **Hand drill**<br><br> | A hand drill is a manual tool used in conjunction with twist drill for drilling holes. Its main components include:<br>**Main handle:** The primary grip for control.<br>**Frame:** The structure that supports the drill.<br>**Side handle:** Provides additional leverage.<br>**Turning handle:** Rotates to drill the bit.<br>**Pinion:** A gear that helps convert motion.<br>**Jaws:** Hold the drill bit securely.<br>**Chuck:** Allows quick bit changes.<br>**Drive Wheel:** Turns the drill bit.<br>**Idle Gear:** Optimizes torque and speed. | A hand drill is used to hold twist drills to create precise holes in wood, offering control over depth and angle. |
| | **Countersunk bit**<br> | A countersink bit creates a conical hole in wood, allowing screws to sit flush or below the surface for a neat finish and preventing wood damage. These bits, available in various sizes, typically feature an 82-degree angle to match standard wood screw heads. Made from high-speed steel, cobalt, or carbide, they provide durability and heat resistance for different materials. | Countersink bits are used to drill conical holes that allow screw heads to sit flush or below the wood surface. |
| | **Centre bit**<br> | Centre bits are wood-boring tools with a central point and a semi-circular cutting edge, used in hand braces for drilling. | It is used to:<br>• drills wide, shallow holes in wood.<br>• the central point guides the bit for accurate drilling. |

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| | **Forstner bit**<br> | A Forstner bit is a cylindrical drill bit featuring a flat cutting edge and a central point, designed for drilling smooth, flat-bottomed holes with precise control and stability. | It drills clean, flat-bottomed holes or partial holes in wood, perfect for making recesses. |
| | **Expansion bit**<br> | An expansion bit is a specialized drill bit used for creating holes in wood. It features a central threaded shaft and an adjustable cutting head that allows the diameter of the hole to be expanded. The cutting edges are designed to create smooth, precise holes. | Expansion bits are primarily used for drilling larger holes in wood, such as for dowels or pipes.<br><br>They are ideal for making adjustable holes to fit different sizes and are particularly useful in joinery and cabinetry. Proper use includes starting with a pilot hole for accuracy. |
| | **Gimlet**<br> | A gimlet is a small, hand-operated boring tool, typically used for starting holes in wood for screws or nails. Its crosswise handle provides a secure grip, allowing firm pressure to be applied. | Gimlets are ideal for drilling small starter holes in tight spaces, like corners or areas inaccessible to larger tools, to aid in the placement of nails or screws. |
| | **Bradawl**<br> | A bradawl is a small hand tool made of steel, with one end flattened into a sharp cutting edge and a pointed tip fitted into a round wooden handle. | Bradawls are used for creating small pilot holes for nails or screws.<br><br>When used, the cutting edge is pressed and twisted back and forth across the wood grain, cutting fibres to prevent splitting and making it easier to insert fasteners. |

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| **Impelling and precaution Tools (Driving tools)** | **Cabinet pattern screwdriver**<br> | The cabinet pattern screwdriver has a round shaft made of alloy steel with a flat ground tip. It's hardwood handle, often crafted from materials like beech or hickory, is designed for a comfortable grip. | This screwdriver is ideal for precise work in cabinetry, allowing for secure screw placement and reducing the risk of damage to the wood. It's best used with pilot holes for better control. |
| | **London pattern screwdriver**<br> | The London pattern screwdriver features a flat shaft made of hardened alloy steel, with a flat ground tip and a sturdy hardwood handle designed for grip. | This screwdriver is well-suited for general carpentry, providing excellent leverage for driving larger screws into tougher materials. Proper tip alignment is essential for effective use. |
| | **Claw hammer**<br> | The claw hammer is a durable tool commonly used in construction. It has a flat striking face for driving nails and a curved claw for removing them.<br><br>The hammer's size is based on the head's weight, which is made from medium carbon steel. When extracting a nail, place a block of wood under the claw to protect the surface. | The claw hammer is mainly used for:<br>• driving nails into wood.<br>• pulling out nails when needed, making it a versatile tool for both assembly and disassembly tasks in woodwork construction projects. |
| | **Warrington hammer**<br> | The Warrington hammer (Cross pein hammer), is a specialised tool used mainly by joiners. It features a flat striking face for driving nails and a cross-pein design for reaching into tight corners. | The Warrington hammer is ideal for starting small nails and working in awkward spaces, making it a valuable tool for precision woodworking and cabinetry tasks. |

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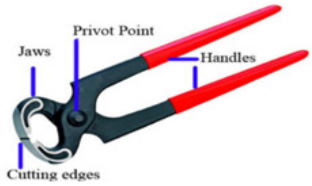
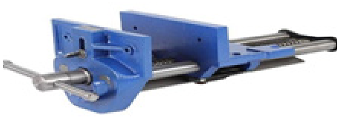
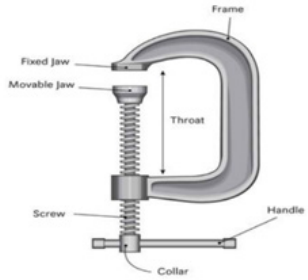
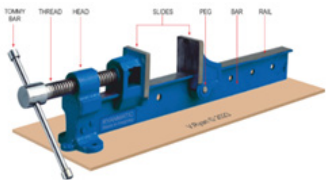
| | **Mallet**  | The mallet is a wooden striking tool made from hardwood like beech, with a block-shaped head (about 100–175 mm long) and a tapered handle fitted into a mortise joint for durability. | Mallets are primarily used for driving tools with wooden handles, such as chisels and gauges, without causing damage. They are also helpful in assembling wooden pieces by providing controlled force without marring the wood. |
| | **Pincers**   | Pincers are hand tools with curved, gripping jaws designed to firmly grasp and pull objects like nails. The pincers' jaws close tightly around the nail or small item, providing strong leverage to remove it effectively. | Pincers are first and foremost used for pulling out nails and small fasteners from wood or other materials. By gripping and levering back, they allow nails to be extracted with minimal effort and reduce damage to the surrounding material. |
| | **Nail punch**  | Nail punches are designed to drive nail heads below the surface of wood or plasterboard. They feature knurled shafts for grip and square heads to prevent rolling. Made from hardened steel, their slightly cupped heads ensure better contact with the nail while driving it below the surface. | A nail punch is used to drive nail heads below the surface of wood or plasterboard. It ensures that the nail sits flush or slightly recessed, allowing for a smoother finish. This is especially useful for concealing nails before filling or painting. |
| **Holding and supporting tools (Vices and Cramps)** | **Bench vice**  | The bench vice, made of cast iron, has a quick-release mechanism for rapid jaw adjustments and a firm grip.it is mounted to the workbench side, and it aligns with the bench's top, often fitted with wooden jaws to prevent damage. | The bench vice is used to secure workpiece for planing, sawing, or chiselling. It is used to hold glued pieces together while drying. |

| | | | |
|---|---|---|---|
| | **G-cramp**   | The G-cramp, shaped like the letter 'G,' consists of a robust steel frame and a threaded shaft/screw. One end features a loose-fitting shoe (or pad) for secure gripping, while the other end has a tommy bar/handle that allows for easy tightening and loosening. The G-cramp's design enables it to hold wood pieces firmly against a workbench, facilitating exact operations such as sawing and chiselling. The size of the G-cramp is determined by the opening of its jaws (fixed and movable), which typically range from 50 mm to 300 mm. | The G-cramp is primarily used to secure wooden pieces to a workbench, providing stability while performing tasks like sawing and chiselling. Additionally, it is effective for holding small components together during glueing, ensuring that the pieces remain aligned as the adhesive sets. This versatility makes the G-cramp an essential tool in woodworking and assembly projects. |
| | **Sash cramp**   | The sash cramp is a long metal tool, typically ranging from 45 to 195 cm. It features a movable jaw operated by a screw, a sliding shoe held in place with a pin, and a head containing the screw and tommy bar for tightening. | Sash cramp holds work pieces securely together during glueing, ideal for assembling sashes, door frames, or carcasses to ensure a firm bond. |

## Activity 1.1.1

### Building a Wooden Shelf with Hand Tools

**Scenario:**

Your team is building a small wooden shelf. Identify at least three hand tools you need for the project. Discuss how each tool helps you complete the task efficiently and safely. Present your findings to the class.

**Materials Needed:**

- Videos demonstrating woodwork hand tools (saws, chisels, planes, screwdrivers)

- Sample wooden pieces
- Safety goggles
- Measuring tape
- Pencil for marking
- Glasspaper
- Clamps
- Wood glue
- Hammer

### Activity Guidelines:

1. Watch a video demonstration on different types of woodwork hand tools.
2. As you watch, think about which tools might be useful for building a small wooden shelf.
3. After the video, discuss in pairs to identify at least three hand tools needed for the project.
4. Ask each other targeted questions to deepen your understanding, such as:
   a. "Why is this tool important for the project?"
   b. "How does this tool make the work safer and more efficient?"
5. Form groups of **five (5)** classmates.
6. Discuss the different classifications and uses of various woodwork hand tools.
7. Each group will list the tools and their specific uses for the shelf project.
8. In your groups, choose the appropriate hand tools for the shelf project.
9. Practice using the tools properly, keeping safety in mind.
10. Each group will work together to assemble the shelf, applying what they learned about tool selection and usage.
11. Share tips with each other on safe tool use and effective techniques.

## Activity 1.1.2

### Uses of Woodwork Hand Tools

**Scenario:**

Your team is assigned to build a simple wooden project, such as a wooden table. To successfully complete this task, you need to explain at least three uses of various woodwork hand tools essential for the project.

**Materials Needed:**

- Video demonstration of woodwork hand tools
- Sample wood pieces for the project
- Safety goggles
- Measuring tape
- Pencil for marking
- Saws, chisels, planes, and other hand tools
- Glasspaper
- Clamps

### Activity Guidelines:

1. Start with a video demonstration showing different types of woodwork hand tools, such as saws, chisels, and planes.
2. After the video, brainstorm as a class to identify various woodwork hand tools.
3. Ask each other these questions to encourage class discussion, such as:
   a. "What is the purpose of each tool?"
   b. "How does this tool help us build a table?"
4. The teacher will bring the class back together for whole-group feedback to review the explanations.
5. Break out into groups with your colleagues.
6. Each group will discuss the uses of the identified woodwork hand tools and classify them based on their functions.
7. In your groups, select the appropriate hand tools for building the wooden table.
8. You will practice using the tools correctly, considering safety and skill levels.

## Activity 1.1.3

### Demonstrating the Use of a Rip Saw

**Scenario:**

Your team is assigned to create a simple wooden chair. To complete this project, you need to demonstrate how to use a rip saw to rip a piece of wood accurately.

**Materials Needed:**

- Rip saws
- Pieces of wood for ripping

- Measuring tapes
- Pencils for marking
- Clamps or workbenches
- Safety goggles

## Activity Guidelines:

1. The facilitator will begin with a brief discussion on the purpose of a rip saw, which is designed for cutting wood along the grain (ripping).
2. You will be asked to explain why using a rip saw correctly is important for achieving clean cuts and ensuring safety during woodworking.
3. The facilitator will emphasise the need to observe safety rules and regulations in the workshop.
4. The facilitator will demonstrate how to use a rip saw effectively. The demonstration will include:
   a. **Preparation:** showing how to select the right piece of wood for ripping and measuring the desired length using a measuring tape.
   b. **Marking:** using a pencil to mark the cut line clearly on the wood.
   c. **Safety Gear:** ensuring everyone is wearing safety goggles and has their hair tied back if long.
   d. **Positioning:** how to securely hold the wood in place using clamps or a workbench.
   e. **Cutting Technique:** showing the proper stance and grip on the rip saw. Explain how to start the cut slowly and then use long, smooth strokes to cut through the wood along the marked line.
5. You will be divided into groups of 5 and will be provided with pieces of wood and rip saws.
6. Each of you will practise using the rip saw to make your cuts. Ensure you follow the demonstrated technique.
7. After practising, come together as a class to discuss the experience.
8. You will be asked to share what you have learned about using the rip saw, any challenges you faced, and how you overcame them.
9. The facilitator will reinforce key points about safety and proper technique for ripping.
10. Selecting and using the correct hand tools for each woodwork operation improves accuracy, safety, and quality. Knowing each tool's purpose and handling it properly makes tasks easier and builds essential woodworking skills.

# UNIT 2

# CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

This unit of section one emphasises the importance of the substructure as part of a building. It indicates the various types of foundations and the various soil conditions under which they are used. The knowledge of substructure will enable you to understand its role in the stability of the entire building. You will also understand that the substructure by its design can ensure that the load of the entire building is successfully transferred onto the natural grounds. The concept of substructure identification through the various components and how they function will enable you to realise the effectiveness of the various components of the substructure. The organised site visits will provide you with practical knowledge and understanding of the effectiveness of the substructure of a building.

**KEY IDEAS**

- Substructure is an important part of a building. It forms the initial subset component of a building and serves as the load bearer of the building to the ground.
- The stability of a building depends greatly on the strength of the substructure.
- For the substructure to be effective, it should successfully transfer the load of the building to the ground without failure.

## THE MEANING OF SUBSTRUCTURE OF A BUILDING

The substructure of a building refers to the part which is partially below ground level. In **Figures 1.2.1** and **1.2.2** below, the foundation and the footing courses are seen below the ground level. However, you can see that the oversite concrete floor is above the ground level, which means that, the substructure as a structure, is partially below and above the ground level. The main purpose of the substructure is to transfer the load of the building to the ground and to provide stability against environmental factors such as wind and seismic activity. Proper design and construction of the substructure are necessary to ensure the safety and duration of the building. The illustrations show the substructures of cavity walls and solid wall buildings.

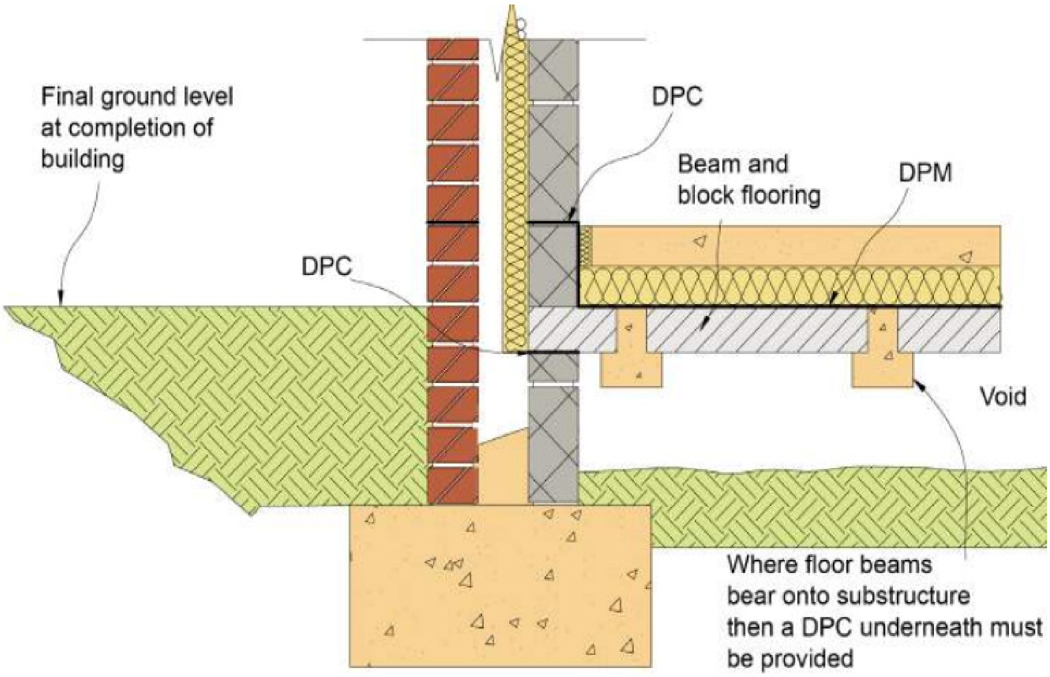



**Figure 1.2.1:** Cross section of the Substructure of a cavity wall building

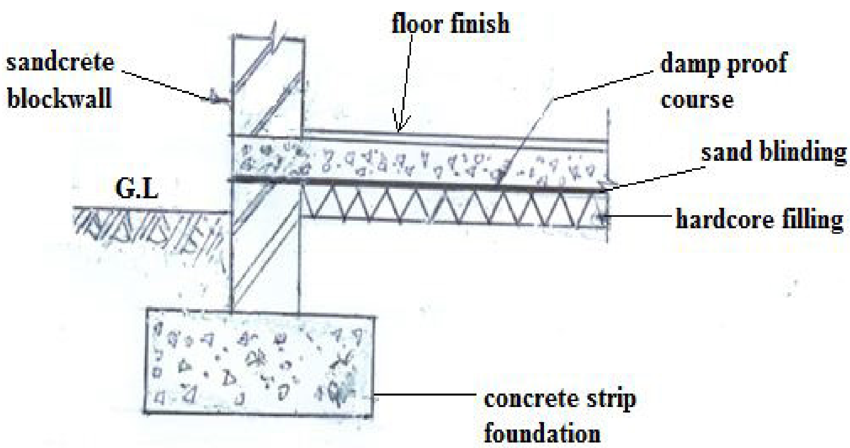



**Figure 1.2.2:** Cross section of the Substructure of a solid wall building.

## Activity 1.2.1

### Meaning of the Substructure

After reading about the meaning of a substructure, think through the term and analyse the various ideas that can be taken from the term substructure of a building.

Use this table as a guide to support your analysis.

| Substructure Meaning | Answer/Analysis |
|---|---|
| What is it?<br>Why is it important?<br>What would happen if it wasn't there? | |

## The Main Components of a Substructure

The main components of the substructure of a building are outlined in the table below.

**Table 1.2.1:** Description of the main components of a substructure

| Components | Description |
|---|---|
| **Foundation concrete** | The foundation is generally referred to as the base of a building. It is a horizontal concrete slab which is in direct contact with the ground. Foundations are generally seen as the main support of every building. They are usually cast in a trench. |
| **Footings** | The footing course can be described as a vertical wall made of either brick or block. It is a link between the foundation concrete and the oversite concrete. |
| **Hardcore filling** | Hardcore is usually referred to as the layer of hard substances, rocks, gravels and aggregate particles provided within the space of the footing course as a firm base for the oversite concrete. |
| **Oversite concrete** | Oversite concrete is defined as the horizontal concrete layer or slab provided over the entire area of the building. It is also called the concrete slab or floor which spans the external and internal walls of a building. |

## Purposes of the Foundation

The purposes of the foundation can be expressed in two ways.

1. The foundation is to carry or support the building safely without failure
2. The foundation is to transmit or distribute the load of the building to the ground without any settlement or failure.

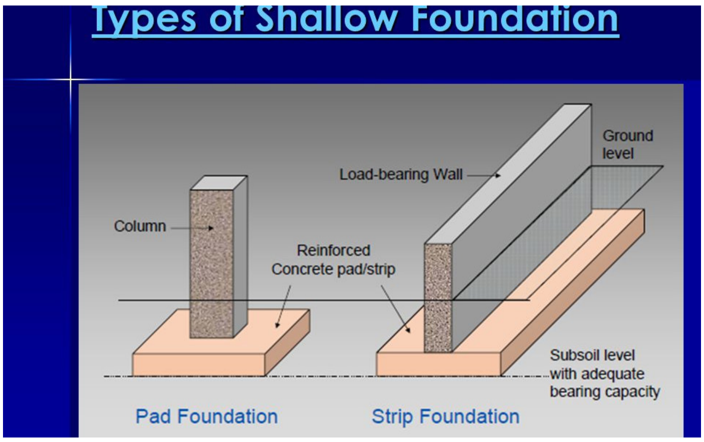



**Figure 1.2.3:** Examples of foundation as a component of substructure

## Purpose of the Footings

These can also be described as the first block work that is provided on the foundation concrete. The purpose of the footing is to provide a link for the building load for effective transmission or distribution to the foundation concrete.

For an effective footing course to be achieved, the following methods are to be used:

1. Use blocks of high cement/sand ratio preferably **1:3** which are of high strength.
2. Ensure the transfer of the footing course from the profile board.
3. Ensure a uniform layer of bed mortar for the footing course.
4. Arrange the blocks to form an effective bond.
5. Ensure correct bat and lapping in the bonding/ Fill the joints to ensure a solid wall.

**Figure 1.2.4:** Example of block footings

## Purpose of the Hardcore Filling

The purpose of hardcore filling is to provide a solid base for the oversite concrete. It is also to ensure that the bigger stones within the hardcore particles can serve as non-passage for moisture. The required levelled nature of the hardcore filling always provides the background for an effective over-site concrete layer.

For effective hardcore filling, it is necessary to:

1. Ensure all backfilling is done to provide support for the footing courses.
2. Use appropriate hardcore filling materials that can be well consolidated to form a solid base.
3. Ensure that the hardcore filling is done when the footing courses are hard enough to withstand pressure on their sides. The diagram of **Figure 1.2.5** is an example of hardcore filling at the construction site.

**Figure 1.2.5:** Example of hardcore filling at the construction site

## Purpose of Oversite Concrete

The purpose of oversite concrete is to provide a truly horizontal layer for the transmission of the loads from the superstructure of the building. The requirements for an effective casting of oversite concrete are:

1. Ensure the provision of a solid hardcore layer to serve as a reliable base for the oversite concrete.
2. The top surface of the hardcore should be truly levelled to serve as a datum forecasting the oversite concrete.
3. Use the correct ratio to mix concrete for the floor and ensure that the mixture is workable.
4. Set the gauge at intermediary spots to ensure the concrete is cast to a uniform thickness.
5. The oversite concrete should be set at a level 150mm above the ground level.
6. Do not allow tipper trucks to move over footing courses to tip hardcore filling materials.

**Figure 1.2.6:** Setting the gauge for the oversite concrete floor

**Figure 1.2.7:** Levelling of concrete slab

**Figure 1.2.8:** Compacting of the concrete slab

**Figure 1.2.9:** Curing of concrete slabs

Activity 1.2.2

### Components of the substructure

Your teacher will divide you into groups, where you will discuss the various components of the substructure in detail and outline the effect of these components on the substructure of a building.

**Hint**

- Use the illustrations as a guide to observe the various components.
- Use the table below as a guide for the discussion.

| Component | Effect on substructure |
|---|---|
| Foundation concrete | |
| Footings | |
| Hardcore filling | |
| Oversite concrete | |

## Details of The Functions of The Substructure of a Building

The substructure of a building is required to perform several functions which will ensure the safety of the entire building. The functions of the substructure of a building are important and necessary for its effectiveness and durability. **Table 1.2.2** gives details of the various functions of the substructure of a building.

**Table 1.2.2:** The functions of the substructure of a building

| Functions of substructure | Details |
|---|---|
| **Load Bearing** | The substructure supports the weight of the building, including walls, floors, roofs, and any live loads (like occupants and furniture). It distributes these loads to the soil below, ensuring that the structure remains stable and does not settle unevenly. |
| **Stability** | A well-designed substructure helps resist lateral forces from wind and seismic activity. By anchoring the building securely to the ground, it prevents movement that could lead to structural failure. |

| | |
|---|---|
| **Moisture Protection** | Substructures often include waterproofing and drainage systems to manage groundwater and surface water. This prevents moisture from entering the building, which can lead to mould, rot, and other damage |
| **Thermal Insulation** | The substructure can help regulate temperature within the building. For example, basements can maintain cooler temperatures in summer and warmer ones in winter, contributing to energy efficiency. |
| **Access to Utilities** | The substructure often contains or provides access to essential utilities like plumbing, electrical wiring, and HVAC systems. This facilitates installation, maintenance, and repairs without disrupting the living spaces above |
| **Space Utilization** | The natural soil or material beneath the foundation must be adequately compacted and prepared to support the building's weight |
| **Durability and Longevity** | A strong substructure enhances the overall durability of the building. By using quality materials and appropriate design, the substructure can withstand environmental stresses and extend the life of the building |
| **Erosion Control** | In areas prone to erosion, substructures (like retaining walls) help prevent soil displacement, maintaining the integrity of the site and the building's foundation |
| **Vibration Isolation** | The substructure can help dampen vibrations from nearby traffic, construction, or natural forces, providing a more stable and comfortable environment within the building |
| **Pest Prevention** | Proper design of the substructure can help minimise the risk of pests entering the building, as it can create barriers or limit access points for insects and rodents |

## Activity 1.2.1

### Functions of The Substructure

Read all the details of the functions of the substructure in Table 1.2.2 and in your groups, discuss the various functions of the substructure of a building and present a report.

In your groups use the following guide to prepare your report:

| Section | Description |
|---|---|
| **Title page** | The title page often includes a descriptive title (not just "Report"), who wrote it, and the date it was presented |
| **Table of contents** | A list showing the sections in the report and their page numbers |
| **List of pictures and diagrams** | Some reports have pictures and diagrams on certain pages and these need to be noted |
| **Summary** | One or two paragraphs explaining briefly what the report findings were |
| **Introduction** | This should clearly state the aim and objectives of the report and why it has been written. It can also include what hasn't been looked at |
| **Main body** | This should include what research methods were used (books, internet, observation etc), what your findings were, and what the results were |
| **Conclusions** | This should be a short summary of what you did and found out and how important it was. You may also want to include any further research that could be done. |

# WOODWORK TECHNOLOGY

## Tools and Machines in the Woodwork Industry

## Introduction

Caring for and maintaining hand tools means keeping them in top shape through regular cleaning, safe storage, and necessary repairs, helping you work safely and produce quality results. As a good craftsman, you should respect your tools, select the right ones for each task, and ensure they are always sharp and well-maintained. Well-maintained tools are safer and work better. Proper care, including grinding and sharpening, prevents faults in your work and helps tools last longer, saving you time, money and effort. This unit will cover the general care and maintenance of various classes/categories of woodworking hand tools, focusing on effective techniques for keeping tools in optimal condition. It will provide guidance on the essential steps to be taken for maintaining a sharp saw (saw sharpening) and the sharpening of plane blades and chisels, both of which are necessary for maintaining sharp, precise cutting edges.

**KEY IDEAS**

- Care and maintenance of hand tools involve keeping tools in good condition by cleaning them regularly, storing them properly, and making any needed repairs or adjustments. Proper care ensures tools stay safe, work well, and last longer.
- Oil or lubricate moving parts to ensure smooth operation.
- Sharpen cutting tools to maintain effectiveness and always use tools correctly to avoid unnecessary wear.

## CARE AND MAINTAINANCE OF HAND TOOLS

Care and maintenance of hand tools means taking steps to keep tools in good condition, such as regular cleaning, safe storage, and making necessary repairs or adjustments. Proper care helps tools stay functional, safe, and last longer.

Caring for hand tools means daily actions to keep tools in good condition, like cleaning, drying, and storing them properly after each use. Proper storage is crucial for all tools

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to prevent damage and maintain their condition. Use toolboxes, racks, or hanging systems to organise tools effectively.

Maintenance of hand tools on the other hand involves periodic tasks to ensure tools stay effective, such as sharpening, adjusting, and repairing any worn parts. Implementing a routine inspection schedule for all tools will help to identify and address issues before they become significant problems.

You must always wear the appropriate personal protective equipment (PPE) when using tools, especially cutting tools, to avoid accidents and injuries.

By following these care and maintenance guidelines, you can ensure your hand tools remain in optimal working condition, enhancing your productivity and safety during tasks.

## General Care and Maintenance of Various Categories of Woodwork Hand Tools

The table below shows the general care and maintenance of the various classes of woodwork hand tools studied under **Unit 1**.

**Table 1.3.1:** Care and maintenance of woodwork hand tools

| Class of hand tool | General care | General Maintenance |
|---|---|---|
| **Geometrical tools** | • Keep measuring, marking, and setting out tools clean and dry to prevent rust and inaccuracies.<br>• Store in a designated area to avoid damage. | • Check for accuracy regularly; adjust if necessary.<br>• Regularly check for accuracy using a calibration tool.<br>• If tools are out of alignment, adjust them according to the manufacturer's specifications.<br>• Replace worn or damaged parts as needed. |
| **Abrading Cutting Tools** | • Clean tools after each use to remove dust, debris, and particles that could dull the edge.<br>• Store in a dry area to prevent moisture build-up. | • Sharpen or replace worn edges to maintain effectiveness.<br>• Regularly sharpen tools using appropriate sharpening equipment or methods.<br>• Inspect for signs of wear or damage and replace when necessary.<br>• Oil any moving parts to prevent rust and ensure smooth operation. |

| | | |
|---|---|---|
| **Paring and Shaving Cutting Tools** | • Wipe tools down with a clean cloth after use to remove residue and moisture to prevent rust and dulling.<br>• Store in protective sheaths or cases to prevent edge damage. | • Sharpen edges as needed for a clean cut.<br>• Sharpen edges using a honing stone or sharpening tool to maintain cutting efficiency.<br>• Check for any damage or chipping and repair as necessary. |
| **Chisels and Files** | • Store chisels with protective covers to avoid damage to sharp edges.<br>• Keep files clean by brushing off debris after use.<br>• Clean file and rasp teeth regularly with a file card or wire brush to prevent buildup.<br>• Attach a handle for safe, effective use. | • Sharpen chisels and remove debris from file grooves regularly.<br>• Regularly sharpen chisels and files, using files to create grooves in wood.<br>• Inspect for wear on edges and replace when they become ineffective. |
| **Boring Cutting Tools (Brace & Bits)** | • Clean after each use and store in a dry place.<br>• Clean the brace and bits after each use to remove wood shavings and dust.<br>• Store in a dry area to avoid rusting. | • Oil the moving parts of all the braces and the hand drill to ensure smooth operation.<br>• Sharpen bits as needed and replace any that are damaged or worn out. |
| **Impelling & Precaution Tools** | • Store driving tools like hammers and mallets in an organised manner to avoid wear on striking surfaces.<br>• Clean after use to remove dirt and grime. | • Check for wear on handles or heads and replace if damaged.<br>• Inspect handles for cracks or splinters and replace them if necessary.<br>• Check for wear on striking surfaces and replace tools that are damaged or worn down. |
| **Holding & Supporting Tools** | • Clean vices and cramps after use to prevent rust and maintain grip.<br>• Ensure they are not overloaded during use to prevent damage. | • Lubricate moving parts and check the alignment periodically.<br>• Lubricate moving parts regularly to ensure smooth operation.<br>• Check alignment and tightening mechanisms periodically to ensure effectiveness.<br>• Replace any damaged or worn parts to maintain |



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## Essential Steps for Maintaining a Sharp Saw (Saw Sharpening)

The teeth of a saw require regular sharpening and reconditioning to maintain optimal cutting performance for key maintenance. There are four key steps for reconditioning a saw. These are :

1. **Topping (or Jointing)**: This step corrects uneven teeth heights. A flat file is used to level the tips of the teeth by filing across their tops. Hold the file square to the saw blade to achieve a uniform height. This process levels all saw teeth to prevent inaccurate cuts and binding, ensuring smooth performance.

**(a)** **(b)** **(c)**

**Figure 1.3.1:** Topping/jointing processes

2. **Re-shaping**: When teeth become irregular from frequent sharpening or are flattened after topping, re-shaping is necessary. Secure the saw in a vice with the gullets about 3 mm above it. Use a triangular file to file the gullets across, keeping the file perpendicular to the saw blade and at a 70°–80° angle to the front edges of the teeth. It restores irregular or worn teeth to their original profile, enhancing cutting ability and efficiency.

**Figure 1.3.2:** Re-shaping: Triangular file straight across. Front edges of teeth inclined at an angle of $70^0$ -$80^0$

3. **Setting**: To prevent the saw from jamming, adjacent teeth are bent to alternate sides, creating a slightly wider kerf. This setting is achieved using a plier saw-set or saw-setting hammer and should only affect the top 1/3 to 1/2

of each tooth. Irregularities are adjusted by filing lightly along each side of the teeth. The process bends alternate teeth outward to create a wider kerf, which prevents binding and allows for smoother cutting.

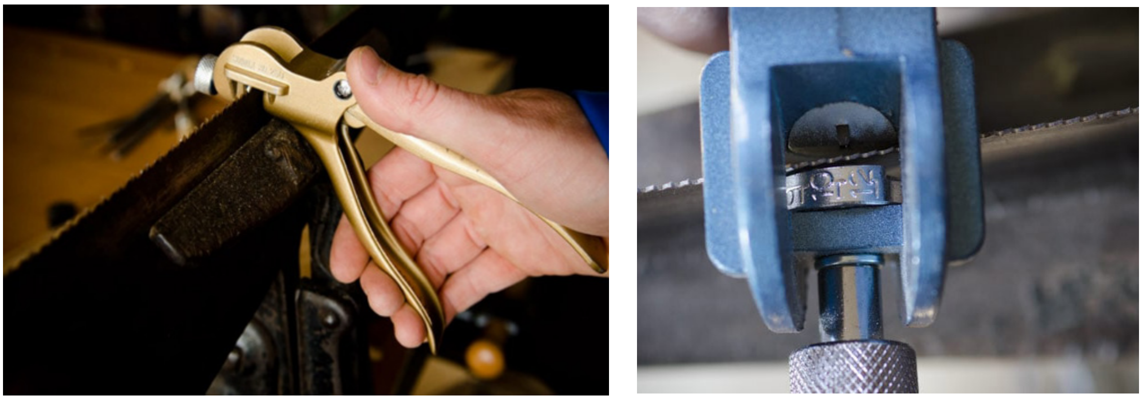

Figure 1.3.3: Setting: Bend the top half of each alternate tooth to opposite sides.

4. **Sharpening**: This step creates a pointed, knife-like edge on each tooth. Place the saw in a vice with about 3 mm of the teeth above the jaws. Starting from the toe of the saw, file each gullet at the correct angle. For general cross-cut saws, use a 45° angle; for hardwood-specific cross-cuts, a 60° angle is recommended to increase tooth strength. Ripsaws perform best with a 90° sharpening angle. The process hones the cutting edges to restore sharpness, improving cutting effectiveness and reducing user fatigue.

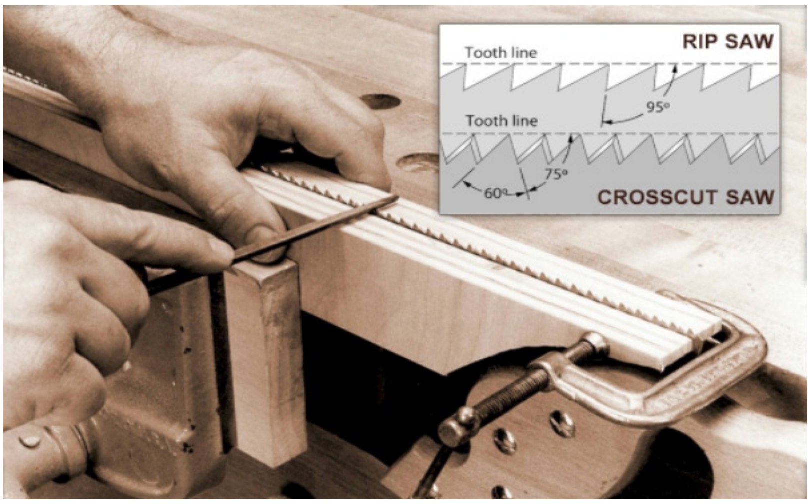


**Figure 1.3.4:** Sharpening. P176-1.jpg (1024×686)

## Sharpening Plane Blades and Chisels

Sharpening a cutting tool creates a fine edge for efficient cutting. This honing/whetting process involves rubbing the tool edge on an oilstone with oil to reduce friction, remove metal particles, and prevent clogging of the stone's pores. To effectively sharpen tools like plane blades and chisels, calls for the use of the following:

1. **Grinding Stone**: normally, a sandstone wheel mounted on a horizontal axle and submerged in a water bath, serves as an effective tool for sharpening. The water provides a constant coolant supply, preventing overheating, and

keeps the stone clean during use. Using water while grinding is essential for two main reasons:

**a.** It reduces heat from friction, which can ruin the tool's cutting edge by softening the steel.

**b.** It washes away metal and stone particles, allowing the stone to cut more efficiently.

It is important to wet the entire surface of the stone to avoid uneven wear, but do not leave the stone submerged in water, as this can soften it.

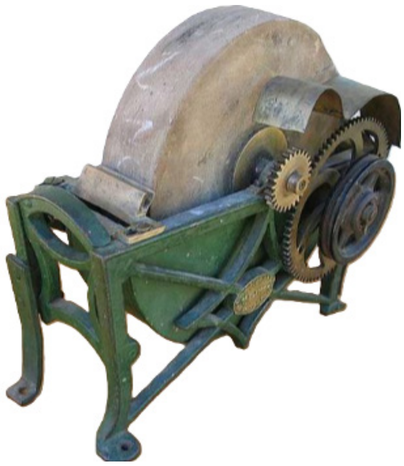

**Figure 1.3.5:** Grinding stone.

2. **Grinding Wheel**: A carborundum (silicon Carbide) wheel, also set on an axle, uses its circular edge for grinding. To avoid overheating, it is crucial to dip the grinding edge into a coolant periodically. This cooling process maintains the grinding efficiency and prolongs the lifespan of both the tool and the wheel. Regular inspection for wear, along with a balanced setup, ensures safe and precise operation.

**Figure 1.3.6:** Bench grinder.

3. **Oilstones**: These come in two types: natural and artificial. Natural stones, such as **Arkansas** and **Washita** are prized for their grit and durability. The Arkansas stones come in hard and soft grades, with the hard grade suitable for achieving extremely sharp edges required by precision tools like carving

tools and Washita stones, softer and faster cutting, are ideal for tools that do not demand such a fine edge. **Artificial stones** are made from materials like **silicon carbide** and **aluminium oxide**, bonded and shaped into various grades (fine, medium, and coarse). The commonly used **carborundum** and **India stones** are valued for their versatility and durability. It is best to store these stones in a solid wooden box with a lid and have a supply of lubricating oil on hand. Without lubrication, the stones can become clogged and ineffective for sharpening.

## Tips for Oilstone Care and Storage:

**a.** Keep the oilstone surface clean and moist with fresh oil.

**b.** Wipe off dirty oil immediately after sharpening.

**c.** Smooth any rough spots by rubbing the stone on wet sandstone, brick, or with water and emery powder.

**d.** Store the oilstone in a covered box for protection.


**Figure 1.3.7:** Arkansas


**Figure 1.3.8:** Washita


**Figure 1.3.9:** India stone

## Technique for Using Oilstone

**a.** Firmly hold the oilstone in a vice or against a stopper to stabilize it during use.

**b.** Use enough oil for the sharpening process. If using a coarse grit (soft stone), opt for water instead of oil.

**c.** Hold the cutting tool at a constant angle of 30°-35° against the oilstone and hone until a burr forms on the edge.

**d.** Flip the cutting edge over and gently rubs it flat against the oilstone to remove the burrs, ensuring a sharp edge.

**e.** Perform the honing and burr removal process several times to achieve the desired sharpness.

**f.** Use the full surface of the oilstone to prevent grooves from forming, promoting even wear of the stone.

**g.** Check the sharpness by lightly dragging the cutting edge against your fingernail; a sharp edge should not show any thickness.

**4. Sharpening Angles**: Most woodworking tools should be ground to an angle between 20° and 25°, then sharpened to an angle of 25° to 30° for optimal performance.



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## Grinding Plane Cutting Irons and Chisels

Grinding a cutting edge involves reshaping the worn edge to create a new level using a rotating grinding wheel or grindstone. Here is a guide on how to properly grind cutting tools:

1. Ensure the grinding machine is in good condition and that the grinding wheels are crack-free.
2. Set the tool rest close to the wheel to prevent the cutter or chisel from getting trapped.
3. Have water ready to quench the cutting-edge during grinding to prevent overheating.
4. Turn on the grinding machine and allow the wheel to reach full speed.
5. Hold the cutting edge against the rotating wheel at a consistent angle of 20°—25°.
6. Glide the cutting edge across the wheel's full width to avoid creating grooves.
7. Frequently dip the cutting edge in coolant to prevent overheating, which can soften the metal.

### Activity 1.3.1

#### Maintaining Hand Tools for Project Success

**Scenario:**

Your team has been assigned a picture frame project. First, you need to identify the woodwork hand tools needed to make the frame. Then, state two ways to care for and maintain these tools.

**Materials Needed:**

- A short video showcasing methods of tool care
- Woodwork hand tools for demonstration (e.g., saw, chisel, measuring tools)
- Cleaning supplies (e.g., brush, oil, cloth, oilstone, etc.)
- Worksheets for feedback and reflection

#### Activity Guidelines:

1. The whole class will watch a short video showcasing methods of tool care such as cleaning tools after each use and storing them properly.
2. The teacher will divide the class into pairs to identify and discuss at least two essential general ways to care for and maintain the woodwork hand tools needed in the picture frame project.
3. You will use guiding questions like:

a. Why is cleaning after each use important?
b. How does proper storage affect tool longevity?
c. What could happen if tools are not stored safely?
d. Each pair will briefly share their insights with the class.

4. Then, the teacher will place you in groups of 5 to discuss the importance of regular tool maintenance, focusing on safety, effectiveness and extending the lifespan of each tool. This is to ensure you understand how basic care practices can prevent accidents and ensure tools remain sharp and efficient.
5. Each group will choose a hand tool (e.g., chisel or saw) and members will demonstrate basic care and maintenance, such as cleaning, oiling, and proper storage, grinding or sharpening while following tips from the video.
6. The facilitator will give you a practical understanding of maintaining hand tools and let you experience the benefits of proper care firsthand.
7. The facilitator will guide and support you in practising maintenance, ensuring you follow safe and effective methods.

## Activity 1.3.2

### Essential Tool Care for Building a Wooden Bookshelf

**Scenario:**

Your team is tasked with building a simple wooden bookshelf in the woodwork shop. As part of this project, explain three important methods of caring for and maintaining the tools needed.

**Materials needed:**

- A short video showcasing on maintenance tool
- Various hand tools (e.g., saws, chisels, measuring tools) for demonstration
- Cleaning supplies (e.g., brush, cloth, oil)
- Worksheet or whiteboard for group notes and feedback

### Activity Guidelines:

1. Learners in pairs, watch a short video on hand tool care and maintenance.
2. After viewing, you and your partner will identify and discuss three key maintenance methods, such as cleaning after use, proper storage, and regular sharpening.
3. You will use these guiding questions to probe further their understanding:
   a. How does proper storage prevent rust?
   b. Why is sharpening important before use?



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4. After the discussions, share your findings with the class in a feedback session.
5. Then the teacher will place you in groups of 5 to discuss why these maintenance methods are essential for safe and effective tool use in the woodwork shop.
6. Each group will select a tool for their bookshelf project (e.g., a chisel) and you will each demonstrate one maintenance method, like cleaning or sharpening.
7. The facilitator will guide you in applying correct care techniques. Proficient learners will assist their groups by demonstrating the proper steps in tool care.

## Activity 1.3.3

### Tool Care Techniques for Effective Woodwork Maintenance

**Scenario:**

Your team has been assigned three tools-rip saw, mortise chisel, and jack plane. Demonstrate how to care for and maintain any two of these tools.

**Materials needed:**

- Video on tool care and maintenance
- Rip saw, mortise chisel, jack plane
- Cleaning cloths, oil, sharpening stone

### Activity Guidelines:

1. In pairs, watch a short video on caring for hand tools, focusing on cleaning, sharpening, and storing techniques. Afterwards, discuss with your partner two key methods shown in the video.
2. The facilitator will ask you this guiding question: “How does regular cleaning affect tool performance?”
3. With your partner share your insights with the whole class.
4. The teacher will place you in groups of 5 where you will discuss why maintaining tools is essential, especially for the rip saw, mortise chisel, and jack plane.
5. Each group will select one of the tools provided and each member will demonstrate a care method, like oiling, cleaning, or sharpening.
6. The facilitator will monitor the demonstration, ensuring that you practice safe and proper maintenance techniques.

## Conclusion

In conclusion, proper care and maintenance of hand tools, such as regular cleaning, sharpening, and correct storage, are vital to keep them in good working condition. These practices outspread the tools' lifespan, ensure safe operation, and improve work quality in the woodwork shop. By following these maintenance methods, tools remain reliable, safe, and ready for use in any project.

# UNIT 4

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

Setting out is a very important process that increases the successful and accurate construction of the substructure of a building. In this unit, you will be learning about how the designs of buildings on drawing sheets are interpreted into the actual activity of building construction. Because setting out is intended to put the ideas that are in the building design into practice, you will study the importance of measurement and its application in ensuring accurate dimensioning and position of the various of the building. You will also be introduced to the various methods and techniques that are usually employed at construction sites to achieve effective and successful construction of substructure buildings.

### KEY IDEAS

- **Accuracy and Verification:** This highlights the importance of maintaining accuracy throughout the setting out process through continuous level checks, implementing checks and balances, and establishing temporary benchmarks to ensure the building is positioned and constructed correctly.
- **Planning and Interpretation:** This encompasses the initial site survey, site planning, and the crucial step of accurately interpreting the building drawings to understand the project's spatial requirements.
- **Precise Ground Demarcation:** This focuses on the practical execution of transferring the design onto the physical site. It includes establishing reference points, determining the building's dimensions and outline, and accurately positioning the foundation and walls.

## SETTING OUT AND REASONS FOR IT

The concept of setting out a building refers to the process of marking the precise location and dimensions of a building on the ground before construction begins. This crucial step ensures that the building is constructed in the correct position, orientation, and alignment according to the architectural plans.

There are several reasons why setting out is taken as a very serious stage in the field of building construction. Building structures involves a lot of financial undertakings

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for which care needs to be taken to avoid financial loss. It is important that setting out is conducted accurately thereby avoiding mistakes. Whenever a setting out is wrongly done, it can result in the cancellation of the whole project and end up losing money and other investments. As you start the study of setting out, it is necessary that you become familiar with reasons why setting out must be a one-time effort. The following are some of the main reasons for setting out as indicated in **Table 1.4. 1**.

**Table 1.4.1:** Reasons for setting out

| Reason | Explanation |
|---|---|
| Accuracy | Ensures the building is constructed precisely according to the design plans, preventing costly errors and structural issues. |
| Boundary Definition | Clearly marks the legal boundaries of the construction site, avoiding encroachment on neighboring properties. |
| Alignment | Ensures that all parts of the structure are correctly aligned, maintaining the integrity of the design and function. |
| Structural Integrity | Provides accurate reference points for the foundation and other critical components, supporting overall stability. |
| Compliance | Ensures adherence to building codes, regulations, and zoning laws, preventing legal complications and ensuring safety. |

The setting-out process is expected to aid and guide workers as they begin construction work. Usually, the nature of setting out demands that the construction works remain within the legal boundary such that no disputes arise regarding property boundaries and rights of access. As indicated in **Table 1.4.1**, setting out ensures compliance with regulatory requirements, building codes, and safety standards. Since setting out is a critical phase in construction work, precision according to the design is expected to minimise errors and discrepancies

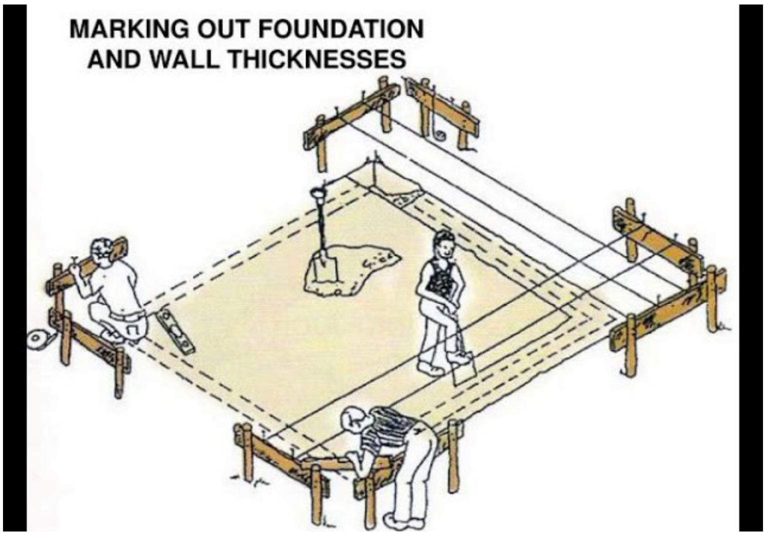


**Figure 1.4.1:** A Typical setting out process of marking out the foundation and wall thickness

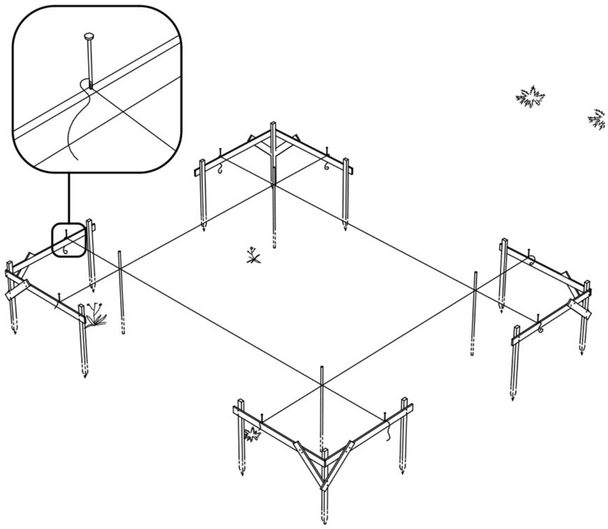

**Figure 1.4.2:** A setting out the corners of a building

## Activity 1.4.1

Your teacher will arrange a field trip to a construction site where you will be introduced to the activities involved in setting out. At the site, you will carry out the following activities:

1. Observation of all the methods of setting out being undertaken at the site.
2. Interacting with the professionals and listening attentively to explanations and other information being provided.
3. Write down all key points and take snapshots of the major activities going on.

## The tools, plant and equipment available for setting out a building

Setting out a building requires various tools, plants, and equipment to ensure accuracy and efficiency. The tools and equipment commonly used for setting out are outlined in **Table 1.4.2.**

**Table 1.4.2:** Tools, plant and equipment required for setting out

| Tools | Uses |
|---|---|
| **Measuring Tape** | For measuring distances accurately |
| **Surveying Instruments** | • **Total Station:** Combines electronic distance measurement and angle measurement for precise surveying.<br>• **Theodolite:** Used for measuring horizontal and vertical angles.<br>• **Level:** Ensures the ground is level and helps set reference points. |

| | |
|---|---|
| **Plumb Bob** | A simple tool for ensuring vertical alignment |
| **Chalk Line** | Creates straight lines over long distances for marking boundaries |
| **Spirit Level** | Ensures surfaces are horizontal or vertical |
| **Square (Carpenter's Square)** | Used to check right angles and ensure corners are square |
| **Plant** | **Uses** |
| **Excavators** | For digging foundations and preparing the site |
| **Bulldozers** | Used for levelling the ground and site preparation |
| **Dump Trucks** | For transporting materials to and from the site |
| **Equipment** | **Uses** |
| **GPS Equipment** | Provides high-accuracy positioning for setting out. |
| **Laser Level** | Projects a level line over long distances for accurate height measurement |
| **Site Plans and Drawings** | Essential for reference during the setting out process. |
| **Stakes and Marking Paint** | Used to mark points and lines on the ground. |
| **String or Twine** | Helps create straight lines between reference points |
| **Accessories** | **Uses** |
| **Hammers and Mallets** | For driving stakes into the ground |
| **Surveying Rods** | Used in conjunction with levelling instruments to measure height |
| **Field Notebook** | For documenting measurements and observations during the setting out process |

## Activity 1.4.2

Undertake research through the internet and use YouTube to carefully observe and note the following:

1. Step-by-step demonstrations of all setting out procedures practically in the video.
2. Note down the descriptions presented alongside the video to enable you to see the link between theoretical and practical applications.
3. Participate in a general class discussion on your understanding of the course.

## The categories of the different methods adopted for setting out a building

The methods adopted for setting out a building can be c categorised into several key approaches. Each method has its applications and is chosen based on project requirements, site conditions, and available resources. Here are the main categories:

**Table 1.4.3:** Main categories for setting out a building

| Methods | Details |
|---|---|
| **Traditional Methods** | • ***Tape Measurement Method:***<br>Uses measuring tapes to establish reference points and measure distances directly on the ground. Often combined with chalk lines for marking.<br>• ***Theodolite Method:***<br>Involves using a theodolite to measure angles and establish points based on horizontal and vertical angles. |
| **Surveying Methods** | • ***Total Station Method:***<br>Utilises a total station for precise measurements of angles and distances, allowing for the creation of accurate site plans. This method is highly efficient and can be used for complex layouts.<br>• ***GPS Surveying:***<br>Involves the use of Global Positioning System (GPS) technology for high-accuracy positioning, ideal for large sites or areas where traditional methods are challenging |
| **Geometric Methods** | • ***Triangulation Method:***<br>Involves creating a network of triangles to establish control points. By measuring the sides and angles of the triangles, precise locations can be determined.<br>• ***Offset Method:***<br>Uses a baseline to establish offsets for laying out lines or points parallel to a reference line, commonly used for roads and large buildings |
| **Digital Methods** | • ***Building Information Modelling (BIM):***<br>Advanced digital techniques that integrate 3D modelling with setting out processes. BIM can generate accurate site layouts and facilitate the setting-out process through digital tools.<br>• ***Laser Scanning:***<br>Employs laser technology to capture detailed 3D measurements of the site. This method is useful for complex geometries and existing structures |
| **Hybrid Methods** | • ***Combination of Tools and Techniques:***<br>Many projects use a combination of traditional, surveying, and digital methods to enhance accuracy and efficiency. For example, combining GPS with traditional measuring tools to validate site layouts |

**Activity 1.4.3**

You will be divided into groups of five. In your groups, discuss the following:

1. The activities involved in the specific methods of setting out.
2. The effects of the various methods of setting out on the building

## The major activities undertaken during the setting out process.

The major activities undertaken from the start to the end of a setting out process include steps to serve as checks and balances on the setting out exercise. During the setting out process, several key activities are performed to ensure accuracy and reliability. These activities serve as checks and balances to prevent errors and ensure that the construction aligns with design specifications. Here are the major activities involved:

**Table 1.4.4:** Major activities of setting out

| Activities | Details |
|---|---|
| **Establishing Control Points** | • **Activity:** Set fixed reference points on the site using surveying instruments (like total stations or GPS).<br>• ***Check:*** Verify the accuracy of these points against known coordinates or site plans |
| **Creating a Grid Layout** | • **Activity:** Use strings and stakes to create a grid that outlines the building footprint.<br>• ***Check:*** Measure distances and angles to confirm that they match the architectural plans, ensuring the grid is square and aligned |
| **Verification of Dimensions** | • **Activity:** Measure all key dimensions of the layout with a measuring tape or laser distance measurer.<br>• ***Check:*** Compare measurements with the plans, and use methods like the 3-4-5 triangle to verify right angles |
| **Marking the Footprint** | • **Activity:** Mark the outline of the building on the ground using paint, stakes, or chalk.<br>• ***Check:*** Review the marked outline against the original plans to ensure all features (like walls and openings) are accurately represented |
| **Checking Elevation Levels** | • **Activity:** Use levels or laser levels to establish elevation points for the foundation.<br>• ***Check:*** Cross-verify elevation points to ensure they are consistent with design specifications |
| **Reviewing Site Conditions** | • **Activity:** Inspect the site for existing conditions that might affect the layout (e.g., trees, slopes, or utilities).<br>• ***Check:*** Confirm that any necessary adjustments to the layout have been made and documented |

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|---|---|
| **Documentation and Record Keeping** | • **Activity:** Maintain detailed records of measurements, adjustments, and observations during the setting out process.<br>• ***Check:*** Periodically review documentation to ensure all aspects of the setting out are accurately captured and can be referenced later |
| **Final Verification** | • **Activity:** Conduct a final walkthrough of the layout with the project team, including architects and engineers.<br>• ***Check:*** Ensure that everyone agrees with the marked layout before proceeding with construction |

## The Checks and Balances of Setting Out and Their Impact on the Building Project

The checks and balances of the setting out process have significant impacts on the overall success and quality of a building project. The following are the various aspects:

### 1. Accuracy and Precision

**Impact:** Ensuring that all measurements and alignments are accurate prevents misalignment during construction. This accuracy is needed to ensure the integrity of structural elements, such as walls, foundations, and roofs.

### 2. Structural Integrity

**Impact:** Proper setting out helps maintain the structural integrity of the building. Accurate placement of foundations and load-bearing walls is essential to distribute loads effectively, preventing future settlement issues or structural failure.

### 3. Cost Efficiency

**Impact:** Effective checks and balances reduce the risk of errors that can lead to costly rework. Identifying issues early in the setting out process saves time and materials, contributing to a more efficient budget and timeline.

### 4. Compliance with Regulations

**Impact:** Adhering to checks ensures that the building meets local zoning laws and building codes. Compliance is crucial for obtaining necessary permits and avoiding legal issues, which could delay the project.

### 5. Quality Control

**Impact:** The systematic approach to checks and balances acts as a quality control mechanism. By verifying dimensions, angles, and elevations, the quality of the construction is upheld, leading to a better-finished product.

## 6. Construction Efficiency

**Impact:** Clear and accurate layout facilitates smoother operations on-site. When workers have a reliable framework to follow, tasks like excavation, foundation pouring, and framing can proceed without confusion or delay.

## 7. Future Modifications and Expansions

**Impact:** A well-set-out building provides a clear reference for future modifications or expansions. Accurate documentation and marking allow for easier planning of additions or changes.

## 8. Safety

**Impact:** Proper setting out reduces the likelihood of accidents caused by construction errors. Ensuring that all elements are correctly positioned helps maintain a safe working environment for construction workers.

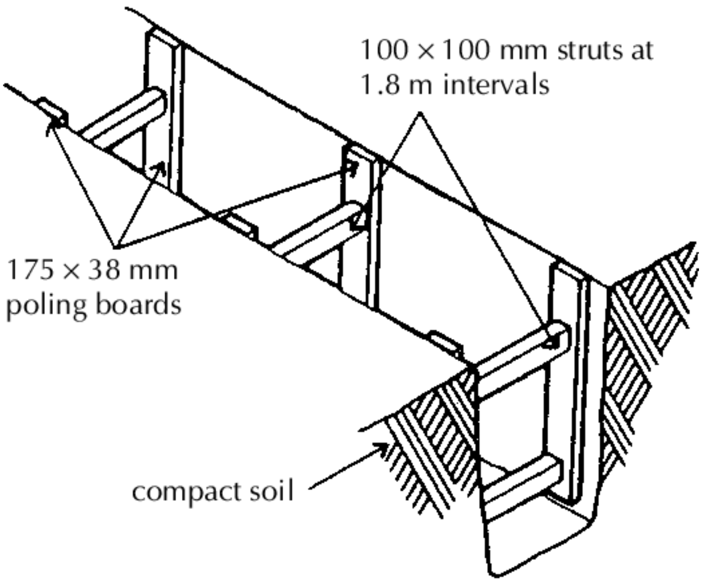


**Figure 1.4.3:** Setting out

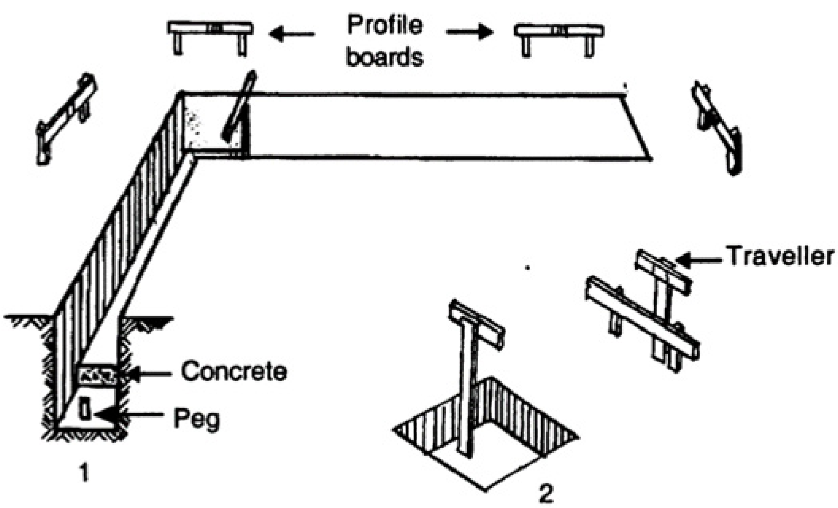


**Figure 1.4.4:** A guide on measurement and setting out practices

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## EXTENDED READING


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# Review Questions

## Questions 1.1

1. Your team is preparing to cut wood accurately for a project. Which tool would you use for each of the following tasks?
   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. Before using a jack plane to smooth a piece of wood, what is one adjustment you should make to ensure effective use?
3. Your team needs to cut a large hole in the centre of a plywood sheet. Which tools would you use, and how would you do it?
4. How do you choose the correct hand tool for a woodwork task?
5. Why is it important to use the correct tool for each operation?
6. What should you check before using any hand tool?

## Questions 1.2

1. Outline the various components of the substructure.
2. Explain what is meant by the substructure of a building.
3. Discuss the functions of the various components of a substructure of a building.

## Questions 1.3

1. Imagine you are in a workshop cleaning up after a project. What are two general ways you would care for and maintain the hand tools you used?
2. While cleaning up in the workshop, you notice a saw blade is starting to rust. What would you do to prevent further rusting?
3. You are preparing a saw for a woodworking project and notice the teeth are uneven and dull. Why is it important to go through the steps of topping, re-shaping, setting, and sharpening?
4. While working in the workshop, you find a blunt rip saw, a dull jack plane blade, and a firmer chisel that needs sharpening. How would you sharpen each of these tools?
5. Why is regular cleaning important for hand tools?

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6. How does proper storage affect the lifespan of hand tools?
7. Why should hand tools be sharpened periodically?

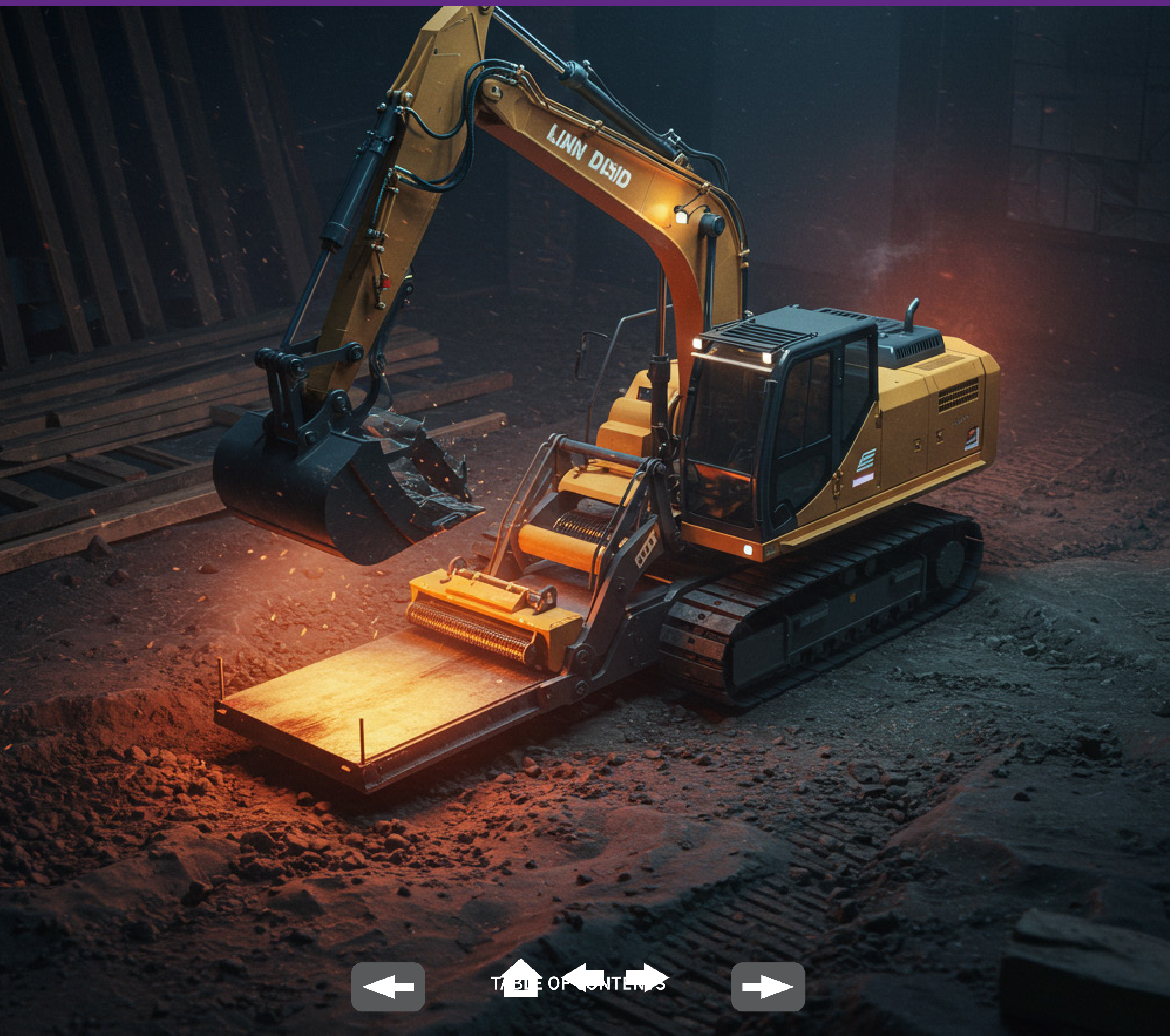
## Questions 1.4

1. Outline the popular methods used in setting out a building.
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. 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.

SECTION

# 2

# WOODWORK MACHINES, EXCAVATION AND FOUNDATIONS



# UNIT 5

# WOODWORK TECHNOLOGY

## Tools and Machines in the Woodwork Industry

## Introduction

Deciding on the right machine for specific woodwork tasks is important in woodworking. Woodworking machines are tools used to process wood in the industry. They are usually powered by electric motors and help shape, cut, carve, and create intricate designs on wood. Understanding how to select and use these machines properly is essential for producing high-quality work and developing skills in woodworking. By learning this, you will become more confident and efficient in your woodwork projects.

**KEY IDEAS**

- In woodworking, specific machines are chosen based on the task to be done.
- Woodworking machines, usually powered by electric motors, are essential for shaping, cutting, carving, and adding detailed designs to wood.
- Selecting the right machine for each job is crucial to completing tasks accurately and efficiently.

## WOODWORK MACHINES

Woodworking machines, powered by electric motors, are essential tools in the woodworking industry for shaping, cutting, carving, and creating intricate or complex designs on wood. These machines are divided into two main categories: handheld power machines and stationary machines, both of which enable diverse woodworking projects and, with practice, can produce beautiful and functional pieces.

Before operating any woodworking machinery, you must follow these general safety guidelines:

1. Wear appropriate safety gear: Safety glasses, hearing protection, dust mask, and sturdy work gloves are essential.
2. Inspect the machine: Ensure it's in good working condition, free of damage, and properly lubricated.
3. Clear the work area: Remove any debris or obstructions that could cause accidents.

4. Secure the workpiece: Use clamps or hold-downs to keep the workpiece stable.
5. Avoid loose clothing: Tie back long hair and refrain from wearing loose-fitting clothing that could get caught in the machinery.
6. Stay alert and focused: Avoid distractions and maintain concentration.
7. Know the machine: Understand its capabilities and limitations.
8. Regularly maintain the machine: Keep it clean and well-maintained.

The machines that will be discussed follow along with pictures of them to show what they look like.

## Crosscut Saw Machine

A **crosscut saw machine** is a versatile woodworking tool designed to accurately cut wood across the grain. It's primarily used for cutting boards, planks, or beams to length, but it can also perform angled cuts, trenching, tenoning, and ploughing with specialised cutters. This machine is essential for various woodworking and carpentry tasks, providing precision and efficiency in cutting wood to the desired shape and size.

Below is a description of the features of the machine followed by a picture of it:

1. **Extension Table**s: Durable, powder-coated steel tables for non-roller applications.
2. **Measuring System**: Aluminium rail with clear markings; smooth sliding for precise stops.
3. **Blade Cover**: Interlocked to prevent starting without cover for safety.
4. **Manual Clamp**s: Guarded to avoid pinch points, hold materials in place, and seal dust in.
5. **Plexiglass Cove**r: Protects operator while allowing full visibility of the cutting area.
6. **Dust Collection Port**: Rear port connects to the dust system (**900 Cubic Feet of air per Minute** [CFM] minimum).
7. **Beam, Carriage, Motor**: Heavy steel beam, smooth carriage on rollers, and a reliable 5 or 7.5 HP motor.
8. **Operator Handle**: Provides manual control on non-automatic models.
9. **Adjustable Handle**: Easily customized for user comfort.
10. **Control Panel**: Centralised and easy to operate.
11. **Electrical Access Door**: Safe, easy access to electrical components.



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**Figure 2.5.1:** Crosscut saw machine.

## Procedure for Crosscutting

1. **Check the Blad**e: Ensure the crosscut saw blade is securely mounted.
2. **Set Blade Height**: Adjust the blade height to 6mm above the workpiece.
3. **Adjust the Fence**: Position the fence to allow the workpiece to pass freely.
4. **Position the Mitre Gauge**: Set the mitre gauge to 90 degrees for straight cuts.
5. **Engage Safety Guard**: Ensure the blade guard is in place.
6. **Power On**: Turn on the machine.
7. **Make the Cut**:
   a. **Support the Workpiece:** Hold the workpiece firmly against the mitre gauge.
   b. **Guide the Cut:** Slowly and steadily push the workpiece into the rotating blade.
   c. **Use Push Sticks:** Use push sticks for safety, especially when cutting smaller pieces.
8. **Cutting Multiple Piece**s:
   a. Set the Fence: Clamp a wooden block to the fence to set the desired cutting length.
   b. Support the Workpiece: Position the workpiece against the mitre gauge and block.
   c. Make the Cut: Push the workpiece and mitre gauge into the rotating blade.
9. **Power Off**: Turn off the machine after completing the cuts.

## Procedure for Trenching

1. **Mount the Crosscutting Saw**: Securely attach the crosscutting saw blade to the saw arbour.
2. **Adjust the Fence**: Position the fence to the desired width of the trench.
3. **Set the Mitre Gauge**: Align the mitre gauge to a 90-degree angle for straight cuts.
4. **Adjust Cutting Depth**: Set the saw blade's depth of cut to the desired depth of the trench. Ensure the blade guard is properly positioned.
5. **Power On**: Turn on the saw machine.
6. **Cutting Process**:
    a. **Support the Workpiece:** Securely support the workpiece against the miter gauge.
    b. **Make the Cut:** Carefully guide the workpiece into the saw blade.
    c. **Repeat Cuts:** Make successive cuts, adjusting the workpiece's position, until the desired trench width is achieved.
    d. **Use Push Sticks:** Use push sticks to guide the workpiece safely, especially when cutting small pieces.
7. **Power Off**: Turn off the machine after completing the trenching operation.

# Circular Saw

A **circular saw** is a versatile power tool used for cutting wood. It is primarily used for ripping lumber (cutting along the grain) to achieve desired widths (flatting) and depths (deepening), as well as crosscutting (cutting across the grain) and cutting sheet goods like plywood. The machine typically has a sturdy cast iron or steel base with a table, allowing for precise cuts. The saw assembly can be adjusted to different heights using a handwheel.

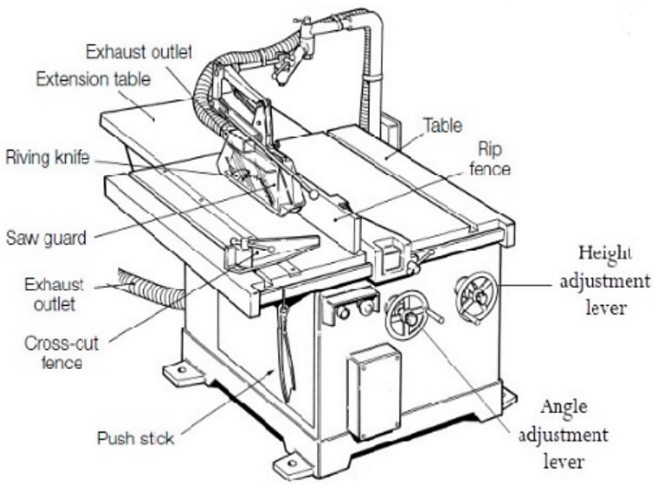


**Figure 2.5.2:** Circular saw machine.

## Main features of circular saw machine:

1. **Blade**: The toothed circular blade that performs the cutting.
2. **Spindle**: The shaft that holds the blade and rotates it.
3. **Motor**: Provides power to the blade.
4. **Upper Handle**: The main handle is used to grip and control the saw.
5. **Lower Handl**e: Provides additional support and control.
6. **Depth Adjustment Lever**: This allows you to adjust the depth of the cut.
7. **Bevel Adjustment Leve**r: This allows you to adjust the angle of the cut.
8. **Blade Guard:** Protects the user from the moving blade.
9. **Dust Port**: Connects to a dust collection system to reduce mess.
10. **Base Plat**e: The flat bottom of the saw that rests on the workpiece.

# Dimension Saw Bench

A **dimension saw bench** is a versatile woodworking tool that can perform a variety of precise cutting operations. It is capable of crosscutting, ripping, bevelling, compound bevelling, grooving, mitring, and rebating. This machine is essential for achieving accurate dimensions and intricate cuts in woodworking projects. It is used in woodworking for:

1. **Ripping**: Cutting wood along the grain.
2. **Crosscutting**: Cutting wood across the grain.
3. **Angled/Mitre Cut**s: Making precise angled cuts.
4. **Grooving**: Cutting narrow channels.
5. **Bevel Cuts**: Adjusting blade angle for sloped cuts.

**These are the key components of the Dimension saw bench**:

1. **Saw Blade**: A circular saw blade mounted on a spindle, responsible for cutting the wood.
2. **Spindle**: The shaft that holds and rotates the saw blade.
3. **Motor**: Provides the power to drive the saw blade.
4. **Table**: A sturdy, flat surface where the workpiece is placed for cutting.
5. **Fence**: A movable guide that ensures straight cuts.
6. **Mitre gauge**: A device that allows for angled cuts.
7. **Rip fence**: A specialised fence for making long, straight cuts along the grain of the wood.
8. **Dust collection system**: A port or hood that connects to a dust collection system to remove sawdust and debris.

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9. **Blade guard**: A safety feature that protects the operator from the moving blade.
10. **Spindle lock**: A mechanism that locks the spindle in place, allowing for easy blade changes.


**Figure 2.5.3:** Dimension saw bench

# Procedure for cutting a groove

## Safety First

- Always wear appropriate safety gear, such as safety glasses and hearing protection.
- Use a sharp, clean blade designed for ripping.
- Ensure the blade guard is securely in place and adjusted correctly.
- Verify that the anti-kickback finger is functioning properly.
- Have push sticks ready to guide the workpiece safely.

## Grooving Process

1. Clamp the workpiece firmly to the saw bench table, ensuring it's stable and secure.
2. Position the fence to the desired width of the groove.
3. Adjust the saw blade height to the desired depth of the groove.
4. Ensure the blade guard is in place to protect you from the blade.
5. Turn on the saw bench.
6. Slowly and carefully feed the workpiece into the spinning saw blade, guiding it along the fence.
7. Once the groove is cut, turn off the saw bench.

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## Procedure for Ripping

1. Clamp the workpiece firmly to the saw table, ensuring it is stable and won't move during the cut.
2. Position the fence to the desired width of the rip cut.
3. Adjust the blade height to slightly above the thickness of the workpiece.
4. Ensure the blade guard is in place and adjusted to cover the blade.
5. Turn on the saw bench.
6. Slowly and steadily feed the workpiece into the spinning blade, using a push stick to guide the wood.
7. Keep a firm grip on the workpiece and push-stick, guiding the wood smoothly through the blade.
8. Continue feeding the workpiece until the desired length is reached.
9. Once the cut is complete, turn off the saw bench.

## Procedure for Bevel cuts

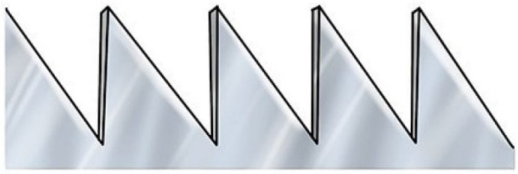
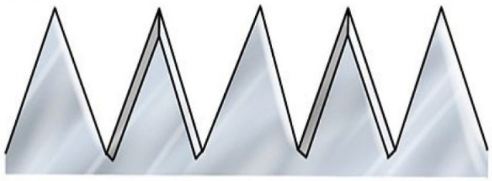
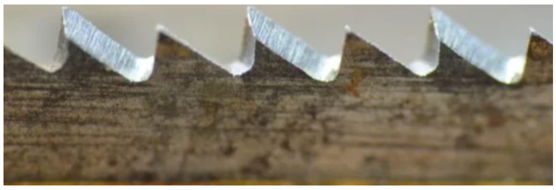
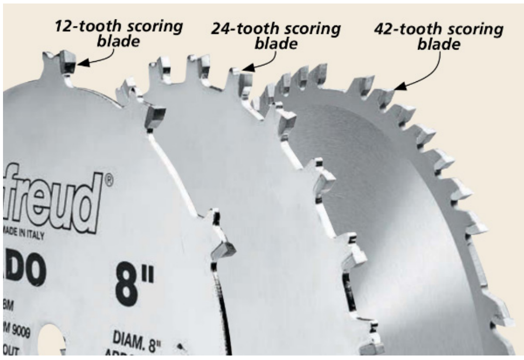
1. Set the mitre gauge to the desired bevel angle.
2. Clamp the workpiece firmly to the saw table, ensuring it's stable and won't move during the cut.
3. Adjust the blade height to slightly above the thickness of the workpiece.
4. Ensure the blade guard is in place and adjusted to cover the blade.
5. Turn on the saw bench.
6. Slowly and steadily feed the workpiece into the spinning blade, guiding it along the mitre gauge. Use push sticks to guide the wood safely.
7. Continue feeding the workpiece until the desired cut is complete.
8. Turn off the saw bench.

## Procedure for Angled/Mitre cuts

1. Set the Mitre gauge to the desired angle.
2. Clamp the workpiece firmly to the saw table, ensuring it's stable and won't move during the cut.
3. Adjust the blade height to slightly above the thickness of the workpiece.
4. Ensure the blade guard is in place and adjusted to cover the blade.
5. Turn on the saw bench.
6. Slowly and steadily feed the workpiece into the spinning blade, guiding it along the mitre gauge. Use push sticks to guide the wood safely.
7. Continue feeding the workpiece until the desired cut is complete.
8. Turn off the saw bench.

# Saw Blades

Saw blades are crucial components in woodworking tools. Their tooth design determines their cutting capabilities.

| S/N | SAW BLADE TEETH WITH DESCRIPTION | SKETCHES |
|---|---|---|
| 1 | **Ripsaw Teeth:** Ideal for cutting along the grain of wood. They have large, angled teeth for efficient material removal. |  Rip Teeth |
| 2 | **Crosscut Teeth:** Designed for cutting across the grain. They have smaller, more frequent teeth for precise cuts. |  Crosscut Teeth  |
| 3 | **Novelty Type Teeth**: Specialised saw blades for unique cuts, including:<br>• **Dado Blades:** For cutting grooves of specific width and depth.<br>• **Ploughing Blades:** For creating edge rebates or grooves.<br>• **Tenoning Blades:** For cutting tenons for mortise joints. |   |
| 4 | **Carbide-Tipped Teeth**: These are highly durable, and ideal for cutting tough materials like hardwood, plywood, etc. It resists wear, lasts longer than steel; delivers precise cuts with minimal chipping; allows higher cutting speeds and is suitable for wood. |   |

## Packing Saw Blades

Packing saw blades are large, flat blades designed for cutting large pieces of wood, especially lumber. They are typically used on stationary saw benches.


**Figure 2.5.4:** Packing saw blade

## Push-Sticks

Push sticks are safety tools used to guide the workpiece through the saw blade, especially when cutting small pieces or when the workpiece is too close to the blade. They prevent fingers from coming into contact with the blade.

**Figure 2.5.4:** Push-sticks.

# Narrow Band Saw

A **narrow band saw** is a versatile woodworking tool that uses a continuous, narrow blade to cut intricate shapes in wood and other materials. It's ideal for curved cuts, straight cuts, and combinations of both.

This machine is widely used in various settings, including:

1. **Woodworking shops**: For general woodworking tasks.
2. **Cabinet shops**: For creating custom cabinetry components.
3. **Patternmaker's shops**: For crafting intricate patterns and moulds.
4. **Sample maker's shops**: For producing prototypes and samples.
5. **Schools**: For woodworking education and training.
6. **Timber industry**: For cutting logs into planks, boards, and smaller sections.


**Figure 2.5.5:** Narrow bandsaw blades


**Figure 2.5.6:** Narrow Bandsaw

## Key Parts of a Narrow Band Saw

1. **Top Pulley Guard**: Encloses the top pulley to prevent accidental contact and to contain sawdust.
2. **Tracking Device**: This keeps the blade aligned with the pulleys to ensure smooth operation and prevent blade breakage.
3. **Saw Tensioning Wheel**: Adjusts the tension on the blade to optimise cutting performance and prevent blade breakage.
4. **Saw Blade Guard**: Protects the operator from the moving blade.
5. **Fence**: A guide that helps maintain straight cuts.
6. **Table**: The flat surface where the workpiece is placed.
7. **Bottom Pulley Guard**: Encloses the bottom pulley to prevent accidental contact and to contain sawdust.

# Surface Planer

A **surface planer** (or thickness planer) is a woodworking machine that flattens and smooths one face of timber to a precise thickness, producing a straight, flat surface and a 90° edge. It's essential for accurate surfacing, and edging, and can also handle tasks like rebating, bevelling, and tapering.

## Uses of a Surface Planer

1. **Thicknessing:** Reducing the thickness of a board to a specific dimension.
2. **Flattening:** Removing unevenness and cupping from a board's surface.
3. **Smoothing:** Creating a smooth, finished surface ready for further processing.

## Key Parts of a Surface Planer

1. **Outlet Table:** The flat surface where the wood exits after being planed, ensuring a smooth and even finish.

2. **Bridge Guard:** A safety guard covering the cutting blades to protect the user during operation.
3. **Fence:** A guide that holds the wood at a consistent angle, typically 90°, for accurate edging.
4. **Inlet Table:** The surface where wood is fed into the planer for initial cutting and levelling.
5. **Control Board:** The panel with controls to operate and adjust the planer's functions.
6. **Knob for Table Height Adjusting:** A knob is used to set the table height, controlling the thickness of the woodcut.

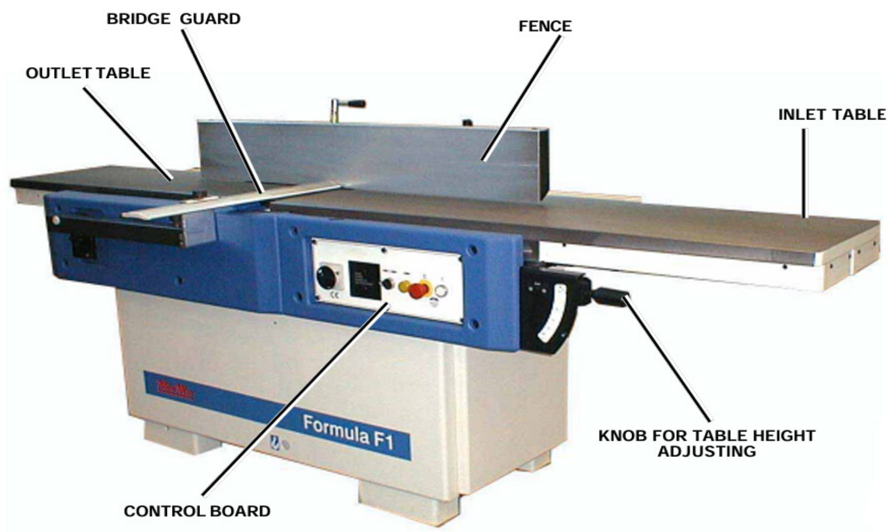



**Figure 2.5.7:** Surface planer.

## How a Surface Planer works

1. **Feeding the Wood:** The workpiece is placed on the inlet table and pushed against the feed rollers.
2. **Cutting:** The feed rollers pull the wood into the cutter head, where the blades remove material.
3. **Smoothing:** The planed surface exits the machine on the outlet table, ready for further processing.

# Thicknesser Machine

A **Thicknesser machine** (or planer Thicknesser) is a woodworking tool designed to plane timber to a precise, uniform thickness. With an adjustable table below the cutter block, it uses powered feed rollers and anti-friction rollers to guide the wood, ensuring even thickness, especially useful for joinery and other projects. Beyond thicknessing, its functions include flattening warped or uneven boards and creating a smooth, ready-to-finish surface.


**Figure 2.5.8:** Thicknesser machine.

## Key Parts of a Thicknesser Machine

1. **Infeed Table:** The flat surface where the workpiece is placed before entering the machine.
2. **Outfeed Table:** The surface where the workpiece exits the machine after being planed.
3. **Cutterhead:** A rotating cylinder with sharp blades that remove material from the workpiece.
4. **Feed Rollers:** These rollers pull the workpiece through the cutter head at a consistent speed.
5. **Depth of Cut Adjustment:** A lever or knob that controls the amount of material removed with each pass.
6. **Dust Collection Port:** Connects to a dust collection system to keep the work area clean.

## How a Thicknesser Machine Works

1. **Feeding the Wood:** The workpiece is placed on the infeed table and pushed against the feed rollers.
2. **Cutting:** The feed rollers pull the wood into the cutter head, where the blades remove material from the top surface.
3. **Smoothing:** The planed surface exits the machine on the outfeed table, ready for further processing.

# Combined Surfacing and Thicknesser Machine

A **combined surfacing and thicknesser machine** is a versatile woodworking tool that combines a surface planer and thickness planer in one, saving workshop space. This makes it ideal for both professional woodworkers and hobbyists. It features two tables—an upper split table for surfacing, edging, and edge jointing, and a lower table on vertical slides for thicknessing. The machine uses a single cutter block for both

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operations, allowing only one function at a time. It is ideal for flattening one side of a board (surfacing), reducing a board to a precise thickness (thicknessing), and joining the edges of boards together to create larger panels (edge jointing).

## Key parts of a combined surfacing and thicknesser machine

1. **Infeed table:** The flat surface where the workpiece is placed before entering the machine for surfacing.
2. **Outfeed table:** The surface where the workpiece exits the machine after being surfaced.
3. **Cutterhead:** A rotating cylinder with sharp blades that remove material from the workpiece.
4. **Feed Rollers:** These rollers pull the workpiece through the cutterhead at a consistent speed.
5. **Depth of cut adjustment:** A lever or knob that controls the amount of material removed with each pass.
6. **Dust collection port:** Connects to a dust collection system to keep the work area clean.
7. **Thicknessing table:** A separate table for feeding the workpiece into the machine for thicknessing.
8. **Thicknessing feed rollers:** Pull the workpiece through the cutterhead for thicknessing.

**Figure 2.5.9:** Combined Surfacing and Thicknesser Machine.

## Safety measures to observe when using the machines described

1. **Blade guard:** Always use the blade guard to protect yourself from the rotating blade.

2. **Kickback prevention:** Use push sticks to guide the workpiece and prevent kickback.
3. **Material handling:** Be cautious when handling large or heavy pieces of wood.
4. **Blade alignment:** Ensure the blade is properly aligned to prevent binding and kickback.
5. **Dust collection:** Use a dust collection system to reduce exposure to wood dust.

## Portable Power Hand Machines

They are electrically powered tools designed for easy handling and use both in workshops and on construction sites. Essential for woodworking, they offer versatility, portability, and precision, enhancing the woodworker's range and quality of work. Having a variety of these tools available allows for improved efficiency and craftsmanship across various tasks.

**Examples are:**

### 1. Portable power circular handsaw:

#### Uses

a. Cutting wood, plywood, and other materials.
b. Making straight, crosscuts, and bevel cuts.
c. Demolishing structures or cutting through framing materials.

#### Parts

a. **Blade:** The toothed circular blade that performs the cutting.
b. **Spindle:** The shaft that holds the blade and rotates it.
c. **Motor:** Provides power to the blade.
d. **Upper Handle:** The main handle is used to grip and control the saw.
e. **Lower Handle:** Provides additional support and control.
f. **Depth Adjustment Lever:** Allows you to adjust the depth of the cut.
g. **Bevel Adjustment Lever:** Enables you to adjust the cutting angle.
h. **Blade Guard:** Protects the user from the moving blade.
i. **Dust Port:** Connects to a dust collection system to reduce mess.
j. **Base Plate:** The flat bottom of the saw that rests on the workpiece.

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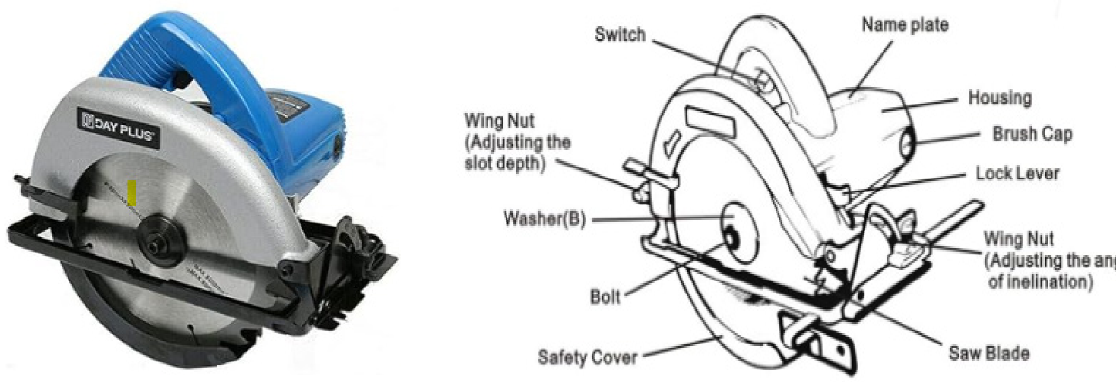


**Figure 2.5.10:** Portable Power Circular Handsaw.

## 2. Portable Power Jigsaw:

### Uses

a. Cutting intricate shapes in wood and other materials.
b. Making curved cuts, plunge cuts, and straight cuts.
c. Cutting through various materials, such as plastic and plywood.

### Parts

a. **Blade:** A thin, toothed blade that reciprocates to make cuts.
b. **Blade Clamp:** Holds the blade in place.
c. **Motor:** Provides power to the blade.
d. **Trigger Switch:** Controls the power to the motor.
e. **Base Plate:** The flat bottom of the saw that rests on the workpiece.
f. **Bevel Adjustment Lever:** Allows you to adjust the angle of the cut.
g. **Dust Port:** Connects to a dust collection system to reduce mess.
h. **Shoe:** A protective plate that guides the blade and protects the workpiece.


**Figure 2.5.11:** Portable Power Jigsaw.

## 3. Power Plane:

### Uses

a. Smoothing and shaping wood surfaces.

b. Removing excess material from rough-cut lumber.

c. Creating bevels and edges on wooden surfaces.

### Parts

a. **Blade:** A rotating blade that removes material from the workpiece.

b. **Motor:** Provides power to the blade.

c. **Depth Adjustment Knob:** Controls the depth of the cut.

d. **Handle:** Provides grip and control.

e. **Dust Port:** Connects to a dust collection system to reduce mess.

f. **Base Plate:** The flat bottom of the plane that rests on the workpiece.

**Figure 2.5.12:** Power Plane.

## Safety measures to observe when using these machines

### (Portable Power Circular Handsaw, Portable Power Jigsaw, Power Plane)

1. **Secure Grip:** Maintain a firm grip on the tool to control it effectively.
2. **Blade Guard:** Use the blade guard to protect yourself from the moving blade.
3. **Cord Management:** Keep the power cord away from the blade and other moving parts.
4. **Work Area:** Ensure a clear work area to prevent accidents.
5. **Avoid Forceful Cutting:** Excessive force can lead to kickback and loss of control.

# Introduction to Computer Numerical Control (CNC) Machines

Computer Numerically Controlled (CNC) machinery is computer-operated equipment that allows woodworkers to make precise measurements, cuts, and designs using pre-programmed instructions. Examples of CNC Machines are listed below.

## 1. CNC Crosscut Saw Machine:

### Uses

a. Precisely cutting wood to specific lengths and angles.
b. Mass production of identical wood components.
c. Cutting complex shapes and patterns in wood.

### Descriptive Parts

a. **Saw Blade:** A circular saw blade that rotates to cut the wood.
b. **Spindle:** The shaft that holds the saw blade.
c. **Motor:** Provides power to the saw blade.
d. **X-Y-Z Axes:** Allow for precise movement of the saw blade in three dimensions.
e. **Control Panel:** Used to input the cutting program and control the machine.


**Figure 2.5.13:** CNC Crosscut Saw Machine

## 2. CNC Circular/Panel Saw Machine:

### Uses

a. Cutting large sheets of wood and panel products.
b. Making intricate cuts and shapes in panels.
c. Mass production of identical panel components.

### Descriptive Parts

a. **Saw Blade:** A large circular saw blade that rotates to cut the material.

b. **Spindle:** The shaft that holds the saw blade.

c. **Motor:** Provides power to the saw blade.

d. **X-Y Axes:** Allow for precise movement of the saw blade in two dimensions.

e. **Control Panel:** Used to input the cutting program and control the machine.


**Figure 2.5.14:** CNC Circular/Panel Saw Machine

## 3. CNC Bandsaw Machine:

### Uses

a. Cutting intricate shapes and curves in wood and metal.

b. Cutting thick materials with precision.

c. Mass production of identical curved components.

### Descriptive Parts

a. **Band Saw Blade:** A continuous loop of blade that rotates around two pulleys.

b. **Motor:** Provides power to the blade.

c. **X-Y Axes:** Allow for precise movement of the saw blade in two dimensions.

d. **Blade Guides:** Keep the blade aligned and tensioned.

e. **Control Panel:** Used to input the cutting program and control the machine.

**Figure 2.5.15:** CNC Bandsaw Machine



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## 4. CNC Four-Sided Planer Machine:

### Uses

a. Planing all four sides of a piece of wood to a precise thickness and width.

b. Creating smooth, flat surfaces on wood.

c. Mass production of identical wooden components.

### Descriptive Parts

a. **Cutterheads:** Rotating cylinders with sharp blades that remove material from the workpiece.

b. **Feed Rollers:** Pull the workpiece through the machine.

c. **X-Y-Z Axes:** Allow for precise movement of the workpiece and cutterheads.

d. **Control Panel:** Used to input the planing parameters and control the machine.


**Figure 2.5.16:** CNC Four-Sided Planer Machine

# Safety Measures To Observe When Using These Machines

## CNC Machines (Crosscut Saw, Circular/Panel Saw, Bandsaw, Four-Sided Planer)

1. **Machine Guards:** Ensure all guards and safety devices are in place and functioning.
2. **Emergency Stop:** Know the location and operation of the emergency stop button.
3. **Tool Changes:** Only change tools when the machine is powered off and the tool is completely stopped.

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4. **Program Verification:** Double-check the CNC program to avoid errors and accidents.
5. **Regular Maintenance:** Keep the machine clean and well-maintained.

## Activity 2.5.1

### Identifying and Using Woodwork Machines

**Scenario:**

You are in the woodwork shop for a hands-on learning activity. Your facilitator has asked you to explore the workshop and identify at least two machines used for woodwork operations.

**Materials needed:**

- Video demonstration equipment (projector or screen)
- Notebooks and pens for brainstorming
- Safety gear (gloves, goggles) for using machines
- Access to woodworking machines (e.g., table saw, jigsaw, router)
- Safety manuals or guidelines for each machine

### Activity Guidelines:

1. You will watch a short video that shows different types of woodworking machines and their functions.
2. After the video, discuss with your classmates to identify various woodworking machines you saw.
3. You can use these guiding questions to further understand:
   a. What machines can you name from the video?
   b. What are the main uses of each machine?
4. Organise yourselves into groups of no more than five.
5. In your groups, select a machine to focus on.
6. Discuss how to use the chosen machine correctly, considering safety rules and each group member's skill level.
7. Practise using the selected machine under the facilitator's supervision.

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## Activity 2.5.2

### Demonstrating Machine Operations

**Scenario:**

You are in the woodwork shop for a practical learning activity. Your facilitator has asked you to demonstrate how to use specific woodworking machines to perform a particular operation, such as making a straight cut or creating a groove.

**Materials needed:**

- Video demonstration equipment (projector or screen)
- Notebooks and pens for brainstorming
- Safety gear (gloves, goggles) for using machines
- Access to woodworking machines (e.g., table saw, router)
- Safety manuals or guidelines for each machine
- Wood pieces for practice demonstrations

### Activity Guidelines:

1. You will begin by watching a video that shows how to use different woodworking machines for various operations.
2. After watching, discuss with your classmates to identify the machines and their uses.
3. The facilitator will ask you questions like:
   a. What machines were shown in the video?
   b. How would you use each machine for a specific task?
4. Share your ideas with the class. The facilitator collects explanations about how to use the machines.
5. Organise yourselves into groups of no more than five.
6. In each group, you will discuss how to use the machines identified for specific operations.
7. In your group, you will choose a machine to demonstrate.
8. Discuss how to use the selected machine safely and effectively, considering each member's skill level.
9. Demonstrate the operation, such as making a straight cut or creating a groove, while following safety rules.

## Conclusion

Selecting and using the appropriate machine for each woodwork operation is essential for safety, accuracy, and quality results. By understanding the purpose and function of each machine, you can complete tasks more efficiently and produce high-quality work. Always prioritise safety and follow proper techniques when operating any machine.

# UNIT 6

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

Excavation is a fundamental part of construction which requires activities that are undertaken with the help of setting out, which leads to the erection of profile boards. It is on profile boards that the positions of trenches and walls are marked by nails struck into the profile boards. This unit is intended to help you see the link between the setting out and the excavation of the trenches on construction sites. Your understanding of the processes involved will enable you to have a personal view of how safety and accuracy are ensured during the excavation of the trenches at the sites.

### KEY IDEAS

- Implementation of safety measures such as sloping, benching, or trench boxes to protect workers.
- Manual or mechanical means to remove the soil or rock to the required depth.
- Practical interpretation of trench positions as indicated on the profile boards during setting out.
- Removal of soil to form the required shape of a trench for the foundation of buildings.
- Specified size of holes or trenches developed through digging and collection of soil.

## PROCESSES INVOLVED IN EXCAVATING FOUNDATION TRENCHES

Excavation involves the removal of soil or rock from a site to prepare it for construction. This process can seem straightforward, but it requires careful planning and execution to avoid any complications or hazards. Let's break down the main steps involved in excavation:

1. **Site Assessment and Preparation**

   Before any digging can begin, a thorough assessment of the site is necessary. This includes:

   **a.** Surveying the land to understand the topography.

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   b. Conducting soil tests to determine its composition and stability.
   c. Obtaining the necessary permits and marking utility lines to prevent accidents.

2. **Setting Out and Marking**

   This step involves the precise marking of the excavation area according to the project's blueprints. Accurate setting out ensures that the excavation is carried out within the designated boundaries and to the correct depth.

3. **Excavation**

   The actual digging begins, often with the help of heavy machinery such as excavators, backhoes, and bulldozers. The type of machinery used depends on the size and nature of the excavation. This phase focuses on removing the required amount of soil or rock to reach the necessary depth and shape for the foundation.

4. **Soil Stabilisation and Safety Measures**

   Once excavation is complete, it's crucial to stabilise the excavated area to prevent cave-ins or collapses. This may involve:

   a. **Shoring:** Providing temporary support to the sides of the excavation.
   b. **Sloping:** Angling the sides of the excavation to reduce the risk of collapse.
   c. **Benching:** Cutting steps into the sides of the excavation for added stability.
   d. **Trench boxes:** Reinforcing trenches to protect workers.

Understanding these processes ensures that excavation is performed safely and efficiently, laying the groundwork for a stable and secure foundation.

## What Is the Meaning of Excavation

Excavation refers to the process of removing earth, rock, or other materials from a site to create a cavity or hole. This activity is essential in construction and civil engineering for various purposes, including Trenching, Foundation Preparation, and Site Grading. Excavation can be done manually with hand tools or mechanically using equipment like excavators, bulldozers, and backhoes. Proper excavation is crucial to ensure structural integrity and compliance with design specifications. Precautions and steps to take before, during and after a trench has been excavated.

The following tables outline some of the key points around excavation including steps taken, key tools, plant and equipment that need to be considered for use and safety precautions.

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**Table 2.6.1:** Steps and precautions that must be taken when excavating trenches.

| Item | Precautions and steps to take before, during and after a trench has been excavated. |
|---|---|
| 1 | **Excavation plan;** 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 the location of underground service 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 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 cm 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:** The 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 work the trenches have been dug for. |
| 8 | **Protecting workers:** removing water out of the trench and supporting sides of the trench. |
| 9 | **Use of a laser to check the 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 | **The casting of concrete**: the casting of foundation concrete that the trench has been dug for. |
| 11 | **Backfill of the trench**: filling back soil and compacting as specified. |

**Table 2.6.2:** What are the main reasons for excavating for foundation trenches

| Reason | Description |
|---|---|
| Load Distribution | Trenches provide a stable base for the foundation, ensuring the weight of the structure is evenly distributed across the soi |
| Soil Assessment | Excavation allows for an assessment of soil conditions, helping to determine if additional stabilisation or reinforcement is needed. |

| | |
|---|---|
| Water Drainage | Proper excavation helps manage water drainage, preventing water accumulation that could damage the foundation over time. |
| Utility Installation | Trenches facilitate the installation of underground utilities (e.g., plumbing, electrical lines) necessary for the building's operation |
| Foundation Type Accommodation | Different foundation types (e.g., strip, pad) require specific trench dimensions to ensure structural integrity |
| Preventing Settlement Issues | Well-excavated trenches reduce the risk of uneven settlement, which can lead to structural damage. |
| Site Preparation | Excavation clears the site of vegetation, debris, and unsuitable materials, preparing it for construction |
| Building Code Compliance | Many local regulations mandate specific trench depths and widths to ensure safety and stability |

**Table 2.6.3:** The hand tools, equipment and plant required for excavation

| Tools | Description |
|---|---|
| **Hand Tools** | • ***Shovels:*** For digging and moving soil.<br>• ***Spades:*** Useful for cutting through soil and creating edges.<br>• ***Pickaxes***: Effective for breaking up hard or compacted soil.<br>• ***Mattocks:*** Combines features of a pick and a hoe for versatile digging.<br>• ***Trowels:*** For smaller, more precise excavation tasks |
| **Measuring Tools** | • ***Measuring Tape:*** For measuring trench dimensions.<br>• ***Levels***: To ensure trenches are properly graded.<br>• ***String Lines:*** For marking straight trench lines. |
| **Equipment** | **Description** |
| **Excavators** | • ***Tracked Excavators:*** Ideal for larger projects; can reach deeper depths.<br>• ***Wheeled Excavators:*** Suitable for projects requiring mobility across varied terrain |
| **Backhoes** | • Versatile equipment that combines a digging bucket on one end and a loader on the other, suitable for trenching in smaller spaces |
| **Mini-Excavators** | • Smaller, manoeuvrable machines ideal for tight spaces and residential projects |
| **Trenchers** | • Specialised machines designed specifically for digging narrow trenches, often used for utility installations |

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| Plant | Description |
|---|---|
| **Bulldozers** | • Used for site preparation and moving large amounts of soil before trenching |
| **Skid Steer Loaders** | • Versatile machines that can perform various tasks, including trenching when fitted with appropriate attachments |
| **Dump Trucks** | • For transporting excavated soil away from the site |

**Table 2.6.4:** Categories of tools, plant and equipment for the different methods adopted for excavating trenches

| Methods | Description |
|---|---|
| **Manual Excavation**<br><br>**(Tools)** | • ***Shovels:*** For digging and moving soil.<br>• ***Spades:*** Useful for cutting through soil and creating edges.<br>• ***Pickaxes:*** Effective for breaking up hard or compacted soil.<br>• ***Mattocks:*** Combines features of a pick and a hoe for versatile digging.<br>• ***Trowels:*** For smaller, more precise excavation tasks |
| **Mechanical Excavation**<br><br>**(Equipment)** | • • ***Excavators***<br>• ***Tracked Excavators:*** Suitable for larger projects and deeper trenches.<br>• ***Wheeled Excavators:*** For mobility in varied terrain.<br>• ***Backhoes***: Versatile for both digging and loading, ideal for smaller sites.<br>• ***Mini-Excavators***: Compact and manoeuvrable, perfect for residential projects.<br>• ***Trenchers:*** Specialised for digging narrow trenches efficiently |
| **Site Preparation and Soil Movement**<br><br>**(Plants)** | • ***Bulldozers:*** For moving large quantities of soil and levelling the site before trenching.<br>• ***Skid Steer Loaders*****:** Versatile machines that can assist with trenching using appropriate attachments.<br>• ***Dump Trucks:*** For transporting excavated soil away from the site |
| **Safety and Stability**<br><br>**(Accessories)** | • ***Shoring and Bracing Systems:*** To support trench walls and prevent collapses during excavation.<br>• ***Compactors:*** For compacting soil around the trench after excavation<br>• ***Total Stations or GPS:*** For accurate trench placement and measurement of depth and alignment. |

**Table 2.6.5:** Safety precautions are used for the methods of excavation**.**

| Methods | Safety Precautions |
|---|---|
| Manual Excavation | • ***Personal Protective Equipment (PPE):*** Hard hats, safety boots, gloves, and high-visibility vests.<br>• ***Proper Tool Use:*** Use tools correctly and ensure they are in good condition to prevent injuries.<br>• ***Training:*** Ensure all workers are trained in safe manual handling techniques |
| Mechanical Excavation | • ***Equipment Inspection:*** Conduct regular checks on machinery (excavators, backhoes) to ensure they are functioning properly.<br>• ***Operator Training:*** Ensure operators are trained and certified to use machinery safely.<br>• ***Clear Work Area:*** Keep the excavation site clear of debris and obstacles to prevent accidents.<br>• ***Warning Signs:*** Use appropriate signage to warn of excavation activities |
| Site Preparation and Soil Movement | • ***Stability Checks:*** Assess soil conditions to prevent equipment from tipping over or causing slides.<br>• ***Traffic Control:*** Implement traffic management plans to keep vehicles and pedestrians safe around the excavation site. |
| Safety and Stability | • ***Shoring and Bracing:*** Use shoring or bracing to support trench walls and prevent collapses, especially in deep excavations.<br>• ***Trench Inspections:*** Regularly inspect trenches for signs of shifting or instability and address any issues immediately. |

The following additional safety and working practices precautions should also be considered:

1. **Support:** Plan temporary support before digging and batter the sides to a safe angle. If battering isn't possible, use timber, sheeting, or other support systems.
2. **Protection:** Protect the edges of the trench with barriers to prevent people from falling in. Wear head protection and other personal protective equipment (PPE).
3. **Materials:** Keep materials and equipment at least two feet away from the trench. Don't place materials around the edge of the trench.
4. **Vehicles and equipment:** Keep vehicles and equipment away from the trench. Don't work ahead of the support.
5. **Atmosphere:** Test for hazardous atmospheres, such as low oxygen or toxic gases, before starting work and throughout the day. If hazardous levels are detected, don't enter the trench.



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6. **Ventilation:** Install ventilation systems, such as exhaust fans, to prevent toxic gas buildup. Train workers on how to use and maintain the ventilation systems.
7. **Inspection:** Inspect the trench daily before work begins.
8. **Training:** Ensure workers are properly trained and suitable.
9. **Planning:** A competent person should plan and implement safety measures.
10. **Weather:** Check the weather forecast before work and be mindful of rain and storms.

## What Impact Do Safety Precautions Have On Construction Projects Like Excavation?

1. **Reduction in Accidents and Injuries:** Proper safety measures minimise the risk of accidents, protecting workers from injuries such as falls, equipment-related incidents, or collapses.
2. **Increased Productivity:** A safe work environment leads to fewer disruptions due to accidents, allowing work to proceed smoothly and efficiently.
3. **Enhanced Worker Morale:** When workers feel safe, their job satisfaction and morale improve, leading to better performance and reduced turnover rates.
4. **Compliance with Regulations:** Adhering to safety standards helps ensure compliance with local regulations and building codes, reducing the risk of fines or legal issues.
5. **Cost Savings:** Fewer accidents result in lower medical costs, insurance premiums, and potential legal fees, ultimately saving money on the project.
6. **Reputation Management:** Demonstrating a commitment to safety enhances the company's reputation, making it more attractive to clients and potential workers.
7. **Risk Mitigation:** Implementing safety precautions helps identify and mitigate risks early, reducing the likelihood of serious incidents that could halt or delay the project.
8. **Improved Quality of Work:** A focus on safety can lead to more careful and deliberate work practices, which can enhance the overall quality of the construction.
9. **Emergency Preparedness:** Established safety protocols prepare workers to respond effectively to emergencies, critical situations and potential injuries during incidents.

The following images show various aspects of excavation taking place

**Figure 2.6.1:** The following tables and images show examples of various types of excavations taking place.

**Table 2.6.6:** Digging out for a basement floor at the sloping side of a plot of land**.**

| 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 the upper floor and lower basement floor in the sections of the working drawing. |
| **3** | Set out the building according to the block plan and set the datum as indicated on the sections. |
| **4** | Part of the land to be excavated to accommodate the 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 plants to excavate to reduce the level of the ground at the space indicated to accommodate the basement floor. |
| **6** | The retaining wall on the sectional drawing in **Figure 2.6.4** indicates where soil pressure builds up and where groundwater is likely to come from into the interior basement space. Apart from providing reinforced concrete walls to deal with the pressure, the retaining basement wall must receive tanking and damp-proof coarse as well as membrane for the basement floor. |

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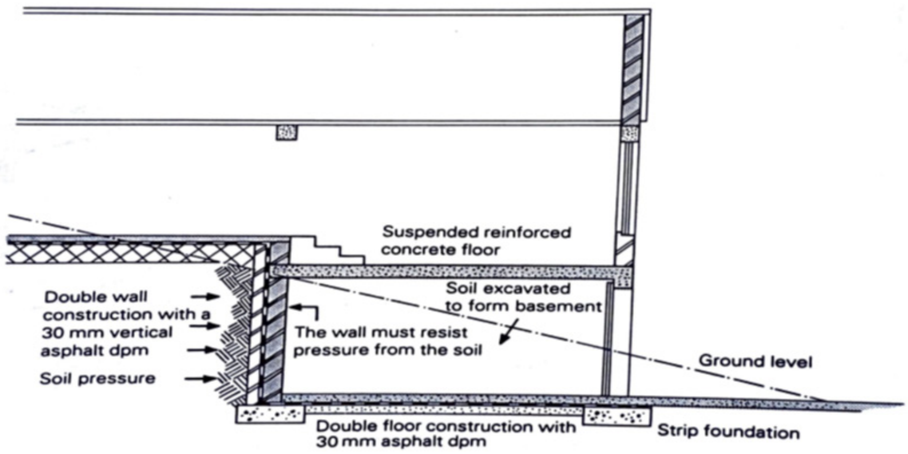


**Figure 2.6.2:** Excavate a sloping side of land to create a basement floor

**Table 2.6.7:** Excavating Pits for piers or columns

| Step | Activity |
|---|---|
| **1** | Calculate the depth from the top of the profile to the desired level of excavation using the working drawing at the site. |
| **2** | Make a measuring staff called a boning rod, which is the same length as the distance between the top of the profile and the bottom of the trench |
| **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. |

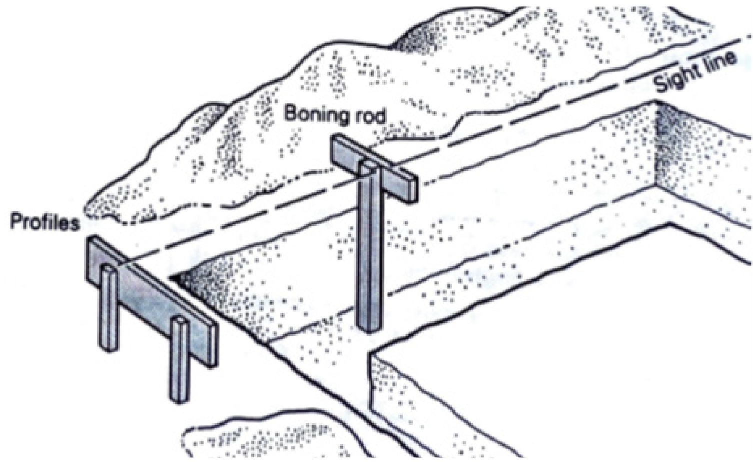


**Figure 2.6.3:** Excavation to create a basement at the lower level of a plot of land

## Excavating for Strip Foundations

Strip foundations (or strip footings) are a type of shallow foundation that is 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.

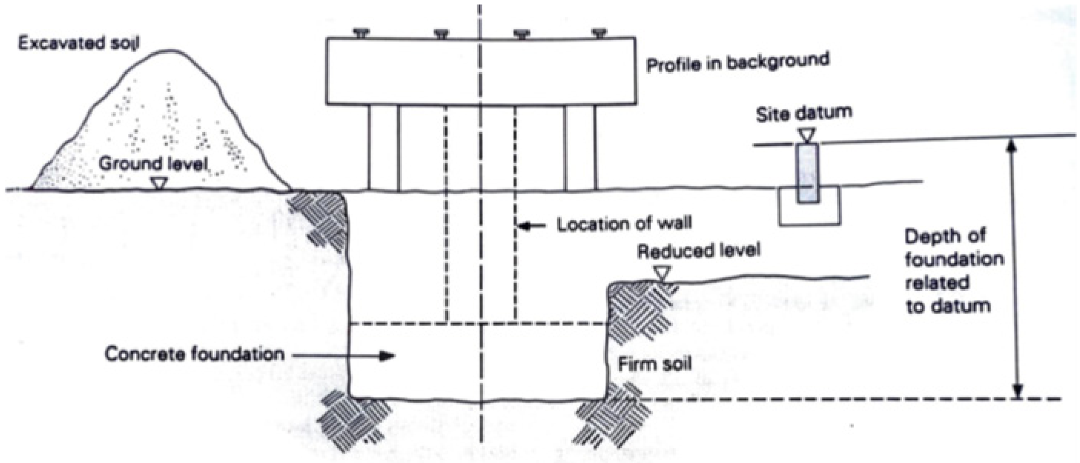


**Figure 2.6.4:** Excavated trench for strip foundation

## Activity 2.6.1

Explain the meaning of and reasons for excavating foundation trenches.

## Activity 2.6.2

Organise yourselves into groups of no more than five. In your groups, discuss the various tools, plants and equipment used for excavating trenches and categorise them according to the different methods adopted for excavating trenches.

## Activity 2.6.3

Remain in your groups and discuss methods of excavation alongside safety precautions and the impact the precautions can have on the project.

# UNIT 7

# WOODWORK TECHNOLOGY

## Tools and Machines in the Woodwork Industry

## Introduction

Machines are our hardworking tools. To keep them working well, we need to take good care of them. This means cleaning them regularly, oiling the moving parts, and checking for any damage. By doing this, we can prevent breakdowns, save money, and make sure our machines are safe to use.

### KEY IDEAS

- Always stay alert for warning signs like strange noises or heat and fix broken parts promptly to avoid bigger problems.Consistent care extends a machine's lifespan and ensures safe performance.
- Correct machine maintenance is key for smooth, safe operation.
- Regular cleaning, oiling, and checking parts like belts for wear can prevent issues from happening or getting worse.

## CARE AND MAINTENANCE OF WOODWORK MACHINES

The term "care and maintenance of machines" refers to the routine and hands-on practices performed to ensure machinery operates efficiently and safely. This includes tasks such as cleaning surfaces, lubricating gears, and inspecting parts like belts for wear and tear. It also involves identifying potential issues, such as unusual vibrations, increased energy use, or elevated temperatures, to address problems before they lead to damage. Additionally, it covers actions taken after a breakdown, like assessing damage and replacing faulty parts. Correct care and maintenance not only keep machines functional and safe but also extend their lifecycle.

Woodwork machines can be hazardous if not used correctly, so you must receive thorough instructions and understand all safety precautions before operating them. You must also obtain permission from a facilitator before using any machine.

For the correct operation of woodwork machines, there is a factory ordinance that governs and allows the smooth operation of those machines. The Factories Ordinance of 1952 is a legal framework in Ghana that regulates the safe operation and maintenance of woodwork machines in workshops and industrial settings. It sets out specific guidelines and safety standards to ensure the protection of workers and machinery. Anyone using these machines is required to have a thorough understanding of the regulations to operate them safely and in compliance with the law. This ordinance aims to minimise risks, prevent accidents, and maintain a safe working environment.

Here are examples of vital provisions under the ordinance:

1. **Fencing of dangerous parts:** All moving parts of machinery, including belts, pulleys, and blades, must be securely fenced or guarded to prevent accidental contact. Circular saws require proper fencing with metal plates of specified measurements and thickness to ensure user safety. Similarly, narrow band saws must have their pulleys fully enclosed, with blades securely guarded except for the portion between the table and the top guide.
2. **Safety guards on machines:** Machines like circular saws must have protective guards over the blade and riving knives to prevent kickback and protect operators.
3. **Provision of safety devices:** Push-sticks and jigs must be provided and used for machines like circular saws and vertical spindle moulders to reduce the risk of hand injuries.
4. **Maintenance of floors and surroundings:** Floors around machines must be kept clean, level, and free from chips or other debris to prevent slips and falls.
5. **Operator training and safety compliance:** Workers must receive proper training on the use of woodworking machines and comply with safety rules, including the use of guards and safety devices.
6. **Inspection and maintenance of machines:** Machines must be regularly inspected and maintained to ensure they remain in good working condition and meet safety standards.
7. **Chain mortising machine regulations:** Chains and cutters on mortising machines must be fully enclosed with guards to protect operators and prevent accidental contact.
8. **Vertical spindle moulding machines:** Efficient guards must be installed on machines to ensure safety, and when guards cannot be used, operators should use jigs or holders to minimise risk.
9. **Cylindrical cutter blocks:** Planing machines must use cylindrical cutter blocks, particularly for manually operated machines, to reduce risks.
10. **Record-keeping:** Employers must maintain detailed records of machine maintenance, training, and inspections as part of compliance.

## General Safety Rules

To maintain a safe working environment, the following general safety rules must be strictly observed when using any machinery:

1. Ensure that the cutters in the machine reach maximum speed before feeding material into the machine.
2. Never make adjustments to a machine while the cutter is in motion.
3. The cutter must stop moving before you leave the machine.
4. Do not allow yourself to become distracted while operating a machine.
5. Always make sensible use of safety guards and devices provided with the machines.
6. Always isolate the machine and clean it thoroughly after use to prevent accidents.

## General Maintenance of woodwork machines

Caring for and maintaining woodworking machines involves a series of practices intended to ensure tools operate safely, efficiently, and for an extended period. This comprises several key areas such as:

1. **Regular cleaning:** Keeping machines clean is fundamental to their performance. Dust, wood shavings, and debris can accumulate on and inside machines, leading to malfunctions, overheating, or safety hazards. Regularly cleaning surfaces, interiors, and moving parts helps maintain the best operation and extends the machine's lifespan.
2. **Lubrication:** Woodwork machines have numerous moving parts that require lubrication to reduce friction and wear. Applying the appropriate lubricants as specified by the manufacturer reduces the risk of overheating and mechanical failure. Regular lubrication preserves machines running smoothly and efficiently.
3. **Inspections and monitoring:** Regular inspections involve checking machines for signs of wear and tear, damage, or malfunction. This includes examining belts, blades, gears, and electrical components. Early detection of issues allows for timely repairs or replacements, preventing more significant problems and potential safety hazards.
4. **Scheduled maintenance:** Following a maintenance schedule based on the manufacturer's recommendations is crucial. This may include routine tasks like changing blades, tightening screws, or replacing filters. Adhering to these schedules helps ensure machines function correctly and safely.
5. **Operator training:** Proper training is vital for anyone operating woodworking machines. Operators should be familiar with the correct use of the machinery, safety protocols, and maintenance procedures. Well-trained users can identify potential issues and handle machines responsibly, reducing the risk of accidents.

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6. **Repairs and replacement of parts:** Promptly addressing any identified issues is essential for machine longevity. Worn or damaged parts should be repaired or replaced as soon as possible to prevent further damage to the machine or reduce efficiency.
7. **Correct storage:** When not in use, woodwork machines must be stored correctly to protect them from environmental factors such as moisture, dust, and temperature extremes. Correct storage helps maintain the condition of the machines and prolongs their lifespan.
8. **Use of safety guards and devices:** Safety features such as guards, shields, and emergency stop buttons must be maintained and used appropriately. These devices are critical for protecting the operator and minimising the risk of accidents while using the machines.
9. **Documentation and record keeping:** Keeping accurate records of maintenance activities, repairs, inspections, and operational history allows for better management of machine care. This documentation can help identify patterns in repairs and inform future maintenance strategies.
10. **Upgrades and improvements:** As technology advances, upgrading machines can enhance their performance, efficiency, and safety features. Regularly assessing the machines for potential upgrades ensures they remain effective and competitive in a changing environment.

The table below gives specific care and maintenance of woodwork machines in the workshop:

**Table 2.7.1**

| Name of Machine | How to Care For | Maintenance |
|---|---|---|
| **Crosscut Saw Machine** | Keep sawdust and debris off the blade and table surface. | Regularly inspect the blade for sharpness and clean it; lubricate moving parts. |
| **Circular Saw Machine** | Clean sawdust buildup, especially around the motor. | Check blade sharpness, align the blade with the guide, and ensure guard functionality. |
| **Dimension Saw Bench** | Keep the table free of dust and remove residue buildup. | Regularly inspect and adjust fence alignment; lubricate the adjustment mechanism and check blade alignment. |
| **Narrow Bandsaw** | Clean the blade and surrounding area; ensure the work area is clear of wood debris. | Check blade tension and sharpness; adjust guides and replace the blade if worn or cracked. |
| **Surface Planer** | Clear debris from the feed rollers and cutter head. | Check and sharpen or replace blades as necessary; ensure proper roller alignment and lubricate moving parts. |

| | | |
|---|---|---|
| **Thicknesser Machine** | Remove chips and dust from feed rollers and bed surface. | Inspect cutter head and feed rollers; sharpen or replace blades; lubricate chains and rollers as needed. |
| **Combined Surfacing and Thicknesser machine** | Clean dust from the planer and jointer areas. | Regularly inspect and sharpen blades; check roller feed mechanisms and lubricate parts to reduce wear. |
| **Portable Power Circular Handsaw** | Blow out sawdust from vents; keep the blade guard clean. | Check blade sharpness and guard function; periodically inspect and lubricate bearings. |
| **Portable Power Jigsaw** | Remove dust from blade area; keep vent clear to avoid overheating. | Inspect blade for wear; tighten blade securely, lubricate blade guide and check the footplate alignment. |
| **Power Plane** | Clean chips from the blade and discharge area. | Regularly check blade sharpness and alignment; lubricate the cutting head and check that bolts are secure. |
| **CNC Crosscut Saw Machine** | Clean the work area and remove any wood particles that could clog components. | Regularly calibrate saw and replace worn components; inspect and lubricate rails and bearings to ensure accuracy. |
| **CNC Circular/ Panel Saw Machine** | Clear debris from the blade area and clean surrounding surfaces. | Perform regular calibration; inspect blade sharpness and belt condition, lubricate slides, and monitor software updates for optimal performance. |
| **CNC Bandsaw Machine** | Clean sawdust and debris from blade and guide areas. | Inspect blade tension and alignment; lubricate guides and ensure the drive system is operating smoothly. |
| **CNC Four-Sided Planer Machine** | Keep rollers, cutters, and work area clean from dust and wood particles | Sharpen or replace cutters; check the alignment of heads and feed rollers; lubricate chains, rollers, and mechanical parts regularly. |
| **Saw Blades** | Clean blades after each use to prevent resin buildup. | Inspect for dullness or damage, sharpen or replace as needed; store in a dry area to avoid rusting and use blade protectors when not in use. |

## Duties of Persons Employed on Woodworking Machines

Operators of woodworking machines play a critical role in ensuring workplace safety and efficiency. Their duties include:

1. **Correct use of safety guards:** Always use and maintain the guards provided on machines, ensuring they are in place and functioning correctly before operation.

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2. **Utilising safety tools:** Use tools such as push-sticks, jigs, and holders provided for specific machines to keep hands and body parts away from moving blades and cutters.
3. **Following safety regulations:** Adhere strictly to safety protocols and regulations, such as the Factories Ordinance of 1952, to minimise risks and ensure compliance.
4. **Inspecting Machines Before Use:** Conduct routine checks on machines for wear, damage, or malfunction to ensure safe operation. Report any issues immediately.
5. **Correct training and skill application:** Operate only machines for which they have been trained and approved to use. Seek permission when required and avoid using machines outside their expertise.
6. **Maintaining clean workspaces:** Keep the work area around machines free from debris, chips, or tools that could cause accidents or obstructions.
7. **Avoiding distractions:** Stay focused during machine operation to prevent accidents caused by distractions or inattentiveness.
8. **Shutting down machines safely:** Ensure machines are properly shut down after use, including isolating power and cleaning the machine for the next operator.

## Activity 2.7.1

Your teacher will introduce and explain the following activities to you. They will then place you into groups of 5 for you to complete each activity.

### Safety Briefing and Preparation

1. Ensure you are wearing the necessary PPE, such as gloves, safety goggles, and dust masks, to protect against debris and accidental injuries.
2. Your teacher will confirm that each machine is turned off and unplugged before beginning maintenance. They will emphasise the importance of lockout/tag-out procedures to prevent accidental start-up during maintenance.
3. In your group make sure the work area is clear of unnecessary materials, tools, and obstructions, maintaining a clean and organised space to prevent tripping hazards or interference with machine maintenance.

**Materials Needed:**

- A short video on machine maintenance.
- Workshop machines (crosscut saw, surface planer, or narrow band saw).
- Cleaning supplies (brushes, rags, compressed air).
- Lubricants and oil.

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- Basic tools for adjustments (screwdrivers, wrenches).
- Maintenance logs.
- **PPE:** gloves, safety goggles, dust masks.

### Activity Guidelines:

1. Your group will watch a short video showing the essential care and maintenance steps for workshop machines, including cleaning, lubrication, and part inspection.
2. Discuss different ways to care for and maintain machines. Use the following questions to guide your thinking.
   a. What might happen if machines are not maintained?
   b. Why is it important to check each machine part regularly?
3. Each group then discusses the importance of machine maintenance, documenting discussion points and insights on a shared digital platform or worksheet.
4. Your group will select a machine (e.g. crosscut saw, surface planer, or narrow band saw) and demonstrate the proper maintenance steps, including cleaning, inspecting, and lubricating key components.
5. You will follow safety procedures closely, handling tools and materials appropriately. Each group member has a specific role, such as cleaning, inspecting, or recording findings in the maintenance log.
6. Group members with highly proficient knowledge will assist with discussions and demonstrating maintenance steps, ensuring all group members understand the process and safety rules.
7. Your teacher will bring the class back together for feedback, and your group will present it the machine, steps taken, and any challenges faced during maintenance.
8. Your group will highlight key takeaways, reinforcing the critical role of regular maintenance in workshop safety and efficiency.
9. The activity will end with a reflection on the skills you have learned and how these skills apply to real-world manufacturing environments.

## Activity 2.7.2

### Caring for Woodwork Machines

**Scenario:**

Imagine you are a workshop technician tasked with ensuring the machines in a busy manufacturing workspace operate smoothly, safely, and efficiently.

This activity will support you in learning how to care for and maintain key machines to minimise stoppage.

**Activity 2.7.3**

### Importance of Caring for and Maintaining Machines in the Workshop

**Scenario:**

Imagine you are a workshop technician tasked with ensuring that all machines in a busy manufacturing workspace operate efficiently, safely, and with minimal interruption. This activity aims to highlight the importance of caring for and maintaining workshop machines, emphasising the impact of correct maintenance on productivity and safety.

**Activity 2.7.3**

### Woodwork Machines Maintenance Demonstration

**Scenario:**

Imagine you are a workshop technician responsible for maintaining key machines in a busy manufacturing workspace. Your goal is to ensure each machine operates smoothly and safely while minimising lost time. In this activity, you will demonstrate your ability to care for and maintain three different machines in the woodwork shop. One of the machines must be portable/handheld.

## Conclusion

Correct care and maintenance of machines ensure they function efficiently, last longer, and remain safe to use. Regular cleaning, timely servicing, lubrication, and prompt repairs are essential. Following manufacturer guidelines and handling machines correctly prevents damage and reduces downtime.



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# UNIT 8

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

Foundations are the crucial components upon which buildings and structures stand. Understanding the interaction between various types of foundations and the soil on which they rest is essential for constructing stable, long-lasting structures. This unit is intended to introduce you to the various types of foundations used for specific conditions of soil.

**KEY IDEAS**

- Deep foundations are appropriate for soft and unstable soils.
- Foundation types are based on the soil conditions.
- Isolated foundations are designed for columns, piers and stanchions.
- Shallow foundations are designed for hard soil or clay. Ideal for stable, hard soils like clay or silt or silt.

## FOUNDATIONS

### Soil Types

Here are 4 common soil types found when excavating for laying foundations

1. **Clay:** Can hold significant weight but can also expand and contract with moisture changes, potentially leading to structural shifts.
2. **Silt:** Generally, stable but can become unstable when wet. It requires special attention to drainage and moisture control.
3. **Sand:** Drains water quickly, reducing the risk of moisture-related expansion, but can be prone to shifting if not compacted properly.
4. **Gravel:** Excellent for foundations due to its high load-bearing capacity and drainage properties.

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**Figure 2.8.1:** Soil Types

Understanding the intricate relationship between these foundations and the soil types is vital for ensuring the stability and safety of any structure. Choosing the right foundation for the soil type can make the difference between a stable and unstable building.

## The Meaning of Foundation Concrete

The foundation of a building is the element that connects the building to the ground. It is located at the very bottom of the building. Generally, foundations are identified as the load-bearing components of buildings and serve as the required anchors for the buildings. Also, foundations are described as that part of the building called substructure which is below the ground level.

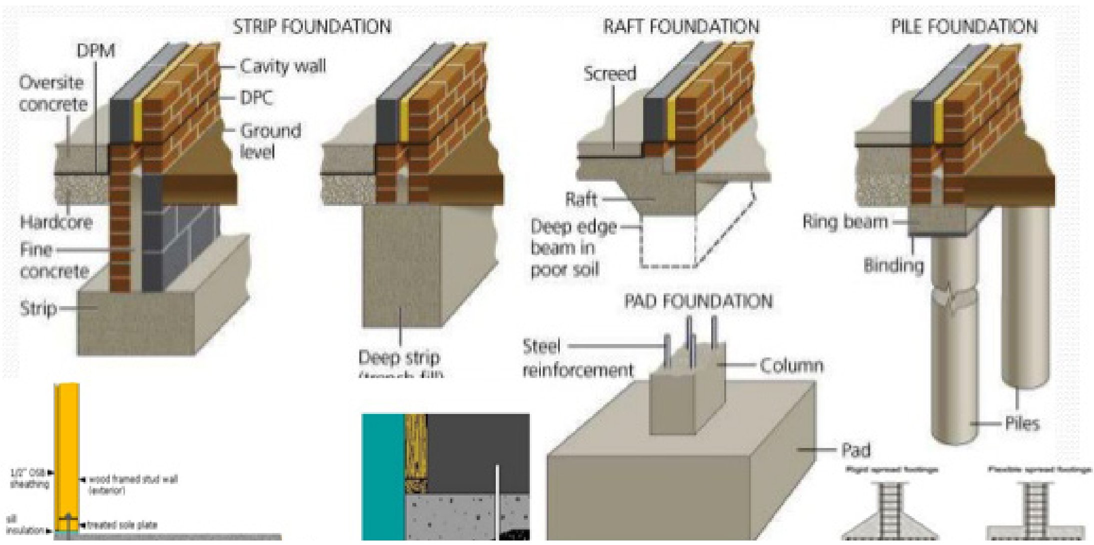


**Figure 2.8.2:** Examples of foundation concretes used

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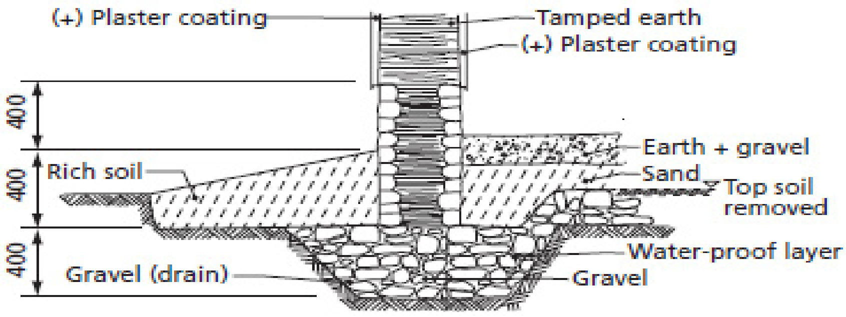


Foundation wall from outside in:
-Bitumen coating
-Stone facing with cement-lime mortar
-Tamped earth
-Stone with cement-lime mortar
-Ant and water proofing
-Plaster coating

**Figure 2.8.3:** A section of the details of a typical foundation

**Activity 2.8.1**

Study the meaning of the term 'foundation concrete' independently. Note the keywords involved, then brainstorm the meaning of the keywords in relation to the term foundation.

## What Are the Requirements Of A Foundation Concrete Used For Buildings?

For the foundation concrete to be effective, it must meet certain conditions or requirements. It is these requirements that the construction team for the foundation concrete must meet to achieve a successful foundation concrete.

The following are the requirements that you need to know to be an efficient and effective construction worker.

### Compressive Strength

Concrete must have adequate compressive strength to support the loads of the building. This is typically measured in megapascals (MPa) or pounds per square inch (psi).

The strength is determined by the mix design, including the type and proportion of cement, aggregates, and water.

### Durability

The concrete should be durable enough to withstand environmental factors such as moisture, temperature variations, and chemical exposure.

The use of additives or specific types of cement (e.g., sulphate-resistant cement) can enhance durability.

## Workability

The concrete mix must be workable enough to allow for easy placement and consolidation without segregation of materials.

Adjustments to the water-cement ratio and the use of admixtures can improve workability.

## Water-Cement Ratio

A low water-cement ratio is essential for achieving higher strength and durability while avoiding excessive porosity.

Typically, a ratio of 0.4 to 0.6 is used for foundation concrete, depending on the desired strength.

## Setting Time

The concrete must be set and cured properly to achieve its intended strength without excessive shrinkage or cracking.

The setting time can be influenced by ambient temperature and humidity, as well as the use of accelerators or retarders.

## Resistance to Shrinkage and Cracking

The concrete should have minimum shrinkage during curing to prevent cracks that can compromise structural integrity.

Incorporating fibres or using shrinkage-reducing admixtures can help mitigate cracking.

## Temperature Resistance

Foundation concrete must perform well under temperature fluctuations, especially in regions with freeze-thaw cycles.

Using air-entraining agents can improve freeze-thaw resistance.

## Chemical Resistance

The concrete should resist chemicals present in the soil or groundwater that could lead to degradation.

This may involve selecting specific types of concrete or applying protective coatings.

## Control of Hydration Heat

For large foundations, managing the heat generated during curing is critical to prevent thermal cracking.

Techniques such as using low-heat cement or cooling the concrete can be employed.

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## Quality Control and Testing

Regular testing of concrete during mixing, placement, and curing is essential to ensure it meets design specifications.

Standard tests (e.g., slump test, compressive strength test) should be conducted to verify quality

# What are the Different Types of Foundations Used in a Building?

In the construction industry, there are different types of foundation in use. The type of foundation that is to be selected will depend on whether it will be suitable or appropriate for the situation. The images below show different types of foundations.

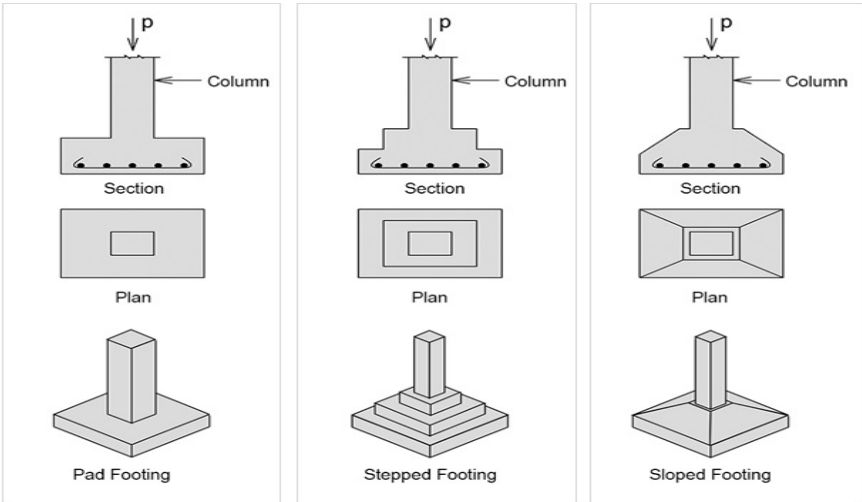


**Figure 2.8.4:** Types of foundations for buildings

**Table 2.8.1:** Different types of foundation concrete for types of buildings

| Types | Purposes |
|---|---|
| **Deep Foundations** | These are used when the surface soil is weak or unstable, and loads must be transferred to deeper, more stable soil or bedrock.<br>• **Piles:** Long, slender columns driven deep into the ground to support heavy structures, transferring loads to deeper soil layers.<br>• **Caissons:** Large, hollow columns filled with concrete, used for supporting heavy loads, often used in bridge construction.<br>• **Drilled Shafts (Bored Piles):** Cylindrical shafts drilled into the ground and filled with concrete, providing support for tall structures |

| | |
|---|---|
| **Shallow Foundations** | These are placed close to the ground surface and are typically used for smaller structures.<br>• **Spread Footings:** A wide base that supports a load-bearing wall or column, distributing the weight over a larger area.<br>• **Slab-on-Grade:** A single concrete slab poured directly on the ground, often used in residential buildings.<br>• **Strip Footings:** Continuous footings that support load-bearing walls, suitable for low-rise buildings. |
| **Special Foundations** | • **Mat Foundations (Raft Foundations)**: A large concrete slab that supports multiple columns and walls, suitable for heavy buildings on weak soils.<br>• **Anchor Foundations**: Used to secure structures in areas prone to high winds or seismic activity, where anchors are embedded in the ground.<br>• **Floating Foundations**: Designed for buildings in areas with poor soil conditions or high-water tables, where the foundation is buoyant and reduces settlement |

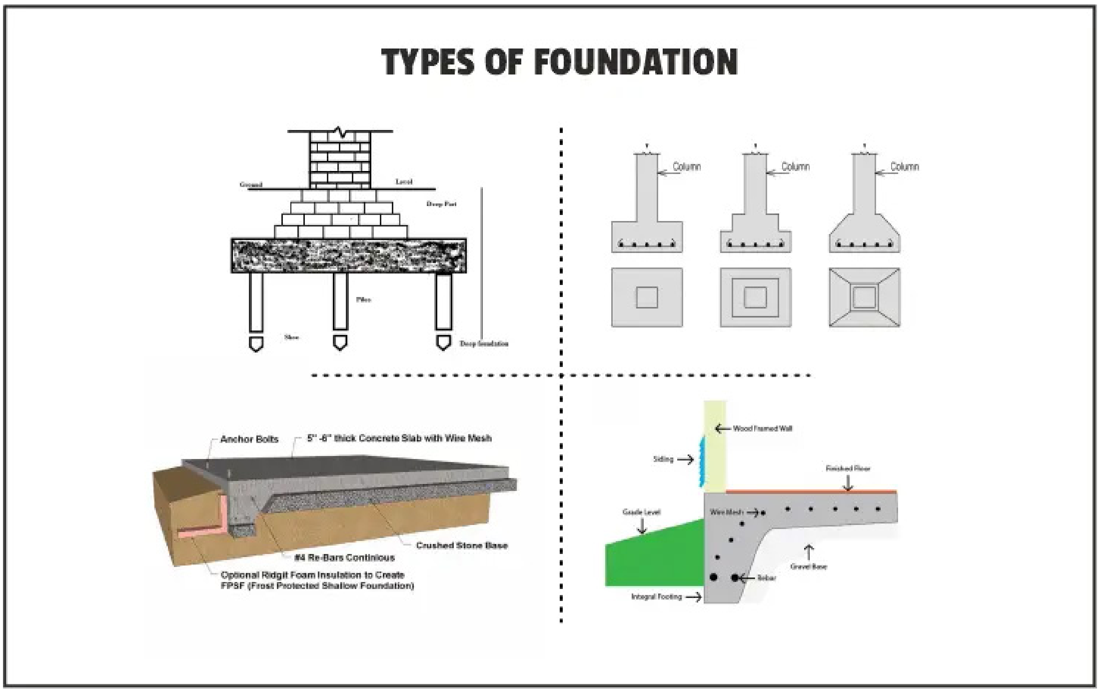


**Figure 2.8.5:** Elevations and sections of types of foundations

## Activity 2.8.2

In groups of no more than 5, discuss the types of foundation found and write down the requirements that will enable the construction of a foundation concrete for a building.

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# Factors that Can Affect the Choice of a Foundation for a Building.

There are several factors that usually affect the choice of a foundation type for a building. It is these factors that serve as a guiding principle which always results in an effective and efficient foundation concrete for buildings.

**Table 2.8.2:** Factors that affect the choice of foundation type for a building

| Factors | Description |
|---|---|
| **Soil Conditions** | • **Type of Soil:** Different soil types (clay, sand, gravel, silt) have varying bearing capacities and drainage characteristics.<br>• **Soil Stability:** The presence of loose, saturated, or expansive soils can influence foundation selection.<br>• **Soil Tests:** Geotechnical investigations provide data on soil properties, which guide foundation design |
| **Load Requirements** | • **Building Size and Weight:** Heavier buildings may require deeper foundations or special types to support the loads effectively.<br>• **Load Type:** Static vs. dynamic loads (e.g., wind, seismic forces) influence foundation design and depth |
| **Site Topography** | • **Slopes and Elevation:** Steep or uneven terrain may necessitate specific foundation types, such as stepped or retaining foundations.<br>• **Water Table Level:** A high water table can affect foundation stability and drainage considerations |
| **Environmental Conditions** | • **Climate:** Areas with regular freeze-thaw cycles may require frost-protected foundations.<br>• **Natural Hazards:** Sites prone to earthquakes, floods, or landslides may need specialized foundations for added safety |
| **Construction Method** | • **Building Design:** The architectural design can influence foundation choice, as some designs may require specific support systems.<br>• **Construction Techniques:** The availability of equipment and technology may dictate which foundation types are feasible |
| **Regulatory and Code Requirements** | • **Local Building Codes:** Compliance with regulations regarding foundation design and construction practices is essential.<br>• **Zoning Laws:** Restrictions may apply based on the location and type of building, influencing foundation depth and type |
| **Cost Considerations** | • **Budget Constraints:** The cost of materials, labour, and required site preparation can significantly impact foundation choice.<br>• **Long-Term Value:** Considering the longevity and maintenance costs of different foundation types can influence decisions |

| | |
|---|---|
| **Utilities and Infrastructure** | • **Existing Utilities:** The presence of any underground utilities (water, gas, electricity) may affect foundation design and excavation plans.<br>• **Accessibility:** The ease of access to the site for construction and transportation of materials can influence foundation choice |
| **Future Expansion** | **Potential for Additions:** If future expansion is anticipated, the foundation must be designed to accommodate additional loads or structural changes |
| **Construction Timeline** | **Project Schedule:** The required speed of construction may influence the choice of foundation, with some methods being quicker than others |

## Activity 2.8.3

In groups of no more than 5, discuss, agree and write down the factors that affect the choice of foundation concrete for a building.

**Figure 2.8.6:** A typical picture of a foundation under construction

## EXTENDED READING


- Sackey, J.K.N (1999), The Motivate Series Woodwork Technology, pages 82-114. Macmillan, London.
- Walton, John A. (1970). Woodwork Theory in and Practice (metric edition), pages 387-413.


- Sackey, J.K.N (1999), The Motivate Series Woodwork Technology, pages 82-114. Macmillan, London.
- Walton, John A. (1970). Woodwork Theory in and Practice (metric edition), pages 387-413.

# Review Questions

## Questions 2.1

1. You need to rip timber to get the desired width and thickness. Which machine should you use?
2. You have a workpiece that requires cutting curved shapes. Which machine is best for this operation?
3. You want to create one straight, flat, and smooth surface on the timber, as well as one edge at a 90-degree angle to that surface. Which machine would you use?
4. You need to saw a workpiece using a narrow bandsaw. Why should the table of the narrow bandsaw be set at an angle up to 45 degrees before sawing?
5. You have pieces of wood labelled A, B, C, and D. How would you produce a curved cut?
6. You need to create a specific design or shape in the wood. What machine should you use for a pattern cut?
7. You want to create a channel or slot in the wood. How can you produce a groove cut?
8. You need to create a step or recess along the edge of a piece of wood. Which method is best for a rebate cut?
9. What factors should you consider when selecting a woodworking machine?
10. How do you ensure safety when using woodworking machines?
11. Why is it important to use the correct machine for each woodwork task?

## Questions 2.2

1. Explain excavation and outline the reasons why excavations of trenches are done.
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. Discuss the major methods of excavating trenches and the impacts of any safety precautions that go with the project's processes.

## Questions 2.3

1. Imagine you have just finished a busy day in the workshop. When should you clean the surfaces of the machines to ensure they remain in good condition?

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2. You notice that one of the machines is making unusual noises during operation. When should you lubricate the gears to prevent this issue?
3. Before starting a new project, you want to ensure all machines are in optimal condition. How often should you check them for wear and tear?
4. You are responsible for the maintenance of machines in a busy workshop, and you've noticed that maintenance has been neglected. What are the consequences of neglecting machine maintenance in the workshop?
5. You are a workshop technician tasked with optimizing and optimising the performance and efficiency of key machines in the workshop.
   a. How will you specifically care for and maintain the band saw to optimise and optimise its performance?
   b. What specific maintenance steps will you take to ensure the thicknesser machine operates efficiently?
   c. What maintenance practices will you implement for the circular saw to enhance its efficiency?
6. What is the first step in caring for machines in the workshop?
7. How often should machines be lubricated?
8. Why is it important to check machines for wear and tear?

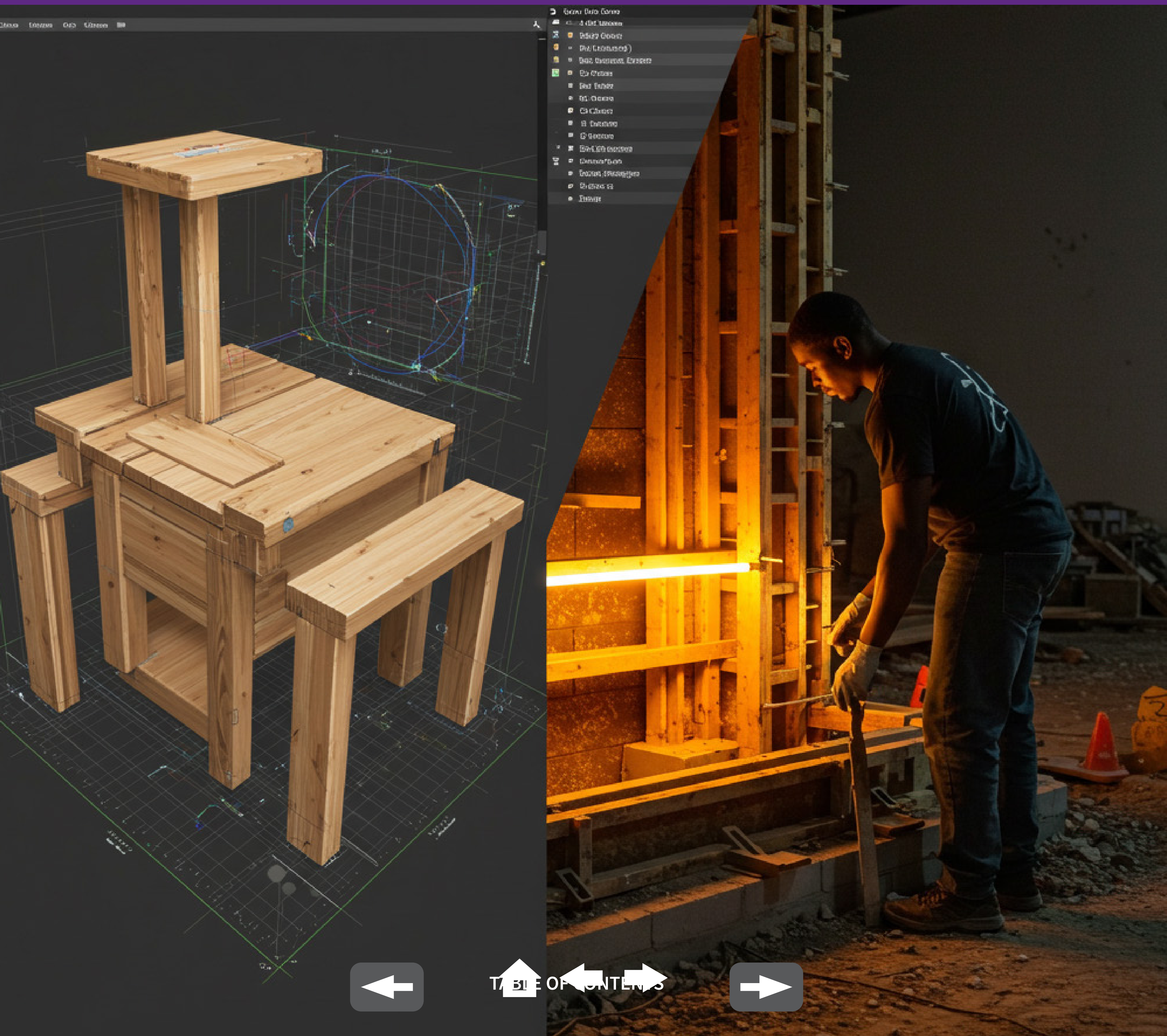
## Questions 2.4

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

SECTION

# 3

# ARTEFACTS DESIGN WITH CAD, FOUNDATION AND FORMWORK



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# WOODWORK TECHNOLOGY

## Materials and Artefact Production in Woodwork Industry

## Introduction

This unit focuses on using Computer-Aided Design (CAD) to design and create artefacts. CAD allows you to design accurately and efficiently while exploring creative solutions. It emphasises design thinking, which combines logic, imagination, and reasoning to develop innovative ideas that benefit end users. You will also build skills in freehand sketching and mechanical drawing to express your design concepts effectively. This knowledge is important for creating artefacts that address user needs and promote future improvements.

### KEY IDEAS

- Adopting a solution-focused approach through design thinking, which emphasises creativity, logic, imagination, and systemic reasoning will help to develop innovative solutions that meet user needs.
- Prioritising action and building ideas for improved outcomes, creates a problem-solving, forward-thinking work environment.
- Using Computer-Aided Design (CAD) tools to design and produce artefacts assists with precision and efficiency.
- Using CAD as a tool for freehand sketching and mechanical drawing can help bring designs to life.

## COMPUTER-AIDED DESIGN [CAD] IN DESIGNING AND MAKING OF ARTEFACTS

**Computer-Aided Design (CAD)** in designing and making artefacts refers to the use of computer software to create, modify, analyse, and optimise designs before they are physically made. It is a powerful tool used in many fields, including engineering, architecture, and product design, to enhance the process of designing and producing artefacts.

Design is the purposeful process of planning and creating solutions to meet specific needs or solve problems. It is the practical expression of ideas that bring about change in man-made objects, whether for functional or aesthetic purposes.

Wood design refers to the intentional planning, inventing, and making of wooden artefacts for a particular use. This process involves considering the artefact's construction, operation and appearance. A design may be created manually (by hand) or with the help of machines, and it is influenced by various factors such as the materials used, the shape and structure of the artefact, its intended use, and its visual appearance. In essence, design is about turning an idea into a tangible product that serves a specific function or fulfils a purpose, whether in everyday life or specialised industries.

Designing is the process of solving problems by identifying a situation or need, investigating it, and generating possible solutions. It includes selecting and developing the best solution, creating the final product, and testing or evaluating its effectiveness.

The problem-solving process can be represented in a diagrammatic format as follows:


**Figure 3.9.1:** Stages of the Design Process

1. A **situation** refers to the description of a problem or a need that requires a solution. It is a statement that identifies and outlines the issue to be addressed. Situations can be discovered in various ways, such as examining daily activities at home, school, or work. They may also arise from observing the need for equipment, furniture, or tools in places like lounges, bedrooms, kitchens, or classrooms. Additionally, studying how others live, and work can help identify areas where improvements or solutions are needed.

   **For example:** *Little children under the age of two find it difficult to waddle. While waddling, they often fall and injure themselves. This sometimes results in fragmented legs, and hands as well as bodily pains. There is therefore the need to create a unit to aid tots to walk.*

2. A **brief** is a concise statement that summarises what the designer plans to make. It defines the purpose and goal of the design, providing clear direction for the project. For example, a brief could be: "***Design and make a unit that would help toddlers to walk.***" It sets the foundation for the design process by identifying the intended outcome. You can select a word from each column of the table below to write your brief.

**Table 3.9.1:** Constructing a brief – useful words

| | | | | | |
|---|---|---|---|---|---|
| Design | and | make/produce/ construct/fabricate/ manufacture/realise | a/an | unit/item/system/ device/artefact/ structure | Plus, a clue from the situation to complete your brief statement. |

3. **Investigation** is the process of gathering detailed information about a design problem to better understand and analyse it. This involves critically examining the situation through thoughtful questions such as ***why***, ***how***, ***where***, ***who***, ***when*** *and* ***what*** is related to the problem. These questions guide the designer in making informed decisions about potential solutions and determining the steps to address the issue effectively. For example, one key question during the investigation could be: ***"What is the function of the artefact?"*** This helps clarify its purpose and ensures the design meets the intended need.

   Detailed information can be obtained through methods such as interviewing people, including experts, or conducting surveys using questionnaires, which serve as primary sources. Alternatively, information can be drawn from secondary sources, which are data or materials previously collected by others.

   To obtain the necessary and relevant information for generating ideas, use the investigation layout provided. This layout serves as a detailed guide throughout the investigation process.


**Figure 3.9.2:** Investigation layout

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4. A **solution** is the outcome of addressing a design problem. It involves two stages: generating ***possible solutions*** and arriving at the ***final solution***. By understanding the problem, the designer brainstorms various ideas and selects the most suitable one. This chosen idea is then refined and developed into a final solution that effectively meets the identified need or solves the problem.
5. **Realisation (Construction)** refers to the process of constructing the final solution or making the designed artefact. This stage involves carefully following a plan, known as the **operational sequence**, which outlines the steps, tools, and materials needed to complete the project efficiently and on time. Sketches of the process may also be included to guide the workflow.

***To ensure high-quality results during realisation, the following steps should be observed:***

a. Follow safety precautions when using tools and machines.
b. Use the detailed drawing as a reference, measuring and marking parts accurately with allowances.
c. Organise tools and equipment in an orderly manner.
d. Work sequentially, completing one process before moving to the next.
e. Choose operations that will yield the best results.
f. Seek guidance from your facilitator to address challenges during the process.

Careful planning and execution are crucial to achieving a successful and functional artefact.

6. **Testing/Evaluation** is the procedure of assessing how well an artefact performs and whether it meets the needs or solves the problem described in the design brief. This stage involves checking if the artefact fulfils its intended function. Before conducting the evaluation, it is important to clearly define what the artefact is meant to do. Once the function is understood, testing can determine if the artefact successfully performs its job and achieves the desired outcome.

## Applications

**Freehand sketching** refers to the ability to draw without using any tools or mechanical instruments like grids, rulers, or compasses. It is a fast and convenient method for visually representing ideas and objects. Freehand sketching is especially useful in the early stages of the design process, as it allows designers to quickly capture and communicate their thoughts. This method is used to sketch different types of drawings, such as perspective, isometric, or orthographic, either on paper with an HB pencil or through digital tools like AutoCAD. Since it requires no precise measurements or tools, freehand sketching is ideal for brainstorming, conceptualising, and developing design ideas rapidly.

**AutoCAD** is a software application used for Computer-Aided Design (CAD) and Computer-Aided Drafting (CADD). It helps users create precise 2D and 3D drawings and designs, which can be printed out to scale. AutoCAD is widely used in industries such as architecture, engineering, and manufacturing for designing and drafting. It allows for detailed, accurate representations of objects, structures, and systems, enabling users to visualise their ideas and plans. The software supports various commands and tools that make it easier to develop and modify designs, offering a range of features for both simple and complex tasks. AutoCAD is an essential tool for professionals looking to improve their design skills and create high-quality, precise drawings.

## The Structure of AutoCAD

AutoCAD has a structured interface designed to make it as easy as possible for users to locate commands and perform tasks with minimal effort. Before starting to draw, it's important to understand the layout and key elements of the AutoCAD interface.

The following components are essential for using AutoCAD effectively:

1. **Launching AutoCAD:** This is the first step, where you open the software and prepare to begin the drawing process.
2. **Exploring the AutoCAD Interface:** The interface provides access to various tools and commands needed for creating and modifying designs.
   a. ***World Coordinate System (WCS):*** This system helps position objects in a 3D space using the X, Y, and Z axes. It ensures the precise placement of drawings.
   b. ***Crosshair Cursor:*** The crosshair cursor is used to navigate and select points on the screen. It helps you align and place objects accurately.
   c. ***Start Tab:*** The Start tab allows you to choose a sheet setup (such as acad, acadiso, architecture, etc.) to begin your drawing. It defines the workspace and drawing environment.
   d. ***Draw/Graphic Area:*** This is the central area where the drawing takes place. It displays the current design and allows you to interact with it.
   e. ***Ribbon:*** The ribbon contains various command tools used for modelling and editing artefacts, including options like layers, draw, modify, solid editing, mesh, and views. It is organised into tabs to make it easy to access different tools.
   f. ***Command Window/Line:*** This window allows users to input commands directly. It is where you can type commands for specific actions or operations.
   g. ***Status Bar:*** The status bar at the bottom of the screen provides settings like grid mode, snap mode, ortho mode, polar tracking, object snapping,

workspace switching, and line weight. These settings help customise your drawing environment for better accuracy and ease of use.

h. ***Menu Bar:*** The menu bar includes various options for managing your drawing, such as Home, Solid, Surface, Mesh, Visualise, Parametric, View, Manage, and more. These menus help you navigate through AutoCAD's powerful features.

i. ***Application Menu***, accessed via the "A" button in the top-left corner, manages files and settings. It includes options like New, Open, Save, Print, Export, and Close for core AutoCAD functions.

By familiarising yourself with these components, you will be able to efficiently use AutoCAD to create, modify, and manage your design projects. The user interface is designed to provide quick access to tools, commands, and settings with minimal clicks, which improves overall productivity and ease of use as shown below:

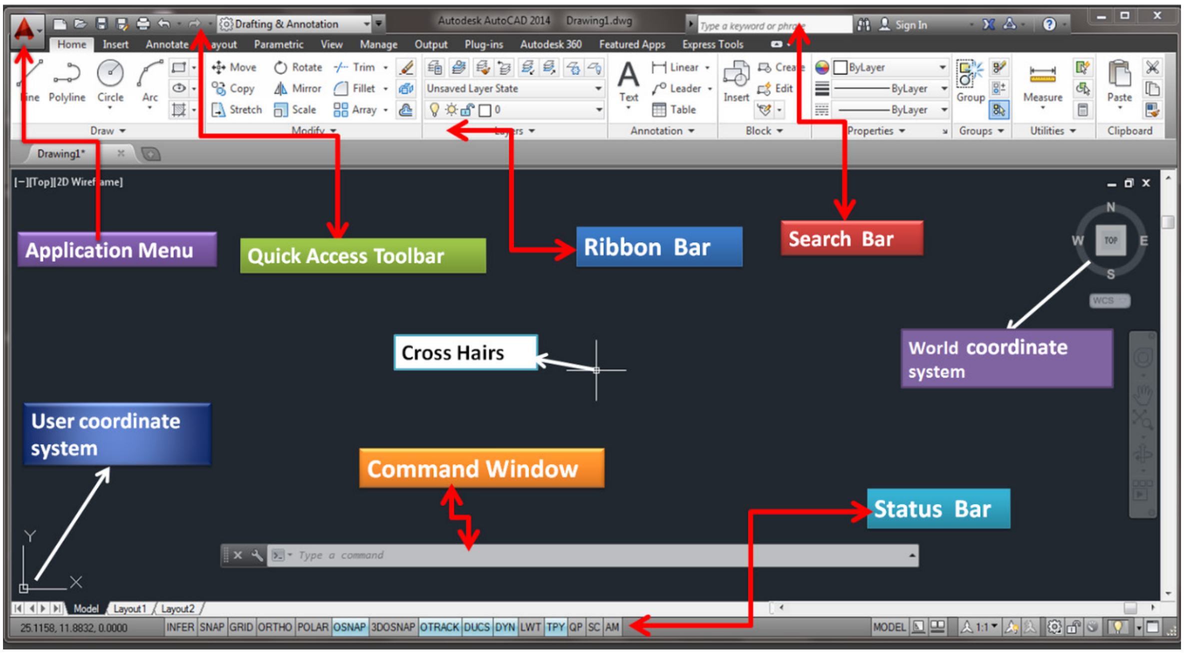


**Figure 3.9.3:** AUTOCAD Interface

# Factors That Affect Solutions to Situations or Problems

When designing solutions, many factors can influence the effectiveness and functionality of the final product. These include:

1. **Functionality:** The solution must meet its intended purpose effectively. Customer satisfaction increases when the product fully addresses the problem it was designed to solve.
2. **Materials:** A thorough understanding of materials is essential. Designers must stay updated on new materials and technologies to create durable, efficient, and high-quality products.


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3. **Durability:** The product must withstand environmental conditions and protect itself from potential damage to ensure long-lasting performance.
4. **User Requirements:** Knowing the needs, preferences, and behaviours of the target users is critical to creating user-friendly and relevant solutions.
5. **Cultural Considerations:** Products should align with the cultural values and norms of their intended market. What works in one culture may not be acceptable in another.
6. **Regulatory Requirements:** Designers must adhere to laws, regulations, and industry standards to ensure safety and compliance.
7. **Sustainability:** Solutions should minimise environmental and social impacts, considering factors like resource efficiency and ease of maintenance over time.
8. **Technological Advancements:** Staying informed about emerging technologies and trends ensures the solution remains innovative and competitive.

Your teacher will place you into groups of 5. They will then introduce and explain the following activities to you.

## Activity 3.9.1

### Exploring the AutoCAD Interface

**Scenario:**

You are part of a team learning how to identify and use the key parts of the AutoCAD interface. Your task is to explore, discuss, and identify the main components of the interface, such as the ribbon, toolbar, workspace, command line, status bar, etc.

**Materials Needed:**

- Computers or laptops with AutoCAD software installed
- Projector or large screen for demonstration
- Internet access for additional reference materials
- Writing materials (notebooks, pens, markers)
- Printed guides or charts of the AutoCAD interface.

### Activity Guidelines:

1. Your teacher will demonstrate the AutoCAD interface via video or live screen sharing.
2. You will note down key parts like the ribbon, toolbar, command line, and workspace.



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3. In your groups brainstorm and discuss the identified parts in pairs.
4. Use these guiding questions to help the discussion:
   a. What is the role of the ribbon in AutoCAD?
   b. Why is the command line important?
5. Your teacher will then facilitate a whole-class feedback session, encouraging everyone to share and explain their observations.
6. Your group will then discuss and write a description of the main components of the AutoCAD interface.
7. Group members with highly proficient knowledge will support others to understand complex features.
8. Your group will collaboratively sketch or annotate a diagram of the AutoCAD interface using freehand drawing or basic CAD tools.
9. Your group will produce at least two annotated diagrams with clear labels and explanations.
10. You will make sure all safety rules and etiquette for using computers are followed.

## Activity 3.9.2

### Designing a Solution for the Headmaster's Office

**Scenario:**

You are tasked with addressing a problem in the headmaster's office, which currently contains only a table and a plastic chair. Your goal is to propose a solution by identifying the problem, writing a situation and design brief, and sketching possible solutions. You will be divided into small groups for this activity.

**Materials Needed:**

- Writing materials (notebooks, pens, pencils, erasers)
- Large sheets of paper or drawing pads for sketches
- Computers with basic design software or CAD (if available)
- Printed examples of situation and design briefs
- Rulers and markers for annotations

### Activity Guidelines:

1. In your group discuss the problem, focusing on questions like:
   a. What challenges does the current setup create?
   b. What features would a better solution include?

2. Your teacher will encourage an open discussion and then facilitate a whole-class discussion/feedback session to refine ideas.
3. Your group will then collaborate to write:
   a. A *situation* describing the current issue.
   b. A *design brief* outlining the intended solution (e.g., furniture suitable for meetings and long work hours).
4. Your group will sketch **two possible solutions** for the office setup, using either freehand or basic CAD tools. Each sketch includes labels explaining features (e.g., ergonomic chair, multi-purpose table, storage drawers).
5. You will make sure all safety rules and etiquette for using computers are followed.

## Activity 3.9.3

### Sketching Solutions for a Workspace Improvement

**Scenario:**

You are tasked with proposing two solutions to improve a specific challenge in a busy manufacturing workshop. You will work in groups to create freehand or CAD sketches, ensuring the designs are practical, safe, and efficient.

**Materials Needed:**

- Drawing paper or sketch pads
- Pencils, erasers, and markers for freehand sketching
- Computers with CAD software installed
- Rulers and protractors for precision
- Examples of annotated sketches for guidance
- Reference materials on safe and efficient workspace designs

### Activity Guidelines:

1. You will be shown a video or a live demonstration on how to sketch solutions with annotations, either freehand or using CAD.
2. Your group will discuss the process of sketching solutions, focusing on:
   a. What makes a good design practical and safe?
   b. Why are annotations important in sketches?
3. Your group will identify a specific problem in the workshop (e.g., machine layout, storage, or workflow) and brainstorm two possible solutions.
4. Your group will co-create two annotated sketches, ensuring each member contributes.

5. Each sketch will include clear labels explaining the design's features and their purpose (e.g., safety barriers, ergonomic improvements, better accessibility).
6. Your group will present their solutions to the class, highlighting their design's practicality, safety, and efficiency.

## Conclusion

In conclusion, applying Computer-Aided Design (CAD) in the design and making of artefacts enhances accuracy, efficiency, and creativity. CAD enables precise 2D and 3D modelling, simulations, and material selection, improving the overall design process. It supports rapid prototyping, testing, and innovation, ensuring that the final product meets the required specifications and performance. By integrating CAD, designers can create high-quality, functional, and reliable artefacts more efficiently while considering factors like sustainability and user needs.

# UNIT 10

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

Foundation footings are key components in the construction of buildings. They are designed to distribute the load of a building evenly across the soil thereby preventing settling and ensuring stability of the building. They are sometimes composed of concrete and reinforced with steel bars. The foundation footings are provided in various forms like strip footings for continuous walls, isolated footings for individual columns, and mat foundations for heavy loads or poor soil conditions, which are all placed below the frost line to avoid freeze-thaw damage. The footing ultimately supports the structure's durability and integrity under diverse environmental and load conditions, making them indispensable for safe and durable building construction

### KEY IDEAS

- **Frost Protection:** Footings are usually placed below the frost line to avoid movement caused by freeze-thaw cycles. This helps maintain the stability and longevity of the building.
- **Load Distribution:** Footings help distribute the weight of the building evenly across the soil. By spreading the load, they prevent the foundation from sinking or settling unevenly.
- **Materials Used:** Typically made from concrete due to its strength and durability. Reinforcing steel (rebar) is often embedded in the concrete to enhance its tensile strength.
- **Types of Footings:** Different types include strip footings for load-bearing walls, isolated footings for individual columns, and mat or raft foundations for heavy or soft soil conditions.

## FOUNDATION FOOTING

### What is the Meaning of Foundation Footing?

Foundation footing is the part of a building's foundation that sits directly on the ground and supports the structure above. It spreads the load from the building to a larger area of soil, reducing stress and preventing excessive settlement. Typically made of concrete, footings ensure stability, distribute the building's weight evenly, and prevent shifting or settling. **Figure 3.10.1** shows how foundation footings look.

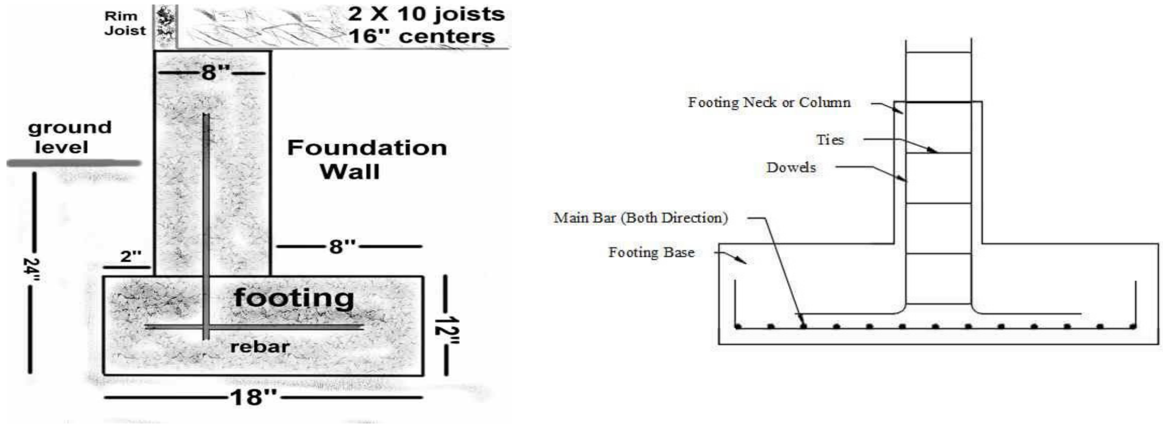


**Figure 3.10.1:** Sections of typical foundation footing

## Activity 3.10.1

Individually read about foundation footings and then brainstorm about the following;

1. The meaning of the term foundation footings.
2. Outline the various elements used for the foundation footings.
3. Note down the key issues and points for general class presentations and discussion.

## The Elements Used for Foundation Footings

The elements used for foundation footings are essential components that ensure the stability and durability of the foundation of the building. The following are the elements used:

1. **Concrete:** The primary material, providing strength and support. It must be mixed and cured properly to achieve the necessary durability.
2. **Rebar (Reinforcing Steel):** Steel bars embedded within the concrete to increase its tensile strength and prevent cracking. They provide additional support to the footing.
3. **Formwork:** Temporary moulds made of timber, steel, or aluminium that shape the concrete as it sets. Formwork ensures the footing has the correct dimensions and shape.
4. **Gravel or Crushed Stone Base:** A layer placed beneath the concrete to improve drainage and provide a stable base. This prevents water accumulation and helps distribute the load.

5. **Anchor Bolts:** Used to connect the structure above to the footing, ensuring that the building is securely anchored to the foundation.


**Fig. 3.10.2:** An example of a foundation footing showing some of the elements

**Activity 3.10.2**

In groups of no more than 5, discuss the various elements used for foundation footings.

## The Functions of Foundation Footings

Foundation footings are very important in the construction of the substructure of a building. This is because they provide the essential support that keeps buildings stable and secure. These critical components distribute the weight of the structure to the ground, to ensure that the building stands firm against various forces. Look at the functions of foundation footings as presented in **Table 3.10.1** and also the images in **Figures 3.10.3** and **3.10.4** to aid your understanding.

**Table 3.10.1:** Detailed description of the functions of foundation footings

| Functions | Description |
|---|---|
| **Load Distribution** | Footings support the weight of the building and distribute loads to the soil, preventing excessive pressure on any single point |
| **Stability** | They provide a stable base that resists lateral forces, such as wind and seismic activity, helping maintain the building's position |
| **Preventing Settlement** | Footings help prevent differential settlement by ensuring even weight distribution across the foundation, reducing the risk of structural damage |
| **Moisture Control** | They assist in managing groundwater and drainage around the foundation, minimizing issues related to water accumulation, erosion, or soil weakening |
| **Connection to Ground** | Footings anchor the structure to the ground, creating a solid connection that ensures the foundation walls remain secure and stable |

| | |
|---|---|
| **Support for Vertical Loads** | Footings are designed to carry vertical loads from the building's superstructure, ensuring that the entire structure remains upright. |
| **Reinforcement** | Many footings incorporate reinforcement (like rebar) to enhance their strength and durability, particularly in areas with challenging soil conditions or heavy loads |
| **Compliance with Regulations** | Properly designed and constructed footings are necessary for meeting local building codes and regulations, which are crucial for ensuring safety |
| **Longevity** | By providing a reliable foundation, footings contribute to the long-term durability and lifespan of the building, reducing the need for repairs |

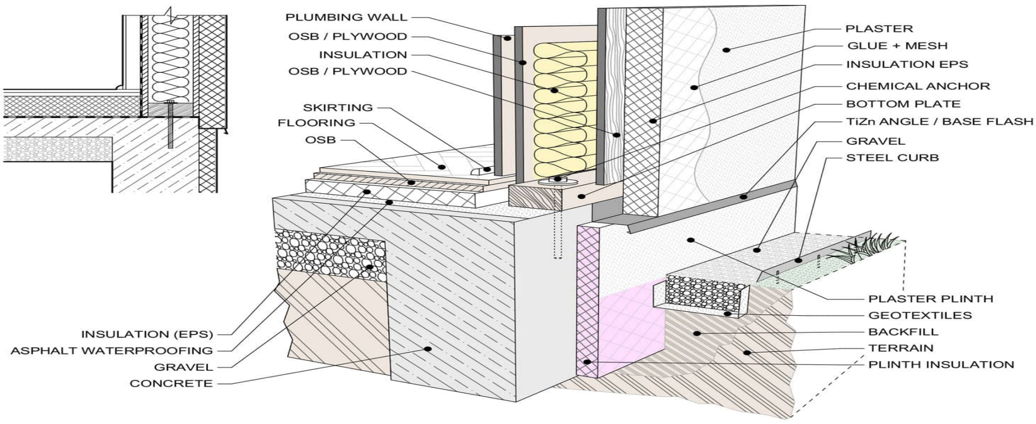


**Figure 3.10.3:** The section of a substructure showing the foundation footing.

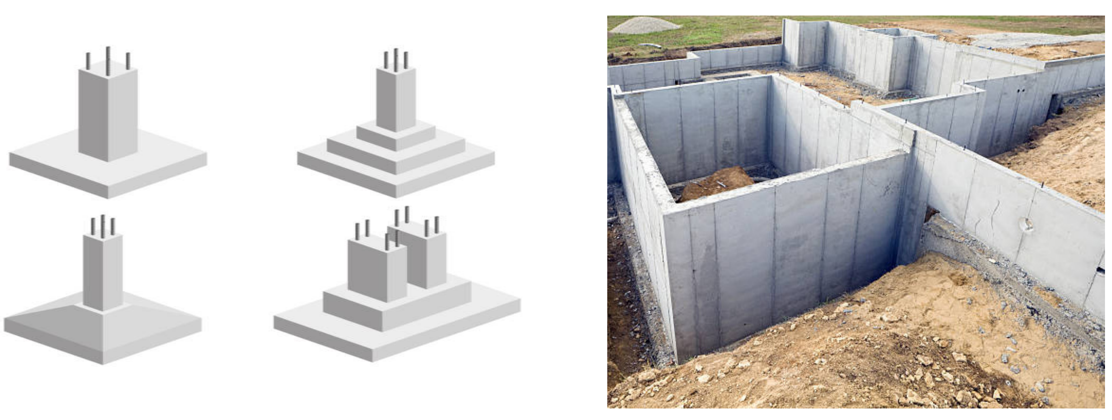

**Figure 3.10.4:** Examples of foundation footings

## Activity 3.10.3

In groups of no more than 5, consider the numerous functions of the foundation footings and the illustrations attached, discuss in detail and record, their functions for wider class discussion.

# UNIT 11



# WOODWORK TECHNOLOGY

## Materials and Artefact Production in Woodwork Industry

## Introduction

This unit shows you how to produce working drawings from a final design solution. After developing a design through sketching or CAD, an accurate representation of sizes, proportions, and relationships is needed. Standard drawing tools or AutoCAD are used for graphic communication. Drawings serve as visual symbols of the actual object. The two main types of drawings are pictorial, which shows multiple views at once, and orthographic, which shows views separately. This helps communicate design ideas clearly.

**KEY IDEAS**

- A drawing visually represents the actual object.
- Standard drawing tools or AutoCAD are used for graphic communication.
- There are two main types of drawings: pictorial, which shows multiple views at once, and orthographic, which shows views separately in different positions.
- Working drawings are produced from the final design solution, focusing on accurately representing sizes, proportions, and relationships.

## WORKING DRAWING

A working drawing in woodwork is a detailed and dimensioned plan that clearly shows how to construct a specific project, such as furniture, cabinets, or decorative items. It provides essential guidance for craftsmen, woodworkers, and manufacturers, ensuring the accurate creation of the designed piece.

### Pictorial Drawing

Pictorial drawings are used to represent objects in three dimensions (3D), showing the length, width, and height of the object. There are three main types of pictorial drawings:

## Isometric Drawing

In isometric drawing, all vertical lines are drawn perpendicular to the horizontal, while the length and width lines are drawn at a 30° angle to the horizontal. These lines are parallel to each other, creating a clear, three-dimensional view of the object.

## Principles of Isometric View

**a.** Isometric drawings represent the length, width, and height of an object, making it appear three-dimensional.

**b.** All dimensions (length, width, and height) are drawn to the same scale, maintaining proportionality throughout the drawing.

**c.** Lines representing height are drawn vertically, perpendicular to the horizontal plane.

**d.** Lines representing the length and width are drawn at an angle of 30° to the horizontal plane.

**e.** All lines representing the same dimension (e.g., length, width, height) are parallel to one another in the drawing.

**f.** Unlike perspective drawings, isometric views do not include vanishing points, so objects retain their true shape and dimensions.

**g.** Edges and corners of the object are visible, helping to define its shape.

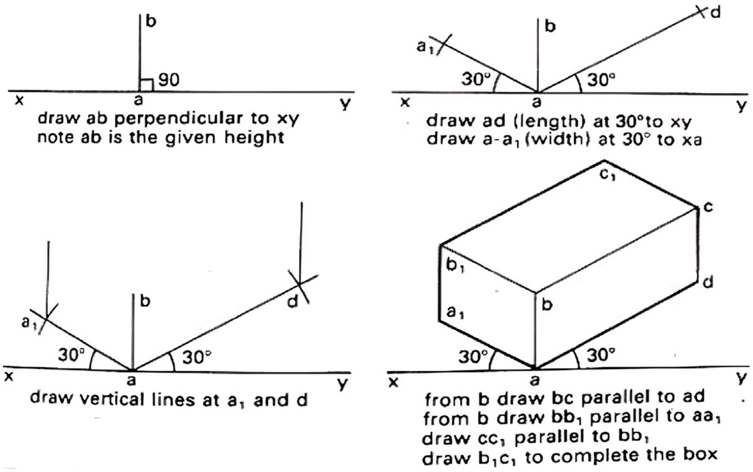


**Figure 3.11.1:** Method of drawing in isometric

These principles ensure that isometric views provide an accurate and visually clear representation of the object in three dimensions.

## Oblique Drawing

This is a method of representing objects where one face is drawn in true proportions as if viewed straight on, while the other faces are projected at an angle of 45° to the horizontal line. The lines representing the angled sides are parallel to each other, creating a three-dimensional appearance.

Objects in oblique drawings can appear slightly distorted. When the angled sides are drawn at their full length, the drawing is referred to as a ***cavalier projection***. However, to reduce distortion and create a more realistic appearance, the angled sides can be shortened, though this method, often called ***cabinet projection***, still does not look as accurate as isometric or perspective drawings.

## Principles of Oblique Drawing

a. The front face of the object is drawn in true shape and proportions as if viewed straight on.

b. The sides of the object are projected at a 45° angle to the horizontal line.

c. All projection lines representing the depth of the object are parallel to each other.

d. Objects in oblique drawings may appear distorted, particularly when the depth is drawn at full scale.

e. **Types of Projections:**

   i. **Cavalier Projection:** Depth lines are drawn at full scale.

   ii. **Cabinet Projection:** Depth lines are halved to reduce distortion and achieve a more realistic appearance.

f. Oblique drawings are easy to create and are useful for quickly visualising designs.

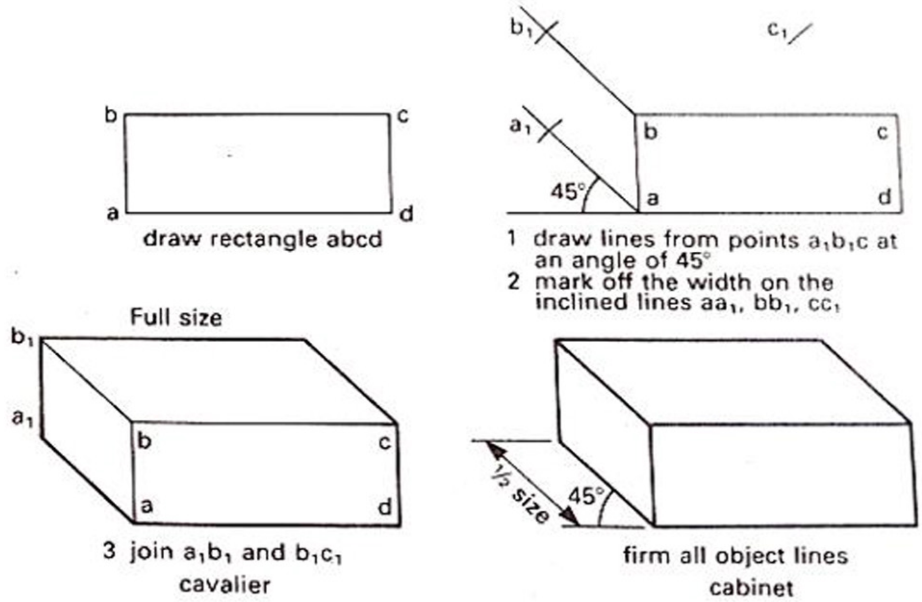


**Figure 3.11.2:** Method of drawing in oblique

Despite its limitations, oblique drawing is simple to construct and useful for quickly visualising the shape and details of an object, particularly when one face needs to be shown in exact proportions.

## Perspective Drawing

Perspective drawing is a method of representing objects in a way that mimics how they appear to the eye. In this type of drawing, all vertical lines are drawn parallel and upright, representing the height of the object. The lines representing the length and width of the object converge at one or more vanishing points on the horizon line.

This convergence creates a sense of depth, making the object appear more realistic than in isometric or oblique drawings. For this reason, perspective drawing is commonly used by designers to present ideas, especially when a lifelike visualisation is required.

### Principles of Perspective Drawing

a. **Vanishing Point**: Lines representing the length and width of the object converge at one or more vanishing points on the horizon line.

b. **Horizon Line**: This is the eye level of the viewer, where vanishing points are located.

c. **Parallel Vertical Lines**: All vertical lines in the object are drawn parallel to each other and perpendicular to the ground.

d. **Convergence of Lines**: Lines representing depth and width gradually converge as they move away from the viewer, creating the illusion of depth.

e. **Realistic Proportions**: Objects closer to the viewer appear larger, while those farther away appear smaller, mimicking how the eye perceives distance.

f. **Perspective Types**:

- ***One-Point Perspective:*** Lines converge to a single vanishing point.
- ***Two-Point Perspective:*** Lines converge to two vanishing points, often used for corners.

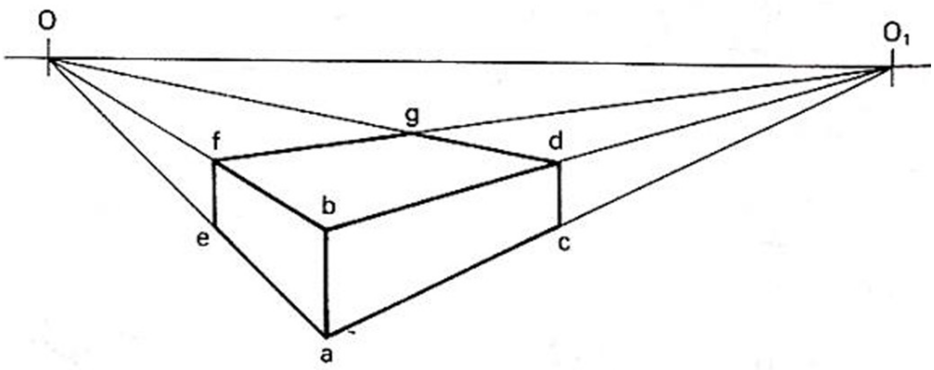


**Figure 3.11.3:** Two-Point Perspective Drawing

- ***Three-Point Perspective:*** Includes a third vanishing point for height, often used for tall structures.

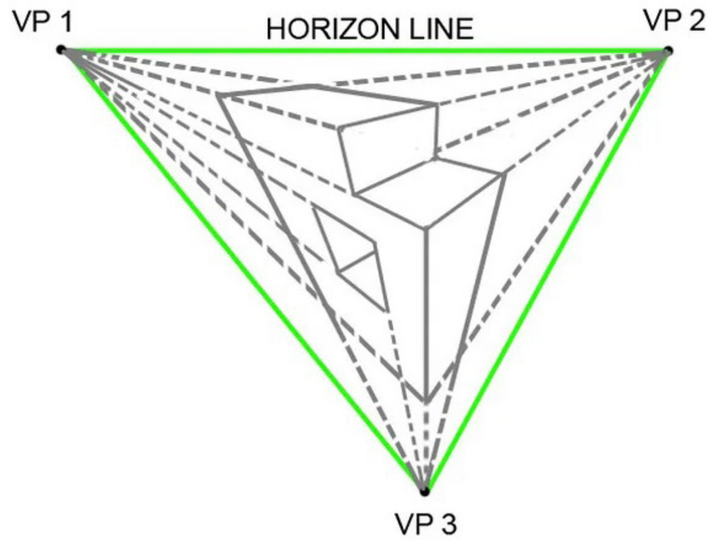


**Figure 3.11.4:** Three-point perspective drawing

g. **Realism**: Perspective drawings are highly realistic, making them ideal for presenting final designs.

Perspective drawings are ideal for showcasing the final appearance of an object or structure, giving a clear and realistic view that helps communicate the design effectively.

## Orthographic Projection

Orthographic projection is a method used to represent three-dimensional objects in two dimensions. This technique involves creating multiple two-dimensional views of an object by projecting its features at right angles (perpendicular) to the planes of projection. The main views typically include;

1. **Front Elevation**: Shows the front view of the object.
2. **Plan**: Displays the top view of the object.
3. **End Elevation**: Represents the side view of the object.

There are two main types of orthographic projection:

a. **First Angle Projection**: Commonly referred to as European or British projection. In this method, the object is placed between the observer and the projection plane.

b. **Third Angle Projection**: Known as the American projection, where the projection plane is placed between the observer and the object.

Both types are widely used, and you should be familiar with both systems. First-angle projection is typically introduced earlier, while third-angle projection examples are often included for comparison and further understanding. Orthographic projection is essential for creating accurate and detailed representations of objects, ensuring clear communication of designs.

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# Planes of Projection

Planes of projection are the surfaces onto which the views of an object are projected in orthographic drawing. There are two principal planes:

1. **Horizontal Plane**: Used for projecting the top view (plan) of the object.
2. **Vertical Plane**: Used for projecting the front view (front elevation) of the object.

These planes intersect at right angles, forming four quadrants. In third-angle projection, the object is placed in the third quadrant, meaning the planes are positioned in front of the object. To visualise the object clearly, the planes are assumed to be transparent, allowing views to be projected without obstruction.

This arrangement ensures accurate and clear representation of the object from different perspectives, aiding in effective design communication.

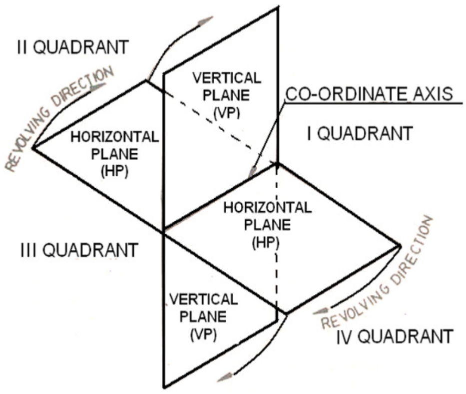


**Figure 3.11.5:** Planes of projection

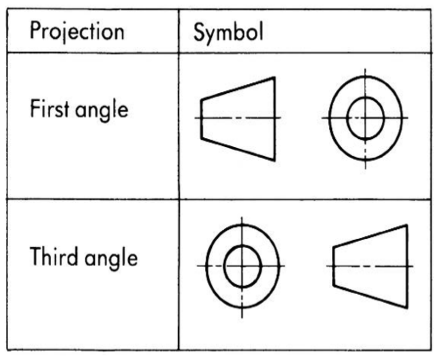


**Figure 3.11.6:** Symbols of orthographic projection

# Principles of Third Angle Projection

In third-angle projection, the object is assumed to be suspended in a transparent projection box, allowing views to be projected onto specific planes. The object is placed between the observer and the projection planes. This means the views are projected onto planes located behind the object. The principles for projecting each view are as follows:

1. **Front Elevation (Front View):** The object is viewed from the front, with projection lines perpendicular to the vertical plane (VP). The front view is then projected back onto the vertical plane.
2. **Plan (Top View):** The object is viewed from above, with projection lines perpendicular to the horizontal plane (HP). The top view is then projected back onto the horizontal plane.
3. **Right-End Elevation (Right-Side View):** The object is viewed from the right side, with projection lines perpendicular to the right auxiliary vertical plane. The right-side view is then projected back onto this plane.

4. **Left-End Elevation (Left-Side View):** The object is viewed from the left side, with projection lines perpendicular to the left auxiliary vertical plane. The left-side view is then projected back onto this plane.

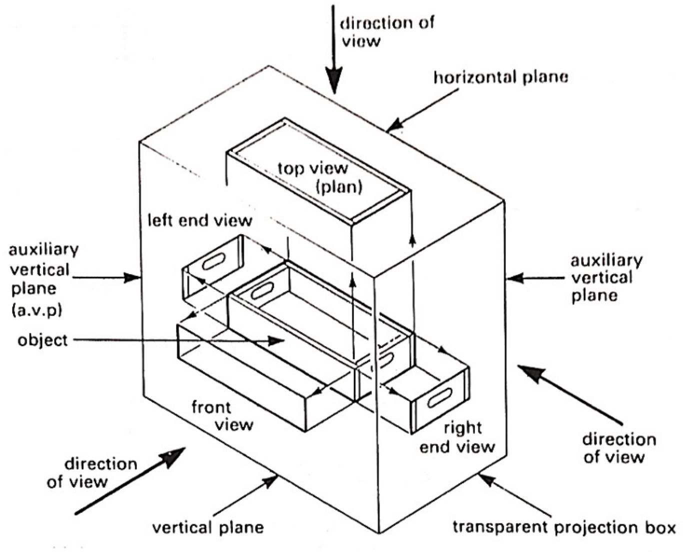


**Figure 3.11.7:** Principles of third-angle orthographic projection

These principles ensure accurate and systematic representation of the object's views, maintaining proper alignment and proportions for clear interpretation.

## Exploded View

An exploded drawing is a visual representation used to show how the individual parts of an artefact fit together. This type of drawing presents the parts as though they are separated or "dismantled," making it easier to understand the construction process and the relationship between components. Exploded isometric drawings are commonly used because they display the parts in a three-dimensional layout, offering a clear perspective of how they align and connect.

This makes the exploded view an essential tool, especially for beginners, as it provides a step-by-step guide for assembling the artefact as shown below. By showing each part's position and orientation, exploded drawings simplify the process of understanding complex structures and ensure accurate assembly.

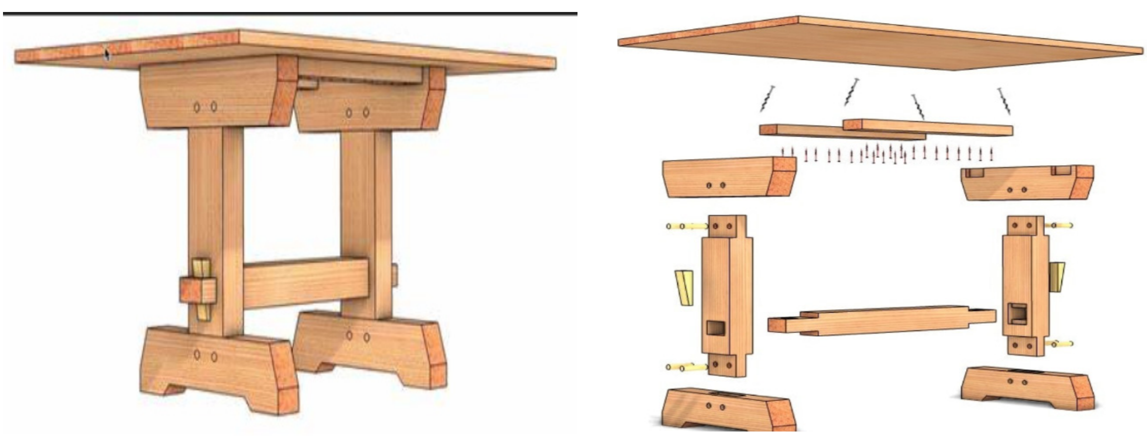

**Figure 3.11.8:** Frame dining room table with its exploded view

# Rendering

Rendering is a technique used to enhance the appearance of a surface, making it more visually appealing or realistic. It can be applied to drawings or artefacts, either by freehand or using AutoCAD.

## Freehand Rendering Techniques

a. **Hatching:** Creating parallel lines to show shading or texture.

b. **Cross-hatching:** Overlapping sets of parallel lines at angles to create deeper shading effects.

c. **Stippling:** Using dots to create texture or shading.

d. **Blending:** Smoothly transitioning between tones for a soft appearance.

e. **Thick and Thin Line Shading:** Using varying line widths to depict depth and form.

f. **Texture Shading:** Replicating specific surface textures, such as wood grain or fabric.

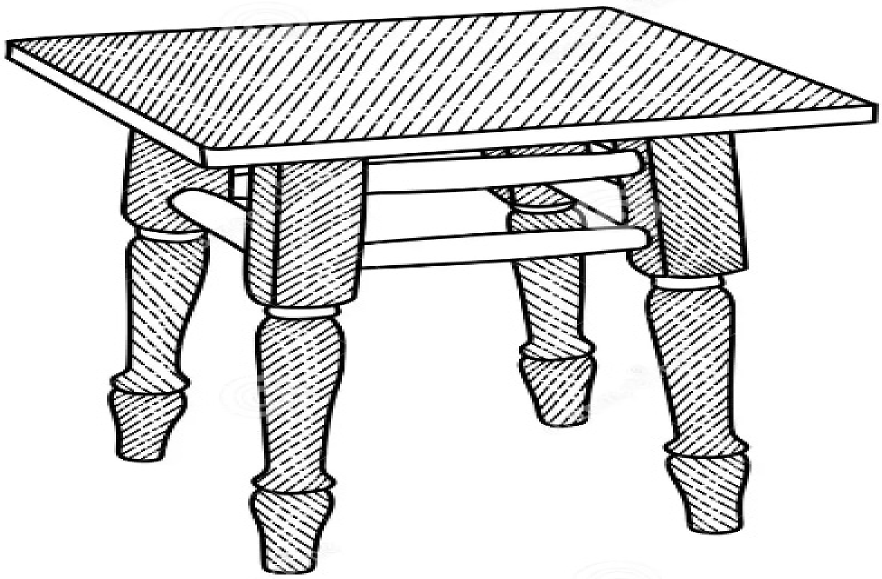

**Figure 3.11.9:** Freehand rendering technique-hatching with thick and thin lines

## AutoCAD Rendering Techniques

a. **Shading:** Adding shadows and light for a realistic effect.

b. **Realistic Rendering:** Applying lifelike textures and materials to surfaces.

c. **Conceptual Rendering:** Focusing on the overall design concept with simplified effects.

d. **Sketchy Rendering:** Mimicking hand-drawn styles.

e. **X-Ray Rendering:** Displaying transparent surfaces to reveal internal components.

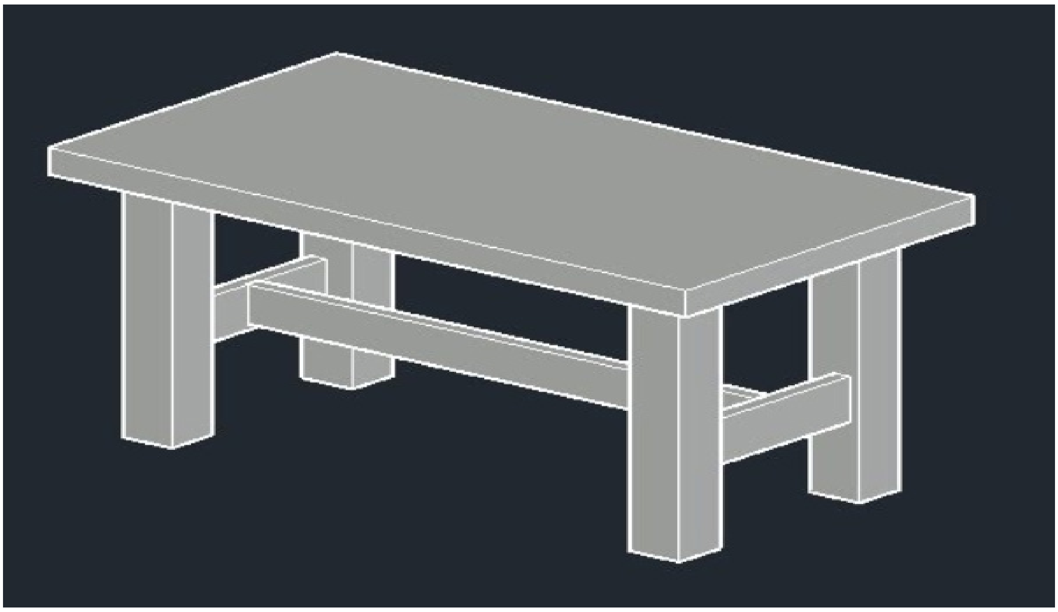

**Figure 3.11.10:** AutoCAD X-Ray Rendering Technique

In AutoCAD, these effects can be managed and applied using the ***Visual Style Manager***, enabling designers to achieve specific aesthetic goals. Rendering is crucial in both design and presentation, as it helps convey the appearance and texture of an object more effectively.

## Drawing Instruments/AutoCAD Application in Designing a Table

The design of a table can be effectively represented using both AutoCAD software and traditional drawing instruments. These tools are essential for creating accurate and detailed working drawings, showcasing various views of the artefact. Both approaches are valuable in designing a table, with AutoCAD offering speed and precision, while drawing instruments provide a hands-on understanding of technical drawing principles.

1. **Using AutoCAD Software**

   AutoCAD provides powerful tools for producing precise and professional working drawings of a table. Depending on the version used, the following views can be created:

   a. **Isometric or Pictorial View**: Displays the table in three dimensions, showing its length, width, and height.

   b. **Orthographic Projections**: Includes the front elevation, plan (top view), and end elevation, offering detailed two-dimensional representations.

   c. **Exploded View**: Presents the parts of the table separated, showing their arrangement and relationship for easy assembly.

   d. **Rendered View with Materials**: Enhances the appearance by applying realistic materials, textures, and finishes to depict the final look of the table. AutoCAD simplifies the process through tools like hatching, shading, and material application, ensuring high-quality visuals and precision.

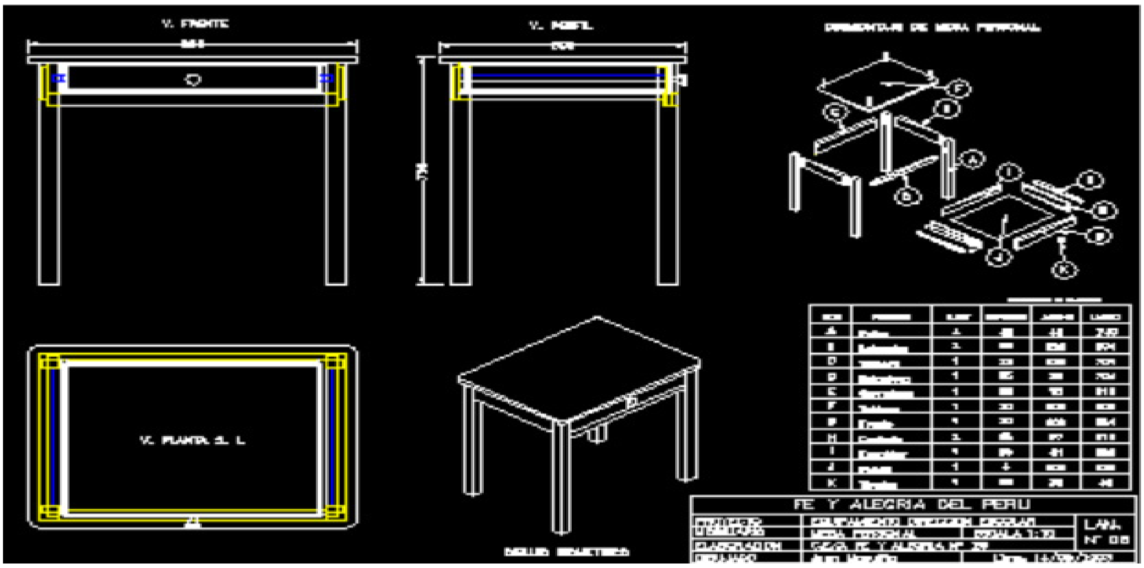


**Figure 3.11.11**: Drawing a table using AutoCAD showing isometric, orthographic projection and exploded view

## 2. Using Drawing Instruments

Traditional drawing tools such as Tee squares, set squares, compasses, and rulers can also be used to manually create the same views:

a. **Isometric or Pictorial Views**: Drawn with proper angles to give a three-dimensional perspective.

b. **Orthographic Projections**: Produced by projecting the table's dimensions onto vertical and horizontal planes.

c. **Exploded View**: Created by sketching the parts separately but aligned to show their assembly.

d. **Rendered View**: Achieved through techniques like shading, hatching, and blending to give a realistic appearance. These are illustrated in the drawings below:

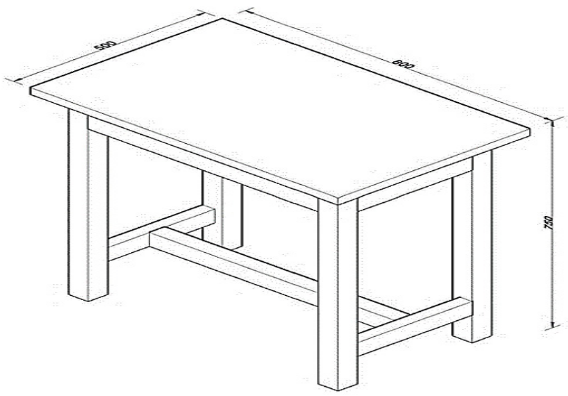


**Figure 3.11.12:** Table in an Isometric drawing with thick and thin line rendering techniques

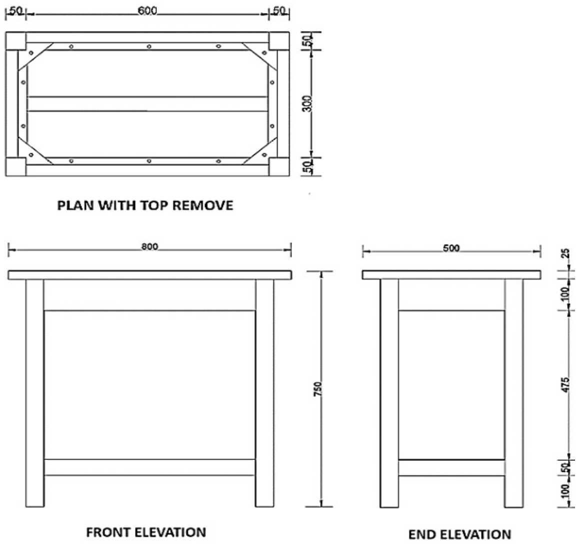


**Figure 3.11.13:** Third angle projection of a table

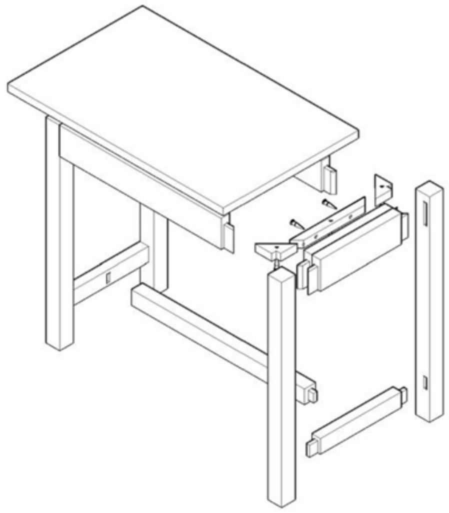

**Figure 3.11.14:** Exploded view of a table

## Activity 3.11.1

### Designing a Table for the Headmaster/Headmistress

Your teacher will place you into groups of 5. They will then introduce and explain the following activity.

**Scenario:**

You have been assigned by the headmaster/headmistress of your school to design a functional and aesthetically pleasing table for their office. The table must meet the specified dimensions of **800mm × 500mm × 750mm** and be both practical and elegant. Your task is to create accurate working drawings that include a **two-point perspective view**, **isometric view**, and **third-angle orthographic projection**, ensuring the design can be clearly understood and constructed.

**Materials Needed:**

**Manual Drawing Tools**

- Drawing board
- T-square
- Set squares
- Compass
- Ruler
- Protractor
- Pencils (HB and 2H)

- Eraser
- Drawing paper

**Digital Tools**

- Computer with AutoCAD software
- Input devices (mouse, keyboard)
- Printer (optional for printouts)

**Reference Materials**

- Example drawings or templates
- Instructional guides on perspective, isometric, and orthographic drawings

## Activity Guidelines:

1. **Preparation:**
   a. Your teacher will make sure your group has access to the required materials (manual or AutoCAD).
   b. You will provide a brief explanation of the scenario, emphasising the importance of creating a professional design for the headmaster/headmistress's office.
   c. Your teacher will share examples of similar table designs and explain the key drawing types.
2. In your group, start working on the assignment by following these steps
   a. **Two-Point Perspective:**
      - Draw a horizon line and place two vanishing points.
      - Start with the front edge of the table and project lines to the vanishing points for depth and width.
      - Complete the table structure, including legs and supports.

   c. **Isometric View**
      - Begin by setting the base dimensions (800mm × 500mm) at 30° angles.
      - Add vertical lines to represent the table height (750mm).
      - Draw connecting lines to form the tabletop and legs, ensuring accurate proportions.

   d. **Third Angle Orthographic Projection**
      - **Front Elevation**: Draw the height (750mm) and width (800mm).
      - **Plan (Top View)**: Represent the 800mm × 500mm tabletop, showing internal details if the top is removed.
      - **End Elevation**: Depict the 500mm width and 750mm height.

- Align all views correctly using projection lines.

3. In your group some members will be assigned certain roles (e.g., team leader, recorder, drawer).
4. Group members with highly proficient knowledge support others in using drawing instruments or AutoCAD tools.
5. In your group, undertake discussions to clarify challenging concepts.
6. Once completed your group will present its completed drawings to the class for feedback and discussion

## Conclusion

Producing working drawings from the final solution is key to translating design ideas into real-world products. These drawings provide clear, accurate details for construction or manufacturing. Using tools like drawing instruments or AutoCAD, designers create various views, including isometric, orthographic, and exploded drawings, that communicate size, proportions, and relationships between components. Mastering these techniques ensures effective design communication and successful project implementation.

# UNIT 12

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

Formwork is an essential component in the construction process, acting as a mould to shape and support concrete until it gains sufficient strength. Understanding the types, materials, and functions of formwork is crucial for ensuring the quality, safety, and efficiency of any concrete structure.

### KEY IDEAS

- Formwork is an ideal mould or container for concrete slabs.
- Formwork determines the shape and size of the concrete structures.
- Formwork provides an appropriate container for fresh concrete.
- Formwork determines the outlook of concrete slabs.
- Temporary mould for various concrete structures.

## FORMWORK

1. **Timber:** Commonly used for smaller projects. It is easy to work with but has limited reuse due to wear and tear.
2. **Steel:** Strong, durable, and reusable. Ideal for large, repetitive projects where precision and longevity are crucial.
3. **Aluminium:** Lightweight and easy to handle, providing a balance between strength and weight. Often used in prefabricated formwork systems.
4. **Plywood:** Typically used as sheathing for timber formwork. It is flexible and adaptable to various shapes, offering a smooth finish.
5. **Plastic:** Durable, reusable, and easy to clean. Suitable for creating custom shapes and smooth finishes, often used in modular formwork systems.

# Functions of Formwork

1. **Shaping Concrete:** Provides the desired shape, size, and surface finish of the concrete element.
2. **Supporting Loads:** Holds the weight of the wet concrete and construction loads until the concrete cures and gains sufficient strength.
3. **Ensuring Alignment:** Maintains the correct position, alignment, and dimensions of the concrete structure.
4. **Safety:** Offers a safe working platform for construction workers during the pouring and setting of concrete.

## The Concept of Formwork in a Building Construction

Formwork is a temporary structure used in building construction to mould concrete into specific shapes and support it while it sets and gains strength. Formwork is a vital component in concrete construction, influencing both the structural integrity and aesthetic quality of the final product. Its proper design and execution are essential for the successful completion of building projects.

# The Purposes of Formwork

1. **Moulding Shape**: Formwork shapes and contains wet concrete, allowing it to be cast into specific designs, such as walls, columns, slabs, and other structural elements.
2. **Support During Curing**: It supports the concrete until it has gained sufficient strength to hold its weight, ensuring stability during the curing process.
3. **Load Distribution**: Formwork distributes the weight and pressure of the wet concrete evenly, preventing localised stress that could lead to deformation or failure.
4. **Surface Finish**: The type of formwork used can significantly affect the surface finish of the concrete. Smooth formwork can provide a high-quality finish, while rougher materials can create a different texture.
5. **Precision and Accuracy**: Properly designed formwork helps ensure accurate dimensions and alignment of structural elements, which is critical for the overall integrity of the building.
6. **Facilitating Construction Process**: Formwork allows for faster construction by providing a quick and efficient way to shape and pour concrete, enabling multiple elements to be constructed simultaneously.
7. **Safety**: Well-constructed formwork systems contribute to the safety of workers by providing stable platforms and reducing the risk of collapse during concrete placement.

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8. **Reuse and Cost Efficiency**: Many formwork systems are designed for reuse, which can lower costs and reduce material waste over time.

**Table 3.12.1:** The significance of formwork in a building construction work

| Significance | Description |
|---|---|
| **Structural Integrity** | Formwork is essential for ensuring that concrete elements are shaped correctly and can support loads effectively, contributing to the overall stability of the building |
| **Quality of Finish** | The type of formwork used influences the surface finish of the concrete. High-quality formwork can result in smoother surfaces and fewer defects, reducing the need for extensive finishing work |
| **Efficiency in Construction** | Properly designed formwork systems speed up the construction process by allowing multiple concrete elements to be poured simultaneously, thus shortening project timelines |
| **Cost-Effectiveness** | Although formwork can be a significant part of the construction budget, effective planning and reuse of formwork can lead to significant cost savings |
| **Safety** | Well-constructed formwork provides a stable working platform and helps prevent accidents by ensuring that wet concrete is contained safely during curing |
| **Customisation** | Formwork can be customised to accommodate complex architectural designs, allowing for creative and innovative building shapes and features |
| **Load Management** | It supports the weight of wet concrete and distributes loads evenly, preventing potential structural failures during the curing process. |
| **Environmental Considerations** | Many modern formwork systems are designed for reuse, which reduces waste and promotes more sustainable building practices |
| **Compliance with Standards** | Proper formwork is critical for meeting building codes and regulations, ensuring that the structure adheres to safety and performance standards |

## The materials used in formwork

1. **Timber**

   **Plywood:** Used for flat surfaces; provides a smooth finish.

   **Lumber:** Solid wood planks used for framing and bracing.

2. **Steel**

   **Steel Plates:** Durable and reusable, ideal for heavy loads.

   Steel Frames: Provides structural support; often used in high-rise construction.

3. **Aluminium**

**Aluminium Panels:** Lightweight and easy to handle; suitable for repetitive use.

**Aluminium Formwork Systems:** Provides quick assembly and disassembly.

4. **Plastic**

   **Plastic Formwork Systems:** Lightweight and reusable; good for small-scale projects and complex shapes.

5. **Composite Materials**

   **Fiber-Reinforced Plastics (FRP):** Combines strength with lightweight properties; often used in specialised applications.

6. **Insulated Concrete Forms (ICFs)**

   **Foam Panels:** Used for walls; provides insulation and stays in place as part of the final structure.

**Table 3.12.2:** The types of formwork used

| Types | Description |
|---|---|
| **Timber Formwork** | • **Description:** Made from timber or plywood, it's one of the most common types of formwork.<br>• **Advantages:** Versatile, easy to handle, and can be customized on-site.<br>• **Applications:** Suitable for a variety of structures, particularly in residential construction. |
| **Steel Formwork** | • **Description:** Consists of steel panels and frames, known for durability and reusability.<br>• **Advantages:** Strong, capable of handling heavy loads, and provides a smooth finish.<br>• **Applications:** Commonly used in high-rise buildings and industrial structures |
| **Aluminium Formwork** | • **Description:** Lightweight aluminium panels that are easy to assemble and disassemble.<br>• **Advantages:** Fast construction times, good for repetitive use, and reduces labour costs.<br>• **Applications:** Ideal for residential and commercial buildings |
| **Plastic Formwork** | • **Description:** Made from durable plastic materials; lightweight and modular.<br>• **Advantages:** Resistant to moisture and easy to clean; reusable.<br>• **Applications:** Suitable for small projects and complex shapes |

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|---|---|
| **Insulated Concrete Forms (ICFs)** | • **Description:** Foam panels used to form walls and stay in place as insulation after pouring.<br>• **Advantages:** Provides insulation and structural support; energy-efficient.<br>• **Applications:** Ideal for residential and commercial buildings focusing on energy efficiency |
| **Stay-in-Place Formwork** | • **Description:** Formwork that remains as part of the finished structure, such as precast panels or insulated forms.<br>• **Advantages:** Reduces construction time and labour, and provides thermal insulation.<br>• **Applications:** Often used in walls and slabs |
| **Modular Formwork** | • **Description:** Pre-fabricated, standardized components that can be easily assembled.<br>• **Advantages:** Quick to set up, adaptable to different shapes and sizes.<br>• **Applications:** Suitable for various construction projects, including commercial buildings |
| **Column Formwork** | • **Description:** Specifically designed for shaping concrete columns.<br>• **Advantages:** Allows for quick and precise shaping of columns.<br>• **Applications:** Used in buildings, bridges, and other structures with column support |

**Table 3.12.3:** What are the functions of the different types of formwork?

| Types | Functions |
|---|---|
| **Timber Formwork** | **Versatility**: Easily shaped and customised for different structural elements.<br>**Accessibility**: Simple to construct on-site, making it suitable for various designs.<br>**Cost-Effectiveness**: Generally, less expensive than some alternatives, especially for small projects. |
| **Steel Formwork** | **Durability**: Capable of withstanding heavy loads, making it ideal for high-rise buildings.<br>**Smooth Finish**: Provides a high-quality surface for concrete, reducing finishing work.<br>**Reusability**: Can be used multiple times, making it economical for large projects. |
| **Aluminium Formwork** | **Lightweight**: Easy to handle and transport, which speeds up assembly and disassembly.<br>**Rapid Construction**: Designed for quick installation, allowing for faster project timelines.<br>**Precision**: Ensures accurate dimensions and alignment, critical for structural integrity |

| | |
|---|---|
| **Plastic Formwork** | **Lightweight and Modular**: Easy to assemble and disassemble, suitable for complex shapes.<br><br>**Water Resistance**: Resistant to moisture, making it ideal for various weather conditions.<br><br>**Reusable**: Offers cost savings for small to medium projects due to reusability |
| **Insulated Concrete Forms (ICFs)** | **Thermal Insulation**: Provides energy efficiency by remaining as part of the finished structure.<br><br>**Structural Support**: Combines formwork and insulation, simplifying the construction process.<br><br>**Ease of Use**: Lightweight and easy to handle, reducing labour costs |
| **Stay-in-Place Formwork** | **Integration**: Becomes part of the final structure, providing insulation or additional structural support.<br><br>**Reduced Labour**: Eliminates the need for formwork removal, saving time and effort.<br><br>**Design Flexibility**: Can accommodate various architectural designs while providing stability. |
| **Modular Formwork** | **Standardisation**: Allows for quick assembly with standardised components, improving efficiency.<br><br>**Adaptability**: Can be reconfigured for different shapes and sizes, making it versatile.<br><br>**Reduced Waste**: Efficient use of materials and less construction debris |
| **Column Formwork** | **Specialisation**: Specifically designed for shaping concrete columns, ensuring uniformity and strength.<br><br>**Quick Assembly**: Facilitates fast installation, which is essential in multi-column structures.<br><br>**Load Management**: Supports the weight of wet concrete, preventing deformation. |

## Activity 3.12.1

Organise yourselves into groups of no more than five (5). In your group, discuss the following questions and record your answers for a whole class discussion.

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

## Conclusion

Formwork is a critical aspect of the concrete construction process. Selecting the appropriate materials and understanding their functions ensures that the formwork performs effectively, leading to high-quality and safe concrete structures. The right formwork contributes significantly to the overall efficiency and success of any construction project.

## EXTENDED READING


- Cheng, C. H., & Li, L. (2020). CAD/CAM: Computer-aided design and computer-aided manufacturing (2nd ed.). CRC Press. (Pages 50-72 for fundamentals of CAD in design); (Pages 200-230 for CAD in the making of artefacts and product lifecycle).
- Finkelstein, M. (2021). Principles of CAD: Applications in design, analysis, and manufacturing. Springer. (Pages 78-95 for CAD and its role in product design); (Pages 165-185 for CAD in artefact creation and prototyping).
- Groover, M. P. (2016). Automation, production systems, and computer-integrated manufacturing (4th ed.). Pearson Prentice Hall. (Pages 88-110 for CAD applications in design); (Pages 220-235 for CAD and manufacturing integration).
- Shih, Y. (2018). Computer-aided design and manufacturing: An integrated approach. Pearson Education. (Pages 45-67 for introduction to CAD systems); (Pages 120-145 for CAD applications in design and manufacturing).
- Zhao, Y., & Chen, J. (2019). Introduction to computer-aided design (CAD) and its applications in engineering and architecture. Wiley-Blackwell. (Pages 33-50 for CAD tools and their functions); (Pages 101-125 for using CAD in designing artefacts).

# REVIEW QUESTIONS

## REVIEW QUESTIONS 3.1

1. What is the role of CAD in designing artefacts?
2. How does design thinking improve artefact creation?
3. What are the common methods for expressing design ideas using CAD?

## REVIEW QUESTIONS 3.2

1. Outline the various elements used for foundation footings.
2. Explain the foundation footings of a building.
3. Discuss the functions and importance of foundation footings

## REVIEW QUESTIONS 3.3

1. Imagine you are tasked to create a visual representation of a bedside cabinet for a furniture catalogue. How would you draw the cabinet in a two-point perspective using a drawing instrument or AutoCAD?
2. You have been asked to design a bedside cabinet with dimensions 400mm × 400mm × 500mm. How would you use drawing instruments or AutoCAD to create its isometric view?
3. You are tasked with designing a bedside cabinet with dimensions 400mm × 400mm × 500mm. How would you use drawing instruments or AutoCAD to create its third-angle orthographic projection, including the front elevation, plan, and sectional end elevation through the centre?
4. What is the purpose of producing working drawings in design?
5. What are the two main types of drawings used to produce working drawings?
6. Why is it important to use standard drawing instruments or AutoCAD for working drawings?

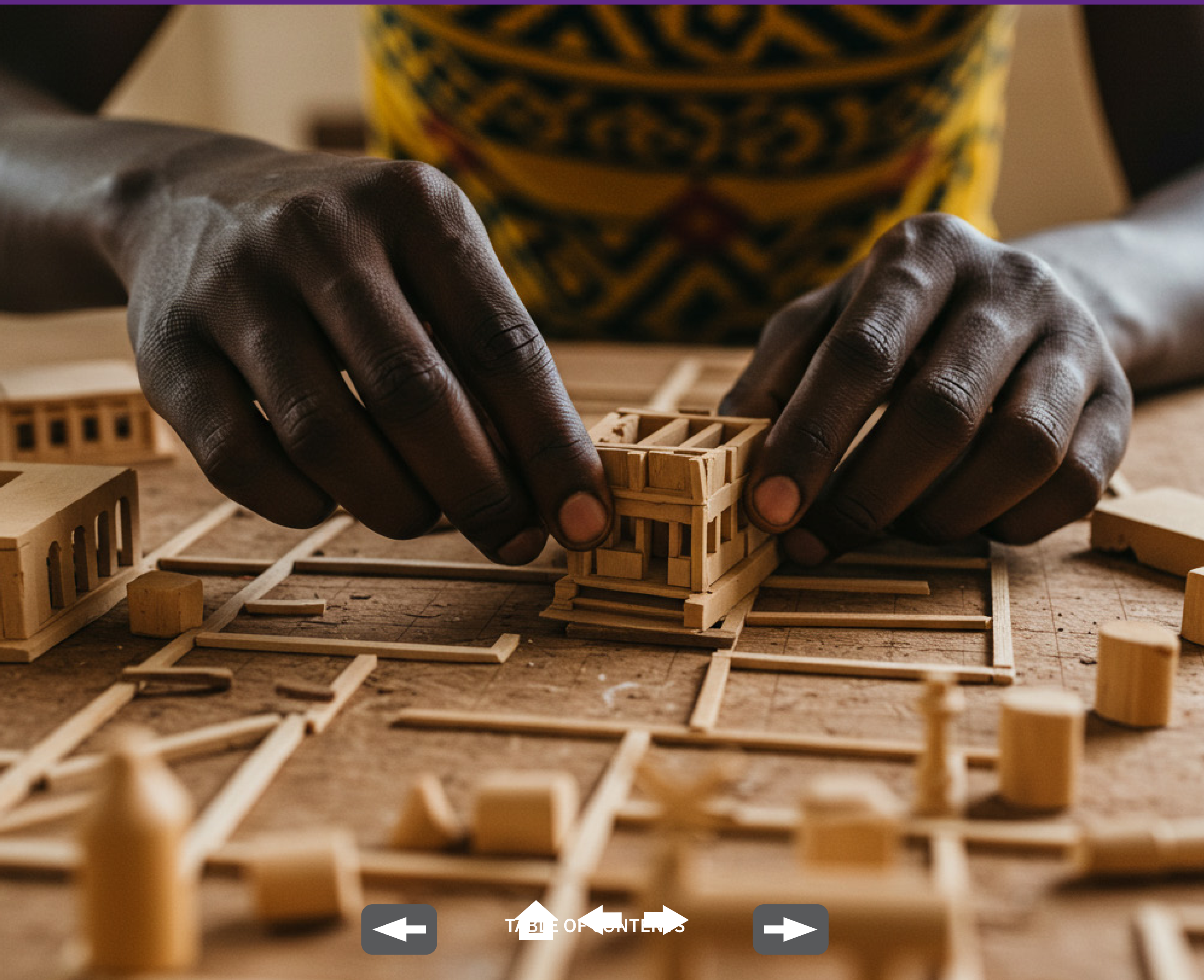
## REVIEW QUESTIONS 3.4

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

SECTION

4

# WOODWORK MODELLING WITH MATERIALS AND FLOOR, WALL CONSTRUCTION



# UNIT 13

# WOODWORK TECHNOLOGY

## Materials and Artefact Production in the Woodwork Industry

## Introduction

Selecting materials involves matching the material's properties strength, durability, cost, and suitability to the needs of the design and production process. Understanding this ensures the final product is functional, cost-effective, and long-lasting.

### KEY IDEAS

- Common materials include;
  - **Engineered Wood:** Glulam and LVL are used for strong beams and supports.
  - **Fabrics:** Natural or synthetic textiles add style and cushioning to furniture.
  - **Glass:** Used for decorative and functional elements like doors and frames.
  - **Leather:** Processed animal skins provide strength and comfort for upholstery.
  - **Manufactured Boards:** Plywood, MDF, and OSB are reliable for furniture and construction.
  - **Metals:** Both ferrous and non-ferrous metals are chosen for durability and versatility.
  - **Plastics**: Thermosetting and thermoplastics like ABS and polyester resin are versatile and long-lasting.
  - **Timber:** Strong hardwoods like mahogany, teak, and iroko are ideal for lasting structures.
  - **Wood Composites:** WPCs and WFCs are eco-friendly options for decking and panels.
- Durable materials are essential for artefacts, especially furniture in high-use areas.
- Selecting the right material ensures artefacts are durable, functional, and fit for purpose.

## MATERIAL SELECTION

Choosing the right materials is essential for creating durable and functional artefacts, especially furniture that will be frequently used or placed in high-traffic areas. Selecting suitable materials involves considering their strength, durability, cost, and ability to meet the intended purpose.

## Timber

Timber, particularly West African hardwoods, is an ideal material for furniture production due to its outstanding properties. These woods, including mahogany, sapele, iroko, Wawa, teak, and Mansonia, offer durability, beauty, and versatility that meet the demands of high-quality and long-lasting furniture.

### Reasons for selecting West African hardwoods for furniture

a. **Durability**: These hardwoods are naturally durable, making them ideal for furniture that must withstand frequent use and last for decades. Their resistance to pests, rot, and moisture ensures the longevity of the furniture.

b. **Aesthetic Appeal**: The rich colours, unique grains, and smooth textures of these woods enhance the visual appeal of furniture. They allow for a variety of finishes, from natural oil to polished varnish, to suit different tastes and styles.

c. **Workability**: Most of these woods, especially mahogany, sapele, and wawa, are easy to cut, carve, and shape. This makes them suitable for intricate furniture designs and detailed craftsmanship.

d. **Structural Strength**: Hardwoods like iroko and teak are dense and strong, providing the structural integrity needed for furniture such as beds, tables, and chairs.

e. **Environmental Resistance**: Teak and iroko are particularly resistant to environmental factors, making them ideal for outdoor furniture. Their natural oils prevent decay and insect damage, reducing maintenance requirements.

f. **Versatility**: These woods can be used for a wide range of furniture types, from heavy-duty structural pieces like dining tables and beds to decorative items like cabinets and veneers.

g. **Sustainability**: Using West African hardwoods supports local industries and promotes sustainable forestry practices when managed responsibly.

**Table 4.13.1:** West African hardwood timber types, properties, applications and reasons for use

| Timber | Properties | Applications | Why Selected |
|---|---|---|---|
| **Mahogany**  | Mahogany is renowned for its rich reddish-brown colour, fine grain, and excellent workability. It is resistant to decay, warping, and shrinking. | Used in high-end furniture, doors, panelling, and veneers. | Mahogany's natural beauty and durability make it ideal for elegant and long-lasting furniture pieces. Its resistance to weathering ensures furniture remains stable in various conditions. |
| **Sapele**  | Sapele has a distinctive interlocking grain, rich reddish-brown colour, and high resistance to wear. It is slightly denser and harder than mahogany. | Often used for furniture, flooring, and cabinetry. | Its strength and resistance to wear make it suitable for frequently used furniture, such as chairs, tables, and beds. The interlocking grain adds aesthetic appeal to finished pieces. |
| **Iroko (Odum)**  | Iroko is a dense, durable hardwood with a coarse texture and natural resistance to insects and rot. Its colour ranges from golden to dark brown. | Commonly used in outdoor furniture, decking, and heavy-duty furniture. | Iroko's high durability and weather resistance make it perfect for both indoor and outdoor furniture. Its natural insect resistance reduces maintenance needs. |
| **Wawa (Obeche)**  | Wawa is a lightweight, soft hardwood with a pale yellowish colour and a smooth texture. It is easy to work with but less durable compared to other hardwoods. | Used for non-structural furniture, carvings, and veneers. | Wawa is ideal for lightweight furniture or components that do not require heavy-duty strength. Its ease of workability makes it suitable for intricate designs and veneers. |

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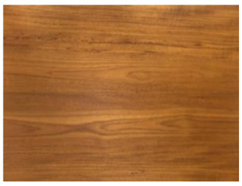
| **Teak**  | Teak is highly valued for its natural oils, which make it resistant to moisture, decay, and termites. It has a golden-brown colour and smooth texture. | Used for premium indoor and outdoor furniture, boatbuilding, and flooring. | Teak's exceptional durability and resistance to environmental factors make it ideal for outdoor and high-quality indoor furniture. Its natural lustre adds a luxurious touch to finished pieces. |
| **Mansonia (Oprono)**  | Mansonia is a medium-density hardwood with good stability, a fine texture, and resistance to pests. It has a brownish-to-greyish colour. | Often used in cabinetry, musical instruments, and fine furniture. | Its balance of durability and workability makes it a versatile choice for furniture that combines functionality and aesthetic appeal. |

## Bamboo

Bamboo is an increasingly popular material for furniture and construction due to its sustainability, versatility, and aesthetic appeal. Known for its strength, lightweight nature, and rapid renewability, bamboo is used globally for a variety of applications, including furniture, flooring, and decorative elements.

**Figure 4.13.1:** Bamboo

**Table 4.13.2:** Bamboo properties, applications and advantages

| Properties | Applications | Advantages |
|---|---|---|
| • Bamboo is incredibly strong, with a tensile strength comparable to steel. It can withstand heavy loads, making it ideal for structural applications and furniture.<br>• Its durability allows it to resist wear and tear, ensuring long-lasting products.<br>• Despite its strength, bamboo is lightweight, making it easy to transport and work with during production. This feature is particularly advantageous for large furniture pieces like beds and shelves.<br>• Bamboo's natural, elegant appearance is highly sought after in modern and traditional designs. Its smooth texture and warm tones enhance the visual appeal of furniture and architectural elements.<br>• Bamboo is one of the fastest-growing plants in the world, reaching maturity in 3–5 years. This makes it an eco-friendly alternative to hardwoods, which take decades to mature.<br>• Its ability to regenerate from its root system without replanting further enhances its sustainability.<br>• Bamboo is naturally resistant to moisture, pests, and fungi, making it suitable for indoor and outdoor applications. When treated properly, it can endure various environmental conditions. | 1. **Bamboo Furniture:** Bamboo is widely used in furniture production, offering both functionality and aesthetic value.<br>• **Chairs and Tables:** Bamboo is ideal for crafting chairs and tables due to its strength and stability. It can be shaped into intricate designs, offering both traditional and contemporary styles.<br>• **Shelves and Cabinets:** Bamboo's lightweight nature makes it perfect for shelving units and cabinets. These pieces are easy to move yet sturdy enough to hold heavy items.<br>• **Bed Frames:** Bamboo bed frames are strong, stylish, and sustainable. Their natural appearance blends well with various interior designs, adding a touch of elegance to bedrooms.<br>• **Stylish and Eco-Friendly:** Bamboo furniture is not only functional but also environmentally friendly. Its renewable nature aligns with the growing demand for sustainable products, appealing to environmentally conscious consumers.<br>2. **Bamboo in Construction and Building Materials:** Beyond furniture, bamboo plays a significant role in construction, offering a sustainable alternative to traditional materials.<br>• **Flooring:** Bamboo flooring is durable, moisture-resistant, and visually appealing. It mimics the appearance of hardwood flooring while being eco-friendly and cost-effective.<br>• **Bench Tops and Countertops:** Bamboo is used for bench tops and countertops due to its resilience and smooth surface. These surfaces are durable and can be easily cleaned, making them suitable for kitchens and workspaces.<br>• **Fences and Screens:** Bamboo is often used to create fences and privacy screens. Its natural aesthetics and durability make it a popular choice for outdoor spaces, providing both functionality and a decorative touch. | **Eco-Friendly:** Bamboo absorbs more carbon dioxide and produces more oxygen compared to other plants, making it beneficial for the environment.<br>**Renewable Resource**: With its rapid growth rate, bamboo can be harvested more frequently than hardwoods, reducing the strain on forest resources.<br>**Versatility:** Bamboo can be processed into sheets, strips, or planks for a variety of applications, from delicate furniture pieces to robust structural components.<br>**Affordability:** Bamboo is generally less expensive than hardwoods, offering a cost-effective solution for high-quality furniture and building materials.<br>**Minimal Waste:** Every part of the bamboo plant can be utilised, reducing waste during production. |

# Plastics

Plastics are synthetic or semi-synthetic materials made primarily from polymers, which are large molecules composed of repeating structural units. These polymers are derived from natural substances such as crude oil, natural gas, or biomass, and they can be moulded into various shapes during manufacturing. Plastics are lightweight, versatile, and durable, making them widely used in industries like packaging, construction, electronics, and furniture.

There are two main types of plastics. These are ***thermosetting plastics*** and ***thermoplastics***.

The choice of thermosetting plastics and thermoplastics in artefact production is based on their unique properties, which make them suitable for a wide range of applications.

**a. Thermosetting Plastics**

Thermosetting plastics are polymers that undergo an irreversible curing process when heated. Once hardened, they maintain their shape, offering high thermal and structural stability. These properties make them ideal for durable and heat-resistant products.

**b. Thermoplastics**

Thermoplastics are polymers that soften when heated and harden upon cooling. Unlike thermosetting plastics, they can be reshaped multiple times, making them highly versatile and recyclable.

**Table 4.13.3:** Thermosetting plastic types, properties, applications and reasons for use

| Examples of thermosetting plastics | Properties | Application | Why selected |
|---|---|---|---|
| **Phenol-formaldehyde (PF)** | High heat resistance, excellent electrical insulation, and superior mechanical strength. | Used in electrical fittings, laminates, and heat-resistant components. | It can withstand high temperatures and mechanical stress, making it ideal for industrial and household items requiring durability and heat resistance. |
| **Urea-Formaldehyde (UF)** | Strong, lightweight, and resistant to abrasion and heat. | Used in adhesives for plywood, particle boards, and decorative laminates. | Its strong adhesive properties and cost-effectiveness make it indispensable in furniture production and construction materials. |

| | | | |
|---|---|---|---|
| **Polyester Resin** | Lightweight, durable, resistant to moisture, and easy to mould. | Commonly used in fiberglass products, boat building, and automotive parts | Its versatility and resistance to environmental factors make it suitable for both structural and decorative applications. |
| **Epoxy Resin** | Excellent adhesive qualities, chemical resistance, and high mechanical strength. | Used in coatings, adhesives, and electronic components. | Its ability to bond diverse materials and withstand harsh conditions ensures strong, long-lasting artefacts. |
| **Polyurethane (PU)** | Flexible, durable, resistant to abrasion, and available in rigid or foam forms. | Found in furniture, insulation materials, and coatings. | Its versatility and durability make it ideal for a wide range of uses, from upholstery to structural components. |

**Table 4.13.4:** Thermoplastic types, properties, applications and reasons for use

| Examples of thermoplastics | Properties | Application | Why selected |
|---|---|---|---|
| **Polymethyl Methacrylate (PMMA)** | Transparent, lightweight, and impact resistant. | Used in windows, signage, and lighting fixtures as a glass substitute. | Its clarity and strength make it an excellent choice for decorative and functional items requiring transparency. |
| **Polytetrafluoroethylene (PTFE)** | Non-stick, chemically inert, and resistant to high temperatures. | Found in cookware coatings, industrial seals, and gaskets. | Its non-reactive and heat-resistant nature makes it ideal for demanding industrial and household applications. |
| **Polystyrene (PS)** | Lightweight, easy to mould, and cost-effective. | Used in packaging, disposable cups, and insulation. | Its affordability and ease of processing make it suitable for mass-produced items. |



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| **High-Impact Polystyrene (HIPS)** | Stronger and more impact-resistant than regular polystyrene. | Used in appliances, toys, and automotive parts. | Its enhanced toughness makes it suitable for applications requiring durability and resilience. |
| **Acrylonitrile Butadiene Styrene (ABS)** | Tough, rigid, and resistant to chemicals and impact. | Common in automotive parts, electronic housings, and toys (e.g., LEGO bricks). | Its combination of strength and ease of moulding makes it ideal for functional and aesthetic products. |
| **Polyethylene (PE)** | Flexible, durable, and resistant to moisture and chemicals. | Used in pipes, containers, and packaging films. | Its low cost and versatility make it one of the most widely used thermoplastics. |
| **Polyvinyl Chloride (PVC)** | Durable, flame-resistant, and versatile | Found in pipes, window frames, and cable insulation. | Its strength and affordability make it ideal for both construction and consumer products. |

## Glass

Glass is a versatile and timeless material widely used in the production of artefacts. It is created by melting a mixture of **soda ash, limestone, sand**, and a quantity of **cullet (recycled glass)** at high temperatures. The resulting material is both functional and aesthetic, making it an ideal choice for applications like glazed doors, windows, picture frames, louvre blades, and sliding cabinet doors.

**Table 4.13.5:** Glass properties, advantages and uses

| Properties | Advantages | Specific uses |
|---|---|---|
| ***Visual Clarity and Aesthetic Appeal***: Glass is transparent, allowing for maximum light transmission and creating a sense of openness. It also offers a sleek and modern look, enhancing the aesthetic appeal of any space. | ***Aesthetic Appeal:*** Glass can be customised to suit various design styles. Its clarity, colour, and texture options offer endless possibilities for creating visually stunning spaces. | ***Glazed Doors and Windows:*** Glass doors and windows allow natural light to illuminate spaces, while providing insulation and soundproofing. They can be tinted or frosted to balance privacy and light transmission. |

| | | |
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| ***Durability and Longevity***: With proper treatment, glass can be highly durable and resistant to breakage and environmental factors. This ensures its longevity and reduces the need for frequent replacements.<br><br>***Versatility:*** Glass can be shaped and moulded into a wide range of forms, making it adaptable to diverse design needs. It can also be customised with coatings, tints, and patterns to achieve specific aesthetic effects.<br><br>***Sustainability:*** Glass is 100% recyclable, reducing the need for raw materials and energy consumption. Its non-porous nature also minimises maintenance requirements.<br><br>***Safety:*** Tempered and laminated glass offers enhanced safety features, reducing the risk of injury in case of breakage. | ***Environmental Friendliness:*** Glass is hundred percent recyclable, making it an eco-friendly choice. By recycling glass, we reduce the demand for raw materials and energy consumption.<br><br>***Durability and Longevity:*** Glass is highly resistant to weathering, moisture, and aging, ensuring long-lasting performance. Its smooth surface is easy to clean and maintain, making it a practical choice for various applications. | ***Louvre Blades:*** Glass louvre blades offer a blend of functionality and style. They provide ventilation and light control while adding a modern touch to buildings.<br><br>***Picture Frames:*** Glass protects artwork and photographs from damage, ensuring longevity and visual appeal.<br><br>***Sliding Doors:*** Glass sliding doors offer unobstructed views and easy access to cabinets and showcases. They can be customised with different finishes to complement various interior designs. |

# Leather

Leather is a versatile and durable material made from animal hides such as cow, goat, pig, or horse skin. Its unique qualities make it ideal for artefacts, particularly in upholstery and furniture. The production process involves three main steps. First, animal skins are cleaned to remove hair, wool, and impurities. Then, they are tanned using natural or synthetic tannins to preserve and strengthen them. Finally, the leather is dyed, polished, and sometimes embossed or coated to enhance its appearance and functionality, resulting in various types suited for specific uses.

**Table 4.13.5:** Leather properties, types, applications and advantages

| Properties of leather | Types of leather with their uses | Application of leather | Advantages of using leather |
|---|---|---|---|
| • Leather is strong, long-lasting, and resistant to wear, becoming more durable with age and proper care. | 1. **Full-Grain Leather**<br>• Retains natural marks and imperfections. | 1. **Upholstery**<br>• Used for covering lounge seats, chair backs, and padded tabletops. | • Long-lasting and resistant to tearing and cracking. |

| | | | |
|---|---|---|---|
| • It is flexible, moulding to shapes and contours, providing comfort, especially in upholstered furniture.<br>• Leather has a rich, natural texture and develops a patina over time, enhancing its visual appeal with various colours and finishes.<br>• Leather resists water and stains to some degree and can be treated to improve these properties for long-term use.<br>• Leather is easy to clean and maintain, with proper conditioning ensuring its longevity and retaining its quality. | • Used for premium upholstery and luxury furniture.<br>2. **Top-Grain Leather**<br>• Slightly sanded for a smooth finish.<br>• Common in high-quality chairs and sofas.<br>3. **Split Leather**<br>• A lower layer is treated for affordability.<br>• Used in mid-range furniture.<br>4. **Bonded Leather**<br>• Made from leather scraps bonded with adhesives.<br>• Cost-effective for decorative artefacts. | • Provides a luxurious and comfortable finish.<br>2.**Furniture Accents**<br>• Leather is used for armrests, headboards, and decorative panels, adding a touch of elegance to designs. | • Provides a soft, luxurious feel, ideal for furniture.<br>• Available in various finishes and colours to match different styles.<br>• A by-product of the meat industry, minimising waste. |

# Fabrics

A fabric is a textile material that can be either **woven** or **non-woven**, with non-woven types including methods such as **knitting, tufting, knotting, or bonding**. These production techniques allow fabrics to meet diverse functional and aesthetic requirements. Fabrics play a key role in artefact production, particularly in furniture and upholstery, due to their versatility and decorative appeal.

## Types of Fabrics

1. **Natural Fibres:** Natural fibres are derived from plants or animals.
   a. **Plant-based fibres:** Examples include cotton, linen, and jute, known for their breathability, softness, and eco-friendliness.
   b. **Animal-based fibres:** Examples include wool and silk, valued for their warmth, luxurious feel, and durability.
2. **Synthetic Fibres:** Synthetic, or artificial, fibres are man-made using chemical processes.

Examples include polyester, nylon, and acrylic, which are durable, resistant to stains, and available in a wide variety of colours and textures.

## Applications of Fabrics in Artefact Production

Fabrics are primarily used in upholstery to enhance the comfort and aesthetic of furniture. They add a decorative touch by providing a range of textures, colours, and patterns that complement furniture design. Whether for chairs, sofas, cushions, or decorative accents, fabrics offer both functionality and style.

## Benefits of Using Fabrics

1. Available in numerous types, patterns, and finishes to suit various design needs.
2. Fabrics enhance the softness and usability of furniture.
3. They contribute to the visual appeal by adding vibrant colours and intricate designs.
4. Natural fabrics are eco-friendly, while synthetic options can be produced efficiently and affordably.

# Manufactured Boards and Metals in Artefact Production

Manufactured boards and metals are essential materials in artefact production due to their versatility, durability, and suitability for a range of applications. They offer cost-effective, high-performance solutions for both structural and decorative purposes.

## Manufactured Boards

Manufactured boards are engineered wood products made by binding wood fibres, veneers, or particles with adhesives. They are versatile, sustainable, and widely used in furniture and construction.

1. **Plywood** is created by layering thin sheets of wood veneer, glued and pressed together.
   a. **Birch Plywood:** Used for furniture and cabinets due to its strength and smooth surface.
   b. **Oak Plywood:** Suitable for furniture and construction, valued for its durability.
   c. **Marine Plywood:** Water-resistant, ideal for boat building and outdoor furniture.
2. **Medium-Density Fibreboard (MDF)**: MDF is made from wood fibres bonded with resin under high pressure. It is dense, smooth, and easy to paint or finish, commonly used for cabinets, shelves, and mouldings.

3. **Oriented Strand Board (OSB):** OSB is a structural board made from compressed wood strands. It is strong and affordable, ideal for construction purposes such as flooring, sheathing, and shelving.
4. **Solid Surface Materials:** Solid surface materials like *Corian* and *Hi-Macs* are non-porous and durable, often used for countertops, sinks, and bathroom fixtures due to their resistance to stains and scratches.
5. **Engineered Wood Products:**
   a. **Glulam:** Made by bonding layers of wood, used for beams and columns in construction.
   b. **Laminated Veneer Lumber (LVL):** Strong and lightweight, suitable for beams and headers.
6. **Wood Composites**
   a. **Wood-Plastic Composites (WPCs):** A mix of wood fibres and plastics, used for decking and fencing.
   b. **Wood-fibre composites (WFCs):** Panels and boards with high stability and uniformity.

## Metals

Metals, both ferrous (containing iron) and non-ferrous (non-iron-based), are widely used in artefact production due to their strength, durability, and versatility.

1. ***Ferrous Metals**:* Steels and cast iron are used in structural components, furniture frames, and fittings.
2. ***Non-Ferrous Metals**:* Aluminium, brass, and copper are lightweight, corrosion-resistant, and ideal for decorative and functional applications such as trims, handles, and hardware.

## Advantages of Manufactured Boards and Metals

a. **Strength and Durability:** Both materials provide excellent structural integrity.
b. **Versatility:** Manufactured boards come in a variety of types, while metals offer flexibility for design and functionality.
c. **Cost-Effectiveness:** Manufactured boards maximise the use of wood waste, and metals are recyclable and reusable.
d. **Aesthetic Appeal:** Both materials enhance artefacts with clean finishes and modern designs.

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## Activity 4.13.1

### Identifying Materials for Effective Artefact Production.

**Scenario:**

You are a product designer working on a new line of furniture for a local store. Your task is to select the most appropriate materials for various parts of the furniture, considering factors like durability, comfort, cost, and aesthetics. You will organise yourselves into groups of 5 to analyse the materials available, discuss their advantages and disadvantages, and make decisions about which materials would be the best fit for different furniture pieces.

**Materials Needed:**

- Sample materials (e.g., timber, MDF, plywood, fabric swatches, leather, foam, plastic sheets, metal pieces, glass sheets).
- Material properties chart (detailing the characteristics of each material such as strength, weight and cost).
- Markers and flipchart paper for group brainstorming.
- Digital devices for research.
- Material selection templates.

### Activity Guidelines:

1. Organise yourselves into groups of 5
2. Each group is tasked with identifying suitable materials for a specific artefact (e.g., chairs, tables, or storage units).
3. In your groups, discuss the following questions:
   a. What properties are needed for this particular artefact (e.g., strength, flexibility, aesthetics)?
   b. What advantages and disadvantages do the available materials have?
   c. How can the selected materials meet the sustainability requirements for the product?
4. Presents your material selections and reasoning to the whole class for feedback.
5. Engage with your class in a discussion about the material selection process.
6. In a whole class discussion,
   a. Reflect on the materials you selected and the reasons for your choices.
   b. Discuss how these materials would be used effectively in the final artefact and how their sustainability could be ensured.

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## Activity 4.13.2

### Explaining Material Selection for Artefact Production.

**Scenario:**

You are a product designer tasked with creating a new collection of kitchen furniture for a local business. You are responsible for explaining why certain materials were chosen for different parts of the furniture, such as tables, chairs, and storage units. Your task is to ensure that each material selected not only meets the aesthetic and functional needs of the product but also aligns with sustainability and cost-efficiency goals. Working in groups, you will explore the reasons behind material selection, considering durability, cost, and environmental impact.

**Materials Needed:**

- Sample materials (e.g., wood, metal, plastic, glass, fabric, leather, plywood, MDF, foam, rubber)
- Material property charts (showing key properties such as strength, weight, cost, environmental impact, etc.)
- Whiteboards or large paper for group brainstorming
- Markers and pens for notes and presentations
- Digital devices (for additional research on material properties.)
- Material selection guides (with specific product use cases and factors to consider)

### Activity Guidelines:

1. Organise yourselves into groups of 5. Work with your group to choose materials for a specific part of the furniture (e.g., chairs, tables, shelves).
2. Select materials for different components of the furniture. For example, you may choose a material for the tabletop, chair legs, or upholstery.
3. Discuss the reasons for selecting each material, considering the following factors:
   a. **Durability:** Will the material withstand frequent use and wear?
   b. **Cost:** Is the material affordable within the budget?
   c. **Aesthetics:** Does the material align with the desired look of the furniture?
   d. **Sustainability:** Is the material environmentally friendly and long-lasting?
   e. **Functionality:** Does the material serve the intended purpose (e.g., comfort for chairs, sturdiness for tables)?

4. You can use the internet to research materials online, finding up-to-date information on their properties and uses.
5. Present your material selections to the class, explaining why your group chose each material and how it aligns with the overall design goals
6. After the presentations, engage with your class in a discussion on:
   a. The importance of each factor in material selection and how the materials contribute to the final product's quality, sustainability, and functionality.
   b. The real-world implications of your material choice, emphasise the importance of selecting appropriate materials for producing artefacts that are both functional and environmentally responsible.

## Activity 4.13.3

### Ensuring the Sustainability of Materials for Artefact Production.

**Scenario:**

You are a sustainable design consultant working with a company that specialises in creating eco-friendly furniture. Your role is to guide a team of designers in selecting and ensuring the sustainability of the materials used in the production of a new line of chairs and tables. The challenge is to find materials that are not only durable and functional but also environmentally friendly and cost-effective. In your team you will collaborate to explore ways to ensure the long-term sustainability of the materials used in your designs, considering environmental impact, cost, and resource management.

**Materials Needed:**

- Sample materials (e.g., wood, metal, bamboo, recycled plastic, glass, fabric, leather, plywood, MDF)
- Sustainability charts or handouts showing material impact (carbon footprint, recyclability, renewability)
- Material selection guides (focusing on eco-friendly materials and sustainable practices)
- Whiteboards or large paper for brainstorming and listing materials
- Markers and pens for note-taking and group presentations
- Digital devices (for additional research on sustainable materials and production processes)
- Laptops/tablets for researching sustainability certifications (e.g., FSC, Fair Trade, recycled content)

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### Activity Guidelines:

1. Organise yourselves into groups of 5. Each group will focus on different aspects of the furniture production process (e.g., sustainability of material sources, waste reduction during production, end-of-life disposal).
2. In your groups, research and discuss ways to ensure the sustainability of the materials you are working with. You should focus on key factors such as:
   a. **Renewability:** Is the material sourced from renewable resources (e.g., bamboo, certified wood)?
   b. **Recyclability:** Can the material be recycled or repurposed at the end of its life (e.g., metals, plastics)?
   c. **Environmental Impact:** Does the production of the material contribute to carbon emissions, pollution, or deforestation? How can the impact be minimized?
   d. **Local Sourcing:** Can materials be sourced locally to reduce transportation emissions and support local economies?
   e. **Waste Reduction:** How can material waste during the manufacturing process be minimised or reused?
3. Groups can use digital resources to gather information on sustainable materials, such as websites, databases, or videos that provide data on the environmental impact of different materials.
4. Select materials for a specific product (e.g., chairs or tables) and think about sustainability strategies.
5. Present this to the class for a whole class discussion and feedback.
6. Reflect on what you have learnt about sustainability in material selection. What challenges did you encounter? How can you apply this to real-world scenarios?

## Conclusion

Selecting appropriate materials for producing a final solution is crucial for creating functional, durable, and cost-effective artefacts. The choice of materials should consider factors such as strength, durability, cost, availability, and environmental impact. By carefully evaluating these aspects, the final product will meet its purpose efficiently and sustainably.

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

As part of the substructure, floors support the weight of walls, furniture, and occupants, ensuring stability and safety. They also play a significant role in the thermal and acoustic insulation thereby contributing to the comfort and functionality of the space. Floors are expected to be carefully designed and constructed to handle the various loads and environmental conditions. Floors therefore form an integral part of the building's overall structural strength and aesthetic outlook.

**KEY IDEAS**

- Floors provide the essential base for buildings, supporting the weight of occupants, furniture, and equipment.
- Floors also serve as functional and safe surfaces for daily activities, from walking and standing to placing furniture and appliances.
- Floors are designed to offer thermal insulation, keeping interiors comfortable, and acoustic insulation, reducing noise transmission between the various floor levels.
- Floors provide the aesthetic appeal of a space, contributing to the overall design and ambience through various materials and finishes.

## FLOOR CONSTRUCTION

### The Meaning of Floor in Building Construction

In building construction, the term "floor" refers to the horizontal layer with the surface on which people walk within a building. It serves as a platform for various activities and is typically supported by beams, columns, or walls. Floors can be made of different materials, such as concrete, wood, or tile, and they can be part of different levels or stories within a structure.

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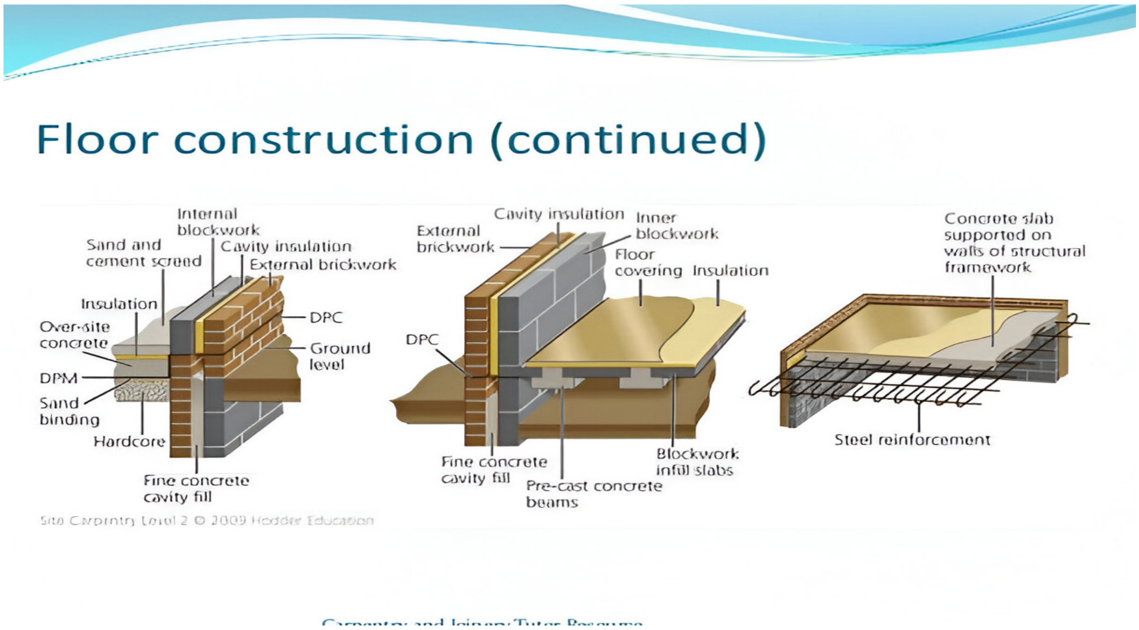


**Figure 4.14.1:** Type of floors in use on construction sites.

## The Various Floors Used in Building Construction

Floors used in building construction are classified into groups, namely ground floors, upper floors, and basements.

a. **Ground floors** are the first level of a building, resting directly on the ground or slightly above it. They are usually constructed using materials like concrete, tiles, or hardwood, designed to support heavy foot traffic and loads from furniture and equipment. These floors are typically insulated to prevent heat loss and moisture ingress, providing a stable and comfortable living or working environment. In residential and commercial buildings, ground floors often contain key areas such as living rooms, kitchens, and entryways.

b. **Upper floors** are the levels above the ground floor, forming additional stories in a multi-level building. These floors can be constructed using various materials, including wood, steel, and concrete, depending on the building's design and requirements. Upper floors are supported by a framework of beams and columns that distribute loads down to the foundation. They house essential spaces like bedrooms, offices, and other functional areas, providing separation from the ground floor and additional living or working space.

c. **Basement floors** are located below the ground level and are constructed as part of the building's substructure. These floors are often made from concrete to provide durability and resistance to moisture and pressure from the surrounding soil. Basements can serve various purposes, such as storage, utility rooms, or additional living spaces, and are designed to be waterproof and insulated to protect against dampness and temperature fluctuations.

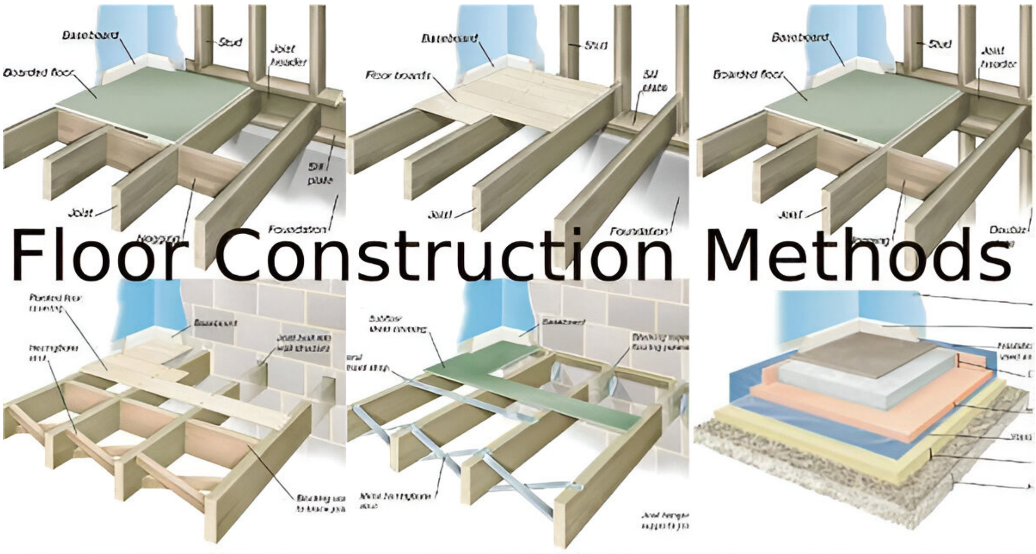


**Figure 4.14.2:** Wooden floor construction methods

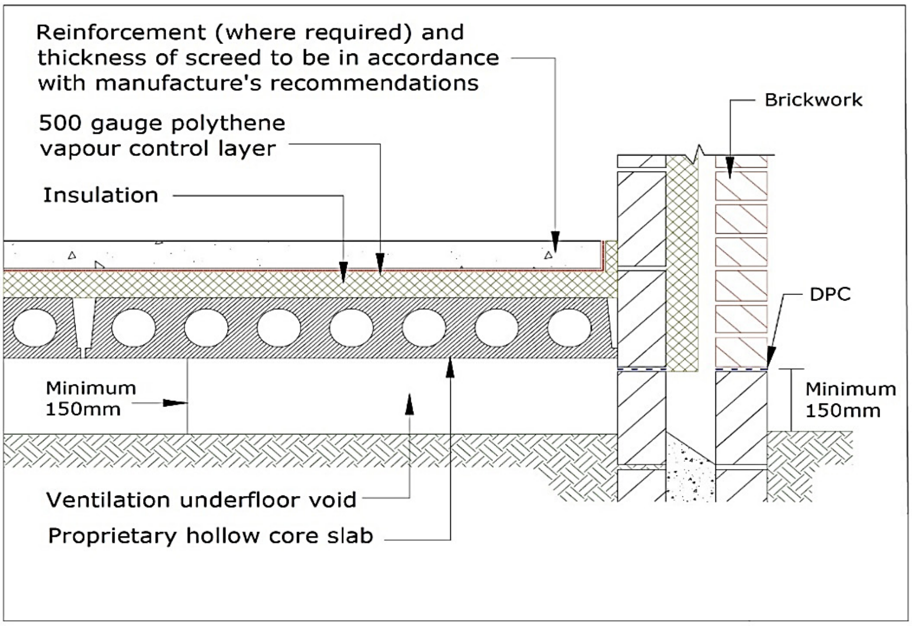


**Figure 4.14.3:** Section of the concrete floor construction

**Table 4.14.1:** The various floors used in construction

| Type of Floor | Description | Common Uses |
|---|---|---|
| Ground Floor | The first floor is at or near ground level. | Entry areas, lobbies, retail spaces. |
| Upper Floors | Any floor above the ground level. | Residential units, offices, or commercial spaces. |
| Raised Floor | Elevated above the base level, often with a space underneath. | Data centres, and office buildings for cabling. |
| Suspended Floor | Supported by beams or joists, not directly on the ground. | Basements, multi-story buildings. |

| | | |
|---|---|---|
| Structural Floor | Designed to support heavy loads. | Parking garages, industrial buildings. |
| Concrete Floor | Made of poured or precast concrete. | Warehouses, industrial spaces, high-rise buildings. |
| Wood Floor | Constructed from timber or engineered wood products. | Residential homes, cabins, and some commercial spaces. |
| Composite Floor | Combines materials like concrete and steel. | High-rise buildings, bridges. |
| Vinyl or Tile Floor | Finished with vinyl, tiles, or other materials. | Residential, commercial, and healthcare facilities. |
| Carpeted Floor | Covered with carpet for comfort and aesthetics. | Offices, hotels, and residential spaces. |

## The Functions of a Floor in a Substructure

Floors form one of the main components of any building structure. They serve a variety of essential functions. First of all, they provide a firm and stable surface for occupants and furniture, ensuring the safe and efficient use of the building's interior spaces. Floors also play a crucial role in distributing structural loads to the foundation, enhancing the overall stability and strength of the building as expressed in **Table 4.14.2**. In addition to these structural functions, floors contribute to thermal and acoustic insulation, thereby improving the comfort and energy efficiency of the building. The floors also promote the beauty of the space, using various materials and finishes available to make the floor look very desirable.

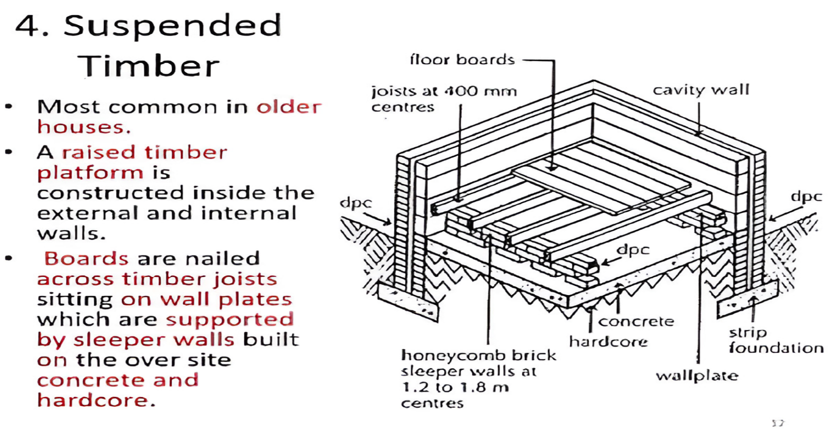


**Figure 4.13.5:** Details of timber floor construction

**Table 4.14.2:** The functions of floors.

| Function | Description | Importance |
|---|---|---|
| **Load Distribution** | Floors distribute loads from above to the foundation. | Ensures structural stability and integrity. |
| **Base for Superstructure** | Provides a level base for constructing the above-ground structure. | Facilitates accurate alignment and support. |

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| Function | Description | Importance |
|---|---|---|
| **Moisture Barrier** | Floors can act as barriers against moisture from the ground. | Protects materials and spaces from water damage. |
| **Thermal Insulation** | Contributes to temperature regulation by insulating against ground temperature fluctuations. | Enhances energy efficiency and comfort. |
| **Sound Insulation** | Reduces sound transmission between the ground and the superstructure. | Improves acoustic comfort in buildings. |
| **Vibration Dampening** | Absorbs vibrations from activities above, reducing disturbance. | Enhances comfort and protects sensitive equipment. |
| **Accessibility** | Provides access to lower levels or basements of a building. | Essential for functionality and movement. |
| **Utility Integration** | Houses utilities like plumbing and electrical systems. | Facilitates efficient building operation. |
| **Foundation Connection** | Connects to the foundation, ensuring stability and load transfer. | Critical for overall structural integrity. |
| **Pest Control** | A well-designed floor can help deter pests from entering a building. | Contributes to hygiene and safety in buildings. |

## The Various Floors and Their Components

All floors are made up of specific parts put together from the component of the type of floor being constructed. It is through the components that the type of floor can be identified. The composition of floors varies depending on their intended use, the building type, and specific design requirements. Typically, the components of floors as shown in **Table 4.14.3**, are made up of several layers constructed together to provide stability, insulation, and durability for the floor. Understanding the parts of the different floors will enable you to select the right materials and construction techniques and the desired performance and duration of the floor. The details of the parts of the floors are provided in **Table 4.14.3**.

**Table 4.14.3:** The components of the various floors

| Type of Floor | Components | Description |
|---|---|---|
| **Ground Floor** | • Foundation<br>• Slab<br>• Subfloor<br>• Finishing Layer | The base level is typically at or near ground level. |
| **Upper Floors** | • Joists or Beams<br>• Floor Decking<br>• Finishing Layer | Floors located above the ground floor, supporting walls and roofs. |

| Type of Floor | Components | Description |
|---|---|---|
| **Raised Floor** | • Support Pedestals<br>• Floor Panels<br>• Void Space | Elevated floors allow for utility management underneath. |
| **Suspended Floor** | • Beams<br>• Joists<br>• Flooring Material | Floors that are not directly on the ground, are used in basements or multi-story buildings. |
| **Structural Floor** | • Reinforced Concrete<br>• Steel Beams<br>• Floor Finishes | Designed to bear heavy loads, often used in industrial settings. |
| **Concrete Floor** | • Concrete Slab<br>• Reinforcement (rebar)<br>• Finishing | Durable, strong floors are suitable for various uses. |
| **Wood Floor** | • Joists<br>• Plywood or OSB (Oriented Strand Board)<br>• Finishing (carpet, varnish) | Natural material floors provide aesthetic warmth. |
| **Composite Floor** | • Concrete<br>• Steel Decking<br>• Insulation Layer | Combines different materials for enhanced performance. |
| **Vinyl or Tile Floor** | • Subfloor<br>• Tile/Vinyl Layer<br>• Grout (for tiles) | Easy to clean and maintain, available in various designs. |
| **Carpeted Floor** | • Padding<br>• Carpet Layer<br>• Tack Strips | Soft flooring option for comfort and warmth. |

## How the Various Floors are Constructed or Put Together

Floors are usually constructed or put together through a series of laydown steps that ensure the floors are stable and can function effectively. The process begins with preparing and levelling the site, followed by the hardcore filling, which provides the support before casting for the concrete floor. For wooden floors, joists are then added to distribute the weight evenly to ensure structural firmness. Finally, the chosen

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finish flooring material, such as hardwood, tile, or carpet, is installed, completing the construction and providing the desired aesthetic and functional surface. The content of **Table 4.14.4** shows how the various floors are constructed.

**Table 4.14.4:** How the various floors are constructed or put together

| Type of Floor | Construction Method | Description |
|---|---|---|
| **Ground Floor** | Excavation.<br>Foundation Footing.<br>Concrete Slab. | Excavated to set footings; a concrete slab is poured on top. |
| **Upper Floors** | Joist Installation.<br>Floor Decking.<br>Finishing Layer. | Wooden or steel joists are spaced and decked with plywood or concrete. |
| **Raised Floor** | Support Pedestals.<br>Panel Placement.<br>Finishing. | Pedestals are installed, then panels are placed on top; a finishing layer is added if needed. |
| **Suspended Floor** | Beam Framework.<br>Joists Installation.<br>Flooring Material. | Beams are installed first, followed by joists; then flooring is attached. |
| **Structural Floor** | Reinforcement setup.<br>Concrete Pouring.<br>Finishing. | The rebar is laid out, concrete is poured and finished for strength. |
| **Concrete Floor** | Formwork Creation.<br>Reinforcement Placement.<br>Concrete Pour. | Forms are built to shape the floor, and reinforcement is added before pouring concrete. |
| **Wood Floor** | Joists Installation.<br>Plywood or OSB Installation.<br>Finishing. | Joists are placed, then plywood or OSB is laid; and finished with carpet or varnish. |
| **Composite Floor** | Steel Deck Installation.<br>Concrete Pouring.<br>Finishing. | A steel deck is installed, and then concrete is poured on top for a composite action. |
| **Vinyl or Tile Floor** | Subfloor Preparation.<br>Tile/Vinyl Installation.<br>Grouting (for tiles). | The subfloor is levelled, tiles or vinyl sheets are adhered, and grout is applied to the tiles. |
| **Carpeted Floor** | Subfloor Preparation.<br>Padding Installation.<br>Carpet Installation. | The subfloor is prepared, padding is laid, and carpet is installed over it. |

# How Safety Precautions are Observed During the Construction of Floors to Prevent Failure.

Ensuring safety precautions observation during the construction of floors is a very necessary requirement to prevent structural failure which may result in injury to the workers. The following are the main safety precautions that need to be observed during the construction of floors:

1. Ensure that there is proper planning and design of the floor that meets all building codes and standards.
2. Conduct thorough soil testing and structural analysis before construction to avoid any unforeseeable problems.
3. Select high-quality materials that are suitable for the specific type of floor construction.
4. Verify the quality and consistency of concrete, wood, or other materials used for the floor construction.
5. Ensure that all workers are adequately trained in safe construction practices of floors.
6. Highly experienced supervisors should oversee the construction process of floors.
7. Avoid overloading the floor during construction by distributing materials and equipment evenly.
8. Monitor and manage loads to prevent excessive stress on the structure.
9. Provide temporary support (shoring) during construction to maintain stability and safety of workers.
10. Ensure that beams, columns, and joists are correctly positioned and secured.
11. Conduct frequent inspections to identify and address potential issues promptly.
12. Check for cracks, uneven surfaces, and other signs of structural weakness.
13. Ensure all workers use personal protective equipment (PPE) such as helmets, gloves, and safety boots.
14. Implement safety protocols like fall protection systems and guardrails.

For the following activities organise yourselves into groups of five (5). You can use the internet, videos provided by the teacher and pictures to support your discussions.

**Activity 4.14.1**

In your group, outline and discuss the definition of a floor and analyse the types of floors used in building construction projects.

## Activity 4.14.2

Read extensively about the various functions of floors and in your group, discuss the functions of floors. Write down the core points for the portfolio.

## Activity 4.14.3

Use the internet to search for, identify and record the safety measures that are observed during floor construction to prevent upper floors from failing.

# UNIT 15

# WOODWORK TECHNOLOGY

## Materials and Artefact Production in Woodwork Industry

## Introduction

In the design process, once a design is completed using manual drawing or CAD, a model must be created. A model is the first version of the final product used to test and improve the design before full production. Making a model is important because it shows if the design works, helps to find and fix problems, and gives a clear visual example of the product. Models can be of different types: prototypes (working versions), mock-ups (non-working displays), scale models (smaller versions), and pilot models (small working samples). Models help ensure the final product meets quality, function, and design needs while reducing mistakes and costs.

**KEY IDEAS**

- Assembling the parts of the model step-by-step, checking for accuracy.
- Choosing the right materials and tools for building the model.
- Creating and using a working drawing as a guide to create an accurate model.
- Finishing and polishing the model for a neat presentation.
- Following the measurements and details in the working drawing carefully.
- Making any necessary adjustments to ensure the model matches the drawing.

## MODEL FROM WORKING DRAWINGS

In woodwork, a model from working drawings is a prototype or sample created using detailed plans with exact measurements and instructions. These models serve many purposes. They verify that the design works as intended (proof of concept) and allow for testing and improving materials, methods, and designs (testing and refinement). Models also provide a clear idea of the final product (visual representation) and help identify and fix mistakes before full production (quality control). Additionally, they allow for changes to enhance quality and function (design iteration) and serve as a tool for teaching woodworking skills. This process ensures the final product is functional, accurate, and high-quality.

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## Common Woodwork Models

Common woodwork models are items crafted from detailed working drawings. They serve as prototypes or finished pieces, showcasing craftsmanship and precision. These models can include functional, decorative, or architectural designs, made by following exact measurements and techniques. The following are some common woodworking models created from working drawings:

1. **Furniture Models**
   a. **Chairs:** Examples include dining chairs, lounge chairs, and rocking chairs.
   b. **Tables:** This includes coffee tables, dining tables, and desks.
   c. **Cabinets:** Types include kitchen, bathroom, and storage cabinets.
   d. **Beds:** Examples are bed frames, headboards, and dressers.
2. **Wood Carvings**
   a. **Sculptures:** These include figurines and abstract designs.
   b. **Decorative Figurines:** Examples are carvings of animals and human figures.
   c. **Wooden Signs:** These include nameplates and directional signs.
3. **Architectural Models:**
   a. **Buildings:** This category includes houses, bridges, and skyscrapers.
   b. **Bridges**
   c. **Historical Landmarks:** Examples are monuments and temples.
4. **Decorative Items:**
   a. **Picture Frames**
   b. **Mirror Frames**
   c. **Wooden Boxes:** These can include jewellery and treasure boxes.

By carefully following the working drawing and using different woodwork techniques, craftsmen can create detailed and accurate models. The working drawing acts as a guide, ensuring the final model meets all design requirements.

## Techniques in Making a Model from a Working Drawing

1. **Interpretation:** Study the drawing to understand the design, dimensions, and requirements.
2. **Material Selection:** Choose the right type and amount of wood, considering grain, texture, and durability.

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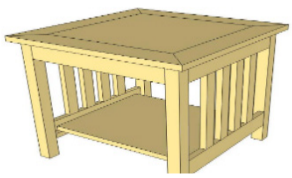
3. **Workpiece Preparation:** Measure and mark the wood using tools like a tape measure, pencil, and saw.
4. **Cutting:** Cut the wood to size using tools like saws or jigsaws. Use correct methods, stay safe, and reduce waste.
5. **Marking of Joints:** Mark out joints using tools like a try square, marking gauge, and pencil.
6. **Cutting of Joints:** Cut the joints using tools such as saws and chisels.
7. **Assembly:** Fit parts together for a trial assembly, then do a final assembly using joinery techniques.
8. **Shaping and Sanding:** Use tools like chisels, planes, and glass paper to smooth and shape the model.
9. **Finishing:** Apply finishes like lacquer, stain, or paint to protect the wood and improve its appearance.
10. **Quality Control:** Check the model for accuracy and quality, making any needed adjustments.

**Table 4.15.1:** Types of models with their names, images and description

| Model Name and Image | Description |
|---|---|
| **Cantilevered Shelves**  | Cantilevered shelves are wall-mounted shelves that appear to float because they are supported by hidden brackets. They are strong, stylish, and save space, making them perfect for holding books, decorations, or other items. Proper installation ensures they are secure and can hold weight safely. |
| **Basic Framed End Table**  | A Basic framed end table is a small table with a simple wooden frame used next to chairs or beds. It usually has a flat top for holding items like lamps, books, or decorations. The design is easy to build, making it ideal for beginners in woodworking. Its sturdy frame provides good support while adding a neat and functional touch to any room. |
| **Bamboo Chair**  | A Bamboo chair is a lightweight and durable chair made from bamboo stalks. It has a natural, eco-friendly look and is often used for both indoor and outdoor settings. Bamboo chairs are strong, yet flexible, making them comfortable to sit on. They are also easy to maintain and add a simple, stylish touch to any space. |
| **Bamboo Stool**  | A Bamboo stool is a small, lightweight seat made from bamboo. It is strong and durable, yet easy to move around. Bamboo stools have a natural look, making them perfect for both indoor and outdoor use. They are simple to make, comfortable to sit on and add a stylish touch to any space. |

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## Activity 4.15.1

### Demonstrating How to Create a Model from a Working Drawing.

***For this activity, you will organise yourselves into groups of 5.***

**Scenario:**

You are working in a woodworking workshop tasked with creating a wooden model based on a detailed working drawing. Your group's goal is to ensure everyone understands the procedures and techniques, working together to discuss, support, and practice each step.

**Materials Needed:**

- Video demonstration equipment (projector or screen)
- Notebooks and pens for brainstorming.
- Working drawing for reference.
- Access to woodworking tools (e.g. tape measure, pencil, try square, marking gauge, saws).
- Safety goggles and gloves.
- Material for the model (wood or bamboo).

### Activity Guidelines:

1. All groups will watch a video demonstration of how to create a model from a working drawing.
2. After watching the video, in your groups, discuss each step shown in the video
3. Share your key insights with the class for feedback and discussion.
4. Each group will discuss and describe the steps needed to produce a model using the working drawings as a guide.

## Activity 4.15.2

### Creating a model from a working drawing using suitable materials.

**Scenario:**

You are in the woodwork shop for a practical learning activity. Create a model based on a detailed working drawing using a suitable material (e.g., wood). Your task is to accurately follow each step of the production process, always ensuring precision and safety.

**Materials Needed:**

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- Video demonstration equipment (projector or screen)
- Working drawing of the model.
- Tape measure, pencil and marking tools (try square, marking gauge).
- Saw (hand saw and jigsaw), Chisels, Sandpaper, Jack plane, Clamps.
- Safety goggles and gloves.
- Material for the model (wood or bamboo).
- Finishing products (lacquer, stain, paint, etc.)

### Activity Guidelines:

You will create a model using your working drawing, following each step outlined in the process below, while ensuring all safety rules.

Step-by-Step Procedure:

1. Carefully study the working drawing to understand the design and measurements fully.
2. Choose a suitable material (wood or bamboo) based on grain, texture, and durability.
3. Measure and mark the wood accurately using appropriate tools.
4. Cut the wood into required sizes and shapes, using tools correctly and minimising waste.
5. Mark out the joints using precise tools such as squares and marking gauges.
6. Cut the joints with tools like saws and chisels.
7. Fit and trial-assemble parts before final assembly.
8. Smooth and refine the model using sandpaper and shaping tools.
9. Apply protective finishes such as lacquer, stain, or paint.
10. Inspect for accuracy and make any necessary adjustments.

## Conclusion

Producing a model from working drawings allows you to turn design plans into a tangible form. By following each step carefully, from interpreting the drawing to selecting materials, cutting, assembling, and finishing, you ensure accuracy and quality. Creating a model helps test and refine your design, reducing errors and improving the final product. It demonstrates practical skills, attention to detail, and the ability to bring ideas to life.

# UNIT 16

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

This unit introduces to you the load and non-load bearing members of the substructure and superstructure respectively. Load-bearing members are critical components of both the substructure and superstructure of a building, providing essential support and stability. In a substructure, foundations and footings ensure that the loads are evenly distributed to the ground, thereby preventing settlement and structural failures. Key elements like piles and pile caps provide additional support in challenging soil conditions. In the superstructure, columns and beams play a vital role, transferring loads from floors, roofs, and walls to the foundation. These members are carefully designed and constructed to maintain the desired strength, safety, and durability of the entire building.

**KEY IDEAS**

- Load-bearing members of the superstructure of a building are necessary and important.
- Load-bearing members, such as walls and columns, provide essential structural support, carrying and distributing loads from the roof and upper floors down to the foundation.
- Non-load-bearing members, like partition walls, do not support structural loads but are crucial for dividing interior spaces and providing privacy.
- Non-load-bearing members allow for flexibility in the interior design and layout.
- Non-load bearing members allow for modifications without any effect on the structural integrity of the building.

## STRUCTURAL TERMINOLOGIES ASSOCIATED WITH LOAD-BEARING COMPONENTS OF THE SUPERSTRUCTURE

There are several terms that are linked to load-bearing structures which are necessary to know and understand.

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**Table 4.16.1:** Load-bearing structures terms

| Term | Description |
|---|---|
| **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 superimposed loads. |
| **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. |
| **Live or Superimposed Load** | These are created by the weights of the people and the movable fittings such as furniture. Wind pressure is also a live load. |
| **Compression Load** | One of the functions of the structure of the building is to transfer loads safely to the foundation and the subsoil. 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 is 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. |

## The Load-Bearing Members in a Building.

Load-bearing members in a building are structural elements that support and transfer the loads from the building, such as the weight of the building itself, occupants, furniture, and other forces, down to the foundation and the ground. These members ensure the stability and safety of the structure by evenly distributing these loads. The load-bearing members of the superstructure play a very important role in ensuring the effective stability and safety of the building. Among the load-bearing members of the superstructure are as follows:

1. ***Columns:*** Vertical members that carry the loads from the floors and roof down to the foundation.
2. ***Beams:*** Horizontal members that distribute loads from floors, roofs, and walls to the columns.
3. ***Load-Bearing Walls***: Walls that support vertical loads in addition to their own weight, transferring these loads to the foundation.

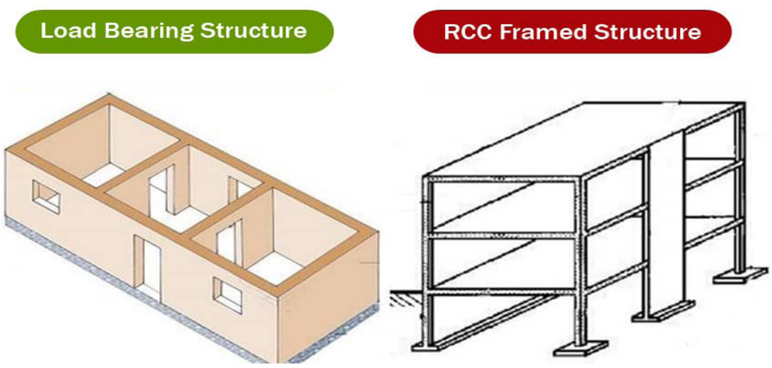


**Figure 4.16.1:** Examples of load-bearing members of a building.

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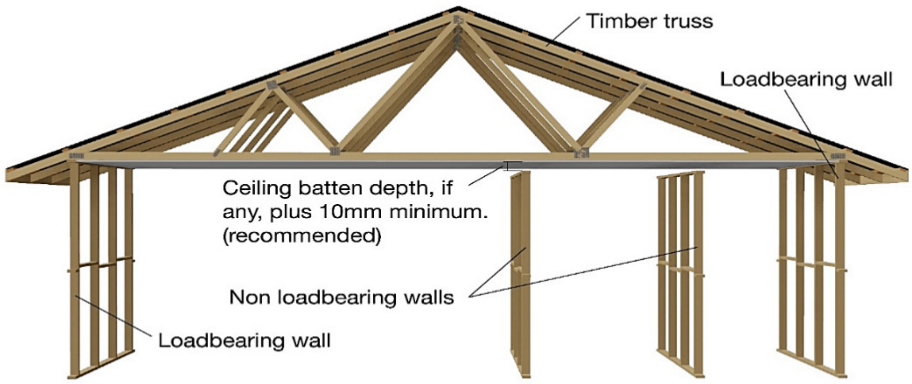


**Figure 4.16.2:** Illustration of the various load-bearing members of the superstructure

## Activity 4.16.1

Organise yourselves into groups of no more than five. In your groups, read and brainstorm about the meaning of load-bearing and non-load-bearing members of the superstructure and write your reports in the group portfolio.

# Load-Bearing and Non-Load-Bearing Members of a Building

Load-bearing members are components that support and transfer loads (weight) from the structure above to the foundation below. Examples load bearing members are; walls, columns, beams and foundations. However, non-load-bearing members are the components that do not support any structural loads other than their own weight. Examples of non-load bearing members are; partition walls, cladding or facades and decorative elements. **Tables 4.16.2 and 4.16.3** provide a thorough analysis of both load-bearing and non-load-bearing members, highlighting their specific roles and functions, which will enable you to gain a deeper understanding of the issues associated with load-bearing and non-load-bearing members in building construction.

**Table 4.16.2:** Load-bearing members of the superstructure of a building

| Load-Bearing Member | Roles | Function |
|---|---|---|
| **Columns** | Vertical supports that transfer loads from beams and slabs to the foundation. | Vertical structural elements that support loads from beams and slabs, transferring them to the foundation. |
| **Beams** | Horizontal structural elements that span between columns, supporting floor and roof loads. | Horizontal structural elements that span between columns, supporting floor and roof loads. |

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| **Slabs** | Horizontal planes form the floors and roofs, distributing loads to beams and columns. | Horizontal structural elements that form the floors and roofs of a building, distributing loads to beams and columns. |
| **Walls** | Vertical elements that enclose spaces and support loads, transferring them to the foundation. | Vertical structural elements that enclose spaces and can also support loads, especially in load-bearing wall systems. |
| **Trusses** | Triangular frameworks that efficiently span long distances are often used for roofs and bridges. | Triangular frameworks are composed of interconnected members that efficiently span long distances, often used for roofs and bridges. |
| **Girders** | Large, primary beams that support other beams and loads. | Large, primary beams that support other beams and loads. |

**Table 4.14.3:** Non-load bearing members of the superstructure

| Non-Load-Bearing Member | Role | Description |
|---|---|---|
| **Partition Walls** | Space Division | Create separate rooms or areas without supporting loads. |
| **Curtain Walls** | Weather Protection | Provide exterior cladding that shields from the elements but does not support structural loads. |
| **Facade Elements** | Aesthetic Enhancement | Enhance the visual appeal of the building's exterior. |
| **Interior Finishes** | **Surface Treatment** | Cover walls, ceilings, and floors for aesthetic and functional purposes (e.g., paint, wallpaper). |
| **Ceiling Tiles** | Acoustic Control | Improve sound insulation and aesthetics in interior spaces. |
| **Windows and Doors** | Access and Ventilation | Allow light, access, and airflow without bearing structural loads. |
| **False Ceilings** | Utility Concealment | Hide HVAC systems, electrical wiring, and other utilities while enhancing aesthetics. |
| **Cladding** | Insulation and Protection | Provide thermal insulation and weather resistance without structural function. |
| **Decorative Elements** | Visual Appeal | Enhance the building's design (e.g., mouldings, trims, or sculptures). |
| **Shelving and Fixtures** | Functional Utility | Serve practical purposes within spaces without contributing to structural integrity. |

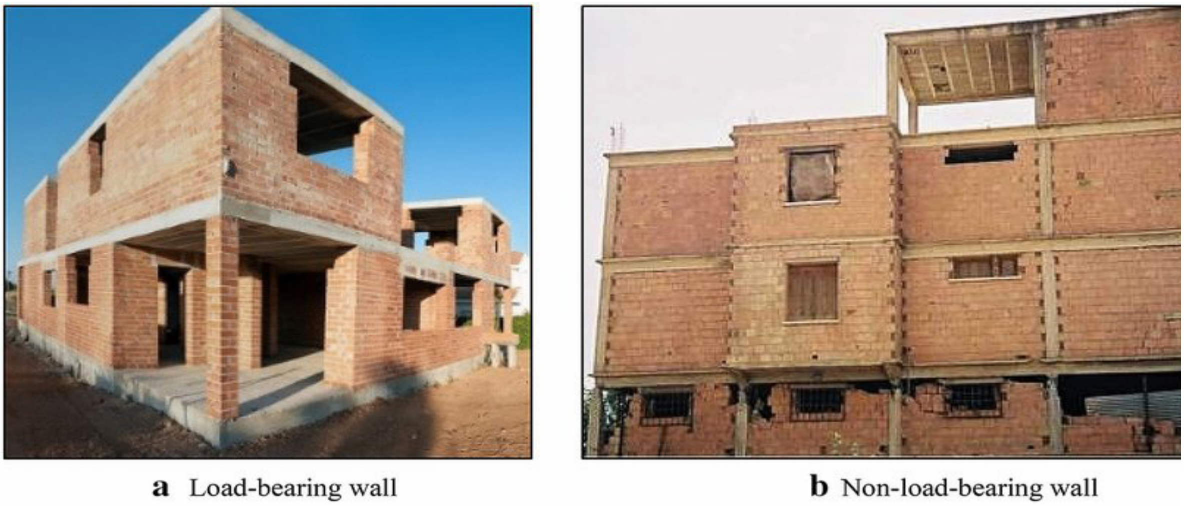


**Figure 4.16.3:** Examples of load-bearing and non-load-bearing members of the superstructure.

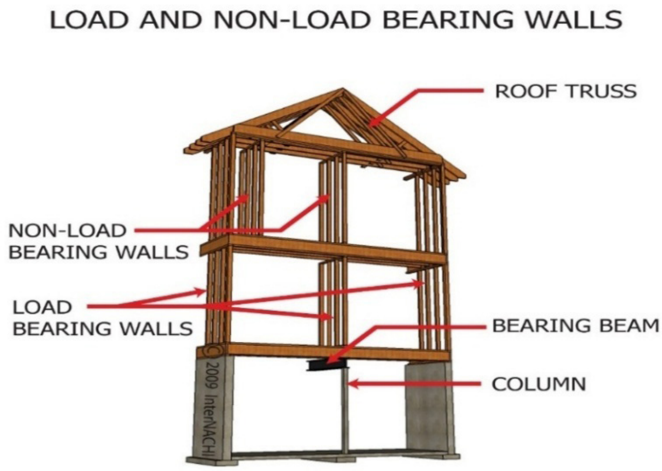


**Figure 4.16.4:** Examples of framed load-bearing and non-load-bearing members of the superstructure.

**Activity 4.16.2**

In your groups, categorise and discuss load and non-load-bearing members of the superstructure.

## The Characteristics Associated with Building Components That Are Load-Bearing Members of the Superstructure.

Load-bearing and non-load-bearing members of the superstructure of a building play very important roles, for which you need to study the characteristics they are associated with. In this regard, you will read about the importance of the issues of structural functions, material strength, design complexity and modification flexibility as outlined in **Table 4.16.4**. As you read about the characteristics of the members, your knowledge and understanding of the applications of the load and non-load-bearing members of the superstructure will be enhanced effectively.

**Table 4.16.4:** The characteristics of load-bearing and non-load-bearing members of the superstructure of a building

| Characteristics | Load-Bearing Members | Non-Load-Bearing Members |
|---|---|---|
| **Structural Function** | Supports and transfers loads to the foundation | Does not support any structural loads |
| **Material Strength** | Typically made from strong materials (concrete, steel, masonry) | Usually constructed from lighter materials (drywall, wood) |
| **Design Complexity** | Requires careful design and engineering to ensure stability | Simpler design, as they don't affect structural integrity |
| **Modification Flexibility** | Alteration may compromise structural stability | Can be easily modified or removed without affecting the overall structure |
| **Load Capacity** | Designed to withstand significant loads (dead and live) | Limited to self-weight, not designed for load-bearing |
| **Impact on Layout** | Defines overall building layout and configuration | Allows flexibility in interior layout without altering the structure |
| **Connection to Other Elements** | Often connected to other load-bearing elements (columns, beams) | Typically connected to load-bearing elements but do not transfer loads |
| **Regulatory Requirements** | Must adhere to strict building codes and safety regulations | Fewer restrictions, though still subject to general safety codes |
| **Cost Implications** | Generally, more expensive due to materials and engineering requirements | Usually less expensive, focusing on aesthetic and functional roles |

## Activity 4.16.3

In your groups, read thoroughly and discuss how the load imposed from the upper part of the building is managed safely till it is distributed to the foundation.

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## EXTENDED READING


- Allen, E., & Iano, J. (2013). Fundamentals of Building Construction: Materials and Methods. 6th Edition. Wiley.
- Ching, F. D. K. (2014). Building Construction Illustrated. 5th Edition. Wiley.
- Dobrowolski, J. A. (2004). Concrete Construction Handbook. 3rd Edition. -Hill.
- Walton, John A. (1970). Woodwork Theory in and Practice (metric edition), pages 387-413.
- Walton, John A., (1970). Woodwork Theory in and Practice (metric edition). Pages 362-38

# Review Questions

## Questions 4.1

1. You are tasked with creating a new piece of furniture for a high-traffic area. The furniture should be durable, stylish, and cost-effective. Identify three materials that would be suitable for producing the final solution, explaining why each material is appropriate.
2. You are designing a piece of furniture that will be exposed to high moisture levels, such as a bathroom cabinet. Explain three reasons why you would select a non-wood material for the production of this artefact.
3. You are designing a new piece of furniture and want to ensure that the materials used are sustainable. How will you ensure the sustainability of your artefact's materials?
4. What factors should be considered when selecting materials for a final product?
5. Why is material durability important in furniture production?
6. How do material properties affect the design and function of a product?

## Questions 4.2

1. Explain floors and outline the various types used in building construction.
2. Distinguish Upper Floors from Ground Floors.
3. Discuss how safety precautions observed during the construction of Upper Floors will help prevent them from failing.

## Questions 4.3

1. With your working drawing as a guide, what steps would you take to produce your model?
2. Referencing your working drawing, create a model using at least two suitable materials to accurately bring your design to life.
3. What is the purpose of producing a model from your working drawings?
4. What steps should you follow to produce a model?
5. Why is safety important when producing a model?

## Questions 4.4

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

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2. Distinguish between load-bearing and non-load-bearing members of the superstructure.
3. 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.

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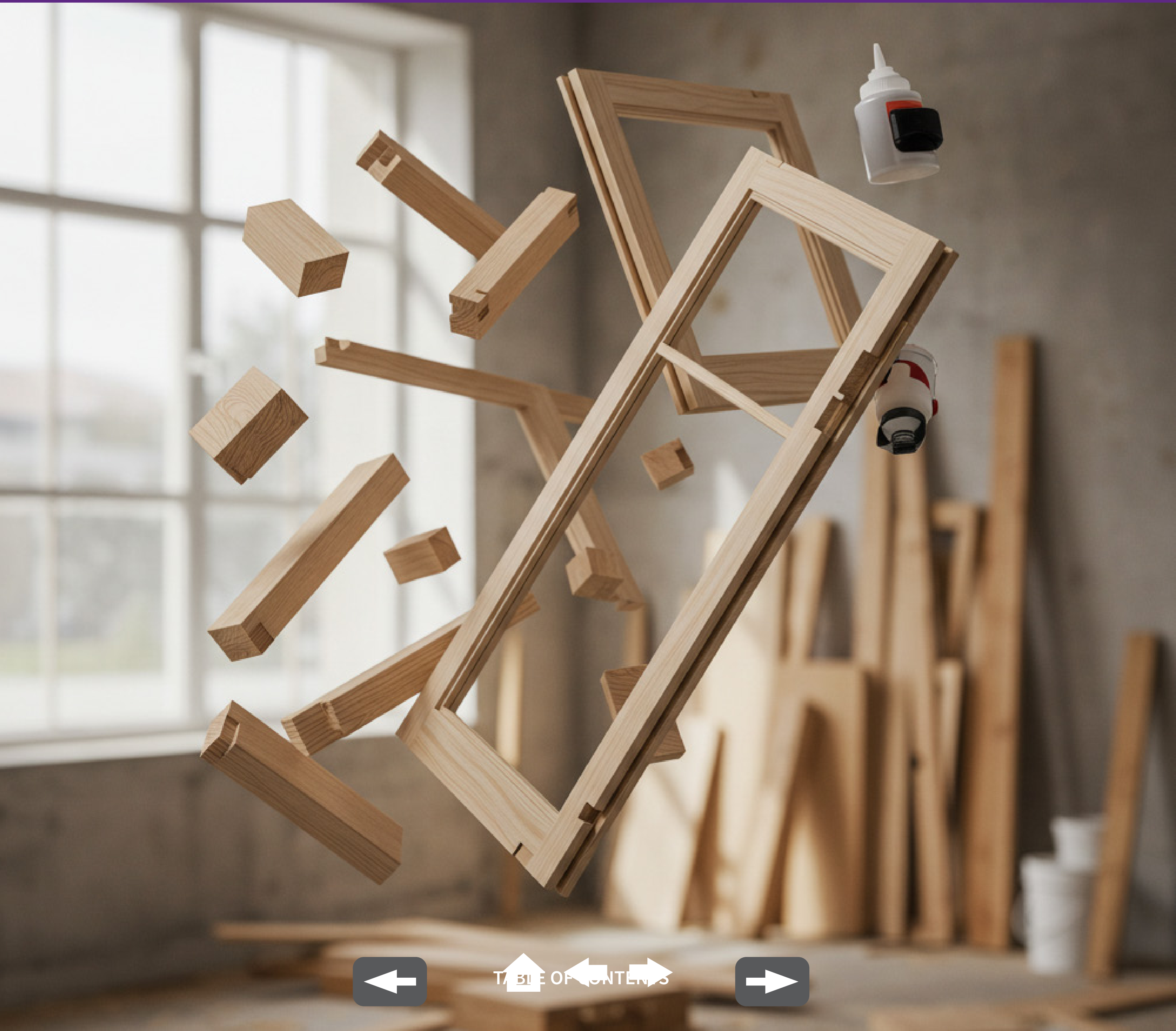
# WOODWORK JOINT, ADHESIVES AND WALL, DOOR, WINDOW, FRAME CONSTRUCTION



# UNIT 17

# WOODWORK TECHNOLOGY

## Materials and Artefact Production in the Woodwork Industry in Ghana

## Introduction

Choosing the correct joint is important to ensure that the wood pieces are securely joined and used effectively. While there are many types of wood joints, most are variations of a few basic designs. Understanding these joints will help you create strong, durable, and efficient woodwork, improving the quality and longevity of the finished piece.

**KEY IDEAS**

- Ensure joints are secure and fit well to enhance the durability and stability of woodwork projects.
- Identify the best wood joint to use based on the type of project (e.g., tables, cabinets, or frames).
- Learn the purpose and strength of each type of joint in woodworking.
- Practise making different joints accurately using appropriate tools and techniques.
- Understand different types of wood joints such as butt joints, dovetail joints, and mortise-and-tenon joints.

## WOODWORK JOINT

A woodwork joint is used to connect two or more pieces of wood members/parts to form a single unit. Choosing the right joint ensures strength, stability, and alignment, making the wood pieces work together effectively for the project.

## Types of Joints

There are different types of woodwork joints, each suited for specific needs. The common ones include:

### Angle joints

These joints are used for box-like constructions where parts meet at right angles.



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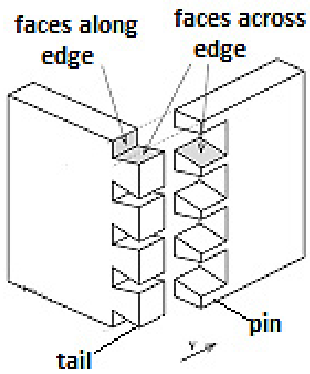
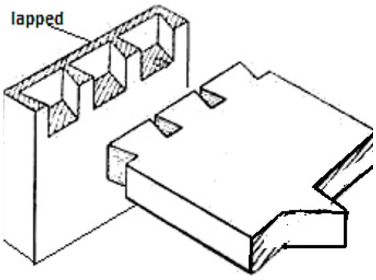
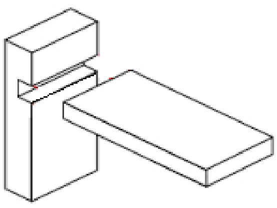
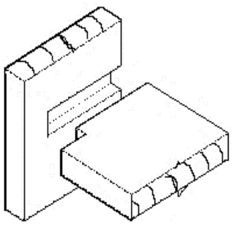
**Table 5.17.1 – Angle joint types, descriptions and uses**

| Name and sketch of joint | Description | Uses |
|---|---|---|
| There are two ways of **dovetail construction**:<br>**a. Through dovetail joint**<br><br>**b. Lapped dovetail joint**<br> | The dovetail joint is a very strong type of wood joint commonly used at the corners of boxes and frames. It consists of two main parts: the dovetails (tails) and the pins, with the pins arranged so that one is at each end of the joint. To make a dovetail joint, you first mark and cut the dovetails, then mark the pins using the dovetails to ensure a tight fit.<br>**a. Through Dovetail Joint:** This joint is visible on both sides, showing the dovetails and pins. It's a strong but noticeable joint.<br>**b. Lapped dovetail joint:** This joint, hides the end grain on one side by overlapping the parts. It gives a cleaner, smoother appearance on one side. | **a. Through Dovetail Joint:** It is used where strength is needed, like in boxes or drawers, even if both sides are visible.<br>**b. Lapped dovetail joint:** The lapped dovetail is often used when a more polished look is needed, such as in fine furniture or cabinetry, where the joint's appearance matters. |
| **There are three ways of housing joint construction:**<br>**a. Through housing joint**<br><br>b. **Stopped housing joint**<br> | To increase the strength, shelves must be provided into the side of a cabinet. A groove is cut into the side of the cabinet where the shelf will rest, making the shelf stronger and more stable.<br>**a. Through housing joint:** This type of housing joint goes all the way through the side of the cabinet, creating a groove that can be seen from both sides.<br>**b. Dovetail housing joint:** A stopped housing joint has a groove that does not go all the way through, leaving the front edge of the shelf looking cleaner. | **a. Through housing joint:** It is used when the strength of the joint is important, and the appearance of the groove on the side is not a concern.<br>**b. Dovetail housing joint:** It is used when a neat, professional appearance is needed, especially for the front of the shelf. |

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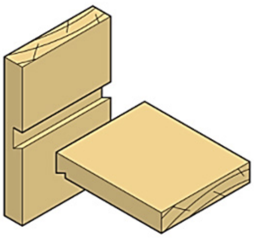
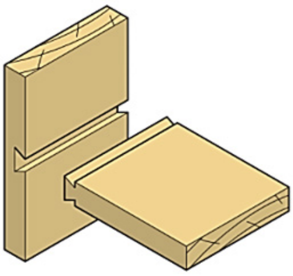
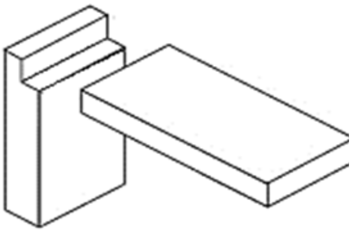
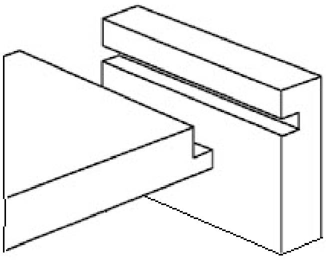
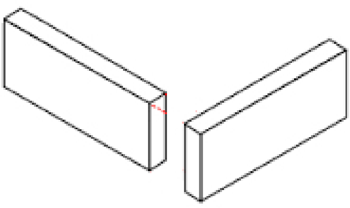
| **c. Dovetail housing joint**<br>***Single tail***<br><br>***Double tail***<br> | **c. Dovetail housing joint:** The dovetail housing combines the strength of a dovetail joint with the housing joint. The groove is shaped like a dovetail for a stronger hold. | **c. Dovetail housing joint:** It is used when extra strength is required, especially for heavy shelves or cabinets. |
| **Rebate joint**<br> | The rebate joint is similar to a lapped dovetail but easier to make. It involves cutting a step or groove on one edge of a piece of wood to fit with another piece. | This joint is used when ease of construction is important. However, it is not very strong and needs to be glued and nailed for stability. |
| **Barefaced tongue and groove joint**<br> | This joint has a tongue on one piece of wood that fits into a groove on another. It has more contact surface than a rebate joint, making it slightly stronger. | It is used when a stronger joint is needed. However, the short piece of end grain can still be weak. |
| **Butt joint**<br> | A butt joint is made by simply placing two pieces of wood together end-to-end or at an angle. | It is easy to make but not very strong on its own. It requires glue, screws, or nails to hold the pieces together since there is minimal contact surface. |

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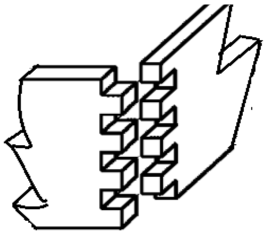
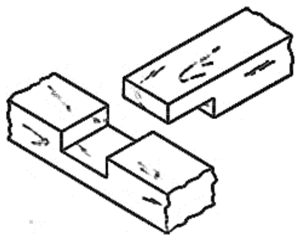
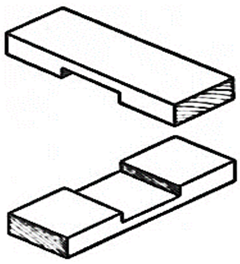
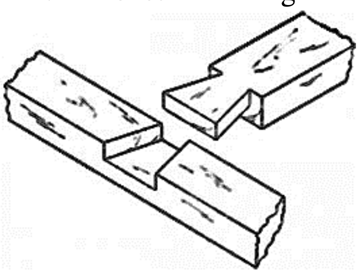
| **Box/pin joint**<br> | This joint is created by cutting matching interlocking shapes (pins) in two pieces of wood that fit together, usually at right angles. | It is stronger than a butt joint and is often used for boxes and drawers. The pieces are usually glued for extra stability. |

## Framing Joints

These joints are used to connect pieces of wood at right angles, often for frame-like constructions such as doors and window frames.

**Table 5.17.2 –** Framing joint types, descriptions and uses

| Name and sketch of joint | Description | Uses |
|---|---|---|
| **Framing Joint:**<br>**a.** ***Halving joint***<br>**i.** Halving joint<br><br>**ii.** Cross-halving joint<br> | **Framing Joint:** These joints are used to connect pieces of wood at right angles, often for frame-like constructions such as doors and window frames.<br>**a.** ***Halving joint:*** This joint involves removing half the thickness from each piece of wood, allowing them to overlap and stay flush without increasing overall thickness. | **a.** It is used to connect pieces of wood at right angles for frames where maintaining the same thickness across the joint is important. |
| **b.** ***Dovetail halving joint and Skew having***<br>**i.** Dovetail halving<br> | **b.** There are different types, such as the dovetail halving, which adds more strength, and the skew halving, used for angled connections. | **b.** It is used for frames where maintaining the same thickness across the joint is important. |

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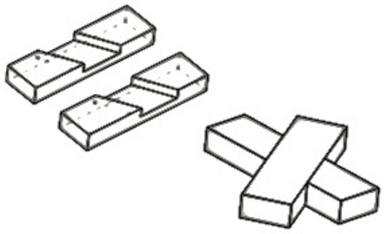
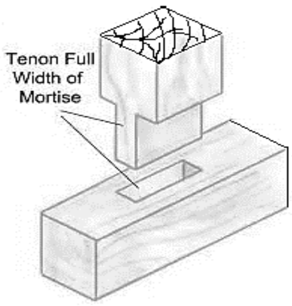
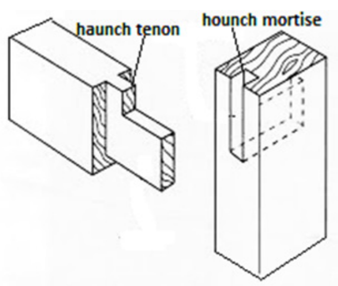
| **ii.** Skew having<br> | | |
| **c.** ***Dowel joint***<br> | **c.** This is an improved version of the butt joint where wooden dowels are inserted into holes in the connected pieces to add strength. | **c.** It is commonly used to strengthen simple butt joints, providing more stability and durability. |
| **Mortise and tenon joint:**<br>**a.** ***Through Mortise and tenon joint***<br> | **The mortise and tenon joint** have a hole (mortise) in one piece and a matching end (tenon) on another piece that fits into it. The tenon is usually one-third the thickness of the wood. The mortise is made by drilling and chiselling out the wood, while the tenon is shaped to fit exactly into the mortise.<br>**a.** **Through Mortise and Tenon Joint:** This type has the tenon passing through the mortise, making it visible on the opposite side for extra strength. | **a.** **Through Mortise and Tenon Joint:** This joint is used in furniture and frame construction (e.g. workbench, tables, and wooden doors) where high strength is needed. |
| **b.** ***Square and Secret haunch M&T***<br>**i.** Square haunch M&T<br> | **b.** **Square Haunch or Secret Haunch:** These features are added at the top corner to make the joint stronger and more stable. | **b.** **Square Haunch or Secret Haunch:** The square haunch or secret haunch is used to strengthen the joint at the top corners of frames, such as window or door frames. |

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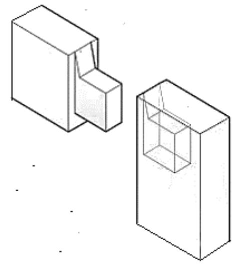
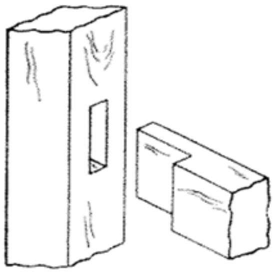
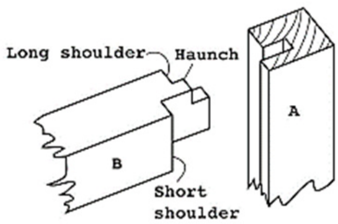
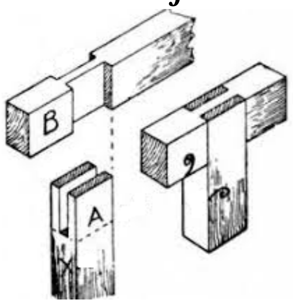
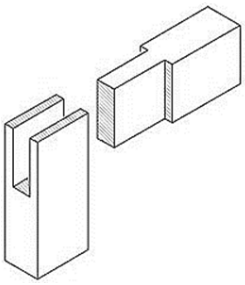
| **ii.** Secret haunch M&T<br> | | |
| **c.** ***Barefaced Mortise & tenon***<br><br>**d.** ***Long and short shoulder mortise and tenon***<br><br>Long and short shoulder mortise and tenon | **c.** **Barefaced Tenon:** Used when the material with the mortise is thinner than the piece with the tenon, leaving one face of the tenon exposed.<br><br>**d.** **Long and Short Shoulder Mortise and Tenon:** This type is used when additional strength is needed, especially for frames that have a recess to hold glass or a panel. | **c.** **Barefaced Tenon:** This type is used when the material containing the mortise is thinner than the piece with the tenon.<br><br>**d.** **Long and Short Shoulder Mortise and Tenon:** This variation is used for frame construction that needs to accommodate a rebate or recess for glass or plywood panels, such as window frames, cabinet doors, and display cases. |
| **Bridle joint**<br>**a.** ***Plain bridle joint***<br><br>**b.** ***Angle bridle joint***<br> | The bridle joint is similar to a mortise and tenon joint but simpler. It can be used at corners or away from corners. One piece has a slot (or open mortise), while the other piece has a matching tongue (tenon). | It is used for frame structures, offering a strong and simple way to join two pieces of wood. |

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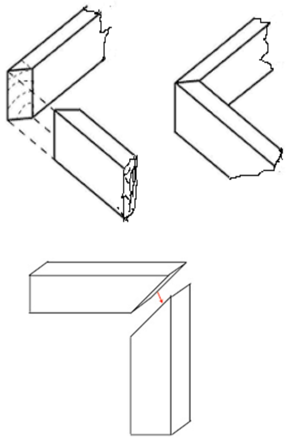
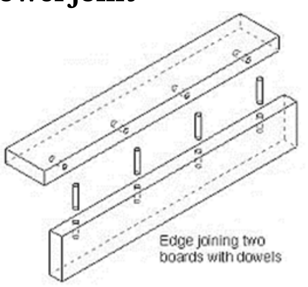
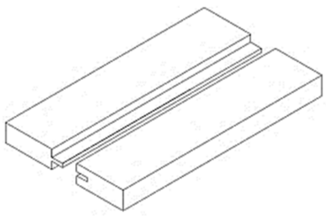
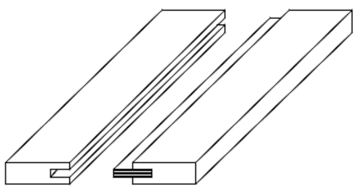
|---|---|---|
| **Mitre joint**<br> | This joint connects two pieces at a 45-degree angle to form a right angle (90 degrees). It creates a neat, clean look as the ends meet without showing the cut edges. | Mitre joints are used for picture frames, mouldings, and other projects where appearance is important. |

## Widening and Lengthening Joints

These joints are used to increase the width and length of a piece of wood. It is also used to connect boards edge-to-edge to form a larger surface.

**Table 5.17.3 –** Widening joint types, descriptions and uses

| Name and sketch of joint | Description | Uses |
|---|---|---|
| **Dowel joint**<br><br> | This joint strengthens a butt joint by adding dowels. Holes are drilled into each piece, and dowels are inserted, fitting tightly with glue. Grooves in the dowels allow excess glue to escape. | Dowel joints are used to reinforce and align wood pieces, often in furniture construction. |
| **Tongue and groove joint:**<br>**a.** ***Tongue and groove***<br><br>**b.** ***Loose Tongue and groove***<br> | This joint connects narrow pieces of timber to make a wider board. One piece has a groove and the other has a tongue that fits into it. It keeps the pieces level and increases contact for a stronger bond. For more glueing area, grooves can be cut, and a thin plywood tongue added. | It is used for flooring, panelling, and making wide boards from smaller pieces. |

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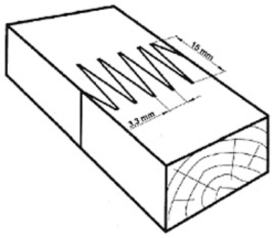
| **Finger joint**   | This joint is made by cutting interlocking "fingers" in two pieces of wood that fit together and are glued. The shape resembles interlocking fingers. | It is used for making long boards and for strong, attractive joints in box-making and furniture. |

## Purpose of Joints in the Construction of Artefacts

Common uses for joints in the making of artefacts are as follows:

1. **Connect Pieces**: Join various wood pieces together, forming a single, strong unit.
2. **Provide Strength**: Joints add stability and rigidity, making the artefact durable and resistant to stress.
3. **Improve Appearance**: Create a smooth, professional finish using joints that hide gaps and seams.
4. **Distribute Loads**: Spread weight and pressure evenly, preventing damage or collapse.
5. **Facilitate Assembly**: Make assembly and disassembly easier by using joints, simplifying transportation and storage.
6. **Generate Functionality**: Create moving parts like drawers, doors, and lids by using appropriate joints.
7. **Enhance Flexibility**: Allow woodworkers to create complex shapes and designs that would be difficult with a single piece of wood.

***For the following activities, organise yourselves into groups of no more than five.***

### Activity 5.17.1

### Identifying and analysing joints in woodwork artefacts

**Scenario:**

You are a woodcraft expert responsible for evaluating a range of handmade artefacts in a craft exhibition. Your goal is to identify the types of joints used, assess their effectiveness, and explain why these joints were selected for each

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artefact. You will work with your peers to examine the artefacts closely and share your insights with the group.

**Materials Needed:**

- Video demonstration equipment (projector or screen) or physical samples showcasing different woodwork joints.
- Notebooks and pens for brainstorming.
- Wooden artefacts with visible joints (e.g., wooden frames, cabinets, boxes, etc.)
- Chalkboard/whiteboard or interactive display for group feedback.
- Markers and pens
- Safety glasses (if handling physical artefacts).

### Activity Guidelines:

1. The whole class will watch a video demonstration showing different types of woodwork joints used in the construction of artefacts.
2. Each group will be provided with wooden artefacts or images showcasing different joints. In your groups,
   a. Identify the types of joints used in their artefacts.
   b. Discuss the following questions with your group members:
      i. Why do you think this type of joint was chosen for this artefact?
      ii. What advantages or disadvantages does this joint offer for this artefact's purpose?
      iii. How does this joint contribute to the artefact's strength or appearance?
3. Present your findings to the class for a discussion.

## Activity 5.17.2

### Exploring the Purpose of Joints in Artefacts

**Scenario:**

You are part of a team designing a new wooden artefact. Your task is to discuss and understand the purpose of different woodwork joints to ensure the artefact is strong, functional, and visually appealing.

**Materials Needed:**

- Video demonstration equipment (projector or screen)
- Sample wooden artefacts showing different joints.

- Notebooks and pens for brainstorming.
- Whiteboard, markers, and sticky notes for group feedback and brainstorming.
- Tablets/computers for research
- Safety goggles and gloves.

### Activity Guidelines:

1. The whole class will watch a video demonstration showing an explanation of the purposes of joints (e.g., strength, appearance, assembly).
2. After watching the video, organise yourselves into groups of 5 and examine the artefacts or images provided.
3. Discuss and identify how joints are used in the construction of artefacts and consider questions such as:
   a. How do joints improve the strength and stability of this artefact?
   b. Why might a particular joint have been chosen for this purpose?
4. Present your findings on the purpose of joints in their artefact to the class for feedback and discussion

## Activity 5.17.3

### Sketching examples of different woodwork joints

**Scenario:**

You are part of a design team in a woodwork shop tasked with preparing visual examples of common joints used in woodworking. Your task is to sketch and understand the structure and purpose of angle joints, framing joints as well as widening and lengthening joints, working collaboratively in groups.

**Materials Needed:**

- Video demonstration equipment (projector or screen)
- Diagrams or models of different woodwork joints for reference.
- Drawing paper and sketchbooks.
- Pencils, erasers, rulers, and markers.
- Interactive whiteboard or posters for group discussion and demonstration.
- Tablets or reference books with illustrations of woodwork joints.

### Activity Guidelines:

1. The whole class will watch a video demonstration showing the different joint types (Angle, Framing, Widening/Lengthening) and their applications.

2. After watching the video, organise yourselves into groups of 5.
3. Sketch examples of angle joints, framing joints, and widening/lengthening joints.
4. Present your sketch to the rest of the class focusing on the key features and uses of each joint type.
5. Reflect on the purpose and structure of each joint type and how these sketches can be applied to real-world artefacts.

## Conclusion

Selecting and using the appropriate joint for a specific woodwork project ensures strength, stability, and a good appearance. The right joint improves durability, supports the function of the artefact, and creates a professional finish. Understanding and choosing the best joint type for each task is key to successful woodworking.

# UNIT 18

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

A wall is a structure that defines spaces, supports loads, provides security and shelter, and can be decorative. Walls have various functions and types, such as solid, cavity, curtain, and partition walls. They are constructed using materials like bricks, blocks, stones, and concrete. Understanding wall construction is essential for appreciating how buildings are made safe, stable, and functional.

**KEY IDEAS**

- Proper wall construction ensures the safety, stability, and comfort of a building.
- Walls are vertical structures that divide or enclose spaces in a building.
- Walls can also provide insulation, soundproofing, and fire protection
- Wall materials include bricks, concrete, wood, and glass.
- Walls support roofs, floors, and upper parts of a building.

## WALLS

### The Meaning of Walls in a Building

Walls in a building are vertical structures that serve essential functions. They provide structural support thereby bearing the load of the roof, floors, and upper levels. A wall also transfers the weight of the building to the foundation. Usually, the walls provide enclosed spaces, offering privacy and thereby separating the rooms. The walls also protect the interior from external elements like weather and intruders. A wall contributes to the aesthetic and design of the building. It creates soundproofing and insulation for comfort and enhances safety by compartmentalising spaces, especially in preventing the spread of fire. Overall, walls are fundamental to the building's integrity, functionality, and safety.

# The Different Types of Walls Used in Building Construction

Walls in building construction serve various functions, such as providing structural support, dividing spaces, and offering protection. They help to enclose the building, ensuring privacy and security, while also shielding the interior from weather, noise, and other external factors. Some walls are designed to support the weight of the structure, while others simply partition spaces. Additionally, certain walls contribute to energy efficiency by providing insulation, moisture control, and soundproofing. In terms of safety, walls can help prevent the spread of fire and resist external forces like wind or earthquakes.

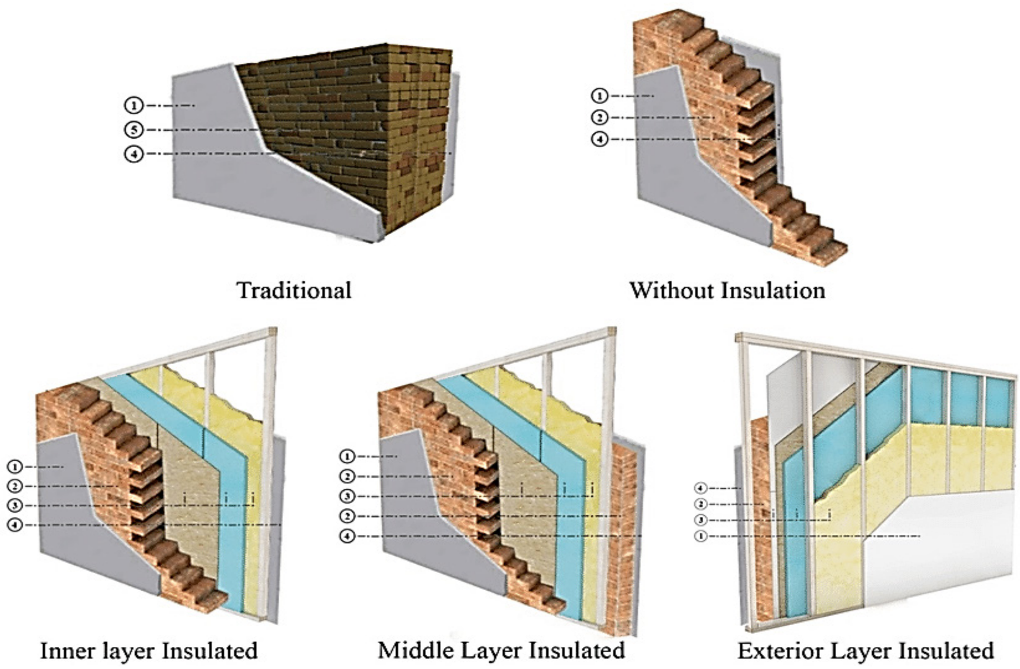


**Figure 5.18.1:** Types of walls

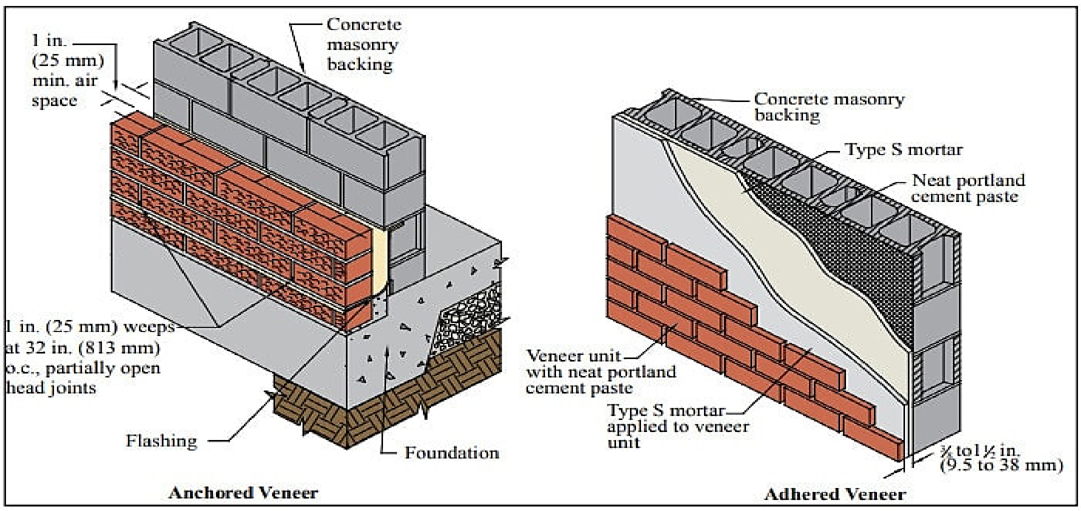


**Figure 5.18.2:** Substructure for wooden floor



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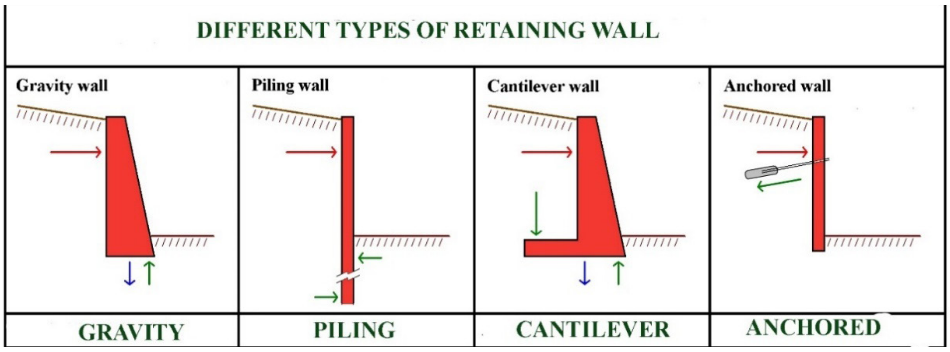


**Figure 5.18.3:** Different types of retaining walls.

There are different types of walls used in building construction; they are included in the table below.

**Table 5.18.1:** Types of walls used in building construction

| Type of Wall | Description | Purpose |
|---|---|---|
| **Load-Bearing Walls** | Walls that support and transfer loads from above to the foundation. | Provide structural support and stability. |
| **Non-Load-Bearing Walls** | Walls that do not support any structural loads from above. | Divide spaces without affecting structural integrity. |
| **Exterior Walls** | Walls that form the outer shell of a building. | Provide protection from weather and environmental elements. |
| **Interior Walls** | Walls that separate rooms within a building. | Define functional areas and improve privacy. |
| **Partition Walls** | Non-load-bearing walls that create separate rooms or spaces. | Flexibly divide interior spaces for different uses. |
| **Retaining Walls** | Walls that hold back soil or other materials, preventing erosion or collapse. | Stabilise slopes and prevent ground movement. |
| **Curtain Walls** | Non-structural walls typically made of glass or lightweight materials, are attached to the frame of a building. | Provide aesthetic appeal and natural light while protecting from the elements. |
| **Firewalls** | Walls are designed to contain fire and prevent its spread between different sections of a building. | Enhance safety by providing fire resistance. |
| **Shear Walls** | Vertical walls that provide lateral stability to a building, especially in high-rise structures. | Resist lateral forces from wind and earthquakes. |
| **Soundproof Walls** | Walls are constructed with materials that minimise sound transmission. | Enhance acoustic comfort and privacy in living or working spaces. |
| **Cavity wall** | A cavity wall is a type of wall construction that consists of two parallel masonry walls separated by a gap or cavity and usually made of brick, concrete blocks, or other masonry materials. | Provides insulation and helps prevent moisture intrusion. |

# The Differences Between the Types of Walls Used in Building Construction

The main differences between wall types in building construction lie in their functions and materials. Load-bearing walls support structural weight, while non-load-bearing walls divide spaces. Exterior walls help protect from the weather, whereas interior walls separate rooms. Cavity walls have a gap for better insulation, while partition walls divide spaces inside. Retaining walls hold back soil, shear walls resist forces like wind or earthquakes, and curtain walls are non-structural cladding. Firewalls are designed to contain and prevent the spread of fire. Each wall type serves a specific role in a building's design and stability.

There are differences between the types of walls used in building construction, among them are included in the table below.

**Table 5.18.2:** Differences between the types of walls used in building construction

| Type of Wall | Load-Bearing | Function | Material | Location | Structural Role |
|---|---|---|---|---|---|
| **Load-Bearing Walls** | Yes | Supports structural loads | Masonry, concrete, or steel | Exterior & interior | Essential for stability and support |
| **Non-Load-Bearing Walls** | No | Divides spaces without supporting loads | Drywall, wood, or lightweight materials | Primarily interior | Does not contribute to structural integrity |
| **Exterior Walls** | Often | Protects from weather and elements | Brick, concrete, or siding | Outermost layer | Provides enclosure and insulation |
| **Interior Walls** | Typically, no | Separates interior spaces | Drywall, plaster, or wood | Inside the building | Defines room layout |
| **Partition Walls** | No | Flexible space division | Drywall or lightweight materials | Interior | Can be moved or altered |
| **Retaining Walls** | Yes | Holds back soil | Reinforced concrete or masonry | Foundation | Prevents soil erosion or movement |
| **Curtain Walls** | No | Non-structural facade | Glass or lightweight panels | Exterior | Aesthetic and weather protection |
| **Firewalls** | Yes | Contains fire | Fire-resistant materials (concrete, masonry) | Divides sections | Provides fire resistance |

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|---|---|---|---|---|---|
| **Shear Walls** | Yes | Provides lateral stability | Reinforced concrete or masonry | Vertical locations | Resists lateral forces (wind, earthquakes) |
| **Soundproof Walls** | Typically, no | Minimises sound transmission | Special acoustic materials | Interior | Enhances privacy and acoustic comfort |

## The Functions of the Various Walls

The functions of walls in building construction include providing structural support, dividing spaces for privacy and organisation, protecting the interior from external elements, and ensuring safety. Some walls offer insulation, moisture control, and soundproofing, while others prevent soil movement or resist lateral forces like wind and earthquakes. Additionally, some walls are designed to contain and limit the spread of fire, contributing to the overall safety and stability of the building. Each wall type plays a crucial role in the building's design, functionality, and protection.

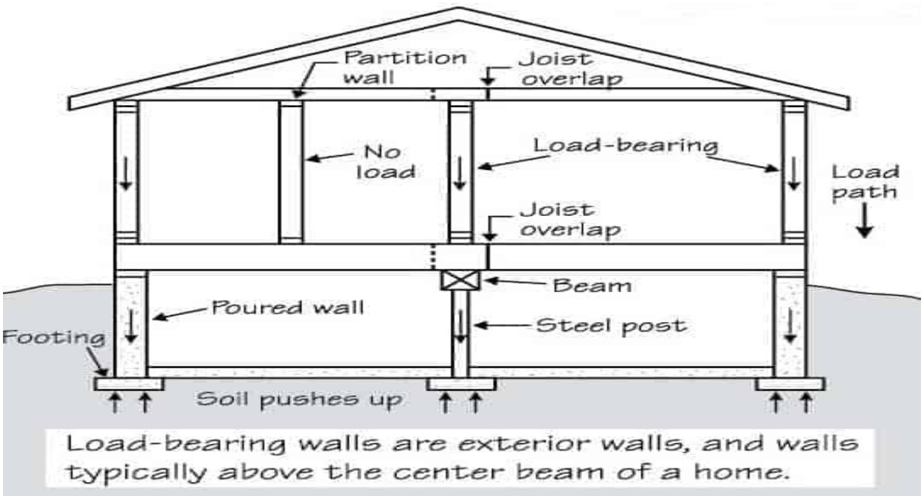


**Figure 5.18.4:** Functions of walls

The table below lists the functions of various walls

**Table 5.18.3:** Functions of various walls

| Type of Wall | Functions |
|---|---|
| **Load-Bearing Walls** | • Support and transfer loads from floors and roofs to the foundation.<br>• Provide structural stability and integrity to the building. |
| **Non-Load-Bearing Walls** | • Divide spaces into rooms or areas.<br>• Allow for flexibility in interior layouts without affecting structural integrity. |
| **Exterior Walls** | • Protect the interior from weather elements (rain, wind, snow).<br>• Provide insulation for temperature control.<br>• Enhance the building's aesthetic appeal. |

| | |
|---|---|
| **Interior Walls** | • Separate different functional spaces within the building.<br>• Provide privacy and acoustic separation between rooms. |
| **Partition Walls** | • Create flexible divisions in space that can be easily modified or removed.<br>• Help in configuring spaces for different uses. |
| **Retaining Walls** | • Hold back soil or prevent erosion.<br>• Stabilise slopes and prevent ground movement, especially in hilly areas. |
| **Curtain Walls** | • Provide a non-structural facade that allows natural light while protecting from the elements.<br>• Enhance the aesthetic appeal of the building. |
| **Firewalls** | • Contain and limit the spread of fire between different sections of a building.<br>• Provide additional time for occupants to evacuate safely. |
| **Shear Walls** | • Resist lateral forces from wind and seismic activity.<br>• Provide vertical stability and strength to tall buildings. |
| **Soundproof Walls** | • Minimise sound transmission between spaces.<br>• Enhance acoustic comfort in residential and commercial buildings. |

The following are all group-based activities. Organise yourselves into groups of no more than five and complete the following.

## Activity 5.18.1

Assume the role of an architect designing a school. In your group, identify and explain what walls are, and their purposes, and choose the right types, like solid or partition walls, for different parts of the building. You will discuss in your team your ideas and agree on the best type.

## Activity 5.18.2

Consider yourself a member of a construction team designing an office building. In your group, discuss the differences between types of walls. In your discussion decide which walls are best for different parts of the building and share your findings with the rest of the class.

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## Activity 5.18.3

Imagine you are an engineer designing a hospital. In your group, discuss the functions of walls, such as support, dividing spaces, or weather protection. Share your group ideas with the rest of the class on how to ensure the building is safe and functional.

# WOODWORK TECHNOLOGY

## Materials and Artefact Production in Woodwork Industry in Ghana

## Introduction

Adhesives are bonding agents used to glue wood surfaces together. They are essential for ensuring the strength, durability, and quality of wooden products. Adhesives can be classified by their composition, curing methods, and application techniques. Modern advancements in adhesives have improved woodworking, enabling greater creativity and innovation.

### KEY IDEAS

- Adhesives can be defined as a substance used to bond materials together.
- Adhesives provide strength, improve appearance, and enhance flexibility in joining materials.
- Contact adhesive bonds large surfaces like plywood or veneers.
- Epoxy creates strong, durable bonds for outdoor or heavy-duty projects.
- Hot glue is used for temporary fixes or lightweight materials.
- PVA glue is suitable for wood, paper, and porous materials.
- Wood glue is used to securely join pieces of wood.

## TYPES OF ADHESIVES

The adhesive is a substance used to bond two or more surfaces together in woodworking, they ensure strong and durable connections between pieces.

Different types of adhesives serve various purposes:

1. **Protein Adhesives/Natural Adhesives**: These adhesives are derived from natural proteins found in animals or plants. Two common types used in woodwork are animal glue and casein glue.

**Table 5.19.1:** Various types of natural adhesives.

| Type of Adhesive | Description | Preparation | Uses |
|---|---|---|---|
| **Animal glue** | Animal glue is a versatile adhesive that is derived from animal protein. It is commonly available in pearl or cake form. It needs to be heated to work and requires a special glue pot. | It needs to be heated to be effective. The glue is soaked in water overnight, then heated in a special glue pot and stirred until it reaches the right consistency for use.  | Animal glue is mainly used for indoor projects. However, it is not suitable for outdoor items because it has low resistance to moisture. |
| **Casein glue** | Casein glue is made from a protein found in milk. It is sold in powder form and must be mixed with water to create the adhesive. | To prepare casein glue, the powder is mixed with water to form a paste-like consistency. | Casein glue is more resistant to moisture than animal glue, making it suitable for both indoor and outdoor woodworking projects. It can be used for furniture or other items exposed to damp conditions. |

2. **Synthetic resin adhesives** are widely used in woodworking due to their strong bonding properties. Here are some common types:

**Table 5.19.2:** Types of synthetic resin adhesives.

| Type of Adhesives | Description | Preparation and uses |
|---|---|---|
| **Polyvinyl Acetate (PVA)/White Glue** | PVA glue is a white liquid that is ready to use. It is a versatile adhesive suitable for many types of wood projects. | It works well for general wood bonding, but it is not ideal for outdoor projects as it has low resistance to moisture. |
| **Contact Glue/ Impact adhesive** | This adhesive is commonly used for attaching materials like plastic laminates, veneers, and other surfaces to wood. It is applied to both surfaces to be joined. | After applying the glue, you must wait 10-15 minutes for it to become tacky. Once ready, the two parts are carefully pressed together. The glue sticks instantly, so careful alignment is important as movement is difficult once the surfaces are joined. |
| **Epoxy Resin** | Epoxy resin is a two-part adhesive, usually used for bonding metal to wood. It consists of a resin and a hardener. | The two parts are mixed in equal amounts, then applied to both surfaces. After joining the parts, they should be left for 24 hours to fully set. The curing process can be sped up by applying moderate heat. |

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| **Urea Formaldehyde Resin** | This adhesive comes in three forms, all of which are applied cold. It has high moisture resistance, making it suitable for outdoor woodwork.<br><br>**Types include**:<br>**a.** The first type is a syrupy resin mixed with a powder or liquid hardener. It has a shelf life of 3-6 months.<br>**b.** The second type is a white powder resin mixed with a hardener, with a shelf life of 1-2 years.<br>c. The third type consists of a pre-mixed powder resin and hardener, which also lasts 1-2 years. | When using powdered resins, they must be mixed with water, following the manufacturer's instructions carefully for the correct ratio of resin to hardener. |

When using adhesive resins, there are two main ways to apply the glue to ensure a strong bond:

1. The resin and hardener can be mixed as one liquid and spread on both parts of the work. After applying the glue, the parts are assembled and clamped before the glue begins to set or gel.
2. The resin is applied to one part of the work, and the hardener is applied to the other part. The parts are then assembled and clamped while both parts are still moist with the glue.

## Factors to Consider in Selecting an Adhesive

When choosing the right adhesive for your project, there are several important factors to consider.

1. **Resistance to dampness:** If the finished object will be used or kept outside, you need an adhesive that resists moisture. For indoor use, a less expensive adhesive with lower resistance to dampness can be sufficient.
2. **Setting time:** Different adhesives have different setting times. If you need extra time to assemble and clamp the pieces, choose an adhesive with a longer setting time.
3. **Application of pressure:** Some adhesives require pressure to be applied until they cure, while others do not. It's important to know whether the adhesive needs pressure and how this will affect your work.

**Note:** *Some 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

Here are some important terms related to adhesives that you should know:

1. **Shelf Life**: This is the amount of time an adhesive can be stored before it becomes unsuitable for use. It refers to the period between when the adhesive is made and when it is mixed for use.
2. **Pot Life**: The time an adhesive remains usable after it has been mixed. It indicates how long you can work with the adhesive after preparation.
3. **Assembly Time**: This is the time allowed between applying the adhesive and joining the parts of the work together.
4. **Setting Time**: The amount of time needed for the glued work to reach its maximum strength after clamping.
5. **Open Assembly**: The period between applying the adhesive and assembling the parts of the job.
6. **Closed Assembly**: This is the time during which adjustments can be made, such as squaring and aligning the parts, before the final tightening of the clamps.
7. **Clamping Time**: The time the glued work should remain in the clamps before they can be safely removed.
8. **Curing or Setting Time**: This is the time it takes for the glue to fully harden and reach its maximum strength after being applied to the workpiece.

All of the following activities are group-based. Organise yourselves into groups of five and complete the following.

### Activity 5.19.1

#### Identifying the Types of Adhesives in Woodworking

**Scenario:**

You are a woodworking expert tasked with selecting the right adhesives for different projects in the workshop. Identify which adhesives are best for bonding wood surfaces based on their properties. You will work in teams to discuss and test different adhesives and then share your findings with the class.

**Materials Needed:**

- Video demonstration equipment (projector or screen) or physical samples showcasing different woodwork joints.
- Notebooks and pens for brainstorming.
- Samples of adhesives (e.g., PVA, Epoxy, Animal Glue, Contact Glue).

- Chalkboard/whiteboard or interactive display for group feedback.
- Markers and pens
- Handouts with a list of adhesive types and their uses.

### Activity Guidelines:

1. The whole class will watch a video demonstration showing the different types of adhesives used in woodworking.
2. After watching the video, each group will be provided with a set of adhesive samples. In your groups, identify the adhesive type and discuss the following:
   a. What is the purpose of each adhesive?
   b. Which adhesive would be best for outdoor projects? Why?
   c. What are the advantages and disadvantages of each adhesive type?
3. Present your findings to the class for feedback and discussion.

## Activity 5.19.2

### Discussing Factors for Choosing an Adhesive

**Scenario:**

As a woodworking expert, your task is to select the appropriate adhesive for various woodworking projects. In groups, you will discuss key factors that influence adhesive selection, such as strength, drying time, and environmental conditions.

**Materials Needed:**

- Video demonstration equipment (projector or screen)
- Notebooks and pens for brainstorming.
- Whiteboard, markers, and sticky notes for group feedback and brainstorming.
- Tablets/computers for research

### Activity Guidelines:

1. The whole class will watch a video demonstration showing factors for Choosing an Adhesive.
2. In your groups, discuss the factors that affect adhesive choice for different woodwork projects:
   a. What types of adhesives are suitable for outdoor versus indoor projects?
   b. How does the time needed to set or cure affect your project?
   c. Which adhesives require pressure and which do not?

3. Share your findings with the class, summarising the most important factors to consider when choosing an adhesive.

## Activity 5.19.3

### Demonstrating Effective Adhesive Application in Woodworking

**Scenario:**

As a woodworking technician, you are responsible for applying adhesives correctly to ensure strong bonds. In this activity, in your groups, you will practice applying adhesives effectively.

**Materials Needed:**

- Samples of different adhesives (e.g., PVA, Epoxy, Contact Glue).
- Wooden sample pieces for testing.
- Brushes, spatulas, or glue spreaders for application.
- Clamps for holding the pieces together during bonding.
- Measuring cups or spoons (for mixing adhesive, if needed).
- Gloves (for safety while handling adhesives).

Activity Guidelines:

1. Each group will discuss the factors that affect adhesive choice for different woodwork projects.
2. Each group will be given a set of adhesives and wooden pieces.
3. In your groups, apply adhesive to wooden pieces following the guidance you have been provided with.
4. After applying the adhesive, clamp the pieces and observe the setting process.
5. Share your experience with the class.

## Conclusion

Adhesives are key in woodworking, each with specific uses. PVA is for indoor work, epoxy bonds wood to metal, and contact glue suits veneers. Animal glue is for indoor furniture, casein resists dampness for outdoor use, and urea-formaldehyde is strong and moisture-resistant. Choosing the right adhesive ensures reliable bonds.

# UNIT 20

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

Doors and windows are important parts of buildings. A door is a movable barrier fixed in a door frame, providing access, security, and privacy. A window is an opening in a wall or roof that allows light and air to enter, supported by a frame that also improves appearance and energy efficiency. You will study different types of doors, like sliding, panel, and flush doors, and windows, such as casement, sliding, and double-hung windows. These are made from materials like wood, aluminium, and fibreglass.

**KEY IDEAS**

- Correct alignment and fitting ensure durability and functionality.
- Doors and windows are moveable openings in buildings used for entry, exit, ventilation, and light.
- Doors provide security, privacy, access and egress.
- Regular cleaning and repairs prevent wear and tear.
- Windows allow natural light, and air circulation, and provide views.

## DOORS AND WINDOWS

### The Concept of Doors and Windows in A Building Construction

In building construction, doors and windows are essential architectural elements that serve both functional and aesthetic purposes; Doors are movable barriers that provide access to and from spaces within a building. Windows are openings in walls that are typically filled with glass to allow light and air into a building while providing a view of the outside. Both doors and windows are crucial in building design, balancing functionality, security, aesthetics, and energy efficiency. They enhance the living experience by allowing natural light, facilitating ventilation, and providing access and views, all while contributing to the overall architectural expression of a building.

# Roles of Doors and Windows in A Building Construction

Doors and windows play essential roles in building construction. Doors provide access and exit, ensuring security and privacy for occupants while enhancing the building's aesthetic appeal. Windows allow natural light and ventilation into the building, improving comfort and reducing energy costs. They also offer views of the surroundings, contributing to the overall design and appearance of the structure. Together, doors and windows improve functionality, comfort, and the visual appeal of buildings.

The roles of doors and windows in building construction are included in the table below:

**Table 5.20.1a:** Roles of doors in a building construction

| Element | Roles | Description |
|---|---|---|
| **Doors** | Access Control | Provide entry and exit points for occupants. |
| | Security | Offer protection against unauthorised access. |
| | Privacy | Allow for separation between different spaces. |
| | Thermal Insulation | Help maintain indoor temperature by reducing heat loss. |
| | Acoustic Insulation | Minimise noise transmission between rooms. |
| | Aesthetic Appeal | Contribute to the overall design of the building. |
| | Safety | Can be designed as fire doors to enhance safety. |
| | Ventilation | Some doors facilitate airflow when opened. |

**Table 5.20.1b:** Roles of windows in a building construction

| Element | Roles | Description |
|---|---|---|
| **Windows** | Natural Light | Allow daylight to enter spaces, reducing reliance on artificial lighting. |
| | Ventilation | Can be opened to improve air circulation. |
| | Views | Provide visual connection to the outside environment. |
| | Thermal Performance | Designed to minimise heat loss or gain, enhancing energy efficiency. |
| | Aesthetic Value | Enhance the architectural character of a building. |
| | Safety | Can be designed to prevent break-ins and enhance occupant safety. |

# The Various Types of Doors and Windows Used in Building Construction

There are various types of doors and windows used in building construction, each serving different purposes. Types of doors include hinged doors, which open outward or inward on hinges; sliding doors, which move horizontally; pocket doors, which slide into a wall cavity; rolling shutter doors, commonly used for security; panel doors, made from wooden panels for aesthetic appeal; flush doors, with a smooth surface; and ledged and braced doors, reinforced for strength and stability. For windows, common types include casement windows, which open outward like a door; sliding windows, which slide horizontally; single-hung and double-hung windows, which have movable sashes that slide vertically; louvred windows, with slats that allow ventilation; and fixed windows, which do not open but provide light and views. These different types of doors and windows contribute to the functionality, security, and aesthetic value of buildings.

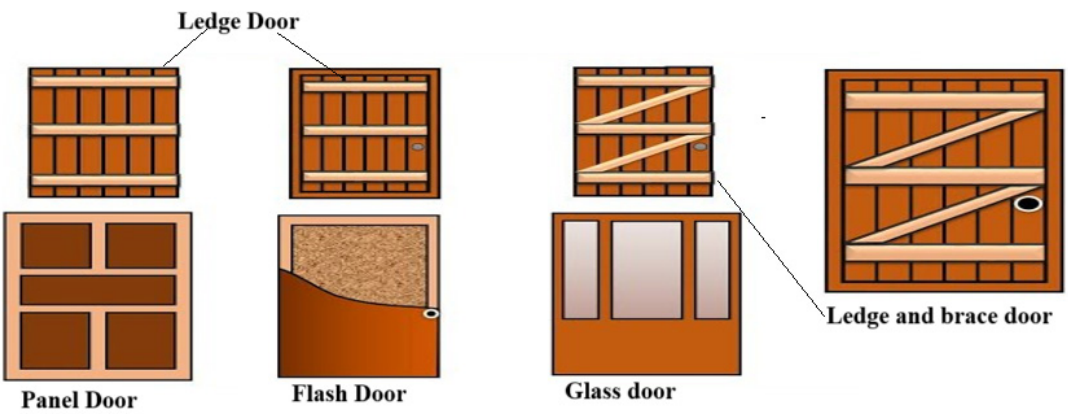


**Figure 5.20.1:** Types of Doors

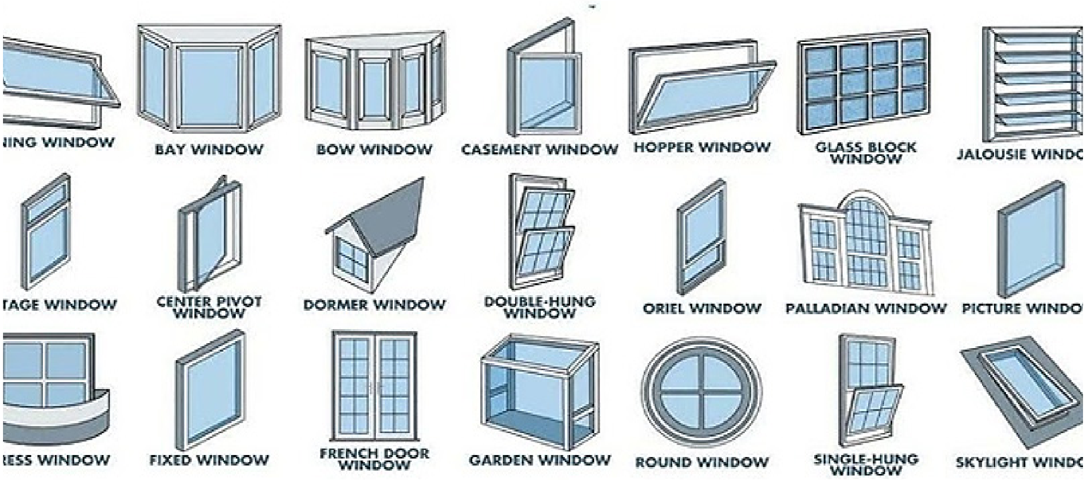


**Figure 5.20.2:** Types of windows


**Figure 5.20.3:** Types of windows with plan

There are various types of doors and windows in building construction, among them are included in the table below:

**Table 5.20.2a:** Types of doors in building construction

| Type | Sub-Type | Description |
|---|---|---|
| **Doors** | **Hinged Doors** | Attached to a frame by hinges, allowing them to swing open or closed |
| | **Single Swing Doors** | Open in one direction; common in residential and commercial settings. |
| | **Double Swing Doors** | Open in both directions; often used in restaurants and shops. |
| | **Sliding Doors** | Open horizontally by gliding along a track, typically used to save space and provide wide access |
| | **Pocket Doors** | Slide into the wall, saving space. |
| | **Bypass Doors** | Slide on a track and overlap each other. |
| | **Folding Doors** | Made of multiple panels connected by hinges that fold together when opened. |
| | **Bi-fold Doors** | Multiple panels fold to one side, ideal for wide openings. |
| | **Accordion Doors** | Similar to bi-fold but usually lighter. |
| | **French Doors** | Double doors that open outward or inward, featuring glass panes. |
| | **Patio Doors** | Designed for access to outdoor spaces; can be sliding or hinged. |

| | | |
|---|---|---|
| | **Storm Doors** | Installed outside of an exterior door for added weather protection. |
| | **Security Doors** | Reinforced doors to prevent break-ins, are often used in commercial buildings. |
| | **Fire Doors** | Fire-resistant doors to prevent the spread of fire and smoke. |

**Table 5.20.2b:** Types of windows in building construction

| Type of Windows | | Description |
|---|---|---|
| | **Fixed Windows** | Non-operable windows that provide views and light. |
| | **Single-Hung Windows** | The bottom sash opens; the top remains fixed. |
| | **Double-Hung Windows** | Both sashes can open for ventilation. |
| | **Sliding Windows** | One or more sashes slide horizontally. |
| | **Casement Windows** | Hinged on the side; open outward for maximum ventilation. |
| | **Awning Windows** | Hinged at the top; open outward to allow ventilation while keeping rain out. |
| | **Hopper Windows** | Hinged at the bottom; open inward, often used in basements. |
| | **Bay and Bow Windows** | Project outward from the building, creating a nook or alcove. |
| | **Skylights** | Windows installed in the roof to bring natural light into the space below. |
| | **Transom Windows** | Small windows above doors or larger windows for additional light. |
| | **Architectural Windows** | Custom-designed windows that enhance aesthetic appeal. |

## The Functions of Various Types of Doors and Windows in Building Construction

Doors and windows are essential elements in building construction, serving both functional and aesthetic purposes. They play a key role in providing access, security, ventilation, and natural light while also contributing to the overall design of a building. The choice of door and window types can affect the space's usability, energy efficiency, and appearance. Understanding the different functions of doors and windows is important for creating comfortable, secure, and well-designed living or working environments. These doors and windows improve a building's functionality, security and ventilation.

There are functions of various types of doors and windows in building construction, among them are included in the table below.

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**Table 5.20.3a:** Functions of various types of doors in building construction

| Type | Sub-Type | Function |
|---|---|---|
| **Doors** | **Hinged Doors** | Provide access and security; can be decorative or functional. |
| | **Single Swing Doors** | Commonly used for entryways; easy operation. |
| | **Double Swing Doors** | Facilitate high traffic flow; ideal for commercial spaces. |
| | **Sliding Doors** | Save space; provide seamless access to outdoor areas. |
| | **Pocket Doors** | Concealed when open; maximize floor space. |
| | **Bypass Doors** | Efficient use of space; allow for wider openings. |
| | **Folding Doors** | Create large openings; ideal for connecting indoor and outdoor spaces. |
| | **Bi-fold Doors** | Expand usable space; enhance natural light. |
| | **Accordion Doors** | Flexible space management; is often used in partitioning. |
| | **French Doors** | Add elegance; allow natural light and ventilation. |
| | **Patio Doors** | Provide access to patios or decks; enhance outdoor living. |
| | **Storm Doors** | Protect against weather; improve energy efficiency. |
| | **Security Doors** | Enhance safety; deter break-ins with reinforced construction. |
| | **Fire Doors** | Contain smoke and flames; provide safe egress during emergencies. |

**Table 5.20.3a:** Functions of various types of windows in building construction

| Type | Sub-type | Function |
|---|---|---|
| **Windows** | **Fixed Windows** | Allow natural light; provide views without ventilation. |
| | **Operable Windows** | Enable ventilation; improve indoor air quality. |
| | **Single-Hung Windows** | Cost-effective; easy to operate; common in residential settings. |
| | **Double-Hung Windows** | Versatile ventilation options; easy to clean. |
| | **Sliding Windows** | Space-efficient; easy to operate. |
| | **Casement Windows** | Maximises airflow; easy to clean; ideal for hard-to-reach areas. |
| | **Awning Windows** | Protect against rain while allowing ventilation; good for wet climates. |
| | **Hopper Windows** | Suitable for basements; allows for ventilation without compromising security. |

| | | |
|---|---|---|
| | **Bay and Bow Windows** | Enhance aesthetics; provide additional space and light. |
| | **Skylights** | Bring natural light into interior spaces; improve energy efficiency. |
| | **Transom Windows** | Enhance light and air circulation; often used for decorative purposes. |
| | **Architectural Windows** | Customised designs to improve aesthetics and functionality. |

## The Advantages and Disadvantages of Doors and Windows in Building Construction

Doors and windows offer many benefits, such as providing access, security, privacy, natural light, and ventilation, which improve comfort and energy efficiency. They also enhance the aesthetic appeal of a building. However, they can have drawbacks, such as wear and tear, security risks, and higher energy costs due to heat loss or gain. Poor installation or weather damage can also cause issues, especially with wooden doors and windows. Despite these challenges, proper maintenance and installation help minimise problems, making doors and windows crucial for building functionality and design.

**Table 5.20.4a:** Advantages and disadvantages of doors in building construction

| Type | Advantages | Disadvantages |
|---|---|---|
| | **Doors** | |
| **Hinged Doors** | Easy to install and operate; versatile designs available. | Space-consuming when opened; can be less secure if poorly installed. |
| **Single Swing Doors** | Simple operation; common and affordable. | Limited access space; can block pathways when open. |
| **Double Swing Doors** | Allow for wider openings; suitable for high-traffic areas. | Requires more space for operation; can be more complex to install. |
| **Sliding Doors** | Space-saving; seamless transition between indoor and outdoor spaces. | Can be less secure; tracks may require maintenance. |
| **Pocket Doors** | Concealed when open, maximising space; modern look. | Installation can be complex; and requires wall space. |
| **Bypass Doors** | Efficient space use; suitable for closets or sliding partitions. | Limited access when closed; may need frequent maintenance. |
| **Folding Doors** | Create large openings; and flexible space usage. | Can be more expensive; may require more maintenance. |
| **Bi-fold Doors** | Enhance natural light and views; expand living space. | Installation can be complex; may require significant space. |

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|---|---|---|
| **Accordion Doors** | Good for dividing spaces; flexible use. | Less durable; may not provide the same insulation as solid doors. |
| **French Doors** | Aesthetic appeal; allow for light and airflow. | Can be less secure; may require more space to swing open. |
| **Patio Doors** | Improve access to outdoor living areas; enhance views. | Can be difficult to operate; and potential security risks. |
| **Storm Doors** | Provide weather protection; enhance energy efficiency. | Can block some light; installation may be tricky. |
| **Security Doors** | Enhanced safety and security; durable materials. | Can be expensive; and may require professional installation. |
| **Fire Doors** | Essential for safety; prevent the spread of fire and smoke. | Heavy and may require special hardware; can be costly. |

**Table 5.20.4b:** Advantages and disadvantages of windows in building construction

| Type | Advantages | Disadvantages |
|---|---|---|
| **Windows** | | |
| **Fixed Windows** | Provide unobstructed views; enhance natural light. | No ventilation; harder to clean. |
| **Operable Windows** | Allow for ventilation; improve indoor air quality. | May require more maintenance; and can be less energy efficient. |
| **Single-Hung Windows** | Affordable; easy to operate; commonly available. | Limited ventilation options; harder to clean exterior. |
| **Double-Hung Windows** | Versatile; easy to clean; provide better airflow. | More complex design; can be more expensive. |
| **Sliding Windows** | Space-efficient; easy to operate; modern aesthetics. | Tracks may require maintenance; can be less secure. |
| **Casement Windows** | Excellent ventilation; easy to clean; good for tight spaces. | Can be less secure; may not fit all architectural styles. |
| **Awning Windows** | Protect against rain while allowing airflow; energy-efficient. | Limited ventilation when closed; can be difficult to clean. |
| **Hopper Windows** | Secure; good for basements; allow for ventilation. | Limited size options; may require special installation. |
| **Bay and Bow Windows** | Add character and light; create additional space. | More expensive; may require structural modifications. |
| **Skylights** | Bring natural light into dark spaces; improve aesthetics. | Can lead to heat loss/gain; potential leaks if not installed properly. |
| **Transom Windows** | Enhance light and airflow; decorative appeal. | Limited function; may require special installation. |
| **Architectural Windows** | Custom designs enhance aesthetics and functionality. | Can be very costly; and may require longer lead times for installation. |

All of the following activities are group-based. Organise yourselves into groups of five and complete the following.

### Activity 5.20.1

- Imagine you are a building consultant choosing different doors and windows for a commercial building. In your groups discuss, agree and explain the various doors and windows that fit the building's needs for security, privacy, energy, and design.
- Present your group's findings to the rest of the class for feedback and further discussion.

### Activity 5.20.2

- Consider yourself a building constructor selecting the appropriate windows and doors for various rooms in a new structure. In your group discuss and outline the types of doors and windows based on security, ventilation, appearance, and functionality.
- Present your group's findings to the rest of the class for feedback and further discussion.

### Activity 5.20.3

- Imagine you are a building manager choosing the right doors and windows for a new project. In your group discuss, agree and record the function, advantages and disadvantages of doors and windows, to make the best decisions for the building.
- Present your group's findings to the rest of the class for feedback and further discussion.

## EXTENDED READING


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# Review Questions

## QUESTIONS 5.1

1. In a woodworking project, you are asked to identify different joints used in constructing a variety of artefacts, and identify the types of joints used in the construction of artefacts.
2. You are building a wooden cabinet and need to choose the right joints to ensure it looks good. Discuss the purpose of joints in the construction of artefacts.
3. You are tasked with building a bedside cabinet that requires strong and precise connections. To ensure the best results, sketch examples of types of joints to decide which is most suitable for each part of the stand. Specifically, you must focus on creating sketches for Angle joints, framing joints, and Widening and Lengthening joints.
4. Why is it important to select the right joint for a woodwork project?
5. What factors should be considered when choosing a joint?
6. How does the choice of a joint affect the final product?

## Questions 5.2

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

## Questions 5.3

1. Imagine you are building a wooden table, identify at least two types of adhesives commonly used to bond surfaces together in woodwork.
2. You are constructing a wooden chair for a customer, explain at least three factors to consider when choosing an adhesive for the construction of an artefact.
3. You are working on a wood project and need to apply adhesive. Demonstrate how would you apply the adhesive for effective adhesion.
4. What is PVA adhesive used for?
5. When should you use epoxy resin?
6. Why is casein glue good for outdoor projects?

## Questions 5.4

1. Explain the doors and windows that are used in buildings.
2. Outline the various types of doors and windows used in buildings.
3. Outline the various materials used in the production of doors and windows.
4. Discuss the function of doors and windows as used in buildings.
5. Discuss the advantages and disadvantages of doors and windows

SECTION

6

# FASTENERS, FITTINGS, FINISHES AND ROOF, CEILING CONSTRUCTION

# UNIT 21

# WOODWORK TECHNOLOGY

## Materials and Artefact Production in the Woodwork Industry in Ghana

## Introduction

Fasteners and fittings are essential in the construction and assembly of wooden structures and furniture. They provide strength, stability, and functionality, ensuring that wood pieces are securely joined and can withstand pressure and weight. Understanding the different types of fasteners and fittings and knowing when to use them is important for anyone working in woodwork, whether as a hobbyist or a professional carpenter. This knowledge is crucial for creating durable and reliable woodworking projects.

### KEY IDEAS

- Fasteners and fittings are metal hardware used to join or assemble wood pieces in woodwork projects.
- They are used when wood alone cannot perform certain functions, such as securing or closing parts of an artefact.
- Steel is an affordable material but is prone to rust, while brass is more expensive but resists corrosion.
- Choose the right fastener or fitting based on the artefact's function, durability needs, and environment.
- Properly install fasteners and fittings to ensure the artefact is strong and functional.

## FASTENERS AND FITTINGS

Fasteners and fittings are hardware used to join or assemble wood pieces in woodwork projects. They are essential when wood alone cannot perform specific functions, such as securing or closing parts of a structure. These hardware pieces are typically made of metal, with steel being a more cost-effective option but prone to rust, while brass is more expensive but resistant to corrosion. By using the appropriate fasteners and fittings, woodwork artefacts can be made stronger, more stable, and functional. Common types of fasteners and fittings used in woodwork include:

1. **Nails**

   Nails are one of the most commonly used fasteners in woodwork. They come in a wide range of types, sizes, and finishes, making them versatile for various applications. Choosing the right type of nail is essential to ensure the durability and effectiveness of a project.

**Table 6.21.1:** Types of nails, features and uses

| Types of nails with image | Features | Uses |
|---|---|---|
| **Common Nail (Wire Nail/ Framing Nail)**  | A common nail (wire nail/framing nail) has a large, flat head and a thick, strong shank for securing heavy-duty woodwork-like framing. It comes in various sizes and is durable for general construction use. | A common nail (wire nail/ framing nail) is used for general construction and framing work. It is ideal for securing large wooden structures, such as beams, studs, and other heavy-duty applications where the appearance of the nail head is not important. |
| **Finishing Nail (Lost Head Nail)**  | A finishing nail (lost headnail) has a small head that sits below the surface, allowing for a smooth finish. Its slim shank reduces wood splitting, making it ideal for fine work. | A finishing nail (lost headnail) is used for fine woodworking tasks where a clean, smooth finish is needed. It is ideal for attaching mouldings, trim, and panelling, as well as other decorative woodwork where the nail head should not be visible. |
| **Oval Wire Nail**  | An oval wire nail has an oval-shaped cross-section and a small head that sits below the surface. Its smooth shank reduces splitting, making it ideal for fine work like moulding and trim. | An oval wire nail is used for fine woodworking tasks, such as attaching moulding, trim, and delicate woodwork, where a discreet and stronghold is needed without visible nail heads. |
| **Panel Pin**  | A panel pin is a small, thin nail with a tiny head that sits below the surface. Its smooth shank prevents splitting, making it ideal for attaching lightweight items like mouldings or thin panels. | A panel pin is used for light tasks such as attaching mouldings, trims, and thin panels. It is ideal for delicate work where a small, discreet nail is needed. |
| **Tack Nail**  | A tack nail has a large flat head for gripping fabric securely, a small, thin shaft, and a short length. | A tack nail is used for securing fabrics in upholstery, attaching carpets to floors, and holding lightweight materials in place. Its large head prevents tearing and ensures a secure grip. |



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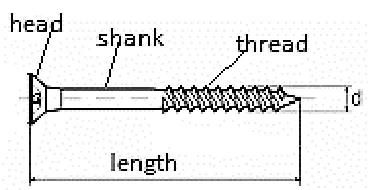
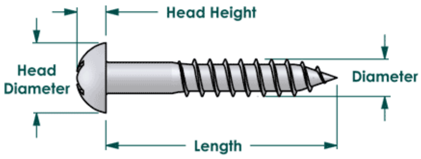
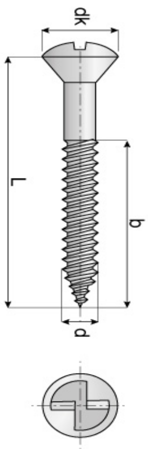
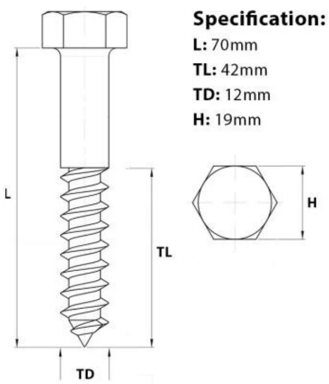
|---|---|---|
| **Clout Nail**  | A clout nail has a large, flat head for a strong grip and a short shaft. | A clout nail is used for securing roofing felt, webbing in upholstery, and other soft materials. Its large head prevents tearing and ensures a strong hold. |
| **Cut Floor Brad**  | A cut floor brad has a wedge-shaped, heavy-duty shank and a blunt end that prevents wood splitting. | A cut floor brad is used for securing floorboards and other tough materials. Its design helps prevent wood splitting while providing a strong grip for flooring applications. |
| **Roofing Nail**  | A roofing nail has a large, flat head, a barbed shank for a secure grip, and a short length. | A roofing nail is used to secure roofing materials, such as shingles, roofing felt, and other coverings, to the roof structure. Its large head and barbed shank provide a strong, secure hold. |

## 2. Screws

Screws are used in woodworking when a strong but removable joint is needed. They provide better holding power than nails and can be easily removed. Screws have a tapered body with a sharp, twisted thread that screws into the wood fibres. They are made from materials like mild steel or brass and can be coated for protection or decoration, such as black japanned or galvanised finishes. Screws come in different head shapes and types, and their size is determined by the diameter of the shank (gauge) and their length, measured from the head to the tip of the thread. Common gauge numbers include 4, 6, 8, and 10, and these remain the same regardless of the screw's length.

**Table 6.21.2:** Types of screws, features and uses

| Types of screws with their names | Features | Uses |
|---|---|---|
| **Countersunk head screw**   | A Countersunk head screw has a flat, conical head that sits flush with the surface. It requires a pre-drilled countersunk hole and is available in sizes from 6.5mm to 150mm. This screw is used for a smooth, level finish. | A Countersunk head screw is used when a flush, smooth surface is needed. It is ideal for applications like fastening materials where the screw head should be hidden, such as in cabinetry, furniture, or when attaching trim or mouldings. |

| | | |
|---|---|---|
| **Roundhead screw**   | A Roundhead screw is used for fixing fittings like metal strips or plastic to wood. It does not require countersinking, so it won't weaken the material, but it does not provide a flush finish. Roundhead screws are often coated with black japanned for protection when used outdoors. They are commonly available in sizes ranging from 6.5mm to 87mm. | A Roundhead screw is used for attaching fittings like metal strips, plastic, or hardware to wood. It is ideal when a flush finish is not required and is commonly used in outdoor applications due to its protective black japanned coating. |
| **Raised head screw**   | A Raised head screw is a decorative screw that provides a round head finish while offering the holding power of a countersunk screw. It is commonly used for attaching door handles, cupboard catches, and letter plates. Raised head screws are often coated with materials like chromium or nickel to match the fittings. They are typically available in sizes ranging from 8mm to 50mm. | A Raised head screw is used for decorative purposes, such as attaching door handles, cupboard catches, and letter plates. It provides a rounded head finish while offering secure holding and is often coated to match the appearance of the fittings. |
| **Coach screw**   | A Coach screw is the largest type of screw and requires a spanner to turn. It is designed for heavy-duty construction and framing applications. Coach screws are available in sizes ranging from 25mm to 406mm. These screws provide strong holding power for large, sturdy projects. | A Coach screw is used for heavy-duty constructions, such as building large frames, securing beams, and joining thick timber or metal components. It provides strong and durable fastening for robust structures and is commonly used in construction, decking, and outdoor furniture. |

## Fitting Screws

Before fitting screws, a clearance hole matching the screw shank's size is drilled into the object to be fastened. If a flush finish is needed, the hole can be countersunk. Next, the pieces to be joined are positioned, and a smaller pilot hole (about half the clearance hole size) is drilled into the holding material. The screw's length should be 2½ to 3 times the thickness of the object being held for a secure fit.

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## Stages for Drilling a Countersunk Woodscrew

Drilling a countersunk woodscrew ensures a secure fit and a smooth finish. It involves creating holes to match the screw size and head, improving strength and appearance. It involves the following stages:

1. Drill a hole slightly smaller than the diameter of the screw shank.
2. In hardwood, drill a smaller pilot hole, less than the diameter of the thread core.
3. Countersink the hole to match the diameter of the screw head.
4. Choose one of the following options for finishing:

   **4a:** Counterbore the hole and insert a wooden plug.

   **4b:** Use a screw cap for a neat finish.

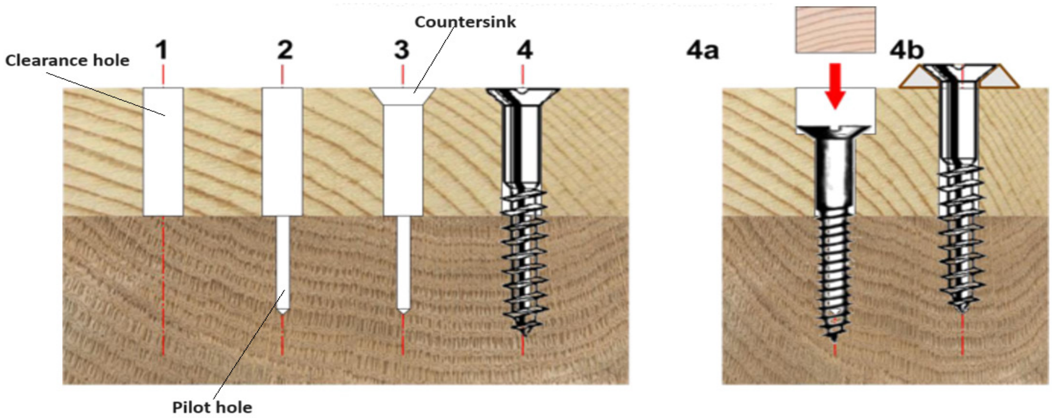



**Figure 6.21.1:** Fitting Screws with Clearance Hole, Pilot Hole, and Countersink

## Points to Remember

When screwing into the end grain of manufactured boards, the screw may not grip well. To improve this, there are two simple methods you can use.

The first method is using a ***plastic wall plug***. Instead of drilling a standard pilot hole, drill a hole for a plastic wall plug that matches the screw size. Once the plug is inserted, it expands and grips the sides of the hole, providing a better hold for the screw.

**Figure 6.21.2:** Plastic wall plug

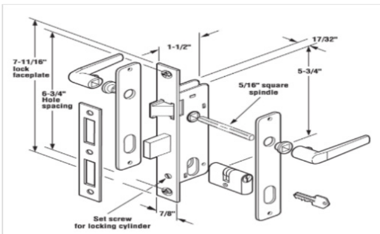
The second method is using a ***dowel.*** If the wood or board is not too wide, you can drill a hole at right angles to the direction of the screw, then glue a wooden dowel into the hole. This provides a side grain for the screw to grip.

Additionally, when using wood screws, always screw the thinner piece of wood into the thicker piece for a stronger and more secure joint.

### 3. Locks

Locks are used to secure doors, boxes, or other items, preventing access by anyone without the correct key. Many locks also include a latch, which keeps the item closed without fully locking it. Locks are commonly used for securing house doors and ensuring safety. Different types of locks are designed for specific purposes.

**Table 6.21.3:** Types of locks, features and uses

| Examples of locks with names and images | Features | Uses |
|---|---|---|
| **Mortise Lock**<br><br><br> | A mortise lock is installed by cutting a mortise (a deep recess) into the edge of a door. It is paired with a striking plate fixed to the door frame. This lock provides added security as it is completely hidden when the door is closed, making it impossible to remove from the outside. | A mortise lock is used to secure both external and internal doors in homes and offices. It is ideal for doors that require higher security due to its concealed design, making it more difficult to tamper with. This lock is commonly installed on wooden doors, providing durability and enhanced protection. |
| **Drawer lock**<br><br> | A drawer lock is designed for securing drawers and cupboards. It is fitted by creating a recess (letting-in) to accommodate the lock. This ensures a neat and secure installation, keeping the drawer or cupboard safely closed. | Drawer locks are used to secure drawers and cupboards, preventing unauthorised access. They are commonly found in desks, cabinets, and furniture to protect valuables or confidential items. |

### 4. Hinges

Hinges are hardware used in woodwork to allow movement between two parts of a structure, such as a door and its frame. They consist of two plates connected by a pin, enabling rotation. Hinges are typically made from steel or brass, with brass offering better corrosion resistance.

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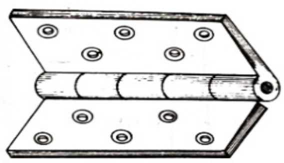
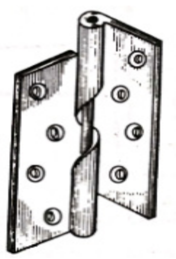
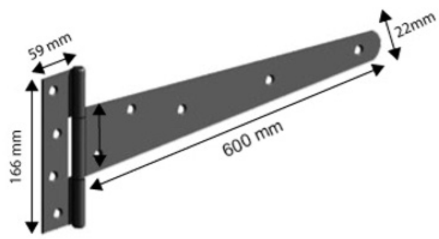
**Table 6.21.4:** Types of hinges, features and uses

| Types of hinges with their names and images | Features | Uses |
|---|---|---|
| **Butt hinge**  | A butt hinge is available in various sizes, from small hinges for models to large ones for heavy doors. It comes in brass or steel and consists of two plates (leaves) that are recessed into the edges of the two pieces being joined. | Butt hinges are used to join doors, cabinets, or windows to frames, allowing them to open and close smoothly. They are commonly used for their strength and neat appearance, making them suitable for both heavy and light applications. |
| **Rising butt hinge**  | A rising butt hinge is designed for internal doors, especially those that need to swing over raised flooring like carpets. It allows the door to rise slightly as it opens and automatically closes when released. This hinge is practical for smooth door movement and self-closing functionality. | Rising butt hinges are commonly used for doors that need to swing open over raised flooring, such as carpets or uneven surfaces. Their sloped design allows the door to close automatically when released, making them ideal for self-closing internal doors. |
| **Tee hinge**   | Tee hinges are inexpensive hinges mainly used for outdoor applications, such as gates and shed doors. They are typically finished with a black japanned or galvanized coating to protect them from weather damage. | Tee hinges are commonly used for outdoor purposes, such as hanging gates, shed doors, and barn doors. They are ideal for applications where durability and resistance to weather conditions are important. The strong, wide design of the hinge provides support for heavy doors and gates, making them suitable for these types of structures. |
| **Cabinet/Spring hinge**  | A cabinet or spring hinge is designed with a spring mechanism that automatically or manually closes the door after it is opened. This ensures the door stays closed when not in use. These hinges are commonly used on furniture like wardrobes, dressers, and cupboards to attach and function the doors. | Cabinet or spring hinges are used in furniture like wardrobes, cupboards, and dressers. They are mainly used to attach doors to the furniture and ensure that the doors close automatically or remain closed when not in use. They help keep doors securely shut without the need for additional latches or locks. |

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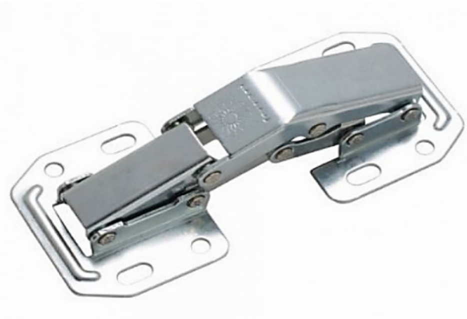
| **Hidden Spring hinge**  | Hidden Spring hinges are designed to be concealed when the door is closed, providing a clean and smooth appearance. They include a spring mechanism that helps the door close automatically after being opened, ensuring it stays shut when not in use. These hinges are commonly used in furniture like wardrobes, cupboards, and dressers to attach doors while maintaining a neat look. | Hidden Spring hinges are mainly used in furniture and cabinetry where a clean, seamless look is desired. They are commonly used in wardrobes, cupboards, dressers, and kitchen cabinets. These hinges are ideal for ensuring doors automatically close after being opened, keeping them securely shut without the need for manual latching. They are especially useful in maintaining a neat and smooth exterior, as the hinge mechanism is concealed when the door is closed. |

5. **Drawer runner**

A drawer runner, also called a drawer slide or guide, is hardware that helps drawers open and close smoothly. It allows the drawer to slide in and out of its frame easily. Drawer runners come in different designs and mechanisms to suit various types of drawers and their specific uses.

**Table 6.21.5:** Types of drawer runner, features and uses

| Types of Drawer runner with their names and images | Features | Uses |
|---|---|---|
| **Side-mounted drawer runners**   | Side-mounted drawer runners are fixed to the sides of the drawer and the inside walls of the cabinet. They are visible when the drawer is open and are known for being durable and easy to install. | Side-mounted drawer runners are used to ensure the smooth sliding of drawers in furniture like cabinets, desks, and wardrobes. They provide strong support, making them suitable for holding heavier items while allowing easy access to the drawer's contents. |

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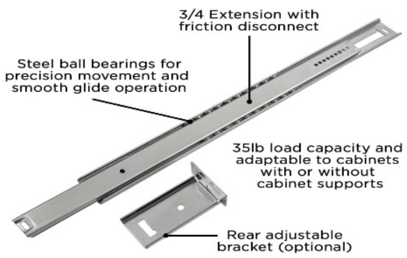
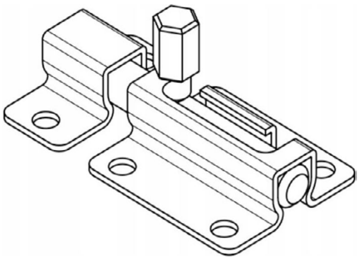
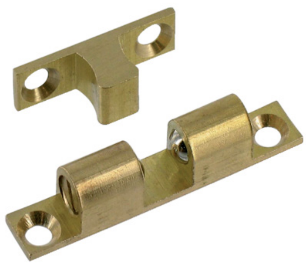
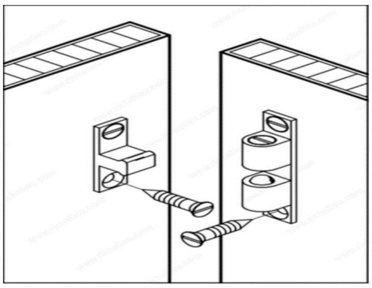
| **Centre Mounted (Undermount) Drawer Runners**<br><br><br> | Centre-mounted (undermount) drawer runners are installed beneath the drawer, making them invisible when the drawer is open. They are common in high-end furniture due to their neat appearance. Additionally, their placement reduces the build-up of dust and debris, ensuring smooth operation over time. | Centre-mounted (undermount) drawer runners are used in high-end cabinetry to provide a clean, seamless appearance since they are hidden beneath the drawer. They ensure smooth and stable movement, reduce dust and debris build-up, and are ideal for lightweight to medium-duty drawers in wardrobes, dressers, and kitchen cabinets. |
| **Roller Runners**<br><br> | Roller runners use a system of rollers to facilitate smooth drawer movement. They are easy to install, affordable, and suitable for light to medium loads. However, they are less durable compared to ball-bearing runners and may not support heavy drawers effectively. | Roller runners are used in furniture with light to medium-weight drawers, such as office desks, dressers, and cabinets. They ensure smooth opening and closing of drawers and are cost-effective for general-purpose furniture. |

## 6. Furniture and door fittings

Furniture and door fittings are important hardware used to enhance the functionality of furniture and doors. Some common fittings include barrel bolts, ball catches, magnetic catches, castors and stays. These fittings are essential in improving security, ease of use, and movement in woodwork projects. The table below gives descriptive features and their uses:

**Table 6.21.6:** Types of furniture and door fittings, features and uses

| Examples with their names and images | Features | Uses |
|---|---|---|
| **Barrel bolts**  | Barrel bolts are used to secure doors by holding them closed. They consist of round, rectangular, or square bars inside a barrel. The bolt is moved by a handle, providing extra security compared to a simple catch. Barrel bolts are often used on doors to ensure they stay in place. | Barrel bolts are used to secure doors, gates, or windows by holding them firmly in place. They provide added security by preventing unauthorised entry and are commonly used on internal and external doors, as well as on cabinets and storage units. Barrel bolts are easy to operate and can be installed both horizontally and vertically. |
| **Ball catch**   | A ball catch consists of a spring-loaded ball inside a barrel that is fixed into the door. It works with a catch plate that has a ramp, allowing the ball to smoothly slide into a hole in the plate, holding the door in place. This fitting is commonly used to keep doors closed without the need for a latch or lock. | A ball catch is commonly used to keep doors closed without the need for a traditional latch or lock. It is often found in interior doors, such as closet doors or bi-fold doors, where the door needs to stay in place but not be fully locked. The ball catch provides a secure closure while still allowing the door to be easily opened when needed. |
| **Magnetic catch**  | A magnetic catch uses a magnet to hold a door in place when it is closed. The magnet pulls the door tightly against the frame, keeping it securely shut without the need for a latch **or bolt.** | A magnetic catch is commonly used to keep doors, cabinets, or drawers securely closed without the need for a handle or bolt. It is often used in furniture such as cupboards, wardrobes, and kitchen cabinets, providing a simple and clean way to keep doors shut. |

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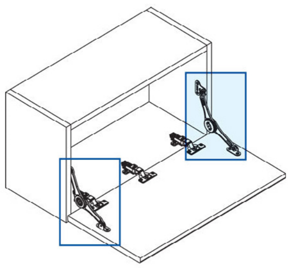
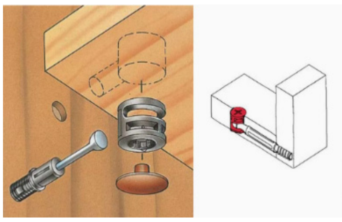
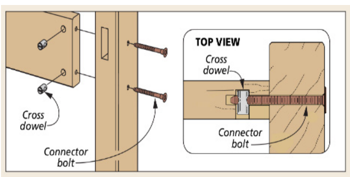
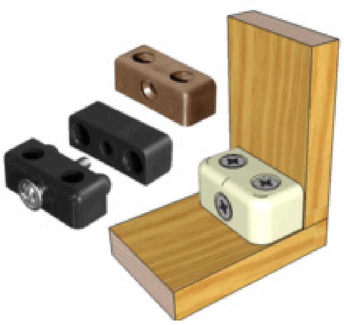
| **Castors (screw and plate)**<br><br> | Castors (screw and plate) are small wheels that are attached to the underside of furniture to make it easier to move around. They are fitted using screws and plates, providing mobility to items like chairs, tables, and cabinets. Castors allow furniture to be moved smoothly without lifting. | Castors (screw and plate) are used to provide mobility to furniture and other heavy objects. They are commonly fitted to the underside of items like chairs, tables, cabinets, and carts, allowing them to be easily moved without lifting. Castors are especially useful in areas where furniture needs to be rearranged frequently or moved for cleaning purposes. |
| **Stays**<br>**a. Rule joint stay**<br><br>**b. Sliding stay**<br> | Stays are used to restrict the movement of a door or flap. They help keep the door or flap in a fixed position when opened. There are two types of stays:<br><br>a. A **rule joint stay** is a metal strip hinged in the middle, with its ends attached to the box and the flap. When the flap is fully open, the strip straightens to hold it in place. It is important to position the stay properly to ensure there is enough space inside the box for it to fold when not in use.<br><br>b. A **sliding stay** is a strip with a slot that is hinged to a flap. As the flap closes, a pin on the box slides along the slot. Care must be taken to ensure there is enough space inside the box for the strip when the flap is closed. | Stays are used to control the movement of doors, flaps, or lids. They keep doors open at a fixed angle, preventing them from closing or swinging too far. Stays are commonly found in furniture like cabinets and chests to hold lids open securely. There are two types:<br><br>a. A **rule joint stay** is used to keep a door, lid, or flap open at a fixed angle. It is often found on chests, boxes, and cabinets to prevent the lid from closing accidentally.<br><br>b. A **sliding stay** is used to control the movement of doors or lids, keeping them open at a set angle and preventing them from closing too quickly. It is commonly used in furniture, such as boxes and cupboards. |

## 7. Woodwork Knockdown Fittings

Knockdown fittings are specialised hardware used in woodworking to facilitate easy assembly and disassembly of furniture or structures. They are commonly used in flat-pack furniture, like those from IKEA, because they are convenient for storage and transportation.

**Table 6.21.7:** Types of knockdown fittings, features and uses

<table>
<tr><th>Types of knockdown fittings with names and images</th><th>Description</th><th>Uses</th></tr>
<tr><td>Cam lock connectors<br><br></td><td>Cam lock connectors are hardware fittings made up of two main parts: a cam and a dowel. The cam is inserted into a pre-drilled hole in one piece of wood, while the dowel is inserted into a corresponding hole in the adjoining piece of wood. When the cam is turned, it locks into place, securing the two pieces of wood together.<br>This system provides a strong and reliable joint, commonly used in flat-pack furniture and other woodworking projects that require easy assembly and disassembly.</td><td>Cam lock connectors are mainly used in flat-pack furniture, where they provide strong and secure joints. They are designed for easy assembly and disassembly, making them ideal for furniture that needs to be put together quickly and taken apart when needed.</td></tr>
<tr><td>Cross Dowel and Bolt<br><br><br></td><td>A cross dowel is a metal fitting that is inserted into a perpendicular hole in one piece of wood. It connects to a bolt passed through a hole in the adjoining piece of wood, creating a strong and secure joint.</td><td>Cross dowels are used to create strong, secure joints. They are commonly found in bed frames and other furniture where high strength and stability are needed.</td></tr>
<tr><td>Plastic corner blocks<br></td><td>Plastic corner blocks are small, durable blocks that use screws to secure joints between two pieces of wood at right angles. These blocks make it easy to assemble furniture, offering a strong and simple method for joining wooden panels, especially in flat-pack furniture.</td><td>Plastic corner blocks are commonly used in furniture, particularly in kitchen cabinets, to securely join panels at right angles. They provide a simple, effective, and reliable way to create strong joints, making assembly easier and more efficient.</td></tr>
</table>

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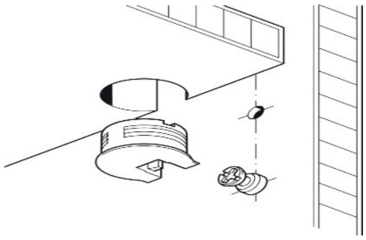
|---|---|---|
| **Rafix connectors**   | Rafix connectors are two-part fittings made up of a dowel and a locking mechanism. The dowel is inserted into a pre-drilled hole in one piece of wood, while the locking mechanism fits into a corresponding hole in the adjoining piece, securing the two parts together. | Rafix connectors are widely used in flat-pack furniture. They offer a fast and easy way to assemble and disassemble furniture, providing strong and reliable joints. These connectors are ideal for creating secure connections in various types of furniture, making them popular in both residential and office furniture designs. |

## Advantages of Knockdown Fittings

Knockdown fittings make assembling, disassembling, and moving furniture easier. They are commonly used in flat-pack furniture and allow for flexible, modular designs. Here are some key benefits of using these fittings.

1. **Ease of Assembly and Disassembly**: Knockdown fittings make it simple to put furniture together and take it apart, which helps move or reconfigure furniture.
2. **Transportability**: Furniture with knockdown fittings can be flat-packed, making it easier and cheaper to transport.
3. **Versatility**: These fittings allow furniture to be adapted or expanded over time, offering flexibility in design.
4. **Damage Reduction**: Knockdown fittings are designed for repeated assembly and disassembly, which helps reduce damage to the wood.

## Considerations when using knockdown fittings

When using knockdown fittings, it's important to keep a few key factors in mind to ensure the best results. These considerations help with proper assembly, strength, and the overall appearance of the furniture. Here are some key considerations for using these fittings.

1. **Precision in Drilling**: It is important to drill holes accurately to ensure the fittings align and fit properly.
2. **Material Compatibility**: Make sure the fittings are suitable for the type of wood or material being used.
3. **Load Capacity**: Choose fittings that can handle the weight and stress to avoid joint failure.

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4. **Aesthetics**: Some fittings may be visible after assembly, so consider how they will look if appearance matters.

All of the following activities are group-based. Organise yourselves into groups of five to complete each activity.

## Activity 6.21.1

### Exploring and Identifying Types of Nails and Screws for Woodwork Projects

**Scenario:**

Imagine you are part of a design team tasked with building a functional wooden shelf. Before construction begins, you must identify the types of nails and screws required to join the wood pieces securely. You will observe examples, discuss their characteristics and applications, and demonstrate their use to ensure the project's success.

**Materials Needed:**

- Assorted nails: common nails, finish nails, brad nails, etc.
- Assorted screws: wood screws, drywall screws, deck screws, etc.
- Sample wooden pieces for demonstration.
- Videos or images showcasing various nails and screws.
- Labels or flashcards with the names and uses of fasteners.
- Screwdrivers, hammers, and drills.
- A worksheet for notes and sketches.

### Activity Guidelines:

1. You will watch a brief video demonstration showing various types of nails and screws and their characteristics.
2. Discuss the features and applications of each type as a class.
3. Each group will be provided with an assortment of nails, screws, and wooden pieces.
4. Examine the fasteners closely and discuss their uses, strengths, and limitations.
5. Match the provided nails and screws to their names and intended applications using labels or flashcards.
6. Experiment with different fasteners and observe their effectiveness.
7. After the practical work, discuss your group's observations with the class.

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## Activity 6.21.2

### Understanding Applications of Fasteners and Fittings in Woodwork

Scenario

Imagine you are a furniture designer collaborating with a team to create a multifunctional cabinet. To ensure it functions properly, your team needs to discuss and decide the appropriate fasteners and fittings for various parts of the cabinet, such as hinges for doors, locks for security, and castors for mobility. By identifying their applications, you can ensure the cabinet meets the client's requirements.

**Materials Needed:**

- Assorted fasteners and fittings: hinges, stays, locks, magnetic catches, castors, screws, and nails.
- Sample woodwork models or images showing applications of fasteners and fittings.
- Labelled flashcards or a chart with descriptions of each fastener and fitting.
- Discussion worksheets for group notes and presentations.
- Access to a whiteboard or digital collaboration tool for whole-class feedback.

### Activity Guidelines:

1. Watch a video or presentation demonstrating different types of fasteners and fittings and their applications in woodwork.
2. Each group will be given a set of fasteners and fittings along with example wood pieces or diagrams. Discuss and record the applications of each item, linking them to specific woodwork scenarios.
3. You can also use the internet to research additional applications. Present your findings to the class, focusing on the applications of 2–3 fasteners or fittings.

## Activity 6.21.3

### Hands-On Demonstration: Fixing Fasteners and Fittings in Woodwork

**Scenario:**

Imagine you are part of a team building custom furniture for a client. To complete the project, each team member must demonstrate how to properly fix various fasteners and fittings, such as hinges for doors, locks for compartments, and screws for structural support. This ensures the furniture is both functional and professionally assembled.

**Material Needed:**

- Assorted fasteners and fittings: screws, nails, hinges, locks, stays, magnetic catches, and castors.
- Wooden panels or smaller woodwork samples for practice.
- **Tools:** hammers, screwdrivers, drills, measuring tapes, and clamps.
- Safety equipment: goggles and gloves.
- Instruction sheets or diagrams showing proper installation techniques for each fastener or fitting.

### Activity Guidelines:

1. Watch a video demonstration on how to fix various fasteners and fittings.
2. In your groups, discuss and highlight safety precautions, such as wearing goggles and securing wood pieces.
3. Each group will be assigned specific fasteners or fittings to fix (e.g., one group works on hinges, another on locks). In your groups, practice fixing the assigned fasteners or fittings onto wooden panels. Take turns using tools and share observations about your experience.
4. Present your work to the class by explaining the steps you followed and highlighting any challenges you may have encountered.

## Conclusion

Selecting and using the right fasteners and fittings ensures the strength, functionality, and durability of a woodwork artefact. Proper choice depends on the artefact's design, purpose, and material, and secure installation is key to achieving a professional finish.

# UNIT 22

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

Roof construction is a vital aspect of building construction. It involves the designing, planning and assembly of the top covering structure that protects the interior from environmental elements. The process involves selecting appropriate materials such as shingles, tiles, metal, or membranes, which are durable and suitable for the building's architectural style and climate conditions. Proper installation ensures not only aesthetic appeal but also functionality, including effective water drainage and thermal insulation. Structural integrity is paramount, requiring precise engineering and craftsmanship to withstand loads and weather conditions. In essence, roof construction combines both practical and aesthetic considerations to create a reliable and attractive shelter.

**KEY IDEAS**

- For roofs to be durable, provide proper design and effective construction to ensure minimal maintenance over a period of time, it is very necessary to use quality materials.
- Roofs contribute to a building's thermal insulation, reducing energy costs by maintaining consistent indoor temperatures.
- Roof design and materials significantly impact the overall aesthetic of a building, enhancing its visual appeal and architectural style.
- Roofs provide essential structural support, safeguarding the building and its occupants from environmental elements such as rain, wind, and snow.

## ROOF CONSTRUCTION

### The Roof as a Component of The Superstructure of a Building

The roof is one of the main components of the superstructure of a building. It has several key elements that contribute to the overall function, aesthetics, and performance of a building. The roof of a building has a variety of components that play crucial roles in the protection, energy efficiency, aesthetics, and structural integrity of the structure.

The design of the roof and materials for the construction are essential considerations that will lead to an effective structure.

The roof as a component of the superstructure of a building is very important for the following reasons:

1. The roof serves as a protective barrier against environmental elements such as rain, wind, sunlight, and snow, ensuring the safety and comfort of the building's occupants.
2. As part of the superstructure, the roof contributes to the building's overall structural stability and durability, supporting loads such as its weight, weather forces, and additional installations like solar panels.
3. A well-designed roof enhances energy efficiency by providing thermal insulation, reducing heat loss in colder climates and heat gain in warmer regions.
4. The roof significantly influences the building's appearance and architectural style, offering options such as flat, pitched, or curved designs tailored to functional and aesthetic needs.
5. Roofs incorporate drainage systems, such as slopes and gutters, to channel water away from the building, preventing structural damage and ensuring longevity.

## Types of Roofs

There are different types of roofing in use. The diagram of **Figure 6.22.1** shows the illustrations of the various types of roofing in use in building construction. Your study of the roof types will enable you to identify the roof styles that are used for the buildings in your community.

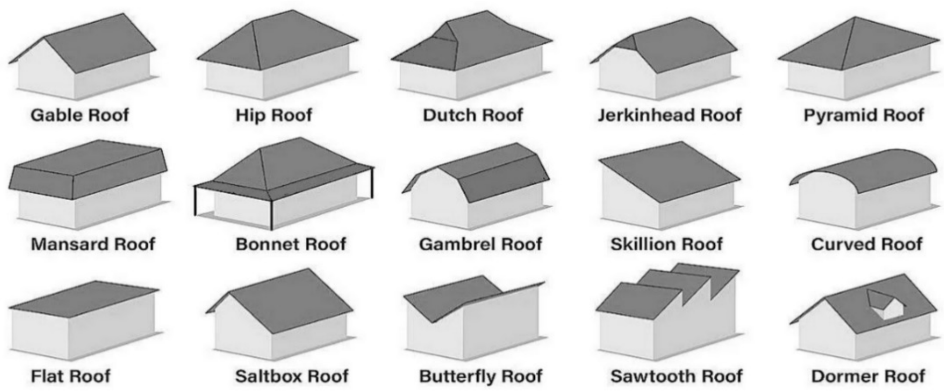


**Figure 6.22.1:** Types of Roofs

## The Types of Roofing Styles in Ghana

The popularity of simple house roof designs in Ghana has increased in recent years, along with their low-cost advantages.



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## Gable Roof

This is the traditional house roofing design in Ghana and is also a popular choice for many homeowners because of its affordability and durability. The gable roof is primarily the only roofing design that was known to the local Ghanaian carpenters for many years until the recent roof designs became popular in the country.

**Figure 6.22.2:** Gable roof

The gable roof is made up of two sloping sides that meet at a ridge to form a triangle. In gable roofing, there is always an A-shaped section of the wall where the sides are supported by rafters, which are long pieces of wood that run from the ridge to the walls of the house.

### Some Advantages of a Gable Roof

**a.** Gable roofs are simple and easy to build. This makes them a cost-effective option.

**b.** They are also very versatile. Gable roofs can be adapted for a variety of architectural styles.

**c.** Gable roofs are strong and durable. This is because they can withstand high winds and heavy snow loads.

**d.** They provide good openings for ventilation.

**e.** Gable roofs are easy to maintain and repair.

## Hip Roof

This roofing style typically has four sides that gently slope downhill to the walls and perform well in high-wind areas. A hip roof does not have a gable or vertical end. They provide excellent wind resistance for buildings in high-wind zones. Hip roofs are classified into three types: simple-hipped, cross-hipped, and half-hipped.

**Figure 6.22.3:** Hip roof

## Some Advantages of a Hip Roof

a. Hip roofs are very durable and can withstand high winds and heavy rainfall.
b. Hip roofs are very watertight, which allows water to flow easily down the slope
c. Hip roofs do not leak easily and are energy-efficient
d. Hip roofs can be used in a variety of home styles
e. Hip roofs are easy to maintain and do not require much upkeep.
f. Hip roofs are relatively affordable to build.

# Flat Roof

Homeowners in Ghana see flat roof styles as cost-effective options for roofing their homes since the style uses fewer materials in construction. This type of roofing is usually used for box houses in Ghana, where there is an extended two-course wall above the roofing height. It is one of the most attractive options for 3–to 4-bedroom houses since the installation is relatively quick and simple.

**Figure 6.22.4:** Flat roof

## Some Advantages of a Flat Roof

**a.** Flat roofs are less expensive compared to other roofing types.

**b.** It is simple to construct and maintain.

**c.** It has cheap labour and saves time.

**d.** Flat roofs allow the use of many different roofing materials

**e.** A flat roof makes interior space more versatile.

## Sloping Roof

This is one of the most popular roofs you can find in Ghana. It is most preferable for residential homes. The sloping house roof design has a steeply sloped roof that creates extra space, improving your house's heating and cooling. Another advantage of a sloping roof is that it allows water, dirt, and other stuff to slide off without accumulation, giving you a lasting roof.

**Figure 6.22.5:** Sloping roof

## Some Advantages of a Sloping Roof

a. It can help shed water and snow more effectively than a flat roof.

b. It can create additional space in a home, as it can be used to create attics or lofts.

c. It can be used to improve the energy efficiency of a home, as it can help to keep the heat in during the winter and the cool air in during the summer.

d. It can add visual interest to a home.

## L-Shaped Roof

An L-shaped roof in Ghana is a type of roof that has two slopes, one of which is longer than the other. This type of roof is commonly seen in Ghanaian houses, with an L-shape indicating the long and short slopes. The longer slope is typically parallel to the long side of the building, while the shorter slope is parallel to the short side of the building.

**Figure 6.22.6:** L-shaped roof

L-shaped roofs are often used on buildings with a rectangular footprint, as they provide good drainage and ventilation. They can also be used to create a more interesting visual effect than a traditional gable roof.

## Some Advantages of an L-shaped roof

- **a.** They provide good drainage and ventilation.
- **b.** They are relatively easy to construct.
- **c.** They are relatively inexpensive to build.
- **d.** They can be used to create a more interesting visual effect than a traditional gable roof.

## Lean-To-Roof

A lean-to roof is a single-sloped roof that is attached to an existing building. Homeowners in Ghana often use lean-to roofs for home and outbuilding additions. The most significant advantage of a lean-to roof is its easy construction. Since these roofs only have one slope, they don't require a lot of material or labour costs.

1. Lean-to roofs provide comfort for the installation of PV solar panels
2. It is one of the simplest, most affordable, and easily designed roofs
3. It has a high aesthetic appeal compared to other roof types
4. It lasts longer than a standard flat roof.

## Mixed Roof

To make a house stand out, use mixed roof designs. As the name suggests, this roofing style combines different roofing patterns, making it look attractive. This structure combines flat, gable, triangle, and semi-circle roofing designs, creating a unique beauty.



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It is further elevated by lighting and a combination of colours. The combination of various roof types offers the best possible function for any building in Ghana.

## Curved Roof

This type of roofing in Ghana is commonly seen in industrial warehouse buildings where the roof is designed such that its planes are curved, giving it a unique and very creative roof design. However, homeowners in Ghana who like this type of roof usually want their homes to stand out.

# Distinguish Trusted Rafter-Purlin System Roofing from the Purlin System of Roofing

Roof systems play very crucial roles in the overall function of buildings. There are a variety of roof systems employed at the construction sites depending on the choice of the client. It is also based on the aesthetic appeal of the roof systems. The trusted rafter purlin system and the purlin system of roofing are two distinct methods used in roof construction, each with its own advantages and applications. The trusted rafter purlin system involves using rafters, which are individual beams cut and set in place to form the roof's framework, providing flexibility in design and potential for attic conversions. On the other hand, the purlin system typically refers to a method where roofing materials are applied directly to a solid deck or substrate, often used in conjunction with trusses, which are prefabricated triangular structures that offer strength and efficiency. Understanding the differences between these systems can help in selecting the best approach for a specific roofing project.

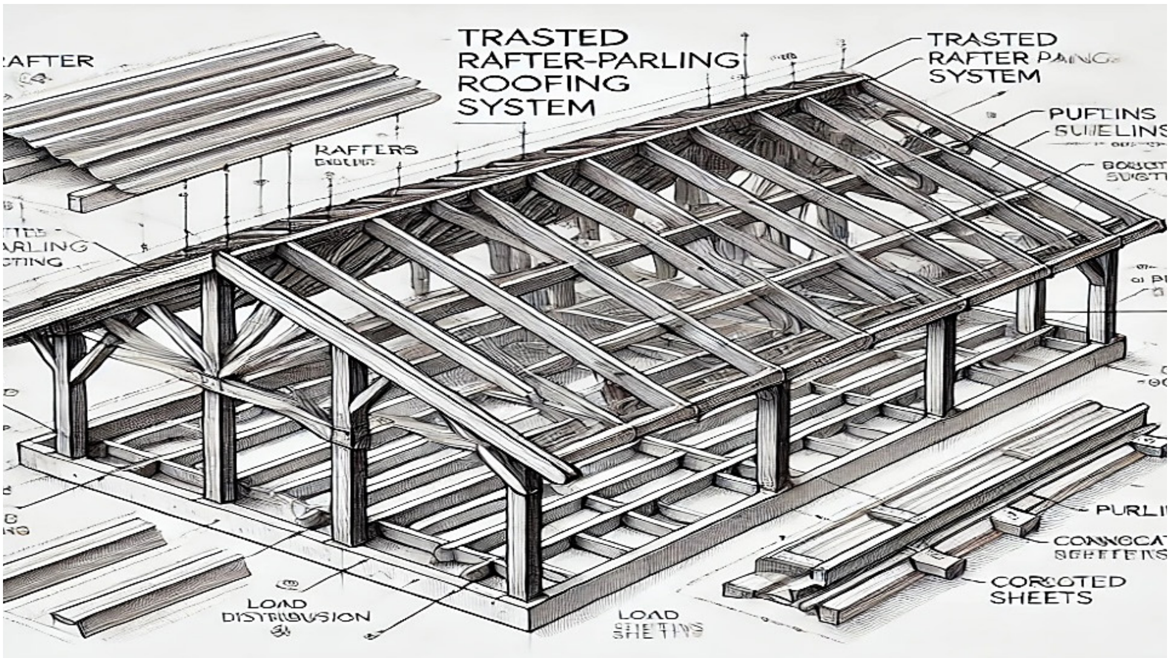


**Figure 6.22.7:** The rafter and purlin system roof

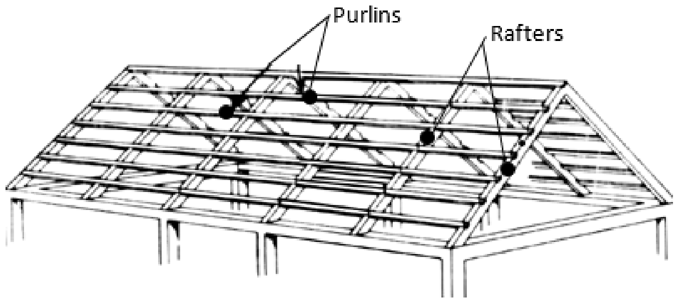


**Figure 6.22.8:** The rafter and purlin roof frame

**Table 6.22.1:** Difference between trusted rafter- purlin roof system and purlin roof system

| Aspect | Trusted Rafter-Purlin System | Purlin System |
|---|---|---|
| **Definition** | A roofing system using trusses that incorporate rafters and purlins for structural support. | A roofing system that relies on purlins attached directly to the rafters, without trusses. |
| **Structural Support** | Utilises a combination of trusses and rafters for enhanced load distribution and stability. | Primarily supported by rafters alone, which can lead to higher stress on individual members. |
| **Material Efficiency** | More material-efficient due to the use of engineered trusses that span larger distances. | May require more rafters to support the same span, potentially increasing material use. |
| **Load Distribution** | Provides better load distribution due to the truss design, minimizing risk of failure. | Load is concentrated on individual rafters, which can be a concern in heavy snow or wind conditions. |
| **Construction Complexity** | Generally, more complex to design and construct due to truss fabrication and assembly. | Simpler to construct as it involves fewer components and straightforward connections. |
| **Design Flexibility** | Offers greater design flexibility with potential for larger spans and varied roof shapes. | Limited design flexibility; more suitable for traditional roofing shapes. |
| **Cost** | Often higher initial costs due to truss fabrication but can save on materials in the long run. | Typically, lower initial costs, but may require more materials and labour depending on the design. |
| **Installation Time** | May require more time for installation due to truss assembly and alignment. | Generally faster installation since it involves fewer parts and simpler connections. |
| **Applications** | Commonly used in commercial buildings, larger residential homes, and structures requiring large spans. | Frequently used in traditional residential buildings and simpler structures. |

# The Functions of the Main Parts of a Roof

The various parts of the roof system as described in **Table 6.22.2**, perform very special functions that go a long way to effectively enhance the ultimate performance of the entire roof structure as a component of the superstructure of a building. A careful study of the table and cross-section of the purlin and rafter roof system will enrich your knowledge and understanding of the contribution of the various parts to the roof as a whole structure.

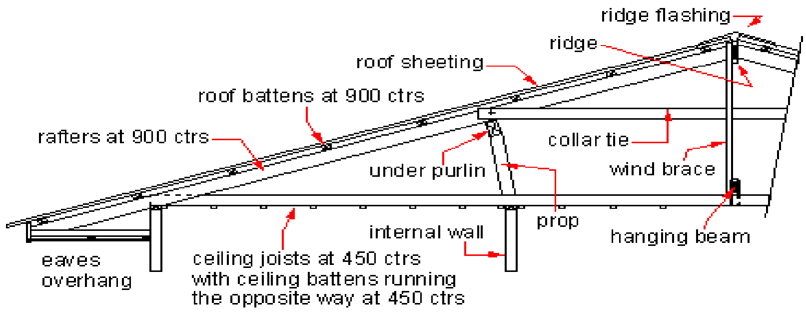


**Figure 6.22.9:** Cross section of purlin and rafter roof system showing the vital members

**Table 6.22.2:** The functions of main parts of the roof system

| Part | Description | Functions |
|---|---|---|
| **Rafters** | Sloped structural members that support the roof. | Provide the primary framework and shape of the roof. |
| **Trusses** | Pre-fabricated triangular structures used instead of rafters. | Support the roof load over larger spans. |
| **Purlins** | Horizontal members that run between rafters or trusses. | Provide additional support for roofing materials. |
| **Decking** | The flat surface material (usually plywood or OSB) attached to rafters. | Acts as a base for roofing materials and provides a surface for walking during installation. |
| **Underlayment** | A layer of material (like felt or synthetic) placed under roofing materials. | Provides additional waterproofing and protects the decking. |
| **Roof Covering** | The outermost layer of materials (shingles, tiles, metal, etc.). | Protects the building from weather elements and enhances aesthetics. |
| **Eaves** | The lower edge of the roof that overhangs the walls. | Helps to direct water away from the building and provides shade. |
| **Soffit** | The underside of the eaves. | Provides ventilation and protects the rafters from weather. |
| **Fascia** | Vertical board that runs along the edge of the roof. | Supports the lower edge of the roof and holds the gutter system. |
| **Gutters** | Channels attached to the fascia to collect and redirect rainwater. | Prevents water damage to the foundation and walls. |

| | | |
|---|---|---|
| **Downspouts** | Pipes that carry water from gutters to the ground. | Directs water away from the building's foundation. |
| **Ventilation** | Systems or openings (like ridge vents, soffit vents) for airflow. | Prevents heat buildup and moisture accumulation in the attic. |

**Figure 6.22.10:** Typical positioning of rafters and purlins during roof construction

## The Functions of the Roof Part as a Component of Superstructure of a Building

The roof is a vital component of the superstructure of any building, serving multiple essential functions that ensure the structure's usability and durability is assured. As the uppermost part of the building, the roof acts as a protective shield against environmental elements like rain, snow, wind, and sunlight. The roof safeguards the interior and its occupants against the effects of the elements. Besides protection, roofs contribute to the thermal regulation of buildings by preventing excessive heat loss or gain, enhancing energy efficiency. They also play a critical role in structural stability thereby distributing loads and withstanding external forces such as wind pressure. Additionally, the design of the roof influencing its overall outlook to enhance its aesthetic appeal and character which aligned with architectural styles to meet the functional requirements. Effective drainage systems are usually integrated into roofs to ensure the safe removal of water to prevent structural damage and maintain the integrity of the building over a long time.

**Table 6.22.3:** The functions of the roof as a component of the superstructure of a building.

| Functions of the roof as a component of the superstructure of a building | Description of the functions of the roof |
|---|---|
| **Protection from weather** | The primary role of a roof is to shield the interior of the building from rain, snow, wind, and sunlight, preventing damage and ensuring comfort. |
| **Insulation** | Roofs help regulate temperature by providing insulation, keeping the building warm in winter and cool in summer. This contributes to energy efficiency. |

| | |
|---|---|
| **Structural support** | The roof contributes to the overall structural integrity of the building, distributing loads (like snow and wind) and supporting other components such as ceilings and walls. |
| **Aesthetic appeal** | Roofs contribute to the architectural design and visual appeal of a building, influencing its style and character. |
| **Ventilation** | Certain roof designs allow for ventilation, helping to reduce moisture buildup and improve air quality within the building. |
| **Drainage** | Roofs are designed to direct rainwater away from the structure through gutters and downspouts, preventing water accumulation and potential damage. |
| **Space utilisation** | In some designs, roofs can provide usable space (like terraces or green roofs) or accommodate mechanical systems (like HVAC units). |
| **Fire resistance** | Depending on the materials used, roofs can provide a level of fire resistance, helping to protect the building from fire spread. |

## The Limitations to Roofing Materials in Ghana

Though there are different roofing styles and designs in Ghana to choose from, you need to consider the location of the house and the direction of the wind before deciding on any roofing style in Ghana.

There are several types of roofing sheets available in Ghana, but four of the most common types include aluminium roofing sheets, zinc roofing sheets, galvanised roofing sheets and asbestos roofing sheets. The following are some of the limitations to the roofing materials in Ghana:

1. ***Asbestos roofing:*** Asbestos was a popular roofing material in the past due to its durability and fire resistance. However, it has since been banned in many countries due to its dangerous health effects.
2. ***Built-up roofing (BUR)*** is heavier than other flat roofing systems, which may require additional support structures.
3. BUR roofing has a shorter lifespan than other roofing options, such as PVC or TPO.
4. ***Aluminium*** is softer and more malleable than other metals, so it can dent more easily during and after installation.
5. Roof leaks can occur due to standing water, poor seams, and improper installation of flashing and moisture barriers.

The following activities are all group-based. Organise yourselves into groups of five and complete each one.

## Activity 6.22.1

Carry out research using the internet or other visual means about roofs. In your group, discuss and agree on the meaning of roof as a component of the superstructure of a building and note down the key points.

## Activity 6.22.2

In your group discuss and agree on the categories of the different roof styles in use. You will also identify each type of roof noting the structures that support the system and their effectiveness.

## Activity 6.22.3

In your group discuss and agree on the factors that can limit the use of roofing materials and the impact this can have on the building. Your group will also discuss the types of systems of roofing that can be specified by architects or structural engineers.

# UNIT 23

# WOODWORK TECHNOLOGY

## Materials and Artefact Production in Woodwork Industry in Ghana

## Introduction

In woodwork, applying the right finish is a crucial step before assembling timber pieces. This ensures the wood is both protected and visually appealing. For flat surfaces, a well-sharpened plane provides a smooth finish, while more complex shapes may require scrapers. Glasspaper is commonly used for achieving a consistent, smooth surface. By using the right techniques, you will gain skills in applying finishes that enhance both the durability and appearance of woodwork.

**KEY IDEAS**

- Oil finishes highlight the natural grain and give a soft finish but need regular upkeep.
- Polyurethane is tough and ideal for heavy-use surfaces, while lacquer gives a quick-drying glossy finish for fine furniture.
- The choice of finish depends on the purpose, appearance, and environment.
- Varnish adds shine and durability to furniture and outdoor items.
- Wax creates a smooth shine for indoor use.
- Wood finishes protect and improve the look of wooden items.

## USES AND APPLICATION OF FINISHES

Finishes are essential in woodwork as they protect wooden surfaces and enhance their appearance. In addition to improving the aesthetic appeal, finishes also play a vital role in preserving wood, making it more durable, and providing resistance against moisture, dirt, and wear. The choice of finish depends on the type of wood, its intended use, and the desired effect.

### Surface Preparing for Finishing

Before applying a finish to an artefact, the surface must be properly prepared to ensure a smooth and even application. This is done by using abrasives such as glasspaper or a scraper to remove rough spots, imperfections, and any previous finishes. The preparation process smooths the wood, making it easier for the finish to adhere properly. Starting with coarse grit abrasives and gradually moving to finer grits ensures an even, clean surface that will allow the finish to achieve the desired result. Proper surface preparation is key to achieving a high-quality, durable finish.

# Abrasives

To smooth the surface of an artefact after construction, abrasives are used. These are materials like sand, glass, and silicon carbide, attached to paper. Abrasive paper comes in various grades, from coarse to fine, to remove rough spots and create a smooth surface. The standard size for abrasive paper is about 280mm x 230mm. Using the right abrasive material and grade ensures a polished surface, allowing the finish to adhere better and enhancing the artefact's final appearance and durability.

## Using Abrasive Paper

To achieve a smooth surface, abrasive paper is typically used with a sanding block or cork rubber, which helps maintain an even pressure while sanding. The paper is wrapped around the block, and sanding should always be done in the direction of the wood grain to avoid scratching the surface. Scratches can be difficult to remove and may affect the final finish.

Start with the coarsest grade of abrasive paper to remove rough spots, then gradually move to finer grades to achieve a smooth, polished surface. For most tasks, three grades of abrasive paper are sufficient, but they should not be spaced too far apart to ensure a consistent finish. Proper use of abrasive paper ensures a smooth surface that prepares the wood for the final finish.

## Types of Abrasive Paper

1. **Glasspaper**: Glasspaper is the most common and affordable abrasive paper, with glass particles as the abrasive grit. It is available in nine grades, ranging from the finest (00) to the coarsest (3). The grades are labelled as follows: 00 (floor paper), 0, 1, 1½, F2, M2, S2, 2½, and 3, with grit sizes ranging from 60 to 180. Glasspaper is adequate for basic sanding but tends to wear down more quickly and clog faster compared to other types of abrasive paper.
2. **Garnet Paper**: Garnet paper uses crushed semi-precious stones (garnet) as its abrasive grit. This type of paper lasts longer than glasspaper because garnet particles remain sharp for a longer period and are less prone to clogging. However, garnet paper is more expensive than glass paper. It comes in various grades, with the finest being 8/0 and the coarsest being 2. The available grades are: 8/0, 6/0, 5/0, 4/0, 3/0, 2/0, 2/0, ½, 1, 1½, and 2.

Both types of abrasive paper serve different purposes in woodwork, with glasspaper being more affordable for general tasks and garnet paper being preferred for finer, long-lasting sanding.

### Steps for Surface Preparation

a. **Coarse glasspaper:** Use coarse-grade glass paper to remove small faults and rough spots on the surface.

b. **Medium Glass Paper:** Use medium-grade glass paper to further smooth the surface.

c. **Fine Glass Paper:** Use fine-grade glass paper for an extra-smooth surface, ready for finishing.

d. **Dusting:** Clean the surface by dusting off all sanding debris to ensure a clean finish.

## Finishes

Wood finishes are essential for protecting and enhancing the appearance of wood surfaces. They help to preserve the wood by providing a protective layer that shields it from moisture, dirt, and wear. At the same time, finishes enhance the natural beauty of the wood, bringing out its colour, texture, and grain pattern.

Various types of finishes can be applied, each offering different levels of protection and aesthetic qualities. These include varnishes, lacquers, oils, and waxes, among others. However, finishes should only be applied after the correct surface preparation process has been completed. This ensures that the wood is smooth and free of imperfections, allowing the finish to adhere properly and provide an even, lasting coat. Proper application of finishes not only improves the appearance but also increases the durability and longevity of the wood.

### Types of Finishes

1. **Lacquer**: Lacquer is a thin, fast-drying finish that is often applied using a spray method. It dries quickly, offering a smooth and glossy finish. When using a brush, it's important to use a very soft brush to avoid streaks. Lacquer fumes can be unpleasant, so it should be applied in a well-ventilated area. Cleaning brushes after use requires a special cellulose thinner. Lacquer is popular for its speed and efficiency, but care must be taken to avoid streaking and fumes.

2. **Varnish**: Varnish is a mixture of resins dissolved in oil or spirit and provides a durable finish for wood. Before applying varnish, the wood should be sized with a glue-water mixture or a thin coat of varnish to seal the pores and prevent over-absorption. Traditional varnish is not resistant to heat, stains, or water, but modern polyurethane varnish offers better resistance to these elements and is more durable and abrasion-resistant. It's a good choice for creating a long-lasting finish on wood surfaces.

3. **Oil Paint**: Oil paint is made from a base (white lead), a binder (linseed oil), a thinner (white spirit), and a drier. It is available in a wide range of colours and is applied in multiple coats. The first coat serves as an undercoat, and a

second coat can be applied after rubbing down the surface. Oil paint is often used for painting wooden surfaces, giving them a smooth and durable finish. However, it is essential to allow proper drying time between coats to ensure the best results.

4. **Shellac**: Shellac is a natural resin secreted by the lac insect, and it is used to create a transparent finish. The resin is dissolved in methylated spirits and can be applied to wood surfaces. Shellac provides a thin seal, preventing further applications from soaking into the wood. It is known for its good adhesion and ease of application with a high-quality brush, such as one made from squirrel or camel hair. Shellac is often used as a preparation for polished surfaces and can be further coloured if needed.

## Reasons for Using Finishes

Wood finishes are essential in woodworking for various practical and aesthetic reasons. Some of the key reasons to apply finishes include:

1. **Protection and Preservation**: Finishes help protect the wood from environmental damage such as moisture, dirt, and wear. They preserve the wood, preventing it from degrading over time due to exposure to the elements, moisture, or regular handling.
2. **Hygiene**: Applying a finish makes the surface more hygienic by sealing the wood and preventing the absorption of bacteria, dirt, or grime. This is particularly important for items like kitchen counters or furniture that encounter food or the human body.
3. **Ease of Cleaning**: A finished surface is easier to clean because it prevents dirt and stains from penetrating the wood. It creates a smooth and durable layer that allows dirt to be wiped off easily without affecting the wood beneath.
4. **Aesthetic Enhancement**: Finishes enhance the natural beauty of the wood by bringing out its grain, colour, and texture. A well-applied finish can give the wood a polished, glossy, or matte appearance, making it more visually appealing.

# Factors to Consider in the Selection of a Finish

When choosing a finish for a woodworking project, several factors must be considered to ensure that the right finish is applied to the specific needs of the artefact:

1. **The Type of Material**: Different types of wood and materials require different finishes. For example, softwoods may need a different finish compared to hardwoods. The grain structure, porosity, and texture of the material influence the finish selection.
2. **The Use of the Artefact (Exterior or Interior)**: The intended use of the artefact is crucial. If the item is to be used outdoors, it will need a finish that protects from the elements such as rain, sun, and temperature changes. For

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indoor items, a less durable but more aesthetically pleasing finish might be chosen.

3. **The Degree of Gloss or Lustre Required**: The appearance of the final product is influenced by the finish's gloss level. Some projects may require a high-gloss finish for a shiny, reflective surface, while others may benefit from a satin or matte finish for a subtler appearance.
4. **The Method of Application (Spraying or Brushing)**: The method of applying the finish is an important consideration. Some finishes are better suited to spraying, while others may be more effective when brushed on. The application method can affect the final look and smoothness of the surface.
5. **The Durability of the Finish**: Durability is a critical factor when selecting a finish. The finish should be able to withstand the wear and tear the item will face, including resistance to heat, moisture, chemicals, stains, and scratches. The durability of the finish will depend on its composition and the conditions the item will be exposed to during its use.

## Application of Finishes

The application of finishes is a crucial step in woodworking, ensuring both the protection and aesthetic enhancement of wooden artefacts. Several tools and equipment are commonly used to apply finishes, each suited to specific types of finishes and techniques.

1. **Brushes**: Brushes are widely used for applying finishes, especially when precision is required. A high-quality brush, typically made from natural bristles, helps apply the finish evenly. It is used for brushing varnishes, lacquers, and oils.
2. **Spraying gun and equipment**: A spraying gun is often used for applying finishes like lacquers and varnishes. It provides a smooth, even coat without brush marks, especially useful for large surfaces or intricate details. This method requires proper ventilation and safety precautions due to fumes.
3. **Rubbing pads**: Rubbing pads are used for smoothing the surface after applying a finish. They help to even out the finish and remove any imperfections. They are often used in the final stages of applying oil or wax finishes to give a polished look.
4. **Roller coater**: A roller coater is used to apply finishes quickly and evenly across large flat surfaces. This equipment is typically used for varnishing or lacquering large items such as panels or furniture, offering a uniform application without streaks.

### Application of Finishes with Spray Gun

A spray gun is a vital tool for applying finishes efficiently and evenly on wooden surfaces. It consists of several key components that work together to deliver the desired finish:

1. **Spray Gun Components**: The spray gun has a container that holds the finishing liquid (paint, varnish, lacquer, etc.) and a nozzle through which the liquid is sprayed. The trigger is the most important part of the sprayer, as pulling it activates the mechanism that releases the liquid. The trigger is connected to the plunger rod, needle, and valves, which control the flow of the liquid through the nozzle.
2. **Fluid Inlet**: The fluid inlet is the area where the finishing material enters the spray gun. From here, it is directed through the gun, where air pressure pushes it through the nozzle onto the surface being sprayed.
3. **Air Pressure and Trigger Control**: The amount of finish applied depends on the air pressure and how hard the trigger is pulled. The harder the trigger is pulled, the greater the flow of the finish. The air pressure regulates the spray pattern and ensures the material is evenly distributed over the surface.

Using a spray gun allows for a smooth, even finish, especially on large or complex surfaces. It is essential to work in a well-ventilated area, as spraying creates fumes and to adjust the air pressure according to the type of finish being applied to avoid over-spraying or drips.

The following activities are all group-based. Organise yourselves into groups of five and complete each one.

## Activity 6.23.1

### Identifying Types of Finishes in Woodwork

**Scenario:**

You are part of a woodworking team tasked with designing and finishing a high-quality wooden artefact for a client. Before choosing the finish, you must identify and evaluate the various types of wood finishes available and their applications to ensure the final product meets the client's expectations for durability and aesthetics.

**Materials Needed:**

- **Wood Finish Samples:** Pieces of wood finished with varnish, oil, lacquer, wax, polyurethane, etc.
- **Unfinished Wood Pieces:** Small blocks of different wood types for comparison.
- **Video Equipment:** A screen or projector to display a video demonstration on types of wood finishes.
- **Reference Guides:** Charts or handouts explaining the properties and uses of different finishes.
- **Whiteboard/Markers:** For listing finishes and observations.

- Notepads and Pens to take notes during the activity.

### Activity Guidelines:

1. Watch a video demonstration highlighting the types of finishes, commonly used in woodwork (e.g., varnish, oil, polyurethane, lacquer, and wax) including examples of their application and finished results on wood.
   a. As you watch the video, think about the following questions: what finishes were mentioned in the video?
   b. Which finishes seemed to highlight the wood grain the most?
   c. What might be the benefits of each finish?
2. Each group will be provided with samples of wood finished with different types of finishes. In your groups;
   a. examine and identify the type of finish on each sample.
   b. discuss the uses and benefits of each finish based on its texture, sheen, and protective qualities.
   c. record your findings in a table with columns for ***finish type***, ***appearance***, and ***ideal applications***.
3. Present your findings to the class, explaining your reasoning for identifying each finish and its uses.
4. Reflect on the following questions:
   a. which finish would you use for outdoor furniture, and why?
   b. if a client wanted a natural-looking finish, which type would you recommend?

## Activity 6.23.2

### Evaluating Factors for Choosing the Right Wood Finish

**Scenario:**

You are part of a team in a woodworking workshop tasked with creating a premium wooden artefact for a client. The client has specific requirements regarding durability, aesthetics, and functionality. Before applying a finish, your team must discuss and determine the key factors to consider when choosing the most suitable finish for the artefact.

**Materials Needed:**

- **Reference charts/Handouts:** information on different wood finishes (varnish, oil, wax, lacquer, polyurethane) and their properties.
- **Wood samples:** small wooden blocks showcasing different finishes.

- **Unfinished wooden artefacts:** sample artefacts such as boxes, frames, or coasters.
- **Notepads and pens:** to jot down notes and observations.
- **Whiteboard or Flip chart:** for capturing group ideas during feedback sessions.
- **Video equipment:** to display a short video or slideshow demonstrating wood finishes and their applications.

### Activity Guidelines:

1. Watch a video that explains the properties, uses, and visual effects of different types of wood finishes.
2. As you watch the video, think about the following:
   a. what factors might influence the choice of finish for a wooden artefact?
   b. why would durability or aesthetics be more important for certain items?
3. In your group, discuss and identify the key factors to consider when choosing a finish. Examples include:
   a. **Purpose of the artefact:** Is it decorative or functional?
   b. **Environment:** Will it be indoors or outdoors?
   c. **Appearance:** What finish will enhance the wood's grain and colour?
   d. **Maintenance:** How easy is it to maintain the finish over time?
4. Record your findings in a table or list format and share it with the class for feedback and discussion.
5. Reflect on the following questions:
   a. Which factor do you think is most important when choosing a finish, and why?
   b. How might the choice of finish affect the client's satisfaction with the artefact?

## Activity 6.23.3

### Hands-On: Applying a Finish to a Wooden Artefact

**Scenario:**

You are part of a workshop team responsible for creating high-quality wooden artefacts. The artefact is complete, but it needs a finish to protect it and enhance its appearance. Your team must work together to prepare the artefact and demonstrate how to apply a chosen wood finish properly.

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**Materials Needed:**

- **Wooden artefacts:** Pre-sanded wooden pieces (e.g., small boxes, plaques, or coasters).
- **Wood finishes:** A selection of finishes such as varnish, oil (e.g., tung or linseed), polyurethane, lacquer, and wax.
- **Application tools:** Brushes, foam applicators, lint-free cloths, and sponges.
- **Sandpaper:** Different grits (coarse, medium, fine) for surface preparation.
- **Tack cloth:** For removing dust after sanding.
- **Safety gear:** Gloves, safety goggles, and dust masks for personal protection.
- **Protective coverings:** Plastic sheets or drop cloths to protect work surfaces.
- **Instructional video equipment:** A screen or projector for demonstrating the application techniques.
- **Drying rack:** To store finished pieces while the finishes dry.

## Activity Guidelines:

**1.** Watch a video demonstration showing the step-by-step process for applying different finishes to wooden artefacts.

**2.** As you watch the video, think about the following questions:

- **a.** Why is sanding an essential step before applying a finish?
- **b.** What challenges might arise during the application process?

**3.** Each group will be provided with the necessary materials and tools to:

- **a.** Prepare an artefact by sanding it thoroughly with appropriate grit sandpaper and cleaning off the dust with a tack cloth.
- **b.** Plan the application method, considering the type of finish and the tools required.

**4.** Demonstrate the application of your chosen finish:

- **a.** **For varnish:** Use even brush strokes and thin coats, allowing drying time between layers.
- **b.** **For oil:** Rub the oil into the wood with a cloth in circular motions, removing excess oil.
- **c.** **For wax:** Apply sparingly with a cloth and buff to a shine.

**5.** Discuss your findings with the class, focusing on:

- **a.** Explaining the finish applied.
- **b.** Outlining the steps followed.
- **e.** Stating challenges faced and how they had resolved them.

6. Engage in a class discussion and reflect on how these skills are transferable to real-world woodworking projects.

## Conclusion

Different types of wood finishes, such as varnish, oil, wax, and polyurethane, serve specific purposes based on their properties:

- **a.** Varnish offers durability and a glossy appearance, ideal for high-use items.
- **b.** Oil finishes enhance the natural grain and provide a subtle, matte look.
- **c.** Wax creates a soft sheen and is best for decorative items.
- **d.** Polyurethane provides strong protection against wear and moisture.

Choosing the right finish depends on the artefact's purpose, desired appearance, and environmental exposure. The correct application enhances both the durability and aesthetics of the wood.

# UNIT 24

# BUILDING CONSTRUCTION TECHNOLOGY

## Substructure and Superstructure

## Introduction

The ceiling is an important part of a building's superstructure, serving as the overhead covering of a room. It enhances the room's appearance, provides insulation, and conceals electrical and plumbing systems. Various materials, such as wood, plaster and gypsum board, are used to construct ceilings, each selected based on factors like durability, cost, and design preference. Methods of installation differ depending on the type of ceiling chosen, such as flat, suspended, or vaulted designs. This unit highlights the functions, materials, selection criteria, and installation methods of ceilings, supported by illustrations for better understanding.

**KEY IDEAS**

- A ceiling provides insulation and soundproofing.
- Materials used involve wood, plaster, gypsum board, metal, or PVC
- Strong and fire-resistant materials are best used to prevent hazards.
- The ceiling enhances the room's appearance.
- The ceiling is the overhead surface that covers the top of a room.

## CEILING CONSTRUCTION

### What is the Concept of a Ceiling in a Building?

The ceiling in a building is the horizontal surface that forms the underside of the roof or the floor above. It acts as the interior overhead covering of a room, providing a smooth and finished look while concealing structural elements like beams, pipes, or electrical wiring. They can be designed in various styles and materials to suit the overall design of the building. The ceiling of a building's roof plays a crucial role in functionality, aesthetics, insulation, soundproofing and comfort, enhancing both the building's performance and the occupants' experience.

# The Purpose of a Ceiling in a Building

The ceiling of a building serves several key purposes: it enhances the interior's appearance, provides insulation against temperature and noise, and hides structural elements like beams and wiring. It also contributes to the overall comfort and safety of the space, making it an important part of the building's design. It includes the following:

1. **Aesthetic appeal**: Ceilings enhance the interior design by providing a finished look. They can be customised with various materials, colours, and textures to match the overall decor.
2. **Thermal insulation**: Ceilings help to insulate the building, reducing heat transfer between the roof and the interior space. This contributes to energy efficiency by maintaining comfortable temperatures.
3. **Sound insulation**: Ceilings can absorb and dampen sound, reducing noise from outside and between rooms, which enhances the acoustic environment.
4. **Structural support**: The ceiling helps support the roof structure, distributing loads and contributing to the overall stability of the building.
5. **Concealment of systems**: Ceilings can hide ductwork, plumbing, electrical wiring, and other mechanical systems, creating a cleaner and more organised appearance.
6. **Fire resistance**: Depending on the materials used, ceilings can enhance fire safety by slowing the spread of flames and smoke, providing occupants with more time to evacuate.
7. **Lighting integration**: Ceilings provide a surface for installing light fixtures, allowing for effective lighting design that improves functionality and ambience.
8. **Moisture control**: Properly designed ceilings can help manage moisture levels, preventing condensation and related issues like mould growth.

# Types of Ceiling

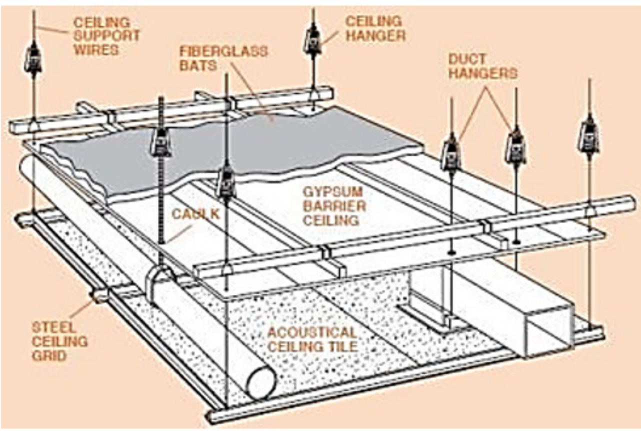
1. **Tightly attached ceilings:** Ceilings made of gypsum, plasterboard, tongued and grooved timber and so on, may be attached tightly to timber joists or rafters, steel joists or concrete slabs. Careful detailing is required where beams or other obstructions protrude through the plane of the ceiling, such as vents, conduits, pipes, sprinkler heads and so on.
2. **Suspended ceilings:** Suspended ceilings are secondary ceilings suspended from the structural floor slab above 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.

3. **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, and shops.

## The Differences Between Suspended Ceiling and Tightly Attached Ceiling

A suspended ceiling hangs below the main ceiling, supported by a metal grid and tiles, often used in offices to hide wiring and pipes. A tightly attached ceiling, on the other hand, is directly fixed to the building's structure with minimal support, typically found in homes. The key difference lies in the installation method, where the suspended ceiling hangs with a visible gap, whereas the tightly attached ceiling is directly fixed to the structure without the need for a grid system.



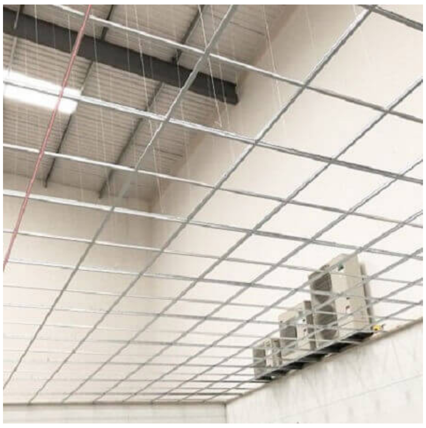



**Figure 6.24.1:** Suspended ceilings


**Figure 6.24.2:** Tightly attached ceiling

**Table 6.24.1:** Difference between suspended ceiling and tightly attached ceiling

| Feature | Suspended Ceiling | Tightly Attached Ceiling |
|---|---|---|
| **Definition** | A ceiling that hangs below the main ceiling structure, typically using a grid system. | A ceiling that is directly affixed to the roof structure, often with minimal support. |
| **Installation** | Requires a grid framework for installation; more complex. | Generally simpler installation, directly attached to the structural elements. |
| **Accessibility** | Allows easy access to above-ceiling space for maintenance of utilities. | Limited access; more difficult to reach any systems above. |
| **Aesthetic Options** | Offers various design options, including tiles and panels that can be easily changed. | Typically has a more uniform appearance, with fewer design options. |
| **Sound Insulation** | Provides better sound absorption and insulation due to the materials used in tiles. | May offer less acoustic performance depending on the materials used. |
| **Fire Resistance** | Can enhance fire safety with specific fire-rated tiles. | Fire resistance depends on the materials used; may not have dedicated fire features. |
| **Cost** | Usually more expensive due to the grid system and tiles. | Generally, more cost-effective due to simpler installation and fewer materials. |
| **Weight** | Lightweight due to the use of lightweight tiles. | May be heavier, depending on the materials used for the ceiling. |
| **Ceiling Height** | Can reduce ceiling height slightly, depending on the grid system. | Minimal impact on ceiling height, as it is attached directly. |

## The Functions of a Ceiling as a Component of The Superstructure of a Building

The ceiling, as a key component of a building's superstructure, serves several important functions. It provides a finished, smooth surface for the interior of a room, enhancing the overall aesthetic appeal. It helps conceal structural elements such as beams, pipes, and electrical wiring, creating a neat and organised space. Additionally, the ceiling plays a critical role in thermal insulation, helping to maintain a comfortable temperature inside by reducing heat loss or gain. It also contributes to soundproofing, minimising noise between rooms or from the outside. Overall, the ceiling not only improves the appearance of a room but also adds to the comfort and functionality of a building.

**Table 6.24.2:** Functions of a ceiling as a component of the superstructure of a building

| Function | Description |
|---|---|
| **Structural support** | Provides support for the roof structure and distributes loads evenly, enhancing stability. |
| **Aesthetic enhancement** | Contributes to the visual appeal of interior spaces with various designs, textures, and finishes. |
| **Thermal insulation** | Minimises heat transfer, helping to regulate indoor temperatures and improve energy efficiency. |
| **Acoustic control** | Absorbs and dampens sound, reducing noise pollution from outside and between rooms. |
| **Concealment of systems** | Hides mechanical systems like ductwork and wiring, resulting in a cleaner appearance. |
| **Fire safety** | Enhances fire resistance by slowing the spread of flames and smoke, improving occupant safety. |
| **Moisture management** | Helps control moisture levels, reducing the risk of condensation and mould growth. |
| **Lighting integration** | Provides surfaces for mounting light fixtures, facilitating effective illumination. |
| **Access to systems** | Allows easy access to electrical and HVAC systems for maintenance and repairs in certain designs. |

## Interstitial Spaces

Interstitial space, which is also referred to as an interstitial ceiling, allows for a larger space to be located between regular-use floors. It generally includes an access walkway and has a low room height. They are commonly used in buildings such as hospitals and laboratories that have complex services which may include:

1. **Air-conditioning ducts.**
2. **Water and waste pipework.**
3. **Electrical and communications wiring.**
4. **Compressed air lines.**
5. **Oxygen.**
6. **Chilled water.**
7. **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.

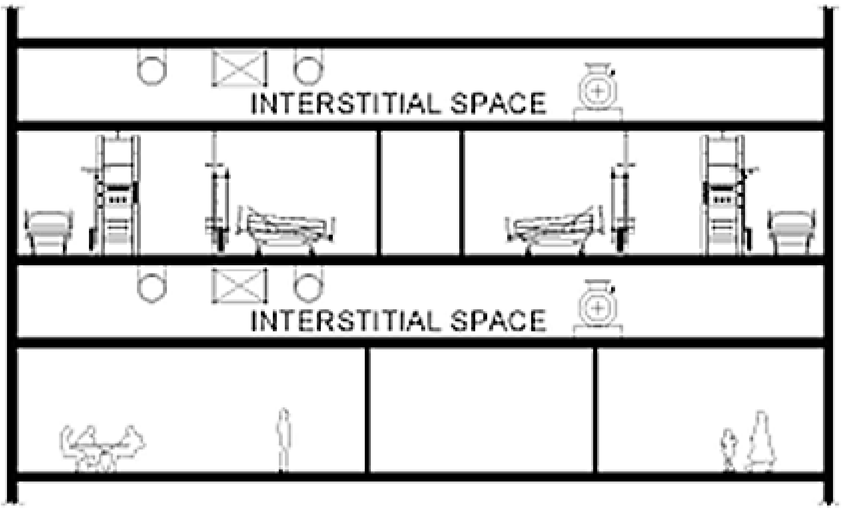



**Figure 6.24.3:** Interstitial spaces

The following activities are all group-based. Organise yourselves into groups of five and complete each one.

## Activity 6.24.1

- A building's superstructure plays a significant role in ensuring the stability and safety of the structure. In your groups, discuss, agree and explain the ceiling as a component of the superstructure of a building to show how it interacts with other components to support the roof and provide insulation.
- Record your findings for reference.

## Activity 6.24.2

- When designing interior spaces, it's essential to choose the right type of ceiling based on the building's needs. In your groups, discuss and distinguish between the suspended ceiling and the tightly attached ceiling to highlight the differences in construction.
- Record your findings for reference.

## Activity 6.24.3

In building design, each component of the superstructure serves a specific purpose. In your groups, discuss and record the functions of the ceiling as a component of the superstructure that has an impact on the interior environment.

## EXTENDED READING

- "Architectural Drafting and Design" by Alan Jefferis and David A. Madsen (Latest edition 2016).
- "Fundamentals of Building Construction: Materials and Methods" by Edward Allen and Joseph Iano (Latest edition 2019).
- "Interior Design Illustrated" by Francis D.K. Ching (Latest edition 2020).
- Jackson, A. & Day, D. (1997). Woodworker's manual. London: Harper Collins "Building Construction Illustrated" by Francis D.K. Ching (Latest edition 2018).
- Walton, John A. (1970). Woodwork Theory in and Practice (metric edition). Pages 254-294.

# Review Questions

## Questions 6.1

1. You are working on a woodworking project and need to join pieces of wood securely. Identify three types of nails and three types of screws you could use for this task.
2. You are designing a piece of furniture with movable and secure parts. Describe the applications of the following fasteners and fittings:
   a. Hinges
   b. Stays
   c. Locks
   d. Magnetic catch
   e. Castors
3. You are assembling your designed artefact. How would you fix the following fasteners and fittings?
   a. Screws
   b. Hinges
   c. Locks
4. How do you choose the right fastener for a woodwork artefact?
5. What are common fasteners used in woodwork?
6. How do you ensure fasteners are securely attached?

## Questions 6.2

1. Explain the roof as a component of the superstructure of a building.
2. Distinguish the Trussed Rafter-Purlin system from the Purlin system and outline the main limitations each has.
3. Outline the different categories of roofing materials available in the Ghanaian building Industry and discuss the major limitations one may encounter in using them.

## Questions 6.3

1. You are tasked with finishing a wooden chair for a customer. Identify at least three types of finishes you could use for this project and briefly explain their key characteristics.

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2. You are choosing a finish for a wooden artefact. What are three important factors you should consider when making your decision?
3. You have completed constructing a wooden artefact. How will you apply the chosen finish to your artefact?
4. What is the main use of varnish in wood finishing?
5. How is oil finish applied, and what is its purpose?
6. When should polyurethane be used as a wood finish?

## Questions 6.4

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 how ceilings can improve the comfort levels of users of the facilities.

# ANSWERS TO REVIEW QUESTIONS

## SECTION 1

### Questions 1.1

1.
   a. Try square
   b. Marking gauge
   c. Mitre square
2. Adjust the blade depth for the desired cutting thickness.
3. First, use a marking gauge to outline the hole. Then, drill a starter hole inside the marked area. Finally, use a bow saw/pad saw/fret saw to cut along the outline, completing the hole.
4. Select a tool based on the specific task, such as a saw for cutting or a plane for smoothing.
5. Using the correct tool ensures efficiency, safety, and a high-quality finish.
6. Ensure the tool is in good condition and safe to use.

### Questions 1.2

1. The various components of the substructure are as follows:
   - Foundation Concrete
   - Footing course
   - Hardcore filling
   - Oversite concrete
   - Retaining Walls
2. Explaining the substructure of a building as:

   The substructure is the part of the building located below ground level, including all the structural elements that provide support to the superstructure (the portion above ground). It transfers loads from the building to the ground, ensuring stability and preventing settlement or collapse.
3. Discussing the functions of the various components of a substructure of a building:
   a. **Foundation concrete:** The foundation functions in two ways:
      - The foundation carries or supports the building safely without failure

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- The foundation also transmits or distributes the load of the building to the ground without any settlement or failure.

d. **Footing course (walls):** the footing serves as the link for effective transmission or distribution of the building load to the foundation concrete.

e. **Hardcore filling:** The hardcore filling provides a solid base for the oversite concrete.

It also ensures that the bigger stones within the hardcore particles can serve as non-passage for moisture.

f. **Oversite concrete:** The oversite concrete provides a truly horizontal layer for the transmission of the loads from the superstructure of the building.

## Questions 1.3

**1.**

- Clean each tool thoroughly after use to remove dust and debris, which helps prevent rust and damage.
- Store tools properly in a dry, organised space to keep them safe, dry, and ready for the next use.

**2.**

- Apply a thin layer of oil to the blade to protect it from moisture.
- Store the saw in a dry area to avoid exposure to humidity, which can cause rusting.

**3.**

- Topping ensures that all saw teeth are the same height, which makes cutting smoother and more efficient.
- Re-shaping restores the correct tooth shape, keeping the saw balanced and effective after repeated use.
- Setting involves adjusting the teeth to prevent the saw from jamming, allowing it to cut more easily through wood.
- Sharpening creates a fine, sharp edge on each tooth, making the saw effective and precise for accurate cuts.

**4.**

- **Rip Saw:** Secure the saw in a vice, use a triangular file at the correct angle to sharpen each tooth, and ensure consistent tooth height.
- **Jack Plane Blade:** Grind the blade on a grinding wheel to set the edge angle, then refine it on a fine oilstone until sharp.

- **Firmer Chisel:** Use a grinding stone to set the edge angle, then finish on an oilstone, maintaining a consistent angle to ensure a sharp edge.

5. Regular cleaning prevents rust, removes dirt buildup, and keeps tools in optimal working condition, extending their lifespan.
6. Proper storage protects tools from moisture, dust, and damage, which keeps them sharp, safe, and ready for future use.
7. Sharpening maintains a tool's effectiveness and precision, making work easier and safer by reducing the risk of slips or damage.

## Questions 1.4

1. Outline the popular methods used in setting out a building:
   - **Baseline Method:** Using a reference line (baseline) from which all other measurements are taken.
   - **Grid Method:** Setting out a grid of intersecting lines to mark out the positions of foundations, walls, and other elements.
   - **Corner Peg Method:** Placing pegs at the corners of the building site to outline the footprint of the structure.
   - **Total Station Method:** Utilising a total station for precise measurements and angles, often in combination with GPS for larger projects.
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:

### Simple Methods

- **Tools:** Tape measures, string lines, pegs, and spirit levels.
- **Approaches:** Baseline Method and Corner Peg Method.
  - **Tape Measure and String Lines:** Used for straightforward distance measurements and creating straight lines.
  - **Spirit Levels:** Ensures horizontal accuracy.

### Complex Methods

- **Tools:** Theodolites, total stations, GPS units, and laser levels.
- **Approaches:** Grid Method and Total Station Method.
  - **Theodolites and Total Stations:** Provide accurate angular measurements and distances.
  - **GPS Units:** For precise positioning, especially on large or remote sites.
  - **Laser Levels:** Ensure consistent levels over large areas.

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3. Discussing the major activities undertaken from the start to the end of a setting out exercise including those steps that serve as checks and balances on the setting out exercise:
   i. Site Survey and Preparation
      - Conduct a detailed site survey.
      - Clear the site of obstacles and vegetation.
   ii. Establishing Reference Points
      - Set up baseline using tape measures and string lines.
      - Verify accuracy with spirit levels.
      - Install corner pegs at the building's footprint.
   iii. Marking Out the Building
      - Use total stations or theodolites for precise measurements.
      - Mark key points and lines using pegs and string lines.
   iv. Setting Up Grids
      - Create a grid pattern using string lines.
      - Check for square corners using the 3-4-5 triangle method.
   v. Checking and Verification
      - Double-check all measurements and angles for accuracy.
      - Use laser levels to verify height consistency.
      - Conduct cross-checks by measuring diagonals.
   vi. Final Review and Adjustments:
      - Re-check all reference points and grids.
      - Adjust any discrepancies noted during the verification process.
      - Confirm that all points align with the building plans

# SECTION 2

## Questions 2.1

1. A table saw.
2. A jigsaw.
3. A **planer** and a **joiner**.
4. The table should be set at an angle to allow for angled cuts, which helps create precise shapes and designs in the workpiece

5. Use a jigsaw on piece A to make a curved cut.
6. Use a bandsaw on piece B for a pattern cut.
7. Use a router on piece C to make a groove cut.
8. Use a chisel or router on piece D to perform a rebate cut.
9. Consider the type of cut needed, the size of the wood, and the desired precision.
10. Always wear protective gear, follow the machine's instructions, and keep your hands away from the blade.
11. Using the right machine ensures better accuracy, efficiency, and quality in the finished work.

## Questions 2.2

1. Excavation is the process of removing earth, rock, or other materials from a site to form a cavity or cut. Trenching, a specific type of excavation, involves creating narrow but deep cuts in the ground, primarily to install pipelines, cables, or drainage systems.

**Reasons for trench excavations include:**

- **Utility Installation:** Laying underground pipelines, cables, or other utility infrastructure.
- **Foundation Work:** Preparing ground for the foundations of structures.
- **Drainage Systems:** Creating pathways for water drainage.
- **Road and Rail Construction:** Forming sub-structures for transport routes.

2.

### Simple Methods

- **Manual Excavation:** Using hand tools like shovels, spades, and pickaxes for small-scale, shallow work.
- **Light Machinery:** Employing small excavators or backhoes for less complex projects.

### Complex Methods

- **Hydraulic Excavation:** Utilising hydraulic excavators, which provide more power and precision for larger or deeper excavations.
- **Trenching Machines:** Using specialised trenchers for efficient and precise trench creation.
- **Blasting:** Involving explosives to break hard rock or dense materials, typically requiring rigorous planning and safety protocols.

3. **Major Methods of Excavating Trenches**

- **Manual Digging:** Suitable for small, shallow trenches. Limited by labour intensity and time.
- **Excavators:** Commonly used for moderate to large-scale trenches. Provide efficiency and depth control.
- **Trenchers:** Specialised machines that can create trenches quickly and uniformly. Ideal for installing utilities.
- **Directional Drilling:** Used when surface disruption must be minimised. Suitable for utilities under existing infrastructure.

### Safety Precautions

- **Shoring and Shielding:** Prevents trench collapse and protects workers.
- **Sloping and Benching:** Reduces the risk of soil slides in deeper trenches.
- **Trench Boxes:** Provides a safe working environment within the trench.
- **Utility Location:** Marking existing underground utilities to prevent accidental damage.
- **Personal Protective Equipment (PPE):** Ensures workers are equipped with helmets, gloves, and other necessary safety gear.

## Questions 2.3

1. Surfaces should be cleaned daily, ideally at the end of each workday, to remove dust and debris that can affect machine performance.
2. Gears should be lubricated at least once a week, or more frequently if the machine is in heavy use, to ensure smooth operation and prevent wear.
3. Machines should be checked for wear and tear at least once a month, and also before and after heavy usage, to catch any potential issues early.
4. Neglecting machine maintenance can lead to equipment breakdowns, decreased efficiency, increased safety hazards, higher repair costs, and ultimately, longer downtime, which can affect overall productivity.
5. 
   a. To maintain the band saw, regularly check and adjust the blade tension, ensure the blade is sharp and free from debris, clean the guides, and lubricate the wheels as needed.

   b. To care for the thicknesser machine, regularly clean the feed rollers and blades, check for wear on the cutting knives, adjust the height settings accurately, and lubricate moving parts as specified by the manufacturer.

   c. For the circular saw, ensure the blade is sharp and properly aligned, clean the saw table and surrounding area, lubricate the pivot points, and check the safety features regularly to ensure optimal performance.

6. The first step is to clean the machines regularly to remove dust, debris, and any build-up that can affect performance.
7. Machines should be lubricated according to the manufacturer's instructions, typically once a week or more frequently if used heavily.
8. Regularly checking for wear and tears helps identify potential problems early, preventing breakdowns and ensuring the machines operate safely and efficiently.

## Questions 2.4

1. Outline two requirements of foundation concrete:
    - **Strength and durability:** The concrete must be strong enough to support the load of the building and resistant to wear and environmental conditions.
    - **Workability:** The concrete should be easily mixable, transportable, and placeable, ensuring it can be properly installed into the foundation mould.
2. A foundation is a structural element that connects a building to the ground. Its primary function is to evenly distribute the load of the structure to the soil or rock beneath, providing stability and preventing excessive settlement. Foundations can be shallow or deep, depending on soil conditions and the building's load requirements. They ensure the building remains upright and stable under various conditions, including weight, weather, and natural events like earthquakes.
3. Discuss the types of foundation concrete used for building
    - **Plain Concrete:** Used in areas where loads are relatively light. It's typically used in small projects, like sidewalks or patios.
    - **Reinforced Concrete:** This type includes steel bars or mesh to increase its tensile strength. It's commonly used in most building foundations where significant loads need to be supported.
    - **Precast Concrete:** Made in a controlled environment and then transported to the site. It offers high quality and consistency, often used in large-scale projects.
    - **High-Performance Concrete:** Designed to meet specific performance requirements such as high strength or durability, often used in demanding environments.
4. Discuss the factors that affect the choice of a foundation type for a building
    - **Soil Characteristics:** The type, stability, and bearing capacity of the soil play a crucial role in determining the appropriate foundation type.
    - **Load Requirements:** The weight and distribution of the building's load influence whether a shallow or deep foundation is needed.

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- **Water Table Level:** High water tables can affect the choice of foundation, requiring solutions that prevent water infiltration.
- **Environmental Factors:** Climate and natural events like earthquakes or flooding can dictate the type of foundation necessary for stability.
- **Building Design:** The architectural design and intended use of the building will also guide foundation selection to ensure structural integrity. Choosing the right foundation is a balance of these factors to ensure a safe and durable structure. Happy building!

# SECTION 3

## Questions 3.1

1. CAD helps create precise and efficient designs, allowing for better visualisation and accuracy in making artefacts.
2. Design thinking encourages creativity, logic, and problem-solving to develop innovative and user-focused solutions.
3. Design ideas can be expressed through freehand sketches and detailed mechanical drawings created in CAD software.

## Questions 3.2

1. Outlining the various elements used for foundation footings as:
   - **Concrete:** The primary material for footings, providing strength and durability.
   - **Rebar (Reinforcing Steel):** Steel bars embedded in the concrete to increase tensile strength and prevent cracking.
   - **Formwork:** Temporary moulds are used to shape and hold the concrete in place until it sets.
   - **Gravel or Crushed Stone:** A base layer that improves drainage and stability under the concrete footings.
2. Explaining the **foundation footings of a building** as:

   Foundation footings are the lower portion of a building's foundation. They are typically made of concrete and are placed below the frost line to prevent shifting due to freeze-thaw cycles. Footings distribute the weight of the building evenly across a larger area of soil, preventing excessive settlement and providing a stable base for the entire structure.
3. Discuss the functions and importance of foundation footings as;
   - **Load Distribution:** Footings spread the weight of the building over a wider area, reducing the stress on the soil and preventing settlement.

- **Stability:** They provide a stable base for the building, ensuring that it remains upright and secure.
- **Frost Protection:** By extending below the frost line, footings prevent the foundation from being affected by freeze-thaw cycles, which can cause soil movement.
- **Preventing Differential Settlement:** Footings help to prevent uneven settling of the building, which can lead to structural damage over time.

## Questions 3.3

1. To draw the bedside cabinet in a two-point perspective:
   - **a.** Draw a horizon line and place two vanishing points on it.
   - **b.** Start with a vertical line to represent the front corner of the cabinet.
   - **c.** Project lines from the top and bottom of the vertical line to both vanishing points.
   - **d.** Mark the width (400mm) and depth (400mm) along the projected lines.
   - **e.** Draw vertical lines at these points for the cabinet's edges.
   - **f.** Connect these edges to the vanishing points to form the cabinet's shape.
   - **g.** Add details like doors or drawers within the structure, maintaining the perspective.
2. To draw the isometric view of the bedside cabinet:
   - **a.** Begin by setting up a 30° angle from the horizontal for the base edges.
   - **b.** Draw a 400mm × 400mm base rectangle at this angle.
   - **c.** Project vertical lines from the base corners to a height of 500mm.
   - **d.** Connect the top edges to complete the isometric box shape.
   - **e.** Add features like drawers or handles, ensuring all lines follow the isometric perspective.
3. To draw the bedside cabinet in third-angle orthographic projection

### Front Elevation:

- **a.** Draw the height (500mm) and width (400mm) as viewed from the front.
- **b.** Include visible features like drawers or doors.

**Plan**: Represent the top view (400mm × 400mm) with the arrangement of internal features if the top is removed.

### Sectional End Elevation:

- Draw a vertical cut through the centre of the cabinet to show internal details.
- Represent the depth (400mm) and height (500mm) from the side.

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4. Working drawings provide detailed and accurate information about the size, proportions, and relationships of the components of a design to guide construction or manufacturing.
5. The two main types are pictorial drawings (e.g., isometric) and orthographic projections (e.g., front, plan, and end views).
6. They ensure precision, clarity, and adherence to design standards, making the drawings easy to interpret and implement.

## Questions 3.4

1. **Column Formwork:**
   - Designed to shape and support concrete columns.
   - Typically, vertical and may include internal bracing to handle high loads.
   - Often requires stiffening to prevent bulging due to the height and pressure of the wet concrete.

**Beam Formwork:**

- Used to shape and support concrete beams.
- Generally horizontal, supported by props or scaffolding.
- Needs to accommodate the width and depth of the beam, with provisions to support the sides and bottom until the concrete sets.

2. The various materials used for formworks during construction
   - **Timber:** Easy to work with, commonly used for smaller projects.
   - **Steel:** Durable and reusable, ideal for large, repetitive projects.
   - **Aluminium:** Lightweight, easy to handle, offers a good balance between strength and weight.
   - **Plywood:** Used as sheathing for timber formwork, flexible and adaptable.
   - **Plastic:** Reusable, easy to clean, suitable for custom shapes and smooth finishes.
3. The various types and functions of formworks
   - **Traditional Timber Formwork:**
     - Made from wood, cost-effective for small-scale projects.
     - **Functions:** Provides shape, supports loads, and ensures alignment.
   - **Engineered Formwork Systems:**
     - Prefabricated modules, often made of steel or aluminium.
     - **Functions:** Reusable, efficient, speeds up construction time.

- **Permanent Insulated Formwork:**
  - Stays in place after the concrete has cured, providing additional insulation.
  - **Functions:** Supports concrete during pouring, adds insulation, and improves energy efficiency.
- **Plastic Formwork:**
  - Modular, made from durable plastic.
  - **Functions:** Easy to assemble, reusable, and provides a smooth finish.
- **Slip Formwork:**
  - Continuous formwork that moves steadily upwards as concrete is poured.
  - **Functions**: Ideal for tall structures like chimneys, towers, or silos, allows continuous concrete pouring for seamless construction.

# SECTION 4

## Questions 4.1

**1.**

- **Plywood:** Plywood is durable and strong, making it ideal for furniture that will be used frequently. It is also cost-effective and easy to work with, making it a popular choice for both construction and design.
- **Leather:** Leather is a durable material that offers comfort and luxury. It is resistant to wear and tear, making it suitable for high-traffic areas like lounge seats or chair backs.
- **Steel:** Steel is a strong and durable material, perfect for structural support in furniture. It is resistant to wear and can withstand heavy use in high-traffic environments.

**2.**

- **Moisture Resistance:** Non-wood materials like plastic or metal are water-resistant, making them ideal for environments with high moisture, such as bathrooms. They won't warp or rot like wood might.
- **Durability:** Materials like metal or plastic are often more durable and resistant to wear and tear, making them suitable for furniture exposed to regular use in moist conditions.
- **Ease of Maintenance:** Non-wood materials are easier to clean and maintain in damp environments. They are less prone to absorbing water, which can cause damage to wooden materials over time.

**3.**

- **Use of Recycled Materials:** I will choose materials like recycled wood, metal, or plastic to reduce waste and minimise the environmental impact. Sourcing from Sustainable Providers: I will select materials from suppliers who follow sustainable practices, ensuring that the raw materials are responsibly harvested or produced.
- **Durability and Longevity:** I will choose durable materials that can withstand wear and tear, reducing the need for replacements and extending the lifespan of the furniture.

**4.** Factors include durability, cost, suitability for the intended use, aesthetic appeal, and environmental impact.

**5.** Durability ensures the furniture can withstand frequent use, wear, and environmental factors, making it last longer and remain functional.

**6.** The properties like strength, flexibility, and resistance to moisture influence how well the material performs in the intended environment and how the product can be shaped or styled.

## Questions 4.2

**1.** Explaining the floors as: Explaining the horizontal layer with the surface on which people walk within a building. It serves as a platform for various activities and is typically supported by beams, columns, or walls. Floors can be made of different materials, such as concrete, wood, or tile, and they can be part of different levels or stories within a structure.

The various types used in building construction are listed in the table below.

| Type of Floor | Description | Common Uses |
|---|---|---|
| **Ground Floor** | The first floor is at or near ground level. | Entry areas, lobbies, retail spaces. |
| **Upper Floors** | Any floor above the ground level. | Residential units, offices, or commercial spaces. |
| **Raised Floor** | Elevated above the base level, often with a space underneath. | Data centres, and office buildings for cabling. |
| **Suspended Floor** | Supported by beams or joists, not directly on the ground. | Basements, multi-story buildings. |
| **Structural Floor** | Designed to support heavy loads. | Parking garages, industrial buildings. |
| **Concrete Floor** | Made of poured or precast concrete. | Warehouses, industrial spaces, high-rise buildings. |
| **Wood Floor** | Constructed from timber or engineered wood products. | Residential homes, cabins, and some commercial spaces. |
| **Composite Floor** | Combines materials like concrete and steel. | High-rise buildings, bridges. |

| | | |
|---|---|---|
| **Vinyl or Tile Floor** | Finished with vinyl, tiles, or other materials. | Residential, commercial, and healthcare facilities. |
| **Carpeting Floor** | Covered with carpet for comfort and aesthetics. | Offices, hotels, and residential spaces. |

2. Distinguishing ***upper floors from ground floors are as follows:***
   - Upper floors are the levels above the ground floor, forming additional stories in a multi-level building. These floors can be constructed using various materials, including wood, steel, and concrete, depending on the building's design and requirements. Upper floors are supported by a framework of beams and columns that distribute loads down to the foundation. They house essential spaces like bedrooms, offices, and other functional areas, providing separation from the ground floor and additional living or working space.
   - Ground floors are the first level of a building, resting directly on the ground or slightly above it. They are usually constructed using materials like concrete, tiles, or hardwood, designed to support heavy foot traffic and loads from furniture and equipment. These floors are typically insulated to prevent heat loss and moisture ingress, providing a stable and comfortable living or working environment. In residential and commercial buildings, ground floors often contain key areas such as living rooms, kitchens, and entryways.
3. Ensuring safety precautions observation during the construction of floors is a very necessary requirement to prevent structural failure which may result in injury to the workers. The following are the main safety precautions that need to be observed during the construction of floors:
   - Ensure that there is proper planning and design of the floor that meets all building codes and standards.
   - Conduct thorough soil testing and structural analysis before construction to avoid any unforeseeable problems.
   - Select high-quality materials that are suitable for the specific type of floor construction.
   - Verify the quality and consistency of concrete, wood, or other materials used for the floor construction.
   - Ensure that all workers are adequately trained in safe construction practices of floors.
   - Highly experienced supervisors should oversee the construction process of floors.

## Questions 4.3

1. Steps to produce the model:
   - Study the design, dimensions, and requirements.

- Choose the appropriate type and quantity of wood.
- Measure and mark the wood accurately.
- Cut the wood to the required shapes and sizes.
- Mark the joints using appropriate tools.
- Use tools like saws and chisels to cut the joints.
- Fit and trial-assemble parts before final assembly.
- Smooth and refined surfaces.
- Apply a protective finish.
- Check for quality, and accuracy, and make adjustments as needed.

**2.** Use the following appropriate materials: Mahogany, Sapele, and /or bamboo by following the steps in the response for question 1 answers above.

**3.** The purpose is to create a tangible version of the design to test, refine, and ensure it meets the required standards before final production.

**4.** The steps include interpreting the drawing, selecting materials, preparing and cutting pieces, marking and cutting joints, assembling, shaping, finishing, and quality checking.

**5.** Safety ensures that tools are used correctly, prevents injuries, and protects both the user and the quality of the model during production.

## Questions 4.4

**1.** Explaining load-bearing and non-load-bearing members of the superstructure as:

- **Load-bearing members** are components that support and transfer loads (weight) from the structure above to the foundation below. Examples are; walls (load-bearing walls), columns, beams and foundations. On the other hand, **Non-Load-Bearing members** are the components that do not support any structural loads other than their own weight. Examples of non-load bearing members are; partition walls, cladding or facades and decorative elements.

**2.** Differences between load-bearing and non-load-bearing members of the superstructure

| Load-Bearing Member | Role | Description/Function |
|---|---|---|
| **Columns** | Vertical supports that transfer loads from beams and slabs to the foundation. | Vertical structural elements that support loads from beams and slabs, transferring them to the foundation. |
| **Beams** | Horizontal structural elements that span between columns, supporting floor and roof loads. | Horizontal structural elements that span between columns, supporting floor and roof loads. |

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| **Slabs** | Horizontal planes that form the floors and roofs, distributing loads to beams and columns. | Horizontal structural elements that form the floors and roofs of a building, distributing loads to beams and columns. |
| **Walls** | Vertical elements that enclose spaces and support loads, transferring them to the foundation. | Vertical structural elements that enclose spaces and can also support loads, especially in load-bearing wall systems. |
| **Trusses** | Triangular frameworks that efficiently span long distances are often used for roofs and bridges. | Triangular frameworks are composed of interconnected members that efficiently span long distances, often used for roofs and bridges. |
| **Girders** | Large, primary beams that support other beams and loads. | Large, primary beams that support other beams and loads. |

| Non-Load-Bearing Member | Role | Description/Function |
|---|---|---|
| **Partition Walls** | Space Division | Create separate rooms or areas without supporting loads. |
| **Curtain Walls** | Weather Protection | Provide exterior cladding that shields from the elements but does not support structural loads. |
| **Facade Elements** | Aesthetic Enhancement | Enhance the visual appeal of the building's exterior. |
| **Interior Finishes** | Surface Treatment | Cover walls, ceilings, and floors for aesthetic and functional purposes (e.g., paint, wallpaper). |
| **Ceiling Tiles** | Acoustic Control | Improve sound insulation and aesthetics in interior spaces. |

**3.** The characteristics of the load-bearing and non-load-bearing members of the superstructure.

| Characteristics | Load-Bearing Members | Non-Load-Bearing Members |
|---|---|---|
| **Structural Function** | Supports and transfers loads to the foundation | Does not support any structural loads |
| **Material Strength** | Typically made from strong materials (concrete, steel, masonry) | Usually constructed from lighter materials (drywall, wood) |
| **Design Complexity** | Requires careful design and engineering to ensure stability | Simpler design, as they don't affect structural integrity |

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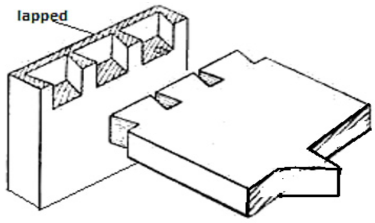
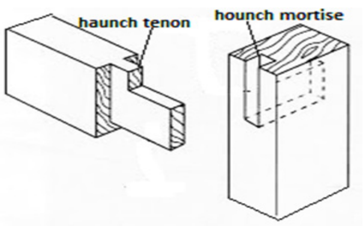
# SECTION 5

## Questions 5.1

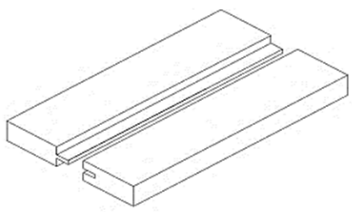
1. Joints used in artefact construction:
   - Mortise and Tenon Joint.
   - Dovetail Joint.
   - Butt Joint.
   - Tongue and Groove Joint
2. Joints connect wood pieces, making the artefact strong and stable. They improve the appearance by hiding gaps and helping spread the weight to prevent damage. Joints also make it easier to assemble and disassemble parts, allow for moving parts like doors or drawers, and help create complex shapes that would be hard with just one piece of wood.
3. Sketch of joints:
   a. **Angle joint:** Lapped dovetail




   b. **Framing joint:** Haunch mortise and tenon joint




   c. **Widening joint:** Tongue and groove



4. Selecting the right joint ensures strength, stability, and a professional finish for the project, making it durable and functional.
5. Consider the purpose of the joint, the type of stress it will bear, the appearance needed, and the ease of assembly.

6. The right joint provides a secure connection, enhances the overall structure, and contributes to the artefact's durability and visual appeal.

## Questions 5.2

1. Explaining walls in construction is as follows:

Walls are vertical structures that define spaces within a building. They serve several purposes, including supporting the weight of the roof and floors, dividing spaces for privacy and organisation, protecting the interior from weather and intruders, providing insulation and soundproofing, and sometimes serving decorative or aesthetic functions.

2. Outline of various types of walls in construction is as follows:

| Type of Wall | Description | Purpose |
|---|---|---|
| **Load-Bearing Walls** | Walls that support and transfer loads from above to the foundation. | Provide structural support and stability. |
| **Non-Load-Bearing Walls** | Walls that do not support any structural loads from above. | Divide spaces without affecting structural integrity. |
| **Exterior Walls** | Walls that form the outer shell of a building. | Protect from weather and environmental elements. |
| **Interior Walls** | Walls that separate rooms within a building. | Define functional areas and improve privacy. |
| **Partition Walls** | Non-load-bearing walls create separate rooms or spaces. | Flexible divided interior spaces for different uses. |
| **Retaining Walls** | Walls that hold back soil or other materials, preventing erosion or collapse. | Stabilise slopes and prevent ground movement. |
| **Curtain Walls** | Non-structural walls, typically made of glass or lightweight materials, are attached to the frame of a building. | Provide aesthetic appeal and natural light while protecting from the elements. |
| **Firewalls** | Walls are designed to contain fire and prevent its spread between different sections of a building. | Enhance safety by providing fire resistance. |
| **Shear Walls** | Vertical walls that provide lateral stability to a building, especially in high-rise structures. | Resist lateral forces from wind and earthquakes. |
| **Soundproof Walls** | Walls constructed with materials that minimise sound transmission. | Enhance acoustic comfort and privacy in living or working spaces. |

3. Discussion of various types of walls and their functions in construction are as follows:

| Type of Wall | Functions |
|---|---|
| **Load-Bearing Walls** | • Support and transfer loads from floors and roofs to the foundation.<br>• Provide structural stability and integrity to the building. |

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|---|---|
| **Non-Load-Bearing Walls** | • Divide spaces into rooms or areas.<br>• Allow for flexibility in interior layouts without affecting structural integrity. |
| **Exterior Walls** | • Protect the interior from weather elements (rain, wind, snow).<br>• Provide insulation for temperature control.<br>• Enhance the building's aesthetic appeal. |
| **Interior Walls** | • Separate different functional spaces within the building.<br>• Provide privacy and acoustic separation between rooms. |
| **Partition Walls** | • Create flexible divisions in space that can be easily modified or removed.<br>• Help in configuring spaces for different uses. |
| **Retaining Walls** | • Hold back soil or prevent erosion.<br>• Stabilise slopes and prevent ground movement, especially in hilly areas. |
| **Curtain Walls** | • Provide a nonstructural facade that allows natural light while protecting from the elements.<br>• Enhance the aesthetic appeal of the building. |
| **Firewalls** | • Contain and limit the spread of fire between different sections of a building.<br>• Provide additional time for occupants to evacuate safely. |
| **Shear Walls** | • Resist lateral forces from wind and seismic activity.<br>• Provide vertical stability and strength to tall buildings. |
| **Soundproof Walls** | • Minimise sound transmission between spaces.<br>• Enhance acoustic comfort in residential and commercial buildings. |

## Questions 5.3

**1.** Two types of adhesives commonly used:

- PVA (White Glue)
- Epoxy Resin

**2.** Three factors to consider when choosing an adhesive:

**a.** **Resistance to Damp:** Choose an adhesive that resists moisture for outdoor furniture.

**b.** **Setting Time:** Consider how long the adhesive takes to set, especially if you need time to align parts.

**c.** **Application of Pressure:** Some adhesives need pressure to form a strong bond, so ensure you can apply it during assembly.

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3. How to apply adhesive:
   a. Evenly spread the adhesive on both surfaces.
   b. Press the pieces together firmly to ensure a strong bond.
   c. Clamp the pieces in place and allow the adhesive to set according to the recommended time.
4. PVA is used for general indoor woodworking projects.
5. Epoxy resin is used for bonding wood to metal or for strong, durable joints.
6. Casein glue is moisture-resistant, making it suitable for outdoor use.

## Questions 5.4

1. Explaining the doors and windows that are used in buildings as:

Buildings use various types of doors and windows for different purposes. Doors include hinged doors for easy access and security, sliding doors to save space, pocket doors for small spaces, panel doors for durability and style, and flush doors for a modern look. Windows include casement windows for good ventilation, sliding windows for space-saving, double-hung windows for flexible airflow, and fixed windows for light without opening. Each type is chosen based on space, security, and design factors.

2. For doors, I would choose:
   - **Single Swing Doors:** Open in one direction; common in residential and commercial settings.
   - **Double Swing Doors:** Open in both directions; often used in restaurants and shops.
   - **Sliding doors:** to save space and suit large openings.
   - **Pocket doors:** Slide into the wall, saving space.
   - **Bypass Doors:** Slide on a track and overlap each other.

For windows, I would choose:

- **Casement windows:** Hinged on the side; open outward for maximum ventilation.
- **Sliding-hung windows:** Bottom sash opens; top remains fixed.
- **Double-hung windows:** Both sashes can open for ventilation.
- **Awning Windows:** Hinged at the top; open outward to allow ventilation while keeping rain out.
- **Hopper Windows:** Hinged at the bottom; open inward, often used in basements.

3. Outlining the various materials used in the production of doors and windows as:

- **Wood:** for its durability, natural appearance, and insulation properties.
- **Aluminium:** for its lightweight, strength, and resistance to corrosion.
- **Steel:** for its high strength and security features.
- **Vinyl:** for its affordability, low maintenance, and energy efficiency.
- **Glass:** for allowing natural light and enhancing aesthetics.
- **Fiberglass:** for its strength, weather resistance, and insulation.

4. **For doors:**

- **Single Swing Doors:** Commonly used for entryways; easy operation.
- **Double Swing Doors:** Facilitate high traffic flow; ideal for commercial spaces.
- **Sliding doors:** Save space; provide seamless access to outdoor areas.
- **Pocket doors:** Concealed when open; maximize floor space.
- **Bypass Doors:** Efficient use of space; allow for wider openings.

**For Windows:**

- **Casement windows:** Maximises airflow; easy to clean; ideal for hard-to-reach areas.
- **Sliding-hung windows:** Cost-effective; easy to operate; common in residential settings.
- **Double-hung windows:** Versatile ventilation options; easy to clean
- **Awning Windows:** Protect against rain while allowing ventilation; good for wet climates.
- **Hopper Windows:** Suitable for basements; allow for ventilation without compromising security

5. Discussion of advantages and disadvantages of doors and windows are as follows:

| Type | Advantages | Disadvantages |
|---|---|---|
| **Doors** | | |
| **Hinged Doors** | Easy to install and operate; versatile designs available. | Space-consuming when opened; can be less secure if poorly installed. |
| **Single Swing Doors** | Simple operation; common and affordable. | Limited access space; can block pathways when open. |
| **Double Swing Doors** | Allow for wider openings; suitable for high-traffic areas. | Requires more space for operation; can be more complex to install. |

| | | |
|---|---|---|
| **Sliding Doors** | Space-saving; seamless transition between indoor and outdoor spaces. | Can be less secure; tracks may require maintenance. |
| **Pocket Doors** | Concealed when open, maximising space; modern look. | Installation can be complex; and requires wall space. |
| **Bypass Doors** | Efficient space use; suitable for closets or sliding partitions. | Limited access when closed; may need frequent maintenance. |
| **Folding Doors** | Create large openings; and flexible space usage. | Can be more expensive; and may require more maintenance. |
| **Windows** | | |
| **Fixed Windows** | Provide unobstructed views; enhance natural light. | No ventilation; harder to clean. |
| **Operable Windows** | Allow for ventilation; improve indoor air quality. | May require more maintenance; and can be less energy efficient. |
| **Single-Hung Windows** | Affordable; easy to operate; and commonly available. | Limited ventilation options; harder to clean exterior. |
| **Double-Hung Windows** | Versatile; easy to clean; provides better airflow. | More complex designs; can be more expensive. |
| **Sliding Windows** | Space-efficient; easy to operate; modern aesthetics. | Tracks may require maintenance; and can be less secure. |
| **Casement Windows** | Excellent ventilation; easy to clean; good for tight spaces. | Can be less secure; may not fit all architectural styles. |
| **Awning Windows** | Protect against rain while allowing airflow; energy-efficient. | Limited ventilation when closed; can be difficult to clean. |

# SECTION 6

## Questions 6.1

**1.**

| Nails | Screws |
|---|---|
| Common nails<br>Finish nails<br>Cut floor brad, etc. | Countersunk head screw<br>Roundhead screw<br>Raised head screw, etc. |

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**2.**

- **a. Hinges:** Allow doors or lids to pivot open and closed.
- **b. Stays:** Hold lids or flaps in a fixed position, either open or closed.
- **c. Locks:** Secure doors or compartments to prevent unauthorized access.
- **d. Magnetic Catch:** Keeps doors or panels closed with magnetic force.
- **e. Castors:** Enable furniture to move easily by adding wheels.

**3.**

- **a. Screws**: Drill pilot holes, align the screw and tighten with a screwdriver or drill.
- **b. Hinges**: Mark hinge positions, drill pilot holes, and secure with screws.
- **c. Locks**: Align the lock mechanism, mark screw holes, and attach with screws, ensuring proper alignment with the locking counterpart.

**4.** Consider the artefact's purpose, the type of wood, and the load or stress it will bear.

**5.** Screws, nails, hinges, and brackets are commonly used.

**6.** Use the correct size, drill pilot holes if needed, and tighten properly without damaging the wood.

## Questions 6.2

**1.** Explaining the roof as a component of the superstructure of a building as:

- The roof is one of the main components of the superstructure of a building. It has several key elements that contribute to the overall function, aesthetics, and performance of a building. The roof of a building has a variety of components that play crucial roles in the protection, energy efficiency, aesthetics, and structural integrity of the structure. The design of the roof and materials for the construction are essential considerations that will lead to an effective structure.

**2.** Distinguishing the Trussed Rafter-Purlin system from the Purlin system and outline the main limitations each has as:

- Roof systems play very crucial roles in the overall function of buildings. There are a variety of roof systems employed at the construction sites depending on the choice of the client. It is also based on the aesthetic appeal of the roof systems. Your study of the difference between the main types of roof systems very often used at the building sites will enhance your knowledge and understanding of roofs construction on sites. The trusted rafter purlin system and the purlin system of roofing are two distinct methods used in roof construction, each with its own advantages and applications. The trusted rafter purlin system involves using rafters, which are individual beams cut and set in place to form the roof's framework, providing flexibility in design and potential for attic conversions.

On the other hand, the purlin system typically refers to a method where roofing materials are applied directly to a solid deck or substrate, often used in conjunction with trusses, which are prefabricated triangular structures that offer strength and efficiency. Understanding the differences between these systems can help in selecting the best approach for a specific roofing project.

**3.** Outlining the different categories of roofing materials available in the Ghanaian building Industry and discuss the major limitations one may encounter in using them as:

| Part | Description | Functions |
|---|---|---|
| **Rafters** | Sloped structural members that support the roof. | Provide the primary framework and shape of the roof. |
| **Trusses** | Pre-fabricated triangular structures are used instead of rafters. | Support the roof load over larger spans. |
| **Purlins** | Horizontal members that run between rafters or trusses. | Provide additional support for roofing materials. |
| **Decking** | The flat surface material (usually plywood or OSB) is attached to the rafters. | Acts as a base for roofing materials and provides a surface for walking during installation. |
| **Underlayment** | A layer of material (like felt or synthetic) is placed under roofing materials. | Provides additional waterproofing and protects the decking. |
| **Roof Covering** | The outermost layer of materials (shingles, tiles, metal, etc.). | Protects the building from weather elements and enhances aesthetics. |
| **Eaves** | The lower edge of the roof overhangs the walls. | Helps to direct water away from the building and provides shade. |
| **Soffit** | The underside of the eaves. | Provides ventilation and protects the rafters from the weather. |
| **Fascia** | A vertical board that runs along the edge of the roof. | Supports the lower edge of the roof and holds the gutter system. |
| **Gutters** | Channels attached to the fascia to collect and redirect rainwater. | Prevents water damage to the foundation and walls. |
| **Downspouts** | Pipes that carry water from gutters to the ground. | Directs water away from the building's foundation. |
| **Ventilation** | Systems or openings (like ridge vents, and soffit vents) for airflow. | Prevents heat buildup and moisture accumulation in the attic. |

### Limitations to the roofing materials in Ghana are as follows

- **Asbestos Roofing:** Asbestos was a popular roofing material in the past due to its durability and fire resistance. However, it has since been banned in many countries due to its dangerous health effects.
- **Built-up roofing (BUR) is heavier than other flat roofing systems, which may require additional support structures.**
- BUR roofing has a shorter lifespan than other roofing options, such as PVC or TPO.
- Aluminium is softer and more malleable than other metals, so it can dent more easily during and after installation.
- Asbestos was a popular roofing material in the past, but it has been banned in many countries due to its dangerous health effects.
- Roof leaks can occur due to standing water, poor seams, and improper installation of flashing and moisture barriers.

## Questions 6.3

**1.**

- **Varnish:** A durable finish that provides a glossy, protective coating. It is ideal for furniture that will be exposed to moisture or wear.
- **Oil (e.g., Tung or Linseed Oil):** Penetrates the wood to enhance the natural grain. It provides a matte finish and is easy to apply but requires regular maintenance.
- **Polyurethane:** A tough, long-lasting finish that comes in both glossy and satin finishes. It provides excellent protection against scratches, stains, and water damage.

**2.**

- **Purpose of the Artefact:** Consider if the artefact will be used indoors or outdoors, as outdoor items require finishes that can withstand weather conditions.
- **Durability:** Choose a finish based on how much wear and tear the item will endure. For high-use items, select finishes that are resistant to scratches and stains.
- **Aesthetic Appearance:** Think about the desired look (e.g., glossy, matte, or natural). The finish should enhance the wood's colour and grain without overpowering its natural beauty.

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**3.**

- **Prepare the Surface:** Sand the artefact to ensure it's smooth and free from dust, using appropriate grit sandpaper.
- **Apply the Finish:** Use a brush, cloth, or applicator to evenly apply the finish (e.g., varnish, oil, polyurethane) in thin coats.
- **Allow Drying Time:** Let each coat dry completely before applying the next and wipe off any excess finish to prevent streaks or uneven layers.

**4.** Varnish is used to provide a durable, glossy finish that protects wood from moisture, stains, and wear, making it ideal for furniture and high-use items.

**5.** Oil finishes, like tung or linseed oil, are applied by rubbing the oil into the wood to enhance the grain and provide a natural, matte finish. It's ideal for indoor furniture and decorative items.

**6.** Polyurethane is used for items that need strong protection against scratches, moisture, and stains, such as floors, tables, or kitchen items. It provides a tough, durable coat.

## Questions 6.4

**1.** Explaining the ceiling as a component of the superstructure of a building as:

The ceiling is an essential part of the building's superstructure. It provides a finished surface for the interior, helps insulate the room, conceals structural elements like beams and pipes, and contributes to the building's overall appearance and comfort.

**2.** Distinguishing between the suspended ceiling and the tightly attached ceiling as:

| Feature | Suspended Ceiling | Tightly Attached Ceiling |
|---|---|---|
| **Definition** | A ceiling that hangs below the main ceiling structure, typically using a grid system. | A ceiling that is directly affixed to the roof structure, often with minimal support. |
| **Installation** | Requires a grid framework for installation; more complex. | Generally simpler installation, directly attached to the structural elements. |
| **Accessibility** | Allows easy access to above-ceiling space for maintenance of utilities. | Limited access; more difficult to reach any systems above. |
| **Aesthetic Options** | Offers various design options, including tiles and panels that can be easily changed. | Typically has a more uniform appearance, with fewer design options. |
| **Sound Insulation** | Provides better sound absorption and insulation due to the materials used in tiles. | May offer less acoustic performance depending on the materials used. |
| **Fire Resistance** | Can enhance fire safety with specific fire-rated tiles. | Fire resistance depends on the materials used; may not have dedicated fire features. |

| | | |
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| **Cost** | Usually more expensive due to the grid system and tiles. | Generally, more cost-effective due to simpler installation and fewer materials. |
| **Weight** | Lightweight due to the use of lightweight tiles. | May be heavier, depending on the materials used for the ceiling. |
| **Ceiling Height** | Can reduce ceiling height slightly, depending on the grid system. | Minimal impact on ceiling height, as it is attached directly. |

**3,** Discussing how ceilings can improve the comfort levels of users of the facilities :

The ceiling can improve comfort in several ways. It helps with insulation, keeping the room warmer in cold weather and cooler in hot weather. It also reduces noise by acting as a sound barrier, creating a quieter environment. A well-designed ceiling can also enhance lighting, making the space brighter and more pleasant. Additionally, it can conceal electrical wires and pipes, making the space feel cleaner and more organised, all of which contribute to a more comfortable experience for users.

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# GLOSSARY

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|---|---|
| **Abrasive** | A material used to smooth or polish a surface by rubbing or grinding. |
| **Access** | The ability to enter or move through a space, facilitated by doors. |
| **Accuracy** | The precision of measurements and cuts in a model. |
| **Acoustic Control** | Techniques and materials used to manage and reduce sound transmission within a building, enhancing privacy and comfort. Examples: Soundproofing insulation, acoustic panels, and sound-absorbing materials. |
| **Acoustic Insulation** | Materials or techniques used to prevent the transmission of sound between spaces, enhancing privacy and reducing noise pollution. |
| **Aesthetic Enhancement** | Improvements made to a building's appearance to increase its visual appeal and contribute to its overall design. Examples: Decorative elements, colour schemes, and architectural features. |
| **Aesthetic** | The principles or elements that define the visual appeal or beauty of an object or space. |
| **Aesthetics** | The visual appeal or design of doors and windows in a building. |
| **Aesthetics** | The visual appeal or design quality of the ceiling that enhances the interior of a room or building. |
| **Air Pressure** | The force of air that helps spray paint or finish evenly through a spray gun. |
| **Anchor Bolt** | A fastener used to attach structures or objects to concrete, providing stability. |
| **Appearance** | The visual quality or finish of a woodwork project. |
| **Application** | The act of spreading or applying adhesive to surfaces. |
| **Appropriate** | Suitable or correct for a specific task. |

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| **Artefact** | A product or object designed and made for a specific purpose, often by hand or machine. |
| **Assemble** | The process of fitting and joining parts together to create a model. |
| **Assembly** | The process of putting together various parts of a piece of furniture or structure using fasteners and fittings. |
| **Basement Floor** | A floor located below the ground level, often used for storage, utilities, or additional living space. |
| **Beam** | A horizontal structural element that supports loads and transfers them to vertical supports like columns or walls. |
| **Bevel Cut** | An angled cut along the edge of a wood, used for joining pieces. |
| **Boundaries** | The defined limits of a property or construction site, often marked to prevent encroachment. |
| **Breakdown Maintenance** | Repairs performed after a machine has stopped working due to failure. |
| **Brief** | A short, clear statement outlining the purpose and goals of a design project. |
| **Brush** | A tool used to apply finishes to surfaces, typically made of bristles attached to a handle. |
| **Building Codes** | Regulations and standards established by authorities to ensure the safety, health, and welfare of occupants by governing building design, construction, and maintenance. |
| **Building codes** | Regulations that specify the standards for construction, ensuring safety and compliance with legal requirements. |
| **Building drawing** | Technical diagrams that represent the design, dimensions, and specifications of a building. |
| **Building footprint** | The area of ground covered by the building structure, often used to determine zoning and compliance with regulations. |

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| **Calibration** | Adjusting machine settings to ensure accuracy and optimal performance. |
| **Cavity wall** | A wall consisting of two separate layers (or "skins") with a gap (or "cavity") between them, often used for insulation. |
| **Chemical Exposure** | The contact of materials with potentially damaging chemicals, which can lead to degradation. |
| **Cleaning** | Removing dirt and debris from tools to prevent rust and ensure proper functionality. |
| **Clearance Hole** | A hole drilled to allow a screw or bolt to pass through without touching the surrounding material, ensuring smooth movement. |
| **Comfort** | The state of physical ease and well-being, which can be improved by the ceiling's insulation, soundproofing, and design. |
| **Command Window** | The input area in CAD software where users type commands to execute specific actions. |
| **Complex Method** | Techniques or procedures that are intricate and involve multiple steps or considerations. |
| **Component** | An individual part or element of a larger system or structure. |
| **Concealment** | The act of hiding structural elements like beams, pipes, and wiring within the ceiling. |
| **Concrete Structure** | A construction made from concrete, such as buildings, bridges, or roads, known for its durability and strength. |
| **Conditions** | The state of something regarding its appearance, quality, or working order; it can also refer to circumstances affecting the functioning or outcome of a process or event. |
| **Consistent Concrete** | Concrete that has a uniform composition and properties throughout the entire mix. It ensures that the concrete has the desired strength, durability, and workability, leading to reliable performance. |

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| **Consolidate** | To make something physically stronger or more solid; in other contexts, to combine multiple elements into a single, more efficient whole. |
| **Construction** | The process of building or assembling structures like walls. |
| **Container** | The part of a spray gun where the finishing liquid (paint, varnish, etc.) is held. |
| **Control points** | Key points established on a construction site that guide the positioning of all other elements. |
| **Cost Effective** | Providing good value for the amount of money spent; economical. |
| **Countersink** | A technique of enlarging the opening of a hole so that the head of a screw sits flush with or below the surface of the wood. |
| **Cross Section** | A view or drawing showing what the inside of an object looks like when it is cut through horizontally or vertically. |
| **Curing** | The process by which adhesive reaches its maximum strength after application. |
| **Customisation** | Modifying something to suit a particular individual or task, often seen in design and construction to meet specific needs. |
| **Debris** | Dust, chips, and other residues that accumulate during machine operation and may affect performance. |
| **Design Complexity** | The intricacy and detail involved in the design of a structure, considering factors like aesthetics, function, and engineering requirements. Examples |
| **Design plans** | Detailed plans that outline the structure, materials, and systems to be used in a construction project. |
| **Differential Settlement** | Uneven settling of a building's foundation can cause structural issues. |
| **Digital methods** | Modern techniques using electronic devices like total stations, GPS, and laser levels for precise measurements and layout. |

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| **Dimensioning** | Adding measurements to a drawing to define the size and proportions of the object. |
| **Directional Drilling** | A method of drilling that allows the drill bit to be steered along a curved path, often used to install utilities without disturbing the surface. |
| **Dowels** | Cylindrical wooden or metal pins used to align and reinforce joints in woodworking, ensuring stability and precision in assembly. |
| **Downtime** | The period when a machine is out of service due to maintenance, repair, or malfunction. |
| **Drainage** | The removal of excess water from an area, often through systems like pipes or channels. |
| **Drains** | Channels or pipes that carry away unwanted water from areas like roofs, roads, or building foundations. |
| **Durability** | The ability of a finish to withstand wear, weather, chemicals, or other damaging factors. |
| **Durability** | The ability of a material to withstand wear, pressure, or damage over time, ensuring longevity in the final product. |
| **Durability** | The ability of an adhesive to maintain its bonding strength over time. |
| **Durability** | The ability of an artefact to withstand wear, pressure, or damage over time. |
| **Efficiency** | Achieving maximum productivity with minimum wasted effort or expense. |
| **Elements** | Basic building materials or parts of a structure, such as beams, columns, and walls. |
| **Energy Efficiency** | The ability of doors and windows to reduce energy use by minimising heat loss or gain. |
| **Engineered Wood** | Wood products that are manufactured by binding or fixing strands, fibres, or veneers of wood together with adhesives. |

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| **Environmental Element** | Any external factor or natural condition that affects a building, such as sunlight, rain, wind, snow, and temperature changes, which the structure must be designed to withstand. |
| **Erosion** | The process by which soil and other ground materials are worn away, which can undermine foundations and other structures. |
| **Evaluation** | The assessment of a completed artefact to determine how well it meets its intended function. |
| **Excessive Porosity** | The presence of too many pores or voids within a material, which can weaken its structure. |
| **Exploded View** | A diagram showing the components of an object separated but in their relative positions. |
| **Facade** | The exterior face or front of a building, often treated with decorative materials. |
| **Facades** | The exterior faces of a building, especially the front, which are designed for aesthetic appeal and protection. Examples |
| **Fiberglass** | A strong, lightweight material used in doors and windows, resistant to weather and decay. |
| **Finish** | A coating applied to a surface to protect, enhance, or decorate it. |
| **Finishing** | The final steps to protect and enhance a model's appearance (e.g., painting, varnishing). |
| **First Angle Projection** | A method of orthographic projection used commonly in Europe, showing views arranged as if seen from inside the object. |
| **Fitting** | A hardware component used to connect, secure, or adjust parts in woodwork, such as screws, bolts, or hinges. |
| **Flat-Pack Furniture** | Furniture that is sold in a disassembled form, typically with knockdown fittings for easy assembly and transport. |
| **Flexibility** | The ability of a material to bend or flex without breaking, important for design and comfort. |

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| **Fluid Inlet** | The area in a spray gun where the finish material enters the gun to be sprayed onto the surface. |
| **Foams** | Lightweight materials used for padding or insulation, often used in furniture production for comfort. |
| **Foundation Footings** | The lowest part of a building's foundation that spreads the weight of the structure to prevent settling. |
| **Foundation** | The lower part of a building that transfers structural loads to the ground. |
| **Frontage line** | The boundary line of a property that faces a road or street, used in zoning and planning. |
| **Frost Protection** | Measures taken to prevent the freezing and thawing cycles from damaging the foundation and other structural components. |
| **Function** | The practical purposes of the ceiling, such as insulation, soundproofing, and aesthetic enhancement. |
| **Functional Utility** | The practical and efficient use of space and elements within a building to meet the needs of its occupants. Examples |
| **Functionality** | The practical use or purpose of a wood joint in construction. |
| **Geometric method** | Using geometric principles and calculations to ensure accurate placement of building components. |
| **Glass** | A transparent material made from soda ash, limestone, sand, and recycled glass, used for windows, doors, and decorative features. |
| **Glasspaper** | Abrasive paper used to smooth wood surfaces by rubbing. |
| **Gloss** | The level of shine or reflectivity on the finished surface, ranging from matte to high gloss. |
| **Glue** | An adhesive used to bond wood pieces together in joints. |

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| **Graphic Communication** | The process of conveying ideas through drawings and diagrams. |
| **Grid layout** | A method of setting out where a grid of reference lines is established to guide the placement of building elements. |
| **Grooving** | Cutting a narrow channel into wood for joints or decoration. |
| **Ground Floor** | The floor of a building that is level with the ground, typically serving as the main entry point. |
| **Guard** | A protective device that covers moving parts to prevent accidents. |
| **Hand tools** | Tools operated manually, without electricity, such as saws, hammers, and chisels. |
| **Hardcore filling** | Coarse, hard materials like broken bricks or stones used to create a stable base for floors or pavements. |
| **High Load Bearing** | The capacity of soil or materials to support large loads or weights. |
| **IKEA** | A popular Swedish furniture and home goods retailer known for flat-pack furniture that is easy to assemble using knockdown fittings. |
| **Inspection** | A thorough examination of machinery to detect signs of damage, wear, or potential malfunction. |
| **Insulation** | Material used in walls to reduce heat loss and sound transmission. |
| **Insulation** | The ability of the ceiling to regulate temperature, keeping a room warmer in winter and cooler in summer. |
| **Interface** | The user-friendly layout of tools, menus, and commands in CAD software that facilitates design tasks. |
| **Intricate Shape** | A detailed design cut into wood, requiring precision tools. |
| **Investigation** | The process of researching and analysing a design problem to identify possible solutions. |

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| **Isometric Drawing** | A three-dimensional drawing where all dimensions are scaled equally along three axes. |
| **Joist** | A horizontal support beam used in floors or ceilings to carry loads. |
| **Lacquer** | A type of fast-drying finish applied to wood that provides a hard, glossy surface. |
| **Lateral Forces** | Forces acting horizontally on a structure, such as wind or seismic activity, that can cause it to sway or shift. |
| **Leather** | A flexible, durable material made from animal hides, often used for upholstery and decorative elements in furniture. |
| **Legal boundary** | The defined limits of a property as established by law and legal documents. |
| **Load bearing** | Capable of supporting weight or load; typically refers to walls or beams that carry the weight of the structure above. |
| **Load** | The weight or force carried by a structure, including live loads (people, furniture) and dead loads (building materials). |
| **Load-Bearing** | Refers to structural elements that carry and transfer loads from the building, including its own weight and external forces, down to the foundation. Examples; Walls, columns, and beams that support the building's weight. |
| **Low Bearing** | The ability of soil or material to support relatively small loads without failing. |
| **Lubrication** | The application of oil or grease to moving parts to reduce friction. |
| **Maintenance** | Routine activities to ensure machines operate efficiently and safely, such as cleaning, lubricating, and inspecting. |
| **Maintenance** | Routine practices, including cleaning and inspecting, to keep tools in good working condition and safe to use. |
| **Masonry** | The construction of walls using stone, brick, or concrete blocks. |

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| **Material Selection** | Choosing the right type of wood or materials for the model. |
| **MDF (Medium-Density Fibreboards)** | A manufactured wood product made from compressed wood fibres, commonly used in furniture production. |
| **Mechanical Parts** | Components such as belts, gears, and pulleys that enable machines to function. |
| **Metals** | Materials such as iron, steel, aluminium, and others, used for strength and durability in various applications including furniture and fixtures. |
| **Mitring** | Cutting wood at a 45-degree angle for corner joins. |
| **Model** | A prototype or representation created from a working drawing. |
| **Modification Flexibility** | The ease with which a structure or its components can be altered or adapted without compromising its stability and functionality. Examples |
| **Moisture Control** | Techniques and measures used to manage and prevent the intrusion of water into building materials, helping to avoid mould and decay. |
| **Moisture Resistance** | The ability of an adhesive to withstand exposure to wet conditions. |
| **Needle** | A component of a spray gun that regulates the flow of liquid through the nozzle. |
| **Noise Reduction** | The ceiling's role in minimising sound transmission between rooms or from outside. |
| **Non-Load-Bearing** | Refers to structural elements that do not carry any structural loads apart from their own weight. Examples |
| **Nozzle** | The part of a spray gun that directs the finish onto the surface being sprayed. |
| **Orthographic Projection** | A technique for representing three-dimensional objects in two dimensions, showing different views. |

**Overhang** The part of a roof that extends beyond the exterior walls of a building, providing shade and protection from rain and directing water away from the walls.

**Perspective Drawing** A drawing method where lines converge at vanishing points to create a realistic 3D view.

**Pictorial Drawing** A type of drawing that shows an object in three dimensions, such as isometric, oblique or perspective views.

**Pilot Hole** A small, pre-drilled hole in wood used to guide the insertion of screws or nails and to prevent the material from splitting.

**Plasterboard** A building material made of a gypsum core, used for interior walls and ceilings.

**Plastic** Synthetic material made from polymers, which can be moulded into different shapes, often used for furniture parts and other products.

**Platform** A horizontal surface raised above the surrounding area, used for various purposes in construction.

**Plywood** A type of engineered wood made from thin layers of wood veneer glued together, commonly used in furniture and construction.

**Polishing** The process of smoothing a surface to create a shiny, reflective finish.

**Polyester Resin** A synthetic resin used in the production of composite materials, often used for solid surfaces like countertops.

**Pressure Application** The need to apply force to the adhesive to ensure a strong bond.

**Preventive Maintenance** Scheduled maintenance tasks to prevent machine breakdowns, such as replacing worn-out parts.

**Profile Board** A temporary wooden board set up at construction sites to help mark out levels and positions for foundations or other structures.

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| **Projection Plane** | A flat surface onto which the views of an object are projected in a drawing. |
| **Protective Coating** | A finish that shields the wood surface from environmental damage, such as moisture or heat. |
| **Purlin Roof** | A roofing system where purlins, horizontal beams, are used to support the roof covering and are typically laid across the rafters or trusses to distribute loads. |
| **Push-Stick** | A safety tool used to guide material through a machine, keeping hands at a safe distance from blades. |
| **Rafter** | A sloped structural beam extending from the ridge or hip of a roof to the wall plate, supporting the roof deck and transferring loads to the walls of the structure. |
| **Realisation** | The stage where the designed artefact is constructed or brought to life based on drawings. |
| **Rebar** | Short for reinforcing bar; steel rods used to strengthen concrete by providing tensile strength. |
| **Rebating** | Creating a recess along the edge of the wood for snug joining. |
| **Reference points** | Fixed points used to establish the location and elevation |
| **Regulatory requirement** | Rules and standards set by authorities that must be adhered to in construction projects. |
| **Rendering** | The process of adding details like shading or texture to make a drawing more realistic. |
| **Reputation Management** | Actions taken to influence and maintain a positive perception of an individual or organisation, particularly in the public eye. |
| **Resin** | A solid or semi-solid organic compound used in varnishes and other finishes to form a hard-protective layer. |
| **Resistance to Shrinkage** | The ability of a material to retain its size and shape, especially when drying or curing. |

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| **Ribbon** | A toolbar in CAD software that provides access to various tools and commands for designing. |
| **Ridge** | The highest horizontal line where two sloping roof planes meet, forming the peak of the roof. It is often capped with ridge tiles or other materials to ensure waterproofing. |
| **Risk Mitigation** | Strategies and actions taken to reduce the potential negative impacts of risks associated with a project. |
| **Rust Prevention** | Techniques, such as applying oil, to protect tools from moisture and rust formation. |
| **Safety Protocols** | Rules and procedures established to ensure safe operation and handling of machinery. |
| **Sanding** | Smoothing and refining the surface of the model with sandpaper or tools. |
| **Sectional View** | A representation of an object as if it has been cut to show its internal details. |
| **Segregation** | The separation of different components within a mixture, such as concrete, which can reduce the material's uniformity and strength. |
| **Seismic** | Related to earthquakes or other vibrations of the Earth, often used when talking about seismic activity or seismic waves. |
| **Select** | To choose the correct tool based on the task requirements. |
| **Setting out** | The process of marking the positions of various elements of a building on the ground to guide construction. |
| **Settlement** | The process of a structure or ground slowly sinking which can be due to the weight of the building or natural causes like soil compaction. |
| **Sharpening** | The process of honing the cutting edges of tools to enhance their effectiveness and precision. |
| **Shifting** | Movement of soil or structures, which can lead to misalignment or damage. |

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| **Site Assessment** | The evaluation of a site to determine its suitability for a particular project, considering factors like soil conditions, environmental impact, and regulations. |
| **Site Grading** | The process of levelling or sloping the ground to prepare for construction, ensuring proper drainage and foundation support. |
| **Sketching** | The process of drawing ideas, either freehand or digitally, to represent design concepts. |
| **Soil stabilisation** | Techniques used to improve the strength and stability of soil, making it suitable for construction. |
| **Solid wall** | A wall made from a single material layer, with no cavity, providing structural support. |
| **Soundproofing** | The process by which the ceiling helps reduce noise, improving the acoustic quality of a space. |
| **Spray Gun** | A tool that uses air pressure to apply finishes evenly to a surface by spraying the material through a nozzle. |
| **Stability** | The ability of a structure to remain secure and not collapse under loads or stress. |
| **Stability** | The strength and resistance of a joint to movement or deformation. |
| **Storage** | Organising tools in a safe, dry place to protect them from damage and prolong their lifespan. |
| **Strength** | The ability of a joint to hold and support loads effectively. |
| **Structural Failure** | The loss of load-carrying capacity in a structural component, leading to collapse or significant deformation. |
| **Structural Function** | The role or purpose that a structural element serves within a building, ensuring it supports and resists various loads and forces. Examples |
| **Structural Integrity** | The ability of a structure to withstand its intended loads without experiencing failure or excessive deformation. Examples |

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| **Structural Integrity** | The ability of a structure to withstand its intended load without failing due to deformation, cracking, or collapse, ensuring safety and durability over its intended lifespan. |
| **Structural Support** | A component or system within a building or structure that bears loads, providing stability and strength to resist forces such as gravity, wind, and seismic activity. Examples include beams, columns, and walls. |
| **Subfloor** | The structural layer that supports the finish flooring, providing a stable and level base. |
| **Substructure** | The part of a building or structure that is below ground level, primarily focused on supporting the superstructure. Examples |
| **Substructure** | The part of a building that is below the ground level, including the foundation and other structures that support the superstructure. |
| **Superstructure** | The part of a building above the ground level, including walls, floors, and the roof. |
| **Superstructure** | The part of a building or structure that is above ground level. Examples; Floors, walls, roofs, and any other elements built above the foundation. |
| **Surveying method** | The overall approach or technique used to measure and map a site, such as triangulation or GPS surveying. |
| **Sustainability** | Designing with minimal environmental impact, focusing on efficient use of materials and long-term viability. |
| **Sustainability** | The practice of using materials and methods that do not deplete resources or harm the environment, ensuring long-term ecological balance. |
| **Temperature Regulation** | The ceiling's role in controlling heat flow, improving energy efficiency, and comfort levels within a room. |

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| **Temporary benchmarks** | Temporary reference points used during construction to maintain consistent elevation levels. |
| **Temporary Support** | Provisional structures or devices used to support loads during construction until the permanent structure is in place. |
| **Tensile Strength** | The resistance of a material to breaking under tension. |
| **Thermal Insulation** | A material or method used to reduce the transfer of heat between objects or spaces, helping to keep a building warm in winter and cool in summer. |
| **Third Angle Projection** | A method of orthographic projection where views are arranged as seen from outside the object. |
| **Threaded Insert** | A metal sleeve with internal threads that is embedded into a wood to provide a secure attachment point for bolts or machine screws. |
| **Timber** | Wood used for building and construction, often chosen for its strength and natural aesthetic qualities. |
| **Topography** | The arrangement of natural and artificial features of an area, including its terrain and elevations. |
| **Traditional methods** | Manual techniques such as tape measurements and transits are used in setting out and surveying. |
| **Transportability** | The ability to easily move and assemble furniture, particularly when using knockdown fittings for flat-packed designs. |
| **Trench Boxes** | Protective structures placed in trenches to prevent cave-ins and protect workers during excavation. |
| **Trenching** | Digging long, narrow ditches, typically for laying pipes, cables, or foundations. |

COVER
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SECTION 6
ANSERS TO REVIEW QUESTIONS
GLOSSARY

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| **Trusses** | A framework of triangular units made of straight members, designed to distribute loads efficiently. Trusses are commonly used in roofs and bridges for their strength and lightweight design. |
| **Upper Floor** | Floors that are above the ground floor in a multi-story building, providing additional living or working spaces. |
| **Utility Installation** | The process of installing essential services like water, electricity, gas, and telecommunications on a site. |
| **Vanishing Point** | The point where parallel lines appear to meet in a perspective drawing. |
| **Variations** | Differences or changes in materials, conditions, or processes that can affect outcomes. |
| **Vaulted Ceiling** | A ceiling design that is arched or curved, often used to create a sense of openness and space. |
| **Versatility** | The ability of a material to be used in a wide range of applications, contributing to its selection in different types of products. |
| **Vertical Loads** | Forces acting vertically on a structure, primarily due to the weight of the building and its contents. |
| **Vibration Analysis** | A method of detecting issues in machinery by measuring and analysing vibration patterns. |
| **Visibility** | The aspect of the ceiling that contributes to the overall clarity and brightness of the interior space, often related to lighting design. |
| **Water Drainage** | The system or method used to remove excess water from a site, preventing flooding and erosion. |
| **Water-resistant** | A property of materials that prevents water from damaging or affecting the material, essential for use in environments with high moisture levels. |
| **Wear and Tear** | Gradual deterioration of parts due to regular use over time. |

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| **Weather Forces** | Natural forces caused by weather conditions, including wind pressure, snow loads, hail, heavy rain, and temperature fluctuations, which can impact the performance and durability of a structure. |
| **Weight Distribution** | The way a joint help spread loads evenly across a structure. |
| **Woodwork operation** | Specific tasks in woodworking like cutting, shaping, smoothing, or assembling wood. |
| **Workability** | How easy it is to mix, handle, and place building materials like concrete. |
| **Working Environment** | The conditions and surroundings in which a person performs their job. This includes factors like safety, ergonomics, noise levels, lighting, temperature, and overall workplace culture, all of which can impact an employee's productivity and well-being. |

This book is intended to be used for the Year Two Building Construction and Woodwork Technology Senior High School (SHS) Curriculum. It contains information and activities to support teachers to deliver the curriculum in the classroom as well as additional exercises to support learners' self-study and revision. Learners can use the review questions to assess their understanding and explore concepts and additional content in their own time using the extended reading list provided.

All materials can be accessed electronically from the Ministry of Education's Curriculum Microsite.

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