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Construction Skill Development Council

Participant Handbook

Sector
Construction

Sub-Sector
Real Estate and Infrastructure Construction

Occupation
Construction Painting

Reference ID: **CON/Q0201, Version 4.0**
NSQF Level 2

Helper Bar Bender and Steel Fixer

Published by

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Disclaimer

"Skilling is building a better India. If we have to move India towards development then Skill Development should be our mission."

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 Occupational Standards of

Job Role/Qualification Pack:'Helper Bar Bender and Steel Fixer'

QP No.'CON/Q0201, Version 4.0 NSQF Level 2'

Date of Issuance: Aug 22nd 2019
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Authorised Signatory
(Construction Skill Development Council)

Acknowledgements

This participant's handbook meant for Helper Bar Bender and Steel Fixer 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 Helper Bar Bender and Steel Fixer. 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 Helper Bar Bender and Steel Fixer. 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 Helper Bar Bender and Steel Fixer. 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 Helper Bar Bender and Steel Fixer QP:

- **CON/N0201:** Shift and Stack Materials, Tools and Equipment for Reinforcement Work
- **CON/N0202:** Mark and Cut Reinforcement Bars to the Required Length
- **CON/N0203:** Tie Reinforcement Bars using Different Types of Ties
- **CON/N0101:** Erect and Dismantle Temporary Scaffold up to 3.6 – meter height
- **CON/N9001:** Work according to Personal Health, Safety and Environment Protocols at Construction Site
- **DGT/VSQ/N0101:** Employability Skills (30 Hours)

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

Participants may choose to delve into the carrying out manual earthwork at construction site by selecting the appropriate elective module.

- **Elective 1: CON/N0104:** Carry out Manual Earthwork at Construction Site

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


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Table of Contents

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1. Introduction of Construction Sector and Job Role

Unit 1.1 – Introduction to Construction Industry

Unit 1.2 – Brief about Bar Bending & Steel Fixing Occupation

Key Learning Outcomes

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

- Describe the size and scope of the construction industry and its sub-sectors.
- Discuss the role and responsibilities of a Helper Bar Bender and Steel Fixer.
- Identify various employment opportunities for a Helper Bar Bender and Steel Fixer.

Unit 1.1 Introduction to Construction Painting

Unit Objectives

At the end of this unit, you will be able to:

- Describe the size and scope of the construction industry and its sub-sectors
- Compare urban and rural construction
- Observe and outline modernization of construction
- Know about major occupations in the construction sector

1.1.1 Overview of Construction Sector in India

Construction industry helps in developing and enhancing economic sector as well as aids in the development of the country. Construction activity plays an important role in country's infrastructure and industrial development. Construction refers to building of different structures such as hospitals, schools, townships, offices, and houses and other buildings (including water supply, sewerage, and drainage), highways, roads, ports, railway tracks, dams etc. If we are covering a wide spectrum, construction activity becomes the basic input for socio-economic development.

Fig. 1.1.1 Construction Industry

Construction is the second largest employment generating sector in India after agriculture.

This sector comprises of small, medium and large industries or companies which are involved in different types of projects. This creates a diverse requirement of work force.

Some examples of Infrastructure are:

Buildings	
Bridges	
Dams	
Power Plants	

Railway Bridges	
Hotels	
Airports	
Buildings	

Table 1.1.1 Various infrastructure related to Construction

Construction industry is broadly divided into two major sub-sectors:

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

Real Estate & Infrastructure Construction

The real estate sector holds significant global recognition, encompassing housing, retail, hospitality, and commercial sub-sectors. Its growth is closely linked to the expansion of the corporate landscape and the rising demand for office spaces, urban, and semi-urban accommodations. Among the 14 major sectors, the construction industry ranks third, considering its direct, indirect, and induced effects on the economy as a whole.

In India, the real estate sector stands as the second-largest employment generator, trailing only the agriculture sector. There is a strong expectation of increased investment from non-resident Indians (NRIs) in both the short and long terms. Bengaluru is anticipated to be the most favored destination for NRI property investments, followed by Ahmedabad, Pune, Chennai, Goa, Delhi, and Dehradun.

According to the Economic Times Housing Finance Summit, about three houses are built per 1,000 people per year compared with the required construction rate of five houses per 1,000 populations. The current shortage of housing in urban areas is estimated to be ~10 million units. An additional 25 million units of affordable housing are required by 2030 to meet the growth in the country's urban population

Fig. 1.1.2 Township Construction

Fig. 1.1.3 Bridge Construction

Government Initiatives under Urban Development

Indian government has undertaken several initiatives under urban development to address the challenges posed by rapid urbanization and to promote sustainable and inclusive growth in cities and towns.

Fig. 1.1.4 Building Construction Site

Fig. 1.1.5 Industrial Building Construction Site

Some of the key government initiatives include:

- Smart Cities Mission: Launched in 2015, the Smart Cities Mission aims to develop 100 smart cities across the country. These smart cities are intended to be equipped with advanced infrastructure and technology to enhance quality of life, promote sustainable development, and provide efficient urban services to residents.
- Atal Mission for Rejuvenation and Urban Transformation (AMRUT): The AMRUT scheme was launched in 2015 to focus on providing basic urban infrastructure in cities and towns, such as water supply, sewerage, and urban transportation. The goal is to improve the quality of life for urban residents.
- Pradhan Mantri Awas Yojana (PMAY): This scheme, launched in 2015, aims to provide affordable housing for all by 2022. It consists of two components: Pradhan Mantri Awas Yojana (Urban) for urban areas and Pradhan Mantri Awas Yojana (Gramin) for rural areas.
- Swachh Bharat Mission (Urban): The Swachh Bharat Mission focuses on promoting cleanliness, sanitation, and hygiene in urban areas. It aims to eliminate open defecation, improve solid waste management, & ensure a clean urban environment.
- Heritage City Development and Augmentation Yojana (HRIDAY): This scheme aims to preserve and revitalize the rich cultural heritage of heritage cities in India, making them more livable and tourist-friendly.
- National Urban Livelihoods Mission (DAY-NULM): DAY-NULM was launched to reduce poverty and vulnerability of urban poor households. It provides self-employment opportunities, skill development, and access to credit and capital.

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. 1.1.6 Rural Roads

Fig. 1.1.7 Rural House

Rural infrastructure is not only an important element of rural expansion but also a significant element in ensuring any sustainable poverty reduction plan. The appropriate expansion of infrastructure in rural zones improves the rural financial system and quality of life. It encourages augmented agricultural profits, satisfactory employment etc.

Government Initiatives under Rural Development

Indian government has launched various initiatives under rural development to uplift rural areas, improve the living standards of rural communities, and promote inclusive growth. Some of the key government initiatives under rural development include:

- Pradhan Mantri Gram Sadak Yojana (PMGSY): Launched in 2000, PMGSY aims to provide all-weather road connectivity to unconnected rural habitations. The program focuses on improving rural access and connectivity, which has a positive impact on economic development and social integration.
- Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA): MGNREGA, launched in 2005, guarantees 100 days of wage employment to every household in rural areas. It aims to provide livelihood security to rural households and promote rural development through the creation of durable assets and infrastructure.
- Pradhan Mantri Awaas Yojana - Gramin (PMAY-G): Launched in 2016, PMAY-G aims to provide affordable and quality housing to rural households. It focuses on improving the living conditions of the rural poor and providing them with a safe and secure dwelling.
- Swachh Bharat Mission (Gramin): Similar to the urban counterpart, this mission focuses on promoting cleanliness and sanitation in rural areas. It aims to achieve an open defecation-free rural India and improve rural sanitation facilities.

"Bharat Nirman"

"Bharat Nirman" was an initiative launched by the Indian government in 2005 to accelerate rural development and bridge the infrastructure gaps in rural areas.

Fig. 1.1.8 Bharat Gramin Yojna for improving Rural Infrastructure

It aimed to enhance the quality of life and economic opportunities for rural communities by focusing on six key areas:

- **Rural Housing:** Bharat Nirman aimed to provide affordable housing to the rural poor and ensure that every rural household had access to a safe and secure dwelling.
- **Rural Roads:** The initiative focused on improving rural connectivity by constructing and upgrading rural roads under the Pradhan Mantri Gram Sadak Yojana (PMGSY). This helped in facilitating easier access to markets, healthcare, and education for rural residents.
- **Rural Water Supply:** Bharat Nirman aimed to provide safe and sustainable drinking water to rural areas under the National Rural Drinking Water Programme (NRDWP). The goal was to ensure that every rural household had access to potable water.
- **Rural Electrification:** The initiative sought to electrify all unelectrified villages and provide electricity connections to rural households. The focus was on enhancing rural electrification and promoting energy access in remote areas.
- **Rural Telecommunication:** Bharat Nirman aimed to extend telecommunication services to rural areas, including mobile and broadband connectivity, to bridge the digital divide and enable access to information and services.
- **Irrigation:** The initiative sought to increase the irrigation potential in rural areas to enhance agricultural productivity and income. This was done through various schemes and projects promoting water conservation and management.

Bharat Nirman played a significant role in boosting rural development and improving the overall socio-economic conditions in rural India. It brought attention to the importance of infra development in rural areas and contributed to rural empowerment and growth.

1.1.2 Major occupations in Construction Sector

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

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:

- Building of structure by laying material such as bricks, blocks, tiles and other construction materials, and bonding them by mortar.
- Constructing, altering, repairing and maintaining walls, sidewalks, street curbs, floors, sink counters, partitions, manholes, and other related structures or surfaces.
- Carry out structural finishes like tiling, grit wash, cement wash, POP, plastering, stone cladding etc. on finished masonry surface to impart an aesthetic appeal to the finished structure.

Fig. 1.1.9 Brick work

Fig. 1.1.10 Plastering Work

Few job roles under masonry occupation are:

i. Helper Mason

ii. Assistant Mason

iii. General Mason

iv. Mason Tiling

v. Mason Concrete

vi. Mason marble, granite & stone; and

vii. Mason Special Finishing

viii. Mason Form Finishes & Special concrete.

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.

Fig. 1.1.11 Bar bending

Few job roles under bar bending occupation are:

i. Helper bar bender & steel fixer;

ii. Assistant bar bender & steel fixer;

iii. Bar bender & steel fixer; and

iv. Reinforcement fitter.

Fig. 1.1.12 Reinforcement bars fixed at site

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. After fixing these boards or plates in designated area, concrete can be dispensed within these fixed moulds. These moulds contain the concrete in its place till it sets, thereby generating a hard, smooth structure.

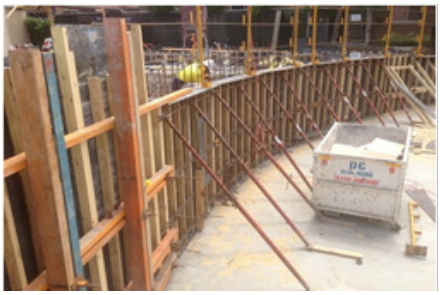


Fig. 1.1.13 Conventional formwork

Fig. 1.1.14 System formwork

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.

Scaffolding: Scaffolding works involve creation of temporary support structure for providing support to workman during construction process. It is use as a platform to carry on construction works and keep tools and materials.

Fig. 1.1.15 Scaffolding work

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

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

Fig. 1.1.16 Welding

Few job roles under Fabrication occupation are:

i. Grinder Construction;

ii. Construction fitter;

iii. Construction welder;

iv. Fabricator; and

v. Plasma cutter.

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. 1.1.17 Rigging work at site

1.1.3 Typical Layout of a Construction Site

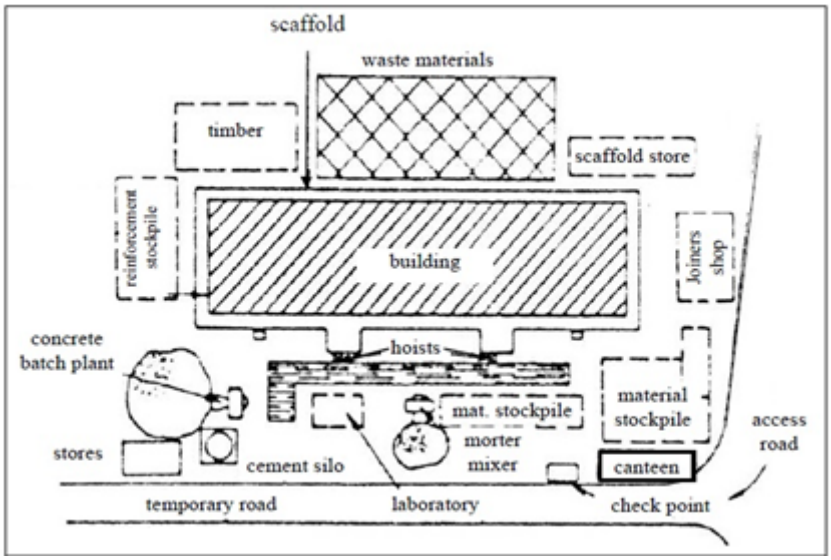


Fig. 1.1.18 Layout of a construction site

Notes

Scan the QR code to watch the video

https://youtu.be/yhjDhav4Pfw

Overview of Construction Sector in India

UNIT 1.2: Brief about Bar Bending & Steel Fixing Occupation

Unit Objectives

At the end of this unit, you will be able to:

- Discuss the role and responsibilities of a Helper Bar Bender and Steel Fixer.
- Identify various employment opportunities for a Helper Bar Bender and Steel Fixer.

1.2.1 About Bar Bending & Steel Fixing

Bar Bending and Steel Fixing are essential aspects of construction that revolve around reinforcing concrete structures with steel bars (rebars) to enhance their strength, durability, and structural integrity. These processes are critical for creating buildings, bridges, dams, and other structures that can withstand the forces they will be subjected to over time.

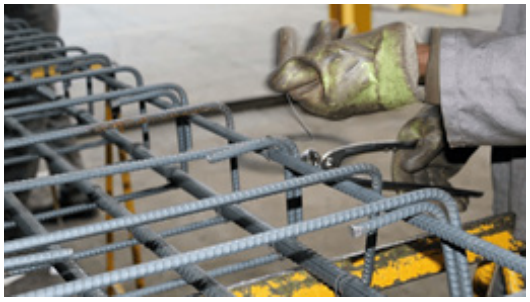


Fig. 1.2.1 Bar bending & steel fixing

Bar Bending: Bar bending involves cutting and shaping steel reinforcement bars (rebars) according to the specifications provided by structural engineers and architects. The rebars are typically made of high-strength steel and are used to reinforce concrete structures by adding tensile strength to the concrete. Bar bending is a precise process that requires accurate measurements and angles to ensure the rebars fit properly within the concrete forms.

Steel Fixing: Steel fixing, often referred to as rebar fixing, focuses on assembling and installing the pre-cut and pre-bent rebars within the formwork or molds before concrete is poured. Steel fixers position the rebars according to the design and engineering plans, ensuring they are properly spaced, aligned, and secured. This process creates a framework of steel within the concrete that helps distribute loads, prevent cracks, and improve the overall structural stability.

- **Key Concepts and Processes:**
- **Blueprint Reading:** Bar benders and steel fixers need to understand construction blueprints and drawings to accurately interpret the design requirements for the placement and arrangement of rebars.
- **Cutting and Bending:** Rebars are cut and bent using specialized tools and machines to achieve the desired shapes and lengths. The bending process is critical to creating rebars that fit the contours of the structure accurately.
- **Assembling Reinforcement Cages:** Steel fixers create reinforcement cages by assembling rebars into complex arrangements, ensuring they match the specified patterns and configurations.

- **Placement and Fixing:** Once the reinforcement cages are assembled, they are positioned within the formwork. Steel fixers use various methods, such as tying wires, clips, or supports, to secure the rebars in their designated locations.
- **Tying Rebars:** Tying techniques involve securing rebars together at intersections using wire or other materials. This process maintains the proper spacing and alignment of the rebars.
- **Safety:** Both bar bending and steel fixing require strict adherence to safety protocols. Construction sites can be hazardous environments, and ensuring the safety of workers is a top priority.

Helper Bar Bender & Steel Fixer job role is responsible for identification, handling and use of materials, tools, and equipment. The responsibilities also include identification, straightening, marking and cutting of rebar, tying reinforcement for prefabricated cages and at in-situ using hand tools.

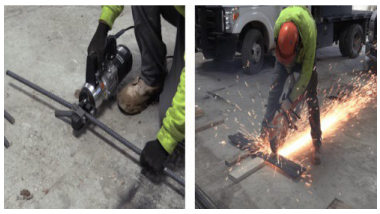
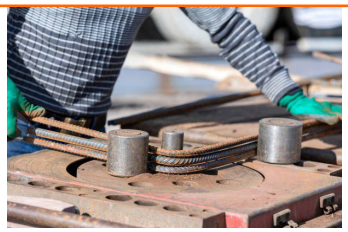
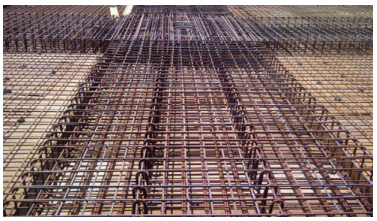
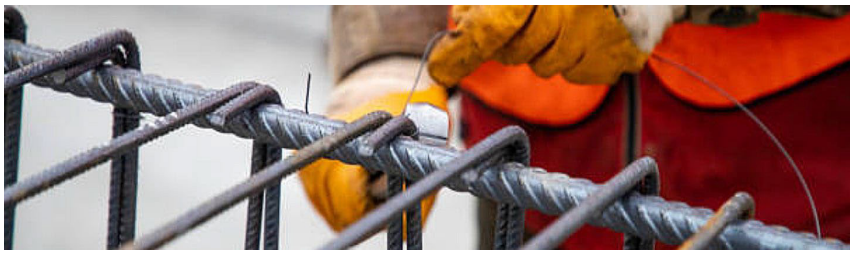
<table>
<tr><td>Measuring and marking of rebars</td><td>  </td><td>Cutting of rebars (Manual / Machine)</td><td>  </td></tr>
<tr><td>Bending of rebars (Manual / Machine)</td><td>  </td><td>Placing of rebars</td><td>  </td></tr>
<tr><td>Tying of rebars</td><td colspan="3">  </td></tr>
</table>

Table 1.2.1 Various works performed by a Helper Bar Bender & Steel Fixer

1.2.2 Responsibilities of Helper Bar Bender and Steel Fixer

At the construction site, the bar bender is commonly referred to as lohar. Helper Bar Bender and Steel Fixer is expected to perform the following tasks:

- Identify, shift and stack materials, tools and equipment relevant to reinforcement work.
- Straighten the bars of different diameter, from the bundle.
- Cut the bar as per instructions.

- Use different types of ties to tie reinforcement bar.
- Work according to personal healthy safety and environment, protocol at a construction site.
- Erect and dismantle temporary scaffold of 3.6-meter height.
- Carry out manual earthwork at a construction site.
- Carry out cleaning and prepare tools for future use.

Measuring of a rebar:

Fig. 1.2.2 Measuring of a rebar

Cutting of rebars:

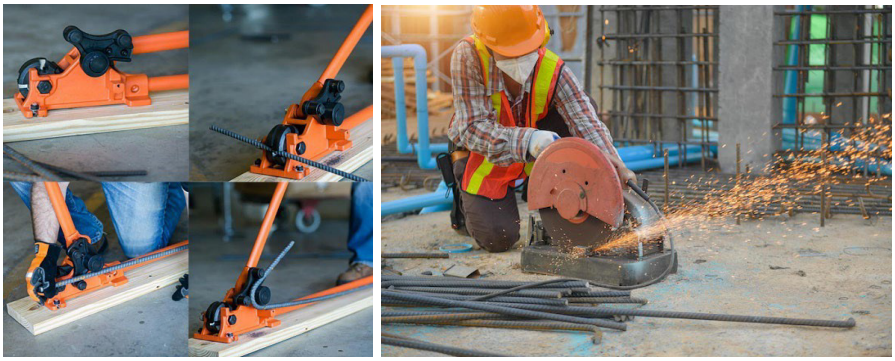


Fig. 1.2.3 Cutting of rebars

Bending of a rebar:

Fig. 1.2.4 Bending of a rebar

Placing of rebars:

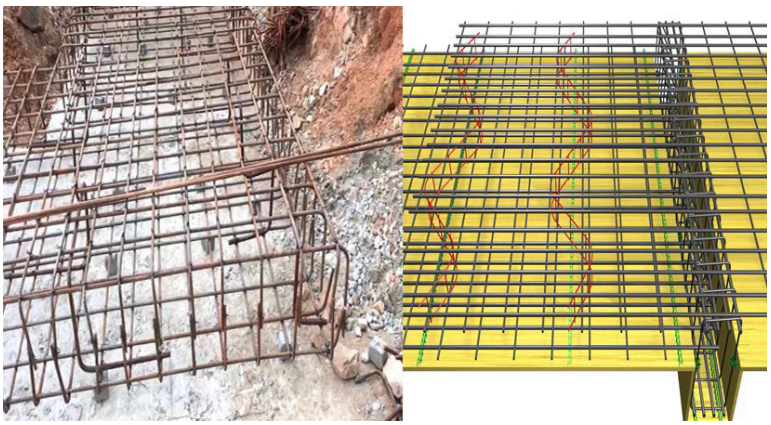


Fig. 1.2.5 Placing of rebars

Carry out manual earthwork:

Fig. 1.2.6 Carrying out manual earthwork

Erection of temporary scaffolding:

Fig. 1.2.7 Performing scaffolding work and ensuring correctness

Carry out cleaning and prepare tools for future use:

Fig. 1.2.8 Carrying out cleaning of debris/wastes and cleaning used tools

1.2.3 Personal Attributes of a Helper Bar Bender & Steel Fixer

A Helper Bar Bender & Steel Fixer in addition to his technical skills should also possess certain soft skills and personal qualities such as:

- Good communication skill with supervisors, co-workers, and other tradespeople
- Ability to work in a well-organized and accurate way
- Awareness of safety issues, especially when working at heights and carrying loads
- Ability to work as part of a team
- A good level of fitness
- Awareness of personal hygiene
- Reliable
- Honest
- Hardworking
- Courteous
- Dedicated
- Punctual

Fig. 1.2.9 A helper bar bender & steel fixer performing his work

1.2.4 Career Progression of a Helper Bar Bender & Steel Fixer

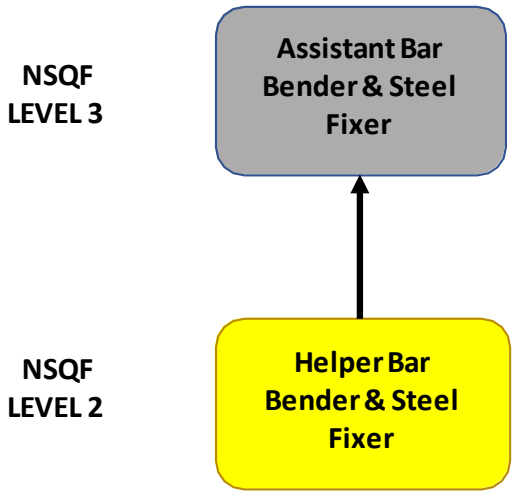


Fig. 1.2.10 Career progression of helper bar bender & steel fixer

Exercise

Answer the following questions:

A. Short Questions:

1. What is the scope of the construction industry and its sub-sectors?
2. What are the primary responsibilities of a Helper Bar Bender and Steel Fixer?
3. How does the construction industry contribute to the economy?
4. What are the potential employment opportunities for Helper Bar Benders and Steel Fixers?
5. Why is the construction industry considered a diverse sector?

B. Fill-in-the-Blanks Questions:

1. The construction industry encompasses the creation, maintenance, and renovation of _____ (physical / digital) structures.
2. The role of a Helper Bar Bender and Steel Fixer involves assisting in _____ (bending / painting) and _____ (assembling / disassembling) steel components.
3. The construction industry provides employment opportunities for various roles, including _____ (architects / musicians), _____ (engineers / chefs), and _____ (surveyors / writers).
4. The scope of the construction industry ranges from residential buildings to _____ (underwater / extra-terrestrial) infrastructure projects.
5. Helper Bar Benders and Steel Fixers work with reinforcing _____ (fabrics / rebars) used in concrete structures.

C. True/False Questions:

1. The construction industry only involves the creation of new buildings and structures. (True/False)
2. Helper Bar Benders and Steel Fixers are responsible for electrical installations in construction projects. (True/False)
3. The construction industry does not significantly impact economic growth and job creation. (True/False)
4. A Helper Bar Bender and Steel Fixer is responsible for cutting and welding metal components. (True/False)
5. The construction industry includes sectors such as residential, commercial, and industrial construction. (True/False)

Notes

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https://youtu.be/KQ_hc3-Ol-A

Responsibilities of Helper Bar Bender and Steel Fixer

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2. Core/Generic Skills

Unit 2.1 – Numeracy Skills

Unit 2.2 – Systems of Measurements

(CON/N0505)

Key Learning Outcomes

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

- Use skill of measuring and marking
- Conversion of linear measurement units

UNIT 2.1: Numeracy Skills

Unit Objectives

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

- Perform basic mathematical calculation
- Identify the different types of shapes
- Calculate the perimeter of a square, rectangle, triangle and circle

2.1.1 Mathematical Calculation

A Mason Concrete works involve the skills required to mark the dimensions of the concrete structure to be constructed, set up the temporary scaffold as per the dimensions, repair and maintain concrete structures such as buildings, bridges, heavy plant and heavy duty floorings. He must have a good knowledge of mathematical calculations and geometrical techniques. He must be able to perform basic arithmetic calculations.

Basic Calculations:

Addition

Vertical addition	Horizontal Addition
2 + 2 4	2 + 2 = 4

Addition of 2 digit Numbers	Addition of 2-digit number with 2-digit number	Addition of 3 digits with 2-digit number
24 + 32 56	57 + 34 91	156 + 37 193

Adding two 3 digit numbers with one 2-digit number	Addition with decimal point	Addition with decimal point
224 321 + 31 576	57.4 + 34.3 91.7	156.71 + 371.30 528.01

Subtraction

Subtraction of 2 digit numbers with borrowing	Subtraction of 3 digit numbers with borrowing	Subtraction of 4 digit numbers
74 - 31 43	574 - 343 231	7121 - 1130 5991
Subtraction of 3-digit number from 4-digit number	**Subtraction of decimal numbers**	**Subtraction of decimal numbers**
7456 - 314 7142	57.42 - 34.32 23.10	711.15 - 113.04 598.11

Multiplication

Multiplication of 2-digit number by 1-digit number	Multiplication of two 2-digit number by 2-digit number	Multiplication of 3-digit number by 2-digit number
24 X 3 72	27 X 13 81 +27 108	127 X 23 381 + 254 635
Multiplication of 3-digit number by 2-digit number	**Multiplication of decimal numbers**	**Multiplication of decimal numbers**
427 X 23 1281 + 854 2135	27.3 X 3 81.9	2.7 X 6.3 8.1 + 16.2 24.3

Multiplication

Division of 3-digit number by 1-digit number	Division of 4-digit number by 2-digit number
20 5 | 100 - 10 00	153 14 | 2142 - 14 74 - 70 42 -42 00
Division of 5-digit number by 1-digit number	**Division of given value in decimal**
3206 6 | 19236 - 18 12 - 12 36 -36 00	75.5 4 | 302 - 28 22 - 20 20 -20 00

Division

Division of 3-digit number by 1-digit number	Division of 4-digit number by 2-digit number
20 5 | 100 - 10 00	153 14 | 2142 - 14 74 - 70 42 -42 00
Division of 5-digit number by 1-digit number	**Division of given value in decimal**
3206 6 | 19236 - 18 12 - 12 36 -36 00	75.5 4 | 302 - 28 22 - 20 20 -20 00

2.1.2 Basic Geometrical Shapes

The common shapes comprise of square, triangle and rectangle.

Curved Shapes

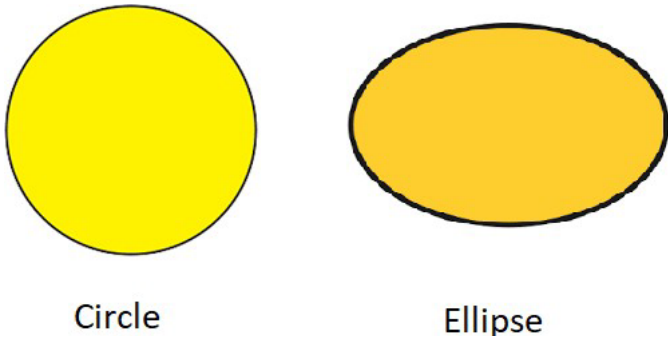


Fig. 2.1.2 Basic Shapes

Basic Shapes

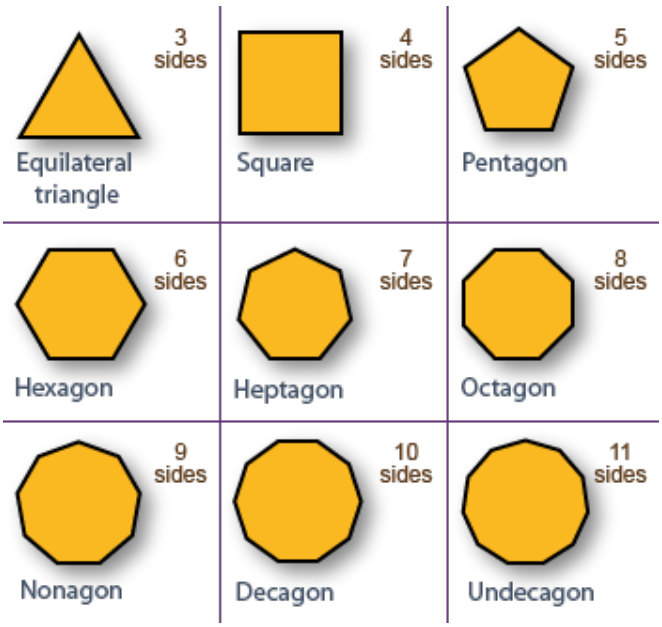


Fig. 2.1.1 Curved Shapes

Other Shapes

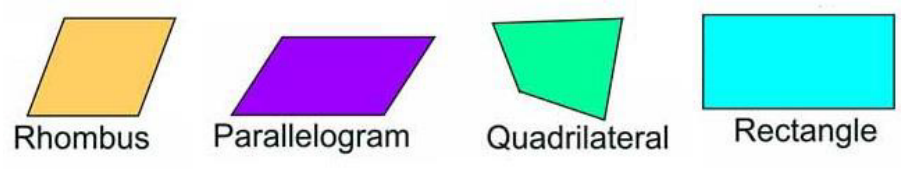


Fig. 2.1.3 Other Shapes

Notes

Scan the QR code to watch the video

https://youtu.be/H1xo5UVJKVo

Different System of Measurement

UNIT 2.2: Systems of Measurement

Unit Objectives

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

- List the different types of systems of measurement
- Follow the conversion of measurements
- Read a measuring tape in imperial system
- Read a measuring tape in metric system

2.2.1 Systems of Measurement

Different measurements have to be used together in order to calculate complex measurements. However, the calculation will only work if all the three measurements are taken in the same system of measurement.

There are two types of systems of measurement which are currently in practice:

1. MKS or Metric System: This system uses Meter, Centimeter and Millimeter
2. FPS or Imperial system: This system uses Yard, foot and Inch

2.2.2 Conversion of Measurement

Units of Measurement for Length

Length is measured in millimeters (mm), centimeters (cm), meters (m), inch (in), and feet (ft).

Conversion from one system to another should be done based on the table below:

1 Meter (m)	100 Centimeter (cm)
1 Centimeter (cm)	10 Millimeter (mm)
1 Meter (m)	1000 Millimeter (mm)
1 Inch (in)	2.54 Centimeter (cm)
1 Foot (ft)	12 Inches (in)
1 foot (ft)	30.50 Centimeter (cm)
1 Meter (m)	39.4 Inches (in)
1 Meter (m)	3.28 Foot (ft)

Table 2.2.1 Measurement unit's conversion

2.2.3 Reading of Tape in FPS System

Use the big numbered marking for inches.

- The height of marking line at each 1 inch is generally long and may be half width and full width of tape depends on manufacturer and perpendicular to length direction of tape.
- The feet graduation line is generally numbered in different colour and followed by symbol Ft
- Numerals of inch graduation line repeat from 1 - 11 after graduation line at 1 feet.
- The marking line is straight and perpendicular to longitudinal direction of tape.

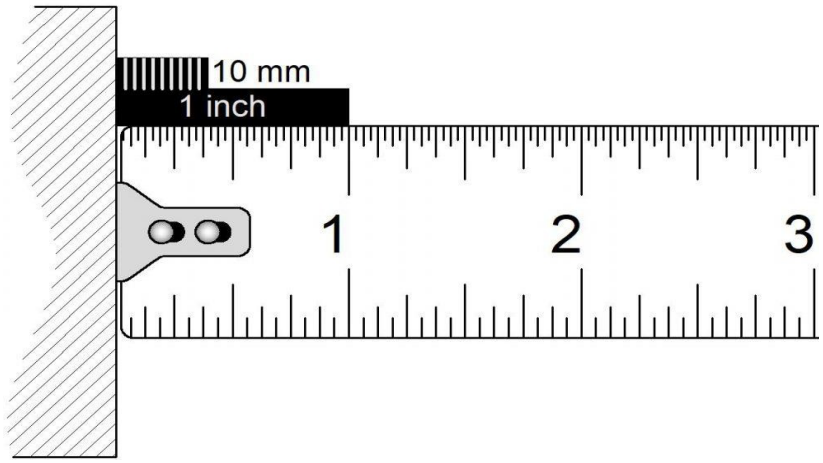


Fig. 2.2.1 Measuring in Inches

The graduation/marking line at 1/2 inch is longer in length than smaller increment marks like 1/4 and 1/8 inch. There is one graduation line between two inch lines which is used for measurement in terms of quarter inch.

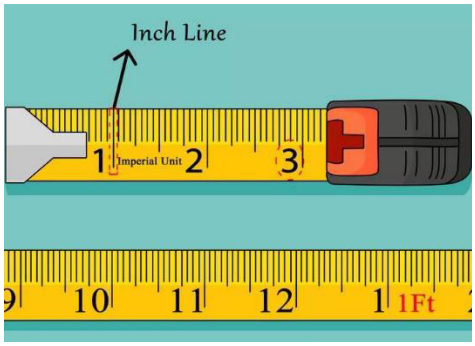


Fig. 2.2.2 Measuring in Inches

There are 3 graduation lines between two inch lines which is used for measurement in terms of quarter inch

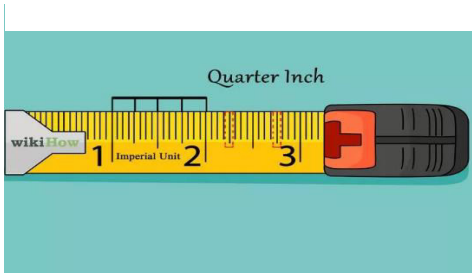


Fig. 2.2.3 Measuring in Inches

The height of marking line for one-eight of inch is longer than sixteenth of inch, there are 7 graduation lines between every inch lines which are used for measurement in terms of one-eighth of inch.

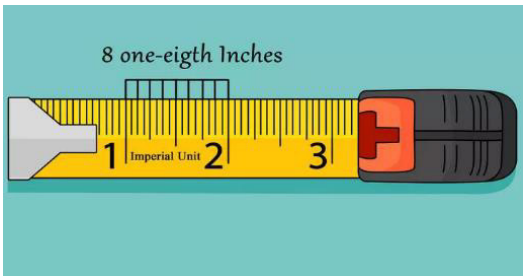


Fig. 2.2.4 Measuring in Inches

There are 15 graduation lines between two inch lines which are used for measurement in terms of one -sixteenth of inch.

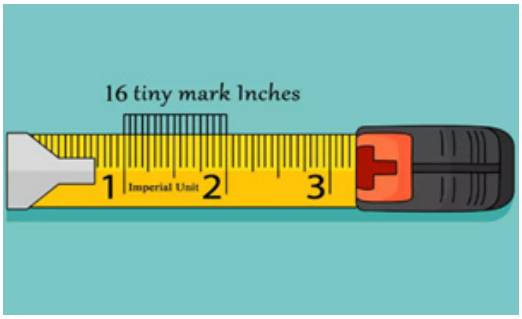


Fig. 2.2.5 Measuring in Inches

Finding measurement in terms of Finding measurement in terms of quarters of inch or one eighth

1. First mark or note down the graduation line which is matching or coinciding with end point of dimension of objects to be measured
2. For an example, in term of quarter inch measurement. The edge shall coincide with either of 3 graduation line between two inch marked line.
3. In case of one eight-inch measurement, the end edge of dimension of objects shall coincide, we need to add:
4. 1 (our inches) + 1/4 (our quarter-inches) + 1/8 (our eighth-inches).

   Since there are two eighth-inches in a quarter-inch, we can rewrite this as:

   1 + 1/8 + 1/8+ 1/8 = 1 3/8 inches.

   1 + 1/8 + 1/8+ 1/8 = 1 3/8 inches.

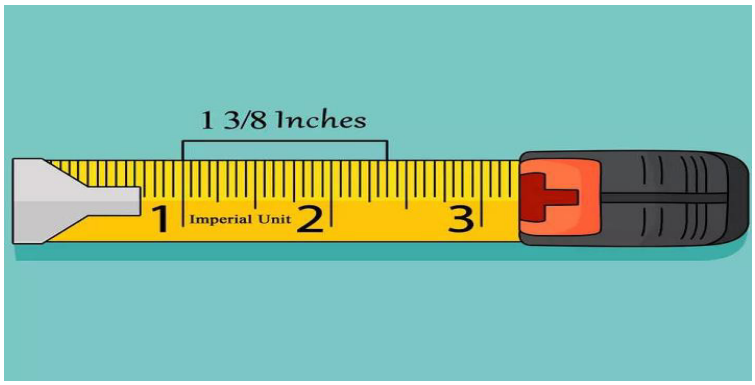


Fig. 2.2.6 Measuring Tape

2.2.4 Reading of Tape in Metric System

The marking line at every 1 meter is numbered and followed by abbreviation m.

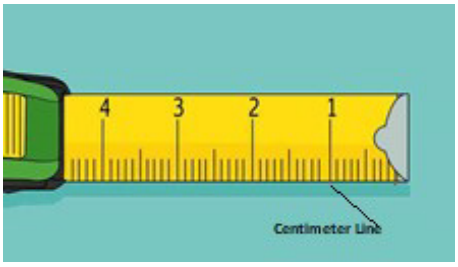


Fig. 2.2.7 Measuring in Centimeter

The height of marking line at each centimeter is longer than millimeter graduation and may be half width and full width of tape and perpendicular to length direction of tape and size.

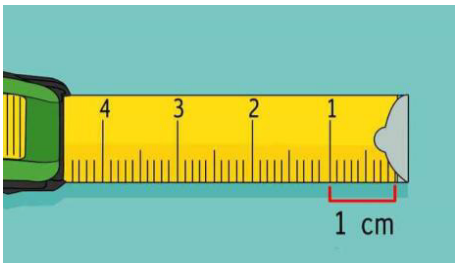


Fig. 2.2.8 Measuring in Centimeter

There are 9 graduation lines between each centimeters line.

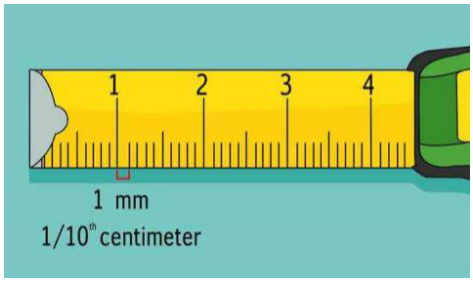


Fig. 2.2.9 Measuring in Centimeter

To measure with a metric measuring tape,

First note down graduation line coinciding or nearly matching with end edge of dimension of objects to be measured

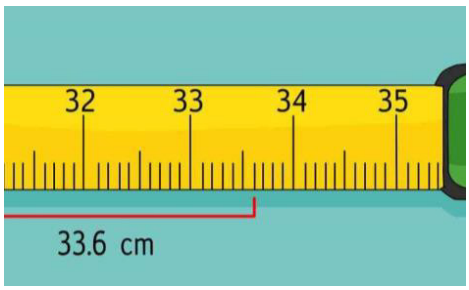


Fig. 2.2.10 Measuring in Centimeter

For example, see below:

- As shown in above figure 2.3.10. the graduation line is noted down which is found to be 6th graduation line past 44 centimeter line so the reading will be = 44 +0.6 =4.6 centimeters.
- To find out measurement in terms of meters, covert centimeters into meters. There are 100 centimeters into one meter.
- To find out measurement in terms of millimeters, covert centimeters into millimeters. There are 10 millimeters into one centimeters. Therefore, multiply it by 10.

2.2.5 Taking Measurements with Metal and Cloth Tape

Measuring tapes are used by a Mason Concrete for marking and measuring in concreting work as per the requirements and specifications. The concrete structure takes the shape as per the form constructed hence the measurements should be accurate.

2.2.5.1 Steps to Take Measurement with Metal

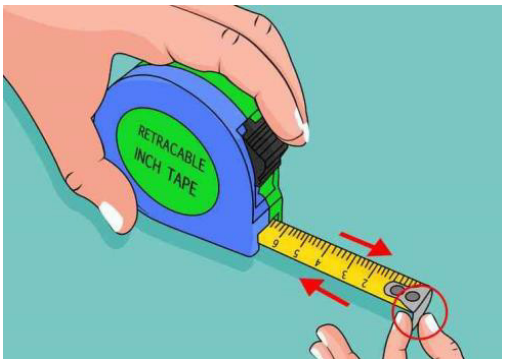


Fig. 2.2.11 Step1. Hold the hooked end of tape and fix this to starting point of distance to be measured

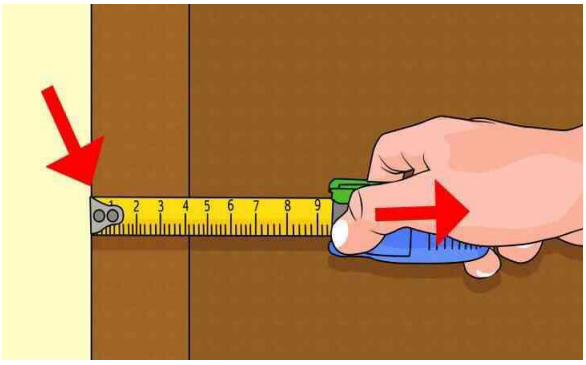
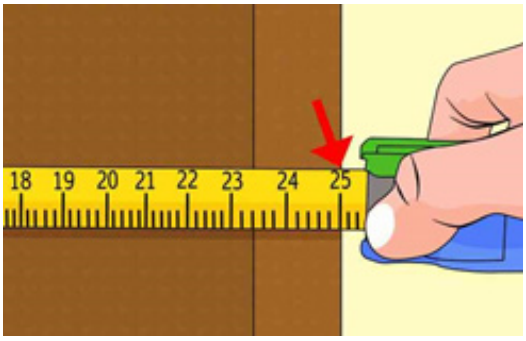


Fig. 2.2.12 Step 2: Stretch the tape across your object



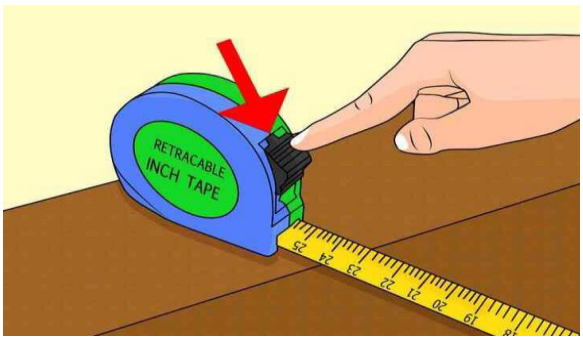
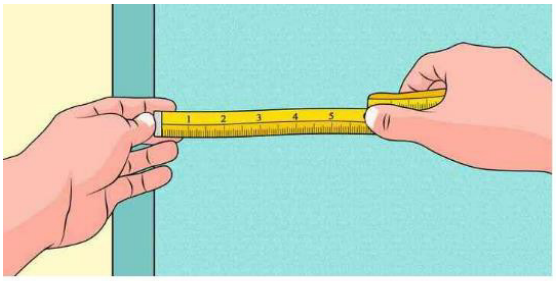
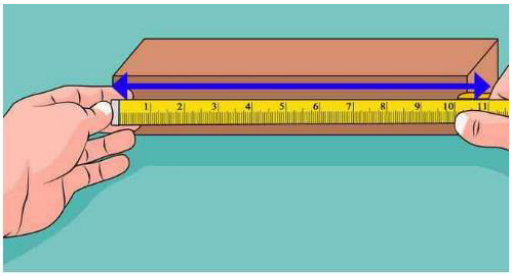


Fig. 2.2.13 Step 3: Take the reading by noting down numerals mentioned in marking line or by calculating marking line past or before the nearest numerals marked line

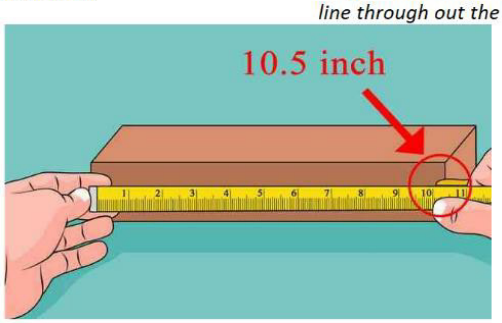
2.2.5.2 Steps to Take Measurement with Cloth Tape



Step 1: Fix the hooked end of tape to starting point of distance to be measured.



Step 2: Stretch the tape maintaining its same level and line through out the length.



Step 3: Take the reading by noting down numerals mentioned in marking line or by calculating marking line past or before the nearest numerals marked line

Fig. 2.2.14 Using Cloth Tape for Measurement

2.2.6 Measurement units relevant to a Helper Bar Bender & Steel Fixer

Here are some common measurement units relevant to their work:

- **Length:**
  - Millimeters (mm): Rebars are often measured in millimeters, especially for precise cuts and bends.
  - Centimeters (cm): Sometimes used for measuring lengths and dimensions on construction sites.
  - Meters (m): Used for larger measurements, such as the overall length of a rebar or the size of a structure.
- **Angles:**
  - Degrees (°): Angles for bending rebars are measured in degrees to ensure accurate and consistent shapes.
  - Spacing and Positioning:

- Millimeters (mm): Used to specify the spacing between rebars and their positions within concrete forms.

- **Volume and Area:**
  - Cubic Meters (m^3): Used for measuring the volume of concrete required for certain structures.
  - Square Meters (m^2): Used to quantify the area that needs to be covered with concrete or reinforcement.
- **Weight:**
  - Kilograms (kg): Rebars are often sold and measured by weight, especially when ordering large quantities.
  - Metric Tons (t): Used for bulk orders of rebars.
- **Thickness and Diameter:**
  - Millimeters (mm): Used to specify the diameter of rebars and the thickness of materials.
- **Linear Feet and Inches:**
  - While the metric system is commonly used in construction, linear measurements in feet and inches might still be used in some regions.
- **Units of Count:**
  - When working with individual pieces of rebar, the number of units might be used for tracking and ordering.
- **Percentages:**
  - Used in cases where overlap lengths or splicing of rebars are calculated as a percentage of the total rebar length.
- **Time:**
  - Not a measurement unit in the same sense, but time management is important in construction projects. Efficiently completing tasks within specified timeframes is crucial.

These measurement units help bar benders and steel fixers ensure the accurate placement and alignment of rebars, leading to structurally sound and safe concrete structures. It's important for professionals in these roles to be familiar with both metric and imperial measurements, as construction practices may vary based on regional standards.

Fig. 2.2.15 Measurement units relevant to Bar Bending & Steel Fixing

Here are some common unit conversions that are relevant to their work:

1. **Length:**
   - 1 meter (m) = 100 centimeters (cm)
   - 1 meter (m) = 1,000 millimeters (mm)
   - 1 foot (ft) = 0.3048 meters (m)
   - 1 inch (in) = 2.54 centimeters (cm)
2. **Area:**
   - 1 square meter (m^2) = 10,000 square centimeters (cm^2)
   - 1 square meter (m^2) = 1.19599 square yards (yd^2)
   - 1 square foot (ft^2) = 0.092903 square meters (m^2)
3. **Volume:**
   - 1 cubic meter (m^3) = 1,000,000 cubic centimeters (cm^3)
   - 1 cubic meter (m^3) = 35.3147 cubic feet (ft^3)
4. **Weight:**
   - 1 kilogram (kg) = 2.20462 pounds (lb)
   - 1 metric ton (t) = 1,000 kilograms (kg)
5. **Diameter:**
   - 1 millimeter (mm) = 0.0393701 inches (in)
6. **Angles:**
   - 1 degree (°) = (π/180) radians (rad)
   - 1 radian (rad) = (180/π) degrees (°)
7. **Temperature:**
   - Celsius to Fahrenheit: (°C × 9/5) + 32 = °F
   - Fahrenheit to Celsius: (°F - 32) × 5/9 = °C
8. **Linear Feet and Inches:**
   - 1 linear foot (ft) = 12 inches (in)
   - 1 linear yard (yd) = 3 feet (ft)
9. Metric and Imperial Tons:
   - 1 metric ton (t) = 0.9842 long tons (UK tons)
   - 1 metric ton (t) = 1.1023 short tons (US tons)

2.2.7 Calculation of Perimeter and Area by a Helper Bar Bender & Steel Fixer

Bar benders and steel fixers often need to calculate the perimeter and area of shapes to determine the lengths of rebars, the amount of concrete required, and the placement of reinforcement. Here are calculations for some common shapes:

1. **Rectangular Slab:** For a rectangular slab, the perimeter (P) and area (A) calculations are as follows:
   - Perimeter (P) = 2 × (Length + Width)
   - Area (A) = Length × Width
2. **Circular Column:** For a circular column, the perimeter (P) and area (A) calculations are:
   - Perimeter (P) = 2 × π × Radius
   - Area (A) = π × Radius^2
3. **L-Shaped Beam:** For an L-shaped beam, the perimeter (P) and area (A) calculations can be more complex due to the combination of different shapes:
   - Divide the L-shaped beam into simpler shapes (e.g., rectangles and triangles).
   - Calculate the perimeter and area of each simpler shape separately.
   - Add the perimeters of the simpler shapes to get the total perimeter.
   - Add the areas of the simpler shapes to get the total area.
4. **Complex Shapes:** For more complex shapes, such as irregular polygons, the following steps can be followed:
   - Divide the shape into smaller, simpler shapes (triangles, rectangles, etc.).
   - Calculate the perimeter and area of each smaller shape.
   - Sum up the perimeters to get the total perimeter.
   - Sum up the areas to get the total area.
5. **Circular Slab or Footing:** For a circular slab or footing, the perimeter (P) and area (A) calculations are:
   - Perimeter (P) = 2 × π × Radius
   - Area (A) = π × Radius^2

These calculations help bar benders and steel fixers determine the amount of rebar needed and the layout of the reinforcement within concrete structures. Accurate measurements and calculations are crucial to ensuring the structural integrity and safety of the finished construction project.

Fig. 2.2.16 Area & perimeter

Exercise

Answer the following questions:

A. Short Questions:

1. What skills are required for Helper Bar Benders and Steel Fixers to perform basic mathematical calculations?
2. Why is it important for Helper Bar Benders and Steel Fixers to identify various types of shapes?
3. How can Helper Bar Benders and Steel Fixers calculate the perimeter of a square?
4. Name different types of measurement systems that Helper Bar Benders and Steel Fixers should be familiar with.
5. What is the significance of being able to read a measuring tape in both the imperial and metric systems for Helper Bar Benders and Steel Fixers?

F. Fill-in-the-Blanks Questions:

1. Helper Bar Benders and Steel Fixers need to ..... (measure / draw) various shapes accurately.
2. Calculating the perimeter of a square involves adding all four ..... (sides / angles).
3. Conversion of measurements is essential for ensuring consistency between different (units / materials).
4. Helper Bar Benders and Steel Fixers should be skilled in reading a measuring tape in ..... (fractions / both fractions and decimals).
5. Different types of ..... (measurement / scaling) systems are used across construction projects.

F. True/False Questions:

1. Helper Bar Benders and Steel Fixers do not need to perform mathematical calculations as part of their job. (True/False)
2. Identifying shapes is important for estimating material requirements accurately. (True/False)
3. The perimeter of a rectangle is calculated by adding the lengths of all its sides. (True/False)
4. Helper Bar Benders and Steel Fixers only need to know one system of measurement. (True/False)
5. Being proficient in reading both imperial and metric measuring tapes is not necessary for construction work. (True/False)

Notes

Scan the QR code to watch the video

https://youtu.be/OhTubw4C0to

Area, volume and perimeter of geometrical shapes

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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

3. Shift and Stack Materials, Tools and Equipment for Reinforcement Work

Unit 3.1 – Reinforcement Materials & Its Protection

Unit 3.2 – Handling and Storage of Reinforcement Steel

Unit 3.3 – Tools used in Bar Bending Works

Key Learning Outcomes

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

- Explain the different types, diameters, and grades of reinforcement materials.
- Show how to interpret and follow diagrams and blueprints for shifting and stacking materials in reinforcement work.
- Identify and classify the different hand tools used in reinforcement work.
- Identify and classify different power tools used in reinforcement work.
- Demonstrate how to inspect, maintain and handle the relevant hand and power tools.
- Elucidate potential hazards associated with reinforcement work.
- Demonstrate the proper usage, maintenance, and storage of PPE.
- Explain different types of slings, shackles, and lifting belts.
- Explain the importance of inventory management and stock control procedures for materials, tools and equipment for reinforcement work.
- Show proper manual handling techniques to prevent injuries during lifting and moving operations.
- Identify common causes and types of corrosion affecting reinforcement steel.
- Explain how to protect the reinforcement steel from corrosion and weather conditions
- Demonstrate the techniques for safe and efficient loading, unloading, shifting, and stacking of reinforcement steel.

Unit 3.1 Tools and materials used in painting works

Unit Objectives

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

- Explain the different types, diameters, and grades of reinforcement materials
- Identify common causes and types of corrosion affecting reinforcement steel
- Explain how to protect the reinforcement steel from corrosion and weather conditions

3.1.1 Introduction to Common Construction Materials

Construction materials are essential components used in building and infrastructure projects to create safe, durable, and functional structures. All the building structures are constructed using different types of materials known as building materials or construction materials. There are two types of construction materials:

- **Natural materials** – They are naturally occurring substances, such as mud or clay, stone, gravel, rocks, sand, wood, etc.

Fig. 3.1.1 Stone dust

Fig. 3.1.2 Sand and boulders

- **Artificial materials** – They are man-made products, such as cement, bricks, blocks, tiles, etc.

Fig. 3.1.3 Cement in bags

Fig. 3.1.4 Bricks

3.1.2 Bricks

There are different types of bricks used in construction work. The most common type is clay brick.

Types of Bricks

Clay Bricks:

- These are used to make walls, pavements and other elements in masonry construction.
- They are artificial material made by moulding clay in rectangular blocks of uniform size, which are finally dried and burnt at high temperature.
- They are bonded together with cement mortar.
- Easy availability, light weight, comparative cheapness, ease in handling, flexibility of moulding into required shape and size and ease in working are the main characteristics of bricks.

Fig. 3.1.5 Clay bricks

Standard size of a clay brick:

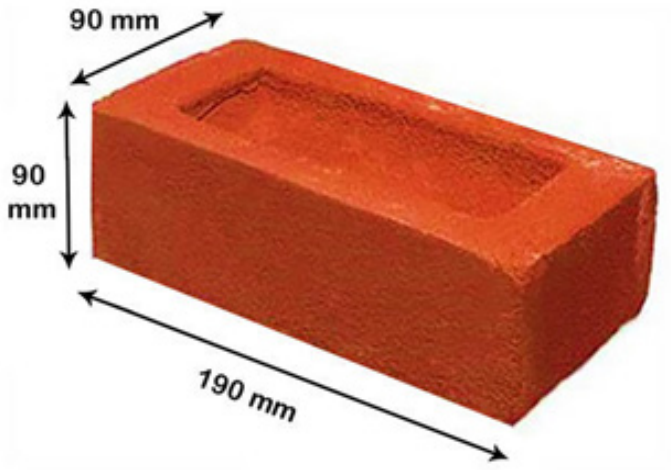


Fig. 3.1.6 Dimensions of a clay brick

Fly ash bricks:

- Fly ash bricks are environmental friendly which can be used as an alternate of burnt clay bricks.
- These are made of fly ash which is a by-product of thermal power station, hydrated lime, gypsum, sand/stone dust and water.
- These are moulded, air dried for one or two days and then water cured for 14-21 days.
- They are grey or dark grey in colour.
- These bricks are uniform in size and shape.
- They require less mortar in brick work.
- These bricks have high compressive strength and lower water absorption.

Fig. 3.1.7 Fly ash bricks

Standard size of a fly ash brick:

- 230 x 150 x 80 mm
- 230 x 150 x 100 mm
- 230 x 100 x 75 mm
- 230 x 100 x 100 mm

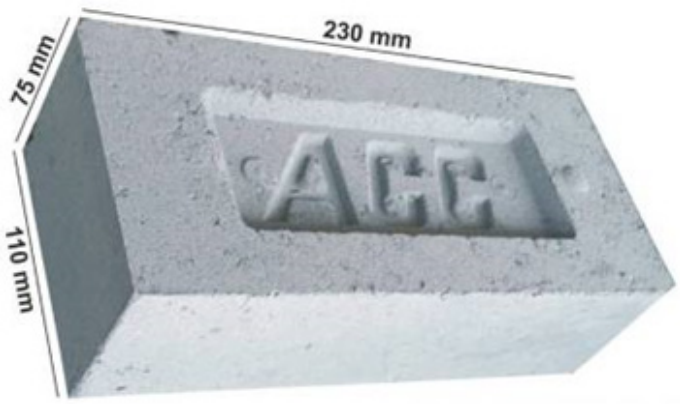


Fig. 3.1.8 Size of a fly ash brick

Fire bricks:

- These bricks are also known as refractory bricks.
- They usually contain aluminium oxide and silicon dioxide.
- These are molded rectangular block of clay that has been baked and treated to be heat resistant.
- They can tolerate long exposure to high temperatures without cracking, decomposition, or distortion.
- Refractory and fire clay mortar are often used to join fire brick together.
- They used in lining furnaces, kilns, fireboxes, wood fired oven, and fireplaces.

Fig. 3.1.9 Fire brick

Standard size of a fire brick:

There are two standard sizes of fire-brick:

- 229 × 114 × 76 mm
- 229 × 114 × 64 mm
- Also available are firebrick "splits" which are half the thickness and are often used to line wood stoves and fireplace inserts. The dimensions of a split are usually 229 × 114 × 32 mm.

Fig. 3.1.10 Size of a fire brick

Quality of Bricks

Based on the quality of bricks they are classified in 4 categories. To classify the bricks following checks are carried out:

- Colour: The colour of good brick should be uniform. It may deep red, cherry or copper coloured.
- Shape: Bricks should be uniform in shape with sharp straight right angled edges.
- Size: Size of the bricks should be standard as prescribed by Indian standards.
- Soundness: A good brick should give metallic ringing sound when struck with another brick.
- Hardness: A good brick should be sufficiently hard which can be tested by a finger nail. No mark should be left on the surface of the brick when scratched with thumb-nail.
- Water absorption: First class brick should not absorb water more than 20% of its dry weight when soaked in water for 24hrs.
- Structure: A good brick should show fine, compact and uniform structure in broken form.
- Strength: Bricks should not break when dropped on hard ground from a height of about 1m.

- **Types of bricks based upon quality**
- First class bricks:
- These bricks are table-moulded and of standard shape.
- The surfaces and edges of the bricks are sharp, square, smooth and straight.
- They are well burnt and have uniform texture, metallic ringing when struck against each other.
- These bricks are used for superior work.

Fig. 3.1.11 First class brick

Second class bricks:

- These bricks are ground-moulded.
- The surface of these bricks is rough and shape is also slightly irregular.
- These bricks may have hair cracks and their edges may not be sharp and uniform.
- These bricks are commonly used at places where brickwork is to be provided with a coat of plaster

Fig. 3.1.12 Second class brick

Third class bricks:

- These bricks are ground-moulded.
- These bricks are not hard and they have rough surfaces with irregular and distorted edges.
- These bricks give dull sound when struck together.
- They are used for unimportant and temporary structures.

Fig. 3.1.13 Third class brick

Fourth class bricks:

- These are over-burnt with irregular shape and dark color.
- These bricks are used as aggregate for concrete in foundations, floors, roads, etc.

Fig. 3.1.14 Fourth class brick

3.1.3 Blocks

- They are also called hollow block, concrete block, cement block, or cinder block.
- Concrete blocks are made from cast concrete, e.g. cement and aggregate, usually sand and fine gravel.
- They are moulded and cured at a manufacturing plant.
- Most concrete blocks have one or more hollow cavities, and their sides may be cast smooth or with a design.
- They are bonded together with cement mortar.

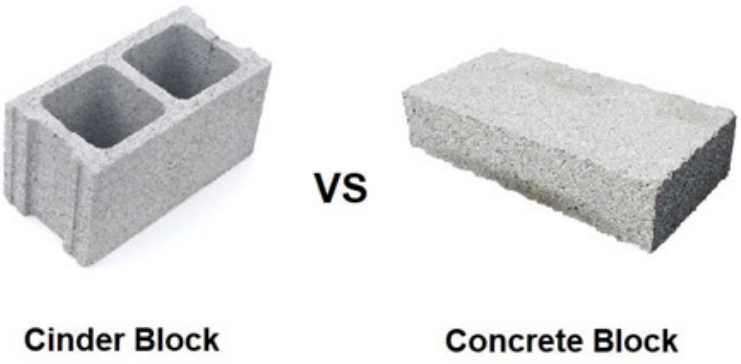


Fig. 3.1.15 Cinder versus concrete blocks

Standard size of a block:

- Concrete blocks can be made in nearly any size.
- The most common are 6 X 8 X 16 inches and 8 X 8 X 16 inches.

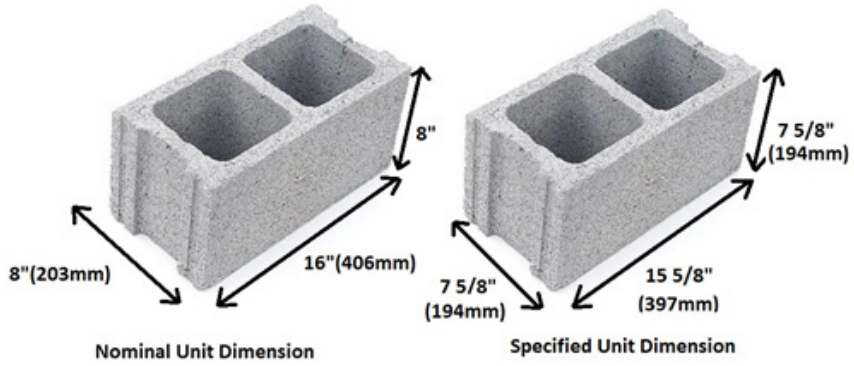


Fig. 3.1.16 Blocks of different shapes and sizes

3.1.4 Stone

- Stone is a natural construction material.
- They may be used in construction as is or after cutting to proper shape.
- They are used for building foundations, walls, pillars, arches, cladding work, pavements, etc.

Fig. 3.1.17 Stone masonry work

3.1.5 Cement

- Cement is fine, soft and powder type binder that sets and hardens.
- It can bind other material together.
- Cement is usually gray. White cement can also be found but it is usually more expensive than gray cement.
- Cement mixed with water, sand and gravel, forms concrete.
- Cement mixed with water and sand, forms cement mortar.

Fig. 3.1.18 Cement usage in masonry

3.1.5 Cement

- It gives body to concrete and reduce shrinkage.
- They are of different types depending on weight, structure and size.

Fig. 3.1.19 Aggregate

3.1.7 Sand

- It is a natural product obtained from pit, river beds, shores, sea beds, etc.
- It is used in cement mortar, lime mortar, Reinforced Cement Concrete, etc.
- It is also used for plinth filling.

Fig. 3.1.20 Sand types

3.1.8 Concrete

- Concrete is a mixture of cement, sand, aggregate and water.
- It is durable and hard.
- When fresh it can be moulded in any shape.
- It requires little maintenance and it is cheaper than steel.

Fig. 3.1.21 Concrete

3.1.9 Admixtures

- Admixtures often are added to mortar.
- It can either fasten or slow down the setting time of cement mortar.
- It can make concrete water replant.
- It minimizes efflorescence at the mortar joint.
- It improves workability.
- It prevents cracks and other defects during the setting process.

Types:

- Plasticizers
- Retarding admixtures
- Accelerating admixtures
- Air-entraining admixtures
- Water proofing admixtures

Fig. 3.1.22 Admixtures

3.1.10 Marble

Fig. 3.1.23 Marble types

- Marble is a natural stone used for flooring and wall cladding.
- They are available in a variety of colour, from black to brown, green, red, pink, white.
- Each slab of stone has its own unique patterns and streaks of color.
- They are available in pre-polished finish as well as unpolished finish.
- Some common marbles are Botticino, Emperador, Travertine, Agaria white, Carrara, Udaipur green, Jaisalmer yellow, Dyna, Onyx, Makrana white, Katni, Marquina, etc

3.1.11 Granite

- Granite is one of the most durable stone, ranging in color from pink to grey and black.
- It is used in buildings, bridges, paving, monuments and many other exterior projects.
- Indoors, polished granite slabs and tiles are used in countertops, floors, stairs.

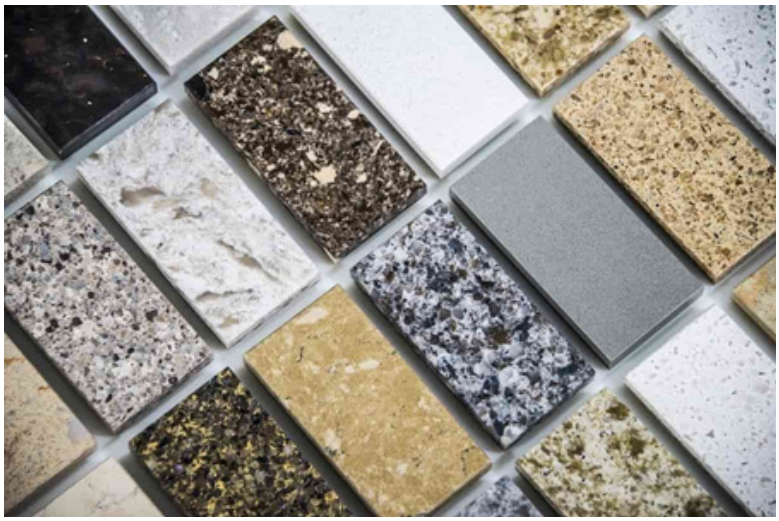


Fig. 3.1.24 Granite used in flooring/finishing work

3.1.12 Tiles

- Tiles made from hard-wearing material such as ceramic, stone, metal, or even glass.
- Tiles can be used on interior walls, ceilings and floors.
- They Protect walls from moisture damage.
- They are decorative.
- They are available in a variety of shapes, colours and sizes.

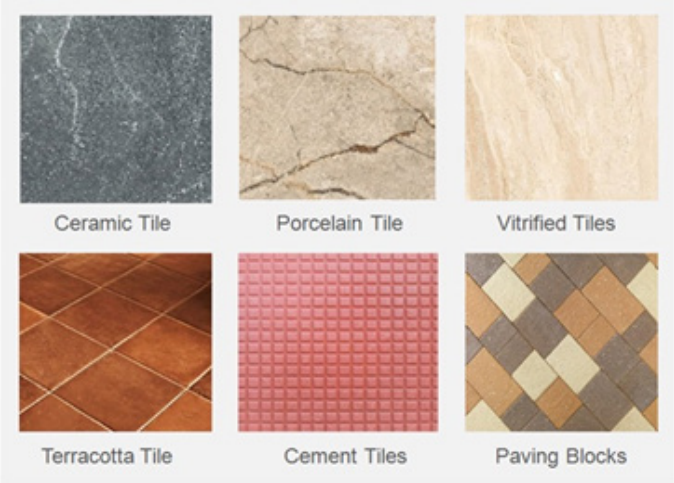


Fig. 3.1.25 Tiles in masonry use

3.1.13 Architectural glass

- It is mostly used as transparent glazing material in the building, including windows. It is also used for internal partitions.
- There are different types of glass - Float glass, Tinted glass, Toughened glass, laminated glass, Shatterproof glass.
- Glass blocks are used for partitions and also in windows.

Fig. 3.1.26 Glass in use and glass block

3.1.14 Reinforcement bars and binding wires:

- They are also known as rebar, reinforcing steel, or reinforcement steel.
- They are used to provide strength to the concrete, such a concrete is called reinforced cement concrete.
- They are generally ribbed so that the concrete can have a better grip.
- They are binded together using binding wire to form reinforcement cage.

Fig. 3.1.27 Reinforcement bars and binding wires

3.1.15 Timber:

Timber/wood is a natural resource which is suitable for building/carpentry purposes.

It is remarkably strong in relation to its weight, and it provides good insulation from the cold.

It can be fabricated into all kinds of shapes and sizes to fit any construction need.

Wood is classified into two primary categories – hardwood and softwood.

Hardwoods are commonly used in the construction of walls, ceilings and floors. Some examples – Oak, Maple, Mahogany, Cherry, Walnut and Teak.

Softwoods are often used to make doors, furniture and window frames. Some examples – Pine, Cedar.

Fig. 3.1.28 Timber for construction use

3.1.16 Plywood:

- Plywood as a building material is very widely used.
- Plywood is an engineered wood product made from three or more plies or thin sheets of wood. These are glued together to form a thicker, flat sheet.
- Some of its common uses are:
  - To make light partition or external walls
  - To make formwork, or a mould for wet concrete
  - To make furniture, cupboards, kitchen cabinets and office tables, etc.
  - To make doors and shutters

Fig. 3.1.29 Plywood

3.1.17 Bamboos and Ballis:

Fig. 3.1.30 Bamboos/Balli used in conventional scaffold

- Bamboo is a widely available resource.
- It has high strength and low weight, and is easily worked using simple tools.
- It is usually used as a temporary exterior structural material.
- Because of its load-bearing capacity and weight, bamboo is used for the construction of scaffoldings, even for very tall buildings.

3.1.18 Paint, Paint roller and Shade card:

- Paint provides a protective layer against weathering, corrosion, and moisture, while also contributing to the aesthetics of buildings. Different types of paints, such as water-based, oil-based, or specialty coatings, are chosen based on the surface type, environmental factors, and the desired finish.
- A paint roller is a tool used to apply paint quickly and evenly onto surfaces. It consists of a cylindrical roller cover attached to a handle, allowing masons to cover large areas efficiently. Paint rollers are particularly useful for walls, ceilings, and other broad surfaces. Selecting the right roller cover, which can vary in nap length, helps achieve the desired texture and coverage.
- A shade card, also known as a color chart or paint swatch, displays a range of available paint colors and their variations. It assists masons and clients in choosing the right color for a construction project, helping to visualize how different hues will look in various lighting conditions. A shade card ensures informed color choices that align with the project's aesthetics and design objectives.

Fig. 3.1.31 Paint, paint and shade card

3.1.19 Steel Bars

Steel bars, commonly known as rebars, are essential construction materials used to reinforce concrete structures and provide them with added strength and durability. There are different types of steel bars, each designed for specific applications and requirements.

Fig. 3.1.32 Common types of steel bars

Here are some common types of steel bars:

- **Mild Steel Bars (MS Bars):**
  - Also known as "plain bars," these are the most basic type of steel bars.
  - They are used for general construction purposes and have a low tensile strength.
- **Deformed Steel Bars (Tor Steel):**
  - These bars have deformations or ribs on the surface to improve bonding with concrete.
  - Deformed bars provide better tensile strength and are commonly used in reinforced concrete structures.
- **High Strength Deformed Bars (HYSD Bars):**
  - "High Yield Strength Deformed" bars have higher tensile strength compared to regular deformed bars.
  - They are suitable for heavy-load-bearing structures and seismic-resistant constructions.
- **TMT Bars (Thermo-Mechanically Treated Bars):**
  - TMT bars are manufactured by subjecting mild steel bars to a combination of heat treatment and mechanical processes.
  - They exhibit superior strength, ductility, and resistance to corrosion.
  - TMT bars are widely used in modern construction projects.
- **Epoxy-Coated Rebars:**
  - These rebars are coated with epoxy to enhance corrosion resistance, making them suitable for areas exposed to harsh environmental conditions or saltwater.
- **Galvanized Rebars:**
  - Galvanized rebars are coated with a layer of zinc to prevent corrosion.
  - They are commonly used in coastal regions or areas with high humidity.
- **Carbon Steel Bars:**
  - Carbon steel bars are widely used for various construction purposes.
  - They have good tensile strength and are cost-effective.
- **Stainless Steel Bars:**
  - Stainless steel bars are resistant to corrosion and staining.
  - They are used in structures where corrosion resistance is a critical factor.
  - Here are some common types of steel bars along with their typical grades and approximate weights per unit length. Keep in mind that these weights can vary depending on the specific manufacturer, region, and standards followed.
- **Mild Steel Bars (MS Bars):**

- Grade: Generally not specified by a specific grade.
- Weight: Approximately 0.785 kg/m for a diameter of 6 mm.

- **Deformed Steel Bars (Tor Steel):**
  - Grades: Fe 415, Fe 500, Fe 550, Fe 600, etc.
  - Weight: Varies based on diameter and grade. For example, approximately 0.222 kg/m for a diameter of 6 mm Fe 415 bar.
- **High Strength Deformed Bars (HYSD Bars):**
  - Grades: Fe 500, Fe 550, Fe 600, etc.
  - Weight: Varies based on diameter and grade. For instance, approximately 0.261 kg/m for a diameter of 6 mm Fe 500 bar.
- TMT Bars (Thermo-Mechanically Treated Bars):
  - Grades: Fe 415, Fe 500, Fe 550, Fe 600, etc.
  - Weight: Similar to deformed bars, weights vary by diameter and grade.
- **Epoxy-Coated Rebars:**
  - Grades: Typically Fe 415 or Fe 500.
  - Weight: Similar to standard deformed bars, depending on diameter and grade.
- **Galvanized Rebars:**
  - Grades: Typically Fe 415 or Fe 500.
  - Weight: Similar to standard deformed bars, depending on diameter and grade.
- **Carbon Steel Bars:**
  - Grades: Various, depending on specific use.
  - Weight: Similar to mild steel bars, with variations based on diameter.
- **Stainless Steel Bars:**
  - Grades: Various grades of stainless steel (e.g., 304, 316).
  - Weight: Depending on the type of stainless steel and diameter.
- It's important to note that the weight of steel bars per unit length (e.g., per meter or per foot) varies based on factors such as the diameter of the bar, the specific grade of steel, and any additional coatings or treatments applied. Different regions and standards might have variations in terms of grades and weight calculations.

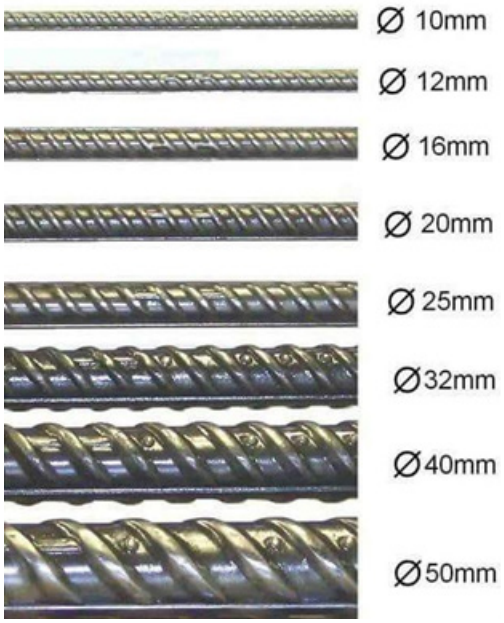


Fig. 3.1.33 Size of steel bars

3.1.20 Binding Wires

Binding wires are an essential component in construction, particularly in the field of reinforcing concrete structures. They are used to secure steel reinforcement bars (rebars) together at intersections, ensuring proper spacing and alignment as per design specifications. Binding wires play a critical role in maintaining the integrity and strength of reinforced concrete elements.

Binding wires are commonly used to:

- Secure the intersection points of rebars in reinforced concrete grids.
- Hold reinforcement cages together before they are placed within concrete forms.
- Tie vertical rebars to horizontal rebars to maintain spacing and alignment.

Binding wires are typically twisted around the intersecting rebars using pliers or wire-twisting tools. The ends of the binding wire are then secured to prevent them from unravelling. Properly tied binding wires ensure that rebars are held securely in place and maintain the structural integrity of the concrete element.

Fig. 3.1.34 Binding Wires

3.1.21 Bar Connecting Coupler

A bar connecting coupler, commonly known as a rebar coupler or reinforcement coupler, is a mechanical device used in construction to connect two steel reinforcement bars (rebars) together. These couplers provide a reliable and efficient method for joining rebars without the need for overlapping them, which can save time, reduce material wastage, and improve the structural integrity of concrete elements.

Fig. 3.1.35 Bar Connecting Coupler

The installation process of rebar couplers involves threading the ends of the rebars using specialized threading machines. The coupler is then screwed onto the threaded ends of the rebars, creating a secure connection. Proper installation is crucial to ensure the effectiveness of the joint.

Bar connecting couplers play a significant role in modern construction by providing a reliable and efficient method of connecting rebars. Their use helps streamline construction processes and ensures the long-term durability and safety of reinforced concrete structures.

3.1.22 Thread Protection Cap

A thread protection cap, also known as a thread protector, is a device used to cover and protect threaded portions of rods, pipes, or components from damage, contamination, corrosion, and other environmental factors. In construction and various industries, thread protection caps are particularly important to safeguard threaded connections during transportation, storage, and handling. Thread protection caps can be easily removed when the threaded parts are ready for use. Some caps feature pull tabs or handles to facilitate quick removal.

In construction and industrial settings, thread protection caps are essential for maintaining the quality of threaded components, preventing costly damage and delays. They provide a simple yet effective solution to ensure that threaded connections remain intact and ready for use when needed.

Fig. 3.1.36 Bar

3.1.23 Scaffolding Materials

Scaffolding is a temporary structure used in construction, maintenance, and repair projects to provide a safe and elevated working platform for workers. Scaffolding materials play a crucial role in ensuring the stability, safety, and accessibility of the structure.

Scaffolding Pipes:

- Scaffolding pipes, also known as tubes or standards, are the vertical components that form the main framework of the scaffolding structure.
- They are typically made of steel and come in various lengths and diameters.
- Scaffolding pipes are designed to support the weight of the entire scaffolding system and the workers using it.

- They are connected horizontally by ledger beams to create main load-bearing structure.

Fig. 3.1.37 Bar

Fig. 3.1.38 Bar

Scaffolding Couplers:

- Scaffolding couplers are connectors used to join scaffolding pipes together securely at the required angles.
- There are various types of couplers, including swivel couplers, double couplers, and putlog couplers, each serving different purposes.
- Swivel couplers allow pipes to be connected at various angles, while double couplers connect two pipes parallel to each other.
- Putlog couplers are used to attach scaffold boards or planks to the scaffolding structure.
- Couplers are designed to provide a strong and rigid connection between pipes while ensuring safety and stability.

Fig. 3.1.39 Bar

3.1.24 Protecting Reinforcement Steel from Corrosion and Weather Conditions

Protecting reinforcement steel from corrosion and weather conditions is crucial for ensuring the longevity and structural integrity of a construction project.

Fig. 3.1.40 Prevent reinforcement corrosion

Here's a short explanation of the measures taken:

Corrosion Protection: Reinforcement steel is vulnerable to corrosion due to exposure to moisture and chemicals. To protect it:

- **Surface Coating:** Apply coatings like epoxy, zinc, or paint to create a barrier against moisture and corrosive substances.
- **Galvanization:** Coat the steel with a layer of zinc to provide a sacrificial layer that corrodes instead of the steel.
- **Cathodic Protection:** Use sacrificial anodes or impressed current systems to counteract corrosion electrochemically.
- **Proper Cover:** Ensure sufficient concrete cover over the steel to prevent direct exposure to corrosive agents.
- **Weather Protection:** Weather conditions can impact reinforcement steel, leading to deterioration. To safeguard against this:
- **Temporary Covers:** Cover exposed steel with tarps or protective sheets during rainy or snowy weather.
- **Storing:** Store steel materials in dry and covered areas to prevent direct exposure to weather elements.
- **Immediate Placement:** Install steel promptly after preparation to minimize exposure to the environment.
- **Regular Inspection:** Regularly inspect steel for signs of rust, corrosion, or degradation caused by weather conditions.

By implementing these protective measures, the reinforcement steel's durability and performance can be maintained even in challenging environmental conditions

Notes

Scan the QR code to watch the video

https://youtu.be/a1cQcIJfjPw

Introduction to Common Construction Materials

UNIT 3.2: Handling and Storage of Reinforcement Steel

Unit Objectives

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

- Show how to interpret and follow diagrams and blueprints for shifting and stacking materials in reinforcement work.
- Elucidate potential hazards associated with reinforcement work.
- Demonstrate the proper usage, maintenance, and storage of PPE.
- Explain different types of slings, shackles, and lifting belts.
- Show proper manual handling techniques to prevent injuries during lifting and moving operations.
- Demonstrate the techniques for safe and efficient loading, unloading, shifting, and stacking of reinforcement steel.

3.2.1 Storage and Stacking of Reinforcement Bars

In a construction site the reinforcement bars are stored and stacked in a steel yard. All fabrication activity i.e. straightening, cutting, bending is done in this yard only.

One should remember that reinforcement shall ordinarily be stored in such a way as to avoid distortion and to prevent deterioration and corrosion.

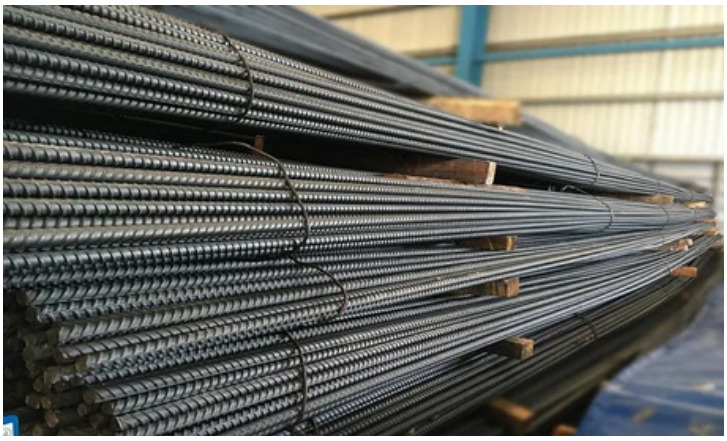


Fig. 3.2.1 Stacking of rebars

There are some norms to be followed while storing and stacking of reinforcement bars, these are:

1. The reinforcement bars shall be stacked on a wooded beams or platforms to avoid contact from ground. Min ground clearance of 150mm.
2. The bars shall be covered with plastic sheets to avoid contact with moisture.
3. The bars shall be segregated (separated) based on their length, size and shape and stacked

accordingly.

4. They should be stacked to a height such that they do not slide or tip.
5. The bars should always be stored at designated areas such that they do not cause obstruction in approach way.
6. Barrication around the steel stock shall not be disturbed or removed while storing and stacking.
7. Scrap shall be stored separately in the steel yard. It will also be segregated based upon its length and stacked at instructed location only.

Fig. 3.2.2 Bars stored on wooden beams or platforms to avoid rusting

Interpreting and following diagrams and blueprints is crucial for the precise shifting and stacking of materials in reinforcement work. These visual representations provide essential guidance on material placement, ensuring accuracy and structural integrity.

By understanding symbols, dimensions, and spatial arrangements, workers can identify materials and their intended positions. Blueprints also outline safety considerations, load-bearing capacities, and stacking heights, minimizing risks during the process.

Following the sequence and alignment instructions in the blueprint helps maintain stability and prevents errors. Additionally, elevation levels guide workers in stacking materials at the correct heights.

Effective communication within the team ensures a unified approach to interpreting and implementing the plans. Keeping documented records of interpreted diagrams and blueprints facilitates ongoing reference and troubleshooting.

Overall, meticulous adherence to diagrams and blueprints guarantees that materials are shifted and stacked according to the project's design, contributing to a successful and safe reinforcement process.

3.2.2 Handling of Steel Bars

Steel is a heavy material and care should be taken while handling it manually. Following norms should be followed while handling steel bars:

1. Helpers should wear proper personal protective equipment (helmet, shoes, jacket, gloves) while handling steel.
2. Maximum weight lifted by one helper should not be more than 20Kgs.
3. Bars should never be thrown down; they are to be lowered properly to avoid accidents
4. Care should be taken that no damage is done to the bars while transporting.

Potential hazards in reinforcement work include manual handling injuries from lifting heavy bars, falls from heights while working on scaffolds, struck-by hazards from falling materials, cuts from sharp edges, equipment misuse, chemical exposure, fire risks from welding, confined space dangers, noise and vibration hazards, and adverse weather conditions. Proper training, PPE, safe practices, risk assessments, and regulatory compliance are essential for mitigating these risks.

Fig. 3.2.3 Using PPE for mitigating risks

After completing reinforcement work, it's crucial to demonstrate proper usage, maintenance, and storage of Personal Protective Equipment (PPE):

- **Usage:** Guide workers to remove PPE correctly, starting with gloves, then goggles, helmets, and other items. Emphasize not touching the face during removal. Dispose of disposable PPE safely.
- **Maintenance:** Show how to clean reusable PPE properly. Wipe down hard hats and goggles with a damp cloth. Wash fabric items as needed. Inspect for damage and ensure PPE remains in good condition.
- **Storage:** Instruct workers to store PPE in designated areas. Hang up hard hats, keep goggles in protective cases, and store gloves away from direct sunlight or extreme temperatures.
- **Regular Checks:** Remind workers to inspect PPE before each use. Replace damaged items immediately to maintain effectiveness.
- **PPE Training:** Provide training on proper PPE use, maintenance, and storage regularly to reinforce safety practices.
- **Compliance:** Stress the importance of following company guidelines and relevant safety regulations.

Remember, proper PPE usage, maintenance, and storage enhance safety and reduce the risk of injuries on the job.

3.2.3 Types of Slings, Shackles, and Lifting Belts

Different types of slings, shackles, and lifting belts play crucial roles in safe lifting and moving of heavy loads in construction and reinforcement work:

Slings:

- Wire Rope Slings: Made of strong wire ropes twisted together for durability and flexibility. Suitable for heavy loads and rugged environments.
- Chain Slings: Comprise welded chains and are highly resistant to heat, abrasion, and cutting. Ideal for high-temperature applications.
- Webbing Slings: Constructed from sturdy woven materials, offering flexibility and load protection. They're versatile and gentle on loads.

Fig. 3.2.4 Slings

Shackles:

- D-Shackles: Shaped like the letter "D," these are commonly used for single-leg slings and offer secure connections.
- Bow Shackles: Shaped like a bow, they have a larger opening for accommodating multiple connections and angle

Fig. 3.2.5 Shackles

Lifting Belts:

- Flat Lifting Belts: Made of strong fabric, they are lightweight and flexible, suitable for various lifting applications.
- Round Lifting Slings: Circular in shape, these slings distribute the load evenly and offer protection to delicate loads.

Fig. 3.2.6 Lifting belt

Each of these equipment types is designed to handle specific weight capacities and conditions. Proper selection, inspection, and usage are essential to ensure the safety of workers and materials during lifting operations.

3.2.4 Types of Slings, Shackles, and Lifting Belts

Proper Manual Handling Techniques:

- **Assess the Load:** Examine the weight, shape, and size of the load before lifting.
- **Maintain Proper Posture:** Keep your back straight, bend your hips and knees, and use your leg muscles.
- **Get a Secure Grip:** Hold the load with your full hand and fingers for a firm grip.
- **Keep Load Close:** Hold the load close to your body to maintain balance and control.
- **Lift Smoothly:** Lift gradually using the strength of your legs, not your back.
- **Avoid Twisting:** Pivot your feet instead of twisting your torso when changing direction.
- **Use Teamwork:** For heavy loads, work with a partner to share the weight and coordinate movement.
- **Use Mechanical Aids:** Utilize tools like trolleys or forklifts for heavy or awkward loads.
- **Know Your Limits:** Don't lift loads beyond your capacity; ask for help if needed.
- **Take Breaks:** Rest periodically and adjust your grip to avoid fatigue.
- **Demonstration:** Safe Handling of Reinforcement Steel:
- **Loading and Unloading:** Use a forklift or hoist to load and unload steel safely, avoiding manual lifting.
- **Shifting:** If manually shifting steel, keep it close to your body, pivot your feet to change direction, and use your leg muscles.
- **Stacking:** Place steel bars evenly on sturdy supports to prevent collapse. Stack vertically if possible.
- **Securing:** Use straps or clamps to secure stacked steel and prevent movement during storage or transportation.

Fig. 3.2.7 Safe Handling of Reinforcement Steel

3.2.5 Do's and Don'ts to follow when Dealing with Steel Bars

Proper storage, stacking, and handling of steel bars (rebars) are crucial to maintaining their quality, preventing damage, and ensuring the safety of workers.

Here are some important do's and don'ts to follow when dealing with steel bars:

- **Do's:**
    - Do Store in a Dry Area: Store steel bars in a dry and well-ventilated location to prevent corrosion and rust formation.
    - Do Use Proper Supports: When storing rebars, use pallets or wooden blocks to keep them elevated off the ground, preventing contact with moisture and dirt.
    - Do Keep Covered: If stored outdoors, cover the rebars with waterproof and UV-resistant covers to protect them from rain, sunlight, and environmental factors.
    - Do Follow First-In, First-Out (FIFO) Principle: When using rebars, use the oldest stock first to prevent excessive storage time and potential deterioration.
    - Do Stack Vertically: If stacking is necessary, stack rebars vertically with enough spacing to avoid entanglement and bending.
    - Do Bundle and Secure: Bundle rebars using steel wires or straps to keep them organized and prevent them from rolling or falling.
    - Do Inspect Before Use: Before using rebars, inspect them for signs of rust, bending, or damage. Damaged rebars should not be used as they can compromise the structural integrity of the construction.
    - Do Use Proper Lifting Equipment: When handling rebars, use appropriate lifting equipment such as cranes, forklifts, or hoists to prevent injury and damage.
- **Don'ts:**
    - Don't Store on Bare Ground: Avoid storing rebars directly on the ground, as this can lead to moisture absorption and rust formation.
    - Don't Overstack: Avoid stacking rebars too high, as this can lead to deformation, entanglement, and difficulty in accessing the rebars at the bottom.
    - Don't Drag: Never drag rebars on the ground or against other surfaces, as this can damage the protective coating and the steel surface.
    - Don't Overload: Avoid overloading storage areas with excessive weight, as this can lead to bending or warping of rebars.
    - Don't Mix Different Grades or Sizes: Do not mix different grades or sizes of rebars in the same storage area, as this can lead to confusion during construction.
    - Don't Store with Chemicals: Keep rebars away from chemicals or materials that could cause corrosion or damage.
    - Don't Expose to Acidic or Alkaline Environments: Avoid exposing rebars to environments with high levels of acidity or alkalinity, as this can accelerate corrosion.

- Don't Walk on Bundles: Do not walk on or step over bundles of rebars, as this can cause bending or deformation.
- By following these do's and don'ts, you can ensure that steel bars are stored, stacked, and handled properly, minimizing damage, ensuring safety, and maintaining the quality of the construction materials.

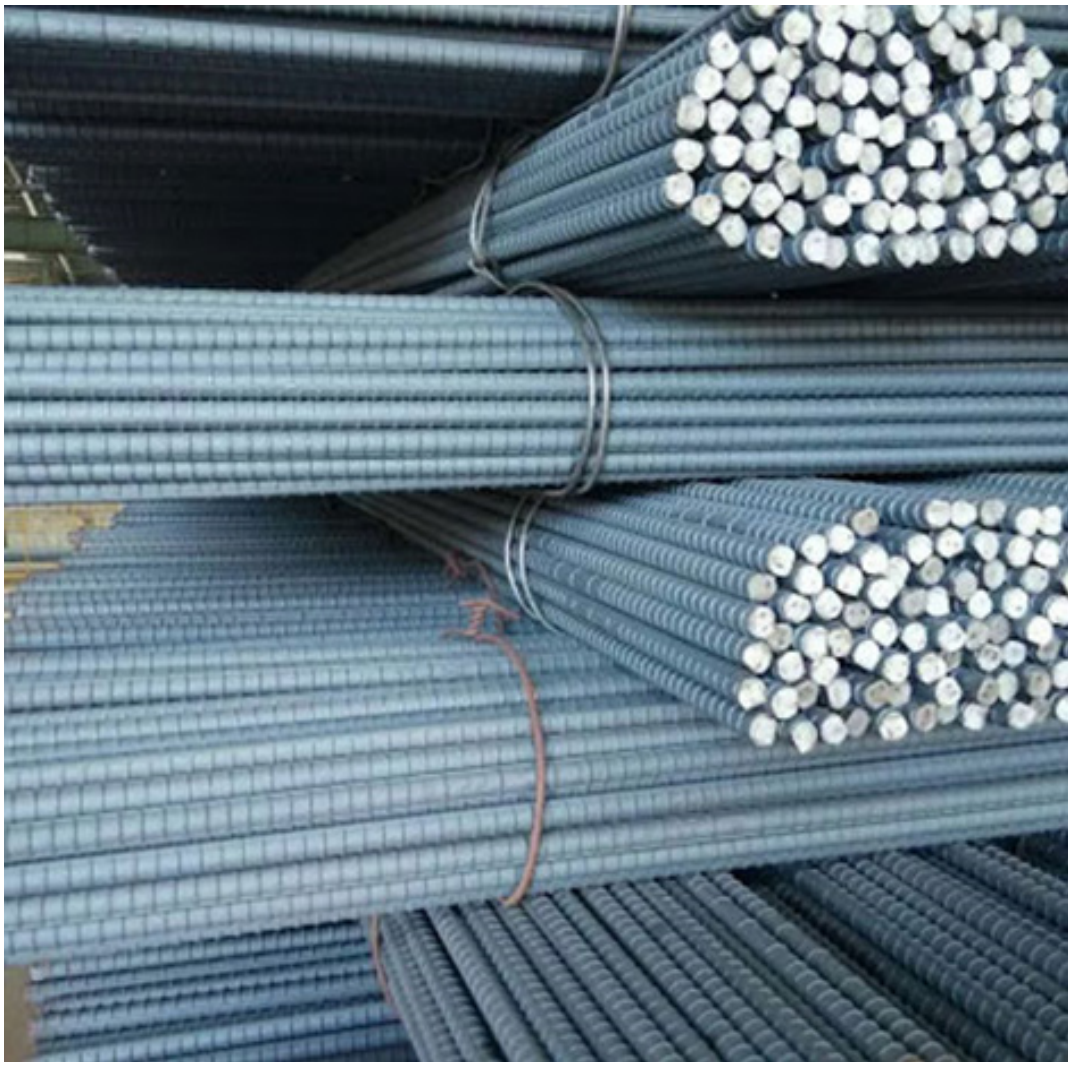


Fig. 3.2.9 Storing of rebars

Notes

Scan the QR code to watch the video

https://youtu.be/WA1PWw6Re2E

Storage and Stacking of Reinforcement Bars

UNIT 3.3: Tools used in Bar Bending Works

Unit Objectives

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

- dentify and classify the different hand tools used in reinforcement work.
- Identify and classify different power tools used in reinforcement work.
- Demonstrate how to inspect, maintain and handle the relevant hand and power tools.
- Explain the importance of inventory management and stock control procedures for materials, tools and equipment for reinforcement work.

3.3.1 Hand and Power Tools

Bar bending works require specific tools set to perform various operations involved. Hence based upon the operation the tools and equipment can be classified as:

- Measuring and marking tools
- Cutting tools and equipment
- Bending tools and equipment
- Tying tools and equipment
- Lifting tools and equipment
- Threading tools and equipment

Fig. 3.3.1 Hand and power tools

Fig. 3.3.2 Bending process

Name	Type	Uses	Picture
Measuring tape	Measuring tool	• A flexible measuring tool used to measure lengths of rebars, lap lengths, and dear covers accurately.	
Chalk	Marking tool	• Chalk is commonly used as a marking tool in bar bending and steel fixing due to its ease of use, visibility, and temporary nature. • It allows workers to mark precise positions on rebars, indicating where cuts, bends, or placements need to be made.	
Flat or bolster chisel	Cutting tool	• It is used to cut bricks or stone into specific sizes. • It is also used to remove old hard mortar from walls. • The chisel is held with one hand and struck with a hammer. • Chisel width ranges from 2.5 to 3.5 inches.	

Moil (poit) chisel	Cutting tool	• It is used for cutting through concrete and stone. • It has a sharp tip rather than a sharp edge.	
Sledge Hammer	Cutting tool	• A sledgehammer is a heavy-duty hand tool with a large, flat head made of metal, attached to a long handle. • It is primarily used for heavy striking and demolition tasks that require significant force.	
Piler	Cuttigtool	• Pliers are versatile hand tools with two handles that are used to grip, hold, manipulate, bend, or cut various materials. • They come in various shapes and sizes, each designed for specific tasks.	
Twist Cutter Plier	Cutting tool	• Twist cutters, also known as wire twisting pliers or wire twisting tools, are specialized tools used to twist together wires or other flexible materials.	

Claw Hammer	Cutting tool	• A claw hammer is a commonly used hand tool that combines two functional ends: a flat striking face and a curved claw for pulling nails. • It's one of the most fundamental and versatile tools found in many households and construction sites.	
Hacksaw	Cutting tool	• A hacksaw is a hand tool designed for cutting materials like metal, plastic, and wood. • It consists of a frame with a removable blade that has fine teeth.	
Bar Cutting Machine	Cutting tool	• A bar cutting machine, also known as a rebar cutter or a steel cutting machine, is a specialized tool used in construction and steel fabrication to cut steel reinforcement bars (rebars) accurately and efficiently.	

Bending Lever	Bending tool	• A bending lever is a specialized tool used in construction for bending steel reinforcement bars (rebars) to specific angles and shapes required by the design of concrete structures. • It provides leverage and mechanical advantage, allowing construction workers to apply force and create precise bends in the rebars.	
Bar Bending Machie	Bendig tool	• A bar bending machine is a specialized piece of equipment used in construction and steel fabrication to bend steel reinforcement bars (rebars) to specific angles and shapes required by the design of concrete structures.	
Hand Tool	Tying tool	• These hand tools are specifically designed for twisting and securing wire ties around materials, such as rebar. • They provide manual control and precision for creating secure ties.	

Power Tool	Tying tool	• This is a powered tool that automates the process of tying materials, such as rebar, together. It uses preloaded wire coils to create ties quickly and efficiently.	
Lifting tools	Lifting tool	• Lifting and handling rebars (steel reinforcement bars) safely and efficiently is crucial in construction projects. • There are various lifting tools designed to facilitate the movement of rebars, ensuring worker safety and preventing damage to the rebars.	
Threading Tools	Threading tool	• Threading is a process of creating a Screw Thread. Threading tools are used to cut screw threads on the outside diameter of rebars.	

Table 3.3.1 Bar bending & steel fixing tools & equipment

3.3.2 Storing and Upkeep of Tools

The reinforcement elements should be carefully indexed and classified according to their diameter, type of grades, length and batch of origin. The cleanness of the steel without stains, such as grease, oil, paint, earth, non-adherent rust or any other substance which is harmful to its good preservation and bonding is important. The whole of protective coating, if any, shall be protected during storage and steel-fixing.

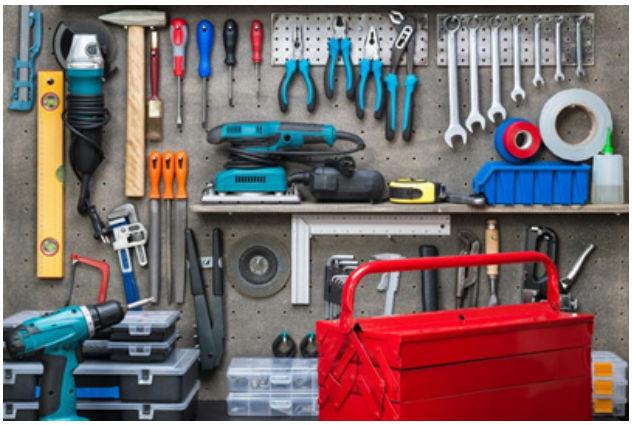


Fig. 3.3.3 Storing & upkeep of tools

Clean, Inspect and Care for Tools:

- Clean tools after each use before you return them to storage.
- Wipe them down with a rag or old towel and be sure they are free of dust, grease and debris before you put them into their proper places.
- Check your tools' handles for splinters, breaks and cracks.
- Also, make sure that metal parts show no signs of corrosion or rust.
- Repair or replace any tools that show signs of damage.
- Periodically inspect power tools for any signs of wear or damage.
- Pay special attention to power cords. Get them repaired or replaced immediately by a professional. Damaged power cords can potentially lead to injury from electric shock or can cause a fire.
- Keep moving parts lubricated for premium performance.

3.3.3 Terminology used in Bar Bending & Steel Fixing

Bar bending and steel fixing are crucial processes in construction and civil engineering that involve shaping and placing steel reinforcement bars (rebars) within concrete structures to provide strength and stability. Here are some important terminologies used in these processes:

- **Rebar (Reinforcement Bar):** A steel bar or mesh of steel wires used as a tension device to reinforce and strengthen concrete structures.

- **Bending:** The process of shaping rebar into the desired configuration using bending machines or tools to fit the design requirements of the structure.
- **Cranked Bar:** A rebar with a bend or hook at one or both ends, used to anchor the rebar within the concrete structure.
- **Stirrup:** A small U-shaped or rectangular-shaped rebar used to provide lateral support to the main longitudinal rebar by forming a closed loop around them.
- **Tie Wire:** Thin wire used to tie rebar intersections and junctions securely to ensure they maintain their positions within the concrete.
- **Lap Length:** The length by which one rebar overlaps another rebar in order to create a continuous and structurally sound connection.
- **Bending Radius:** The minimum radius allowed for bending a rebar without causing it to crack or deform excessively.
- **Hook Length:** The length of rebar that is bent at the end to form a hook, used for anchoring the rebar within the concrete.
- **Bar Schedule:** A document detailing the size, shape, quantity, and placement of rebars within a concrete structure, as per the design specifications.
- **Stirrup Spacing:** The distance between individual stirrups along the length of a rebar, crucial for providing lateral support and maintaining the structural integrity.
- **Cage:** A framework or assembly of interconnected rebars formed to fit the shape and structure of a concrete element, like columns or beams.
- **Chair Supports:** Devices placed on the ground to hold rebar off the ground and maintain proper positioning within the concrete formwork.
- **Concrete Cover:** The thickness of concrete that covers the outer surface of the rebar. It helps protect the rebar from corrosion and provides fire resistance.
- **Clear Cover:** The distance between the outer surface of the rebar and the inner face of the concrete element, ensuring that the rebar is adequately embedded within the concrete.
- **Bending Schedule:** A schedule or plan indicating the exact locations, angles, and degrees of bends required in each rebar for construction.
- **Bar Marking:** A unique identifier or code assigned to each rebar for tracking its placement and alignment in the structure.
- **Rebar Cutter:** A tool or machine used to cut rebars to the desired lengths.
- **Rebar Tier:** A tool that automatically ties rebar intersections with tie wire, enhancing efficiency and reducing labor.
- **J-Hook:** A type of rebar end that is bent into a J-shape, often used for anchoring rebar to the existing structure.
- **Tension and Compression:** The forces that rebars experience within the concrete structure due to external loads. Tension is when rebars are stretched, while compression is when they are pushed together.

3.3.4 Tips related to Bar Cutting Machine

- There are 5 kinds of tools used to cut bars:
  - Measuring, marking, checking and cutting tools.
  - Bending, binding and fixing tools.
  - Bar bending and cutting machine.
- A bar cutting machine is used for cutting the reinforcement bars to the required length and generally used for bars of which the dia. is greater than 12mm.
- A bar bending machine is used for bending the bars at a specific angle, and to give them shape. It is also used for bars of which the dia. is greater than 12mm.

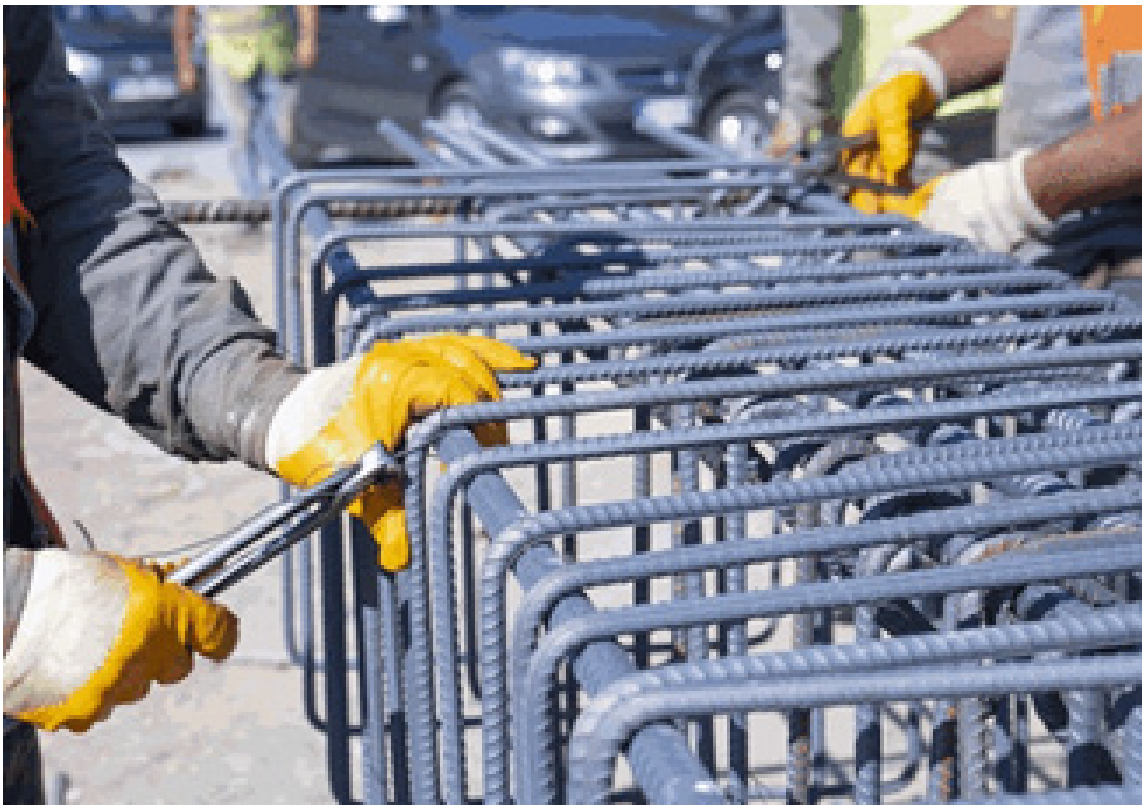


Fig. 3.3.4 Tying rebars for construction use

3.3.5 Inventory Management and Stock Control Procedures

Inventory management and stock control procedures are of paramount importance in the context of reinforcement work. They play a crucial role in ensuring the smooth and efficient execution of construction projects, optimizing resources, and maintaining a safe and organized work environment.

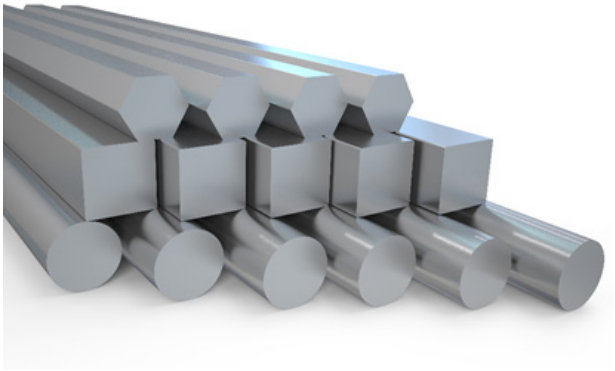


Fig. 3.3.5 Inventory management and stock control procedures

Here's why they are essential:

- Resource Optimization: Efficient inventory management helps prevent overstocking or shortages of materials, tools, and equipment. This ensures that resources are available when needed, minimizing project delays and downtime.
- Cost Efficiency: Proper stock control prevents excess purchasing and reduces wastage, leading to cost savings. It helps track expenses, identify trends, and make informed procurement decisions.
- Timely Project Completion: Availability of required materials and tools on time facilitates uninterrupted work progress, meeting project timelines and deadlines.
- Preventing Production Hiccups: Inventory shortages can lead to work stoppages, affecting productivity and causing delays. Effective stock control prevents such hiccups by ensuring a continuous supply of necessary items.
- Safety and Compliance: Proper inventory management ensures that the right safety equipment and tools are readily available. It prevents instances where workers might use inappropriate tools due to unavailability.
- Accountability and Tracking: Clear stock control procedures establish accountability for materials, tools, and equipment. This reduces the chances of theft, loss, or misuse.
- Reduced Clutter: Proper organization and control reduce clutter and congestion at the worksite, enhancing safety and efficiency.
- Efficient Resource Allocation: Inventory data aids in allocating resources to different tasks effectively, optimizing work allocation and crew deployment.
- Maintenance Planning: Effective inventory management enables planned maintenance of tools and equipment, prolonging their lifespan and reducing unplanned downtime.
- Regulatory Compliance: Proper record-keeping and control procedures ensure compliance with industry standards, legal requirements, and regulations.

In the context of reinforcement work, where precise materials and tools are critical for structural integrity, proper inventory management and stock control are vital to maintaining project quality, safety, and efficiency.

Exercise

Answer the following questions:

A. Short Questions:

1. Can you explain the different types of reinforcement materials used in construction?
2. How would you interpret and follow diagrams and blueprints for shifting and stacking materials in reinforcement work?
3. What are some common hand tools used in reinforcement work, and how are they classified?
4. Identify some power tools used in reinforcement work and classify them accordingly.
5. How do you inspect, maintain, and handle hand and power tools used in reinforcement work?

B. Fill-in-the-Blanks Questions:

1. Different types of slings, shackles, and lifting belts are used for ..... (scaffolding / lifting) operations.
2. Proper ..... (inventory management / waste disposal) procedures ensure the availability of materials and tools.
3. Protection against ..... (corrosion / vibration) is essential for reinforcement steel.
4. Personal Protective Equipment (PPE) includes items like helmets, gloves, and ..... (sunglasses / safety shoes).
5. Safe and efficient loading, unloading, shifting, and stacking of reinforcement steel require proper ..... (training / documentation).

C. True/False Questions:

1. Diagrams and blueprints are not essential for shifting and stacking materials in reinforcement work. (True/False)
2. Power tools are generally safer to use than hand tools in reinforcement work. (True/False)
3. Inventory management and stock control procedures are not necessary for reinforcement work. (True/False)
4. Corrosion is not a common issue affecting reinforcement steel. (True/False)
5. Personal Protective Equipment (PPE) is not required for reinforcement work. (True/False)

Notes

Scan the QR code to watch the video

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Hand and Power Tools

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4. Mark and Cut Reinforcement Bars to the Required Length

Unit 4.1 – Process of Marking and Cutting Reinforcement Bars

(CON/N0202)

Key Learning Outcomes

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

- Explain the different types, grades, and diameters of reinforcement bars.
- Demonstrate how to accurately measure and mark cut lengths on reinforcement bars.
- Identify different types of ties used in reinforcement work.
- Elaborate on the purpose and appropriate applications of each type of tie on different structural elements.
- Explain the techniques and precautions to maintain the integrity of reinforcement bars during the straightening process.
- Show how to straighten reinforcement bars of different diameters using a bending lever and pipe.
- Explain the purpose, functions, and specific applications of each hand and power tool used in reinforcement work.
- Demonstrate how to select and use the appropriate cutting tools, such as hand-cutting machine, circular cutting machine, or shearing machine, for cutting rebar.
- Show proper techniques and safety measures when using hand tools for cutting rebar.
- Describe the standard stacking practices to ensure safe and organized storage of cut reinforcement bars based on length and diameter.
- Demonstrate the tagging and stacking techniques for cut reinforcement bars.

Unit 4.1 Application of paint on masonry surface

Unit Objectives

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

- Explain the different types, grades, and diameters of reinforcement bars.
- Demonstrate how to accurately measure and mark cut lengths on reinforcement bars.
- Identify different types of ties used in reinforcement work.
- Elaborate on the purpose and appropriate applications of each type of tie on different structural elements.
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- Show how to straighten reinforcement bars of different diameters using a bending lever and pipe.
- Explain the purpose, functions, and specific applications of each hand and power tool used in reinforcement work.
- Demonstrate how to select and use the appropriate cutting tools, such as hand-cutting machine, circular cutting machine, or shearing machine, for cutting rebar.
- Show proper techniques and safety measures when using hand tools for cutting rebar.
- Describe the standard stacking practices to ensure safe and organized storage of cut reinforcement bars based on length and diameter.
- Demonstrate the tagging and stacking techniques for cut reinforcement bars

4.1.1 Types, Grades, and Diameters of Reinforcement Bars

Types of Reinforcement Bars:

Mild Steel Bars (MS Bars): Also known as "plain bars" or "black bars," mild steel bars are commonly used for general construction purposes. They have a smooth surface and are easily bendable.

High-Strength Deformed Bars (HYSD Bars): These bars have deformations on their surface that enhance the bond between the bar and the concrete. They are available in various grades and are suitable for structures subjected to higher loads.

TMT Bars (Thermo-Mechanically Treated Bars): TMT bars are a type of HYSD bar that undergoes a heat treatment process to enhance their strength and ductility. They are widely used in modern construction due to their superior properties.

Epoxy-Coated Bars: Epoxy-coated reinforcement bars have a protective epoxy layer that provides corrosion resistance. They are used in aggressive environments, such as marine structures or areas exposed to chemicals.

Galvanized Bars: Galvanized bars are coated with a layer of zinc, offering corrosion resistance. They are used in environments with high humidity or where exposure to moisture is a concern.

Stainless Steel Bars: Stainless steel reinforcement bars offer exceptional corrosion resistance, making them suitable for structures exposed to harsh weather conditions or corrosive environments.

Fig. 4.1.1 Types of reinforcement bars

Grades of Reinforcement Bars:

Reinforcement bars are typically designated by their grade, which indicates their yield strength. Common grades include:

- **Fe 415:** Yield strength of 415 MPa (60,200 psi), often used for general construction purposes.
- **Fe 500:** Yield strength of 500 MPa (72,500 psi), suitable for structures subjected to moderate to heavy loads.
- **Fe 550:** Yield strength of 550 MPa (79,750 psi), used for structures that require higher strength and load-bearing capacity.
- **Fe 600:** Yield strength of 600 MPa (87,000 psi), utilized in specialized applications where high strength is crucial.

Fig. 4.1.2 Grades of reinforcement bars

Diameters of Reinforcement Bars:

Reinforcement bars come in various diameters, measured in millimeters or inches. Common diameters include:

- **6 mm to 10 mm:** Used for light construction, such as residential buildings and small structures.
- **12 mm to 16 mm:** Suitable for medium-scale construction, including commercial buildings and industrial structures.
- **18 mm to 25 mm:** Used for heavy-duty construction, such as bridges, high-rise buildings, and major infrastructure projects.
- **28 mm and above:** Employed in specialized applications where significant loads and structural demands are present.

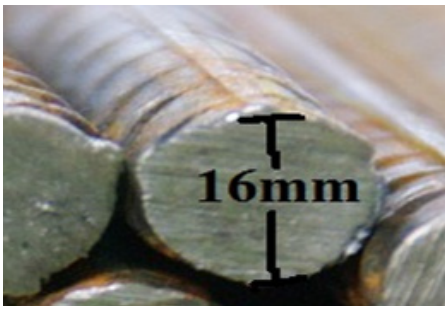

Fig. 4.1.3 Diameters of Reinforcement Bars

The choice of the type, grade, and diameter of reinforcement bars depends on the structural design, load requirements, environmental conditions, and project specifications. It's essential to select the appropriate reinforcement based on the specific needs of the construction project to ensure safety, stability, and durability of the structure.

4.1.2 Different Types of Ties Used in Reinforcement Work

Different types of ties are used in reinforcement work to secure and hold together reinforcement bars (rebars) in various configurations. The choice of tie depends on the specific structural element, the arrangement of rebars, and the construction requirements.

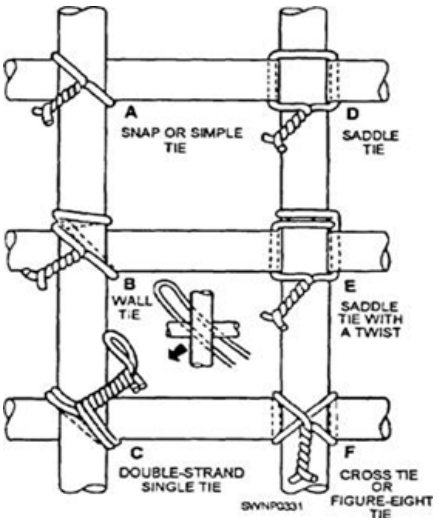

Fig. 4.1.4 Types of ties used in reinforcement work

Here are some common types of ties used in reinforcement work:

- **Square Ties:** Square ties are used to secure intersecting rebars at corners or crossings. They involve wrapping wire around the intersection and twisting it tightly to hold the rebars in place.
    - Appropriate Applications: Square ties are commonly used at the intersections of vertical and horizontal rebars in columns, beams, and slab corners. They maintain alignment and prevent rebars from shifting during concrete pouring.
- **Cross Ties:** Cross ties are similar to square ties but are used at the intersection of beams and columns. They provide stability and ensure that the vertical and horizontal rebars are securely held together.
    - Appropriate Applications: Cross ties are used at the junctions of beams and columns to hold the intersecting rebars together, preventing misalignment and maintaining structural integrity.
- **Diagonal Ties:** Diagonal ties are used to secure inclined or diagonal rebars. They help maintain the proper positioning and alignment of these rebars within the concrete.
    - Appropriate Applications: Diagonal ties are commonly used in structural elements that require inclined or diagonal reinforcement, such as shear walls, slanted columns, or sloped beams.
- **Shear Ties (Stirrup Ties):** Shear ties, also known as stirrup ties, are used to secure vertical stirrups within beams and columns. They prevent the stirrups from shifting during concrete placement and contribute to shear resistance.
    - Appropriate Applications: Shear ties are used in beams and columns to secure the vertical stirrups. They enhance shear resistance and prevent the displacement of stirrups during concrete placement.
- **Continuous Ties:** Continuous ties are used in large horizontal members like slabs and flat surfaces. They involve placing rebar perpendicular to the main reinforcement and connecting them at intervals to maintain spacing.
    - Appropriate Applications: Continuous ties are used in large horizontal elements like slabs to secure rebars perpendicular to the main reinforcement and maintain spacing throughout the surface.
- **U-Type Ties:** U-type ties are used to secure longitudinal rebars within beams and columns. They are placed perpendicular to the longitudinal rebars and bent around them to create a secure connection.
    - Appropriate Applications: U-type ties are suitable for securing vertical bars within beams and columns. They maintain proper positioning and alignment of the reinforcement.
- **Saddle Ties:** Saddle ties are used to secure horizontal bars over vertical bars, commonly seen in slab and beam intersections. The horizontal bars are placed in a saddle-like manner over the vertical bars and tied together.
    - Appropriate Applications: Saddle ties are commonly used in intersections of slabs and beams to hold the horizontal bars in place over the vertical bars, preventing displacement.
- **Spot Ties:** Spot ties are used to tie separate layers of rebars together. They are applied at specific

points to ensure that different layers of reinforcement maintain their relative positions.

- Appropriate Applications: Spot ties are used where different layers of reinforcement intersect, ensuring that layers remain aligned in structures like walls and slabs.

- **Hook Ties:** Hook ties involve bending the ends of rebars into hooks and interlocking them to create a secure connection. They are often used in structures that require additional anchorage and stability.
  - Appropriate Applications: Hook ties are used in structural elements that require extra reinforcement, such as deep foundation elements like pile caps or footings.
- **Snap Ties:** Snap ties are used to secure formwork (temporary molds) during concrete pouring. They hold the formwork panels together and maintain proper alignment until the concrete sets.
  - Appropriate Applications: Snap ties are used in formwork systems to hold the form panels together, ensuring that the formwork maintains proper alignment until the concrete sets.
- **Spacing Ties:** Spacing ties are used to maintain proper spacing between parallel rebars. They ensure that the rebars remain equidistant from each other within the concrete.
  - Appropriate Applications: Spacing ties are used wherever rebars need to be maintained at a specific distance from each other, such as in slabs, walls, and columns.

The choice of tie depends on the specific reinforcement configuration, the type of structural member, and the requirements of the construction project. Properly applied ties ensure that rebars are securely held in place, maintaining the desired structural integrity and performance of the concrete elements.

4.1.3 Techniques and Precautions to Maintain Integrity of Reinforcement Bars

Maintaining the integrity of reinforcement bars (rebars) during the straightening process is crucial to ensure that the rebars retain their structural integrity and intended properties. Improper handling or excessive bending can lead to weakening, cracking, or even failure of the rebars.

Fig. 4.1.5 Maintain integrity of reinforcement bars during the straightening process

Here are techniques and precautions to follow when straightening rebars:

- **Use Proper Equipment:** Use specialized rebar straightening tools designed for the task. Manual rebar straightening tools or hydraulic straightening machines are common choices. Avoid using makeshift tools that can cause damage.
- **Inspect Rebars:** Inspect the rebars for signs of damage, such as bends, kinks, or rust. Avoid straightening rebars that are severely damaged, as they may not regain their original strength.
- **Straighten Gradually:** Straighten rebars gradually and in small increments. Applying excessive force all at once can cause the rebars to crack or snap. Apply steady pressure and work slowly to ensure the rebars regain their shape without compromising their integrity.
- **Apply Uniform Pressure:** Apply pressure evenly along the length of the rebar. Uneven pressure can lead to localized deformation or stress concentrations.
- **Avoid Over-Bending:** Avoid over-bending the rebars beyond their intended shape. Repeated bending and straightening can cause fatigue and weaken the rebars.
- **Follow Manufacturer Guidelines:** If using mechanical straightening tools, follow the manufacturer's guidelines for operation, maintenance, and safety precautions.
- **Heating Consideration:** If rebars are heat-treated or have been used in high-temperature applications, be cautious when straightening. High temperatures can alter the properties of the rebars, affecting their strength and ductility.
- **Check for Cracks:** Inspect the rebars for cracks during and after the straightening process. If cracks appear, the rebar may need to be replaced to ensure structural integrity.
- **Prevent Excessive Cold Work:** Excessive cold working (bending and straightening) can lead to embrittlement and reduced ductility in the rebars. Minimize the number of times a rebar is straightened to avoid this issue.
- **Consider Professional Assistance:** For critical applications or situations involving specialized rebars, consider seeking the assistance of professionals with experience in rebar handling and straightening.
- **Document Rebar History:** Keep records of any straightening and reworking done on the rebars. This information can help in monitoring the rebars' performance and ensure they meet project specifications.
- **Maintain Safe Environment:** Ensure that the straightening process takes place in a safe environment with proper personal protective equipment (PPE) and safety measures in place.
- **Follow Codes and Standards:** Adhere to construction codes and standards that provide guidelines for rebar handling, straightening, and usage.

By following these techniques and precautions, you can maintain the integrity of reinforcement bars during the straightening process, ensuring that the rebars remain strong and reliable for their intended structural applications.

4.1.4 Purpose, Functions, and Specific Applications of Hand & Power Tool used in Reinforcement Work

- **Tying Pliers:**
  - Purpose: Tying pliers are used to manually twist and secure wire ties around rebar intersections.
  - Functions: Tying pliers have a hook or hook-like mechanism that grabs and twists wire ties, creating a secure connection between rebars.
  - Applications: Tying pliers are used to tie rebars at intersections in columns, beams, and other structural elements, ensuring proper alignment and stability.
- **Wire Cutters:**
  - Purpose: Wire cutters are used to trim excess wire after tying rebars.
  - Functions: Wire cutters provide a clean cut and prevent sharp edges on cut wire pieces.
  - Applications: Wire cutters are used to trim wire ties after they've been twisted, ensuring a neat finish without any protruding wires.
- **Tying Twisters:**
  - Purpose: Tying twisters are specialized tools for twisting and securing wire ties around rebars.
  - Functions: Tying twisters provide mechanical advantage, reducing the effort needed to achieve a tight tie.
  - Applications: Tying twisters are used to secure wire ties at intersections and corners, particularly when a stronger grip is required.
- **Tying Hooks:**
  - Purpose: Tying hooks are simple tools for manually twisting and securing wire ties.
  - Functions: Tying hooks have a hooked end that is used to wrap and twist wire ties around rebar intersections.
  - Applications: Tying hooks are used for basic tying tasks in smaller-scale construction projects.
- **Rebar Tying Guns:**
  - Purpose: Rebar tying guns automate the process of tying rebar intersections, increasing efficiency and productivity.
  - Functions: Rebar tying guns use preloaded wire coils to create ties quickly and consistently.
  - Applications: Rebar tying guns are used in large-scale construction projects to accelerate the rebar tying process and reduce manual labor.
- Each of these tools serves a specific purpose and function in reinforcement work, from manual tying to more automated processes. The choice of tool depends on factors such as the scale of the project, the volume of rebar tying required, and the desired level of automation. Using the right tool for the job ensures that the reinforcement bars are securely tied, contributing to the overall strength and stability of the concrete structure.

Fig. 4.1.6 Tool used in reinforcement work

4.1.5 Standard Stacking Practices to Ensure Safe and Organized Storage of Cut Reinforcement Bars Based on Length and Diameter

Proper stacking practices for cut reinforcement bars are essential to ensure safe and organized storage, prevent damage, and maintain the structural integrity of the bars.

Fig. 4.1.7 Safe and organized storage of cut reinforcement bars

Here are standard guidelines for stacking cut reinforcement bars based on their length and diameter:

- **Sorting and Grouping:** Sort and group the cut reinforcement bars based on their lengths and diameters. This will facilitate organized stacking and easy retrieval when needed.
- **Length-Based Stacking:** Stack bars of similar lengths together. Create separate stacks for different lengths to prevent excessive overhang and ensure stability.
- **Diameter-Based Stacking:** Within each length-based stack, further organize the bars by their diameters. Group bars with similar diameters together to prevent bending or distortion.
- **Use Support Blocks:** Place support blocks or wooden planks on the ground to create a stable base for stacking. This helps distribute the weight of the bars evenly and prevents direct contact with the ground, reducing the risk of corrosion.
- **Create Even Layers:** Stack the bars in even layers to maintain stability and prevent bars from sliding or falling. Avoid creating uneven piles that could lead to instability.
- **Stack Height:** Avoid stacking the bars too high, as excessive height can increase the risk of collapse. Maintain a reasonable stack height based on the weight and stability of the bars.
- **Interlocking Stacks:** When creating multiple stacks, ensure that they are interlocked or spaced appropriately to prevent toppling. Leave enough space between stacks for easy movement and a**ccess.**
- **Keep Labels Visible:** If the bars are labelled with information such as grade, diameter, or project details, ensure that the labels remain visible for easy identification.
- **Protect from Weather:** Cover the stacks with weather-resistant materials, such as tarps or plastic sheets, to protect the bars from rain, moisture, and direct sunlight. This helps prevent corrosion and maintain the bars' integrity.
- **Regular Inspection:** Regularly inspect the stacks for signs of rust, corrosion, or damage. Replace any damaged bars and take necessary measures to address any issues promptly.
- **Clear Aisles and Walkways:** Maintain clear aisles and walkways around the stacks to ensure safe access for workers and equipment.
- **First In, First Out (FIFO):** Follow the "First In, First Out" principle. Use bars from older stacks before newer ones to prevent bars from staying in storage for extended periods.
- **Avoid Overloading:** Do not overload the stacks with excessive weight that exceeds their capacity. Overloading can lead to collapse and injury.
- **Training and Supervision:** Ensure that workers are trained in proper stacking practices and supervised during the stacking process to prevent errors.

By following these stacking practices, you can ensure the safe and organized storage of cut reinforcement bars, promoting workplace safety and maintaining the quality of the bars for use in construction projects.

Fig. 4.1.8 Control wastage of reinforcement bars

4.1.6 Tagging and Stacking Techniques for cut Reinforcement Bars

Tagging and stacking techniques for cut reinforcement bars are crucial aspects of proper material management in construction. They ensure organized storage, easy identification, and safe handling of the bars. Here's how to implement these techniques effectively:

Tagging Techniques:

- Labelling: Attach tags to cut reinforcement bars with essential information, such as bar size, length, batch number, and project phase. This ensures accurate identification during handling and usage.
- Color Coding: Use colored tags or tapes to signify different bar sizes, types, or intended locations. This simplifies identification and sorting during stacking and installation.
- Bar Codes or QR Codes: Implement digital tagging by using bar codes or QR codes that link to a database containing detailed information about each bar. Scan the code for quick access to data.
- Hanging Tags: Attach tags with strings or wires to the bars, allowing them to hang freely. This prevents interference during stacking and ensures the tags remain visible.

Stacking Techniques:

- Grouping by Size and Type: Stack cut bars of the same size and type together. This facilitates easy access and prevents confusion during installation.
- Interlocking Stacking: Place the bars in an interlocking pattern, which enhances stability and prevents bars from rolling or shifting.
- Use Supports: Lay bars on sturdy supports or pallets to keep them off the ground, minimizing contact with moisture and preventing rusting.
- Stack Height: Avoid stacking bars too high to prevent instability. Maintain a manageable

height that ensures easy access and reduces the risk of collapse.

- Aisle Space: Create sufficient aisle space between stacks for safe movement and easy retrieval of bars without causing damage.
- Covering: Use weather-resistant covers or tarps to protect stacked bars from rain, dust, and debris, preventing corrosion and maintaining their quality.
- Weight Distribution: Distribute the weight evenly across the stack to maintain stability and prevent bars at the bottom from being crushed.
- Secure Stacking: Use strapping or bands to secure stacks and prevent shifting during transportation or handling.

By implementing proper tagging and stacking techniques for cut reinforcement bars, construction teams can streamline material management, reduce the risk of errors, and ensure that the bars remain in optimal condition until they are ready for installation.

Exercise

Answer the following questions:

A. Short Questions:

1. Can you explain the different types, grades, and diameters of reinforcement bars used in construction?
2. How would you accurately measure and mark cut lengths on reinforcement bars?
3. What are the various types of ties used in reinforcement work?
4. Why are ties used in reinforcement work, and how are they applied to different structural elements?
5. What precautions should be taken to maintain the integrity of reinforcement bars during the straightening process?

B. Fill-in-the-Blanks (with 2 options):

1. The purpose of ties in reinforcement work is to secure ..... (tools / rebars).
2. Different hand and power tools have specific functions and applications in ..... (bending / reinforcement) work.
3. Accurate measurement and marking of cut lengths on reinforcement bars are essential for ..... (safety / precision).
4. Proper stacking practices for cut reinforcement bars help ensure ..... (corrosion / safe storage).
5. The selection of cutting tools like hand-cutting machines or circular cutting machines depends on the ..... (weather / diameter) of the rebar.

C. True/False Questions:

1. Reinforcement bars are available only in one type, grade, and diameter. (True/False)
2. Ties are used in reinforcement work to create decorative patterns on the structure. (True/False)
3. It is not necessary to measure and mark cut lengths accurately on reinforcement bars. (True/False)
4. The integrity of reinforcement bars cannot be compromised during the straightening process. (True/False)
5. There are no specific stacking practices for cut reinforcement bars. (True/False)

Notes

Scan the QR code to watch the video

https://youtu.be/lQbKYg-DN8s

Types, Grades, and Diameters of Reinforcement Bars

https://youtu.be/ldLNOmp3olA

Different Types of Ties Used in Reinforcement Work

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5. Process of Tying Reinforcement Bars

Unit 5.1 – Tying Reinforcement Bars

(CON/N0203)

Key Learning Outcomes

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

- Explain the importance of proper tying of reinforcement bars.
- Demonstrate the use of different types of binding wire, including the calculation of the appropriate length of binding wire required for different types of ties.
- List the different types of binding wires used for tying reinforcement bars.
- Explain the application of different types of ties in different structural members, like columns, beams, slabs, etc.
- Demonstrate the use of different types of ties used in reinforcement work, such as slash tie, ring slash tie, hairpin tie, ring hairpin tie, crown tie, and splice tie.
- State the characteristics of binding wires, including tensile strength, flexibility, and corrosion resistance.
- Show how to accurately measure and cut the binding wire to the required length using appropriate cutting tools.
- Identify and classify different hand and power tools used for tying rebar.
- Explain the importance of appropriate spacing in tying reinforcement bars.
- Show how to ensure proper alignment and positioning of reinforcement bars during the tying process.

Unit 5.1 Application of paint on structural steel fabricated assemblies

Unit Objectives

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

- Explain the importance of proper tying of reinforcement bars.
- Demonstrate the use of different types of binding wire, including the calculation of the appropriate length of binding wire required for different types of ties.
- List the different types of binding wires used for tying reinforcement bars.
- Explain the application of different types of ties in different structural members, like columns, beams, slabs, etc.
- Demonstrate the use of different types of ties used in reinforcement work, such as slash tie, ring slash tie, hairpin tie, ring hairpin tie, crown tie, and splice tie.
- State the characteristics of binding wires, including tensile strength, flexibility, and corrosion resistance.
- Show how to accurately measure and cut the binding wire to the required length using appropriate cutting tools.
- Identify and classify different hand and power tools used for tying rebar.
- Explain the importance of appropriate spacing in tying reinforcement bars.
- Show how to ensure proper alignment and positioning of reinforcement bars during the tying process.

5.1.1 Importance of Proper Tying of Reinforcement Bars

Proper tying of reinforcement bars, also known as rebar, is of paramount importance in construction projects. Rebar serves as the backbone of reinforced concrete structures, adding strength, durability, and load-bearing capacity to the construction. The correct placement and secure tying of rebar play a critical role in ensuring the integrity and longevity of the structure.

Fig. 5.1.1 Proper tying of reinforcement bars

Here are some key reasons why proper tying of reinforcement bars is crucial:

- **Structural Integrity:** Rebar provides tensile strength to reinforced concrete, enabling it to withstand various forces, including bending, compression, and tension. Properly tied rebar ensures that the structural elements, such as columns, beams, and slabs, work cohesively to bear loads and resist deformations.
- **Load Distribution:** Rebar distributes loads effectively across the structure, preventing concentrated stress points that could lead to cracks, fractures, or even collapse. Proper tying helps create a uniform load distribution that enhances the overall strength of the construction.
- **Concrete Bonding:** Tied rebar helps the concrete adhere better to the reinforcement, forming a strong bond between the two materials. This bond prevents slippage between the concrete and rebar, ensuring that they act together as a single unit.
- **Preventing Concrete Cracking:** Improperly positioned or loosely tied rebar can lead to inadequate support for the concrete. This can result in cracks due to the inability to handle applied loads and temperature changes.
- **Construction Stability:** During the construction process, well-tied rebar helps maintain the stability of formwork and molds, preventing shifting or misalignment. This stability ensures that the concrete is poured in the correct position and with the intended design.
- **Durability:** Proper tying of rebar helps prevent corrosion and rust formation by maintaining adequate concrete cover over the rebar. This prolongs the lifespan of the structure, reducing maintenance needs over time.
- **Safety:** A structure with improperly tied rebar is at risk of structural failures, endangering the safety of construction workers, occupants, and the general public. Securely tied rebar contributes to the overall safety and reliability of the building.
- **Compliance with Codes and Standards:** Many construction codes and standards stipulate the proper tying of rebar to ensure that structures meet safety regulations and can withstand expected loads and conditions.

In essence, proper tying of reinforcement bars is the backbone of reinforced concrete construction. It ensures that the structure can bear loads effectively, resist deformations, and maintain its durability over time. Neglecting proper rebar tying compromises the structural integrity of the building, leading to potential safety hazards and increased maintenance costs. Therefore, skilled and experienced construction professionals ensure that rebar is tied correctly according to design specifications to create robust and reliable structures.

5.1.2 Measure and Mark cut lengths on Reinforcement Bars

Accurately measuring and marking cut lengths on reinforcement bars is essential to ensure precise fabrication and installation. Here's a step-by-step demonstration of the process:

- Materials Needed:
- Reinforcement bars
- Measuring tape or ruler

- Chalk or marker

Fig. 5.1.2 Measuring and marking cut lengths

Procedure:

- **Preparation:** Ensure you have the necessary tools and materials ready.
- **Select the Bar:** Choose the appropriate reinforcement bar for the required length.
- **Measurement:** Using a measuring tape or ruler, locate the point where you need to make the cut on the reinforcement bar.
- **Marking:** Gently place a chalk mark or use a marker at the desired measurement point. Make sure the mark is clear and easily visible.
- **Double-Check:** Measure the marked length once again to ensure accuracy. Take into account the thickness of the cutting tool when measuring.
- **Reinforce the Mark:** To prevent the mark from fading during cutting, you can make a small groove using a pointed tool or gently tap the marked point with a hammer.
- **Cutting:** Proceed with cutting the reinforcement bar using the appropriate cutting tool, such as a cutting torch, angle grinder, or hydraulic cutter. Follow proper safety precautions while cutting.
- **Inspect the Cut:** After cutting, visually inspect the cut end to ensure it is clean and even. Remove any sharp edges or burrs.
- **Double-Check Length:** Measure the cut length again using a measuring tape to verify that it matches the required dimension.
- **Documentation:** If necessary, record the cut length and any relevant details on a record sheet or tag for future reference.
- Tips:
    - Always wear appropriate Personal Protective Equipment (PPE) while measuring and cutting reinforcement bars.
    - Double-check measurements before cutting to avoid mistakes.
    - Ensure the cutting tool is sharp and in good condition for clean cuts.
    - Use a straight edge or square to ensure accurate marking.

By following these steps, you can accurately measure and mark cut lengths on reinforcement bars, ensuring that they fit seamlessly into the construction project and meet the required specifications

5.1.3 Types of Binding Wires used for Tying Reinforcement Bars

Various types of binding wires are used for tying reinforcement bars (rebars) in construction. The choice of binding wire depends on factors like the construction environment, corrosion resistance requirements, and project specifications.

Here are some common types of binding wires:

- **Annealed Steel Wire:** Annealed steel wire is a commonly used binding material. It is flexible and easy to work with, making it suitable for various rebar tying applications.
- **Galvanized Steel Wire:** Galvanized binding wire is coated with a layer of zinc, providing corrosion resistance. It is often used in environments where exposure to moisture and corrosive elements is a concern.
- **Stainless Steel Wire:** Stainless steel binding wire offers excellent corrosion resistance, even in aggressive environments. It is commonly used in marine and coastal construction projects.
- **Black Iron Wire:** Black iron wire is another option for binding rebar. It is often used for temporary ties and can be coated with protective materials to enhance corrosion resistance.
- **PVC-Coated Wire:** PVC-coated binding wire has a layer of PVC (polyvinyl chloride) insulation, providing additional protection against corrosion and environmental factors. It is suitable for situations where rebar comes in direct contact with concrete.
- **Copper-Coated Wire:** Copper-coated binding wire offers corrosion resistance due to the copper coating. It is used in environments where rust and corrosion need to be minimized.
- **Aluminium Wire:** Aluminium binding wire is lightweight and has corrosion-resistant properties. It is used in specific applications where aluminium's characteristics are advantageous.
- **Brass Wire:** Brass binding wire is used in situations where aesthetics is important, as it has a pleasing appearance. It also offers some corrosion resistance.

Fig. 5.1.3 Binding wires used for tying reinforcement bars

Each type of binding wire has its advantages and is selected based on factors such as the project's location, exposure to moisture, corrosion risk, and the specific needs of the construction site. Properly selected and applied binding wire helps ensure the durability and longevity of reinforced concrete structures.

5.1.4 Application of different Types of Ties

Different types of ties are used in construction to secure reinforcement bars (rebars) in various structural members, such as columns, beams, slabs, and more. The specific type of tie used depends on the structural element's configuration, the forces it will experience, and the desired level of reinforcement.

Fig. 5.1.4 Different Types of Ties

Here's how different types of ties are applied to different structural members:

Column Ties:

Columns are vertical load-bearing members that require secure ties to hold the vertical rebars in place. The most common type of tie used for columns is the "square tie" or "column tie." This involves wrapping the horizontal ties around the vertical rebars, creating a grid-like pattern to ensure proper spacing and alignment. The column ties help maintain the structural integrity of the columns and prevent the rebars from shifting during concrete placement.

Beam Ties:

Beams are horizontal members that bear the load transferred from the floors above. For beams, "stirrup ties" are commonly used. Stirrup ties are formed by bending rebar into a U-shape and placing them around the longitudinal rebar within the beam. These ties provide lateral support and help distribute loads evenly along the length of the beam.

Slab Ties:

Slabs are horizontal members that cover the floor area of a building. For slabs, "continuous ties" are often used. Continuous ties involve placing longitudinal rebar across the slab and then connecting them with short lengths of rebar in between. This configuration helps maintain the proper spacing of the rebar and prevent displacement during concrete pouring.

Column-Beam Junction Ties:

Where columns and beams intersect, ties are used to connect the vertical and horizontal rebars. "Cross ties" are commonly employed in these junctions. Cross ties are formed by placing rebar diagonally across the intersection point to ensure that the vertical and horizontal bars are securely held in place.

Mesh Ties (Mat Ties):

For larger areas like slabs and foundations, "mesh ties" or "mat ties" are used to secure the mesh reinforcement. These ties involve using short lengths of rebar to connect the intersecting points of the mesh, maintaining the spacing and positioning of the mesh within the concrete.

Stirrup Ties:

Stirrups are vertical or inclined rebar used to provide additional lateral support to columns and beams. For stirrups, "twist ties" are commonly used. Twist ties involve twisting a length of wire around the intersection point of the stirrup and the longitudinal rebar, ensuring the stirrups remain in place.

In summary, different types of ties are used to secure rebars in various structural members based on their configuration, load-bearing requirements, and construction needs.

Properly applied ties ensure that the rebars maintain their intended positions, allowing the structural elements to effectively distribute loads and withstand the forces they'll experience over time.

5.1.5 Characteristics of Binding Wires

Binding wires used for securing reinforcement bars (rebars) in construction possess specific characteristics that are essential for their effective performance.

Fig. 5.1.5 Characteristics of binding wires

Here are the key characteristics of binding wires, including tensile strength, flexibility, and corrosion resistance:

Tensile Strength:

Tensile strength refers to the maximum amount of tensile (pulling) force a material can withstand without breaking. For binding wires, a higher tensile strength is desirable because it ensures that the wire can withstand the forces applied during the tying process without snapping or breaking. This is particularly important when binding thicker or denser rebar bundles. A strong binding wire contributes to the stability and integrity of the tied rebar assembly.

Flexibility:

Flexibility is crucial for ease of handling and manoeuvring the binding wire around the rebar. Flexible binding wire is less likely to kink or break during the tying process, making it easier for construction workers to achieve secure ties. The wire should be pliable enough to wrap around the rebar and create a tight knot without becoming brittle or prone to fracturing.

Corrosion Resistance:

Corrosion resistance is vital because construction sites often expose binding wires to various environmental factors that can lead to rust and degradation. When binding wires corrode, they weaken and lose their effectiveness in holding rebars together. Corrosion-resistant binding wires, such as galvanized or stainless steel wires, offer protection against rust and maintain their structural integrity over time, even in humid or corrosive environments.

It's important to note that the ideal characteristics of binding wires may vary depending on the specific construction project, the materials being tied, and the environmental conditions. The choice of binding wire should align with the project's requirements and local building codes to ensure that the tied reinforcement bars remain secure and durable throughout the life of the structure.

To accurately measure and cut binding wire, follow these steps using proper cutting tools:

- Measure desired length.
- Mark if needed.
- Use wire cutter or pliers.
- Apply even pressure to cut.
- Inspect for clean cut.
- Wear PPE for safety.
- Dispose of excess properly.

5.1.6 Tools used for Tying Rebar

Different hand and power tools are used for tying reinforcement bars (rebars) in construction. These tools help ensure that rebar bundles are securely tied, contributing to the structural integrity of concrete elements.

Here's how these tools can be identified and classified:

Hand Tools:

- Tying Pliers: Tying pliers are essential hand tools for manually twisting and securing wire ties around rebar bundles. They often have a hook or hook-like mechanism for grabbing and twisting the wire, creating a tight and secure tie.
- Wire Cutters: Wire cutters are used to trim excess wire after tying. They come in various sizes and designs to cleanly cut through the wire without leaving sharp edges.
- Tying Twisters: Tying twisters are handheld tools specifically designed to twist and secure wire ties around rebar bundles. They provide mechanical advantage, reducing the effort required to achieve a tight tie.
- Tying Hooks: Tying hooks are simple hand tools with a hooked end that can be used to manually twist and secure wire ties around rebar bundles.

Fig. 5.1.6 Hand tools used for tying rebar

Power Tools:

- Rebar Tying Guns: Rebar tying guns are powered tools designed to automate the process of tying rebar. They use preloaded wire coils to create ties quickly and efficiently. Rebar tying guns significantly speed up the tying process, reducing manual labor and improving productivity.

Fig. 5.1.7 Power tools used for tying rebar

Selecting and using the right cutting tools for rebar involves several steps. First, assess the project's scale and the rebar's diameter. For small-scale tasks, a handheld cutter suffices, while a circular cutting machine or shearing machine suits larger projects. Ensure the chosen tool's blade matches the rebar's thickness.

When using hand tools, prioritize safety by wearing appropriate personal protective equipment (PPE) like gloves, safety goggles, and ear protection. Secure the rebar firmly in place, either in a vise or against a stable surface. Maintain a safe distance from the cutting edge while operating the tool. Make slow, steady cuts, allowing the tool's blades to do the work without forcing it.

For circular and shearing machines, follow manufacturer guidelines for setup, blade installation, and operation. Maintain a safe work area and adhere to safety precautions outlined in the machine's manual. Remember, proper selection, cautious technique, and PPE adherence are vital for efficient and secure rebar cutting.

5.1.7 Importance of appropriate Spacing in Tying Reinforcement Bars

Appropriate spacing in tying reinforcement bars (rebars) is crucial for the structural integrity, load-bearing capacity, and overall durability of reinforced concrete structures. The spacing between rebars directly influences the performance of the concrete elements and how they withstand various loads and forces.

Fig. 5.1.8 Spacing in tying reinforcement bars

Here's why appropriate spacing in tying reinforcement bars is so important:

- Load Distribution: Properly spaced rebars distribute loads evenly across the concrete element, preventing localized stress concentrations. When loads are distributed evenly, the structure is better equipped to handle forces such as tension, compression, and bending without developing weak points that could lead to structural failure.
- Stress and Strain: Correct spacing helps control the stress and strain distribution within the concrete. Improper spacing can result in overloading certain rebars, leading to excessive stress that may cause cracking, deformation, or even collapse.
- Shear Strength: Adequate spacing is essential for achieving the required shear strength of reinforced concrete members. Inadequate spacing could compromise the ability of the structure to resist shear forces, leading to shear failure.
- Concrete Cover: Appropriate spacing ensures that the rebars are suitably covered by the surrounding concrete. Adequate concrete cover protects the rebars from environmental elements, preventing corrosion and ensuring the long-term durability of the structure.
- Workability: Proper spacing allows for efficient concrete placement and consolidation. If rebars are too closely spaced, there may be difficulties in achieving proper compaction of the concrete around them, resulting in voids and reduced concrete quality.
- Construction Tolerances: Tolerances are inevitable in construction. Proper spacing accounts for these tolerances, ensuring that rebars remain in the desired positions even when minor deviations occur during the construction process.
- Fire Resistance: Adequate spacing can enhance the fire resistance of reinforced concrete structures. Proper spacing allows for better heat dissipation and minimizes the risk of localized overheating and structural failure during a fire.
- Structural Integrity: Ultimately, appropriate spacing contributes to the structural integrity of the concrete element. It ensures that the reinforcement is optimally positioned to work in harmony with the concrete, providing the desired strength and performance as intended by the structural design.

In summary, proper spacing in tying reinforcement bars is essential for achieving a well-balanced and robust concrete structure. It influences load distribution, stress distribution, shear strength, concrete cover, workability, fire resistance, and overall structural integrity. Designers, engineers, and construction professionals must adhere to recommended spacing guidelines to ensure that the constructed elements meet safety standards, withstand forces, and deliver the expected longevity.

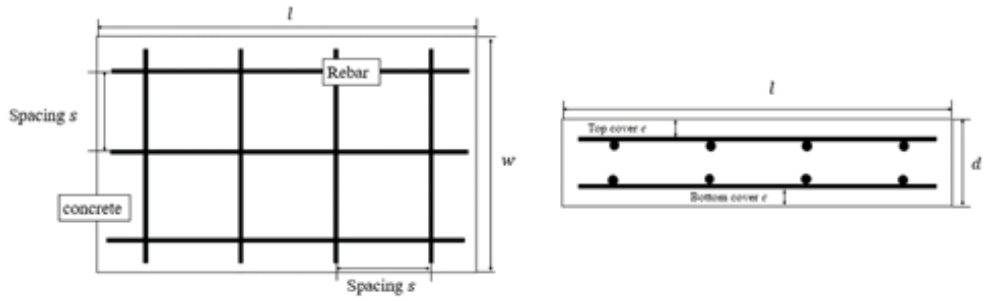

Fig. 5.1.9 Proper spacing in tying reinforcement bars

During the tying process, ensure proper alignment and positioning of reinforcement bars by:

1. Aligning Bars: Arrange the bars according to the design layout, ensuring they are correctly placed and spaced.
2. Tying Spots: Identify specific spots for tying, usually intersections or overlap points.
3. Holding Firm: Hold the bars firmly in position while tying to prevent movement.
4. Tying Technique: Use appropriate tying techniques, like the square or granny knot, to secure the bars tightly.
5. Checking Alignment: Continuously check and adjust bar alignment and positioning as you proceed.
6. Final Inspection: After tying, perform a final inspection to verify that bars are correctly aligned and positioned.

This ensures structural integrity and adherence to design specifications.

Exercise

Answer the following questions:

A. Short Questions:

1. Why is proper tying of reinforcement bars important in construction?
2. Can you demonstrate the use of different types of binding wire for tying reinforcement bars?
3. What are the various types of ties used in reinforcement work?
4. How do different types of ties vary in their application for different structural members?
5. Can you show how to use different types of ties like slash tie and hairpin tie in reinforcement work?

B. Fill-in-the-Blanks Questions:

1. The characteristics of binding wires include tensile strength, flexibility, and ..... (weight / corrosion resistance).
2. Proper alignment and positioning of reinforcement bars during tying ensure structural ..... (stability / integrity).
3. Different ..... (cutting tools / binding wires) are used for measuring and cutting binding wire to the required length.
4. The types of ties used in reinforcement work include slash tie, ring slash tie, and (square tie / crown tie).
5. Appropriate spacing in tying reinforcement bars ensures proper ..... (ventilation / concrete cover).

C. True/False Questions:

1. Proper tying of reinforcement bars is essential for ensuring structural strength and integrity. (True/False)
2. Different types of binding wires have the same characteristics in terms of tensile strength and flexibility. (True/False)
3. The spacing between ties in reinforcement work does not impact the structural stability. (True/False)
4. The same type of tie can be used for all structural members like columns, beams, and slabs. (True/False)
5. Alignment and positioning of reinforcement bars are not important during the tying process. (True/False)

Notes

Scan the QR code to watch the video

https://youtu.be/34mtpno_3pE

Tools used for Tying Rebar

https://youtu.be/4vlBLE4_dhs

Importance of appropriate Spacing in Tying Reinforcement Bars

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6. Process of Erecting and Dismantling Temporary Scaffold Up to 3.6 Meter Height

Unit 6.1 - Basics of Scaffolding

Unit 6.2 - Concept of Conventional Scaffolding

Unit 6.3 - Concept of Modular Scaffolding System

Unit 6.4 - Erecting and Dismantling of Temporary Scaffolding

(CON/N0507)

Key Learning Outcomes

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

1. Explain the use of different types of scaffolds, e.g. cup-lock and frame scaffold.
2. Demonstrate how to level the area where the scaffold needs to be erected and check the ground compactness.
3. Elucidate the identification and use of different scaffolding components.
4. Show how to use appropriate components and erect a temporary scaffold up to 3.6 m in height.
5. List the standard size of scaffolding components.
6. Describe the standard procedure for erecting and dismantling a 3.6 m temporary scaffold.
7. Demonstrate the use of relevant tools and tackles in erecting and dismantling temporary scaffolds.
8. Demonstrate the process of setting up walk-boards, guard rails, toe-boards and other components on the scaffold's working platform.
9. Show how to clean and stack all components properly after dismantling.

Unit 6.1 Application of paint on wooden surface

Unit Objectives

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

- Explain the use of different types of scaffolds, e.g. cup-lock and frame scaffold.
- Elucidate the identification and use of different scaffolding components.
- List the standard size of scaffolding components.

6.1.1 Scaffolding

- Scaffolds are temporary work platforms.
- Scaffolds are used when work cannot be performed from the ground level.
- Scaffolds provide a platform for workers to work at
- heights, and keep materials and tools.
- Scaffolds are erected used, and dismantled and removed to another construction site for reuse.
- Scaffolds are made from various types of material including wood, bamboo etc.

Now-a-days metal scaffolding is used as they are easy to erect and dismantle.

Fig. 6.1.1 Scaffolding

6.1.1 Scaffolding

Scaffolding:

- Provides a secure elevated work area for workers and tools.
- Offers a safer alternative for working at heights store than ladders.
- Helps workers to access the work area.
- Provides a stable platform to transport and store building materials from the base to the topmost parts of structures.

6.1.1 Scaffolding

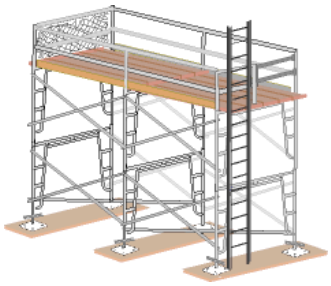
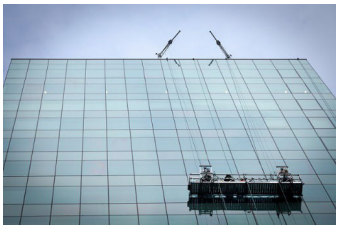
Types	Description	Picture
Supported Scaffolding	• The most commonly used form of scaffolding • Built from the base upwards • The easiest, safest, and most cost effective form of scaffolding • Very convenient and flexible in terms of application/use.	
Suspended Scaffolding	• Suspended from a tall building or roof • Used when constructing a base is difficult or impossible • Ideal for just one or two workers • Allows workers to reach very high levels on buildings • Commonly used by window cleaners	
Rolling Scaffolding	• Castor wheels on the base • The wheels allow the scaffolding to be moved without dismantling it • The wheels are locked when workers or materials are on the scaffolding	
Aerial Lifts	• The most common are vehicle-mounted aerial platforms • Allow workers to access multiple levels in order to do their job • Save the time in erecting and dismantling scaffolding • Commonly seen when people are working on lampposts and telephone poles	

Table 6.1.1 Types of scaffolding

6.1.4 Types of Scaffolding - Based on Material

There are mainly two types of systems of scaffolding:

Conventional System (Bamboo & Ballie and Pipe & Coupler)

In this system, Vertical and horizontal members are bamboo which are joined together at the intersection of joints by means of knotted rope.

Fig. 6.1.2 Bamboo system

Modular System (Cuplock and Frame)

In this system, different prefabricated parts are assembled together with the help of pins, wedges or cups.

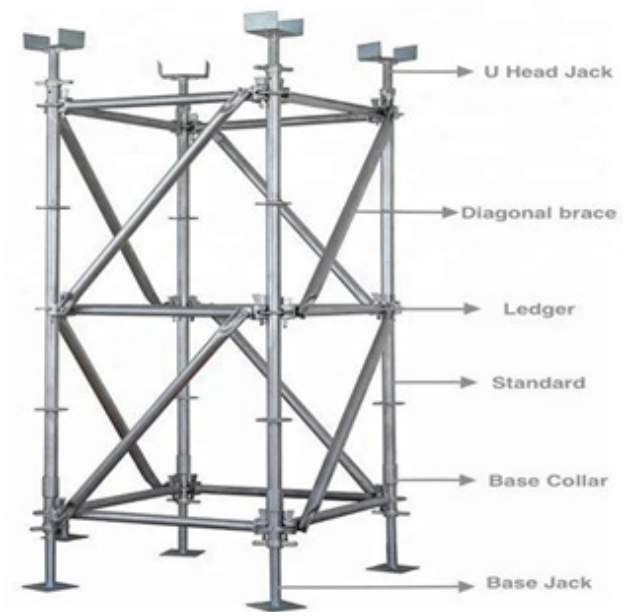


Fig. 6.1.3 Cuplock system

Fig. 6.1.4 Frame system

6.1.5 Identification and Use of different Scaffolding Components

Identifying and using different scaffolding components is crucial for ensuring the safety and stability of the scaffold structure.

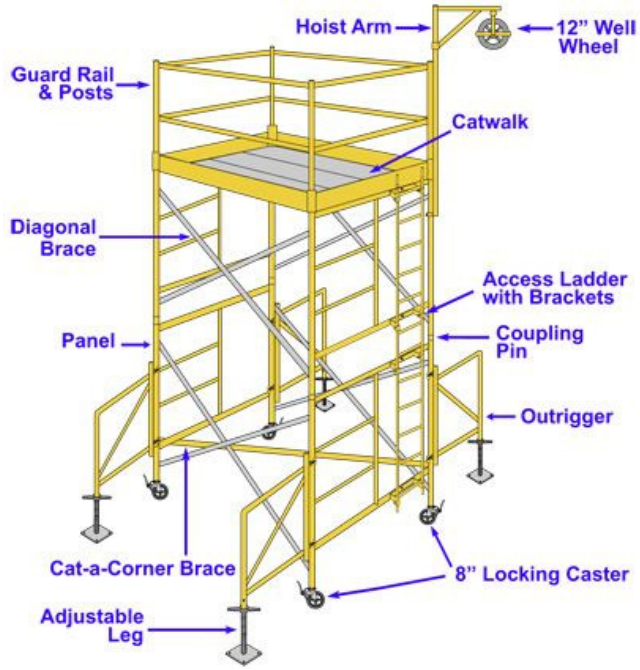


Fig. 6.1.5 Scaffolding Components

Here are some common scaffolding components and their uses:

- **Standards (Uprights):** Vertical tubes that provide the main support for the scaffold structure. They determine the height of the scaffold and are connected to the ground or base.
- **Ledgers:** Horizontal tubes that connect the standards. They provide lateral support and help distribute the load evenly across the scaffold.
- **Transoms:** Horizontal tubes that run perpendicular to the ledgers. They enhance the stability of the scaffold and provide additional support for scaffold boards.
- **Diagonal Braces:** Diagonal tubes that connect the standards and ledgers diagonally. They prevent lateral movement and add rigidity to the scaffold.
- **Scaffold Boards (Planks):** Flat platforms where workers stand and place materials. They rest on the ledgers and provide a safe working surface.
- **Guardrails:** Vertical and horizontal tubes that form a protective barrier along the edges of the scaffold platform. They prevent workers from accidentally falling off the scaffold.
- **Toeboards:** Horizontal barriers placed along the edges of the scaffold platform to prevent tools and materials from falling.
- **Base Plates:** Flat plates placed under the standards to distribute the weight and provide stability. They are often adjustable to level the scaffold on uneven surfaces.

- **Adjustable Jacks:** Devices placed under the base plates to level the scaffold on uneven ground. They can be adjusted to raise or lower the scaffold's height.
- **Casters:** Wheels attached to the base of the scaffold to make it mobile and easy to move. Casters are often used on rolling scaffolds.
- **Hooks and Clips:** Fasteners used to secure components together. They ensure that the scaffold remains stable and secure during use.
- **Ties and Brackets:** Devices used to secure the scaffold to the building or structure. They prevent the scaffold from swaying or collapsing.

It's essential to use scaffolding components according to manufacturer instructions and industry standards. Proper training and understanding of the purpose of each component are necessary to ensure the safety of workers and the stability of the scaffold structure.

6.1.6 Standard Size of Scaffolding Components

Fig. 6.1.6 Size of Scaffolding Components

Standard sizes of scaffolding components can vary based on regional regulations, industry practices, and the specific type of scaffolding being used. However, here are some general guidelines for standard sizes of common scaffolding components:

- **Standards (Uprights):** Typically, standards come in lengths of 1.8 meters (6 feet), 2.4 meters (8 feet), and 3.6 meters (12 feet). They can be joined together for greater height requirements.
- **Ledgers:** Ledger lengths often match the lengths of standards, such as 1.8 meters, 2.4 meters, and 3.6 meters. They provide horizontal support between the standards.
- **Transoms:** Transoms are used to provide lateral support between ledgers. They are available in lengths that match ledger sizes.
- **Scaffold Boards:** Scaffold boards are commonly 2.4 meters (8 feet) in length and around 225mm (9 inches) in width. However, sizes can vary.

- **Braces:** Diagonal braces, used for stability, are available in various lengths based on the scaffold's dimensions.
- **Base Plates/Jacks:** Base plates or adjustable jacks are often 150mm x 150mm (6 inches x 6 inches) in size.
- **Guardrails:** Guardrails are usually around 1.1 meters (44 inches) high and are installed around the working platform.
- **Toeboards:** Toeboards are typically around 150mm (6 inches) in height and are placed along the edges of the working platform to prevent tools and materials from falling.

It's important to note that these sizes are general guidelines and can vary based on the scaffolding system, regional regulations, and specific project requirements. Always refer to local codes and standards when determining the appropriate sizes for scaffolding components.

Notes

Scan the QR code to watch the video

https://youtu.be/YuBFUtGGcbk

Types of Scaffolding

UNIT 6.2: Concept of Conventional Scaffolding

Unit Objectives

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

- Describe the material used in bamboo scaffolding
- Know how to erect and dismantle a bamboo scaffolding

6.2.1 Introduction

Scaffolding is a temporary structure constructed to support man and materials for various construction activities.

- In bamboo scaffolding, plastic fibre straps or coconut and bamboo shoots together form a solid and secure scaffold structure without screws.
- Bamboo scaffolding does not need to have a foundation on the ground as long as the scaffolding has a fulcrum for structural support.
- Bamboo scaffolding is widely used in India for construction.
- It was widely used in the building of houses and multi-story buildings (up to four stories high) prior to metal scaffolding.
- It is also useful for short-term construction projects such as durga puja pandals, marriage pandals etc.
- Bamboo is an ideal material for scaffolds due to its high resistance and its lightness. The joints are done so that a vertical force acts directly on the tied node.
- In the case of high diameter canes, the friction can be increased by making the rope pass between the two canes.
- The ropes used are soft, so that it's possible to modify their tension.

Fig. 6.2.1 Bamboo scaffolding

Fig. 6.2.2 Safety net

6.2.2 Material used in Conventional Bamboo

Bamboo Members

- The Bamboo members should be 3 to 5 years old and air-dried in vertical positions under indoor condition for at least 3 months before use.
- All bamboo members should be free from visual defects, and meet the following requirements on the cross-sectional dimensions:
    - The nominal external diameter should not be less than 40-70 mm with a nominal minimum thickness of 10 mm.

Fig. 6.2.3 Bamboo and ropes used in conventional bamboo scaffolding

Organic ropes (mostly bamboo and rattan coconut, or Nylon Strips for Knotting

- Usually these natural materials are softened in water and only after tied they get dry and create a very strong joint
- Nylon strips of adequate strength, stiffness and durability can be used for knotting in bamboo scaffolds.
- All knots should be tightened with at least 5 rounds of rope. The ends of the ropes should be crossed and twisted to form a single twisted end which passes through the knot twice to give one round turn for proper anchorage.

Lateral Restraints

- Effective lateral restraints should be provided to the main posts of the outer layer of double-layered bamboo scaffolds.
- An effective lateral restraint takes the form of putlog which consists of a metal tie and a bamboo strut. It should be properly anchored to structural elements with the use of an anchor bolt together with a properly installed bamboo strut.
- The free-standing portion of bamboo scaffolds at the top should be tied back to the building structure.

6.2.3 Sequence of Operations to Join Two Bamboo Culms

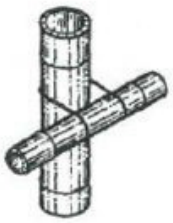
	
Step 1: Put bamboos in a cross form or parallel as may be required	Step 2: First fix the rope around the vertical culm making a loop
	
Step 3: Then start to pass the rope diagonally between the two beams some times in one sense and then some times in the other sense (the number depends on the specific case).	Step 4: Finally tie the rope with a simple knot

Table 6.2.1 Sequence of operations to join two bamboo culms

About Balli Joints

"Bamboo Balli Joints" typically refer to a traditional method of joining bamboo poles together in construction. Bamboo is a versatile and sustainable material that has been used for centuries in various construction practices, particularly in regions where it is abundant. "Balli" is a term used to describe a specific type of joint used to connect bamboo members.

Bamboo Balli Joints have been utilized in various construction applications, such as building frameworks for huts, temporary shelters, scaffolding, and even more complex structures. These joints capitalize on bamboo's natural strength, flexibility, and resilience, making them suitable for lightweight construction purposes.

Fig. 6.2.4 Balli joints

6.2.4 Erection Procedure of Bamboo Scaffolding

To start the erection, erect two bamboos as the main vertical posts. Posts are the vertical members which rest on the ground or steel brackets and are usually in good quality and strong. They would then be connected with horizontal ledgers in order to fix their position. Then, three bamboos will be erected in between the two vertical bamboos as standards.

Standards are vertical members that overhang on the ledgers and would not rest on ground and brackets. Thus, a total of five bamboo poles now span over a distance of about 3m so that the distance between two adjacent standards is about 750mm. The vertical distance between two ledgers (i.e. distance between an upper ledger and a lower ledger) is also about 750mm (2.5 feet); therefore, the bamboo scaffolding is in square form. The inner layer is erected in the same way.

Transoms: They are erected to connect the inner and the outer layers. These transoms are used to support the working platform.

Bracing: The integrity and lateral stability of bamboo scaffolding structure rely on the provision of bracing. Each bracing section should consist of two pieces of bamboo, which are fixed in an "X" shape and usually in an angle between 60 - 70° over the section of bamboo scaffolding to be braced. Each bracing should also be tied to both the standards and the transoms of the scaffolding. In this way, the loading on the scaffolding can be distributed evenly.

Working platforms: These are used to provide access for workers and provide a levelled and safe working area for workers to carry out their construction work. Working platforms may be covered by planks and are mainly used by plasterers and painters.

Fig. 6.2.5 Bamboo Scaffolding with working platforms

6.2.5 Systems to Anchor the Scaffold to the Building and to the Ground

- To anchor of the scaffold to the building there are different methods, like ropes (the same used to tie the beams) fixed to some hooks put into the facade or to the gutter pipes or to any other element and bamboo beams that pierce windows or walls.
- Sometimes we can find other beams contrasting the detachment of the scaffold from the building.

- For the ground joint, the beams are simply lean and aren't fixed in any way.
- They are many times cut at the end so that the surface in contact with the ground is less, to limit the problems with water infiltration.

Fig. 6.2.6 Anchoring bamboo scaffold with building

6.2.6 Dismantling of Scaffolding

- Bamboo scaffolds must be immediately removed once the construction/repair works are completed.
- Dismantling work must be carried out by trained workmen under the immediate supervision of a competent person.
- Before dismantling the critical members, such as ledgers, ties, struts, transoms or bracings, the stability of the bamboo scaffolds must be assured by fixing a similar piece of bamboo member at a lower level before removing that critical member.
- Dismantling should start from upper level to lower level, from exterior to interior and from non-loadbearing parts to load-bearing parts.
- No materials or debris shall be stacked on the scaffold.

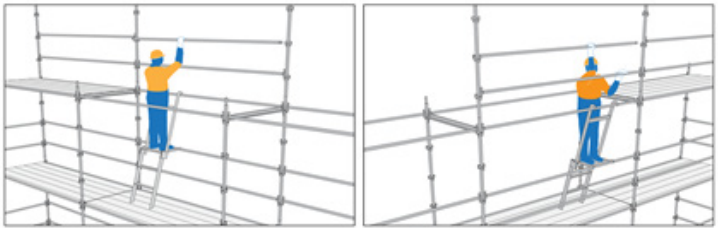


Fig. 6.2.7 Dismantling of scaffolding

6.2.7 Do's and Don'ts for Bamboo Scaffolding

Fig. 6.2.8 Working on bamboo scaffolding

- **For material shifting and Stacking**
- **Do**
  - A suitable place should be provided at the site for storage of bamboo members and the associated materials, tools or equipment.
  - The storage area should be clearly shown on the site plans.
  - The bamboo members should be stored in dry area and in vertical position to prevent the accumulation of waste water inside, thus causing them to decay.
  - Bamboo should be properly stacked and tied to prevent accidental displacement and collapse.
  - Don't
  - Don't use defective materials.
  - Defective material on the site should be properly labelled to show that they are defective and should not be used.

For Erection

Do

- The ground or structure on which a scaffold is constructed should be solid, levelled and rammed to give a hard surface, and should be strong enough to keep the scaffold upright.
- Bamboo scaffolds shall be erected, added to, or altered by trained workmen under the immediate supervision of a competent person

- All workers must wear protective equipment. For example, safety helmets, safety nets and safety belts with suitable anchorage.
- Guard-rails and toe-boards shall be installed at edges where persons are liable to fall from height.
- Work should be started from the bottom level to the top level and from the interior part to the exterior part.
- The height of the bamboo scaffold erected at any side should not be higher than the topmost part of the building/structure by one storey.
- Where a scaffold is erected adjacent to a road or pathway, overlay or screen nets must be erected to envelop the scaffold for the protection of person or vehicular traffic against falling objects.
- All the fastenings between bamboo members should be tight and secure.

- **For Dismantling**
- **Do**
  - For dismantling start the work from upper level to lower level, from exterior to interior and from non-loadbearing parts to load-bearing parts.
  - Dismantling should be orderly and planned and should proceed generally from the top in horizontal sections.
  - If dismantling has reached the stage at which a critical member has to be removed, for example, a tie or a brace, fix an adequate member in place lower down before the member to be taken out is removed.
  - All the stacked materials and debris placed on the scaffold should be removed.
  - Every scaffolder involved in the dismantling work at height should wear safety belt attaching to suitable and sufficient anchorage and suitable fixings as well as other PPE
- **Don't**
  - Scaffolds should not be dismantled in vertical sections from one end towards the other unless special consideration is given to ties and bracings.
  - Lower level of scaffolds should not be loosened till upper ones are completely removed.
  - Don't keep the removed bamboos and ropes close to the dismantling area otherwise it can result in tripping or slippage

Notes

Scan the QR code to watch the video

https://youtu.be/8DP_7OK6dCw

Material used in Conventional Bamboo

UNIT 6.3: Concepts of Modular Scaffolding Systems

Unit Objectives

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

- Understand about types of modular scaffolding
- Summarize the components of cuplock system scaffolding
- Identify the components of frame system scaffolding

6.3.1 What is a Modular Scaffolding System?

Modular scaffolding system consists of different prefabricated individual components that can be connected with each other.

The basic components of modular scaffolding are tubes, couplers and boards. Tubes are usually made either of steel or aluminium. They are either galvanized (tinted black), or painted with other darker colours in order to prevent accidents caused by glare.

Fig. 6.3.1 Modular scaffolding system

6.3.1 What is a Modular Scaffolding System?

- Modular Scaffolding System:
- can be adjusted to any shape
- are quick to erect and dismantle
- can be erected outside as well as in inside the structure
- are safe and reliable
- are easy to transport
- are easy to store; they can be easily stacked
- have higher strength compare to similar sized
- conventional bamboo scaffolding system

6.3.3 Types of Modular Scaffolding System

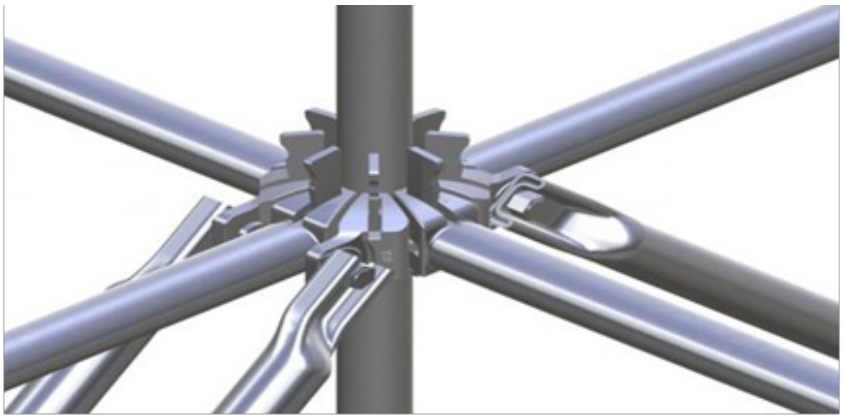


Fig. 6.3.2 Ring system scaffolding

Fig. 6.3.3 Cuplock system scaffolding

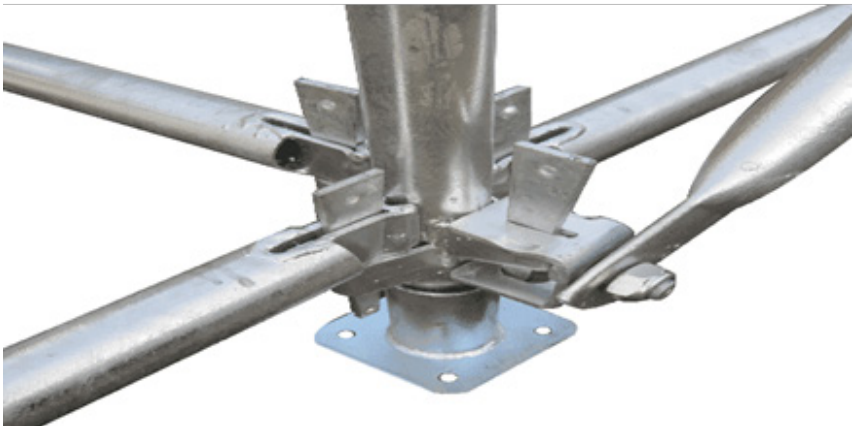


Fig. 6.3.4 Kwikstage scaffolding

6.3.4 Cuplock System Scaffolding and Its Advantage

Cuplock system scaffolding is widely used in construction because of its easy-to-use and highly versatile nature.

In cuplock system, there is a node point connection which allows up to four horizontal members to be connected to a vertical member in one single action - without the use of nuts and bolts, or wedges.

Advantages of cuplock system scaffolding:

- Easy to erect - does not use nuts and bolts or wedges
- Versatile
- Time tested and proven design with safety accessories
- Quick fastening of horizontals
- Time and labour saving
- Lightweight
- Low maintenance

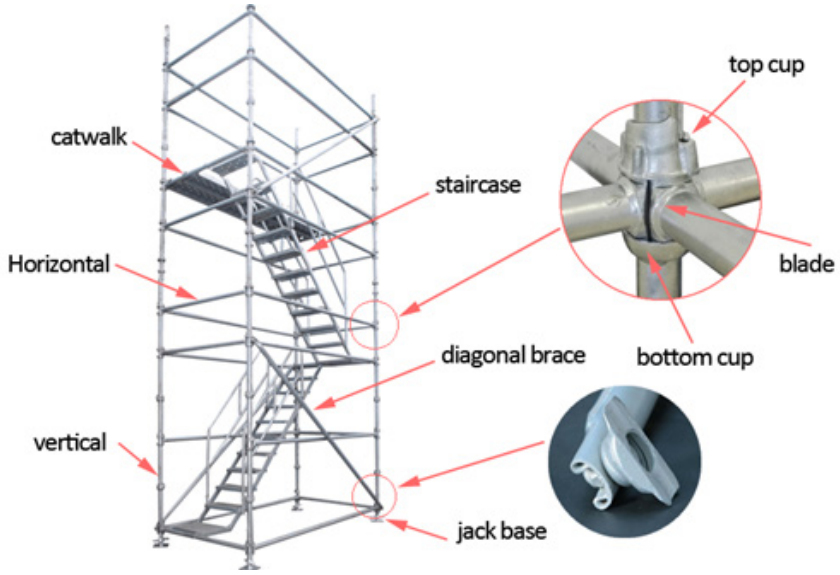


Fig. 6.3.5 Components of cuplock system scaffolding

6.3.4 Cuplock System Scaffolding and Its Advantage

Standards

- They are vertical load-carrying members.
- They are made from high grade steel tubing.
- All standards have lower fixed cups at 500mm intervals.
- They are available

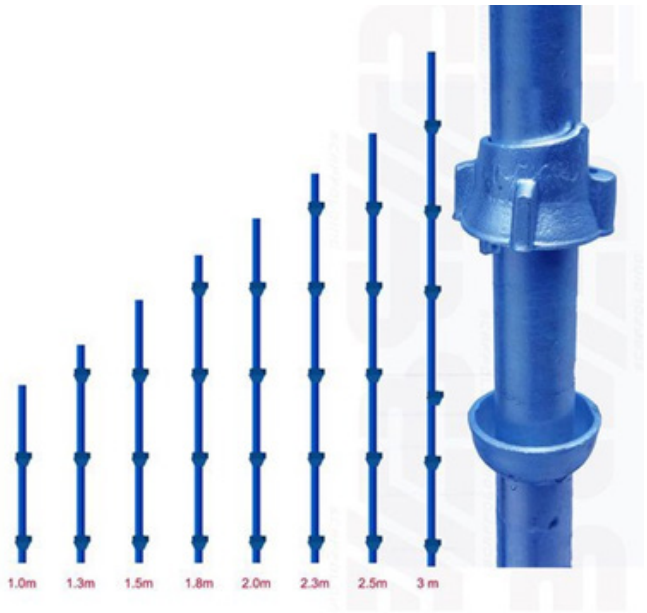


Fig. 6.3.6 Standards

Ledgers

They are horizontal members made from tube.

- They have two forged blades at both sides which fit in bottom cups of the standards and are locked in place by the corresponding top cups.
- They are available in various lengths from 0.6m to 2.5m.
- They are also used as guardrail and midrail.

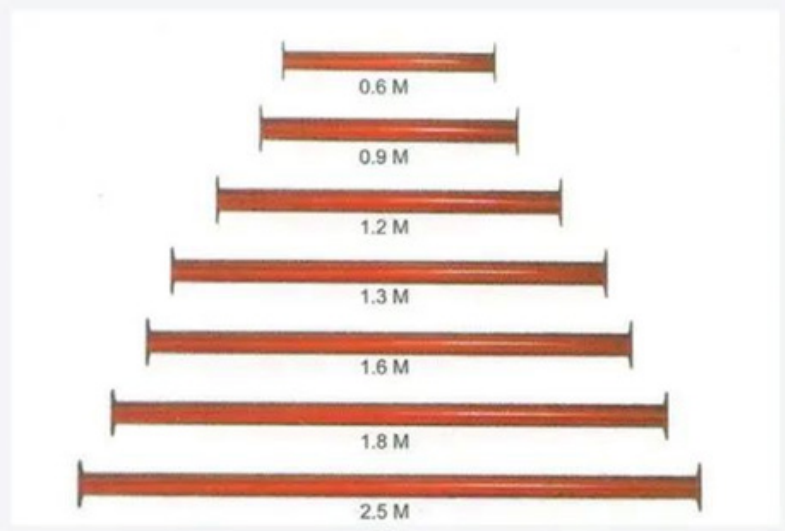


Fig. 6.3.7 Ledgers

Transoms

- They are made of high grade steel tubing.
- They are fabricated from angles fixed back to back with a drop forged blade at each end.
- The transom blade locates into a bottom cup and is locked in position by the top cup.
- Intermediate transoms have two 'U' shape hooks at both sides and they can be put to anywhere between horizontals to decrease the free space.
- They are available in various lengths.

Fig. 6.3.8 Transoms

Braces

- The vertical braces are made of high grade steel tubing with wedge connections at both ends.
- The vertical braces increase the stiffness of the scaffold.

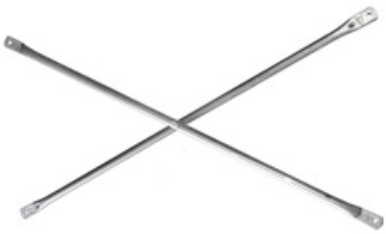


Fig. 6.3.9 Braces

Base jack

- It is a square plate that distributes the load of the scaffolding.
- It is connected with the standards.
- The adjustable base jack is used for levelling the standards at the same height.
- U-Head is used to insert in the top of the vertical standard to support beam etc.

Fig. 6.3.10 Base jack

Side bracket

- The side bracket can be used to expand the working platform.
- This expansion can be made by a one board bracket (0.39m wide bracket) or by a two board bracket (0.73m wide bracket).

Fig. 6.3.11 Side bracket

Toe board

The toe boards are mounted on every working platform.

They prevent material from falling down from the working platform.

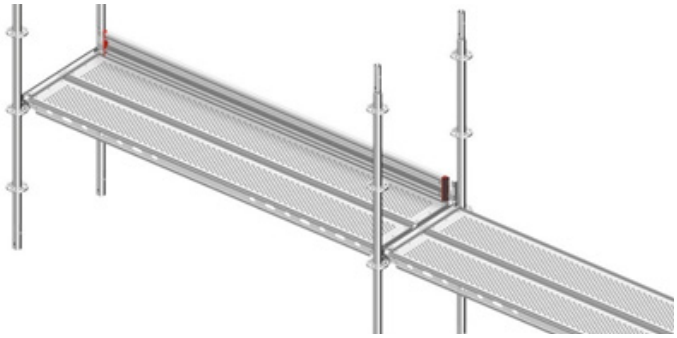


Fig. 6.3.12 Toe board

Platforms/walk boards – Steel deck

- The steel deck is used to create platforms.
- The decks are made of light-weight steel sheets with a non-skid surface.
- The steel decks are placed on the transoms.
- They have two hooks at both sides which fit in the horizontals.

Fig. 6.3.13 Platforms/walk boards – Steel deck

Timber sole plate

- It is laid under base jacks.
- Base jack is screwed with sole plate.
- It prevents scaffolding from displacement or sinking.
- It should be of at least 25cm wide and 5cm thick.

Fig. 6.3.14 Timber sole plate

6.3.6 Frame System Scaffolding

Frame scaffolds are a common type of scaffold because they are versatile, economical and easy to use.

Frame system scaffolding has two frames. These frames are rigid welded frame of horizontal and vertical pipes. They can be connected with diagonal/cross brace, horizontal brace, walk board, adjustable jack base etc.

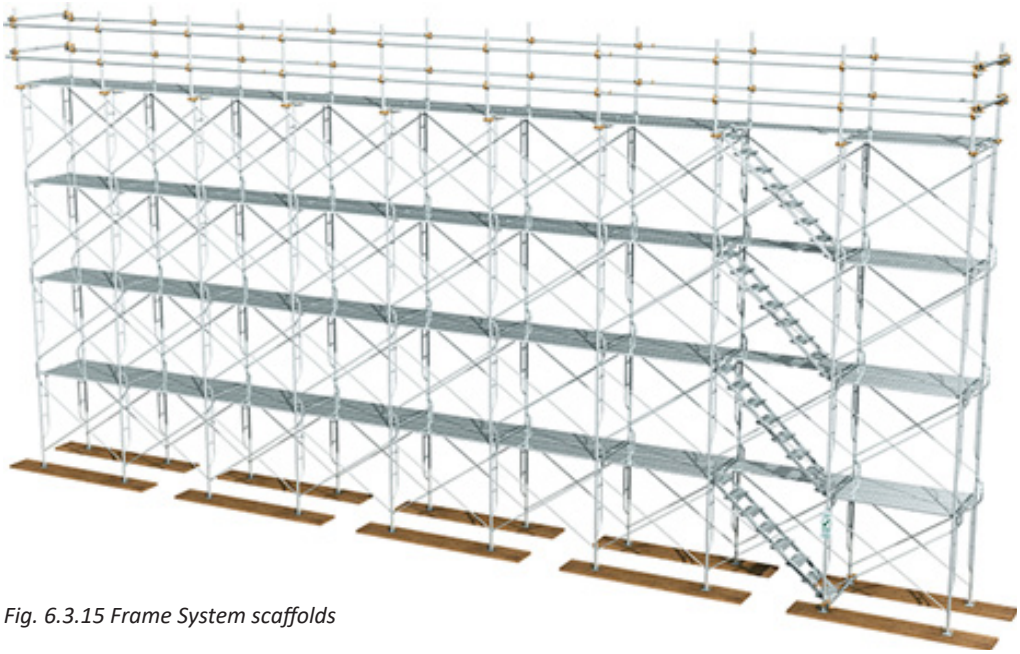


Fig. 6.3.15 Frame System scaffolds

H-frame or U-frame:

- These frames are prefabricated.
- They are fabricated from galvanized tubing.
- Vertical and horizontal members are welded together to form a frame.
- Walkthrough frames provide an easy access for human mobilization with clear head room throughout the erected scaffolding structure.

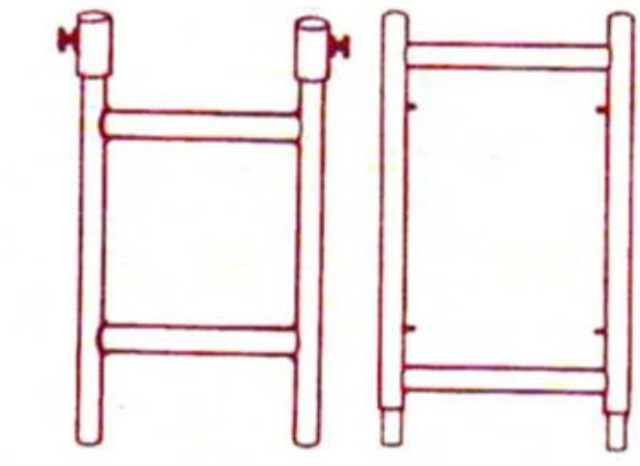


Fig. 6.3.16 H-frame or U-frame

Cross braces:

- All cross braces are fabricated from galvanized steel tubing.
- Cross braces are used to brace the frames with drop locks at various spacings.

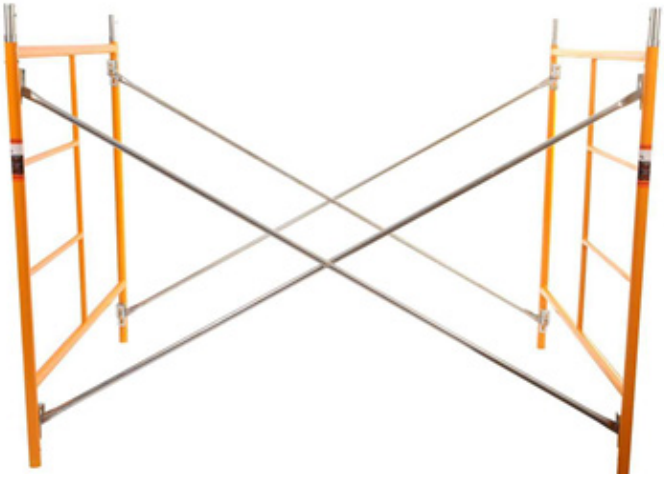


Fig. 6.3.17 Cross braces

6.3.7 Components of Frame System Scaffolding

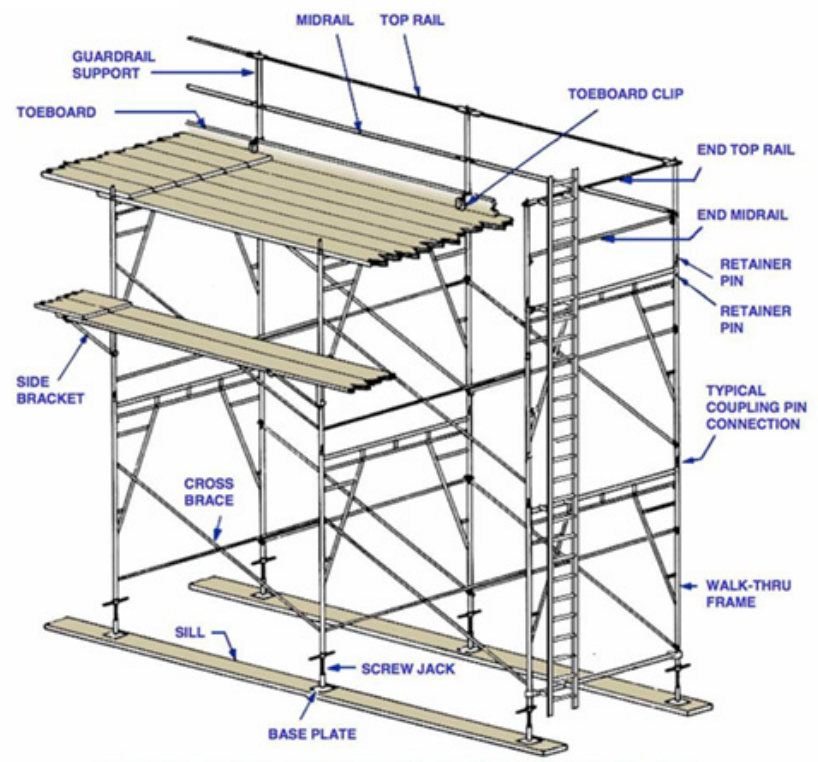


Fig. 6.3.18 Components of Frame System

Notes

Scan the QR code to watch the video

https://youtu.be/oRxg2LLfxO4

Modular Scaffolding System

UNIT 6.4: Erecting and Dismantling Modular Scaffolding System

Unit Objectives

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

- Describe the standard procedure for erecting and dismantling a 3.6 m temporary scaffold.
- Demonstrate how to level the area where the scaffold needs to be erected and check the ground compactness.
- Show how to use appropriate components and erect a temporary scaffold up to 3.6 m in height.
- Demonstrate the use of relevant tools and tackles in erecting and dismantling temporary scaffolds.
- Demonstrate the process of setting up walk-boards, guard rails, toe-boards and other components on the scaffold's working platform.
- Show how to clean and stack all components properly after dismantling.

6.4.1 Scaffolding Tools

A scaffold has four basic parts: the planks, cross-bars, frame and connecting pins or clamps. It is very important to correctly assemble different parts to prevent accidents. Several scaffolding tools are necessary to properly erect scaffold sections and secure them in place.

	**Level:** It is used to check the plumb and level of the assembled components of the scaffold.
	**Measuring tape:** It is used to measure the height, the distance between the scaffold and building and helps to square up the frames.

	**Hammer:** A heavy-duty hammer is used to drive the pins or cups into place or to help remove them when scaffold is dismantled.
	**Ratchet, Wrenches & Podger:** Ratchet and wrench is used to tighten or loosen the nuts.
	**Pliers:** It is a hand tool used to hold objects firmly.

Table 6.4.1 Scaffolding tools

Erect a Frame-System Scaffold

Erecting a scaffold is a team work. It should be erected by a team of 2 persons.

Let us now look at how to erect a frame-system scaffold. This type of scaffold is put together using prefabricated components.

Resources needed:

Components	Scaffolding tools	PPE & Warning signages
• Sole plates • Leveling jacks • 5' high frames • Cross-braces • Decks § Guardrail • Midrail § Toeboard • Side bracket	• Level • Measuring tape • Hammer • Ratchet • Wrench • Plier • Nails	• Safety helmet • Safety shoes • Safety gloves • Safety goggles • Warning signage • Safety harness

Table 6.4.2 Scaffolding resources

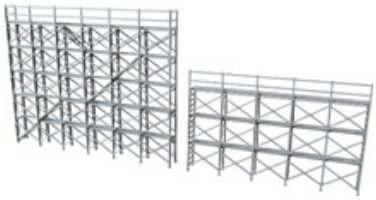


Fig. 6.4.1 Scaffolding work

Steps to erect a frame system scaffold:

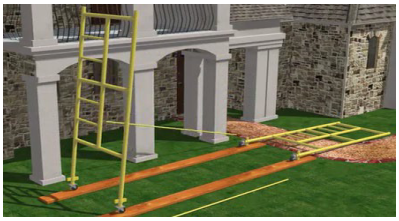
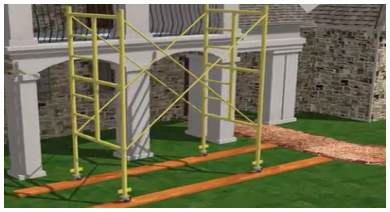
	
Step 1: Place sole plates, set out their position and bed them as level as possible.	Step 2: Set levelling jacks to their lowest adjustment and place on top of the sole plates.
	
Step 3: Stand a unit frame on each jack at one side. Step 4: Attach cross-braces to one frame on one side. Step 5: Stand another unit frame on other pair of jacks.	Step 6: Attach cross-braces to second frame and Fit another cross-brace to the other side of the same bay. Step 7: Check the level and plumb of the bay and adjust the jacks. Step 8: Fix jacks to the sole plates.
	
Step 9: Deck the working platform with planks.	Step 10:Fit toeboards, guardrails and midrails.

Table 6.4.3 Steps to erect a frame system scaffold

Steps to Erect a Cuplock-System Scaffold

Let us now look at how to erect a cuplock-system scaffold.

Resource needed

Components	Scaffolding tools	PPE & Warning signages
• Sole plates • Leveling jacks • Standards • Ledgers • Vertical component • Toeboards • Walkways	• Level • Measuring tape • Hammer • Ratchet • Wrench • Plier • Nails	• Safety helmet • Safety shoes • Safety gloves • Safety goggles • Warning signage

Table 6.4.4 Steps to erect a cuplock-system scaffold

Steps to erect a cuplock systems scaffold

- Step 1: Sift and stack all the components to the place where scaffold has to be erected.
- Step 2: Place sole plates, set out their position and Set levelling jacks to their lowest adjustment and place on top of the sole plates.
- Step 3: Stand vertical on each jack at one side.
- Step 4: Attach ledgers between two adjacent erected vertical.
- Step 5: Stand another vertical on other pair of jacks.
- Step 6: Attach ledgers to second frame.
- Step 7: Fit another ledger to the other side of the same bay
- Step 8: Fix ledgers at multiple levels.
- Step 9: Adjust the jacks as per levelling requirement.
- Step 10: Place walkways on the ledgers.
- Step 11: Deck the working platform with planks as shown in the picture.
- Step 12: Fit toe boards, guardrails and midrails as shown in the picture.

Fig. 6.4.2 Scaffolding work by mason

6.4.2 Dismantling the Scaffold

The scaffold should be dismantled section by section as it was erected.

- Remove the toeboards, guardrail and midrail.
- Remove the decks.
- Loosen the top cups using hammer.
- Remove ledgers.
- Remove standards.
- Clean all parts properly.
- Check all parts for any damage.
- Stack them in the store for re-use

6.4.3 Safety Precautions and Practices

- Erect the scaffolding on level and solid ground.
- Plumb and level the scaffold as it is being erected.
- Ensure all components are installed and fixed in proper way.
- Check all components for any damage before erecting the scaffolding.
- Scaffolding components must not be allowed to drop at any time.

6.4.4 Storage of Scaffolding Material

- Store material of same size and type at one place
- Stack material properly up to desirable height
- Provide adequate ground clearance to the material stack to avoid contact with water/ moisture
- Store damaged material separately
- Tag stacked material as per their size and type

Fig. 6.4.3 Scaffolding storage

Exercise

Answer the following questions:

A. Short Questions:

1. Can you explain the use of different types of scaffolds, like cup-lock and frame scaffold, in construction?
2. How do you level the area and check ground compactness before erecting a scaffold?
3. What is the importance of identifying and using different scaffolding components?
4. Can you demonstrate the process of erecting a temporary scaffold up to 3.6 meters in height?
5. What are the standard sizes of scaffolding components used in construction?

2. Fill-in-the-Blanks Questions:

1. Scaffolding components need to be …… (disassembled / stacked) properly after dismantling.
2. Walk-boards, guard rails, and toe-boards are essential components for the scaffold's …… (stability / working platform).
3. The process of setting up a temporary scaffold involves using (hand tools / appropriate components).
4. Cup-lock and frame scaffold are examples of different types of ……. (building materials / scaffolds).
5. Erecting and dismantling a temporary scaffold requires the use of relevant tools and ……. (tackles / power tools).

3. True/False Questions:

1. The ground's compactness does not impact the stability of erected scaffolds. (False)
2. Different scaffolding components have distinct purposes and functions. (True)
3. Temporary scaffolds can only be erected up to 3 meters in height. (False)
4. The process of setting up walk-boards and guard rails is not necessary for scaffold safety. (False)
5. Proper cleaning and stacking of scaffold components after dismantling are not important. (False)

Notes

Scan the QR code to watch the video

https://youtu.be/VQ1e0VZmTmM

Erecting a Frame-System Scaffold

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MINISTRY OF SKILL DEVELOPMENT
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National
Skill Development
Corporation
Transforming the skill landscape

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

Unit 7.1 – Hazards and Emergency Situations

Unit 7.2 - Safety Drills, PPEs and Fire Safety

Unit 7.3 - Hygiene and Safe Waste Disposal Practices

Unit 7.4 - Infectious Disease and Its Cure

(CON/N9001)

Key Learning Outcomes

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

- Describe the reporting procedures in cases of breaches or hazards for site safety, accidents, and emergencies as per guidelines.
- Explain different types of safety hazards at construction sites.
- Demonstrate how to follow emergency and evacuation procedures in case of accidents, fires, or natural calamities.
- Discuss basic ergonomic principles as per applicability.
- Describe the procedure for responding to accidents and other emergencies at the site.
- Explain the importance of handling tools, equipment, and materials as per applicable norms.
- Explain the effect of construction material on health and environments as per applicability.
- Describe various environmental protection methods as per applicability.
- 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.
- Show how to collect, segregate and deposit construction waste into appropriate containers based on their toxicity or hazardous nature.
- Explain how to use hazardous material in a safe and appropriate manner as per applicability.
- Explain types of fire.
- Describe the procedure of operating different types of fire extinguishers.
- Show how to operate different types of fire extinguishers corresponding to various types of fires as per EHS guidelines.
- State safety relevant to tools, tackles, and equipment as per applicability.
- 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).
- Demonstrate how to check and install all safety equipment as per standard guidelines.
- List housekeeping activities relevant to the task.
- Elucidate ways of transmission of infection Explain the ways to manage infectious risks at the workplace.
- Describe different methods of cleaning, disinfection, sterilization, and sanitization.
- Show how to clean and disinfect all materials, tools and supplies before and after use.
- List the symptoms of infection like fever, cough, redness, swelling, and inflammation.

Unit 7.1 - Hazards and Emergency Situations

Unit Objectives

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

- Understand the types of hazards at the construction sites and identify the hazards specific to the domain related works.
- Recognize the safety control measures and actions to be taken under emergency situations.
- 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

Workplace 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:

Fig. 7.1.3 Risk Associated with Hazards

- **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.

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:

1. Roofing Hazards: Roofers face the risk of falls from heights, especially if proper fall protection measures are not in place.
2. Demolition Hazards: Demolition work involves risks of flying debris, structural collapses, and exposure to hazardous materials.
3. Welding and Cutting Hazards: Welders are exposed to sparks, fumes, and electrical hazards during welding and cutting processes.
4. Crane and Heavy Equipment Hazards: Improper operation of cranes and heavy machinery can lead to struck-by and caught-in accidents.
5. Scaffolding Hazards: Improperly assembled/unstable scaffolding poses fall risks for workers.
6. Concrete and Masonry Hazards: Workers involved in concrete pouring and masonry work face risks of heavy lifting injuries and ergonomic issues.
7. Highway and Roadwork Hazards: Road construction workers are at risk of being struck by vehicles passing through the work zone.
8. Electrical Installation Hazards: Electricians face the dangers of electric shocks and arc flashes during installation and maintenance work.
9. Painting Hazards: Painters may encounter risks from working at heights, using chemicals in paints, and exposure to fumes.
10. 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:

Fig. 7.1.6 Workplace Warning Signs

- Red
- Blue
- Yellow
- Green

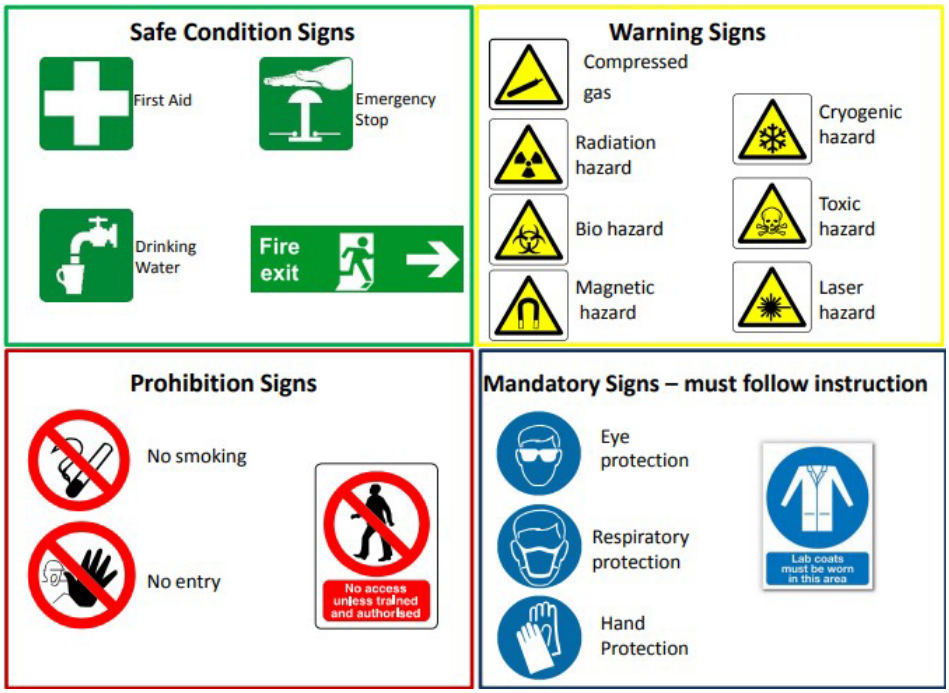

Fig. 7.1.7 Four Types of Safety Signs and their Colour

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. 7.1.8 Emergency Response Plan (ERP)

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. 7.1.10 Reporting Emergency Situations

Notes

Unit 7.2 - Safety Drills, PPEs and Fire Safety

Unit Objectives

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

- Explain the classes of fire and types of fire extinguishers.
- Demonstrate the operating procedure of the fire extinguishers.
- Explain the importance of participation of workers in safety drills.
- List out basic medical tests required for working at construction site.
- Explain the purpose and importance of vertigo test at construction site.
- Explain the types and benefits of basic ergonomic principles, which should be adopted while carrying out specific task at the construction sites.
- 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.

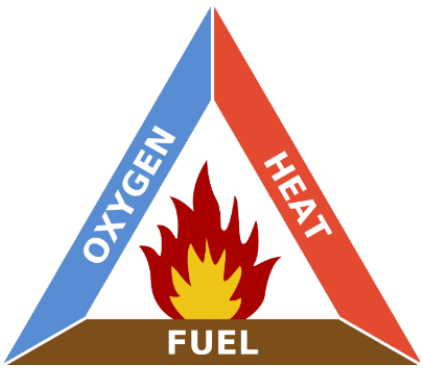

Fig. 7.2.1 Fire Triangle

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

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.

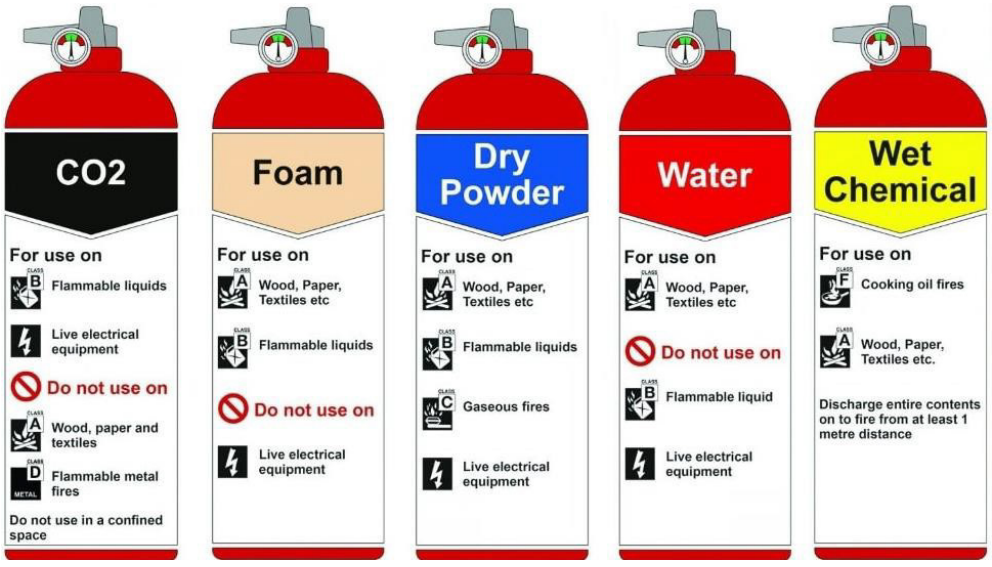

Fig. 7.2.4 Types of Fire Extinguishers

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.

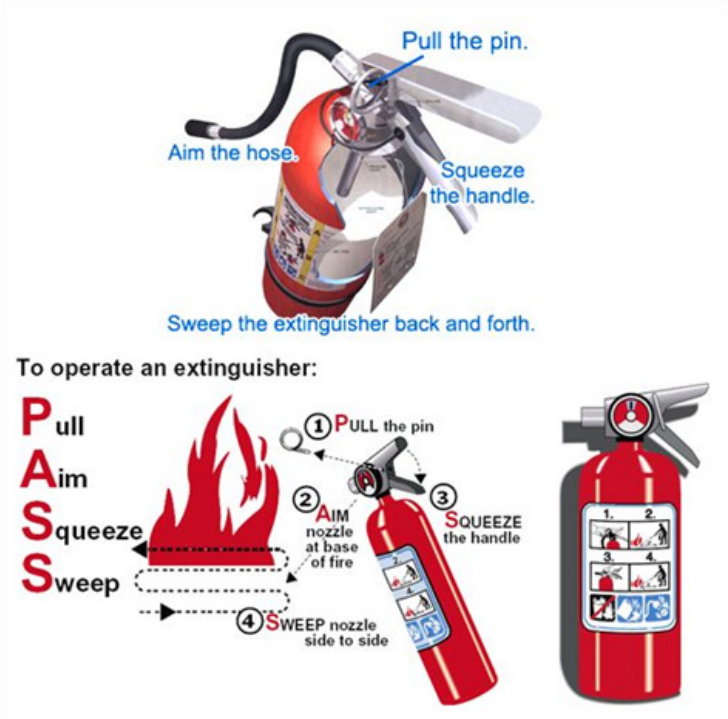

Fig. 7.2.5 Using a Fire Extinguisher

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.

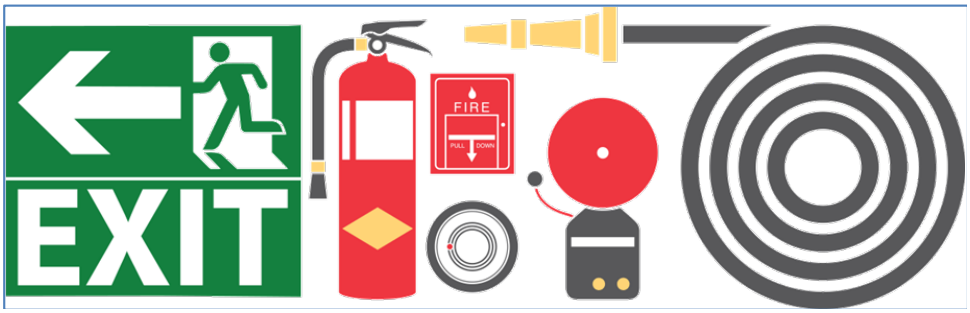

Fig. 7.2.6 Components related to Safety Drill

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

1. **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.
2. **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.
3. **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.
4. **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.
5. **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.
6. **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.

7. 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.
8. 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.
9. 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.
10. 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 1948, both contractual and permanent employees in manufacturing businesses are required to undergo periodic health examinations. These examinations aim to protect the health and safety of factory workers.

The type of medical examination varies according to an employee's job description or the nature of the industrial process in which he is involved. For instance, if an employee works in the food

business, their hands are routinely inspected for skin disorders. If someone is involved in a hazardous manufacturing process, chest X-rays may be 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.

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 1948. The certificate of fitness is only valid for one year from the date it was issued.

Fig. 7.2.8 Medical Examination for Construction Workers

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:

1. Complete Physical Examination
2. Blood Group, Rh factor
3. Blood CBC, ESR, RBS
4. Urine Test (Routine & Microscopic)
5. Creatinine
6. Electrocardiogram (Computerised ECG)

7. Chest X-Ray (Standard Size)
8. Lung Function Test
9. Vision Test (Screening)
10. Audiometric Test
11. HIV & HBS Tests

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.

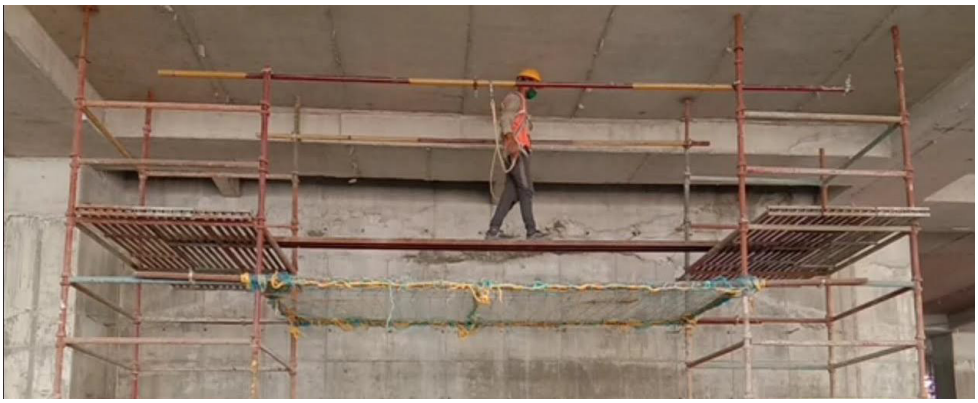

Fig. 7.2.9 Vertigo Test for Construction Workers

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:

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.

Fig. 7.2.11 First Aid to Injured Person

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.

Fig. 7.2.12 First Aid Kit

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.

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.

Fig. 7.2.15 PPEs in Construction Industry

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.

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 partides, 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 levels can lead to permanent hearing loss, physical strain, and 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

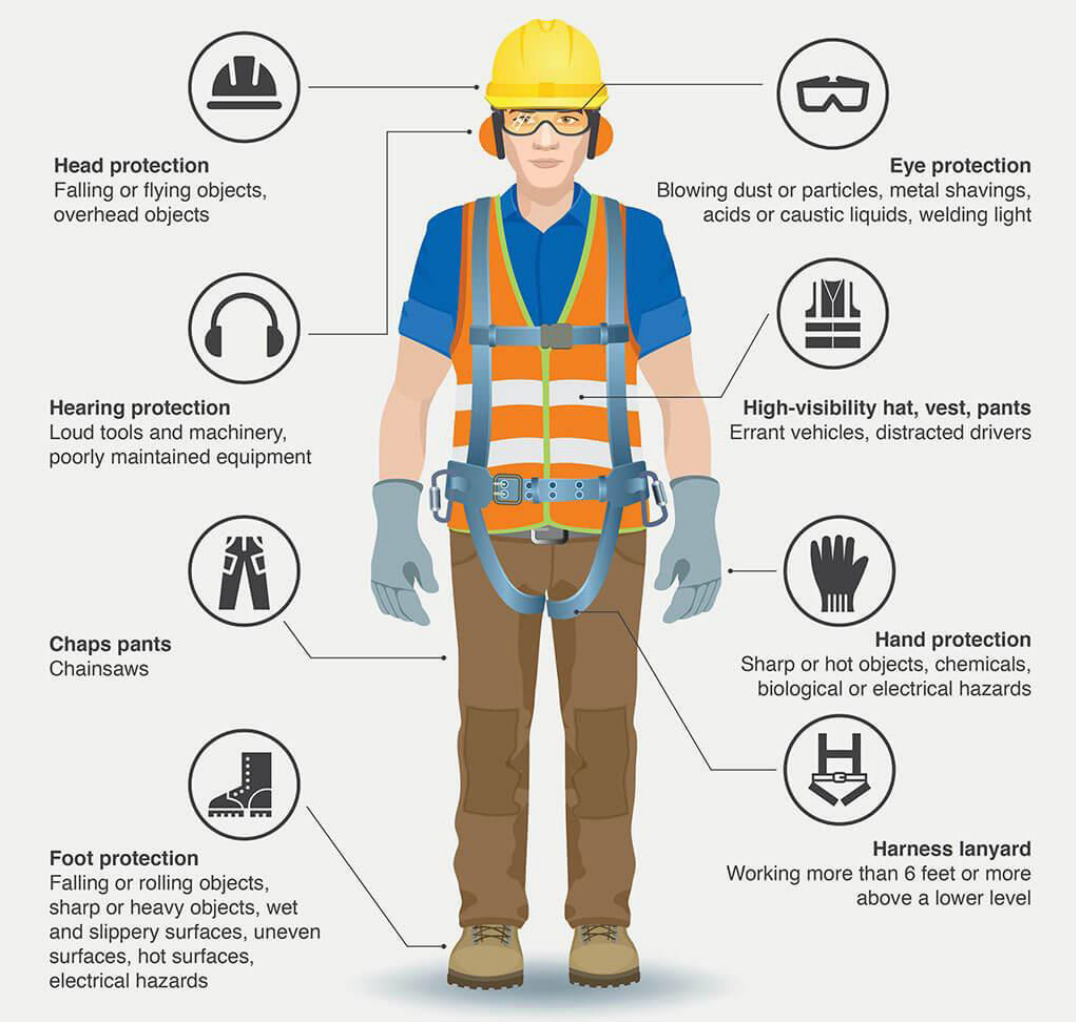

Fig. 7.2.16 A Construction Worker with proper PPEs

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.

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.

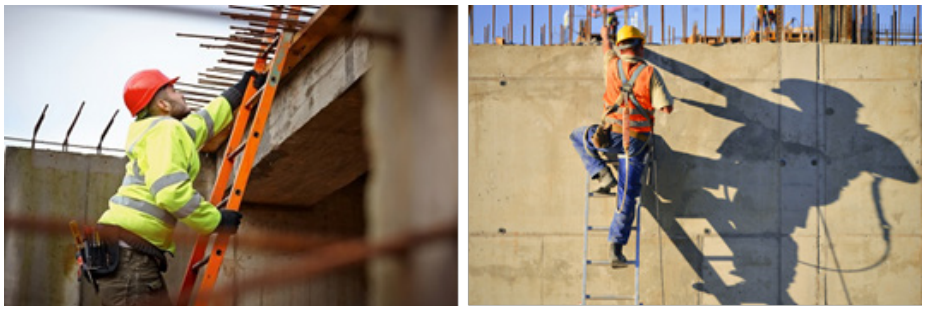

Fig. 7.2.17 Ladder safety

Notes

Unit 7.3 - Hygiene and Safe Waste Disposal Practices

Unit Objectives

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

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

7.7.1 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 foodborne 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.
- The 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

7.7.2 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.

7.7.3 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:

Fig. 7.3.4 Designated 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.

2. Regular Cleanup:

Fig. 7.3.5 Clean-up Debris and Waste

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.

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.

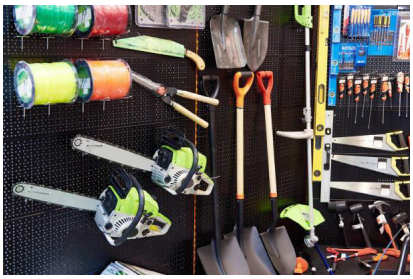

Fig. 7.3.12 Securing Tools & Equipment

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.

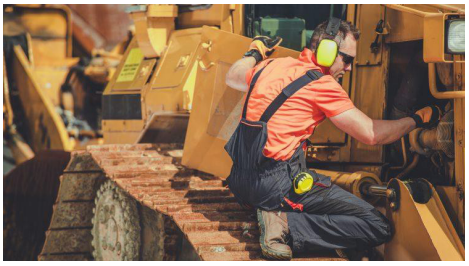

Fig. 7.3.13 Inspect and Maintain Equipment

Fig. 7.3.14 Good Housekeeping and Safety relevance

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.

7.7.4 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 Birthday" 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

7.7.5 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.

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.

Fig. 7.3.17 Avoid Bad Habits

- 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.

7.7.6 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.

7.7.7 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.

- 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.

Fig. 7.3.19 Waste Management

7.7.7 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.

7.7.9 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

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

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

7.4.1 Infectious Diseases

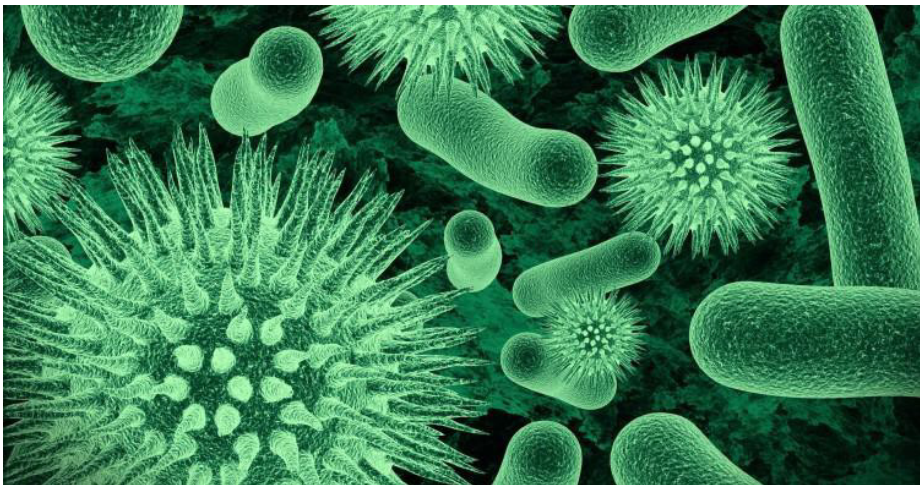

Fig. 7.4.1 Infectious Diseases

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.
- 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:

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

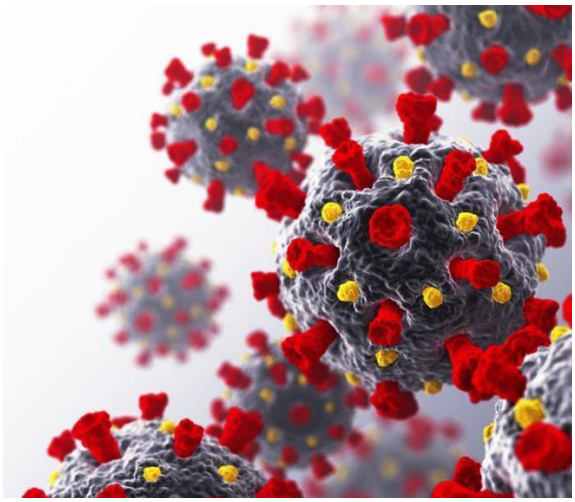

Fig. 7.4.5 Spread of Disease

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

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Notes

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9. Process of Carrying out Manual Earthwork at Construction Sites (Elective -1)

Unit 9.1 – Preparatory Work and Soil Cutting

Unit 9.2 – Backfilling and Compaction Manually

(CON/N0104)

Key Learning Outcomes

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

1. List the appropriate hand tools for removing unwanted materials and objects from the earth's surface before marking activity and earth work.
2. Describe the preparatory works carried out before the excavation of the pit/trench.
3. Explain the importance of excavation and its purpose in construction projects.
4. Explain the methods to excavate a pit/ trench of desired depth/ slope, length and width.
5. Demonstrate the application of different excavation techniques and relevant safety measures.
6. Demonstrate the process of excavating a pit/trench, maintaining the required slope, length, width and depth of the excavation, using the appropriate tools.
7. Show how to properly handle and dispose of materials removed during earth work.
8. Elucidate the concept of slope and its significance in excavation.
9. List the appropriate tools for shifting and placing earth.
10. Demonstrate the proper handling and storage of fencing/ barricading materials, safety signage, ladders, ropes, and earth-cutting and shifting tools.
11. Show how to inspect the excavated pit for loose material, soil lumps, pebbles, or any other debris.
12. Show how to compact the base layer of the excavated pit to achieve the desired compaction levels.
13. Explain the purpose and importance of sorting gravels or oversized aggregates from the soil for backfilling.
14. Demonstrate the process of refilling the excavated trenches, pits, or areas surrounding structures.

UNIT 9.1: Preparatory Work and Soil Cutting

Unit Objectives

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

- List the appropriate hand tools for removing unwanted materials and objects from the earth's surface before marking activity and earth work.
- Describe the preparatory works carried out before the excavation of the pit/trench.
- Explain the importance of excavation and its purpose in construction projects.
- Explain methods to excavate a pit/ trench of desired depth/ slope, length and width.
- Demonstrate application of excavation techniques and relevant safety measures.
- Demonstrate the process of excavating a pit/trench, maintaining the required slope, length, width and depth of the excavation, using the appropriate tools.
- Show how to properly handle and dispose of materials removed during earth work.
- Elucidate the concept of slope and its significance in excavation.
- List the appropriate tools for shifting and placing earth.
- Demonstrate the proper handling and storage of fencing/ barricading materials, safety signage, ladders, ropes, and earth-cutting and shifting tools.
- Show how to inspect excavated pit for loose material, soil lumps, pebbles, or debris.

9.1.1 Introduction to Earthwork

The preliminary step of any construction activity is earthwork. Excavation is carried out to lay foundation of various structures. Excavation are carried out manually and also by using heavy equipments. Earthwork in construction mainly involves two operations:

- Excavating the earth
- Backfilling and compacting the earth

Fig. 9.1.1 Soil excavation

Fig. 9.1.2 Back filling

Importance of Earthwork

Earthworks are to be carried out as a part of the development of any construction work.

The earth may be moved to another locations and form into a desired shape for a purpose.

Earthworks are carried out prior to construction of buildings, roads, railway beds, causeways, dams, levees, canals and berms. Other common earthworks application land grading is for reconfiguring the topography of a site and to stabilize slopes.

Fig. 9.1.3 Earth work for roads

Fig. 9.1.4 Earth work for canals

Operations done Under Earthwork

Earthwork and related operations consists of excavation for the construction of the roadway, excavation for structures and pipe, constructing backfill around structures and pipe and constructing embankments as required for the roadway, ditches and channel changes.

Operations done under earthwork include clearing, grubbing, removing and disposing of all vegetation and debris within the limits of construction and soil cutting and dressing as per requirement for construction works.

Clearing, grubbing, removing and disposing of all vegetation and debris

Fig. 9.1.5 Clearing the construction area

Soil cutting and dressing

Excavation (soil cutting) is used in construction to create foundations. The process used in excavation work includes marking, digging and removal of soil/rock.

Each of these processes requires different techniques, tools and machinery to get the job done right.

Fig. 9.1.6 Soil marking

Fig. 9.1.7 Soil cutting

Fig. 9.1.8 Soil dressing

9.1.2 Earthwork Process

Excavation (soil cutting) is carried out to create foundations for various structures. The process used in excavation work includes marking, digging and removal of soil/rock. Each of these processes are done using different techniques, tools and machinery.



Fig. 9.1.9 Excavated trench and pit (large and circular)

Tools for cutting earth

			
Trenching hoe	**Pick axe**	**Rake**	**Fork**
			
Spade	**Shovel**	**Rope**	**Flags**
			
Wooden sign	**Marking lime**	**Wheelbarrow**	**Pan**

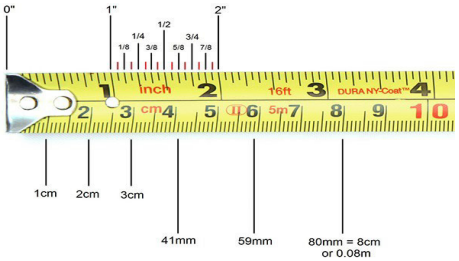
			
Safety helmet	**Gumboots**	**Safety goggles**	**Dust mask**
			
Warning signage & barricading materials		**Measuring tape for Measurement**	

Table 9.1.1 Tools for cutting earth

The helper mason is responsible for carrying out manual earthworks at construction sites. The helper mason carries out the following activities for manual earthwork:

- Identification and selection of tools of earthwork.
- Preparatory activities for earthwork such as removing vegetation, unwanted materials etc. from the site
- Marking the ground as per instructions and cutting of soil manually using appropriate tools
- Carry out surface dressing works.

Preparatory Work Prior to Earthwork

There are certain works at construction sites which are required to be completed before carrying out the earthwork.

Fig. 9.1.10 Preparatory work prior to earthwork process

Step 1: Ready all earth cutting tools needed to complete the work on hand before

Step2: 101 Wear personal protective equipment

Step 3: Remove unwanted materials, organic substances manually using spade, shovel and rake

Step 4: Remove and dispose gravels, plant roots, sludge, muck or debris

Step 5: Have all marking tools like lime, wooden pegs, rope, flag, etc. ready.

Step 6: Assist in the marking of layout.

Step 7: Barricade the area using fencing or barricade materials and place safety signage.

How to Cut Soil Manually

Cutting soil manually for masonry work or construction typically involves excavating or removing soil from a specific area to achieve the desired depth or slope.

Fig. 9.1.11 Cutting soil manually

Fig. 9.1.12 Soil types

	
Step 1: Loosen hard soil using a pick axe or fork.	Step 2: Define the sides of the trench or pit using the point of spade.
	
Step 3: Start digging using trenching hoe.	Step 4: Lift the soil on the blade of shovel and pull it out.
	
Step 5: Place all the soil that you pull out of the trench or pit on one side. This will leave the other side of the trench/pit easier to access. Dispose soil as per instructions.	Step 6: Continue digging until the desired depth is not achieved.
	
Step 7: Check the depth and slope of the pit or trench.	Step 8: Continue digging until the whole trench or pit is complete. Recheck the depth and slope of the trench or pit.

Table 9.1.3 Processing of cutting soil manually

Surface dressing work after excavation

	
Step 1: Dispose the excavated earth from the site using wheel barrow, pans, and etc.	Step 2: Check and clean the trench/pit for any lump, gravel, or debris etc.
	
Step 3: Compact the base layer of the pit or trench by ramming manually.	

Table 9.1.4 Surface dressing work after excavation

Ways to avoid the collapse of trench or pit

Shoring and Timbering: The length, breadth and depth of trench should be as per the drawing and design given in the map. Where the soil is wet or cohesion less the side slopes are supported by the use of cross bars and side shutters (planks) in order to prevent the collapse of the trench.

Fig. 9.1.13 Shoring and timbering

Providing Soil Embankment: If it is required to construct a soil embankment, at least 10% more soil should be added i.e. if the designed height of the embankment is 6.0 m, the embankment of 6.6 m height should be constructed initially to allow for the settlement of soil at a later stage.

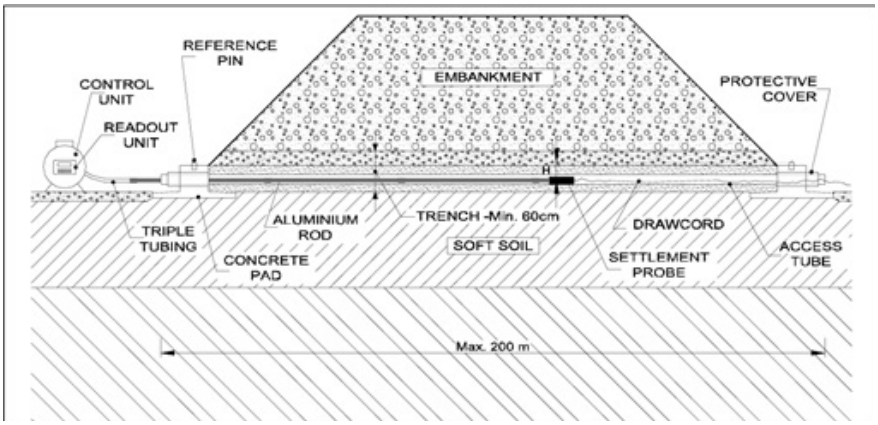


Fig. 9.1.14 Soil embankment

Sloping: Sloping digging the trench wall at an angle away from the opening, so that soil weight is away from the worker. The trench is somewhat funnel shaped.

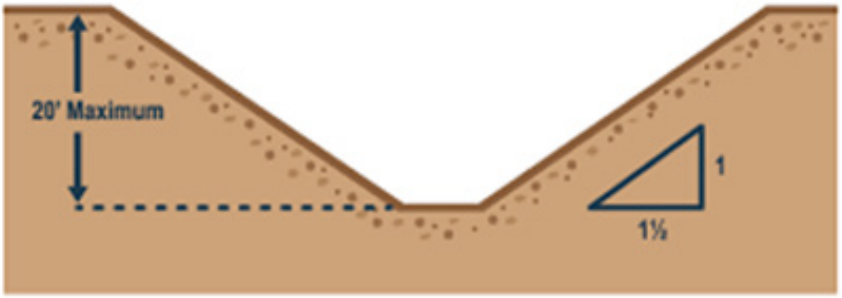


Fig. 9.1.15 Slopping a trench

Benching: If it is required to put new soil over old soil, Benching is required to be done so that a perfect bonding between old and new soil is achieved. Benching means construction of steps.

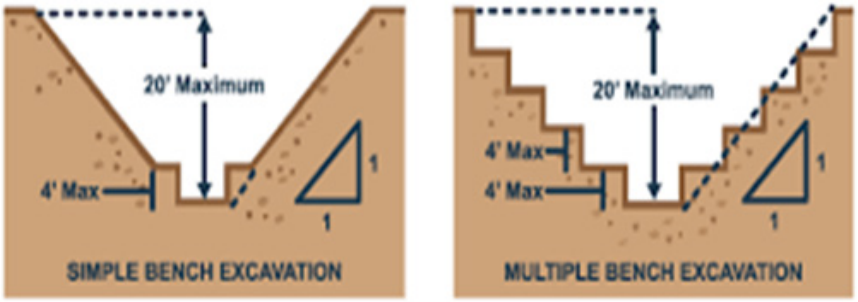


Fig. 9.1.16 Benching a trench

Do and Don'ts of Excavation

Do's	Don'ts
Planning reduces the chance that something will go wrong when a job is started. So execute prior planning before performing task.	Never use damaged chains or frayed cables, slings, straps, or ropes.
Remove debris near the excavation site	Never stand in line with, or next to, a sling that is under tension.
Provide safe means of access in to the excavated place.	Do not allow vehicles and other mobile equipment to operate near the excavation sites.
Provide barriers to protect people from falling into the excavation	Don't excavate below the base or footing of any foundation
Plan for possibility of water in the excavation	--
Check for stability of soil at the excavation site	--
Use an appropriate lifting shackle for attaching cables or slings.	--
All excavations exceeding 1.2m depth to be supported against collapse.	--

Table 9.1.5 Excavations related do's and don'ts

9.1.3 Safety precautions to follow:

- Always wear personal protective equipment while excavating the earth.
- Look for any underground cables in the location marked for excavation.
- Excavation should be done to the required level, slope, shape, and pattern.
- Excavated material should be deposited away from the pit to prevent collapsing of edges.
- Do not operate heavy equipment near the sides of a trench/pit.
- Provide a safe means for entering and exiting the deep trench/pit, such as ladder.
- Protect the trench/pit with fencing, flagging, or other means to prevent someone from accidentally falling into it.
- Report to the supervisor for any potential risk or hazard.

Fig. 9.1.17 Safety related precautionary measures

Notes

Scan the QR code to watch the video

https://youtu.be/0yVyFD5RAFc

Introduction to Earthwork

UNIT 9.2: Backfilling and Manual Compaction

Unit Objectives:

At the end of this unit, you will be able to:

- Show how to compact the base layer of the excavated pit to achieve the desired compaction levels.
- Explain the purpose and importance of sorting gravels or oversized aggregates from the soil for backfilling.
- Demonstrate the process of refilling the excavated trenches, pits, or areas surrounding structures.

9.2.1 Backfilling: Importance and need

Backfilling is the process of putting soil back inside a trench or in a foundation when the excavation has been completed. Backfilling can be done in several ways and can be used in tasks such as protecting foundations, landscaping, or filling in voids in underground structures.

- It is used to strengthen and support a structure's foundation.
- The excavated material from the pits or procured from outside is used for back filling.
- The space between sub-structure that is foundation and sides of excavation should be filled back to the original surface level in layers.
- These layers should not exceed more than 250mm in thickness.
- It should be watered and well compacted by means of rammer to achieve maximum consolidation.

Fig. 9.2.1 Backfilling

There are four key elements to proper backfilling:

- Protecting the foundation wall from damage during backfilling
- Using the right backfill materials
- Compacting the backfill
- Final finishing to the subgrade to ensure that water drains away from the foundation

Fig. 9.2.2 Backfilling

9.2.2 What is Compaction?

Compaction is the process in which a stress applied to the soil or concrete to consolidate and remove any voids.

Advantage of Effective Compaction:

- Compaction increases density of soil.
- It reduces porosity of soil.
- It increases shearing resistance of soil.

Difference between Soil Compaction and Concrete Compaction:

- Soil compaction involves compacting loose soil.
- Concrete compaction involves compacting concrete to fit tightly into certain required area.
- Soil compaction is done by using hand rammer or plate compactor.
- Concrete compaction can be either done manually or mechanically.
- Manual concrete compaction is either done by rodding with the steel rods or tamping using rammer.

- Manual concrete compaction is suitable for small jobs.
- Mechanical concrete compaction is done by using vibrators.
- Vibrators are very effective in compacting the concrete stiffer resulting in highly dense concrete.

Fig. 9.2.3 Soil compaction by power rammer

Fig. 9.2.4 Concrete compaction by vibrator

Above process can be done manually also.

9.2.3 Steps for Carrying out Backfilling and Compaction

Backfilling and compaction are crucial steps in construction to ensure the stability and proper settlement of foundations, trenches, and other excavated areas.

Remember that specific procedures and equipment may vary based on the type of project, soil conditions, and local regulations.

Fig. 9.2.5 Carrying out Backfilling and Compaction

It's essential to follow industry best practices and guidelines to ensure effective backfilling and compaction.

- Step 1: Have all things and tools needed to complete the work on hand before beginning.
- Step 2: Wear personal protective equipment.
- Step 3: Place safety signage.
- Step 4: Remove gravels or oversized aggregates from soil to be used for backfilling.
- Step 5: Transport the soil to the pit or trench using the wheelbarrow or pan.
- Step 6: Place and spread the soil in pit or trench in uniform layers, each being 15cm to 25cm thick.
- Step 7: Water uniformly over the layer to be compacted.
- Step 8: Pound the earth with hand tamper to compact the soil.
- Step 9: Repeat step 6 to step 8 until soil stops to settle.

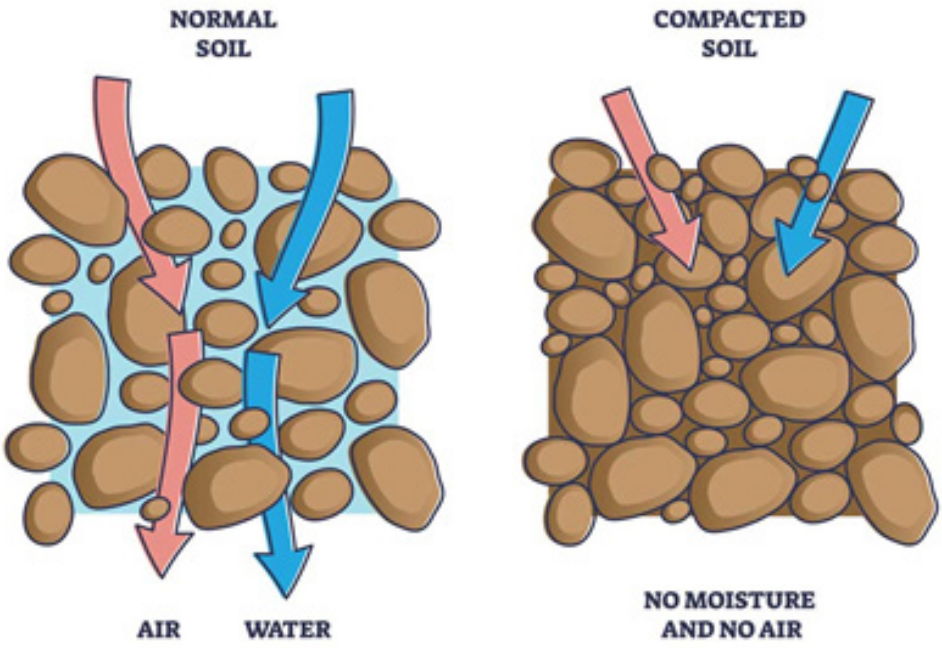


Fig. 9.2.6 Soil compaction

9.2.4 Do's and Don'ts of Backfilling and Compaction

Do's	Don'ts
Backfilling should be done after the foundation has completely set.	Inadequate compaction is likely to cause settlement of backfilling resulting in development of cracks in flooring.
Backfilling should be carried out in layers.	Don't do backfilling with large clumps of clay, with soil full of roots or tree branches, or other organic materials.
Each layers should be thoroughly compacted.	--
Choose the right backfill material: granular fill makes it easier for water to move toward the Foundation wall.	--
Compact the backfill; Compaction is needed to reduce the amount of soil settlement that occurs with time.	--
While compacting use precautions to protect the foundation columns, plinth wall etc.	--

Table 9.2.1 Soil

Fig. 9.2.7 Do's and Don'ts of Backfilling and Compaction

9.2.5 Tips to achieve the desired Compaction Levels in the base layer of the Excavated Pit

- **Clear Debris:** Remove any debris, loose soil, or vegetation from the excavated pit to ensure a clean and even surface.
- **Moisture Management:** Depending on the type of soil, adjust the moisture content to achieve optimal compaction. Soil that is too dry or too wet can hinder proper compaction.
- **Layer Thickness:** Divide the base layer into manageable sections or lifts. Each lift should be a uniform thickness, typically around 6 to 8 inches.
- **Add and Spread Soil:** If needed, add suitable compactable material to the base layer. Spread the soil evenly across the lift using equipment like a bulldozer or backhoe.

- **Compaction Equipment:** Use compaction equipment such as a plate compactor, vibratory roller, or a compaction machine to compress the soil. The choice of equipment depends on the soil type and the area's size.
- **Overlap Passes:** When using compactors or rollers, make overlapping passes over the entire lift. This ensures consistent compaction throughout the layer.
- **Proper Technique:** Operate the compaction equipment systematically, moving in straight lines across the lift. Avoid sudden starts and stops, as they can create uneven compaction.
- **Number of Passes:** Make multiple passes over each section, gradually increasing compaction forces. Follow manufacturer guidelines regarding the appropriate number of passes for effective compaction.
- **Check Compaction Levels:** Periodically check the compaction levels using methods like the sand cone test or nuclear density gauge. Ensure that the achieved density meets the project's requirements.
- **Repeat for Additional Lifts:** If the base layer is thicker than the lift's thickness, repeat the process for each subsequent lift until the desired depth is achieved.
- **Quality Assurance:** Conduct regular quality checks during and after compaction to ensure uniform density and compaction across the entire base layer.
- **Surface Smoothing:** Once compaction is complete, use equipment to smooth the surface of the compacted base layer. This prepares it for the next construction phase.

Proper compaction of the base layer is essential to create a stable foundation for further construction. Following these steps and adhering to industry standards will help you achieve the desired compaction levels, ensuring the durability and stability of the project.

Exercise

Answer the following questions:

A. Short Questions:

1. What are some appropriate hand tools used for removing unwanted materials before earthwork?
2. What preparatory works are carried out before excavating a pit or trench?
3. Why is excavation important, and what is its purpose in construction projects?
4. Can you explain the methods used to excavate a pit or trench with desired depth, slope, length, and width?
5. How can you demonstrate the process of excavating a pit or trench while maintaining the required slope and dimensions?

B. Fill-in-the-Blanks Questions:

1. Slope is a key concept in excavation that ensures proper ..... (drainage / ventilation).
2. Sorting gravels or oversized aggregates from soil is essential for proper ..... (compaction / backfilling).
3. Excavation involves removing earth to create a (foundation / cavity) for construction.
4. Appropriate tools are needed for shifting and placing ..... (concrete / earth) during construction.
5. Preparatory works before excavation include ..... (inspection / site analysis) for potential hazards.

C. True/False Questions:

1. Excavation is not an essential process in construction projects. (True/False)
2. Slope plays no role in ensuring stable and safe excavations. (True/False)
3. Sorting gravels from soil is not necessary for backfilling. (True/False)
4. Excavation involves only removing unwanted materials from the earth's surface. (True/False)
5. Preparatory works before excavation do not impact safety during the process. (True/False)

Notes

Scan the QR code to watch the video

https://youtu.be/BxSLst_fVP4

Steps for Carrying out Backfilling and Compaction

Annexure

Annexure of QR Codes for Helper Bar Bender and Steel Fixer

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/yhjDhav4Pfw	15	Overview of Construction Sector in India
	UNIT 1.2: Brief about Bar Bending & Steel Fixing Occupation	Responsibilities of Helper Bar Bender and Steel Fixer	https://youtu.be/KQ_hc3-Ol-A	23	Responsibilities of Helper Bar Bender and Steel Fixer
Chapter 2: Core/Generic Skills	Unit 2.1 – Numeracy Skills	Different System of Measurement	https://youtu.be/H1xo5UVJKVo	31	Different System of Measurement
	Unit 2.2 – Systems of Measurements	Area, volume and perimeter of geometrical shapes	https://youtu.be/OhTubw4C0to	42	Area, volume and perimeter of geometrical shapes
Chapter 3: Shift and Stack Materials, Tools and Equipment for Reinforcement Work (CON/N0201)	Unit 3.1 – Masonry Hand Tools and Equipment	Introduction to Common Construction Materials	https://youtu.be/a1cQcIJfjPw	68	Introduction to Common Construction Materials
	UNIT 3.2: Handling and Storage of Reinforcement Steel	Storage and Stacking of Reinforcement Bars	https://youtu.be/WA1PWw6Re2E	76	Storage and Stacking of Reinforcement Bars

	UNIT 3.3: Tools used in Bar Bending Works	Hand and Power Tools	https://youtu.be/NIh1CXfw880	88	Hand and Power Tools
Chapter 4: Mark and Cut Reinforcement Bars to the Required Length (CON/N0202)	Unit 4.1 – Cutting and Bending of Rebar	Types, Grades, and Diameters of Reinforcement Bars	https://youtu.be/lQbKYg-DN8s	104	Types, Grades, and Diameters of Reinforcement Bars
		Different Types of Ties Used in Reinforcement Work	https://youtu.be/ldLNOmp3olA	104	Different Types of Ties Used in Reinforcement Work
Chapter 5: Process of Tying Reinforcement Bars (CON/N0203)	UNIT 5.1: Tying Reinforcement Bars	Tools used for Tying Rebar	https://youtu.be/34mtpno_3pE	120	Tools used for Tying Rebar
		Importance of appropriate Spacing in Tying Reinforcement Bars	https://youtu.be/4vlBLE4_dhs	120	Importance of appropriate Spacing in Tying Reinforcement Bars
	Unit 6.1 – Basic Concept of Temporary Scaffolding	Types of Scaffolding	https://youtu.be/YuBFUtGGcbk	130	Types of Scaffolding

Chapter 6: Process of Erecting and Dismantling Temporary Scaffold Up to 3.6 meter height (CON/N0101)	Unit 6.2 – Concept of Conventional Scaffolding	Material used in Conventional Bamboo	https://youtu.be/8DP_7OK6dCw	138	Material used in Conventional Bamboo
	Unit 6.3 – Concept of Modular Scaffolding System	Modular Scaffolding System	https://youtu.be/oRxg2LLfxO4	148	Modular Scaffolding System
	Unit 6.4 – Erecting and Dismantling of Temporary Scaffolding	Erecting a Frame-System Scaffold	https://youtu.be/VQ1e0VZmTmM	155	Erecting a Frame-System Scaffold
Chapter 9: Process of Carrying out Manual Earthwork at Construction Sites (CON/N0104)	Unit 9.1 – Preparatory Work and Soil Cutting	Introduction to Earthwork	https://youtu.be/0yVyFD5RAFc	225	Introduction to Earthwork
	Unit 9.2 – Backfilling and Compaction Manually	Steps for Carrying out Backfilling and Compaction	https://youtu.be/BxSLst_fVP4	233	Steps for Carrying out Backfilling and Compaction

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