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Construction Skill Development Council

Participant Handbook

Sector
Construction Skill Development Council of India

Sub - Sector
Real Estate and Infrastructure Construction

Occupation
Shuttering Carpentry

Reference ID: **CON/Q3001, Version 2.0**

NSQF Level 4

SHUTTERING CARPENTER
(Elective: System Formwork /Conventional Formwork)

Published by

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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: "Shuttering Carpenter"
QP No. 'CONQ3001, Version 2.0, NSQF Level 4'

Date of Issuance: March 31st 2022
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Authorised Signatory
(Construction Skill Development Council)

Acknowledgements

This participant's handbook meant for 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 Shuttering Carpenter. 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 a 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 a 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 Shuttering Carpenter QP:

- **CON/N0302:** Make wooden shutters used in shuttering carpentry
- **CON/N0304:** Carry out quality check for shuttering works
- **CON/N8001:** Work effectively in a team to deliver desired results at the workplace
- **CON/N8002:** Plan and organize work to meet expected outcomes
- **CON/N9001:** Work according to personal health, safety and environment protocols at construction site
- **DGT/VSQ/N0102:** Employability Skills (60 Hours)

Participants may choose to delve into the Formwork details specific to System and Conventional Formwork by selecting the appropriate elective modules.

Elective 1: System Formwork

CON/N0303: Assemble and dismantle system formwork for R.C.C structures

Elective 2: Conventional Formwork

CON/N0315: Assemble and dismantle conventional shuttering / formwork for RCC structures

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

Notes

Unit Objectives

Activity

Table of Contents

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

Key Learning Outcomes

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

1. Understand broadly the construction activities in India
2. Differentiate between real estate & infrastructure and rural construction
3. Know about major occupations in construction sector
4. Understand few job roles under each occupation
5. Know about role and duties of a Shuttering Carpenter- System
6. Know about personal and professional attributes under the Shuttering Carpentry
7. Know about career path as a Shuttering Carpenter- System

Unit 1.1: Introduction to Scaffolding

Unit Objectives

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

1. Understand broadly the construction activities in India; and
2. Differentiate between real estate & infrastructure and rural construction.

1.1.1 Introduction

The construction industry contributes significantly to the growth and enhancement of the economy while also playing a pivotal role in the overall development of the nation. Construction activities hold a crucial position in shaping a country's infrastructure and industrial progress. Construction encompasses the creation of various structures such as hospitals, schools, residential areas, office complexes, houses, along with essential facilities like water supply, sewerage, drainage systems, as well as the construction of transportation networks like highways, roads, ports, railway tracks, and dams. When we consider its broad scope, construction activity emerges as a fundamental catalyst for socio-economic advancement. Notably, construction stands as the second largest employment-generating sector in India, following agriculture. This sector comprises a diverse range of businesses, including small, medium, and large enterprises, all engaged in different types of projects. As a result, a varied workforce is required to meet the demands of this sector. Construction industry is broadly divided into two major sub-sectors: -

1. Real estate & infrastructure construction; and
2. Rural construction

1.1.1.1 Real Estate & Infrastructure Construction

Only 30% of India's population resides in urban areas. According to the latest projections from the Government of India, urban development in the country is poised to surge at an impressive rate of 38%. The existing Indian urban infrastructure and services, established during the British colonial era, are ill-equipped to adequately address such burgeoning demands.

Approximately INR (Rs.) 43,55,000 crores is projected to be necessary for urban development over the upcoming two decades. A significant portion of this amount, nearly 45%, is earmarked for the construction of urban roadways. The Twelfth Five Year Plan outlines that 48% of these funds are expected to originate from private sources, capitalizing on various national

Fig 1.1.1: Township construction

Fig 1.1.2: Bridge construction

policy initiatives designed to restore investor confidence. To expedite the pace of urban development throughout the nation, the government has undertaken various measures, allocating a substantial sum of INR (Rs.) 13,400 crores under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM). Additionally, for the enhancement of small and medium-sized towns, the government has launched the Urban Infrastructure Development Scheme, involving an investment of INR (Rs.) 6,700 crores, aimed at addressing the infrastructural requirements of these smaller urban centers.

Government initiatives under urban development

Through the implementation of the 'City Challenge Competition,' a subset of Smart Cities (as part of the Smart Cities Mission, encompassing fewer than 100 cities) will be designated based on their ability to align funding with their capacity to achieve multifaceted goals in urban infrastructure development. These objectives include ensuring access to clean and safe water sources, effective sanitation and solid waste management, streamlined and effective public transportation, accessible housing options for marginalized populations, efficient power distribution, robust IT connectivity with a specific focus on e-governance and citizen engagement, as well as prioritizing the well-being, safety, and security of residents, along with promoting healthcare, education, and fostering a sustainable urban environment.

Fig 1.1.3: Building construction site

Fig 1.1.4: Industrial Building construction site

- The Swachh Bharat Mission (SBM) is aimed at eradicating open defecation, implementing scientific municipal solid waste management, eliminating manual scavenging, and fostering a shift in behavior towards healthy sanitation practices.
- The expansion of heritage cities focuses on improving the quality of life with a strong emphasis on hygiene, waste management, tourism, heritage preservation, and maintaining the essence of the city's identity.
- The Indian Government plans to establish several new airports in the upcoming years to enhance local connectivity.
- The Sagarmala project is launched to develop India's ports and inland waterways, promoting port-led growth and industrialization along the coastlines. The project entails an investment of INR 670 billion.
- The Indian Government has allocated Rs 50,000 crore for the development of 100 smart cities across the country. A list of 98 cities was shortlisted for the smart cities project in August 2015.
- Ambitious road network projects are underway, including the expansion of the road network by 2020 and the construction of 15,000 kilometers of new roads by 2017.

Various Indian railway initiatives have been initiated, encompassing the establishment of new railway stations, high-speed rail networks, modernization of rolling stock, improved port-rail connectivity, and other measures aimed at enhancing railway development and connectivity.

1.1.1.2 Rural Construction

Rural Construction: This sub-sector aims at the constructional requirements of rural India and Construction of rural households, warehouses, village roads etc.

Fig 1.1.5: Rural roads

Fig 1.1.6: Rural house

Rural infrastructure serves as a vital component of both rural growth and a sustainable strategy for poverty alleviation. The proper development of infrastructure in rural areas not only enhances the rural economy but also plays a crucial role in supporting effective poverty reduction initiatives. By strategically expanding infrastructure in rural regions, we can bolster the rural economy and elevate the overall standard of living. This approach contributes to increased productivity, higher agricultural incomes, improved employment opportunities, and various other positive outcomes.

Government initiatives under rural development

- The Bharat Nirman initiative is dedicated to enhancing rural connectivity across diverse geographical landscapes in India, encompassing coastal, mountainous, backwater areas, tribal regions, plains, hills, deserts, swamps, and more, spanning over 6 lakh villages.
- Central to the Bharat Nirman initiative is the construction of rural housing, with the government committed to providing adequate housing for rural communities.
- The Pradhan Mantri Gram Sadak Yojna (PMGSY) is designed to ensure road connectivity to every village, making it a cornerstone of rural infrastructure development.
- Facilitating the transfer of technology from the workshop to the field, including the dissemination of information on the cost-effective and environmentally friendly (CEEF) construction of buildings in both rural and urban areas.
- The improvement and elevation of workforce skills are emphasized, creating a skilled pool of individuals capable of undertaking various construction services in both rural and urban contexts.

Notes

QR Codes

Scan the QR code to watch the video

https://youtu.be/p4f0Ni15EaM?si
=FLKuZWQ7vm2dLZ9N

Overview of Construction Sector in India

UNIT 1.2: Occupation in Construction Sector

Unit Objectives

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

1. Know about major occupations in construction sector; and
2. Understand few job roles under each occupation.

1.2.1 Major Occupations in Construction Sector

Following occupations are very common in most of the construction projects:

1. **Masonry:** Masonry involves the work to use mortar for fixing constituents like brick, stone, Block or others to build walls and buildings.

The basic objectives of masonry work include:

- The process of creating structures by arranging materials such as bricks, blocks, tiles, and other construction elements and binding them together using mortar.
- Engaging in the construction, modification, repair, and upkeep of walls, sidewalks, street curbs, floors, sink counters, partitions, manholes, and comparable structures or surfaces.
- Executing structural finishes such as tiling, grit wash, cement wash, POP (Plaster of Paris), plastering, stone cladding, and more on completed masonry surfaces to enhance the visual appeal of the finalized structure.

Fig 1.2.1: Brick work

Fig 1.2.2: Plastering work

Few job roles under masonry occupation are:-

- Helper Mason
- Assistant Mason
- Mason General;

- Mason Tiling;
- Mason Concrete;
- Mason marble, granite & stone; and
- Mason Special Finishing
- Mason Form Finishes & Special concrete.

2. **Bar Bending and Fixing:** Bar bending and Steel Fixing involves works like shifting, straightening, cutting, bending and placing of the reinforcement bars in order to assemble cage /mesh according to given working structural drawing or specifications. Few job roles under bar bending occupation are:-

Fig 1.2.3: Reinforcement bars fixed at site

Fig 1.2.4: Bar bending

i. **Assistive Role:** Bar Bending and Steel Fixing Helper
ii. **Junior Role:** Bar Bending and Steel Fixing Assistant
iii. **Skilled Role:** Bar Bending and Steel Fixing Technician
iv. **Specialized Role:** Reinforcement Fitting Specialist

3. **Shuttering Carpentry:** Shuttering Carpentry involves the use of timber boards or metal Plates to create a temporary structure for casting of concrete. These timber boards or Metal plates are placed, positioned and fixed using rods and stakes known as false work.

Fig 1.2.5: Conventional formwork

Fig 1.2.6: System formwork

After fixing these boards or plates in designated area, concrete can be poured within these Fixed molds. These molds hold the concrete in its place till it sets, thereby generating a Hard, smooth structure.

Few job roles under shuttering carpentry occupation are:-

i. Helper shuttering carpenter;

ii. Assistant shuttering carpenter;

iii. Shuttering carpenter – system; and

iv. Shuttering carpenter – conventional.

Fig 1.2.7: Scaffolding work

4. **Scaffolding:** Scaffolding works involve creation of temporary support structure for providing Support to workman as well as original structure during construction process. It is use as a platform to carry on construction works and keep tools and Materials. Few job roles under scaffolding occupation are:-

   i. Assistant scaffold - system; and;

   ii. Assistant scaffold - conventional.;

   iii. Scaffolder -System

   iv. Scaffolder-Conventional.

   v Chargehand Scaffolding -System

   vi. Foreman Scaffolding

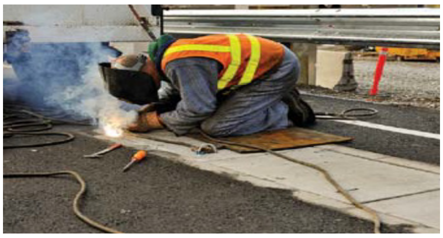


Figure 1.2.8 Welding

5. **Fabrication:** Fabrication is the process of construction of an item from raw materials using Cutting, bending assembling process, instead of creating it from ready to use components Or parts. It involves various tasks such as Cutting & heating, welding followed by final assembly of welded, sand-blasted, primed, painted components. Key part of this process is also the initial phases of grinding, drilling and surface preparation, essential for fabrication. Few job roles under Fabrication occupation are:

   I. Grinder Construction;

   II. Construction fitter;

   III. Construction welder;

   IV. Fabricator; and

   V. Plasma cutter.

6. **Rigging:** Rigging is a set of actions used for moving, lifting and transferring objects by scheming and fitting various components and equipment. A team of riggers designs and installs the lifting or rolling equipment needed to raise, roll, slide or lift objects such as with a crane. Few job roles under rigging occupation are:-
   I. Khalasi;
   II. Rigger structural erection;
   III. Rigger precast erection; and
   IV. Rigger piling.

Fig 1.2.9: Rigging work at site

Notes

UNIT 1.3: Role and Responsibilities of a Shuttering Carpenter

Unit Objectives

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

1. Know role and duties of a shuttering carpenter - system
2. Know personal and professional attributes under the shuttering carpentry occupation
3. Identify various employment opportunities for a Shuttering Carpenter.
4. Know about career path as a shuttering carpenter – system

1.3.1 Role of a Shuttering Carpenter – System

- Shuttering Carpentry is one of the most important occupation/ skill area of construction.
- A Shuttering Carpenter should possess skills like making of wooden shutter board, erecting shuttering board for column, beam, slab, wall, foundation and other various structures. Shuttering carpenter should be able to assemble and dismantle formwork for RCC structure and carryout quality checks in terms of stability of the erected formwork all as per health, safety and environmental protocol
- Shuttering Carpenter has to deal with his assistants; his colleagues and tradesmen with related skills (i.e. masonry, bar-bending etc.) and has to co-ordinate with the activities of the other tradesmen also.
- Shuttering carpenter should have proficiency in use of different tools, knowledge of commonly used construction material, ability to identify quality of shuttering materials, techniques of using latest steel shuttering.
- Shuttering carpenter have to plan and organise the work and achieve desired results within available resources.

1.3.2 Duties of a Shuttering Carpenter - System

At any construction site, the shuttering carpenter plays a vital role such as:

- Read & understand sketches, simple architectural/structural drawings and formwork scheme drawings.
- Sort out and use the material like, shuttering plates, plywood board, wooden planks, supporting components etc. required for shuttering work.
- Measure, mark, cut, make and place the shuttering material in position as per the requirement.
- Fill the gaps as per suitability in shuttering work wherever required.
- Perform quality checks as per drawings/requirements.
- Remove the shuttering (De-shuttering) after the stripping time as applicable.
- Finally remain present during concreting to set in position the displaced shuttering member.

1.3.3 Personal Attributes for Job Role of Shuttering Carpenter-System

A shuttering carpenter-system in addition to his skills should also possess certain personal attributes such as:

- Ability to work in a well-organized and accurate manner
- Awareness of safety issues, especially when working at heights and carrying loads
- Ability to plan and organize of his own work
- Ability to work as a part of team
- A good level of fitness
- Awareness of personal hygiene
- Hard working and reliable
- Courteous and dedicated
- Good Communication Skills

1.3.4 Various employment opportunities for a Shuttering Carpenter

A Shuttering Carpenter, also known as a Formwork Carpenter, specializes in creating molds and temporary structures that hold concrete in place until it sets. Their skills are essential in the construction industry for various projects such as buildings, bridges, dams, and more. Here are some employment opportunities for a Shuttering Carpenter:

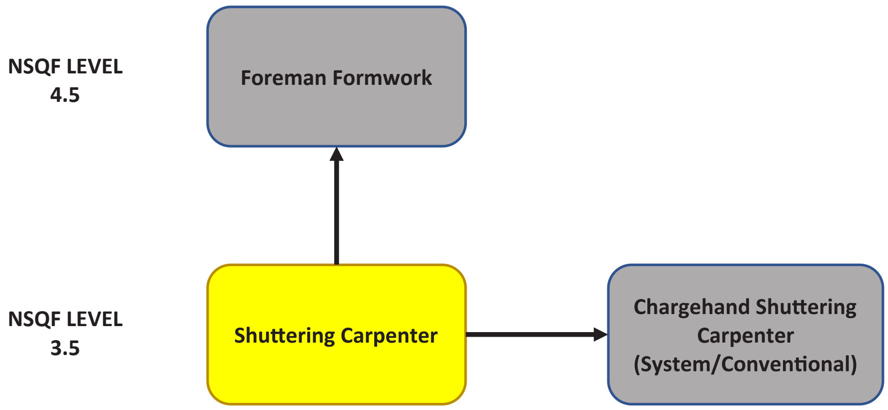
- **Construction Companies:** Shuttering Carpenters are in high demand in construction companies that undertake various projects like residential, commercial, and industrial buildings. They work on creating formwork systems to shape the concrete structures.
- **Civil Engineering Firms:** Civil engineering firms often require Shuttering Carpenters for their expertise in creating intricate formwork systems for projects like bridges, tunnels, and other civil infrastructure.
- **Road and Highway Construction:** Infrastructure projects related to roadways, highways, and transportation systems often require formwork for constructing concrete barriers, retaining walls, and other structures. Shuttering Carpenters play a crucial role in these projects.
- **Concrete Contractors:** Concrete contractors specialize in providing concrete-related services, including formwork. Shuttering Carpenters are employed to create the molds and shapes needed for pouring and setting concrete.
- **Residential Construction:** Shuttering Carpenters are also needed in residential construction for tasks like creating foundation formwork, basement walls, and other concrete structures within homes.
- **Commercial Construction:** Commercial buildings, such as offices, retail spaces, and hotels,

often require customized formwork solutions for their unique architectural designs. Shuttering Carpenters help bring these designs to life.

- **Bridge Construction:** Bridges require complex formwork systems to create the various components of their structures. Shuttering Carpenters are crucial in building support columns, piers, and other bridge elements.
- **Tunnel Construction:** Tunnels often involve intricate formwork for creating curved and confined spaces. Shuttering Carpenters are needed to build these structures within tunnel projects.
- **Dam and Water Projects:** Shuttering Carpenters play a role in dam construction and other water-related projects where concrete structures are needed, such as reservoirs and water treatment facilities.
- **Industrial Projects:** Industries like manufacturing and petrochemicals might require formwork for constructing concrete structures within their facilities. Shuttering Carpenters can find opportunities in these sectors.
- **Renovation and Restoration:** Shuttering Carpenters can also work in renovation and restoration projects that involve repairing or replacing existing concrete structures, such as historical buildings or infrastructure.
- **Event and Temporary Structures:** Some events or temporary structures might require formwork for concrete elements like stages, platforms, or support structures. Shuttering Carpenters can assist in these scenarios as well.
- **Freelance and Contract Work:** Shuttering Carpenters with experience and a strong reputation in the industry might choose to work as freelancers or on a contract basis, offering their services to various construction projects.
- **International Opportunities:** In regions with active construction and infrastructure development, there might be international opportunities for Shuttering Carpenters to work on large-scale projects.

1.3.5 Career progression chart

Flowchart given below shows the career progression for shuttering Carpenter



Exercise

Answer the following questions:

1. List down major occupations of construction industry.
2. What is the role of a Shuttering Carpenter in the field of construction?
3. List some essential skills that a Shuttering Carpenter should possess.
4. Pradhan Mantri Gram Sadak Yojna (PMGSY) addresses need of:
    a) Urban construction development
    b) Rural construction development
    c) Urban slum dwellers and homeless
    d) All of the above
5. Scaffolding work is related to fixing of timber boards for temporary structure. True / false
6. A mason general repair and maintain walls by using mortar and cement. True / false
7. A bar bender only cuts and bends the rebars. True / false
8. Shuttering Carpentry is a crucial skill area in the field of construction. True/False
9. A Shuttering Carpenter is responsible for assembling and dismantling formwork for RCC structures. True/False
10. Shuttering Carpenters only work independently and do not need to coordinate with other tradesmen. True/False
11. A Shuttering Carpenter needs to have knowledge of commonly used construction materials. True/ False
12. Personal attributes such as fitness and awareness of safety issues are not important for a Shuttering Carpenter's job role. True/False
13. ________________ is the process of construction of an item from raw materials using cutting, bending assembling process.

Notes

QR Codes

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https://youtu.be/YLN-_KCM-RUE?si=3c6Pb-P_w4rGkBae

Responsibilities of Shuttering Carpenter

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2. Generic Mathematical Skills

Unit 2.1 - Basic principles of measurement, Geometry, and arithmetic Calculation

Key Learning Outcomes

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

1. Differentiate between the metric and inch systems of measurement, including their units and applications in various contexts.
2. Demonstrate the ability to perform basic arithmetic calculations using both metric and inch measurements, enabling accurate computations in construction scenarios.
3. Calculate the area, volume, and perimeter of basic geometric shapes, equipping participants with practical skills for geometry-related tasks in construction and related fields.
4. Perform preventive maintenance on diesel generators

UNIT 2.1: Unit Conversion & Measurement

Unit Objectives

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

1. Differentiate between the metric and inch systems of measurement, including their units and applications in various contexts.
2. Demonstrate the ability to perform basic arithmetic calculations using both metric and inch measurements, enabling accurate computations in construction scenarios.
3. Calculate the area, volume, and perimeter of basic geometric shapes, equipping participants with practical skills for geometry-related tasks in construction and related fields.
4. electrical devices
5. Perform preventive maintenance on diesel generators

2.1.1 Different System of Measurement

There are two systems of measurement used are:

1. Metric MKS system; and
2. Inch/FPS system.

Metric System	Inch System
1. It is based on meter as the standard unit of	1. It is based on the foot as the standard unit of measurement standard unit of
2. A meter contains 10 equal parts called decimeter. parts called	2. A foot is divided into 12 similar inches.
3. Decimeter is divided into 10 parts called centimeters and centimeter is divided into 10 parts called millimeters.	3. Inch system does not have benefit of the Metric System.
2. Most usually used system of measurement in the world.	3. Fractions of foot cannot be written inches.
	4. For example, in the metric system 5 millimeters = 0.5 centimeters = 0.05 decimeters = 0.005 meters. But 5 inches = 0.416667 which in feet = 0.138889 yards and so on.

Table 2.1.1: Metric system and Inch system

2.1.2 Metric System

This system is much easier. It consists of a series of basic units corresponding to mass, distance and volume and utilizes prefixes to denote multiples of unit being used.

Basic Unit	Measuring
Meter	Distance
Kilogram	Mass
Liter	Volume

Table 2.1.2: Basic metric system units

The prefixes and what they mean are:

Prefix	Symbol	Number
Giga-	G	1,000,000,000
Mega-	M	1,000,000
Kilo-	K	1,000
Hecto	H	100
Deca-	D	10
(none)		1
Deci-	D	0.1
Centi-	C	0.01
Milli-	M	0.001

Table 2.1.3: Metric system units prefix and their meaning

2.1.3 Inch System

Length or distance

Lengths and distances are measured in inches, feet, yards and miles:

12 inches = 1 foot

3 feet = 1 yard

1760 yards = 1 mile

2.1.4 Conversion Between Metric And Inch Systems

There are various approximations used for conversion of units. For example:

1. 1 meter is approximately equal to 1 yard.
2. 1.5 KM is about equal to 1 mile; alternatively, or 1 KM is about equal to 2/3 of a mile.
3. 1 Kg is about equal to 2 pounds (lb)

Weight, mass, length, volume, and temperature used for measurement conversions.

Metric to Imperial Conversion chart		
Convert	To	Multiply by:
Kilometer	Feet	3280.8
Kilometer	Mile	0.62
Meter	Feet	3.28
Millimeter	Inch	0.039
Centimeter	Inch	0.39
Liter	Gallon	0.264
Liter	Quart	1.057
Milliliter	Ounce	0.0338
Celsius	Fahrenheit	(Temperature + 32) * 9/5
Kilogram	Pounds	2.2046
Kilogram	Ton	0.0011
Gram	Pounds 0.002205	0.002205
Gram	Ounce	0.035
Milligram	Ounce	0.000035

Table 2.1.4: Conversion from metric to imperial syste

Imperial to Metric Conversion chart		
Convert	To	Multiply by:
Inch	Meter	0.0254
Inch	Centimeter	2.54
Inch	Millimeter	25.40
Ton	Kilogram	907.18
Feet	Meter	0.3048
Yard	Kilometer	0.00091
Yard	Meter	0.91
Mile	Kilometer	1.61
Fahrenheit	Celsius	(Temperature in 0F - 32)*5/9

Table 2.1.5: Conversion from imperial to metric system

2.1.5 Basic Mathematical Calculations

The same thing can be explain by the use of basic mathematics:

Symbol	Words Used
+	Addition, Plus, Sum, Increase
−	Subtraction, Minus, Less, Decrease, Difference, Deduct
×	Multiplication, Product
÷	Division, Quotient

Table 2.2.1: Basic mathematical symbols and formations

Addition

To make a new total, bring two or more numbers (or things) together.

"Addends" are the numbers which are to be added together:

$$8 + 3 = 11$$

Subtraction

Can be defined by taking one digit away from another digit.

$$8 - 3 = 5$$

Multiplication

.... (In its simplest form) repeated addition.

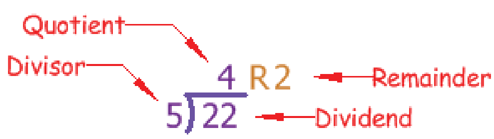
Below we see 6+6+6 (three 6s) make 18:

$$8 \times 3 = 18$$

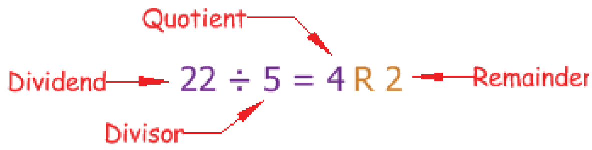
Multiplication can also be defined as 3+3+3+3+3+3 (six 3s) make 18 Also multiply by fractions or a decimal, which goes outside the humble idea of repetitive addition:
Example: 3.5 × 5 = 17.5 which is 3.5 lots of 5, or 5 lots of 3.5

Division

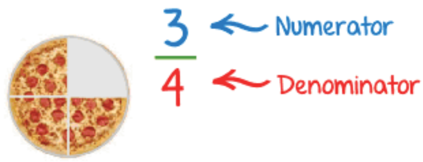
... is splitting into equivalent parts or groups. Division is the result of "fair sharing .It has its own singular words to remember.For example; take the simple query of dividing 22 by 5. By 2 left over and the answer is 4. See the



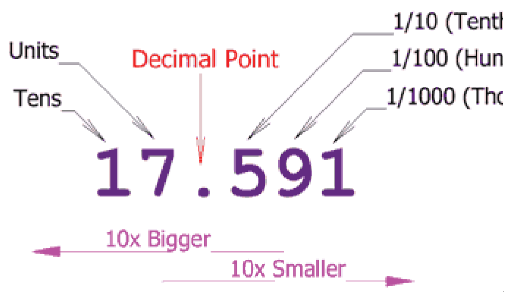
Which is the same as:



Fraction is part of a whole.



It is written with the lowest portion (the denominator) telling how many parts the whole is separated into, and the top portion (the numerator) telling how many portion we have. A Decimal Point contain in a Decimal Number



Part of per 100 is called a Percentage. The symbol is % Example: 25 per 100 is called 25% (25% of this pattern is green) Average (Mean) is the total divided by the sum. We analyze the average by adding up all the figure and then split by how many figure. Example: What is the average of 9, 2, 12 and 5? Add up all the values: 9 + 2 + 12 + 5 = 28 How many values are required to divide (there are four of them): 28 ÷ 4 = 7 So the average is 7

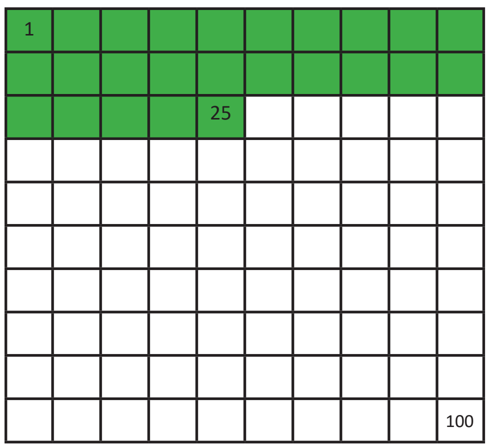
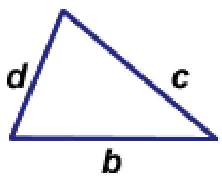
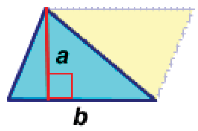
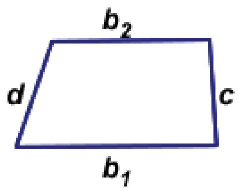
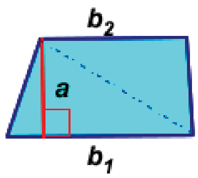
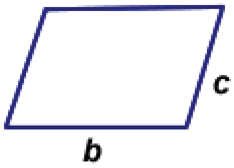
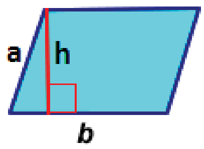
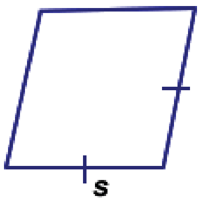
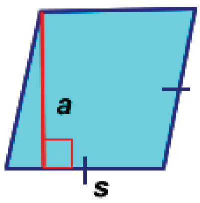
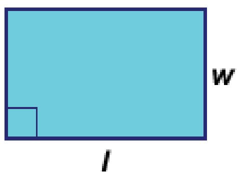


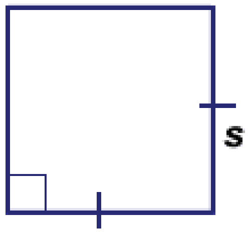
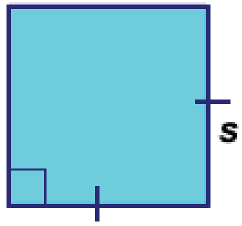
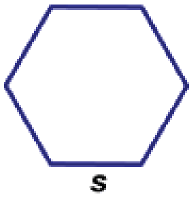
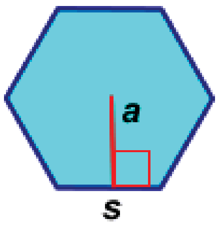
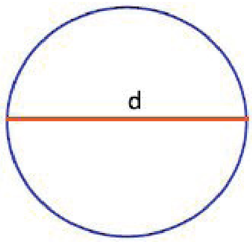
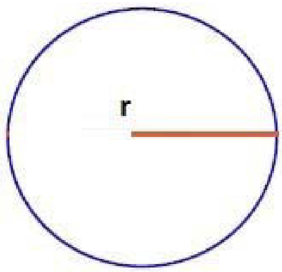
Fig 2.2.1: Part percentage

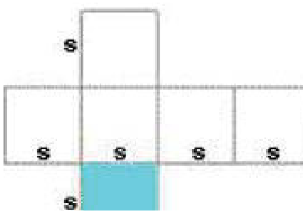
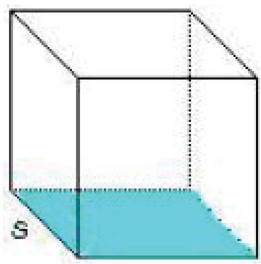
2.1.6 Area, Volume And Perimeter Of Geometrical Shapes

Units	Perimeter	Cm	m	ft.
	Area	Sq.cm.	Sq.m.	Sq. ft
	Volume	Cu.cm.	Cu.m.	Cub. ft

Table 2.2.2: Area, volume and perimeter units

Polygon/Circle	Perimeter(P)	Area(A)	Sides
Triangle	 P= b+ c+ d	 A= 1/2ab	a=altitude b=base c,d=sides
Trapezoid	 Perimeter = b1 + b2 + c + d	 Area = 1/2a(b1 + b2)	a= altitude b1,b2=base c,d=sides
Parallelogram	 Perimeter = 2b + 2c	 Area = b x h	a= altitude b1,b2=base c,d=sides
Rhombus	 Perimeter = 4s	 Area = a x s	a= altitude b1,b2=base c,d=sides
Rectangle	 Perimeter = 2l + 2w	 Area = l x w	l=length w=width

Square	 Fig 2.2.1: Part percentage	 Area = s2	s= side length
Regular polygon pentagon has fi ve sides hexagon has six sides heptagon has seven sides octagon has eight sides nonagon has nine sides decagon has ten Side	 P = ns P=5s P=6s P=7s P=8s P=9s P=10s	 A = 0.5a x n x s A=2.5 a x s A= 3.0 a x s A= 3.5 a x s A= 4.0 a x s A=4.5 a x s A=5.0 a x s	a = length s = side length n = No. of sides n=5 n=6 n=7 n=8 n=9 n=10
Circle	 C= Circumference C= πd	 A=Area A= πr2	r=radius d= Diameter

Geometric Shape	Surface Area	Volume	Sides
Cube	 A = 2B + Ph SA = 2(s2) + (4s)s = 6s2	 Volume = Bh Volume = s3	s = side length B = area of the base P = perimeter of the base h = height

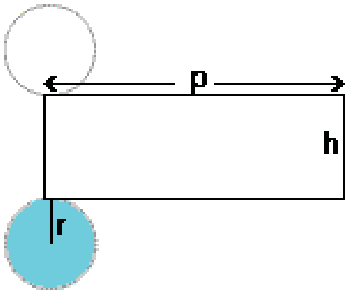
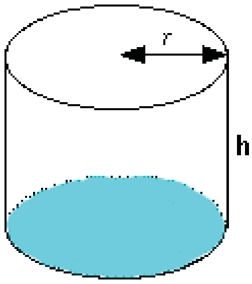
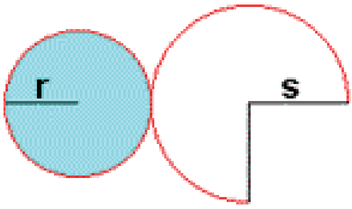
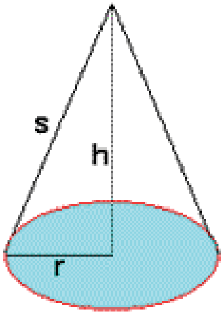
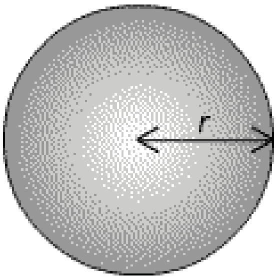
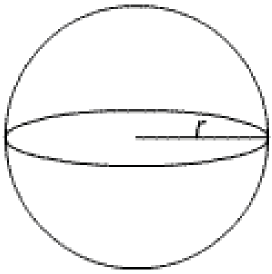
Cylinder	 S A = 2(π r2) + (2πr)h	 V= B x h V = π r2 x h	B = area of base P = perimeter of base r = radius of circle h = height
Cone, here **B = area of base** **r = radius of circle** **h = height** **SA**	 SA = πr 2 + πrs	 V = 0.33 Bh V = 0.33 πr2h	B = area of base r = radius of circle h = height s=slant height
Sphere, here **r = radius of circle**	 SA = 4πr2	 V = 1.33πr3	r = radius of circle

Table 2.2.3: Area, volume and perimeter formulae

Exercise

Answer the following questions:

1. What is the standard unit for length?

   a) Meter b) Inch c) Kilometer d) Centimeter

2. The Metric System is also called as:

   a) CGS b) MKS system c) SI d) None of the above

3. 145 mm = ____ m

4. 333 cm = 3.33___________

5. 100 yards = __________miles

6. 15% of R560 – 15% of R500 is:

   a) R9 b) R12 c) R11 d) R10

7. A rectangular field is 40m long and 30m wide. Perimeter of rectangular field is

   a) $200m^2$ b) $180m^2$ c) $160m^2$ d) $140m^2$

Notes

QR Codes

Scan the QR code to watch the video

https://youtu.be/H1xo5UVJKVo

Different System of Measurement

https://youtu.be/OhTubw4C0to

Area, volume and perimeter of geometrical

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3. Making Wooden Shutters Used in Shuttering Carpentry

Construction Skill Development Council

Unit 3.1 – Hand and Power Tools

Unit 3.2 – Measuring Instruments

Unit 3.3 – Handling and Maintenance of Tools

Unit 3.4 – Shutter Panel Materials –System

CON/N0302

Key Learning Outcomes

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

1. Explain the use of different tools used for carpentry work.
2. Describe the sequence and standard practice of marking, laying out and cutting of form sheathing and stiffeners as per requirement for carpentry works.
3. Explain the handling and maintenance procedure of hand and power tools.
4. List the safety precautions followed while using power tools for the preparation of shutters/ frames.
5. Explain the various features of different types of timber used in shuttering works.
6. Demonstrate the visual checks to determine the quality of timber, plywood and other materials used for preparation of shutters.
7. Discuss about the seasoning of timber and common defects in timber.
8. Explain the methods to select quality materials and tools as per requirement in carpentry work.
9. Show how to Interpret sketches and working drawings used for shuttering work.
10. Show how to prepare cutting plan for the plywood/ timber as per the shape and size of the shuttering components.
11. Show how to measure and mark plywood and timber using measuring and marking tools.
12. Show how to measure and mark sheathing and stiffeners at sketched location.
13. Demonstrate the cutting of sheathing material within the tolerance limit using various hand and power tools as per instructions /specifications.
14. Explain the importance of using different types of joints such as dovetail joint, Tenon and mortise and lap joints.
15. Discuss the steps for the preparation of different types of joints used in wooden shutters.
16. Demonstrate making the wooden shutter panels using different types of joints such as dovetail, tenon and mortise, and lap joints as per specifications.
17. Show how to repair defects on the prepared shutters as per instructions.

Unit 3.1: Hand and Power Tools Used in Shuttering Carpentry Works

Unit Objectives

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

1. Explain about various hand and Power tools Used for Shuttering Works
2. Show how to prepare cutting plan for the plywood/ timber as per the shape and size of the shuttering components.
3. Demonstrate the cutting of sheathing material within the tolerance limit using various hand and power tools as per instructions /specifications.

3.1.1 Hand Tools

Tool	Image	Use
Handsaw		Handsaw is used to cut the plywood panels to different shapes.
Chisel		Chisel is used to cut the plywood with the help of hammer
Hammer		Hammer is used to strike over the chisel to cut the plywood.

Table 3.1.1: Hand tools

3.1.1.1 Handsaw

Plywood panels can be cut to different sizes and shapes using handsaw.

Cutting with a handsaw - Steps

Step1: Hold the handsaw and keep it straight.

Step2: Place the handsaw blade on the mark and make few backward strokes across the corner of the wood to make the primary cut.

Step3: Make sure cut is on the line marked.

Step4: Make few strokes of the blade across the mark with the forearm in line with the blade of handsaw.

Step5: Make sure the blade is always straight and not tilted sideways.

Step6: Now using deliberate long strokes, move the handsaw back and forth to cut the wood.

Step7: Repeat the stroke to and fro until the wood cut entirely.

Step8: When cutting process is being carried out, support the piece of wood that is being cut off, so that it does not break off causing splintered cut

Fig 3.1.2: Handsaw

Fig 3.1.3: Measuring wooden board

that is being cut off, so that

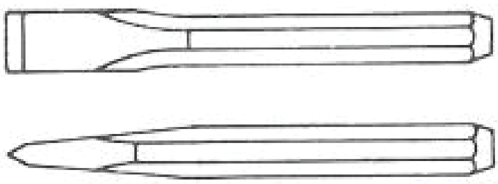
3.1.1.2 Chisels

Chisels are hand tools made of a good quality grade steel with hard cutting edge and slant head. It is used to cut the wooden plank/plywood by applying force on its slant head to cut through materials. These chisels are used for cutting wood based materials only.

Common types of chisel are described below

Chisels are classified according to its cutting edge and purpose:

1. **Flat Chisel:** These are widely used and are used for cutting fl at surfaces, trimming castings etc.



2. **Cross cut chisel:** These chisels have the blade wider at cutting edge and are used for making grooves and key ways.

3. The Round nose chisel is used to cut oil grooves in bearing surfaces and for making drainage channels.

4. Diamond point chisel is used to cut V shaped grooves and sharp corners. In diamond point chisel, the blade is molded in square section and is pointed towards the cutting end. Diamond point is formed by grinding the end diagonally.

5. The side cutting chisel is similar to the flat chisel and has one slope at the cutting end. It is used for chipping and cutting works.

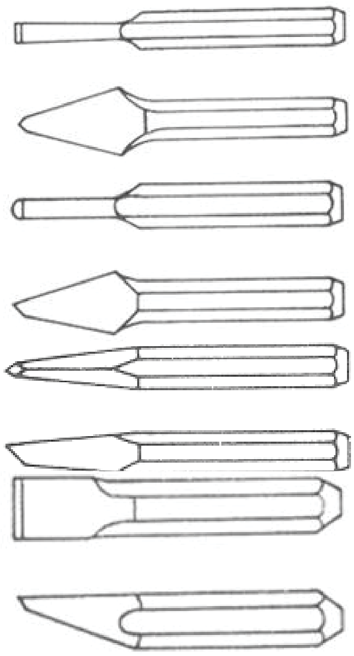


Fig 3.1.5: Different types of chisel

Cutting Angles on Chisels

Cutting edge is formed by placing two facets or bevel of same angle and width.

The widely used cutting angle is 65°, but it may vary from 55° to 85° with respect to requirements.

Larger the cutting angle harder it is to cut. Commonly used cutting angles are:

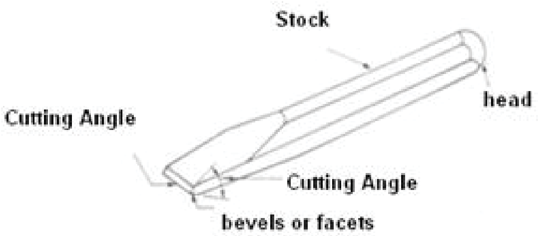


Fig 3.1.6: Chisel parts

Procedure to Use chisel

Fig 3.1.7: Procedure to use chisel

Step1: Hold the chisel steady with the thumb of left hand and keep the first finger one inch from the top. Make sure to hold the chisel in light grip.

Step2: While holding the chisel, the muscles of finger should be calm, so if the hammer hit the hand, the hand is able to move down the tool and subsequently reduce the effect of the blow.

Step3: Always focus on the cutting edge of the chisel, not on the head, and swing the hammer in the same level as the body of the chisel.

Step4: When working with chisels always wear goggles to protect your eyes.

Different Cutting Techniques using Chisels:

Technique 1: Mosaic cut

Fig 3.1.8: Mosaic cut using chisel

1. Face the cutting part of the chisel down on the wood.
2. To remove thin slices gently push the back of the chisel into the wood.
3. Depth and width of chip of the wood can be controlled by raising and pulling down the handle of the chisel.
4. Mark boundary around part that has to be cut by a sharp knife or chisel cuts. This boundary is called mortises or recesses.
5. Chip wood inside the mortise using chisel.
6. Now remove the wood from the perimeter by hitting the chisel with a hammer.

Technique 2: Paring cut

Fig 3.1.9: Paring cut using chisel

1. Keep the wood at horizontal level and the bottom of the chisel flat on the wood.
2. Make sure back of the chisel is also in line with

the wood.

3. Cut thin slices of wood, flattening any opening/ break in the wood
4. For easier slicing, move the chisel blade in an arc.
5. If the break is open on one side, like a hinge mortise, smooth the bottom by carving out thin slices with the back. Unbeveled side of the chisel should be held flat to the wood.
6. For shaving of pieces of wood, face the bevel down into the wood.
7. For leveling of a cut and have access from the side, face the bevel up and hold the back of the chisel tight to the surface.

Technique 3: Chopping cut

1. By carving out small amount of wood with each cut, chop out large amount of wood.
2. Hammer the chisel and slice down about ½ inches.
3. Chisel deeper to remove the cut piece of wood.
4. Put the chisel in line with the cut edge and hammer it gradually to remove wood from notches.
5. Since the cut will remain hidden by another board, fine work is not required here.

Fig 3.1.10: Chopping cut using chisel

Technique 4: Scraping

1. Keep the blade at right angle to the wood and back of the chisel should be in your front.
2. Support the blade with finger and gently push down while moving forward, to remove thin shavings.
3. This process requires sharp and fl at edge on the chisel.
4. Make sure chisel trip should scrape cleanly avoiding the occurrence of scratch marks in the wood.

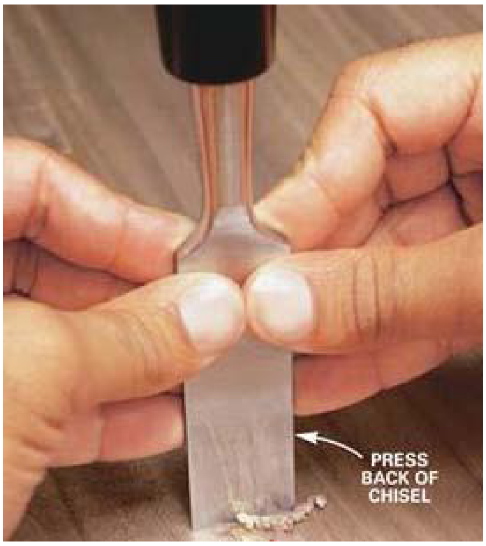


Fig 3.1.11: Scrapping by chisel

3.1.1.3 Hammers

One of the impact tools used by a shuttering carpenter is hammer. These hammers impact directly or indirectly on chisels to change the shape or position of the materials.

Parts of a hammer

1. Traditionally hardest wood such as ash or hickory is used in handle.
2. Different types of head are used in hammer and these heads usually made of
3. metals.
4. Because of the brittleness of the steel head it is used to work with wood and not with metals.
5. Claw: The forged steel of the head terminates at the rear of the hammer, two metal trip of
6. termination about 1/8 inch apart.
7. There are different types of punches, hammers, and mallets. Few of them are explained:

Fig 3.1.12: Hammer and its parts

Types of Hammers

- **Ball peen hammer -** It is used for general purpose and consists of a face, peen, eye and handle. Its weight ranges from 55 g to 1400 g. For layout work the smaller sizes are used and the larger ones are used for general bench work.


Fig 3.1.13: Ball peen hammer

- **Cross peen hammer –** It is used for bending and stretching inside curves. These are also used for striking soft material as the peen is usually made for soft material.


Fig 3.1.14: Cross peen hammer

- Straight peen hammer - The straight-peen hammer has the wedge is kept parallel to the hammer's handle. It is generally used for stretching of metal.

Fig 3.1.15: Straight peen hammer

- Soft hammer (Mallet) – This type of hammer is made of rubber or wood and it has a large head.

Fig 3.1.16: Soft hammer

- **Nailing Hammer:** Its face is convex at one end and hemispherical ball-pinned at the other end. Its weight ranges from 100 grams to approximately 1.5 kilograms. To strike on chisels or punch on the job surface, flat or slightly convex face is used.

Fig 3.1.17: Nailing hammer

Selecting the Correct Hammer

When a hammers is being chosen keep in mind the weight of its head. For heavy blows heavy hammers should be used and for light purpose light hammer should be used. Three most important fea**tures of a hammer are: -**

- **The length and shape of the handle -** Shape of the head is chosen according to the work requirement. Without flexibility in hand perfect blow cannot be generated

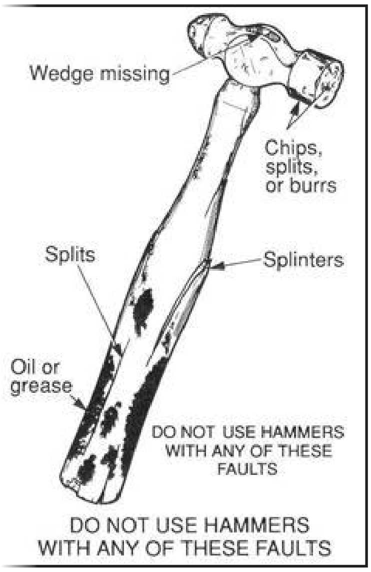


Fig 3.1.18: Selection of hammer

- **The method of wedging** - The handle should completely fit in the head. For this wooden wedge inserted lengthwise and steel wedge inserted crosswise
- **The shape and contour of the face -** It has a fl at face and its edge is slightly round. - Convex face is usually found in hard hammers and sledge hammers

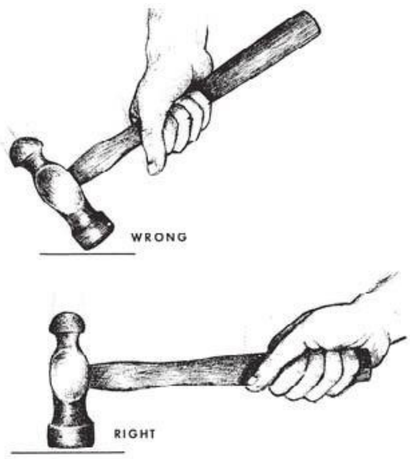


Fig 3.1.19: Correct use of hammer

Points to remember while using hammers

- Do not hold the hammer too close to the head as it reduces the force of the blow. This is known as choking the hammer.
- For making perfect blow hold the handle close to the end. But for light blows, hold the handle near the top.
- Fingers are used to hold the handle and make sure the thumb should be in rest condition on handle top or sideways and overlap the fingers.

- The object should be hit with the full power of the hammer.
- The angle of hammer should be in such a way that, the face of hammer and surface of the object being hit should be in parallel to each other.

3.1.2 Power Tools Used In Shuttering Carpentry

Measuring instrument	Image	Use
Drilling Machine		Drill machine is extensively used by shuttering carpenter for drilling, reaming, counter boring, and tapping holes.
Circular saw		It is a hand held power saw used for cutting materials.
Jig saw		It is a power tool with electric motor which is used to cut curves and complex shapes in wood.
Planar machine		Planer machine is a power tool which cut and plane wood and then create a parallel and fl at surface

Table 3.1.2: Power tools

3.1.2.1 Drilling Machine

Drilling machine is motor driven device. It is used to drill hole or enlarge the existing one. It consists of a drill bit or driver bit which used for boring holes in various materials. Drilling machine are commonly used in Carpentry work.

Fig 3.1.20: Drill machine

3.1.2.2 Circular Saw

Circular saw is a hand held power tool which is extensively used in carpentry work for cutting the wooden materials. It consists of toothed cutting disc that rotates extremely quickly to make long, fast, straight cuts. The metal disc with sharp edge is used for cutting wood. It can be table mounted or hand held. Most circular saws come with blades with 24 teeth, but a 50-60 tooth blade produces much cleaner cuts. The standard, 24 tooth blade works well for solid wood. The saw blades are available in different sizes:

Fig 3.1.21: Use of circular saw

Different types of circular saws based on their sizes are enumerated below:

- 5 inch trim saw, with its blade located generally on the left side of the motor
- 6 1⁄2 inch saws are used for cutting nominal length and ripping lumbers, and also cutting composite material like plywood.
- 7 ¼ inch skill saws is used for cutting timber up to 5.7 cm thick
- 8 and 10 inch saws, used for cutting lumber or timbers larger in length and of thickness up to 4 inches (10.2 cm).

Step to Use circular saw

1. Firstly, Support the cutting material/ wood in such a way that the blade does not touch with any other object other than the wood.

2. Mark on lumber using measuring tape or scale rule, use steel square, tri square or angle square to provide the direction to the blade while cutting.

Fig 3.1.22: Use of circular saw

3. Set the saw as per the depth of cut required. To cut 40mm thick timber, set blade to about 45mm or 50mm. This will help to minimize kickback.

4. Saw should be returned to its appropriate position just after the lifting procedure. Also ensure that it should be in down position before putting the saw down on the bench.

Fig 3.1.23: Use of circular saw

5. Keep saw guard in smooth running condition. To push onto the work it should slide up easily as push onto the work

6. Then start cutting. All the time looking forward along the pencil line mark and always remove any saw dust.

7. Always keep eyes on the saw base while cutting. Keep the base of the circular saw fl at on the timber.

Fig 3.1.23: Use of circular saw

8. While cutting the material ensure that right amount of force is applied. Do not push hard or else motor speed will affected and binding does not occur on the blade.

9. Finally, lower blade guard should return to its position just after cutting process has been completed.

Fig 3.1.25: Use of circular saw

3.1.2.3 Table Mounted Saw

In a table mounted saw a hand held circular saw is attached to the table. The table includes a removal panel. Following steps are followed to build a table mounted saw:

Step1: Make the table: Build the table using thick plywood or timber. Make sure there is enough space to mount and adjust the saw.

Fig 3.1.26: Working table

Fig 3.1.27 Table mounted saw

Step2: Make a removable panel: Leave a hole in the middle of the table. The removable panel enables to mount the saw and allows you to use the table with others tools.

Step3: Make a flat edge for the fence: A flat piece of wood of approximate thickness is used for making flat edge. It is glued into place ensure that is true/ parallel to the blade

Step4: Make the fence: Fence is a bit of wood that gets as guide when you are cutting it must be adjustable but firm enough to allow consistent cuts

Fig 3.1.28: Table mounted saw

Step5: Mount the saw to the panel: Cut a slot in the panel and mount circular saw or the bottom of it.

Step6: True the fence to the blade: Fence must be parallel to the blade put a single screw in the T of the fence and square it with the end of table. Add at least one screw to set the angle

3.1.2.4 Jigsaw

Jig saw is hand operated power tool used to cut complex shapes and curves in carpentry work. The advantage of jigsaw is that it is much faster than handsaw.. A jigsaw is considered one of the most versatile tools because of the wide range of cuts it's capable of. Jigsaw can be used for cutting wood ranging from long, straight cuts to curved and beveled cuts. In fact, the jigsaw can cut a variety of materials. It includes both soft and hardwoods, particleboard and plywood.

Jigsaw blades include U-shank blades, progressive tooth blades and reverse tooth blades. To choose the correct blade, remember that the blades with larger but fewer teeth are good for fast cuts, but it it will produce a rough edge. Blades with smaller teeth are slower, but result in a smoother surface. For better quality cuts replace the blade when it wears out Prevent the saw blade from binding on tight curves by using relief cuts to remove waste.

Step to use jigsaw for cutting wood:

Step1: Keep the jigsaw on the work piece.

Step2: Start the cut by pressing the saw shoe firmly on the work piece with the blade away from the edge.

Step3: After starting the motor, travel the blade along the outside of the cutting pattern and move from curves to **inside corners.**

Step4: Move the saw in forward direction at such speed that allows the blade to cut without deflecting and also allow the motor to smooth run.

Fig 3.1.29: Jigsaw

Step5: For removal of waste, prefer relief cut so that it helps to prevent the saw blade from binding on tight curves.

Fig 3.1.30: Cutting by jigsaw

3.1.2.5 Planer Machine

It is a power oriented machine tool designed to produce plane and fl at surface on large and heavy work piece. Work piece is fixed on a table and it moves parallel against a single edge cutting tool The planer is used for:

1. Planning fl at horizontal, vertical and curved surfaces.
2. Planning at an angle and machining dovetails.
3. Planning slots and grooves.

Fig 3.1.31: Planer machine

Planning of wood panel by a planer

Step 1: Select the piece of wood

First step while selecting wood is to ensure its quality considering the purpose for which it will be used.

Step 2: Set the planer to desired thickness

- The planer consists of crank which is used to lift the planers housing. To get desired thickness higher the housing planer will cut shallower.
- Avoid planer more than 1/16 or 1/8 inch at a time.

Step 3: Set the depth stop

- Just to get desired depth and also to avoid cutting beneath a certain depth, depth stop mechanism is used by which it can be locked.

Fig 3.1.32: Planer machine

- Dead stop is so useful that if it is set to 1 inch, then it will not cut the wood less than 1 inch thickness.

Step4: Turn the planer on and pass wood through

- In a running planer the wood should be move in a straight and precise motion.
- Once the wood is gathered by the rollers, it should begin to feed through on its own.
- Repeat the process until the required thickness is obtained.
- Wood's process can be tracked by scribbling casually on the surface with a pencil before planning.
- Spots in the wood remove by planner.

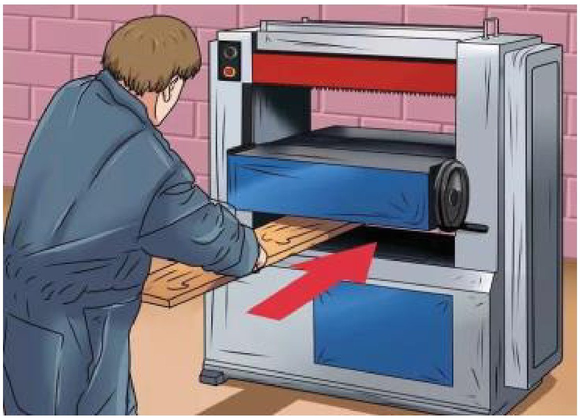


Fig 3.1.33: Passing wood through planer machine

Step5: To avoid snipe pull up on the wood as it passes the rollers

- "Snipe" is a situation in which deeper cuts spotted on the wood.
- To get the slighter deeper cut at the edges of the wood pull the planer roller in upward direction
- In this situation, during the rolling of roller pull up on the end of wood.
- Feed wood into the machine and pull up on the "back" end and similarly pull up on the "front" end of the wood as it passes out of the machine.

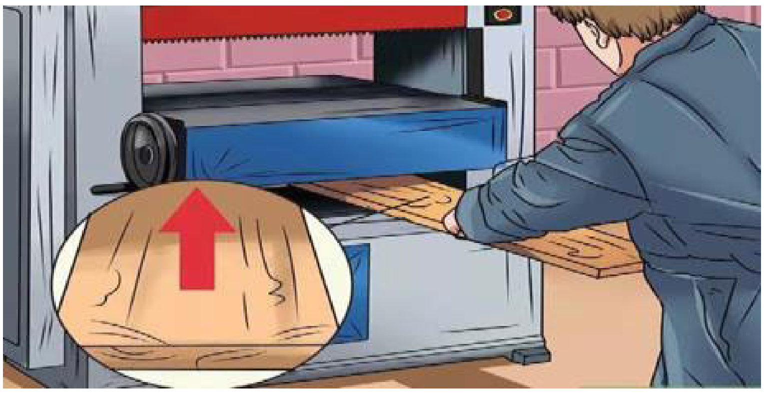


Fig 3.1.34: Pulling wood out from planer machine

Notes

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https://www.youtube.com/watch?v=-dERDiwZiHlM

Construction Tools

Unit 3.2: Measuring Instruments Used by Shuttering Carpenter

Unit Objectives

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

1. Discuss about measuring instruments Used in Shuttering Carpentry works
2. Explain the methods to select quality materials and tools as per requirement in carpentry work.
3. Know about how to use measuring instruments.
4. Describe the sequence and standard practice of marking, laying out and cutting of form sheathing and stiffeners as per requirement for carpentry works.
5. Show how to measure and mark plywood and timber using measuring and marking tools.

3.2.1 Measuring Instruments

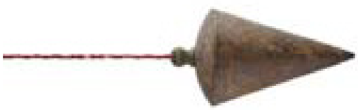
Measuring instrument	Image	Use
Spirit level		A spirit level is used to check the vertical and horizontal accuracy of the formwork
Plumb bob		A plumb bob is used to check the vertical accuracy of the formwork.
Steel rule		It is made up of stainless steel and used for measurement and marking
Tape measure		Tape measure use a stiff curved metallic ribbon tha can remain stiff and straight when extended, but retracts into a coil for convenient storage
Engineers square		It is used to check t shuttering panels of 90 degree angle.

Table 3.2.1: Measuring instrument

3.2.1.1 Spirit Level

It is a device consisting of sealed glass tube partially filled with alcohol or other liquid, containing an air bubble whose central position revels that a surface is perfectly horizontal. Spirit levels are generally fixed on a flat surface to check the level of surface. Its length may be varying from 6 inches to 2 feet.

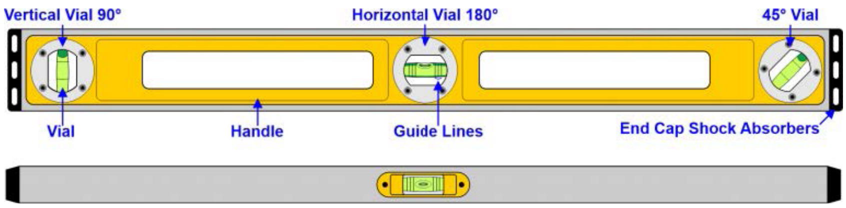


Fig 3.2.1: Spirit level

Checking a Spirit Level for Accuracy

1. Hold the level against a vertical flat surface, like a wall.
2. Make one mark at the end of the level.
3. Make another mark along the side of the level.
4. Look at the vial and take a reading of the bubble's position.
5. Rotate the level 180° end-to-end and align the level with your marks.
6. Take the second reading. If the level is accurate, the bubble will be in same position for both readings.
7. To test the vertical vial, follow the same procedure against a flat vertical surface.

Working principle

A glass tube is set in the base and adjusted in such a way that when the base is horizontal the bubble rests at the center of the scale. When the base of the level turned to horizontal, the bubble tries to reach at the highest point of the tube and thus moves along the scale.

Using a spirit level

1. First of all, clean the spirit level, remove all the dirt from the edges.
2. Place the spirit level on top of the surface where level is to be checked
3. Check the position of the bubble inside level tube. If bubble is exactly at the center the tube the surface is at level. If it is away from its center then the surface is not leveled.
4. Similarly verticality can also be checked

3.2.1.2 Plumb Bob

Plumb bob is a hand tool in which a pointed weight is suspended on a string. To obtain accurate reading, the weight must be in rest condition and string must hang freely. It helps to check, if the formwork is in "plumb" or vertical.

Fig 3.2.2 Plumb bob

Using a plumb bob

1. Fix the nail on marked point.
2. Marked point should be on horizontal face and perpendicular to vertical face..
3. Suspend the plumb bob by attaching string; make sure nothing is touching the string.
4. Wait for the weight to stop swinging or have a steady state. The weight should hang just above the floor so it is still in the air and can move freely.
5. Then measure horizontal distances one from the vertical surface to the top of the string and second one from the vertical surface to the tip at the bottom of the weight. When the two measurements match, the surface is in plumb. If not, adjust the surface until both the measurements match.

Fig 3.2.3: Use of Plumb bob

3.2.1.3 Steel Ruler

It is used to measure linear dimensions to a moderate degree of accuracy. Marks on the ruler are usually in millimeters, centimeters and inches. For precise accuracy the ruler must be in good condition with straight, flat and true edges.

Fig 3.2.4: Marking on wooden board

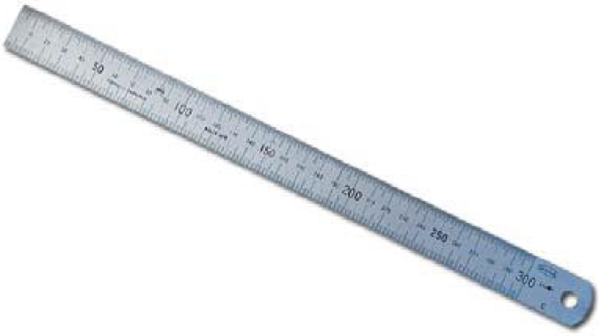


Fig 3.2.5: Steel rule

Practical uses:

- guide to scribe or draw a straight line
- Straight edge to test the accuracy of a flat surface
- Scale for setting dividers and other marking tools.

3.2.1.4 Tape Ruler

Tape ruler or measuring tape is used to measure large lengths. It is preferable to use steel rule with linear-measurement markings. It can be easily be carried in pocket. The most important feature is that it allows to measure curves or corners.

Practical uses:

- Scale for setting dividers and other marking tools.

Fig 3.2.6: Tape rule

Fig 3.2.7: Measurement by tape rule

3.2.1.5 Engineer's Square

It consists of a metal blade set at 90 degrees to a solid metal block. Engineer's square is perfect for checking 90 degrees in carpentry works.

Practical uses:

- To guide a scriber when marking out lines at right angles at the edge of work
- Guide to setting up or checking work for square.

Fig 3.2.8: Engineers square

3.2.1.6 Marking on Wood Materials

Measuring is the first step in wood working. The second point is to mark the measured point. These two process, measuring and marking accurately is the very important point to be kept in mind while shutter making.

Step 1: Ruler Selection & Marking

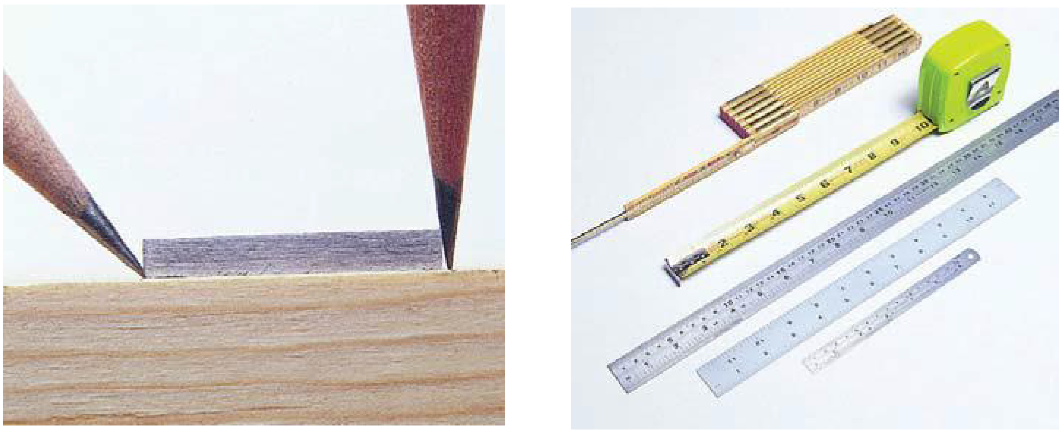


Fig 3.2.9: Different measurement rules

Various measuring tools such as wood folding ruler, measuring tape and few steel rulers 6 inch to 24 inches generally meet most of the measuring needs. Sharp pencil (2H) is used for marking on wooden materials. While marking a line with a ruler, ensure to hold the pencil at an angle so that its points meets the work piece at the same place the ruler does.

Step 2: Basic Measurement

Fig 3.2.10: Marking by pencil

- While measuring from the one end of the work piece, keep a stop block next to the edge and then take readings using ruler.
- This way, the ruler’s markings meet the work piece surface.
- Then mark the dimension on the work piece

Step 3: Middle Marking and Finding Center

Fig 3.2.11: Measurement and marking

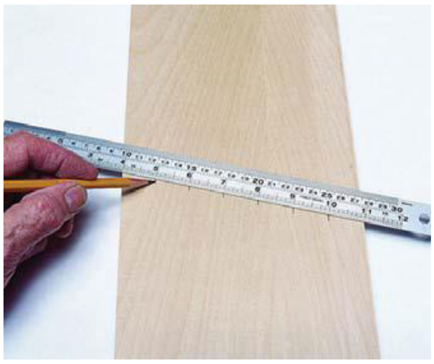


Fig 3.2.12: Measurement and marking

- Center can be find out by dividing a board into any number of equal spaces.
- Also rulers can be set diagonally across the board with the desired number of inch graduations divided between the board edges. Then put a mark at each graduation.
- Similar method is used to find out center of different boards.
- To get center point, mark between the two numbers.

Notes

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ture=shared

Using of Spirit Level

Unit 3.3: Handling and Maintenance of Tools

Unit Objectives

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

1. Explain the handling and maintenance procedure of hand and power tools.

3.3.1 Shuttering Carpentry Tools

Handling and maintenance of shuttering carpentry tools are an important aspect to be taken care by a shuttering carpenter. Few pointers are given below.

Keep the tools clean

- Tools should be cleaned after use
- To clean tools, use old towel or rag so as to remove dust particle, grease and debris

Fig 3.3.1: Shuttering carpentry tools

Maintenance of hand and power tools

- Check for signs of corrosion or rust on tools, if present repair or replace it.
- For reducing the chances of corrosion and rust use oil and apply lubricants on adjustable parts, while taking care to remove excess oil and lubricants
- To make the handle smooth for gripping, sand across the grain in a shoe shine fashion.
- To have a comfortable grip, handles should be smooth.
- Coat the dry handle with heavy coat of linseed oil to revive or protect the wood.
- Periodically inspect power tools for any signs of wear or damage

Safe handling of tools

- Always use heavy gloves while cleaning or removing rust from tools
- Wear goggles when using a wire brush to remove rust from the tools.
- Pay special attention to power cords. Damaged power cords can potentially lead to injury from electric shock or can cause a fi re. Also, check the cord's prongs to see if they are bent or loose.

If any damage is found, report to the supervisor for getting the cord repaired or replaced

Just like hand tools, routine maintenance is required for power tools also .Few examples of power Tools which require routine maintenance are electric drills, power saw, grinders etc. Power Tools consist of mechanical and electrical parts, and they are more vulnerable to problems. Poor Maintenance of power tools will cause dust and debris gathering eventually causing general Malfunction of tools

Storing tools and accessories

Some helpful tips on how to store your tools and accessories are as given below.

- Store tools and accessories properly in the designated places in order to protect it from dust, moisture and other adverse conditions.
- Keep them in their original boxes if possible as this will help in finding the tools easily when needed.
- If you detect frayed insulation or exposed wires, report to the supervisor for getting it repaired or replaced.
- Lubricate power tools periodically as it leads to premium performance.
- Consult manufacturer's manual to see the recommendations for any specific type of oil re-quired for lubrication.

Fig 3.3.2: Storing of shuttering carpentry tools

Notes

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Care and Maintenance of hand tools

UNIT 3.4: Shutter Panel-Materials

Unit Objectives

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

1. Explain the various features of different types of timber used in shuttering works.
2. Demonstrate the visual checks to determine the quality of timber, plywood and other materials used for preparation of shutters.
3. Discuss about the seasoning of timber and common defects in timber.
4. Show how to repair defects on the prepared shutters as per instructions.
5. Understand the seasoning techniques used for timber
6. Understand cutting of wood using power tools
7. Understanding of various types of plywood used in shuttering works.

3.4.1 Timber

Timber is used as a building construction material and used in carpentry works. The age, type, color, structure and water content of wood, are all factors that need to be considered before using it for construction purposes. Timber has various applications and few applications relevant to construction field is as given below.

Natural timber: Natural Timber is a forest product which is used for construction purpose all around the world. It is used in buildings both large and small scale. Timber can have economic benefits for construction, as modern timber is largely factory prepared and brought to site for rapid assembly.

Classification of wood

Woods are divided into two categories; hardwoods and softwoods

Fig 3.4.1: Natural forest timber

Hard wood

Mahogany, teak, sheesham and balsa wood is examples of hardwood. Hardwoods is used for building high-quality furniture, flooring, and other construction purposes

1. **Mahogany -** This type of timber is falls under hardwood category and is extremely durable. It has a distinctive grain which makes it appealing and used to create high end furniture

Fig 3.4.2: Mahogany wood

2. **Balsa wood:** Balsawood is a hardwood obtained from stems of Ochroma pyramidal by kiln drying and milling wood.
3. **Teak:** It is a hardwood that contains oils therefore it is resistant to decay. This is open used to make furniture or for wood block flooring
4. **Sheesham:** It is a hard and tough wood, with straight and interlocked grains. It can grow up to 10-15 meters tall in dry areas, and even taller at 30 meters in wet areas.

Fig 3.4.3: Balsawood

Softwood

Cedar, pine, fir are examples of soft wood. Softwoods is typically used to build joists, rafters and the frame of a building.

5. **Cedar -** Cedar wood is falls under softwood category it has a pale appearance. It is strong, dense, solid and used for structural applications. Its fi ne texture can create an almost seamless effect when joined, making it a highly sought after wood in the construction industry.

6. **Pine:** It is a relatively cheap wood used in the building trade and for furniture falls under softwood category. It is pale in color, quite easy to cut and shape, and machines relatively well.

7. **Fir:** falls under softwood category. It has a Uniform texture and non-resinous. It has low resistance to decay. It is generally used in furniture, doors, frames, windows, plywood, veneer etc.

Fig 3.4.4: Cedar

Fig 3.4.5: Pine

Fig 3.4.6: Fir

Standard Size of timber used for shuttering purpose

Sheeting for slabs, beam, column side and beam bottom	25 mm to 40mm thick
Joints, edges	50 x 70 mm to 50 x 150 mm
Posts	75 x 100mm to 100 x 100 mm

Table 3.4.1 Standard size of timber

3.4.1.1 Defects In Timber

Following are the defects observed in timber:

1. Defects due to conversion
2. Defects due to fungi
3. Defects due to insects
4. Defects due to natural forces
5. Defects due to seasoning

Defects due to conversion

While converting timber to commercial form different types of defects may occur. Few of these are given below.

1. **Chip mark:** This defect appears as timber marks or signs of chips on the finished surface of wood. They may also be formed by the parts of a planning machine.

Fig 3.4.7: Chipmark

2. **Diagonal grain:** This defect is formed due to improper sawing of timber. It is indicated by diagonal mark on straight grained surface of timber.

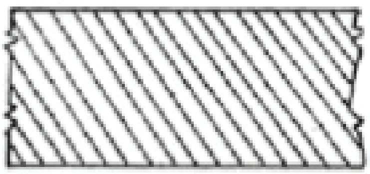

Fig 3.4.8: Diagonal grain

3. **Torn grain:** It is a small depression formed on the finished surface of timber by falling of a tool etc.

Fig 3.4.9: Torn grain

4. **Wane:** Wane is the circular impression found on manufactured piece of timber.

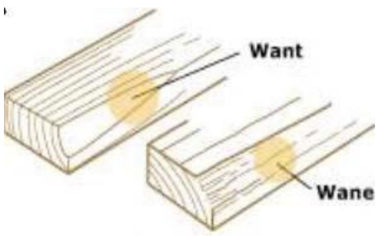

Fig 3.4.10: Wane

Defects due to fungi

Fungi are tiny microscopic plant organisms. The timber gets affected due to fungi only when the following two favorable conditions are satisfied simultaneously.

1. The moisture content is about 12-15% in timber.
2. There is presence of air and warm condition. In the absence of any one of the favorable condition, decay of wood will take longer period and dry wood will remain durable and sound for centuries. Following are the defects in timber due to fungi effects are as given below:

- Sap stain
- Blue stain
- Dry rot
- Brown rot
- Heart rot

Fig 3.4.11: Defects due to fungi

Defects due to insects

For the decay of timber insects given below are usually responsible:

- Marine borers
- Beetles
- Termites

Fig 3.4.12: Defects due to insect

Defects due to natural force

Mainly abnormal growth and Rupture of tissues are responsible for causing defects in timber.

Following defects are caused by these forces:

- Burls
- Chemical stain
- Coarse grain
- Dead wood

Fig 3.4.13: Defects due to naural force

Defects due to seasoning

Irregular shrinkage caused by irregular drying results in the setting up of internal stresses between the fibers. When these stresses become strong enough to overcome the bond of the fibers, then the timber warps and shakes are formed. Following defects occur during seasoning process of wood.

- Bow
- Case-hardening
- Check
- Collapse
- Cup
- Honey-combing
- Radial shakes
- Split
- Twist

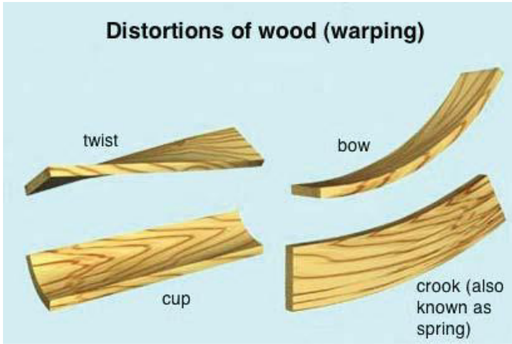

Fig 3.4.14: Wood distortion

3.4.1.2 Seasoning Of Timber

The seasoning of timber involves extracting the moisture under controlled conditions at a uniform rate from all parts of timber and to leave the remaining moisture that cannot be extracted Objects of Seasoning

1. Decay in timber is restricted.
2. Timber becomes lighter.
3. It is easier to paint and polish on seasoned timber.
4. It is easier to preserve seasoned timber.
5. It makes timber stronger and more stable.
6. It helps in stopping shrinkage of timber on drying.
7. It makes timber electrically resistant.

Type of Seasoning

a. Natural seasoning or Air Seasoning
b. Artificial seasoning or Kiln Seasoning

Natural seasoning or air seasoning Stack timber on a well-drained place in the shade as shown in fi g.3.4.15. These stacks should be placed on concrete supports a few centimeters above the ground. Allow natural air movement around the stacked timber. Care should be taken so as not to expose the newly converted timber to severe wind or to sun. This type of natural seasoning is very slow and it takes more than six months for timber to season in moderate climates, but it makes the timber very strong and durable.

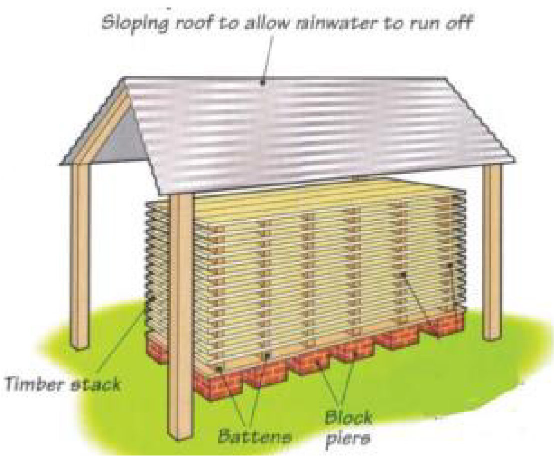

Fig 3.4.15: Natural Seasoning or air seasoning

Artificial Seasoning For large scale production artificial seasoning is used. Artificial seasoning is done in a chamber, where any temperature and humidity can be attained for its circulation across the timber stacked in the chamber for seasoning. For heating and humidifying the air in the kiln, steam is generally used. Low temperature and high humidity is required to start artificial seasoning. There is an alert system provided which activates the system if the timber dries. The temperature inside the chamber is fairly high and the humidity is low.

Fig 3.4.16: Artificial Seasoning

3.4.2 Plywood

Plywood sheets are made by bonding several individual wood veneers (plies) together. Veneers are thin layers of wood usually obtained by rotary cutting timber logs obtained from trees. Laminated veneer lumber is formed by coating and stacking together a group of thin timber veneers with adhesive. Most veneers run in the longitudinal direction.

Fig 3.4.17: Plywood

Plywood's are used for decorative finishing's in buildings as well as in formwork making. For manufacturing plywood both hardwood and softwood are used.

Basic types of Plywood

Based upon the use of plywood it is divided into three categories.

1. **MR grade Plywood:** The most common type of plywood that is used for making furniture for our homes and offices is MR grade plywood. The acronym MR stands for Moisture Resistant. This is interior grade plywood meant for indoor use.
2. **BWR grade Plywood:** BWP (Boiling Water Proof) or BWR (Boiling Water Resistant) plywood are called exterior grade plywood. These are used in outdoors as they are waterproof. These type are commonly used for shuttering work also.
3. **Marine Grade Plywood:** They are commonly used for marine applications such as in the construction of boats and ships. Has better resistance to water than any other type of plywood.

Structural Plywood

Structural plywood shall confirm to requirement of BWP grade. It is used in construction applications where structural stability is required. Concrete Shuttering Plywood is an example of structural plywood.

Concrete Shuttering Plywood

Plywood which is used in building construction work to create the wooden molds into which concrete will be cast is called concrete shuttering plywood. It can be reused several times before being discarded or used for other purposes. Indian standards specify 3 type of plywood under BWP grade for shutter making:

1. Plain Plywood
2. Plastic-coated Plywood
3. Film faced shuttering plywood

Types of plywood used in construction work

1. 1. **Plain shuttering plywood:** It is manufactured with selected, naturally cross band veneers impregnated with specially formulated phenolic resin. It is ideally suited for concrete formwork

for beams, columns; flooring and slab form work, vertical or inclined concrete work, etc.

2. **Plastic coated plywood:** This type of plywood is plastic coated and 100% boiling waterproof, if handled and stored carefully the product could be reused up to 10 – 15 times.

Fig 3.4.18: Shuttering plywood with plastic coating

3. **Film faced shuttering plywood:** Film-faced shuttering plywood has a shiny phenolic fi lm over the surface, so that the concrete does not stick to the plywood, and the dampness does not damage the ply.

Fig 3.4.19: Phenolic plywood

Plywood Standard Sizes

Plywood is manufactured in standard sizes. The varied sizes are 8x4, 8x3, 6x4, 7x3, 6x3, 7x4 sq. □ . Standard size of plywood in square feet and its corresponding size in mm are as given below:

Plywood Size in sq .ft .	Corresponding size in mm (millimeters)
8’ x 4’	2440 x 1220
8’ x 3’	2440 x 920
7’ x 4’	2140 x 1220
7’ x 3’	2140 x 920
6’ x 4’	1830 x 1220
6’ x 3’	1830 x 920

Table 3.4.2: Size of plywood used for construction purpose

Standard thickness of plywood for various grades in millimeters area as given below:

Plywood grade	Thickness in mm
MR grade (Moisture Resistant)	3, 4, 6, 8, 12, 15, 18, 21, 25 mm
BWR grade (Boiling Water Resistant)	4, 6, 9, 12, 16, 19, 25 mm
Shuttering plywood	6, 12, 15, 18, 21, 25 mm

Table 3.4.3: Grade & thickness of plywood used for construction purpose

Notes

1. The range of thickness for Marine grade, FR grade (Fire Retardant) and BWR grade plywood is same as mentioned above.
2. The sizes mentioned above shuttering plywood are used for building construction purposes.

Advantageous of plywood shutter material:

1. Ideal formwork material for pre-cast, concrete molds.
2. It can be used a number of times and thus save construction cost.
3. Gives smooth plywood face to concrete work.
4. Improves the speed in construction.
5. Compared to steel plates its cheaper thus saves on the initial investment.
6. Saves on re-plastering work & finishing cost as it is free from dents and imparts evenly smooth finish.

Fig 3.4.20: Cutting wood by circualar saw

Fig 3.4.22: Cutting wood by circualar saw

Fig 3.4.21: Cutting wood by jigsaw

Notes

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Shuttering Panel Material

Unit 3.5: Making of Wooden Shutter

Unit Objectives

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

1. Explain the importance of using different types of joints such as dovetail joint, Tenon and mortise and lap joints.
2. Discuss the steps for the preparation of different types of joints used in wooden shutters.
3. Demonstrate making the wooden shutter panels using different types of joints such as dovetail, tenon and mortise, and lap joints as per specifications.
4. Show how to measure and mark plywood and timber using measuring and marking tools.
5. Show how to measure and mark sheathing and stiffeners at sketched location.
6. List the safety precautions followed while using power tools for the preparation of shutters/ frames.

3.5.1 Wood Joints In Shuttering Carpentry

Jointing is an art of wood working and one of the principal functions of the carpenter where pieces of timber and lumber joined together without use of nail and screws. Depending upon the method of joining it is classified. We will elaborate on 3 types of joints, which is commonly used by a shuttering carpenter.

1. Dovetail Joint
2. Lap Joint
3. Mortise and Tenon joint

Dovetail Joint

Dovetail joint consists of pins and slots which interlock into each other. The pin and slot combination as shown in figure no. gives the joint a great strength and therefor it is considered as a one of the hardest joints. Dovetail joint is very robust due to its structure and positioning of its tail and pins.

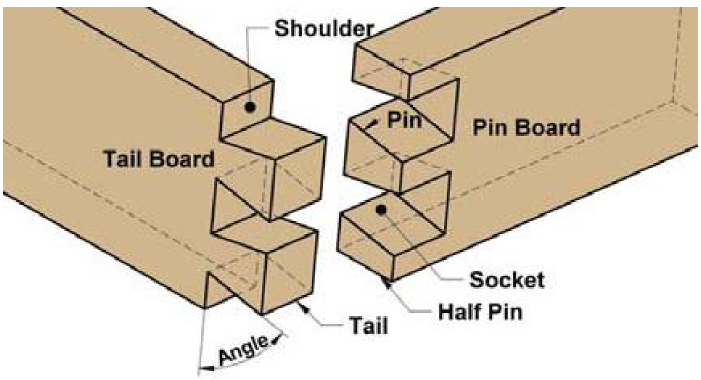


Fig 3.5.1: Dovetail joint

Lap Joints. In Lap joint connections the end of a piece of wood is laid over and connected to another piece of wood. It has wide application in wood, plastic or metal. This type of joint used in timber framing, construction, and cabinetry for framing.

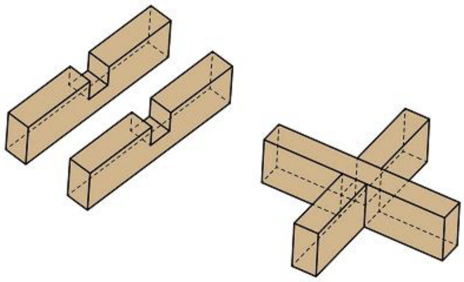


Fig 3.5.2: Lap joint

Lap joints are further classified as half lap joint, end lap joint cross lap joint etc.

Mortise and Tenon joint

The mortise and Tenon joint is another one of the strongest woodwork joints. It is most effective and best suited to support a large amount of weight. The tenons should be of correct length and thickness.

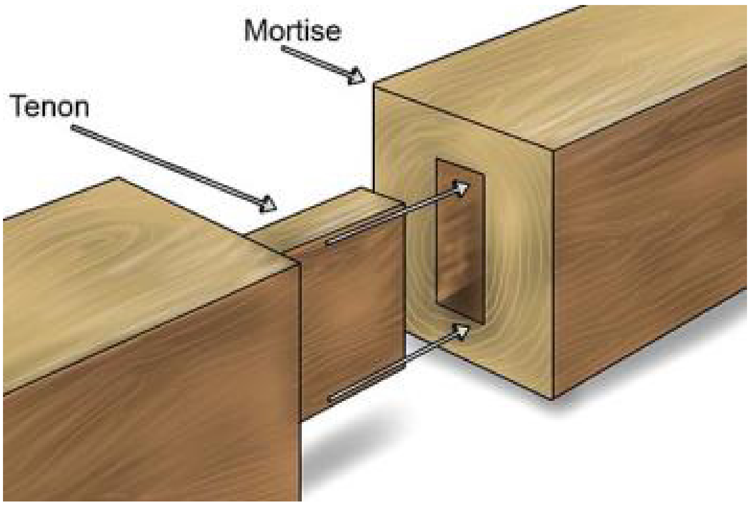


Fig 3.5.3: Mortise and tenon joint

3.5.2 Make Shutter Panels for Column

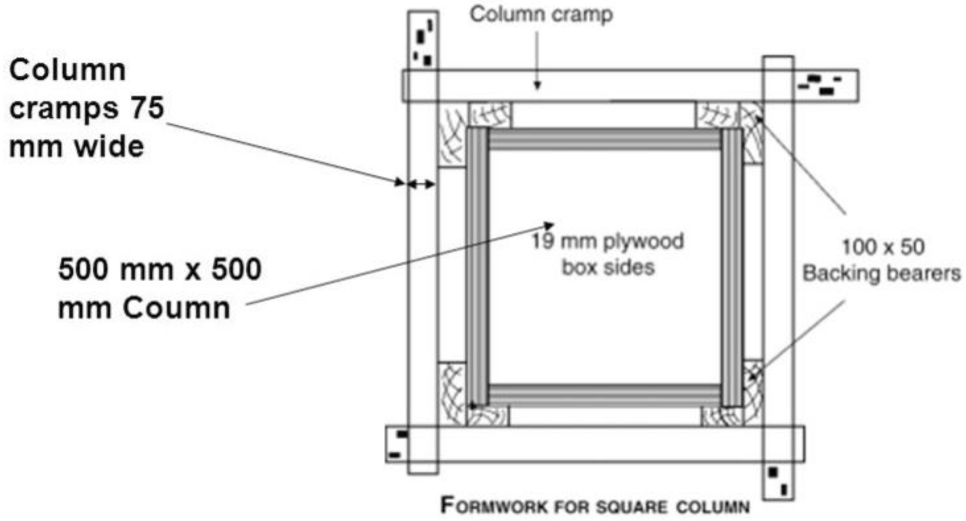


Fig 3.5.4: Column shutter mold drawing

As a shuttering carpenter, you should know how to make column box or mould at construction site using plywood or processed timber with the help of formwork drawing. We will learn about making shutter panels using plywood in the coming session. As a first step towards shutter making, you should be able to read and understand the drawing. Secondly identify and select, shutter board as per the requirement.

1. **Selection of panels**

   Selection of panels is considered to be the first step while making of shutter boards. As we know that plywood is available in various sizes, it is very important to select it as per the requirement. During selection of panels consider the following points:

   1. Determine the size of board required including wastages
   2. There should be not be any dead or loose knots in straight grained timber, matching each board for grain pattern and colour
   3. Make sure that timber is properly seasoned and it has low moisture content to avoid excessive shrinkage.

2. **Measuring and marking on panels** The next step to be followed is measurement and marking on panel board as per sketch/drawing. Generally measurement is carried out using measuring tape and steel rule and to mark a sharp pencil is used.

Fig 3.5.6: Measuring and marking on ply board

3. Cutting of panels After marking on panels Plane and cut the timber to the required size and finish. Cut all the components lengthwise .For easy work all face sides and edges should be marked.

Fig 3.5.7: Cutting board by circular saw

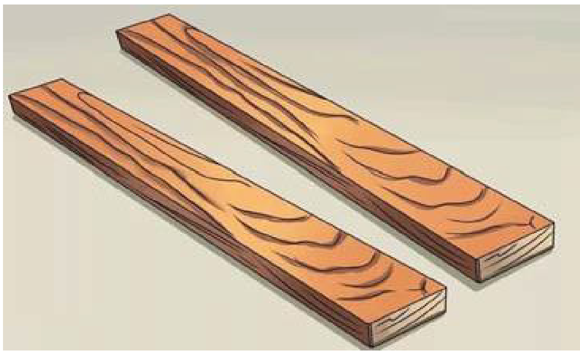


Fig 3.5.8: Wooden boards

Fig 3.5.9: Measuring wooden board by taperuler

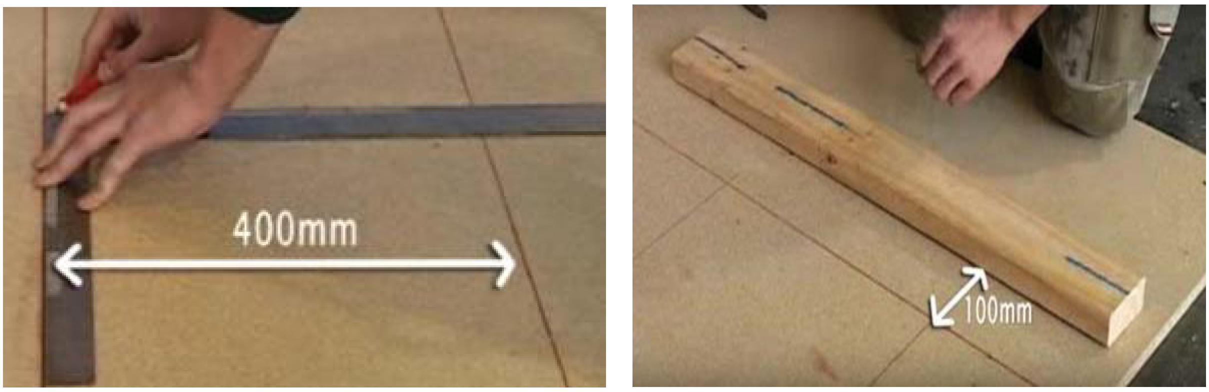


Fig 3.5.10: Marking L-shape on wooden board

4. **Making L shape:**

Connect the shutter panels into L-shape with the help of nails.

- Take the wooden panel, place and fi x the wooden batten below the panel.
- Fix the wooden batten using nails.
- Hammer the nail and place the nail securely, so that both the panel are fixed.

Exercise

1. Handsaw is used to ……………………..?

   A. bend the materials
   B. cut the shuttering materials
   C. strike on the materials
   D. measure the material.

2. Which one of the following is used to strike on the chisel?

   A. Hand saw
   B. Hammer
   C. Steel rule
   D. planer

3. Identify the metal used to make the blade of the chisel is _____.

   A. Carbon steel
   B. Steel
   C. Forged steel
   D. High carbon steel

4. Which part of the chisel is fixed inside the ferrule?

   A. tang
   B. Handle
   C. Blade
   D. Ferrule

5. What is the name of the chisel used for cutting rough surface quickly?

   A. Firmer chisel.
   B. Gauge chisel.
   C. Skew chisel.
   D. mortise chisel

6. Which tool used to check and transfer on the job?

   A. Bevel square
   B. Try square
   C. Engineers square
   D. Divider

7. The smallest unit on a tape measure is:

   A. a millimeter
   B. 1/16 inch
   C. ¼ inch
   D. ½ inch

8. Which of the tool used for testing the straightness of large surface?

   A. Steel rule
   B. Try square
   C. straight edge
   D. Foot rule

9. What is the name of special rule used by the pattern maker to prepare the pattern?

   A. Steel rule
   B. Foot rule (wood)
   C. Shrink or contraction rule
   D. Tape rule

10. Why it is important to store the tools?

11. List the hand tools commonly used in shuttering activities.

12. Which one of the following saw is having a reinforcement strip (rib) on its back?

    A. Hand saw
    B. Tenon saw
    C. Coping saw
    D. Feat saw

13. Which board is made up of country wood strips of various sizes ranging from 18-38mm in thickness?

    A. Hard board
    B. Ply board
    C. Chip board
    D. Black board

14. Which one of the portable machine tool is very competent for cutting wood, composition board, Veneer, Plastics, chard board, Leather?

    A. Portable electric circular hand saw
    B. Portable Sander
    C. Portable electric jig saw
    D. Portable electric Router

15. Which layer is called “core” in ply wood?

    A. side layer
    B. top layer
    C. bottom layer
    D. middle layer

16. Which one of the statement is not an advantage of ply wood?

    A. It will shrink and warp easily
    B. It is manufactured in very large size
    C. It is lighter in weight
    D. It can be easily worked and bent in shaped and designs

17. The horizontal support piece used in slab is called?

    A. Braces
    B. Batten
    C. Ledges
    D. Panel

18. Which of the following is not recommended for chiseling?

    A. Secure the work piece with clamps
    B. Keep the chisel close to your body
    C. Always hit the tool squarely on top of the handle
    D. Never allow the edge to touch other tools

19. Which of the following is not recommended for sanding?

    A. Always sand against the grain
    B. Take care to prevent round corners
    C. Sand end grain in only one direction
    D. Never use a coarser grit than necessary

20. Before making panels, inspect the surface for

    A. Sawdust B. Warp

    C. Correct dimensions D. finishes

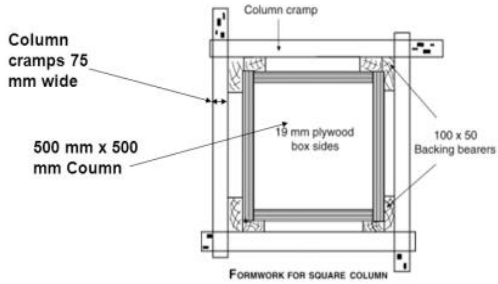
22. Which of the following is not recommended for panelling?

    A. If you are right handed, grasp the knob in your left hand

    B. Lift the plane off the board on the return stroke

    C. Always plane with the grain

    D. None of the above



Formwork for square column

23. Which plane is very much used for planning the wood quickly and truly?

    A. Smoothing plane B. Jack plane

    C. Trying plane D. Plough plane

24. Which plane is more suitable for further smoothing a planed surface?

    A. Router plane B. Trying plane

    C. Smoothing plane D. Plough plane

25. The standard height of the band saw table above the table is --------------------.

    A. 31-34 B. 35-38

    C. 39-42 D. 43-46

26. What is the name of person who is making pattern?

    A. Core making B. Sand making

    C. Pattern maker D. Mould making

Notes

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4. Quality Checks on Shuttering Work

Unit 4.1 - Carry out Quality Check For Shuttering Works

Unit 4.2 - Checks on Footing, Column, Wall, Beams and Slab Formwork

CON/N0304

Key Learning Outcomes

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

1. Explain different types of system formwork/ conventional formwork.
2. Describe the different types of material and components used in system formwork/ conventional formwork with specification
3. Explain the various checks for plumb, level and alignment of the formwork.
4. Describe the importance of Indian Standard / International codes and maximum tolerance limits for key quality checks of shuttering works.
5. Discuss the sequence followed for quality checks in shuttering works.
6. State the do's and don'ts required during rectification of shuttering works.
7. Explain the basics and fundamentals of reinforcement work, shuttering work and concreting works.
8. Discuss the application of release agent on shuttering panels.
9. Explain the process of obtaining approval for the assembled formwork.
10. Show how to interpret of the rough sketches / schematic working drawings/ cutting plans used in shuttering carpentry work.
11. Demonstrate the scope for covers to the reinforcement steel in shuttering works as per the given sketches.
12. Show how to check for the location, dimensions, rigidity of joints of plywood and timber.
13. Show how to check for verticality, position and spacing of props as per the load bearing capacity and support.
14. Demonstrate the corrective measure to be taken if twist is observed in alignment of the formwork.
15. Demonstrate the rectification measures of formwork boards / plates after their removal.
16. Perform checks to ensure the line, level and alignment of the shuttering woks with in tolerance limit and according to sketches / instructions.
17. Demonstrate the use of different type of support for formwork to ensure its stability.
18. Demonstrate procedure of obtaining approval for the assembled formwork.
19. tenon and mortise, and lap joints as per specifications.
20. Show how to repair defects on the prepared shutters as per instructions.

UNIT 4.1: Carry Out Quality Check for Shuttering Works

Unit Objectives

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

1. Explain the various features of different types of timber used in shuttering works.
2. Demonstrate the visual checks to determine the quality of timber, plywood and other materials used for preparation of shutters.
3. Discuss about the seasoning of timber and common defects in timber.
4. Show how to repair defects on the prepared shutters as per instructions.
5. Understand the seasoning techniques used for timber
6. Understand cutting of wood using power tools
7. Understanding of various types of plywood used in shuttering works.

4.1.1. Material and components used in system formwork/ conventional formwork

Formwork is an essential part of construction, used to shape and support concrete until it sets and gains enough strength to bear its own weight. There are two main types of formwork: system formwork and conventional formwork. Here's an overview of the different types of materials and components used in both types of formwork:

System Formwork:

System formwork refers to pre-designed and pre-engineered systems that are modular and reusable, making construction processes more efficient and cost-effective. These systems are often made of lightweight, durable materials.

- **Aluminum Formwork:** Made from lightweight aluminum, this formwork system is known for its quick assembly and disassembly. It's commonly used for large-scale projects due to its high strength-to-weight ratio.
- **Steel Formwork:** Steel formwork offers durability and reusability. It's ideal for projects where a high number of repetitions are expected, such as in the construction of bridges and tunnels.
- **Plastic Formwork:** Plastic formwork is lightweight and can be easily handled. It's commonly used for small and medium-sized construction projects and is known for its ease of use and resistance to moisture.
- **Modular Formwork:** This system comprises standardized panels and components that can be easily assembled in various configurations. It's versatile and suitable for a wide range of projects.

- **Engineered Formwork:** These systems are designed to meet specific project requirements and are often used for complex geometries or unique structures. They can be a combination of different materials and components.

Conventional Formwork:

Conventional formwork involves the use of traditional materials and methods, where formwork is built from scratch on-site. This approach can be more labor-intensive but provides flexibility for custom designs.

- **Timber Formwork:** Timber is a common choice due to its availability, affordability, and ease of handling. It's used for simpler structures and low-rise buildings.
- **Plywood:** Plywood sheets are often used in combination with timber to create formwork panels. Plywood provides a smooth surface finish and can be reused multiple times.
- **Lumber:** Wooden planks and beams are used to create the framework of formwork. They are cut and assembled on-site to match the required shape and dimensions.

Nails, Screws, and Fasteners: These are used to secure the formwork components together. Proper fastening is essential to maintain the shape and stability of the formwork during concrete pouring.

Formwork Accessories: Various accessories such as formwork ties, wedges, clamps, and braces are used to secure and stabilize the formwork components.

Release Agents: These substances are applied to the formwork surfaces to prevent adhesion between the concrete and the formwork, making it easier to remove the formwork once the concrete is set.

The choice between system formwork and conventional formwork depends on factors such as project complexity, budget, schedule, and the desired quality of the concrete finish. System formwork offers efficiency and reusability, while conventional formwork provides flexibility for custom designs. Regardless of the chosen method, proper design, assembly, and maintenance of formwork are crucial to ensure the safety and success of the construction project.

4.1.2 Importance of Quality Work in Formwork

Quality check on formwork is important to ensure the strength, rigidity, position, and dimensions of the forms. Shuttering carpenter should do a quality work because size, shape, and alignment of slabs, beams, and other concrete structural elements depend on accurate construction of the forms. Good quality checks on formworks result in:

- Time saving and fast construction: Performing quality checks during erect on of formwork reduces the chance of errors, minimizing repletion resulting in time saving and faster construction.
- Protection of formwork from damage: Quality checks helps in protection of formwork from any structural damage caused by failure of form structure. Checking ensures all support and formwork requirements meet the specific criteria and as per drawing.

- **Good appearance of structures:** For good appearance of concrete inside surface of formworks should be smooth. Smooth concrete surface could only can be achieved by maintaining good quality work during erection of formwork. It is important to apply releasing agent on form surface which enables easy removal of forms during dismantling.
- **Safety at construction site:** Placement and fixing of formwork panels should be followed in manner, to ensure the safety of workers at construction site.
- **cost savings:** Following quality practices can save cost at construction site in terms of – cost of material, cost of lab our, cost for fabrication, erection and removal of formwork .

Major Points to be remembered during Quality Checks:

- **Materials**

  Ensure that the formwork materials and components satisfy the requirements and are as per the specification/ instruction. Check that releasing agent is applied appropriately on shutter panels for easy removal during de shuttering
- **Marking**

  Marking the dimensions on shutter panels should be accurate and as per given drawing. Measure the dimensions and mark the dimensions. Small difference in marking will affect the layout, which could be disastrous. Even an error of a few millimeters will compound several times even within short lengths.
- **Levelling**

  Check the leveling of shutter panels by suitable tools or instruments to ensure that shutter panels are placed properly over the surface. You should ensure that panels do not move or bend during the concreting work.
- **Supporting**

  Ensure that shutter panels are placed and supported properly as per drawing. Check that props, walers and support equipment's are fixed properly and it is properly jammed by clamps, screws and bolts, so that it can take the load of concrete.
- **Alignment**

  Ensure that shutter panels are aligned properly. Check that there is no gap le in the shutter panels after erect on of formwork. Do not leave any gap to prevent leakage of cement slurry during concreting work. A tiny error in alignment can alter a building line and result in inappropriate layout. The

4.1.3 Tolerance in Formwork

The formwork shall be such that the finished concrete shall be in the proper position with respect to certain predefined reference points. Tolerance limit is defined as an allowable amount of variation of a specified dimension in formwork. The variation can usually be in either of two directions and so can be regarded as positive or negative. The tolerances limit should be followed as per the drawing and the technical specification given in the contract document. The tolerances on the lines and dimensions shown in the formwork drawing shall be within the specified limits.

Tolerance limits of few structural member are given below for your understanding:

Type of formwork	Tolerance
Columns (deviation from specified dimensions of cross-section)	6 mm/+12 mm
Beams (deviation from specified dimensions of cross section)	-6 mm /+12 mm
Footings Linear dimension (deviation from dimensions in plan) Thickness	-12 mm /+50 mm -0.05/+0.05 mm times the specified thickness

Table 4.1.1: Tolerance limits of few structural members

Reference has been taken from IS code 14687:1999

4.1.4 Quality Checks on Formwork

The inspection should be undertaken with direct reference to drawing or specification that has been issued to shuttering carpenter. First step is to check and ensure design requirements as specified in the drawing and specifications are met with. As per IS code 14687:1999, quality checks on formwork can be performed at ground level as well as above ground level which are mentioned below:

Checks at Ground Level:

- The setting out is correct;
- The ground has been adequately prepared and at a satisfactory level;
- Suitable sole plates or other bases have been provided and have been properly levelled;
- Sole plates or other bases have not sealed;
- Sole plates have been properly bedded down (no cavities underneath), and steps taken to prevent erosion;
- Sole plates and other load-distributing members laid on the slope are adequately prevented from moving down the slope;
- Check that the supports are adequately secured;
- Base plates have been spaced properly and centered on the sole plates; and
- The extension of each screw or adjustable base is within the permitted limits, and braced, if necessary.

Checks above Ground Level

- All provisions of the design and drawings are complied.
- Any member which is to remain in position during or after the general releasing of false work

should be clearly marked.

- The materials used should be checked to ensure that undesirable or rejected items are not used.
- Any excavations nearby which can affect the safety of the false work.
- All safety measures are be taken to prevent any accidents.
- Adequate bracings, struts and ties are installed to ensure strength and stability of false work at intermediate and final stages.
- Inclined forms which give rise to very high horizontal forces should be taken care of by trussing and diagonal bracing
- The places of stacking of materials should be marked as per provision in false work design and it should be ascertained that the stacking is done only at proper places.
- The deterioration of materials due to storage, reuse and misuse should be checked and corrective steps taken for safety.
- Wedges should be provided for adjustment of the false work to the required position, after any settlement or elastic shortening of props occur.
- The inclined plane of the wedges should not be too steep and the pair should be nailed down after adjustment to prevent their shitting. A pair of two matched and equal wedges should be used in opposition and not one wedge only by itself.

Notes

QR Codes

Scan the QR code to watch the video

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Design and Tolerance in Shuttering

UNIT 4.2: Checks on Reinforcement Work, Shuttering Work and Concreting Works

Unit Objectives

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

1. State the do's and don'ts required during rectification of shuttering works.
2. Explain the basics and fundamentals of reinforcement work, shuttering work, and concreting works.
3. Discuss the application of release agent on shuttering panels.
4. Explain the process of obtaining approval for the assembled formwork.
5. Show how to check for verticality, position and spacing of props as per the load bearing capacity and support.
6. Demonstrate the corrective measure to be taken if twist is observed in alignment of the formwork.
7. Demonstrate the rectification measures of formwork boards / plates after their removal.
8. Perform checks to ensure the line, level and alignment of the shuttering woks with in tolerance limit and according to sketches / instructions.
9. Demonstrate the use of different type of support for formwork to ensure its stability.
10. Demonstrate procedure of obtaining approval for the assembled formwork.

4.2.1 Checks on Footing Formwork

Footings /Foundation can be of columns or walls. So it is always very important to check the footing formwork very precisely as described below:

1. Read the formwork drawing and confirm the type of footing.
2. Check the condition of erected shutter boards along with supporting materials for its adequateness.
3. Perform check to make sure that size and dimension of shutter boards are as per requirement.
4. Chek the center line of footing as per given reference points.
5. Check the size and dimension of footing formwork as per drawing.
6. Check diagonal of the footings formwork in case of square or rectangle footing.
7. Checks for cover blocks between reinforcement and shutter boards.
8. Check proper supports are provided to the formwork as per drawing.

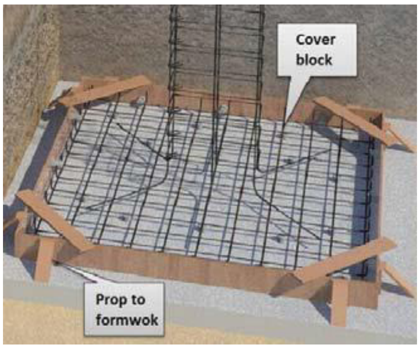

Fig 4.2.1: Measuring footing area

Fig 4.2.2: Fixing footing box

Fig 4.2.3: Cover blocks and props in footing box

9. Check for any gaps between the boards or between the boards and PCC top level.
10. Checks for verticality of boards.

4.2.2 Checks on Column Formwork

Reinforced concrete column forms are subjected to lateral pressure because of their small cross section, large heights and relatively high rates of concrete placement. Thus It is necessary to provide tight joints and stronger support to the formwork. Column formwork shall be checked before pouring of concrete as well as immediately after the pouring has been finished. Shuttering carpenter should present at the site during casting the mould, and final check should be performed for its be verticality. The following checks are to be done:

1. Check erected formwork with approved column drawings
2. Check the condition size, height of shuttering boards and ensure that specific finish boards are used for column formwork.
3. Check the application of releasing agent on inner surface of panel board.
4. Check and ensure the position of erected formwork is in place with reference to provided grid line or marking.
5. Check the position and fixing of waler to its wall tie as per drawing.
6. Check that all pins, wedges and tie rods are properly secured and tightened.
7. Ensure that steel props are provided as per drawing and it is properly secured to the column formwork and the floor. Also ensure that alteration for pushing and pulling is operational.
8. Check that adequate battens and stiffeners are fixed with plywood sheet in case any cracks are visible on plywood.
9. Dimensional accuracy should be checked for length, width and diagonal of column form.
10. Check the verticality of formwork by use of plumb bob.
11. Ensure that all gaps are properly filled so that leakage of slurry can be prevented.
12. Ensure the proper placement of � e rods should be arranged so that at the time of concreting it would not move horizontally.

13. Make sure that cover blocks are used as per recommended by site in-charge and appropriate spacing are maintained between the inner face of column board and reinforcement.
14. Before and immediately after the concrete has been poured a final check must be made for vercality and column alignment.

Fig 4.2.4: Checks for verticality

Fig 4.2.5: checks by using Plumb Bob

Fig 4.2.6: Checks for props and fixing

Fig 4.2.7: Checks for Cover blocks

4.2.3 Procedure For Checking of Wall Formwork

As a shuttering carpenter quality checks for wall formwork should be carried out after erection of formwork as well as after concreting. Quality of concrete is affected when the formwork is not properly aligned, leak proof etc. Checks on wall formwork can be performed by following:

1. Use approved wall formwork drawing while checking the erected formwork.
2. As per the previous drawn grid line or marking check the position of erected formwork.
3. Check the condition of material, size, height and other specification details of wall formwork

4. Check the application of releasing agent on inner surface of panel board.
5. Check the position and fixing of waler to its wall tie as per drawing.
6. Ensure that the length of tie rod is providing sufficiently and it is properly tight with anchor nut.
7. Ensure that steel props are provided as per drawing and it is properly secured to the wall formwork and the floor. Also ensure that alteration for pushing and pulling is operational.
8. Check that adequate battens and stiffeners are fixed with wall panel if required.
9. Dimensional accuracy of wall should be checked.
10. Check the verticality of erected formwork.
11. Check walls for proper spacing and joints should be staggered from one tie to the next.
12. Ensure that all gaps are properly filled so that leakage of slurry can be prevented.
13. Check that lapping over previously casted concrete is provided as per instruction given by site in-charge.
14. Ensure that cover blocks are provided as per requirement of wall formwork.
15. Check that there is no gap between panels and joints between old concrete and panels above them.

Fig 4.2.8: Wall formwork

Fig 4.2.9: Wall formwork

Fig 4.2.10: Wall formwork

4.2.4 Checks on Beam and Slab Formwork

Formwork for reinforced concrete slabs and beam depends on the type of slabs to be constructed. The floor slabs can be structural slabs supported on a steel or concrete structural frame. So as a shuttering carpenter, he should be sincere and active to check slab and beam formwork.

1. The quality of shuttering material should be checked before concreting.
2. Check that panels of beam and slab are cleaned properly.

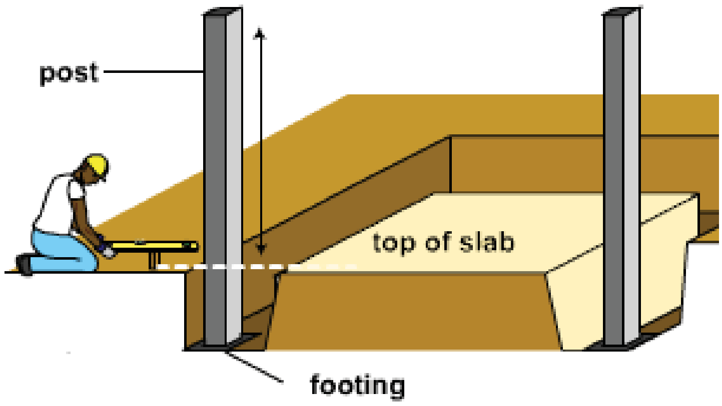

Fig 4.2.11: Slab formwork

3. Check that releasing agent is applied on the shutter panels.
4. Plinth/slab level is used to check height of Slab.
5. Check the width of the beam bottom plank.
6. Check the depth of the beam along with outer line of beam sides.
7. Check the line and level of beam.

Fig 4.2.12: Checks for dimension of beam and slab formwork

8. The side of beam in line, level and plumb should be checked properly.
9. Location and depth of the slab should be checked as different location.
10. Check for individual level at each bay of the slab.
11. Check that all gaps are filled properly to entire area.

12. Check the diagonal of each bay of slab and also to openings or cut outs.
13. Check that slab panels are supported properly at suitable distance.
14. Check that support to the vertical joint of shuttering for approx 24” beam and 30” beam.
15. Fixing of the steel plates over beam sides in flush position should be checked.
16. The fixing of cap on the column so that it can take the load should be check.
17. Proper fixing of the beam bottom over the cap should be checked.
18. Proper fixing of props for line and level shall be checked, at regular interval.
19. Check for proper packing of props by use of wooden planks.
20. Check for horizontal bracing of props.

Fig 4.2.13: Checks for damage

Fig 4.2.14: Measuring depth of panel

Fig 4.2.15: props below the panel

21. Check if the plate’s joints are water tight.
22. The internal panel measurements, beam to beam and diagonal of the panel should be checked.
23. Check that beam and column junctions are water tight and proper supported.

Fig 4.2.16: Checks near the column beam joint 6.5 Fig 4.2.17: props below the panel:

Exercise

1. Which instrument is used to check the height of slab?

   A. Spirit Level B. Measuring Tape

   C. Plumb bob D. None of above

2. Which instrument is used to check the depth of slab?

   A. Spirit Level B. Measuring Tape

   C. Plumb bob D. None of above

3. Which of the following is not used as a marking tool?

   A. Scratch awl B. lead pencil

   C. triangle D. utility knife

4. Which utility is used for providing proper spacing in inner face of columns shutter and reinforcement?

   A. Cover Blocks B. Tie Rods

   C. Wedges D. None of the above

5. Which utility is used for providing proper spacing in inner face of walls shutter and reinforcement?

   A. Cover Blocks B. Tie Rods

   C. Wedges D. None of the above

Notes

QR Codes

Scan the QR code to watch the video

https://www.youtube.com/watch?v=q2JsyYB0TeI

Checklist for Site Supervision of Concreting Work

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

5. Work effectively in a Team to deliver Desired Results at the Workplace

Unit 5.1 - Effective Communication and Teamwork

Unit 5.2 - Working Effectively and Maintaining Discipline at Work

Unit 5.3 - Maintaining Social Diversity at Work

CON/N0304

Key Learning Outcomes

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

1. Elucidate own roles and responsibilities.
2. Explain the importance of effective communication.
3. Elucidate the consequence of poor teamwork on project outcomes, timelines, safety at the construction site, etc.
4. Demonstrate how to pass on work related information/ requirement clearly to the team members.
5. Explain different modes of communication used at workplace.
6. Explain the importance of creating healthy and cooperative work environment among the gangs of workers.
7. Show how to report any unresolved problem to the supervisor immediately.
8. Elucidate applicable techniques of work, properties of materials used, tools and tackles used, safety standards that co-workers might need as per the requirement.
9. Demonstrate ways to hand over the required material, tools, tackles, equipment and work fronts timely to interfacing teams.
10. Explain the importance of proper and effective communication and the expected adverse effects in case of failure relating to quality, timeliness, safety, risks at the construction project site.
11. Explain the importance and need of supporting co-workers facing problems for the smooth functioning of work.
12. Demonstrate ways to work together with co-workers in a synchronized manner.
13. Discuss the fundamental concept of gender equality.
14. Explain how to recognise and be sensitive to issues of disability, culture and gender.
15. Discuss legislation, policies, and procedures relating to gender sensitivity and cultural diversity including their impact on the area of operation.
16. Demonstrate effective implementation of gender neutral practices at workplace.
17. Demonstrate ways to address discriminatory and offensive behaviour in a professional manner as per organizational policy.

Unit 5.1 - Effective Communication and Teamwork

Unit Objectives

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

1. Elucidate own roles and responsibilities.
2. Explain the importance of effective communication.
3. Explain different modes of communication used at the workplace.
4. Elucidate the consequence of poor teamwork on project outcomes, timelines, safety at the construction site, etc.
5. Demonstrate how to pass on work-related information/requirements clearly to the team members.
6. Show how to report any unresolved problem to the supervisor immediately.

5.1.1 Communication at Workplace

The communication process refers to the steps involved in the exchange of information, ideas, thoughts, or messages between individuals or groups. It is a dynamic process that involves a sender, a receiver, a message, and various channels to convey the information effectively. The communication process typically follows these steps:

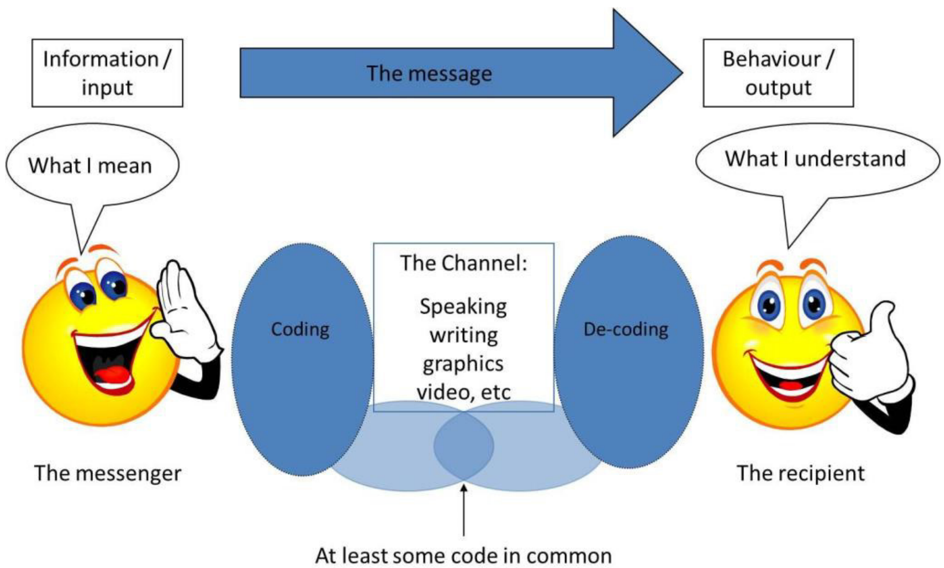

Fig. 5.1.1 Effective Communication – Two-way Process

- **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.

The 7Cs of communication are essential principles to follow for effective and impactful communication:

- **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

Fig. 5.1.2 C's of Communication

5.1.2 Type of Communication at Construction Worksite

Communication at a construction worksite is crucial for ensuring efficiency, safety, and coordination among workers, supervisors, and other stakeholders.

Several types of communication are utilized to facilitate smooth operations and enhance safety at construction sites.

Fig. 5.1.3 Communication at Construction

Some common communication methods include:

- **Verbal Communication:** This involves face-to-face conversations, discussions, and instructions between workers, supervisors, and managers on the site. Verbal communication is essential for conveying immediate instructions and clarifications.
- **Hand Signals:** Hand signals are commonly used in noisy construction environments where verbal communication may be difficult. Workers use specific hand gestures to communicate instructions or warnings to each other.
- **Written Communication:** Written communication includes various documents, such as construction plans, safety guidelines, work permits, and daily progress reports. Written communication helps in conveying detailed information and serves as a reference for all stakeholders.
- **Radios and Walkie-Talkies:** Two-way radios and walkie-talkies are popular communication tools at construction sites, especially for larger projects. They allow instant communication between workers and supervisors across different areas of the site.
- **Visual Communication:** Visual aids, such as signs, symbols, and safety posters, are used to convey important information and warnings. These aids help in reminding workers of safety protocols and hazard awareness.
- **Digital Communication:** Construction sites may use digital communication platforms like mobile apps or messaging services to facilitate real-time communication, share updates, and coordinate tasks.
- **Meetings and Toolbox Talks:** Regular meetings and toolbox talks are conducted to discuss project progress, safety updates, and address any concerns or questions raised by workers.
- **Project Management Software:** Construction companies often use project management software that enables seamless communication between project teams, provides updates, and tracks tasks and schedules.

- **Emergency Communication Systems:** In case of emergencies, construction sites may have emergency communication systems like alarms or sirens to alert workers and initiate evacuation procedures.

Effective communication at construction sites plays a vital role in preventing accidents, minimizing delays, and ensuring the successful completion of projects. It is essential for all team members to be well-versed in the various communication methods used to maintain a safe and productive worksite.

Fig. 5.1.4 Coordination during Construction Work

5.1.3 Adverse

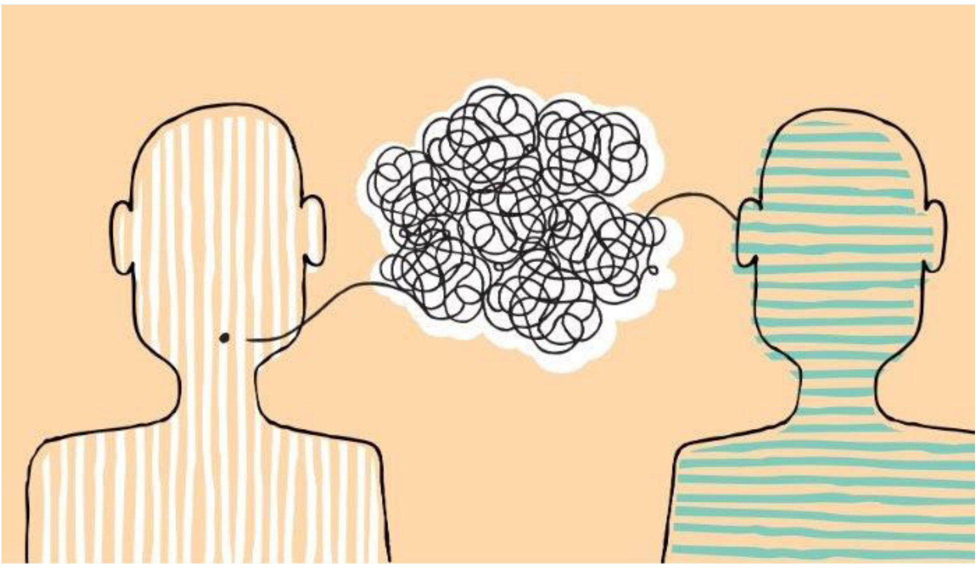

Fig. 5.1.4 Coordination during Construction Work

Poor communication at a construction workplace can lead to various adverse effects, some of which include:

1. **1Safety Risks:** Inadequate communication about safety protocols, hazards, and instructions can increase the risk of accidents and injuries at the construction site.
2. **Misunderstandings:** Miscommunication among workers, supervisors, and managers can lead to misunderstandings about tasks, timelines, and project requirements, resulting in errors and delays.
3. **Inefficiencies:** Poor communication can cause delays in project progress, resource allocation, and decision-making, leading to inefficiencies and increased project costs.
4. **Decreased Productivity:** Lack of clear communication can hinder workers' ability to perform their tasks efficiently, reducing overall productivity at the construction site.
5. **Cost Overruns:** Miscommunication about project budgets, timelines, and scope can lead to cost overruns and financial losses for the construction project.
6. **Quality Issues:** Inadequate communication regarding construction specifications and standards may result in quality issues and subpar workmanship.
7. **Safety Violations:** Poor communication about safety guidelines and procedures may lead to safety violations and non-compliance with safety regulations.
8. **Increased Conflicts:** Communication gaps can create conflicts and tensions among workers and teams, negatively impacting the construction site's working environment.
9. **Lack of Coordination:** Insufficient communication between different construction teams and subcontractors can lead to a lack of coordination, hindering the seamless progress of the project.
10. **1Client Dissatisfaction:** Poor communication with clients can lead to misunderstandings, unmet expectations, and client dissatisfaction with the construction project.
11. **Project Delays:** Miscommunication about project timelines and tasks can result in delays, affecting project completion dates and potentially leading to contract disputes.
12. **Reputation Damage:** Repeated instances of poor communication at a construction site can damage the reputation of the construction company, impacting future projects and business opportunities.
13. **Health and Environmental Concerns:** Lack of proper communication about hazardous materials, waste disposal, and environmental regulations can result in health and environmental risks.

To mitigate these adverse effects, construction companies should prioritize effective communication strategies, ensure clear and consistent information flow, and foster a culture of open and transparent communication among all stakeholders involved in the construction project.

Role of Active Listening at Construction Site:

Active listening is a critical skill at a construction site as it lays the foundation for effective communication, promotes safety, and fosters a cohesive and productive work environment. Construction projects involve numerous tasks, complex instructions, and potential hazards, making it essential for workers to actively listen and comprehend information accurately.

Hearing	Listening
Receiving any message through ears is known as hearing.	On the other hand explanation of the received message can be labeled as listening.
	
Function of hearing is just to receive the verbal message.	Listening involves decoding or interpretation of the message.

mUnderstanding instructions correctly is crucial for project success. Active listening ensures that workers grasp the requirements, specifications, and safety measures provided by supervisors and project managers. It minimizes the risk of miscommunication and mistakes that could lead to delays, rework, or even accidents.

Safety is of paramount importance in the construction industry. Active listening helps workers' pay attention to safety briefings, hazard warnings, and emergency procedures. By actively engaging in safety protocols, workers can protect themselves and their colleagues from potential risks, accidents, and injuries.

Teamwork is vital on construction sites, where multiple professionals collaborate to achieve project objectives. Active listening fosters a culture of open communication, where workers feel comfortable sharing ideas, concerns, and feedback. It promotes mutual respect, trust, and inclusivity, leading to better collaboration and problem-solving.

Adaptability is essential in the dynamic construction environment. Active listening keeps workers informed about changes, updates, and unexpected challenges. Being receptive to new information enables them to adjust their approach and work efficiently, ensuring project progress remains on track.

Moreover, active listening enables construction professionals to build strong relationships with team members, clients, and stakeholders. By understanding and acknowledging others' perspectives, workers demonstrate empathy and enhance client satisfaction

Overall, active listening at a construction site enhances safety, teamwork, productivity, and client relations. It empowers workers to communicate effectively, respond to challenges proactively, and contribute to the successful completion of construction projects.

5.1.4 Teamwork at Workplace

Teamwork is of utmost importance in various aspects of life, whether it's in the workplace, sports, education, or personal relationships.

Fig. 5.1.6 Teamwork at Workplace

Here are some key reasons highlighting the importance of teamwork:

- **Achievement of Common Goals:** Teamwork brings together individuals with diverse skills and expertise to work collectively towards a shared objective. When team members collaborate effectively, they can accomplish more than what could be achieved individually.
- **Enhanced Creativity and Innovation:** Working in a team allows for the exchange of different perspectives and ideas. This diversity fosters creativity and innovative problem-solving, leading to better solutions and approaches.
- **Improved Productivity:** Team members can divide tasks based on their strengths and expertise, leading to improved efficiency and productivity. This distribution of workload ensures that each aspect of a project is handled by the most suitable team member.
- **Shared Responsibility and Accountability:** In a team, each member has a specific role and responsibility. This sense of accountability motivates individuals to perform their best and take ownership of their contributions.
- **Effective Decision Making:** Teams can pool their knowledge and insights to make well-informed decisions. When diverse viewpoints are considered, the decisions tend to be more balanced and comprehensive.
- **Support and Motivation:** Team members can provide emotional support and motivation to each other, boosting morale during challenging times and celebrating achievements together.
- **Learning and Skill Development:** Teamwork allows individuals to learn from one another, acquire new skills, and improve existing ones. This continuous learning enhances personal and professional growth.

- **Building Trust and Camaraderie:** Effective teamwork strengthens the bond between team members, fostering trust, respect, and camaraderie. This positive team dynamic contributes to a harmonious work environment.
- **Adaptability and Resilience:** Teams are often better equipped to handle changes and uncertainties as they can brainstorm strategies and adapt collectively to new situations.
- **Efficient Problem Solving:** When faced with complex challenges, teamwork enables the pooling of resources and expertise, leading to more comprehensive and efficient problem-solving.
- **Synergy and Performance: T**he collective efforts of a high-performing team create a synergy where the overall performance is greater than the sum of individual contributions.
- **Improved Work-Life Balance:** Effective teamwork can distribute workloads and responsibilities, reducing the burden on individual team members and promoting a better work-life balance.

In conclusion, teamwork is vital for achieving success, fostering innovation, and creating a positive and supportive work culture. Emphasizing the importance of teamwork enables organizations and individuals to harness the full potential of collaboration, leading to remarkable achievements and overall well-being.

5.1.5 The 5Cs of Teamwork

The 5Cs of teamwork are fundamental principles that contribute to effective and successful collaboration within a team. These principles help create a positive team dynamic and foster a cohesive and high-performing group.

The 5Cs of teamwork are:

1. **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.

Fig. 6.1.7 Effective and Successful Collaboration

2. **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.

3. **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.

4. **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.

5. **Commitment**

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

By embracing the 5Cs of teamwork, teams can cultivate an environment of trust, respect, and collaboration, leading to enhanced performance and achievement of shared objectives.

5.1.6 Consequence of Poor Teamwork

Poor teamwork at a construction site can have significant consequences that impact project outcomes, timelines, safety, and overall project success.
Some of the key consequences of poor teamwork include:

- **Delayed Project Completion:** Lack of effective collaboration and coordination among team members can lead to delays in project progress. When tasks are not properly assigned or synchronized, the project timeline may be extended, resulting in increased costs and client dissatisfaction.

Fig. 6.1.8 Poor Teamwork

- **Reduced Productivity:** Poor teamwork can result in inefficiencies and a decrease in overall productivity. Team members may duplicate efforts, make mistakes due to miscommunication, or lack the support needed to perform their tasks efficiently.

- **Lower Quality Work:** Inadequate teamwork can lead to a decline in the quality of work performed. Without effective collaboration and accountability, errors and defects may go unnoticed, compromising the final deliverables.

- **Increased Rework:** Miscommunication and lack of coordination can result in rework and additional costs. Correcting mistakes and addressing issues that arise due to poor teamwork can be time-consuming and financially burdensome.
- **Safety Hazards:** Construction sites are inherently hazardous environments, and poor teamwork can exacerbate safety risks. When team members fail to communicate effectively or work together safely, it can lead to accidents, injuries, and even fatalities.
- **Conflict and Tension:** Poor teamwork may create a negative work environment characterized by conflict, tension, and lack of trust among team members. This can hamper communication and cooperation, further hindering progress.
- **Budget Overruns:** When teamwork is lacking, projects may experience cost overruns due to inefficiencies, rework, and delays. This can strain the project budget and negatively impact the overall financial performance.
- **Missed Opportunities:** Poor teamwork can result in missed opportunities for innovation, improvement, and optimization. Team members may not leverage their collective expertise and diverse perspectives to identify and capitalize on potential opportunities.
- **Client Dissatisfaction:** Clients expect a well-coordinated and smoothly executed project. Poor teamwork can lead to client dissatisfaction due to missed deadlines, quality issues, and breakdowns in communication.
- **Reputation Damage:** Repeated instances of poor teamwork on construction projects can damage the reputation of the construction company, leading to a loss of trust among clients and stakeholders.

In summary, poor teamwork at a construction site can have serious consequences on project outcomes, timelines, safety, and overall project success. It is essential for construction teams to prioritize effective collaboration, communication, and coordination to mitigate these adverse effects and ensure the successful completion of projects.

Notes

Unit 5.2: Working Effectively and Maintaining Discipline at Work

Unit Objectives

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

1. Explain the importance of creating healthy and cooperative work environment among the gangs of workers.
2. Elucidate applicable techniques of work, properties of materials used, tools and tackles used, safety standards that co-workers might need as per the requirement.
3. Explain the importance of proper and effective communication and the expected adverse effects in case of failure relating to quality, timeliness, safety, risks at the construction project site.
4. Explain the importance and need of supporting co-workers facing problems for the smooth functioning of work.
5. Demonstrate ways to hand over the required material, tools, tackles, equipment and work fronts timely to interfacing teams.
6. Demonstrate ways to work together with co-workers in a synchronized manner.

5.2.1 Discipline at Work

Discipline at work refers to the adherence to rules, policies, and professional standards within a workplace. It involves employees maintaining a responsible and focused approach to their work duties, following established protocols, and upholding ethical principles.

Here are some key aspects of discipline at work:

- **Punctuality:** Being punctual is a fundamental aspect of discipline. Employees are expected to arrive at work and meetings on time, ensuring smooth operations and respect for others' time.
- **Following Policies and Procedures:** Employees must follow the company's policies, procedures, and guidelines related to various aspects of work, such as safety, communication, and data privacy.

- **Professional Conduct:** Discipline at work involves maintaining professional conduct and demeanor in all interactions with colleagues, clients, and stakeholders.
- **Meeting Deadlines:** Adhering to deadlines and delivering work on time is a critical aspect of discipline, as it ensures the timely completion of projects and tasks.
- **Respect for Authority:** Discipline requires showing respect for supervisors, managers, and leadership, following their directions, and seeking guidance when needed.
- **Self-Discipline:** Individual employees should possess self-discipline to stay focused on their tasks, avoid distractions, and prioritize their responsibilities.
- **Quality of Work:** Disciplined employees take pride in their work and strive for excellence, ensuring the delivery of high-quality output.
- **Compliance with Company Values:** Employees should align their actions with the company's values and ethical standards, promoting a culture of integrity and trust.
- **Conflict Resolution:** Handling conflicts and disagreements in a respectful and constructive manner is an essential part of discipline, maintaining a harmonious work environment.
- **Accountability:** Disciplined employees take ownership of their actions, admit mistakes, and work towards rectifying any errors they may make.
- **Adherence to Dress Code:** Following the organization's dress code and appearance guidelines contributes to maintaining a professional and cohesive image.
- **Attendance and Leave Management:** Discipline includes managing attendance and leave in accordance with company policies and providing prior notice when taking time off.
- **Use of Resources:** Disciplined employees use company resources responsibly and efficiently, avoiding wastage and abuse.

Discipline at work is crucial for creating a productive and positive work environment. It fosters a sense of responsibility, reliability, and accountability among employees, leading to improved performance and overall organizational success. Employers should also provide clear expectations, guidance, and support to encourage and reinforce a culture of discipline within the workplace.

5.2.2 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.

Fig. 6.1.8 Poor Teamwork

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 your company's staff turnover.

Time management at construction by workers is essential for ensuring that individual tasks and responsibilities are completed efficiently, contributing to the overall success of the project. Here are some time management tips that construction workers can follow to optimize their productivity:

- **Daily Planning:** Begin each workday with a clear plan of tasks to be completed. Prioritize the most critical tasks and allocate time accordingly.
- **Set Goals and Deadlines:** Set specific and achievable goals for each workday or week. Establish personal deadlines for completing tasks to stay focused and motivated.
- **Minimize Distractions:** Limit distractions during work hours, such as personal phone use or excessive socializing. Stay dedicated to tasks at hand to maximize productivity.
- **Use Tools and Equipment Efficiently:** Familiarize yourself with the tools and equipment required for each task and use them efficiently to avoid wasted time.
- **Organize Work Area:** Keep your work area clean and organized. A well-organized workspace minimizes the time spent searching for tools or materials.
- **Time Tracking:** Track the time spent on each task to identify areas where efficiency can be improved and to better estimate future project timelines.
- **Collaborate with Team Members:** Communicate and coordinate with other team members effectively to ensure a smooth workflow and prevent delays caused by miscommunication.
- **Break Tasks into Smaller Steps:** For larger tasks, break them down into smaller, manageable steps. This approach helps in maintaining focus and progress.
- **Take Short Breaks:** Incorporate short breaks into your workday to recharge and avoid burnout. However, ensure that the breaks are kept within reasonable limits to maintain productivity.
- **Adapt to Changes:** Construction projects often encounter unforeseen challenges or changes. Be flexible and adaptable to adjust your schedule as needed without compromising quality.
- **Avoid Multitasking:** Instead of trying to tackle multiple tasks simultaneously, focus on completing one task at a time to ensure better quality and efficiency.
- **Learn Time-Saving Techniques:** Seek out and learn time-saving techniques specific to your tasks or trade. Efficiency comes with experience and knowledge.
- **Seek Feedback:** Ask for feedback from supervisors or experienced colleagues on ways to improve your time management skills.
- **Reflect and Improve:** Regularly assess your time management and productivity. Identify areas for improvement and actively work towards refining your approach.

By implementing these time management practices, construction workers can optimize their work efficiency, meet project deadlines, and contribute to the overall success of the construction project.

5.2.3 Interpersonal Conflicts at Construction by Workers

Interpersonal conflicts among construction workers can arise due to various reasons, and if left unaddressed, they can negatively impact the work environment, team morale, and project progress.

Some common causes of interpersonal conflicts at construction sites include:

- **Communication Issues:** Miscommunication, misunderstandings, or poor communication skills can lead to conflicts among workers, especially when instructions are unclear or not effectively conveyed.
- **Differences in Work Styles:** Workers may have different approaches to completing tasks, leading to clashes in how work should be performed.
- **Competition for Resources:** Limited resources, such as tools, equipment, or materials, can create tensions and conflicts when workers need to share or prioritize their use.
- **Personal Differences:** Diverse backgrounds, personalities, and work habits can lead to clashes in values, beliefs, and interpersonal dynamics.
- **Role Ambiguity:** Unclear or overlapping roles and responsibilities can cause conflicts between workers who are unsure about their tasks or areas of authority.
- **Working Conditions:** Challenging working conditions, tight deadlines, and long hours can contribute to stress and tensions among workers.
- **Safety Concerns:** Differences in safety practices or attitudes towards safety can lead to conflicts, especially when one worker perceives another's actions as risky.
- **Leadership Issues:** Conflicts can arise when workers feel their supervisors or managers are not effectively leading or addressing issues.
- **Past Conflicts or Grudges:** Lingering issues from past conflicts that were not adequately resolved can resurface and escalate over time.

Fig. 5.2.3 Interpersonal Conflicts

To manage and resolve interpersonal conflicts at construction sites, the following steps can be taken:

- **Open Communication:** Encourage open and honest communication among workers to address concerns and resolve misunderstandings promptly.
- **Conflict Resolution Training:** Provide conflict resolution training to workers to equip them with skills to address and resolve conflicts constructively.
- **Establish Clear Roles and Expectations:** Clearly define roles, responsibilities, and performance expectations to reduce ambiguity and prevent conflicts.
- **Promote Team Building:** Organize team-building activities to foster better understanding and collaboration among workers.
- **Mediation and Third-Party Intervention:** Utilize mediation or involve a neutral third party to help facilitate discussions and find solutions when conflicts are difficult to resolve within the team.
- **Encourage Respect and Empathy:** Foster a culture of respect and empathy where workers understand and appreciate each other's perspectives and backgrounds.
- **Address Safety Concerns:** Ensure that safety protocols are well-communicated and followed to reduce safety-related conflicts.
- **Regular Feedback and Performance Reviews:** Provide regular feedback and conduct performance reviews to address any performance-related conflicts.

By proactively addressing interpersonal conflicts and promoting a positive work culture, construction teams can maintain a harmonious work environment, improve collaboration, and enhance overall project outcomes.

Fig. 5.2.4 Positive Work Culture

Notes

Unit 5.3:Working Effectively and Maintaining Discipline at Work

Unit Objectives

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

1. Discuss the fundamental concept of gender equality.
2. Explain how to recognise and be sensitive to issues of disability culture and gender.
3. Discuss legislation, policies, and procedures relating to gender sensitivity and cultural diversity including their impact on the area of operation.
4. Demonstrate effective implementation of gender-neutral practices at the workplace.
5. Demonstrate ways to address discriminatory and offensive behaviour in a professional manner as per organizational policy.

5.1.1 Communication at Workplace

Gender sensitivity is the act of being sensitive towards people and their thoughts regarding gender. It ensures that people know the accurate meaning of gender equality, and one's gender should not be given priority over their capabilities.

Women are an important source of labour in many sectors, yet they have limited access to resources and benefits. Women should receive the same benefits and access to resources as men. A business can improve its productivity and quality of work by providing better support and opportunities to women.

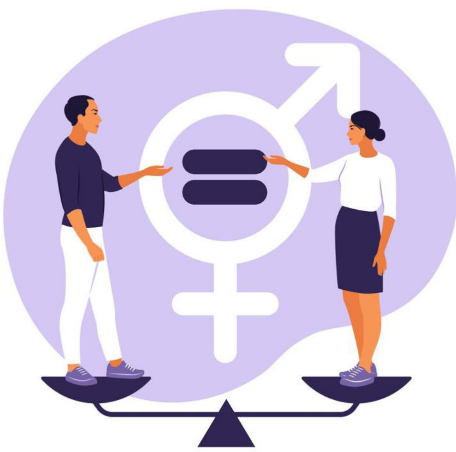

Fig. 5.2.4 Positive Work Culture

Important Terms

- Gender Sensitivity-Gender sensitivity is the act of being sensitive to the ways people think about gender.

- **Gender Equality:** It means persons of any gender enjoy equal opportunities, responsibilities, and rights in all areas of life.
- **Gender Discrimination:** It means treating an individual unequally or disadvantageously based on their gender, e.g. paying different wages to men and women for similar or equal job positions.

Fig. 5.2.4 Positive Work Culture

Strategies for Enhancing Gender Equity

To enhance gender equity, one should:

- Follow gender-neutral practices at all levels at work.
- Participate together in decision-making.
- Help in promoting women's participation in different forums.
- Assist women in getting exposure to relevant skills and practices.
- Assist women in capacity building by mentoring, coaching or motivating them, as appropriate.
- Assist in the formation and operation of women support groups.
- Assist in the implementation of women-centric programmes.
- Combine technical training with reproductive health and nutrition for coffee farming households.
- Assist in making a work environment that is healthy, safe, and free from discrimination.

Bridging Gender Differences

Men and women react and communicate very differently. Thus, there are some work differences as both genders have their style and method of handling a situation.

Although, understanding and maturity vary from person to person, even between these genders, based on their knowledge, education, experience, culture, age, and upbringing, as well as how one's brain functions over a thought or problem.

In order to bridge the gap, one should:

- Not categorize all men and women in one way.

- Be aware of the verbal and non-verbal styles of communication of every gender to avoid any miscommunication and work better.
- Be aware of partial behaviour and avoid it.
- Encourage co-workers of different genders to make room by providing space to others.
- Ways to reduce Gender Discrimination
- Effective steps against sexual harassment by the concerned authorities and general public.
- Gender stereotypes are how society expects people to act based on their gender. This can only be reduced by adopting appropriate behaviour and the right attitude.
- Objectification of females must be abolished.

Fig. 5.2.4 Positive Work Culture

Ways to Promote Gender Sensitivity in the Workplace

- Practices that promote gender diversity should be adopted and promoted.
- All genders should receive equal responsibilities, rights, and privileges.
- All genders should have equal pay for similar or the same job roles/ positions.
- Strict and effective workplace harassment policies should be developed and implemented.
- An open-minded and stress-free work environment should be available to all the employees, irrespective of their gender.
- Women should be encouraged to go ahead in every field of work and assume leadership roles.
- Follow appropriate measures for women's empowerment.
- Men should be taught to be sensitive to women and mindful of their rights.

5.3.2 PwD Sensitivity

Some individuals are born with a disability, while others may become disabled due to an accident, illness or as they get old. People with Disabilities (PwD) may have one or more areas in which their functioning is affected. A disability can affect hearing, sight, communication, breathing, understanding, mobility, balance, and concentration or may include the loss of a limb. A disability may contribute to how a person feels and affect their mental health.

Fig. 5.3.4 Disability-Friendly Workplace

Important Terms

- Persons with Disabilities (PwD) – Persons with Disabilities means a person suffering from not less than 40% of any disability as certified by a medical authority.
- **Types of Disability:**
    a) Blindness – Visually impaired
    b) Low Vision
    c) Leprosy Cured
    d) Hearing impairment
    e) Locomotor disability
    f) Mental retardation
    g) Mental illness

PwD Sensitivity

PwD sensitivity promotes empathy, etiquette and equal participation of individuals and organizations while working with individuals with a disability, e.g. sensory, physical or intellectual.

Ways to be PwD Sensitive

To be sensitive to PwD, one should:

- Be respectful to all Persons with Disabilities (PwD) and communicate in a way that reflects PwD sensitivity.
- Always be supportive and kind towards a PwD with their daily chores.
- Be ready to assist a PwD to help them avail of any benefit/ livelihood opportunity/ training or any kind that helps them grow.
- Encourage and try to make things easier and accessible to PwD so that they can work without or with minimum help.
- Protest where feasible and report any wrong act/behaviour against any PwD to the appropriate authority.
- Learn and follow the laws, acts, and policies relevant to PwD.
- Appropriate Verbal Communication
- As part of appropriate verbal communication with all genders and PwD, one should:
- Talk to all genders and PwD respectfully, maintaining a normal tone of voice with appropriate politeness. It is important to ensure one's tone of voice does not have hints of sarcasm, anger, or unwelcome affection.
- Avoid being too self-conscious concerning the words to use while also ensuring not to use words that imply one's superiority over the other.
- Make no difference between a PwD and their caretaker. Treat PwD like adults and talk to them directly.
- Ask a PwD if they need any assistance instead of assuming they need it and offering assistance spontaneously.

Appropriate Non-verbal Communication

Non-verbal communication is essentially the way someone communicates through their body language. These include:

- **Facial expressions -** The human face is quite expressive, capable of conveying many emotions without using words. Facial expressions must usually be maintained neutral and should change according to the situation, e.g. smile as a gesture of greeting.
- **Body posture and movement -** One should be mindful of how to sit, stand, walk, or hold their head. For example - one should sit and walk straight in a composed manner. The way one moves and carries self, communicates a lot to others. This type of non-verbal communication includes one's posture, bearing, stance, and subtle movements.
- **Gestures -** One should be very careful with their gestures, e.g. waving, pointing, beckoning, or using one's hands while speaking. One should use appropriate and positive gestures to maintain respect for the other person while being aware that a gesture may have different meanings in different cultures.
- **Eye contact -** Eye contact is particularly significant in non-verbal communication. The way someone looks at someone else may communicate many things, such as interest, hostility,

affection or attraction. Eye contact is vital for maintaining the flow of conversation and for understanding the other person's interest and response. One should maintain appropriate eye contact, ensuring not to stare or look over the shoulders. To maintain respect, one should sit or stand at the other person's eye level to make eye contact.

- **Touch -** Touch is a very sensitive type of non-verbal communication. Examples are - handshakes, hugs, pat on the back or head, gripping the arm, etc. A firm handshake indicates interest, while a weak handshake indicates the opposite. One should be extra cautious not to touch others inappropriately and avoid touching them inadvertently by maintaining a safe distance.

Rights of PwD

PwD have the right to respect and human dignity. Irrespective of the nature and seriousness of their disabilities, PwD have the same fundamental rights as others, such as:

- Disabled persons have the same civil and political rights as other people
- Disabled persons are entitled to the measures designed to enable them to become as self-dependent as possible
- Disabled persons have the right to economic and social security
- Disabled persons have the right to live with their families or foster parents and participate in all social and creative activities.
- Disabled persons are protected against all exploitation and treatment of discriminatory and abusive nature.

Making Workplace PwD Friendly

- One should not make PwD feel uncomfortable by giving too little or too much attention
- One should use a normal tone while communicating with a PwD and treat them as all others keeping in mind their limitations and type of disability
- Any help should be provided only when asked for by a PwD
- One should help in ensuring the health and well-being of PwD.

Expected Employer Behaviour

Some of the common behavioural traits that employees expect from their employers are:

- **Cooperation:** No work is successful without cooperation from the employer's side. Cooperation helps to understand the job role better and complete it within the given timeline.
- **Polite language:** Polite language is always welcomed at work. This is a basic aspect that everybody expects.
- **Positive Attitude:** Employers with a positive attitude can supervise the work of the employees and act as a helping hand to accomplish the given task. A person with a positive attitude looks at the best qualities in others and helps them gain success.
- **Unbiased behaviour:** Employers should always remain fair towards all their employees. One should not adopt practices to favour one employee while neglecting or ignoring the other. This

might create animosity among co-workers.

- **Decent behaviour:** The employer should never improperly present oneself before the employee. One should always respect each other's presence and behave accordingly. The employer should not speak or act in a manner that may make the employee feel uneasy, insulted, and insecure.

Fig. 5.3.5 Ramp for PwD Persons

Exercise

Answer the following Questions:

A. Short Questions:

1. Why is effective communication important in construction job roles?
2. What are the consequences of poor teamwork on project outcomes and safety at a construction site?
3. How can you pass on work-related information clearly to your team members?
4. What are some different modes of communication used in the workplace?
5. Why is creating a healthy and cooperative work environment important among gangs of workers?

B. Fill-in-the-Blanks Questions:

1. _________________ (Effective / Limited) communication ensures that project goals and tasks are understood by everyone.
2. Poor teamwork can lead to delays, compromised _________________ (Quality / Efficiency), and increased safety risks.
3. To ensure clarity, it's essential to provide work-related information to team members in a _________________ (Concise / Detailed) manner.
4. Communication modes include verbal, written, visual, and _________________ (Digital / Auditory) forms.
5. Creating a cooperative work environment fosters efficient collaboration and _________________ (Unity / Isolation) among workers.

C. True/False Questions:

1. Effective communication is only important for supervisory roles. (True/False)
2. Poor teamwork rarely affects project timelines or safety on a construction site. (True/False)
3. Passing on work-related information is not necessary if everyone has their own tasks. (True/False)
4. Communication modes in the workplace are limited to verbal and written forms. (True/False)
5. A cooperative work environment can enhance productivity and worker morale. (True/False)

Notes

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6. Plan And Organize Work to Meet Expected Outcomes

Unit 6.1 - Planning and Organizing Work Activities

Unit 6.2 - Efficient Implementation and Resource Management

CON/N8002

Key Learning Outcomes

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

1. Explain the importance of proper housekeeping including safe waste disposal.
2. Discuss policies, procedures and work targets set by superiors.
3. Explain how to identify work activities that need to be planned and organized.
4. Explain how to determine the task requirements.
5. Explain how to determine the quality requirements related to the task.
6. Elucidate how to undertake all aspects of planning and organizing the task, including interpretation of task, reading drawings/schedules, arranging resources, reporting problems etc.
7. Explain how to implement the planned activities.
8. Demonstrate ways to determine the work requirements corresponding to the task (drawings/ schedules/instructions/methodology), safety, tools and equipment prior to the commencement of the task.
9. Show how to prepare the work areas in coordination with team members.
10. Demonstrate the procedures for organizing the required materials, tools and tackles required for the task.
11. Demonstrate how to use resources in an optimum manner to avoid any unnecessary wastage. Demonstrate the practices to use tools, tackles, and equipment carefully to avoid damage.
12. Show how to clean and organize the workplace after completion of tasks.

UNIT 6.1: Planning and Organizing Work Activities

Unit Objectives

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

1. Explain the importance of proper housekeeping, including safe waste disposal.
2. Discuss policies, procedures, and work targets set by superiors.
3. Explain how to identify work activities that need to be planned and organized.
4. Explain how to determine the task requirements.
5. Explain how to determine the quality requirements related to the task.
6. Elucidate how to undertake all aspects of planning and organizing the task, including interpretation of task, reading drawings/schedules, arranging resources, reporting problems etc.

6.1.1. Importance of proper housekeeping, including safe waste disposal

The importance of proper housekeeping, including safe waste disposal, in the context of construction and carpentry work cannot be overstated. It goes beyond maintaining a clean and organized workspace; it directly impacts safety, efficiency, and the overall success of a project. Here are some key reasons why proper housekeeping and waste disposal are crucial:

- **Safety of Workers:** A clutter-free and well-organized work area reduces the risk of accidents and injuries. Trips, falls, and other mishaps are minimized when tools, materials, and debris are properly stored and managed.
- **Preventing Hazards:** Disorganized or improperly stored materials can create hazards such as fire risks, sharp objects, or toxic substances. Proper housekeeping minimizes these risks and promotes a safe work environment.
- **Efficiency:** When tools, equipment, and materials are organized and easily accessible, workers can perform tasks more efficiently. Time that might be wasted searching for items can instead be used productively.
- **Enhanced Productivity:** A clean and organized workspace can boost the morale and motivation of workers. They can focus more on their tasks, resulting in increased productivity and better-quality work.
- **Quality Control:** Proper housekeeping helps prevent dust, debris, and contaminants from affecting the quality of the finished work. Clean surfaces and controlled environments lead to better outcomes.
- **Compliance with Regulations:** Many construction sites are subject to regulations and standards related to cleanliness and waste management. Proper housekeeping ensures compliance with

these regulations, avoiding potential fines or legal issues.

- Preventing Cross-Contamination: Separating waste materials from usable materials helps prevent cross-contamination. This is particularly important in construction, where different materials often coexist in the same space.
- Environmental Impact: Proper waste disposal, including recycling and responsible disposal of hazardous materials, contributes to environmental sustainability and reduces the impact of construction on the ecosystem.
- Professionalism: A clean and well-maintained work area reflects professionalism and a commitment to quality work. It creates a positive impression on clients, inspectors, and visitors.
- Project Management: Organized workspaces make it easier for project managers to track progress and allocate resources effectively. This leads to better project planning and execution.

6.1.2 Policies, procedures, and work targets set by superiors

In the context of construction activities specific to a Shuttering Carpenter, the establishment of clear policies, procedures, and work targets by superiors is crucial to ensuring efficient and safe operations. Here's how these elements apply to the role of a Shuttering Carpenter:

Policies:

- **Safety Policies:** Superiors should establish safety policies that outline mandatory safety measures and practices for Shuttering Carpenters. This includes guidelines for working at heights, using personal protective equipment (PPE), and adhering to construction site safety protocols.
- **Quality Standards:** Policies should specify the quality standards expected in the construction of formwork. This includes guidelines for accurate measurements, precise angles, and proper alignment to ensure the structural integrity of concrete components.
- **Environmental Policies:** Shuttering Carpenters may encounter policies related to waste disposal, recycling, and minimizing the environmental impact of construction materials.

Procedures:

- **Formwork Construction Procedures:** Detailed procedures should be provided for constructing different types of formwork structures. This includes step-by-step instructions for assembling and installing formwork components accurately.
- **Material Handling Procedures:** Procedures for handling and transporting materials, such as lumber, plywood, and scaffolding, are essential to prevent damage and ensure efficient utilization.
- **Safety Procedures:** Specific safety procedures must be outlined, covering aspects like securing the formwork, using fall protection equipment, and working in confined spaces.
- **Inspection and Maintenance Procedures:** Regular inspection and maintenance procedures should be established to ensure that formwork remains in good condition throughout the construction process.

Work Targets:

- **Formwork Completion Targets:** Shuttering Carpenters might have targets to complete a specific number of formwork structures within a given timeframe, aligning with the project schedule.
- **Quality Targets:** Work targets could emphasize the achievement of high-quality formwork with precise measurements, minimal defects, and proper alignment to meet engineering specifications.
- **Safety Targets:** Meeting safety targets involves strict adherence to safety procedures, zero incidents of non-compliance with safety measures, and proactive identification of potential **hazards.**
- **Efficiency Targets:** Work targets might focus on increasing work efficiency by optimizing material usage, minimizing wastage, and streamlining construction processes.
- **Project Milestones:** Work targets could align with critical project milestones, ensuring that formwork construction progresses in alignment with the overall project timeline.

6.1.3 Prioritize Work

Prioritize work means evaluating the group of work and doing first thing first. Examples of how to Prioritize work are mentioned below:

1. **Collect a list of work:** Gather all the list of work to be done within time frame. While prioritizing the work need not worry about the order or the number of item.

   List of tasks for shuttering work:

   - Understanding layout
   - Selection and collection of tools and materials
   - Measurement and marking on shutter panels
   - Making shutter molds
   - Fixing of shutter panels
   - Fixing walers with the shutter panels

Dismantling of shutter panels

2. **Distinguish urgent vs. important:** Distinguish urgent vs important: The next step should be consider to identify the task that need immediate attention, i.e. if not finished in limited time will have serious negative consequences.
3. **Assess Value:** Among all find out the task that carries the highest value to work. As a general always recognize exactly which types of task have priority over the others to get the maximum output.

4. **Order tasks by estimated effort:** After identification of task on the basis of importance, the further step to be followed is calculate the estimated effort need to complete the work. Also, to increase the productivity it is good tactic of starting the lengthier task first.

5. **Be flexible and adaptable:** In a common practice priority of work can be change time to time just because of uncertainty and requirements. So, for smooth run of work it is best practice to be flexible and adaptable towards work and surroundings.

6. **Know when to cut:** It is difficult to complete the all task from your list. So, after finalizing the priority and estimates cut all the remaining task and focus to achieve the priorities that must and can complete for the day.

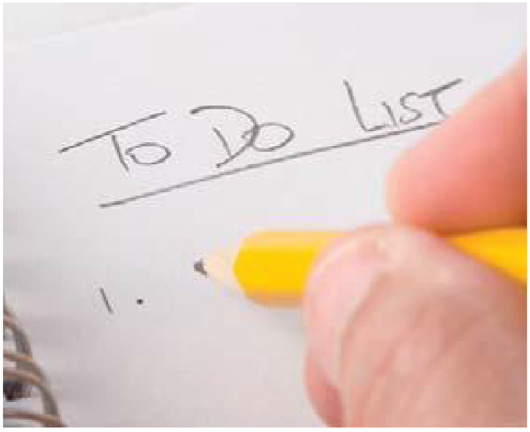

Fig 6.1.1: To-do list

Fig 6.1.2: Identifying priority work

6.1.4 Optimizing Work

Schedule: Scheduling means plan an activity to take place at a particular time. Schedule should always be little flexible. The benefits of scheduling are:

- Helps in increasing efficiency.
- Helps in decreasing stress
- Achievement of desired results as per deadlines.

While scheduling one should remember to:

- Analyze how much time each task will take and schedule the task accordingly.
- Plan in such a way that multiple jobs are not assigned to the same timeline unless planning to multitask.
- It is essential to share the prepared schedule with team members for successful execution of tasks.

Multitask: Multitasking means the art of doing multiple tasks at the same time. To multitask efficiently, following things should be taken care:

- Allot time to routine activities before juggling with two or three tasks.

- Combine the correct activities for efficient multitasking.
- Review how multitasking affects performance of tasks.

Track the work Progress: The progress of work can be tracked by

- Reviewing work progress at regular intervals.
- Analyzing the performance and making amendments to the scheduling of tasks so as to streamline the plan.
- Finding out the reasons for deviation from the schedule.
- Shuffling the order of tasks to avoid boredom without affecting the sequence.

Fig 6.1.3: work schedule

6.1.5 Planning And Organizing Work

Planning and organizing makes simple and most efficient use of time for work and also help to focused on work from beginning to end. Following points should follow while planning and organizing work:

Step 1: Identify the scope and goals of each work. Also, identify the employees who will play the role in the task if it is a team project.

Step 2: Divide the major work into number of parts and organize to take for completion. Assign the task to each person a role and specific responsibilities to complete faster.

Step 3: Establish the timeline for completing the work activity. Give yourself enough time to complete all associated tasks before the deadline passes.

Step 4: Write-down each due date for the project tasks on your calendar.

Step 5: Make an action plan to avoid any potential problems to keep the project on track.

Step 6: Plan and organize meeting and make active participation. Collect all the feedback and execute as per requirement.

Step 7: Send out Clear message and updates to all other collogue who are working on the projects.

Material Planning

Material planning involves checking the availability of all the raw materials that would be required in the concreting process and to ensure that they are available as and when required. The basic materials required in shuttering work are:

- Shutter panels
- Walers
- Releasing agent

The shuttering carpenter should check with his supervisor that all these are available on the site in the required quantity.

- The quality of the materials is as per the standards.
- They are located at comfortable distance from the site so that transportation does not cause un-necessary delay.
- They are stored as per the correct stacking and storing guidelines.
- In case there is shortage of material, it should immediately report to the supervisor well in advance and get them sourced before the work begins.

Fig 6.1.4: Shutter Panels

Fig 6.1.5: Planning work schedule

Proper material planning helps in:

- Proper utilization of manpower as they will not have to sit ideal due to unavailability of materials.
- Reducing the project cost by minimizing delay.

- Helps in achieving the deadlines.
- Reduces the wastage of material due to unavailability of other necessary material.

Work Planning

- Divide the work among the team members
- Distribute the work as per individual capability and skills.
- Ensure sufficient number of manpower is allocated to each task so that the work gets completes as planned.
- Allot all the necessary tools and equipment's to the members.
- Organize work output such that no process causes delay for the other.
- Provide guidance to the team members as and when required.

Notes

UNIT 6.2: Efficient Implementation and Resource Management

Unit Objectives

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

1. Demonstrate ways to determine the work requirements corresponding to the task (drawings/ schedules/instructions/methodology), safety, tools and equipment prior to the commencement of the task.
2. Show how to prepare the work areas in coordination with team members.
3. Demonstrate the procedures for organizing the required materials, tools and tackles required for the task.
4. Demonstrate how to use resources in an optimum manner to avoid any unnecessary wastage.
5. Demonstrate the practices to use tools, tackles, and equipment carefully to avoid damage.
6. Show how to clean and organize the workplace after completion of tasks.

6.2.1 Organization Of Resources

Organizing is a process of engaging physical, financial and human resources and developing a productive relationship amongst them for the purpose of completing a given task. Organizing and planning are the two most important factors for efficient and successful job. Organizing includes:

- Identification of activities.
- Classification and grouping of activities.
- Identification of appropriate tools, equipment and materials before starting work.
- Identification and arranging proper Manpower.
- Assignment of duties to appropriate people.
- Creation and delegation of responsibilities among co-workers for completion of work.
- Coordination of work among the team and across teams.
- Organizing training or providing guidelines to avoid damage of equipment's.
- Planning and organizing work environment to avoid accidents.
- Organizing resources to avoid waste of materials.

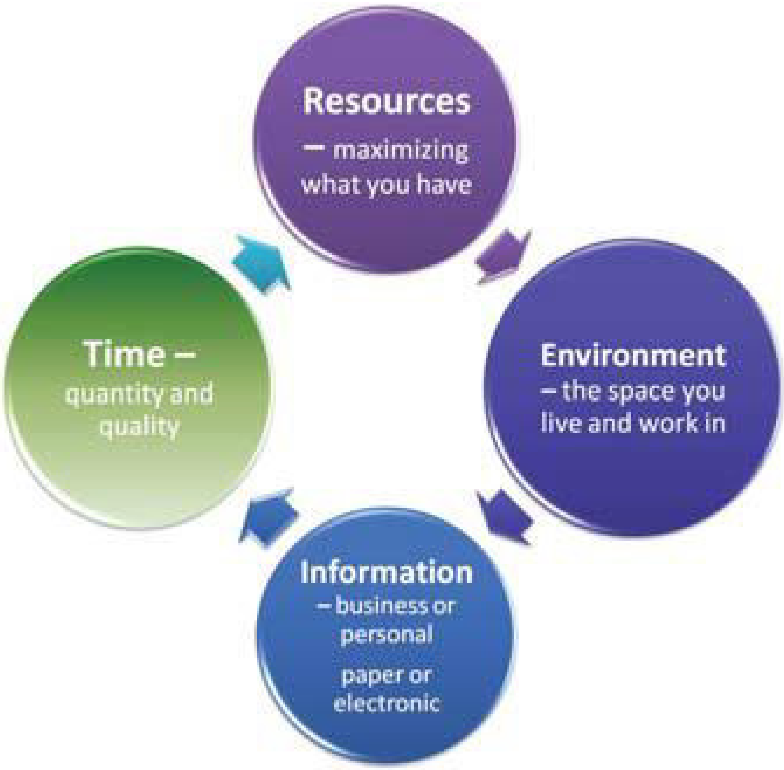

Fig 6.2.1: Resource organization

Benefits of Organizing

Being organized helps to

- Make better decisions.
- Identify available resources.
- Anticipate needs and problems.
- Get work done accurately by avoiding costly mistakes.
- Be more efficient and productive.
- Complete desired tasks and activities.

Fig 6.2.2: Organization of resource

Controlling

The motivation behind controlling is to guarantee that everything goes according to set rules and guidelines. A productive arrangement of control predicts deviations before they really happen.

Steps for Controlling

- Establishing a plan
- Measuring actual work progress at regular intervals
- Comparing actual work done with the plan and identifying the gaps if any

- Analyzing the performance and making amendments to the scheduling of tasks so as to streamline the plan
- Finding out the reasons for deviation from the schedule
- Taking corrective measures to rectify the deviation

Fig 6.2.3: Resource organization

Optimizing use of Resources

Resources can be used in an optimum way by following the guidelines mentioned below.

- Analyze the capabilities of individuals and the characteristics job requirements
- Match the right people with the right job
- Rotate jobs to avoid boredom
- Rotate people to give them varied experience and training opportunities
- Make provisions for absenteeism

6.2.2 Practicing the careful use of tools, tackles, and equipment

Practicing the careful use of tools, tackles, and equipment is crucial to ensure their longevity, maintain safety, and produce quality work. Here are the steps to follow:

Familiarize Yourself:

- Before using any tool or equipment, read the manufacturer's instructions, safety guidelines, and specifications.
- Understand the purpose and functionality of each tool, tackle, or equipment you'll be using.

Inspect Regularly:

- Before each use, visually inspect tools, tackles, and equipment for signs of wear, damage, or malfunction.
- Check for loose parts, cracks, rust, or any other issues that could affect performance.

Use the Right Tool for the Job:

- Select the appropriate tool or equipment for the specific task at hand.
- Using the wrong tool can lead to inefficiency, damage, or even safety hazards.

Handle with Care:

- Always handle tools and equipment gently. Avoid dropping, throwing, or mishandling them.
- Carry tools properly, using handles or designated grips.

Avoid Overexertion:

- Do not force tools beyond their designed capacity. If a tool feels strained, stop using it and find an alternative solution.

Follow Proper Techniques:

- Use tools and equipment as instructed. Follow correct techniques to avoid strain on the tool and your body.
- Use proper posture and positioning to prevent unnecessary wear on tools.

Keep Tools Clean:

- Regularly clean tools and equipment after use. Remove dirt, dust, and debris to prevent clogs, corrosion, and deterioration.

Store Correctly:

- Store tools and equipment in designated places, away from moisture, extreme temperatures, and direct sunlight.
- Use toolboxes, racks, or hooks to prevent tools from coming into contact with each other.
- Secure During Transport:
- If tools need to be transported, secure them properly to prevent shifting, impacts, or damage during transit.

Use Protective Measures:

- Utilize protective accessories such as guards, covers, or cases when applicable.
- Wear personal protective equipment (PPE) to safeguard yourself from potential accidents.

Avoid Improvisation:

- Do not modify tools or equipment unless it's specified in the manufacturer's instructions.
- Using modified tools can lead to unsafe or unpredictable outcomes.

Report Issues Immediately:

- If you notice any damage or malfunction during use, stop using the tool and report it to your supervisor or maintenance team.

Regular Maintenance:

- Follow recommended maintenance schedules for tools and equipment, such as oiling, sharpening, or replacing worn parts.

Exercise

1. Steps to prioritizing projects are:
   a) Collect a list of all your tasks
   b) Identify urgent vs. important:
   c) Order tasks by estimated effort
   d) All of the above
2. Scheduling means plan an activity to take place at a particular time. True or False
3. Material planning involves checking the availability of all the raw materials that would be Required in the concreting process. True or False
4. Proper material planning helps in:
   a) Reducing the project cost by minimizing delay
   b) Helps in achieving the deadlines.
   c) Reduces the wastage of material due to unavailability of other necessary material.
   d) All of the above
5. Being organized helps to:
   a) Make better decisions.
   b) Anticipate needs and problems.
   c) Get work done accurately by avoiding costly mistakes.
   d) All of the above
6. The purpose of controlling is to ensure that everything goes as per set guidelines and standards. True or False

Notes

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7. Work according to Personal Health, Safety and Environment Protocols at Construction Site

Construction Skill Development Council

CON/N9001

Key Learning Outcomes

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

1. Describe the reporting procedures in cases of breaches or hazards for site safety, accidents, and emergencies as per guidelines.
2. Explain different types of safety hazards at construction sites.
3. Demonstrate how to follow emergency and evacuation procedures in case of accidents, fires, or natural calamities.
4. Discuss basic ergonomic principles as per applicability.
5. Describe the procedure for responding to accidents and other emergencies at the site.
6. Explain the importance of handling tools, equipment, and materials as per applicable norms.
7. Explain the effect of construction material on health and environments as per applicability.
8. Describe various environmental protection methods as per applicability.
9. Explain the storage requirement of waste including non-combustible scrap material and debris, combustible scrap material and debris, general construction waste and trash (non-toxic, non-hazardous), any other hazardous wastes and any other flammable wastes at the appropriate location.
10. Show how to collect, segregate and deposit construction waste into appropriate containers based on their toxicity or hazardous nature.
11. Explain how to use hazardous material in a safe and appropriate manner as per applicability.
12. Explain types of fire.
13. Describe the procedure of operating different types of fire extinguishers.
14. Show how to operate different types of fire extinguishers corresponding to various types of fires as per EHS guidelines.
15. State safety relevant to tools, tackles, and equipment as per applicability.
16. Demonstrate the use of appropriate Personal Protective Equipment (PPE) as per work requirements for Head Protection, Ear Protection, Fall Protection, Foot Protection, Face and Eye Protection, Hand and Body Protection, and Respiratory Protection (if required).
17. Demonstrate how to check and install all safety equipment as per standard guidelines.
18. List housekeeping activities relevant to the task.
19. Elucidate ways of transmission of infection Explain the ways to manage infectious risks at the workplace.
20. Describe different methods of cleaning, disinfection, sterilization, and sanitization.
21. Show how to clean and disinfect all materials, tools and supplies before and after use.
22. List the symptoms of infection like fever, cough, redness, swelling, and inflammation.

Unit 7.1: Hazards and Emergency Situations

Unit Objectives

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

1. Understand the types of hazards at the construction sites and identify the hazards specific to the domain related works.
2. Recognize the safety control measures and actions to be taken under emergency situation.
3. Know the reporting procedure to the concerned authority in case of emergency situations.

7.1.1 Hazards at Workplace

Hazards versus Risk: A hazard possesses the potential to induce harm, whereas risk pertains to the probability of harm occurring as a result of being exposed to that hazard.

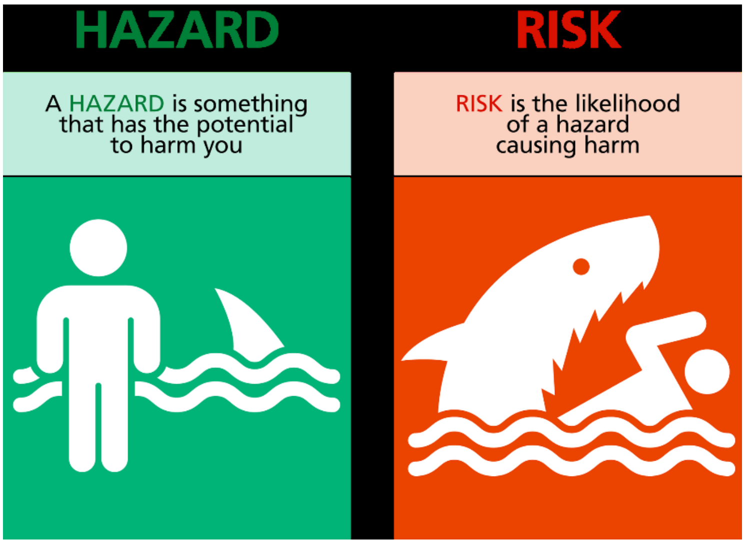

Fig. 7.1.1 Hazards versus Risk

TWorkplace Hazards Types: Workplace hazards can vary depending on the type of work and the industry.

Fig. 7.1.2 Workplace Hazards

Here are some common types of workplace hazards that can be found in various workplaces:

- **Physical Hazards:**
  - Slips, trips, and falls
  - Falling objects or materials
  - Contact with moving machinery or equipment
  - Noise and vibration
  - Extreme temperatures (hot or cold)
  - Poor ergonomics leading to musculoskeletal disorders
- **Electrical Hazards:**
  - Electrical shock or electrocution
  - Short circuits or electrical fires
- **Fire and Explosion Hazards:**
  - Combustible materials
  - Electrical equipment malfunctions
  - Inadequate fire safety measures
- **Vehicle-Related Hazards:**
  - Accidents involving vehicles or heavy machinery
  - Forklift incidents in warehouses and industrial settings
- **Chemical Hazards:**
  - Exposure to toxic or hazardous substances (e.g., chemicals, fumes, gases)
  - Skin contact with irritants or corrosive materials
  - Chemical spills or leaks
- **Psychosocial Hazards:**
  - Workplace stress and pressure
  - Bullying or harassment
  - Job insecurity
  - Long working hours and inadequate rest breaks

Identifying and mitigating workplace hazards is essential to ensuring the health and safety of employees. Employers should conduct regular risk assessments and implement appropriate safety measures and training to minimize the risks associated with these hazards.

Fig. 7.1.3 Risk Associated with Hazards

7.1.2 Hazard Identification and Risk Assessment (HIRA):

Hazard Identification and Risk Assessment (HIRA) is a systematic process used to identify potential hazards in a workplace or any activity and assess the associated risks.

The primary goal of HIRA is to proactively identify and evaluate potential dangers to prevent accidents, injuries, and adverse health effects. It is a fundamental component of occupational health and safety management.

Fig. 7.1.4 Risk Assessment

The HIRA process typically involves the following steps:

- Conduct a comprehensive site survey to identify potential hazards at the construction site.
- Involve workers, supervisors, and safety personnel in the hazard identification process.
- Prioritize hazards based on their severity and likelihood of occurrence.
- Assess the risks associated with each identified hazard, considering potential consequences and exposure frequency.
- Implement appropriate control measures to reduce or eliminate the identified risks.

- Use the hierarchy of controls (elimination, substitution, engineering controls, administrative controls, and PPE) to address hazards effectively.
- Provide necessary training and awareness programs for workers on identified hazards and safety protocols.
- Regularly review and update the hazard identification and risk assessment as the construction progresses.
- Maintain proper documentation of the hazard identification and risk assessment process.
- Foster a culture of safety and encourage workers to report any new hazards or safety concerns.

HIRA is an ongoing process that requires the involvement and cooperation of all stakeholders, including workers, supervisors, safety officers, and management.

It helps create a safer work environment, reduces the likelihood of accidents, and contributes to improved overall occupational health and safety.

Fig. 7.1.5 Risk Management Process

Hazards Specific to Domain-Related Works in Construction:

- **Roofing Hazards:** Roofers face the risk of falls from heights, especially if proper fall protection measures are not in place.
- **Demolition Hazards:** Demolition work involves risks of flying debris, structural collapses, and exposure to hazardous materials.
- **Welding and Cutting Hazards:** Welders are exposed to sparks, fumes, and electrical hazards during welding and cutting processes.
- **Crane and Heavy Equipment Hazards:** Improper operation of cranes and heavy machinery can lead to struck-by and caught-in accidents.

- **Scaffolding Hazards:** Improperly assembled/unstable scaffolding poses fall risks for workers.
- **Concrete and Masonry Hazards:** Workers involved in concrete pouring and masonry work face risks of heavy lifting injuries and ergonomic issues.
- **Highway and Roadwork Hazards:** Road construction workers are at risk of being struck by vehicles passing through the work zone.
- **Electrical Installation Hazards:** Electricians face the dangers of electric shocks and arc flashes during installation and maintenance work.
- **Painting Hazards:** Painters may encounter risks from working at heights, using chemicals in paints, and exposure to fumes.
- **Tunneling Hazards:** Workers involved in tunnel construction face risks of collapse, flooding, and exposure to harmful gases.

Different domain-related works have their unique risks, and it's essential to tailor safety measures accordingly to ensure a safe work environment for all employees.

7.1.3 Workplace Warning Signs:

Workplace warning signs are essential visual cues used in various environments to convey important information, instructions, or potential hazards.

These signs play a crucial role in promoting safety, providing guidance, and preventing accidents.

Safety signs are essential visual cues used to convey critical safety information and promote safety awareness in various environments.

Safety Signs are generally divided into 4 Categories along with their Colour Codes:

- Red
- Blue
- Yellow
- Green

Fig. 7.1.6 Workplace Warning Signs

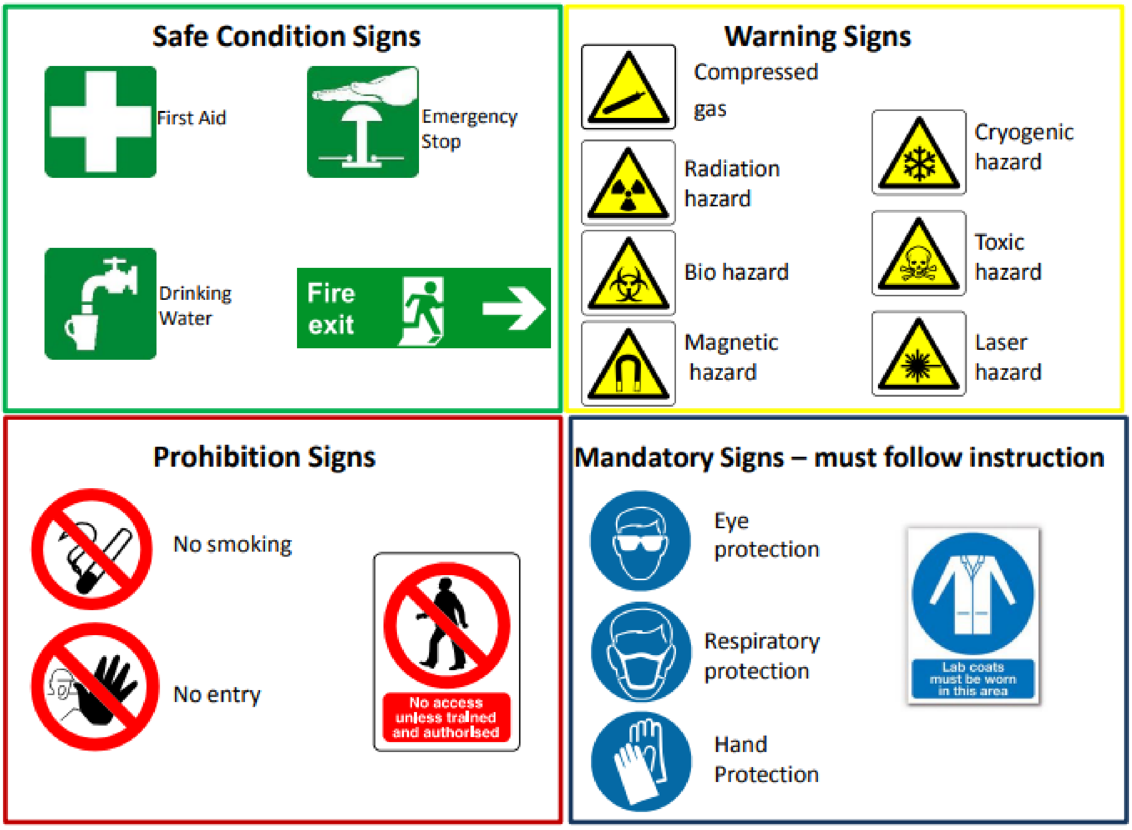

Fig. 7.1.7 Four Types of Safety Signs and their Colour

7.1.4 Emergency Response Plan (ERP)

An Emergency Response Plan (ERP) is a comprehensive document that outlines procedures, protocols, and responsibilities to be followed in the event of emergencies or critical incidents.

The ERP is designed to ensure the safety and well-being of individuals, property, and the environment during emergencies.

Fig. 7.1.6 Workplace Warning Signs

7.1.5 Reporting Emergency

Reporting procedures in case of emergency situations at a construction site play a crucial role in ensuring the safety of workers and facilitating a swift and coordinated response. The specific reporting procedure may vary depending on the construction site's policies and the type of emergency.

Fig. 7.1.9 Emergency Situations

However, here are general steps to follow when reporting an emergency situation at a construction site in India:

1) **Assess the Situation:** Quickly assess the nature and severity of the emergency while ensuring your safety and the safety of others, if possible.
2) **Activate the Alarm:** If the construction site has an alarm or emergency alert system, activate it to alert other workers and personnel about the emergency.
3) **Call Emergency Services:** Dial the appropriate emergency services number in India, which is 112, to connect to Police, Fire, and Medical emergency services.
4) **Provide Essential Information:** When calling emergency services, provide the operator with the following information:
    - The type of emergency (e.g., fire, collapse, injury).
    - The exact location of the construction site, including the address or nearby landmarks.
    - Any specific hazards or risks present at the site.
    - The number of people involved or injured (if known).
5) **Notify On-Site Personnel:** Inform the on-site supervisor, safety officer, or designated emergency response team members about the emergency.
6) **Follow the Construction Site's Emergency Response Plan:** Comply with the specific reporting procedures outlined in the construction site's Emergency Response Plan. This may involve contacting a specific individual or department responsible for handling emergencies.
7) **Cooperate with Authorities:** Once emergency services arrive at the construction site, cooperate fully with the authorities and follow any instructions provided by them.
8) **Inform Contractors or Site Management:** If the construction site involves multiple contractors or has site management, inform them about the emergency situation.

9) **Document the Incident:** After the emergency has been addressed, document the incident thoroughly, including the details of the emergency, response actions taken, and any injuries or damages incurred.

10) **Review and Improve Procedures:** After the emergency situation has been resolved, review the response and reporting procedures to identify any areas for improvement and make necessary adjustments to the Emergency Response Plan.

It is essential for all personnel working at the construction site to be familiar with the site's specific emergency response procedures and protocols. Regular training, drills, and awareness programs can help ensure that everyone knows how to respond effectively in case of emergencies, reducing the risk of injuries and minimizing damage to property.

Fig. 7.1.9 Emergency Situations

Notes

Unit 7.2: Safety Drills, PPEs and Fire Safety

Unit Objectives

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

1. Explain the classes of fire and types of fire extinguishers.
2. Demonstrate the operating procedure of the fire extinguishers.
3. Explain the importance of participation of workers in safety drills.
4. List out basic medical tests required for working at construction site.
5. Explain the purpose and importance of vertigo test at construction site.
6. Explain the types and benefits of basic ergonomic principles, which should be adopted while carrying out specific task at the construction sites.
7. Demonstrate use of PPEs as per work requirements.

7.2.1 Fire Triangle & Fire Types

Fire is a chemical reaction that occurs when a substance combines with oxygen and releases heat, light, and various combustion products.

It is a rapid oxidation process that can lead to destructive consequences if not controlled.

The fire triangle is a simple model used to illustrate the three essential components necessary for a fire to occur. These three components must be present simultaneously for a fire to ignite and sustain itself.

There are several types of fires, categorized based on the fuel involved. The four main classes of fires are:

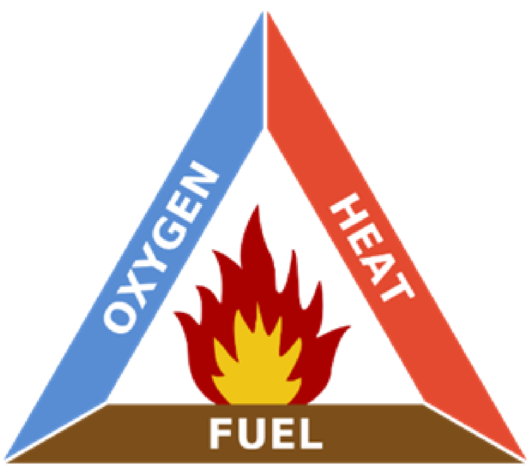

Fig. 7.2.1 Fire Triangle

A		Ordinary Combustibles	Wood, Paper, Cloth, Etc.
B		Flammable Liquids	Grease, Oil, Paint, Solvents
C		Live Electrical Equipment	Electrical Panel, Motor, Wiring, Etc.
D		Combustible Metal	Magnesium, Aluminum, Etc.
K		Commercial Cooking Equipment	Cooking Oils, Animal Fats, Vegetable Oils

Fig. 7.2.2 Types of Fires

It is essential to use the appropriate extinguishing agents and follow proper fire safety protocols based on the type of fire to ensure effective firefighting and minimize risks to life and property. Fire safety training and understanding the different types of fires are crucial for individuals to respond safely and efficiently in the event of a fire emergency.

7.2.2 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.

Fig. 7.2.3 Fire at Construction Site

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 on the ground, and roll to smother the flames if their clothes catch fire.

7.2.3 Fire Extinguisher

A fire extinguisher is a portable firefighting device designed to control and extinguish small fires. It is an essential tool for fire safety, allowing individuals to respond quickly to fires before they become unmanageable.

Fire extinguishers work by discharging a firefighting agent onto the fire, either by cooling the fuel, smothering the flames, or interrupting the chemical reaction required for combustion. Each fire extinguisher is specifically designed to combat certain classes of fires.

The most common types of fire extinguishers are:

1) **Water Fire Extinguisher (Class A):**
   - Suitable for Class A fires involving ordinary combustible materials such as wood, paper, cloth, plastics, and rubber.
2) **Foam Fire Extinguisher (Class A and Class B):**
   - Effective for Class A fires (ordinary combustibles) and Class B fires (flammable liquids and gases).
3) **Dry Powder Fire Extinguisher (Class A, Class B, and Class C):**
   - Versatile extinguisher suitable for Class A, B, and C fires.
4) **Carbon Dioxide (CO2) Fire Extinguisher (Class B and Class C):**

- Suitable for Class B fires (flammable liquids and gases) and Class C fires (energized electrical equipment).

5) **Wet Chemical Fire Extinguisher (Class K):**

- Specifically designed for Class K fires involving cooking oils and fats.

Fig. 7.2.3 Fire at Construction Site

Fire extinguishers should be placed in easily accessible locations throughout buildings, construction sites, vehicles, and other facilities. Regular maintenance, inspection, and employee training on how to use fire extinguishers properly are essential components of fire safety programs. Remember, fire extinguishers are designed for small fires only. For larger fires or situations beyond your control, evacuate the area immediately and call the appropriate emergency services.

Using Fire Extinguisher:

Using a fire extinguisher properly can be instrumental in quickly extinguishing small fires and preventing them from spreading. When using a fire extinguisher, remember the acronym "PASS," which stands for Pull, Aim, Squeeze, and Sweep.

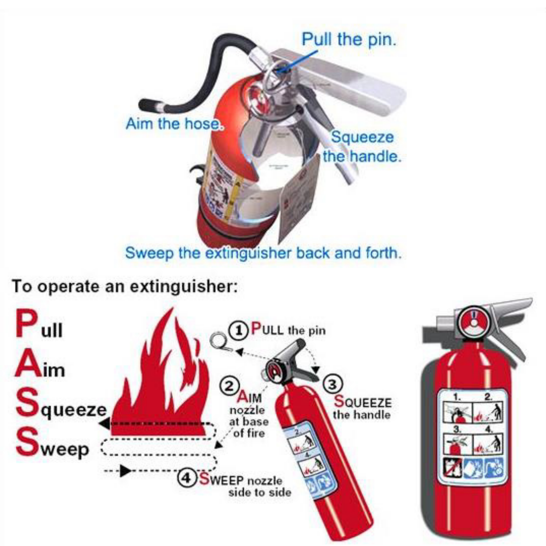

Fig. 7.2.5 Using a Fire Extinguisher

Remember the following important tips:

- Only use a fire extinguisher on small fires that are contained and not spreading rapidly.
- Make sure you are using the right type of fire extinguisher for the specific class of fire (e.g., Class A, B, C, K).
- Always maintain a safe distance from the fire and avoid getting too close to the flames.
- Never turn your back on a fire, and be prepared to evacuate if the fire becomes too large or uncontrollable.
- If the fire does not respond to the extinguisher or starts to grow rapidly, evacuate the area immediately and call the fire department.

7.2.4 Safety Drills and Its Importance for Workers

The participation of workers in safety drills at a construction site is of utmost importance to ensure a safe working environment and reduce the risk of accidents or incidents. Construction sites are inherently hazardous places, and safety drills play a crucial role in preparing workers to respond effectively to emergencies.

Fig. 7.2.6 Components related to Safety Drill

Here are some specific reasons why worker participation in safety drills is vital in a construction site setting:

- **Familiarization with Site-Specific Procedures:** Construction sites can have unique layouts and hazards. Safety drills allow workers to become familiar with site-specific emergency procedures, such as evacuation routes, muster points, and the location of emergency equipment.
- **Practicing Response to Common Construction Hazards:** Safety drills provide an opportunity to practice responding to emergencies related to common construction hazards, such as falls, structural collapses, confined space incidents, and electrical accidents.
- **Building Muscle Memory for Critical Tasks:** By participating in safety drills, workers develop muscle memory for critical safety tasks, such as donning personal protective equipment (PPE), using fire extinguishers, or performing emergency rescues. Muscle memory helps workers

react quickly and instinctively during real emergencies.

- **Testing Effectiveness of Emergency Plans:** Safety drills allow construction site managers to assess the effectiveness of the site's emergency response plans and identify any gaps or weaknesses that need to be addressed.
- **Boosting Confidence and Reducing Panic:** Regular participation in safety drills can boost workers' confidence in their ability to handle emergencies, making them less likely to panic and more likely to respond calmly and rationally.
- **Team Coordination and Communication:** Safety drills encourage teamwork and coordination among workers. It helps them practice effective communication during emergencies, which is essential for a coordinated and efficient response.
- **Compliance with Regulations:** Construction sites are subject to various safety regulations and standards. Worker participation in safety drills ensures that the construction site is compliant with safety requirements.
- **Preventing Injuries and Fatalities:** The ultimate goal of safety drills is to prevent injuries and save lives. Properly trained and prepared workers are more likely to respond effectively to emergencies, reducing the severity of incidents.
- **Emergency Response Performance Evaluation:** Safety drills provide an opportunity to evaluate how well workers respond to emergencies and identify areas that need improvement or additional training.
- **Promoting a Safety Culture:** Encouraging worker participation in safety drills sends a strong message about the importance of safety at the construction site. It fosters a safety-first culture and instills a sense of responsibility for safety among all workers.

By actively involving workers in safety drills, construction site management can significantly enhance the site's emergency preparedness, improve response capabilities, and create a safer working environment for everyone involved.

Evacuation:

Evacuation at a construction workplace/site is a crucial aspect of ensuring the safety of all workers and visitors in case of emergencies. Construction sites can be hazardous environments with various potential risks, making preparedness and efficient evacuation procedures essential.

Fig. 7.2.7 Emergency Evacuation

7.2.5 Medical Examination for Construction Workers

The government has mandated that industrial enterprises undertake annual health checkups on their employees. In accordance with the Factories Act of India from 1947, 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 part of the medical checkup.

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.

Fig. 7.2.8 Medical Examination for Construction Workers

Medical Check-up Prior to Employment: A young person must have a pre-employment medical examination by a Certifying Surgeon to determine and confirm his fitness to work in a factory, according the Factories Act of 1943. The certificate of fitness is only valid for one year from the date it was issued.

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 prior to employment and on a recurrent basis thereafter. Workers employed in a "hazardous process" are medically tested once before to employment by a Factory Medical Officer 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.

Form 7 is completed, and 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 (as specified in the Third Schedule of the Factories Act), 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 Certifying Surgeon and Form 7 in accordance with the Factories Act may a withdrawn employee be rehired for the same process.

List of Recommended Medical Tests under the Factories Act:

- Complete Physical Examination
- Blood Group, Rh factor

- Blood CBC, ESR, RBS
- Urine Test (Routine & Microscopic)
- Creatinine
- Electrocardiogram (Computerised ECG)
- Chest X-Ray (Standard Size)
- Lung Function Test
- Vision Test (Screening)
- Audiometric Test
- HIV & HBS Tests

7.2.6 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. Your doctor may require one or more tests or procedures to better understand your underlying issue. Numerous of these tests require specialised equipment and experienced personnel.

Fig. 7.2.9 Vertigo Test for Construction Workers

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

7.2.7 Basic Ergonomic Principles

Basic ergonomic principles involve designing and arranging workspaces, equipment, and tasks to optimize efficiency, productivity, and worker well-being.

Ergonomics aims to reduce the risk of musculoskeletal disorders (MSDs) and other work-related injuries by ensuring that the work environment fits the worker's capabilities and needs.

Fig. 7.2.10 Basic Ergonomic Principles

Construction sites can be physically demanding and involve various tasks that may lead to musculoskeletal disorders (MSDs) and other injuries if not properly addressed. Here are some basic ergonomic principles to consider at a construction site:

- **Proper Lifting Techniques:**
    - ♦ Train workers in proper lifting techniques to avoid back injuries. Encourage the use of mechanical lifting aids, such as cranes or hoists, for heavy or awkward loads.
- **Worksite Organization:**
    - ♦ Arrange tools, equipment, and materials to minimize excessive reaching or bending.
    - ♦ Keep frequently used items within easy reach to reduce unnecessary movement.
- **Tool Selection:**
    - ♦ Provide ergonomic tools with appropriate grips and handles that reduce hand and wrist fatigue.
    - ♦ Choose tools that require less force to operate to prevent overexertion.

By applying these basic ergonomic principles at construction sites, employers can create a safer and more comfortable working environment, reduce the risk of work-related injuries, and improve the overall well-being and productivity of construction workers.

7.2.7 First Aid

First aid refers to the immediate and initial care given to an injured or ill person before professional medical help arrives. It is crucial in emergencies to stabilize the injured or sick individual and prevent their condition from worsening.

First aid aims to preserve life, alleviate pain, and promote recovery.

Here are some key points about first aid:

Fig. 7.2.11 First Aid to Injured Person

Objectives of First Aid:

- **Preserve Life:** The primary objective of first aid is to assess the situation and provide immediate care to save lives.
- **Prevent Further Harm:** First aid measures aim to prevent the injured person's condition from worsening.
- Relieve Pain: First aid techniques can provide pain relief to the injured or ill person.
- Promote Recovery: Properly administered first aid can help promote the person's recovery and reduce the severity of injuries or illnesses.

Common First Aid Procedures:

- **Assessment:** Assess the situation and the injured or ill person's condition. Ensure your safety and the safety of others.
- **CPR (Cardiopulmonary Resuscitation):** If the person is not breathing or their heart has stopped, perform CPR to maintain blood flow and provide oxygen.
- **Bleeding Control:** Apply pressure to stop bleeding from wounds and injuries.
- **Wound Care:** Clean and dress wounds to prevent infection and aid healing.
- **Fracture and Sprain Care:** Immobilize fractures and provide support for sprains to prevent further damage.
- **Burn Care:** Cool burns with running water and cover with a clean, non-stick dressing.
- **Choking Response:** Perform abdominal thrusts (Heimlich maneuver) on a choking person to clear their airway.
- **Seizure Management:** Keep the person safe during a seizure and provide comfort afterward.

First Aid Kits:

A well-stocked first aid kit is essential in homes, workplaces, and vehicles. It should contain items such as adhesive bandages, gauze pads, antiseptic wipes, adhesive tape, scissors, tweezers, CPR mask, disposable gloves, and pain relievers, among others.

Note: While first aid can be lifesaving, it is not a substitute for professional medical care. In emergencies, call for professional help (e.g., emergency services) as soon as possible, especially for serious injuries or illnesses.

It is crucial to receive formal first aid training to effectively administer first aid and respond appropriately in emergency situations. Proper training ensures that you can provide the most appropriate care and support to those in need until professional help arrives.

Fig. 7.2.9 Vertigo Test for Construction Workers

7.2.9 Ensure Electrical Safety at Construction Sites

Electrical safety is important because hazards such as arc flash and shock can result in death if you are exposed to them.

Fortunately, the likelihood of this occurring is relatively low.

However, the control measures that prevent these hazards require careful management, attention to detail and technical competence.

Fig. 7.2.13 Electrical Hazards

- Conduct regular inspections of electrical equipment and wiring to identify any potential hazards or defects.
- Ensure all electrical installations and equipment meet relevant safety standards and codes.
- Provide proper training to construction workers on electrical safety practices and procedures.
- Clearly label electrical panels, switches, and outlets for easy identification.
- Use ground fault circuit interrupters (GFCIs) to protect against electric shock in wet or damp environments.
- Avoid overloading electrical circuits and outlets by distributing loads evenly.
- Keep electrical cords and cables away from heavy machinery, sharp objects, or areas with high foot traffic.
- Store electrical tools and equipment properly when not in use to prevent damage and accidents.
- Use insulated tools and personal protective equipment (PPE) when working with electricity.
- Have a clear emergency plan in place in case of electrical accidents or incidents and ensure workers are familiar with it.

Fig. 7.2.14 Electrical Safety

7.2.10 PPE and Its Importance

Personal Protective Equipment (PPE) plays a crucial role in the construction industry to protect workers from potential hazards and ensure their safety on the job. PPE is designed to shield workers from various risks, such as falling objects, electrical hazards, chemical exposure, noise, and more.

Importance of PPE in Construction Industry:

1. **Hazard Protection:** PPE serves as a barrier between workers and potential workplace hazards, preventing injuries and illnesses.
2. **Legal Compliance:** Regulatory authorities require the use of appropriate PPE in construction to meet safety standards and comply with regulations.
3. **Injury Prevention:** PPE can significantly reduce the risk of injuries and accidents, protecting workers' health and well-being.
4. **Risk Reduction:** PPE mitigates the risk of exposure to harmful substances, noise, dust, and other occupational hazards.
5. **Enhanced Productivity:** When workers feel safe and protected, their confidence and efficiency increase, leading to improved productivity.

Fig. 7.2.15 PPEs in Construction Industry

Types of PPE in Construction Industry:

Injury Protection	Description	PPE
Head Injury Protection	Head injuries can occur due to falling or flying objects, stationary objects, or contact with electrical wires. Hard hats provide protection against such injuries by shielding the head. Electrician's hard hat is commonly made of nonconductive plastic. It is accompanied by safety goggles for additional eye protection.	
Foot and Leg Injury Protection	Safety shoes, especially those made of leather, provide essential foot protection. They offer protection against various risks, including falling or rolling objects, sharp objects, wet and slippery surfaces, molten metals, hot surfaces, and electrical hazards. Proper use of safety shoes enhances safety measures for workers in hazardous environments like construction sites.	
Eye and Face Injury Protection	Spectacles and goggles provide protection against hazards like flying fragments, large chips, hot sparks, radiation, and splashes from molten metals. Special helmets or shields offer additional protection for the face and eyes in hazardous environments. Spectacles with side shields and face shields enhance eye safety by preventing exposure to various risks. These protective gears also safeguard against particles, sand, dirt, mists, dust, and glare, promoting overall eye health and safety.	

Protection against Hearing Loss	Hearing protection can be achieved through earplugs or earmuffs. Prolonged exposure to high noise can lead to permanent hearing loss, physical strain & mental stress. Self-forming earplugs made of materials like foam, waxed cotton, or fibreglass wool are commonly used as they offer a good fit. For better fit and protection, workers should be fitted with moulded or prefabricated earplugs by a specialist.	
Hand Injury Protection	Hand protection is crucial for workers exposed to hazardous substances through skin absorption, serious wounds, or thermal burns. Gloves are commonly used as protective gear for hands. Electricians often use leather gloves with rubber inserts when working on electrified circuits. Kevlar gloves are employed when stripping cable with a sharp blade to prevent cuts and injuries.	
Whole Body Protection	Full-body protection is essential for workers to safeguard against heat and radiation hazards. Whole-body PPE includes materials like rubber, leather, synthetics, plastic, fire-retardant wool, and cotton. Maintenance staff working with high-power sources like transformer installations and motor-control centers are often required to wear fire-resistant clothes for added safety.	

Table 7.2.1 PPEs for Construction Worker

Care and Maintenance of PPE:

- **Regular Inspection:** PPE should be inspected before each use to ensure it is in good condition and free from damage.
- **Proper Storage:** Store PPE in a clean, dry, and designated area away from direct sunlight and chemical exposure.
- **Cleaning:** Clean PPE regularly according to the manufacturer's guidelines to maintain its effectiveness.
- **Replacement:** PPE should be replaced when damaged, worn out, or beyond its usable life as specified by the manufacturer.
- **Training:** Provide training to workers on the proper use, care, and limitations of PPE.
- **Comfort and Fit:** Ensure that PPE fits properly and is comfortable for the worker to encourage consistent use.

PPE is essential for protecting workers from harm, but it is also the last line of defence.

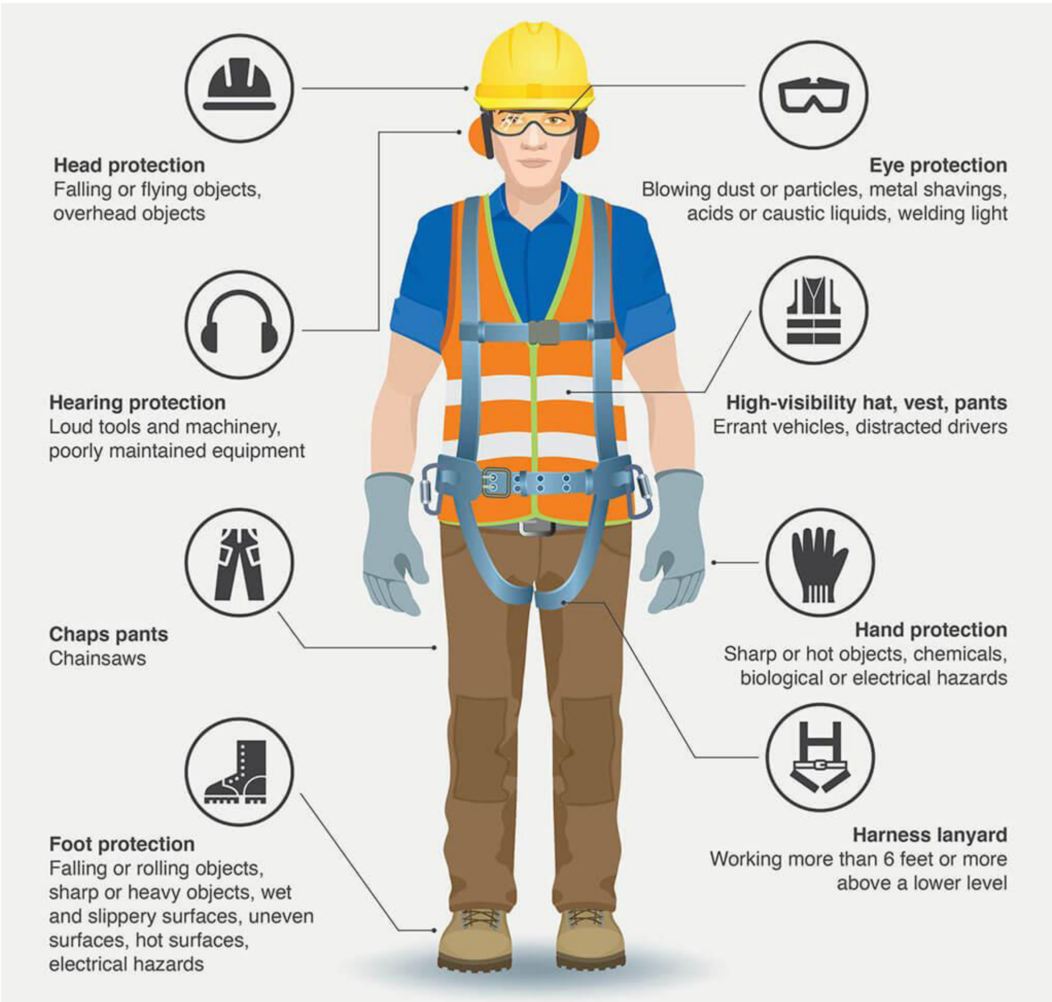

Fig. 7.2.16 A Construction Worker with proper PPEs

Care and Maintenance of Tools & Equipment:

- Regularly inspect tools and equipment for signs of damage or wear.
- Keep tools and equipment clean and free from dirt and debris after each use.
- Store tools and equipment in a dry and secure location, protected from weather elements.
- Follow manufacturer's instructions for battery-operated tools regarding charging and storage.
- Train workers on proper tool usage, care, and maintenance to ensure safe and efficient operation

7.2.11 Ladder Safety in Construction

Ladder safety is crucial in the construction sector to prevent accidents and injuries. Here are some important guidelines and practices that workers should follow when using ladders:

- Choose the right ladder for the task, considering height and weight capacity.
- Inspect the ladder for defects, cracks, and damage before use.
- Place the ladder on a stable and level surface to prevent tipping.
- Maintain three points of contact while climbing (two hands, one foot, or two feet, one hand).
- Never overreach while on the ladder; reposition it if necessary.
- Keep the ladder area clear of obstacles and debris.
- Ensure there are no overhead hazards like power lines or obstacles.
- Secure the ladder at the top to prevent sliding or shifting.
- Use non-conductive ladders when working near electrical sources.
- Provide training to workers on proper ladder usage and safety measures.

Fig. 7.2.17 Ladder safety

Notes

Unit 7.3: Hygiene and Safe Waste Disposal Practices

Unit Objectives

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

1. Follow the practices to maintain personal hygiene, workplace hygiene and site/ workplace sanitization
2. Understand the importance of housekeeping works
3. Keep an eye on safe housekeeping practices
4. Understand different types of waste at construction sites and their disposal method
5. Know safe waste disposal practices followed at construction site

7.3.1 Personal Hygiene and Cleanliness

Personal hygiene and cleanliness are essential practices that involve maintaining cleanliness and taking care of one's body to prevent the spread of germs, illnesses, and maintain overall well-being. These practices are crucial for promoting good health and preventing the transmission of infectious diseases.

Fig. 7.3.1 Personal Hygiene

Here are some key aspects of personal hygiene and cleanliness:

- **Regular Bathing or Showering:** Regular bathing or showering helps to keep the body clean and remove dirt, sweat, and bacteria from the skin.
- **Handwashing:** Proper handwashing with soap and water is one of the most effective ways to prevent the spread of germs and infections.
- **Oral Hygiene:** Brushing teeth twice a day and flossing regularly help maintain good oral health and prevent dental problems.
- **Trimming Nails:** Keeping nails clean and trimmed prevents the accumulation of dirt and germs under the nails.
- **Hair Care:** Regularly washing and maintaining hair cleanliness can prevent scalp issues and promote healthy hair.
- **Wearing Clean Clothes:** Wearing clean clothes helps prevent the spread of germs and keeps the body fresh.
- **Proper Use of Personal Protective Equipment (PPE):** In certain situations, such as during a pandemic or when handling hazardous materials, using appropriate PPE like masks, gloves, and safety gear is crucial for personal protection and hygiene.
- **Handling Food Safely:** Properly handling, preparing, and storing food helps prevent food-borne illnesses.
- **Cough and Sneezing Etiquette:** Covering the mouth and nose with a tissue or elbow when coughing or sneezing helps prevent the spread of respiratory droplets containing germs.
- **Managing Menstrual Hygiene:** Properly managing menstrual hygiene is essential for women's health and well-being.
- **Cleaning and Disinfecting Surfaces:** Regularly cleaning and disinfecting frequently-touched surfaces, such as doorknobs and handles, helps prevent the spread of germs.
- **Managing Personal Waste:** Properly disposing of waste and using clean and sanitary facilities help prevent the spread of infections.

Maintaining personal hygiene and cleanliness is not only important for individual health but also for public health. It is essential for reducing the risk of contagious diseases and maintaining a hygienic living and working environment. By practicing good personal hygiene and cleanliness, individuals can contribute to a healthier and safer community.

Importance of Informing on Personal Health Issues

The importance of reporting to the designated authority about infectious diseases and injuries are:

- The infectious diseases can spread and affect the health of other workers at the farm.
- The infectious diseases can be spread to the consumers if the bacteria and viruses spread through the produces.
- mThe injuries should be timely reported and should be taken care of immediately. If not timely reported it may worsen and may cause severe diseases and even death.

Fig. 7.3.2 Infectious Disease

7.3.2 Workplace Cleanliness and Sanitization

Workplace cleanliness and sanitization are crucial for creating a safe, healthy, and productive work environment.

Clean and sanitized workplaces not only reduce the risk of the spread of infections and illnesses but also contribute to employee well-being and morale.

Fig. 7.3.3 Workplace Cleanliness

Here are some important aspects of workplace cleanliness and sanitization:

1) **Regular Cleaning Routine:** Establish a regular cleaning schedule for the workplace, including workstations, common areas, restrooms, and shared equipment. Cleaning should be done daily or as needed, depending on the nature of the workplace.
2) **Surface Disinfection:** Regularly disinfect frequently-touched surfaces, such as doorknobs, light switches, keyboards, and shared equipment. Use EPA-approved disinfectants that are effective against viruses and bacteria.
3) **Hand Sanitizing Stations:** Place hand sanitizing stations at convenient locations throughout the workplace to encourage employees and visitors to maintain hand hygiene.
4) **Restroom Hygiene:** Maintain clean and well-stocked restrooms with proper sanitation supplies. Regularly clean and disinfect restroom surfaces to prevent the spread of germs.
5) **Waste Management:** Provide clearly marked waste disposal bins and ensure proper waste segregation. Regularly empty trash bins and dispose of waste appropriately.
6) **Kitchen and Break Areas:** Maintain cleanliness in kitchen and break areas by regularly cleaning countertops, sinks, and shared appliances. Encourage employees to clean up after themselves.
7) **Ventilation and Air Quality:** Ensure proper ventilation to improve indoor air quality. Clean air filters regularly to remove dust and allergens from the air.
8) **Personal Protective Equipment (PPE):** Provide appropriate PPE, such as masks and gloves, for employees when needed, especially during pandemics or when handling hazardous materials.
9) **Educate Employees:** Educate employees about the importance of workplace cleanliness and hygiene practices. Encourage them to follow hygiene guidelines and protocols.
10) **Workplace Signage:** Display hygiene-related signage, such as handwashing instructions, cough etiquette, and reminders about cleaning protocols, to reinforce good practices.
11) **Cleaning and Sanitization Training:** Train cleaning staff and employees responsible for workplace cleanliness on proper cleaning and sanitization techniques and the correct use of disinfectants.
12) **Workplace Wellness Initiatives:** Implement workplace wellness programs that promote good health and hygiene practices among employees.

By prioritizing workplace cleanliness and sanitization, employers can create a healthier and safer environment for their employees, clients, and visitors. Regular cleaning and sanitation efforts help prevent the spread of infections, reduce absenteeism, and foster a positive work culture focused on employee well-being and productivity.

7.3.3 Implement Good Housekeeping Practices at Construction Site

Implementing good housekeeping practices at a construction site is essential to maintain a safe, organized, and efficient working environment. Proper housekeeping helps prevent accidents, reduces the risk of injuries, and enhances productivity.

Here are some effective ways to promote good housekeeping practices at construction sites:

1. **Designate Storage Areas:**

   Assign specific areas for storing tools, equipment, and materials. Keep these areas organized and ensure that items are returned to their designated places after use.

Fig. 7.3.4 Designated Areas

2. **Regular Cleanup:**

   Schedule regular cleanup sessions throughout the workday to remove debris, waste, and hazards from the construction site. Encourage all workers to participate in keeping the site clean.

Fig. 7.3.5 Clean-up Debris and Waste

3. **Dispose of Waste Properly:**

   Provide clearly marked waste disposal bins and containers. Train workers to segregate waste materials correctly, including hazardous materials, to ensure safe disposal.

Fig. 7.3.6 Disposing of Waste

4. **Keep Walkways Clear:**

   Ensure that walkways, access routes, and emergency exits are clear of obstructions at all times. Remove trip hazards and obstacles to prevent accidents.

Fig. 7.3.7 Clear Walkways

5. **Store Flammable Materials Safely:** Store flammable materials, such as fuel, solvents, and gases, in designated storage areas away from potential ignition sources. Follow safety guidelines for their storage and handling.

Fig. 7.3.8 Store Flammable Safely

6. **Prevent Slips, Trips, and Falls:** Regularly inspect the site for slippery surfaces, loose debris, and uneven terrain. Address potential hazards promptly to reduce the risk of slips, trips, and falls.

Fig. 7.3.9 Prevent Hazards

7. **Control Dust and Debris:** Use dust control measures, such as wetting down surfaces, using dust collectors, or providing personal protective equipment (PPE), to reduce airborne dust and debris.

Fig. 7.3.10 Wetting Down Dust

8. **Proper Material Handling:** Train workers on proper material handling techniques to prevent injuries caused by lifting, carrying, or moving heavy objects.

Fig. 7.3.11 Material Handling with Safety

9. **Secure Tools and Equipment:** Ensure that tools and equipment are properly stored, secured, and maintained when not in use. Avoid leaving them unattended or in precarious positions.

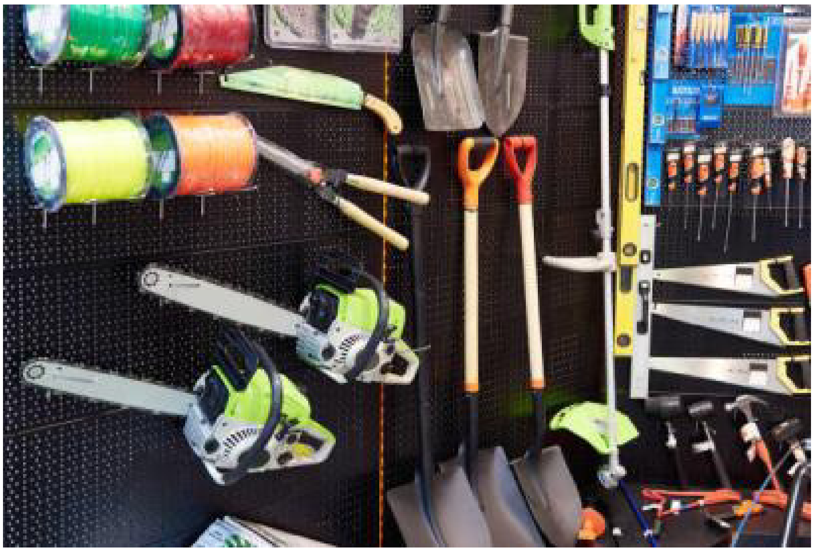

Fig. 7.3.12 Securing Tools & Equipment

10. **Inspect and Maintain Equipment:** Regularly inspect machinery, vehicles, and equipment to identify potential issues or defects. Perform maintenance and repairs promptly to ensure their safe operation.

Fig. 7.3.13 Inspect and Maintain Equipment

Remember that good housekeeping is an ongoing effort and requires the commitment and cooperation of all workers and management.

By prioritizing cleanliness and organization at the construction site, you can create a safer and more productive work environment for everyone involved.

Fig. 3.3.14 Good Housekeeping and Safety relevance

7.3.4 Handwashing

Handwashing is a simple yet highly effective practice that involves cleaning one's hands with soap and water to remove dirt, germs, and other harmful microorganisms.

Proper handwashing is one of the most important measures to prevent the spread of infectious diseases, including common colds, flu, gastrointestinal infections, and respiratory illnesses.

Proper Handwashing Technique:

- **Wet Hands:** Wet your hands with clean, running water (warm or cold).
- **Apply Soap:** Apply enough soap to cover all hand surfaces.
- **Rub Hands Together:** Rub your hands palm to palm to create lather. Continue rubbing the backs of your hands, between your fingers, and under your nails.
- **Scrub for at least 20 Seconds:** Scrub your hands for at least 20 seconds. Singing "Happy Birth-day" twice is a useful timer.
- **Rinse Thoroughly:** Rinse your hands thoroughly under clean, running water.
- **Dry Hands:** Dry your hands using a clean towel or air dry them. If possible, use a paper towel to turn off the faucet to avoid recontamination.

Fig. 7.3.15 Handwashing

When to Wash Hands:

- Before preparing or eating food
- After using the restroom
- After coughing, sneezing, or blowing your nose
- After touching surfaces in public places
- After handling garbage or waste
- After caring for someone who is sick
- Before and after tending to wounds or injuries

Fig. 7.3.16 Wash Hands Properly

7.3.5 Avoid Bad Habits

Avoiding bad habits like smoking, drinking alcohol, and addiction to tobacco and gutkha is essential for maintaining good health and well-being. These habits can have severe negative impacts on physical health, mental health, and overall quality of life.

Fig. 7.3.17 Avoid Bad Habits

Here are some reasons to avoid these habits:

- Understand the health risks associated with smoking, drinking alcohol, and using tobacco and gutkha.
- Seek support from family, friends, or support groups to help quit these habits.
- Replace bad habits with healthier alternatives, such as exercise, hobbies, or mindfulness practices.
- Set specific and achievable goals to gradually reduce and eliminate these habits.
- Avoid triggers or situations that may tempt you to engage in these bad habits.
- Practice stress management techniques to cope with stress without turning to harmful substances.
- Stay informed about the benefits of quitting and the negative impacts of these habits.
- Use nicotine replacement therapies or medications to aid in quitting smoking.
- Find healthy ways to socialize and relax without relying on alcohol or tobacco.
- Celebrate small milestones and successes in your journey to quit these bad habits.

7.3.6 Waste Types at Construction Sites

Construction sites generate various types of waste during the building process.

Some common types of waste found at construction sites include:

1. **Concrete and Bricks Waste:** Excess or damaged concrete, bricks, blocks, and precast elements.
2. **Wood Waste:** Includes timber offcuts, pallets, and packaging materials.
3. **Metal Waste:** Scrap metal from structural elements, reinforcement bars, and metal packaging.
4. **Plastic Waste:** Packaging materials, plastic sheets, and pipes.
5. **Cardboard and Paper Waste:** Packaging materials and documents.
6. **Glass Waste:** Broken or excess glass from windows, doors, and mirrors.
7. **Asphalt Waste:** Leftover asphalt from road or pavement construction.
8. **Paints and Chemicals:** Unused or leftover paints, solvents, adhesives, and other construction chemicals.
9. **Electrical Waste:** Old or damaged electrical components, cables, and wiring.
10. **Insulation Materials:** Unused or waste insulation materials.
11. **Hazardous Waste:** Materials containing asbestos, lead, mercury, or other hazardous substances.
12. **Packaging Waste:** Cardboard boxes, plastic wraps, and other packaging materials.

Fig. 7.3.18 Construction Wastes

Proper waste management and disposal methods are crucial to handle these various types of waste responsibly and minimize their impact on the environment. Recycling, reusing, and responsible disposal in designated landfills or waste treatment facilities are some of the ways to manage construction site waste effectively.

7.3.7 Waste Management

The collection, disposal, monitoring, and processing of waste materials is known as waste management. These wastes affect living beings' health and the environment. For reducing their effects, they have to be managed properly. The waste is usually in solid, liquid or gaseous form.

Fig. 3.3.19 Waste Management

The importance of waste management is:

- Waste management is important because it decreases waste's impact on the environment, health, and other factors. It can also assist in the reuse or recycling of resources like paper, cans, and glass. The disposal of solid, liquid, gaseous, or dangerous substances is the example of waste management.
- When it comes to trash management, there are numerous factors to consider, including waste disposal, recycling, waste avoidance and reduction, and garbage transportation. Treatment of solid and liquid wastes is part of the waste management process. It also provides a number of recycling options for goods that aren't classified as garbage during the process.

7.3.8 Methods of Waste Management

Construction waste management is crucial for reducing environmental impact and promoting sustainable practices in the construction industry. The 5Rs framework offers a systematic approach to managing construction waste, focusing on reducing waste generation and maximizing resource efficiency. The 5Rs stand for: Reduce, Reuse, Recycle, Recover, and Residuals. Here's how each of these methods is applied in construction waste management:

1) **Reduce:**

   - **Design for Minimal Waste:** Employ design strategies that aim to minimize waste generation during the construction phase. This includes accurate quantity estimation, optimizing material use, and choosing construction methods that generate less waste.
   - **Prefabrication:** Prefabrication and modular construction techniques can significantly reduce on-site waste by producing components off-site with precise measurements and minimal material wastage.
   - **Waste Audits:** Conduct waste audits to identify the major sources of waste and implement measures to reduce waste generation.

2) **Reuse:**

   - **Salvage and Reuse Materials:** Salvage and reuse materials from demolition or renovation activities that are still in good condition and can be repurposed in other projects. This includes doors, windows, fixtures, and lumber.

- **Temporary Structures:** Utilize temporary structures and materials that can be disassembled and reused in other projects to reduce waste.

3) **Recycle:**

- **On-Site Recycling:** Set up on-site recycling facilities to process construction waste, such as concrete, wood, metal, and plastics, into reusable materials like aggregates, mulch, or recycled content products.
- **Use Recycled Content:** Incorporate recycled content materials, such as recycled concrete aggregate or reclaimed wood, in new construction to reduce the demand for virgin resources.

4) **Recover:**

- **Energy Recovery:** Some non-recyclable construction waste can be converted into energy through waste-to-energy processes, helping to minimize landfill disposal and generate electricity or heat.
- **Anaerobic Digestion:** Organic waste can be processed through anaerobic digestion to produce biogas, which can be used as a renewable energy source.

5) **Residuals Management:**

- **Landfill Diversion:** For waste that cannot be reduced, reused, recycled, or recovered, focus on diverting it from landfills and explore alternative disposal methods that have a lower environmental impact.
- **Responsible Disposal:** Ensure that waste that ends up in landfills is disposed of responsibly, adhering to local regulations and guidelines.

Fig. 7.3.20 Waste Bin Types and their Colour

By implementing the 5Rs framework, construction companies can minimize waste generation, conserve resources, reduce environmental pollution, and move towards a more sustainable and environmentally friendly approach to construction waste management.

7.3.9 Waste Management on a 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 than 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 prior to 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 your 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.

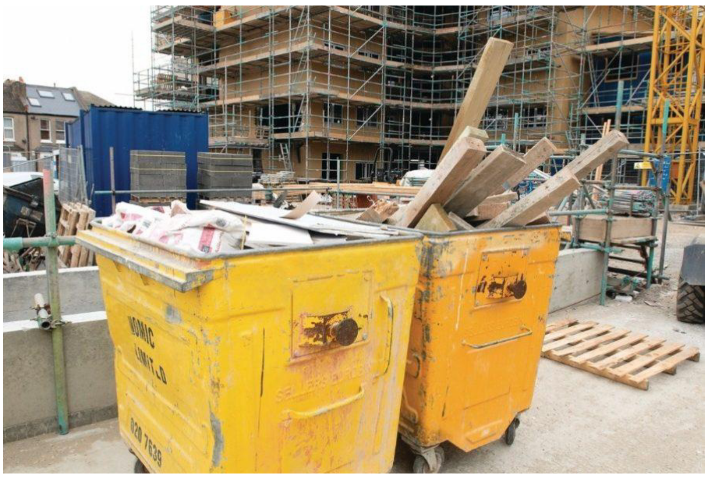

Fig. 7.3.21 Waste Management on a Construction Site

Notes

Unit 7.4: Infectious Disease and Its Cure

Unit Objectives

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

1. Know different types of infectious disease that can spread/ originate at a construction site
2. Understand the ways of transmission of the various infectious disease.
3. Recognize the methods to check the spread of the infectious disease.
4. Understand the symptoms and cure of the various infectious disease.
5. Apprehend the procedure to report to the concerned authority regarding the outbreak/ hazard of any infectious disease/ pandemic.

7.4.1 Infectious Diseases

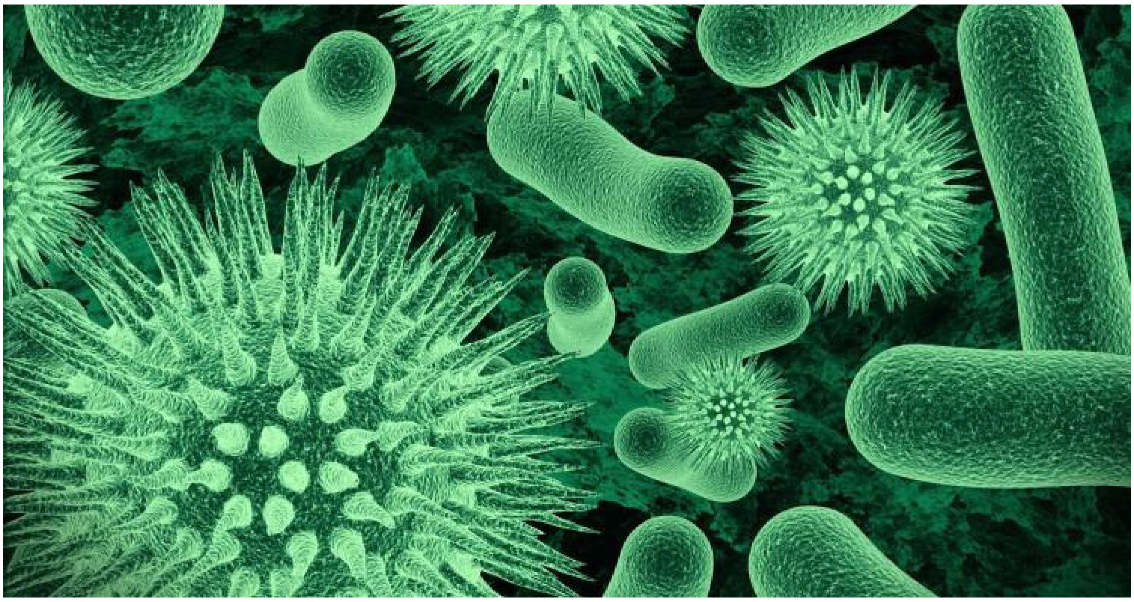

Fig. 7.4.1 Infectious Diseases

Viruses, bacteria, parasites, or fungi can cause infectious diseases. Additionally, uncommon viral disorders known as transmissible spongiform encephalopathies exist (TSEs).

- Viral infections
- Bacterial infections
- Fungal infections
- Parasitic infections

- Transmissible spongiform encephalopathies (TSEs/prion diseases)

Infectious diseases are extremely common worldwide, but some are more common than others.

Some of the most common infectious diseases are listed here by type.

Common infectious diseases caused by viruses:

- Common cold.
- The flu (influenza).
- COVID-19.
- Stomach flu (gastroenteritis).
- Hepatitis.
- Respiratory syncytial virus (RSV).

Common infectious diseases caused by bacteria:

- Strep throat.
- Salmonella.
- Tuberculosis.
- Whooping cough (pertussis).
- Chlamydia, gonorrhea and other sexually transmitted infections (STIs).
- Urinary tract infections (UTIs).
- E. coli.
- Clostridioides difficile (C. diff).

Common infectious diseases caused by fungi:

- Ringworm (like athlete's foot).
- Fungal nail infections.
- Vaginal candidiasis (vaginal yeast infection).
- Thrush.

Common infectious diseases caused by parasites:

- Giardiasis.
- Toxoplasmosis.
- Hookworms.
- Pinworms.

7.4.2 Prevention of Infectious Diseases

There are numerous simple strategies to minimise the chance of contracting an infectious disease and even prevent certain diseases entirely. While each of them reduces your chance of contracting and transmitting infectious diseases, there is typically no single method that is 100 percent effective. Therefore, it is essential to have several risk-reduction behaviours.

Vaccines

Vaccines lessen the likelihood of contracting an infectious disease by preparing the immune system to recognise and combat dangerous invaders.

Vaccinated individuals may occasionally still get an illness, although their symptoms are typically milder than they would have been without vaccination.

Fig. 7.4.2 Vaccines for Infectious Diseases

Vaccines are available for a number of common infectious diseases, such as:

- **Chickenpox:** Highly contagious viral infection causing itchy skin rash and fever.
- **COVID-19:** Respiratory illness caused by the novel coronavirus, leading to a wide range of symptoms from mild to severe.
- **Diphtheria, tetanus, and whooping cough (whooping cough):** Bacterial infections with symptoms like severe throat inflammation, muscle stiffness, and persistent cough.
- **Hepatitis A:** Liver infection caused by the hepatitis A virus, transmitted through contaminated food and water.
- **Hepatitis B:** Viral infection affecting the liver, transmitted through blood and body fluids, leading to acute or chronic liver disease.
- **Human papillomavirus (HPV):** Common sexually transmitted infection, linked to cervical and other cancers.
- **Influenza:** Viral respiratory infection causing fever, body aches, and respiratory symptoms.

- **Malaria:** Mosquito-borne infectious disease characterized by fever, chills, and flu-like symptoms.
- **Rubella, measles, and rubella:** Viral infections causing rashes, fever, and respiratory symptoms, with potential complications.
- **Polio:** Highly contagious viral infection affecting the nervous system, leading to paralysis in severe cases.
- **Rotavirus:** Common cause of severe diarrhea in young children.
- **Rabies:** Deadly viral disease affecting the nervous system, transmitted through animal bites.
- **Shingles:** Painful viral rash caused by the reactivation of the chickenpox virus.
- **Tuberculosis:** Bacterial infection primarily affecting the lungs, causing persistent cough and fatigue.

The CDC provides current vaccination recommendations for children, adolescents, and adults. Before you travel, ensure that you have had all of the necessary vaccines for your location.

Other methods of infectious illness prevention:

In addition to immunisations and appropriate food handling procedures, you can lower your risk of contracting or transmitting an infectious disease by a few common actions.

- Hands should be washed with soap and water. Before making a meal or eating, after using the restroom, after contact with faeces (human or animal), and after gardening or dealing with dirt, it is essential to wash hands thoroughly.
- When you sneeze or cough, cover your nose and mouth.
- Sanitize regularly touched surfaces in your home and place of business.
- Avoid contact with infectiously ill individuals and the exchange of personal goods with them.
- While suffering from an infectious ailment, you should avoid contact with others.
- Do not drink or swim in potentially contaminated water.
- When sick or as recommended by the CDC, you should wear a mask in public.
- Always use a condom during sexual activity.
- To limit the risk of tick or mosquito bites, apply tick- and mosquito-approved insect repellent, cover as much exposed skin as possible with clothing, and check for ticks after spending time in wooded or grassy areas.

Fig. 7.4.3 Mask and Hand wash during Infectious Disease

7.4.3 General Health Issues and their Symptoms & Cure

General health issues like fever, cough, and cold can affect construction workers, especially when working in diverse weather conditions and exposed to various environmental factors.

Fig. 7.4.4 Symptoms of Fever, Cough and Cold

Here are their symptoms and some recommendations on what construction workers can do to manage these health issues:

- **Fever:**
  - ♦ **Symptoms:** Elevated body temperature, chills, body aches, fatigue.
  - ♦ **To-Do:**
    - Rest and avoid strenuous physical activity.
    - Stay hydrated by drinking plenty of fluids.
    - Use over-the-counter fever-reducing medications if necessary.
    - Seek medical attention if the fever persists or becomes severe.
- **Cough:**
  - ♦ **Symptoms:** Persistent coughing, irritation in the throat, chest discomfort.
  - ♦ **To-Do:**
    - Avoid exposure to irritants like dust and fumes as much as possible.
    - Stay well-hydrated to soothe the throat.
    - Use a mask or respirator to protect the airways from particles and pollutants.
    - Seek medical advice if the cough worsens or is accompanied by other symptoms.

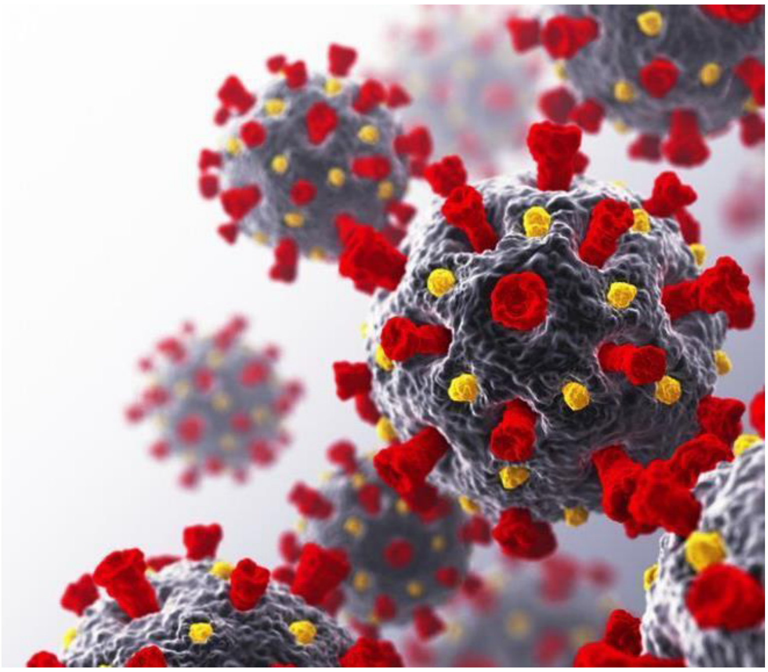

Fig. 7.4.5 Spread of Disease

- **Cold:**
  - **Symptoms:** Runny or stuffy nose, sneezing, sore throat, mild body aches.
  - **To-Do:**
    - Rest and take sufficient breaks to recover.
    - Keep warm and dress appropriately for the weather.
    - Drink warm fluids like soups and herbal teas.
    - Use over-the-counter cold remedies to alleviate symptoms.

General Health Tips for Construction Workers:

- Stay hydrated throughout the day, especially in hot weather.
- Wear appropriate protective gear such as safety shoes, gloves, and helmets.
- Take regular breaks and rest when needed to prevent fatigue.
- Practice proper hand hygiene to reduce the risk of infections.
- Use masks or respirators when working in dusty or polluted environments.
- Eat a balanced diet to maintain overall health and immunity.
- Get regular medical check-ups and vaccinations as recommended.

It's important for construction workers to prioritize their health and safety, as their job often involves physical exertion and exposure to potential health hazards. If any health issue persists or worsens, it is advisable for them to seek medical attention promptly.

7.4.4 Reporting an Outbreak or Hazard of any Infectious Disease or Pandemic

Reporting an outbreak or hazard of any infectious disease or pandemic is crucial for prompt action and preventing further spread of the illness. The specific reporting procedure may vary based on the organization, industry, or country. Here's a general procedure to report such incidents to the concerned authority:

- Identify the signs and symptoms of the infectious disease or pandemic hazard.
- Isolate affected individuals to prevent further spread.
- Inform immediate supervisors or managers about the situation promptly.
- Contact the appropriate health authorities or public health department.
- Cooperate with contact tracing efforts and provide necessary information.
- Implement preventive measures recommended by health authorities.
- Communicate updates and preventive measures to employees to maintain transparency.

Remember that reporting an outbreak or hazard of any infectious disease or pandemic promptly is essential for quick containment and mitigation. Cooperate with healthcare professionals, follow their advice, and work together to protect the health and safety of your community and workplace.

Exercise

Answer the following questions:

A. Short Questions:

1. What are the reporting procedures for breaches or hazards at the construction site as per guidelines?
2. Can you identify different types of safety hazards commonly found at construction sites?
3. How would you demonstrate following emergency and evacuation procedures in the case of an accident or fire?
4. What are basic ergonomic principles and how are they applicable to construction work?
5. What steps should you take in responding to accidents and other emergencies at the construction site?

B. Fill-in-the-Blanks Questions:

1. Proper handling of tools, equipment, and materials is essential as per .... (project schedule / applicable norms).
2. Different types of fire extinguishers correspond to various types of .... (weather conditions / fires).
3. Using hazardous materials safely involves following .... (project deadlines / standard guidelines).
4. Proper .... (cleaning / disposal) methods are important to manage construction waste.
5. Personal Protective Equipment (PPE) includes items like head protection, ear protection, and .... (sunglasses / fall protection).

C. True/False Questions:

1. Accidents and hazards don't need to be reported if they result in minor injuries. (True/False)
2. Ergonomic principles focus on optimizing workspaces and equipment for worker comfort and safety. (True/False)
3. All types of fire extinguishers can be used interchangeably on different types of fires. (True/False)
4. Using Personal Protective Equipment (PPE) is not necessary if you're experienced in construction work. (True/False)
5. Proper cleaning and disinfection of materials, tools, and supplies is not important in construction work. (True/False)

Notes

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8. Employability Skills (60 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

Scan the QR code below to access the eBook

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9. Assemble and Dismantle System Formwork (Elective-1)

CON/N0303

Key Learning Outcomes

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

1. Explain how to interpret the sketches/schematic working drawing relevant to system formwork.
2. Discuss the differences between conventional and system formwork.
3. Discuss system formwork and its types.
4. List the various types of shuttering materials with their specifications.
5. Discuss consumables used in shuttering work.
6. Explain different types of releasing agents (shuttering oil, cream emulsions, chemical release agents).
7. State the general tolerance limit for shuttering works.
8. Determine the shuttering materials required for work.
9. Demonstrate reading schematic working drawings for shuttering works.
10. Show how to perform checks to ensure cleanliness of shutters, suitability of the supporting base, availability of tools, availability of components, availability of fixtures prior to the erection/use of system formwork.
11. Explain the importance of stripping time for removing the shuttering of various R.C.C structural elements.
12. Describe the procedure for repairing the formwork.
13. Discuss the use of lifting gears for shifting and fixing formwork components.
14. Explain the standard procedure for stacking and storing formwork components.
15. Demonstrate assembling system formwork for R.C.C footing, column, wall, beam, and slab.
16. Demonstrate methods to check the erected formwork for line, level, alignment, and plumb within tolerance limits.
17. Discuss the standard procedure for dismantling system formwork for R.C.C footing, column, wall, beam, and slab.
18. Show how to check the quality of formwork materials for reusability after dismantling.
19. Demonstrate stacking of formwork components.

UNIT 9.1: Introduction to System Formwork

Unit Objectives

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

1. Explain how to interpret the sketches/ schematic working drawing relevant to system formwork.
2. Discuss about system formwork and its types.
3. Describe the difference between conventional and system formwork.
4. List the various types of shuttering material with their specifications.
5. Discuss about consumables used in shuttering work.
6. Explain different types of releasing agents (shuttering oil, cream emulsions, chemical release agents).
7. Demonstrate reading of schematic working drawing for shuttering works.
8. Show how to perform checks to ensure cleanliness of shutters, suitability of supporting base, availability of tools, availability of components, availability of fixtures prior to erection/use of system formwork.

9.1.1 Introduction to System Formwork

In a construction site number of concrete structures such as column, beam, slab, wall etc. to be erected. Moulds of various size and shapes according to the shuttering drawings are to be assembled so that concrete can be placed. System formworks are used to store and hold wet concrete until curing is achieved. System formwork has the standard prefabricated modular components with large casting panel. System formwork enhances the casting quality, increase speed of construction it can be reused more number of times than the conventional formwork. Some of the commonly used system formworks are MIVAN, Aluform, Doka, Peri, etc.

According to the material used, formwork is divided into 3 different types.

1. Timber formwork
2. Ply wood formwork
3. Steel formwork

We will discuss about Steel and plywood formwork in this unit Formwork is needed for the construction of structural members. Structural members are integral part of any structre. Few of the structural members in any structure are listed below

1. RCC beams
2. RCC slabs
3. Wall footing
4. Column footing
5. Column

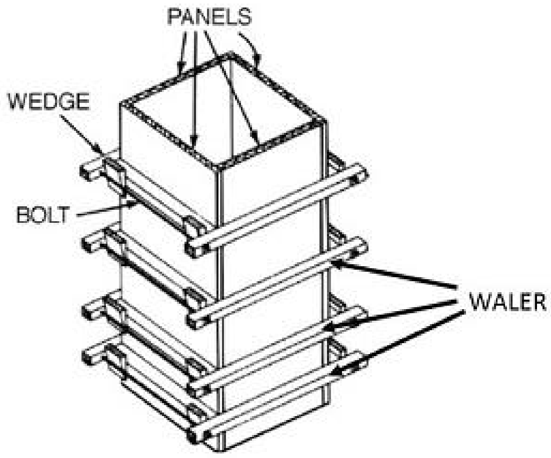


Fig 9.1.1: Column formwork

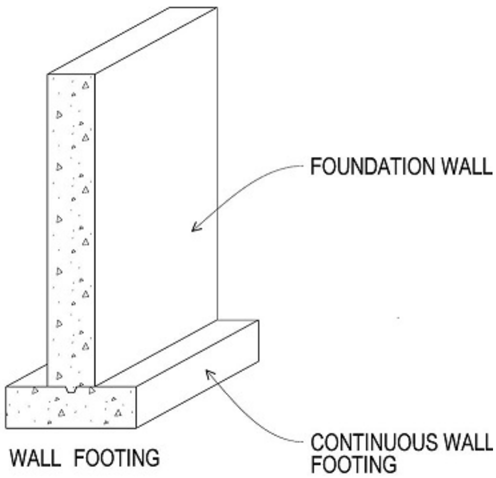
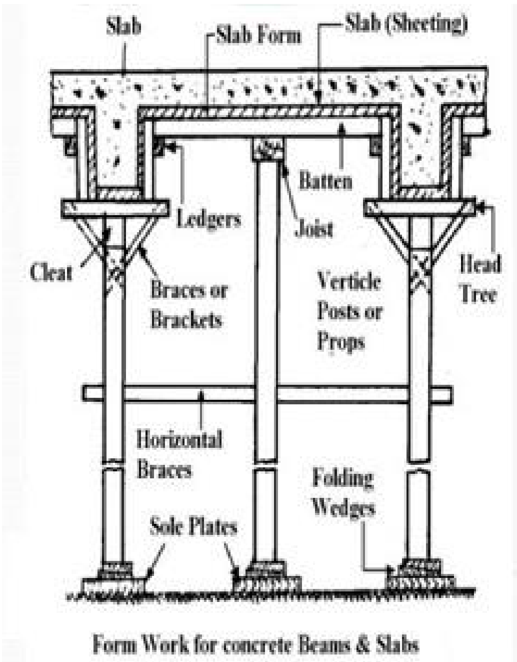


Fig 9.1.3: Beam and slab formwork



MMFig 9.1.2: Wall formwork

9.1.2. Introduction To Shuttering Drawing

Drawings are the most important documents we need to refer prior to starting our work. There are different types of drawings for different purposes. We will discuss about different types of Construction drawings which is also known as working drawings.

Types of Drawings used in construction

Construction drawings provide detail measurements and clear section of every building part. The different types of construction drawings are listed below.

1. Architectural drawing
2. Structural Drawing
3. Electrical Drawing
4. Plumbing and sanitary drawings
5. Finishing Drawings

As a shuttering carpenter the relevant drawings you need to understand is architectural drawing and structural drawing.

Architectural Drawing

This type of drawing provides complete view of a building. It demonstrates the location of building and all building parts and where they will be placed. There are different types of architectural drawings with different names such as plan, elevation, section etc. An example of an architectural drawing is as given below.

Structural Drawing

These types of drawing provides information about different structural elements such as column, beam, slabs etc its size, reinforcement materials to be used along with its diameter and the center to center distance, cover details etc. A typical example of a detailed structural drawing is given below.

Working drawings for formwork

The working drawing comprises plan, elevation and section of formwork assembly which covers types, dimensions, arrangement of components and accessories of formwork. Few typical examples of formwork working drawings are given below.

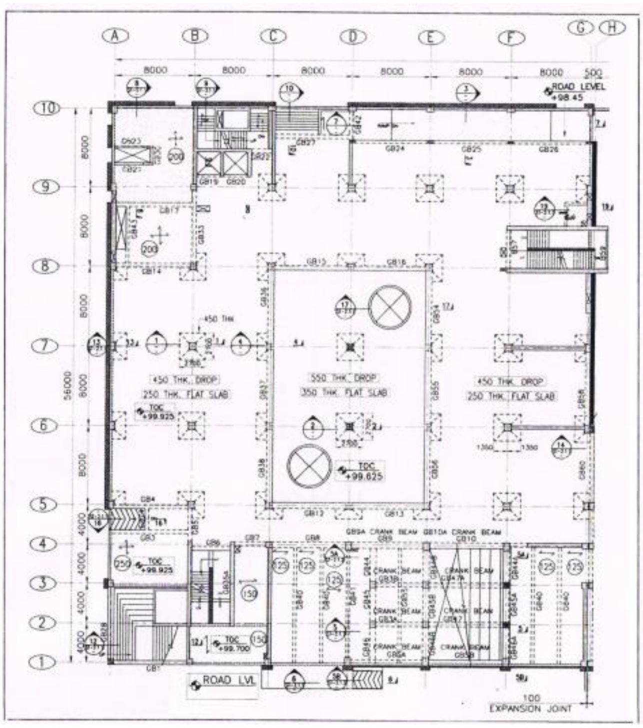


Fig 9.1.4: Typical Plan of formwork working drawing for a multistory building

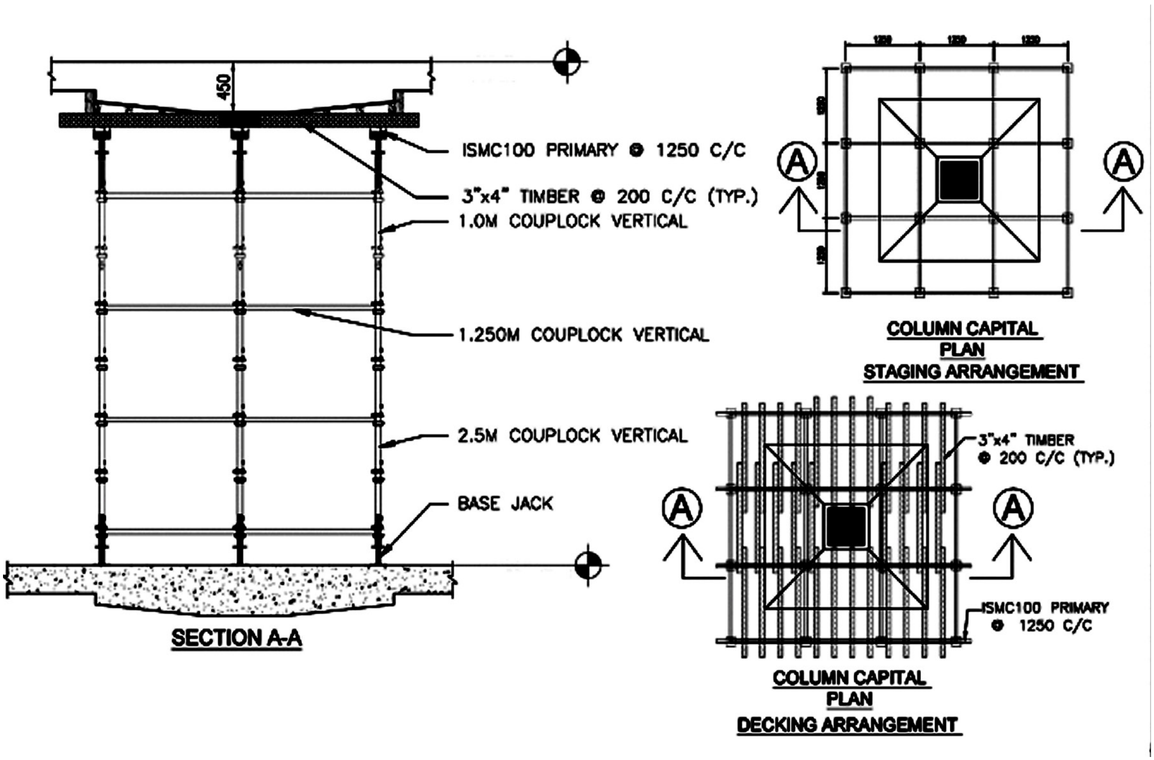


Fig 9.1.5: Plan & Section view of column capital with decking and supporting arrangement

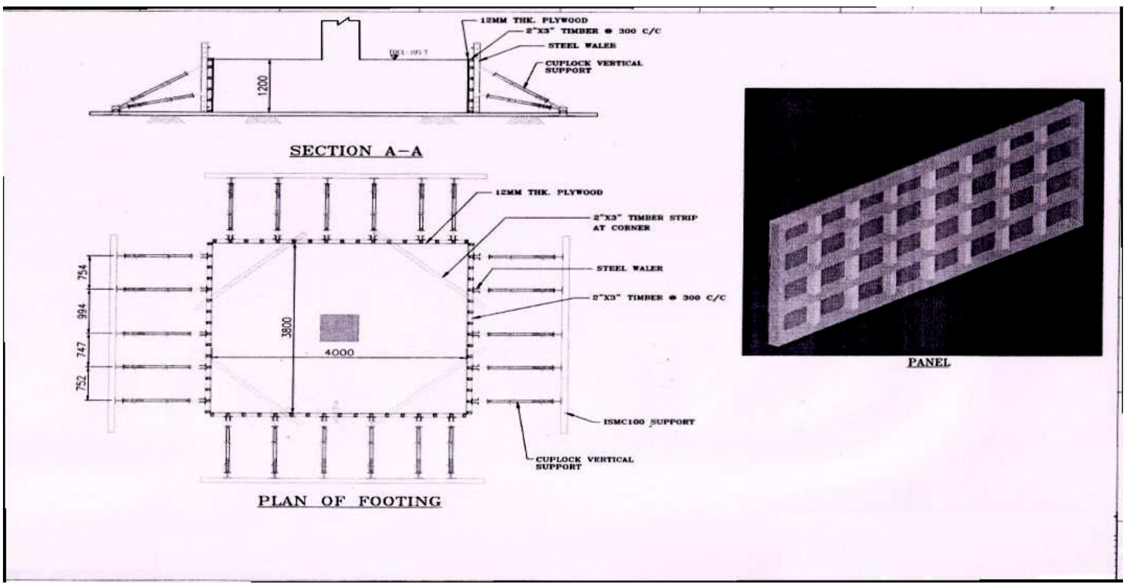


Fig 9.1.6: Plan and Section of Footing Formwork

Plan Details of column formwork-

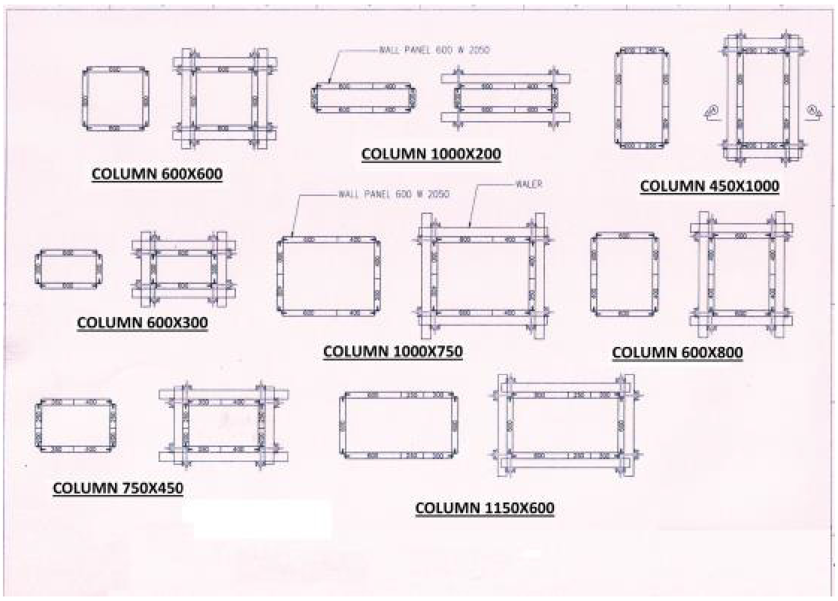
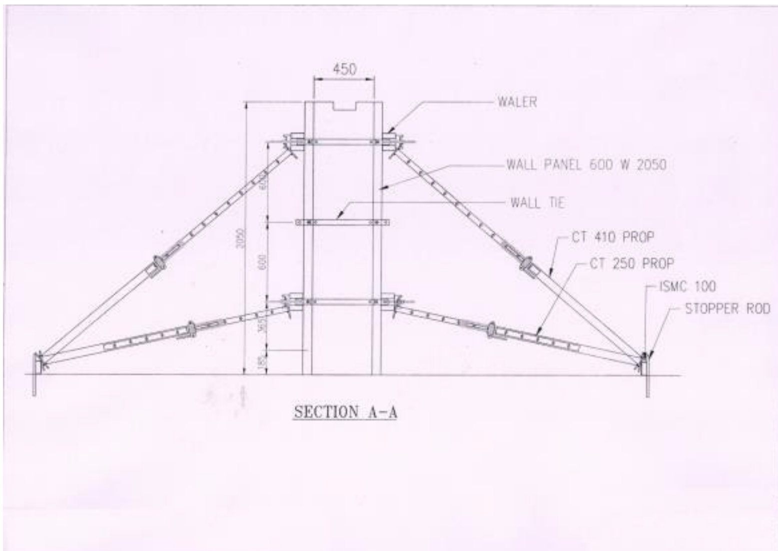


Fig 9.1.7: Plan Details of column formwork

Section Details of Column formwork:



118Fig 9.1.8: Section details of column formwork

121Plan and Section of Wall Formwork-

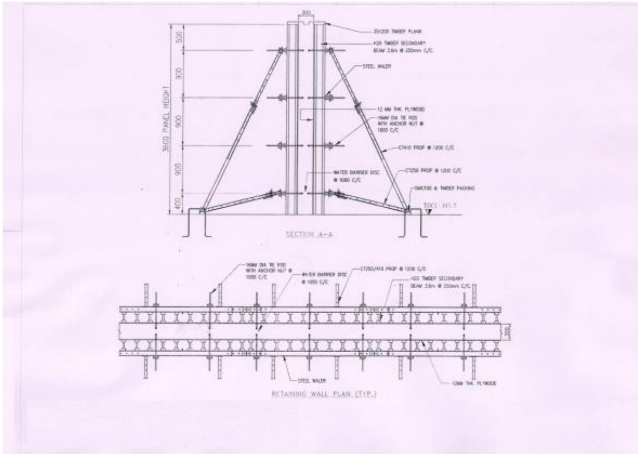


Fig 9.1.9: Plan and section of wall formwork

Section of Beam and Slab Formwork-

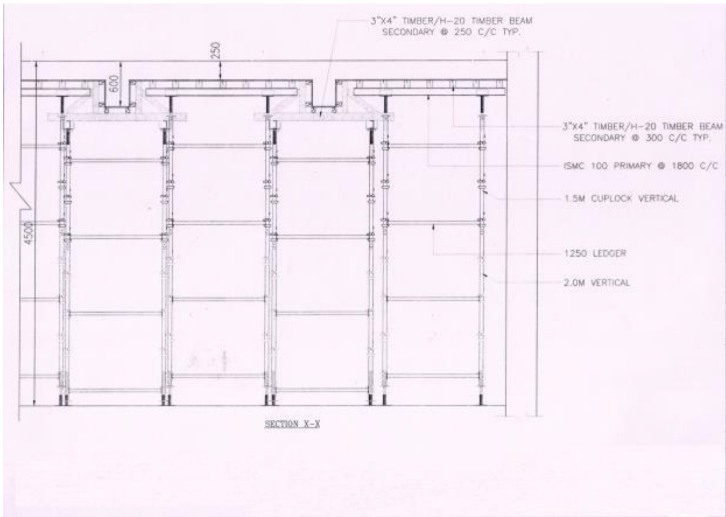


Fig 9.1.10: Section of beam and slab formwork

9.1.3 System Formwork

There are two types of formworks which are generally used in construction works. They are system formwork and conventional formwork. In conventional formwork the form work components are of timber and plywood. In system formwork the materials majorly used are steel, Aluminum, manufactured/processed wood. The two major advantages of formwork systems, compared to conventional formwork, are speed of construction and higher durability leading to saving cost, if the components are made of wood they may have to be replaced after a few no of uses, but if the covering is made with steel or aluminum the form can be used large no of times as metal is almost indestructible. We will discuss here few of the commonly used system formwork in India.

9.1.3.1 Aluminum Formwork

Aluminum form work is a system form work wherein walls, floor slabs, columns, beams, stairs, balconies etc. can be casted at one go. The formwork components are made up of aluminum. Aluminium form system is generally deployed for construction of tall structures with load bearing wall and the floor plan remains same for the entire floor. In this construction, load bearing walls and slabs are cast monolithically resulting in faster construction. Also de-shuttering of slabs can be done earlier resulting in faster cycle time. It is a fast, adaptable and very cost effective formwork. All panels are clearly labelled to ensure identification and can be smoothly fitted together with the help of formwork drawings. The simplicity of Aluminum Formwork and the repetitive nature of the assembly process make it possible to accurately programme construction sequences and thus cycle times well in advance.

The assembly system of Aluminum formwork is simple and is explained below.

1. Pin and wedge system: The panels are held in position by a simple pin and wedge system that passes through holes in the outside rib of each panel.
2. Quick strip prop head: One of the principal technical features which enables this speed to be attained using a single set of formwork panels is the unique V shaped prop head which allows the ‘quick strip’ to take place whilst leaving the propping undisturbed. The deck panels can therefore be reused immediately.

Advantage of Aluminum Formwork:

- It is simple, easy to erect and dismantle than traditional system of formwork.
- It is cost effective
- The in-situ construction of all walls and partition increases the speed of construction.
- High degree of precision items such as door and window frames can be directly installed on site with minimal re-sizing.
- Good quality Aluminum formwork panels produces accuracy in dimension.
- After removal of formwork panel, a good finishing on concrete surface is obtained and also accurate verticality within permissible tolerances can be achieved
- Due to high quality of tolerance of the finish, no further plastering is required.

9.1.3.2 MIVAN Formwork

Mivan is an aluminum formwork system. It is suitable for constructing residential and commercial buildings within short span of time in one continuous pour. It produces total quality work which requires minimum maintenance. For cast–in–situ structure this system is most suitable for Indian condition. These are easy to handle, strong, well built and fabricated with precise accuracy. Around 200 repetitions can be achieved using Mivan Formwork System.

Fig 9.1.11: MIVAN Formwork

9.1.3.3 Steel Formwork

Steel formwork is another example for system formwork. The formwork components are made up of steel. Steel formwork panels are fabricated with thin steel plates stiffened along the edges by small angles. The panels are assembled together by suitable clamps or bolts and nuts. The panels can be fabricated in any desired size and shape. These types of formwork are generally used in larger projects or where large number of reuses of the shuttering material is required. Steel formworks are most suitable for circular or curved structures.

Fig 9.1.12: Steel shuttering

Features of Steel forms:

1. Steel forms are harder, durable, and have longer life span
2. These can be installed and dismantled with greater speed.
3. The quality of exposed concrete surface by using steel forms is good and such surfaces need no further treatment.
4. Steel formwork does not absorb moisture from concrete.
5. This formwork doesn't shrink or twist.

9.1.3.4 Doka Formwork

Doka is another type of system formwork. Its components majorly comprises of processed timber and plywood. The primary member is plywood, the supporting members are made up of processed timber.

It is a monolithic formwork solution that allows walls, floor-slab, columns, floor beams and stairs are cast in a single pour. It is convenient as the components can custom made as per the requirement at site. In residential construction where the same designs are used multiple times, Doka formwork is used. The range of application spans from single family houses, apartment complexes and high rise buildings.

In all fields of the construction sector the Doka is a main supplier of formwork and an international producer. Doka One Go is one of the techniques used in Doka formwork.

Column Formwork: For column form-work, the Doka beams, multipurpose wailings and Doka formwork sheets are mainly used.

Fig 9.1.13: Doka formwork

Fig 9.1.14: Doka formwork

Column Formwork using Doka system

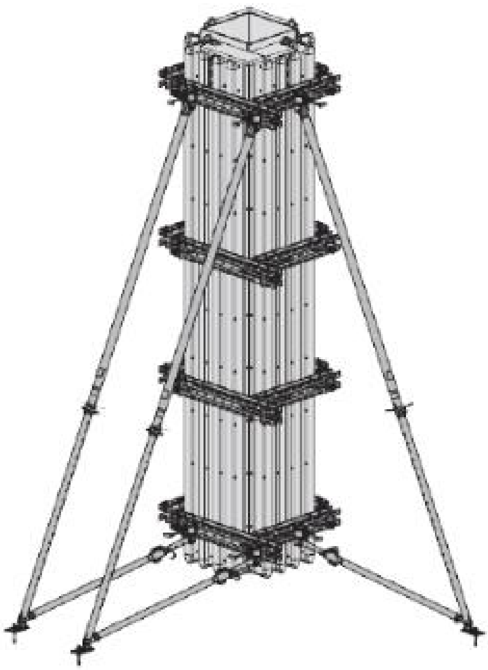
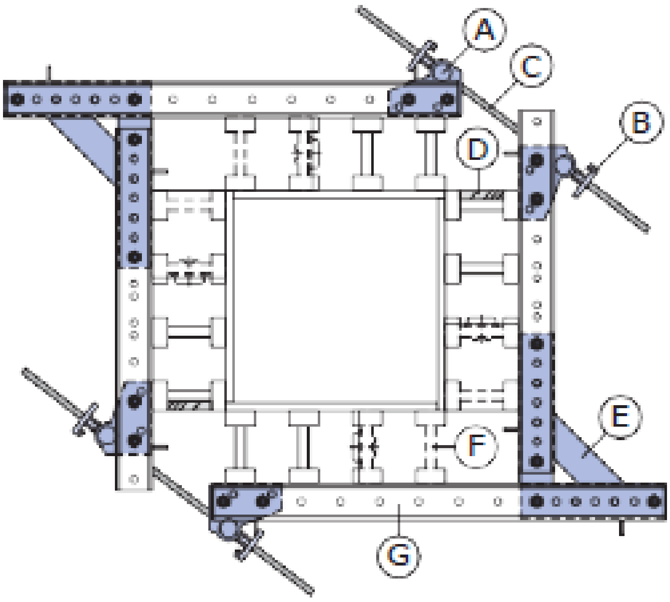


Fig 9.1.15: Column formwork using Doka system

Plan of doka column formwork



A - Universal angle tie bracket

B - Wing nut 15.0

C - Tie-rod 15.0

D - Flange reinforcement

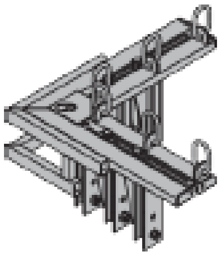
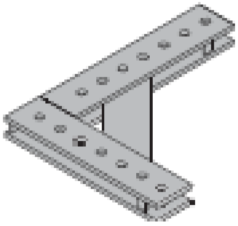
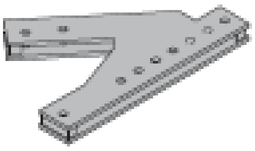
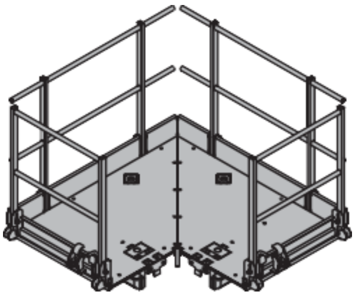
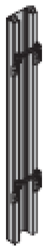
E - Corner connecting plate 90/50

F - Doka beam H20

G - Multipurpose waling

In Doka formwork system No form-ties through the column are used. It gives Easy assembly and handling along with Clean and smooth concrete surfaces.

Major Doka Components use for Column formwork:

Major Components for Doka column formwork	Images
Lifting bracket for column formwork	
Corner connecting plate 90/50	
Column connecting plate 6/8	
Doka column formwork platform 150/90cm	
Framax circular forming plate	

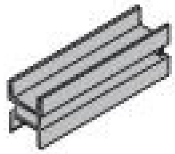
Framax steel waling RD 0.40m	

Table 9.1.1: Doka components for column formwork

Slab

Doka Flex: The Dokaflex hand-set systems allowed to form custom floor-slabs, drop beams and filigree slabs easily and quickly, while offering full flexibility with regard to the layout.

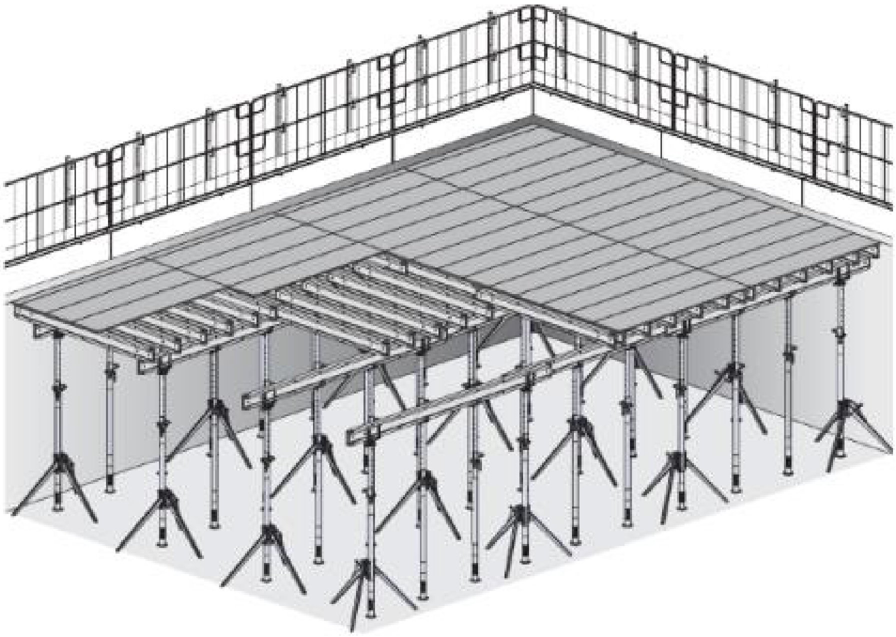


Fig 9.1.16: Doka flex

De

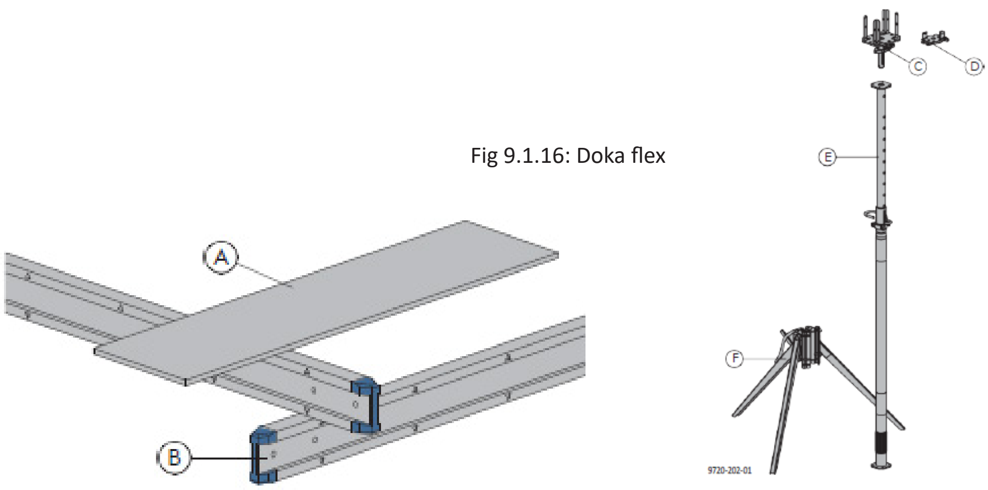


Fig 9.1.17: Dokaflex components

A Doka formwork sheet 3-SO

B Doka beam H20

C Lowering head H20

D Supporting head H20 DF

E Doka floor props Eurex

F Removable folding tripod top

Doka flex consist of three types;

1. **Doka flex 1-2-4:** The easy-to-use floor-slab formwork with a logical, built-in system for setting up the formwork.

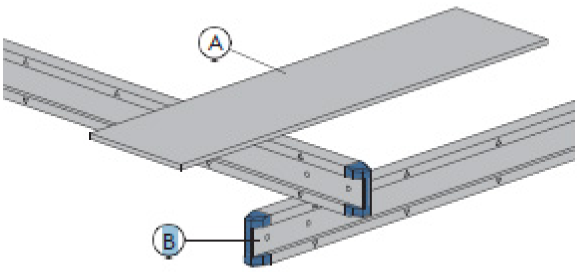


Fig 9.1.18: Doka flex 1-2-4 components

2. **Dokaflex 20:** It is tailor-made solution use as per specific project requirements where drop beams and floor extensions can easily be managed 'within the system'. In this system the beam and prop spacings are optimized depending on the layout, and in accordance with the slab load.

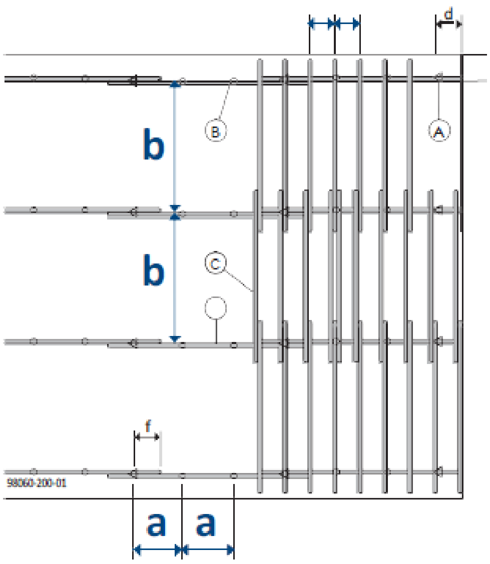


Fig 9.1.19: Doka flex 20 components

A. Prop spacing

B. Primary-beam spacing

C. Secondary-beam spacing

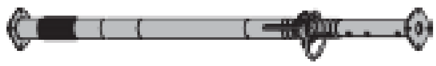
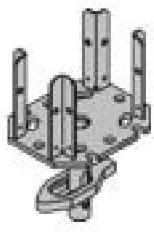
D. max. 50 cm or half of prop spacing

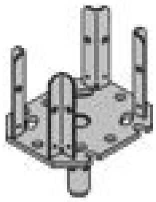
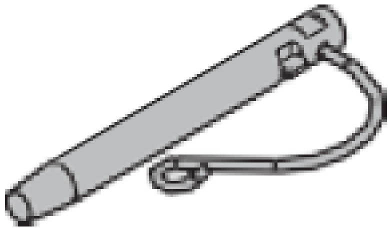
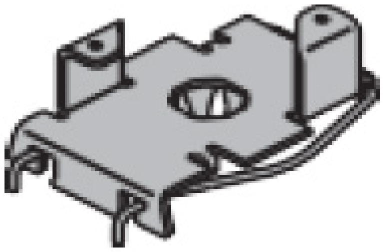
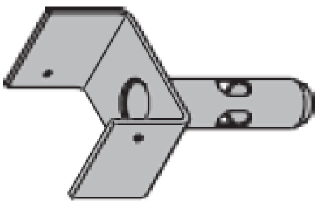
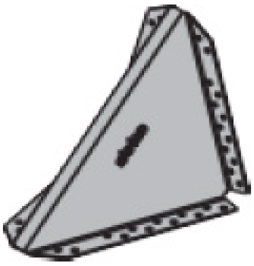
E. max. 50 cm

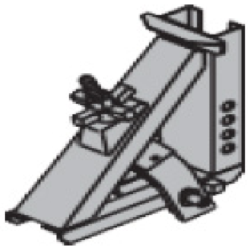
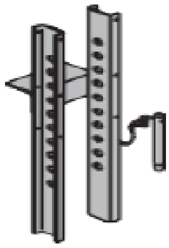
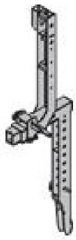
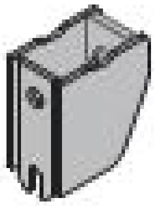
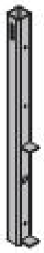
F. min. 30 cm

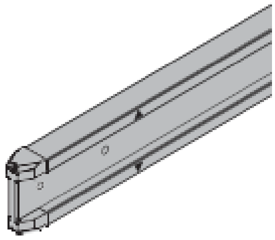
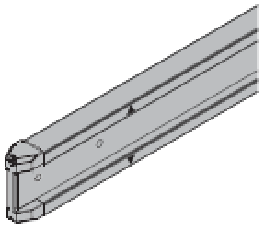
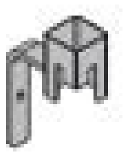
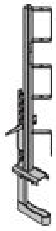
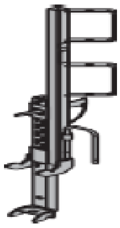
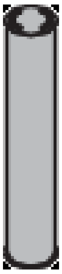
3. **Dokaflex 30 tec:** In Dokaflex 30 tec the timber-beam floor formwork with particularly sturdy components reduces the number of items required and hence it is fast to erect and dismantle, resulting in savings in labour costs.

Major components of slab and beam formwork:

Major Components for Doka column formwork	Images
Doka floor prop	
Removable folding tripod top	
Removable folding tripod.	
Lowering head H20	

4-way head H20	
Spring locked connecting pin	
Supporting head H20 DF	
U-head	
Bracing frame Eurex	
Universal end-shutter support 30cm	

Beam forming support	
Extension for beam forming support	
Doka floor end- shutter clamp	
End shutter shoe	
End-shutter tie rod	
Floor end-shutter profile XP	

Doka beam	
Toeboard holder XP 0.60m	
Toeboard holder XP	
Handrail clamp S	
Handrail clamp T	
Attachable sleeve	

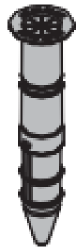
Screw sleeve	

Table 9.1.2: Components of slab and beam formwork

9.1.3.5. PERI Formwork

PERI is also a system formwork similar to DOKA formwork. This is a German company that provides formwork such as self-climbing formwork, wall formwork, shoring, column formwork, stage systems, slab formwork, climbing systems, props, formwork panels, brace frames for single-sided concreting and anchor systems. The primary member is plywood; the supporting members are made up of processed timber/steel. This is a self-climbing formwork and it ensures faster construction within a shorter period of time. PERI products have been exclusively designed as technical work equipment for use in the industrial sectors only by suitably trained personnel.

Fig 9.1.20: Peri formwork

Column and wall

PERI LIWA, the lightweight panel formwork for easy and quick forming of column, walls and foundations with and without the use of a crane. Each standard panel is at the same time, a multipurpose panel and the variety of applications is increased through the integrated perforated strip.

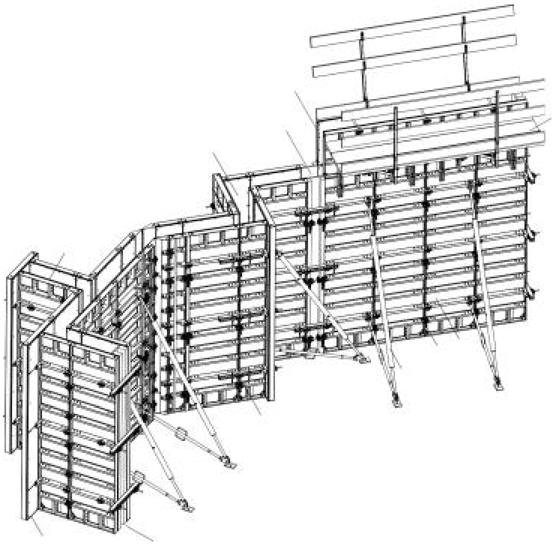
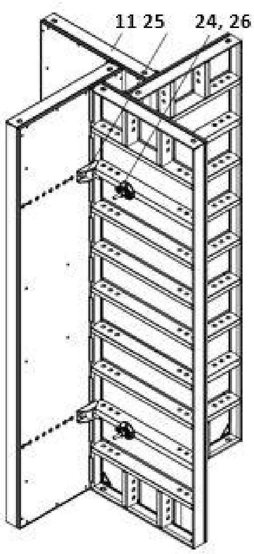


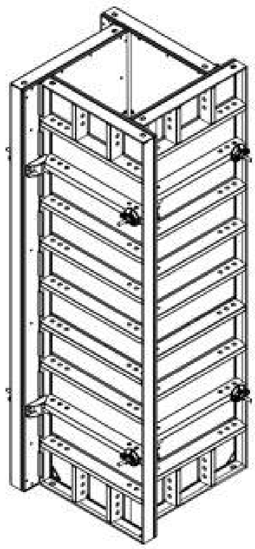
Fig 9.1.21: PERI Wall formwork

A3 Panel
A4 Panel Connection
A5 Tie Point
A6 Push-Pull Prop
A7 Working and Concreting Scaffold
B1 Corner
B2 T-junction
B3 Wall Offset
B4 Longitudinal Infills
B5 Stopend Formwork
B6 Extension Waler

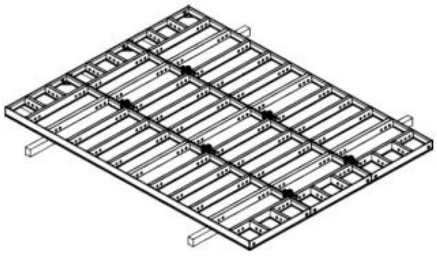
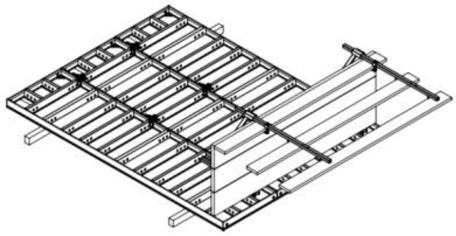
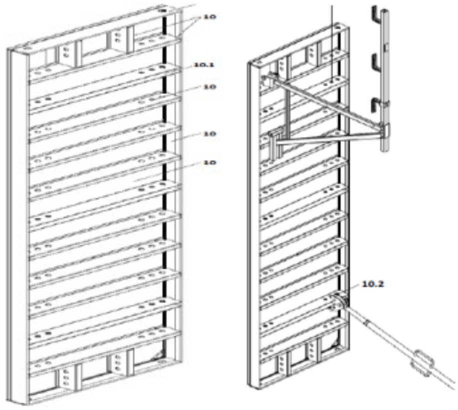
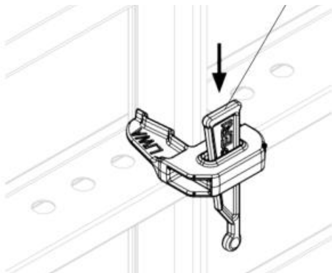
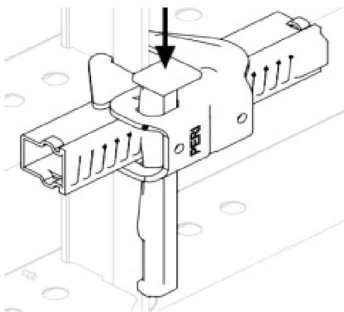
Column Formwork



11 Multi Panel LWM 300 x 75 1x
24 Tie Rod DW 15* 3x
25 Corner Connector LIWA* 3x
26 Wingnut Counterplate DW 15* 3x



PERI Components used for Column and Wall formwork:

Major Components for Doka column formwork	Images
Primary formwork	
Closing formwork	
Panel LW 300 x 75	
Wedge Clamp LIWA	
LIWA Alignment Coupler LRS	

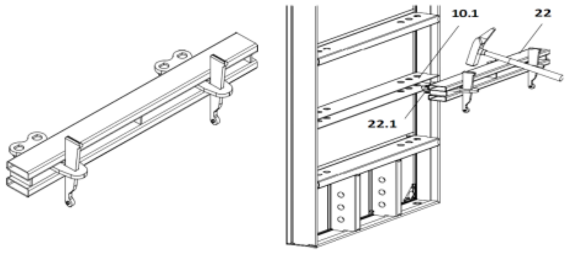
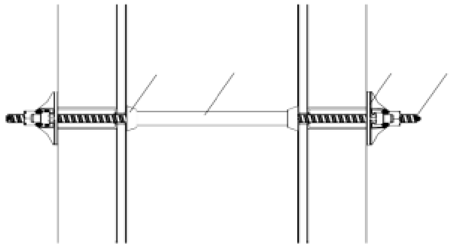
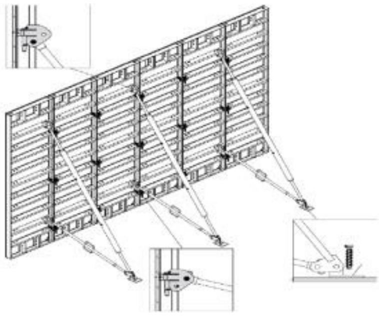
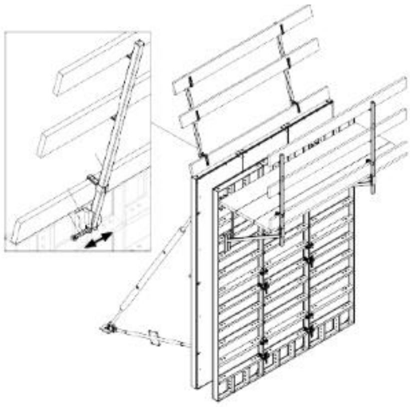
Compensation Waler LWR 60	
Tie Rod	
Push-Pull Props and Kickers	
Working and Concreting Scaffold	

Table 9.1.3: PERI Components used for column and wall formwork

Slab & Beam Formwork

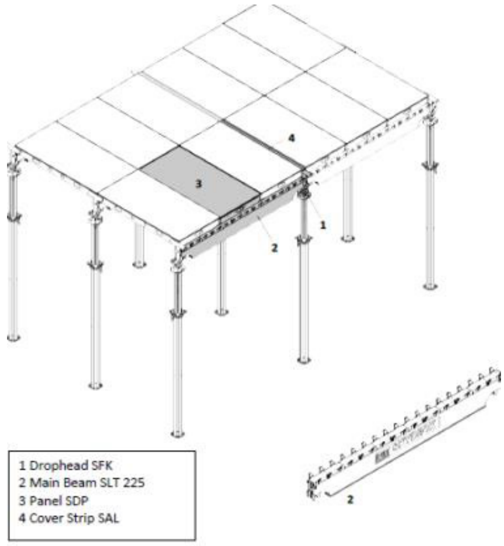


Fig 9.1.23: PERI Slab and beam formwork

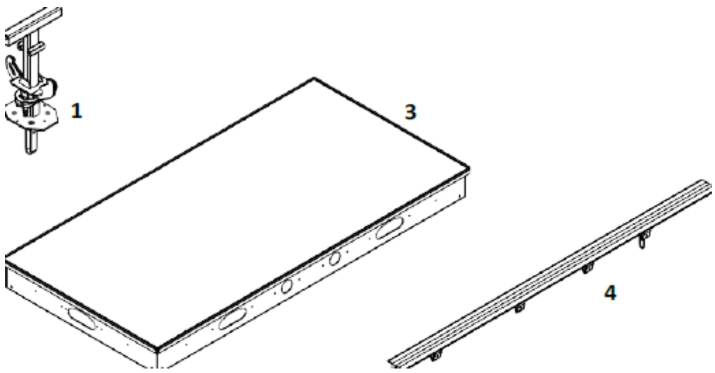


Fig 9.1.23: PERI Slab and beam formwork

PERI SKYDECK is a panel slab formwork system used for constructing slab thicknesses up to 109 cm. Depending on the slab thickness and concrete strength, the SKYDECK drophead allows striking to take place after only 1 day. The panels and main beams are made of aluminium which means they are very light. Due to early striking, the panels and main beams can be used for the new concreting cycle. Only the props with dropheads and the cover strips remain in position until the full concrete strength has been reached. The on-site material requirements are therefore clearly reduced.

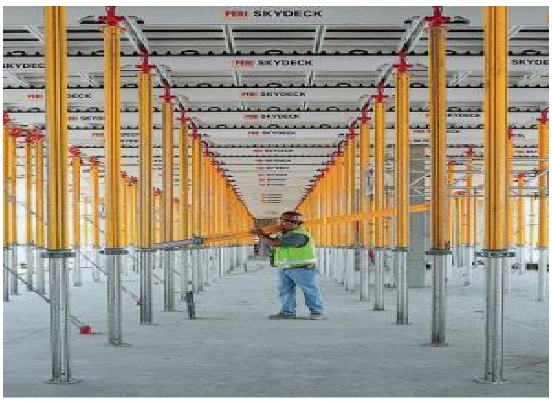
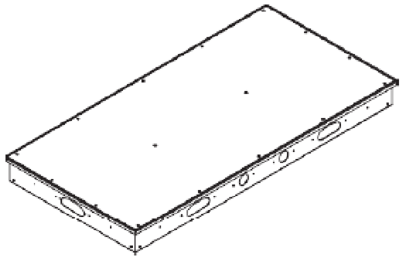
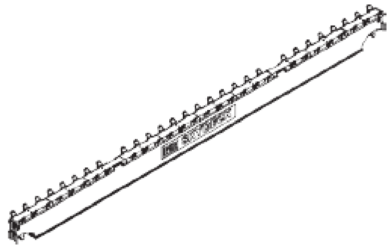
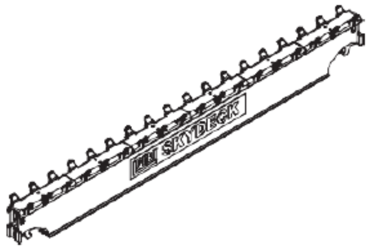
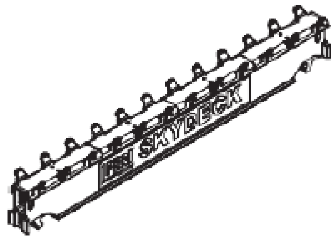
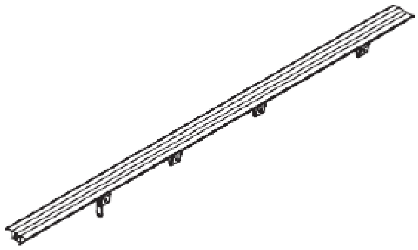
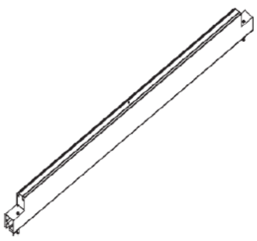


Fig 9.1.24: PERI SKYDECK system

Major Components of PERI SKYDECK system for Slab & Beam formwork	Images
Panel Slab Formwork	
Main Beam SLT 375 For cantilevers	
Main Beam SLT 225 For standard fields.	
Main Beam SLT 150 For filler areas	
Cover Strips SAL Cover Strip SAL 150 Cover Strip SAL 75 Cover Strip SAL 50 Cover Strip SAL 37.5 Plastic. Panel with 21 mm plywood. For use with drophead SFK.	
Edge Beams SRT-2 Edge Beam SRT-2 150 Edge Beam SRT-2 75	

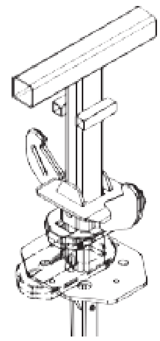
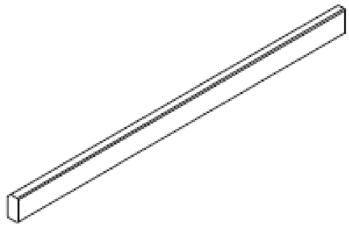
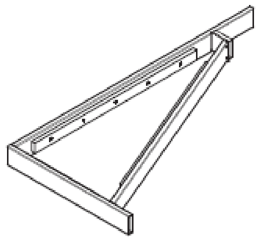
Drop head SFK With self-locking coupling. Supports main beam as well as cover strip and form lining. Lowering height 6 cm. For 21 mm plywood form lining.	
Filler Timbers SPH Filler Timber SPH 150 Filler Timber SPH 225 For compensations with 21 mm plywood form lining.	
Triangular Frames SDR Triangular Frame SDR 150 x 75 Triangular Frame SDR 75 x 75 For compensations on inclined walls. For compensations with 21 mm plywood form lining.	

Table 9.1.4: Components of PERI SKYDECK system

1. **Easy handling:** Effortless working operations and short shuttering times through the lightweight system components; panels and main beams each weighing only 15.5 kg

Fig 9.1.25: Handling of SKYDECK system

2. **Early striking:** Depending on the slab thickness and strength of the concrete, early striking can take place only one day after concreting.

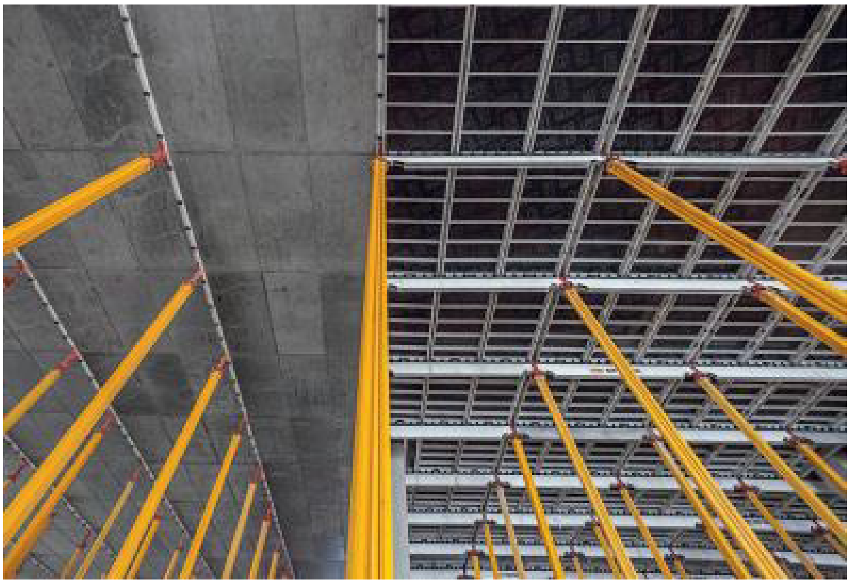


Fig 9.1.26: striking of PERI SKYDECK system

3. **Fast work operations:** Very efficient due to systematic, easy assembly and minimum prop requirements.

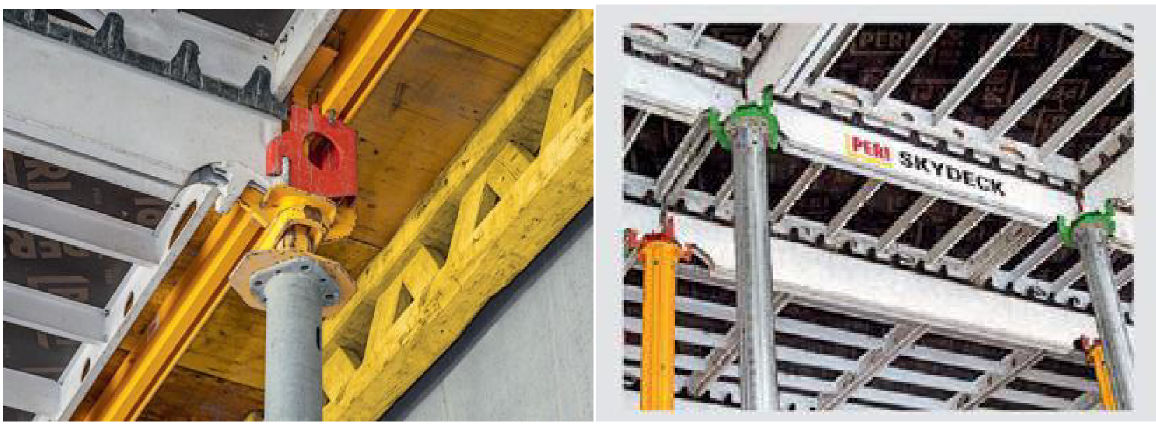
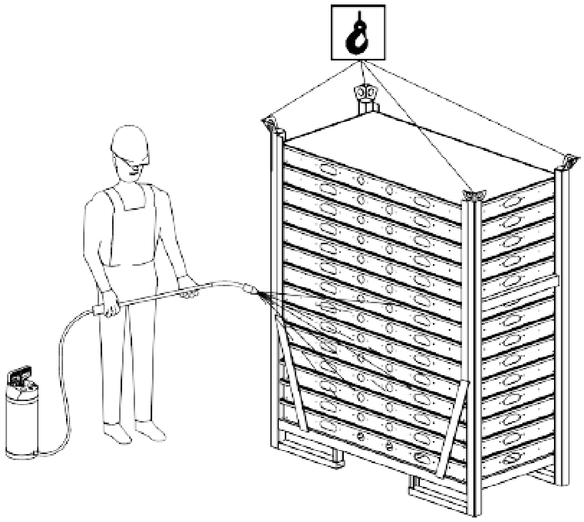


Fig 9.1.27: PERI SKYDECK system

4. **Easy to clean:** Powder-coated elements, plastic components and undercut panel edges ensure that cleaning is kept to a minimum



Maintenance and Cleaning

In order to maintain the value and operational readiness of the SKYDECK slab formwork over a long time, ensure that the formwork is carefully handled at all times. Maintenance instructions:

1. Concrete vibrator with rubber end cap reduces the risk of damage to the form lining.
2. Spacers used for the reinforcement with large contact surfaces prevent impressions forming on the form lining.
3. When placing heavy items on the form lining, use support timbers in order to prevent any impressions on and damage to the form lining surface.
4. Spray the components with PERI Bio Clean before every use and clean the rear of the formwork with water immediately after concreting.
5. Spray moving parts, if required, with PERI Bio Clean.
6. For damage-free transportation, suit- able PERI pallets and stacking devices are available.
7. Due to the powder coating, cleaning requirements are kept to a minimum. Panels and main beams are equipped with self-draining edges. They prevent the side areas from getting dirty and make cleaning easier.

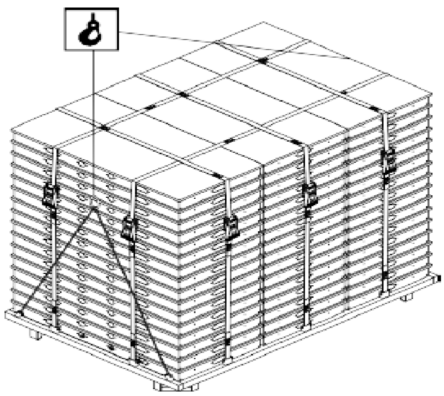


Fig 9.1.29: Handling of PERI SKYDECK panels

9.1.4 Releasing Agents

Releasing agents are coatings applied on the formwork surface, prior to concreting. Concrete mould release agents are used to prevent the adhesion of freshly placed concrete to a forming surface, whether that may be of plywood, steel or aluminum. Releasing agent used at construction site is generally known as shuttering oil. It facilitates easy removal of shuttering forms. If the appearance of the concrete surface is of significance, it is important that care is taken with the finish surface of the shuttering. Most important function of Releasing Agents is to permit easy removal of shuttering.

Fig 9.1.30: Application of releasing agents on shuttering panels

9.1.4.1 Functions of Releasing Agents

Major functions of releasing agents:

- Easy removal of shuttering form.
- Produce the recommended surface finish of the concrete member.
- Reduce the incidence of blowholes
- Protect the formwork and thereby increased reuse of shuttering materials
- It reduces cracks due to internal restrains.
- Reduce the loss of water from the concrete due to absorption in case of timber forms

Fig 9.1.31: Releasing agent

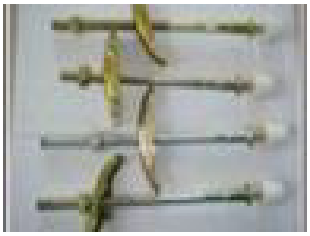
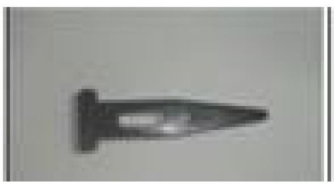
9.1.4.2 Type of Releasing Agents

There are two-types of mold release agents. They are called barrier release agents, reactive release agents and water released reacting agents.

1. **Barrier release agents -** prevent adhesion by the development of a physical film or barrier between the forming surface and the concrete.
2. **Reactive release agents -** are chemically active and work by the process of a chemical reaction between the release agent and the free limes available in fresh concrete.
3. **Water-based release agents -** It is a water-based formulation, which is an environment friendly releasing agent.

9.1.5 Fasteners used in Formwork

There are numbers of fasteners used in system formwork. Range and scope of inclusion such details can be varies as per there different types. Few of them are listed in table given below:

S.No	Name	Function/description	Image
1.	Form Tie	It is used to connect the forms together	
2.	Tie Rod	This rod is a slim structural member, used as a tie and capable of carrying tensile loads.	
3.	Standard Pin	a standard pin which is commonly used in Aluminum formwork	
4.	Wedge Bolt	It is a wedge bolt.	

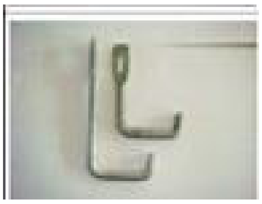
5.	Anchor Bolt	This is used to attach objects or structure to concrete.	
6.	Hook	It is bent in a shape and used for attachment ofobjects.	
7.	U-Clip	This U shape clip used in joining for panels in shuttering carpentry	
8.	Wedge	Wedge used at construction site have triangular in shape and portable inclined plane. It is used to hold the materials at its place.	
9.	Aluminum Form Pin	It is a metal pin used in aluminum formwork to hold two or more pieces of plates together.	
10.	Hex Nut/wig nut	Hex nut/wig nut have internal thread. It is used to fix and tighten the tie rod in carpentry works.	

Table 9.1.5: Fasteners used in shuttering formwork

9.1.6. Construction Joints

During construction work, where concreting of structural members could not be completed at one go, concreting is stopped beyond specified time a construction joint is provided. Construction joints in RCC beams, slabs and columns are provided when the concreting has to be stopped for the day or more than a specified time. A typical construction joints is required to maintained bond between set concrete and fresh concrete.

- These joints are provided using some kind of bulkhead made of wood, steel, plastic or precast concrete.
- A construction joint can be provided in case of equipment breakdown, an unexpected shortage of materials, or bad weather during concrete, although the joint should still be worked into the jointing pattern - placed where a contraction joint was planned. In case of pavement slab where no significant traffic the joint can be a plain butt joint.
- Use internal vibration during placement of concrete at construction joint. This will ensure
- proper consolidation along the edge and around the dovel bar.

Fig 9.1.32: Construction joint

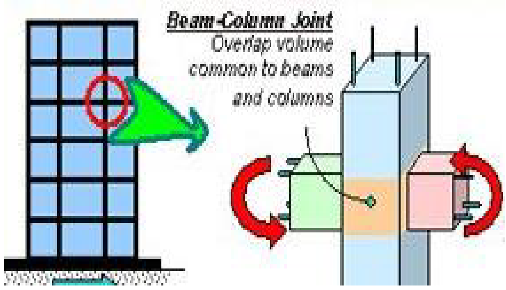


Fig 9.1.33: Beam-column joint

1. **Construction joints in column**

   Construction joint in column is provided as illustrated in the figure. The top area of the column should be rough with parts of coarse aggregates being seen.

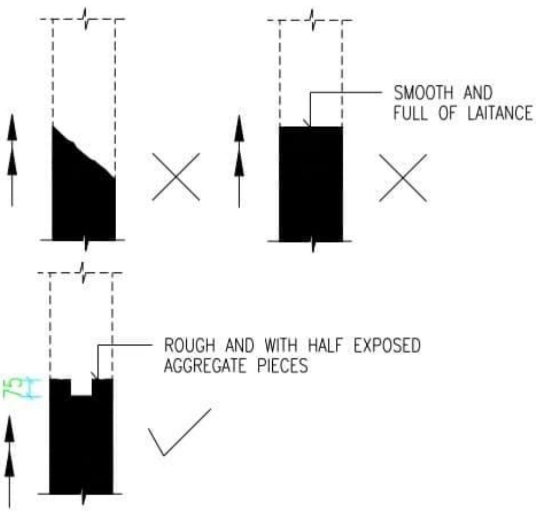


Fig 9.1.34: Typical Construction Joint in RCC Column

2. Construction joints in beams and beam-column joint:

Construction joint to be given in beams and beam column joints is explained in following figure:

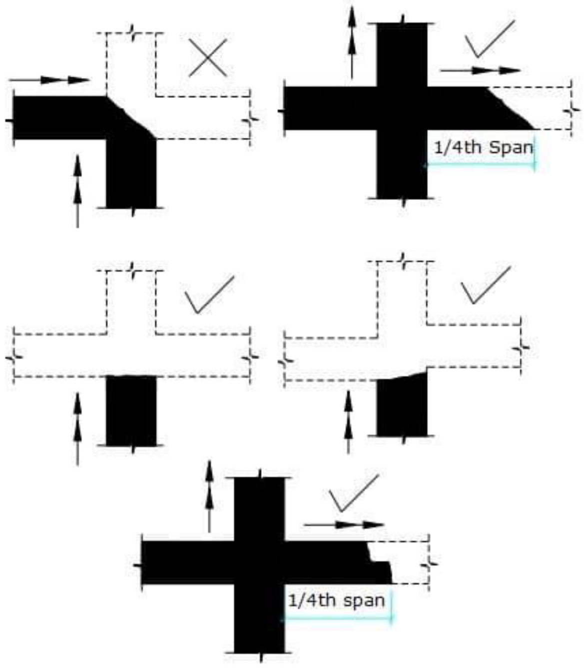


Fig 9.1.35: Typical Construction Joint in Beams and Beam-Column Joint

- The flow of concreting is explained by the arrow symbol.
- The correct method of providing construction joint is explained by tick mark. The wrong method is explained by cross-mark. As explained in figure, construction joint in the beams should be provided at 1/4 the span of beam from the face of the column. For a beam column joint, the construction joint for the column should be provided after construction of some length of column above beam level, and for the beam, it should be provided at a span of 1/4th from the face of the column.

Important Points to remember for construction joints in Beam and Slab:

1. Formwork should be rigidly constructed and efficiently propped and braced both horizontally and vertically, so as to retain its shape.
2. The joints in the formwork should be tight against leakage of cement grout.
3. Erection of formwork should be done in a such a way that during removal of various parts no damage to the concrete occurs.
4. The formwork for construction joint should be set accurately to the desired line and levels
5. It should rest on firm base

Notes

UNIT 9.2: Assemble and Dismantle System Formwork

Unit Objectives

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

1. Demonstrate assembling of system formwork for R.C.C footing, column, wall, beam and slab.
2. Demonstrate methods to check the erected formwork for line, level, alignment and plumb within tolerance limit.
3. Demonstrate dismantling of system formwork for R.C.C footing, column, wall, beam and slab.
4. Show how to check the quality of formwork materials for reusability after dismantling.

9.2.1 Formwork Erection

Formwork must be erected systematically and tied in and/or braced progressively to stabilize the structure. Formwork must be erected on a stable base to prevent the risk of collapse.

Fig 9.2.1: Measuring and digging footing area

9.2.1.1. Erection of Formwork For Footing

The first step for any concrete construction starts with the construction of foundation. Foundation can be for columns or walls. So, based on type of structural member, the shape and size of footing are designed. Thus formwork size and shape depends on the type and dimension of the footing. Consumables required for footing formwork is mainly Line Thread, Cotton Chalk Piece.

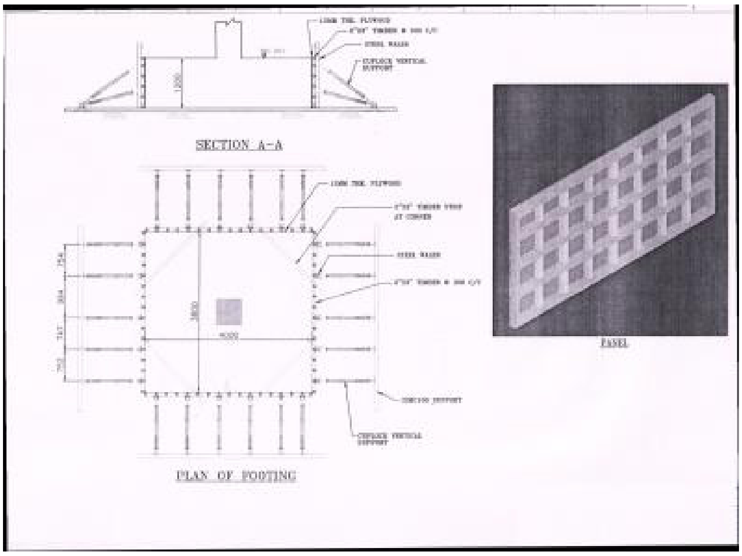


Fig 9.2.2: Footing drawing

- After completion of bed for the footing, check the size and slope of the pit as per drawing by measuring tape and mason's rope.
- Collect and stack all the required materials near the work place.
- Ensure that the releasing agent is applied appropriately on the formwork panels
- Place formwork panel at one corner
- Place formwork panel of suitable size on one side of the panel corner and join them properly

Fig 9.2.3: Erection of formwork for footing

- Repeat the same procedure for erection of formwork at remaining three corners.
- Place the pipe waler at the bottom of the footing panel.
- Connect the formwork panel with waler at both ends using hand tools
- Repeat the same procedure for fixing the waler at top.
- Connect the lapping plate between formwork panels and align to suit the correct footing size.
- Repeat the same procedure to fixing lapping plate at remaining three sides.

- Mark a point as per drawing from the edge of floor form corner for fixing the steel waler.
- Place steel waler vertically at the marked location.
- Insert and tighten waler connectors with pipe waler at bottom and top of the steel waler.
- Repeat same procedure for connecting steel walers and waler connectors at the remaining three corners.
- Position supporting bracket assembly and insert head adaptor assembly at top and bottom of the steel waler.
- Tight the head adaptor assembly using wing nuts.
- Repeat the same procedure for other corners also.
- Anchor foot adaptor assembly with ground using bit rod.
- Measure the dimension of foundation and align the floor forms using supporting brackets.
- Make sure that inner surface should be clean before concreting.

Fig 9.2.4: Centering footing form box

9.2.1.2 Erection of Formwork for Column

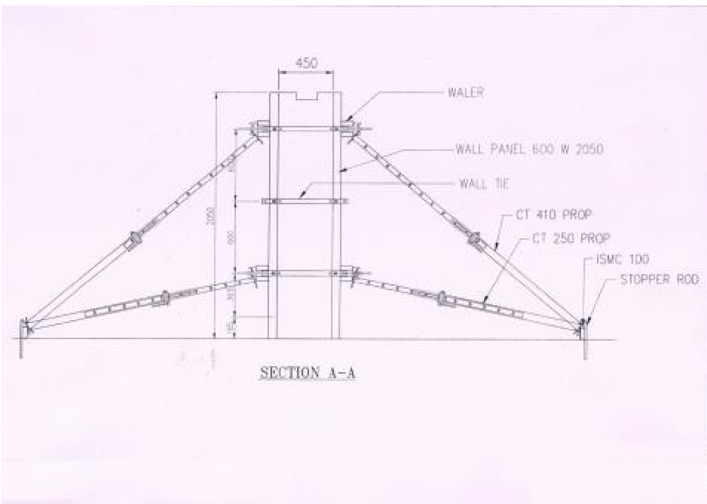


Fig 9.2.5: Column formwork drawing

- Plywood sheets fabricated with adequate battens and stiffeners is used for making of column shuttering. For easy removal of column board after the concrete a thin film of oil or release agent should be applied to the inner surfaces of the shuttering materials. Make sure that the cover block is used as per requirement at appropriate location. For erection of column form-work, following step should be followed:
- Use and follow the shuttering drawing approved by site-in charge before commencing the erection procedure
- Shift and lift L-shutter panels and place on side of column starter
- Place supporting bracket assembly on each one end of the shutter and fix head adaptors using wing nuts on the top and bottom steel walers of this shutter

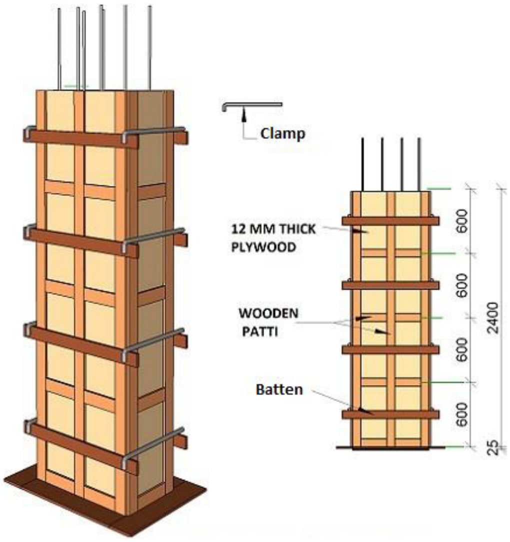


Fig 9.2.6: Column formwork

Fig 9.2.7: Checking plumb

- Place one more supporting bracket assembly and fix head adaptors at the center of top and bottom steel walers of this side shutter
- Fix both foot adaptors with bit rods using hand tools
- Check verticality of the shutter board using plumb bob and correct by adjusting length of sup-porting brackets as required
- Shift and lift one more L–shutter and place on the other side of the column starter
- Insert tie rods, fixed at top and bottom steel walers and tighten using wing nuts on both the ends of tie rods
- Check the verticality of the shutter using plumb bob.
- Check dimension of column formwork

Fig 9.2.8: Fixing props with formwork

Fig 9.2.9: Cover in column formwork

9.2.1.3 Erection of Formwork for Wall

Plywood sheets fabricated with adequate battens and stiffeners is used for making of wall shuttering. For easy removal of wall board a thin film of oil or release agent should be applied to the inner surfaces during erection. For erection of wall formwork, following step should be followed:

- Follow the drawing approved by site in-charge for erection of wall.
- Collect all the materials and consumables required for wall shuttering and ensure that the
- releasing agent is applied on the panels before staring of erection of wall.
- Place the wall shutter on the side of starter

9.2.1.3 Erection of Formwork For Wall

Shuttering Carpenter-System

- Place supporting bracket assembly on each one end of the shutter and fix head adaptors using wing nuts on the top and bottom steel walers
- Fix both foot adaptors with bit rods using hand tools
- Check verticality of the shutter board using plumb bob and correct by adjusting length of supporting brackets as required
- Erect side wall shutter near the width of wall starter and connect with the shutter erected earlier using tie rods and wing nuts at top and bottom
- Insert tie rods and fixed at top and bottom steel walers and tight it using wing nuts on both

the ends of tie rods

- Fix one supporting assembly with steel walers at centre of the shutter and correct the verticality
- Erect another side shutter on the opposite side similarly and connect with the tie rods using wing nuts
- Connect this shutter with small side shutter already nearby by fixing tie rods into the steel walers
- Erect another small side shutter near the width side and connect both the corners with tie rods
- Check the verticality of the shutter using plumb bob and align by adjusting length of supporting brackets
- At last, check the dimension, verticality and support for its durability.

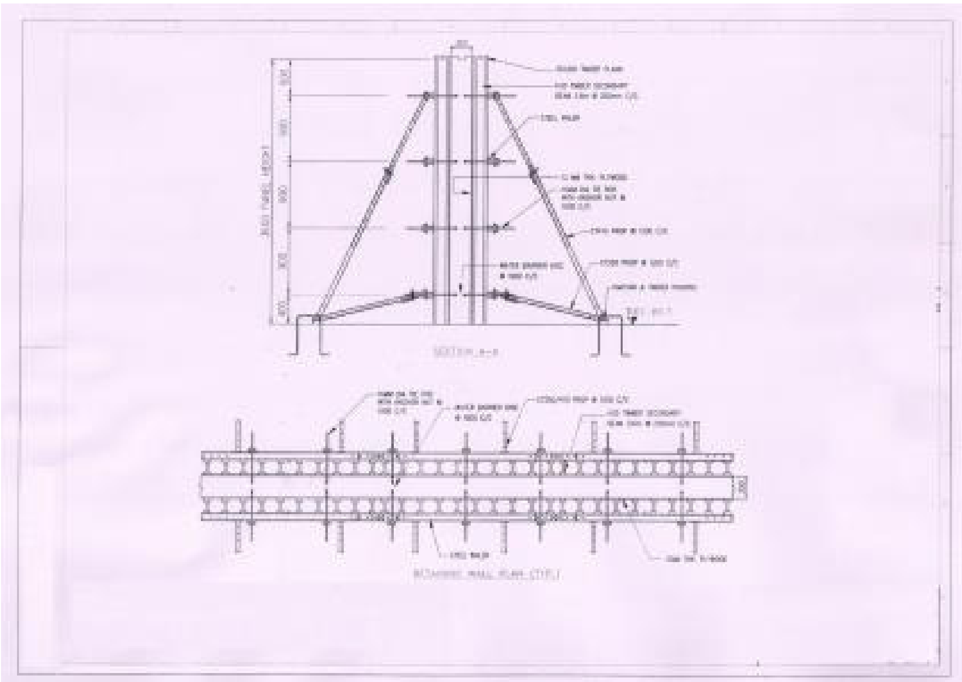


Fig 9.2.10: Wall formwork drawing

9.2.1.4 Erection of Formwork For Beam

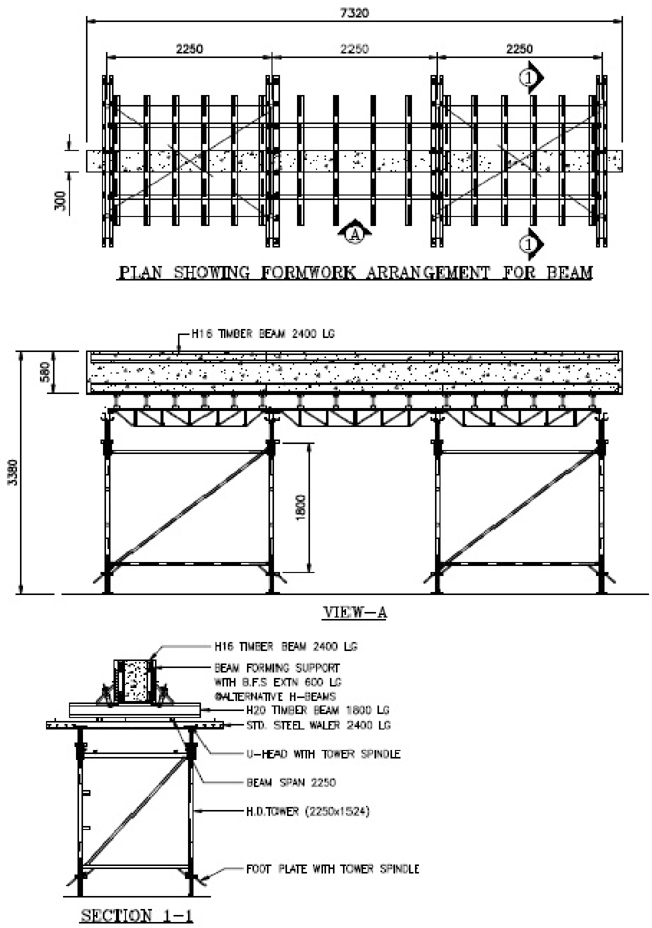


Fig 9.2.11: Beam formwork drawing

- Erection of formwork for beam is explained. The figure above is used as an example:
- Place foot plates assembled with tower spindle on each of the four center markings on the platform
- Erect basic frame 1.80m on one side over the placed tower spindles
- Erect second basic frame 1.80 on the opposite side having direction of welded bracing reversed to bracing of first frame
- Connect both such placed basic frames using horizontal bracing H225 at bottom
- Connect diagonal bracing D-18.225 diagonally on one end at bottom click & pawl of 1st frame and other end at top of 2nd placed basic frame
- Connect both the basic frames using one more horizontal bracing H-225 at top
- Connect H-225 and D-18.225 on the opposite side of the tower similarly by following the above methods
- Insert plane bracing D-12.225 diagonally and check the correctness of the diagonal on both direction and fix on one direction

- Place foot plates assembled with tower spindle on each of next two center markings
- Erect third basic frame 1.80 similarly over these tower spindles and connect this frame with second basic frame using H225 at bottom and top on both sides
- Place foot plates assembled with tower spindle on each of next two center markings adjoining
- Erect fourth basic frame 1.80 over these tower spindles and connect this frame with third basic frame using H225 and D-18.225 on both sides
- Align the vertical member of basic frames using line thread
- Check and correct top level of the spindle nuts using water tube level on all the legs placed so far
- Remove D-12.225 plane bracing and fix walk ways with basic frames two for each tower using hammer
- Insert tower spindle assembled with U-head two for each basic frames on all locations
- Check and adjust to same level the height of all U-heads by using water tube level and lever nut in the spindles
- Place steel walers in the same direction over two U-heads one for each basic towers and position
- Place beam spans 2250 connecting two steel walers at U-head locations on both sides on all locations
- Place H-20 beam on top of beam span on both the ends, position and connect brace strips using double end spanner
- Tie mason thread at the outer ends of both H-20 beams to ensure alignment.
- Place remaining H-20 beams and position in between in appropriate spacing to match verticals of beam span and on the steel walers
- Mark the outer edge of the beam on the H-20 beams using line thread and measuring tape
- Place beam bottom ply wood over the marking on beams and nail using hammer and remove the line thread
- Place floor forms as beam shutters, align and fix using form clip and position
- Place H-16 beams at bottom and top of beam shutters and fix using beam forming supports with extension and continue on the other side similarly
- Fix safety brackets four no. with H20 beams connect with handrails using screw on couplers on both sides
- Align and adjust the straightness using line thread
- Check verticality and alignment of beam

Actual relevant figure of beam during erection procedure at site using props is shown below:

Fig 9.2.12: Erection of formwork for beam

Fig 9.2.13: Fixing of formwork for beam

Fig 9.2.14: Fixing formwork for beam

Fig 9.2.15: Beam formwork

9.2.1.5. Erection of Formwork For Slab

Formwork for reinforced concrete slabs depends on the type of slabs to be constructed. The floor slabs can be structural slabs supported on a steel or concrete structural frame, or slab-on-grade.

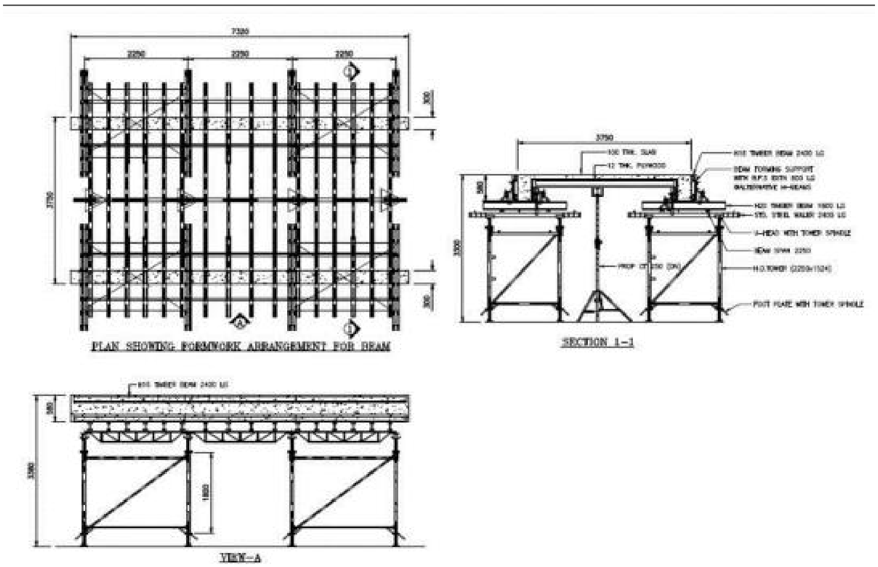


Fig 9.2.19: Slab formwork drawing

Erection of formwork for slab with the use of above drawing is explained in step given below:

- Place foot plates assembled with tower spindle on each of the four precast slabs and over the center markings.
- Erect basic frame of 1.80 m on one side over tower spindles.
- Erect second basic frame 1.80 on the opposite side having the direction of the welded bracing reversed to the previous bracing of first frame.
- Connect both such placed basic frames using horizontal bracing H225 at bottom.
- Connect diagonal bracing D-18.225 diagonally on one end at bottom click & pawl of 1st frame and other end at top of 2nd placed basic frame.
- Connect both the basic frames using one more horizontal bracing H-225 at top.
- Connect H-225 and D-18.225 on the opposite side of the tower similarly by following the above methods.
- Insert plane bracing D-12.225 diagonally and check the correctness of the diagonal on both direction and fix on one direction.
- Place foot plates assembled with tower spindle on each of next two center markings.
- Erect third basic frame 1.80 similarly over these tower spindles and connect this frame with second basic frame using H225 at bottom and top on both sides.
- Place foot plates assembled with tower spindle on each of next two center markings adjoining

- Erect fourth basic frame 1.80 over these tower spindles and connect this frame with third basic frame using H225 and D-18.225 on both sides
- Erect one more set of towers parallel to this set up similarly following the above method over the center markings on the other side
- Check and correct top level of the spindle nuts using water tube level on all the legs placed so far
- Remove D-12.225 plane bracing and fix walk ways with basic frames two for each tower using hammer
- Insert tower spindle assembled with U-head two for each basic frames on all locations
- Check and adjust to same level the height of all U-heads by using water tube level and lever nut in the spindles
- Align the vertical member of basic frames using line thread
- Place steel walers in the same direction over two U-heads one for each basic towers and position
- Place beam spans 2250 connecting two steel walers at U-head locations on both sides on all locations
- Place H-20 beam on top of beam span on one end and connect with steel waler using brace strips and position
- Place one more H-20 beam on top of beam span on the other opposite end and connect with steel waler using brace strips and position
- Tie mason thread at the outer ends of both H-20 beams and align
- Place balance H-20 beams and position in between in appropriate spacing to match verticals of beam span
- Mark the inner edge of the beam on the H-20 beams using line thread
- Place beam bottom ply wood over the marking on beams and nail using hammer and remove line thread
- Place inner side beam shutters, align and fix using two beam forming supports for one shutter
- Erect short props at the inside ends of steel walers and tighten using nuts and bolts
- Insert four way heads on top of all short props and position in the required direction
- Place beam spans 2250 connecting two four way heads on both sides
- Place precast slabs in between two tower setups and mark the centre
- Place CT props and four way heads on the markings and lock with tripods
- Place H-16 beams over the four way heads of the CT props
- Place H-16 beams connecting the inner beam side shutters over the beam spans placed
- on short props and adjust the height of telescopic pipe of CT props till touching these H-16

beams

- Erect two Nos of CT props with supporting head between already placed CT props and position
- Tie line thread at ends of beam shutters and place ply wood in alignment
- Check the verticality of the inner side beam shutter, adjust using plumb bob and nail the slab shutter using hammer
- Fix ply wood similarly on the balance portion and nail
- Fix outer side beam shutters using beam forming supports two for each shutter on all sides(align and adjust width of beam by inserting wooden gauges)
- Align and adjust the width of beam by inserting wooden gauges
- Check dimensions, verticality and alignment of beam and level of slab

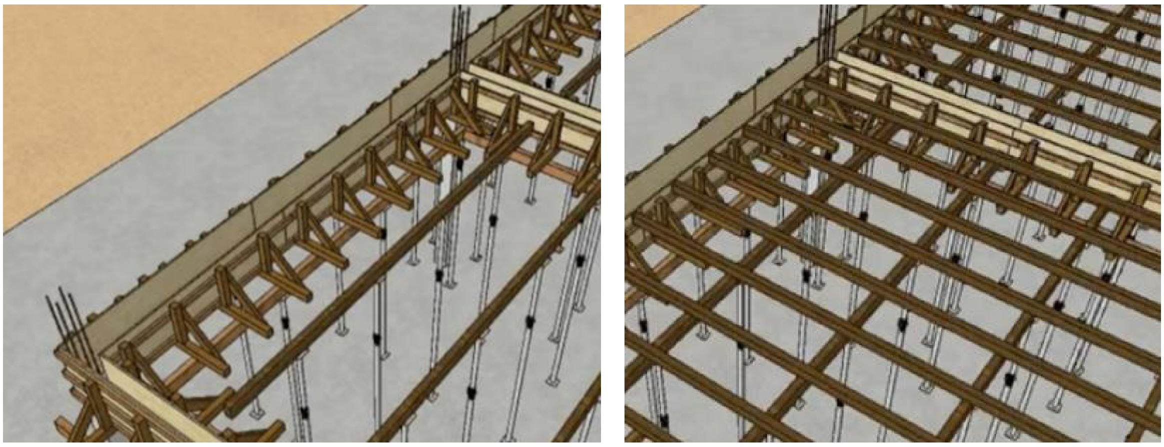


Fig 9.2.17: Slab formwork

Fig 9.2.18: Covering airgap by tape

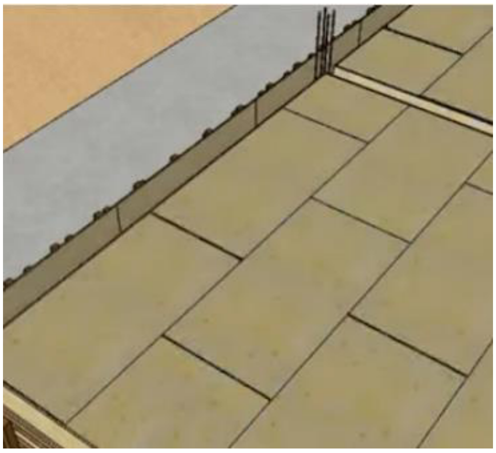


Fig: 9.2.19: Slab formwork

9.2.2 Dismantling of Wall, Column, Beam And Slab Formworka

The removal of concrete formwork also called as strike-off or stripping of formwork should be carried out only after the time when concrete has gained sufficient strength for all kind of respective structure. The rate of hardening of concrete or the concrete strength depends on temperature and grade of concrete materials. Concrete strength affects the formwork removal time. While dismantling of formwork, following points should be consider:

1. Stripping of the formwork panels of the wall and column section is usually done after 12 hours while for slab it is usually done after 36 hours. However, this process shall subject to approvals of site in-charge and concerned authority.

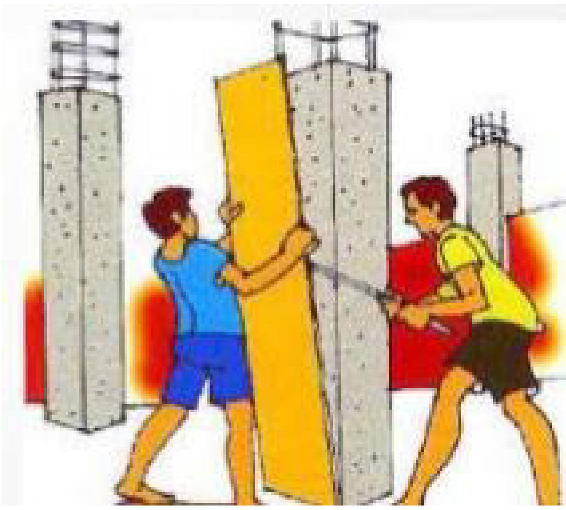


Fig 9.2.20: Dismantling of column formwork

1. For removing the formwork panels use only panel puller and it shall be removed without damaging the concrete surface.

2. Always ensure that the wall section panels are removed first followed by the column section then slab and beam.
3. To prevent any damages to the formwork panels and to the finished concrete surface, formwork are removed systematically i.e. remove the supports, loose the nuts, remove the waler and then shuttering panels.
4. Ensure that no workers are facing any kind of accidents while removing formwork for safety reason.
5. In order to minimize loss and replacement cost make sure that all accessories are collected and kept as per requirement.
6. The formwork panels after dismantle shall be stack in such a way that proper housekeeping is maintained at work site and as per instruction given by site in-charge for its further use.
7. The stacked formwork panels shall be transferred to the next level/floor for subsequent assembly process via predetermined access such as slab opening or staircase area, in an orderly manner.
8. Numbering is to be done on the formwork panels and it is also recommended that color coding to be implemented, to ease identification purpose for further use.
9. Properly clean and apply the form release agent to protect the surface of the formworks
10. before re-use.

Fig 9.2.21: Dismantling panels from wall

Fig 9.2.22: Dismantling panels from column

Notes

QR Codes

Scan the QR code to watch the video

https://www.youtube.com/watch?v=gzWdR1wmBHU

Stripping Time of Formwork

UNIT 9.3: Assembling and Dismantling of Aluminum Formwork

Unit Objectives

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

1. Discuss the standard procedure for assembling and dismantling of system formwork for R.C.C footing, column, wall, beam, slab.

9.3.1 Assembling of Aluminum Formwork

The panels of aluminum formwork are made from high strength aluminum alloy, with the face or contact surface of the panel, made up of 4mm thick plate. The panels are held in position by a simple pin and wedge arrangement system that passes through holes in the outside rib of each panel. The walls are held together with high strength wall ties, while the decks are supported by beams and props.

Step1: Before starting the assembling process the formwork release agent is to be applied on the surface of all the panels.

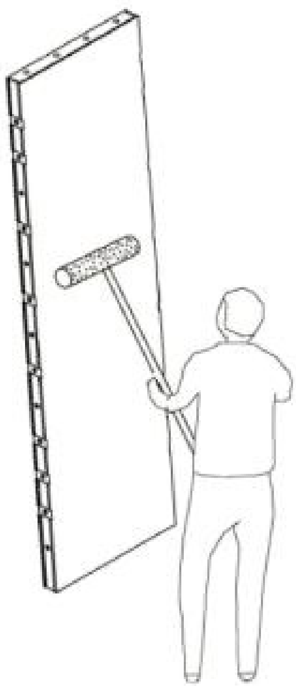


Fig 9.3.1: Application of releasing agent

Step2: Outer Corner is fixed to External Wall Corner panel by round pin and Wedge as shown in figure:

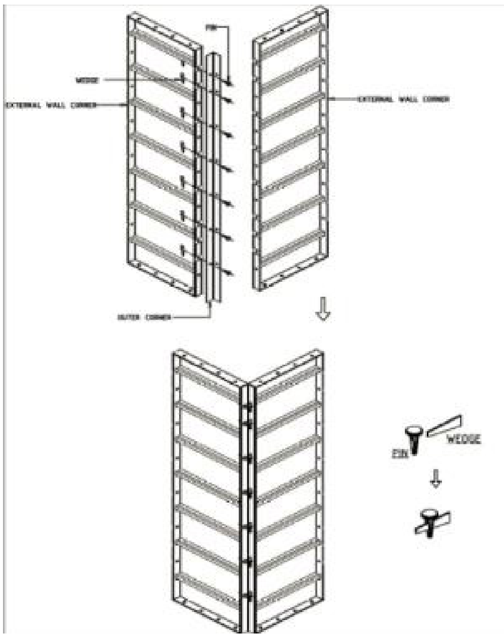


Fig 9.3.2: Fixing of outer shutter corner

Step3: Inner Corner is fixed to the Internal Wall panels by round pin & wedge. The Internal and External Wall Panels are kept by Flat Tie with Tie Bar Shield in between the panels.

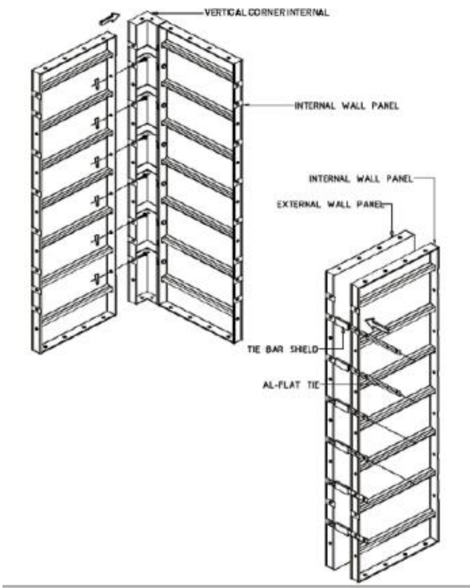


Fig 9.3.3: Fixing of inner shutter corner

Step4: Repeat and follow step NO. 3 to complete the assembly of both the Internal and External Wall Panels.

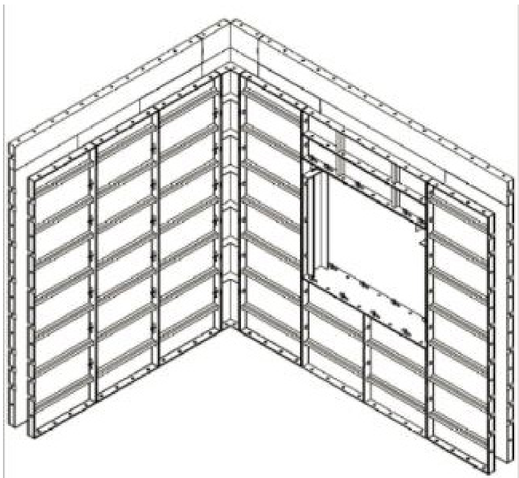


Fig 9.3.4: Assembly of wall panels

Step5: InsAtall Slab Corner on the top portion of the Wall Panels with round pin & wedge.

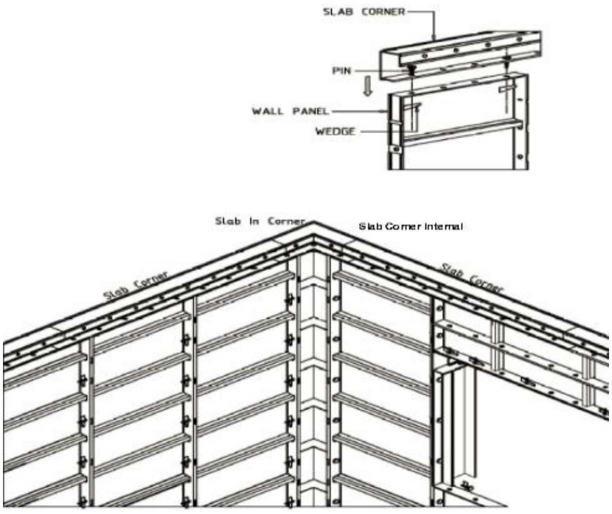


Fig 9.3.5: Installation of Slab corner

Step6: Aluspans mid beams / end beams and Prop head are combined by Beam splice bar with long pin and wedge at the bottom section.

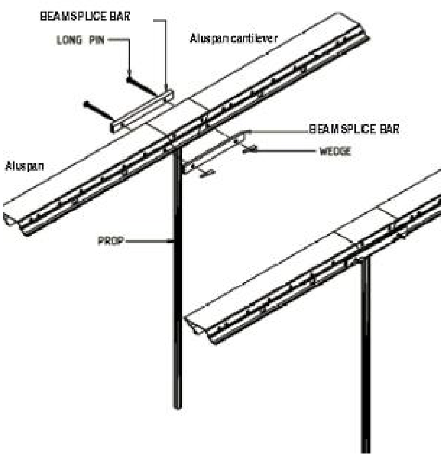


Fig 9.3.6: Beam propping

Step7: Now, assemble the Slab Panels from the Slab corner Internal. Then, fill out the whole slab area by pinning the slab panels together with the Aluspans.

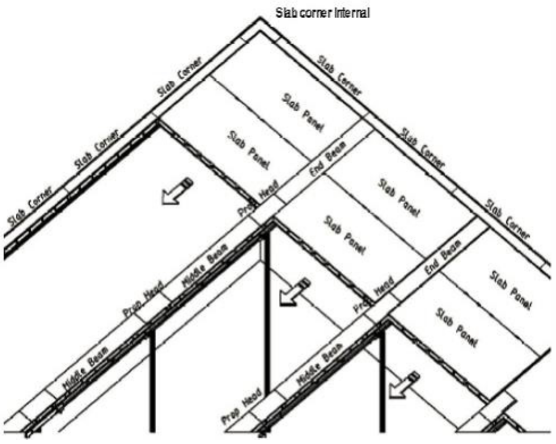


Fig 9.3.7: Slab propping

Step8: Now, if required fixed additional Wall Panels or Kickers to the external Wall Panels to raise the appropriate height to contain the slab concrete when it is poured.

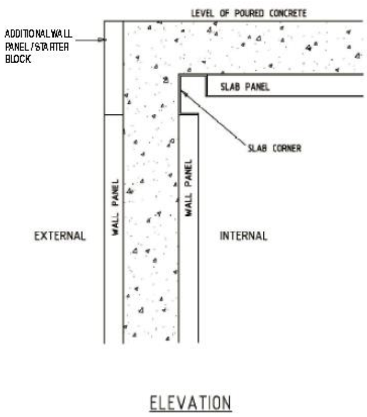
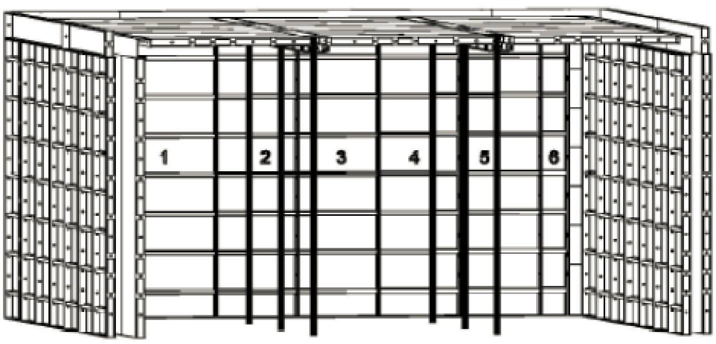


Fig 9.3.8: Fixing of wall panels or kicker

Step9: After the completion of formwork in the entire wall, column and slab area a marking should be done on panels to differentiate each of the unit with colour coding or numbering. These coding will helps in to determine the exact position of panels once they are transferred to the next level for installation or further use.



OVERALL FRONT ELEVATION

Fig 9.3.9: Front elevantion of aluminium formwork

Note:

Always ensure that wall ties, pins and wedges are properly installed and secured before pouring concrete into the forms. Make sure that before commencing to cast the slabs level area the concrete pouring is distributed evenly throughout the Wall Panels section.

9.3.2 Dismantle of Aluminum Formwork

The formwork can only be removed if concrete is developing sufficient strength so that it supports all loads placed upon it. The formwork removal is decided based upon the rate of strength gain of the concrete and the structural function of the member. The other parameter which influences the rate of strength gain of concrete is the grade of concrete, type of cement, W/C ratio, and temperature during curing. During stripping, internal wall panels should remove first after approval from site in-charge by pulling out the wedges and pins. The panels are then transferred to upper floor through slab openings as shown in figure.

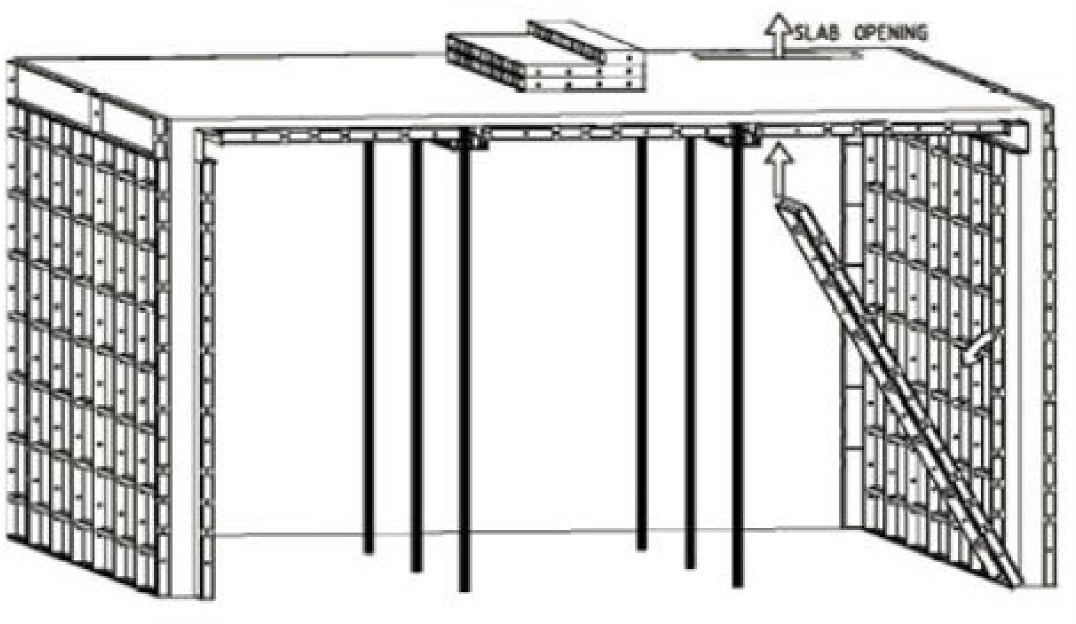


Fig 9.3.10: Dismantling shutter panel

Step for Dismantling of Aluminum Formwork:

Step1: After removing the External Wall Forms the dismantled wall forms are moved to upper floor. In this process the starter block (kicker) should remain undisturbed and the external wall forms from level 1 onward shall be supported by the kickers.

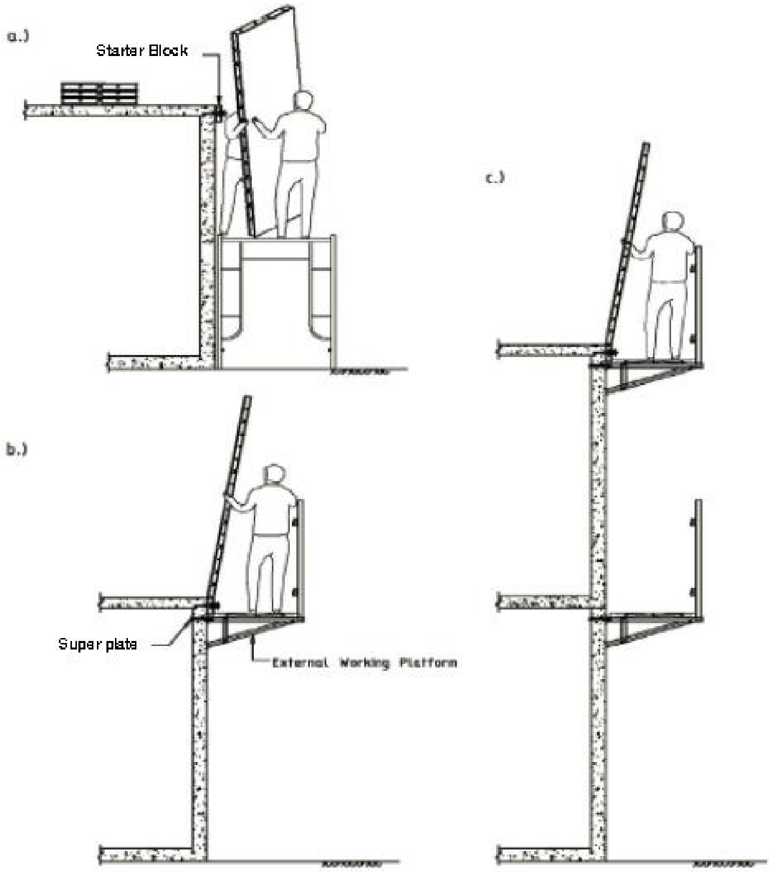


Fig 9.3.11: Removing shutter panel

Step2: After removal of wall panels, proceed to the removal of slab panels after instruction from site in-charge by removing the long pins and wedges on the joint bars at the end and middle beam section.

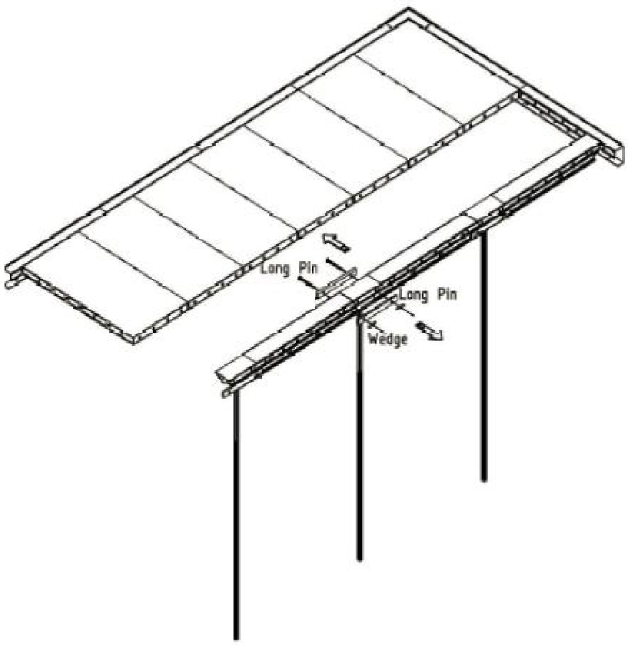


Fig 9.3.12: Removing of slab panels

Step3: After removal of Aluspans Mid Beams and Aluspan cantilevers End Beams, the prop shall remained undisturbed to support the concrete slab.

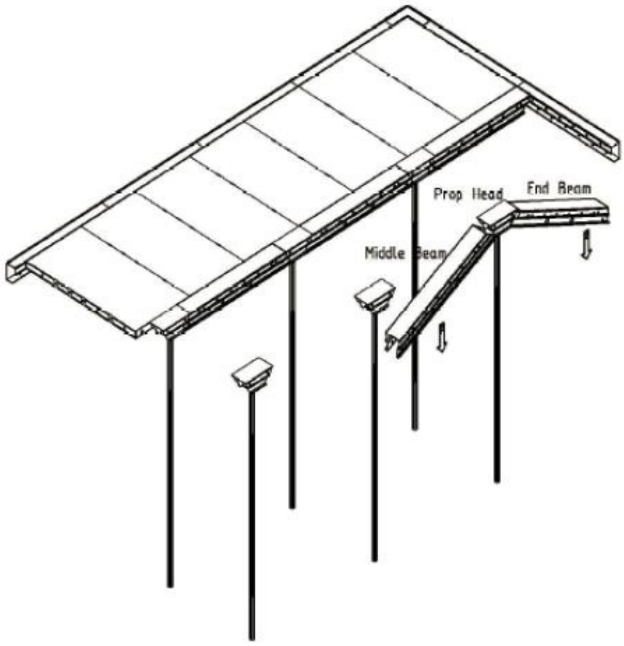


Fig 9.3.13: Removing of Aluspans Beams

Step4: Now, proceed to strip the Slab Panels and transfer to the next level according to the designated area and installation sequence.

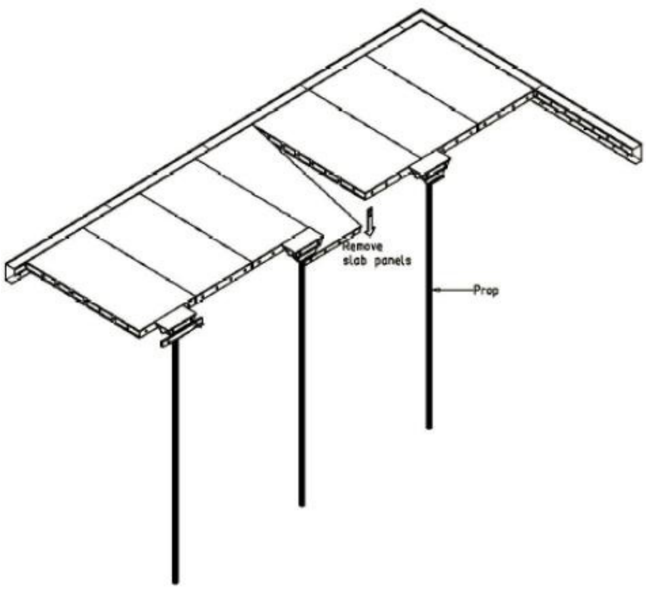


Fig 9.3.14: Removing of slab panels

Step5: Strip the Slab Corner.

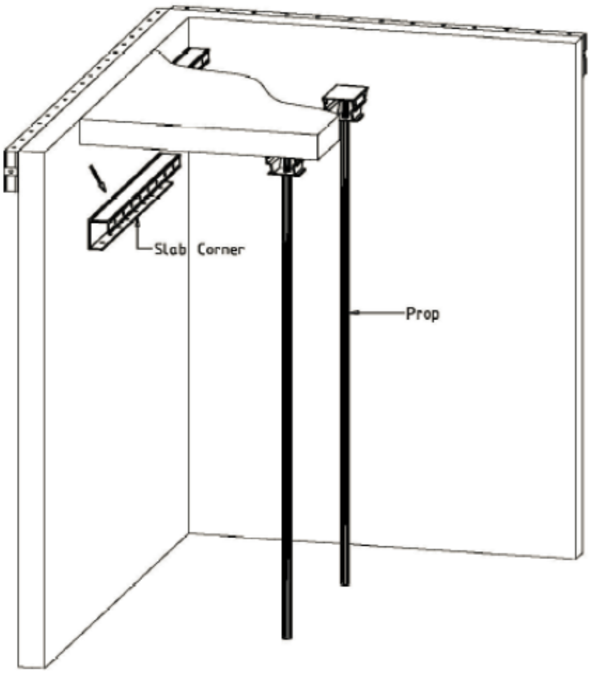


Fig 9.3.15: Striping Slab Corner

Step6: Pull out Wall flat Tie using Wall Tie puller and remove the Wall tie sleeve using nose player.

Step7: When the concrete cube test satisfied that the slab concrete is sufficiently strong, the prop together with the prop heads are removed and transferred to the next level.

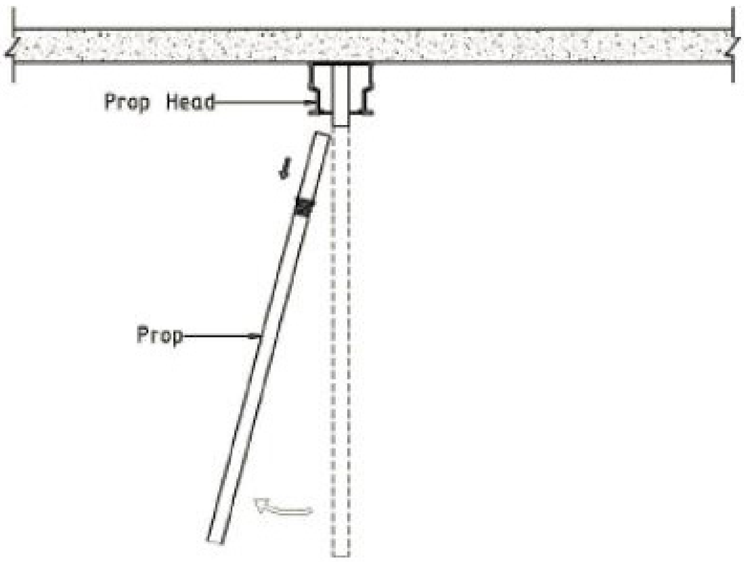


Fig 9.3.16: Removing props

Notes

UNIT 9.4.1: Stripping Time of Formwork

Unit Objectives

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

1. Explain the importance of stripping time for removing shuttering of various R.C.C structural elements.

9.4.1 Stripping Time of Formwork

Form shall not be released until the concrete has achieved sufficient strength and without the approval of site in-charge. In normal circumstances where ambient temperature does not fall 15 degree Celsius and ordinary Portland cement is used, the time period recommended in IS 456: 2000 for stripping time is given in following table:

Type of Formwork	Minimum Period before striking formwork
1. Vertical formwork to column, walls and beams	16-24 Hour
2. Soffit formwork to slab (props to be re fixed immediately after removal of formwork)	3 days
3. Soffit formwork to beam (props to be re fixed immediately after removal of formwork)	7 days
4. Props to slabs: a) Spanning up to 4.5 m b) Spanning over 4.5 m	7 days 14 days
5. Props to beam and arches: a) Spanning up to 6 m b) Spanning over 6 m	7 days 14 days

Table 9.4.1: Stripping time of various formworks

In case of aluminum formwork the stripping time is varies from the time given in above table. In aluminum formwork the drop head facilitates early striking – as a result, panels and main beams are quickly made available for subsequent concreting sections. Depending on the slab thickness and strength of the concrete, striking can be carried out after only one day.

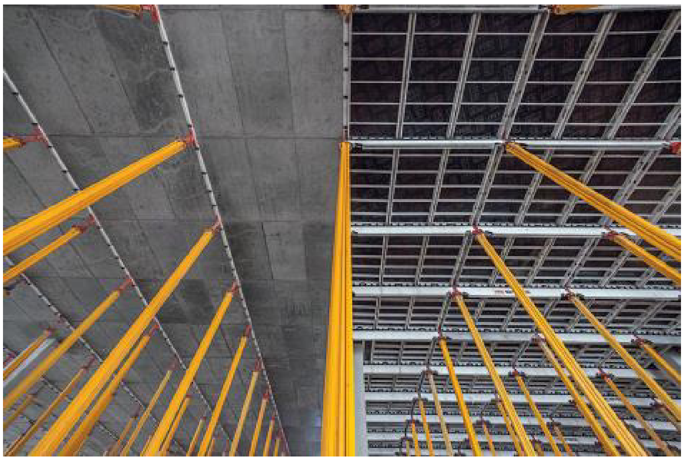


Fig 9.4.1: Stripping of Formwork

During stripping of formwork, following points must be remembered

- Make sure to prevent damage to concrete and formwork panels and also parts and connections should be arranged properly so that it can be reused without extensive repair.
- Under the supervision of an engineer to ensure that quality of hardened concrete in structural member, i.e. it should be free from or has minimum casting defects such as honeycombing, size and shape defects etc. Defects can influence the strength and stability of structure. Thus immediate repair works can be done or the members can be rejected.
- To avoid the damage to concrete de shuttering should not be done by forcing crowbars and wooden wedges against the concrete.
- Beam and joist bottom should kept in place until all supports are removed beneath this.

Fig 9.4.2: Stripping components from formwork

Notes

UNIT 9.5: Repair of Shutter Panels

Unit Objectives

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

1. Describe the procedure for repairing the formwork.
2. Discuss the use of lifting gears for shifting and fixing of formwork components.
3. Explain the standard procedure for stacking and storing of formwork components.
4. Demonstrate stacking of formwork components.

9.5.1 Formwork Repair

As we know that shutter panels goes through lot of stresses and strains at construction site during its use and therefore it get damaged. Damages to shutter panels are mostly caused due to vibrator pressure during concreting and various impacts on panels while assembling and dismantling. If such damages are not repaired, then it will reduce the life of shutter boards. It is highly appreciated to reuse maximum number of formwork materials. During repairing of formwork first evaluate the shutter panel:

- Formwork is in good condition – only cleaning required
- Formwork is damaged – minimal repair required
- Plywood is unusable – plywood should be replaced
- Panel with minimal damaged frame – refurbishing needed including welding in case of steel
- Panel is unusable – disposal as scrap Damaged or broken formwork panel can be repaired by nailing method.

Nailing Method:

- Identified the area which is to be repaired.
- Evaluate if extra support of wooden batten will provide sufficient strength to the panel.
- Take a wooden bar and cut it equal to the width of the shutter panel.

Fig 9.5.1: Repairing by nailing method

Fig 9.5.2: After repairing by nailing method

- Place the wooden bar below the damaged area of the panel.
- Hammer the nail and place the nail entirely, so that panel is fixed with wooden batten
- Check the evenness of panel and suitability for its further use.

Other methods followed for Repairing of shutter panel:

If you found nails, holes cracks on panels following process can be adopted for repair. This method for repairing of shutter panel is widely used in yard.

1. Clean the shutter panels.
2. Paint scraper is used to remove the paint on the shutter panel.

Fig 9.5.3: Cleaning of shutter panel

Fig 9.5.4: Shutter panels after removing Paint

3. By the use of plier or nail remover machine, nails shall be removed if found in the panel.
4. Use the planer machine to level the surface of the panel.
5. Cylindrical head drill bit is used to remove damaged spots from the face of plywood panel.

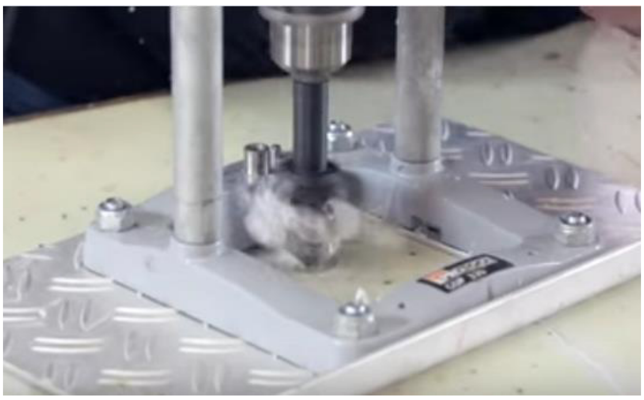


Fig 9.5.5: Drilling hole in panel

Fig 9.5.6: Inserting wooden disc in hole

6. Insert the wooden disks that are glued to be flush with the original panel surface.

Fig 9.5.7: Wooden disc

Fig 9.5.8: After repairing by wooden disc

7. Large holes or cracks in the shutter panel can be repaired. Use putty or wooden filler to fill the hole.

Fig 9.5.9: Filling corners by wood filler

Fig 9.5.10: Repaired panel

Notes

UNIT 9.6: Stacking and Storing of Formwork Panels

Unit Objectives

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

1. Know about stacking and storing of formwork panels

9.6.1 Stacking and Storing of Shutter Panels

Formwork panels are to be handled and stored appropriately to prevent deterioration and damage to the materials. Shuttering materials at construction site shall be stored and handled in such a way that it ensures safety of workmen, public property and natural environment. It should be stacked on well drained, flat and unyielding surface. The materials are sorted according to type, size and length and placed in neat and orderly piles.

Important Points to be remembered while Storing

- Always clean the forms with stiff brush and clean water before storing. Scrapers should be used as a last resort.
- Prior to storing ensure that oil is applied or other necessary precaution had been taken to prevent delamination of plywood/ rusting of steel.
- Dry storage place is best for any formwork having steel components.
- Avoid direct sunlight on timber forms.

Stacking of wooden shutter panels

Plywood, fiber board, particle board, block board etc. shall be stacked over wooden planks or the storage floor should be waterproof. Plywood Shutters should be placed horizontally over each other

- Roofs should be leak proof to prevent rain water from entering into the go down.

Fig 9.6.1: Stacking of plywood panels

Fig 9.6.2: Stacking of wooden panels

Stacking of steel or aluminum shutter panels

Aluminum and steel panels shall be stacked at least 200 mm above ground level. Aluminium panel of different types, sizes, lengths steel sections all should be stored separately. This will facilitate issuing them in required sizes and lengths without cutting from standard lengths.

- Steel shutter panels, aluminum shutter panels etc. should be kept horizontally lengthwise on ground.
- To protect from water and dampness stacked materials should be properly covered.
- Stack materials as per classification, sizes and lengths.
- The aluminum sections should not be pulled/ pushed/ slide from the stack in order to protect the anodizing layer

Fig 9.6.3: Stacking of steel panels

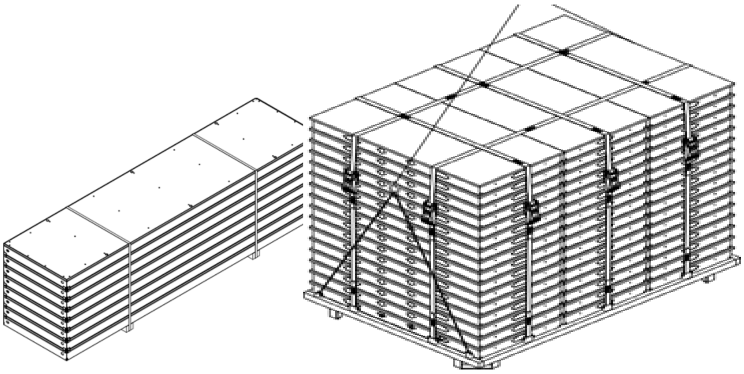


Fig 9.6.4: Handling of steel panels

9.6.2 Do's and Don'ts During Formwork

Do's

1. Start the work under skilled supervision.
2. Always wear suitable PPE (Personal Protective Equipment).
3. Placement of shutter panels should be carried out with adequate manpower, proper equipment's and tools.
4. Always choose right shuttering material for the particular job. If you are in doubt, ask the technical person.
5. Check the plumb and leveling of shutter panels before concreting.
6. Check the airways or for any damage before using the shutter panel.
7. Always check the stability of props/ supports of formwork.
8. See that the cover block inserted doesn't get displaced.
9. Do proper finishing at joints.

Don'ts

1. Don't use damaged formwork. It affects the concrete resulting in honeycomb.
2. Don't remove formwork until the concrete has gained sufficient strength.
3. Don't use damaged tools.
4. Don't use inappropriate size of fasteners and props for the work.

Exercise

1. A three-view working drawing usually includes _____ views.
   - A. front, back, and left-side
   - B. back, front, and top
   - C. top, front, and right-side
   - D. left-side, right-side, and front

2. An assembled mortise-and-tenon joint looks like a simple _____ joint.

   A. cross-lap   B. dado

   C. miter   D. butt

3. A shallow dent in wood can sometimes be repaired by

   a) using steam to swell the wood   b) filling it with glue

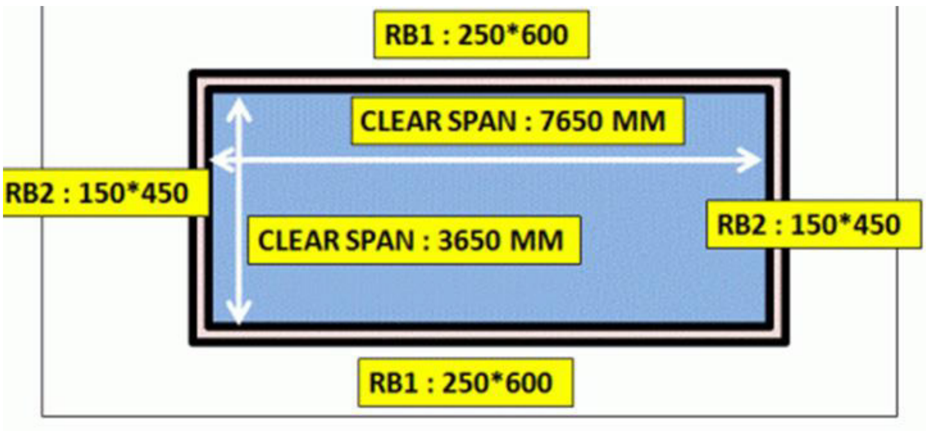
   c) filling it with a sliver of wood   d) rubbing it with white shellac

4. In given statement which one is not an advantage of a wooden pattern?
   - a) It is cheap and easily available.
   - b) It can be shaped easily into different form a designs.
   - c) It can be repaired and reused.
   - d) The cost of work man ship is more than other materials.

5. Find out the formwork area for a beam of span 6750 mm.

   Beam size: 250 mm*650 mm……………………………………………….

6. Calculate the formwork area for the given slab.



7. What is the most modern type of formwork?

   A. Mivan   B. Aluform

   C. Doka   D.Peri

8. How do you erect formwork for columns?

9. What are the points need to remember while erecting formwork for beams?

10. What is side shuttering?

11. How should one take care of shuttering work while reusing it?

12. Pumice is used to

    A. removes old paint B. clean brushes

    C. removes excess glue D. rub down a finish

13. Which pallets are best suited for storing larger and heavier units?

    A. Hoop iron B. Single faced pallets

    C. Double faced pallets D. Boy pallets

14. In which direction wooden shutter panels can be stacked.

    A. Horizontally B. Vertically

    C. Randomly D. None of the above

15. In which direction Aluminum shutter panels can be stacked.

    A. Horizontally B. Vertically

    C. Randomly D. None of the above

Notes

QR Codes

Scan the QR code to watch the video

https://www.youtube.com/watch?v=-P-VHYX7Hhw

Stacking and Storing of Material

सत्यमेव जयते
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MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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Skill India
कौशल भारत-कुशल भारत

10. Assembling and dismantling conventional shuttering / formwork for RCC structures (Elective-2)

Construction Skill Development Council

Unit 10.1 - Conventional Formwork

Unit 10.2 - Quality Checks and Assurance

Unit 10.3 - Erection and Dismantling

CON/N0315

Key Learning Outcomes

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

1. Explain how to interpret sketches / schematic working drawing/ cutting plan relevant to shuttering work.
2. Discuss about conventional formworks.
3. Discuss the importance of handling of hand and power tools and their basic maintenance.
4. Discuss the defects in bamboo, ballies, timber and plywood etc.
5. Explain the application of different types of timber and non-timber materials used in different shuttering works.
6. Discuss the standard shape and size of carpentry tools.
7. Discuss the use different types of material used in conventional shuttering works.
8. Explain the importance of tying knots and different type of knots used for connection of bamboos and ballies.
9. Discuss the various components of the conventional formwork such as pipes, coupler, tying thread and other fixtures.
10. Discuss the sequential steps for erection and bracing of formwork, as per standard procedure.
11. Explain the method statement used for the erection of conventional staging using bamboo, ballies, pipe and coupler.
12. List the do's and don'ts applicable for erection of conventional staging either using bracings or bamboo and ballies or pipe and coupler.
13. Explain the importance of checks with respect to plumb, level and alignment for the formwork.
14. Discuss the different type of shuttering required for various structures with its applicable limits of tolerances.
15. Describe the procedure for positioning or attaching tie systems, soldiers and walling.
16. Explain the properties and method of application of release agents.
17. Explain the sequential step for dismantling of conventional formwork shutters.
18. Show how to perform check to ensure cleanliness of shutters, suitability of supporting base, availability of tools, availability of components, availability of fixtures prior to erection/use of conventional formwork.
19. Demonstrate the application of releasing agent to sheathing materials as per the specification.
20. Demonstrate how to position and strike box-outs and bolt boxes, grout checks, level controls, angle fillets and features
21. Show how to use the supports such as runner pieces, timber, props, tie systems appropriately for positioning and providing support.
22. Show how to provide the braces for formwork support as per the specification and requirement.
23. Show how to use form sheet or other appropriate packing material for ensuring the water tightness of form.
24. Demonstrate how to fix tie rods, supports, bracings after erection of formwork shutters.
25. Show how to perform checks for line, level and alignment of the erected formwork as per permissible tolerance limits.
26. Show how to perform checks for dimensional accuracy and right angle, and take necessary corrective action if required.
27. Demonstrate the standard procedure for dismantling of formwork shutters manually or by mechanical means as per the requirements
28. Show how to check the quality of formwork materials for reusability after dismantling.
29. Demonstrate proper storing, stacking and cleaning of formwork materials after dismantling

Unit 10.1: Conventional Formwork

Unit Objectives

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

1. Discuss about conventional formworks.
2. Discuss the defects in bamboo, ballies, timber, and plywood etc.
3. Explain the application of different types of timber and non-timber materials used in different shuttering works.
4. Discuss the various components of conventional formwork such as pipes, coupler, tying thread, and other fixtures.
5. Explain the method statement used for the erection of conventional staging using bamboo, ballies, pipe, and coupler.
6. Discuss the sequential steps for erection and bracing of formwork, as per standard procedure.
7. Discuss the standard shape and size of carpentry tools.
8. Discuss the use of different types of material used in conventional shuttering works.
9. Explain the importance of tying knots and different types of knots used for connection of bamboos and ballies.
10. List the do's and don'ts applicable for erection of conventional staging either using bracings or bamboo and ballies or pipe and coupler.

10.1.1 Conventional Formworks

Conventional formwork serves as the cornerstone of concrete construction, providing the fundamental framework that guides the transformation of liquid concrete into solid structures. This time-tested technique involves the assembly of temporary molds made from materials like timber, plywood, and steel on the construction site. These molds, or formworks, are meticulously crafted to match the architectural and structural requirements of the project. While labor-intensive, conventional formwork allows for a high degree of customization, making it ideal for shaping diverse elements such as columns, beams, walls, and slabs. As the construction industry evolves, the enduring reliability of conventional formwork continues to complement modern advancements, ensuring a seamless fusion of tradition and innovation in building design and execution.

10.1.2 Types of defects in bamboo, timber, ballies and plywood

Various materials such as bamboo, timber, ballies, and plywood are commonly used to create temporary molds for shaping and supporting freshly poured concrete. However, these materials can sometimes be susceptible to defects that can impact the quality and stability of the formwork structure. Here are some common defects associated with each material:

Bamboo:

- **Cracking and Splitting:** Bamboo can be prone to cracking and splitting due to changes in moisture content and environmental factors. This can weaken the structural integrity of the formwork.
- **Uneven Surfaces:** Irregularities in the surface of bamboo can lead to uneven contact with the concrete, affecting the smoothness of the finished concrete surface.

Timber:

- **Warping and Twisting:** Timber can warp or twist as it dries, causing misalignment and instability in the formwork. This can result in uneven concrete surfaces and compromised structural integrity.
- **Rot and Decay:** Exposure to moisture and pests can lead to rot and decay in timber formwork, reducing its strength and longevity.
- **Knots and Weak Points:** Natural knots and weak points in timber can affect its load-bearing capacity and contribute to uneven pressure distribution.

Ballies (Bamboo Stakes or Poles):

- Brittleness: Ballies can become brittle over time, particularly if they are not properly cured or if they are exposed to harsh weather conditions. Brittle ballies are more likely to break under load.
- Inconsistent Diameter: Variations in the diameter of ballies can result in uneven pressure on the formwork, leading to irregular concrete surfaces.

Plywood:

- **Delamination:** Plywood is made up of layers glued together, and poor-quality glue or exposure to moisture can cause delamination, resulting in weakened and swollen sections.
- **Warping:** Similar to timber, plywood can also warp when exposed to moisture or changes in temperature, leading to misaligned formwork.
- **Surface Imperfections:** Knots, voids, or patches on the surface of plywood can create irregularities in the concrete finish.

10.1.3 Types of timber and non-timber materials used

Timber Materials

1) **Plywood:**

   Application: Plywood is versatile and used for creating smooth surfaces in shuttering works for walls, columns, beams, and slabs.

2) **Sawn Timber:**

Application: Sawn timber is used for vertical formwork in applications like walls and columns, providing structural support.

Non-Timber Materials:

1) **Steel/Formwork Systems:**

Application: Steel formwork systems are employed in large-scale projects like high-rises and bridges due to their strength and quick assembly.

2) **Plastic/Formwork Panels:**

Application: Plastic panels suit simple structures like slabs and beams, offering lightweight, modular solutions with smooth finishes.

3) **Aluminum/Formwork Systems:**

Application: Aluminum systems are ideal for precise, high-quality finishes, often seen in residential and commercial construction.

4) **Fiber-Reinforced Plastic (FRP):**

Application: FRP panels are used in corrosive environments or where a non-reactive surface is needed, commonly in marine and chemical projects.

10.1.4 Components of conventional formwork such as pipes, coupler, tying thread, and other fixtures

Conventional formwork is a construction technique that involves using temporary molds or frameworks to shape and support freshly poured concrete until it reaches the required strength to stand on its own. Various components are used in conventional formwork systems to create these molds and provide structural support.

Some of the components include:

Sr. No.	Name of Component	Description	Image
1	Formwork Panel	These are large sheets made of materials such as plywood, steel, or aluminum. They provide the primary surface against which the concrete is poured. Formwork panels can be easily assembled and disassembled, allowing for reusability.	

2	Formwork Frames	Frames are structural elements that support the formwork panels and help maintain the desired shape and dimensions of the concrete structure. They are usually made of steel or wood and come in various sizes and shapes.	
3	Formwork Props	Also known as shoring or scaffolding, formwork props are adjustable vertical supports used to bear the weight of the formwork and the wet concrete. They are crucial for maintaining the formwork's stability and preventing collapse.	
4	Ties and Tie Rods	Ties are used to hold the formwork panels together and ensure they maintain their position during concrete pouring. Tie rods are used to anchor the formwork system and provide additional strength. They are typically made of steel.	
5	Formwork Clamps and Connectors	These are used to secure the formwork panels and components together, ensuring that there is no movement or shifting during concrete placement. Clamps and connectors can be made from various materials like steel, aluminum, or plastic.	
6	Corner Fillet	These are used to create rounded corners in the formwork, ensuring that the edges of the concrete structure are smooth and well-defined.	

7	Formwork Release Agents	These substances are applied to the formwork panels before concrete pouring to prevent adhesion between the concrete and the formwork. This helps in easy removal of the formwork once the concrete has cured.	
8	Formwork Accessories	Various additional components are used to address specific formwork challenges. These might include formwork spacers to maintain proper concrete cover, chamfer strips to create beveled edges, and end caps to seal the open ends of formwork.	
9	Nails, Screws, and Bolts	These fasteners are used to secure the formwork components together. Nails and screws are used for wooden formwork, while bolts are used for steel formwork.	
10	Pipes and Coupler	These components are used in scenarios where formwork needs to support complex shapes or where vertical connections are needed. Pipes and couplers provide additional structural support and stability.	

11	Tying Thread or Wire	Tying thread or wire is used to secure the formwork components and reinforcements in place. It's commonly used to tie rebar together and to attach formwork panels to the frame.	

Table 10.1.1 Various components used in conventional formwork systems to create molds and provide structural support

10.1.5 Procedure for Assembling Traditional Staging with Bamboo, Balleys, Pipes, and Couplers

The erection of conventional staging, often used for construction, maintenance, or repair work, can indeed involve materials like bamboo, balleys (wooden or metal beams), pipes, and couplers. This type of staging is typically used to provide a platform for workers to access elevated areas safely. Here's a general overview of the method used for erecting such staging:

Materials Needed:

Bamboo poles (mainly for vertical support), Balleys (wooden or metal beams for horizontal support) Pipes (usually metal pipes for diagonal bracing), Couplers (to connect pipes and other components) Ropes and ties (to secure the structure), Procedure for Assembling Traditional Staging

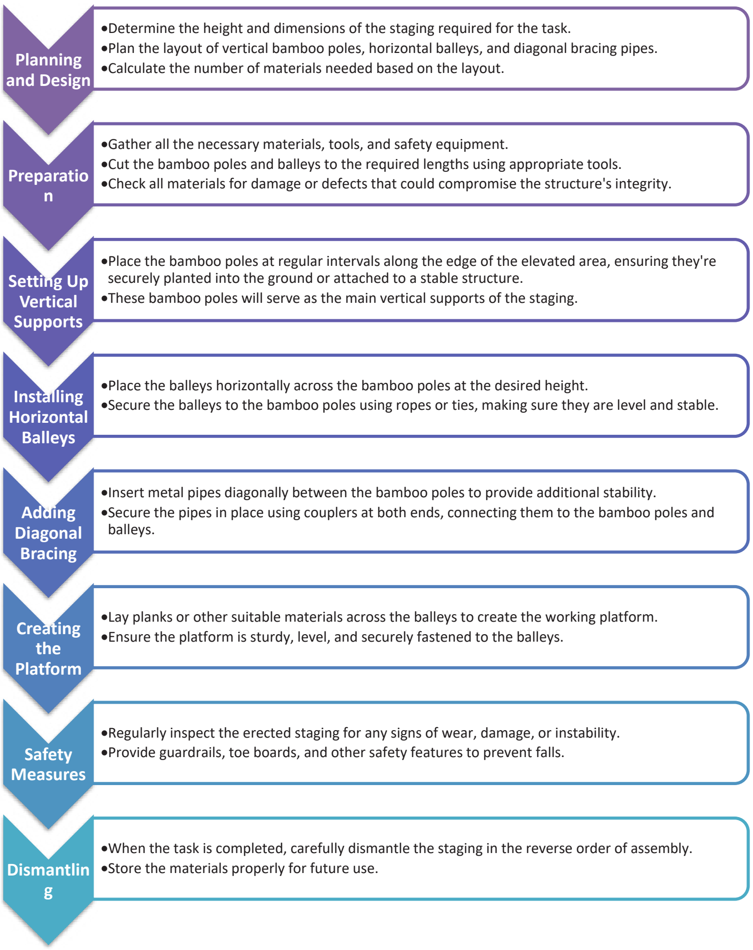


Table 10.1.1 Steps for Staging Conventional Formwork

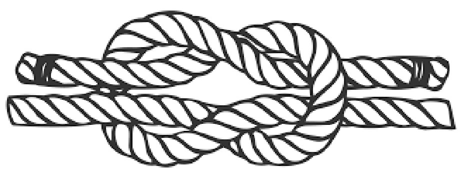
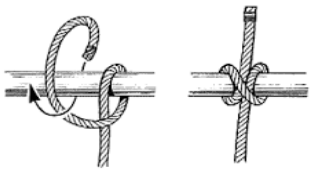
10.1.6 Carpentry Tools and Material for Conventional Shuttering Work

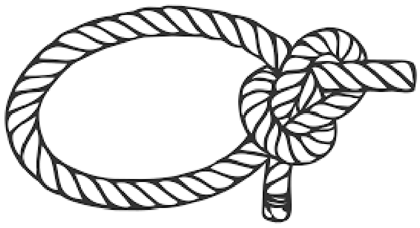
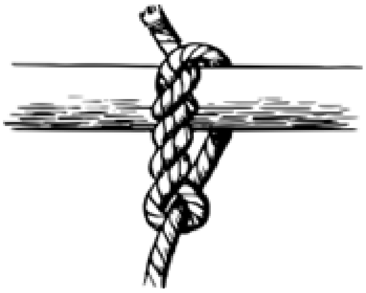
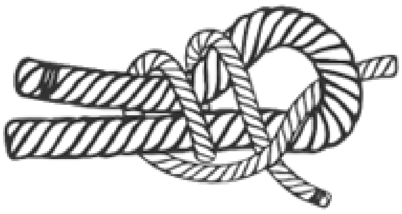
In the realm of carpentry, it is crucial to understand the standard shapes and sizes of various tools, as well as the diverse materials employed in conventional shuttering works. Carpenters rely on tools with standardized dimensions to ensure precision and consistency in their work. From saws and chisels to measuring instruments and hammers, each tool's size and shape contribute to its specific function and application in woodworking tasks.

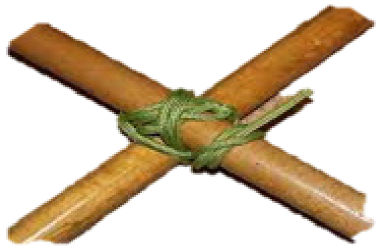
Equally significant is comprehending the array of materials used in conventional shuttering works. These materials encompass a variety of options, such as timber, plywood, steel, and concrete. The selection of materials hinges on factors like the project's nature, load-bearing requirements, and durability considerations. Timber provides versatility and ease of manipulation, while plywood offers strength and uniformity. Steel reinforces structural integrity, particularly in formwork applications, while concrete forms the backbone of construction. Understanding the properties and applications of these materials is vital for executing effective and safe conventional shuttering works in the field of carpentry. The topic has already been discussed in detail in the previous chapters.

10.1.7 Knots and different types of knots used for connection of bamboos and ballies

Knots play a crucial role in carpentry and construction, particularly when connecting bamboo and balleys for various applications. Different types of knots are employed based on their strength, security, and ease of tying. Here are some common knots used for connecting bamboos and balleys:

Sr. No.	Type of Knot	Description	Image
1	**Square Knot (Reef Knot)**	The square knot is widely used for joining ropes of the same diameter. While it may not be the best choice for heavy loads, it's useful for simple connections and lashing.	
2	**Clove Hitch**	This knot is simple to tie and is often used to start or finish lashings. It provides a temporary grip on poles or bamboo, which makes it useful for initial securing before more stable knots are applied.	 Clove Hitch

3	**Round Turn and Two Half Hitches**	This knot offers good stability and security. The round turn provides additional friction, and the two half hitches ensure the connection stays in place. It's commonly used for tying ropes to poles or bamboo.	
4	**Bowline**	The bowline forms a secure loop at the end of a rope. While it's not typically used for connecting bamboo and balleys directly, it can be used to secure ropes or lines to the ends of these materials.	
5	**Timber Hitch**	The timber hitch is designed for attaching a rope to a cylindrical object like a bamboo or a pole. It's reliable and becomes even more secure with tension.	
6	**Sheet Bend**	The sheet bend is useful for connecting two ropes of different diameters or materials. While it's not directly used for bamboo and balleys, it could be employed for joining ropes that are part of the setup.	
7	**Square Lashing**	Square lashings are vital in construction. They involve wrapping rope around two bamboo poles and then securing them with frapping turns and clove hitches. This is an effective method for creating frameworks and supports.	

8	**Diagonal Lashing**	Diagonal lashings provide stability when securing poles at angles. They are essential for constructing frames or scaffolding.	

10.1.8 Do's and don'ts applicable for erection of conventional staging

Do's:

- **Plan and Design:**
  - Do thoroughly plan the staging setup, considering load requirements and working conditions.
  - Do consult engineering and safety guidelines before beginning the setup.
- **Choose Quality Materials:**
  - Do use sturdy and reliable materials like high-quality bamboo, strong balleys, and well-maintained pipes and couplers.
- **Inspect Materials:**
  - Do inspect all materials for defects, damage, or signs of wear before using them.
  - Do ensure that couplers are securely fastened and pipes are free from dents or deformities.
- **Safety Measures:**
  - Do provide adequate fall protection measures such as guardrails, toe boards, and safety harnesses.
  - Do ensure all workers are wearing appropriate personal protective equipment (PPE).
- **Proper Installation:**
  - Do follow proper installation procedures for vertical supports, horizontal balleys, and diagonal bracing.

- Do ensure that the staging is level, stable, and securely anchored.

- **Regular Inspection:**
    - Do inspect the staging regularly for signs of wear, movement, or instability.
    - Do address any issues promptly and reinforce or adjust components as needed.
- Follow Codes and Regulations:
    - Do adhere to local building codes, regulations, and safety standards.
    - Do obtain any necessary permits before commencing work.

Don'ts:

- **Don't Compromise on Safety:**
    - Don't neglect safety measures at any stage of the setup.
    - Don't allow workers to access the staging without proper safety gear.
- **Don't Overload the Staging:**
    - Don't exceed the recommended load capacity of the staging.
    - Don't stack heavy materials or equipment on the staging platform.
- **Avoid Poor Quality Materials:**
    - Don't use low-quality, damaged, or deteriorated materials that could compromise the stability of the staging.
- **Don't Ignore Environmental Factors:**
    - Don't set up staging in hazardous weather conditions, such as high winds or heavy rain.
    - Don't underestimate the impact of weather on the stability of the staging.
- **Don't Improvise Inadequately:**
    - Don't attempt to modify or improvise components without proper engineering approval.
    - Don't use makeshift or inadequate connectors that might fail under load.
- **Avoid Rushing the Setup:**
    - Don't rush through the setup process, as haste can lead to errors or oversight in safety measures.
- **Don't Skip Inspections:**

- Don’t neglect regular inspections during the project’s duration.
- Don’t assume the staging remains secure without ongoing evaluation.

- **Don’t Disregard Local Regulations:**
  - Don’t disregard local laws, regulations, and guidelines related to construction and safety.

Notes

QR Codes

Scan the QR code to watch the video

https://www.youtube.com/watch?v=RS8rmMTdhHQ

Formwork/Conventional Shuttering Support

Unit 10.2: Quality Checks and Assurance

Unit Objectives

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

1. Explain the importance of checks with respect to plumb, level, and alignment for the formwork.
2. Discuss the different types of shuttering required for various structures with its applicable limits of tolerances.
3. Describe the procedure for positioning or attaching tie systems, soldiers, and walling.
4. Show how to perform checks to ensure cleanliness of shutters, suitability of supporting base, availability of tools, availability of components, availability of fixtures prior to erection/use of conventional formwork.
5. Demonstrate the application of releasing agent to sheathing materials as per the specification.
6. Demonstrate how to position and strike box-outs and bolt boxes, grout checks, level controls, angle fillets, and features.

10.2.1 Importance of checks with respect to plumb, level, and alignment for the formwork

Checking for plumb, level, and alignment is of paramount importance when it comes to formwork in construction. These checks ensure the accuracy, stability, and quality of the concrete structure being poured within the formwork. Here's why these checks are crucial:

1. **Plumb:**

   Ensuring that the formwork is plumb (perfectly vertical) is essential for several reasons:

   - **Structural Integrity:** A plumb formwork ensures that the final concrete structure will have consistent thickness throughout, contributing to its overall strength and stability.
   - **Aesthetic Appeal:** Vertical elements like walls or columns need to be plumb to maintain a visually pleasing appearance.
   - **Uniform Load Distribution:** Plumb formwork helps distribute the weight of the wet concrete evenly, preventing uneven stress on the supports.

2. **Level:**

   Checking for levelness across the formwork is vital for the following reasons:

   - **Uniform Thickness:** A level formwork ensures that the concrete will have a consistent thickness, avoiding weak spots that could compromise the structure's integrity.
   - **Proper Drainage:** For slabs or horizontal surfaces, a level formwork ensures that water will drain evenly after the concrete is poured.
   - **Avoid Misalignments:** Level formwork prevents any unwanted slopes or tilts that could

cause misalignments in the final concrete structure.

3. **Alignment:**

Ensuring proper alignment of the formwork components is crucial for various reasons:

- **Accurate Dimensions:** Proper alignment ensures that the final concrete structure will match the intended dimensions and shape outlined in the plans.
- **Attachment Stability:** Proper alignment guarantees that formwork panels, beams, and supports are securely connected, preventing movement during concrete pouring.
- **Straight Edges:** For walls or slabs, aligned formwork ensures straight edges, contributing to a neat and professional finish.

Overall Importance:

- **Structural Strength:** Plumb, level, and aligned formwork directly influence the structural integrity of the concrete element being cast.
- **Quality Finish:** Proper checks result in a high-quality, well-finished concrete surface that meets design specifications.
- **Time and Material Savings:** Accurate formwork reduces the need for rework, saving time and resources during construction.
- **Safety:** Formwork that is not plumb, level, or aligned can lead to instability during concrete pouring, risking worker safety.
- **Compliance:** Meeting plumb, level, and alignment requirements ensures adherence to engineering and safety standards.

10.2.2 Shuttering and its applicable limits of tolerances

The topic has been covered under 4.1.1 and 4.1.5

10.2.3 Procedure for positioning or attaching tie systems, soldiers, and walling

Positioning and attaching tie systems, soldiers, and walings in conventional shuttering is a critical process to ensure the stability and integrity of the formwork during concrete pouring. Here's a procedure for this task:

1. **Review Plans and Design:**
   - Study the construction plans and design drawings to understand the layout of the formwork, the location of tie systems, soldiers, and walings, and the spacing requirements.
2. **Site Preparation:**

- Clear the work area of debris and obstacles that might hinder the installation process.
- Ensure the ground is level and compacted to provide a stable foundation.

3. **Erect Vertical Supports (if Required):**
    - Set up vertical supports or frames at the perimeter of the formwork area, if specified in the design. These supports will serve as anchor points for tie systems.
4. **Position Tie Systems:**
    - Determine the locations where tie systems (such as tie rods or threaded bars) will be inserted through the formwork.
    - Position tie cones or form savers on the external face of the formwork panels to receive the tie systems.
5. **Attach Tie Systems:**
    - Insert the tie rods or threaded bars through the tie cones or form savers, ensuring they pass through the entire thickness of the formwork.
    - Fasten nuts on both ends of the tie systems to secure them tightly. Use appropriate wrenches to achieve the desired tension.
6. **Install Soldiers:**
    - Place horizontal soldiers (also known as walers) parallel to each other along the formwork's vertical sides.
    - Position the soldiers at the desired heights according to the design. Soldiers provide lateral support and help distribute the load evenly.
7. **Attach Soldiers to Tie Systems:**
    - Attach the soldiers to the tie systems using clamps, brackets, or other suitable connectors.
    - Ensure that soldiers are securely fastened and level across their lengths.
8. **Position and Secure Walings:**
    - Install vertical walings perpendicular to the soldiers and between them.
    - Position walings at the specified intervals to provide additional support and prevent bulging of the formwork.
9. **Bracing and Alignment:**

- Install diagonal bracing between vertical supports, if required by the design.
- Use leveling instruments to ensure that the tie systems, soldiers, and walings are plumb, level, and aligned accurately.

10. **Verify Measurements:**
    - Double-check the measurements and positions of tie systems, soldiers, and walings against the design plans before proceeding.
11. **Inspection:**
    - Conduct a thorough inspection to confirm that all components are properly positioned, securely fastened, and aligned correctly.
12. **Proceed with Concrete Pouring:**
    - Once tie systems, soldiers, and walings are correctly in place, the formwork is ready for concrete pouring.

10.2.4 Pre-Erection Checks for Conventional Formwork: Ensuring Cleanliness, Suitability, and Adequate Resources

Performing checks before the erection or use of conventional formwork is essential to ensure the quality, safety, and efficiency of the construction process. Here are the checks you should carry out:

1. **Cleanliness of Shutters:**
    - Ensure that the formwork panels, soldiers, walings, and all related components are clean and free from dirt, debris, or concrete residue.
    - Remove any hardened concrete or foreign materials that might affect the formwork's fit and stability.
2. **Suitability of Supporting Base:**
    - Inspect the ground or foundation where the formwork will be placed.
    - Verify that the base is level, compacted, and able to support the weight of the formwork, wet concrete, and workers.
3. **Availability of Tools:**
    - Check that all necessary tools are available and in good condition.
    - Tools may include hammers, wrenches, measuring tapes, levels, plumb bobs, and safety equipment.
4. **Availability of Components:**
    - Ensure that all required formwork components are available and ready for use.
    - This includes formwork panels, soldiers, walings, tie systems, fasteners, and bracing materials.

5. **Availability of Fixtures:**
    - Check if any specialized fixtures, brackets, or connectors needed for the formwork are present.
    - Confirm that these fixtures are suitable for the specific formwork configuration.
6. **Alignment and Fit:**
    - Verify that formwork panels, soldiers, and walings are aligned correctly according to the construction plans.
    - Ensure that the components fit together smoothly and securely.
7. **Structural Integrity:**
    - Examine the formwork components for any visible damage, cracks, or signs of wear that might compromise their structural integrity.
8. **Safety Features:**
    - Check that safety features such as guardrails, toe boards, and access points are properly installed if required by the design.
9. **Weather Conditions:**
    - Consider the weather conditions and whether they might impact the formwork's stability or the concrete curing process.
10. **Documentation:**
    - Review the project documentation to ensure you have the most recent plans, drawings, and instructions available on-site.
11. **Site Access:**
    - Ensure that workers have safe and clear access to the formwork area.
12. **Clearance for Pouring:**
    - Confirm that there is enough space for concrete pouring and that no obstacles will interfere with the process.
13. **Supervisor's Approval:**
    - If required, have a supervisor or engineer verify that all pre-erection checks have been successfully completed.

10.2.5 Application of releasing agent to sheathing materials as per the specification

Releasing agents: The main purpose of treating formwork with a release agent is to make it easy to strike and release the formwork away from the concrete face. It is often observed that burnt transformer oil and other cheap oils are used as release agents. They can cause severe stains and result in inefficient removal of formwork from the concrete surface. It is therefore extremely important to select the right type of release agent. Some commonly used release agents are a follows:

- Neat oils with surfactants: They can be used on steel, timber or ply faces of the formwork.
- Mould cream emulsions: The most general-purpose release agent used on all types of form faces.
- Chemical release agents: Recommended for all high-quality form finished concrete works.

As unused and untreated plywood and timber surfaces have a tendency to absorb the coating of the release agent, the surfaces should be given a primary coat of release agent 36 hours before being used and a secondary coat of release agent should be applied just before using it for the first time.

10.2.6 Positioning & Striking Construction Elements

Positioning and striking box-outs, bolt boxes, grout checks, level controls, angle fillets, and other features in construction is essential for accurate and successful concrete work. Here's a general procedure for these tasks:

Positioning:

1. **Box-Outs and Bolt Boxes:**
    - ♦ Mark the locations of box-outs and bolt boxes on the formwork or structure based on design plans.
    - ♦ Ensure precise dimensions and alignment.
    - ♦ Install formwork components or inserts to create the box-outs and bolt boxes.
    - ♦ Verify that the openings are clean and clear of debris before concrete placement.
2. **Grout Checks:**
    - ♦ Grout checks are usually used to ensure proper alignment of structural components.
    - ♦ Install temporary formwork or metal spacers adjacent to the elements that require alignment.
    - ♦ Create openings where grout will be poured to ensure alignment accuracy.

- Once the grout cures, remove the formwork or spacers to reveal aligned components.

3. **Level Controls:**

   - Position leveling devices, such as level plates or laser leveling equipment, on the construction surface.
   - Ensure the devices are securely fixed and accurately calibrated.
   - Use the level controls to ensure the construction elements are at the desired heights or angles.

4. **Angle Fillets and Features:**

   - Mark the locations of angle fillets or other specific features on the structure or formwork.
   - Place the appropriate formwork or templates to create the desired angles or features.
   - Make sure the formwork is securely fastened and aligned.

Striking (Removal):

1. **Box-Outs and Bolt Boxes:**

   - After the concrete has cured sufficiently, remove the formwork used to create box-outs and bolt boxes.
   - Ensure that the removal process doesn't damage the surrounding concrete surface.

2. **Grout Checks:**

   - After the grout has cured, remove any temporary formwork or spacers used for alignment.
   - Inspect the alignment of the components to ensure accuracy.

3. **Level Controls:**

   - Once the construction elements have been positioned correctly, remove the leveling devices or equipment.
   - Store the leveling equipment properly for future use.

4. **Angle Fillets and Features:**

   - After the concrete has cured, carefully remove the formwork used to create angle fillets or features.
   - Inspect the resulting angles or features for accuracy and quality.
   - Perform these tasks carefully to avoid damaging the concrete or affecting the structural integrity.
   - Remember that specific procedures may vary based on the project's requirements, the materials used, and the construction methods employed.

Notes

Unit 10.3: Erection and Dismantling

Unit Objectives

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

1. Show how to use the supports such as runner pieces, timber, props, tie systems appropriately for positioning and providing support.
2. Show how to provide the braces for formwork support as per the specification and requirement.
3. Show how to use form sheet or other appropriate packing material for ensuring the water tightness of form.
4. Demonstrate how to fix tie rods, supports, bracings after the erection of formwork shutters.
5. Show how to perform checks for line, level, and alignment of the erected formwork as per permissible tolerance limits.
6. Show how to perform checks for dimensional accuracy and right angle, and take necessary corrective action if required.
7. Demonstrate the standard procedure for dismantling of formwork shutters manually or by mechanical means as per the requirements.
8. Show how to check the quality of formwork materials for reusability after dismantling.
9. Demonstrate proper storing, stacking, and cleaning of formwork materials after dismantling.

10.3.1 Erecting formwork:

Formwork is a temporary structural arrangement which is removed as soon as concrete is capable of taking adequate load. It is therefore to be designed in an engineering manner so that it can withstand the pressures and loads occurring during the concreting operations and also after, till such time concrete has achieved reasonably good strength.

Each erection job is specific to its requirements and therefore will have its own individual problems. Some general tips, which may help to avoid serious problems, are given below:

- All fixtures, fittings and fastenings must be in the right place and each panel to avoid mistakes.
- All tie bolts or wall ties must be removed.
- Formwork must be cleaned and checked to ensure that nothing has fallen within.
- Avoid drilling holes or cutting standard panels.
- Any make up or fill-in pieces or closure panels should marry with the main formwork. They should be so designed that they can be easily fixed and stripped without causing any damage to themselves and the neighbouring panels.

- Holes made in the formwork on site should be neat so that plugging is easier. Timber formwork must be drilled from the face to avoid splintering.
- Make sure, that while fixing the upper lift panels, the lower edge of the panel is tightly fixed against the hardened concrete of the previous lift. Foamed plastic strip at the panel edges, stop ends and construction joints are fixed to prevent grout leakage.
- Make sure that inserts, blocking out pieces, boxes and battens are securely fixed.
- Ensure that dirt, wooden shavings, tie wire clippings, nails etc. from the formwork are removed prior to commencement of concreting.
- Ensure that proper walkways, working platforms and approaches are available for free and safe movement of work force. Guardrails must be provided to ensure safety.
- Sloping or horizontal top forms are subjected to uplift pressure from freshly placed concrete and therefore need to be firmly restrained.
- Large prefabricated formwork panels must be provided with a spreader or lifting beam to prevent damage or distortion.

10.3.2 Formwork Removal

The formwork must not be removed until the concrete has achieved a strength that is at least double the stress it could experience during formwork removal. This strength measurement should correspond to concrete made with the same cement, aggregate, and admixture (if present), using identical proportions, and cured under conditions like temperature and moisture similar to those on the construction site.

Order and Method of removing formwork

The formwork should be planned and constructed in such a manner that it is possible to remove the different components in the following order of sequence.

- Shuttering forming vertical faces of walls, beams and columns sides (which bear no load but are used only to retain the concrete) should be removed first.
- Shuttering forming soffit to slabs should be removed next.
- Shuttering forming soffit of beams, girders or other heavily loaded shuttering should be removed in the end.

The duration for which formwork should remain in place depends on various factors, including the type of cement employed, the member’s orientation (horizontal, vertical, or inclined), the anticipated loads, and the ambient temperature. Typically, rapid hardening cement, warm weather, and lighter loads enable the early removal of formwork. This early release facilitates formwork reuse in different sections, optimizing material usage and accelerating construction. However, it’s crucial to avoid prematurely removing formwork, as doing so can pose risks and hazards that should be strictly prevented.

Following should be checked before and during release of falsework:

- The person concerned and the workers are in the knowledge of the sequence of releasing of forms and the props to be left in position.
- All false work material are properly stacked and maintained in good condition. Any items, which may be damaged or wrecked while stripping, are segregated. Any member should not be allowed to be dropped from a height but should be carefully brought down.
- Forms are eased off from concrete faces such as to prevent damage to both concrete and forms.
- The sequence of dismantling, as laid down, is adhered to. If not laid down, the sequence is planned by the agency doing falsework, and that are safe for the workers and the permanent construction.
- The formwork should be designed in such a manner that it can be struck easily without damaging the concrete or form itself.
- Formwork must be struck when the concrete has gained has gained enough strength to be self supporting and also be able to carry any other loads that may be put on it.
- The removal time of formwork is generally specified in the drawings or specification. This time will depend on the following factors:
    - ♦ Size and shape of the member
    - ♦ Span of the member (beams)
    - ♦ The concrete mix used
    - ♦ The type of cement used
    - ♦ The ambient temperature and weather conditions. o Curing of concrete prior to removal.
- For walls, columns, beams, sides, the forms can be usually removed within 16 to 24 hrs of placing the concrete. However, care should be exercised, as concrete will still be green and therefore easily prone to damage.
- During cold weather forms should be left for longer period of time.
- At the time of removal, ties, clamps and wedges should be loosened gradually to prevent the last tie from bending.
- Ensure that all bolts, nuts, clamps, and wedges removed are collected in a box and not dropped down.
- If the forms are not easily detachable, cautiously use hardwood wedges to pry them loose. Crowbars should be avoided as they can harm both the concrete and form.
- When removing soffit formwork, release props evenly in gradual stages, starting from the mid-span and moving towards the support. This prevents overloading of props towards the center due to slab and beam deflection.

- Never drop large sections of formwork all at once, as it's hazardous for workers and can cause damage to the formwork and the underlying structure.
- Exercise caution when lowering large formwork panels to prevent damage from scaffolding or projections.
- Place panels on level surfaces to avoid twisting or deformations.
- Always hammer down protruding nails as formwork is removed from concrete, as they can pose injury risks.
- During formwork removal, cordon off areas below and keep workers away to prevent accidents.
- When using cranes for formwork handling, the operator must be knowledgeable about proper sling placement and signal codes.
- The number, size, and arrangement of props left under the formwork should safely support the dead and live loads of the structure during curing and further construction.
- For elements with re-entrant angles, remove formwork as soon as concrete sets to prevent shrinkage cracking due to imposed restraint.

10.3.3 Safe Storage

Storage of formwork is extremely important. Most of the formwork material deteriorates very fast if not repeatedly used and not preserved and stored properly. The main aim for good storage is to avoid doing any damage when formwork is not in use. If immediate re-use of formwork materials is not required, formwork must not be allowed to lie on site unprotected.

Fig. 10.3.1 Safe storage of formwork

- After cleaning and oiling, panels and plywood sheets should be stored horizontally on a flat, leveled base to prevent twisting. Stacking them face to face protects the surface.
- Larger panels are best stored on edge using specialized racks.
- Loose components like wailings, soldiers, and struts are ideal for storage with their respective panels, numbered for easy matching in the future.
- Store small items such as bolts, clamps, keys, pins, wedges, and ties in designated boxes.
- Elevate props off the ground to prevent deterioration due to contamination, mud, and moisture.
- Ensure working fire extinguishers are readily accessible in the storage area.
- Safeguard the storage area from rain and moisture. Maintain proper ventilation and tidiness to facilitate easy access to required materials for reuse.

Exercise

A. Answer the following questions:

a) Name a defect that bamboo can be susceptible to due to changes in moisture content.

b) Name a versatile timber material used in shuttering works for creating smooth surfaces.

c) Which type of hitch is designed for attaching a rope to a cylindrical object like a bamboo or a pole?

B. Multiple Choice Questions:

1. Which of the following is a defect associated with bamboo formwork?
   a) Warping and twisting
   b) Delamination
   c) Uneven diameter
   d) Knots and weak points

2. Sawn timber is frequently used for vertical formwork in applications like:
   a) Roofs
   b) Beams
   c) Foundations
   d) Columns

3. Which material is commonly chosen for its versatility and ease of manipulation in carpentry?
   a) Steel
   b) Concrete
   c) Plywood
   d) Fiber-reinforced plastic

4. In conventional shuttering works, plywood is preferred for its:
   a) Lightweight properties
   b) Corrosion resistance
   c) Structural reinforcement
   d) niformity and strength

5. The clove hitch knot is often used to:
   a) Join ropes of different diameters
   b) Create a loop at the end of a rope
   c) Secure heavy loads
   d) Start or finish lashings

C. Fill in the blanks:

1. Plywood is made up of layers glued together, and poor-quality glue or exposure to ___________ can cause delamination.
2. Variations in the diameter of ballies can result in uneven pressure on the formwork, leading to ___________ concrete surfaces.
3. Plywood is susceptible to delamination due to issues with its ___________.
4. Plywood is widely used for creating smooth surfaces in shuttering works for walls, columns, ___________, and slabs.

5. The ___________ knot is widely used for joining ropes of the same diameter and is useful for simple connections and lashing.
6. The clove hitch knot provides a temporary grip on poles or bamboo, making it useful for initial securing before more stable ___________ are applied.

Notes

QR Codes

Scan the QR code to watch the video

https://www.youtube.com/watch?v=-bA1KGJ4oDh0

Dismantling Formwork

11. Annexure

Annexure I - QR Codes - Video Links

Annexure-III

Annexure of QR Codes for Shuttering Carpenter

Chapter Name	Unit Name	Topic Name	URL	Page No.	QR Code
Chapter 1: Introduction of Construction Sector and Job Role	UNIT 1.1 - Introduction to Construction Industry	Overview of Construction Sector in India	https://youtu.be/p4f0Ni15EaM?si=-FLKuZWQ7vm-2dLZ9N	5	Overview of Construction Sector in India
	UNIT 1.3 - Brief about Shuttering Carpenter	Responsibilities of Shuttering Carpenter	https://youtu.be/YLN-_KCMRUE?si=3c6Pb-P_w4rGkBae	17	Responsibilities of Shuttering Carpenter
Chapter 2: Core/Generic Skills	Unit 2.1 - Basic principles of measurement, Geometry, and arithmetic Calculation	Different System of Measurement	https://youtu.be/H1x-o5UVJKVo	30	Different System of Measurement
		Area, volume and perimeter of geometrical shapes	https://youtu.be/OhTub-w4C0to		Area, volume and perimeter of geometrical shapes
Chapter 3: Making WoodenShutters Used inShuttering Carpentry (CON/N0302)	Unit 3.1 - Hand and Power Tools	Construction Tools	https://www.youtube.com/watch?v=dERDiw-ZiHlM	49	Construction Tools
	UNIT 3.2 - Measuring Instruments	Using of Spirit Level	https://youtu.be/FxV940bkG2Y?feature=shared	59	Using of Spirit Level

	UNIT 3.3 - Handling and Maintenance of Tools	Care and Maintenance of hand tools	https://youtu.be/UH0BaZUFUEE?feature=shared	56	Care and Maintenance of hand tools
	UNIT 3.4 - Shutter Panel Materials – System	Shuttering Panel Material	https://www.youtube.com/watch?v=S-DYRICOTRSs	59	Shuttering Panel Material
Chapter 4: Quality Checks on Shuttering Work (CON/N0304)	Unit 4.1 - Carry Out Quality Check for Shuttering Works	Design and Tolerance in Shuttering	https://youtu.be/t2q8jzkHK8E?feature=shared	70	Design and Tolerance in Shuttering
	Unit 4.2 - Checks on Reinforcement Work, Shuttering Work and Concreting Works	Checklist for Site Supervision of Concreting Work	https://www.youtube.com/watch?v=q-2JsyYB0TeI	87	Checklist for Site Supervision of Concreting Work
Chapter 9: Assemble and Dismantle System Formwork (Elective-1) (CON/N0303)	Unit 9.2: Assemble and Dismantle System Formwork	Assembling of System Formwork	https://www.youtube.com/watch?v=xXSu-ZfOFptA	96	Assembling of System Formwork
	Unit 9.4: Stripping Time of Formwork	Stripping Time of Formwork	https://www.youtube.com/watch?v=gzW-dR1wmBHU	249	Stripping Time of Formwork

	Unit 9.6: Stacking and Storing of Formwork Panels	Stacking and Storing of Material	https://www.youtube.com/watch?v=-P-VHYX-7Hhw	270	Stacking and Storing of Material
Assembling and dismantling conventional shuttering / formwork for RCC structures (Elective-2) (CON/N0315)	Unit 10.1: Conventional Formwork	Formwork/Conventional Shuttering Support	https://www.youtube.com/watch?v=RS8rm-MTdhHQ	285	Formwork/Conventional Shuttering Support
	Unit 10.3: Erection and Dismantling	Dismantling Formwork	https://www.youtube.com/watch?v=bA1K-GJ4oDh0	301	Dismantling Formwork

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