Department of Empowerment of Persons with Disabilities (Divyangjan)
Ministry of Social Justice & Empowerment

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Skill Council for Persons with Disability

Participant Handbook

Sector
Construction Skill Development Council of India

Sub - Sector
Real Estate and Infrastructure Construction

Occupation
Construction Electrical Works

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Assistant Electrician (Divyangjan) for Locomotor Disability

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The book caters to the job role aligned to the following disabilities as per the NQR codes mentioned below.
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Shri Narendra Modi
Prime Minister of India

Certificate

COMPLIANCE TO
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for

SKILLING CONTENT: PARTICIPANT HANDBOOK

Complying to National Occupational Standards of

Job Role/ Qualification Pack: Assistant Electrician (Divyangjan) QP. No. PWD/CON/Q0602, Version 3.0, NSQF LEVEL 3

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Acknowledgements

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

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

About this book

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

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

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

Compulsory NOS:

- **CON/N0602:** Handling Construction Hand and Power Tools
- **CON/N0603:** Installing Temporary Lighting
- **CON/N0604:** Assist in LV (low voltage) Electrical Wiring at Permanent Structures
- **CON/N0605:** Assembling, Installing and Maintaining Temporary LV Electrical Panels
- **CON/N8001**: Work effectively in a team to deliver desired results at the workplace
- **CON/N8002**: Planning and Organizing Work
- **CON/N9001**: Work according to personal health, safety and environment protocols at the construction site
- **DGT/VSQ/N0101:** Employability Skills (30 Hours)

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

Symbols Used


Key Learning Outcomes


Exercise


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Unit Objectives


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

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1. Introduction to Assistant Electrician Job Role

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Unit 1.1 - Introduction to Construction Industry
Unit 1.2 - Role and Responsibilities of an Assistant Electrician

Key Learning Outcomes

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

1. Describe the role and responsibilities of an assistant electrician.
2. Define the personal attributes required in occupation of construction electrician works.
3. Explain future possible progression and career options for role of an assistant electrician.

Unit 1.1: Introduction to Construction Industry

Unit Objectives

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

1. Overview of construction industry.

1.1.1Construction Industry

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

Construction Industry in India

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

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

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

1.1.2 Types of Construction

The following are the types of construction:

a. Building construction:

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

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

In the case of commercial building construction, multiple strategies are utilised. They consist of Design & Build, Cost Estimating, Competitive Bidding, Contract Management, Construction Management, and Design-Build Bridging (will be explained in detail later).

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

b. Industrial Construction:

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

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

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

Fig. 1.1.1 Industrial Construction Site Plan

Large-scale building projects necessitate the completion of several jobs by a large number of individuals. Different jobs are provided to different teams. For instance, a Project Manager is responsible for Project management, while a Construction Manager oversees Project construction.

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

c. Infrastructure Construction

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

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

1.1.3 Construction Project Categories

Each sort of construction project necessitates a specialised team for planning, design, building, and maintenance. There are typically three basic categories of construction projects:

1. Residential projects

Residential projects involve residences, housing developments, structures, and garages. Individual landowners (self-build), expert house-builders, property developers, general contractors, and suppliers of public or social housing can all engage in residential construction (eg: local authorities, housing associations). Local building authority laws and codes of practise must be complied with by residential construction techniques, technologies, and materials.

2. Non-residential/ Commercial Projects

These projects involve the construction of large and small commercial structures, such as businesses, churches, schools, and hospitals. Depending on the type of building, a diverse variety of private and public entities, including local authorities, educational and religious bodies, transit undertakings, shops, hotels, property developers, and financial institutions, can procure non-residential building construction. The majority of building in these industries is performed by general contractors.

3. **Engineering projects**
   Construction of bridges, roads, reservoirs, big public works, dams, motorways, trains, water or wastewater, and utility distribution are examples of engineering projects. Civil engineering include the planning, building, and upkeep of such massive enterprises.

1.1.3 Market Segment of Construction Industry

Fig. 1.1.3 Market segments of construction industry

Notes

Unit 1.2: Role and Responsibilities of an Assistant Electrician

Unit Objectives

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

1. Describe the role and responsibilities of an assistant electrician.
2. Define the personal attributes required in occupation of construction electrician works.
3. Explain future possible progression and career options for role of an assistant electrician.

1.2.1 Assistant Electrician

An assistant electrician is an entry-level position within the field of electrical work, typically assisting and supporting more experienced electricians in various tasks related to electrical installations, repairs, maintenance, and troubleshooting. Their role is crucial in ensuring that electrical systems are functioning correctly and safely.

1.2.2 Roles and Responsibilities of an Assistant Electrician

The role of an assistant electrician is a stepping stone to becoming a skilled and knowledgeable electrician. As they gain experience and expertise, they can progress in their career to take on more complex responsibilities and eventually become fully-fledged electricians themselves.

Role and Responsibilities of an Assistant Electrician are:

1. **Assisting Senior Electricians:** The primary responsibility of an assistant electrician is to work under the guidance of senior electricians. They assist in tasks such as installing electrical systems, wiring, fixtures, and equipment according to established standards and regulations.
2. **Material Preparation:** Assistant electricians help gather and organize materials, tools, and equipment required for various electrical projects. They ensure that all necessary components are available and ready for use.
3. **Installing Electrical Systems:** Assistant electricians assist in the installation of electrical systems, which can include wiring, outlets, switches, circuit breakers, lighting fixtures, and other electrical components. They follow instructions from senior electricians to ensure accurate and safe installations.
4. **Maintenance and Repairs:** They participate in routine maintenance and repair activities for electrical systems. This involves identifying and fixing issues with wiring, circuits, and equipment to ensure they function optimally and safely.
5. **Safety Compliance:** Assistant electricians adhere to safety guidelines and regulations to prevent accidents and ensure a secure working environment. They may assist in testing and inspecting electrical systems to confirm compliance with codes and standards.
6. **Troubleshooting:** When electrical problems arise, assistant electricians help identify and diagnose issues under the direction of senior electricians. They may use tools and testing equipment to pinpoint problems and suggest potential solutions.

7. **Documentation:** Keeping accurate records and documentation of work performed is important. Assistant electricians may assist in documenting work progress, materials used, and any changes made to electrical systems.
8. **Learning and Training:** One of the key aspects of this role is to learn and gain practical experience in the field of electrical work. Assistant electricians have the opportunity to learn from experienced professionals and gain valuable skills and knowledge over time.
9. **Communication:** Effective communication is vital in this role. Assistant electricians may need to communicate with senior electricians, other team members, clients, and supervisors to provide updates, ask questions, and share relevant information.
10. **Adhering to Regulations:** Assistant electricians should have a basic understanding of electrical codes, regulations, and safety protocols to ensure that their work meets legal and industry standards.
11. **Project Support:** They provide general support to senior electricians during larger projects, helping with tasks such as setting up equipment, running cables, and managing work areas.

1.2.3 Personal Attributes of an Assistant Electrician

In addition to possessing technical skills, an assistant electrician should also demonstrate a range of essential soft skills and personal attributes. These qualities enable them to excel in their role and contribute positively to the work environment. Specifically, an assistant electrician should be capable of:

- Clearly communicating with both superiors and subordinates, ensuring effective information exchange.
- Providing support to colleagues in order to fulfill project requirements successfully.
- Collaborating efficiently within a team setting, fostering a productive group dynamic.
- Cultivating and sustaining a harmonious and cooperative work atmosphere among peers.
- Maintaining optimal mental and physical well-being to consistently perform at a high level.
- Exemplifying reliability and honesty in all aspects of their work and interactions.
- Approaching interactions with co-workers in a courteous and respectful manner.
- Upholding personal hygiene standards consistently and without exception.
- Skillfully planning, organizing, and completing assigned tasks with diligence and efficiency.

1.2.4 Career Path of an Assistant Electrician

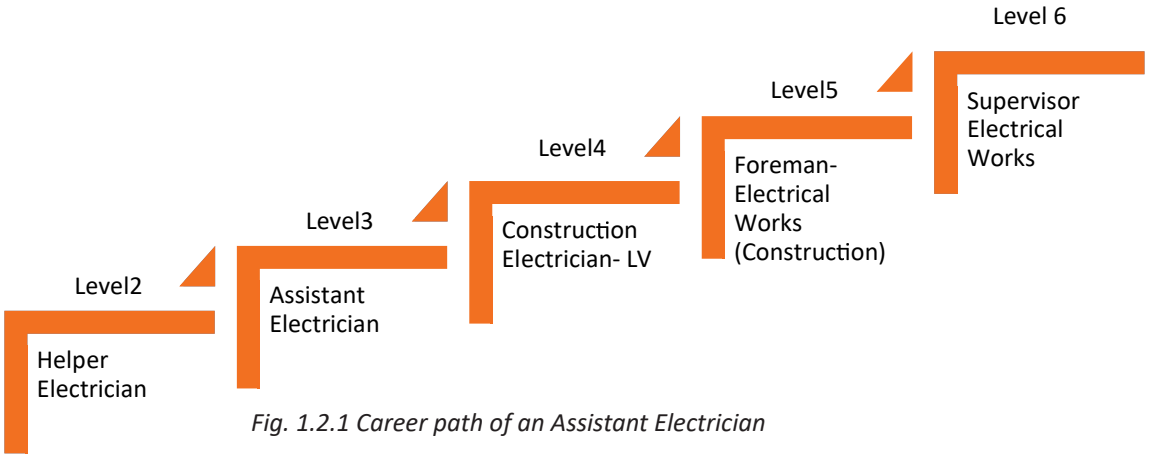

Fig. 1.2.1 Career path of an Assistant Electrician

Exercise

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

Notes

QR Codes

Scan the QR code to watch the video

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

Introduction to Assistant Electrician Trade

https://www.youtube.com/watch?v=3nmWxgUCuvE

Assistance Electrician importance

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2. Handling Construction Hand and Power Tools

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Unit 2.1 - Construction Hand and Power Tools

CON/N0602

Key Learning Outcomes

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

1. Explain basic principle of electrical current flow and fundamental concept of alternate and direct current, voltage, resistance, temperature, cross section of conductors, etc.
2. Explain Ampere's law, Ohm's law, and electromagnetic field.
3. Explain the application of tester, mustimeter, digital ammeter etc.
4. Interpret wiring symbols, SLDs, manufacturer's guidelines and electrical specifications
5. Discuss use of various electrical hand and power tools such as pliers, crimping tools, electrical drill machines, cutting machines etc. during electrical wiring of house/ building.
6. Explain type of electrical devices like starters, relays and circuit breakers, their power ratings, working principles and use in circuits.
7. Describe features of switches, fuses, resistors and various circuit protecting devices and their use in electrical circuits and connections.
8. Discuss about the electrical measuring/ testing tools and devices such as voltage tester, earth tester, mustimeter, digital ammeter, meggers, tong tester, etc.
9. Demonstrate how to check proper and safe working of hand and power tools.
10. Perform fitting of conduits, cables wiring, fixing of electrical fixtures, electrical connection termination at power outlets, etc. using hand and power tools.
11. Measure size and dimension of wires, conduits as per electrical installation/ maintenance work requirement using measuring instruments
12. Perform basic inspections of electrical circuits/ wiring using electrical devices like ammeter, voltmeter, meggers, multi-meter, tong tester, earth tester, etc.
13. Install electrical components like starter, circuit breakers, relays, etc.
14. Perform maintenance of electrical tools, devices post use as per manufacturer's guidelines.

Unit 2.1: Construction Hand and Power Tools

Unit Objectives

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

1. Explain basic principle of electrical current flow and fundamental concept of alternate and direct current, voltage, resistance, temperature, cross section of conductors, etc.
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9. Demonstrate how to check proper and safe working of hand and power tools.
10. Perform fitting of conduits, cables wiring, fixing of electrical fixtures, electrical connection termination at power outlets, etc. using hand and power tools.
11. Measure size and dimension of wires, conduits as per electrical installation/ maintenance work requirement using measuring instruments
12. Perform basic inspections of electrical circuits/ wiring using electrical devices like ammeter, voltmeter, meggers, multi-meter, tong tester, earth tester, etc.
13. Install electrical components like starter, circuit breakers, relays, etc.
14. Perform maintenance of electrical tools, devices post use as per manufacturer's guidelines.

2.1.1 Electric Current

Electric current is the constant flow of charged particles in a circuit. The direction of the passage of electric current is from higher to lower electric potential. The movement of an electron in an electric current is opposite to that of the current. Below is a comparison of AC and DC current.

DC (Direct Current): Here, just one direction of electric charge flow is present. Used in cell phones, torches, etc.

AC (Alternating Current): Unlike DC, the flow of electric charge periodically reverses direction in AC. The current supplied to offices and homes, for instance.

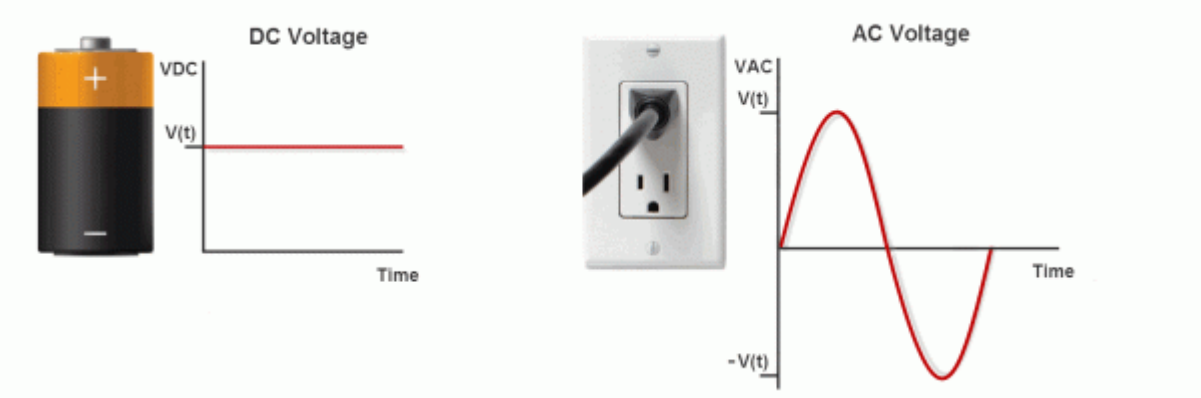


Fig 2.1.1 DC Voltage and AC Voltage

2.1.2 Electric Circuit

A circuit is the path along which electrons move from a voltage or current source.

The location where electrons enter an electrical circuit is known as their "source." The point in an electrical circuit where electrons leave is known as the "return" or "earth ground." Because electrons always return to the source as they complete the path of an electrical circuit, the exit point is called the "return."

The portion of an electrical circuit between the electrons' starting point and the point at which they return to the source is referred to as the "load." The load of an electrical circuit can be as basic as domestic appliances such as refrigerators, televisions, and lamps, or it can be more complex, such as the load on the output of a hydroelectric power producing facility.

The two types of electrical power used in circuits are alternating current (AC) and direct current (DC) (DC). AC is typically used to power large appliances and motors and is produced by power plants. DC is used to power battery-powered cars, machines, and gadgets. Converters may switch between AC and DC. Transmission of high-voltage direct current requires large converters.

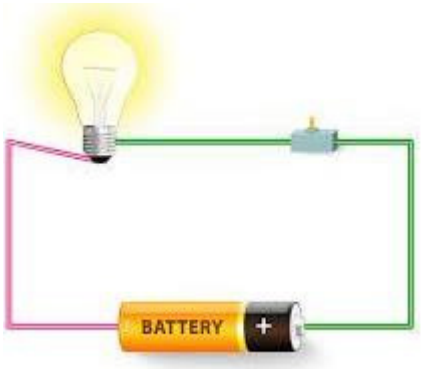


Fig. 2.1.2 Electric Circuit

2.1.3 Parts of Electric Circuit

An electric circuit consists of four parts:

- The Energy Source
- The Conductors
- The Switch (Control Device)
- The Load

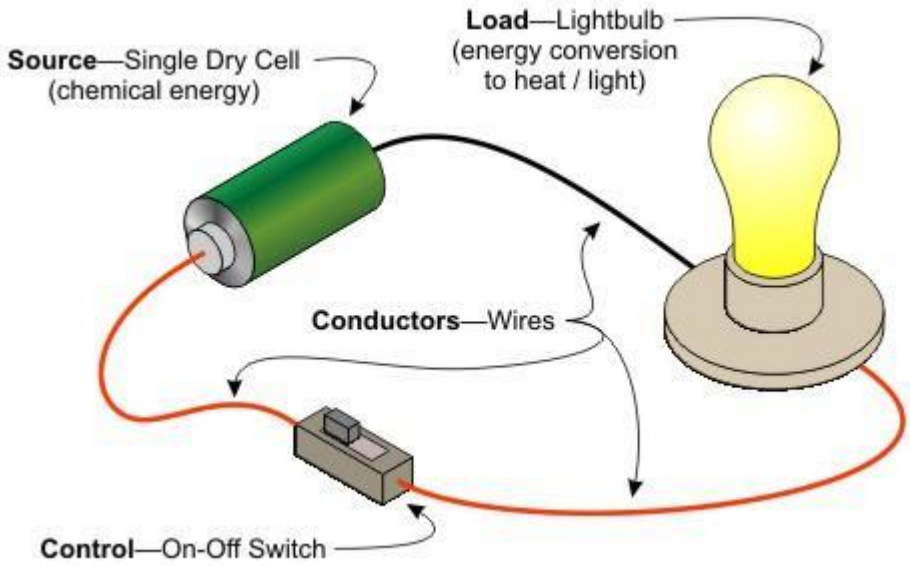


Fig. 2.1.3 Parts of an Electric Circuit

The Energy Source

In an electrical circuit, the voltage (the force that pushes electrons through a conductor — measured in volts) and current (the rate of electron movement — measured in amperes) supplied by the power source are used to energise a device connected to the circuit.

A voltage power source supplies the circuit with a consistent voltage level. Batteries, such as those in your laptop computer or car, solar panels, the alternator in your car, and the electricity from your local power plant or hydroelectric dam are examples of voltage power sources.

A current power source, also known as a constant-current source, supplies a constant current of energy independent of its voltage. Typically, constant-current circuits are incorporated into a system to protect the device supplying the circuit's electrical load. For instance, an LED requires a steady current level to prevent it from burning out or becoming damaged.

The Conductor

In an electrically powered environment with common electrical equipment, the conductor is the wire in a home or device that supplies the path of the circuit along which energy travels. The conductor (conduction) system connects all the other circuit components.

The flow of electricity is comparable to the flow of water through a pipe or hose. The conductor functions as the conduit through which electrical energy passes from its source to its load and occasionally back again. And, similar to the flow of water via a hose, the quantity of energy required

on the circuit (as demanded by the load device) defines the gauge of the conductor wire.

The Switch

The switch offers the control that either shuts (continues) or opens (breaks) the circuit's electrical current flow. There are numerous types of circuit switches, such as wall switches, push buttons, key toggles, and numerous biometric devices.

A closed circuit switch may feature either continuous or transitory contact. A sustained contact, such as a light switch, maintains the circuit in a state that permits a continuous energy flow. A transitory or momentary contact only supplies electricity to a circuit while a button or similar device is pressed or engaged. The circuit is reopened when the button is released.

The Load

Any device connected to an electrical circuit that is energised by the passage of electricity to it constitutes the circuit's electrical load. The load is the quantity of electrical energy a device requires to perform its function. This electrical consumption is measured in watts, which is equal to the circuit's current (amps) multiplied by its voltage (volts). Lights, televisions, motors, and heaters are load devices that consume electricity.

2.1.4 Passive Circuit Elements

Passive Elements are elements that have the ability to regulate the flow of electrons through them. The voltage is either increased or decreased. Here are some instances of passive elements.

- A resistor opposes the flow of electrical current through it. Ohm's law applies to linear circuits, which asserts that the voltage across a resistor is directly proportional to the current flowing through it, with the resistance serving as the proportional constant.
- An inductor stores electrical energy in the form of an electromagnetic field. The voltage across an inductor is proportional to its current's rate of change.
- A capacitor stores electrical energy in the form of an electrostatic field. A capacitor's voltage is proportional to its charge.

2.1.5 Types of Electric Circuit

There are three types of electric circuits:

Series Circuit

A series circuit contains only one path for the flow of electricity between two points. The amount of electricity in the circuit is uniform across all circuit components. When electricity flows across a series circuit, the flow rate (speed) is constant. In a series circuit, the overall resistance equals the sum of the individual resistances. The greater the number of resistors in a series circuit, the more challenging it is for electrons to flow.

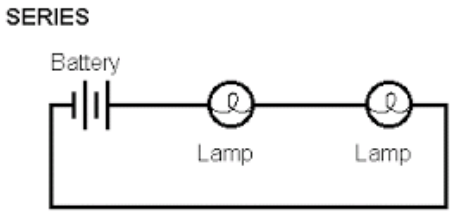


Fig. 2.1.4 Series Circuit

Parallel Circuit

A parallel circuit provides numerous routes for the passage of electricity between two points. According to website All About Circuits, "all components are connected between the same set of electrically common points." Resistors and sources are frequently connected between two sets of electrically shared locations. In a parallel circuit, electricity can flow in numerous directions horizontally and vertically. The components in a parallel circuit will have the same voltage across their ends and will have identical polarity.

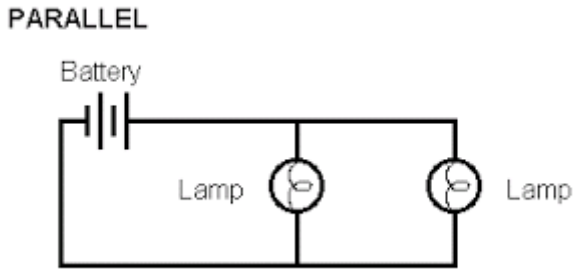


Fig. 2.1.5 Parallel Circuit

Combination Circuit

A combination circuit consists of both series and parallel pathways for the passage of electricity. It possesses a combination of the two traits. In this example, the parallel segment of the circuit functions as a subcircuit and is actually a component of a larger series circuit.

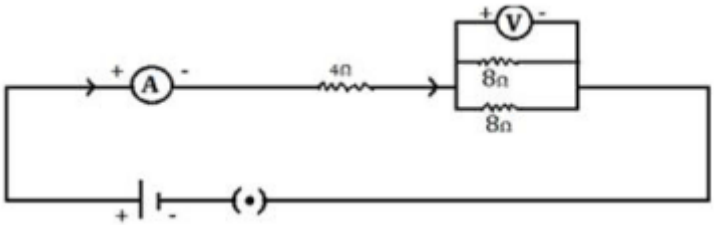


Fig. 2.1.6 Combination Circuit

2.1.6 Circuit Breaker

A circuit breaker is a switch that can be activated automatically or manually for the purpose of safeguarding and managing an electrical power supply. In the modern power system, the design of the circuit breaker has altered in response to the large working currents and to prevent arcing.

From the power distribution networks, electricity flows to homes, offices, schools, industries, and other locations, forming a huge circuit. The lines that are linked to the power plant are referred to as the hot wire, while the lines that are connected to the ground are referred to as the other end. Whenever electrical current passes between these two lines, a potential is created. The connection

of loads (appliances) provides resistance to the passage of charge over the entire circuit, allowing the electrical system in a home or business to function without interruption.

They perform smoothly as long as the appliances are sufficiently resistant and do not generate any excess current or voltage. Too much charge travelling through the circuit, a short circuit, or the rapid connecting of the hot end wire to the ground wire would cause the wires to overheat and catch fire. The circuit breaker will prevent instances in which the remaining circuit is simply switched off.

Types of Circuit Breaker

Ground fault circuit interrupter (GFCI) circuit breakers interrupt the entire circuit's power supply. A current overload, short circuit, or line-to-ground fault will trigger them. When an unintended path arises between an electrical current and a grounded element, this can occur.

Fig. 2.1.7 GFCI circuit breakers

Arc fault circuit interrupter (AFCI) circuit breakers protect against an inadvertent electrical discharge that could create a fire in an electrical cable or wiring. Once the circuit breaker detects the electrical jump and irregular path, it immediately disconnects the faulty circuit before the arc can generate sufficient heat to ignite.

Fig. 2.1.8 AFCI circuit breakers

Combination arc fault circuit interrupters (CAFCI) guard against low-energy series arcing in addition to the arcs covered by AFCI. As a result of their ability to protect downstream branch circuit wiring and power cords, they are gaining popularity in households.

Fig. 2.1.9 CAFCI circuit breakers

2.1.7 Relay

Relays are straightforward electromechanical switches. While regular switches are used to manually close or open a circuit, a Relay also connects or disconnects two circuits. A relay, however, uses an electrical signal to drive an electromagnet, which connects or disconnects a second circuit.

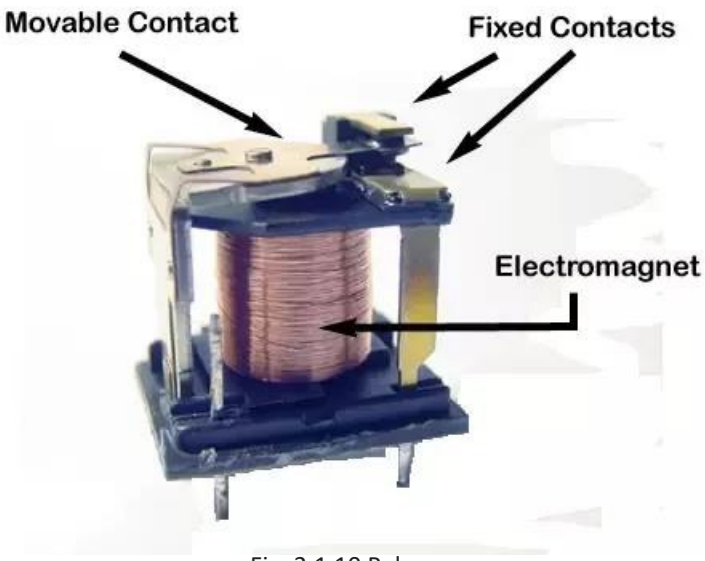


Fig. 2.1.10 Relay

Every electromechanical relay is comprised of:

- Electromagnet
- Mechanically movable contact
- Switching points and
- Spring

The construction of an electromagnet involves winding a copper coil around a metal core. As seen, the two ends of the coil are linked to two pins of the relay. These two are used for the DC supply.

- Relay operates on the electromagnetic induction principle.
- When a current is applied to the electromagnet, a magnetic field is produced around it.
- The graphic above depicts the operation of the relay. Utilizing a switch to supply DC current to the load.
- Copper coil and iron core serve as electromagnets in the relay.
- As demonstrated, when a DC current is given to the coil, it begins to attract the contact. This is known as relay energising.
- When the supply is removed, the object returns to its initial position. This is referred to as de-energizing the relay.
- There are also relays whose contacts are initially closed and open when a power supply is present, i.e. the exact opposite of the relay depicted above.

Types of Relays

Relays can be categorised based on their functionality, construction, and application, among other factors. Here are some of the most frequent types of relays.

- Electromagnetic
- Latching
- Electronic
- Non-Latching
- Reed
- High-Voltage
- Small Signal
- Time Delay
- Multi-Dimensional
- Thermal
- Differential
- Distance
- Automotive
- Frequency
- Polarized
- Rotary
- Sequence
- Moving Coil
- Buchholz
- Safety
- Supervision
- Ground Fault

2.1.8 Starter Motor

A starter motor is an electrical device utilised to consistently start and stop a motor. Similar to a relay, the motor starter switches the power ON/OFF, but unlike a relay, it also provides safety against low voltage and overcurrent.

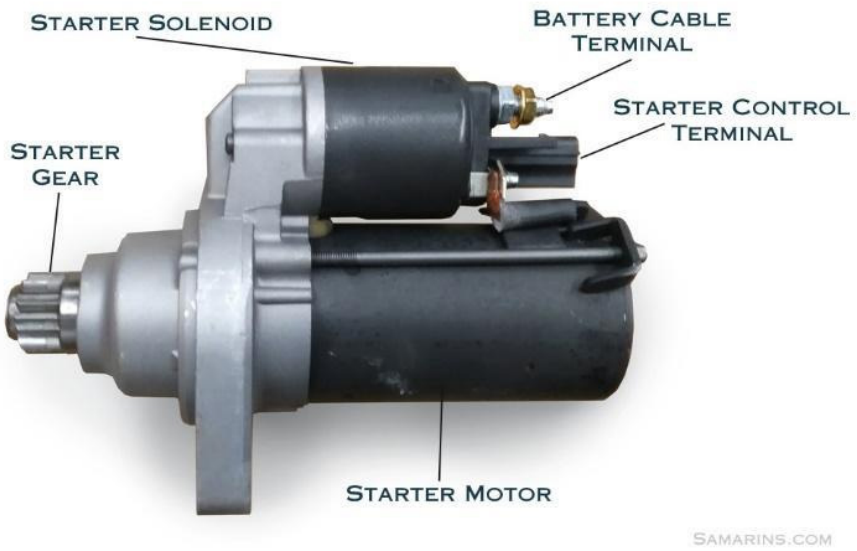


Fig. 2.1.11 Starter

A motor starter's principal duty is to safely halt a motor.

- To start a motor safely.
- To reverse the direction of the motor.
- To safeguard the gadget against low voltage and excessive current.

Types of Starter Motor

Different types of starter motors are as the below:

1. **Manual Starter**

   This sort of starter is manually operated and requires no prior experience. A button is used to switch ON and OFF the motor that is attached to it. The mechanism that follows the button push contains a mechanical switch that interrupts the circuit or causes the motor to stop or start.

2. **Magnetic Starter**

   Magnetic starter motors are the most common type of starter, and they are typically utilised in AC motors with high power. These starters perform electromagnetically like a relay that uses magnetism to make or break contacts.

   Magnetic starters are comprised of two circuits:

   - The power circuit is responsible for supplying energy to the motor. It features electrical contacts that, via an overload relay, turn ON/OFF the power provided from the line to the motor.
   - Control circuit_ this circuit regulates the connections of the power circuit to either disconnect or reconnect the motor's power source. To modify the electrical connections, the

electromagnetic coil is de- or re-energized. Consequently, this type offers remote control.

3. **Direct Online (DOL) Starter**

   Direct Online Starting, also known as DOL, is the simplest motor starter that links the motor directly to the power source. A magnetic contactor connects the motor to the supply line, and an overload relay safeguards against overcurrent. There is no voltage decrease necessary for starting a motor reliably. Therefore, the engine using such starters has a horsepower rating of less than five. It contains two easy-to-use push buttons for starting and stopping the motor.

4. **Stator Resistance starter**

   To start motors, a stator resistance starter employs the low voltage starter approach. External resistance is connected in series with all three phases of the stator of a three-phase induction motor. The role of the resistor is to reduce the line voltage (and, consequently, the starting current) linked to the stator.

5. **Slip Ring or Rotor Resistance Starter Motor**

   This type of motor starter runs on a motor system with full voltage. It is known as a slip ring starter motor because it only runs with a slip ring induction motor.

Through the slip ring, external resistances are coupled to the rotor in a star configuration. These resistors reduce rotor current and increase torque, hence decreasing starting stator current. Additionally, it contributes to the enhancement of the power factor.

The resistors are only utilised during the motor's start-up. It is eliminated once the engine attains its calculated speed.

2.1.9 Ampere's Law

Ampere's law is a fundamental principle in electromagnetism that describes the relationship between the electric current flowing through a closed loop and the magnetic field it generates. It is named after the French physicist André-Marie Ampère.

Mathematically, Ampere's law is often stated using the integral form:

$\oint B \cdot dl = \mu_o * I$,

where:

- $\oint B \cdot dl$ is the line integral of the magnetic field B around a closed loop.
- μ_o (mu naught) is the permeability of free space, a constant.
- I is the total current passing through the surface bounded by the closed loop.

In simpler terms, Ampere's law indicates that the circulation of the magnetic field around a closed loop is directly proportional to the electric current passing through the loop. It provides a way to calculate the magnetic field created by a current-carrying conductor and is a crucial tool in understanding and predicting the behavior of magnetic fields.

Ohm's Law: Ohm's law is a fundamental principle that relates the relationship between voltage, current, and resistance in an electrical circuit. It is named after the German physicist Georg Simon Ohm.

Mathematically, Ohm's law is expressed as:

V = I * R,

where:

- V is the voltage across a resistor or component (measured in Volts).
- I is the current passing through the resistor or component (measured in Amperes).
- R is the resistance of the resistor or component (measured in Ohms).

In simpler terms, Ohm's law states that the current flowing through a conductor is directly proportional to the voltage applied across it and inversely proportional to the resistance of the conductor. It is a foundational principle in electrical engineering and is used extensively in circuit analysis and design.

2.1.10 Electromagnetic Field

An electromagnetic field refers to the combined electric and magnetic fields that are generated by charged particles in motion. This phenomenon is fundamental to the behaviour of electricity and magnetism and is described by Maxwell's equations, a set of fundamental equations in electromagnetism.

When an electric charge is in motion, it generates a magnetic field around it. Similarly, a changing magnetic field induces an electric field. Together, these fields create electromagnetic waves that propagate through space at the speed of light. Electromagnetic fields play a crucial role in various technological applications, including radio waves, microwaves, visible light, and other forms of electromagnetic radiation.

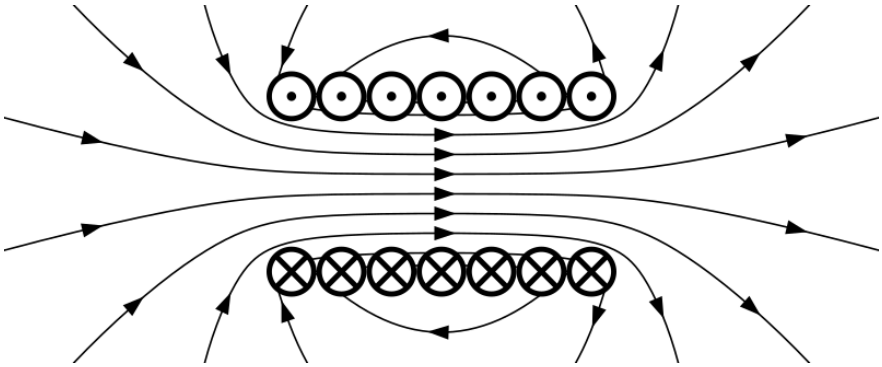


Fig. 2.1.12 Electromagnetic Field

2.1.11 Hand Tools

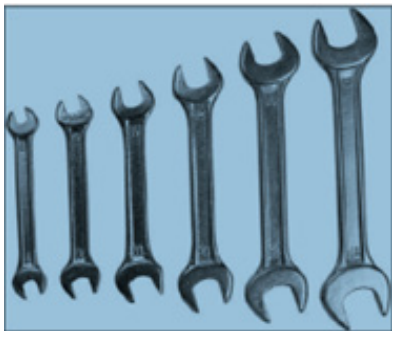
Any tool that is used manually rather than by a motor is referred to as a hand tool. Examples of hand tools include wrenches, pliers, cutters, hammered tools, screwdrivers, saws, drills, and knives.

The Importance of Hand Tools and Their Appropriate Application

- Injuries caused by hand tools are typically attributable to poor use or faulty maintenance. It is essential for electricians, craftsmen, and all other tool users to be familiar with recommendations for the care and safe use of hand tools. When utilising hand tools, you should consider the following information:
- Personal protection equipment (PPE) must be worn when required.
- Utilize the appropriate instrument for the task at hand. Utilizing a tool that is not suited for the task may result in severe damage and injury.
- Utilize the appropriate-sized tool.
- Use a tool only after receiving training in its fundamental safety and appropriate operation.
- Inspect tools regularly to ensure they are in good shape and maintain that state.
- Maintain clean and dry tools. (Clean hand tools are more effective)
- Lubricate tools as required. (Lubrication facilitates the operation of hinged-joint instruments)
- Repair broken or damaged instruments as soon as possible, and dispose of those that cannot be fixed.
- Razor blades and utility knife blades should be disposed of in a puncture-resistant sharps container.
- Use caution when operating tools. (Only those who are trained and qualified should work on electrical lines.)
- When not in use, shop tools properly in a safe location.
- Maintain the sharpness of all cutting instruments to ensure that they move without bending or skipping.
- Maintain a firm grasp on the instrument and maintain a balanced stance to prevent slides.
- Ensure that your work place is clean, dry, well-lit, and uncluttered.

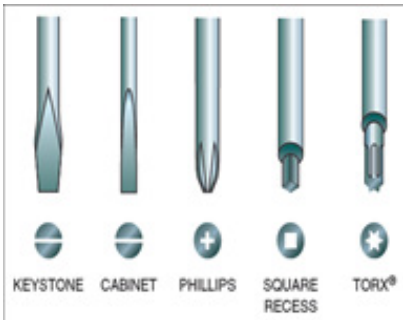
Basic Hand Tools

In the electrical industry, numerous tools are employed. A tool pouch worn on the electrician's hip fits hand tools with ease. Following list is of the most common tools used by electricians.

Tool name	Description	Image
Wrenches/ Spanner	Wrenches are frequent hand tools. Their primary use is to retain and turn nuts, bolts, cap screws, plugs, and other threaded components. Quality wrenches are designed to maintain a healthy balance between leverage and desired load. Standard spanner types with both American standard inch and metric apertures are available for the vast majority of applications and services.	
Chisel	A chisel is a tool having a distinctively formed cutting edge on its blade, used to carve or cut hard materials such as wood, stone, or metal by hand, a mallet, or mechanical force. Some varieties of chisels have handles and blades made of metal or wood with a sharp edge.	

Pliers	Diverse varieties of pliers are utilised by virtually everyone who uses tools. There are several varieties and sizes. Each pair of pliers is designed for a distinct purpose, however its adaptability allows some to be used for a variety of tasks. Here are the most popular types of pliers, sometimes known as pouch tools: • Lineman • Long-nose • Diagonal cutting	
	Lineman **There are two different head styles:** the standard, also known as the bevel nose, and the New England, also known as the round nose. A bevel is any edge that is cut at an angle to a flat surface. Lineman pliers, also known as side-cutter pliers, are one of the most commonly used hand tools among electricians. The purpose of these pliers is to cut wires, conductors, and small screws. In addition to forming massive conductors, they are also used to pull and retain conductors. Always use the appropriate-sized pliers for the job. Typically, the length of the handles should be approximately 9 inches so that minimal hand pressure is necessary to cut the conductor or cable.	
	Long-nose Long-nose pliers, commonly known as needlenose pliers, are used to create small conductors, cut conductors, and hold and pull wires. The long-nose pliers, also known as needlenose pliers, make it easier to work in confined spaces due to its small head. Typically, electricians employ long-nose pliers with at least an 8-inch grip.	

	Diagonal cutting Diagonal cutting pliers, sometimes referred to as dikes, are used to cut cables and conductors in areas with limited working space.	
Wire Cutters	Wire cutters are an instrument made specifically for cutting wire. There are various variations on the basic design, including versions with varying weights for wires of varying thicknesses. These cutters, also known as snips or diagonal pliers, are constructed similarly to pliers, but instead of grips, they include pointed edges that cut through wire. The larger and heavier the wire cutters, the larger the wire gauge they can manage. Wire cutters may also include insulated handles, which can be advantageous in some applications, and some may incorporate a wire stripper, allowing electricians to strip and cut wire with the same instrument.	
Wire Strippers	The main function of wire strippers is to strip (remove) insulation from wires. Additionally, conductors are chopped and formed with this instrument. The two types of wire strippers that electricians most frequently employ are listed below. • T-Stripper Wire Stripper • Cable ripper	
	T -Stripper Wire Stripper The nonadjustable T-Stripper Wire Stripper is the type of wire stripper that is most frequently used in domestic electrical work. Without needing to be modified for each size, the T-Stripper Wire Stripper can remove the insulation from a variety of wire sizes. The most frequent wire sizes used in household power are 10 through 18 AWG. The ideal instrument for removing insulation from cables of this size is the T-Stripper Wire Stripper.	

	Cable Ripper A non-metallic sheathed cable's exterior sheathing is removed using cable rippers. A sheathed cable is one that is shielded by a nonconductive covering, such as vinyl. Sheathing is a protective covering that wraps or surrounds something. The purpose of cable rippers is to slit the cable sheathing. The cable sheathing is then sliced off using a knife or cutting pliers.	
Screwdrivers	The Keystone and Phillips screwdrivers are the two screwdriver types most frequently used in electrical work. Slot-head screws are installed and removed using the Keystone. Slot-head lugs can also be tightened and unfastened using this screwdriver. To instal and remove Phillips-head screws as well as tighten and loosen Phillips-head lugs, use Phillips-tip screwdrivers. The stubby screwdriver is a very useful tool for tightening and loosening screws in small spaces. Keystone and Phillips screwdriver designs are both available for stubby screwdrivers.	
Knife	The electrician's knife is a useful item frequently used by residential electricians. The insulation from large conductors and cables can be removed with the electrician's knife, which can also be used to open cardboard boxes housing electrical equipment. A typical electrician's knife has a cutting blade as well as a screwdriver blade. The utility knife with a retractable blade and the hawkbill knife with a curved blade are two more well-liked electrician's knives.	

Hammer	A very helpful instrument for residential electricians is the electrician's hammer. A hammer is used to strike awls and chisels, drive and pull nails or staples, pry open boxes, and shatter wallboard. An awl is a tiny tool used for making small holes or marking surfaces. A chisel is a cutting-edge edge instrument with a flat steel blade. Long, straight claws on an electrician's hammer are ideal for making it simple to remove electrical apparatus. The electrician's hammer handle needs to be sturdy and shock-absorbing. The handles on the most common hammers are made of fibreglass. The most popular hammers among residential electricians are the 18- and 20-ounce models.	
Hacksaw	Some conduit types are typically cut with a hacksaw, along with larger conductors and cables. Currently, hacksaws are made with sturdy frames that are lightweight but have enough rigidity to allow exceptional cutting control. For electricians, a hacksaw blade with 24 teeth per inch is the finest all-around option. Additionally, electrical work hacksaw blades come in tooth counts of 18 and 32 per inch. Awl, a tiny tool used for making small holes or marking surfaces. Chisel, a cutting-edge tool having a flat steel blade.	
Tape Measure	One of the most helpful items in an electrician's toolbox is the tape measure. It is a measurement device that consists of a thin strip of material (metal or cloth) marked with inches or centimetres. Typically, measurements are taken with a tape measure to establish the proper placement of electrical equipment. Standard lengths for tape measures are 12, 16, 20, and 25 feet. The 25-foot length, 1-inch-wide tape measure is the one that is most frequently used. When the tape is expanded, it may break or bend if it is too small.	

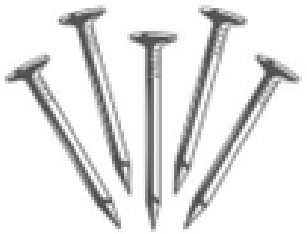
Nail	A nail consists of three fundamental parts: a point that drives into the work pieces, a shank or shaft that binds the work pieces together and provides much of the strength and holding power, and a head that allows the fastener to be driven and prevents it from tearing through the work pieces.	

Table 2. 1.1 Hand Tools

2.1.12 Power Tools

Electric power tools include both those that run on 120-volt alternating current and those that run on low-voltage direct current. Double-insulated ac-powered tools with a two-prong connector are a type of electrical protection that includes two distinct insulation systems to assist protect against electrical shock caused by internal problems. All other power tools feature a grounding attachment plug with three prongs. Power is supplied by rechargeable batteries to cordless power tools. When working with power tools, remember this rule: Only use a tool after you have been educated in basic safety and correct tool use. When utilising power tools, the following guidelines should be followed:

- Wear personal protective equipment (PPE) as necessary.
- Do not use power tools in explosive environments, such as those containing flammable substances like petrol. Power tool sparks have the potential to ignite gasoline fumes.
- Bystanders should be kept away from the work area. Injuries could result from flying debris. Check that grounded tools are plugged into a grounded outlet.
- Polarized attachment plugs are used on double-insulated power tools. A polarised plug is one that has one prong that is longer than the other and can only be placed into an outlet one way. Make sure it's plugged into a properly equipped polarised receptacle.
- In rainy situations, do not use electric power tools.
- Never utilise a power tool's lead incorrectly. Never transport a tool by the lead.
- When using a power tool outside, use an extension lead labelled "W-A" or "W." These cords are intended for outdoor use.
- Never use a power tool if you are tired or on drowsy medicine.
- Wearing loose clothing or jewellery while operating a power tool is never a good idea.
- Before plugging a power tool into an outlet, make sure it is turned off.
- Before applying power, be sure that all chuck keys or other tightening wrenches are removed.
- When utilising a power tool, make sure you have solid footing.
- Always use the appropriate power instrument for the task.
- Always keep power tools in a dry and clean place, away from children and other inexperienced individuals.

- Never use a faulty or broken tool.

The types of power tools are as follows:

Tool name	Description	Image
Power Drills	A power drill fitted with an appropriate bit is used to bore holes in wood, metal, plastic, or other materials for the installation of wire lines, conduits, and other electrical equipment. Power drills are widely used by residential electricians. Power drill versions, like other power tools, are available with a power cord and socket or cordless with rechargeable batteries. The following are the primary types of power drills: • Pistol-grip • Hammer	
	Pistol-Grip Drill The most popular form of drill used nowadays is one with pistol grips. Pistol-grip drills are tiny, lightweight, and simple to operate. This drill resembles and is held in the manner of a pistol. This type of drill is commonly referred to as a variable-speed drill.	
	Hammer Drill The hammer drill is similar to a regular variable-speed drill, but it has a hammer motion for drilling masonry or concrete walls and floors.	
Power Saws	Power saws are frequently used by electricians. Power saws are used to cut plywood backboards for mounting electrical equipment and to cut building structural members during electrical wiring installation. The following are two popular power saws: • Circular • Reciprocating	

	Circular Saw A circular saw is an electric saw that cuts wood, metal, or plastic depending on the blade used. Circular saws have a handle with an on/off trigger switch, an arbour nut to secure the blade, and guards to keep the operator from coming into contact with the spinning blade. A mandrel is a tool component that can be used to grip other moving tool components. The circular saw is sometimes known as a skilsaw.	
	Reciprocating Saw A reciprocating saw is a saw in which a push-and-pull reciprocating motion of the blade accomplishes the cutting action cutting action is accomplished by a push-and-pull reciprocating motion of the blade. The blade on this saw is reciprocating, which means it moves back and forth. Remember that the circular saw blade rotates in a round or round motion. A reciprocating saw is also referred to as a recipro saw, or a sabre saw.	
Wall Chaser	A wall chaser is a specialised power tool that is utilised for the purpose of cutting thin grooves in walls, for example when electrical cable is being laid.	

Table 2.1.2 Power Tools

2.1.13 Electrical Material

Electrical Materials, also known as Electrical Supplies, are key components or elements used in a construction project to link your home, business, or building to an electrical power source. Electrical components can range in size from a tiny home circuit to a sizable industrial plant.

Electrical materials can be categorised as follows based on their characteristics and areas of application:

- Conductors

- Semiconductors
- Insulating Materials
- Magnetic Materials

a. Conductors

Materials with a high conductivity are known as conductors. At normal temperature, a conductor has a large number of free electrons, which is the primary cause of the conductors' high conductivity. Silver, copper, gold, aluminium, etc. are some examples.

Silver is one of the good electrical conductors because it has a large amount of free electrons. The nucleus exerts very little binding force on these free valance electrons. Because of this, these electrons can readily escape from the nucleus and take part in the electrical current.

In equilibrium, a conductor exhibits the following properties:

- A conductor constantly permits electrons and ions to pass through them.
- The electric field within a conductor is zero, allowing free electron flow.
- There is no charge density within a conductor.
- Only on the conductor's surface are there no charges.
- All conductor points have the same potential.

Many metals are excellent electrical conductors. This is the reason why electrically conducting appliance components are comprised of metals. Insulator refers to the plastic covering that surrounds an electrical conductor. It safeguards us against receiving an electric shock.

b. Semiconductors

Semiconductors are substances with conductivities halfway between those of conductors and insulators. The elements of group III, group IV, and group IV are semiconductors. Materials used in semiconductors have covalent bonds. Semiconductors have very low conductivities at room temperature. The conductivity of semiconductors grows exponentially with temperature.

Examples include Germanium, Silicon, Gallium, and Arsenic.

The important properties of a semiconductor are:

- The resistivity of a semiconductor is lower than that of an insulator and greater than that of a conductor.
- Semiconductors have a temperature coefficient of resistance that is negative. The resistance of semiconductors reduces as temperature rises, and vice versa.
- At 0 Kelvin, semiconductors exhibit insulator behaviour. As the temperature rises, it conducts electricity.
- Impurities increase the conductivity of semiconductors. Doping is the process of adding impurities to semiconductors.

c. Insulating Materials

Insulating materials have relatively low conductivities. These materials are ideal for isolating the current-carrying components from earthed metallic structures because of their extremely high resistivity. The electrons and nuclei are closely bonded in insulating materials. As a result, they cannot be released for material mobility. As a result, insulating materials have very high resistance. These are known as bad conductors of electricity.

Examples include PVC, ceramics, and plastics.

i. Physical Properties

Physical characteristics include density, porosity, moisture resistance, thermal expansion coefficient, low odour level, inflammability, compactness, and surface tension. The desirable characteristics of insulated materials are as follows:

- Low density.
- It should not have its own odour and should instead absorb the odour of other particles.
- It must resist moisture penetration and not degrade when moisture accumulates.
- If it were combustible, it would be hazardous in the presence of electricity.

ii. Chemical Properties

Insulation's chemical qualities allow it to keep its own structure in adverse environments and also prevent substances from becoming corrosive. An insulation material intended for use in the chemical sector must be resistant to acid and corrosive gases.

d. Magnetic Materials

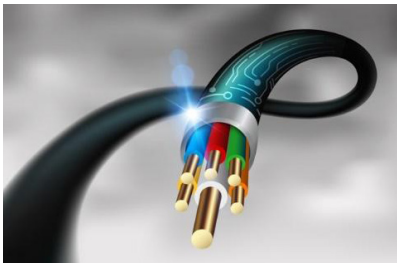
These minerals are crucial to the existence of many different electrical machines. The core is constructed using magnetic materials with high permeability to allow magnetic flux to flow along a channel with low reluctance. The following categories further categorise magnetic materials:

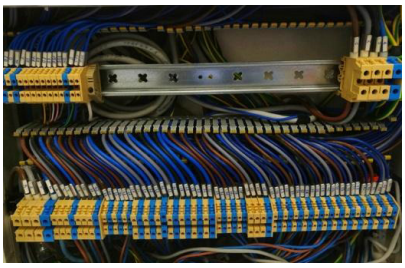
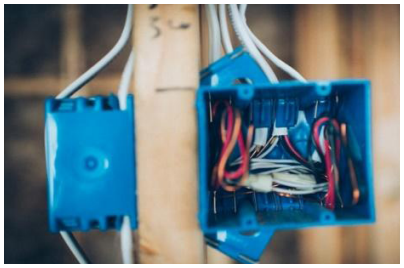
- Ferromagnetic substances
- Magnetic substance
- Diamagnetic substances
- Materials that are antiferromagnetic
- Ferrites

2.1.14 Various Electrical Material

The various electrical material is as follows:

Tool name	Description	Image
Electrical Conduit and Conduit Fitting	A conduit known as an electrical conduit transports electrical wire for communications or power. Rigid steel, lighter steel known as IMC or intermediate conduit, EMT or thin wall conduit, plastic or PVC, aluminium, or PVC coated, which is rigid covered with a 40 mil PVC jacket, are all used to make conduit. Electrical conduit comes in sizes ranging from 3/8" to 6".	

Electrical Wire and Cable	Electrical Copper or aluminium is pulled into wire that delivers energy across an electrical circuit. It is possible to run wire overhead, underground, through conduit or flex conduit, or openly. The design of a wire's jacket is determined by its intended use. It can also be adaptable, as with extension cords. It can range in size from as tiny as 26 gauge to as large as 2,000 MCM.	
Explosion Proof Enclosures	Explosion-Proof is the design of a product that prevents an electrical short from igniting a hazardous environment and generating an explosion. These items would be utilised at refineries, gas stations, and paint booths, among other places. They are constructed of steel or aluminium, and can also be made of fibreglass.	
Distribution Boxes	A distribution box, also known as a distribution board, panel board, breaker panel, or electric panel, ensures that electricity is distributed throughout a facility. It is the electrical distribution system of a structure or property. As a component of an electrical system, it divides electrical power into subsidiary circuits and provides a circuit breaker or fuse for each circuit. All the contact breakers, earth leakage units, doorbells, and timers are contained within a distribution box. The network provides electrical power to the building through the main feeding line. The wire is linked to the distribution board, and the secondary circuit breakers distribute electricity (lights and plugs).	
Circuit Breakers	Circuit breakers are devices that block the flow of an electric current in the event of a short or overload. Multiple manufacturers, including Cutler Hammer/Westinghouse, General Electric, Square D, ITE Sieonans, and Federal Pacific, produce circuit breakers. Circuit breakers protect anything from the smallest residential circuit to the largest industrial needs.	

Electrical Connectors	Electrical Connector is a component that joins or adapts two other components. Connector sizes range from 3/8” to 6”. They may be for indoor or outdoor use, corrosive-resistant, or explosion-proof.	
Electrical Box	Electrical Box is a container that serves multiple tasks, including pulling, connecting, and terminating an electrical circuit. The electrical box can be put screw or installed indoors; it can be weatherproof or installed outdoors. They may be constructed from steel, aluminium, plastic, stainless steel, or cast iron. Design requirements can include corrosion protection and explosive protection.	
Lugs	Lugs are the electrical connectors used to complete the circuit. Copper, aluminium, or bronze are used to create lugs. They are designed for wire sizes ranging from 26 gauge to 2,000 MCM. Mechanical or set screw, compression or crimp, solder or weld, or clamp-type lugs may be used. Several manufacturers of lugs include T&B, Burndy, Penn Union, Panduit, and 3M.	
Motor Control	Motor Control is a device for controlling a motor or mechanism. It can operate everything from the simplest mechanisms to the greatest turbines. There are numerous motor control manufacturers, such as Allen Bradley, Square D, Cutler Hammer, ITE Siemens, General Electric, and Westinghouse.	
Electric Light	A light bulb, lamp, or electric light is an electrical component that creates light. It is the most prevalent artificial lighting source.	

Cable Trays	Cable trays are mechanical support systems that offer a robust structural structure for electrical cables, raceways, and insulated conductors used for power distribution, control, signal instrumentation, and communication. The materials galvanised steel, stainless steel, and aluminium are used to construct cable trays. The non-metallic material for cable trays is plastic bonded with glass fibres.	
Electrical Riser Brackets	Electrical riser brackets are used to elevate the electrical supply wire from the supply pole to the premises above the ground as part of the premises' electrical installation.	
Ladders	Most electricians utilise timber or fibreglass step ladders, with fibreglass typically being favoured due to its higher strength and less weight, which makes it easier to handle and transport.	

Table 2.1.3 Various Electrical Material

2.1.15 Material Handling, and Storage

Employees should seek assistance when a weight is so large that it cannot be properly grasped or lifted, when they cannot see around or above it, or when they cannot securely handle the burden.

Handles or holders should be fitted to loads to avoid the possibility of fingers being pinched or damaged. Workers should also wear suitable protection equipment. Wear gloves or other hand and forearm protection when handling loads with sharp or rough edges. Additionally, utilise eye protection to avoid eye damage. When moving big or bulky goods, the mover should also wear steel-toed safety shoes or boots to prevent foot injuries if he or she falls or loses a load.

All stacked loads must be correctly piled and, where possible, cross-tiered. When stacking and storing materials, precautions should also be observed. Materials in storage must not pose a hazard. Storage facilities must be kept clear of collected objects that could cause tripping, fires, or explosions, or that could harbour rats and other pests.

When stacking and piling materials, keep in mind the height and weight of the materials, how accessible the stored materials are to the user, and the condition of the containers where the products are stored. Non-compatible materials must be stored separately. Employees who operate with stored materials in silos, hoppers, or tanks must wear lifelines and safety belts. To prevent slipping, tumbling, or collapsing, all tied material should be piled, placed on racks, blocked, interlocked, or otherwise secured. No load may be applied on any floor of a building or other structure that is greater than that allowed by a building official. Load restrictions certified by the building inspector should be prominently displayed in all storage facilities, when relevant.

Height restrictions should be considered when stacking materials. For example, if lumber is handled manually, it must be stacked no higher than 16 feet; if a forklift is used, the maximum stacking height is 20 feet. Stripes on walls or posts can be painted to indicate maximum stacking heights for convenient reference.

Before stacking used timber, all nails must be removed. Lumber must be placed and levelled on bracing that is properly supported. The stacks must be self-supporting and stable. Stacks of loose bricks should not be taller than 7 feet. When these stacks reach 4 feet in height, they should be tapered back 2 inches for every foot above that level. When stacking masonry blocks higher than 6 feet, the stacks should be tapered back one-half block for each tier above 6 feet. To be secure, bags and bundles must be piled in interlocking rows. Stepping back the layers and cross-keying the bags at least every ten layers is required when stacking bagged items. Begin removing bags from the stack from the top row. Inside a structure, baled paper and rags must be kept at least 18 inches away from the walls, partitions, or sprinkler heads.

Boxed materials must be banded or held in place using shrink plastic fibre or cross-ties.

Drums, barrels, and kegs must be symmetrically arranged. The lower tiers must be blocked if stored on their sides to prevent rolling. Put boards, sheets of plywood dunnage, or pallets between each tier when stacking on end to provide a sturdy, flat stacking surface. To prevent moving in any direction while stacking materials two or more levels high, the bottom tier must be chocked on both sides. Consider the necessity for material availability when stacking. Materials that cannot be piled owing to their size, form, or fragility can be stored safely on shelves or in bins.

Unless in racks, structural steel, bar stock, poles, and other cylindrical components must be stacked and blocked to prevent spreading or tilting. Pipes and bars should not be housed in racks that face main aisles; this may pose a hazard to passers-by when supplies are removed.

2.1.16 Electrical Measuring Instruments

Electrical measuring instruments consist of all equipment used to measure the magnitude of an electric current for various purposes. Typical values measured with this apparatus are current, voltage, resistance, and power. Each is stated in a unique unit: amps, volts, ohms, and watts, in that order.

The majority of measuring devices are portable, allowing for quick and reliable measurements.

Depending on what must be determined regarding an electrical circuit, various magnitudes can be measured:

- **Voltage:** Voltage is the power difference between two points of an electrically conducting element. Volt is its unit of measurement.
- **Intensity**: Intensity is the magnitude of the current flowing through an electrical circuit. Its measurement unit is the amp.
- **Resistance**: Resistance is the conductor's value relative to the flow of electrons. Ohm is its unit of measurement.
- **Capacitance**: Capacitance is the capacity of an element in an electrical circuit to store charge. Its unit of measurement is the amp as well.
- **Electrical power**: The combination of voltage (volts) and current (amps) produces electrical power (amps). Watt is the unit of measurement for this quantity.

Main Electrical Measuring Instruments

Device name	Description	Image
Galvanom-eter	Indicates the intensity of an electric circuit's current flow.	
Voltmeter	An instrument for measuring the potential difference between two points of a closed electrical circuit or the electromotive force of a battery. This device must have a high electrical resistance so that, when connected to the circuit, it does not generate consumption that affects the measurement result and precision.	
Ammeter	Measures the intensity (i.e. amps) of current in a circuit.	

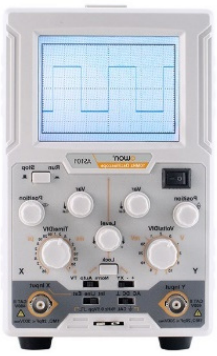
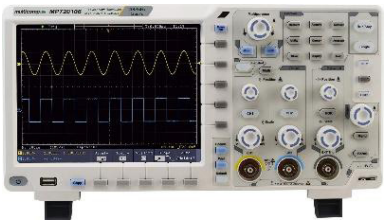
Ohmmeter	Measures the electrical resistance, or ohms, in a circuit.	
Multimeter	A multimeter is a metre that combines the characteristics of different metres; it contains the tools required to measure voltages, resistances, capacitances, etc.	
Oscilloscope	An oscilloscope is a measurement equipment and graphical representation of time-varying electrical signals. This tool enables the visualisation of transient events and improves the diagnosis and investigation of the operation and potential faults of an electrical circuit.	
Spectrum analyser	A piece of measurement equipment that displays the components and spectral ranges of electrical signals originating from electromagnetic, mechanical, acoustic, or optical waves.	

Table 2.1.4 Electrical Measuring Devices

2.1.17 Electrical Installations

Performing electrical installations involves a combination of skills, knowledge, and proper use of tools. Below, I'll outline the general steps for fitting conduits, cable wiring, fixing electrical fixtures, and terminating electrical connections at power outlets using both hand and power tools. Please note that this is a general overview, and specific procedures may vary based on local codes and regulations.

Tools Needed:

- Conduit bender (for bending conduit)
- Hacksaw or conduit cutter (for cutting conduits)
- Screwdrivers (both flathead and Phillips)
- Pliers (needle-nose and lineman's)
- Wire strippers/cutters
- Wire nuts or terminal blocks
- Voltage tester or multimeter
- Electric drill and appropriate bits
- Anchors and screws
- Tape measure
- Level
- Wire fish tape (for pulling cables)
- Wire connectors and cable clips

Fitting Conduits:

- Measure and mark the desired path for the conduit on the wall or ceiling.
- Use a conduit bender to bend the conduit to the required angles.
- Cut the conduit to the desired length using a hacksaw or conduit cutter.
- Secure the conduit to the wall or ceiling using appropriate anchors and screws.

Cable Wiring:

- Measure and cut the cables to the required length, leaving some extra for termination.
- Use wire fish tape to guide the cables through the conduit, if applicable.
- Pull the cables through the conduit carefully, avoiding sharp bends.
- Secure the cables to the conduit using cable clips.

Fixing Electrical Fixtures:

- Measure and mark the location for the fixture.
- Use an electric drill to create holes for mounting brackets or anchors.
- Attach the fixture's mounting brackets or anchors to the wall or ceiling.
- Connect the fixture's wires to the corresponding wires in the conduit, using wire nuts or terminal blocks.
- Secure the fixture to the mounting brackets or anchors using screws.

Electrical Connection Termination at Power Outlets:

- Turn off the power to the circuit at the breaker panel and verify it's off using a voltage tester.
- Remove the cover plate from the power outlet.
- Carefully pull out the outlet from the electrical box.
- Connect the wires from the conduit to the corresponding terminals on the power outlet.
- Use wire nuts to secure the connections and cover them with electrical tape.
- Carefully tuck the wires back into the electrical box and screw the outlet into place.
- Attach the cover plate.

General Safety Tips:

- Always turn off the power before working on electrical installations.
- Wear appropriate personal protective equipment, such as safety glasses and gloves.
- Ensure that all connections are secure and properly insulated.
- Follow local electrical codes and regulations.

Exercise

1. Explain the following in brief:
   a. Electric Current
   b. Series Circuit
   c. Circuit Breaker
2. Name the basic hand tools required in construction.
3. Electric power tools include both those that run on 120-volt alternating current and those that run on low-voltage direct current. Name 5 power tools used in construction.
4. Explain Material Handling, and Storage.
5. What are measuring devices? Explain with examples.
6. Demonstrate how to check proper and safe working of hand and power tools.
7. Explain type of electrical devices like starters, relays and circuit breakers, their power ratings, working principles and use in circuits.

Notes

QR Codes

Scan the QR code to watch the video

https://www.youtube.com/watch?v=1tAkPibrJ3M

Electric Current

https://www.youtube.com/watch?v=RQ3djos_LY8

Types of Electric Circuit

https://www.youtube.com/watch?v=FZ3saUFpDHM

Ampere's Law

https://www.youtube.com/watch?v=qxqGIGjyYTU&list=PLhSp9OSVmeyKvw2DTpzlCdl226DJ-QjTx

Electrical Measuring Instruments

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. Installing Temporary Lighting

Construction Skill Development Council

SCPwD
दिव्यांग व्यक्तियों के लिए कौशल परिषद
Skill Council for Persons with Disability

Unit 3.1 - Installing Temporary Lighting

CON/N0603

Key Learning Outcomes

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

1. Interpret Single line diagram (SLD)/ schematics/electrical wiring diagrams for the requirements and specifications of temporary lighting arrangement at the construction site.
2. Describe types of cables based on insulation, phase and their use as per power rating.
3. Explain types of conduits and fixtures such as switches, sockets, their selection method and respective uses in electrical works.
4. Describe types of safety equipment commonly used for protection of LV wiring circuits and their area of application.
5. Explain standard/ safe practice of cable laying at construction sites such as through underground conduits, through poles.
6. Describe types of lights units, their wattage and respective use in construction sites.
7. Explain standard practices of fixing lights and their respective accessories.
8. Explain type of faults associated with lighting arrangements.
9. Explain type of tests to be undertaken in lighting units and its accessories such as voltage test, leakage test, power interruption/ continuity test etc.
10. Explain standard conditions for storing and stacking electrical units, materials, fixtures, tools and devices.
11. Describe safe procedure of erection and dismantling of temporary scaffolding, ladders or working platforms.
12. Perform visual checks on electrical fixtures and materials related to lighting for their usability as per specified acceptance criteria
13. Select cables, lights and electrical fixtures depending upon electrical load requirement
14. Perform laying of cables through underground and overhead as per requirement as per SLD/ schematics/ electrical wiring diagram
15. Perform joining of cable in 'straight through joint' methods using PVC tapes or other safe methods
16. Demonstrate termination of LV cables as per standard practice
17. Demonstrate method of tagging electrical cables, underground electrical conduits by standard method
18. Perform repairing of electrical lighting arrangements.
19. Demonstrate methods of trace out short circuits, power interruptions/ continuity using appropriate electrical devices
20. Perform preventive maintenance on diesel generators

Unit 3.1: Installing Temporary Lighting

Unit Objectives

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

1. Interpret Single line diagram (SLD)/ schematics/electrical wiring diagrams for the requirements and specifications of temporary lighting arrangement at the construction site.
2. Describe types of cables based on insulation, phase and their use as per power rating.
3. Explain types of conduits and fixtures such as switches, sockets, their selection method and respective uses in electrical works.
4. Describe types of safety equipment commonly used for protection of LV wiring circuits and their area of application.
5. Explain standard/ safe practice of cable laying at construction sites such as through underground conduits, through poles.
6. Describe types of lights units, their wattage and respective use in construction sites.
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9. Explain type of tests to be undertaken in lighting units and its accessories such as voltage test, leakage test, power interruption/ continuity test etc.
10. Explain standard conditions for storing and stacking electrical units, materials, fixtures, tools and devices.
11. Describe safe procedure of erection and dismantling of temporary scaffolding, ladders or working platforms.
12. Perform visual checks on electrical fixtures and materials related to lighting for their usability as per specified acceptance criteria
13. Select cables, lights and electrical fixtures depending upon electrical load requirement
14. Perform laying of cables through underground and overhead as per requirement as per SLD/ schematics/ electrical wiring diagram
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16. Demonstrate termination of LV cables as per standard practice
17. Demonstrate method of tagging electrical cables, underground electrical conduits by standard method
18. Perform repairing of electrical lighting arrangements.
19. Demonstrate methods of trace out short circuits, power interruptions/ continuity using appropriate electrical devices
20. Perform preventive maintenance on diesel generators

3.1.1 Interpreting Single Line Diagram

Interpreting a Single Line Diagram (SLD), schematics, or electrical wiring diagrams for temporary lighting arrangements at a construction site involves understanding the symbols, components, and connections depicted in the diagram.

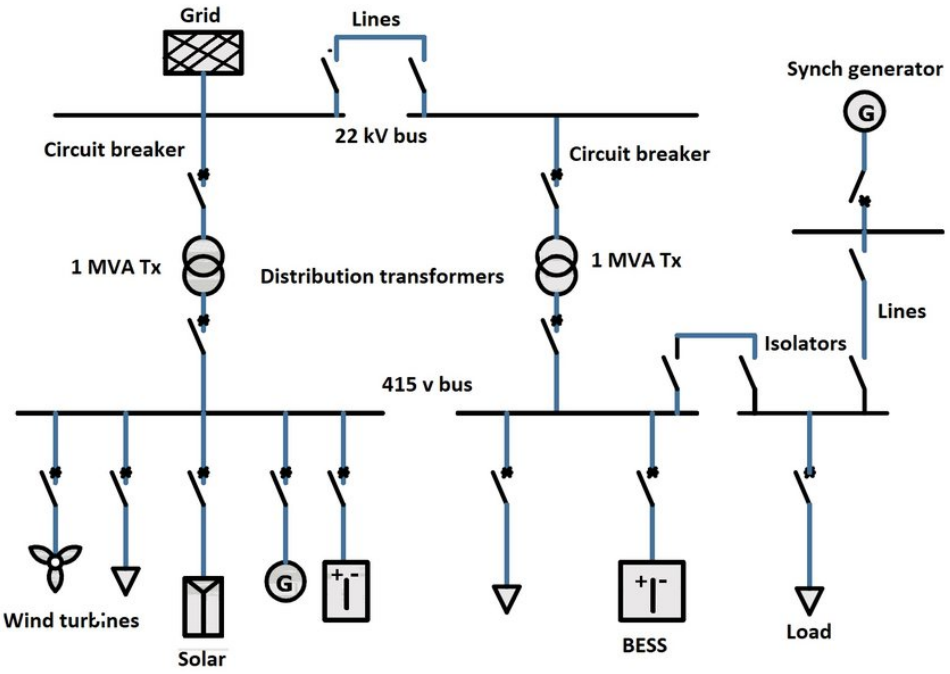


Fig. 3.1.1 Single Line Diagram

Here's a step-by-step guide on how to interpret such diagrams:

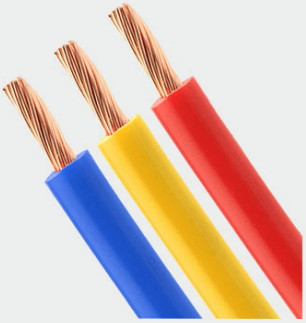
- **Understand the Symbols:** Familiarize yourself with the symbols used in electrical diagrams. Symbols represent various electrical components, such as lights, switches, outlets, circuit breakers, and wires. Refer to the diagram's legend or key to identify each symbol's meaning.
- **Identify Power Source:** Locate the power source on the diagram. It could be a generator, main electrical panel, or other power supply. Note the symbol representing the power source and its associated details.
- **Follow the Flow:** Begin by tracing the path of power from the source to the components. This might involve following lines or arrows that indicate the direction of current flow.
- **Lights and Fixtures:** Look for symbols representing temporary lights or fixtures. These symbols usually resemble a light bulb or a circle with an "X" inside. The diagram should specify the type, location, and number of lights.
- **Switches and Controls:** Identify symbols for switches and controls that operate the temporary lighting. Switches might be depicted as simple lines or as specialized symbols. Note their positions and functions.
- **Wiring and Connections:** Follow the lines connecting the various components. Different line styles may represent different types of connections (e.g., solid lines for conductors, dashed lines for low-voltage connections). Pay attention to wire sizes, colors, and connection points.

- **Circuits and Branches:** Temporary lighting arrangements might involve multiple circuits or branches. Identify how circuits are separated and how they connect to the power source and controls.
- **Circuit Protection:** Look for symbols representing circuit breakers, fuses, or other protective devices. These components ensure the safety of the electrical system by preventing overloads or short circuits.
- **Voltage and Load Details:** Check for voltage specifications and load details indicated on the diagram. This information helps ensure that the correct wiring and components are used to handle the load safely.
- **Grounding and Earthing:** Determine if there are symbols indicating grounding or earthing connections. Grounding is essential for safety in electrical systems.
- **Annotations and Labels:** Pay attention to labels, annotations, or notes on the diagram. These provide additional information or instructions related to the temporary lighting arrangement.
- **Consult Manuals and Codes:** If you encounter unfamiliar symbols or components, refer to electrical standards, codes, or manufacturer's manuals to clarify their meanings.
- **Double-Check Accuracy:** Ensure that your interpretation aligns with the project's requirements, specifications, and safety regulations. Mistakes in interpreting the diagram can lead to improper installations and safety hazards.
- **Seek Assistance:** If you encounter difficulties or uncertainties, don't hesitate to consult with experienced electricians, engineers, or supervisors for guidance.

3.1.2 Cables in Electrical Systems

Cables used in electrical systems can be categorized based on various factors, including insulation, phase configuration, and power rating. Here's a description of different types of cables based on these criteria:

1. Based on Insulation:

Types of Cable	Description	Image
PVC Insulated Cables	These cables have insulation made of Polyvinyl Chloride (PVC), which provides good insulation properties and resistance to moisture. They are commonly used for indoor wiring and low-voltage applications.	

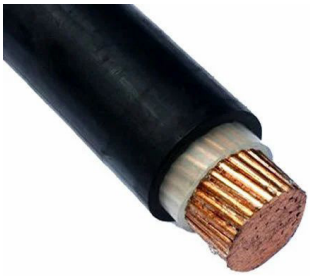
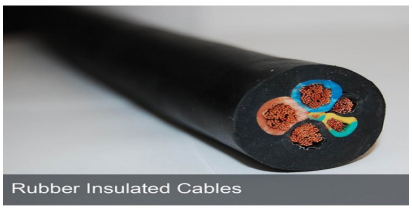
XLPE Insulated Cables	Cross-Linked Polyethylene (XLPE) insulation offers better thermal stability and can handle higher operating temperatures. XLPE cables are used for medium to high-voltage applications, both indoors and outdoors.	
Rubber Insulated Cables	Rubber-insulated cables are flexible and often used in applications where frequent movement or bending is required. They are commonly found in portable tools, machinery, and equipment.	

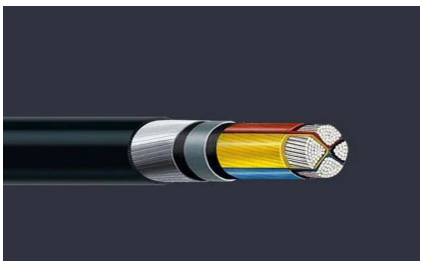
Table 3.1.1 Cables based on Insulation

2. Based on Phase Configuration:

Types of Cable	Description	Image
Single-Core Cables	These cables have a single conductor and are typically used for single-phase applications or as the phase conductors in three-phase systems.	
Multi-Core Cables	These cables have multiple conductors bundled together, commonly used for three-phase power distribution and other multi-phase applications.	

Table 3.1.2 Cables based on Phase Configuration

3. Based on Power Rating:

Types of Cable	Description	Image
Low Tension (LT) Cables	LT cables are designed for low-voltage applications and are used for power distribution, lighting, and general electrical wiring.	
Medium Tension (MT) Cables	MT cables are used for medium-voltage applications, often for power distribution in urban areas and industrial settings.	
High Tension (HT) Cables	HT cables are designed for high-voltage applications and are used for long-distance power transmission and distribution, often in substations and power plants.	
Service Entrance Cable (SE)	Used for overhead and underground service entrances, typically from the utility's distribution lines to the building's service panel.	

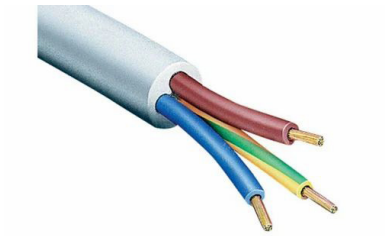
Armored Cables (AC)	These are cables with a metal sheath, providing mechanical protection. They are often used in industrial settings and areas where the cable is exposed to physical damage.	
Flexible Cables	Designed for applications requiring flexibility, such as cords for appliances, extension cords, and portable tools.	
Submersible Cables	Used in underwater applications, such as in submersible pumps or other equipment installed in water bodies.	

Table 3.1.3 Cables based on Power Rating

Safe Practices for Cable Laying

Safe practices for cable laying at construction sites, whether through underground conduits or poles, are crucial to ensure the reliability of electrical systems, prevent accidents, and comply with industry standards. Here are some standard and safe practices for cable laying:

Cable Laying Through Underground Conduits:

1. **Planning and Design:**
    - Conduct a thorough site survey to determine the optimal routing of underground conduits.
    - Consider factors such as load requirements, cable type, conduit size, bends, and clearances.
2. **Conduit Installation:**
    - Choose appropriate conduit materials based on the application (PVC, metal, etc.).
    - Ensure proper depth and trench dimensions according to local codes and standards.

- Use sweeps or bends to maintain gentle curves to prevent cable damage during pulling.
- Provide access points (pull boxes) at regular intervals for cable installation and maintenance.

3. **Cable Pulling:**
    - Use proper cable pulling techniques and equipment to avoid stressing or damaging the cables.
    - Lubricate cables before pulling to reduce friction and minimize the risk of damage.
    - Avoid exceeding the maximum pulling tension recommended for the cable.
4. **Cable Spacing:**
    - Maintain proper spacing between cables to prevent overheating and ensure proper ventilation.
    - Follow manufacturer recommendations for cable spacing and bundling.
5. **Grounding and Bonding:**
    - Install appropriate grounding and bonding conductors along with the cables.
    - Ensure proper grounding connections to prevent voltage buildup and ensure safety.
6. **Marking and Documentation:**
    - Clearly label conduits with the types of cables and their purposes.
    - Document the cable layout, including conduits, bends, junctions, and access points.

Cable Laying on Poles:

1. **Pole Selection and Installation:**
    - Use sturdy and structurally sound poles made of suitable materials (wood, metal, concrete).
    - Follow guidelines for pole spacing, height, and distance from buildings and structures.
2. **Cable Fixing:**
    - Attach cables securely to the poles using appropriate clamps, straps, or hooks.
    - Maintain proper clearance between cables to prevent chafing and wear.
3. **Weather Protection:**
    - Install weatherproof and UV-resistant cable fittings to prevent water ingress and damage from sunlight.
4. **Grounding and Insulation:**
    - Provide adequate grounding and insulating measures to prevent electrical faults and ensure safety.

5. **Cable Sag:**
    - Allow for proper cable sag to accommodate temperature changes and prevent excessive tension.
6. **Safety Measures:**
    - Adhere to safety guidelines when working at heights, using appropriate personal protective equipment (PPE).
    - Follow lockout/tagout procedures when working near live cables.
7. **Inspections and Maintenance:**
    - Regularly inspect cables, poles, and fittings for signs of wear, corrosion, or damage.
    - Perform routine maintenance to ensure the integrity of the cable installation.
8. **Coordination and Clearances:**
    - Coordinate with other utilities to avoid interference and maintain clearances from other overhead utilities.

3.1.3 Types of Conduits and Fixtures

Types of Conduits:

Conduits are protective tubes or pipes used to encase and protect electrical wiring. They come in various materials and types to suit different applications and environments:

Types of Conduits	Description	Image
Rigid Metal Conduit (RMC)	Made of galvanized steel, RMC provides strong protection against physical damage and is suitable for outdoor and industrial applications.	
Electrical Metallic Tubing (EMT)	EMT is lighter and more economical than RMC. It's often used for exposed indoor installations and can be easily bent to accommodate different shapes.	

Intermediate Metal Conduit (IMC)	Similar to RMC but lighter, IMC offers good protection in indoor and outdoor environments and is more cost-effective than RMC.	
Flexible Metal Conduit (FMC)	FMC is a flexible, spiral-wound conduit that's easier to bend and ideal for applications requiring flexibility, such as connecting equipment or machinery.	
PVC Conduit	Made of polyvinyl chloride, PVC conduit is lightweight, corrosion-resistant, and commonly used for residential and commercial indoor wiring.	
Liquidtight Flexible Conduit (LFMC)	LFMC is designed to protect wiring in damp or wet environments and is often used outdoors or in industrial settings.	

Table 3.1.4 Types of Conduits

Types of Fixtures (Switches and Sockets):

Electrical fixtures include switches and sockets, which provide control and access to electrical power in a building. They come in different types, designs, and configurations:

Types of Conduits	Description	Image
Single-Pole Switch	Controls the power to a single circuit or fixture. It's commonly used for lighting control in rooms.	

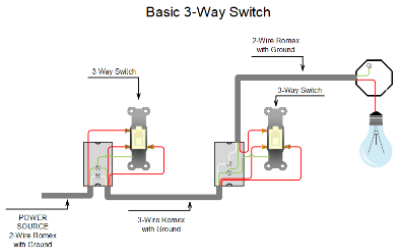
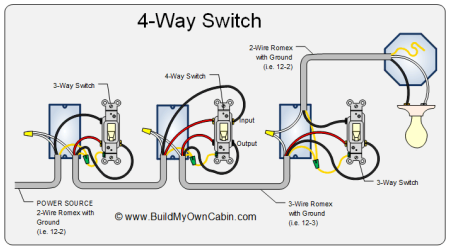
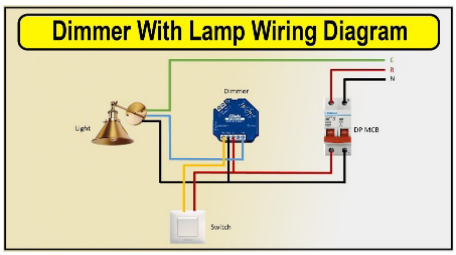
Double-Pole Switch	Controls two separate circuits simultaneously. Often used for controlling large appliances like water heaters or air conditioners.	
Three-Way Switch	Used in pairs to control a single light fixture from two different locations. Common in hallways and staircases.	
Four-Way Switch	Used in conjunction with three-way switches to control a single light fixture from three or more locations.	
Dimmer Switch	Allows variable control of light intensity. Useful for creating different lighting atmospheres in a room.	
Socket Outlet (Receptacle)	Provides a point for plugging in electrical devices. Different types include: • **Duplex Outlet:** Standard socket with two receptacles. • **GFCI Outlet:** Ground Fault Circuit Interrupter outlet, designed to protect against electrical shock in wet or damp environments. • **USB Outlet:** Includes USB ports for charging devices. • **Decora Outlet:** Modern design with a large faceplate and various color options.	

Table 3.1.5 Types of Fixtures

Selection Method and Uses:

Selecting the right conduits and fixtures involves considering factors such as the environment, wiring requirements, load, aesthetics, and safety regulations:

- **Environment:** Choose conduits and fixtures that are suitable for the installation environment, whether indoor, outdoor, dry, damp, or wet areas.
- **Load Requirements:** Consider the electrical load that the conduits and fixtures will carry. Heavy-duty applications may require more robust options.
- **Aesthetics:** Choose fixtures that complement the overall design and aesthetics of the space. Decorative switches and sockets can enhance the appearance of a room.
- **Safety:** Ensure that fixtures are compliant with safety standards. GFCI outlets are essential in wet areas, and switches should be easily accessible.
- **Convenience:** Position switches and sockets for ease of use and accessibility. Use three-way and four-way switches for convenient control from multiple locations.
- **Flexibility:** Flexible conduits are ideal for installations that require bending and maneuvering around obstacles.
- **Cost Consideration:** Balance functionality and cost-effectiveness when selecting fixtures and conduits.
- **Future Needs:** Anticipate future electrical needs and consider installing additional conduits and outlets for potential expansion.

3.1.4 Types of Lights

Different types of light units are used at construction sites to provide adequate illumination for various tasks and ensure a safe working environment. The choice of light units depends on factors such as the size of the area, the nature of the work, and the required brightness. Here are some common types of light units, their wattage, and their respective uses in construction sites:

Types of Lights	Description	Image
Floodlights	• **Wattage:** Typically range from 100 watts to 1000 watts or more. • **Usemm:** Floodlights provide high-intensity, broad-area illumination. They are used for lighting large construction sites, outdoor work areas, and temporary night-time operations.	

LED Work Lights	• **Wattage:** Can vary from around 10 watts to 100 watts or more, depending on the model. • **Use:** LED work lights offer energy-efficient and portable lighting solutions. They are suitable for task lighting, smaller work areas, and indoor spaces.	
Tower Lights	• **Wattage:** Tower lights can have multiple light units with varying wattages, ranging from 100 watts to 1000 watts per unit. • **Use:** Tower lights are elevated structures that provide widespread illumination over a large construction site. They are often used for night work and can cover a significant area.	
String Lights	• **Wattage:** The total wattage of a string light setup depends on the number of bulbs and their wattages. Bulbs typically range from 25 watts to 100 watts each. • **Use:** String lights are used to create well-distributed lighting along pathways, scaffolding, or temporary structures. They are versatile and can be hung in various configurations.	
Handheld Work Lights	• **Wattage:** Handheld work lights can have wattages ranging from 20 watts to 100 watts or more. • **Use:** These portable lights are convenient for task-specific lighting, inspections, and maintenance work. They are easily carried to different areas of the construction site.	

Temporary Light Fixtures	• **Wattage:** Temporary light fixtures often use fluorescent or LED tubes, ranging from 10 watts to 40 watts per tube. • **Use:** These fixtures are designed for quick installation and are used in temporary workspaces, enclosed areas, or where consistent lighting is required.	
Task Lights	• **Wattage:** Task lights are available in various wattages, typically ranging from 10 watts to 100 watts or more. • **Use:** Task lights are used for specific work tasks that require focused lighting, such as detailed inspections, measurements, or fine assembly work.	
Emergency Lights	• **Wattage:** Emergency lights typically have lower wattages, around 5 watts to 20 watts. • **Use:** Emergency lights provide illumination during power outages or emergencies. They are strategically placed to guide people to exits and safe areas.	

Table 3.1.6 Types of Lights

3.1.5 Standard Practices for Fixing Lights and Their Accessories:

Proper installation of lights and their accessories is essential to ensure safety, functionality, and longevity. Here are some standard practices for fixing lights and their respective accessories:

1. **Safety Precautions:**
    - Prioritize safety by following all relevant safety guidelines, wearing appropriate personal protective equipment (PPE), and working in compliance with local electrical codes and regulations.
2. **Fixture Selection:**
    - Choose light fixtures that are suitable for the intended use and environment. Ensure they have the necessary certifications and are rated for the voltage and conditions of

the installation.

3. **Mounting Height:**

   - Install fixtures at appropriate heights to provide adequate illumination. Consider the specific application and the area to be lit.

   Secure Mounting:

   - Ensure fixtures are securely fastened to the mounting surface using the appropriate hardware, such as brackets, screws, or clamps.

4. **Electrical Wiring:**

   - Follow proper wiring practices, including proper stripping and termination of wires, use of wire connectors, and securing cables to prevent strain or damage.

5. **Grounding:**

   - Ensure proper grounding of fixtures and accessories to prevent electrical hazards and ensure safety.

6. **Weatherproofing:**

   - Use weatherproof fixtures and accessories in outdoor or damp locations to protect against moisture and environmental elements.

7. **Proper Alignment:**

   - Align fixtures correctly to provide the desired lighting angle and coverage.

8. **Cable Management:**

   - Route and secure cables properly to prevent tripping hazards and damage to wires.

9. **Testing:**

   - Test each installed fixture to ensure proper operation and adequate illumination.

10. **Maintenance Access:**

    - Ensure fixtures are installed in a way that allows for easy access for maintenance and bulb replacement.

11. **Documentation:**

    - Document the installation details, including the type and location of fixtures, wiring diagrams, and any modifications made.

3.1.6 Types of Faults Associated with Lighting Arrangements:

Several faults can occur in lighting arrangements, affecting the performance and safety of the system:

1. **Open Circuit:**

- An open circuit occurs when the electrical path is interrupted, resulting in a complete loss of lighting in the affected circuit. This can be caused by a broken wire or a faulty connection.

2. **Short Circuit:**
    - A short circuit occurs when two conductors with different potentials come into contact, creating a low-resistance path. This can cause overcurrent, overheating, and even fire.
3. **Overload:**
    - An overload happens when the circuit is carrying more current than it is designed for. This can lead to overheating, tripped circuit breakers, and potential fire hazards.
4. **Faulty Bulbs:**
    - Bulbs may burn out prematurely due to manufacturing defects, voltage fluctuations, or poor quality.
5. **Improper Grounding:**
    - Inadequate grounding or faulty grounding connections can lead to electrical shock hazards and improper functioning of lighting fixtures.
6. **Dim or Flickering Lights:**
    - Dim or flickering lights can result from poor connections, loose wiring, or issues with the electrical supply.
7. **Corrosion and Moisture Damage:**
    - Corrosion or moisture damage can affect fixtures, connectors, and wiring, reducing their lifespan and causing malfunctions.
8. **Accessory Failures:**
    - Accessories such as ballasts, starters, and photocells can fail, affecting the proper functioning of the lighting system.
9. **Misalignment:**
    - Misaligned fixtures can result in uneven lighting distribution and reduced effectiveness.

3.1.7 Standard Conditions for Storing and Stacking Electrical Units, Materials, Fixtures, Tools, and Devices

Storing and stacking electrical units, materials, fixtures, tools, and devices in a construction setting is essential to maintain their integrity, prevent damage, and ensure safety. Here are the standard conditions and practices for proper storage and stacking:

Electrical Units, Materials, Fixtures, Tools, and Devices:

1. **Indoor Storage:**

- Store electrical units, materials, fixtures, tools, and devices indoors whenever possible to protect them from weather elements.

2. **Dry and Clean Environment:**
    - Ensure that the storage area is dry, clean, and free from moisture to prevent damage and corrosion.
3. **Temperature Control:**
    - Maintain a stable temperature within the storage area to prevent extreme heat or cold that can affect the integrity of materials and devices.
4. **Ventilation:**
    - Provide adequate ventilation to prevent the buildup of fumes, dust, or humidity.
5. **Protection from Sunlight:**
    - Store items away from direct sunlight, as UV radiation can degrade materials and affect performance.
6. **Fire Safety:**
    - Keep storage areas well away from potential fire hazards, and avoid storing flammable materials near electrical units.
7. **Organized Shelving and Racks:**
    - Use sturdy and organized shelving, racks, and cabinets to keep items off the ground and easily accessible.
8. **Proper Labeling:**
    - Clearly label all stored items to identify their contents, specifications, and any special handling instructions.
9. **Stacking:**
    - Stacking should be done in a stable and organized manner to prevent items from falling or collapsing.
10. **Weight Limits:**
    - Do not exceed weight limits for shelves, racks, or containers to avoid structural damage.
11. **Protection from Impact:**
    - Protect delicate items from impacts, vibrations, and rough handling to prevent damage.
12. **Separate and Secure:**
    - Store different types of items separately to prevent damage, contamination, or reactions between materials.

13. **Moisture Protection:**
    - Use moisture-resistant packaging or containers for sensitive materials to prevent water damage.
14. **Tool and Device Storage:**
    - Tools and devices should be stored in protective cases or racks designed to hold them securely and prevent damage.
15. **Regular Inspections:**
    - Regularly inspect stored items for signs of damage, wear, or deterioration. Remove any damaged items promptly.
16. **Locking and Security:**
    - Implement security measures to prevent theft and unauthorized access to stored items.
17. **Emergency Access:**
    - Ensure that storage areas are easily accessible in case of emergencies and that exits are unobstructed.
18. **Maintenance Records:**
    - Maintain records of stored items, including their condition, installation dates, and any maintenance or inspections performed.

3.1.8 Erecting and Dismantling Temporary Scaffolding

Erecting and dismantling temporary scaffolding, ladders, or working platforms require careful planning, proper equipment, and adherence to safety procedures to prevent accidents and ensure the safety of workers.

Fig. 3.1.2 Erecting and dismantling temporary scaffolding

Step-by-step guide for the safe procedure of erecting and dismantling these structures:

Erecting Temporary Scaffolding:

1. **Planning:**
    - Assess the work to be performed, including height requirements, load capacities, and access points.
    - Determine the appropriate type of scaffolding (e.g., supported scaffold, suspended scaffold) for the job.
2. **Selection and Inspection:**
    - Choose quality scaffolding components and materials that meet safety standards.
    - Inspect all components, including frames, braces, planks, and guardrails, for any defects or damage.
3. **Foundation and Stability:**
    - Set up the scaffolding on a stable and level surface, using proper base plates or mudsills if needed.
    - Ensure the scaffold is properly anchored or tied to the structure to prevent tipping.
4. **Erection Process:**
    - Assemble the scaffold according to the manufacturer's instructions, using proper locking mechanisms and couplings.
    - Install cross braces and diagonal braces for added stability.
    - Add guardrails, mid-rails, and toe boards at appropriate heights to prevent falls.
5. **Access and Egress:**
    - Provide safe access to the scaffold using proper ladders, staircases, or walkways.
    - Install access gates or openings with secure closures.
6. **Platform Installation:**
    - Place scaffold planks or platforms evenly and securely, ensuring they overlap the support structure properly.
    - Secure planks with locking pins or other approved methods to prevent displacement.
7. **Inspection:**
    - Conduct a thorough inspection of the erected scaffold to ensure all components are secure, properly connected, and compliant with safety regulations.

Dismantling Temporary Scaffolding:

1. **Planning:**

- Plan the dismantling process carefully, considering the sequence of removal and the safety of workers below.

2. **Clear the Area:**
    - Clear the scaffold of all tools, equipment, and debris before starting dismantling.
3. **Platform Removal:**
    - Remove planks or platforms one by one, starting from the highest level and working downward.
    - Use proper tools and techniques to prevent planks from falling.
4. **Guardrail Removal:**
    - Carefully remove guardrails, mid-rails, and toe boards as needed, ensuring workers below are protected.
5. **Brace Removal:**
    - Disassemble cross braces and diagonal braces systematically, following the manufacturer's guidelines.
6. **Frame Disassembly:**
    - Begin disassembling the scaffold frames from the top down, ensuring they are properly secured to prevent tipping.
7. **Component Storage:**
    - Store dismantled scaffold components properly and in an organized manner to prevent damage and ensure reuse.
8. **Inspection:**
    - Inspect dismantled components for damage, wear, or defects before storing.
9. **Documentation:**
    - Keep records of the dismantling process, including any issues encountered and the condition of the components.

Ladder and Working Platform Safety:

- When using ladders or working platforms, ensure they are in good condition and can support the anticipated load.
- Set up ladders on stable and level surfaces, secure them to prevent slipping, and extend them adequately above the landing point.
- Use personal fall protection equipment, such as harnesses and lanyards, when working at heights.
- Adhere to the "Three Points of Contact" rule when climbing ladders: always have two hands and one foot or two feet and one hand in contact with the ladder.

- Never overreach or lean too far to the side while on a ladder.
- When using working platforms, ensure they are properly secured, stable, and have guardrails or fall protection in place.

Exercise

1. Name the types of cables based on insulation, phase and their use as per power rating.
2. Explain standard/ safe practice of cable laying at construction sites.
3. Describe types of lights units, their wattage and respective use in construction sites.
4. Explain standard conditions for storing and stacking electrical units, materials, fixtures, tools and devices.
5. Describe types of safety equipment commonly used for protection of LV wiring circuits and their area of application.

Notes

QR Codes

Scan the QR code to watch the video

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

Interpreting Single Line Diagram

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

Cables in Electrical Systems

https://www.youtube.com/watch?v=_cJopRjNEH0

Types of Conduits and Fixtures

Skill India
कौशल भारत-कुशल भारत

सत्यमेव जयते
GOVERNMENT OF INDIA
MINISTRY OF SKILL DEVELOPMENT
& ENTREPRENEURSHIP

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

4. Assist in LV (low voltage) Electrical Wiring at Permanent Structures

Construction Skill Development Council

SCPwD
दिव्यांग व्यक्तियों के लिए कौशल परिषद
Skill Council for Persons with Disability

Unit 4.1 - Conduit and Cable/Wire Laying

Unit 4.2 - Electrical Earthing Procedure in Domestic Wiring

CON/N0604

Key Learning Outcomes

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

1. Type of electrical hazards associated with domestic wiring work, a consequence of faulty/ improper wiring works and standard safety control measures.
2. Types of safety equipment commonly used for the protection of domestic wiring circuits and their area of application.
3. Type of electrical materials and fixtures such as conduits, raceways, brackets, etc., used for domestic wiring works and their required acceptance criteria for use.
4. Standard conduit laying and fixing procedures through brick and concrete structures.
5. Standard practices of cable/ wire laying through conduits and tests to be done to ensure there is no breakage/ leakage from the wire.
6. Electrical earthing procedure in domestic wiring and its importance
7. Material, tools and equipment used for electrical earthing works.
8. Test to be performed in domestic electrical wiring works using appropriate measuring devices.

Unit 4.1: Conduit and Cable/Wire Laying

Unit Objectives

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

1. Understand type of electrical hazards associated with domestic wiring work, a consequence of faulty/ improper wiring works and standard safety control measures.
2. Understand type of safety equipment commonly used for the protection of domestic wiring circuits and their area of application.
3. Identify type of electrical materials and fixtures such as conduits, raceways, brackets, etc., used for domestic wiring works and their required acceptance criteria for use.
4. Know the standard conduit laying and fixing procedures through brick and concrete structures.
5. Know the standard practices of cable/ wire laying through conduits and tests to be done to ensure there is no breakage/ leakage from the wire.

4.1.1 Standard Safety Control Measures associated with Domestic Wiring Work

When dealing with domestic electrical wiring work, safety should be the top priority to prevent accidents, electrical hazards, and injuries.

Fig. 4.1.1: Follow standard safety control measures

Here are some standard safety control measures associated with domestic electrical wiring work:

- **Hire Qualified Professionals:** Electrical wiring work should be performed by licensed and trained electricians who have the expertise to carry out the job safely and correctly.

- **Follow Electrical Codes and Standards:** Adhere to local, regional, and national electrical codes and standards to ensure that the wiring work meets safety requirements and quality standards.
- **Use Approved Materials:** Use electrical materials, wires, cables, outlets, switches, and fixtures that are approved by recognized safety agencies to ensure their quality and safety.
- **Plan and Design:** Develop a thorough wiring plan and design before starting any work. Determine the placement of outlets, switches, and fixtures to ensure efficient and safe electrical distribution.
- **Ground Fault Circuit Interrupters (GFCIs):** Install GFCIs in areas where water is present, such as kitchens, bathrooms, and outdoor outlets. GFCIs provide protection against electrical shocks.
- **Arc Fault Circuit Interrupters (AFCIs):** Install AFCIs to detect and prevent arc faults, which can lead to electrical fires caused by faulty wiring.
- **Proper Circuit Breakers:** Use circuit breakers that are appropriately sized for the wiring's capacity to prevent overloading and short circuits.
- **Wiring Techniques:** Follow proper wiring techniques, including using correct wire sizes, proper insulation, and secure connections to prevent overheating, sparking, and short circuits.
- **Inspection and Testing:** Regularly inspect and test the wiring, outlets, and switches to identify any signs of wear, damage, or malfunction. This should be done by professionals.
- **Avoid Overloading Circuits:** Do not overload outlets or circuits by plugging in too many devices. Use power strips and extension cords properly and avoid daisy-chaining multiple devices.
- **Proper Grounding:** Ensure proper grounding of electrical systems to prevent electrical faults, shocks, and fires.
- **Labelling and Documentation:** Properly label circuit breakers, outlets, and switches for easy identification. Maintain clear documentation of the electrical layout for future reference.
- **Personal Protective Equipment (PPE):** Electricians and individuals involved in wiring work should use appropriate PPE, including gloves, goggles, and insulated tools.
- **Working Safely:** Avoid working on live circuits whenever possible. Turn off the power to the area where you're working and use voltage testers to verify that circuits are de-energized.
- **Fire Safety:** Have fire extinguishers readily accessible, and ensure that smoke detectors and fire alarms are properly installed and functional.
- **Emergency Procedures:** Have an emergency plan in place for electrical incidents. This should include knowing how to shut off power in an emergency.
- **Education and Training:** Educate household members about basic electrical safety, including not tampering with electrical systems and knowing what to do in case of electrical emergencies.

By following these safety control measures, you can significantly reduce the risks associated with domestic electrical wiring work and ensure the safety of household and property.

4.1.2 Safety Equipment for Protection of Domestic Wiring Circuits

Safety equipment commonly used for the protection of domestic wiring refers to a set of devices and measures put in place to ensure the safety of a household's electrical system and its occupants. These devices are designed to prevent electrical hazards, such as electric shock, fires, and damage to appliances, by detecting and responding to various types of electrical faults and abnormalities. The primary goal of these safety equipment is to minimize the risks associated with electricity in residential settings.

Fig. 4.1.2: Safety equipment for protection of domestic wiring circuits

Safety equipment commonly used for the protection of domestic wiring circuits includes:

- **Circuit Breakers:** Circuit breakers are devices designed to automatically interrupt the electrical current when a fault, such as a short circuit or overload, occurs. They are placed in electrical panels and protect specific circuits or appliances. Different types of circuit breakers include miniature circuit breakers (MCBs) and residual current devices (RCDs).
- **Fuses:** Fuses are older technology, but they still provide basic protection by breaking the circuit when excessive current flows through them. Once a fuse blows, it needs to be replaced. Fuses are often used for individual circuits or appliances.
- **Residual Current Devices (RCDs):** RCDs, also known as ground fault circuit interrupters (GFCIs), monitor the flow of current in a circuit. They quickly disconnect the power if they detect any imbalance between the live and neutral wires, which can occur due to a ground fault or leakage current. RCDs are crucial for protecting against electric shock.
- **Surge Protectors:** Surge protectors are devices that protect electronic devices and appliances from voltage spikes and surges. They are often used to safeguard sensitive equipment like computers, TVs, and entertainment systems.
- **Earthing (Grounding) System:** While not a single device, proper grounding is essential for safety. Grounding provides a path for excess electrical current to dissipate safely into the

ground, reducing the risk of electric shock and fire. Grounding is usually achieved through grounding rods and conductors.

- **Outlet Covers and Safety Plugs:** These are used to prevent accidental contact with electrical outlets, especially in homes with small children. They cover the outlets and prevent objects from being inserted into them.
- **Heat Detectors and Smoke Alarms:** While not directly protecting wiring, heat detectors and smoke alarms are crucial for overall home safety. They alert residents to potential fire hazards, allowing them to take action and prevent damage.
- **Electrical Enclosures:** Enclosures are used to protect electrical components, switches, and connections from environmental factors such as moisture, dust, and physical damage.

These safety measures are crucial to maintaining a secure and hazard-free electrical environment within homes.

4.1.3 Electrical Materials and Fixtures for Domestic Wiring and their Acceptance Criteria

In domestic wiring works, various electrical materials and fixtures are used to create a safe and functional electrical system. These components play a crucial role in distributing electricity throughout the house. Here are some common electrical materials and fixtures used in domestic wiring, along with their required acceptance criteria for safe use:

a) **Conduits:** Conduits are protective tubes used to encase and route electrical wires, providing physical protection and helping to organize the wiring. Common types include PVC, metal (EMT), and rigid steel conduits.

Acceptance Criteria:

- Conduits should be free from visible defects, cracks, or damage that could compromise their integrity.
- The chosen conduit material should be appropriate for the environment (e.g., PVC for non-corrosive areas, metal for areas subject to physical damage).
- Conduits should be properly secured and supported using appropriate brackets or straps.

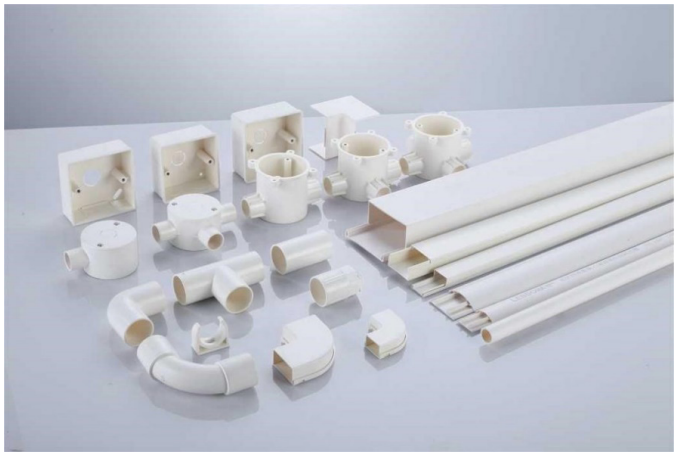


Fig. 4.1.3: Conduits

b) **Raceways:** Raceways are enclosed channels that house electrical wires and cables. They can be surface-mounted or concealed within walls.

Acceptance Criteria:

- Raceways should be securely fastened to surfaces using proper hardware.
- Adequate space should be provided within the raceway to avoid overfilling, which can lead to heat buildup.

Fig. 4.1.4: Raceways

c) **Brackets, Straps, and Hangers:** These components are used to secure conduits, raceways, and cables to walls, ceilings, and other surfaces.

Acceptance Criteria:

- Brackets, straps, and hangers should be securely attached to structural components using appropriate hardware.
- They should be properly sized to prevent sagging or excessive stress on the conduits or cables.

Fig. 4.1.5: Brackets, straps, and hangers

d) **Outlet Boxes and Junction Boxes:** Outlet boxes house switches, outlets, and other electrical devices. Junction boxes provide access points for cable splicing or connections.

Acceptance Criteria:

- Boxes should be properly mounted, securely attached to the structure.
- Boxes should have appropriate covers or plates to prevent access to live wires.

Fig. 4.1.6: Outlet boxes and junction boxes

e) **Switches and Outlets:** Switches control the flow of electricity to lighting and other devices, while outlets provide power for appliances and electronics.

Acceptance Criteria:

- Switches and outlets should be securely mounted, flush with the wall surface.
- Wiring connections should be properly terminated, ensuring proper grounding and insulation.

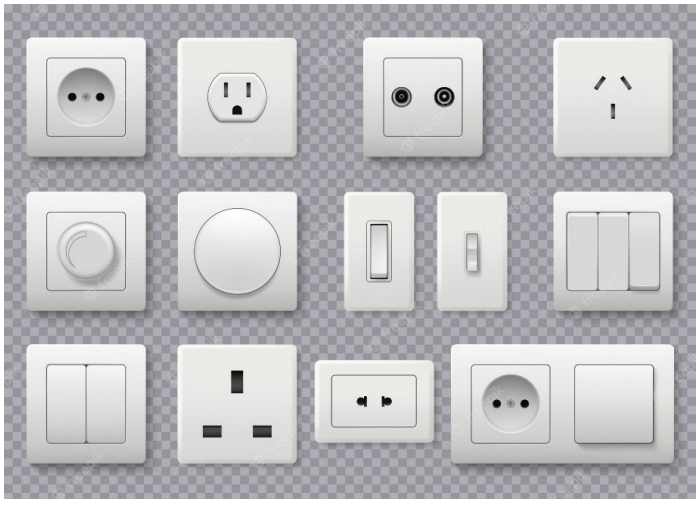


Fig. 4.1.7: Switches and outlets

f) **Wiring:**

- Electrical wires carry electricity from the source to various devices and fixtures. Different types of wires are used for various applications, such as building wiring, lighting, and communication.

Acceptance Criteria:

- Wires should be properly sized based on the load they will carry.
- Wiring should be routed and secured to prevent damage or physical hazards.

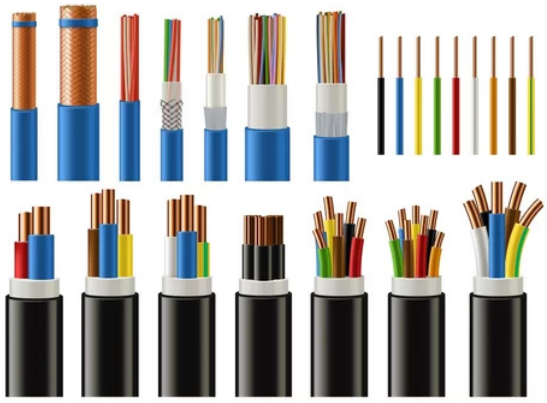


Fig. 4.1.8: Wires

g) **Circuit Breakers and Fuses:** Circuit breakers and fuses protect the electrical system from overloads and short circuits.

Acceptance Criteria:

- Circuit breakers and fuses should be properly installed and rated for the specific circuit load.
- They should be easily accessible for maintenance and resetting.

Fig. 4.1.9: Circuit breakers and fuses

h) **Grounding Components:** Grounding components ensure safety by providing a path for electrical fault currents.

Acceptance Criteria:

- Grounding components should be correctly installed, ensuring proper grounding of equipment and devices.
- Grounding connections should be secure and corrosion-resistant.

Fig. 4.1.10: Grounding components

i) **Cable Management Accessories:** Cable management accessories include cable ties, clips, and conduits fittings that help organize and secure cables.

Acceptance Criteria:

- Cable management accessories should be properly installed to prevent cable strain or damage.

Fig. 4.1.11: Cable management accessories

j) **Labels and Markings:** Labels and markings should indicate the purpose and origin of cables, wires, and devices.

Acceptance Criteria:

- Labels should be clear, legible, and durable.

Always refer to local electrical codes and regulations when selecting and installing electrical materials and fixtures. Regular inspections and compliance with safety standards are essential to ensure the longevity and safety of the electrical system in a domestic environment.

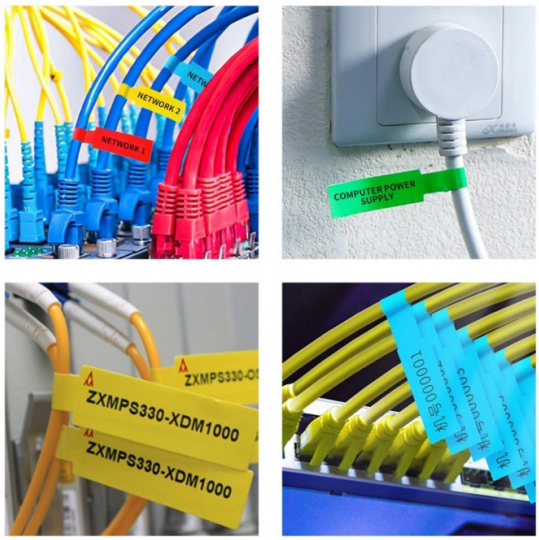


Fig. 4.1.12: Labels and markings

4.1.4 Conduit Laying and Fixing through Brick and Concrete Structures

Concealed conduit wiring refers to a method of electrical wiring installation where electrical cables or wires are placed inside protective conduits that are hidden within the walls, ceilings, or floors of a building. This type of wiring is commonly used in modern construction to provide a neat and tidy appearance while ensuring the safety and protection of the wiring system.

Fig. 4.1.13: Concealed Conduit in Slab

Let's understand how concealed conduit wiring is done in residential, commercial and public buildings.

Method of Concealed Conduit in Slab:

Here concealed P.V.C conduits instead of steel conduits are used, as they are more economical and

lighter to handle. Also, they are resistant to acids, alkalies, moisture and oil. Concealed conduits in slab are done before casting the slabs as per electrical layout. In concealed wiring, standard bends are fixed by bending the conduit pipe itself, to permit easy pulling of wires.

Procedure for laying and fixing concealed conduit in slab

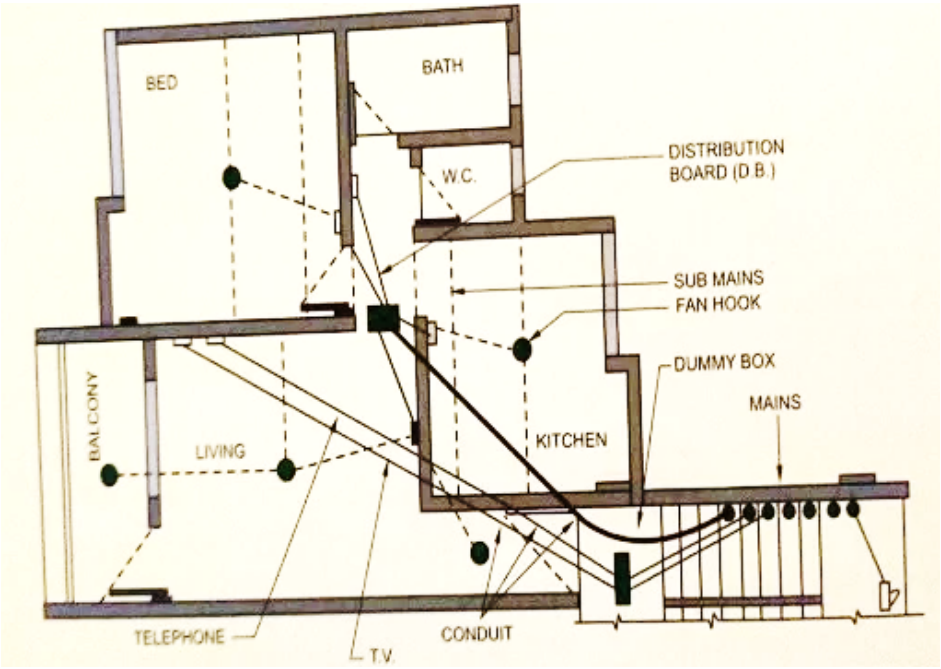


Fig. 4.1.14: Electrical drawing of concealed conduits in slab

- **Step 1:** Study the electrical drawings for the positions of the various points.
- **Step 2:** Fix the location of the distribution board in such a way that it cannot be seen while entering the flat/office.
- **Step 3:** Provide the conduits for mains, light circuits, TV and telephone as per drawings
- **Step 4:** Ensure that the centre of the fan hook box is diagonal as per centre alignment, considering the loft position in the room.
- **Step 5:** Check the locations of all points. \Step 6: Apply the bonding solution to all the pipes and accessories to avoid loose fixing of pipes with accessories.
- **Step 7:** Tie the conduits, using binding wire, to each other and to the slab steel.
- **Step 8:** Provide suitable inspection boxes for periodical inspection and to facilitate removal of wires.
- **Step 9:** Ensure that conduits do not get damaged during movement of labourers on the slab.
- **Step 10:** Ensure that fan box entries/holes are intact to prevent the cement slurry from entering.

4.1.5 Method of Concealed Conduits in Brick Wall

"Concealed Conduits" is also called as drop work. It is done only after completion of masonry work and satisfactory curing period.

Fig. 4.1.15: Concealed Conduits in Brick Wall

This approach is commonly used in construction to ensure that electrical wiring and conduits are hidden within the walls, providing a neat and aesthetically pleasing appearance. Here's an overview of how this method is typically carried out:

- **Masonry Work:** The initial construction phase involves building the brick wall without incorporating any electrical conduits or wiring. This allows the masons to focus on creating a structurally sound and visually appealing wall.
- **Curing Period:** After the brick wall is built, it's important to allow a satisfactory curing period. This typically involves allowing the mortar and bricks to set and strengthen over a specified duration.
- **Planning:** Before starting the concealed conduit work, careful planning is required. This includes determining the locations where electrical outlets, switches, and other electrical components will be installed on the wall. Adequate provisions must be made in the brick wall to accommodate these components.
- **Chasing:** Chasing refers to creating grooves or channels within the brick wall to accommodate the electrical conduits. This is usually done using specialized tools like chisels, grinders, or wall chasing machines. The grooves are created in a way that the conduits can be placed inside them without compromising the structural integrity of the wall.
- **Conduit Installation:** Once the grooves are created, electrical conduits are placed within them. Conduits are hollow pipes that provide a protective enclosure for electrical wires, ensuring safety and preventing damage to the wires. These conduits allow for easy installation, maintenance, and replacement of electrical wiring if needed in the future.
- **Wiring:** After the conduits are securely in place, electrical wiring is fed through them. This wiring connects the various electrical components such as switches, outlets, lights, and other devices.

- **Finishing:** Once the wiring is in place, the grooves in the wall are typically covered with plaster or a suitable filler material. This ensures that the conduits and wiring are concealed and hidden within the wall, providing a clean and finished appearance.
- **Testing:** Before considering the concealed conduit work complete, thorough testing of the electrical system is essential. This ensures that all connections are properly made, and the electrical components are functioning as intended.

It's worth noting that proper planning, skilled workmanship, and adherence to electrical and construction codes are crucial when carrying out concealed conduit work. This method helps create a polished and organized appearance for the finished building while maintaining the functionality and safety of the electrical systems.

Procedure for laying and fixing concealed conduits in brick wall

- **Step 1:** Lay G.I wire of 16 gauge in every conduit in the slab upto the concealed box. Keep an extra length of 15 cm for convenient pulling of wires.
- **Step 2:** Study the drawings in detail and mark the position of switch boxes with respect to the height from F.F.I.
- **Step 3:** Do the line out on the wall by colour marking
- **Step 4:** Start chasing on the wall with cutting tools
- **Step 5:** Provide thick conduit pipes of the approved quality in the chased portion and tie with the help of binding wires and nails.
- **Step 6:** Ensure that the conduit pipe is at least 5mm inside the surface of the wall.
- **Step 7:** Provide an inspection box on the wall, at a suitable location.
- **Step 8:** Fix all the boxes flush to the adjacent finished wall, considering the thickness of plaster.
- **Step 9:** Finish the chased portion with cement mortar.
- **Step 10:** Roughen the surface.
- **Step 11:** Provide a chicken mesh over conduits portion before finishing, if there are 3 or more conduits.
- **Step 12:** Cover all the boxes with dummy plates to prevent damage during plastering.
- **Step 13:** Pass G.I. wires of 16 gauge inside the conduits with additional loop length of 15 cm for mains and sub-mains in case of batten/ casing capping wiring.
- **Step 14:** After completion of all plastering work, clean the concealed boxes.

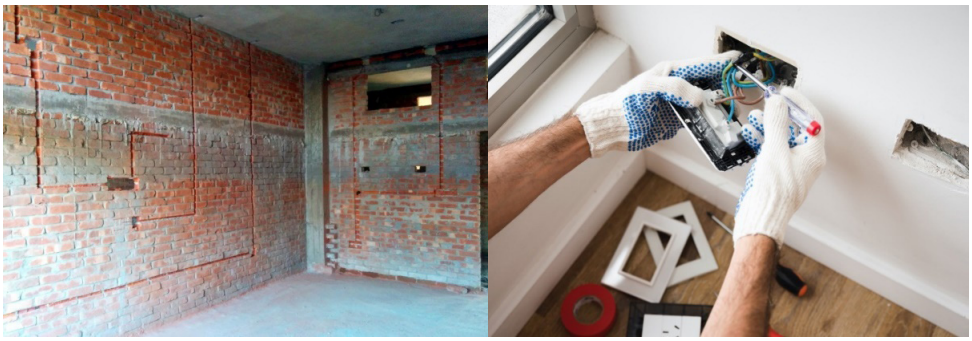


Fig. 4.1.16: Laying and fixing concealed conduits in brick wall

4.1.6 Wiring and Fitting Fixtures

Wiring and fitting fixtures are crucial components of electrical installation in buildings.

These processes involve connecting electrical wires to various fixtures and devices, ensuring they work safely and efficiently.

Fig. 4.1.17: Wiring and fitting fixture

Here's an overview of wiring and fitting fixtures in a building:

1. Wiring:

Wiring refers to the process of installing electrical conductors (wires) within a building to carry electrical current to various devices, fixtures, and outlets. Proper wiring is essential to ensure the safe and reliable distribution of electricity throughout the building.

Steps in Wiring:

- **Selecting Wiring Types:** Different types of electrical wires are used for various applications, such as power distribution, lighting, and communication. Common types include non-metallic sheathed cable (NM), armored cable (AC), and conduit wiring.
- **Routing Wires:** Electricians route the wires through the conduits, cable trays, or other designated pathways, following building codes and safety standards. Wires should be properly secured and protected to prevent damage.
- **Connecting Circuits:** Electricians connect wires to electrical panels, distribution boards, and other junction points. Circuits are designed to ensure that electrical loads are distributed evenly and safely.
- **Color-Coding:** Different wire colors are used to indicate the purpose of each wire. For instance, black wires are often used for hot (live) wires, white or gray for neutral wires, and green or bare for ground wires.

2. Fitting Fixtures:

Fitting fixtures involve installing various electrical devices and components such as switches, outlets, lights, and other electrical fixtures in the building.

Steps in Fitting Fixtures:

- **Choosing Fixture Locations:** The placement of switches, outlets, and light fixtures is determined based on electrical and functional requirements. The wiring should be appropriately routed to these locations.
- **Switches and Outlets:** Electricians install switches to control lighting and other electrical devices. Outlets are installed to provide power to appliances and electronics. The wiring is connected to the terminals on these fixtures.

- **Light Fixtures:** Light fixtures are mounted on walls or ceilings. Wiring connections are made to supply power to the fixtures, and proper grounding is ensured.
- **Safety Considerations:** When fitting fixtures, it's important to follow safety guidelines. Grounding must be done correctly to prevent electrical shocks. The fixtures should be securely fastened to the building's structure.

3. Testing and Inspection:

After completing the wiring and fitting of fixtures, thorough testing and inspection are essential to ensure that the electrical systems are functioning properly and safely. Electricians may use testing equipment to verify that circuits are correctly wired, outlets are properly grounded, and switches operate as intended.

Fig. 4.1.18: Testing and inspection

It's important to note that electrical installation work should always be carried out by qualified and licensed electricians to ensure safety and compliance with electrical codes and regulations. Proper installation, careful wiring, and correct fitting of fixtures contribute to a safe and efficient electrical system in buildings.

Wiring and fitting fixtures starts only after completing the plastering and curing work. Before staring the work check the quality, brand name of wires, gauge, specification of the wire for various points, colour codes.

Procedure for wiring and fitting fixtures

- **Step 1:** Fix the accessories on the boards with line and level.
- **Step 2:** Terminate the extra length wires in accessories.
- **Step 3:** Put the fuse wire of required current rating in the fuse box.
- **Step 4:** Connect the wires in DB and main switch or MCB.
- **Step 5:** Start the supply, switch on the mains and check all the points with megger or test lamp.

4.1.7 Standard Practices of Cable/Wire Laying Through Conduits

Laying cables or wires through conduits is a critical aspect of electrical installations. Following standard practices ensures that the cables are properly protected, organized, and easily accessible for maintenance and repairs. Here are some standard practices for cable/wire laying through conduits:

1. **Proper Conduit Selection:**

   Choose the appropriate type and size of conduit based on the type of cable or wire, the environment, and the specific requirements of the installation. Common conduit materials include PVC, metal (EMT), and rigid steel. The conduit size should allow for easy pulling of the cables without damaging them.

2. **Cable Preparation:**

   Before pulling cables, ensure they are properly prepared:

   Straighten out cables to minimize kinks and twists.

   Remove excessive packaging materials to prevent binding in the conduit.

3. **Lubrication:**

   Use appropriate cable lubricants to reduce friction between the cables and the conduit. This makes it easier to pull the cables and reduces the risk of damage to the insulation.

4. **Cable Pulling:**

   When pulling cables through conduits, follow these steps:

   - Begin with a gentle and steady pull to avoid sudden jerks that could damage the cables.
   - Use proper pulling techniques and equipment, such as cable pullers, rollers, and pulling grips.
   - Avoid overloading the conduit by pulling too many cables at once. Follow conduit fill capacity guidelines.

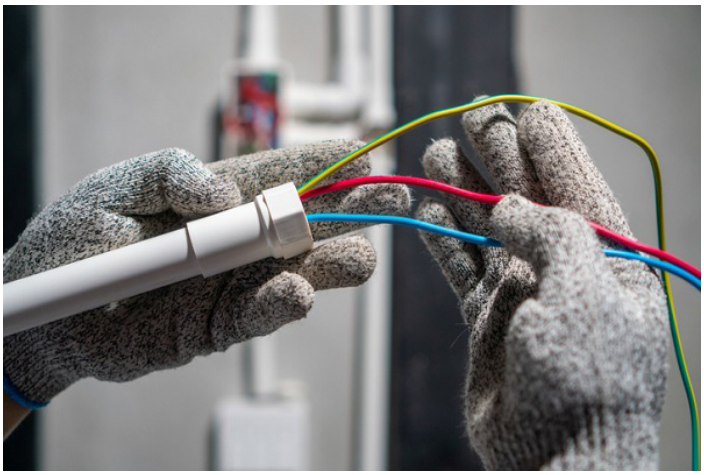


Fig. 4.1.19: Cable pulling

5. **Support and Bending:**

   Maintain proper support and bending radii for the cables:

   Support conduits using appropriate clamps or hangers to prevent excessive strain on cables.

   Maintain bending radii specified by cable manufacturers to prevent cable damage or signal interference.

6. **Labelling and Identification:**

   Label cables at both ends and junction points for easy identification during installation and future maintenance. Labelling helps prevent confusion and simplifies troubleshooting.

7. **Pulling Direction:**

   Always pull cables in the same direction as their natural coil. Avoid reversing the direction, as it can cause twisting and damage.

8. **Segregation:**

   Separate different types of cables based on their purpose (e.g., power, data) to prevent electromagnetic interference.

9. **Junction Points and Pull Boxes:**

   Use junction boxes or pull boxes at appropriate intervals to facilitate cable pulling and provide access for future maintenance.

10. **Cable Length Allowance:**

    Leave a reasonable amount of extra cable length at each end to allow for termination, splicing, and future adjustments.

11. **Cable Types:**

    Different cable types have different installation requirements. Follow manufacturer guidelines for handling, pulling, and bending specific types of cables.

12. **Inspections and Testing:**

    After laying cables, inspect them for any damage or improper bends. Perform continuity and insulation resistance tests to ensure the cables are properly installed and safe.

13. **Documentation:**

    Maintain accurate documentation of the cable installation, including cable types, lengths, routes, and termination points. This documentation is valuable for future reference and maintenance.

    Adhering to these standard practices ensures that cables are laid correctly, minimizing the risk of damage, signal interference, or future operational issues. Properly installed cables enhance the overall performance and safety of the electrical system.

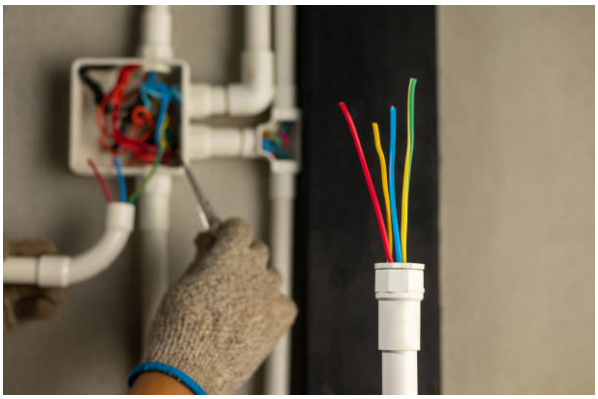


Fig. 4.1.20: Inspection and testing

4.1.8 Procedure for Open Conduit Wiring

Open conduit wiring, also referred to as surface conduit wiring, is a method of electrical wiring where electrical cables are installed within visible conduits that are mounted on the surface of walls, ceilings, or other structural components. This approach is often used when it's not feasible or desirable to conceal the wiring within the walls. Open conduit wiring is commonly employed in industrial settings, commercial buildings, workshops, and areas where the aesthetic appearance is not a primary concern.

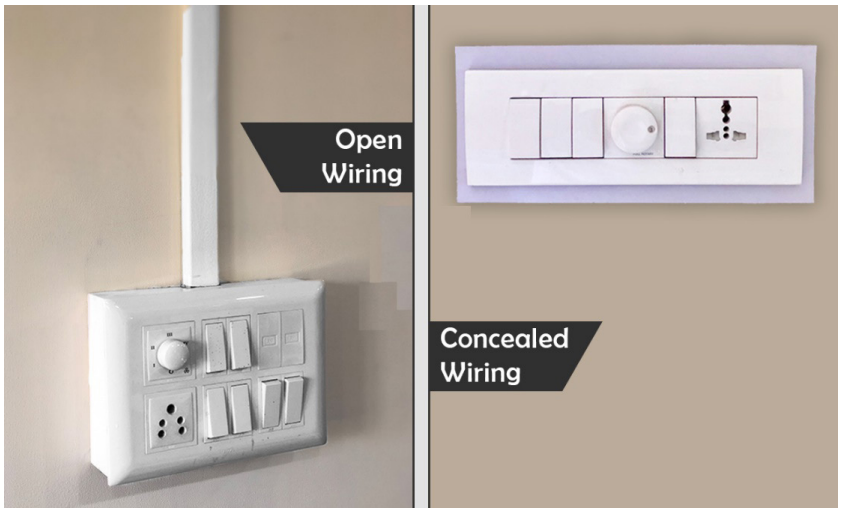


Fig. 4.1.21: Open wiring and concealed wiring

- Step 1: Cut the P.V.C. pipes as per the lines marked.
- Step 2: Fix the saddles as per the lines on wall and ceiling.
- Step 3: Fix only one side of the saddle on the wall.
- Step 4: Fix the other side with screws, while laying the conduit.
- Step 5: Fix the accessories serially to the conduit pipe.
- Step 6: Use P.V.C. adhesive to join accessories, as an additional precautionary measure in P.V.C. conduits.
- Step 7: Cut wires according to the route and the required length.
- Step 8: Keep an excess length of 20-30cm in each wire for termination.
- Step 9: Insert wires in appropriate pipes and accessories.
- Step 10: Pull the wires to the other end of the pipe.
- Step 11: Use fish wire/fish tape to pull cables for longer lengths of P.V.C. conduit runs.
- Step 12: Make a hole in the teak wood boxes to accommodate P.V.C. pipes.
- Step 13: File the edges with a filer and make a round hole. Use half round wooden scraper filer.

- Step 14: Fix the accessories to the wooden board.
- Step 15: Terminate the wires in the accessories.
- Step 16: Start the electricity supply.
- Step 17: Test electricity supply with test lamp or megger.

Fig. 4.1.22: Procedure for Open Conduit Wiring

4.1.9 Termination of Electrical Wires/Cables in Conduit Wiring

Termination of electrical wires or cables in conduit wiring refers to the process of securely connecting the conductors to the components at the ends of the conduit system, such as switches, outlets, junction boxes, or distribution boards. Proper termination ensures electrical continuity, safety, and reliability in the electrical installation.

Fig. 4.1.23: Termination of electrical wires/cables by wire nuts

Tools and Materials Needed:

- Screwdrivers

- Wire Strippers
- Wire Connectors (e.g., wire nuts, terminal blocks)
- Cable Glands (if required)
- Electrical Tape
- Conduit End Caps (if required)
- Conduit Fittings (like couplings, connectors, adapters)
- Voltage Tester (for safety)

Choose an appropriate termination method based on the application. For smaller conductors, wire nut termination involves twisting stripped wire ends together and securing them with clockwise-threaded wire nuts. Terminal block termination requires inserting stripped ends into designated terminals and tightening screws for a secure connection. Gland connectors are used when conduits lead to enclosures, providing waterproof and strain-relieved connections.

Before proceeding, ensure the circuit is de-energized using a voltage tester. After termination, test the connected components to ensure proper functionality.

Label termination points for easy identification and document the wiring connections for future reference. It's crucial to adhere to manufacturer instructions, industry standards, and local regulations to guarantee a safe and compliant installation.

4.1.10 Handling and Storing of Electrical Fixtures and Materials used for Domestic Wiring

Handling and storing electrical fixtures and materials for domestic wiring is crucial for safety and quality. Here are key points to consider:

Handling:

- Handle materials carefully to prevent physical damage or bending.
- Protect items from moisture, which can lead to corrosion and insulation damage.
- Use appropriate tools, like gloves, to avoid sharp edges and electric shock.
- Inspect components for defects before installation; do not use defective items.
- Follow manufacturer instructions for proper handling of specific fixtures.

Storage:

- Store in a dry, well-ventilated area to prevent moisture-related damage.
- Avoid extreme temperatures and direct sunlight to maintain material integrity.

- Protect from dust, debris, and chemicals that could degrade materials.
- Organize storage systematically for easy retrieval and to prevent damage.
- If stacking is needed, stack evenly to avoid excessive weight on top.
- Label materials clearly for easy identification during installation.
- Keep flammable items separate to reduce fire risks.
- Prevent rodents and pests from damaging stored materials.
- For cables, avoid tight winding that could damage insulation or conductors.
- Use a “first in, first out” approach to prevent degradation by using older stock first.

By adhering to these practices, you ensure the longevity, functionality, and safety of electrical fixtures and materials used in domestic wiring. Always follow manufacturer guidelines and industry best practices for specific materials and components.

Fig. 4.1.24: Electrical Fixtures and Materials

Notes

Unit 4.2: Electrical Earthing Procedure in Domestic Wiring

Unit Objectives

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

1. Explain the electrical earthing procedure in domestic wiring and its importance
2. Describe the material, tools and equipment used for electrical earthing works.
3. Explain the test to be performed in domestic electrical wiring works using appropriate measuring devices.

4.2.1 What is Earthing

Earthing, also known as grounding, is a crucial safety measure in electrical systems. It involves connecting electrical equipment, devices, and structures to the Earth's conductive surface to ensure safety and prevent electrical hazards.

Components of Earthing:

- **Electrode:** An electrode, often made of copper or galvanized iron (GI), is buried in the ground. It provides a connection between the electrical system and the Earth.
- **Earth Pit:** The electrode is installed in an earth pit, which is a hole in the ground filled with a mixture of salt and charcoal. This mixture enhances conductivity and reduces resistance.
- **Earth Wire:** The copper or GI wire connects the electrical equipment to the electrode. This wire is commonly referred to as the earth wire or grounding conductor.

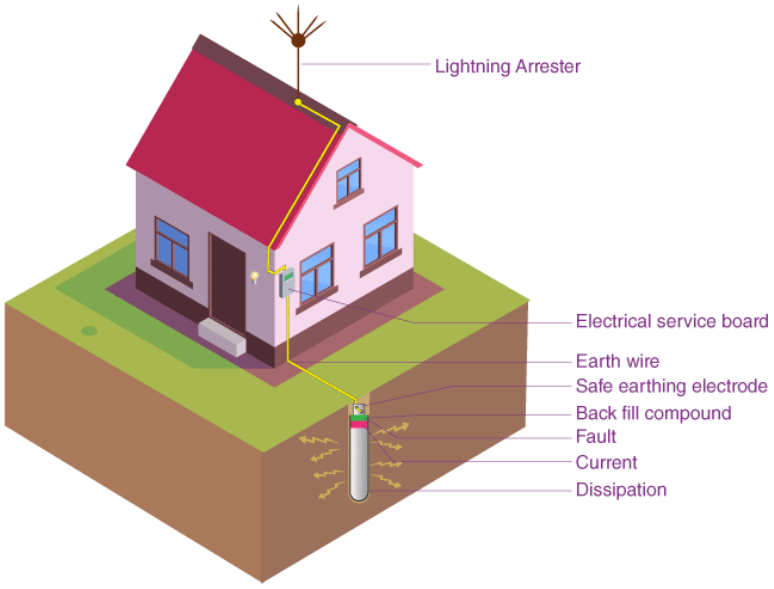


Fig. 4.2.1: Earthing

Earthing serves multiple purposes, including:

- **Safety:** It prevents electric shocks by providing a low-resistance path for fault currents to flow into the Earth, rather than through a person's body.
- **Equipment Protection:** Earthing helps to dissipate fault currents, protecting equipment and preventing damage.
- **Surge Protection:** It helps to redirect transient overvoltages, such as lightning strikes, into the ground, minimizing damage to the system.

An earthing device, often referred to as a grounding device, is a component or system used in electrical installations to establish a safe connection between electrical equipment and the Earth's conductive surface. Primary purpose of an earthing device is to prevent electrical hazards, protect equipment, and ensure the safety of people in and around the installation.

Depth of Earthing Electrode:

- The depth of the earthing electrode, also known as ground rod or earth rod, can indeed vary based on factors like soil resistivity, moisture content, and local regulations.
- While depths of 2.5 to 3 meters are common, the actual depth might be adjusted to ensure optimal conductivity. In some cases, deeper or shallower depths might be chosen.
- The goal is to reach a layer of soil with better conductivity to establish a low-resistance path for fault currents.

Potential of Earth:

- While it's often convenient to assume the potential of the Earth as zero for electrical calculations, it's important to note that the Earth's potential can vary based on factors like geological conditions, nearby currents, and local electrical activities.
- For practical purposes in electrical systems, the Earth's potential is treated as a reference point or ground level.

4.2.2 Need for Earthing

Earthing is a safety device that performs a lot of important functions. Some of its most important functions are:

- It prevents accidents caused by shock. If electrical equipment or machinery leaks current, the earthing fuses the fuse. This prevents those using the equipment or machinery from getting a shock.
- It protects large buildings from lightening.
- It saves machines in cases where overhead lines are fixed with lightening holders. The earthing sends the lightening voltage to the earth.

- It stabilises the line voltage. This is because earth is neutral for every alternator and transformer.

Relevant regulations of the Electricity Supply Authority concerned and as indicated below:

- All metal supports fittings etc. shall be permanently and efficiently earthed. Either a continuous wire may be run with earthing arrangements at 4 points in 1.609 km or each independent structure should be efficiently earthed.
- Similarly, at consumer's premises a suitable earthing point would be provided. Consumer has to make arrangement for independent earthing.
- Sub-stations structures etc. should be provided with two independent earthing points. This should be interconnected or a matting in the s/s area could be laid-down for connecting to the earth points.
- For RCC/PCC poles the metal cross-arms and insulator pins shall be bonded and earthed at every pole for HT lines and at every 5th pole for LT lines.
- All special structures on which switches, transformers, fuses, etc., are mounted should be earthed.
- The supports on either side of the road, railway or river crossing should be earthed.
- All supports (metal, RCC/PCC) of both HT and LT lines passing through inhabited areas, road crossings and along such other places, where earthing of all poles is considered desirable from safety considerations should be earthed.
- In special locations, railway and telegraph line crossings, special structures, etc., pipe/rod earthing should be done. At other locations the coil earthing may be adopted. The coil earthing consists of 10m length of 8 SWG. G.I. wire compressed into a coil 450 mm length and 50 mm dia and buried 1500 mm deep.

4.2.3 Types of Earthing

There are several types of earthing, each serving specific purposes and applications in electrical systems.

The choice of earthing type depends on factors such as the electrical system design, the environment, and the specific safety requirements.

Fig. 4.2.2: Earthing device

Here are some common types of earthing:

- System or Neutral Earthing
- Equipment Earthing (Protective Earthing)
- Combined Earthing (Functional Earthing)
- Grounding for Lightning Protection
- Floating Ground (Ungrounded System)
- Virtual Ground (Artificial Ground)
- Earth Electrode or Rod Earthing
- Plate Earthing
- Pipe Earthing

It is very important to earth the line and electrical equipment. It will be electrically unsafe without earthing. The pole/ body of equipment connected solidly to earth are called earthing.

Earth resistance is a crucial parameter in earthing systems that indicates the effectiveness of the grounding connection and the ability of the system to dissipate fault currents into the Earth. It's a measure of the resistance the soil offers to the flow of electrical current through the grounding electrodes. The lower the earth resistance, the better the earthing system's ability to provide a safe path for fault currents and to stabilize equipment potentials.

Earth resistance depends on:

- Types of soil
- Temperature of soil
- Wetness of soil
- Minerals in soil
- Size of Electrode
- Cross section of electrode
- Deepness of electrode in ground
- Distance between two electrodes

Earth tester measures Earth resistance and its unit is ohm.

Procedure for Plate Earthing

Plate earthing is a type of earthing.

The procedure for plate earthing is as follows:

- A pit is dug 3 meters deep in the earth.
- A copper plate of size 60 cms X 60 cms X 3 mm thick is placed in the pit.
- A copper wire is attached to the plate with the help of a copper nut, bolt and washer.
- While the plate remains in an upright position, a 15 cm layer of salt is poured over it.

- A 15 cm layer of charcoal is poured over the salt. The salt and charcoal reduce the earth resistance and keep the area damp.
- A G.I pipe is placed over the plate.
- The copper wire is taken through the pipe and brought to the surface.
- A funnel with a wire mesh cover is placed over the pipe.
- A cast iron cover is placed over the pipe and plate.
- Water is regularly poured in the pipe, through the funnel. Keeping the area around the earth plate damp, helps keep the earth resistance low.

Note: This type of earthing can be carried out with a GI plate instead of a copper plate. If a GI plate is used, then the wire, nut and bolt should also be made from GI material.

Now that you know the procedure, take a look at a diagram of plate earthing.

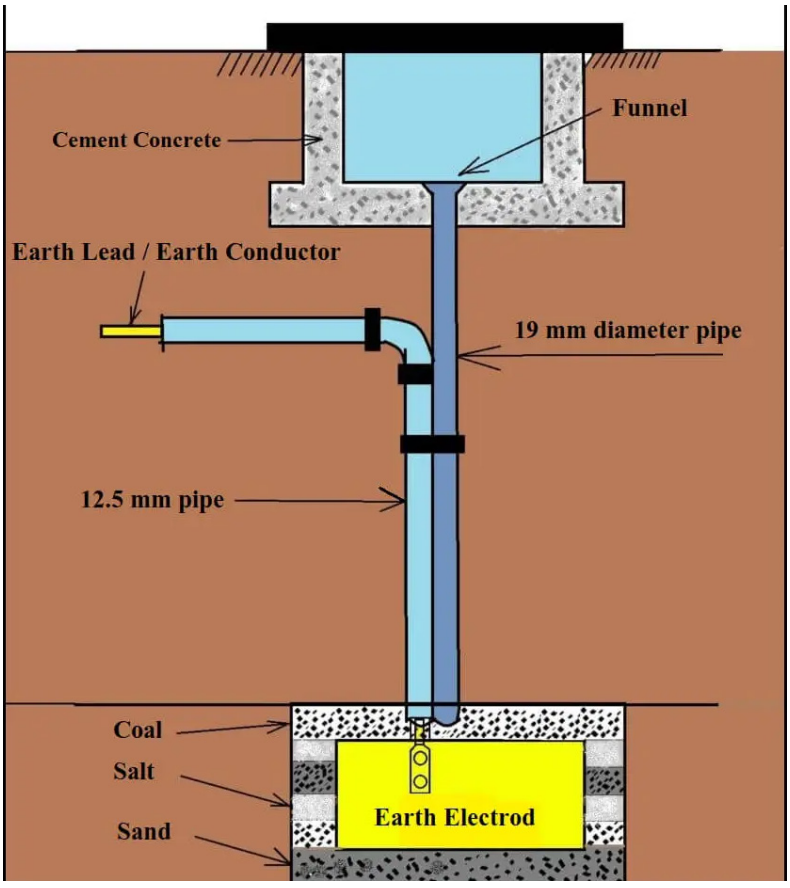


Fig. 4.2.3: Plate earthing

Procedure for Pipe Earthing

Pipe earthing is another type of earthing.

The procedure for pipe earthing is as follows:

- A 2-meter-long GI pipe of 38 mm diameter is directly buried about 3 meters deep in the ground. The pipe acts as an earth electrode.
- An earth wire is attached to the pipe with the help of a nut and bolt.
- The wire is brought to the surface.
- A layer of salt is poured around the pipe.
- A layer of charcoal is poured around the pipe. The salt and charcoal help make the earthing system more efficient.

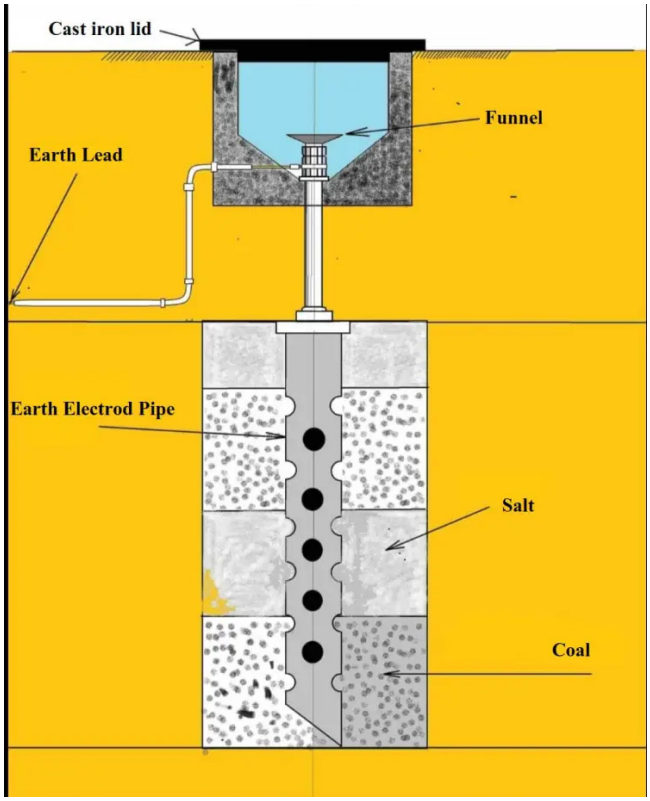


Fig. 4.2.4: Pipe earthing

The system of pipe earthing has two big advantages over plate earthing.

Advantages of Pipe Earthing:

- Pipe earthing is more effective than plate earthing. This is because the pipe is round and can handle more current leakage than the plate.
- Continuity testing for pipe earthing is very easy. This is because the wire remains on the surface. Continuity testing for plate earthing, on the other hand, is very difficult.

4.2.4 Measuring Ground Resistance

Measuring ground resistance is an essential part of ensuring the effectiveness of an earthing system. The process involves using specialized instruments to accurately measure the resistance between

the grounding electrode and the Earth. Here's a general step-by-step process for measuring ground resistance:

Tools and Equipment Needed:

- Earth Tester or Ground Tester
- Test Leads (Current and Potential)
- Grounding Electrodes
- Auxiliary Electrodes
- Measuring Tape
- Safety Gear (Gloves, Eye Protection)

Procedure:

1. **Select the Measurement Method:**
   - Decide on the appropriate measurement method based on factors like the type of installation, available equipment, and regulations. Common methods include the Fall of Potential (Three-Pole) Method and the Wenner Four-Electrode Method.
2. **Prepare the Grounding Electrodes:**
   - Set up the grounding electrodes that will be used for the measurement. These could be existing electrodes or temporary ones, depending on the method chosen.
3. **Set Up the Test Equipment:**
   - Connect the current electrode to the grounding electrode where the current will be injected.
   - Connect the potential electrode at a specific distance from the current electrode to measure the voltage drop.
4. **Measure the Baseline Voltage:**
   - Before applying the test current, measure and record the baseline voltage between the current and potential electrodes.
   - This baseline voltage is important for calculating the actual voltage drop during the test.
5. **Apply the Test Current:**
   - Depending on the method, inject a known test current (usually 10-30 A) into the grounding electrode.
   - Maintain the test current for the duration of the measurement.
6. **Measure the Voltage Drop:**
   - While maintaining the test current, measure the voltage drop between the current and potential electrodes.
   - Record this voltage drop, which will be used in calculating the ground resistance.
7. **Calculate Ground Resistance:**
   - Using Ohm's law (R = V/I), calculate the ground resistance (R) by dividing the voltage drop

(V) by the test current (I).

8. **Consider Corrections and Calculation:**
    - Depending on the method used, you might need to apply correction factors or perform specific calculations to obtain an accurate ground resistance value.
9. **Compare to Standards and Regulations:**
    - Compare the calculated ground resistance to industry standards, regulations, and the requirements of the specific installation.
    - Ensure that the measured ground resistance is within acceptable limits.
10. **Documentation:**
    - Record the measurement results, including the test current, voltage drop, calculated resistance, measurement method, date, and location.
    - Maintain proper records for future reference and compliance documentation.

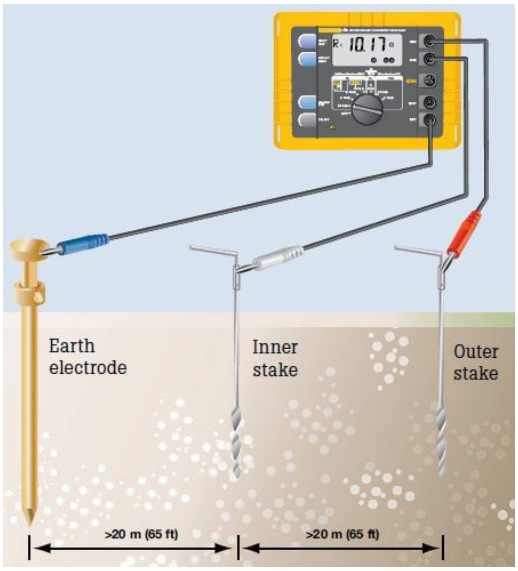


Fig. 4.2.5: Process for measuring ground resistance

Safety Precautions:

- Wear appropriate safety gear, including gloves and eye protection, to ensure personal safety during the measurement.
- Make sure the equipment is properly grounded and insulated.
- Be cautious when working with electricity, especially during the injection of the test current.

4.2.5 Earthing for Electrical Appliances

Earthing is essential for all the equipment with metallic enclosures like; Energy meters, cut-outs, fuse unit and SDF. Service cable armour also has to be grounded. Earthing is an important aspect of board wiring considering personal safety which needs to carry out as per following guidelines and IS: 3043.

- Neutral of the service cable should not be connected to earthing at the service end. It is only armour of the cable and the LT switchgear that needs grounding/earthing at the service end.
- A single run of 25 x 3 mm GI strip in the meter room connected to earthing spike in the earth Pit. This GI flat will be earthed at one place and all the other equipment will be connected to this GI flat with 25/50 sq mm aluminium jumpers with crimping at both ends with aluminium lugs.
- Earthing pit of size 1' x 1' x 3' should be provided near the service cable
- Earth resistance measurement is sometimes difficult, if the ground surface near or in the meter cabin is made using cement concrete. It is therefore essential to have earth measurement pits (of the above size) at about three places in one direction with maximum distance from the service cabin/ room of 25 meters.
- LT Switchgear earthing to main GI strip by 25 sq mm aluminium at diagonally opposite earthing bolts provided on FU / SDF.
- Cable gland earthing by 25 sq mm aluminium jumper.
- Iron clad cut-out of metal meter body should be earthed using 3/16 bare aluminium wire, as shown in figure.

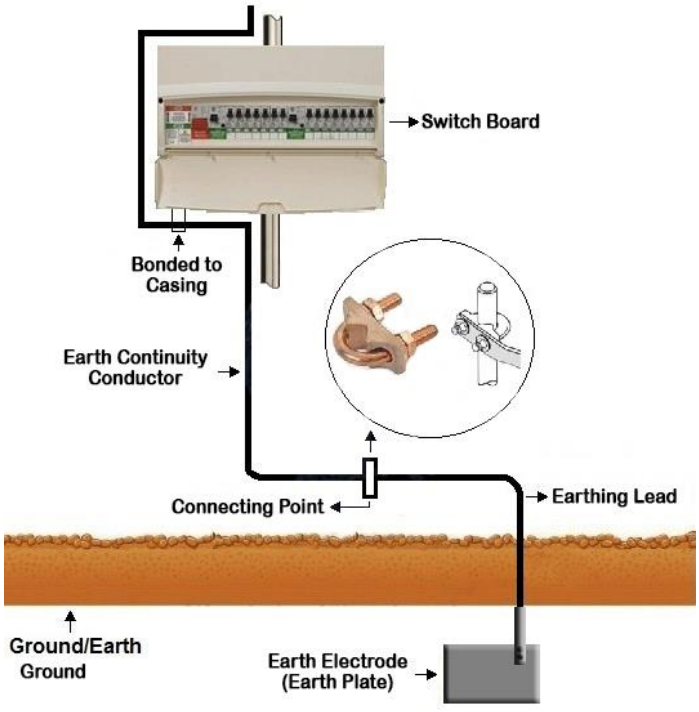


Fig. 4.2.6: Earthing for electrical appliances

4.2.6 Electrical Earthing in Domestic Wiring

The electric power line enters our house through three wires- namely the live wire, the neutral wire and the earth wire. The earth wire is given green plastic insulation.

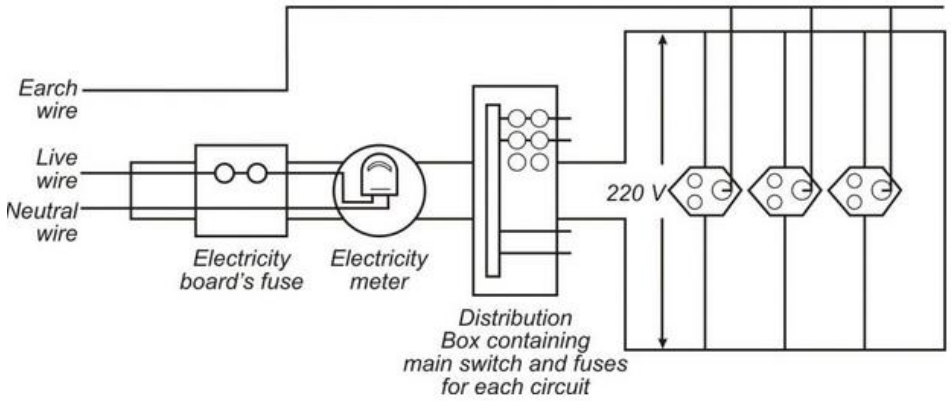


Fig. 4.2.7: Earthing given to common domestic circuit

- The live wire has a high potential of 220 volts whereas the neutral wire has zero potential. Thus the potential difference between the live wire and the neutral wire is 220-0 = 220 volts.
- The earth wire is much thicker in size and is made of copper. One end of it is connected to a copper plate buried deep under the earth. The earth connection is made to the electric meter and then to the main switch.
- In our homes, we receive supply of electric power through a main supply (mains), either supported through overhead electric poles or by underground cables.
- The live wire and neutral wire, coming from the electric pole, enter a box fitted just outside our house which has a main fuse F1. The fuse is connected in series with the live wire. This is done so because it is only the live wire which has a high potential of 220 volts unlike the neutral wire which carries zero potential. The fuse F1 has a high rating of about 50 amperes. Thus it prevents any damage such as fire to the entire electrical wiring entering the house due to short-circuit or overloading.
- The two wires then enter the electricity meter which records the electrical power consumed by us in kilowatt-hour (kWh). This meter is installed by the electric supply Department of our city.
- These two wires coming out of the meter are then connected to a main switch which is placed in a distribution box. Another fuse F2 is placed in series with the live wire in this box for the sake of consumer safety.
- There are two separate circuits in a house namely lighting circuit and power circuit. The lighting circuit with a 5 A fuse is used for running electric bulbs, fan, radio, TV, tube lights etc. and the power circuit with a 15 A fuse is used for running electric heater, electric iron, geyser, refrigerator etc. as it draws more current.
- The distribution circuits are always connected in parallel combination. In a parallel circuit even if there is a fault or short-circuiting in any one line, the corresponding fuse blows off leaving the other circuits and appliances intact and prevents damage to the entire house.
- In case short-circuit occurs in the power circuit, then the power-fuse will blow off but our lights will continue to burn as the lighting circuit remains unaffected.
- A constant voltage of the main line is available for all other electrical appliances.

- Along with the two wires, a third wire called the earth wire also enters our house as shown in the fig. The earth connection is first made to the electric meter and then to the main switch. This wire then goes into the rooms along with the live and neutral wires.

4.2.7 Electrical Earthing in Temporary Panels

- Temporary panel is used to give electrical supply for a short period of time (eg. For construction site)
- If the new construction site in being developed after demolishing a previous site, then the cables of the previous site is used for the temporary panel.
- The old meter cabin is removed and cables of the same are excavated.
- A separate wall is constructed after demolition of the site.
- The temporary panel is constructed on this wall.
- In case if the site is being constructed on new grounds then the cable for temporary panel is obtained from the nearest pillar / pole.
- Generally, 4 core 25mm or 4 core 50mm cables are used for 3 phase supply or 2 core cables of similar diameter are used for Single phase supply

Fig. 4.2.8: Temporary panels

Fig. 4.2.9: MSB

- The incoming cable can be conveniently inserted in the box from any 4 corners.
- There are 2 links provided for Neutral and Earthing. The link that is in contact with the body is called Earthing link (Here the bottom link)
- Neutral from the cable is connected to Neutral link and Earthing cable to Earthing link.

- The number of Earthing connections is decided according to the requirement of the supply.
- From the Earthing link it is connected to the screw that is provided either on the bottom or upper side of the box.
- For earthing of it a cable is connected between the metal body screw and the earthing point.
- For such panels a rod mainly made up of galvanized iron or copper is used as earthing point.
- The length of the rod is approx. 2.5M
- This rod is inserted deep in the ground vertically and part of it is left open to the surface.
- This upper surface that remains outside the ground acts as the earthing point.
- So in case if any leakage current is observed it will be passed to the ground by the copper / iron rod.

Exercise

1. What are the potential electrical hazards associated with domestic wiring work?
2. What can be the consequences of faulty or improper wiring in a residential setting?
3. What safety equipment is commonly used for protecting domestic wiring circuits from overcurrent situations?
4. What type of materials are used for domestic wiring to protect and route electrical cables?
5. What is the purpose of using conduits in domestic wiring?
6. What are the acceptance criteria for selecting conduit materials in domestic wiring?
7. What are the standard safety control measures for ensuring safe domestic wiring practices?
8. What is the purpose of raceways in electrical installations?
9. What are the common practices for laying conduits through brick and concrete structures?
10. What tests should be conducted to ensure there is no breakage or leakage in wires laid through conduits?
11. What is the purpose of electrical earthing in domestic wiring?
12. What are the essential tools and equipment required for installing an earthing system in domestic wiring?
13. What is the purpose of a continuity test in domestic electrical wiring?
14. Explain one good method of earthing from Pipe or Plate earthing.

Notes

QR Codes

Scan the QR code to watch the video

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

What is Earthing

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5. Assembling, Installing and Maintaining Temporary LV Electrical Panels

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Unit 5.1 - Installation and Maintenance of Temporary LV Electrical Panels

Unit 5.2 - Faults Associated with Temporary Electrical Panels

Unit 5.3 - Tests and Quality Checks

CON/N0605

Key Learning Outcomes

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

1. 1.Types of conduits and fixtures such as switches, sockets, MCBs, wire their selection criteria.
2. 2.Method of connection temporary panel/ Distribution boards (DB) with main power outlet.
3. 3.Power rating of fixtures to be used in panel/ DB.
4. 4.Type of faults associated with temporary electrical panels/ DBs and its accessories.
5. 5.Standard procedure of shifting and installing DBs at different locations.
6. 6.Type of tests to be undertaken in temporary panels/ DBs and its accessories such as voltage test, leakage test, power interruption/ continuity test etc.
7. 7.Methods of trace out short circuits, power interruptions/ continuity using appropriate electrical devices.
8. 8.Electrical earthing procedure in temporary panels and its importance
9. 9.Specification and details of material, tools and equipment used for electrical earthing works.
10. Standard storing and stacking procedures of electrical units, materials, fixtures, tools and devices..

Unit 5.1 Installation and Maintenance of Temporary LV Electrical Panels

Unit Objectives

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

1. Understand the method of connecting temporary panel/DBs with main power outlet.
2. Understand the method of electrical termination at power outlets using appropriate fixtures.
3. Recognize the standard procedure of shifting and installing DBs among different work location.

5.1.1 Connecting Temporary Panel/DBs with Main Power Outlet

Temporary panel is only allowed for:

- construction, remodelling, maintenance, repair, or demolition of buildings, structures, or equipment;
- emergencies, tests, experiments, and developmental work.

Hence, temporary panel must be removed immediately upon completion of construction or the purpose for which it was installed.

Procedure for Connecting Temporary Panel

- Step 1: Calculate the requirement of the load at construction site.
- Step 2: Depending upon the load, decide the rating of the panel.
- Step 3: Use safety equipment according to the rating of the load.
- Step 4: Use cross sectional area of the conductor, according to current rating of the load.
- Step 5: Ensure that the energy meter and SFU (switching fuse unit) unit is connected between temporary panel and main supply
- Step 6: The outgoing of the SFU should be the incoming for the temporary panel.
- Step 7: Depending on the rating of panel and if the main supply has more voltage rating, then step down the transformer connected to the temporary panel.
    - ♦ The output of the transformer i.e. R,Y,B and neutral connection of the transformer is given to temporary panel.
    - ♦ Earthing is provided to the whole panel.
    - ♦ Inside the temporary panel, there are safety devices such as fuse in each line and MCB, GFCI connection is given for the safety protection.
    - ♦ Outgoing terminals of the panel through these safety devices are then given to the various switchboards.

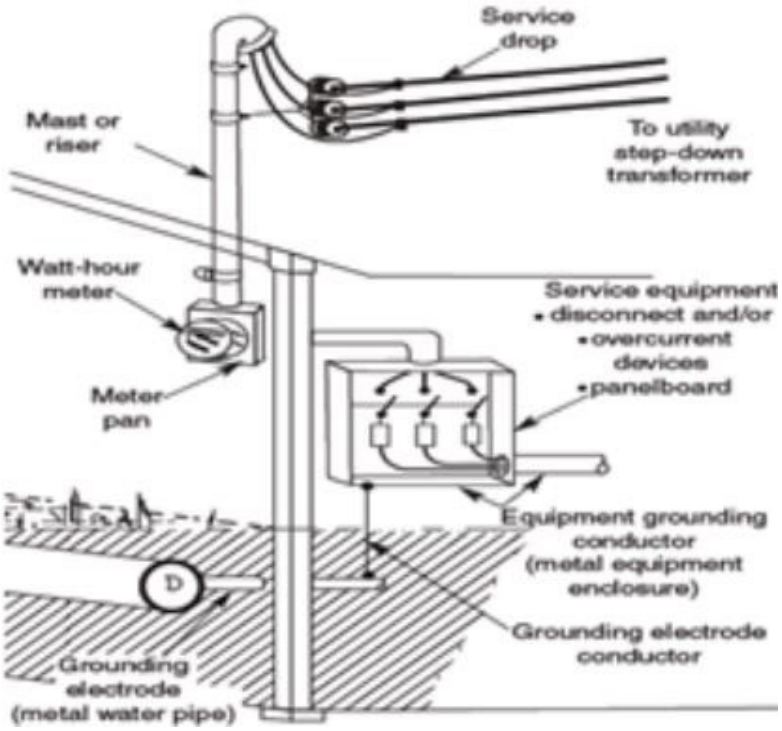

Fig. 5.1.1: Connection of Temporary Panel with Overhead Transmission Line

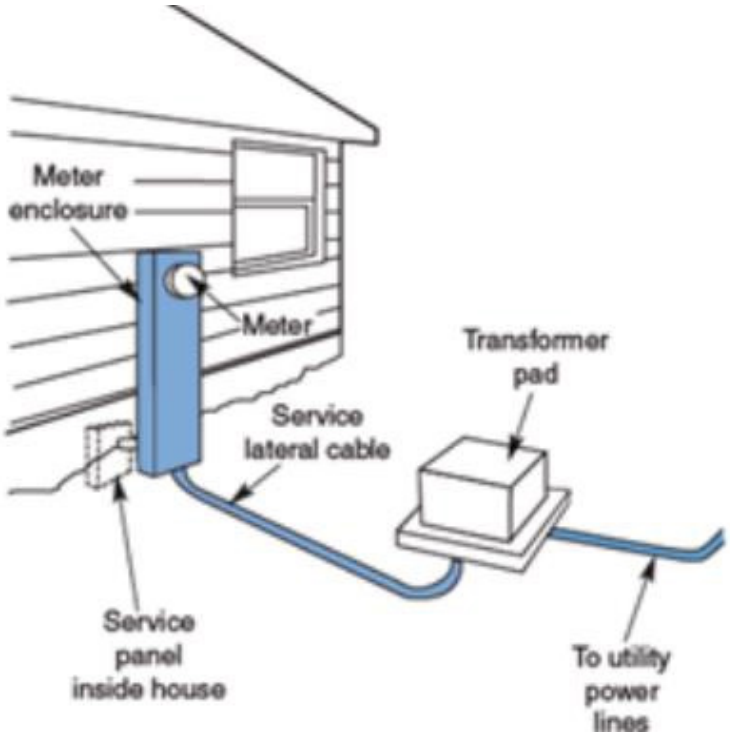

Fig. 5.1.2: Connection of Temporary Panel to Underground Cable

5.1.2 Electrical Termination at Power Outlets

Take a look at the steps for electrical termination at power outlets using appropriate fixtures:

Fig. 5.1.3: Electrical termination

Procedure for Electrical Termination at Power Outlets using Appropriate Fixtures

- Step 1: Place all the cables in proper conduit.
- Step 2: Ensure that branch circuits originate in an approved power outlet or panel board.
- Step 3: Make sure that cables are not laid on the ground.
- Step 4: Ensure no bare conductors nor earth returns are being used for the wiring of any temporary circuit.
- Step 5: Check that branch circuits which supply receptacles or fixed equipment contain a separate equipment grounding conductor, if they run as open conductors.
- Step 6: The mechanical strength of the conduits should be proper as it has to protect the cable from concrete and other raw materials used at construction.
- Step 7: Support the cable assemblies and flexible cords and cables in place at proper intervals to ensure they are protected from physical damage. Support shall be in the form of staples, cables ties, straps, or similar type fittings installed so as not to cause damage.
- Step 8: Install suitable disconnecting switches or plug connectors to permit the disconnection of all ungrounded conductors of each temporary circuit.

- Step 9: Keep the corner point cable should flexible to avoid any breaking of insulation.
- Step 10: Connect the conduit or raceway which carries all the conductors to the switchboard.

5.1.3 Shifting and Installing DBs

Take a look at the steps for Shifting and Installing DBs

Procedure of Shifting and Installing DBs

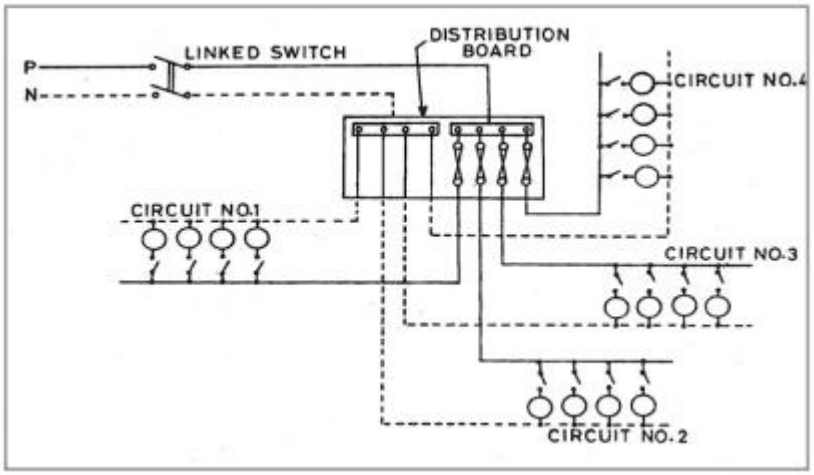

Fig. 5.1.4: Procedure for shifting and installing DBs among different locations

- Step 1: Switch off the temporary panel with the help of the SFU unit and disconnect it from main supply
- Step 2: Switch off the initial DB which is connected to the temporary panel by disconnecting the whole load of that DB.
- Step 3: With the help of switches connected to the bus bar, disconnect the initial DB.
- Step 4: Connect SFU to the temporary panel. Now, the temporary panel is connected the main supply lines.
- Step 5: Check that the bus bar which is connected to the temporary panel consists of various feeder lines which are connected to each DB.
- Step 6: With the help of switches connected to the bus bar, the other feeder lines which are connected to the other DB will switch on.

The power from temporary panel will flow through the new DB.

Notes

QR Codes

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https://www.youtube.com/watch?v=KKaZ22DmzWQ

Connecting Temporary Panel/DBs with Main Power Outlet

Unit 5.2: Faults Associated with Temporary Electrical Panels

Unit Objectives

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

1. Understand the types of faults associated with temporary electrical panels/DBs and its accessories. cation.

5.2.1 Faults Associated with Temporary Electrical Panels

Temporary electrical panels, often used in construction sites, events, or temporary installations, can be prone to several faults due to their temporary nature, potential exposure to harsh conditions, and sometimes hurried setup.

To mitigate these faults, it's important to:

- Use certified and properly rated temporary panels designed for the intended load.
- Ensure proper installation by qualified electricians.
- Follow local electrical codes and regulations.
- Perform regular inspections and maintenance.
- Provide weather protection and proper cable management.
- Implement appropriate safety measures, such as GFCIs and surge protectors.

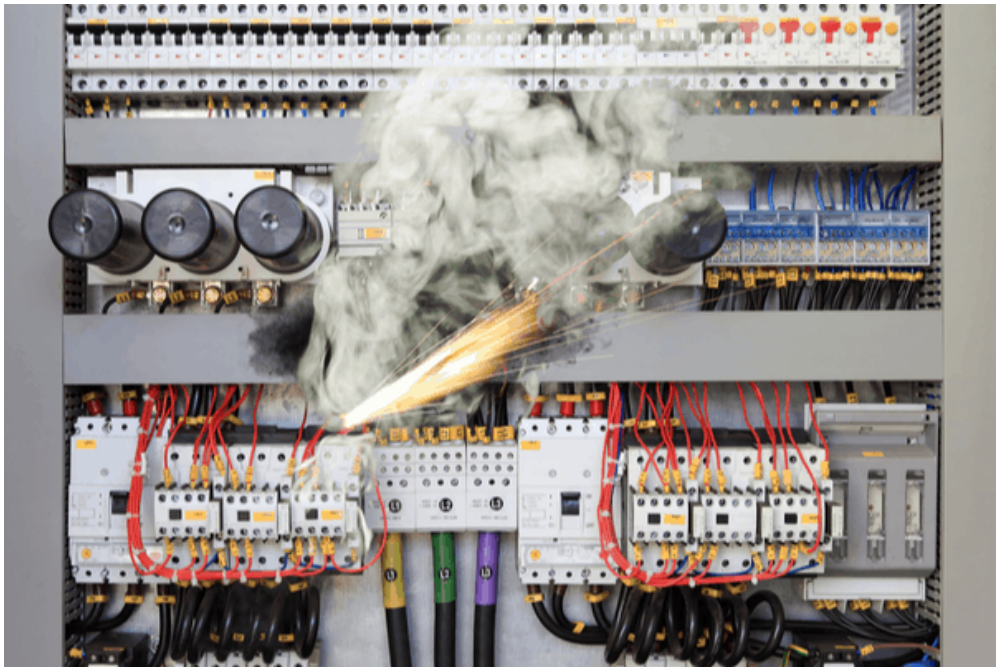

Fig. 5.2.1: Faults in temporary electrical panels

Here are some common faults associated with temporary electrical panels:

S. No.	Type of Fault	Description
1	Short circuit fault/ phase to phase fault	This fault takes place due to overloading of current. In such a case, heavy current flowing through the wire leads to rise in temperature. This results in insulation failure and current carrying conductors come in contact with each other. This is how short circuit takes place.
2	Earth fault	This fault occurs if earthing is not proper in the circuit. In this case, resistance of the earthing is more than the rated resistance. It results in opposition to the flow for earthing current. Thus, the current which flow through the earthing wire will not pass.
3	Leakage fault	This is a current which flows through the outer body of the panel. It happens when the earthing is not proper. The person operating such a panel can suffer from a shock.
4	Open circuit fault	When any of the current carrying conductor breaks down, open circuit occurs. This results in no continuity of supply in the circuit.
5	Faults caused by external factors	If DBs are not located at the correct place, they may get damaged due to concrete falling on them.
6	Safety equipment fault	This fault occurs if the fuses, circuit breakers, MCBs, etc. connected in the panel are not proper, i.e. they are not connected according to the load capacity of the circuit. In this case, although there is no overloading in the circuit, these safety devices, which are connected to the panel, will operate. For e.g. Metallic link of the fuse will melt at rated current and circuit interruption may take place.
7	GFCI fault	If the GFCI (Ground fault current interruption) is not proper, then the fault current will not bypass in the ground through the ground wire.
8	Cable line fault	If the cable line passing from the corners or edges of the construction site is not covered properly, there is a chance of breakdown of conductor as well as short circuit of the conductor.

Table 5.2.1: Common faults associated with temporary electrical panels

5.2.2 Power Rating of Fixtures

The power rating of fixtures (such as circuit breakers, switches, outlets, and other devices) used in a panel or distribution board (DB) is an important consideration to ensure the safe and reliable operation of the electrical system. The power rating of these fixtures is determined by their ability to handle the maximum current and voltage that they might encounter without becoming overheated or

malfunctioning.

Here's a general guideline for selecting fixtures with appropriate power ratings for panels or distribution boards:

- **Circuit Breakers:**
  - ♦ Circuit breakers are rated in terms of both current (amperes) and voltage (volts).
  - ♦ The current rating of the circuit breaker should match or exceed the maximum current that the connected circuits could draw.
  - ♦ The voltage rating of the circuit breaker should match the system voltage.

Fig. 5.2.2: Circuit breakers

- **Switches:**
  - ♦ Switches, such as main switches or disconnect switches, are rated based on current and voltage.
  - ♦ Select switches with current and voltage ratings that match or exceed the requirements of the circuit they are controlling.
- **Outlets and Sockets:**
  - ♦ Outlets and sockets, like those used for power outlets or plugs, are rated in terms of voltage and current.
  - ♦ Ensure the outlets' current rating can handle the expected load, and the voltage rating matches the system voltage.
- **Busbars and Connectors:**
  - ♦ Busbars and connectors should be selected based on their ability to handle the maximum current without excessive heating.
  - ♦ Ensure the material and size of busbars and connectors are suitable for the application.
- **Protection Devices (Surge Protectors, SPDs):**
  - ♦ These devices are rated for surge protection and may have voltage and current ratings.
  - ♦ Choose surge protectors that can handle the system voltage and the expected surge currents.
- **Residual Current Devices (RCDs/GFCIs):**
  - ♦ RCDs and GFCIs have current and voltage ratings.

- Ensure their ratings match the circuit's current and voltage requirements.

Always consult the manufacturer's specifications and guidelines when selecting fixtures for panels or distribution boards. Local electrical codes and regulations should also be followed to ensure compliance and safety. Improperly rated fixtures can lead to overheating, tripping, or even electrical hazards.

5.2.3 Standard Procedure of Shifting and Installing DBs at different Locations

Shifting and installing distribution boards (DBs) at different locations requires careful planning, coordination, and adherence to safety protocols to ensure a successful and safe installation. Here's a standard procedure to follow:

a) Assessment and Planning:

- Evaluate the new location to ensure it meets electrical code requirements, accessibility, ventilation, and load demands.
- Calculate the load requirements to ensure the new DB can handle the connected circuits.

b) Prepare Required Materials:

- Procure the necessary DB, cables, conduits, fittings, mounting hardware, and other accessories.
- Ensure all materials are compliant with regulations and suitable for the intended use.
- Disconnect and Isolate Power:
- Shut off the power supply to the existing DB.
- Disconnect and isolate all circuits connected to the DB to be shifted.

c) Remove Existing DB:

- Carefully disconnect all wires and cables from the existing DB.
- Remove the DB from the wall or mounting surface.

d) Prepare the New Location:

- Ensure the new location is appropriately sized and offers adequate ventilation.
- Install mounting brackets or frames, if needed.

e) Mount the New DB:

- Mount the new DB securely on the designated location, ensuring proper alignment and level installation.

f) Cable Routing and Connection:

- Route the existing cables to the new DB location through conduits, if required.
- Strip and prepare the cables for connection.

g) Wiring and Termination:

- Follow color codes and proper labeling for connecting wires to terminals.
- Use appropriate connectors, terminal blocks, or busbars for neat and secure connections.

h) Grounding and Bonding:

- Ensure proper grounding by connecting grounding conductors to the grounding bar or terminal.
- Bond metal enclosures as required to maintain proper electrical continuity.

i) Circuit Identification and Labeling:

- Label each circuit clearly to indicate its purpose or location.
- Maintain consistency in labeling to avoid confusion.

j) Inspection and Testing:

- Conduct a visual inspection to ensure all connections are secure and there are no exposed wires.
- Test each circuit using appropriate testing equipment to verify proper functionality.

k) Power Restoration:

- After verifying that the new DB installation is safe and functional, restore power to the circuits.

l) Documentation:

- Document the new DB installation, including circuit details, labeling, and testing results.

m) Post-Installation Checks:

- Observe the DB's performance for a period to ensure there are no issues with overheating, tripping, or malfunction.

Remember to follow local electrical codes, regulations, and safety guidelines throughout the installation process. If you're not experienced with electrical work, it's recommended to involve a qualified electrician to ensure a safe and compliant installation.

Fig. 5.2.3: Safe installation

Notes

Unit 5.3: Test and Quality Checks

Unit Objectives

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

1. List the type of tests to be undertaken in lighting units and its accessories.
2. State the methods to trace out short circuit, power interruptions/continuity using appropriate electrical devices.
3. Recall the tests to be done to ensure that there is no breakage/leakage from the wire.
4. List the tests to be performed in domestic electrical wiring works using appropriate measuring devices.
5. State the type of tests to be undertaken in temporary panels/DBs and its accessories.

5.3.1 Testing Lighting Units and Accessories

Providing the correct intensity of light and colour spectrum is extremely important because:

- over-illumination can lead to loss of energy
- it can adversely affect the health of those using it;
- excess light can affect the efficiency of workers.

Now let us understand how to check and assemble a tube light (fluorescent lamp) and its accessories. For this activity, you will require Tool kit which will contain:

- Nose pliers
- Hand drilling machine with a 6.3mm drill bit
- Hammer
- Fluorescent tube light fitting
- Two-way connector
- PVC power cable
- Raw plug no. 10
- Wood screws
- Test lamp
- BC lamp
- Switchboard.

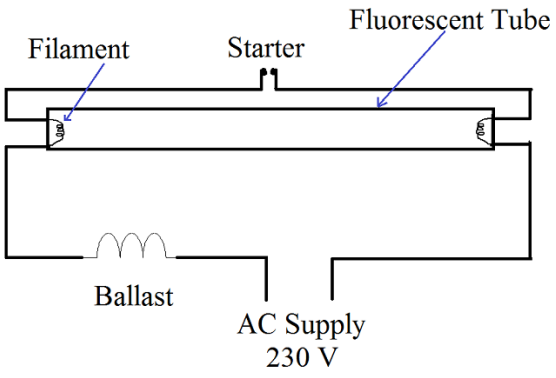

Fig. 5.3.1: Testing Lighting Units and Accessories

Procedure for Testing Lighting Units

- Step 1: Check the choke for its short.
- Step 2: Open with a test lamp.
- Step 3: Record the results.

- Step 4: To test the starter, connect the starter with a series test lamp.
- Step 5: Observe the flickering of the lamp.
  - ♦ This indicates that the starter is in good condition.
  - ♦ If there is no flickering, it means the starter is defective.
- Step 6: Make the connection to test the filament on both sides of the fluorescent tube for its continuity.
  - ♦ If the tube is in good condition, the lamp will glow normally.
  - ♦ If the filament is not glowing, it means the tube has burnt out.
- Step 7: Discard the fluorescent tube if there is an open or fused filament on either side of the tube.
- Step 8: Assemble the fluorescent tube accessories like starter, holder, choke in the fitting base with the help of screws.
- Step 9: Fix the tube in the tube holder.

- **Always ensure that:**
  - ♦ lamps are connected at proper angle and at proper height;
  - ♦ the place where the light is connected is dry;
  - ♦ the outer surface of the lamps is clean and gives proper illumination;
  - ♦ the power rating of the lamp selected is according to area where the work has to be done;
  - ♦ the wiring which connects the lamp to lamp holder should be proper i. the insulation of wiring should be proper.
- **Testing for Accessories:** Always make sure that,
  - ♦ the fixtures should be proper;
  - ♦ the lamp holder should be damage free;
  - ♦ the phase, neutral, earthing point in the switchboard is proper.

5.3.2 Tracing Short Circuits, Power Interruptions and Continuity

When two conductors come in contact with each other (i.e. phase and neutral conductor) due to improper insulation, short circuit takes place in the circuit. Due to this, heavy current starts flowing through the circuit and the person who is operating the circuit suffers from a shock.

Tracing Short Circuits

- Keep multimeter terminal at resistance side.
- Connect two terminals of multimeter to switchboard.
  - ♦ Two terminals mean phase and neutral or neutral and earthing.
- If multimeter gives zero resistance reading, then there is short circuit

Tracing Power Interruptions

Power interruptions in the circuit take place when:

- there is breakdown of any conductor in the circuit;
- the plug is not inserted properly in the supply;
- the safety devices used are not proper;
- the metallic link of the fuse is not proper.

Power interruption takes place when there is an open circuit.

Testing for Open Circuits

- Keep multimeter terminal at resistance side.
- Connect two terminals of multimeter to switchboard two terminals.
- If multimeter gives mega ohm resistance reading, then there is open circuit.

Testing for Earth Fault

- Keep multimeter terminal at voltage side.
- Connect two terminals of multimeter to switch board two terminals i.e. neutral earthing.
- If multimeter shows some voltage reading, then there is earth fault.

Performing Continuity Test

There are 3 main types of continuity tests for the final circuits:

- Protection Conductor Continuity Test
  - ♦ This test is performed to verify the continuity of the protective conductor (also known as the earth or ground conductor) throughout the circuit.
  - ♦ The protective conductor ensures a safe path for fault currents to flow to the ground, preventing electric shock hazards.
  - ♦ By checking the continuity of the protection conductor, you ensure that the circuit's grounding system is intact and capable of carrying fault currents.

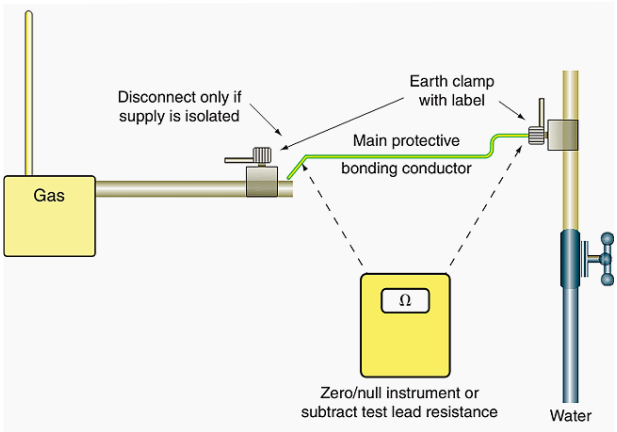

Fig. 5.3.2: Protection Conductor Continuity Test

- Final Ring Circuit Conductor Continuity Test
  - The final ring circuit conductor continuity test focuses on ensuring the continuity of conductors within a ring circuit.
  - A ring circuit consists of a ring of conductors that connect the outlets or sockets. The test ensures that the conductors are continuous and correctly connected, preventing open circuits or interruptions.
  - This test helps identify any breaks, loose connections, or faulty segments in the ring circuit, which could otherwise lead to partial or complete loss of power to outlets.

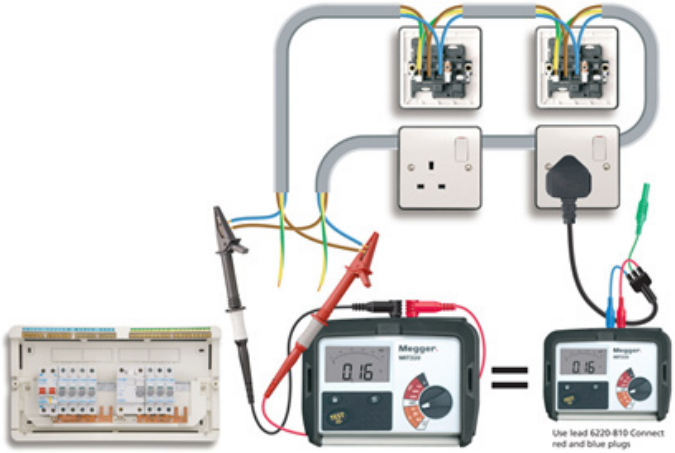

Fig. 5.3.3: Final Ring Circuit Conductor Continuity Test

- Live and Neutral Conductor Continuity Test
  - This continuity test aims to confirm the continuity of both the live (hot) and neutral conductors in the circuit.
  - It ensures that there are no interruptions or faulty connections in the live and neutral conductors, preventing potential hazards such as electrical shock or equipment malfunction.
  - Proper continuity in both live and neutral conductors is crucial for the safe and reliable functioning of electrical devices and appliances.

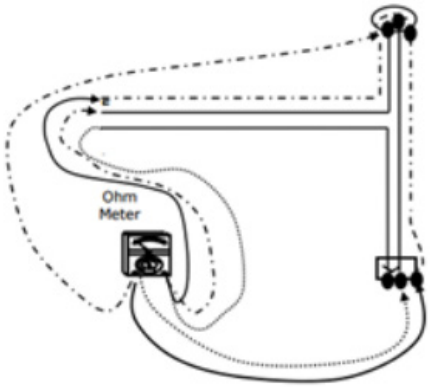

Fig. 5.3.4: Live and Neutral Conductor Continuity Test

5.3.3 Quality Checks for Domestic Electrical Wiring Works

Quality checks for domestic electrical wiring works is done at four levels:

Initial testing of an installation

This includes electrical continuity and conductivity tests of conductors.

- It also tests the insulation resistance of live conductors and protective conductors connected to the earthing arrangement.
- It tests the compliance of SELV (Safety Extra Low Voltage) and PELV (Protection by Extra Low Voltage) circuits for electrical separation.
- It includes checking the insulation resistance/impedance of floors and walls.
- It includes checking the protection by automatic disconnection of the supply.

Putting existing electrical installations out of danger

- It includes replacing defective electrical installations with a new one.

Periodic testing of installation

- This includes checking the effectiveness and adjustments of RCD, MCB and fuse.
- It helps to make sure that appropriate measures are taken for ensuring safety of persons against effects of electric shock and protection against damage to property against fire and heat
- It helps to ensure that the installation is not damaged in any way.
- It helps to identify defects in a timely manner.

Assessing the conformity of equipment

- It helps to ensure quality assurance for equipment used.

When these control procedures are followed diligently, quality and safety is assured. This can also be ensured when:

- The design has been done according to the latest edition of the appropriate wiring rules.
- The electrical equipment complies with relevant product standards.
- The initial checking of conformity of the electrical installation with the standard and regulation has been achieved.

5.3.4 Quality Checks for Temporary Panels

Temporary power panels or power outlet panels (POP) provide safe and reliable temporary power for construction sites. When performing quality check for temporary panels, you must ensure that:

- earthing (GFCI) should be proper;
- MCB should be proper;
- insulation of the wiring should be proper;
- conductor size should be according to current carrying capacity of the wire;
- temporary panel should be properly covered from water;
- panel is given proper protection against lightning;
- clip on meter is there to check leakage current is flowing through the neutral.

Exercise

1. What are the key considerations when selecting a suitable location for installing a temporary LV electrical panel?
2. Why is proper grounding essential during the installation of temporary LV electrical panels?
3. What safety measures should be taken while connecting and disconnecting circuits in temporary panels?
4. How can overloading of circuits in temporary panels lead to safety hazards?
5. Explain the risks associated with improper insulation or exposed wiring in temporary panels.
6. What is the purpose of a continuity test in temporary LV electrical panels?

Notes

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6. Work Effectively in a Team

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Unit 6.1 - Work effectively in a team

CON/N8001

Key Learning Outcomes

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

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

Unit 6.1: Effective Interaction and Communication

Unit Objectives

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

1. Demonstrate effective communication skills while interacting with co-workers, trade seniors and others during the assigned task.
2. Interpret work sketches, formats, permits, protocols, checklists and work-related requirements which are to be conveyed to other team members
3. Handle material/ tools by adhering to instructions or consulting with seniors
4. Demonstrate effective reporting to seniors as per applicable organisational norms
5. Explain effects and benefits of timely actions relevant to fabrication works with examples
6. Explain importance of team work and its effects relevant to fabrication works with examples
7. Demonstrate team work skills during assigned task.

6.1.1 Effective Communication

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

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

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

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

Communication Process

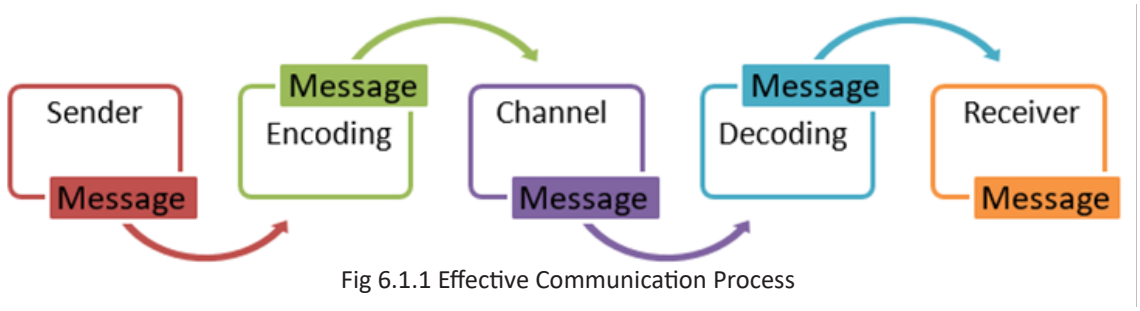

Fig 6.1.1 Effective Communication Process

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

6.1.2 Workplace Communication

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

Effective Communication with Stakeholders

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

1. Establish a Communication Chain of Command

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

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

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

2. Select an Appropriate Communication Method

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

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

3. Be an Active Listener

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

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

4. Prevent Confusion, Be Clear and Concise

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

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

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

5. Keep Written Communication Always Professional

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

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

Stick to the Facts

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

However, you must offer your professional thoughts on a project when you believe they could contribute to its practical completion. Your company's expertise contributed to its selection for the project, so don't be shy.

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

6.1.3 Adverse Effects of Poor Communication

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

misunderstands it.

The following issues are faced due to poor communication:

Confusion

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

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

Unnecessary Delays

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

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

Budget/Cost Overruns

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

Injuries and Safety Issues

Poor safety communication is frequently attributable to three frequent causes:

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

Issues with Stakeholders

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

6.1.4 Teamwork at Workplace

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

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

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

Advantages of Teamwork

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

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

6.1.5 5 C's of Teamwork

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

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

Co-operation

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

Compromise

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

Communication

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

Confidence

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

Commitment

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

6.1.6 Enhancing Teamwork in the Workplace

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

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

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

2. **Communicate Explicitly**

   Communication is the fundamental prerequisite. We must create an atmosphere in which team members are free to share their thoughts. It is advisable to make an effort to prevent such mis-understandings.

3. **Delegate and believe**

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

4. **Establish shared aims and objectives**

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

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

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

6. **Conquer a conflict with success**

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

7. **Build a diverse group**

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

8. **Believe in Team Building**

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

6.1.7 Importance of Teamwork in Construction Industry

1. Teamwork is of paramount importance in the construction industry due to its complex and collaborative nature. Successful construction projects rely heavily on effective teamwork for several compelling reasons:

2. **Diverse Skill Sets:** Construction projects require a variety of specialized skills, from design and planning to execution and management. Effective teamwork ensures that each team member contributes their expertise, leading to a well-rounded and comprehensive project approach.

3. **Task Allocation:** Different tasks and responsibilities need to be distributed among team members. Teamwork allows for proper task allocation based on individual strengths and expertise, maximizing efficiency and productivity.

4. **Knowledge Sharing:** Collaborative teamwork facilitates the sharing of knowledge, best practices, and innovative ideas among team members. This continuous learning and knowledge exchange lead to improved project outcomes.

5. **Effective Communication:** Construction projects involve numerous stakeholders, including architects, engineers, contractors, and subcontractors. Strong teamwork fosters clear and open communication, preventing misunderstandings and minimizing conflicts.

6. **Problem Solving:** Challenges and unexpected issues are common in construction. Team members can collectively brainstorm solutions, drawing from their diverse experiences and perspectives to address complex problems effectively.

7. **Quality Assurance:** A collaborative approach enables team members to review each other's work, providing checks and balances that enhance the quality of construction and ensure compliance with standards.

8. **Efficient Resource Management:** Construction projects involve various resources, such as materials, equipment, and labor. Teamwork helps optimize the allocation and utilization of resources, reducing waste and minimizing costs.
9. **Project Coordination:** Different phases of construction, such as design, planning, and execution, need to be seamlessly coordinated. Teamwork ensures smooth transitions between phases and minimizes delays.
10. **Risk Management:** Teams can collectively identify and mitigate potential risks in the project. By pooling their expertise, team members can develop strategies to address risks and ensure project success.
11. **Flexibility and Adaptability:** Construction projects often encounter changes, such as design modifications or unforeseen issues. A cohesive team can adapt to changes quickly, adjusting plans and strategies as needed.
12. **Workplace Morale:** Positive teamwork creates a supportive and collaborative work environment. When team members feel valued, motivated, and respected, morale improves, leading to increased job satisfaction and overall well-being.
13. **Timely Completion:** Construction projects have tight deadlines. Effective teamwork ensures that tasks are completed on schedule, avoiding delays and penalties.
14. **Client Satisfaction:** Teamwork contributes to delivering high-quality projects that meet or exceed client expectations. Satisfied clients are more likely to provide positive feedback, repeat business, and referrals.
15. **Safety:** Safety is a top priority in construction. Team members can collectively enforce safety protocols, look out for each other, and identify potential hazards to prevent accidents.

6.1.8 Time Management

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

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

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

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

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

3. **Less anxiety and stress:** When employees are stressed and anxious, not only do they miss deadlines and produce subpar work, but it also negatively affects their health. As an employer, you are responsible for ensuring that the mental health of employees is a top priority. Stressed employees are more prone to take sick days and seek alternative jobs.
4. **Better-quality work:** With effective time management, employees have the necessary time to produce work that is not only completed on time but also of a superior quality.
5. **Boosts confidence:** When employees are on top of their responsibilities, it boosts their confidence and enables them to believe in their own talents. In turn, this reduces tension and anxiety because the body produces dopamine.
6. **Reduces procrastination and wasted time:** Knowing how to prioritise decreases procrastination and promotes a "eat the frog" mentality among staff. This saves downtime and increases productivity.
7. **Enhances the work-life balance:** An effective work-life balance when an employee is well-rested and has the opportunity to re-energize, they are in the best position possible to produce their finest work.
8. **Make better decisions:** When employees have time to concentrate and work thoroughly, they are not required to make decisions under duress. Instead, individuals can make selections based on all the necessary information to make the greatest choice.

Time Management in Construction Industry

Effective time management is essential in the construction industry to ensure projects are completed on schedule, within budget, and to the required quality standards. Here are some time management strategies specific to the construction industry:

1. **Detailed Project Planning:** Develop a comprehensive project plan that outlines tasks, milestones, timelines, and resource requirements. A well-structured plan serves as a roadmap for the entire project.
2. **Set Clear Goals and Priorities:** Define clear objectives and prioritize tasks based on their importance and deadlines. This helps ensure that critical tasks are addressed first.
3. **Allocate Resources Wisely:** Assign manpower, equipment, and materials according to the project plan. Efficient resource allocation prevents bottlenecks and delays.
4. **Effective Communication:** Maintain open and consistent communication with all project stakeholders, including team members, clients, contractors, and suppliers. Clear communication

minimizes misunderstandings and facilitates timely decision-making.

5. **Regular Progress Tracking:** Monitor project progress regularly using project management software or tools. Identify any deviations from the schedule and take corrective actions promptly.
6. **Streamline Workflows:** Optimize processes and workflows to eliminate inefficiencies. Identify areas where tasks can be streamlined or tasks can be executed concurrently.
7. **Lean Construction Practices:** Adopt lean principles to minimize waste, reduce non-value-added activities, and improve overall efficiency.
8. **Integrated Project Management:** Implement integrated project management techniques that involve collaboration and coordination among all project stakeholders. This fosters a cohesive and aligned approach to time management.
9. **Risk Management:** Identify potential risks that could impact the project schedule and develop mitigation strategies. Being prepared for unforeseen challenges helps minimize disruptions.
10. **Resource Leveling:** Balance the workload among team members and subcontractors to prevent overloading certain areas while others remain underutilized.
11. **Utilize Technology:** Employ construction management software, scheduling tools, and mobile apps to streamline communication, track progress, and manage tasks efficiently.
12. **Effective Supervision:** Ensure that supervisors are equipped to manage teams, address issues promptly, and keep the project on track.
13. **Collaborative Planning Meetings:** Conduct regular planning and progress review meetings involving all stakeholders. This fosters coordination and ensures that everyone is aligned with the project goals.
14. **Contingency Planning:** Develop contingency plans for potential delays or disruptions. Having backup solutions in place helps maintain project momentum.
15. **Continuous Improvement:** After project completion, conduct a post-mortem analysis to identify areas for improvement in future projects. Learning from past experiences enhances time management in subsequent endeavors.
16. **Empowerment and Accountability:** Delegate responsibilities to team members and empower them to take ownership of their tasks. Encourage accountability for meeting deadlines.
17. **Manage Change Orders:** Handle change orders efficiently, considering their impact on the project schedule and making adjustments as necessary.

6.1.9 Construction Reporting

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

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

Objective of Construction Reporting

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

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

Types of Construction Reports

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

1. Materials Report

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

2. Trend Report

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

3. Cost Report

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

4. Progress Report or Daily Report

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

These reports describe the site's specifics and keep stakeholders updated. In the event of any delays, daily reports clarify the underlying causes, thereby eliminating the time wasted disputing over the surrounding minutiae. The daily report is typically prepared by the construction manager or foreman.

6.1.10 Handle material/ tools by adhering to instructions or consulting with seniors

The poor handling of tools and materials leads to numerous health and safety incidents as well as material loss. In this sense, the construction sector is a high-risk one. To do any task in these industries safely, a high level of ability and competence is required.

Seniors must make sure and instruct that equipment that is made available to workers and employees is handled responsibly. Also, it is their duty to guarantee that the workers are qualified and capable of performing the work in a safe manner.

The workers in return are liable to adhere to the instructions laid by the supervisors for handling materials and tools. The importance of it is as follows:

- To maximise space utilisation by properly storing materialtoolsls and thereby reduce storage and handling costs,
- to minimise accidents during handling,
- to reduce overall cost by improving handling,

Exercise

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

Notes

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

7. Planning and Organizing Work

Construction Skill Development Council

SCPwD
दिव्यांग व्यक्तियों के लिए कौशल परिषद
Skill Council for Persons with Disability

Unit 7.1 - Planning and organizing work to meet the expected outcomes

CON/N8002

Key Learning Outcomes

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

1. Demonstrate prioritising of work activities in order to achieve the desired results.
2. Demonstrate the organising of resources before the commencement of work.

Unit 7.1: Planning and Organizing Work to meet the Expected Outcomes

Unit Objectives

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

1. Explain methods to upkeep, store and stack tools, materials used for domain specific works.
2. Explain the process of planning of the given tasks and activities relevant to the trade/job role within defined scope and duration.
3. Explain the procedure adopted for prioritizing an activity and sequencing of activities.
4. Explain the work plan and flow of activities in sequence for the assigned work.
5. Explain basic concept of labour productivity and work productivity.
6. Explain requisition of resources, reporting for requirement of resources orally and in written to concerned authority.
7. Explain how to minimise wastage of resources.
8. Explain the plan for waste collection and disposal after task.
9. Identify the work target and plan activities to achieve the desired productivity.
10. Demonstrate requisition of resource citing an example.
11. Demonstrate the planning for various activities relevant to task as per the scope and schedule.
12. Demonstrate how to organise the required tool, manpower and material resources for the assigned task.
13. Select required quantity of materials, tools or devices for defined work activities.
14. Demonstrate how to prioritize all works/ activities to maximise output.
15. Demonstrate optimum use of resources while performing domain specific work activities.
16. Demonstrate waste collection and disposal as per organisational norms.
17. Demonstrate completion of work within stipulated time and plan.

7.1.1 Planning in Construction Industry

Planning is a critical aspect of the construction industry that ensures projects are executed efficiently, within budget, and to the highest quality standards. Effective planning involves several key steps and considerations:

1. **Project Scope and Objectives:**
    - Clearly define the scope of the project, including the goals, deliverables, and expected outcomes.
    - Establish project objectives, such as completion dates, budget constraints, and quality benchmarks.
2. **Project Team and Roles:**

- Identify the key team members, their roles, and responsibilities.
- Establish clear lines of communication and reporting within the team.

3. **Site Evaluation and Pre-Construction:**
    - Evaluate the construction site to understand its characteristics, limitations, and any potential challenges.
    - Conduct soil tests, surveys, and environmental assessments as needed.
4. **Budgeting and Cost Estimation:**
    - Develop a comprehensive budget that includes all project costs, such as materials, labor, equipment, permits, and contingencies.
    - Estimate costs accurately to avoid cost overruns and ensure financial feasibility.
5. **Project Schedule and Timeline:**
    - Create a detailed project schedule that outlines the sequence of tasks, milestones, and deadlines.
    - Allocate time for each task, considering dependencies and potential delays.
6. **Resource Allocation:**
    - Allocate resources, including manpower, materials, and equipment, according to the project schedule.
    - Optimize resource utilization to prevent underutilization or overallocation.
7. **Risk Assessment and Management:**
    - Identify potential risks and uncertainties that could impact the project.
    - Develop strategies to mitigate and manage risks to minimize disruptions.
8. **Procurement and Supply Chain:**
    - Plan for the timely procurement of materials and equipment.
    - Establish relationships with reliable suppliers and ensure a smooth supply chain.
9. **Permits and Regulatory Approvals:**
    - Obtain the necessary permits and approvals from local authorities and regulatory agencies.
    - Ensure compliance with building codes and regulations.
10. **Health and Safety Planning:**
    - Develop a comprehensive health and safety plan to protect workers and ensure a safe work environment.
    - Implement safety protocols and provide training to all team members.
11. **Quality Assurance and Control:**
    - Define quality standards and establish procedures for quality assurance and control.
    - Conduct regular inspections and audits to ensure work meets the specified standards.

12. **Communication Plan:**
    - Establish a communication plan that outlines how information will be shared among team members, stakeholders, and clients.
    - Set up regular progress meetings to review project status and address any issues.
13. **Change Management:**
    - Develop a process for managing changes or modifications to the project scope, schedule, or budget.
    - Evaluate the impact of changes and make informed decisions.
14. **Stakeholder Engagement:**
    - Identify project stakeholders, including clients, contractors, subcontractors, and community members.
    - Keep stakeholders informed and engaged throughout the project lifecycle.
15. **Contingency Planning:**
    - Anticipate potential disruptions or delays and develop contingency plans to address them.
    - Have backup strategies in place to ensure the project remains on track.
16. **Documentation and Reporting:**
    - Maintain thorough documentation of project plans, decisions, and communications.
    - Generate regular progress reports to track achievements and identify areas for improvement.
17. **Lessons Learned:**
    - After project completion, conduct a review to assess what went well and identify areas for improvement.
    - Use insights from past projects to enhance planning and execution in future endeavors.

7.1.2 Basic Concept of Productivity and Sequence of Working

Productivity refers to the efficiency and effectiveness with which resources, such as labour, materials, and equipment, are used to produce goods or services. In construction, productivity is often measured in terms of the output of labour, such as the amount of work completed per hour or day.

To improve productivity, it is important to have a clear sequence of work that is optimized for efficiency. The sequence of work refers to the order in which different tasks or activities are performed, and it can have a significant impact on productivity.

Here are some key principles to keep in mind when planning the sequence of work:

- **Plan ahead**: It is important to plan the sequence of working well in advance, taking into account the project scope, schedule, and available resources.
- **Optimize flow**: The sequence of work should be designed to optimize the flow of work, minimizing bottlenecks and delays. This might involve grouping tasks that require similar skills or equipment or arranging tasks in a logical order to minimize travel time and distance.
- **Minimize waste**: The sequence of work should be designed to minimize waste, such as rework, waiting time, and excess inventory. This might involve implementing lean construction practices, such as just-in-time delivery or prefabrication.
- **Prioritize safety**: The sequence of working should prioritize safety, ensuring that workers are protected from hazards and that all necessary safety precautions are taken.
- **Monitor progress**: It is important to monitor progress regularly to ensure that the sequence of work is achieving the desired productivity and efficiency. Adjustments may need to be made as the project progresses, based on changing conditions or unforeseen challenges.

By following these principles, it is possible to design a sequence of work that maximizes productivity and efficiency, while minimizing waste and ensuring worker safety.

7.1.3 Resource Requisition Process

The process of requisitioning resources and reporting requirements for those resources typically involves the following steps:

- **Identify the need**: The first step is to identify the specific resources that are needed for a particular task or project. This may involve reviewing project plans and timelines, consulting with project stakeholders, and analyzing the scope of work.
- **Prepare a requisition**: Once the resources have been identified, a requisition form should be prepared that outlines the type and quantity of resources needed, as well as any special requirements or preferences. The requisition may be prepared in writing or electronically, depending on the organization's policies and procedures.
- **Submit the requisition**: The requisition should be submitted to the appropriate department or individual responsible for fulfilling the request. This may involve submitting the requisition to a procurement or supply chain team, a project manager, or a supervisor.
- **Follow-up**: After the requisition has been submitted, it is important to follow up to ensure that the request is being processed on time. This may involve checking on the status of the request, providing additional information or clarification as needed, and escalating the request if there are any delays or issues.
- **Oral and written reporting**: Throughout the process, it is important to provide regular reporting on the status of the requisition and the resources needed. This may involve providing oral

updates in team meetings or conference calls, as well as preparing written reports or memos that outline the status of the request and any issues or concerns.

Effective communication and reporting are critical to ensuring that resources are requisitioned in a timely and efficient manner. By following a clear process and providing regular updates and feedback, it is possible to ensure that the right resources are available at the right time, and that project goals are met on schedule and within budget.

7.1.4 Procedure for Reporting to Seniors

When it comes to oral and written reporting procedures to superiors, you can follow the process given below:

- Decide on the purpose and scope of your report, such as what you want to inform, persuade or recommend to your superiors.
- Conduct your research and gather relevant data, facts and evidence to support your report.
- Organize your report into a clear structure, such as an introduction, a body and a conclusion.
- Write your report using clear, concise and professional language, following the format and style guidelines of your organization.

Include the following information in your report:

- A title page that indicates the topic, author, date and recipient of the report
- A table of contents that lists the main sections and sub-sections of the report
- An executive summary that summarizes the main points, findings and recommendations of the report
- An introduction that states the background, context, objectives and scope of the report
- A body that presents and analyzes the data, facts and evidence in a logical and coherent manner
- A conclusion that summarizes the main findings, implications and limitations of the report
- A list of recommendations that suggests specific actions or solutions based on the report
- A list of references that cites the sources used in the report
- An appendix that provides additional or supplementary information that is relevant but not essential to the report
- Proofread and edit your report for accuracy, clarity and completeness.
- Submit your report to your superiors via email, mail or online platform, depending on the communication protocol of your organization.

Prepare an oral presentation of your report using visual aids, such as slides, charts or graphs.

- Practice your oral presentation and time yourself to ensure you cover the key points within the allotted time.

- Deliver your oral presentation with clarity and confidence, using appropriate voice, tone, gestures and eye contact.
- Engage with your audience by asking questions, inviting feedback and addressing any queries or concerns.

7.1.5 Handling and Organizing Construction Tools, Material, Fixtures and Devices

Handling and organizing construction tools, materials, fixtures, and devices is a crucial aspect of the construction industry to ensure smooth operations, worker safety, and efficient project execution. Proper handling and organization contribute to productivity, cost-effectiveness, and the overall success of construction projects. Here's a detailed explanation of the process:

Handling Construction Tools, Materials, Fixtures, and Devices:

1. **Safe Handling:** Workers should receive proper training in the safe handling of tools, materials, fixtures, and devices. This includes understanding how to lift and carry heavy items, use tools correctly, and adhere to safety protocols.
2. **Proper Use:** Tools, materials, fixtures, and devices should be used only for their intended purposes. Misusing or using tools improperly can lead to accidents, damage, or poor-quality work.
3. **Regular Inspection:** Regularly inspect tools, materials, and equipment for wear and damage. Defective items should be repaired or replaced promptly to prevent accidents or delays.
4. **Maintenance:** Schedule routine maintenance for tools and equipment to ensure they remain in good working condition. Properly maintained tools last longer, perform better, and reduce the risk of breakdowns.
5. **Cleaning:** Clean tools, materials, and equipment after use to prevent the accumulation of dirt, debris, or hazardous substances. Clean tools are safer to handle and contribute to a healthier work environment.
6. **Proper Storage:** When not in use, tools should be stored properly in designated tool storage areas. This prevents clutter, reduces the risk of accidents, and ensures tools are readily accessible when needed.
7. **Labeling:** Clearly label tools, materials, and containers to avoid confusion and enhance organization. Labels should indicate the contents, usage instructions, and any safety precautions.

Organizing Construction Tools, Materials, Fixtures, and Devices:

1. **Tool Storage:** Designate specific areas for tool storage, whether it's a toolshed, toolbox, or tool rack. Tools should be organized systematically to ensure easy access and quick retrieval.
2. **Material Storage:** Materials should be stored in an organized manner to prevent damage, deterioration, or theft. Use shelves, racks, or pallets to keep materials off the ground and protect them from weather elements.

3. **Categorization:** Categorize tools, materials, fixtures, and devices based on their types or functions. This simplifies inventory management and helps workers locate items efficiently.
4. **Inventory Control:** Maintain an inventory list of tools, materials, and equipment, along with their quantities and conditions. Regularly update the inventory to track usage and restocking needs.
5. **First-In, First-Out (FIFO):** Adhere to the FIFO principle for materials to prevent the use of older materials before newer ones. This prevents wastage and ensures efficient utilization.
6. **Safety Considerations:** Store hazardous materials separately in designated areas, following safety regulations and guidelines. Keep fire extinguishers and emergency response equipment nearby.
7. **Fixture and Device Organization:** Plan the installation locations of fixtures and devices ahead of time. Ensure that wiring, plumbing, and mounting points are in place before fixtures are installed.
8. **Documentation:** Keep records of tools, materials, fixtures, and devices used in each project. Documentation helps track expenses, facilitates warranty claims, and provides insights for future projects.
9. **Accessibility:** Organize tools and materials so that they are easily accessible to workers. This minimizes time spent searching for items, enhances efficiency, and reduces downtime.
10. **Labeling and Signage:** Use clear labeling and signage to indicate storage areas for specific tools, materials, and equipment. This enhances visibility and reduces the chances of items being misplaced.

Effective handling and organizing of construction tools, materials, fixtures, and devices require proactive planning, regular maintenance, and a commitment to safety and efficiency. A well-organized construction site contributes to a more productive and conducive work environment, leading to successful project outcomes.

7.1.6 Prioritizing Work

Prioritizing work and activities is an important skill that can help you to manage your time more effectively and achieve your goals. Here are some steps you can take to prioritize your work and activities:

- **Identify all tasks and activities**: The first step is to make a list of all the tasks and activities that you need to complete. This may involve breaking down larger projects or goals into smaller, actionable tasks.
- **Determine urgency and importance**: Once you have a list of tasks and activities, determine their level of urgency and importance. Urgent tasks are those that need to be completed immediately, while important tasks are those that will have a significant impact on your overall goals and objectives.
- **Assign priorities**: Based on the level of urgency and importance, assign priorities to each task and activity. You may choose to use a numbering or colour-coding system to help you keep track of priorities.

- **Create a schedule**: Once you have assigned priorities, create a schedule or timeline for completing each task. Be realistic about the time required for each task and make adjustments as needed.
- **Review and adjust regularly**: Finally, review your priorities and schedule regularly to ensure that you are on track and make adjustments as needed. This may involve reassigning priorities, shifting deadlines, or delegating tasks to others.

By following these steps, you can prioritize your work and activities effectively, which can help you to manage your time more efficiently and achieve your goals more effectively.

7.1MM.7 Optimum Utilization of Resources

Optimum utilization of resources is of paramount importance in the construction industry for several compelling reasons:

1. **Cost Efficiency:** Efficient utilization of resources minimizes waste, reduces unnecessary expenses, and ensures that materials, labor, and equipment are used effectively. This directly contributes to cost savings and improved project profitability.
2. **Project Budget Adherence:** Proper allocation and management of resources help ensure that construction projects stay within budget. Overspending on resources or inefficient use of funds can lead to financial strain and project delays.
3. **Timely Project Completion:** When resources are utilized optimally, tasks are completed on schedule, and the project progresses smoothly. This facilitates timely project delivery, meets client expectations, and minimizes delays.
4. **Enhanced Productivity:** Resource optimization leads to higher productivity as workers, materials, and equipment are utilized efficiently. This results in faster task completion and overall project progress.
5. **Quality Control:** Efficient resource utilization allows for a consistent focus on quality. When workers have the necessary time, tools, and materials, they can pay greater attention to detail and ensure that work meets or exceeds specified standards.
6. **Reduced Downtime:** Well-planned resource allocation reduces downtime caused by waiting for materials, equipment, or labor. This minimizes idle time and keeps the project moving forward.
7. **Risk Mitigation:** Optimal resource allocation helps identify potential resource shortages or constraints early in the project. This allows for proactive measures to mitigate risks and prevent disruptions.
8. **Improved Decision-Making:** Tracking and analyzing resource usage provides valuable data for making informed decisions. Project managers can adjust strategies based on real-time information to ensure efficient resource utilization.
9. **Client Satisfaction:** Meeting project milestones, deadlines, and quality expectations enhances client satisfaction. Satisfied clients are more likely to provide positive feedback, refer future projects, and contribute to a positive reputation for the construction company.

10. **Environmental Impact:** Efficient resource utilization contributes to sustainability and reduces environmental impact. Minimizing waste, optimizing energy usage, and controlling emissions align with environmentally responsible practices.
11. **Competitive Advantage:** Construction companies that consistently demonstrate efficient resource management gain a competitive edge. Clients are more likely to choose contractors that can deliver projects on time and within budget.
12. **Stakeholder Relations:** Effective resource utilization fosters positive relationships with subcontractors, suppliers, and other stakeholders. Reliable resource planning ensures that partners can meet commitments, strengthening collaborative efforts.
13. **Long-Term Success:** The ability to consistently optimize resource utilization contributes to a construction company's long-term success and growth. Efficient projects lead to improved financial stability and expanded opportunities.

Exercise

1. Briefly explain the importance of sequencing activities.
2. Briefly explain the resource requisition process.
3. Briefly explain the procedure for reporting to seniors.
4. Identify and briefly explain two ways of optimizing the utilization of resources.
5. Explain how to minimise wastage of resources.
6. Explain how to handle and organize tools, materials, fixtures, and devices in construction industry.

Notes

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

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

Construction Skill Development Council

SCPwD
दिव्यांग व्यक्तियों के लिए कौशल परिषद
Skill Council for Persons with Disability

Unit 8.1 - Workplace Hazards

Unit 8.2 - Fire Safety

Unit 8.3 - Safety Measures at Workplace

CON/N9001

Key Learning Outcomes

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

1. Explain the types of hazards at the construction sites and identify the hazards specific to the domain related works.
2. Recall the safety control measures and actions to be taken under emergency situation.
3. Explain the classes of fire and types of fire extinguishers.
4. Explain the importance of participation of workers in safety drills.
5. Explain the reporting procedure to the concerned authority in case of emergency situations.
6. Describe the standard procedure for handling, storing and stacking of material, tools, equipment and accessories.
7. Explain different types of waste at construction sites and their disposal method.
8. Explain the purpose and importance of vertigo test at construction site.
9. List out basic medical tests required for working at construction site.
10. Explain the types and benefits of basic ergonomic principles, which should be adopted while carrying out specific task at the construction sites.
11. Explain the importance of housekeeping works.
12. List different types of infectious disease that can spread/ originate at a construction site
13. Discuss the ways of transmission of the various infectious disease.
14. Explain the methods to check the spread of the infectious disease.
15. Explain the types of hazards at the construction sites and identify the hazards specific to the domain related works.
16. Recall the safety control measures and actions to be taken under emergency situation.
17. Explain the classes of fire and types of fire extinguishers.
18. Explain the importance of participation of workers in safety drills.
19. Explain the reporting procedure to the concerned authority in case of emergency situations.
20. Describe the standard procedure for handling, storing and stacking of material, tools, equipment and accessories.
21. Explain different types of waste at construction sites and their disposal method.
22. Explain the purpose and importance of vertigo test at construction site.
23. List out basic medical tests required for working at construction site.
24. Explain the types and benefits of basic ergonomic principles, which should be adopted while carrying out specific task at the construction sites.
25. Explain the importance of housekeeping works.
26. List different types of infectious disease that can spread/ originate at a construction site
27. Discuss the ways of transmission of the various infectious disease.
28. Explain the methods to check the spread of the infectious disease.

Unit 8.1: Workplace Hazards

Unit Objectives

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

1. Explain the types of hazards at the construction sites
2. Identify the hazards specific to the fabrication works
3. Recall the safety control measures and actions to be taken under emergency situation.
4. Explain the reporting procedures adopted during emergency situations.
5. Describe the standard procedure for handling, storing and stacking of material, tools, equipment and accessories.
6. Explain the types and benefits of basic ergonomic principles, which should be adopted while carrying out specific task at the construction sites.
7. Demonstrate the use of all Personal Protective Equipment (PPE) like helmet, safety shoe, safety belt, safe jackets and other safety equipment relevant to fabrication works requirement.

8.1.1. Workplace Safety

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

The benefits of workplace safety are:

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

Workplace Safety at Construction Site

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

1. **Always wear PPE** All personnel and visitors on the construction site must wear the required PPE to reduce their exposure to potential hazards. Goggles, helmets, gloves, ear muffs or plugs, boots, and high visibility vests and suits are typical PPEs.
2. **Pay attention and obey signs**
   Employees and visitors can be warned and made more aware of health and safety hazards

through the use of safety signs. When necessary, strategically position them throughout the facility. Workers should be aware with construction site safety advice and various signs, including prohibition signs, required signs, warning signs, safe condition signs, and firefighting equipment signs.

3. **Provide precise directions**

   There should be a site induction or contractor induction on the job site. This will familiarise new employees with site operations. Additionally, toolbox presentations are an effective means of communicating health and safety instructions to the employees. On a daily or more frequent basis, a pre-work inspection is performed.

4. **Keep site tidy**

   Ensure that excavation debris, dust, loose nails, and stagnant water are not lying about the site. For the prevention of slips and trips, the building site must be cleaned every day and kept decluttered.

5. **Organize and store equipment**

   Ensure that there are no tools laying around, and unplug all lights and power tools. The observance of building site regulations will prevent tools from becoming damaged or perhaps causing worker injury. Putting them in their proper location will help facilitate navigation.

6. **Use the proper tools for the correct job**

   Frequently, accidents occur due to improper usage of a tool or piece of equipment. Avoid using homemade tools. Use the proper tool to complete the task more quickly and safely.

7. **Have an emergency response plan**

   An emergency response plan instructs employees on what to do in the event of emergencies such as natural disasters, fire, hazardous material spills, and other catastrophes. Have a team committed to addressing emergency situations, answering queries, and reporting potential risks, quality issues, and near misses.

8. **Set up protections**

   Installation of engineering controls, such as barriers, fences, and safeguards, is one method for ensuring site safety. These will aid in isolating individuals from hazardous places like high-voltage electricity or harmful chemicals.

9. **Perform pre-inspection of tools and equipment.**

   Ensure that the tools and equipment to be utilised are free of defects or damage before beginning work.

10. **Report problems immediately**

    Train employees to immediately report flaws and near-misses on the job site. Problems can only be resolved when management is made aware of them. The sooner problems are identified, the less likely they are to worsen and cause accidents or additional damage.

8.1.2. Workplace Hazards

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

Common Workplace Hazards

The common workplace hazards are:

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

Workplace Hazard at Construction Site

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

The following are a few hazards of a construction site:

- **Working at Heights:** Working at heights is the leading cause of fatal workplace injuries. All personnel working at height must receive adequate training in operating on various equipment, and such work must be carefully organised.
- **Moving Objects:** A building site is a constantly-evolving environment with numerous objects in constant motion, frequently on uneven ground. Delivery vehicles, large plant gear, and overhead lifting equipment pose a threat to workers and operators on the job site. Sites should always be designed to manage plant-to-pedestrian contact when physical barriers and enough segregation are present.
- **Slips, Trips, and Falls:** Slips, trips, and falls can occur in practically any environment, but they occur less frequently in the construction industry than in other sectors. Unsurprisingly, slips, trips, and falls are major hazards on construction sites due to the often uneven ground and

ever-changing typography.

- **Noise:** Exposure to loud, excessive, and repetitive noise can result in long-term hearing issues, including deafness. Noise can also be a risky distraction, diverting a worker's attention from the task at hand, which can lead to mishaps. A full noise risk assessment should be conducted if the risk assessment identifies a noise hazard associated with the proposed work.
- **Hand Arm Vibration Syndrome:** HAVS is a painful and debilitating condition affecting the blood vessels, nerves, and joints. It is often brought on by the repeated use of hand-held power tools, such as vibrating power tools and ground-working equipment. HAVS is avoided if construction projects are structured to minimise exposure to vibration during work and if personnel utilising vibrating tools and equipment are monitored and properly protected.
- **Material Handling - Manual and with Equipment:** On construction sites, materials and equipment are continuously lifted and transported, either manually or with equipment. Handling always carries a degree of danger.
- **Excavations:** On construction sites, incidents frequently occur within excavations, such as an unsupported excavation collapse with employees inside.
- **Electricity:** Contact with overhead or subsurface power cables and electrical equipment/ machinery accounts for most of these mishaps. The standard in the construction industry is service strikes. The strikes occur when excavation is performed without a sufficient search for existing utilities. Consequently, problems can be readily averted by employing technologies such as CAT and Genny scanning equipment to scan an area, anticipate prospective services, and prevent service interruptions.

Workplace Hazards Analysis

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

Control Measures of Workplace Hazards

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

- **Elimination:** The most successful control technique is to eliminate a specific hazard or hazardous work procedure or prevent it from entering the workplace.
- **Substitution:** Substitution is the process of replacing something harmful with something less hazardous. While substituting the hazard may not eliminate all of the risks associated with the process or activity, it will reduce the overall harm or health impacts.

- **Engineering Controls:** Engineered controls protect workers by eliminating hazardous situations or creating a barrier between the worker and the hazard, or removing the hazard from the person.
- **Administrative Controls:** To reduce exposure to hazards, administrative controls limit the length of time spent working on a hazardous task that might be used in combination with other measures of control.
- **Personal Protective Equipment:** Personal protective equipment protects users from health and safety hazards at work. It includes items like safety helmets, gloves, eye protection, etc.

8.1.3 Hazard Identification and Risk Assessment (HIRA)

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

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

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

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

Procedure for HIRA:

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

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

and steps should be taken to reduce the risk to an acceptable level.
HIRA Process it consist of four steps as follows:

I. Hazard identification

II. Risk assessment

III. Risk analysis

IV. Monitor and review

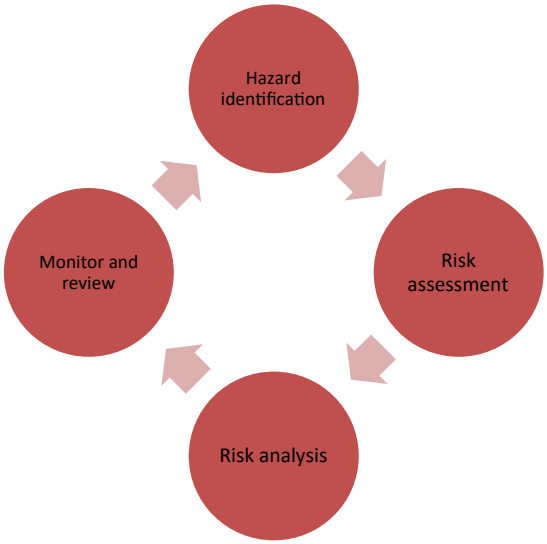

Fig. 7.1.1 HIRA Process

8.1.4 Workplace Warning Signs

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

There are four different types of safety signs:

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

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

Fig. 8.1.2 Prohibition Warning Signs

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

Fig. 8.1.3 Mandatory Signs

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

Fig. 8.1.4 Warning Signs

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

Fig. 8.1.5 Emergency Signs

8.1.5 Personal Protective Equipment

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

PPE used for protection from the following injuries are:

Injury Protection	Protection	PPE
Head Injury Protection	Falling or flying objects, stationary objects, or contact with electrical wires can cause impact, penetration, and electrical injuries. Hard hats can protect one's head from these injuries. A common electrician's hard hat is shown in the figure below. This hard hat is made of nonconductive plastic and comes with a set of safety goggles.	
Foot and Leg Injury Protection	In addition to foot protection and safety shoes, leggings (e.g., leather) can guard against risks such as falling or rolling objects, sharp objects, wet and slippery surfaces, molten metals, hot surfaces, and electrical hazards.	
Eye and Face Injury Protection	Spectacles, goggles, special helmets or shields, and spectacles with side shields and face shields can protect against the hazards of flying fragments, large chips, hot sparks, radiation, and splashes from molten metals. They also offer protection from particles, sand, dirt, mists, dust, and glare.	
Hand Injury Protection	Hand protection will aid workers who are exposed to dangerous substances by skin absorption, serious wounds, or thermal burns. Gloves are a frequent protective clothing item. When working on electrified circuits, electricians frequently use leather gloves with rubber inserts. When stripping cable with a sharp blade, Kevlar gloves are used to prevent cuts.	

Whole Body Protection	Workers must protect their entire bodies from risks such as heat and radiation. Rubber, leather, synthetics, and plastic are among the materials used in whole-body PPE, in addition to fire-retardant wool and cotton. Maintenance staff who operate with high-power sources such as transformer installations and motor-control centres are frequently obliged to wear fire-resistant clothes.	

Table 8.1.1 Personal protective equipment

It is important to use the suggested PPE to ensure effective personal protection during rigging.

8.1.6 Basic Ergonomic Principles

The basic ergonomic principles for construction are:

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

   The neck, elbows, and wrists are additional parts of the body that may be misaligned. To lessen tension in these areas and maintain their alignment, one should try modifying the equipment or work position so that theirmuscles remain relaxed.

2. **Reduce the necessity for excessive force.**
   Heavy pushing, pulling, and lifting can strain one's joints, potentially leading to weariness or injury. Instead of employing unnecessary force, look for equipment or methods that can lighten the load one must move. It may be as easy as using a cart or hoist to transport heavy objects, or one may need to modify the workflow to reduce the distance one must go or the number of objects one must transport.

3. **Keep materials easily accessible.**
   One should try extending their arms in the front and drawing a half-circle with them. This is one's reach envelope, and one should keep goods one uses regularly within this semicircle at their desk. To accommodate one's reach envelope, one may need to rearrange their space so that one no longer has to reach for often used goods. One should adjust their seat and armrests to help alleviate fatigue by bringing machine controls within reach.

   This also applies while reaching into boxes or containers. Before reaching into a box, one should tilt it or lay it on a lower surface instead of straining one's shoulders to reach higher.

4. **Work at the appropriate height.**
   A work surface that is either too high or too low might cause back, neck, and shoulder strain. Standing or sitting, the majority of normal tasks should be performed at elbow height. Nonetheless, if one works with heavy instruments, they may need to change their position to work below elbow height. On the other hand, precision work may necessitate working at heights above the elbow.

5. **Reduce needless movements.**
   Manual repetition can result in overuse injuries, thus it is essential to consider the motions one repeats throughout the day and identify solutions to prevent excessive motion. Is it conceivable, for instance, to replace a screwdriver with a drill, so eliminating the need for manual motion? Additionally, one might seek to alter their position or the arrangement of their workspace to operate more ergonomically.

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

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

8. **Leave adequate clearance.**
   This idea is straightforward: one must have adequate space for their head, knees, and feet. One should adjust their seat to allow sufficient legroom, performing duties while seated. One should removethe overhead obstacles to avoid head injuries. Visibility also plays a role in this scenario. It is essential to have a clear perspective of one's surroundings regardless of where oneis working or what equipment is employed.

9. **Stay active and flexible throughout the day.**
   Sitting or standing in one posture for too long is unhealthy for the human body. One should take time to stretch and exercise muscles. If oneis sedentary for an extended amount of time, they should take frequent breaks to walk around. If oneis on their feet all day, they should wear supportive shoes and rest during breaks. And if one's profession is physically demanding on specific sections of one's body, it may be beneficial to stretch before undertaking tough duties.

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

8.1.7 Emergency Response Plan for Construction Site

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

The Emergency Response Plan must address the following factors:

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

2. **Emergency Preparedness**
   a) The process of hazard identification and risk assessment entails a thorough review of construction activities such as Excavation, Scaffolding, Platforms & Ladders, Structural Work, Laying of Reinforcement & Concreting, Road Work, Cutting /Welding, Working in Confined Space, Proof/Pressure Testing, Working at Heights, Handling & Lifting Equipment, Vehicle Movement, Electrical, Demolition, Radiography, Shot blasting
   b) Listing On-Site (Level I & II) and Off-Site (Level III) Emergency Scenarios in accordance with their effects and available resources.

3. **Measures for Emergency Mitigation**
   To ensure safety during construction activities, the business must have an appropriate Health, Safety, and Environment Management System in place.
   a) Health, Safety, and Environment (HSE) Policy;
   b) Duties and Responsibilities of Contractor/Executing Agency;
   c) Site planning and layout;
   d) Deployment of Safety Officer/Supervision;
   e) Safety committees with fair participation of workers;
   f) Safety audits and inspections shall be conducted using prescribed checklists.
   g) Work permit system h) PPE I Safety awareness and training, etc.

4. **Measures for Emergency Preparedness**
   a) Emergency Drill and Exercise on Identified Scenarios and Evaluations b) Emergency Response Training
   b) Mutual Aid

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

6. **Organization and Responsibilities during Emergencies**
   The entity must create an organisation chart (emergency action flowchart) and specify the

roles and duties of key individuals to properly handle an emergency scenario on the project site. Clause 14.0 of the PNGRB (ERDMP) Regulations may be consulted to establish the emergency organisation and responsibilities.

7. Resources for Emergency Management

1) The following emergency control systems and facilities must be provided on the project/ construction site: -
   - (a) Fire and gas detection system
   - (b) Fire protection and firefighting system (Active and Passive)
   - (c) Ambulance facility on-site; if not, on urgent call basis.
   - (d) Rescue facilities and personal protective equipment (PPEs)
   - (e) First aid stations.
   - (f) Medical facility on-site or affiliation with a local hospital or medical centre
   - (g) Internal and External Communication Facilities as well as a Notification System
   - (h) Gathering places
   - (i) Escape route and evacuation zones
2) Internal and External Emergency contact information for police, fire, hospitals, mutual assistance industry, factory inspectors, Board, State Pollution Control Board, Petroleum and Explosive Safety Organization (PESO), etc.
3) Addresses and Telephone Directories of Technical Support Services and Professional Emergency Responders

8. Emergency Recovery Method

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

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

b) Incident examination.

c) Damage evaluation.

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

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

Notes

Unit 8.2: Fire Safety

Unit Objectives

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

1. Explain the classes of fire and types of fire extinguishers.
2. Explain the importance of the participation of workers in safety drills.
3. Demonstrate the operating procedure of the fire extinguishers.

8.2.1. Fire and its Classes

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

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

There are five distinct classes of fire:

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

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

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

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

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

8.2.2 Fire Safety

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

The basic Fire Safety Responsibilities are:

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

Prevention of a Workplace Fire

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

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

8.2.3 Fire Extinguisher

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

Types of fire extinguishers are:

There are five main types of fire extinguishers:

1. Water
2. Powder
3. Foam
4. Carbon Dioxide (CO2)
5. Wet chemical

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

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

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

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

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

Notes

Unit 7.3: Safety Measures at Workplace

Unit Objectives

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

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

8.3.1 Safety, Health and Environment at Workplace

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

8.3.2 Good Housekeeping

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

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

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

1. **Make a separate area for trash and waste.**
   Make a waste disposal area. After all, if one wantstheir workspace to be free of waste materials, they will need a place to store them. Depending on the amount of waste, this could be a skip or another waste disposal bin. Segregating waste types for reuse, recycling, or landfill is a best practice solution.
2. **Safely stack and store materials.**
   Poorly stacked materials can obstruct access routes or topple over, resulting in crushing injuries or property damage. One will need materials and tools throughout the project; store them safely to avoid them becoming hazardous.

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

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

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

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

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

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

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

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

8.3.3 Safety Drills at Construction Site

Construction is a hazardous field in which employees must become proficient. Fortunately, safety training can reduce workplace injuries while informing employees of necessary precautions to take. Here are five types of construction industry safety training one should be aware of.

Safety in Excavation and Trenching

Training on excavation and trenching safety emphasises the dangers associated with working in

excavation sites and confined spaces. The training enables workers to navigate these areas safely to prevent falls and fatalities. In addition, the programme emphasises preplanning and protective systems (which fall under OSHA-compliant safety material). Workers will be educated on the various excavation methods and techniques to perform their duties safely.

Fall Prevention and Safety Measures

Fall prevention and protection training is another type of safety training that all construction workers must receive. Falls are one of the leading causes of death in the industry; therefore, it is essential that workers protect themselves. Fall prevention programmes illustrate fall protection principles, fall arrest system components, and fall hazard recognition. Moreover, demonstrations familiarise workers with fall protection equipment.

Hazard Communication

On a daily basis, construction workers are exposed to hazardous materials and chemicals at their work sites. A worker's health and safety may be compromised by repeated exposure to such substances. Training on hazard communication includes the numerous types of chemicals used in the workplace as well as methods for minimising worker exposure. In addition, employees are taught how to read material safety data sheets and identify product labels.

Crane Hazards Management

Cranes pose a distinct hazard in the construction industry because of the diverse causes of these injuries. For instance, improper placement of loads, contact with overhead electricity lines, and structural failures can result in injuries and fatalities. Nevertheless, crane hazard management develops a grasp of OSHA compliance rules, which enhances job site safety and decreases the likelihood of employee accidents.

Construction Industry OSHA Course

OSHA courses for the construction sector equip novice and seasoned workers with a general understanding of diverse construction sites. In addition to an introduction to OSHA, employees will receive training on issues including material handling, ergonomics, access to restricted spaces, and site-specific policies. This course is designed to cover industry-wide themes and handle safety issues.

8.3.4 Medical Examination for Construction Workers

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

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

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

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

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

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

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

List of Recommended Medical Tests under the Factories Act:

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

8.3.5 Vertigo Test

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

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

8.3.6 First Aid

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

The aim of first aid is to:

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

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

Need for First Aid at the Workplace

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

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

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

Treating Minor Cuts and Scrapes

Steps to keep cuts clean and prevent infections and scars:

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

8.3.7 Waste Management

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

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

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

Waste and Debris Management on the Construction Site

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

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

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

Exercise

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

Notes

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9. Employability Skills (30 Hours)

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

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

Scan the QR code below to access the eBook

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10. Annexure

Annexure I - QR Codes - Video Links

Annexure - I

Annexure of QR Codes for Assistant Electrician

Chapter Name	Unit Name	Topic Name	URL	Page No.	QR Code
1. Introduction to Assistant Electrician Job Role	Unit 1.2 Role and Responsibilities of an Assistant Electrician	1.1.5 Introduction to Assistant Electrician Trade	https://www.youtube.com/watch?v=-gopyUUJtwxY	11	Introduction to Assistant Electrician Trade
		1.1.8 Assistance Electrician importance	https://www.youtube.com/watch?v=3n-mWxgUCuvE		Assistance Electrician importance
2. Handling Construction Hand and Power Tools	Unit 2.1 Construction Hand and Power Tools	2.1.1 Electric Current	https://www.youtube.com/watch?v=1tAkPi-brJ3M	45	Electric Current
		2.1.5 Types of Electric Circuit	https://www.youtube.com/watch?v=RQ3d-jos_LY8		Types of Electric Circuit
		2.1.9 Ampere's Law	https://www.youtube.com/watch?v=FZ-3saUFpDHM		Ampere's Law
		2.1.16 Electrical Measuring Instruments	https://www.youtube.com/watch?v=qxqGIG-jyYTU&list=PLhS-p9OSVmeyKvw2DT-pzlCdl226DJ-QjTx		Electrical Measuring Instruments

3. Installing Temporary Lighting	Unit 3.1 Installing Temporary Lighting	3.1.1 Interpreting Single Line Diagram	https://www.youtube.com/watch?v=gpb-BhZcLrWs	70	 Interpreting Single Line Diagram
		3.1.2 Cables in Electrical Systems	https://www.youtube.com/watch?v=t-GcTQWOPPYo		 Cables in Electrical Systems
		3.1.3 Types of Conduits and Fixtures	https://www.youtube.com/watch?v=_cJopR-jNEH0		 Types of Conduits and Fixtures
4. Assist in LV (low voltage) Electrical Wiring at Permanent Structures	Unit 4.2 Electrical Earthing Procedure in Domestic Wiring	4.2.1 What is Earthing	https://www.youtube.com/watch?v=wt-xeJ-fRXMU	108	 What is Earthing
5. Assembling, Installing and Maintaining Temporary LV Electrical Panels	Unit 5.1 Installation and Maintenance of Temporary LV Electrical Panels	5.1.1 Connecting Temporary Panel/DBs with Main Power Outlet	https://www.youtube.com/watch?v=KKa-Z22DmzWQ	116	 Connecting Temporary Panel/DBs with Main Power Outlet

Department of Empowerment of Persons with Disabilities (Divyangjan)
Ministry of Social Justice & Empowerment

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Skill Council for Persons with Disability

Skill Council for Persons with Disability
Sector Skill Council Contact Details:
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Website: www.scpwd.in
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