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Participant Handbook

Sector
Construction Skill Development Council of India

Sub - Sector
Real Estate and Infrastructure Construction

Occupation
Shuttering Carpentry

Reference ID: **CON/Q0302, Version 3.0**

NSQF Level 3

Assistant Shuttering Carpenter

Published by

Construction Skill Development Council of India (CSDCI)
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First Edition, July 2023

This book is sponsored by Construction Skill Development Council of India (CSDCI)

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Shri Narendra Modi
Prime Minister of India

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Certificate

COMPLIANCE TO

QUALIFICATION PACK- NATIONAL OCCUPATIONAL STANDARDS

is hereby issued by the

CONSTRUCTION SKILL DEVELOPMENT COUNCIL OF INDIA

for

SKILLING CONTENT: PARTICIPANT HANDBOOK

Complying to National Ocupational Standards of

Job Role/Qualification Pack: **'Assistant Shuttering Carpenter'**
QP No. 'CON/Q0302, Version 3.0, NSQF Level 3'

Date of Issuance: August 22nd 2019
Valid*: July 24th 2023

*Valid up to the next review date of the Qualification Pack or the 'Valid up' date mentioned above(whichever is earlier)

Authorised Signatory
(Construction Skill Development Council)

Acknowledgements

This participant's handbook, meant for Assistant Shuttering Carpenter, is a sincere attempt to ensure the availability of all the relevant information to the existing and prospective job holders in this job role. We have compiled the content with inputs from the relevant Subject Matter Experts (SMEs) and industry members to ensure it is the latest and authentic. We express our sincere gratitude to all the SMEs and industry members who have made invaluable contributions to the completion of this participant's handbook.

This handbook will help deliver skill-based training in the field of Shuttering Carpentry. We hope that it will benefit all the stakeholders, such as participants, trainers, and evaluators. We have made all efforts to ensure the publication meets the current quality standards for the successful delivery of QP/NOS-based training programs. We welcome and appreciate any suggestions for future improvements to this handbook.

About this book

This participant handbook has been designed to serve as a guide for participants who aim to obtain the required knowledge and skills to undertake various activities in the role of an Assistant Shuttering Carpenter. Its content has been aligned with the latest Qualification Pack (QP) prepared for the job role. With a qualified trainer's guidance, the participants will be equipped with the following for working efficiently in the job role:

- **Knowledge and Understanding:** The relevant operational knowledge and understanding to perform the required tasks.
- **Performance Criteria:** The essential skills through hands-on training to perform the required operations to the applicable quality standards.
- **Professional Skills:** The ability to make appropriate operational decisions about the field of work.

The handbook details the relevant activities to be carried out by an Assistant Shuttering Carpenter. After studying this handbook, job holders will be adequately skilled in carrying out their duties according to the applicable quality standards. The handbook is aligned with the following National Occupational Standards (NOS) detailed in the latest and approved version of Assistant Shuttering Carpenter QP:

- **CON/N0312:** Use and maintain tools and equipment relevant to shuttering carpentry
- **CON/N0313:** Assist in making wooden shutters boards using in shuttering carpentry
- **CON/N0314:** Assist in assembling and dismantling conventional and system formwork for R.C.C structures
- **CON/N0101:** Erect and dismantle temporary scaffold up to 3.6 meter height
- **CON/N8001:** Work effectively in a team to deliver desired results at the workplace
- **CON/N9001:** Work according to personal health, safety and environment protocol at construction site
- **DGT/VSQ/N0101:** Employability Skills 30 Hours

The handbook has been divided into an appropriate number of units and sub-units based on the content of the relevant QP. We hope it will facilitate easy and structured learning for the participants, allowing them to obtain enhanced knowledge and skills.

Symbols Used


Key Learning Outcomes


Exercise


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Unit Objectives


Activity

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It is recommended that all trainings include the appropriate Employability skills Module. Content for the same can be accessed https://www.skillindiadigital.gov.in/content/list

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1. Introduction to Shuttering Carpentry Occupation

Construction Skill Development Council

Unit 1.1 - Introduction to Construction Industry
Unit 1.2 - Role and Responsibilities of an Assistant Shut tering Carpenter

Key Learning Outcomes

By the end of this module, participants will be able to:

- Describe the role and responsibilities of an Assistant Shuttering Carpenter.
- Explain the expected personal attributes for the job role
- Recall the basic terms used in the occupation of shuttering carpentry
- Discuss the future possible progression and career options for assistant shuttering carpenter

Unit 1.1: Introduction to Construction Industry

Unit Objectives

By the end of this unit, participants will be able to:

- Give an overview of construction industry.
- Recall the basic terms used in the occupation of shuttering carpentry

1.1.1 Construction Industry

The construction industry is the oldest and one of the largest in the world, with a market size of over 10 trillion dollars. Construction has traditionally been a contracting sector, and the industry consists of a huge number of small businesses. Currently, the building industry is one of the main economic sectors. It contributes significantly to the national economy and employs a substantial number of people.

Construction Industry in India

During the forecast period, India's construction market is expected to grow at a CAGR greater than 10%. (2022–2027). As COVID-19 spread over the country in April 2020, the Indian construction sector, which was already struggling with poor management and a lack of labour force tracking, totally lost its central grip, bringing an end to the business. COVID-19 caused havoc on all levels and scales of the value chain.

- The availability of building supplies and the rate of price rise were major concerns. The lack of timely implementation due to lockdowns led to cost overruns, significant delays, and even the cancellation of projects.
- Many MSMEs were compelled to close their doors or restrict their activities as a direct result of the cancellation and postponement of projects. This was a major concern because the majority of construction firms and design studios are small and specialise in a certain style of structure.
- Despite the impact of COVID-19 restrictions and lockdowns on construction activity, India experienced 45 million square feet of new supply in 2020, with 36 million square feet coming from tier I cities and 8.9 million square feet from tier II and III cities.
- The 3PL and e-commerce sectors, which accounted for 62 percent of total absorption in 2020, continued to drive warehouse demand in 2021, with the manufacturing sector accounting for 14 percent. Delhi-NCR had the highest absorption rate among India's major cities in 2021, at 18%, followed by Pune at 15%. 14 percent and 11 percent absorption rates were recorded in Mumbai and Bangalore, respectively, with 20 percent in tier II and tier III cities.
- In 2021, industrial and logistics sector investments surpassed USD 1.5 billion, making it the second-largest receiver of such money after the office sector. This asset category has maintained its popularity due to its strong growth rate and regular returns.

The commercial real estate subsector is poised for growth as individuals return to the workplace and organisations adopt hybrid work arrangements. As more companies send their employees back to work, the demand for commercial office space gradually increases.

1.1.2 Types of Construction:

The following are the types of construction:

a. Building construction:

Building construction is the act of adding a structure to the undeveloped ground and adapting it for various uses, including residences, commercial buildings, garages, etc. The bulk of building construction projects involve minor improvements, such as adding a room, renovating a bathroom, enhancing a porch, etc.

There are differences between building construction projects, but there are some aspects and procedures that are universal. For example: design considerations, a budgetary estimate, and ethical and legal factors.

In the case of commercial building construction, multiple strategies are utilised. They consist of Design & Build, Cost Estimating, Competitive Bidding, Contract Management, Construction Management, and Design-Build Bridging.

The governments of all states and nations have enacted laws and regulations governing the construction of both commercial and residential buildings. During the designing and building processes, these norms and regulations must be properly adhered to. The materials required for the construction process should be readily accessible at the construction site. Brick construction is the most common technique of house construction in India.

b. Industrial Construction:

Industrial construction represents a minor portion of the construction sector. Even so, it is regarded as quite vital. Planning the layout of an industry, establishing industrial sectors, installing heavy machinery, and planning and constructing the size of an industry are the procedures involved in industrial construction.

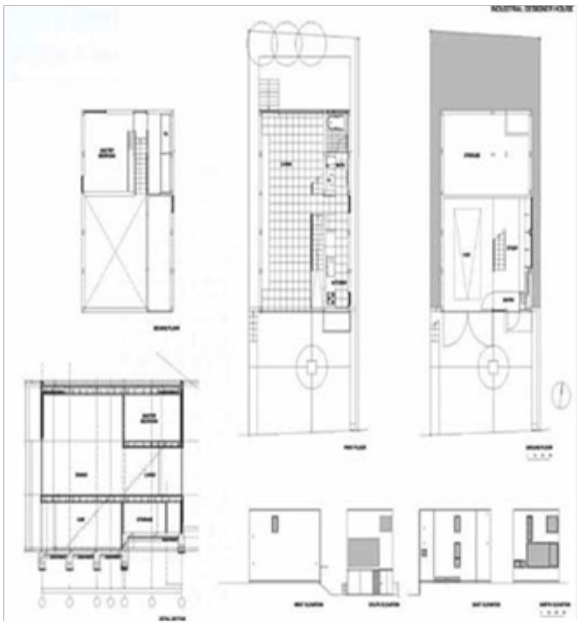

Fig. 1.1.1 Industrial Construction Site Plan

Infrastructure, power transmission and distribution, metallurgy and material handling, medicine, petroleum, chemical, power generation, manufacturing, etc. are the primary aspects to be considered.

This form of building requires extremely specific knowledge of planning, cost estimation, design, and construction. When a large construction business launches a project, it typically assigns the task of ensuring the project's success and safety to a team. Architects and civil engineers are employed to assist in the planning of construction projects. In this instance, construction entails the construction or assembly of infrastructure.

Large-scale building projects necessitate the completion of several jobs by a large number of individuals. Different jobs are provided to different teams. For instance, a Project Manager is re-

sponsible for Project management, while a Construction Manager oversees Project construction. Additional examples include Design engineer, Project architect, and Financial Advisor. If a project is to be conducted successfully, the following must be ensured: Effective planning, successful scheduling, budgeting, construction site safety, availability of building materials, and logistics are essential for a successful construction project (that is transport of raw materials, etc.).

Fig. 1.1.2 Under Construction Bridge

c. Infrastructure Construction

Infrastructure, often known as heavy civil or heavy engineering, consists of massive public works, dams, bridges, highways, railroads, water or wastewater systems, and utility distribution. Civil engineering encompasses the design, building, and maintenance of the physical and naturally built environment, such as roads, bridges, canals, dams, tunnels, airports, water and sewage systems, pipelines, and railways.

The infrastructure sector is an important economic driver in India. The sector is largely responsible for driving India's overall growth, and the government has placed a great deal of emphasis on implementing laws that will expedite the establishment of world-class infrastructure in the country. The infrastructure sector consists of power, bridges, dams, highways, and the development of urban infrastructure. In other words, the infrastructure sector functions as a catalyst for India's economic growth by driving the expansion of associated industries such as townships, housing, built-up infrastructure, and construction development projects.

1.1.3 Market Segment of Construction Industry

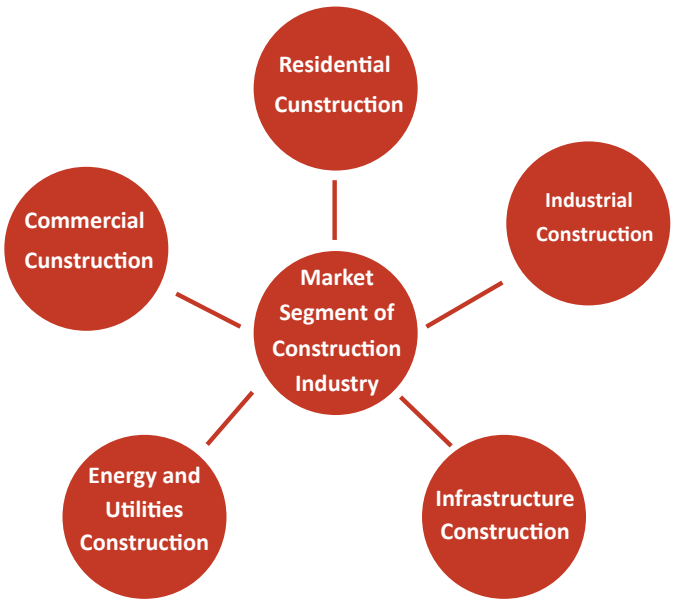

Fig. 1.1.3 Market segments of construction industry

1.1.4 Shuttering Carpentry

Formwork or shuttering are constructions/structures used in the process of pouring concrete. Shuttering is the term for wooden boards or metal plates that are placed and supported by falsework—rods and stakes—so that concrete may be poured into the moulds. As the concrete hardens, the moulds will keep it in place, resulting in a stable, streamlined structure.

Early formworks were constructed out of wood. Nowadays, steel, aluminium, and plastic formwork are currently manufactured. The choice of the framework relies on the type of concrete and the temperature of the pour because they both have an impact on the pressure applied. After the concrete has gained enough strength to support itself, the steel formwork can be taken off.

Formwork may be constructed from wood, steel, plywood, pre-cast concrete, or fibre-glass and may be used singly or in combination.

The formwork market has a 2018 value of USD 5.32 billion and is anticipated to grow to USD 6.37 billion by 2027, at a CAGR of 2.29%.

1.1.5 Common Terminologies used in Shuttering Carpentry

Formwork: Formwork is a temporary structure that serves as a mold for pouring concrete. It is a vertical or horizontal structure used in holding the concrete in place while it grows strength and shape.

Shuttering: This is a type of formwork or a derivative of formwork. Shuttering is a vertical temporary structure used to get concrete into a specific shape. Shuttering is a type of formwork that allows for vertical layout.

Centering: It is a temporary arrangement and element of formwork that is used to support horizontal members.

Scaffolding: Formwork is used to hold structural parts, whereas scaffolding is used to create a workers platform surrounding the building so that workers can work at heights. Scaffolding is a mobile or stationary platform. For further information, please see the image below.

Stripping: When the concrete has acquired an acceptable strength, the formwork should be removed. Stripping is term for the process of removing formwork.

Ties: A form-work tie is a tensile element used to join the formwork's opposing sides. It offers a stable link or is employed to withstand the fresh concrete's actual pressure.

Anchors: The form anchor is a tool used to firmly secure the form to the pre-placed concrete. During installation, the equipment is often embedded in the concrete.

Hangers: A form-work hanger is a tool used to suspend formwork loads from structural steel, precast concrete, or other components.

Props: Props are the vertical supports beneath the formwork. It carries shuttering as well as other loads like building, material, workman crafts, etc.

Spacer from Side: The side spacer is a device that maintains the required distance between the vertical shuttering and the steel bars.

Rebar: Reinforcing bar is abbreviated as rebar. It is a steel bar that is used to strengthen and help the concrete while it is under tension in reinforced concrete and reinforced masonry structures. Concrete has a high compressive strength but a low tensile strength.

Notes

QR Codes

Scan the QR code to watch the video

https://youtu.be/nndLyZrGfWc

Construction Industry

https://youtu.be/1WVzo2UFyo8

Types of Construction

https://youtu.be/WIMNbAWM7r8

Shuttering Carpentry

https://youtu.be/SDYRICOTRSs

Common Terminologies used in Shuttering Carpentry

Unit 1.2: Role and Responsibilities of an Assistant Shuttering Carpenter

Unit Objectives

By the end of this unit, participants will be able to:

- Describe the role and responsibilities of the assistant shuttering carpenter
- Explain the expected personal attributes for the job role
- Discuss the future possible progression and career options for an assistant shuttering carpenter

1.2.1 Assistant Shuttering Carpenter

An assistant shuttering carpenter is in charge of material and equipment identification, handling, and use. The duties also include the use of power tools and equipment for cutting and sizing plywood and wood, as well as supporting the assembly and disassembly of conventional and system formwork for R.C.C. buildings.

The person should be well-versed in proper handling of rebars as well as environmental, health, safety, and working procedures.

1.2.2 Role and Responsibilities of an Assistant Shuttering Carpenter

An Assistant Shuttering Carpenter is responsible for:

1. Helping to assemble and install formwork.
2. Aligning formwork components in order to ensure a perfect joint fit.
3. Loading formwork components onto vehicle for delivery to work site.
4. Carrying out any additional duties which may be required to ensure the successful completion of projects.
5. Ensuring that all formwork components are safely secured before transportation.
6. Cooperating with other trades on site to ensure smooth project completion.
7. Complying with all safety regulations and best practices.
8. Disassembling formwork components when the project is completed.
9. Reporting any issues or potential safety risks to the supervisor.

1.2.3 Personal Attributes required by an Assistant Shuttering Carpenter

An Assistant Shuttering Carpenter should:

- Be physically fit, mentally alert, and safety-minded
- work in different places with different weather and site conditions

- work well as part of a team
- know how to handle different tools, materials and components in shuttering carpentry
- work under instructions and close supervision

1.2.4 Career Progression of an Assistant Shuttering Carpenter

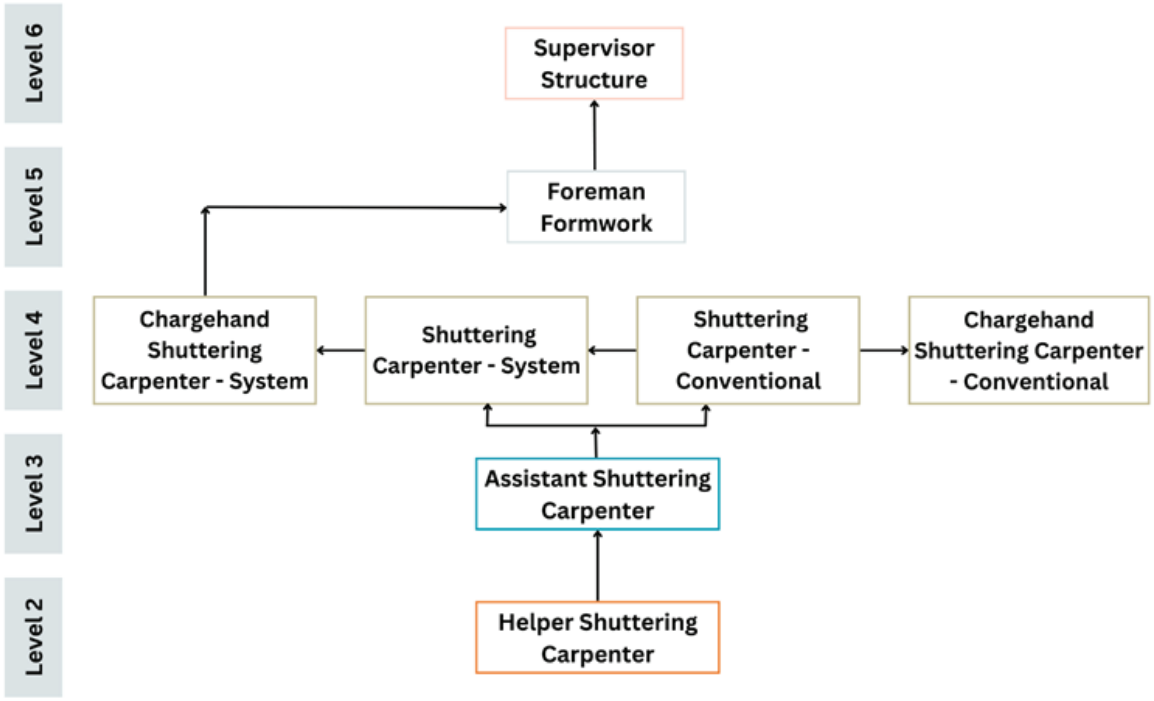

Fig. 1.2.1 Career Progression of an Assistant Shuttering Carpenter

Exercise

1. Show the career path of an Assistant Shuttering Carpenter.
2. What are role and responsibilities of an Assistant Shuttering Carpenter?
3. State few personal attributes required by Assistant Shuttering Carpenter.
4. What are the different types of construction? Name them.

Notes

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2. Operate Tools and Equipment

Unit 2.1 - Use and maintain tools, components, and equipment

CON/N0312

Key Learning Outcomes

By the end of this module, participants will be able to:

- List the different types of hand and power tools used in shuttering works along with their storing and stacking technique
- Describe the process adopted for care and maintenance of hand and power tools used in shuttering carpentry works
- Demonstrate operation of hand tools for cutting, planning and drilling of timber/ plywood.
- Demonstrate operation of power tools for cutting, planning and drilling of timber/ plywood.
- List the different types of woods used in shuttering carpentry works
- Explain the common defects in wood
- Identify common defects in wood visually
- List the different types of plywood and their thickness
- Describe the various type of slings, shackles and lifting belts
- Demonstrate by using slings, shackles and lifting belt for lifting operation of shuttering components.
- Explain the standard procedure adopted for shifting and stacking of various shuttering carpentry and scaffolding materials
- Describe ways to optimize use of consumables
- Recognize importance of housekeeping and various procedures involved in it

Unit 2.1: Use and maintain tools, components, and equipment

Unit Objectives

By the end of this unit, participants will be able to:

- List the different types of hand and power tools used in shuttering works along with their storing and stacking technique
- Describe the process adopted for care and maintenance of hand and power tools used in shuttering carpentry works
- Demonstrate operation of hand tools for cutting, planning and drilling of timber/ plywood.
- Demonstrate operation of power tools for cutting, planning and drilling of timber/ plywood.
- List the different types of woods used in shuttering carpentry works
- Explain the common defects in wood
- Identify common defects in wood visually
- List the different types of plywood and their thickness
- Describe the various type of slings, shackles and lifting belts
- Demonstrate by using slings, shackles and lifting belt for lifting operation of shuttering components.
- Explain the standard procedure adopted for shifting and stacking of various shuttering carpentry and scaffolding materials
- Describe ways to optimize use of consumables
- Recognize importance of housekeeping and various procedures involved in it

2.1.1 Formwork

Concrete formwork is used as a mould to create concrete parts of a specific size and configuration. Typically, it is constructed for this purpose and then taken down once the concrete has reached an acceptable strength. Concrete forms might occasionally be kept in place to become a component of the long-term building.

Formwork needs to be sufficiently strong and rigid to sustain the loads created by the concrete, the workers pouring and finishing it, and any tools or materials supported by the forms in order to perform as intended.

The formwork represents the single highest cost element for many concrete constructions. Concrete forms that are appropriate for the task must be chosen and used in order to keep costs under control. For a finished concrete piece to meet job standards for size, position, and finish, formwork must be both cost-effective and of sufficient quality to be built. The forms must also be created, constructed, and utilised in a way that complies with all safety requirements.

2.1.2 Construction of Formwork

1. **Propping and centering:** Steel, timber posts, or ballies may be employed as props inthe creation of formwork. Also occasionally employed as props are pillars composed of brick masonry and mud mortar.
2. **Shuttering:** The shuttering should be:
   a. Made of plywood, hardwood planks, steel sheets lined with or without metal, or steel plates supported by steel angles.
   b. Supported by vertical ballies or brick pillars covered in mud mortar, as well as battens, beams, and props.
   c. Built such that the seams are tight against cement grout leaking.
3. **Camber provision:** A certain amount of deflection in a structure is unavoidable. To offset the effect of deflection, it is therefore preferable to add an upward camber to the horizontal elements of the concrete structure (particularly in members with long spans).

   The formwork itself should be constructed with the desired camber in mind. For slabs and beams, camber may be used at a rate of 4 mm per metre of span. When dealing with cantilevers, the camber at the free end should typically be taken into account at 1/50th of the cantilever's predicted length.
4. **Cleaning and surface treatment:** Before pouring concrete, the formwork should be thoroughly cleaned of any debris, particularly sawdust shavings and chippings. To reduce the likelihood that dry timber shuttering will absorb water from the concrete, which could lead to warping, swelling, and distortion of the timber in addition to causing a honeycombing defect in the concrete, all surfaces of the timber shuttering that will come into contact with the concrete should be thoroughly wetted with water. Similarly, before pouring concrete, steel forms that have been out in hot weather should be cooled by watering.

2.1.3 Selection of Materials

The selection of material to be used for formwork relies on the style of construction as well as the material's availability and cost.

Formwork can be built of wood, steel, plywood, pre-cast concrete, or fibre-glass and can be used singly or in combination.

Because they may be easily cut or put together on site, plywood and timber are the most often used materials for formwork. Several building projects still make use of bamboo and wooden props (ballies).

With the development of steel forms, the use of timber formwork has decreased, especially for large-scale construction projects and instances where repeated use of the same forms is feasible.

However, timber formwork is more cost-effective for smaller projects with fewer re-uses.

Commercially available formwork may be assembled on location, partially or fully prefabricated, or both, and used as long as it complies with all applicable regulations and specific instructions.

2.1.4 Timber Formwork

The wood used for the formwork should be well-seasoned, lightweight, easily nailed without splitting, and free of knots. Timber must adhere to IS 883 in order to be utilised to construct sturdy scaffolding, beams, columns, props, and bracing.

The ideal softwood for formwork is half-seasoned. Greenwood will shrink whereas really dry wood will absorb moisture from damp pavement and swell. Hardwood is pricy, heavy, and challenging to work with and nail. When the final concrete's look is unimportant, clean sawn wood may be used, and wrought boards should be specified if a smooth finished face is desired. Where a fair finish face is desired under a roof slab, the upper surface of the supports may be covered with oiled soft building board or other water-repellent packing material; oiled paper is not suitable.

Fig 2.1.1 Timber Formwork

The span of the slab or beam, the height from floor to floor, and the centre-to-centre spacing of the centering supports all affect the sizes of the timber sections used for the various formwork components. The table below lists the sizes of members for timber formwork for shuttering with a 4.5 m span and 3.5 m height:

S.No	Component of Formwork	Size (varying from 1 m to 1.2 m- on the basis of the spacing of centering props)
1	Flat sheets for Slabs, Beam and column side and beam bottoms	Thick: 25-40 mm
2	Joists, ledges	Cross section: 50x75 mm to 50x150 mm
3	Posts	Cross section: 75x100 mm to 100x100 mm

4	Ballies	Diameter: At mid-length- not less than 100mm, At thin end_ 80 mm

Table 2.1.1 Size of Components

Note: If there are circumstances that lie outside of these parameters, the formwork should be carefully planned, and the sizes of the individual components should be determined after taking into account every possible combination of dead and live loads as well as other pertinent variables.

The quantity of timber shuttering can be calculated under the presumption that one set of shuttering can be used 10–12 times for typical building work when repetitive usage of shuttering is possible.

Maintenance of Timber Formwork

Timber/Wood should be inspected generally for any visible damage sustained during use, and if any of the following are present, it should be discarded or its safe capacity appropriately decreased.

- Rotting signs
- Cuts on the edge that are deeper than a twentieth of the section's thickness
- Bolt holes in the breadth or length of the two outermost thirds
- Unacceptable shape distortion
- Any mechanical damage
- Splitting

2.1.5 Steel Formwork

Steel formwork is made up of panels made of thin steel plates that are strengthened around the edges by tiny steel angles. Wall and slab panels typically range in size from 60 cm X 60 cm to 60 cm X 120 cm.

Steel sheet plates that meet the requirements of IS 2062, IS 8500, or IS 1977 may be used for form lining, and rolled sections and tubes that meet the requirements of IS 2062, IS 8500, or IS 1161 may be used for steel forming and bracing.

Fig. 2.1.2 Steel Formwork

Large construction projects or circumstances where numerous re-uses of the same shuttering are feasible are the main uses for steel forms. For round or curved-shaped structures like tanks, columns, chimneys, etc., as well as for structures like huge sewage, tunnels, and retaining walls, this style of shuttering is seen to be the most appropriate.

Steel formwork maintenance: Formwork needs to be thoroughly cleaned and repaired after each use. When not in use, concrete or mortar film adhering to the form face or the joining surface should be entirely removed, and the formwork materials should be kept correctly. Periodically, the component needs to be cleaned and painted. After thoroughly cleaning and removing any dirt or slurry, threaded parts should be oiled or greased. Periodic cleaning and lubrication of the telescopic parts is recommended to ensure their free movement.

2.1.6 Plywood Formwork

Plywood formwork uses plywood of various sorts and qualities. The materials are often framed up into the greatest size panels that can be handled by the site's equipment or are convenient for manual handling.

The size will also depend on the geometry of the structural element being produced.

For broad, smooth expanses like walls and floors, plywood panels are appropriate. Timber frames with a plywood face are typically more cost-effective for complex designs than timber boards or other materials, especially when a lot of reuse is necessary.

Plywood surfaces are easily damaged, so proper precautions must be taken during assembly, erection, casting, striking (removal), and storage. The soft surfaces and edges must be guarded since they are more vulnerable to damage than other surfaces.

Fig. 2.1.3 Plywood Formwork

Plywood that complies with IS 4990 can be used for panelling, sheathing, and form lining. Nowadays, using plywood instead of wooden planks is becoming more and more common. In this instance, plywood sheets coated with resin are fastened to wooden frames to form panels in the desired sizes. The panels that are created in this way are simple to bolt together to create shuttering.

This kind of shuttering guarantees a high-quality surface finish and is especially advised for projects involving the construction of large exposed expanses of concrete, such as floor slabs and retaining wall faces.

When compared favourably to timber shuttering, the price of plywood shuttering may end up being less expensive in some circumstances for the reasons listed below:

- By using plywood shuttering, it is possible to have a fully plain and smooth surface (without joint marks). As a result, money can be saved on surface finishing costs.
- The labour cost of setting up and taking down can be reduced by using large-sized panels.
- Compared to wooden shuttering, there are more re-uses. The number of reuses can be estimated to be between 20 and 25.

2.1.7 Wooden Shuttering

Since the dawn of civilisation, wood has been the primary building material utilised by humans. Man had relied on wood as his primary means of habitation before the development of stone and clay homes. Even today, wood is utilised to construct homes, bridges, and other infrastructure in the majority of tropical regions where trees produce an abundance of wood products. Wood shuttering is a widely used engineering tool. Wood is utilised in shuttering in a variety of ways, including wooden logs (bally), wooden panels, wooden boards, and wooden girders.

Types of wood used in shuttering boards

There are two types of wood available: plywood and timber. Both types of wood have some benefits and drawbacks.

1. **Timber:** Timber is a type of wood that has been transformed into beams and planks. In the US and Canada, it is also referred to as “lumber.” Timber is essentially the fuel or wood from growing trees. Timber or lumber is the name for any wood that may provide a minimum dimensional size. Timber is utilised for structural purposes. Timbers are woods that have been prepared for use in construction.

Advantages of Timber

- It can be quickly cut to the desired size.
- Due of its modest weight, it is manageable.
- Because of its temperature resilience, it keeps the concrete structure from being destroyed.

- It is simple to replace a piece of wood that has been damaged.
- It's not difficult to disassemble timber "formwork."

Disadvantages of Timber

- A dry wood absorbs water well. It quickly dries the concrete after absorbing its water. The internal bonding of the concrete material is weakened by this process.
- If the wood is moist, it will absorb too much water, compressing the concrete structure and causing excess water to seep through joints, causing grout to leak and cracks in the concrete structure.
- Timber shuttering cannot be utilised frequently because of its short lifespan. Timber shuttering loses its usefulness after being used five to ten times.

2. Plywood: Although plywood is a synthetic version of wood, it differs from timber in that it has been processed artificially. It is made out of a variety of veneer sheets and ply layers. Because it provides a smooth finish to concrete structures, plywood is now being used in formworks at a rapid rate, which lowers the cost of finishing. The sizes of plywood boards range from 7 mm to 32 mm. Boards with a thickness of 18 mm are typically utilised. Almost all sorts of form work are covered by a board that is 1220 mm wide, 2440 mm long, and 18 mm thick.

Types

- **Grade A:** The sheet's face and back are essentially defect-free, with a smooth, sanded surface and few to no knots. The surface is suitable for cabinet doors and furniture, can be painted or stained, and is meant to be seen rather than covered with another material.
- **Grade B:** Sanded smooth, however the face and back contain a few flaws, some of which have been fixed with patches or wood filler. It is less expensive than Grade A.
- Gra**de C:** Unsanded, with tight knots up to 1 12 inches broad. There might have been extensive filling and patching. Excellent for subflooring or other oblique applications.
- **Grade D**: Unsanded, with knot holes up to 2 12 inches wide, heavy patching and filling, and some unrepaired flaws. Similar to Grade C, suitable for structural applications where it won't be seen.

Advantages of Plywood

- Plywood boards, like timber, can be cut to the necessary sizes.
- Plywood, as opposed to wood, is more durable and has a fa longer lifespan.
- Plywood is very light and easy to handle, just like timber.
- It does not absorb the water from concrete like wood does.
- Plywood offers concrete a flat surface, which later lowers the cost of finishing.
- Plywood is also used in curved formworks.
- The availability of plywood in unusually large proportions facilitates and expedites construction activity.
- Unlike timber, it may be reused repeatedly.

Disadvantages of Plywood

- Plywood is much more expensive than timber.
- Sometimes, thin plywood sheets can't hold up the weight of concrete, and in many cases, the concrete mass bends.
- Plywood sheets are more flexible than wood. Plywood's flexibility can sometimes cause the mould to break.

2.1.8 Different materials of Wooden Shuttering

The most common shuttering material are:

1. **Scaffold boards:** Scaffold boards are made of wood or plywood. They are used as temporary walls for the concrete structure. It stops the concrete from falling. These boards are taken down after a few days when the concrete has dried.

Fig. 2.1.4 Scaffold boards

2. **Wooden Logs:** Wooden logs, which resemble long, round poles, are used to hold up the Shuttering boards. To create a mould, shuttering boards are put on top of the wooden logs. These logs range in length from a few feet to 18 feet.

Fig. 2.1.5 Wooden Logs

3. **Wooden Support Boards:** Wooden Support Boards are used under the concrete structure to help it stay up. Under the concrete of roofs, sport boards are typically used. These are wider but shorter than standard scaffolding boards. These are also known as wooden panels.

Fig. 2.1.6 Wooden Support Boards

4. **Petty Scaffolding:** Bamboo trunks, which are longer than regular logs, are typically used to construct small scaffoldings. Petty Scaffolds are linked together with ropes to form a skeleton. The wooden boards are then put on top of the skeleton. When the concrete structures have dried and solidified, the tiny scaffolding and other shuttering objects are removed.

Fig. 2.1.7 Petty Scaffolding

5. **Nails in Wooden Shuttering:** Steel and iron are used to make nails. Nail-in shuttering is used to join shuttering boards to wooden logs and other types of scaffolding boards. The nails are pulled out and the shuttering is taken apart after the concrete has dried and hardened.

6. **Shuttering Oil:** To prevent the shuttering material from sticking to the concrete, used, viscous, and lubricating engine oil is poured on it. Shuttering material is easier to remove when greasy oil is used.

2.1.9 Hand and Power tools

Tools that aid construction workers, carpenters, and other manual labourers in their work are referred to as hand tools or power tools, depending on whether they are operated manually or electrically. While hand and power tools are very helpful, they also provide a number of physical risks that, if not avoided, can result in minor and serious accidents.

Tool Safety

Without the aid of manual and power tools, no industry can prosper. However, employees and safety experts must make sure that the proper safety precautions are regularly used due to the inherent risks involved in their use. According to OSHA, the following are the five fundamental safety guidelines for avoiding risks related to the use of hand and power tools:

i. **Maintain all tools on a regular basis to keep them in good working order:** To maintain the equipment's dependability and safety throughout usage, regular maintenance is crucial. Regular

tool inspections are necessary to reduce the risk of accidents caused by broken machinery and to avoid unplanned downtimes, which have a detrimental effect on operational effectiveness.

ii. **Use the right tool for the job:** Depending on their intended use, hand and power tools are constructed differently. It is important to select the right tool for the work in order to prevent accidents and injuries. For instance, employing a chisel in place of a screwdriver could result in the tip breaking and flying off, perhaps leading to eye damage.

iii. **Examine tools for any damage prior use and do not use damaged tools:** Before beginning work, hand and power tools need to be checked and inspected in order to find broken or malfunctioning equipment. Both minor and serious injuries, such as cuts, punctures, blindness, electrical shock, and skin infections as a result of scrapes and abrasions, can be brought on by damaged equipment.

Making ensuring that employees never use instruments that are damaged is one of the employers' duties. Equipment should make it simple for workers to complete their tasks and shouldn't endanger them. Tools that are broken might be dangerous and could endanger your company.

iv. **Operate tools according to the manufacturers' instructions:** Employees can be guided by equipment manuals on how to handle and use tools properly. To prevent improper tool usage that results in otherwise avoidable mishaps, employees should read and follow the manufacturer's instructions.

v. **Provide proper personal protective equipment (PPE):** By lowering the overall physical risks brought on by power equipment, PPE aids in guaranteeing employee safety. To prevent physical contact with combustible materials that could result in burns, blindness, respiratory conditions, or other serious health issues, all personnel are required to wear the proper PPE when working around flammable gases, volatile liquids, or other explosive materials.

2.1.10 Tools used in Shuttering

1. **Claw hammer:** A claw hammer is a hammer that is typically used in carpentry to drive or remove nails from wood. A claw hammer has traditionally been employed in woodworking, although it can also be utilised in other situations. Due to the rather brittle steel in its head, it is not suited for hard hammering on metal surfaces (such as in machining operations); the ball-peen hammer is more appropriate for such metalwork.

Fig. 2.1.8 Claw Hammer

2. **Nail Hammer:** Because of their general size, nail hammers are the most popular type of hammer. These hammers have heads that weigh between 14 and 20 ounces and often have smooth faces. They resemble finish hammers in appearance but are a little bigger. These hammers may be used to drive and pull nails,

Fig. 2.1.9 Nail Hammer

as well as pry up wood.

3. **Ball Peen Hammer:** The ball peen hammer was first made for peening, which is the process of shaping metal with a hammer. For this reason, one end of the head is shaped like a ball. The flat end is used for driving.

Fig. 2.1.10 Ball Peen Hammer

4. **Measuring Tape:** One of the most crucial components is the tape measure. The tape measure comes in very handy when you require exact measures. Also, many feature belt clips that let it to be fastened to a belt or pocket opening, making it simple to carry. Also, many tape measures come in both standard and metric sizes, allowing you to choose the one that best suits your requirements. The magnetic grip model is recommended since it may be set down on any surface without risk of tipping over. The majority of usage only require ten to twelve feet, however depending on the task, one may require a longer one.

Fig. 2.1.11 Measuring Tape

5. **Try square:** A try square is a woodworking tool used to mark and inspect 90° angles on wood components. Although there are many various kinds of squares used by woodworkers, the try square is one of the most important ones.

   The 90° angle is indicated by the square in the name. To test a piece of wood, make sure the edges and faces are square, straight, and flat. A try square gets its name because it is used to check how square a piece of work is.

Fig. 2.1.12 Try Square

6. **Straight edge:** A straight edge provides a firm guide for marking, working, and cutting in straight lines. It is a critical component in ensuring precision on any work. Straight edge tools made from steel or aluminium are often the best. Steel is used when a heavier duty product is required. Aluminium for something lighter but no less precise.

Fig.2.1.13 A Straight Edge

7. **Spirit level:** A spirit level is a tool for measuring the level of surfaces, notably tabletops. A spirit level is a bubble instrument. It's an angular measurement device in which the bubble always rises to the highest point of a glass vial fixed to the top surface of the Spirit Level. The Spirit Level is easy to calculate; simply monitor the movement of the bubbles.

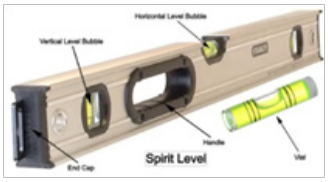

Fig.2.1.14 A Spirit Level

8. **Tube Level:** A Tube Level is just a clear plastic tube filled with a column of water. It is used to move a vertical level over a long distance. It operates on the premise that water seeks its own level. The water surfaces will always rest in the same vertical plane when the two ends of the tube are held up.

Fig.2.1.15 A Tube Level

9. **Plumb Bob:** Plumb bob is a basic tool used by bricklayers to build any vertical bricklaying task. It is typically available in mild steel with a coating weighing 30-40 gms. The plumb bob is a pointed weight connected to a line length enclosed within the bob and fixed in a slot in the lid.

Fig.2.1.16 A Plumb Bob

10. **Hand Saw: Hand saws,** commonly referred to as "panel saws," are used in carpentry and woodworking to shape pieces of wood into various forms. Usually, this is done to carve a wooden object and put the parts together. They typically function by having a number of pointed edges made of a material that is tougher than the wood being cut. With one flat, sharp edge, the hand saw resembles a tenon saw in several ways.

Fig.2.1.17 A Hand Saw

11. **Circular saw:** It is a tool for cutting materials such as wood, stone, plastic, or metal. It can be hand-held or machine-mounted. The word "circular saw" in woodworking applies specifically to the hand-held variety, with the table saw and chop saw being additional prevalent types of circular saws.

Fig.2.1.18 A Circular Saw

12. **Hacksaw:** a hacksaw designed specifically for cutting metals that has a frame and a small, fine-toothed blade. The majority of hacksaws are hand saws with a walking frame in the shape of a C that keeps a blade under tension. These hacksaws feature pins on the handle, which is often a pistol grip, for fastening a thin disposable blade. To fit blades of various sizes, the

Fig. 2.1.19 A Hacksaw

frames may also be movable. The thin blade is tensioned using a screw or another device.

13. **Tenon Saw:** A tenon saw is a hand tool made to cut "tenons," which are a type of hinge or joint that interlocks. This tool belongs to the backsaw family and is typically made of a stiffened metal edge with rip-filed or crosscut-filed teeth.

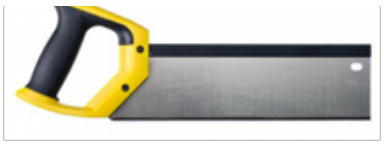

Fig.2.1.20 A Tenon Saw

14. **Line Dori:** A Line Dori, also known as Line Thread, is an essential piece of equipment for any person in construction industry. Often a line dori with a diameter of 3 millimetres is used. There is a layer of wax utilised. These days, nylon line thread is employed, and its diameter can range anywhere from 1mm to 2mm.

Fig.2.1.21 A Line Dori

15. **Wooden planers:** A wooden planer is a tool used to shape wood by pushing the cutting blade across the surface of the wood with force. For fine-scale planing, a small hand plane is utilised instead of some rotational power planers, which are motorised power tools used for the same kinds of larger operations.

    All planes are typically used to flatten, thin out, and smooth out a rough piece of wood or other material. On workpieces that are typically too large for shaping, planing is also used to create horizontal, vertical, or inclined flat surfaces.

Fig.2.1.22 A Wooden

16. **Jack Plane:** It is a bench plane that can be used for a variety of woodworking tasks. It is used to cut wood to size before truing and/or edge jointing. There are two kinds of it: a wooden jack plane and an iron jack plane.

Fig.2.1.23 A Jack Plane

17. **Drill machine:**The simplest, most versatile, and accurate machine tool which is found in all manufacturing facilities and tool rooms is the drilling machine. A drilling machine is a particular kind of machine that uses a spinning instrument called a drill bit or twist drill to create holes on the workpiece.

Fig.2.1.24 A Drill Machine

18. **Auger:** Auger is a wood-cutting or scraping blade is attached to a revolving metal shaft in an auger, which is used to drill into wood or other materials.

Fig.2.1.25 An Auger

19. **Screw Driver Set:** A screwdriver is a necessary instrument that may be used to tighten or loosen screws as well as install and remove them. It usually has a large, lengthy shaft that is attached to a screw head. When the screw head is put into the screw, the screw can then be tightened or loosen by spinning the screwdriver.

Fig.2.1.26 A Screwdriver Set

20. **Screws:** Things like metal or wood pieces can be held together with the use of screws. Screws offer greater strength and holding capability than regular nails. They create a tighter seal as well. Additionally, they can be taken off rather simply, unlike nails.

Fig.2.1.27 Screws

21. **Shuttering Tape:** A shuttering tape is a powerful adhesive that can assist in shuttering joints in order to improve the quality. By preventing water leaks, it extends the life of RCC.

Fig.2.1.28 A Shuttering Tape

22. **Wooden Marking and Mortise Gauge:** To mark out joints and indicate where to cut, measurements are transferred onto wood using a Marking and Mortise Gauge. A marking gauge, a mortise gauge, a ruler, a mortise chisel, a vice, and a pencil are the items you'll need.

Fig.2.1.29 A Wooden Marking and Mortise Gauge

23. **Chisel:** Chisels are cutting implements with metal blades that have been honed at the end. To suit various needs, they are available in a variety of sorts, shapes, designs, styles, and sizes. The workpiece is the primary factor in chisel type selection. In masonry, metals, and woodworking, a chisel is an effective tool.

Fig.2.1.30 Chisels

24. **Cotton Waste:** In order to create a one-of-a-kind form of composite material that resembles concrete but can be cut or fastened like wood, waste cuttings from textiles are combined with cement as a binder and then mixed together. It demonstrates a number of physical and mechanical qualities that point to its possible application in low-cost lightweight construction.

25. **Nails:** Nails have their own categorization system, with a whole nail set ranging from 2d (one inch long) to 60d (six inches). The letter "d" stands for denarius, a Roman penny, which refers to how much they previously cost. Today, the number given to a nail reflects its length and the diameters of its shank and head. For instance, a 16d or 16-penny nail is 3.5 inches long and has a shank that is 0.165 inches in diameter, and a head that is 11/32 inches in diameter.

    Although they may alternatively be marketed with their length listed in inches or another dimension, specialised nails are frequently graded using the 2d to 60d scale.

    In general, denser woods or hardwoods (such maple, oak, and walnut) are better suited to holdnails because there are more fibres to grab the nail, but they are also more likely to splinter. Softwoods (such as cedar, Douglas fir, and pine) don't grasp nails as effectively because they have fewer strands to keep them in place. However, it is required to use longer nails and, in some situations, coatings like cement as well to make up for the decreased density of the fibres.
    The different types of nails used in constrution are:

    1. Common Nails
    2. Duplex Nails
    3. Sinker Nails
    4. Underlayment Nails
    5. Roofing Nails
    6. Annular Ring Nails
    7. Spiral Shank Nails
    8. Decking Nails
    9. Masonry Nails
    10. Finishing Nais
    11. Box Nails
    12. Cut Nails

2.1.11 Lifting Operations

Using slings for lifting operations:Slings are an important tool for proper lifting operations of shuttering components. When securing the shuttering components in a lifting operation:

- The slings should be placed in a way that evenly distributes the load and prevents any accidental movements of the components.
- They should also be inspected for any signs of wear and tear before they are used.
- The number of slings should be sufficient to safely support the load of the components.
- Depending on shuttering component's size and weight, multiple slings may be needed.
- The slings should be securely fastened and be positioned in a way so that they do not choke the lifted object.
- After the object has been positioned, the slings should be released and the shuttering components should be properly secured.

Using shackles for lifting operations: The first step is to attach the shackle to the item to be lifted, typically by means of a wire rope sling. After the shackle is secured, it is attached to the lifting device, such as an overhead crane or a hoist. The shackle should be attached to the crane or hoist at such a position that it will not swing or rotate during the lifting process.

To ensure safety during the lifting operation, the shackle should be inspected prior to use and checked for any signs of wear and tear. If any damage is found, it should be repaired or replaced before using the shackle. The shackle should also be checked for correct size and strength. The correct size and strength are determined based on the weight of the load and the type of operation.

Once the shackle is secured, the operator should ensure that the load is correctly balanced and that the shackle does not restrict the movements of the load. During the actual lifting operation, the operator must remain alert and watch for any sudden shifts in weight or movement. Once the load is in the desired position, the shackle can be removed, and the load can be secured in place.

To ensure safe and efficient operation, it is essential that all personnel involved in the operation have the necessary safety training and knowledge. All personnel should be aware of the potential risks involved with handling lifting equipment, and they should understand the rules and guidelines for safe operation.

Using lifting blets for lifting operations: First, the operator must ensure that the lifting belt is properly secured. This means looping the belt around the component and threading it through the right hole. Once the belt is secure, the operator can begin to lift the component. It is important to use a steady and controlled motion so as to not over-extend the belt and to minimize risk of damage or injury.

It is important to use the correct weight rating for the belt. This will ensure the component is safely lifted and that the belt is not put under excessive strain. The operator should also ensure that their footing is secure and that the belt does not slip or move during the process.

Finally, for extra safety, the operator should also wear personal protective equipment such as safety goggles and gloves. This will help reduce the risk of injury in case of an unexpected accident.

In conclusion, lifting belts are an incredibly useful tool for safely and securely lifting shuttering components. With careful use, they can help operators make sure their operations are completed quickly and without incident.

2.1.12 Storing and stacking shuttering materials

Shuttering equipment should be stored and stacked properly to maintain its safety and readiness for usage. Inadequate equipment storage can lead to damage, a loss of equipment strength, and a loss of safe functioning. The following requirements must always be satisfied, whether the storage is in a rented facility, a scaffolder's warehouse, or on the job site:

- Arrange equipment storage to make it convenient to reach.
- Provide space for trucks, forklifts, and other handling machinery to move safely.
- Shuttering components should not be used to block access/egress points, emergency exits, safety signs and warnings, or emergency equipment.
- Provide shuttering components enough support to keep them off the ground.
- Provide support between layers so that forklifts may handle the appropriate materials.
- Sort pieces of various sizes into distinct piles.
- Label part numbers prominently on each stack.
- Provide containers or boxes for minor parts.
- Separate and isolate any individual component parts that require repair. To prevent them from re-entering the general inventory, keep damaged components in a location that is clearly identified until they are fixed or discarded.
- Dispose of or destroy damaged parts using proper and authorised disposal techniques.
- Avoid piling up equipment to a point where it becomes unstable. Unstable stacks have the potential to collapse, resulting in catastrophic injury, fatality, and component part damage.
- Provide blocking so that tubing won't roll when handled. Unsupported tubing could hurt people by rolling upon them or getting damaged.
- Maintain clean and organised storage spaces.
- Avoid storing Shuttering parts that are moist, especially planks. When putting away component components, always dry them.
- Planks are susceptible to mildew and rot if they are left damp for a long time (months). Any plank that exhibits mildew should be left to dry out before being evaluated for strength.
- Spacers should be placed between each layer of wet planks as they are put on level bearers far away from the ground. Place the stack somewhere dry and well-ventilated, and line up the spacers with the bearers. It is advised to use a minimum of three spacers per layer.
- Dry planks ought to be kept covered in storage.

2.1.13 Optimized use of Consumables

Nails, tape, textile waste, line threads, etc., are some of the consumables used in shuttering works. Optimizing the use of consumables in shuttering work is an important part of ensuring efficient and cost-effective construction.

1. Make sure to use the right materials for the job. Different applications require different types of shuttering materials, so be sure to select the right one for the job. For example, different types and thicknesses of wood require different nails. Usage of wrong nails will lead to waste of nails or even disrupt the shuttering structure.
2. Do not over-order. Many contractors overestimate the amount of shuttering they need, leading to costly waste. Make sure to accurately assess your needs and order the appropriate amount.
3. Reuse whenever possible. If material is still in good condition, you can often reuse it for another job. This will help you save money and conserve resources.
4. Consider alternative materials. Shuttering materials come in a variety of forms and materials, from wood and plastic to steel and aluminium. Be sure to research the options and select the best one for the job.
5. Ensure proper storage. Storing shuttering materials in a safe, dry place can help ensure that they last longer, saving you money in the long run.

2.1.14 Housekeeping

Good housekeeping on a building site is the procedure of keeping your site neat and orderly. A clean workspace increases fire safety and lowers the likelihood of accidents. 10 helpful housekeeping guidelines are:

1. **Set aside a location for trash and waste:** Make a place for trash to go. After all, you need a place to put them if you want your workspace to be clear of trash. Depending on the amount of rubbish, this could be a skip or another type of trash container. Sorting waste into several categories for reuse, recycling, and dumping is a best practise solution.
2. **Securely stack and store goods:** Materials that are incorrectly placed can obstruct access ways or collapse over, resulting in property damage or crushing injuries. Materials and tools are necessary for use throughout your project; store them carefully to prevent hazards.
3. **Keep your workspace secure:** The work on a construction site is probably going to produce waste all day long. Packaging, demolition, or off-cuts are all examples. Throughout the day, check on workspace at regular intervals, and tidy up the work progresses. Clear the area as soon as possible if there are any trip hazards or clutter.
4. **Maintain clear access ways:** Access and egress are components of a safe workspace. That concerns both arrival and departure from work. Avoid leaving equipment, furniture, or other items in gangways or corridors where they could obstruct a person's escape or present a trip hazard.
5. **After finishing, put the tools away:** Put away any tools or equipmentafter usage. It's simple to leave things laying around, but if they are not needed right away, store them. If it's no longer in use, it ought to be out of the way.

6. **Provide a clean example:** If you find anything lying on a floor, stairs, or other area that could make someone to trip and fall, pick it up and place it in a safe location right away. If you wait for someone else to relocate it, the next person may end up getting hurt.
7. **Fix it if it's broken:** Repair it or get rid of it. Maintaining the site's equipment in good operating order is another aspect of proper housekeeping. It is necessary to remove damaged tools or equipment from service so that they can be either repaired or replaced.
8. **Avoid getting tripped up by cables:** Trip hazards are frequently created by equipment cords and leads, especially when utilising portable equipment. Even if there isn't a socket nearby, make sure the lead is routed far from any walkways or access points. Cables should be routed away from areas where you or others could trip over them.
9. **Keep fire threats at bay:** Fire escapes may need to be used at some point, therefore make sure that waste or material storage does not accumulate there. Another useful strategy for avoiding fires on the job site is to clean up and remove garbage. Waste shouldn't be stored close to sources of ignition since fire needs fuel. In the event of a fire, the threat is contained and can be handled more simply if all trash is regularly collected and dumped into the skip.
10. **Inform others:** Everyone must be dedicated to maintaining a clean workspace.. You can create a clean and secure environment for everyone if you can get everyone to practise the same good housekeeping habits.

Exercise

1. What is Formwork? List the different types of formwork used in construction.
2. List the guidelines for avoiding tools-related hazard.
3. Explain the importance of good housekeeping.
4. How should shuttering materials be stored and staked?
5. Match the following:

S.No	Tool Image	Tool Name
1		**Claw Hammer**
2		**Ball Peen Hammer**
3		**Hack Saw**
4		**Try Square**
5		**Plumb Blob**
6		**Tenon Saw**

7		**Circular Saw**
8		**Auger**

Notes

QR Codes

Scan the QR code to watch the video

https://youtu.be/6x_NxC3hgA8

Formwork

https://youtu.be/KGRRxfucXRk

Timber Formwork

https://youtu.be/Z176lfv2kPI

Plywood Formwork

https://youtu.be/eGuF5xc5_EM

Wooden Shuttering

https://youtu.be/yyZ5GB8qQrY

Tools used in Shuttering

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

3. Make Wooden Shutter Boards used in Shuttering Carpentry Works

Construction Skill Development Council

Unit 3.1 - Wooden Shutter Boards

CON/N0313

Key Learning Outcomes

By the end of this module, participants will be able to:

- Demonstrate marking and measurement on shutter board, cutting to the specified size, planning and drilling of holes of required diameter.
- Operate hand and power tools used for making shutter boards applying safe work practices
- Describe the procedure for making shuttering boards
- Describe different types of timber joints and their areas of applications
- Explain the process and importance of wood seasoning
- Demonstrate use of table mounted saw for cutting shutter boards.
- Demonstrate the use of planning machine for planning shutter boards.
- Demonstrate making of lap joint, mortis and Tenon, dovetail and housing joints.

Unit 3.1 Wooden Shutter Boards

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3.1.1 Wood Shutter Boards

Wooden shutter boards are thick, flat wooden planks used to create formwork, which is the temporary structure used to support wet concrete until it sets and gains sufficient strength. The formwork system consists of the shutter boards and supporting frames, braces, and ties.

Fig. 3.1.1 Wooden Shuttering

(Source: https://modernghaleb.com/wooden-shuttering-everything-you-need-to-know/)

The shutter boards are assembled into a rigid structure that is designed to be strong enough to support the weight and pressure of the wet concrete while also maintaining the shape and dimensions of the final concrete structure. The formwork system is usually made to be removable, allowing the shutter boards to be easily dismantled and reused for other projects.

Wooden shutter boards are typically made from softwood species such as pine, spruce, or fir. They are available in a variety of thicknesses and sizes, ranging from 15mm to 50mm thick and from 1m to 4m in length. The boards are often treated with preservatives to protect them from moisture, fungal decay, and insect damage.

Fig. 3.1.2 Wooden Shutter Boards

The use of wooden shutter boards in construction has several advantages. They are relatively inexpensive, easy to handle and assemble, and can be reused for multiple projects, making them a cost-effective solution for temporary formwork. Additionally, wooden shutter boards provide a smooth and even surface for the concrete to be poured onto, resulting in a high-quality finish.

3.1.2 Importance of Wood Shuttering Board in Construction

Wooden shutter boards are an essential component of the construction process because they play a crucial role in ensuring that concrete structures are strong, durable, and of high quality.

Fig. 3.1.3 Use of Wood Shuttering Board for Concrete

(Source: https://www.civilsutras.com/materials-of-construction-for-rcc-formwork/)

Here are some reasons why wooden shutter boards are important:

1. **Support for Wet Concrete:** Wooden shutter boards provide temporary support for wet concrete until it gains sufficient strength to stand on its own. Without shutter boards, the concrete would collapse or deform, resulting in a structurally unsound building.
2. **Even Concrete Surface:** Shutter boards provide a smooth and even surface for the concrete to be poured onto, resulting in a high-quality finish. The surface finish of concrete is essential, especially for exposed concrete elements such as walls, ceilings, and floors.
3. **Customization:** Shutter boards can be cut into different sizes and shapes, allowing for customization of concrete structures. This is particularly useful for constructing complex concrete structures that require specific shapes and sizes.
4. **Reusability:** Wooden shutter boards are reusable, making them a cost-effective solution for temporary formwork. They can be easily dismantled and used again for other projects, reducing the need for new formwork materials.
5. **Strength and Durability:** Wooden shutter boards are made from sturdy and durable softwood species such as pine, spruce, or fir. They are designed to withstand the weight and pressure of wet concrete, and they can last for many years with proper maintenance.

3.1.3 Types of Wood used in making Shuttering Boards

In India, several types of wood are used to make wooden shuttering boards, depending on the specific requirements of the construction project. Here are some of the most common ones:

1. **Timber Wood:** Timber wood is a popular choice for making shuttering boards as it is strong and durable. It is commonly used for constructing walls, columns, and slabs.Timber wood is a general term that refers to any type of wood that is used for construction. It can include both softwood and hardwood species, depending on the specific requirements of the project.
2. **Pine Wood:** Pine wood is another commonly used material for making shuttering boards in India. It is lightweight, easy to handle, and relatively inexpensive. Pine wood is also known for its strength and durability, making it suitable for use in construction projects.
3. **Teak Wood:** Teak wood is a popular choice for making high-quality shuttering boards in India. It is known for its strength, durability, and resistance to moisture, making it suitable for use in humid and wet conditions. Teak wood is also prized for its attractive grain patterns and natural beauty.
4. **Gurjan Wood:** Gurjan wood, also known as Keruing, is a tropical hardwood that is commonly used for making shuttering boards in India. It is known for its strength, durability, and resistance to moisture and pests. Gurjan wood is also prized for its beautiful color and grain patterns.
5. **Sal Wood:** Sal wood is a hardwood species found in India that is commonly used for making shuttering boards. It is known for its strength, durability, and resistance to decay and insect damage. Sal wood is also relatively inexpensive, making it a popular choice for construction projects in India.

6. **Bamboo:** Bamboo is a sustainable and eco-friendly alternative to traditional wood species. It is lightweight, strong, and durable, making it a suitable choice for constructing small concrete structures.
7. **Glulam Wood:** Glulam wood is an engineered wood product made from layers of wood laminated together to form a strong and durable material. It is commonly used for constructing large and complex concrete structures.

Overall, the choice of wood used in making shuttering boards in India depends on factors such as availability, cost, strength, durability, and resistance to moisture and pests. Plywood, timber and pine wood are the most commonly used materials due to their availability and cost-effectiveness.

3.1.4 Types of Plywood used in making Shuttering Boards

Plywood is a popular material for making wooden shuttering boards because of its strength, durability, and resistance to moisture.

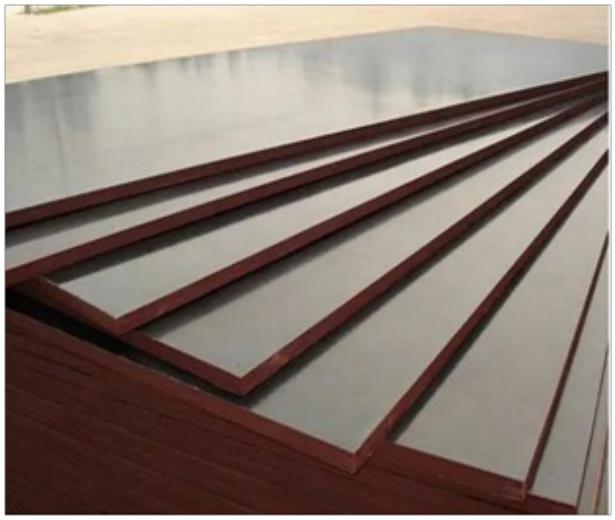


Fig. 3.1.4 Plywood Shuttering Boards

There are several types of plywood that are commonly used for this purpose, including:

1. **Moisture Resistant Plywood:** Moisture resistant plywood is made with special adhesives that make it resistant to moisture and humidity. It is commonly used for shuttering boards in areas with high humidity, such as near the coast.
2. **Exterior Grade Plywood:** Exterior grade plywood is made with a waterproof glue that makes it resistant to moisture and weathering. It is commonly used for shuttering boards in outdoor construction projects.
3. **Boiling Water Resistant Plywood:** Boiling water resistant plywood is made with a special adhesive that makes it resistant to boiling water and moisture. It is commonly used for shuttering boards in concrete structures that require a high degree of moisture resistance.

4. **Film Faced Plywood:** Film faced plywood is coated with a special film that makes it resistant to water and chemicals. It is commonly used for shuttering boards in construction projects where a smooth finish is required.
5. **Anti-Skid Plywood:** Anti-skid plywood is coated with a special layer that makes it resistant to skidding and slipping. It is commonly used for shuttering boards in areas with heavy foot traffic or where safety is a concern.

The choice of plywood for making wooden shuttering boards depends on factors such as the specific requirements of the construction project, the expected level of moisture exposure, and the environmental conditions in which the shuttering boards will be used.

3.1.5 Types of Timber Joints

There are many different types of timber joints that are used in woodworking and construction. Here are some common types of timber joints and their areas of application:

1. **Butt Joint:** A butt joint is a simple joint where two pieces of timber are joined end-to-end. This type of joint is commonly used in framing and other construction projects where strength is not a primary concern.

Fig. 3.1.5 Butt Joint

2. **Lap Joint:** A lap joint is where two pieces of timber are overlapped and fastened together. It is commonly used in framing, cabinetry, and other woodworking projects.A lap joint is created by overlapping two pieces of wood and cutting a notch on each piece where they overlap. The notch can be made using a hand saw or a table saw. Once the notches are cut, the two pieces of wood can be joined by sliding them together, with the notches interlocking.

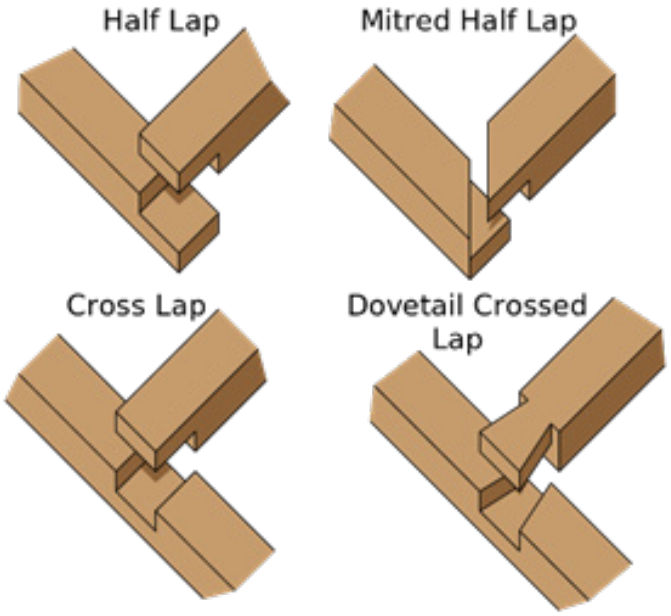


Fig. 3.1.6 Types of Lap Joints

3. **Mortise and Tenon Joint:** A mortise and tenon joint is a strong joint where a projecting tenon on one piece of timber is inserted into a mortise on another piece of timber. This joint is commonly used in furniture making, door and window frames, and other construction projects where strength and durability are important.A mortise and tenon joint is created by cutting a square or rectangular hole (mortise) into one piece of wood and a matching protrusion (tenon) on the other piece of wood. The tenon is then inserted into the mortise, creating a strong and secure joint. Mortise and tenon joints can be made using hand tools such as a chisel, or with a mortising machine.

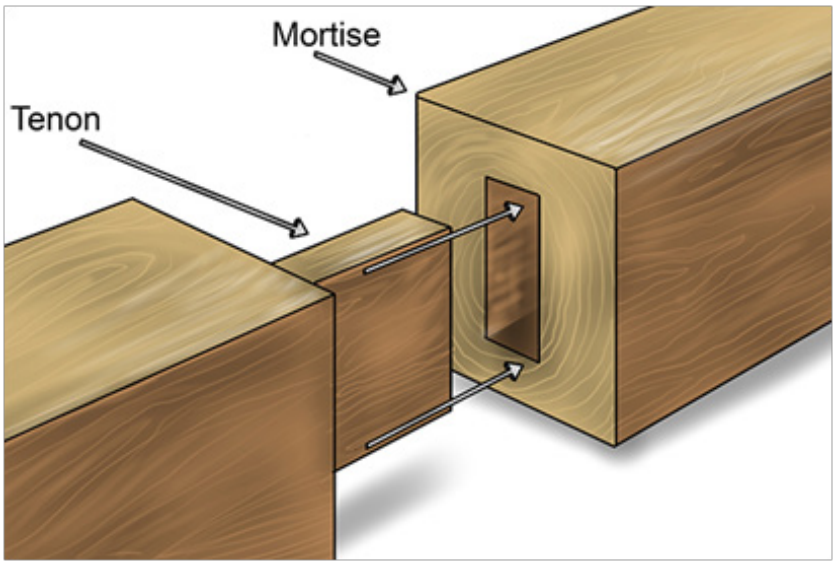


Fig. 3.1.7 Mortise and Tenon Joint

4. **Dovetail Joint:** A dovetail joint is a strong joint where the end of one piece of timber is cut into a series of angled tails that fit into corresponding slots cut into the end of another piece of timber. This joint is commonly used in furniture making and cabinetry.A dovetail joint is created by cutting a series of angled notches on the end of one piece of wood, and a corresponding series of angled protrusions on the end of the other piece of wood. When the two pieces are fitted together, the notches and protrusions interlock, creating a strong and durable joint. Dovetail joints can be made using a hand saw and chisel, or with a dovetail jig on a router table.

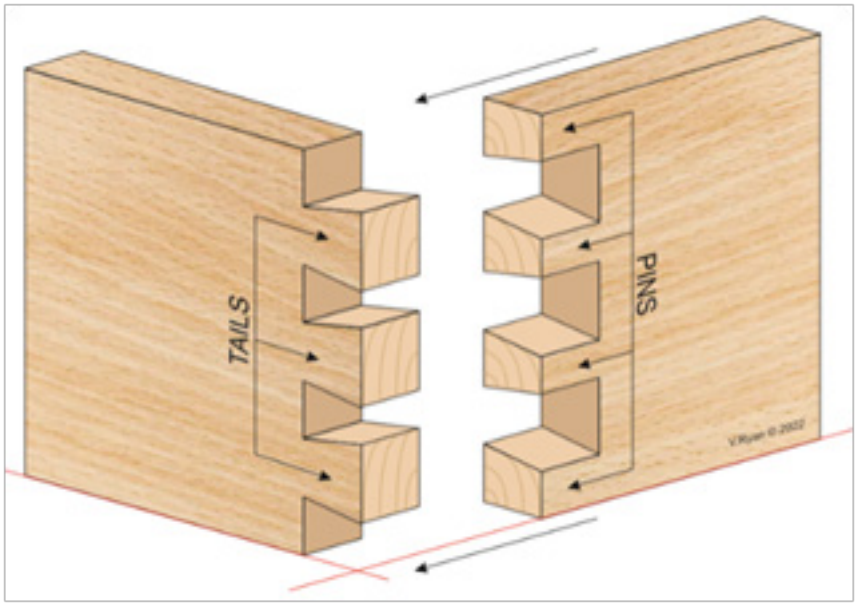


Fig. 3.1.8 Dovetail Joint

5. **Tongue and Groove Joint:** A tongue and groove joint is where a projecting tongue on one piece of timber fits into a corresponding groove on another piece of timber. This joint is commonly used in flooring, paneling, and other woodworking projects.

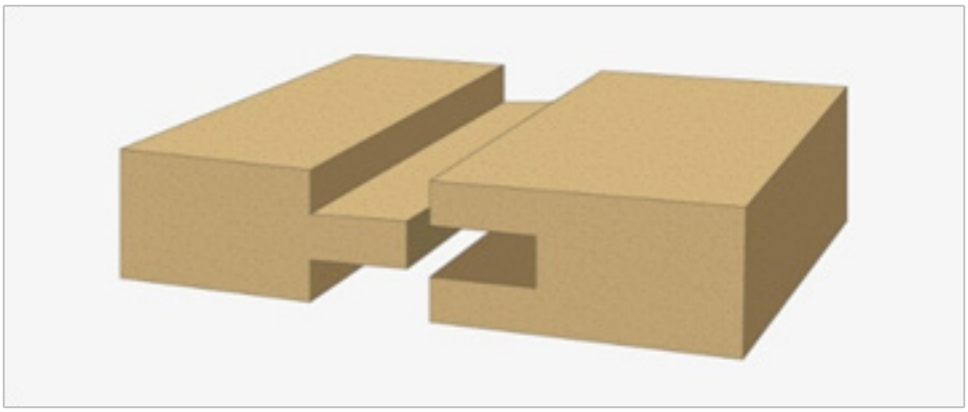


Fig. 3.1.9 Tongue and Groove Joint

6. **Scarf Joint:** A scarf joint is where the ends of two pieces of timber are cut at an angle and joined together to create a longer piece. This joint is commonly used in boat building and other construction projects where longer lengths of timber are required.

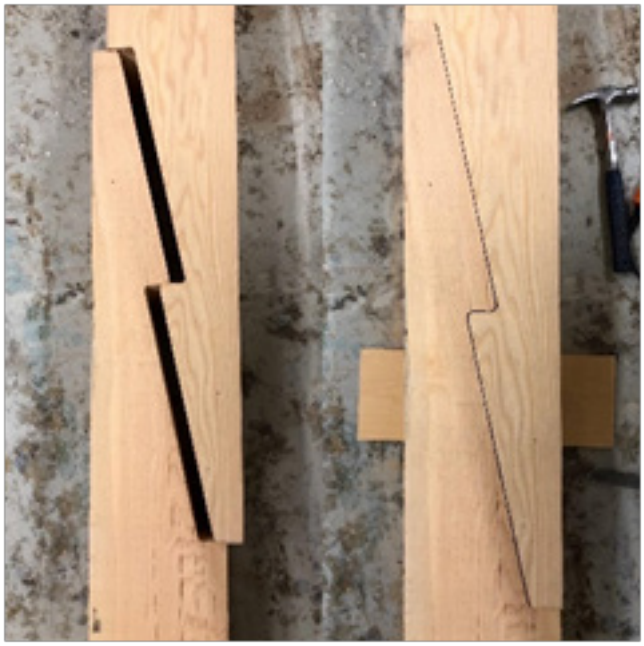


Fig. 3.1.10 Scarf Joint

7. **Housing Joint:** A housing joint is created by cutting a rectangular notch (or "housing") into one piece of wood, and then fitting the end of the other piece of wood into the notch. The joint is secured by screws, glue, or dowels. Housing joints can be made using a hand saw and chisel, or with a dado blade on a table saw.

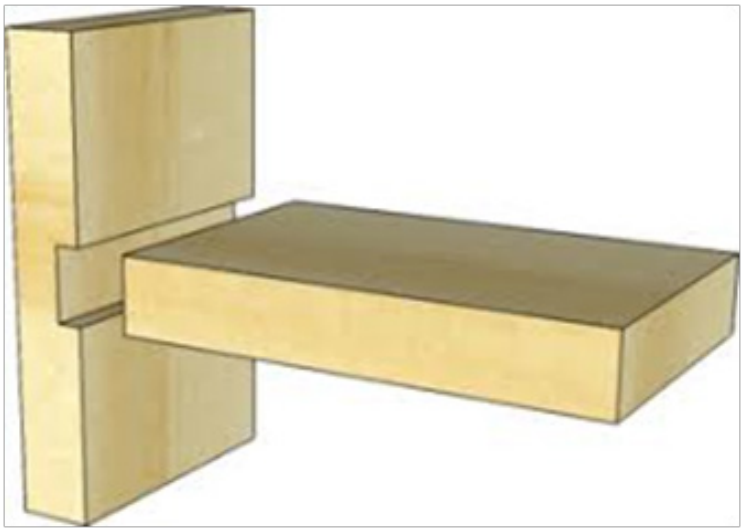


Fig. 3.1.11 Housing Joint

3.1.6 Wood Seasoning

Wood seasoning is the process of reducing the moisture content of freshly cut wood by allowing it to dry naturally or artificially in a controlled environment. The process is important because freshly cut wood has a high moisture content, which can cause it to shrink, twist, warp or crack when it is used in construction.

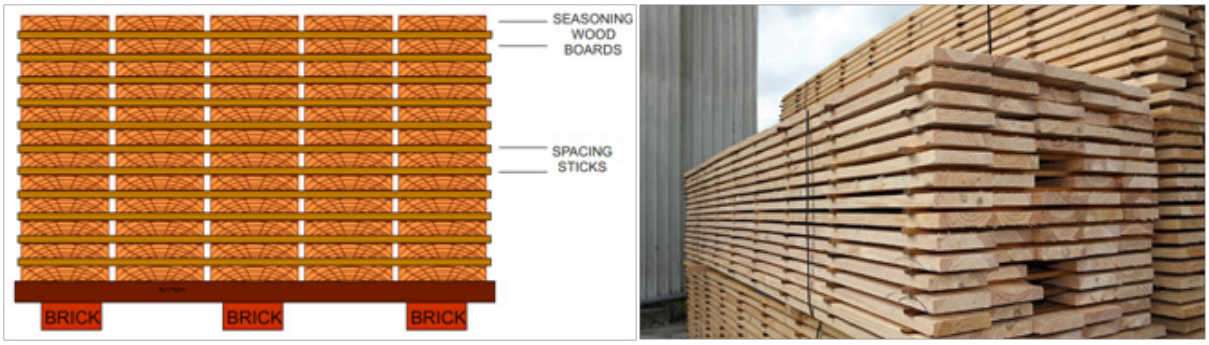


Fig. 3.1.12 Wood Seasoning

(Source: https://tanyadecor.home.blog/2019/08/15/building-material-seasoning-of-timber/)

Here is the process of wood seasoning:

1. **Felling and Log Preparation:** Trees are felled and the logs are prepared for processing.
2. **Rough Milling:** Logs are cut into rough planks using a sawmill or other cutting machine.
3. **Air Drying:** The rough planks are stacked and left to air dry in a controlled environment for several months, typically outdoors in a location with good airflow and protection from direct sunlight and rain.
4. **Kiln Drying:** After the initial air drying process, the planks are moved to a kiln for further drying. A kiln is an enclosed space that uses heat and air circulation to reduce the moisture content of the wood.
5. **Grading:** After the wood is dried, it is graded based on its quality and suitability for different applications.

The importance of wood seasoning is mainly to improve the strength and stability of the wood. Freshly cut wood contains a lot of moisture, which makes it heavy, weak, and prone to decay. By drying the wood, it becomes lighter, stronger, and more stable. Dried wood is also less likely to crack, warp or twist, making it suitable for use in construction, furniture making, and other applications. Wood seasoning is a crucial process in the production of high-quality wood products. By properly seasoning the wood, it becomes stronger, more stable, and better suited for a wide range of applications.

3.1.7 Hand Tools used in making Shuttering Boards

Hand tools are an essential component of making shuttering boards, and there are many types of hand tools that can be used. Here are some common hand tools used in making shuttering boards:

Hand Tool	Description	Image
Hand saws	A hand saw is used for cutting wood to size, and is available in different types, such as crosscut saws and rip saws.	
Chisels	A chisel is used for shaping and carving wood. They come in different sizes and shapes.	
Hammers	A hammer is used for driving nails or brads into wood. They come in different weights and sizes.	
Screwdrivers	A screwdriver is used for driving screws into wood.	
Clamps	Clamps are used to hold wood in place while it is being cut or shaped.	

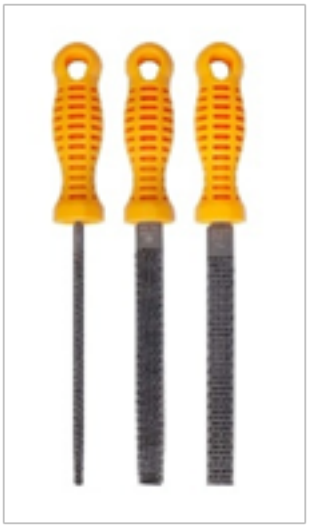
Planes	Planes are used to smooth and flatten wood surfaces.	
Rasps and files	Rasps and files are used for shaping and smoothing wood.	
Hand drills	Hand drills are used for drilling holes in wood.	

Table 3.1.1 Hand Tools used in making Shuttering Boards

3.1.8 Power Tools used in making Shuttering Boards

Power tools are electric or battery-powered tools that are used to perform a variety of tasks in woodworking and construction. Here are some common power tools and their uses:

Power Tool	Description	Image
Handheld Circular Saw	A handheld circular saw is a power tool that is used for cutting straight or curved lines in wood, metal, and other materials. It has a circular blade that rotates at high speeds, and can be adjusted for cutting at different angles and depths.	
Handheld Jigsaw	A handheld jigsaw is a power tool that is used for cutting curves and intricate shapes in wood, metal, and other materials. It has a reciprocating blade that moves up and down rapidly, and can be adjusted for cutting at different angles and depths.	
Hand Drill Machine	A hand drill machine is a power tool that is used for drilling holes in wood, metal, and other materials. It has a chuck that holds the drill bit, and can be adjusted for drilling at different speeds and depths.	
Table Mounted Saw	A table mounted saw is a power tool that is used for cutting large pieces of wood, such as plywood and sheet goods. It has a circular blade that is mounted under a table, and can be adjusted for cutting at different angles and depths.	

Planing Machine	A planing machine is a power tool that is used for smoothing and flattening rough or uneven surfaces on wood and other materials. It has rotating blades that remove thin layers of material, and can be adjusted for cutting at different depths.	
Power Drilling Machine	A power drilling machine is a more powerful version of a hand drill machine that is used for drilling larger holes in wood, metal, and other materials. It has a chuck that holds the drill bit, and can be adjusted for drilling at different speeds and depths.	

Table 3.1.2 Power Tools used in making Shuttering Boards

Power tools can save time and effort compared to traditional hand tools, and can be used for a wide range of woodworking and construction tasks. However, it is important to use power tools safely and follow manufacturer instructions to avoid injury and damage to the tools and materials.

3.1.9 Safely Operate Shutter Board-Making Hand and Power Tools

When operating hand and power tools used for making shutter boards, it is important to follow safe work practices to ensure the safety of the operator and those in the surrounding area. Here are some general safety tips for operating hand and power tools:

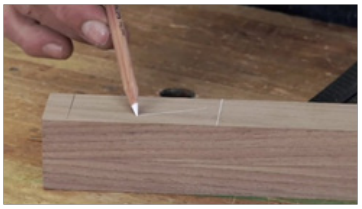
1. Wear appropriate personal protective equipment (PPE) such as safety glasses, gloves, and ear protection.
2. Inspect the tool and its accessories before use to ensure they are in good working condition.
3. Ensure that the tool is properly grounded, and that the electrical cord or battery is in good condition.
4. Read the user manual and follow the manufacturer's instructions for operating the tool.
5. Secure the workpiece firmly before cutting or drilling to prevent it from moving or shifting.
6. Keep the work area clean and free of debris, and ensure there is adequate lighting.
7. Avoid wearing loose clothing, jewellery, or long hair that could get caught in the tool.
8. Never use the tool in wet or damp conditions, or near flammable liquids or gases.

9. Keep your hands and fingers away from the blade or drill bit when in use, and never reach over the cutting area.
10. Turn off the tool and unplug it from the power source when not in use.

By following these safety tips, operators can reduce the risk of accidents or injuries when operating hand and power tools used for making shutter boards. It is important to always prioritize safety and take the necessary precautions to prevent accidents.

3.1.10 Measurement and Marking Tools

To measure and mark timber or plywood correctly, the assistant shuttering system will need some basic tools:

Measurement and Marking Tool	Description	Image
Measuring Tape	A measuring tape is an essential tool for measuring lengths, widths, and heights of the timber or plywood. It comes in different lengths and widths and can measure both metric and imperial units.	
Square	A square is used to make sure that the cuts are straight and accurate. It is also useful for marking right angles.	
Pencil	A pencil is used to mark the cutting lines on the timber or plywood. Make sure to use a sharp pencil to make clear and accurate marks.	
Marking Gauge	A marking gauge is a tool used to mark lines parallel to the edge of the timber or plywood.	

Chalk Line	A chalk line is a tool that is used to mark straight lines over long distances. It is useful for marking large sheets of plywood or for laying out long pieces of timber.	
Combination Square	A combination square is a versatile tool that can be used to measure angles, mark parallel lines, and check the flatness of a surface.	
Bevel Gauge	A bevel gauge is used to measure and mark angles on the timber or plywood.	

Table 3.1.3 Measuring and MarkingTools used in making Shuttering Boards

Using these tools correctly will ensure that the timber or plywood is measured and marked accurately, resulting in precise cuts and a finished product that is of high quality.

3.1.11 Procedure for Making Shuttering Board

The general steps involved in making a wooden shuttering board are:

1. **Selection of wood:** Choose the type of wood that is appropriate for the purpose of the shuttering board. The wood should be straight, without knots or cracks, and free from defects that could weaken the board.
2. **Marking and measuring:** Measure and mark the wood according to the required size of the shuttering board using a measuring tape, square, and pencil.
3. **Cutting:** Use a hand saw or circular saw to cut the wood according to the marked measurements. Be sure to keep the saw blade perpendicular to the wood to ensure straight cuts.

4. **Planing:** Use a hand plane or planing machine to smooth the rough edges of the cut wood.
5. **Drilling:** Use a hand drill or power drill to drill holes in the board at the required locations for screws or other fasteners.
6. **Sanding:** Use sandpaper or a sanding machine to smooth the surface of the board and remove any rough areas.
7. **Finishing:** If desired, apply a coat of wood sealer or paint to protect the wood from moisture and other environmental factors.
8. **Quality Control:** Inspect the board for any defects, such as cracks or warping that may affect its strength or durability.

Following these steps will result in a well-made shuttering board that is strong and durable enough to be used in construction. It is important to take safety precautions while handling the tools and equipment used in making shuttering boards.

3.1.12 Steps for Marking, Measuring, Cutting, Planing and Drilling on a Shuttering Board

The steps for marking and measurement on a shutter board, cutting it to the specified size, planning and drilling of holes of the required diameter are:

1. **Marking and Measurement:**
   - Measure and mark the dimensions of the required size of the shutter board using a tape measure, straight edge, and a pencil.
   - Ensure that the marks are straight, accurate, and clearly visible.
2. **Cutting to the Specified Size:**
   - Use a circular saw or hand saw to cut the shutter board to the required size along the marked lines.
   - Ensure that the saw blade is sharp and the cutting is done with a straight cut.
3. **Planing:**
   - Use a hand plane to smooth and level the surface of the shutter board.
   - Ensure that the surface is flat and free from any irregularities or bumps.
4. **Drilling Holes of Required Diameter:**
   - Use a drill bit of the required diameter to drill holes in the shutter board where necessary.
   - Ensure that the drill bit is sharp and the holes are drilled straight and perpendicular to the surface of the board.
   - Measure and mark the location of the holes accurately before drilling.
5. **Finishing:**
   - Sand the surface of the shutter board with sandpaper to smoothen and remove any rough edges.

- Apply a coat of paint or varnish to protect the shutter board from moisture and weathering.
- The accuracy of the measurements and the quality of the cuts, planning, and drilling are crucial to ensure that the shutter board fits properly and performs well in its intended application.

3.1.13 Use of Table Mounted Saw for Cutting Shutter Boards

The following steps will help ensure that the table-mounted saw is used safely and effectively to cut shutter boards to the desired size and shape. It is important to always take safety precautions when working with power tools.

Fig. 3.1.13 Table Mounted Saw used for Cutting Shutter Boards

The steps for using a table-mounted saw to cut shutter boards:

1. **Preparation:** Before starting, make sure the saw is properly set up and the blade is sharp and in good condition. Adjust the height and angle of the blade to the desired cut.
2. **Measurement and marking:** Use a measuring tape, square, and pencil to mark the shutter board where it needs to be cut.
3. **Setting the saw:** Adjust the fence to the desired position to guide the board through the blade.
4. **Safety:** Make sure to wear personal protective equipment, such as safety goggles and hearing protection, when operating the saw. Keep hands and fingers away from the blade and turn off the saw before making any adjustments.
5. **Cutting:** Turn on the saw and carefully guide the board through the blade, keeping it tight against the fence. Be sure to use a push stick to keep your hands safely away from the blade.
6. **Finishing:** After the cut is complete, turn off the saw and wait for the blade to stop completely before removing the board. Use sandpaper or a sanding machine to smooth the edges of the cut board.

7. **Quality control:** Inspect the board for any defects or rough edges that may affect its performance.

3.1.14 Use of Planing Machine for Planing Shuttering Board

A planing machine is commonly used for preparing the surface of wooden boards, including shuttering boards, by removing any irregularities, roughness, or unevenness. The process of planning involves passing the board through the machine, where multiple cutting blades shave off a small layer of the wood at each pass.

Fig. 3.1.14 Planing Machine used for Planing Shutter Boards

Here are the steps to use a planning machine for shuttering board:

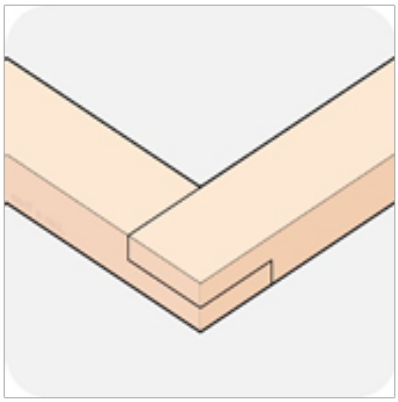
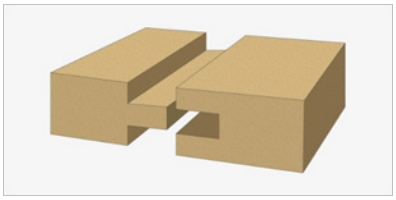
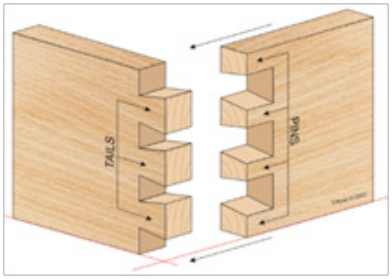
1. **Preparation:** Before starting, make sure the planing machine is properly set up and the blades are sharp and in good condition. Ensure that the machine is positioned securely and the board is aligned correctly.
2. **Measurement and Marking:** Use a measuring tape, square, and pencil to mark the shuttering board where it needs to be planed.
3. **Safety:** Make sure to wear personal protective equipment, such as safety goggles and hearing protection, when operating the planing machine.
4. **Feeding the Board:** Turn on the planing machine and carefully feed the board through the machine, keeping it tight against the infeed rollers.
5. **Adjusting the Blades:** Adjust the cutting depth of the blades to remove the desired amount of material from the board. Make sure to adjust the blades evenly on both sides to maintain a consistent thickness.

6. **Repeating the Process:** After the first pass, check the board for smoothness and make any necessary adjustments. Then, repeat the process of feeding the board through the machine until the desired smoothness and thickness is achieved.
7. **Finishing:** After the board has been planed, turn off the planing machine and wait for the blades to stop completely before removing the board. Inspect the board for any defects or rough spots that may need to be sanded or smoothed.

Following these steps will help ensure that the planing machine is used safely and effectively to prepare shuttering boards by removing any roughness or irregularities, creating a smooth and even surface. It is important to always take safety precautions when working with power tools.

Exercise

1. What are the use of wood shutter boards?
2. What are the types of wood used in making shuttering boards?
3. List various power tools used in making shuttering boards.
4. Explain the process of wood seasoning.
5. Match the different types of timber joints with their photo given below:

A- Timber Joints	B- Image
1. Butt Joint	
2. Dovetail Joint	
3. Lap Joint	
4. Housing Joint	

5. Tongue and Groove Joint	

Notes

QR Codes

Scan the QR code to watch the video

https://youtu.be/Lk-AlCYwUdA

Types of Plywood used in making Shuttering Boards

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

4. Assist in Assembling and Dismantling Conventional Formwork for RCC Structure

Construction Skill Development Council

Unit 4.1 - Assembling and Dismantling Conventional Formwork for RCC Structures

CON/N0314

Key Learning Outcomes

By the end of this module, participants will be able to:

- Apply the basic knowledge of units, measurement and arithmetic calculation relevant to shuttering work
- Describe standard procedure for assembling and dismantling conventional formwork
- Describe the procedure to provide staging support in shuttering works using bamboos, ballis, wooden channels, wedge, base plate etc.
- Explain procedure for erection and dismantling of conventional formwork
- Explain the checks required for line, level and alignment
- Explain the various ties used in conventional shuttering
- Demonstrate transfer of level from reference point
- Demonstrate erection of staging for conventional shuttering
- Demonstrate aligning and supporting of shutter boards as per instruction
- Demonstrate erection of aluminium and steel formwork as per instructions.
- Demonstrate the various checks conducted in erection and dismantling of conventional formwork
- Demonstrate tying of different types of knots
- Describe the corrective actions required for maintaining line, level and alignment
- Demonstrate shifting of materials and tools required for assembling conventional scaffolding
- Demonstrate safe de-shuttering of shuttering boards and other components as per instruction.

Unit 4.1: Assembling and Dismantling Conventional Formwork for RCC Structures

Unit Objectives

By the end of this unit, participants will be able to:

- Apply the basic knowledge of units, measurement and arithmetic calculation relevant to shuttering work
- Describe standard procedure for assembling and dismantling conventional formwork
- Describe the procedure to provide staging support in shuttering works using bamboos, ballis, wooden channels, wedge, base plate etc.
- Explain procedure for erection and dismantling of conventional formwork
- Demonstrate transfer of level from reference point
- Demonstrate erection of staging for conventional shuttering
- Demonstrate aligning and supporting of shutter boards as per instruction
- Demonstrate erection of aluminium and steel formwork as per instructions.
- Demonstrate the various checks conducted in erection and dismantling of conventional formwork
- Demonstrate tying of different types of knots
- Describe the corrective actions required for maintaining line, level and alignment
- Demonstrate shifting of materials and tools required for assembling conventional scaffolding
- Demonstrate safe de-shuttering of shuttering boards and other components as per instruction.

4.1.1 Conventional Formwork

Conventional formwork is a traditional method of constructing temporary structures or moulds that support concrete while it sets and hardens. It involves using wooden or steel frames, called formwork, to create the desired shape and size of a concrete structure before pouring the concrete. The formwork is typically constructed on-site and customized to fit the specific project's requirements. Conventional formwork is widely used in construction projects, including bridges, buildings, and tunnels.

Fig. 4.1.1 Conventional Formwork

(Source: https://theconstructor.org/building/wooden-formwork-design-calculation-concrete/16697/)

4.1.2 Procedure for Erection of Conventional Formwork

The procedure for erecting conventional formwork involves careful planning, design, and execution to ensure that the formwork is safe, stable, and meets the specific requirements of the project. It involves the following steps:

1. **Preparing the site:** The site where the formwork is to be erected must be cleared of any debris or obstructions. The area must be levelled and compacted to provide a stable foundation for the formwork.
2. **Designing the formwork:** The formwork must be designed to meet the specific requirements of the project. This includes the size, shape, and configuration of the structure to be built. The formwork design should also take into account the weight and volume of concrete to be poured.
3. **Erecting the vertical supports:** The vertical supports of the formwork are typically made of timber or steel. They are erected in place and secured to the ground using steel stakes or wooden pegs.
4. **Installing the horizontal supports:** The horizontal supports of the formwork are typically made of timber or steel as well. They are installed between the vertical supports to provide a framework for the formwork.
5. **Placing the sheathing:** The sheathing, or formwork panels, are installed on the horizontal supports. The panels can be made of plywood, metal, or plastic. The panels must be secured in place using nails or screws.
6. **Installing the bracing:** Bracing is installed to provide additional support to the formwork. The bracing can be diagonal or horizontal and should be installed according to the formwork design.
7. **Checking the formwork:** Once the formwork is in place, it should be checked to ensure that it is level, straight, and stable. Any adjustments or modifications should be made at this point.
8. **Pouring the concrete:** Once the formwork is in place and checked, the concrete can be poured. The concrete should be poured evenly and at a consistent rate to prevent any air pockets or voids.
9. **Removing the formwork:** After the concrete has set, the formwork can be removed. The removal process should be done slowly and carefully to avoid any damage to the concrete structure.

Erection of Aluminium and Steel Formwork

The following are the general steps for erecting aluminium and steel formwork as per instructions:

1. **Prepare the site:** Prepare the site where the formwork will be erected by clearing the area and ensuring that it is level and free from debris.
2. **Select the Appropriate Formwork:** Select the appropriate formwork for the job, taking into consideration the size and shape of the structure being built and the type of materials that will be used.
3. **Assemble the Formwork:** Assemble the formwork as per the manufacturer's instructions, ensuring that all components are aligned correctly and secured tightly.
4. **Install the Formwork Panels:** Install the formwork panels into the frame, making sure that they are straight, level, and flush with each other. Secure the panels to the frame using appropriate

fasteners.

5. **Install the Corner Panels:** Install the corner panels as per the manufacturer's instructions, ensuring that they are properly aligned and secured.
6. **Install the Supports:** Install the supports, such as braces and props, as per the manufacturer's instructions to ensure that the formwork is stable and secure.
7. **Check the Alignment:** Check the alignment of the formwork regularly during the pouring of concrete to ensure that it remains straight and level. Make any necessary adjustments or repairs as needed.
8. **Remove the Formwork:** After the concrete has set, remove the formwork carefully and systematically, following the manufacturer's instructions. Use appropriate tools to prevent damage to the formwork and the concrete.
9. **Clean and Store the Formwork:** Clean the formwork after use and store it in a dry, secure location to prevent damage and prolong its lifespan.

By following these steps, you can erect aluminium and steel formwork as per instructions safely and effectively. Always follow the manufacturer's instructions and prioritize safety when working with formwork and scaffolding.

4.1.3 Dismantling of Conventional Formwork

Dismantling of conventional formwork involves the following procedure:

1. **Remove the shuttering boards:** The first step in dismantling the formwork is to remove the shuttering boards. This can be done by loosening the wedges that are holding them in place and then lifting them out of the wooden channels.
2. **Remove the wedges:** Once the shuttering boards are removed, the wedges can be removed by tapping them gently with a hammer. They should be removed carefully to avoid damaging the formwork.
3. **Remove the wooden channels:** The next step is to remove the wooden channels. They can be lifted off the ballis by using a lever or crowbar to pry them loose.
4. **Remove the ballis:** Once the wooden channels are removed, the ballis can be removed. They can be pulled out one by one, starting from the end and working backward.
5. **Remove the bamboo poles:** Finally, the bamboo poles can be removed. They can be pulled out one by one, starting from the top and working downward.
6. **Clean and store the formwork:** Once the formwork is dismantled, it should be cleaned and stored properly for future use. The bamboo poles should be treated with preservatives to prevent rotting, and the other materials should be stored in a dry and safe place.

It is important to follow proper safety procedures when dismantling formwork. Workers should wear appropriate personal protective equipment, such as gloves and safety glasses, and should be trained in safe work practices. The dismantling process should be carried out carefully to avoid any accidents or damage to the formwork. By following these steps, the formwork can be dismantled safely and efficiently.

4.1.4 Various Checks Conducted in Erection and Dismantling of Conventional Formwork

The following are the various checks that should be conducted during the erection and dismantling of conventional formwork:

1. **Site Preparation Check:** Before starting the erection of formwork, check that the site is clear of debris and obstructions, and that the ground is level and stable.
2. **Material Check:** Check that all the materials used for the formwork are of the correct type, size, and strength, and are in good condition.
3. **Formwork Alignment Check:** Check that the formwork is aligned correctly according to the specified design, and that the panels are secured tightly and evenly.
4. **Prop and Support Check:** Check that all the props and supports are installed correctly, and that they are properly braced to prevent movement or collapse.
5. **Plumb and Level Check:** Check that the formwork is plumb and level both vertically and horizontally, and that it is not leaning or sagging.
6. **Reinforcement Check:** Check that the reinforcement is correctly placed according to the specified design, and that it is not in contact with the formwork.
7. **Concrete Pour Check:** Check that the concrete is being poured correctly, and that there are no obstructions or blockages in the formwork that could cause issues during the pour.
8. **Dismantling Check:** Before dismantling the formwork, check that the concrete has set sufficiently and that the formwork can be safely removed without damaging the concrete.
9. **Damage Check:** Check for any damage to the formwork, and repair or replace any damaged components before reuse.

By conducting these checks during the erection and dismantling of conventional formwork, one can ensure that the formwork is erected and dismantled safely and efficiently, and that the resulting concrete structure is of the highest quality.

4.1.5 Materials used in Shuttering Work

Bamboos, ballis, wooden channels, wedge, base plate, etc., are commonly used materials in shuttering work. Each of these materials has its specific function in the construction process. Here is a brief explanation of each of these materials

1. **Bamboos:** Bamboos are commonly used in construction as a low-cost alternative to steel or timber. They are strong and durable, making them ideal for use in shuttering work. Bamboos are used as vertical supports in staging and as the primary material for creating the framework of a structure.

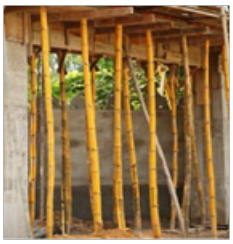


Fig. 4.1.2 Bamboos

2. **Ballis:** Ballis are horizontal bamboo poles that are placed across the vertical bamboo poles to create a platform for the workers to stand on. They provide a sturdy and safe surface for workers to stand on while working at heights.

Fig. 4.1.3 Ballis

3. **Wooden Channels:** Wooden channels are used to provide a solid surface for the shuttering boards to be placed on. They are placed on top of the ballis and provide a level surface for the shuttering boards to be placed on.

4. **Wedges:** Wedges are used to secure the shuttering boards in place. They are placed between the shuttering boards and the wooden channels or between two shuttering boards to prevent them from shifting or moving.

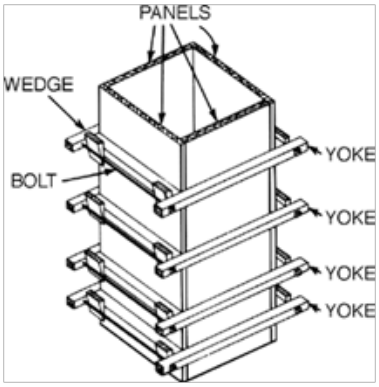


Fig. 4.1.4 Wooden Shuttering Formwork

5. **Base plate:** A base plate is a flat surface that is used to support the vertical bamboo poles. It provides a stable foundation for the support structure and helps

Overall, these to distribute the load of the structure evenly. Materials are critical in shuttering work as they help to provide support and stability during the construction process. When used properly, they ensure the safety and stability of the structure and prevent any accidents or damage during construction.

4.1.6 Procedure to provide Staging Support in Shuttering Works using Various Materials

Providing staging support in shuttering works using bamboos, ballis, wooden channels, wedge, base plate, etc., involves the following procedure:

1. **Assess the site:** Before beginning the work, it is important to assess the site and determine the type and amount of support required. This includes factors such as the height of the structure, the weight of the concrete, and the soil conditions.

2. **Install the base plate:** The base plate is placed on the ground and leveled to provide a stable foundation for the support structure.
3. **Install the bamboo:** The bamboo poles are placed vertically and supported by the base plate. They are then tied together using ropes or wires to create a sturdy support structure.
4. **Install the ballis:** The ballis are horizontal bamboo poles that are placed across the vertical bamboo poles to create a platform for the workers to stand on.
5. **Install the wooden channels:** The wooden channels are placed on top of the ballis to provide a solid surface for the shuttering boards to be placed on.
6. **Install the shuttering boards:** The shuttering boards are placed on top of the wooden channels and secured in place using wedges.
7. **Check for level and stability:** Once the shuttering boards are in place, it is important to check that they are level and stable. This can be done using a spirit level and by checking for any movement or wobbling of the support structure.
8. **Repeat the process:** The process is repeated for each section of the structure that requires support.
9. **Remove the support:** Once the concrete has set, the support structure can be removed by reversing the installation process, starting with the removal of the shuttering boards and working back to the base plate.

By following this procedure, staging support can be provided for shuttering works using bamboos, ballis, wooden channels, wedge, base plate, etc. This helps to ensure the safety and stability of the structure during the construction process.

4.1.7 Erection of Staging for Conventional Formwork

The following are the general steps for erecting staging for conventional shuttering:

1. **Determine the required height:** Determine the height required for the staging to support the formwork. The height will depend on the height of the structure being built and the thickness of the concrete slab.
2. **Select the materials:** Select the appropriate materials for the staging, such as scaffolding tubes, couplers, base jacks, and planks. Make sure that the materials are of the appropriate strength and are in good condition.
3. **Set up the base:** Set up the base of the staging by placing the base jacks on a level surface. Adjust the base jacks as necessary to ensure that they are level.
4. **Install the vertical tubes:** Install the vertical tubes on the base jacks. Make sure that the tubes are plumb and level.
5. **Install the horizontal tubes:** Install the horizontal tubes between the vertical tubes. Use couplers to connect the tubes securely.
6. **Add additional levels:** Add additional levels of tubes and planks as necessary to reach the required height. Make sure that each level is level and secure.

7. **Install guardrails:** Install guardrails on all sides of the staging to prevent falls. Make sure that the guardrails are installed securely and meet all safety standards.
8. **Install access ladders:** Install access ladders or stairs to allow workers to access the staging safely and easily.
9. **Inspect the staging:** Inspect the staging regularly to ensure that it remains level, stable, and secure. Make any necessary repairs or adjustments as needed.

By following these steps, you can erect staging for conventional shuttering safely and effectively. Always prioritize safety and follow all relevant safety standards and regulations.

4.1.8 Aligning and Supporting of Shutter Boards

The following are the general steps for aligning and supporting shutter boards for conventional shuttering as per instruction:

1. **Prepare the surface:** Ensure that the surface where the shutter boards will be placed is clean, level, and free from debris.
2. **Check the dimensions:** Check the dimensions of the shutter boards to ensure that they are the correct size and shape for the formwork.
3. **Align the shutter boards:** Align the shutter boards as per the instruction and place them on the surface in the correct position. Make sure that the boards are straight and level, and that the joints between the boards are flush.
4. **Secure the boards:** Secure the shutter boards in place using appropriate fasteners, such as nails or screws. Make sure that the fasteners are spaced appropriately and are driven in securely to prevent the boards from moving.
5. **Provide support:** Provide support to the shutter boards as per the instruction. This may involve placing props or supports beneath the boards to prevent sagging or bending.
6. **Check the alignment:** Check the alignment of the shutter boards regularly during the pouring of concrete to ensure that they remain straight and level. Make any necessary adjustments or repairs as needed.
7. **Remove the supports:** After the concrete has set, remove the props or supports from beneath the shutter boards carefully. Make sure that the boards are fully supported and do not move during the removal process.

By following these steps, one can align and support shutter boards for conventional shuttering as per instruction. Always follow the manufacturer's instructions and prioritize safety when working with formwork and shuttering.

4.1.9 Measurement

Everyone involved in the construction industry needs to be able to understand, obtain and use measurements accurately in a variety of situations, whether you need to read a plan to find out the height of a wall or check the width of a window frame before it's loaded for delivery.

Plans and drawings show things that are to be constructed, such as foundations, walls and fences. Plans and drawings also show lots of other important information, including levels, gradients, heights and measurements.

The most commonly used unit of measurement in the construction industry is millimeter (mm). Lengths, widths, depths and heights are usually given in millimeters. Where larger dimensions are shown, such as the length of boundaries on a site plan, metres (m) will be used. Centimetres are very rarely used

Unit	Abbreviation	Example	Conversion
Millimetre	mm	A fence could be 1200 high	1 mm = 0.001 m
Centimetre	cm	Rarely used in the construction industry	1 cm = 10 mm 100 cm = 1 m
Metre	m	A fence could be 14.60 long	1 m = 1000 mm

Table 4.1.1 Units of Measurement

Converting metres and millimetres

Sometimes it's necessary to convert metres to millimetres. One metre is 1000 times longer than one millimetre, so you just need to remove the decimal point and make sure there are three figures after the metre amount.

For example:

2.657 m becomes 2657 mm
4.32 m becomes 4320 mm.

To convert millimetres to metres, move the decimal point three places to the left, to make the number read as one thousand times smaller.

2460 mm becomes 2.46 m
12795 mm becomes 12.795 m

If the number of millimetres is less than 1000, put a zero before the decimal point.

For example:
795 mm becomes 0.795 m

Calculating Shuttering area:-

The shuttering is calculated in terms of Sq.M in the Rate Analysis of Shuttering. In order to calculate area of shuttering you must know how to calculate peripheral length (Perimeter) of an any shape.

Peripheral length (Perimeter):
Perimeter is the distance around a two dimensional shape.
For example square has four sides determine one side length is "s"
then peripheral length = s+s+s+s = 4s

Important Formulae for Calculating Shuttering Area:

- Perimeter of Square : 4S (S = Length of Side)
- Perimeter of Rectangle : 2[L+B] (L=Length & B = Breadth)
- Perimeter of Circle : 2πr (r = Radius of circle)
- Area of Rectangle = Length x Breadth
- Area of Square = Side x Side

Remember, each member in a structure either it may be Slab or Beam or Column it has six sides (faces). Shuttering area can be calculated by using two methods. One is by below mentioned formula and other method is by calculating the individual areas of faces. To keep it clear, i used both the methods in this article.

Formulae of Shuttering Area:

Shuttering area = Peripheral length (Perimeter) x Depth

Calculation of Shuttering Area of a Column:-

Consider a column as shown in below figure. To calculate the shmzuttering area follow the below steps:-

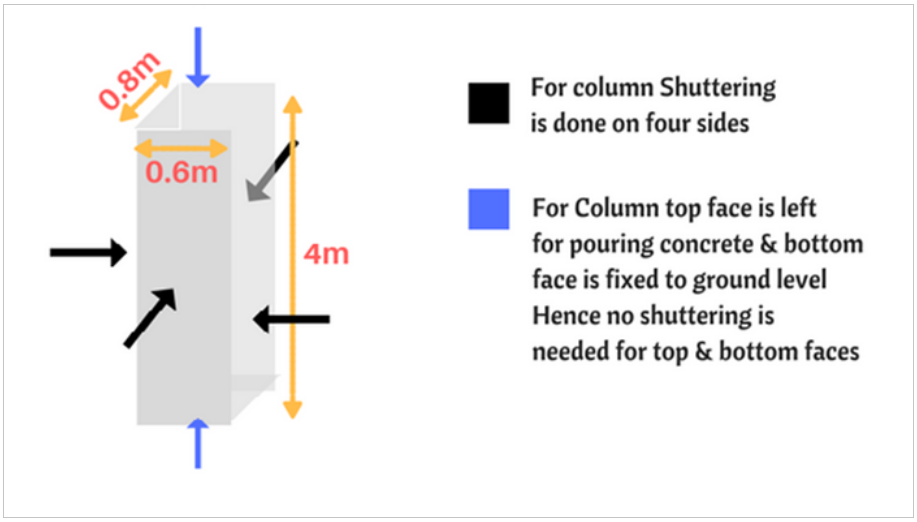


Fig. 4.1.5 Calculation of Shuttering Area of a Column

For Column, shuttering is done for four sides and other two sides (the top of column is left for filling concrete and bottom is fixed to ground level). Neglect top and bottom in calculation.

The side of column is in rectangle shape with side length "l" and breadth "b"

Peripheral length of Rectangle is = l+b+l+b = 2l+2b

Shuttering area = Peripheral length (Perimeter) x Depth

Peripheral length = 2×0.8+2×0.6 = 1.6+1.2 = 2.8Sq.m

Total Area of Shuttering of a column = 2.8 x 4 = 11.2 Sq.m

In case, the shape of column is Circular then the below mentioned formulae is used for calculating shuttering area

Shuttering area of Circular Column = 2πr x Depth

4.1.10 Shifting Scaffolding Materials

The following points should be considered while shifting the materials:

1. **Material type and safety**

You should consider the type of construction materials you are carrying. Forklifts, cranes, or trucks are needed to move bulky items like bricks, concrete, and roofing materials. In addition, make sure you stay away from subpar building supplies that can jeopardise the safety. The best construction materials should be choosen.

2. **Storage area**

To guarantee that the storage space satisfies all safety requirements, it must contain the following:

- Clear hallways, corridors, and exits to prevent tripping over things and falling.
- Items must be carefully stacked or organised in accordance with the instructions provided for each type of material. For instance, it is recommended that timber piles not be more than twenty feet high or that bricks not be placed more than seven feet high.
- The storage facility should be secure, and the maximum storage capacity is not specified.
- The storage space must always be tidy and dry. In fact, falls brought on by moisture are to blame for the vast majority of accidents at construction sites. Also, a dry warehouse will protect your construction components from deterioration.
- The storage space needs to be easily accessible.

4.1.11 Ergonomics in Shifting Materials

Ergonomics is the study of how people utilise their bodies while working and how to adapt the job or task to minimise your risk of damage.

These musculoskeletal injuries, which affect the body's soft tissues including the nerves, tendons, muscles, ligaments, and joints, gradually worsen over time. Low back strain, carpal tunnel syndrome, and tendinitis are a few examples of these ailments. Musculoskeletal disorders, or MSDs, are the medical term for these ailments.

Ergonomics practices to be followed:

Select tools that are more ergonomically sound. Maintain a low level of vibration while using power tools. To utilise tools more effectively and with less effort, use lightweight options. To avoid using additional energy to hold the tool in place, choose instruments that are properly balanced. Ensure sure the tool's handle is comfortable for you to grasp.

Avoid bending at the waist for extended periods of time. If at all feasible, raise the work on two

sawhorses or a bench. If you must spend any time working at lower levels, sit on a sturdy stool. As a result, the strain that comes from bending forward and squatting lessens on both your back and your knees. Keep materials off the ground if possible.

Organize your tool belt. When worn all day, a tool belt that is heavier on one side than the other might cause your back to become misaligned. In order to make up for this, the muscles on the side that isn't burdened have to work harder. Your tool belt should be balanced with the tools and supplies. Avoid carrying more than you need to and avoid wearing a tool belt if you don't have to. Remember to remove your tool belt during breaks to allow your body to relax.

While working, avoid twisting at the waist. A typical error is to repeatedly twist the lower spine when lifting or shovelling. While moving blocks, shovelling, etc., elevate your feet and turn your hips and torso in that direction.

Lift carefully if you must. You are aware of the procedure, but just in case. Design the lift and test the load. Enlist assistance. Make use of a buddy or material handling tools. Keep the burden near. While you raise, contract your abdominal muscles. Maintain a straight back while lifting with your legs. Reduce the burden in the same manner.

Reduce overhead. Back arches from reaching and lifting upwards. Excessive arching puts strain on the spine's tiny joints and adds to the strain on the neck and shoulders. Get as near to your task as you can by standing on a platform or ladder if you need to work overhead. Take regular rests by dropping your hands and leaning forward with your hands on your knees to stretch your back.

Maintain your wrists and arms in a neutral position. You are more likely to experience issues if you work with your wrist bent backward or forward. If at all possible, avoid working with your arms extended; doing so puts greater pressure on your body. Pain won't get better by trying to push through it.

Instead of pulling, push. By pushing weights, you may keep your back's natural curvature and lessen twisting. Just make sure you can see over the weight!

While shovelling, use effective methods. Your front foot should be close to the shovel as you keep your feet apart. Place your lower hand close to the blade. Transfer weight to the back foot. Keep the burden close to your body. Turn your feet in the direction of the toss of your load. To prevent repeatedly loading the same soft tissues, try sometimes switching up your grip or throwing direction.

Identify Challenging Jobs. Due to the variety of jobs in the construction sector, it is crucial to identify tasks that call for one or more of the aforementioned risk factors. The activities can then be redesigned or the work habits changed to decrease risk by investigating the reasons behind these risk factors.

4.1.12 De-Shuttering

Stripping or de-shuttering is the process of removing formwork. The time required to remove a form varies according on the component, cement type, and season.

De-shuttering Safety Measures

- When forms are stripped, there must be no excessive bending or damage to the concrete as a

result of the removal of supports or the stripping processes.

- Provide sufficient curing and shelter from direct sunlight and dry winds in cases where stripping time is less than the recommended curing time.
- Remove supporting props and shores from beams and slabs only when the concrete has become strong enough to withstand the dead load as well as any potential live load with a safety factor of 2.
- Design the forms and scaffolding such that they may be taken down quickly and safely without causing damage or shock.
- Remove the supports so that the concrete can evenly and gradually absorb its fair part of the weight.
- For determining stripping times, cure test cubes under the same circumstances as the concrete they represent.
- Under normal circumstances, forms and supports must be left in place for at least the following

Type of Formwork	Summers	Winters
Walls, columns and vertical faces of structural members	24 hrs.	48 hrs.
Removal of props under slab Spanning up to 4.5 m	7 days	14 days
Removal of props under beams and arches spanning up to 6 m	14 days	28 days
Soffit form work to slabs	3 days	(props to be refixed after removal)
Soffit to beams props	7 days	props to refixed after removal.

Table 4.1.2 De-shuttering time for different seasons

S.no	Type of Formwork	Minimum time before striking forms for OPC-made concrete	For concrete prepared with a different type of cement than OPC or with the use of mineral additives like fly ash and slag
1	Vertical formwork to columns, walls and beams	16 to 24 hours	16 to 24 hours
2	Soffit formwork to slabs (props to be refixed immediately after removal of formwork)	3 days	7 Days
3	Soffit formwork to beams (Props to be fixed immediately after removal of formwork)	7 days	10 Days
4	Props to slabs		

	a. spanning up to 4.5 m	7 days	10 Days
	b. panning over 4.5 m	14 days	14Days
5	Props to beams and arches:		
	a. spanning up to 6 m	14 days	14 Days
	b. spanning over 6 m	21 days	21 Days

Table 4.1.3 De-shuttering time for different concrete

4.1.13 Types of Knots used in Conventional Formwork

Steps on how to tie different types of knots in shuttering:

1. **Square Knot:**
   - Take the two ends of the rope and make a loop with one end over the other.
   - Take the end that is now on top and make another loop over the first loop.
   - Pull both ends to tighten the knot.

Fig. 4.1.6 Square Knot

2. **Clove Hitch:**
   - Loop the rope around a pole or stake and then bring the working end over the standing part of the rope.
   - Make another loop in the same direction, but this time around the opposite side of the pole or stake.
   - Cross the working end over the standing part and tuck it under the second loop.
   - Pull both ends to tighten the knot.

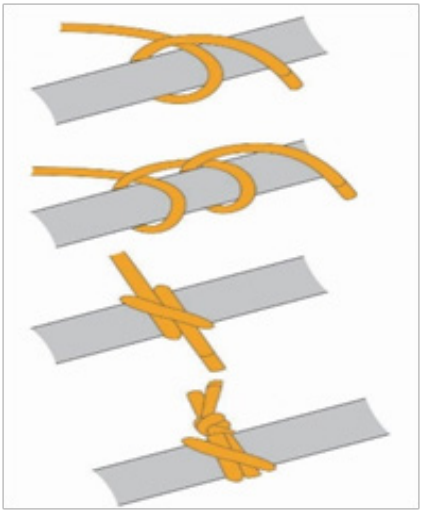


Fig. 4.1.7 Clove Hitch

3. **Bowline:**
   - Make a loop with the rope, leaving a long tail on the work
   - Bring the working end up through the loop and then back the rope.
   - Bring the working end back up through the loop.
   - Pull both ends to tighten the knot.

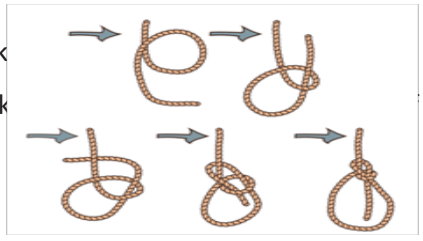


Fig. 4.1.8 Bowline

4. **Timber Hitch:**
    - Wrap the rope around a pole or log, leaving a long tail on the working end.
    - Bring the working end around the standing part of the rope and tuck it under the wrap.
    - Repeat this step several times to create a series of wraps around the pole or log.
    - Tie off the tail of the working end by tucking it under one of the wraps.

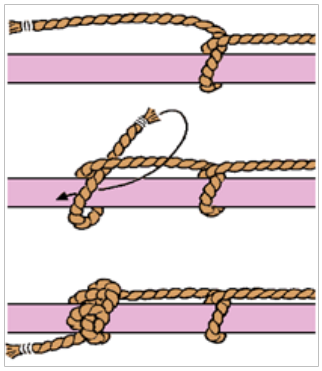


Fig. 4.1.9 Timber Hitch

These knots can be used in shuttering to tie together the wooden planks or boards to form a sturdy and secure structure.

4.1.14 Types of Form Ties used in Conventional Formwork

In conventional shuttering, ties are used to hold the formwork or shuttering in place and provide the necessary support and stability to the structure during the casting of concrete. The various ties used in conventional shuttering are:

1. **Snap Tie:** Snap ties are the most commonly used ties in conventional shuttering. They are made of steel and consist of two parts: the "tie rod" and the "tie wedge". The tie rod is placed through the formwork and then the tie wedge is hammered into the tie rod from the other side, which pulls the two sides of the formwork together and holds them in place.
    - A snap tie is a single rod with an expanded button or loop at each end to make it easier to use certain tie holders.
    - These ties are used as form spreaders and to stop concrete water leakage by being linked to plastic cones, metal washers, or pins.
    - Snap ties have weaker cross sections that are easily snapped because they cannot be entirely detached from the hardened concrete.
    - In order for the ties to break and turn inside the wall by crossing the concrete, they must be broken after the concrete has fully hardened.
    - These ties are made by crimping or weakening a piece of the tie at the necessary distance to prevent spinning and make the tie easier to snap.

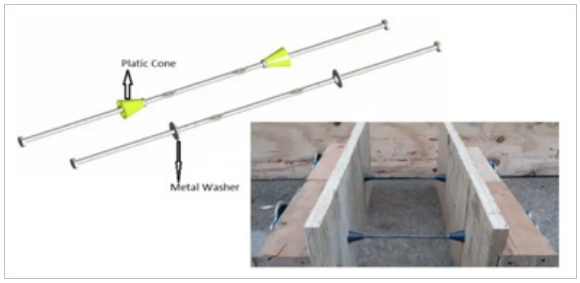


Fig. 4.1.10 Snap Tie System

2. **Flat Tie:** Flat ties are similar to snap ties but they are flat and made of steel. They are used for thicker formwork and are often used with a waler, which is a horizontal support that spans across multiple formwork panels.

    - A flat tie is an extremely thin flat steel plate with holes on both ends. These holes are used to wedge and pin the flat ties into the forms.
    - They are preferred for low duty applications and prefabricated modular form panels.
    - Since they cannot be removed from solidified concrete, they should only be used once.
    - They are eliminated through braking, which is made easier by the inclusion of a notch spaced apart from the ends of the object.
    - The midsection of the knot may have perforations to prevent it from twisting during braking.

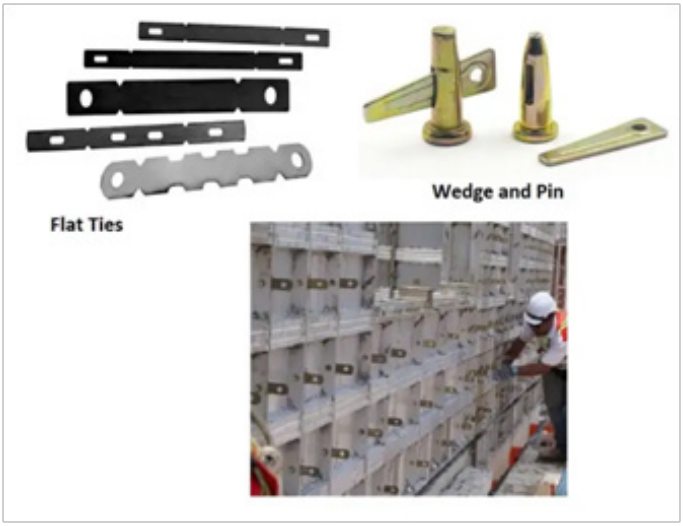


Fig. 4.1.11 Flat Tie and Wedge Bolt TIe

3. **Wedge Bolt Tie:** Wedge bolt ties are made of steel and consist of a bolt and wedge. They are used to hold two panels of formwork together and are tightened by inserting the wedge into the bolt and then hammering it in.
4. **Loop Tie:** A loop tie is a single metal bar with looped ends that allow room for securing mechanisms like a wedge and pin.

    - They are also preferred for low duty uses and prefabricated modular form panels.
    - Loop ties have weaker cross sections because they cannot be removed from cemented concrete.
    - A section of the central portion is crimped to stop turning when the brakes are applied.

Fig. 4.1.12 Loop Ties

5. **Taper Tie:** A taper tie has a rod that is tapered and threaded on both ends. These ends are secured after being placed in forms using a wing nut and washer system.
    - They come in conventional lengths ranging from 34 in. to 60 in. Hence, the needed wall thickness can be achieved utilising taper ties of various lengths.
    - From the larger threaded end to the small threaded end, the taper tie's diameter steadily decreases.
    - After the concrete has dried and become rigid, tapered ties can be totally removed and reused.
    - Before installation, the taper tie needs to be coasted with oil for simple removal.

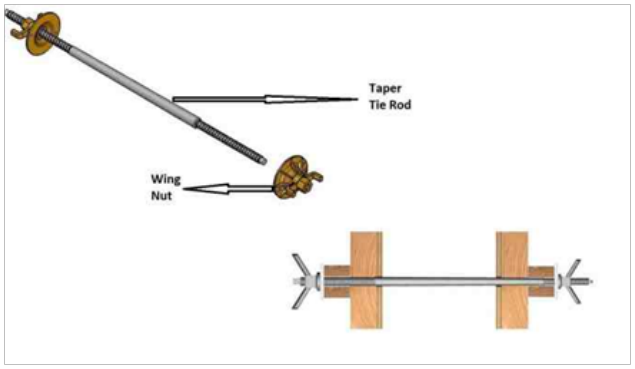


Fig. 4.1.13 Taper Tie System

6. **Threaded Tie:** Threaded Tie is made out of a metal rod that is totally threaded from one end to the other.
    - Nuts and washers are used on each end to secure it to the forms.
    - If a plastic sleeve is placed around it, it can be retrieved from cemented concrete.
    - The sleeve is joined with concrete after hardening, and the threaded tie can be taken off and

reused.

- Higher loads can be supported by it, although in that case, two nuts on each end are suggested.

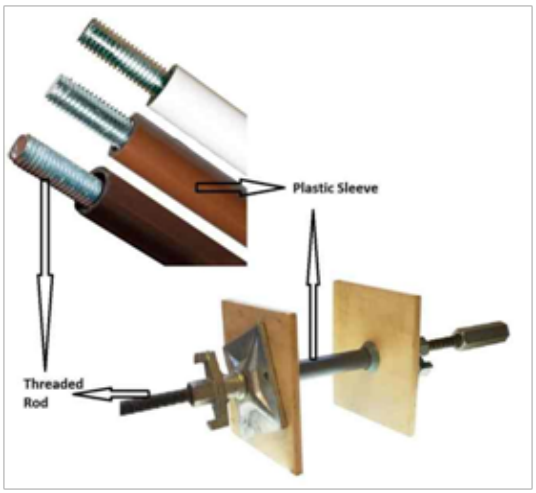


Fig. 4.1.14 Threaded Tie System

7. **Coil Tie:** Coil ties are used for larger formwork and consist of a steel coil and a cone-shaped end. The coil is inserted through the formwork and the cone-shaped end is inserted into the coil to hold the formwork in place.
   - Coil ties are made up of two parts: an inner tension member and an external holding component.
   - Two helical coils are welded to the ends of two or four steel struts to form the inner tension member. This member is still in the concrete after it has hardened.
   - A washer and wale arrangement supports the two bolts that are screwed into the coils on either end of the external holding component. After hardening, these bolts can be taken out and reused.
   - For medium-sized projects, a two-strut coil is employed, and for larger projects, a four-strut coil.
   - If necessary, cones made of wood or plastic can be placed at the coil's ends to serve as form spreaders.
   - The use of two inner members joined by threaded rod is an option if the wall thickness is too great.

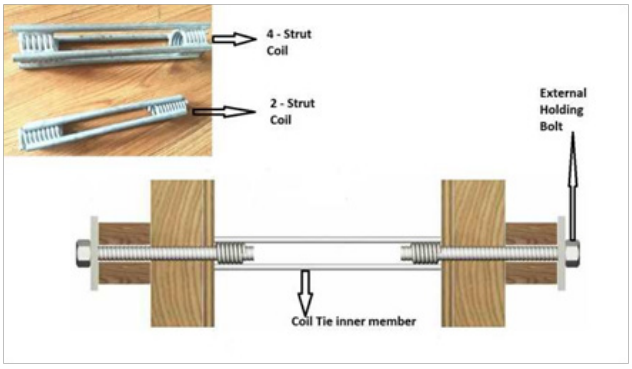


Fig. 4.1.15 Coil Ties

8. **She-bolt tie:** She-bolt ties are used for column formwork and consist of a bolt and a she-bolt that is inserted into the column formwork. The she-bolt is then tightened to hold the formwork in place.
    - A she-bolt tie system consists of one inner tie rod and two she-bolt members. The inner tie rod's ends are threaded on both sides for a while.
    - She-bolts have a tapered end with a threaded hole in addition to a standard threaded end.
    - The tie rod is screwed into the threaded holes of the she-bolts on both sides after the taper end has been inserted internally into the forms.
    - The forms are fastened to the she-bolts using an array of wing nuts and washers on their external threaded ends.
    - The inner tie rod is still in the concrete after it has hardened, and she-bolts can be taken out and reused.

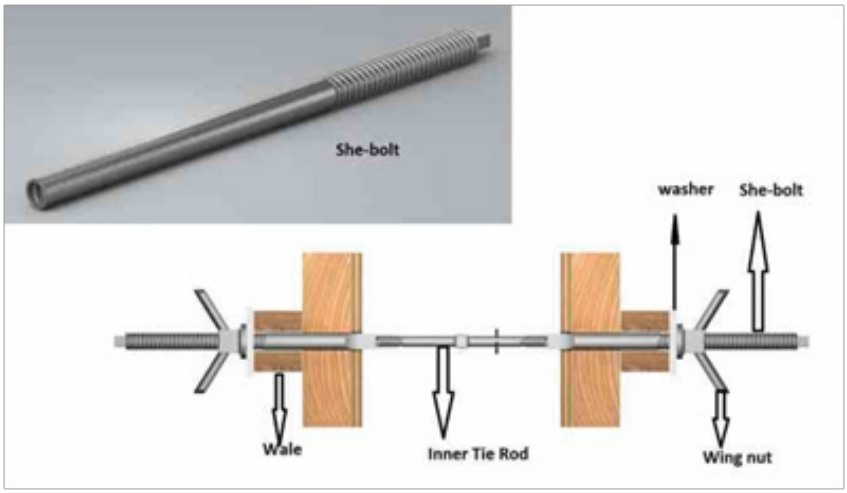


Fig. 4.1.16 She-Bolt Ties

Overall, the type of tie used in conventional shuttering will depend on the size and shape of the formwork being used, as well as the desired level of support and stability needed during the concrete casting process.

4.1.15 Transfer of Level from Reference Point

Transferring the level from a reference point to a new point accurately and effectively involves several steps:

1. **Establish the reference point:** First, you need to establish a reference point that will serve as the starting point for your levelling work. This reference point should be a fixed, stable, and easily identifiable point that is either at the same level as the finished surface or a known height above or below it.
2. **Set up the levelling equipment:** Once you have established the reference point, set up your levelling equipment, such as a laser level or a dumpy level, at the reference point. Ensure that the equipment is level and stable.

3. **Take measurements:** With the levelling equipment set up, take measurements at various points to determine the height difference between the reference point and the point you want to transfer the level to. This can be done using a staff, which is a long, graduated rod that is held vertically at the point being measured.
4. **Calculate the required height adjustment:** Based on the measurements taken, calculate the required height adjustment to transfer the level from the reference point to the new point. This can be done by subtracting the height of the reference point from the height of the new point and adding or subtracting any other relevant factors, such as the depth of the foundation or the thickness of the flooring.
5. **Make adjustments:** Once you have calculated the required height adjustment, make any necessary adjustments to the levelling equipment, such as raising or lowering the laser level or adjusting the level of the dumpy level, to ensure that the new point is at the correct level.
6. **Verify the level:** After making the adjustments, verify the level by taking additional measurements at various points around the new point to ensure that it is level and at the correct height.

Exercise

1. Fill in the blanks:

   (Hint: Loop Tie,She-Bolt Ties, Flat Tie,Snap Ties)

   a. _____is consist of two parts: the “tie rod” and the “tie wedge”.

   b. A _____ system consists of one inner tie rod and two she-bolt members.

   c. A _____ is an extremely thin flat steel plate with holes on both ends.

   d. A _____ is a single metal bar with looped ends that allow room for securing mechanisms like a wedge and pin.

2. List the various types of knots used in conventional formwork.
3. Explain the procedure for erection of conventional formwork.
4. What are the various checks conducted in erection and dismantling of conventional formwork?

Notes

QR Codes

Scan the QR code to watch the video

https://youtu.be/VA27lBDEAgE

Conventional Formwork

https://youtu.be/OAYuQC22Bn0

Procedure for Erection of Conventional Formwork

Skill India
कौशल भारत-कुशल भारत

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5. Assist in Assembling and Dismantling System Formwork for RCC Structures

Construction Skill Development Council

Unit 5.1 - Assembling and Dismantling System Formwork for RCC Structures

CON/N0314

Key Learning Outcomes

By the end of this module, participants will be able to:

- Describe standard procedure for assembling and dismantling system formwork
- Describe the procedure to provide support in shuttering works
- Explain procedure for erection and dismantling of system formwork
- Explain the checks required for line, level and alignment.
- Demonstrate erection of staging/ shuttering for system form works as per instruction.
- Demonstrate the various checks conducted in erection and dismantling of system formwork
- Describe the corrective actions required for maintaining line, level and alignment
- Demonstrate safe de-shuttering of shutter boards and components as per instruction
- Demonstrate shifting of materials and tools required for assembling system scaffolding

Unit 5.1Assembling and Dismantling System Formwork for RCC Structures

Unit Objectives

By the end of this unit, participants will be able to:

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- Describe the corrective actions required for maintaining line, level and alignment
- Demonstrate safe de-shuttering of shutter boards and components as per instruction
- Demonstrate shifting of materials and tools required for assembling system scaffolding

5.1.1 Standard Procedure for Assembling System Formwork

Fresh concrete constructions such as walls, slabs, beams, columns, footings, etc. necessitate the use of concrete formworks (shuttering). For each type of structural member, there are certain formwork requirements, and those needs are reflected in the names of the forms. When fresh concrete is poured into a structural element, formwork (also known as shuttering) acts as a temporary mould to support the concrete until it has dried. The structural member gains the necessary strength as a result to support both its own weight and the weight of other members. Depending on the material used, how it will be used, and the kind of structural components, there are various forms of structural formwork or shuttering. According to that, they can be given names. The formwork's basic operation, though, is unchanged.

Formwork (Shuttering) Variety in Relation to a Structural Member

Formworks, sometimes known as the following, are used to construct reinforced concrete foundations, columns, slabs, walls, etc.

- Footing Forms - Foundation Formwork
- Formwork for the production of RCC columns using column forms
- Wall Forms - Formwork for RCC wall construction
- The use of floor forms as formwork for the construction of RCC slabs

a) Footing Forms – Formworks for Foundation

Building a foundation is the initial step in any concrete construction process. A foundation can support walls or columns. Hence, the size and shape of the footing are developed based on the type of structural member. As a result, the kind and dimensions of the footing determine the size and shape of the formwork.

Fig. 5.1.1 On-going Work of Foundation Formwork

Components of Footing Forms:

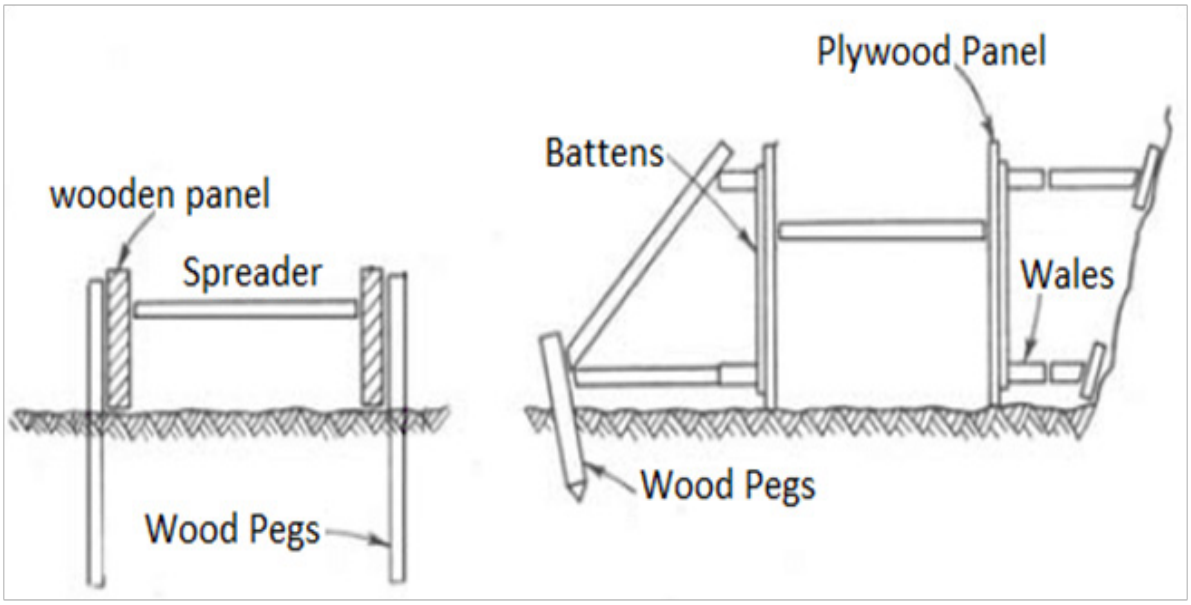

Fig 5.1.2 Continuous Footing Formwork: Footing Formwork Components for Shallow Footing

b) Column Forms – Formwork for Concrete Column Construction

Because of their small cross sections, high heights, and generally rapid rates of concrete placing, reinforced concrete column forms are sensitive to lateral pressure. As a result, the formwork needs to have tight joints and sturdy tie support. The stiffness of the formwork must be improved as concrete column sizes grow, either by thickening the sheathing or by adding vertical stiffeners to avoid sheathing deflection.

Fig 5.1.3Formwork for Concrete Column Construction

c) Wall Forms – Formwork for RCC Wall Construction

Because to their larger cross-sectional area, wall building forms are subjected to far less lateral pressure than column forms.

The components of wall forms are:

- Panel sheathing – It is utilised to mould the wall and hold the concrete in place until it hardens.
- Studs- creating a framework to keep the forms aligned and support the studs, to support the sheathing or Wales.
- Braces – It is used to hold the formwork upright and stop forms from bending when subjected to lateral pressure.
- Ties and spreaders – They are used to maintain the forms' sides at the proper spacing.

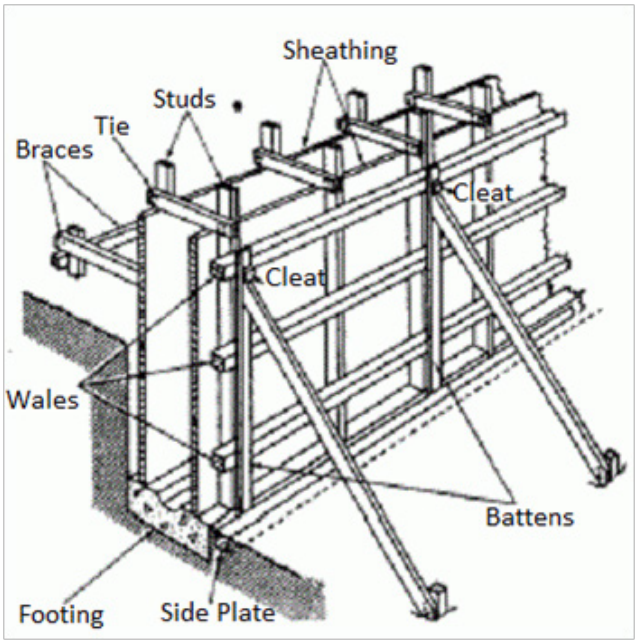

Fig 5.1.4 Components of a Wall Formwork

Floor Forms – Formwork for construction of RCC Slabs

The sort of formwork needed for reinforced concrete slabs depends on the slabs that will be built. The floor slabs may be slabs with a structural structure made of steel or concrete, or they may be slabs on grade. The type of slab affects how the formwork is designed. Building Slab Assembling formwork is done as follows:

- Placing the beam or girder form at the bottom.
- Girder side forms rest on the column form's shore heads and sides, overlapping the bottom form.
- Ledger strips secured to the shore heads with double-headed nails hold the side forms in place.
- To avoid buckling, the side forms of larger girders should be vertically reinforced.
- While building the girder and beam forms, each component must be removed without affecting the remaining parts of the form; strike-off formwork will start with the beam and girder sides and continue with the column forms, beam and gird bottoms, and lastly, the column forms.

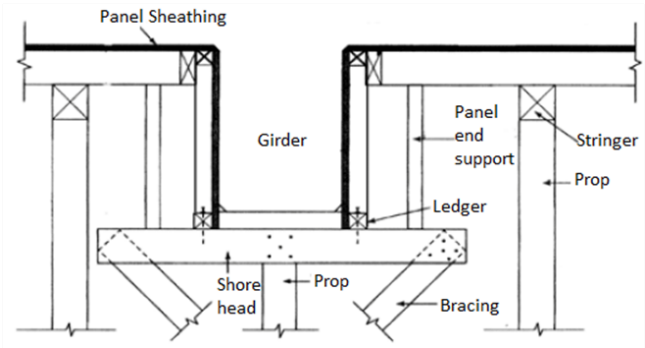

Fig 5.1.5 Structural Slab Formwork Components

Concrete slabs are put on grade using Slab-on-Grade Forms. While concrete is put over a base of compacted dirt or levelled gravel, these slab formworks are typically relatively straightforward. Hence, the lowest concrete layer doesn't need to be supported.

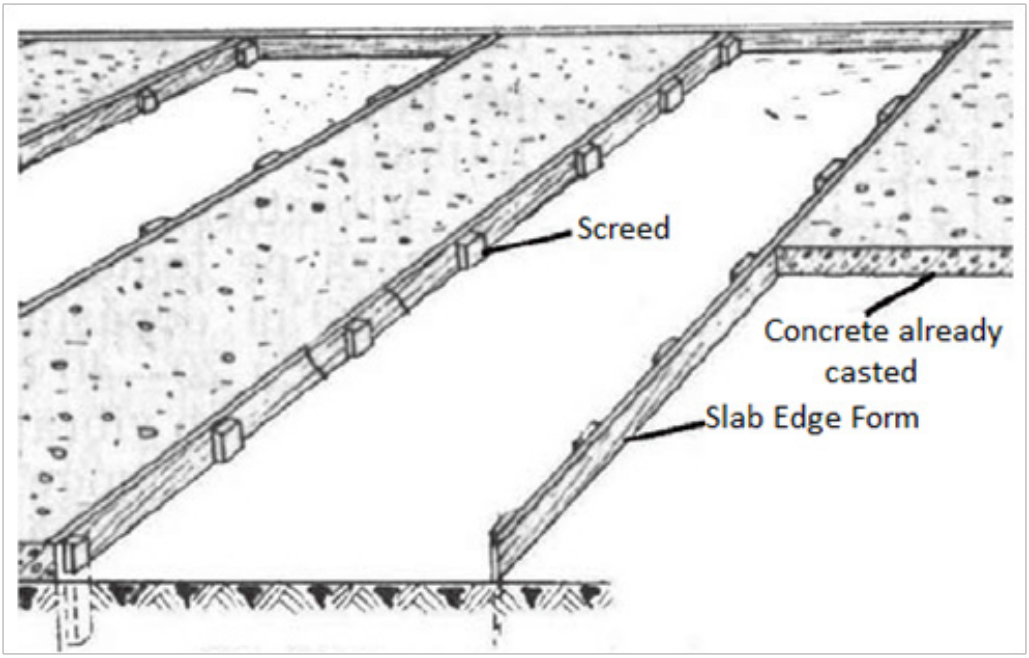

Fig 5.1.6 Components of a Slab-on-Grade Slab Formwork

Slab-on-Grade Formwork assembly is carried out as follows:

- Concrete's open edges are formed or supported using steel forms, plywood, or planks.
- Wooden pegs are used to support these forms and keep them in place.
- On chairs, bolsters, and spacers constructed of either metal or concrete, the reinforcement in the slab (if specified in the structural drawing) should be positioned in accordance with the drawing on its suitable location.
- Construction joints that transmit shear from one to the other must be created between the slab's parts if it is to be cast in pieces. The structural drawing should be followed for the specifics of the building joints.

5.1.2 Dismantling System Formwork

Concrete formwork removal, also known as strike-off or stripping of formwork, should only be done once the concrete has developed adequate strength, which is at least twice as much stress as the concrete may experience when the formworks are removed. During the dismantling of the formwork, it is also essential to guarantee the stability of the remaining formwork.

Concrete Formwork Removal Time

Temperature influences the velocity of concrete hardening or the strength of concrete, which in turn influences how quickly the formwork can be removed. For instance, the amount of time needed to

remove concrete in the winter will be greater than that needed in the summer.

Flexural elements, such as beams and slabs, require special consideration while removing formwork. These members may deflect if the strength gained is insufficient to handle the loads since they are subjected to both self-load and live load even while the structure is being built.

Concrete cube or cylinder tests should be performed to determine the strength of the concrete prior to formwork removal. The concrete cubes or cylinders should be made from the same mix as the structural members and should be dried in conditions that are similar to those of the structural members in terms of temperature and moisture.

Formworks should only be removed once it is certain that the concrete in the structural components has become strong enough to resist the design load. The formworks should be left for as long as possible because doing so aids in curing.

Removal of formwork from the concrete section should not make the structural element to:

- Collapse when put under self-load or intended loads
- in the short- or long-term, excessive structural member deflection
- The structural member sustains physical damage during the removal of the formwork.

The following points must be kept in mind during formwork removal whether the structure will be prone to:

- Freeze thaw damage
- The development of cracks as a result of the concrete's thermal shrinkage after the formwork is struck.

Delaying the removal of the formwork is preferable if there is a considerable chance of any of the aforementioned damages. Formwork must be properly insulated in order to prevent damage if it needs to be removed in order to optimise concrete construction processes.

Fig 5.1.7 Formwork removal

Calculation of Safe Formwork Striking Times:

Construction of structural members is dependent on the intended load. However during the construction phase, structural elements are subjected to their own weight and construction loads before a structure is finished and exposed to all of the stresses assumed during structural design.

The behaviour of the structure under its own load and the load of construction must therefore be calculated in order to move construction operations along more quickly. Formwork may be removed if this is successful and a structural part is determined to be secure.

If these calculations are not feasible, the safe formwork striking times can be determined using the formula below:

When the formwork is removed, a cube with the requisite maturity and characteristic strength must be used.

$$= \frac{\text{Dead load + construction load}}{\text{Total design load}} \times \text{grade of concrete}$$

Harrison (1995) provided this method, which goes into great detail on how formwork removal times are determined.

Conducting non-destructive testing on structural members is another way to assess the strength of a concrete structure.

Factors Affecting Concrete Formwork Striking Times

The strength of the structural element affects the concrete formwork's striking time. Concrete member strength development is dependent on:

- Grade of concrete:Higher the grade of concrete, the rate of development of strength is higher and thus concrete achieves the strength in shorter time.
- Grade of cement: Higher cement grade makes the concrete achieve higher strength in shorter time.
- Type of Cement: Type of cement affects the strength development of concrete. For example, rapid hardening cement have higher strength gain in shorter period than the Ordinary Portland Cement. Low heat cement takes more time to gain sufficient strength than OPC.
- Temperature: The higher temperature of concrete during placement makes it achieve higher strength in shorter times. During winter, the concrete strength gain time gets prolonged.
- A higher ambient temperature makes the concrete gain strength faster.
- Formwork aids in insulating concrete from its surroundings, therefore the longer the formwork is present, the less heat is lost during hydration and the faster the concrete gains strength.
- The size of the concrete member has an impact on the strength increase of concrete. Members of larger concrete sections get stronger faster than those of smaller sections.
- Rapid curing is another way to speed up the rate at which strength develops when heat is applied.

Generally following values of concrete strength is considered for removal of formwork for various types of concrete structural members.

Concrete Strength	Structural Member Type and Span
2.5 N/mm2	Lateral parts of the formwork for all structural members can be removed
70% of design strength	Interior parts of formwork of slabs and beams with a span of up to 6m can be removed
85% of design strength	Interior parts of formwork of slabs and beams with a span of more than 6m can be removed

Table 5.1.1 Strength of concrete vs. Structural Member Type & Span for Formwork Removal

Type of Formwork	Formwork Removal Time
Sides of Walls, Columns and Vertical faces of beam	24 hours to 48 hours (as per engineer's decision)
Slabs (props left under)	3 days
Beam soffits (props left under)	7 days
Removal of Props of Slabs:	
i) Slabs spanning up to 4.5m	14 days
ii) Slabs spanning over 4.5m	14 days
Removal of props for beams and arches	
i) Span up to 6m	14 days
ii) Span over 6m	21 days

Table 5.1.2 Formwork Stripping Time (When Ordinary Portland cement is used)

Important Note:

The period for formwork removal indicated in Table -2 above should only be used when using Ordinary Portland Cement, it is crucial to mention. Portland cement is utilised in standard building procedures. As a result, Table 2's timing should be changed.

For cements other than Ordinary Portland cement, the time required for formwork removal should be as:

- Stripping time for Portland Pozzolana Cement will be 10/7 of the above-mentioned time (Table-2)
- Time for low-heat cement-stripping will be 10/7 of the previously mentioned period (Table-2)
- Except for the vertical sides of slabs, beams, and columns, which should be held for at least 24 hours, Rapid Hardening Cement - stripping time of 3/7 of the time specified above (Table-2) will be sufficient in all circumstances.

Concrete Formwork Removal Specification

Fig 5.1.8 Stripping of formwork

During stripping of formwork, following points must be remembered:

- Formwork shouldn't be taken off until the concrete is strong enough to handle all weights applied to it. The amount of time needed before formwork can be removed depends on the member's structural function and the rate at which the concrete gains strength. The rate at which concrete gains strength depends on factors such as concrete quality, cement type, water-to-cement ratio, curing temperature, etc.
- The formwork components and connections should be set up such that it may be reused without requiring major maintenance, is simple and easy to remove, and doesn't damage the concrete or the formwork panels.
- To ensure that the quality of hardened concrete in structural members, i.e., that it is free from or has a minimum amount of casting flaws such as honeycombing, size and shape defects, etc., the formwork removal method should be under the engineer's supervision. The strength and stability of the structure are impacted by these concrete flaws. So, urgent repairs can be made, or the members can be dismissed.
- Crowbars shouldn't be used to break apart forms by pounding them into the concrete. The hardened concrete might be harmed. Using wooden wedges is the best way to accomplish this.
- Joist forms should be designed and removed so that beaches may be temporarily removed to permit removal of joist forms but must be reinstalled at once.
- Beam and joist bottoms should be left in place until complete removal of all shoring under them. Starting in the centre of the member's span and working symmetrically up the supports, the coasts and joists will be removed.
- The engineer should be consulted regarding the order and pattern of formwork removal.

5.1.3 Procedure to Provide Support in Shuttering Works

It is made sure to be sturdy enough to endure the dead and live loads and forces exerted upon it while and after the concrete is cast, as well as any incidental loads induced by ramming and vibrations of the concrete.

By utilising an adequate number of ties and bracing, it is made sufficiently rigid; where necessary, screw jacks or hardboard wedges are provided to make up any formwork settlement before or during the concrete pour.

The shuttering that is employed is made sure to be strong enough to prevent excessive deflection, and joints are tightly butted to prevent slurry leakage. The concrete shuttering made of steel is suitably robust.

To prevent stains, honeycombing, seepage of slurry via joints, etc., the steel shuttering should be rigid, devoid of bends, dents, etc., and regularly maintained.

5.1.4 Checks Required for Line, Level and Alignment

A better approach would be to examine it twice, once when the beam and slab elements are ready for concreting and the reinforcement is entirely tied up.

- Examine the formwork first before allowing the placement of reinforcement.
- This is required because some formwork flaws are difficult or impossible to fix once reinforcement has been installed.
- Examining the reinforcement.

Centering and Shuttering / Formwork

Checks that need to be made before pouring concrete, while pouring concrete, and after formwork removal are included in the concrete formwork checklist. Threats to both quality and safety exist in concrete formwork. When work is being done at a height and the formwork is improper for the concrete, safety issues may arise. When constructed at the construction site, concrete formwork serves as a temporary supporting structure to hold the concrete in place and in the desired shape until it hardens. When the formwork is not properly aligned or is not leak-proof, for example, the quality of the concrete is impaired. For the project to be cost-effective, concrete formwork must be stored properly.

Concrete Formwork Checklist at Site

Formwork Checklist for Walls:

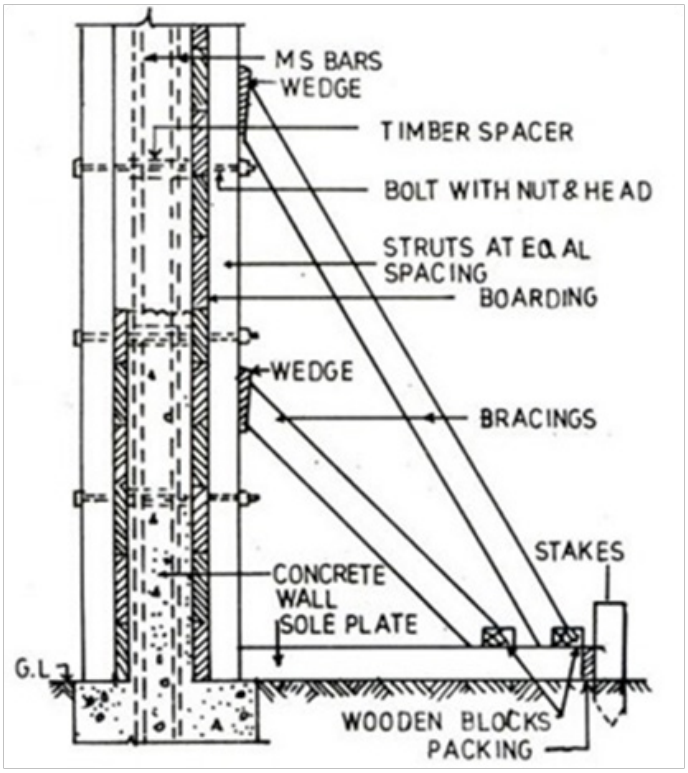

Fig 5.1.9 Centering and shuttering / Formwork

1. Verify that the forms are firmly supported at all points of support by the lateral bracings offered.
2. Braced block out (stop end) to withstand lateral and vertical loads
3. The form panels are properly fastened to one another and supported.
4. Formwork corners must be sufficiently secured to stop leaks, bulging, and concrete spreading.
5. Verify that wall ties have enough length, strength, and spacing to meet requirements.
6. Verify that wales are spaced properly, and joints between tiers should be staggered.
7. One member left continuous across the location of form ties in double member wales.
8. Wall ties and bolts tightened properly.
9. If double member wales are utilised, each wales must have the same depth.
10. Verify that the forms and previously cast concrete have an acceptable amount of lap.
11. Check to make sure that the seams between the panels and the joints between the old concrete and the panels above them do not leak grout.
12. Verify the supply of resistance against uplift in the case of concrete formwork with sloping faces.
13. During the installation of the wall forms and the pouring of concrete, make sure an experienced supervisor is on site.

Formwork Checklist during Concreting

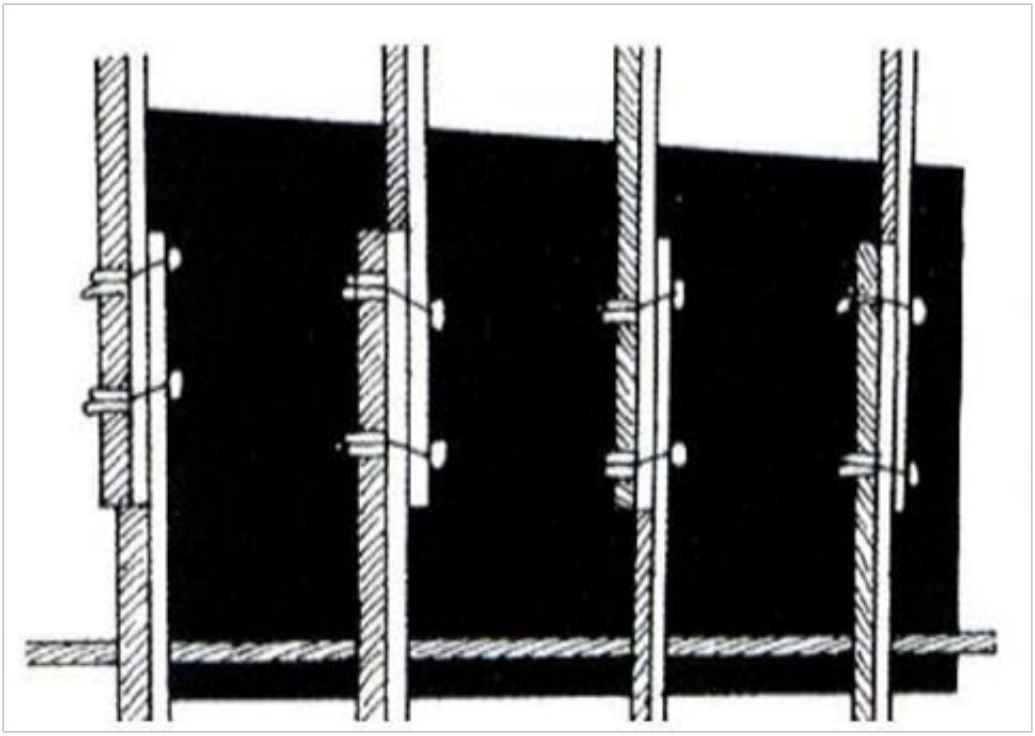

Fig 5.1.10 Concreting

1. Before starting the concreting process, make sure that personnel who will be laying, compacting, and completing the concrete have sufficient access.
2. The presence of an experienced supervisor who is constantly on the lookout for potentially risky situations
3. A sufficient number of competent personnel, spare clamps, wedges, and props are available on site.
4. As concrete pouring is taking place, alignment, camber, level, and plumb (verticality) are maintained.
5. The effective distance between the bottom and top reinforcement remains unaltered.
6. Concrete covering the reinforcement steel is kept in the proper condition.
7. Grout loss as a result of joint movement and measures taken to prevent it.
8. Wedge and fixing loosening as a result of vibrations being transferred to the formwork and countermeasures taken.
9. Clean up any spilled grout or concrete right away.
10. After pouring concrete, all wooden spreaders used to keep vertical form faces apart are removed.
11. Before concrete fully hardens, wooden components used to make pockets are loosened.
12. Concrete pouring order in accordance with formwork drawing (avoid eccentric loading).
13. Preventing high impact drops from concrete buckets and concrete stacking.

14. Concrete pouring rate within permitted limits as depicted on working drawings or as presumpted during formwork design against lateral stresses.
15. If concrete is laid in layers, ensure that the top layer is sufficiently penetrated by the needle vibrator to provide proper bonding between the layers.

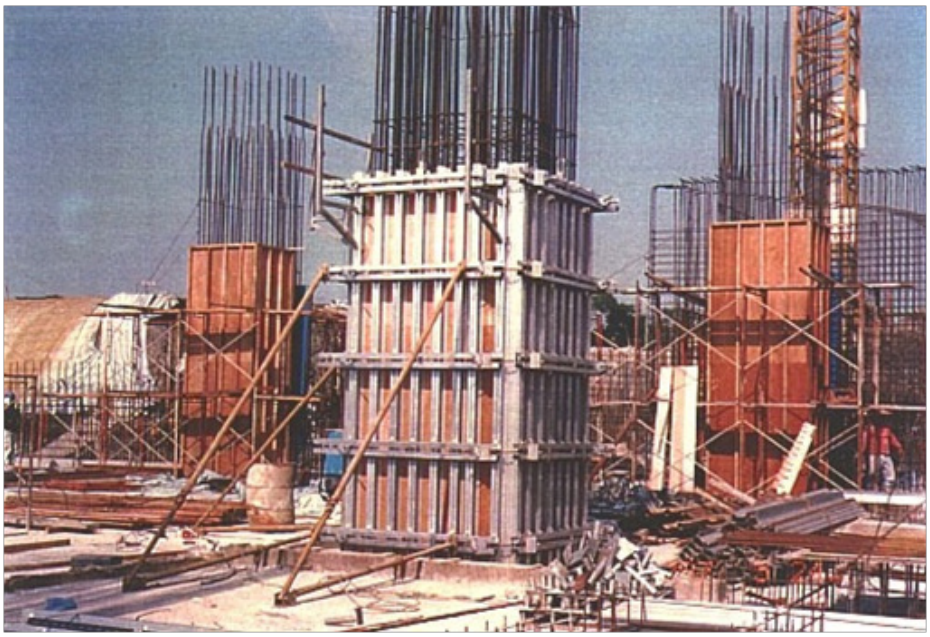

Fig 5.1.11 Formwork Striking (Stripping or Removal)

Checklist during Formwork Striking (Stripping or Removal)

1. Formwork must be designed and laid out such that it can be struck smoothly and sequentially.
2. Concrete's strength, including its ability to support both its own weight and construction loads.
3. Depending on the size, shape, and span of the member, the type of cement, the ambient temperature, the weather, and the degree of curing completed, the removal time will be determined.
4. The corners and edges were undamaged at the time the side form was removed.
5. Slowly loosened and removed wedges, ties, and clamps.
6. Removal times that follow the guidelines in the code of practise (IS 456- 2000).
7. Supports for beams and slabs should be removed in stages, starting at the centre of the span and moving outward.
8. Bolts, nuts, clamps, and wedges are gathered in a box and not carelessly dropped.
9. Steer clear of using crowbars to pry open forms.
10. Wooden wedges were used to pry open the formwork.
11. Carefully descend the forms without dropping or harming them.
12. Panel faces should be gently taken off and lowered without contacting the projections of the scaffold.
13. After removal, panels are set on a surface that is level.

14. Hammered down nail projections.
15. Setting up a perimeter around the region below the proposed site for formwork removal.
16. The presence of a foreman and crane operator who are skilled.

Checklist for Cleaning and Storage of Formwork

1. Formwork should be cleaned with a firm brush as soon as it is removed.
2. Elimination of debris, grout, and tenacious concrete fragments.
3. Before storing, release agent was applied to the wood's surface and uncoated ply.
4. To avoid corrosion, steel forms were lightly coated with oil.
5. Before being stored, damaged formwork is sorted out and fixed.
6. Nail holes and depressions should be filled up with the proper materials and lightly wiped to create a smooth surface.
7. Plywood sheets and panels kept on a horizontally levelled floor.
8. To protect the surface, panels should be stored face to face.
9. A well-ventilated storage place that is dry and shielded from moisture.
10. All formwork supplies should be elevated off the ground.
11. After numbering for suitable match, loose wailing, soldiers (struts), etc. are kept with the appropriate panels.
12. Bolts, nuts, champs, pins, wedges, keys and ties stored in separate bins or boxes.

5.1.5 Moving, Handling, and Storing Materials

Employees should request assistance when manually transferring loads that are too heavy to safely manage, when they can't see around or over them, or when they can't properly grasp or raise them.

To lessen the possibility of having fingers crushed or pinched, handles or holders should be attached to loads. Moreover, employees should wear the proper protective gear. Use gloves or other hand and forearm protection when handling loads that have sharp or rough edges. Use eye protection as well to prevent eye damage. The mover should also wear steel-toed safety shoes or boots when the items are big or bulky to minimise foot injuries if he or she slips or unintentionally drops a load.

All stacked loads must be properly piled and, whenever possible, cross-tiered. Also, when stacking and storing materials, precautions should be taken. Material storage cannot pose a risk. Storage spaces must be kept clear of collected objects that could trip someone, cause fires or explosions, or help pests like rats to breed.

Considerations including the materials' height and weight, their accessibility to the user, and the state of the storage containers should all be taken into account while stacking and piling goods. Material that is incompatible needs to be stored separately. Workers who handle products that have been held in silos, hoppers, or tanks need to have lifelines and safety belts on them. To prevent slipping, falling,

or collapsing, all bound material should be piled, put on racks, blocked, interlocked, or otherwise secured. No level of a building or other structure may be used to support a load that is larger than that authorised by a building official. Where applicable, clearly display any load limitations that have been approved by the building inspector.

Material stacking height restrictions should be followed. For instance, while handling lumber manually, it must be stacked no higher than 16 feet; when using a forklift, the maximum stacking height is 20 feet. To designate limit stacking heights, stripes may be painted on walls or posts for rapid reference.

When stacking used lumber, all nails must be removed. Lumber needs to be levelled and put on bracing that is well supported. The stacks must be secure and able to stand on their own. The height of loose brick stacks shouldn't exceed 7 feet. These stacks should be tapered back 2 inches for every foot of height over the 4-foot level once they have reached a height of 4 feet.Masonry blocks should be tapered back one-half block for each tier above the 6-foot level when piled higher than 6 feet. To stay secure, bags and bundles must be piled in rows that interlock one another. While stacking bagged goods, layers must be stepped back and the bags must be cross-keyed at least every ten layers. Start at the top row of bags in the stack and work your way down. The distance between bales of paper and rags kept inside a structure and any walls, partitions, or sprinkler heads cannot be less than 18 inches.

Materials in boxes need to be banded or secured using cross ties or shrink plastic fibres.

It is necessary to stack barrels, kegs, and drums symmetrically. The lower tiers need to be blocked if they are stored on their sides to prevent rolling. To provide a stable, flat stacking surface when placed on end, place boards, sheets of plywood dunnage, or pallets in between each tier. To prevent moving in any direction while stacking materials two or more levels high, the bottom tier needs to be chocked on both sides. Consider the necessity for material accessibility when stacking. Due to its size, form, or fragility, material cannot be piled safely; nonetheless, it can be stored on shelves or in bins.

In order to prevent spreading or tilting, cylindrical elements like poles, structural steel, bar stock, and other materials must be stacked and blocked, unless they are in racks. While removing supplies, pipes and bars shouldn't be kept in racks that face main aisles since this could endanger onlookers.

Exercise

Q.1 Multiple choice questions

a. The exposed concrete surface created by _____ is superb and doesn't need any more finishing.

a) Timber

b) Teak wood

c) Steel

d) Fibre glass

b. The temporary casing is known as the _____

a) Support

b) Built up

c) Formwork

d) Casing

a) Forms whose components can be reused several times are known as the _____

a) Stripping

b) Panel Forms

c) Newel forms

d) Shuttering

b) The _____ of formwork plays a significant role in the cost of concrete.

a) Conditions

b) Work

c) Economy

d) Period

c) The formwork should be sufficiently strong enough to bear the _____ of weight concrete as well as the weights of the equipment, labour, etc.

a) Snow load

b) Live load

c) Wind load

d) Dead load

d) The inside surface of formwork should be _____ so as to turn out a good concrete surface.

a) Rough

b) Smooth

c) Geometrical

d) Undulated

e) The boxes for beams are play prepared from _____ sides and _____ bottom in formwork for an RCC floor.

a) Two, One

b) Two, Two

c) One, Two

d) One, One

Q. 2.Describe the component used on Form wall.

Q. 3.Create a checklist for the Calculation of Safe Formwork Striking.

Notes

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6.Erect and Dismantle Temporary Scaffold

Unit 6.1 - Erect and Dismantle a Scaffold

CON/N0101

Key Learning Outcomes

Byr the end of this module, participants will be able to:

- Identify different components of scaffold.
- List tools, materials components required for erection of 3.6 meter scaffold.
- Erect a temporary scaffold up to 3.6 metres height.
- Dismantle and stack a temporary scaffold up to 3.6 metres height.

Unit 6.1: Erect and dismantle a scaffold

Unit Objectives

By the end of this unit, participants will be able to:

- Explain scaffolding and its purpose
- List the common materials and tools used for erection of scaffolding (pipe, cup lock (vertical and ledgers), H- frames, bamboo and balli
- List the functions of different hand tools like hammer, spanner, pulleys, hooks, ropes, etc., used for erection/ dismantling of scaffolds
- List the visual checks to be carried out on the scaffolding components to ascertain their usability
- Identify different components of a temporary scaffolding such as base, toe board, guard rails, platform, walkways, ladder and so on
- Explain the functions of materials, components and accessories used in scaffolding
- Demonstrate preparation of scaffolding base
- Explain the methods adopted for the erection of the scaffold to ensure its safety
- Demonstrate erection of a scaffold up to 3.6 m height using pipes and couplers/ cup lock system/ H frame employing appropriate hand tools
- Explain various checks to be done on completion of erection of scaffolds, such as verticality check, stability check etc.
- Demonstrate the checks required for verticality, rigidity and stability during erection of scaffold.
- Explain the sequence and standard procedure of dismantling and stacking of scaffold
- Demonstrate the dismantling of the erected scaffold.
- Demonstrate the stacking of material, components, tools and accessories during erection and after dismantling.

6.1.1 Scaffolding

A scaffold, also known as scaffolding or staging, is a temporary construction that provides a sturdy platform for working at height or in difficult-to-access areas.

These temporary constructions are frequently used to support work crews and materials during the construction, maintenance, or repair of buildings, bridges, and other man-made structures.

Benefits of scaffolding

Scaffolding has been used for thousands of years for a reason: it works. Scaffolding continues to be one of the most useful and efficient means of working at height.

Here are the principal benefits of use scaffolding for work at height:

- **Access.** Scaffolding can provide unobstructed, stable access to virtually any region of a structure.
- **Balance.** Scaffolds provide workers with stable footing, allowing them to maintain balance in a variety of operating situations.
- **Construction ease.** Scaffolding is generally simple to assemble and remove, and may be erected and dismantled quickly.
- **Long-lasting.** Whether they're composed of wood or steel, most scaffolding may last for an extremely long time.
- **Safety.** Safety is one of the most essential benefits of scaffolding, as it provides a stable working platform for personnel. The best option for work at height, however, is to reduce or even eliminate the requirement for a person to be there; in the final portion of this guide, we will discuss how drones can assist inspectors lessen their need to work at height.
- **Functions as a bridge.** A variety of construction tasks necessitate that workers take circuitous paths to reach specific areas, which is a major time waster. By shortening the distance that employees must go, bridging points on scaffolding can aid in solving this issue.

6.1.2 Uses of Scaffold

Nowadays, scaffolding is utilized for a variety of purposes. Here are some of the most prevalent applications for scaffolding:

- **Cleaning:** Workers frequently use scaffolding to clean windows and other components of tall structures.
- **Construction:** Scaffolding is essential for construction because it allows employees to stand on a secure surface at heights. This is notably true for skyscrapers and other high-rise structures, but it is also a typical practise for ground-level construction projects.
- **Occupational inspections:** Scaffolding is commonly used for inspections because it enables inspectors to reach inaccessible regions to conduct visual inspections and other NDT testing. Inspectors frequently employ internal scaffolding or other temporary structures for both internal and external inspections, such as those performed inside enormous industrial boilers or pressure vessels. Regardless of the type of inspection, the scaffolding serves the same purpose: to enable inspectors to stand at height and conduct a variety of tests to satisfy inspection criteria.
- **Maintenance:** Typically, inspections are the initial stage in a maintenance procedure, as they identify areas that may require maintenance. After these faults are discovered by inspectors, maintenance personnel will address them while standing on scaffolding.

Other uses: Different types of scaffolding are also employed for:

- Theatrical stages
- Installations of art
- Exhibition displays
- Observation platforms
- Observation stand seating

- Shoring Ski ramps

6.1.3 Scaffolding Components

Here are all the scaffolding components:

- **Standards.** This structure comprises of vertical elements supported on the ground, on drums, or by ground anchors.
- **Ledgers.** The length of a scaffold bay is defined by tubes with a case wedge fixing device positioned horizontally between two standards and defining the length of the scaffold bay.
- **Braces**. The braces are attached to the standards diagonally.
- **Putlogs.** A putlog connects the wall under construction to the ledger. A putlog hole is drilled into the side of a structure to accommodate a putlog.
- **Transoms.** A transom is a sort of ledger putlog that both ledgers support.
- **Bridle.** Bridles are used to bridge an opening in a wall by supporting one end of the putlog that is used to build the wall.
- **Boarding.** Boarders function as horizontal platforms for supporting workers and materials throughout the construction process.
- **Guard railings.** A rail installed at the same height as the ledger.
- **Toeboard.** A parallel arrangement of boards supported by putlogs that provides protection at the level of the working platform.
- **Ladder scaffolding.** Using scaffolding ladders, employees can simply mount and descend the erected structure.
- **Scaffolding wheels.** Wheels at the base of the scaffold that facilitate its mobility from one location to another.
- **Cup-lock:** Cup-lock Scaffolding is a temporary framework utilized to support a slab, work crew, and materials during the construction, maintenance, and repair of buildings, bridges, and all other man-made structures. Cup-lock is a galvanized or painted, multipurpose steel scaffolding system that is excellent for giving general access and supporting vertical loads. All vertical standards and ledgers tubes are 48.3mm diameter with 3.00 or 3.20 mm thickness.
- **H Frames:** Due to its features, H-frame scaffolding guarantees significant labour and time savings. Essentially, the system consists of interconnected frames. One H frame is 2 metres high, whereas the length between two H frames is 2.5 metres. In addition, auxiliary factors are utilized in this system:
  - Metal plank
  - Stairs with or lacking a landing
  - Adjustable base jack
  - Adjustable support

- Inclined floors are levelled with the aid of screws with a variable length. Steel work platforms improve the safety and durability of scaffolding. Passageways between floors are secure inside scaffolding with some applications such as staircase or access ladder. The use of a scaffolding clamp in jacketing operations improves scaffold safety and facilitates its deployment.

- **Pipes:** Galvanized scaffolding pipes are the most durable type of steel scaffold tubes. There are three distinct variations of galvanized steel scaffolding pipes. Include E-galvanized scaffolding pipes, GI pipes, and hot-dip galvanized steel pipes. HDG scaffold tubes are another term for hot-dip galvanized scaffolding pipe.
- **Bamboo:** In China and Hong Kong, bamboo scaffolding has replaced steel for numerous reasons. In reality, bamboo has a higher tensile strength than steel. It is also considerably less expensive and fully eco-friendly.

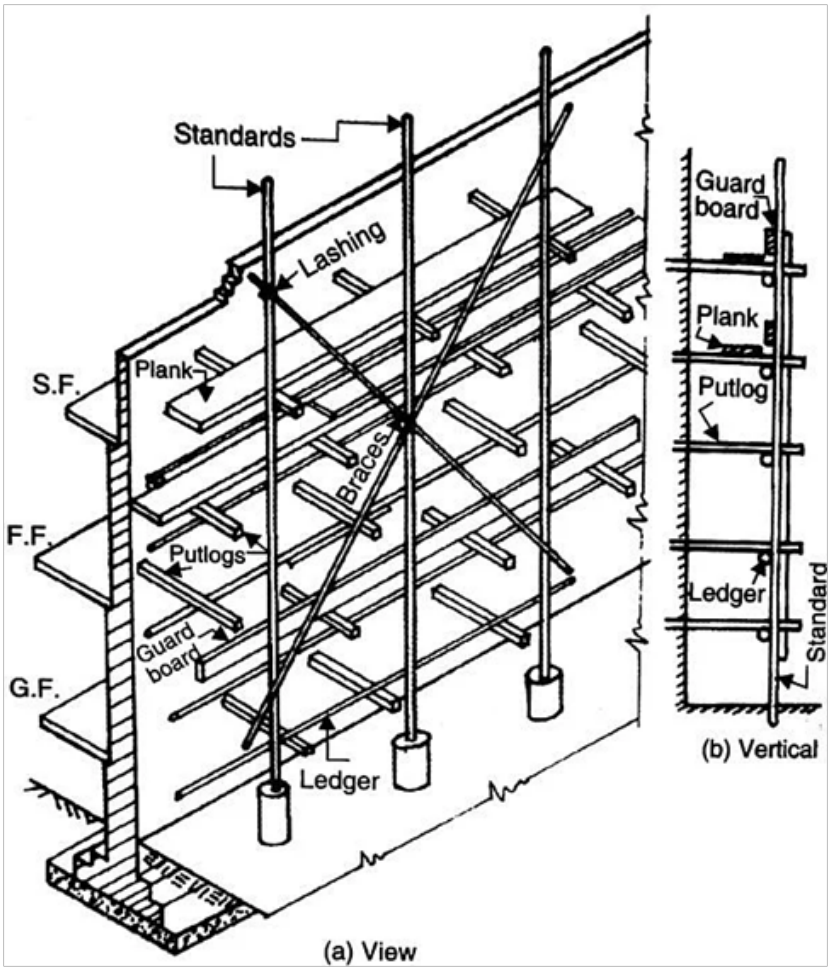

Fig. 6.1.1 Components of Scaffolding

6.1.4 Scaffolding Materials

Here are three of the most prevalent materials used to construct scaffolding:

- Aluminum scaffolding. Aluminum is commonly used for scaffolding because it is lightweight, sturdy, and highly corrosion-resistant.
- Bamboo skeletons. Since it is sturdy, flexible, lightweight, easy to work with, and abundant in certain places of the world, bamboo is an excellent alternative to steel. In Hong Kong, for example, bamboo is the most prevalent material used for scaffolding, and it is frequently repurposed from other applications to reduce waste.
- Iron scaffolding. Steel scaffolding is one of the most prevalent scaffolding materials. Although it is more expensive than bamboo or aluminium, it is quite sturdy and long-lasting, making it a perfect material for urban construction.

6.1.5 Scaffolding Erection and Dismantle

The erection and disassembly of scaffolding remains a hazardous task, not just for those performing the work, but also for other workers and the general public. The measures outlined in this guidance must be considered by everyone engaged in such activities. It is intended not only for scaffolding sector workers, but also for clients, planning supervisors, and general contractors. Listed below are a number of important considerations you must make to ensure the safety of scaffolding activities.

Scaffold Licenses

Before a scaffold can be placed on a public motorway, a permit from the local authority is required. Typically, an additional licence is required to instal a protective fan. A licence may stipulate lighting or painting requirements for a scaffold, or the maximum height at which a fan may be installed. For further guidance you should contact your local highway authority.

Protection of the public

During scaffolding activities, the public must be separated from both the work area and a suitable buffer zone.

- Obtaining a temporary pavement or street closure whilst operations are carried out;
- Carrying out operations during “quiet” hours, i.e. early morning, late evening, or weekends;
- Incorporating fans, crash decks, and “tunnels” as early as possible into a scaffold;
- Erecting barriers and signs and diverting the public away from operations;
- Storing scaffold clips and other loose material safely on the scaffold; and
- Not raising or lowering the scaffold during

Also remember that disabled individuals require proper access along scaffold-covered sidewalks.

6.1.6 Scaffolding Erection

Scaffolding is frequently required for building and home maintenance. Set up scaffolding correctly to ensure your safety and the safety of those utilizing the equipment. A lapse in scaffolding erection could result in a serious accident. The use of scaffolding is an alternative to ladders. In comparison to a

ladder, scaffolding provides a bigger working space and greater manoeuvrability. It provides a walking surface and a place to set your tools. This significantly reduces work hours.

Here is a summary of the processes necessary to construct scaffolding:

- **Establish the foundation.** The scaffolding should be constructed on flat, stable ground. Attach the scaffolding to base plates or mud sills for stability; if you are on an uneven surface, you may need to dig down to level the soil.
- **Level it.** Ensure the scaffolding is level by adjusting the screws. If the terrain is steeply sloping, you may need leg extensions.
- **Consider casting devices.** If you intend to move the scaffolding from one location to another, it should incorporate wheels. Ensure that the casters are locked before installing the item.
- **Guarantee good assembly.** The scaffolding ends must be constructed correctly. First, raise one end portion, then connect the upper cross brace. To attach the upper cross brace of the second end piece, you must support the end by lifting the far end of this brace. Finally, secure the ends of the cross braces to the bottom of the opposing end frame.
- **Place the planks.** Place the planks over the scaffold bar and secure them in place using the provided hardware.
- **Identify access.** Consider accessibility when constructing a scaffold. If ladders are used for access, ensure that they are suited for the exact scaffold you are using and do not offer any other safety risks.
- **Mount guardrails.** Due to the height of the equipment and the risk of falling, guardrails must be installed on all scaffolds. Additionally, you should think about fall prevention measures, such as tie-offs.
- **Observe it.** Inspect the scaffolding thoroughly to ensure that it is safe for use. Ensure that all scaffolding components are secure by reviewing the setup properly. After leaving and returning to the site, always verify the scaffolding to ensure that it is still safe.

6.1.7 Hand Tools used in Erection/Dismantle

The following hand tools are used in erecting or dismantling the scaffold:

1. **Hammer:** A hammer is intended to deliver a large amount of force in a compact area. It is a long wooden stick connected to a metal block. The hammer is circular on one side and sharp on the other. The hammer is your closest friend whether you need to hammer something into place or smash something. However, ensure that the weight is appropriate for the user. When selecting a hammer, one must carefully consider the available sizes and weights.

Fig. 6.1.2 Hammer

2. **Spanner/Wrench:** A spanner is utilized to grasp and rotate items. Aside from plumbing, these instruments can also be used to assemble furniture or repair bicycles by loosening or tightening nuts and bolts. There are numerous types of spanners, including those with closed ends, open ends, and adjustable ends.

Fig. 6.1.3 Spanner/Wrench

3. **Pulleys:** A pulley is a simple machine composed of a rope and a wheel with grooves. The rope fits into the wheel's groove, and pulling on the rope causes the wheel to rotate. Generally, pulleys are used to raise objects, particularly heavy ones. The item lifted by a pulley is referred to as the load.

Fig. 6.1.4 Pulley

4. **Hooks:** A double-action aluminium scaffold hook typically used in conjunction with a fall arrest safety lanyard for rapid attachment to scaffolding or steel structures.

Fig. 6.1.5 Hooks

5. **Ropes:** Bundles of scaffolding rope coir yarn. In shapes such as bales, spools, dholls, and ropes. Cut to lengths suitable for both industrial and agricultural applications. Material used in the production of PVC-tufted pile carpets and mats, wall-to-wall carpets, and doormats. Support for hop plants and scaffolding erection for construction operations. Depending on the twist of the yam and the type of fibre used, a variety of characteristics suitable for various applications are available.

Fig. 6.1.6 Scaffolding rope

6.1.8 Safety Checks

1. **Vertical Safety Check:** Checking verticality would be required at various stages of building construction, such as when constructing vertical column formwork and transferring levels up consecutive floors of multi-story constructions. Several ways for controlling or inspecting verticality work in building construction are discussed.

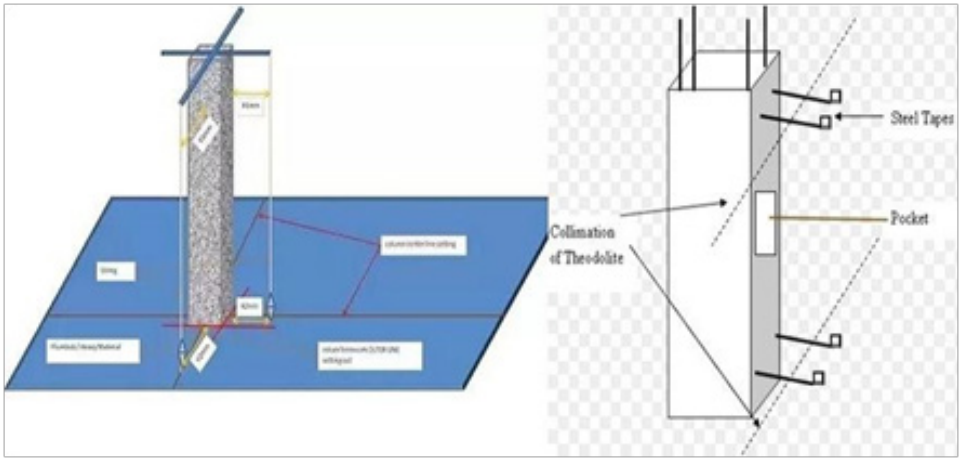

Fig. 6.1.7 Vertical Scaffolding Check

Methods used to check or control verticality works include:

a. Plumb-bob technique
b. Spirit level
c. Theodolite
d. Optical plummet

a. Plumb-Bob Technique

As depicted in the illustration below, a plum-bob consists of a weight with a pointy tip attached to the end of a string. The heavy object will hang under the force of gravity and provide an exact vertical line, known as a plumb line.

Fig. 6.1.8 Plum Bob Technique

This method is used for verifying or controlling the vertical alignment of structural elements, particularly inside, such as lift shafts. In addition, it controls the verticality of the foundation, walls, and columns.

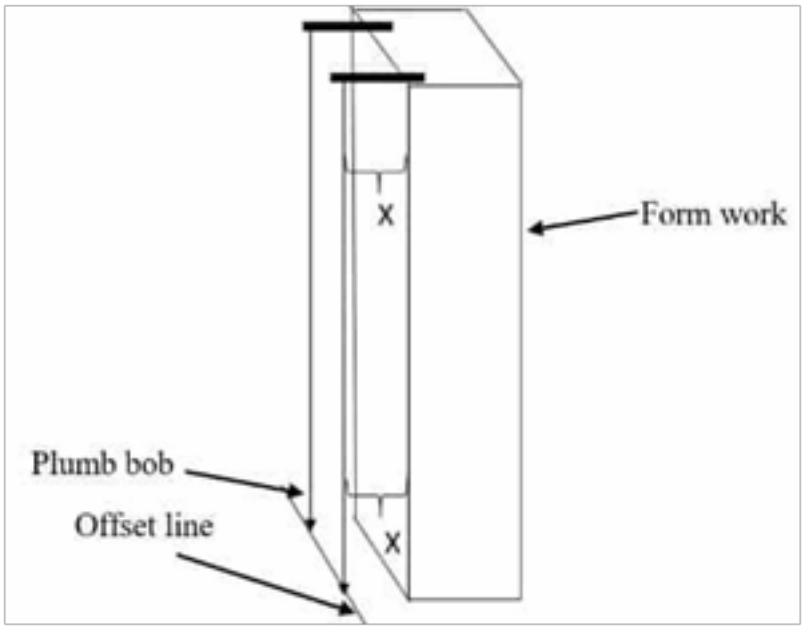

Fig. 6.1.9 Checking Verticality of Columns

The plumb line or vertical line of a plumb-bob will lose its accuracy and precision when subjected to wind force. Small to moderate lateral movement of the plumb-bob can be effectively minimized by soaking it in oil or water. If the height of the structural member is high, it is conceivable to replace the string with a long wire, but substantial precautions must be taken to avoid endangering the workers below.

b. Spirit Level Method

This device is suitable for managing the verticality of small-scale construction projects, such as examining door frames and formwork. If a spirit level is used for approximate inspections, then a more precise technique must be used to evaluate the verticality.

Fig. 6.1.10 Spirit Level

c. Theodolite Method

The theodolite is an extremely potent equipment that may be used to check the verticality of construction projects with high precision and accuracy. It is appropriate for verifying or managing the verticality of towers as depicted in Figure 2.1.9, walls, foundations, and columns as depicted in Figure 2.1.10, particularly a large number of columns along a single grid line. Using a Theodolite in conjunction with a tape, it is possible to measure the slope of the member's out-of-plumb line. The process for verifying column verticality comprises:

Install the digital Theodolite so that it is positioned on a peg that is 500 mm from the column grid.

After Theodolite has been precisely positioned, the laser beam will be activated and focused on the steel tape that is attached to the formwork.

Put the steel tape's reading via the telescope.

Take the readings of two spots at the same level on both the upper and lower formwork levels. By taking two measurements at the same level, any surface curvature can be determined. The figure below illustrates these steps.

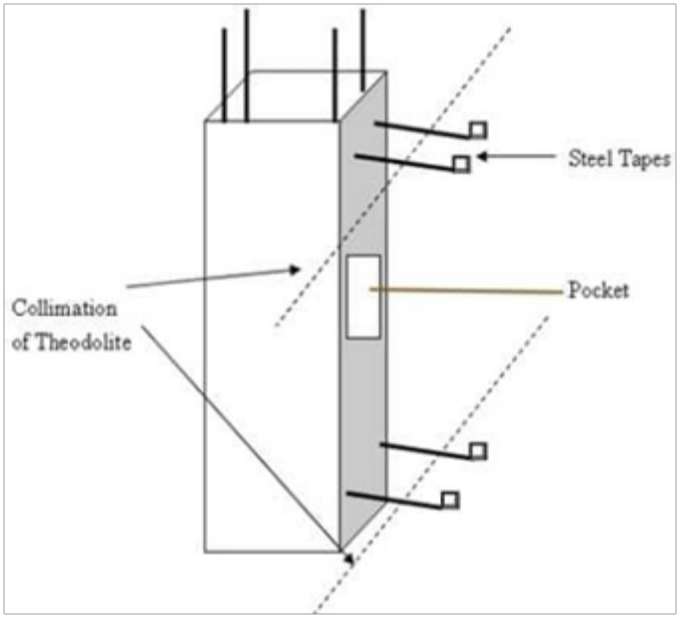

Fig. 6.1.11 Checking Verticality Using Theodolite

d. Optical Plummet Method

It is a device that can look directly up or directly down. In comparison to previous methods utilized for managing verticality, the optical plummet's automatic compensator substantially improves its accuracy.

Fig. 6.1.12 Optical Plummet

2. **Stability Check:** Under each foot's contact with the ground, stabilize the scaffolding with solid, flat wood planks. This will prevent your scaffolding from becoming uneven and sinking into muck. Add weight and bracing to prevent the device from toppling.

6.1.9 Safety Check before Dismantling

Safety must always come first in scaffolding and the construction business. Because disassembling a scaffold is just as tough as assembling one. Therefore, one must first devise a plan for disassembling your scaffold. Before dismantling a scaffold, one should always begin by doing a comprehensive inspection. One may continue as follows:

One may continue as follows:

Step 1: Check the stability and statics of the scaffolding. All scaffolding components should continue to be firmly attached to one another. If individual components have been removed or badly damaged throughout the scaffold's service life, they must be replaced for safe dismantlement.

Step 2: Check whether the scaffolding decks are still firmly in place.

Step 3: Verify the stability of all anchors and fasteners on the scaffold.

Step 4: Check the type of fall protection required during disassembly and install it.

Step 5: Ensure that no unsecured building materials or tools remain on the scaffolding. In the worst-case scenario, these could fall during disassembly and injure those below.

All of these stages are fundamental to a proper scaffold inspection.

6.1.10 Dismantling the Scaffold

Once the scaffold has passed all safety inspections, then can begin disassembling it. Again, one should continue methodically:

Step 1: Make space for the disassembled scaffolding components.

Create a nearby storage area for the disassembled scaffolding components. During disassembly, individual scaffold components should be taken off the scaffold and set away for subsequent inspection. In addition, there must be an access route for the vehicle that will transfer the scaffolding materials away from the construction site.

Step 2: Put safety equipment

Wear the appropriate protective clothes. This comprises PPE, such as safety shoes, a helmet, and gloves, as well as any other safety equipment necessary by the project.

Step 3: Remove scaffolding components from the top to the bottom

Logic dictates that disassembly should occur in the reverse sequence of assembly, from top to bottom. Before disassembling the scaffold decks, remove the tubes and safety railings first. During disassembly, scaffolding components should not be stored on the scaffold, but rather transferred immediately to the ground. This can be accomplished by reaching down to a colleague or by carefully lowering using a rope system or similar device.

Step 4. Remove scaffolding anchors

Stability must also be maintained at all times during scaffold disassembly. Therefore, remove the anchors only after disassembling the complete platform.

Step 5: Check the scaffolding components

After disassembling all scaffolding components, properly inspect them. Defective scaffolding components may cause injury, so any components that cannot be fixed must be set aside for disposal. All undamaged or reparable scaffolding components must be stored properly for transfer off-site.

Exercise

1. Explain scaffolding and its uses.
2. Name any 5 scaffolding components.
3. Explain the steps required for dismantling the scaffold.
4. Name the hand tools used in erection or dismantling of scaffold.

Notes

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7. Work Effectively in a Team

Unit 7.1 - Work effectively in a team

CON/N8001

Key Learning Outcomes

By the end of this module, participants will be able to:

- Demonstrate effective communication with co-workers, superiors and sub-ordinates across different teams
- Provide support to co-workers, superiors and sub-ordinates within the team and across interfacing teams to ensure effective execution of assigned task.

Unit 7.1: Effective Interaction and Communication

Unit Objectives

By the end of this unit, participants will be able to:

- Demonstrate effective communication skills while interacting with co-workers, trade seniors and others during the assigned task.
- Interpret work sketches, formats, permits, protocols, checklists and other work-related requirements which are to be conveyed to other team members
- Demonstrate effective reporting to seniors as per applicable organisational norms.
- Explain effects and benefits of timely actions relevant to system shuttering works with examples
- Explain importance of team work and its effects relevant to system shuttering works with examples
- Demonstrate team work skills during assigned task.

7.1.1 Effective Communication

Effective communication is the process of sending and receiving messages from sender to receiver properly and successfully. The information is passed by signs and signals, speaking, writing or using some other medium and means. The objectives of effective communication are:

1. Sending, receiving and understanding the message or information.
2. Development of Interpersonal Skills.
3. To express effectively & with maximum efficiency.

Effective communication requires one to follow basic principles of communication, i.e., 7Cs:

- **Clear:** Be assertive about what needs to be communicated, whether verbally or in writing
- **Concise:** Use simple words and say only what's needed
- **Concrete:** Use exact words, phrases, Use facts and figures
- **Correct:** Use correct spellings, language and grammar
- **Coherent:** Words should make sense and should be related to the main topic
- **Complete:** A message should have all the needed information
- **Courteous:** Be respectful, friendly and honest

Communication Process

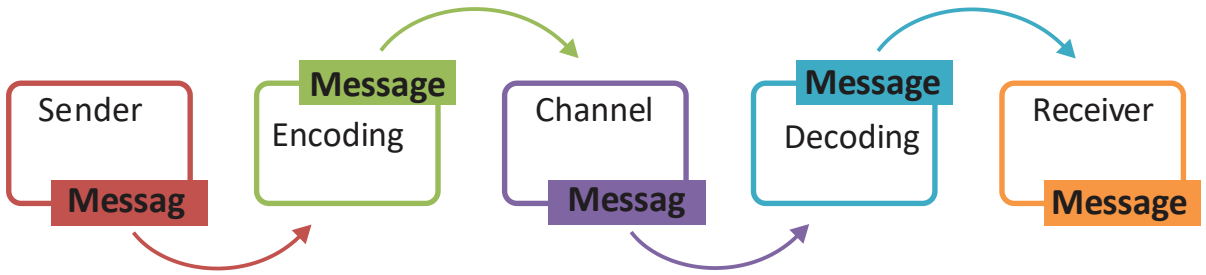

Fig 7.1.1 Effective Communication Process

- **Sender:** The person or entity starting the communication.
- **Message:** The information that the sender wishes to share.
- **Encoding:** Choosing the medium to send a message.
- **Channel:** The medium used to send a message.
- **Receiver**: The person or entity to whom the message is sent.
- **Decoding:** Understanding the message received.
- **Feedback:** The receiver's response to the message.

7.1.2 Workplace Communication

Every workplace organisation requires communication for day-to-day business, regardless of size, location, goals, etc. It forms a bridge between people to exchange ideas, inform, express their feelings, influence others, etc. Communication is required to communicate within the organisation with managers and employees, etc. and outside with suppliers, buyers, etc.

Effective Communication with Stakeholders

The key factors to establishing effective communication in the construction industry are:

1. **Establish a Communication Chain of Command**

   Construction projects need a communication chain. The contract documents usually require the owner and general contractor to communicate through the architect.

   The architect communicates with consultants and the general contractor with suppliers and subcontractors. The general contractor usually contacts the project superintendent.

   Contract documents—drawings, specifications, change order forms, and requests for information—form the basis for construction communication. Any direct communication not in the contract documents must be authorised, and any scope or schedule modifications must be documented and reported.

2. **Select an Appropriate Communication Method**

   We communicate vocally and nonverbally daily, and construction communication is no different. We text, talk on the phone and in person, send emails, and some of us still use fax machines inexplicably in this digital era. We communicate on the building site with signs, drawings, hand gestures, and meetings. We write daily reports, take photographs, generate information requests (RFIs), and examine modification orders.

   There are benefits and drawbacks to each way of communication. Selecting the appropriate mode of communication can facilitate and expedite the transmission of information.

3. **Be an Active Listener**

   One should be an active listener when engaging in oral communication, whether in person or by phone. At best, it is passive listening to sit there and absorb the information like a digital recorder. Try to comprehend what the speaker is trying to convey from their perspective.

   Take notes on significant points, rather than transcribing every word they say, and jot down information that may require clarification. Maintain eye contact and use nonverbal cues such as head nods to demonstrate attentive listening.

4. **Prevent Confusion, Be Clear and Concise**

   When communicating in the construction industry, you want message to be understood the first time you convey it. Avoid jargon and unfamiliar phrases when interacting with others. Your communication should be concise and direct. Keep it as brief and clear as possible.

   Focus on one project at a time if you are working on multiple projects with the same owner or architect to avoid misunderstanding. The real difficulty lies in attempting to be as descriptive as possible while using as few words as possible.

   It takes practice to be concise yet comprehensive in your construction communications. Before sending any written communication, proofread it to determine if it may be shortened without affecting its meaning or omitting vital details.

5. **Keep Written Communication Always Professional**

   Avoid using profanity and allowing your emotions to influence your message. If your feelings are running high, wait 24 hours before sending the email so that you can examine and make any necessary modifications. If a quick answer is required, read the message aloud or have another person review it for a second opinion.

   Separate huge data pieces into smaller paragraphs. People tend to scan rather than read emails; thus, dividing the content into smaller bits facilitates processing. Use numbered or bulleted lists when delivering numerous details or posing innumerable questions.

6. **Stick to the Facts**

   One should solely care about presenting or obtaining facts. In all communications, do not overcomplicate or provide irrelevant details. Keep the personal ideas and feelings about a project to yourself unless asked.

   - However, you must offer your professional thoughts on a project when you believe they could contribute to its practical completion. Your company's expertise contributed to its selection for

the project, so don't be shy.

- Communicate effectively with the plant operator; Lower all ground engagement tools and/or implements to the ground.
- Disengage the plant controls so that they cannot be accidentally activated by the operator or by any other means;
- Visibly remove their hands from the controls of the powered mobile plant; and cease all movement of the plant.

7.1.3 Adverse Effects of Poor Communication

There is poor workplace communication when there is disconnect between what is said and what is heard, whether between co-workers or between an employee and management. Specifically, there is a lack of mutual understanding between two parties when the recipient of your communication misunderstands it.

The following issues are faced due to poor communication:

Confusion

In building, a lack of communication is problematic. Miscommunications can also have a negative effect on a project by causing misunderstandings among significant stakeholders, construction professionals, and field personnel. Inconsistent reporting, incomplete reporting, inaccurate reporting, and delayed reporting can all contribute to errors that result in project delays and cost overruns on the construction site and the office.

Clear and straightforward messages prevent confusion. Keep messages brief, concise, and to the point.

Unnecessary Delays

Poor communication is a primary cause of project delays in the construction sector. It can manifest in various ways, including delays in the flow of information, communication directed to the wrong person or location, and confusing communication that leads to misunderstanding or incorrect interpretation.

Any of these inefficient communication elements can result in errors and cause delays. Ordering unsuitable material, omitting a step in the construction process, or misallocating labour can all result in project delays.

Budget/Cost Overruns

According to the Project Management Institute (PMI), inefficient communications and improper time management of project communications account for more than half of all project budget risks. Poor or erroneous communication frequently results in greater expenditures. Adding a zero to a significant number can wreak havoc on a budget.

Injuries and Safety Issues

Poor safety communication is frequently attributable to three frequent causes:

- Workers lack familiarity with the safety training vocabulary. This is particularly true for trainees who are fresh to safety training. They can disconnect more quickly at this moment.
- Workers are scared to speak out when they find a safety hazard. They may fear judgement if they alert a colleague or supervisor to a potential danger. It is simpler to avoid risk.
- Workers frequently regard safety communication as unfavourable. Typically, only negative situations are discussed or emphasised, while the positive aspects of their behaviour are neglected.

Issues with Stakeholders

Multiple parties are involved in every construction project, including owners, designers, investors, general contractors, project managers, subcontractors, and labourers. Effective and thorough communication among a project's stakeholders is essential to its success. It can lead to increased project expenses, delays, and stakeholder disputes. Poor project data and miscommunications between project stakeholders account for nearly 48% of all project rework.

7.1.4 Teamwork at Workplace

Teamwork is when people of an organisation collaborate to achieve a common objective or set of objectives. In the modern workplace, teamwork can take place in-person or (increasingly) online.

It is important to note that modern teams are vastly different from those of the past. Today's teams, for instance, are more varied and dynamic, with specialised skill sets that present new problems and opportunities. Consequently, any team-based initiative can also serve as an opportunity for personal and professional development.

As technology continues to dominate the workplace, digital literacy, or the ability to use information and communication technologies, has become increasingly vital in team settings.

Advantages of Teamwork

There is no stronger tool in a business' armoury than a strong staff. Effective teams can increase efficiency by tackling more complex tasks (think "two heads are better than one"), improve communication by fostering open discussion and cooperation among team members, maximise output by leveraging each team member's strengths, provide opportunities for personal growth, and serve as a support mechanism for staff.

Unsurprisingly, cooperation in the workplace has also been demonstrated to boost invention and creativity by allowing team members to contribute their own unique perspectives. Effective cooperation supports organisational growth and improves performance and success by capitalising on the unique talents and characteristics of each employee.

7.1.5 5 C's of Teamwork

It is crucial for organisations and corporations to continuously seek ways to increase their productivity and competitiveness. It has been discovered how to make work teams more unified and effective. In other words, work as a team. For this reason, a great number of specialists have sought out the most

efficient method for fostering teamwork.

Tom Peters, who is regarded by many as the "father" of modern management, investigated the variables necessary for teams to achieve high performance. His research established the five C's of teamwork, which are essential for achieving high performance.

Co-operation

Without cooperation between team members, no group will survive. Cooperation is intimately linked to effective communication and self-assurance. Better communication and a transparent and healthy work environment necessitate some degree of clarity and trust.

Compromise

Work relationships are not exempt from the necessity of reaching compromises on particular issues. If our peers' or managers' argument is valid and can contribute to greater performance, we may be required to concur. It is acceptable that not everyone can be on the same page at all times. To manage such circumstances, we must examine the situation and consider potential outcomes.

Communication

Considered vital for organising the individual and group efforts of the team. Communication is essential for conflict resolution and problem-solving, and companies must support healthy communication within and between teams. Communication must be open, honest, and timely so that every team member knows what to do and how to do it.

Confidence

Team members should have confidence in their skills. The leader must provide the team with a clear and simple explanation of the project, each member's responsibilities, and the final objective. It is essential to remember that confidence does not develop in the blink of an eye. It must be constructed step by step.

Commitment

The demands and interests of the team take precedence above individual concerns. Every action should contribute to the overall corporate objective.

7.1.6 Enhancing Teamwork in the Workplace

Working in a team can be complicated due to the fact that we are all unique individuals with varying mental states. Improving teamwork relies heavily on the role of the team's leader. Here are some recommendations that can assist them in achieving greater teamwork:

1. **Concentrate more on "us" than "me"**

   A minor step is to begin speaking in the plural, so that all members feel as though they are a part of the effort. The greater our involvement, the harder we work to obtain the finest results.

2. **Communicate Explicitly**

   Communication is the fundamental prerequisite. We must create an atmosphere in which team

members are free to share their thoughts. It is advisable to make an effort to prevent such misunderstandings.

3. **Delegate and believe**

   When working in a team, each assignment symbolises a problem that can be readily overcome via teamwork. Team leaders should be aware of the abilities and qualities of their team members and assign them jobs where they may demonstrate their value. For this, they must feel at ease while working and have confidence that their bosses have faith in them.

4. **Establish shared aims and objectives**

   It is crucial to establish a unified business objective and effectively communicate it to team members.

5. **Recognize and honour the achievements of others.**

   This attitude strengthens the team's trust and teamwork, which will inspire them to achieve the following objectives.

6. **Conquer a conflict with success**

   Workplace conflicts are prevalent, and people with conflict management abilities are in high demand. Learn this talent if you still lack it.

7. **Build a diverse group**

   People with varied origins, personalities, and experiences can be a source of innovative ideas. Through intelligent reading, we will recognise that we have the opportunity to maximise each individual's qualities.

8. **Believe in Team Building**

   It's been said that teams that have fun remain together, thus establishing personal relationships in the workplace is a fantastic way to boost teamwork.

7.1.7 Importance of Teamwork in Assistant Shuttering System

Teamwork is crucial in any construction project, and it is especially important in assistant shuttering systems. Assistant shuttering involves providing support and assistance to the main shuttering team, and this work requires close coordination and communication with other team members. Here are some of the key reasons why teamwork is essential in assistant shuttering systems:

1. **Safety:** Working in assistant shuttering can be hazardous, and teamwork is essential to ensure the safety of all workers. Team members can watch out for each other, spot potential hazards, and work together to implement safety measures.

2. **Efficiency:** When working in assistant shuttering systems, every member of the team has a specific role to play. By working together, team members can ensure that their tasks are completed efficiently and on time. This can help to avoid delays and keep the project on schedule.

3. **Quality:** The quality of the finished concrete structure depends on the accuracy of the shuttering work. Team members can work together to ensure that the formwork is correctly aligned

and supported, leading to a high-quality finished product.

4. **Communication:** Effective communication is essential in assistant shuttering systems. Team members need to be able to communicate clearly and effectively to coordinate their work and avoid errors or miscommunications.

5. **Support:** Assistant shuttering teams often work in challenging conditions, and teamwork can provide valuable support to workers. By working together, team members can share the workload, provide assistance when needed, and help each other stay motivated and focused.

7.1.8 Time Management

Time management is not about working harder; rather, it is about working smarter so that employees do not overburden themselves and create unnecessary strain. By effectively managing their time, employees will meet deadlines, increase their effectiveness, become more productive, and produce superior work.

By effectively managing their time, employees will meet deadlines, increase their effectiveness, become more productive, and produce superior work. They will also have a higher degree of job satisfaction because they will experience less stress, which will help them advance in their careers and reduce company's staff turnover.

The benefits of time management skills to both for the person and the company are:

1. **Enhanced productivity and performance:** Poor time management causes employees to feel overwhelmed, whereas excellent time management leads to increased efficiency, which in turn improves performance.

2. **Providing work on schedule:** This is the most visible advantage of excellent time management, but it is also one of the most crucial. Time management enables workers to meet deadlines, which is essential for meeting client expectations.

3. **Less anxiety and stress:** When employees are stressed and anxious, not only do they miss deadlines and produce subpar work, but it also negatively affects their health. As an employer, you are responsible for ensuring that the mental health of employees is a top priority. Stressed employees are more prone to take sick days and seek alternative jobs.

4. **Better-quality work:** With effective time management, employees have the necessary time to produce work that is not only completed on time but also of a superior quality.

5. **Boosts confidence:** When employees are on top of their responsibilities, it boosts their confidence and enables them to believe in their own talents. In turn, this reduces tension and anxiety because the body produces dopamine.

6. **Reduces procrastination and wasted time:** Knowing how to prioritise decreases procrastination and promotes a "eat the frog" mentality among staff. This saves downtime and increases productivity.

7. **Enhances the work-life balance:** An effective work-life balance When an employee is well-rested and has the opportunity to re-energize, they are in the best position possible to produce their

finest work.

8. **Make better decisions:** When employees have time to concentrate and work thoroughly, they are not required to make decisions under duress. Instead, individuals can make selections based on all the necessary information to make the greatest choice.

Time Management in Assistant Shuttering System

Effective time management is essential when working on a construction site, especially when it comes to assistant shuttering system work. Here are some tips for managing your time efficiently:

1. **Plan the Day:** Before starting the work, take a few minutes to plan the day. Make a to-do list and prioritize the tasks based on their importance and urgency.

2. **Break down Large Tasks:** If one have a large task to complete, break it down into smaller, more manageable tasks. This will make it easier to focus on the individual steps and help to avoid feeling overwhelmed.

3. **Use a Calendar:** Use a calendar or scheduling software to keep track of deadlines, meetings, and other important events. This will help you stay organized and ensure that one don't miss anything important.

4. **Minimize Distractions:** Minimize distractions such as phone calls, emails, and social media during working hours. Set aside specific times to check your messages and notifications.

5. **Communicate with theTeam**: Communication is key when working on a construction site. Make sure to communicate effectively with the team and that everyone is on the same page.

6. **Take Breaks:** Take regular breaks throughout the day to avoid burnout and stay focused. Use the breaks to stretch, take a walk, or have a healthy snack.

7. **Use the Time Wisely:** Use any downtime during the day to complete smaller tasks or catch up on paperwork. This will help you make the most of your time and avoid feeling overwhelmed.

7.1.9 Construction Reporting

Construction reporting is the preparation of official records that provide stakeholders with information on significant events, project phases, and processes. Typically, these reports are written documents containing data. They can also describe the condition of particular project components or the budget.

Construction reports should be short and written in straightforward language. Additionally, they should be simple to navigate and contain only the essential information. Additionally, they should not be replicated in other reports. Reporting on construction gives the project team excellent visibility and comprehension of what should be done. Inaccurate reporting can have significant effects on project costs and deadlines.

Objective of Construction Reporting

Construction reports are a way to comprehend the activities occurring on construction sites. In order to provide an accurate depiction of the project's state, construction reporting utilises a number of methods to collect and combine project data.

Creating reports improves comprehension of current activities and minimises the likelihood of project

delays and cost overruns. The information flow from construction reporting keeps stakeholders informed and provides psychological comfort as they enjoy a project's efficient operation. Construction reports can reduce safety concerns because problems are identified and documented before they escalate.

Types of Construction Reports

There are numerous types of construction reports that detail various project operations. The majority of construction reports fall under many categories, as illustrated below.

1. Materials Report

Technological advancements have produced new construction technologies that contractors can utilise. Consequently, material reports provide construction organisations with information regarding materials that offer greater cost savings and a longer lifespan. These construction material reports are provided by a variety of organisations, and construction enterprises must enlist in order to receive their services.

2. Trend Report

Standard in the building business, trend reports provide information on various construction styles and whether their market usage is expanding or diminishing. To have access to such information, contractors must subscribe to the websites that publish studies on building industry trends. The majority of these papers are published annually and provide excellent overviews of the most recent trends and industry dynamics.

3. Cost Report

These are construction reports that tell the client and other interested parties on the expected and actual expenditures of a project. Typically, cost consultants such as quantity surveyors or contractors produce cost reports. The project is then constructed in accordance with the client-presented cost estimate. These reports are periodically updated to monitor the project's expenses. Throughout the lifecycle of a project, cost reports are in a state of ongoing evolution. Consequently, the amount of detail and precision improves as the project progresses and more information becomes available.

4. Progress Report or Daily Report

Daily reports are an integral component of project management. A daily report describes the actions of a project on a daily basis. Daily reports augment a contract by recording and confirming project progress.

These reports describe the site's specifics and keep stakeholders updated. In the event of any delays,

daily reports clarify the underlying causes, thereby eliminating the time wasted disputing over the surrounding minutiae. The daily report is typically prepared by the construction manager or foreman.

Exercise

1. What are the 7 Cs of effective communication?
2. State some Adverse Effects of Poor Communication.
3. What do you understand by Workplace Communication?
4. How to enhance teamwork in the workplace?
5. Explain the importance of time management.

Notes

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N·S·D·C
National
Skill Development
Corporation
Transforming the skill landscape

8. Work According to Personal Health, Safety and Environment Protocol

Construction Skill Development Council

Unit 8.1 - Workplace Hazards
Unit 8.2 - Fire Safety
Unit 8.3 - Safety Measures at Workplace

(CON/N9001)

Key Learning Outcomes

By the end of this module, participants will be able to:

- Explain the types of hazards at the construction sites and identify the hazards specific to the system shuttering work
- Recall the safety control measures and actions to be taken under emergency situation
- Explain the classes of fire and types of fire extinguishers
- Demonstrate the operation of fire extinguisher.
- Demonstrate different methods involved in providing First aid to the affected person.
- Explain the importance of participation of workers in safety drills
- Demonstrate the use of all Personal Protective Equipment (PPE) like helmet, safety shoe, safety belt, safe jackets and other safety equipment relevant to shuttering job
- Explain the reporting procedure to the concerned authority in case of emergency situations
- Describe the standard procedure for handling, storing and stacking of material, tools, equipment and accessories
- Explain different types of waste and their disposal method, which are general to the construction sites
- Explain the purpose and importance of vertigo test at construction site
- Demonstrate vertigo test
- List out basic medical tests required for working at construction Site.
- Explain the types and benefits of basic ergonomic principles, which should be adopted while carrying out specific task at the construction sites.
- Explain the importance of housekeeping
- Demonstrate housekeeping practice followed after system shuttering works

Unit 8.1: Workplace Hazards

Unit Objectives

By the end of this unit, participants will be able to:

- Explain the types of hazards at the construction sites and identify the hazards specific to the system shuttering work.
- Recall the safety control measures and actions to be taken under emergency situation.
- Explain the reporting procedures adopted during emergency situations.
- Describe the standard procedure for handling, storing and stacking of material, tools, equipment and accessories.
- Explain the types and benefits of basic ergonomic principles, which should be adopted while carrying out specific task at the construction sites.
- Demonstrate the use of all Personal Protective Equipment (PPE) like helmet, safety shoe, safety belt, safe jackets and other safety equipment relevant to shuttering job

8.1.1 Workplace Safety

Workplace safety is important to be established for creating a safe and secure working environment for the workers. The workplace has to be administered as per the rules of the Occupational Safety and Health Administration (OSHA). It refers to monitoring the working environment and all hazardous factors that impact employees' safety, health, and well-being. It is important to provide a safe working environment to the employees to increase their productivity, wellness, skills, etc.

The benefits of workplace safety are:

- Employee retention increases if they are provided with a safe working environment.
- Failure to follow OSHA's laws and guidelines can result in significant legal and financial consequences.
- A safe environment enables employees to stay invested in their work and increases productivity.
- Employer branding and company reputation can both benefit from a safe working environment.

Workplace Safety at Construction Site

To avoid injuries, accidents, and other health issues on a building site, the following safety guidelines must be followed:

1. **Always wear PPE:** All personnel and visitors on the construction site must wear the required PPE to reduce their exposure to potential hazards. Goggles, helmets, gloves, ear muffs or plugs, boots, and high visibility vests and suits are typical PPEs.
2. **Pay attention and obey signs:** Employees and visitors can be warned and made more aware of health and safety hazards through the use of safety signs. When necessary, strategically position them throughout the facility. Workers should be aware of construction site safety advice and various signs, including prohibition signs, required signs, warning signs, safe condition signs, and firefighting equipment signs.
3. **Provide precise directions:** There should be a site induction or contractor induction on the job site. This will familiarise new employees with site operations. Additionally, toolbox presentations are an effective means of communicating health and safety instructions to the employees. On a daily or more frequent basis, a pre-work inspection is performed.
4. **Keep site tidy:** Ensure that excavation debris, dust, loose nails, and stagnant water are not lying about the site. For the prevention of slips and trips, the building site must be cleaned every day and kept decluttered.
5. **Organize and store equipment:** Ensure that there are no tools laying around, and unplug all lights and power tools. The observance of building site regulations will prevent tools from becoming damaged or perhaps causing worker injury. Putting them in their proper location will help facilitate navigation.
6. **Use the proper tools for the correct job:** Frequently, accidents occur due to improper usage of a tool or piece of equipment. Avoid using homemade tools. Use the proper tool to complete the task more quickly and safely.
7. **Have an emergency response plan:** An emergency response plan instructs employees on what to do in the event of emergencies such as natural disasters, fire, hazardous material spills, and other catastrophes. Have a team committed to addressing emergency situations, answering queries, and reporting potential risks, quality issues, and near misses.
8. **Set up protections:** Installation of engineering controls, such as barriers, fences, and safeguards, is one method for ensuring site safety. These will aid in isolating individuals from hazardous places like high-voltage electricity or harmful chemicals.
9. **Perform pre-inspection of tools and equipment:** Ensure that the tools and equipment to be utilised are free of defects or damage before beginning work.
10. **Report problems immediately:** Train employees to immediately report flaws and near-misses on the job site. Problems can only be resolved when management is made aware of them. The sooner problems are identified, the less likely they are to worsen and cause accidents or additional damage.

8.1.2 Workplace Hazards

A workplace is a situation that has the potential to cause harm or injury to the workers and damage the tools or property of the workplace. Hazards exist in every workplace and can come from a variety of sources. Finding and removing them is an important component of making a safe workplace.

Common Workplace Hazards

The common workplace hazards are:

- **Biological:** The threats caused by biological agents like viruses, bacteria, animals, plants, insects

and also humans, are known as biological hazards.

- **Chemical:** Chemical hazard is the hazard of inhaling various chemicals, liquids and solvents. Skin irritation, respiratory system irritation, blindness, corrosion, and explosions are all possible health and physical consequences of these dangers.
- **Mechanical:** Mechanical Hazards comprise the injuries that can be caused by the moving parts of machinery, plant or equipment.
- **Psychological:** Psychological hazards are occupational hazards caused by stress, harassment, and violence.
- **Physical:** The threats that can cause physical damage to people are called physical hazards. These include unsafe conditions that can cause injury, illness and death.
- **Ergonomic:** Ergonomic Hazards are the hazards of the workplace caused due to awkward posture, forceful motion, stationary position, direct pressure, vibration, extreme temperature, noise, work stress, etc.

Workplace Hazard at Construction Site

Working on a construction site entails working with or alongside massive, functioning plant machinery and tools and working at heights and in potentially hazardous settings.

The following are a few hazards of a construction site:

- **Working at Heights:** Working at heights is the leading cause of fatal workplace injuries. All personnel working at height must receive adequate training in operating on various equipment, and such work must be carefully organised.
- **Moving Objects:** A building site is a constantly-evolving environment with numerous objects in constant motion, frequently on uneven ground. Delivery vehicles, large plant gear, and overhead lifting equipment pose a threat to workers and operators on the job site. Sites should always be designed to manage plant-to-pedestrian contact when physical barriers and enough segregation are present.
- **Slips, Trips, and Falls:** Slips, trips, and falls can occur in practically any environment, but they occur less frequently in the construction industry than in other sectors. Unsurprisingly, slips, trips, and falls are major hazards on construction sites due to the often uneven ground and ever-changing typography.
- **Noise:** Exposure to loud, excessive, and repetitive noise can result in long-term hearing issues, including deafness. Noise can also be a risky distraction, diverting a worker's attention from the task at hand, which can lead to mishaps. A full noise risk assessment should be conducted if the risk assessment identifies a noise hazard associated with the proposed work.
- **Hand Arm Vibration Syndrome:** HAVS is a painful and debilitating condition affecting the blood vessels, nerves, and joints. It is often brought on by the repeated use of hand-held power tools, such as vibrating power tools and ground-working equipment. HAVS is avoided if construction projects are structured to minimise exposure to vibration during work and if personnel utilising vibrating tools and equipment are monitored and properly protected.
- **Material Handling:** Manual and with Equipment: On construction sites, materials and equipment are continuously lifted and transported, either manually or with equipment. Handling always carries a degree of danger.
- **Excavations:** On construction sites, incidents frequently occur within excavations, such as an unsupported excavation collapse with employees inside.
- **Electricity:** Contact with overhead or subsurface power cables and electrical equipment/ma

chinery accounts for most of these mishaps. The standard in the construction industry is service strikes. The strikes occur when excavation is performed without a sufficient search for existing utilities. Consequently, problems can be readily averted by employing technologies such as CAT and Genny scanning equipment to scan an area, anticipate prospective services, and prevent service interruptions.

Hazards Specific to System Shuttering Work

System shuttering work involves the use of temporary structures or formworks to support the freshly poured concrete until it sets and hardens. This process is critical in construction projects, but it also poses various hazards to workers involved in the system shuttering work. Some of the hazards specific to system shuttering work include:

1. **Structural collapse:** The formwork supporting the wet concrete can collapse, leading to severe injuries or fatalities. This can occur due to incorrect assembly, weak materials, or inadequate bracing.
2. **Falls from Height:** System shuttering work is typically performed at elevated levels, which increases the risk of falls from height. Workers may slip, trip, or lose their balance when working on elevated platforms or scaffolding.
3. **Struck-By Hazards:** Workers can be hit by falling formwork components, tools, or equipment. This can cause severe injuries or fatalities.
4. **Caught-Between Hazards:** Workers can become caught between the formwork and other objects, leading to crushing injuries or fatalities.
5. **Electrical Hazards:** Workers may come into contact with live electrical wires or equipment when performing system shuttering work.
6. **Health Hazards:** Exposure to concrete dust, fumes, and other airborne particles during system shuttering work can lead to respiratory problems, skin irritation, and other health issues.
7. **Manual Handling Hazards:** The components of the formwork can be heavy and awkward to handle, leading to strains, sprains, and other musculoskeletal injuries.

To minimize these hazards, employers should provide workers with appropriate training, personal protective equipment (PPE), and engineering controls such as guardrails, toe boards, and safety nets. Employers should also conduct regular inspections of the formwork and scaffolding to ensure that they are assembled correctly and in good condition.

Workplace Hazards Analysis

A workplace hazard analysis is a method of identifying risks before they occur by focusing on occupational tasks. It focuses on the worker's relationship with the task, the tools, and the work environment. After identifying the hazards of the workplace, organisations shall try to eliminate or minimize them to an acceptable level of risk.

Control Measures of Workplace Hazards

Control measures are actions that can be taken to reduce the risk of being exposed to the hazard. Elimination, Substitution, Engineering Controls, Administrative Controls, and Personal Protective

Equipment are the five general categories of control measures.

- **Elimination:** The most successful control technique is to eliminate a specific hazard or hazardous work procedure or prevent it from entering the workplace.
- **Substitution:** Substitution is the process of replacing something harmful with something less hazardous. While substituting the hazard may not eliminate all of the risks associated with the process or activity, it will reduce the overall harm or health impacts.
- **Engineering Controls:** Engineered controls protect workers by eliminating hazardous situations or creating a barrier between the worker and the hazard, or removing the hazard from the person.
- **Administrative Controls:** To reduce exposure to hazards, administrative controls limit the length of time spent working on a hazardous task that might be used in combination with other measures of control.
- **Personal Protective Equipment:** Personal protective equipment protects users from health and safety hazards at work. It includes items like safety helmets, gloves, eye protection, etc.

8.1.3 Hazard Identification and Risk Assessment (HIRA)

Hazard Identification and Risk Assessment (HIRA) is conducted to identify undesired events that can lead to a hazard, analyse the hazard of this undesirable event, and estimate its scope, magnitude, and possibility of detrimental effects. Within the industry, it is commonly acknowledged that the various risk assessment approaches contribute significantly to improving the safety of complex processes and equipment.

This analysis of hazards and risks aims to identify and assess hazards, the event sequences that lead to hazards, and the risk associated with hazardous occurrences. There are numerous strategies for identifying and analysing dangers, ranging from simple qualitative procedures to advanced quantitative methods. Multiple methodologies for hazard analysis are advised because each has its objective, strengths, and weaknesses.

To manage risk, risks must first be identified, and then the risk must be assessed and its acceptability established.

The earlier an effective risk analysis is conducted in the life cycle, the more cost-effective the future safe operation of the process or activity is expected to be. Most of the facility's other process safety management tasks are based on understanding the risk obtained via these studies. An inaccurate perception of risk at any time could result in inefficient use of scarce resources or the unwitting acceptance of hazards that exceed the genuine tolerance of the organisation or community.

Procedure for HIRA:

At each stage of the work life cycle, a review team questions process specialists about potential hazards and evaluates the risk of any detected hazards. There are numerous typical ways to evaluate a design, ranging from straightforward qualitative checklists to extensive quantitative fault tree analysis. Typically, the results of the review process are recorded on a worksheet whose level of information varies according to the stage of the job and the evaluation method employed. Typically, risk evaluations

on operational processes are regularly updated or revalidated.

This work's objective is to detect hazards and risks by assessing each step involved in various building activities and to provide recommendations to remove or reduce the risk assessment (HIRA). The industry achieves success by satisfying production objectives and ensuring high employee satisfaction by meeting workplace safety criteria. Regularly, hazards and risk assessments should be performed, and steps should be taken to reduce the risk to an acceptable level.

HIRA Process it consist of four steps as follows:

I. Hazard identification

II. Risk assessment

III. Risk analysis

IV. Monitor and review

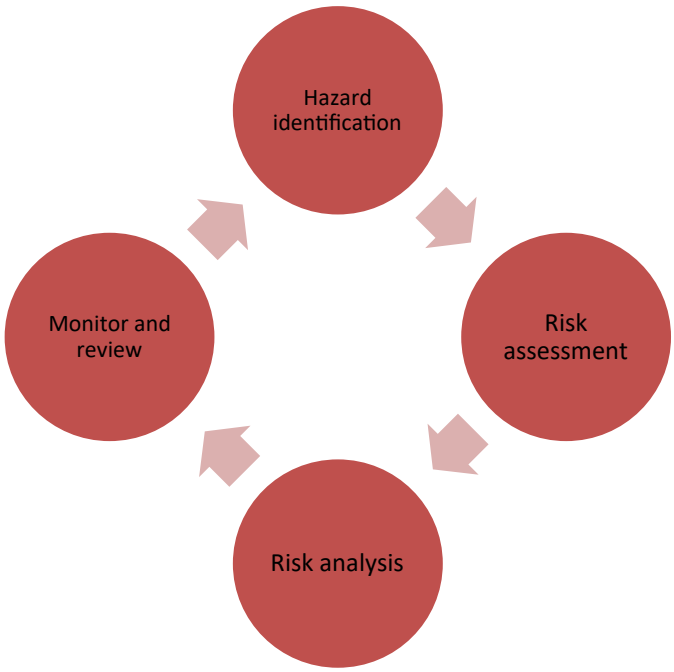

Fig. 8.1.1 HIRA Process

8.1.4. Workplace Warning Signs

A Hazard sign is defined as 'information or instruction about health and safety at work on a signboard, an illuminated sign or sound signal, a verbal communication or hand signal.'

There are four different types of safety signs:

- Prohibition / Danger Alarm Signs
- Mandatory Signs
- Warning Signs
- And Emergency

1. **Prohibition Signs:** A "prohibition sign" is a safety sign that prohibits behaviour that is likely to endanger one's health or safety. The colour red is necessary for these health and safety signs. Only what or who is forbidden should be displayed on a restriction sign.

Fig. 8.1.2 Prohibition Warning Signs

2. **Mandatory Signs:** Mandatory signs give clear directions that must be followed. The icons are white circles that have been reversed out of a blue circle. On a white background, the text is black.

Fig. 8.1.3 Mandatory Signs

3. Warning Signs: Warning signs are safety information communication signs. They are shown as a 'yellow colour triangle'.

Fig. 8.1.4 Warning Signs

4. Emergency Signs: The location or routes to emergency facilities are indicated by emergency signs. These signs have a green backdrop with a white emblem or writing. These signs convey basic information and frequently refer to housekeeping, company procedures, or logistics.

Fig. 8.1.5 Emergency Signs

8.1.5. Personal Protective Equipment

Personal protective equipment, or "PPE," is equipment worn to reduce exposure to risks that might result in significant occupational injuries or illnesses. Chemical, radiological, physical, electrical, mechanical, and other job dangers may cause these injuries and diseases.

The right PPE is essential in shuttering work to ensure the safety of workers. Employers should ensure that all workers are trained on how to properly use and maintain their PPE.

Here are the different types of PPE that are commonly used in shuttering:

Equipment	Description	Image
Helmet	This protects the worker's head from falling objects or bumps. It should fit snugly and be adjusted properly.	
Safety Shoes	This protects the worker's feet from falling objects, sharp objects, and slips. It should have a non-slip sole and be made of sturdy material.	
Safety Belt	This protects the worker from falls. It should be properly anchored and adjusted to fit snugly.	
Safety Glasses	This protects the worker's eyes from dust, debris, and other hazardous materials. It should be made of shatterproof material and fit snugly.	

Gloves	This protects the worker's hands from cuts, abrasions, and other injuries. It should be made of durable material and fit snugly.	

Table 8.1.1 Commonly Used PPE in Shuttering

8.1.6 Basic Ergonomic Principles

The basic ergonomic principles for construction are:

1. Work in neutral space.

Whether working seated or standing and moving throughout the day, it is essential to maintain a neutral posture. Several parts of the body are typically affected by this principle. The foremost is the rear. A healthy spine has an S-curve, and it is essential to maintain this curve when working to prevent back pain. When working in a seated position, lumbar support is essential. When standing stationary, it can be advantageous for those who stand or move around a facility to rest one foot on a footrest, and when lifting, it is important to lift using your legs rather than your back.

Neck, elbows, and wrists are additional parts of the body that may be misaligned. To lessen tension on these areas and maintain their alignment, try modifying your equipment or work position so that your muscles remain in a relaxed state.

2. Reduce the necessity for excessive force.

Imagine a time when you had to move an object using your entire body weight. This is what the principle refers to. Heavy pushing, pulling, and lifting can strain your joints, potentially leading to weariness or injury. Instead of employing unnecessary force, look for equipment or methods that can lighten the load you must move. It may be as easy as using a cart or hoist to transport heavy objects, or you may need to modify your workflow to reduce the distance you must go or the number of objects you must transport.

3. Keep materials easily accessible.

Try extending your arms in front of you and drawing a half-circle with them. This is your reach envelope, and you should keep goods you use regularly within this semicircle at your desk. To accommodate your reach envelope, you may need to rearrange your space so that you no longer have to reach for often used goods. Adjusting your seat and armrests can help alleviate fatigue by bringing machine controls within reach.

Also applies while reaching into boxes or containers. Before reaching into a box, tilt it or lay it on a lower surface instead than straining your shoulders to reach higher.

4. Work at the appropriate height.

A work surface that is either too high or too low might cause back, neck, and shoulder strain. Standing

or sitting, the majority of normal tasks should be performed at elbow height. Nonetheless, if you work with heavy instruments, you may need to change your position to work below elbow height. On the other hand, precision work may necessitate working at heights above the elbow.

5. Reduce needless movements.

Manual repetition can result in overuse injuries, thus it is essential to consider the motions you repeat throughout the day and identify solutions to prevent excessive motion. Is it conceivable, for instance, to replace a screwdriver with a drill, so eliminating the need for manual motion? Additionally, you might seek for possibilities to alter your position or the arrangement of your workspace in order to operate in a more ergonomic manner.

6. Reduce fatigue resulting from static stress.

There may be tasks at work that need you to maintain the same position for a lengthy period of time. This is known as static load. Static load can impact various regions of the body, including the legs while standing for an extended period of time and the shoulders when holding the arms overhead for more than a few seconds. These types of tasks might create muscle fatigue and discomfort that persists long after the work is completed. You may be able to prevent the weariness generated by static load by altering the orientation of your work area, repositioning your body, or using tool extenders.

7. Minimize contact stress.

When a tool or surface repeatedly comes into contact with the same part of your body, contact stress occurs. Sometimes referred to as pressure points, these places of contact can be painful. When you habitually squeeze a tool, such as pliers, or hold a heavy object, such as a nail gun, that exerts pressure on a portion of your hand, this is an example of contact stress. Adding padding, wearing gloves, or selecting equipment with a padded grip can be beneficial. Consider adding anti-fatigue mats to standing surfaces to reduce heel contact stress.

8. Leave adequate clearance.

This idea is straightforward: you must have adequate space for your head, knees, and feet. Adjust your seat to allow sufficient legroom if you perform your duties while seated. Remove above obstacles to avoid head injuries. Visibility also plays a role in this scenario. It is essential to have a clear perspective of your surroundings regardless of where you are working or what equipment you are employing.

9. Stay active and flexible throughout the day.

Sitting or standing in one posture for too long is unhealthy for the human body. Take time to stretch and exercise your muscles. If you are sedentary for an extended amount of time, take frequent breaks to walk around. If you are on your feet all day, wear supportive shoes and rest during your breaks. And if your profession is physically demanding on specific sections of your body, it may be beneficial to stretch before to undertaking tough duties.

10. Keep your atmosphere comfortable.

Depending on your sector and position, work conditions vary widely, but lighting, temperature, vibration, and noise are a few common factors you may want to consider. Consider strategies to reduce glare or improve lighting in dimly lit places. Whenever feasible, maintain a pleasant temperature in the workplace, and when working outside, dress appropriately for the weather. And if the tools produce excessive noise or vibration, give hearing protection and seek methods to attenuate the vibrations.

8.1.7 Emergency Response Plan for Construction Site

Construction projects are commonly recognised as one of the most accident-prone activities. It must be realised that the size and complexity of a project determines the associated dangers and risks. In the majority of cases, poor response, a lack of resources, or the absence of trained staff on a building site will result in chaos. In order to reduce human suffering and financial losses, it is strongly suggested that the emergency response plan be developed prior to project launch.

The Emergency Response Plan must address the following factors:

1. Statutory Obligations

The entity must comply with all applicable Central and State Rules and Regulations, such as The Building and Other Construction Workers' Act of 1996, the Environment (Protection) Act of 1986, the Factories Act of 1948, the Inflammable Substances Act of 1952, the Motor Vehicles Act of 1988, the Public Liability Insurance Act of 1991, the Petroleum Act of 1934, the National Environment Tribunal Act of 1995, and the Explosives Act of 1874, etc.

Incorporate applicability and compliance status into the Emergency Response Plan.

2. Emergency Preparedness

a) The process of hazard identification and risk assessment entails a thorough review of construction activities such as Excavation, Scaffolding, Platforms & Ladders, Structural Work, Laying of Reinforcement & Concreting, Road Work, Cutting /Welding, Working in Confined Space, Proof/Pressure Testing, Working at Heights, Handling & Lifting Equipment, Vehicle Movement, Electrical, Demolition, Radiography, Shot blasting

b) Listing On-Site (Level I & II) and Off-Site (Level III) Emergency Scenarios in accordance with their effects and available resources.

3. Measures for Emergency Mitigation

To ensure safety during construction activities, the business must have an appropriate Health, Safety, and Environment Management System in place.

a) Health, Safety, and Environment (HSE) Policy;

b) Duties and Responsibilities of Contractor/Executing Agency;

c) Site planning and layout;

d) Deployment of Safety Officer/Supervision;

e) Safety committees with fair participation of workers;

f) Safety audits and inspections shall be conducted using prescribed checklists.

g) Work permit system h) PPE I Safety awareness and training, etc.

4. Measures for Emergency Preparedness

a) Emergency Drill and Exercise on Identified Scenarios and Evaluations b) Emergency Response Training

b) Mutual Aid

5. Disaster Recovery Procedures

The entity must develop well-planned and documented response procedures. The action plan may be documented for both On-site and Off-site disaster scenarios.

6. Organization and Responsibilities during Emergencies

The entity must create an organisation chart (emergency action flowchart) and specify the roles and duties of key individuals in order to properly handle an emergency scenario on the project site. Clause 14.0 of the PNGRB (ERDMP) Regulations may be consulted in order to establish the emergency organisation and responsibilities.

7. Resources for Emergency Management

1) The following emergency control systems and facilities must be provided on the project/ construction site: -

   (a) Fire and gas detection system (b) Fire protection and firefighting system (Active and Passive) (c) Ambulance facility on-site; if not, on urgent call basis.

   (d) Rescue facilities and personal protective equipment (PPEs)

   (e) First aid stations.

   (f) Medical facility on-site or affiliation with a local hospital or medical centre

   (g) Internal and External Communication Facilities as well as a Notification System

   (h) Gathering places

   (i) Escape route and evacuation zones

2) Internal and External Emergency contact information for police, fire, hospitals, mutual assistance industry, factory inspectors, Board, State Pollution Control Board, Petroleum and Explosive Safety Organization (PESO), etc.

3) Addresses and Telephone Directory of Technical Support Services and Professional Emergency Responders

8. Emergency Recovery Method

Following the emergency, the following tasks must be completed in detail.

a) Information to legal authorities (Refer to Clause 23.0 for Incident Reporting to PNGRB).

b) Incident examination.

d) Damage evaluation.

d) Product salvage, decontamination, clean-up, and restoration.

e) A comprehensive report shall be compiled based on the complete incident experience, including restorations, restrictions, and lessons learned.

Notes

Unit 8.2: Fire Safety

Unit Objectives

By the end of this unit, participants will be able to:

- Explain the classes of fire and types of fire extinguishers.
- Demonstrate the operating procedure of the fire extinguishers.

8.2.1. Fire and its Classes

Fires can be catastrophic. Burning, hurting, and even killing people, causing property and equipment damage. Disrupting corporate operations. Fire may take lives and destroy businesses.

Fire prevention is the most effective technique to prevent fire from affecting one or their business/ organisation. In addition to preventing fires from starting, one should also have a plan in place for responding to flames if they occur.

There are five distinct classes of fire:

Class A: Ordinary solid combustibles, including paper, wood, fabric, and certain polymers.

Class B: Flammable liquids such as alcohol, ether, oil, gasoline, and grease should be smothered.

Class C: Electrical equipment, appliances, and wiring where applying a nonconductive extinguishing chemical minimise electrical shock-related injuries. Don't use water.

Class D: Certain combustible metals, including sodium and potassium. These items are not often found at the Medical Center.

Class K: Flames caused especially by cooking fat or oil.

8.2.2 Fire Safety

Fire safety is a set of actions aimed at reducing the amount of damage caused by fire. Fire safety procedures include both those that are used to prevent an uncontrolled fire from starting and those that are used to minimise the spread and impact of a fire after it has started. Developing and implementing fire safety measures in the workplace is not only mandated by law but is also essential for the protection of everyone who may be present in the building during a fire emergency.

The basic Fire Safety Responsibilities are:

- To identify risks on the premises, a fire risk assessment must be carried out.
- Ascertain that fire safety measures are properly installed.
- Prepare for unexpected events.
- Fire safety instructions and training should be provided to the employees.

Prevention of a Workplace Fire

- Workplace fire drills should be conducted regularly.
- If one has a manual alarm, one should raise it.
- Close the doors and leave the fire-stricken area as soon as possible. Ensure that the evacuation is quick and painless.
- Turn off dangerous machines, and don't stop to get personal items.
- Assemble at a central location. Ascertain that the assembly point is easily accessible to the employees.
- If one's clothing catches fire, one shouldn't rush about it. They should stop, descend to the ground, and roll to smother the flames if their clothes catch fire.

One should periodically participate in fire drills to be prepared to deal with any fire incident.

8.2.3. Fire Extinguisher

Fire extinguishers are portable devices used to put out small flames or minimise their damage until firefighters arrive. These are maintained on hand in locations such as fire stations, buildings, workplaces, public transit, and so on. The types and quantity of extinguishers that are legally necessary for a given region are determined by the applicable safety standards.

Types of fire extinguishers are:

There are five main types of fire extinguishers:

1. Water
2. Powder
3. Foam
4. Carbon Dioxide (CO_2)
5. Wet chemical

1. **Water:** Water fire extinguishers are one of the most common commercial and residential fire extinguishers on the market. They're meant to be used on class-A flames.

2. **Powder:** The L2 powder fire extinguisher is the most commonly recommended fire extinguisher in the Class D Specialist Powder category, and is designed to put out burning lithium metal fires.

3. **Foam:** Foam extinguishers are identified by a cream rectangle with the word “foam” printed on them. They’re mostly water-based, but they also contain a foaming component that provides a quick knock-down and blanketing effect on flames. It suffocates the flames and seals the vapours, preventing re-ignition.

4. **Carbon Dioxide (CO2):** Class B and electrical fires are extinguished with carbon dioxide extinguishers, which suffocate the flames by removing oxygen from the air. They are particularly beneficial for workplaces and workshops where electrical fires may occur since, unlike conventional extinguishers, they do not leave any toxins behind and hence minimise equipment damage.

5. **Wet Chemical:** Wet chemical extinguishers are designed to put out fires that are classified as class F. They are successful because they can put out extremely high-temperature fires, such as those caused by cooking oils and fats.

Notes

Unit 8.3: Safety Measures at Workplace

Unit Objectives

By the end of this unit, participants will be able to:

- Explain the importance of housekeeping practices followed after construction rigging.
- Demonstrate safe housekeeping practices.
- Explain the importance of the participation of workers in safety drills.
- Explain the purpose and importance of the vertigo test at a construction site.
- List out basic medical tests required for working at a construction site.
- Demonstrate vertigo test.
- Demonstrate different methods involved in providing First aid to the affected person
- Demonstrate safe waste disposal practices followed at a construction site.
- Explain different types of waste at construction sites and their disposal method.

8.3.1 Safety, Health and Environment at Workplace

The Indian Constitution gives explicit standards for people's rights and the Directive Principles of State Policy, which offer a framework for the acts of the government. The government is dedicated to regulating all economic activities for the management of safety and health risks at workplaces and to implementing steps to provide safe and healthy working conditions for every man and woman in the country. This commitment is supported by both these Directive Principles and international instruments. The government recognises that worker health and safety contribute to both economic growth and worker output.

8.3.2 Good Housekeeping

Good housekeeping on construction sites refers to the practice of keeping one's site clean and tidy. After all, construction work is messy, and cleaning up now will only result in more mess later.

A clean work environment reduces the likelihood of accidents and improves fire safety. There are fewer things to trip one up if there are no materials, waste, or discarded tools.

One should see a decrease in slip and fall accidents by following the recommendations:

1. **Make a separate area for trash and waste.**

   Make a waste disposal area. After all, if one wantstheir workspace to be free of waste materials, they will need a place to store them. Depending on the amount of waste, this could be a skip or another waste disposal bin. Segregating waste types for reuse, recycling, or landfill is a best practice solution.

2. **Safely stack and store materials.**

   Poorly stacked materials can obstruct access routes or topple over, resulting in crushing injuries or property damage. One will need materials and tools throughout the project; store them safely to avoid them becoming hazardous.

3. **Maintain a safe working environment.**

   On a construction site, one's job will almost certainly generate daily waste. Whether it's packaging, demolition, or leftovers. One should check and clean the work area regularly throughout the day. If trip hazards and clutter are beginning to accumulate, address them as soon as possible.

4. **Maintain clear access routes.**

   A safe working environment includes access and egress. It is how one arrives at work and how one leaves. Leave no materials/tools/benches in gangways/corridors where they could obstruct someone's escape or cause a trip hazard (it might be a colleague who needs to get out in a hurry).

5. **Place tools at the designated place after use.**

   One should put away tools and equipment after using them. It's easy to leave items lying around, but if one won't need them again soon, store them. If it's not in use, it should be out of sight, or at the very least out of one's way!

   If one sees anything lying on the floor, stairwell, or passageway that could cause people to trip and fall, pick it up and one should put it somewhere safe –instead of waiting for someone else to move it; the next person could be the one who gets hurt.

6. **If something is broken, fix it.**

   Fix it or get rid of it. Good housekeeping also entails keeping things in working order on-site. Damaged tools or equipment must be removed from service so that they can be repaired or replaced.

7. **Avoid tripping over cables.**

   Equipment trailing leads and cables are common trip hazards, especially when using portable equipment. One may not have a socket nearby, but make sure the lead is routed away from walkways or access routes. Cables should be routed so that they do not present a tripping hazard.

8. **Avoid fire hazards.**

   Make sure that waste or material storage does not accumulate in fire escapes, as one may need to use these escapes at some point. Clearing up and removing waste is also a good way to keep fires at bay on the job site. Because fire requires fuel, do not store waste materials near sources of ignition. If all garbage is collected regularly and placed in a skip, the danger is contained and more easily dealt with in the event of a fire.

9. **Inform others.**

   Everyone must work together to keep the workplace clean. If everyone follows the same good housekeeping routines, one will be well on way to a clean and safe site for everyone.

8.3.3 Importance of Housekeeping Practice followed after System Shuttering Works

Housekeeping is an essential practice that should be followed after system shuttering works on a construction site. Here are some of the importance of maintaining good housekeeping practices:

1. **Improved Safety:** A clean and organized worksite is a safer worksite. By removing clutter and debris, workers are less likely to trip, slip or fall, and this helps to reduce the risk of accidents and injuries.

2. **Increased Productivity:** A well-organized worksite allows workers to move around freely and quickly, without obstacles getting in the way. This improves productivity and efficiency, allowing work to be completed more quickly.

3. **Compliance with Regulations:** Many regulatory bodies require construction sites to maintain a high standard of housekeeping. By adhering to these regulations, contractors can avoid fines and penalties and maintain a positive reputation with regulatory agencies.

4. **Enhanced Reputation:** Maintaining a clean and organized worksite is a reflection of the contractor's professionalism and commitment to quality. A well-kept site can help to enhance the contractor's reputation with clients, suppliers, and other stakeholders.

5. **Better Equipment Maintenance:** Cleaning and maintaining equipment after use is essential to ensure it continues to operate safely and efficiently. This can help to extend the life of the equipment and avoid costly repairs.

6. **Improved Morale:** A clean and organized worksite can have a positive impact on worker morale. When the work environment is tidy and well-maintained, workers tend to feel more valued and appreciated, which can lead to increased job satisfaction and lower turnover rates.

Maintaining good housekeeping practices after system shuttering works is crucial for the safety, productivity, and reputation of the construction site. By keeping the site clean and organized, contractors can avoid accidents and injuries, comply with regulations, and enhance their reputation with stakeholders.

8.3.4 Medical Examination for Construction Workers

The government has mandated that industrial enterprises undertake annual health check-ups on their employees. In accordance with the Factories Act of India 1948, both contractual and permanent employees in manufacturing businesses are required to undergo periodic health examinations. These examinations aim to protect the health and safety of factory workers.

The type of medical examination varies according to an employee's job description or the nature of the industrial process in which he is involved. For instance, if an employee works in the food business, their hands are routinely inspected for skin disorders. If someone is involved in a hazardous manufacturing process, chest X-rays may be a part of the medical check-up.

Consequently, depending on the nature of the production process and the job profile, an employee may be subjected to all standard and specific tests.

In addition, the frequency of medical examinations varies. According to the Maharashtra Plant Rules, for instance, if the factory is involved in the production of lead, workers are inspected once every month.

Medical Check-up Before Employment: A young person must have a pre-employment medical examination by a certified medical professional to determine and confirm their fitness to work in a factory, according to the applicable regulations.

Medical Examinations for Workers in Hazardous Occupations: According to the Factories Act, a plant that engages in hazardous procedures is required to have its employees examined by a competent medical professional before employment and on a recurrent basis thereafter. Workers employed in a "hazardous process" are medically tested once before employment to determine their physical fitness and appropriateness for employment in a hazardous process.Once every six months, the health status of all workers exposed to occupational health hazards must be determined.

If the medical findings reveal any abnormality or unsuitability of a person employed in the hazardous process, or if the worker has manifested signs and symptoms of a notifiable disease, the worker must be removed from the process for health protection and cannot be employed in the same process. Alternatively, if the worker is totally handicapped, he or she will receive appropriate rehabilitation. Only after obtaining a fitness certificate from the certified professional in accordance with the applicable regulation may a withdrawn employee be rehired for the same process.

List of Recommended Medical Tests under the Factories Act:

1. Complete Physical Examination
2. Blood Group, Rh factor
3. Blood CBC, ESR, RBS
4. Urine Test (Routine & Microscopic)
5. Creatinine
6. Electrocardiogram (Computerised ECG)
7. Chest X-Ray (Standard Size)
8. Lung Function Test
9. Vision Test (Screening)
10. Audiometric Test
11. HIV & HBS Tests

8.3.5 Vertigo Test

Vertigo is a symptom, not a condition in and of itself. Vertigo is a sort of dizziness that is frequently described as the sensation that one is spinning or that the world is spinning around them, especially when they alter their position. Vertigo affects people of all ages. Middle ear pathology is typically the culprit in younger patients. The danger of falls and associated sequelae necessitates a specialised assessment of the elderly. The key to arriving at a diagnosis is distinguishing vertigo from other causes of dizziness or imbalance, as well as distinguishing central causes of vertigo from peripheral causes.

Vertigo is a symptom that is associated with numerous medical disorders. One's doctor may require one or more tests or procedures to better understand one's underlying issue. Numerous of these tests require specialised equipment and experienced personnel.

Some exams are brief and painless, while others are lengthy and unpleasant. Their doctor can recommend the relevant tests for the condition.

Diagnostic Procedures Typically Employed for Vertigo

Following a discussion of one's symptoms, a review of their medical history, and a general physical examination, their physician may recommend one or more of the following tests:

Dix-Hallpike Maneuver

If one's doctor suspects they have benign paroxysmal positional vertigo (BPPV), the most frequent type of vertigo, he or she may employ the Dix-Hallpike manoeuvre. This procedure can also assist one's doctor in determining if one's vertigo is caused by an inner ear disorder or something in one's head.

The physician will rotate one's head 45 degrees to one side. Then, one will immediately lie on their back with their head off the edge of the table for at least 30 seconds. Their physician will examine their eyes and inquire whether they feel dizzy. The process is repeated on the opposite side.

One should be aware that this examination could induce vertigo. If one experiences symptoms during this examination, one's physician will conclude that they have vertigo.

Head Impulse Test

The head impulse test examines the coordination between one's eyes and inner ears. It is frequently utilised when vestibular neuritis is suspected. One's doctor will quickly twist their head to search for rapid eye movements and reflexes that may indicate a problem with the semi-circular canals of the inner ear.

Romberg Test

The Romberg test requires oneto stand with their feet together. One will then close one's eyes. One's doctor will evaluate the degree to which one wobbles or fall to establish the cause of one's vertigo.

Fukuda-Unterberger Test

The Fukuda-Unterberger test consists of a blindfolded march. To determine which side of one's body is afflicted by vertigo, their doctor will evaluate how their body deviates from the midline.

Electronystagmography (ENG) or videonystagmography (VNG)

Electronystagmography (ENG) and videonystagmography (VNG) are used to identify aberrant eye movements and assess if vertigo symptoms are caused by an inner ear condition.

ENG employs electrodes and VNG uses small cameras to monitor eye movements while the head is put in various postures or while the subject is requested to track specific visual targets. Air or water may also be utilised to regulate the temperature of the ear canal. Typically administered in a dark setting, these examinations may induce jerking eye movements.

Rotation Test

To determine how well the eyes and inner ear work together, rotation tests are administered. Eye movements are analysed while the head is slowly moved from side to side. Different types of rotation tests exist. One may be required to sit in a chair that swivels or to look at a stationary target while moving their head back and forth or up and down.

8.3.6 First Aid

First aid is the treatment or care given to someone who has sustained an injury or disease until more advanced care can be obtained or the person recovers.

The aim of first aid is to:

- Preserve life
- Prevent the worsening of a sickness or injury
- If at all possible, relieve pain
- Encourage recovery
- Keep the unconscious safe.

First aid can help to lessen the severity of an injury or disease, and in some situations, it can even save a person's life.

Need for First Aid at the Workplace

In the workplace, first aid refers to providing immediate care and life support to persons who have been injured or become unwell at work.

Many times, first aid can help to lessen the severity of an accident or disease.

It can also help an injured or sick person relax. In life-or-death situations, prompt and appropriate first aid can make all the difference.

Treating Minor Cuts and Scrapes

Steps to keep cuts clean and prevent infections and scars:

- **Wash Hands:** Wash hands first with soap and water to avoid introducing bacteria into the cut and causing an infection. One should use hand sanitizer while on the go.
- **Stop the bleeding:** Using a gauze pad or a clean towel, apply pressure to the wound. For a few minutes, keep the pressure on.
- **Clean Wounds:** Once the bleeding has stopped, clean the wound by rinsing it under cool running water or using a saline wound wash. Use soap and a moist washcloth to clean the area around the wound. Soap should not be used on the cut since it may irritate the skin. Also, avoid using hydrogen peroxide or iodine, as these may aggravate the wound.
- **Remove Dirt:** Remove any dirt or debris from the area. Pick out any dirt, gravel, glass, or other material in the cut with a pair of tweezers cleaned with alcohol.

8.3.7 Waste Management

The disorderly nature of construction sites can make it difficult for workers to remain productive. By applying waste management methods from the outset of the project, one can aid in maintaining order and keeping everyone focused on their jobs.

- **Avoid Accidents:** To prevent accidents, the workers must ensure that waste and debris are properly disposed of. Ensure that they are aware of which objects are hazardous in the event of a fire or an object being thrown into machinery.

- **Reduce Cost:** Managing garbage on-site can assist decrease costs by minimising the cost of removal, in addition to improving safety.
- **Maintain a wholesome working atmosphere:** To maintain a healthy building site, workers will need a variety of equipment and supplies, such as wheelbarrows for transporting dirt and pallets for storing bricks and other heavy items. Ensure that there are always sufficient rubbish bins available so that the workers may dispose of the trash without difficulty.
- **Keeping Material Records:** All building materials must be accounted for at all times to prevent their accidental disposal. This contributes to cost control and time management. If using Reo mesh for wall stability, one would not want to waste such a valuable resource. This occurs frequently on construction sites and may be controlled with simple procedures. This can be as easy as choosing various colours for waste piles or maintaining a log. Materials that are no longer required should never be discarded until they have reached the end of their functional life on the site; in other words, until nothing can be salvaged from them.
- **Environmentally Responsible:** Waste management is also essential since it ensures the environmental friendliness of a project. If garbage is not disposed of in an environmentally responsible manner, it can negatively impact the local ecology and nearby places by contaminating streams and contributing to air pollution.

Waste and Debris Management on the Construction Site

On the construction site, one must be mindful of how they handle waste and garbage. Having a plan for managing these goods is necessary to protect the safety of both workers and the general public. Here are some waste management strategies:

- Before disposing of them in the dumpster, place any hand tools in containers with lids.
- Place empty paint cans in the trash instead of spilling them down drains or onto pavements.
- Rinse disposable cups and other food containers before placing them in a recycling bin. This will help prevent litter from being blown onto the property during windy or rainy weather.
- Recycle equipment and other metal objects by utilising a magnet or air compressor to remove all non-metal components, such as nails, screws, nuts, bolts, electrical wiring, etc. These are then segregated by category before proper recycling.
- Insulation should be disposed of in the garbage as opposed to being poured down drains or onto pavements, as it can clog sewer systems.
- Use a tarp to pile dirt, rocks, bricks, and other heavy things into the bed of a truck before hauling them away when the work is complete. This will make future clean-up easier.
- Instead of discarding excess lumber, wrap it in plastic to prevent it from becoming wet and infected with termites.
- Use a leak-proof container or urn to transfer hazardous liquids away for proper disposal; this will keep the workers and others on-site dry and healthy.
- Regularly cleaning up will reduce the amount of debris.
- Using trash cans with lids to prevent rubbish from falling to the ground.
- On the site, provide workers with safety vests for simple identification and protection from concealed threats such as electrical cables and sharp instruments.
- Ensure that there is a designated space for recyclable materials such as glass, plastic, cardboard, and metal containers so that they may be sorted later.

It is necessary to have a plan for waste management on construction sites, which are typically untidy places.

Exercise

1. Name the types of fire extinguishers.
2. Explain PPE in brief.
3. Explain the importance of workplace safety at a construction site.
4. What do you understand by good housekeeping?
5. Why are safety drills at construction sites important?

Notes

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9.Employability Skills (30 Hours)

It is recommended that all trainings include the appropriate Employability skills Module. Content for the same can be accessed

https://www.skillindiadigital.gov.in/content/list

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10. Annexure

Annexure I - QR Codes - Video Links

Annexure - I

Annexure of QR Codes for Assistant Shuttering Carpenter

Chapter Name	Unit Name	Topic Name	URL	Page No.	QR Code	Video Duration
Chapter 1: Introduction to Shuttering Carpentry Occupation	Unit 1.1: Introduction to Construction Industry	1.1.1 Construction Industry	https://youtu.be/nndLyZrGfWc	3	Construction Industry	0:16:51
		1.1.2 Types of Construction	https://youtu.be/1WVzo2U-Fyo8	4	Types of Construction	0:13:45
		1.1.4 Shuttering Carpentry	https://youtu.be/WIMNbAW-M7r8	6	Shuttering Carpentry	0:01:23
		1.1.5 Common Terminologies used in Shuttering Carpentry	https://youtu.be/SDYRICOTRSs	6	Common Terminologies used in Shuttering Carpentry	0:07:12
Chapter 2: Operate Tools and Equipment	Unit 2.1: Use and maintain tools, components, and equipment	2.1.1 Formwork	https://youtu.be/6x_NxC3h-gA8	15	Formwork	0:10:53
		2.1.4 Timber Formwork	https://youtu.be/KGRRxfucXRk	17	Timber Formwork	0:04:12

		2.1.6 Plywood Formwork	https://youtu.be/Z176lfv2kPI	19	Plywood Formwork	0:02:20
		2.1.7 Wooden Shuttering	https://youtu.be/eGuF5xc5_EM	20	Wooden Shuttering	0:06:06
		2.1.10 Tools used in Shuttering	https://youtu.be/yyZ5GB8qQrY	25	Tools used in Shuttering	0:04:44
Chapter 3: Make Wooden Shutter Boards used in Shuttering Carpentry Works	Unit 3.1: Wooden Shutter Boards	3.1.4 Types of Plywood used in making Shuttering Boards	https://youtu.be/Lk-AlCYwUdA	44	Types of Plywood used in making Shuttering Boards	0:05:41
Chapter 4: Assist in Assembling and Dismantling Conventional Formwork for RCC Structure	Unit 4.1: Assembling and Dismantling Conventional Formwork for RCC Structures	4.1.1 Conventional Formwork	https://youtu.be/VA27lBDEAgE	66	Conventional Formwork	0:19:30

		4.1.2 Procedure for Erection of Conventional Formwork	https://youtu.be/OAYuQC22Bn0	67	Procedure for Erection of Conventional Formwork	0:09:21

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