General safety precautions

Rule 29 - construction, installation, protection, operation & maintenance of electric supply lines & apparatus

→ In electric supply line & apparatus shall be sufficient in power & size & of sufficient mechanical strength for the work, they are required to do.

Rule 30 - service line & apparatus on consumer's premises.

→ The supplier shall ensure that all electric supply lines, wires & apparatus belonging to him or under his control which are on the consumer's premises are in a safe condition & in all respect fit for supplying energy.

Rule 31 - cutout consumer's premises

→ The supplier shall provide a suitable cut-out in each conductor of every line other than the earthed conductor within the consumer's premises in an accessible position.

→ where more than one consumer is supply through a common service line then each consumer shall be provided with independent cut out at the point of junction to the common service.

Rule 32 - Identification of earthed & earthed neutral conductor & position of switches & cut-outs.

Where the conductors include an earthed conductor of a two wire system or earthed neutral conductor of a multiwire system, which is to be concerned has the following conditions:

Conditions - 1. A permanent indication shall be provided by the owner of the earthed or earthed neutral conductor such that the conductor to be distinguished from any live conductor.

Rule 33 - Earth terminals on consumer's Premises.

→ The supplier shall provide & maintain on the consumer's premises for the consumer's use a earth terminal at the point of starting of supplier.

→ In case of medium, high or extra high voltage installation the consumer shall provide each own earthing arrangement

→ The consumer will take all the ~~responsible~~ resonable precaution to prevent mechanical damage to the earth terminals.

Rule 34 - Accessibility of bare conductors.

→ where bare conductors are used in a building the owner of such conductors shall ensure that they are inaccessible

Rule 35 - caution notice.

→ The owner of every medium, high & extra high voltage installation shall place a caution notice in hindi & local language of the district which is approved by the inspector on

(i) every motor, generator, transformer & other electrical plant & equipment together with apparatus used for controlling or regulating.

(ii) All supports of high & extra high voltage overhead lines.

Rule 36 - Handling of electric supply lines apparatus.

→ Before any conductor or apparatus is handled adiquate precaution shall be taken by earthing or suitable means to discharge electrically if there is danger & to prevent any conductor or apparatus from being accidentally charged

→ No person shall work on any live electric supply lines or apparatus.

Rule 40 - Street boxes.

~~If~~ Electric supply lines forming part of different system pass through the same street box which is distinguishable from one another & all electric supply lines at high or extrahigh voltage in the street box shall be adequately supported so as to prevent the risk of damage or the danger from adjacent electric supply lines.

Rule 41 - Distinction of circuit of different voltages

The owner of every generating station, substation & junction box in which there are many circuit or apparatus for operation at different voltages shall ensure by means of indication of a permanent nature such that the respective circuit are easily distinguishable from one another.

Rule 43 - Provision applicable to protective equipments.

→ The fire buckets filled with clean dry sand & ready for immediate use for extinguishing the fire in addition to fire extinguisher is kept in all generating stations, sub stations & switch stations at accessible position.

→ The firstaid boxes equipped with contents as per the guide line of state government shall provide & maintain in every generating stations, sub stations.

Rule 44 - Instruction for restoration of persons suffering from electric shock

→ The instruction in english, hindi & the local language of the district for restoration of person suffering from electric shock will be affixed by the owner in every generating stations or substations.

Rule 45 - Precaution to be addupted by the consumors, owners, electrical contractors, electrical workman & suppliers.

· No electrical installation work including addition, repair & adjustment to the existing installation except the replacement of lamp, fans, fuse, switches & low voltage domestic appliances will be carried out upon the premises of consumer or owner for the supply to such consumor or owner except by an electrical contractor license by the state Govt. or under the direct supervision of person holding a certificate of license issued by the state govt.

Rule 46- Periodical inspection & testing of consumer installation.

Where an installation is connected to the supply system, the supplier of such installation shall provide a periodical inspection & testing at interval not exceeding 5 years by the inspector or by the supplier directed by state govt. on his behalf.

General conditions relating to supply and use of energy

Rule-47- Testing of consumer's installation

On the receipt of an application for a new or additional supply of energy & before connecting the supply or reconnecting the same after a period of 6 months the supplier shall inspect & test the applicants installation.

Rule 48- Precaution against leakage before connecting:

The supplier shall not connect to the installation or apparatus on the premises of any applicant for the supply unless he is satisfied that the connection will not cause a leakage at the time of making connection.

Rule 49- leakage on consumer premises

If the supplier has the reason to believe that there is a leakage in the system of consumer which is likely to affect the use of energy then the supplier may give a resonable notice in writing to the consumer for inspection & testing of consumers installation.

Rule 50 - supply to the consumers.

The supplier will not provide the supply of energy to any consumers unless.

(i) a suitable switch or CB of required capacity to carry & break the current is placed after the point of commencement

(ii) Every circuit should be protected against excess energy by means of a suitable cut-out

Rule-51 - Provisions applicable to medium, high or extrahigh voltage installation.

The following provisions are observed where energy at medium, high or extra high voltage is supplied, converted, transform or used

(i) all the conductors except overhead lines shall be completely enclosed and adiquately protected against mechanical damage.

(ii) All metal work enclosing, supporting which are associated with the installation other than the conductor is to be connected to the earth

Rule 54 - Declared voltage of supply to consumer

A supplier shall not permit the voltage at the point of commencement of supply to vary from the declared voltage by more than five percent in case of low & medium voltage & more than 12.5 % in case of high or extra high voltage.

<u>Rule 55</u> - Declared frequency of supply to consumer :

A supplier shall not permit to vary the frequency of an alternating current supply from the declared frequency by more than 3% :

<u>Rule 56</u> - Sealing of meters and cutouts.

A supplier may affix one or more seal to any cut-out and to any meter or other apparatus placed on a consumers premises. So that no person other than the supplier shall break the seal :

<u>Rule 57</u> - Meters, maximum demand indicators & other apparatus on consumers premises

Any meter or max^{m} demand indicator or other apparatus placed on a consumer premises shall be of appropriate capacity. Its limit or error do not exceed 3% above or below the absolute accuracy.

Rule 58- Point of commencement of supply

The point of commencement of supply of energy to a consumer shall be assume to be the point at the outgoing terminals of the cut-out inserted by the supplier in each conductor of every service line at the consumers premises.

Rule 59- Precaution against failure of supply

The layout of electric supply lines of the supplier for the supply of energy throughout his area of supply shall under normal working conditions & provided with cut-outs & CB to restrict the fault within reasonable limit to prevent any failure of supply

→ The supplier shall take all the responsible precautions to avoid accidental interruption of supply, to avoid danger to the public or to the employee when engaged on any operation during the installation, extension replacement, repair & maintenance of any work.

Rule 60- Test for the resistance of insulation.

for low & medium voltage

Rule 61 - connection with earth

Rule 62- System at medium voltage.

Rule 63 - 70 for high & E H voltage 2

Rule 63 - Approval by the inspector.

Rule 64 - Use of energy at high and extrahigh voltage

Rule 65 - Voltage test

→ If the normal working voltage does not exceed one thousand volt then the testing voltage will be two thousand volt.

→ If the normal working voltage exceeds one thousand volt, but does not exceed eleven thousand volt then the testing voltage will be double the normal working voltage.

→ If the normal working voltage exceeds 11000 volt then the testing voltage will be the normal working voltage plus 10,000 V.

Rule 66 - Metal sheath electric supply lines, Precautions against leakage.

Rule 67 - connection with earth

Rule 68 - General conditions for transformation and control of energy

Rule 70 - condenser.

Over head lines

Rule 74 - Joint

Rule 75 - Maximus stress or factor of safety.

Rule 76 - clearance above ground of the lowest conductor.

No conductor of an overhead line including service line erected across the street shall be at a height less than

(i) for low and medium voltage lines - 19 feet (5.791 m)

(ii) for high voltage - 20 feet (6.096 m)

(iii) for extra high voltage line the clearance above ground shall not be less than 17 feet (5.182 M) + 1 feet (0.3048 m) for every 33 KV.

Rule 77 - clearance between conductors & trolley wires

~~Rule 78~~ → No conductor of an OH line crossing a tramp way or trolley bus using trolley wire shall have less than the following clearance above any trolley wire.

(i) Low & medium voltage lines - 4 feet (1.219 m)

(ii) High voltage lines upto 11 KV - 6 feet (1.829 m)

(iii) High voltages above 11 KV - 8 feet (2.439 m)

(iv) Extra high voltage lines - 10 feet (3.048 m)

Rule 78 - Clearance from buildings of low & medium voltage lines & service lines.

Where a low or medium voltage OH line passes above or near to any building the following clearances on the basis of max^m sag shall be observe.

(i) For any flat roof, open balkoni, Varanda -

1. When the line passes above the building a vertical clearance of 8 feet (2.439 m) from the highest point.

2. When the line passes near to the building a horizontal clearance of 4 feet (1.219 m) from the nearest point.

(ii) For Pitch roof -

Rule 79 - Clearance from buildings of high & extra high voltage lines.

The vertical clearance above the highest part of the building will not less than

(i) For high voltage lines upto 33KV - 12 feet clearance (3.658 m)

(ii) For extra high voltage - 12 feet (3.658 m) + 1 foot for every additional 33KV.

The Horizontal clearance between the nearest conductor & any part of building will be not less than

5

(i) For high voltage line upto 11KV - 4 feet

(ii) For high voltage line above 11KV & upto & including 33KV - 6 feet &

(iii) For extra high voltage line - 6 feet + 1 foot ; for every additional 33KV

Rule 80 - conductors at different voltages on same support.

Rule 86 - Line crossing or approaching eachother.

Rule 87 - Gaurding

Rule 88 - Service lines from OH Lines.

Rule 89 - Earthing

Rule 90 - safety & protective devices

Rule 91 - Protection against lightening.

Electric Supply lines, systems & Apparatus for low & medium voltages!-

Rule - 60!- Test for the resistance of Insulation.

Where any electrical supply lines for use at low & medium voltage has been disconnected from a system for the purpose of addition or repair of such electric supply line shall not be reconnected to the system until the supplier or the owner has applied for the insulation test.

Rule - 61!- Connection with Earth!-

→ The neutral conductor of a three-phase 4-wire system shall be earthed by not less than two separate earthing both at generating station & at the substation.

→ In DC 3-wire system the middle conductor shall be earthed at the generating station.

→ No person shall make connection with the earth.

Rule - 62!- System at Medium Voltage

Where a medium voltage supply system is employed the voltage betⁿ earth & any conductor shall not exceed low voltage.

Electric supply lines, systems & Apparatus for high & Extra high voltages!-

Rule - 63!- Approval by the inspector

Before making an application to the Inspector for permission to commence supply of energy at high or extra high voltage to a person the supplier shall ensure that all the supply lines & apparatus are place in position properly joined, completed & examined.

Rule - 64!- Use of energy at high & Extra high voltage

The Inspector shall not authorise a supplier to connect the supply unless

(i) All the conductors & apparatus on the premises of the consumer are inaccessible position except the authorized person.

(ii) The consumer has to maintain a separate building with weather proof & fire-proof enclosure for the purpose of housing ~~his~~ his apparatus & metering instruments.

Rule-65!-

Rule-66!- Metal sheathed electric supply lines.

→ The conductor shall be enclosed in metal sheathing.

→ In case of insulation failure, the impedance of the circuit shall be such that the current shall not be twice the value of its normal. ~~condi~~ condition.

Rule-67!- Connection with earth!

→ In case of star connected system the neutral point is earthed.

→ 1ϕ high or extra-high voltage system shall be earthed in a manner approved by the inspector.

→ In case of system having concentric cables the external conductor shall be earthed.

Rule-68!- General condition as to transformation and controll of energy.

→ Substation & switch stations shall preferably erected above ground but where necessary constructed underground with due ~~pro~~ provision for ventilation & drainage.

→ Outdoor substations except polemounted type shall be protected by placing at a height not less than 2.439 mt so as to prevent access to the electric supply lines.

Rule-70!- Condensers.

Suitable provision shall be made for immediate & automatic discharge of every condensers on disconnection of supply.

Overhead lines!

Rule No-74!- Joints

Joints of conductors of overhead lines shall be mechanically & electrically secure under the condition of operation.

Rule - 75!- Maximum stress: Factor of safety.

→ ~~The owner shall ensure that the strength of supports~~

→ The minimum factor of safety for supports are

1. (i) For metal supports — 2.0
2. (ii) for mechanically processed concrete support - 2.5
3. (iii) for hand ~~moulded~~ moulded concrete support - 3.0
4. (iv) for wood support - 3.5

$$\text{Safety factor} = \frac{\text{strength of the material}}{\text{Maximum stress}}$$

Rule-80!- Conductors at different voltages on same supports

Where conductors of different voltages are erected on the same support, the owner shall make adequate provision to guard against danger to line man.

Rule - 86!- Lines crossing or approaching each other.

→ Whenever an overhead line crosses to any telecommunication line, the owner shall protect. ~~it~~

Rule-87!- Guarding

→ Where guarding is required, the provision according to rule is applied

→ Every guard wire shall be connected with the earth.

Rule-88!- Service lines from overhead lines

No service line shall be taken off from an overhead line.

Rule - 89 :- Bandhing :-

→ All the metal supports of the overhead lines and fittings shall be permanently & efficiently earthed.

→ Each stay wire shall be earthed unless the insulator has been placed at a height not less than 3.048 mt (10 ft) above ground.

Rule - 90 :- Safety & Protective devices

→ Every overhead line erected over street or other public places or any consumer's premises shall be protected with a device approved by Inspector.

Rule - 91 :- Protection against lightning.

→ The owner of every overhead line which is so exposed to be liable to injury from lightning shall adopt efficient means for diverting ~~to earth~~ the electrical surges due to lightning.

Wiring System

→ A network of wires connecting accessories for distribution of electrical energy from the supplier to the energy consuming devices is known as a wiring system.

→ The point at which the consumer's wiring is connected to the cutout is known as commencement of supply.

System of distribution of electrical energy

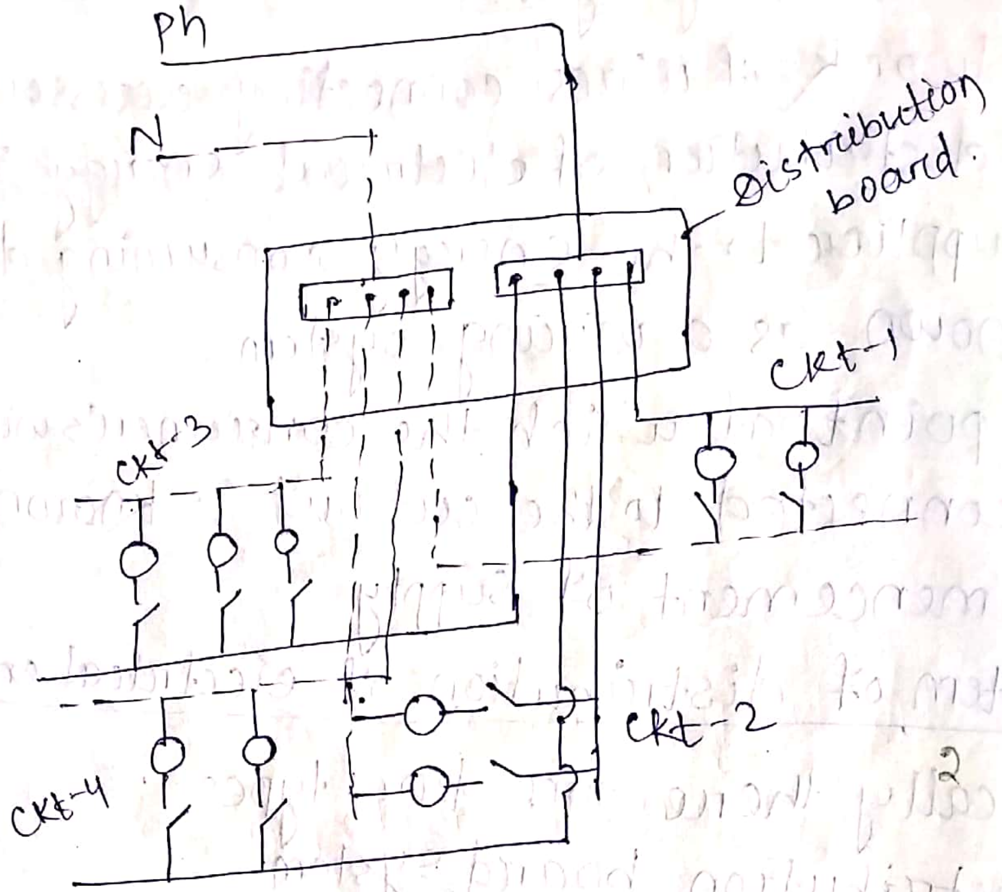
Basically there are two types :

1. Distribution board system.
2. Tree system.

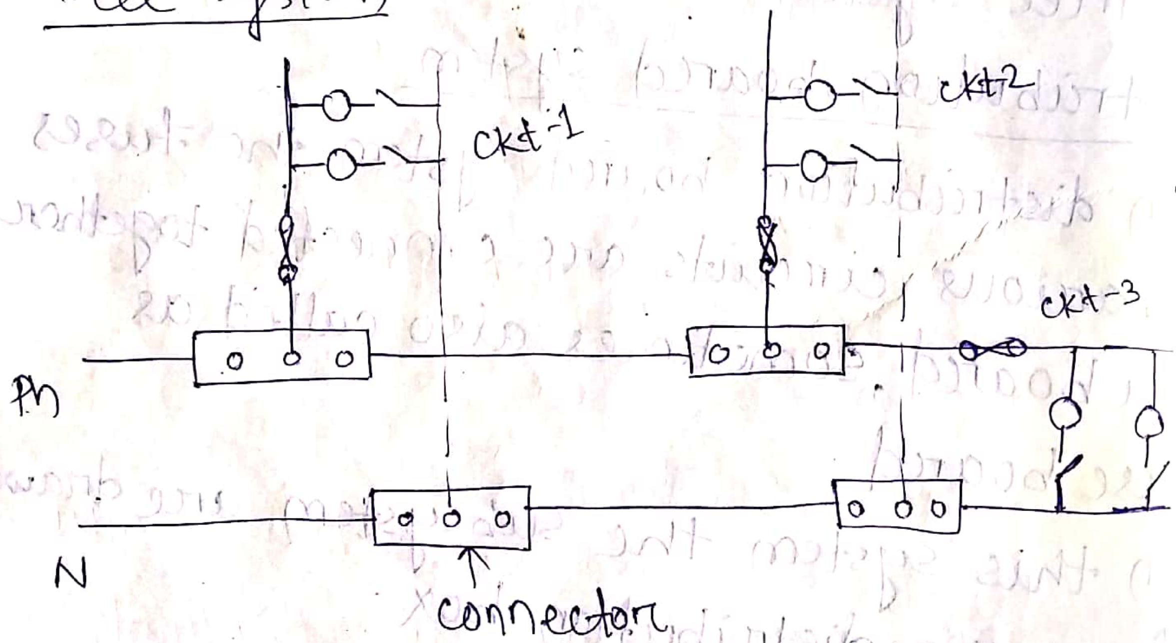
Distribution board system

→ In distribution board system the fuses of various circuits are connected together on a board, sometimes also called as fuse board.

→ In this system the subsystem are drawn from the distribution box.



Tree system



→ In this system branches are taken from the main branch as shown in fig. and the wiring system looks like a tree.

→ As each branch is taken off a fuse is inserted in every branch.

→ Now a days this system is not adopted due to following drawbacks -

1. The voltage across all the lamp does not remain same.
2. A no. of joints are involve in the ckt.
3. The fuses are scattted

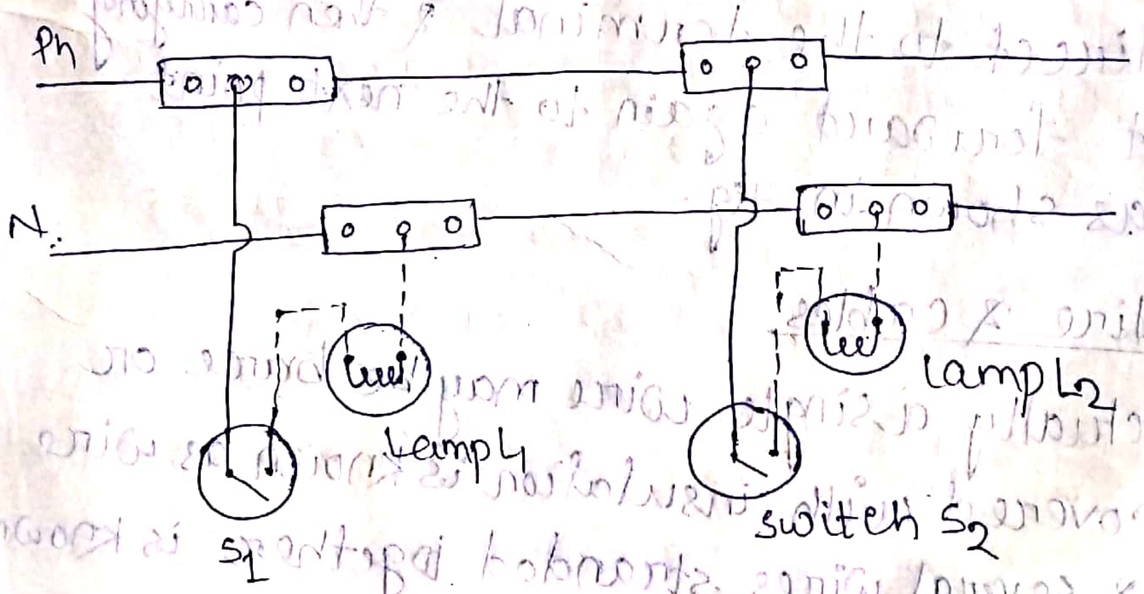
Method of wiring

There are 2 methods of wiring known as Joint box system (Tee system) and Loop-In system

3

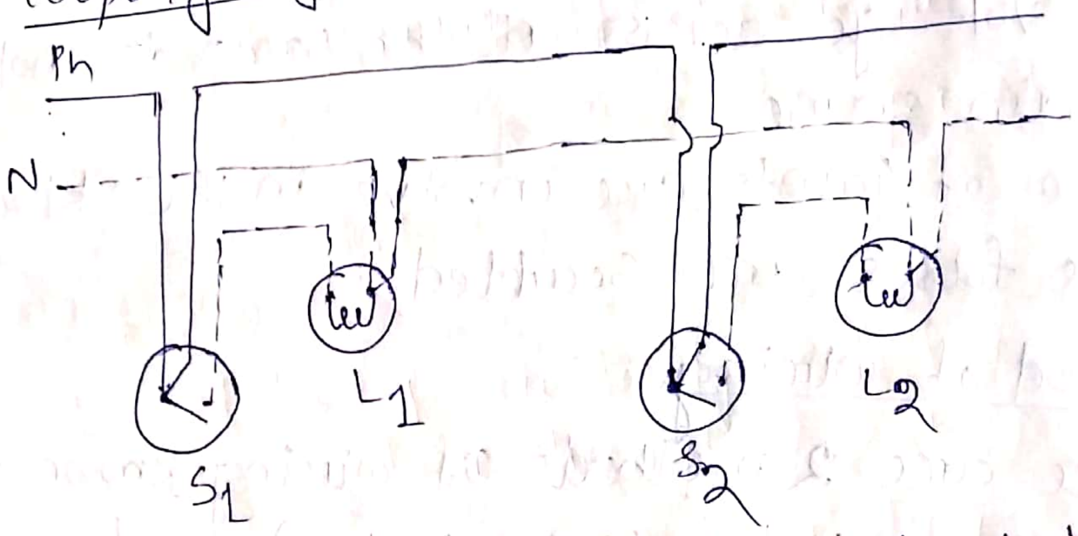
Joint-box system

In this system the connection to the lamp and made through joint by means of suitable connector or joint cut-outs.



→ In this method there is a saving in the quantity of wire or cable required but the saving is offset by the extra cost of joint box

looping in system



→ This system is universaly adoppted for the connection of various lamps in parallel.

→ In this system when a connection is required for a light or switch the feed conductor is looked in by bringing it direct to the terminal & then carrying it forward again to the next point as shown in fig.

Wire & cables

→ Actually a single wire may be bare or covered with insulation is known as wire & several wires stranded together is known as cable.

→ But in practice bare conductors wheather single or stranded together are known as wire & conductors covered with insulation are known as cables.

Conductor materials used in cables

→ The function of the conductor, usually known as core in a cable is to carry the electrical current.

→ Cu & Al are the materials used as conductors

Copper

→ Silver is the best conductor, but due to its higher cost it is rarely used

→ The next best conductor is Cu.

→ The resistivity of pure Cu at 20°C is 1.786×10^{-8} Ωm.

AL

→ AL is frequently used in place of Cu for bare electric cables used for long distance power distribution.

→ The electrical conductivity of Al is about 60% of that Cu. For a given length the Al required will be 1.61 times of that of Cu in volume & 1.26 times of that of Cu in diameter.

Insulating materials

→ The insulating materials used in electric cables must posses the following properties.

(i) High resistivity.
(ii) High dielectric strength.
(iii) High flexibility

(iv) Highly resistive to moisture and acid.
(v) capability to withstand high voltage & high temp. without deterioration.

→ The various types of insulating materials used in cables are

1. Rubber

→ Its relative permitivity is between 2 & 3 & its dielectric strength is 30KV per mm.
→ Though it posses high insulating qualities but it absorved moisture, soften when heated to a temp. of 60° or 70°C.
→ Hence pure rubber can't be used as insulating materials.

2. Vulcanized Indian Rubber (VIR):-

→ VIR is a good electrical insulator doesn't absorve moisture from the atmosphere, water proof when new & remains so for a no. of years.
→ The main drawback with VIR is that the sulphure contain in it attacks Cu & therefore the cable using VIR insulation & the Cu as a conductor, is coated with tin before providing the insulation.

3. Impregnated paper

→ It is quite chep, high dielectric strength

(30KV/mm) & high insulation resistivity,

→ The main advantages of paper insulation over VIR insulation is that it is superior in heat conductivity & is capable to withstand higher temp.

4. PVC (Poly vinyle chloride)

→ It is a synthetic compound.

→ For obtaining this material it is processed with certain materials known as plasticizer & its types.

→ It is inert to oxygen & also inert to oils, acids Therefore it is preferred over VIR.

→ The PVC insulated cables are usually employed for low & medium voltage domestic & industrial light & power installation.

5. Silk & cotton

→ This is used in low voltage cables.

→ The conductor may have a single layer or double layer covering depending upon the requirement of service.

Types of cables used in internal wiring

The wires used for internal wiring of building may be divided into the different groups according to:

(i) conductor used.

(ii) No. of core used.

Scanned by CamScanner

(iii) Voltage grading
(v) Types of insulation used.

→ According to conductor material used in cables these are divided as Cu conductor cables & Al conductor cables.

→ According to the no. of cores the cable consist of is divided as single core cable, twin core cable, & three core cable & two core with E.C.C (Earth continuity conductor).

→ According to voltage grading the cables may be divided into two classes.
1. 250/440 V
2. 650/1100 V cables

→ According to the types of insulation the cables are of following types.
1. VIR insulated cable
2. Tough rubber sheath (TRS) cables
3. Lead sheath cables
4. PVC cables
5. Weather proof cables
6. Flexible cables
7. XLPE (cross linked poly ethylene)

VIR insulated cable

→ The VIR cables are available in 240/450V as well as in 650/1100V grade.

→ The VIR cable consist of a tinned cu conductor covered with a layer of VIR insulation

→ over the rubber insulation cotton tape. sheath is provided with moisture resistance compound bitumen.

→ The thickness of rubber insulation depends upon the voltage grade for which the cable is used.

TRS cable

→ These cables are available in 250/440V & 650/1100V grades

→ The TRS cable is nothing but a vulcanised rubber insulation with an outdoor protective covering of tough rubber which provides additional insulation & protection against wear & tear.

→ These cables are water proof hence can be used in wet condition.

→ These cables are cheaper in cost & lighter in weight as compare to lead sheath cable.

Lead sheath cable

→ These cables are available in 240/415 V grade

→ Lead sheath cable is a vulcanised rubber insulated conductor covered with a continuous sheath of lead.

→ The lead sheath provides protection against the absorbtion of moisture & protection against mechanical injury

PVC insulated cable

→ These are available in 250/440V & 650/1100V grade & are used in cashing caping & batten & conduit wiring system.

→ In this type of cable the conductor is insulated with PVC insulation.

→ The PVC insulation is preferred over VIR insulation because of the following reasons.

(i) The PVC insulation has better insulating quality

(ii) It provides better flexibility.

(iii) It has no chemical effect on the metal of the wire

The PVC coated wire gives smaller diameter of the cable, therefore more no. of wires can be accomodated in the conduit of a given size in comparison to VIR or TRS wires.

Weather Proof cables

→ These cables are used for outdoor wiring & for power supply or industrial supply.

→ These cables are either PVC insulated or Vulcanised rubber insulated conductor being suitably braided.

→ These cables are available in 240/415V & 650/1100V grades

Flexible cables

→ The flexible cable consist of wires covered with silk or cotton or plastic insulation

→ The plastic cover is popular as it is available in different colours.

→ The flexibility & strength is obtained by using conductors having larger no. of strands.

→ These are used as connecting wires for such purposes as from ceiling rose to lamp holder; socket outlet to fans, lamp, heater etc.

XLPE cable

→ These cables are built of insulation made of polymers.

→ The polymers are substances consisting of long macromolecules built up of small molecules or group of molecules.

→ These are divided into homopolymers & copolymers.

→ The homopolymers are built by the reaction of identical monomers.

→ The copolymers are built up of atleast two different kinds of monomers.

Advantages of XLPE cables over both PVC & other types of cables

→ Higher current rating

→ Long service life

→ Higher S.C. current rating

→ Low dielectric loss.

→ Can withstand 130° C for a short time.

→ Have protection against external effects

→ Provides resistance to acid & alkaline.

Multistrand cable

The multistrand cable have the following advantages w.r.t. single solid conductor

(i) The surface area of the multistrand cable is more as compare to equivalent single solid conductor. so the heat radiating capacity being proportional to the surface area is more.

(ii) The skin effect is reduce.

(iii) These cables are more flexible & durable.

The no. of strands in a stranded cable must be three, seven, nineteen, thirty-seven, sixty-one, ninety one & so on in order to obtain a circular shape.

→ In case of three strand cable, the cables are placed at the corner of any equilateral tringle. such that three circles touches one another.

→ A seven strand cable has one central wire with six wires surrounding it.

→ The 19 strand cable has another 12 wires surrounding the 7 strands.

The 37 strand cable has another 18 ~~layer~~ wires surrounding the 19 strands. & so on.

→ The size of cable is given in various manner as explained below.

(i) the size of the cable can be given by giving no of strands & ~~those~~ gauge no. of each strand.

Ex - A cable having 3 strands & each of gauge 20 SWG can be reffered by 3/20

(ii) The size of cables may also given in term of no. of strands & diameter of each strand in mm.

Ex - A cable having 19 strands each strand of diameter 1.12 mm may be reffered as 19/1.12 mm.

(iii) The cable size is also denoted in terms of total cross-sectional area of the core instead of no. & diameter of strand.

Ex - A 19/1.12 mm cable has a cross-section of 19.35 mm^2 can be referred as a 19.35 mm^2 cable.

Voltage grading of cable

→ It specifies the safe voltage which the insulation can withstand.

→ The cable used for domestic wiring are graded as 650/1100V

General specification of cables

The cables are specify providing

→ Size of the cable giving the no. of strands & diameter of each strand.

→ Type of conductor used i.e. Al or Cu

→ The no. of core in the cable

→ The voltage grade

→ Type of cable with clear description regarding insulation.

Ex- A cable may be specified as 7/1.12, Al conductor, twin core, 650/1100V grade with PVC insulation

Conductor size calculation

While determining the size of conductor for internal wiring the following points are taken into account.

1. Min^n size of conductor
2. current carrying capacity
3. Voltage drop.
4. Metal of the conductor.

→ For house wiring the min^m size of cu conductor is 1/1·12 & for Al conductor it is 1·5 mm^2 or 1·40 mm diameter for single strand.

→ For underground cable the min^m size of Al conductor for two core should be 6 mm^2 & for 3 & 4 core it should be 25 mm^2

→ The size ACSR (Al conductor steel Rainforced) conductor should not be less than 6/1 × 0·211 mm having total cross-sectional area 20·71 mm^2

→ The permissible voltage drop on the wiring system should not exceed 2% + ~~loss~~ 1V for light load & 5% for power load.

Q-1- Calculate the size of the cable for a subcircuit consisting of 10 light points or 800W. The supply voltage is 230V ac at 50Hz.

$P = 800W$

$V = 230V$

$I = \frac{P}{V} = \frac{800}{230}$

$= 3.47 A.$

The S.C. current = 1·5 × total current.

$= 1.5 \times 3.47$

$= 5.217 A.$

Main switch & distribution board

→ As per the Indian electricity rule-50 a linked switch is to be provided immediately after the meter.

→ This rule also states that a suitable cut-out must be provided just after the meter to protect the ckt against excessive current.

→ The linked switch & fuse or cut-out may be provided as one unit or as a separate unit.

→ The combine unit is known as an ironclad switch because it is made up of iron.

→ It may be double pole for controlling the 1ϕ two wire ckt or tripple pole for controlling 3ϕ three wire ckt or tripple pole with neutral link for controlling 3ϕ, 4 wire ckt

Distribution board

The distribution board is an assembly of parts including one or more fuse arranged for the distribution of electrical energy to various ckt or other distribution board known as sub-main distribution board.

conduit

The general conduits are classified as
1. light gauge steel-plain (unscrew) conduit
2. Heavy gauge steel screwed conduit.
3. Flexible conduit.
4. PVC conduit.

conduit accessories & fittings

→ conduit couplers
→ Bends, elbows & tees
→ Fixing of conduit (lock nuts or check nuts)
→ conduit Box.

Lighting accessories & fittings

→ switches
(i) one way switch
(ii) Two way switch Tumbler & concealed
(iii) Two way centre off switch
(iv) Double pole main switch
(v) Push button switch

→ Ceiling rose

The ceiling rose is used to connect the lamps, fans & fluorescent tube through flexible plastic or silk covered wire.
It consist of 2 parts known as base & cover

→ socket outlet

→ Plug.

→ Lamp holder.

The lamp holder may be classified into

(i) Batten holder
(ii) pendant holder
(iii) Angle holder
(iv) Bracket holder.
(v) slanting holder
(vi) water tight bracket holder
(vii) Miniacture lamp holder.

Conductor size calculation for underground cable

The permissible voltage drop for different stages of transmission & distribution line will be (i) for underground transmission the voltage drop should not be more than 12.5%.

(ii) For underground distribution the voltage drop should not be more than 5%.

(iii) In case the transmission & distribution both by underground cable then the max^m permissible drop should not be more than 5%.

Fuse

→ Fuse is a simplest & cheapest device used for interrupting an electrical ckt under s.c. or excessive overload.

→ The material used for fuse element must have low melting point, low ohmic loss, high conductivity.

→ Such materials are tin, lead, silver, Cu, Zn, Al & alloy of lead & tin.

Types of fuse

(i) Supply main fuse.

This fuse is provided by the supplier & is fixed just after the servicemeter & sealed by him.

(ii) Consumer main fuse

→ This is another fuse of rating slightly less than that of supply main fuse & placed after the consumers mainswitch.

→ The consumer fuse is kept slightly lower so that in case of overload or s.c. the consumer fuse which can be replaced by the consumer may blow & the supply main fuse remains intact.

(iii) Sub ckt fuse

The total wiring system is divided into a no. of subckts or branch ckts.

→ A separate fuse is provided for each branch ckt & is known as sub ckt fuse.

(iv) point fuse

In good quality indoor wiring every light & plug point is provided with its individual fuse known as point fuse.

Important definition

Fuse:

It is current interrupting device which breaks the ckt by fusing the element when the current exceeds a certain value.

Fuse element

It is the part of the fuse which actually melts when an excessive current flows in the ckt.

Current rating

It is defined as the rms value of current which the fuse wire can carry without break & with temp. rise within specified limit.

Fusing current

It is defined as the min^m value of current at which the fuse element of fuse wire melts.

→ for a round wire type fuse the fusing current is given by $I = Kd^{3/2}$

where K = constant called fuse constant

Fusing factor

The ratio of min^m fusing current & the current rating of fuse element is known as fusing factor & it is always greater than unity

Breaking capacity

The breaking capacity of a fuse is the rating corresponds to the rms value of the ac component of the max^m prospective current & the system voltage.

Determination of size of fuse wire

The factor responsible for determining the size of fuse wire is max^m current rating of the ckt.

Fuse unit

The various types of fuse unit commonly available are (i) Round type fuse

(ii) Kit Kat type fuse.

(iii) catridge type fuse.

(iv) HRC type fuse

(v) semiconductor fuse.

Round type fuse

→ This type of fuse unit consists of procelain or bakelite box & two separated wire terminal for holding the fuse wire.

→ The main drawback of this type fuse is one of the terminals always remain energised. Therefore for replacement the worker will have to touch the live mains.

Kitkat type fuse

It consists of a procelain base carrying the fixed contact to which the incoming & outgoing phase wires are connected & a procelain fuse carreier for holding the fuse element consisting of one or more strands of fuse wire.

Catridge type fuse

This is a totally enclosed type fuse unit. It essentially consist of an insulating container & sealed at its end with metallic cap & filled of with various types of materials like sand, calcium carbonate, quartz etc.

→ Since it is totally enclosed, it will not possible to rewire. Therefore the whole unit is replaced once it blows out.

→ This type of fuse is available upto 660V & the current rating upto 800 Amp.

HRC fuse

→ The rupturing capacity of HRC fuse is as high as 500 ~~Amp~~ MVA upto 66 KV & above

→ The HRC fuse consists of a heat resisting ceramic body having metal end caps to which the fusible current carrying element are welded.

→ The complete space within the body surrounding the elements is filled with a powder which acts as an arc extinguishing agent.

→ The process of fusing consists of the following operations.

(i) pre arcing operation i.e. melting of silver element.

(ii) Arcing operation i.e. vapourisation of element.

(iii) fus-ion of silver vapour & filling powder.

(iv) Extinction of arc under fusion process.

→ on the occurance of fault, the S.C current flows through the fuse element & the element heated of upto melting point.

→ when the melting process is completed an arc is formed.

→ The chemical reacⁿ between the silver vapour & the filling powder establishes a high resistance.

→ This high resistance acts as an insulator & the fault current decreases along with the high pressure created within the fuse by the fault current.

semiconductor fuse

These are very fast acting fuse for protection of thyristor & other electronics ckt.

Earthing conductor

It is of high conductivity Cu & is of either stranded, flat strip or circular or rectangular bar.

Earthing

Earthing means connection of neutral point of a supply system or the non-current carrying parts of electrical apparatus to the earth in such a manner that at all times an immediate discharge of electrical energy takes place without danger.

(Indian standard)

IS specification regarding earthing

→ An earthing electrode shall not be situated within a distance of 1.5 m from the building whose installation is to be earthed.

→ The conductor by means of which the metal body of an equipment is connected to the earth is known as earth continuity conductor (E.C.C). The cross-section of ECC should not be less than 2.9 mm^2 (14 SWG) or half of the installation conductor size.

→ As a general rule the lower the value of earth resistance better it is, but the following earth resistances will give the satisfactory result.

→ For large power station - 0.5 Ω

Major power station - 1.0 Ω

Small substation - 2.0 Ω

In all other cases max^n 5 Ω

→ The earth wire & earth electrode will be of same material.

→ The earth wire shall be taken through GI pipe of 13 mm diameter for atleast 30 cm length above & below the ground surface to the earth electrode to

Protect it from mechanical damage.
→ The earthing electrode always placed in vertical position.

Types of lighting scheme

The lighting scheme may be classified as
(i) Direct lighting
(ii) Semidirect lighting
(iii) Semiindirect lighting
(iv) Indirect lighting
(v) General lighting

Direct lighting

- In this lighting scheme more than 90% of total light flux is made to fall directly on the working plane with the help of reflectors.

Semidirect lighting

In this scheme 60-90% of total light flux is made to fall downward directly with the help of semidirect reflectors & the remaining light is used to light or illuminate the ceiling & walls.

Semiindirect lighting

In this scheme 60-90% of total light flux is thrown upward to the ceiling and the rest reaches the working plane directly.

Scanned by CamScanner

Indirect lighting

In this scheme more than 90% of total light flux is thrown upward to the ceiling.

General lighting

In this scheme the lamps are made of diffusing glass which gives nearly equal illumination in all direction.

Design of lighting scheme

The various factors involve in the design of proper lighting system are -

(i) Illumination Level.

This is the must important factor to decide the illumination so that we are able to see our surroundings.

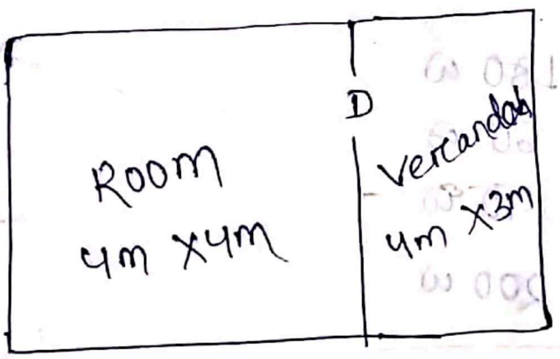
Location	Illumination in lux
Entrance →	100
Living room →	300
Dining room →	150
Bed room →	300
Dressing table →	200
Games or recreation room →	100
Kitchen →	200
Bathroom →	100
Class room →	250

Painting & drawing room → 400
Laboratory → 150
operation table in hospital → 3000
patient ward → 100
Study room → 300

(ii) Uniformity of illumination

The illumination system designer has to make sure that uniformity of illumination is maintained within the place for which illumination is required because human eye is relaxed if light is uniform & subjected to more pressure on eye ~~is felt~~ if uniformity of light is not present

Q-1. Draw the electrical ckt & estimate the quantity of material & their cost required for PVC conduit used in a house the plan of which is given in fig. The other data may be assume.



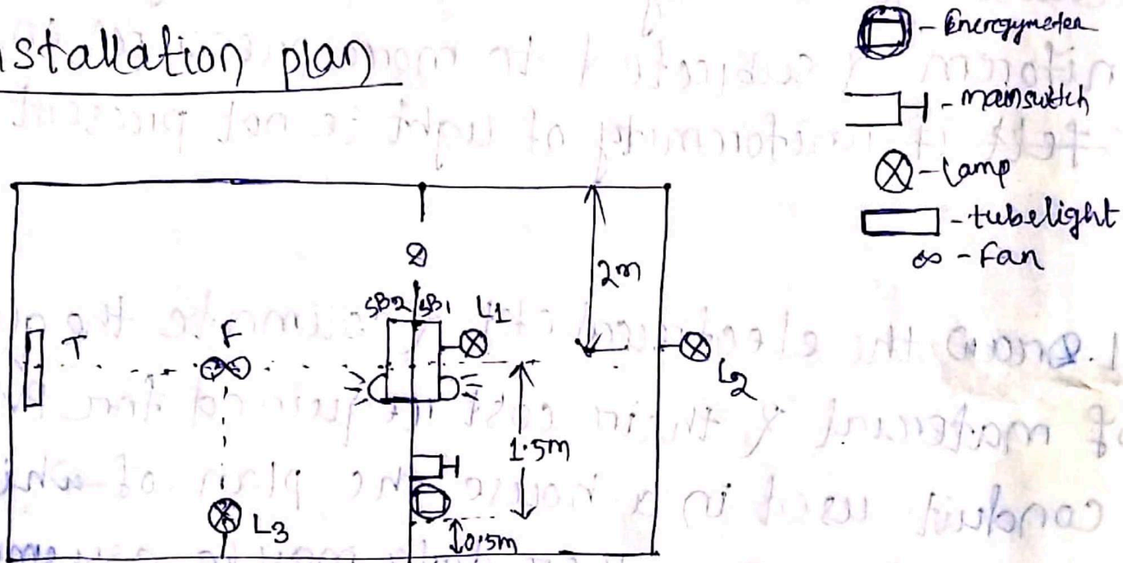
Ans- Assume data

Total height of ceiling = 3.5m

Height of meter & main switch from floor = 2m
Height of horizontal run from floor = 3m
Height of switch board from floor = 1.5m
Location of energy meter & mainswitch = 0.5m inside verandah wall

All dimensions are in meter.
Since it is a room with verandah two light points, one fan & one 5A socket all to be installed in the room. Two Lamp point & socket outlet is installed in the verandah.

<u>Installation plan</u>



<u>Calculation of Load</u>

Lamp - 3 × 60 = 180 W
Fan - 1 × 60 = 60 W
Tubelight - 1 × 40 = 40 W
Socket - 2 × 100 = 200 W

Total = 480 W

Assuming the supply voltage to be 230V.

Load current $(I) = \frac{P}{V} = \frac{480}{230} = 2.1$ Amp.

From the table the cu conductor of size 1/1·12mm or $1.0 mm^2$ of rating 5A is choosen.

A DPIC mainswitch of 5A rating 250V grade is selected.

Calculation of conduit

Main switch (MS) to horizontal run (HR) = 1m

HR to switch board (SB_1) = 1+1·5 = 2·5m

HR ~~SB~~ to L_2 = 0·5+3+0·5 = 4m

wall thickness = 0·5m

HR to SB_2 = 1·5m

HR to Fan = 0·5+2 = 2·5m

Fan to L_3 = 2+0·5 = 2·5m

Fan to tubelight = 2+0·5 = 2·5m

Total = 17m

Allowing 10% of wastage = 17+1·7 = 18·7m
= 19m.

Calculation of phase wire

MS to HR = 1m

HR to SB_1 = 1+1·5 = 2·5m.

SB_1 to L_1 = 1·5m.

SB_1 to L_2 = 1·5+0·5+3+0·5 = 5·5m

wall thickness = 0·5m

HR to SB_2 = 1·5m

SB_2 to Fan = 1·5+0·5+2 = 4m

SB_2 to L_3 = 4+2+0·5 = 6·5m

SB_2 to tubelight = 6.5m (4+2+0.5)

Total = 29.5m.

Allowing 15% of wastage = 29.5 + 4.5 = 34m.

Calculation of neutral wire

MS to HR = 1m

HR to SB_1 = 2.5m

HR to L_2 = 4m (0.5+3+0.5)

wall thickness = 0.5m.

HR to SB_2 = 1.5m

HR to Fan = 2.5m

Fan to L_3 = 2.5m.

Fan to tubelight = 2.5m

Total = 17m.

Allowing 15% of wastage = 17 + 2.5 = 19.5m
= 20m.

Calculation for length of earth wire of size 14SWG of GI

MS to HR = 1m

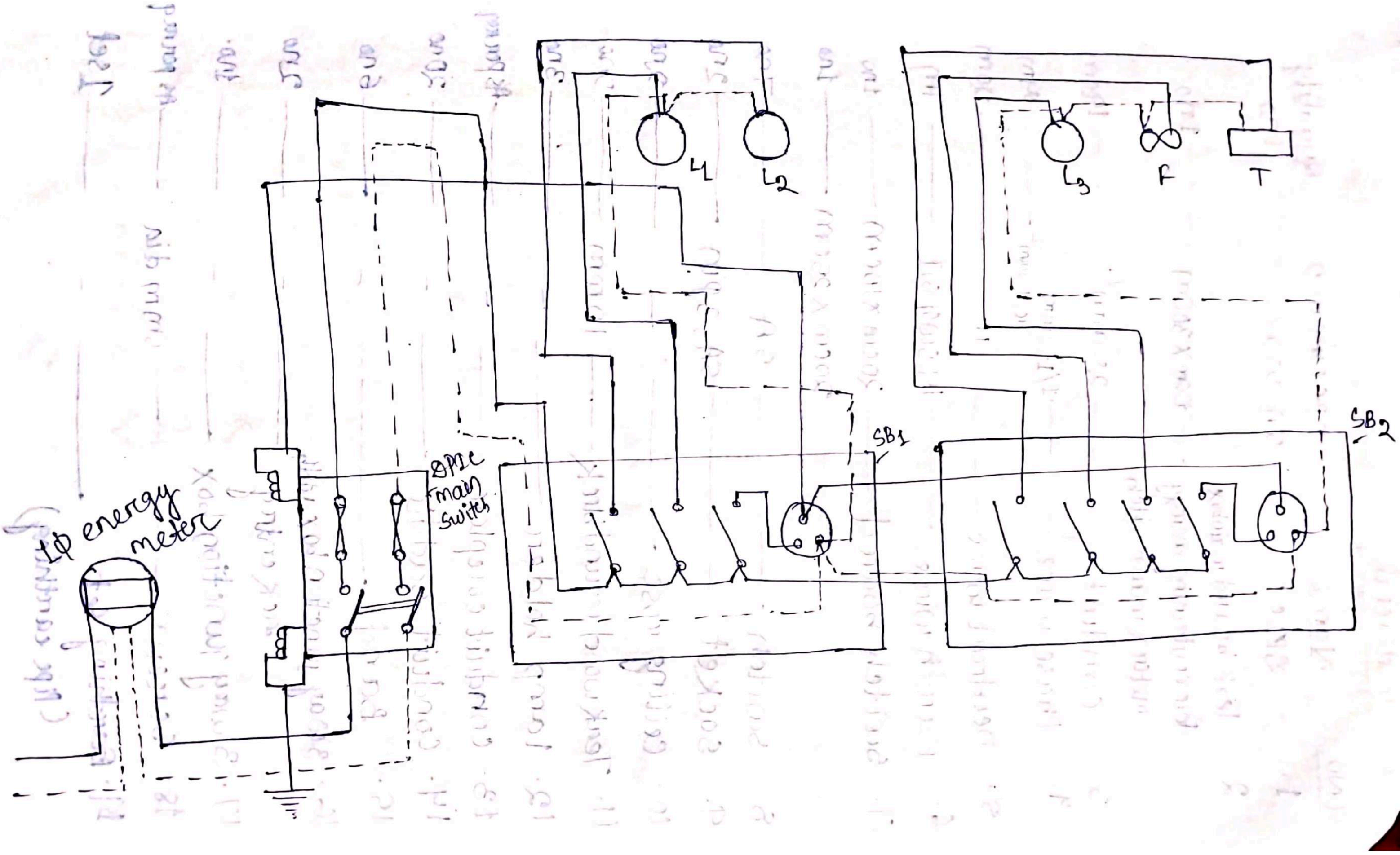
HR to SB_1 = 2.5m

wall thickness = 0.5m

HR to SB_2 = 1.5m

total = 5.5m

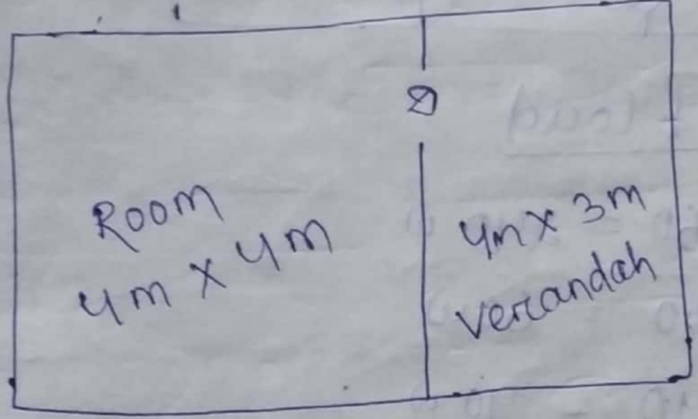
Allowing 15% of wastage = 5.5 + 1 = 6.5m
= 7m.


1φ energy meter
DPIC main switch
L1
L2
L3
F
T
SB1
SB2

List of material

Sl No	Name	Specification	Quantity
1.	DPIC	5A, 250V	1no
2.	Teak board mainbox for containing energy meter & mainswitch	30cm X 30cm	1no
3.	conduit	$25mm^2$	19cm
4.	Phase wire	1/1.12mm or $1.0mm^2$	34m
5.	neutral wire	"	20m
6.	Earth wire	14 SWG GI	7m
7.	switch board	20cm X 10cm	1no
		20cm X 25cm	1no
8.	Switch	5A	7no
9.	socket	5A, 3 pin	2no
10.	ceiling rose	-	2no
11.	Teakwood round block	10mm	5no.
12.	lamp holder	-	3no
13.	conduit coupler	-	As per req.
14.	conduit saddle	-	20no
15.	Band	-	6no
16.	3way junction box with back entry	-	2no
17.	3 way junction box	-	1no.
18.	Screw	5mm dia	As per req.
19.	Earthing set (Pipe earthing)	-	1set

Q.1. Calculate the total length of wire required for a room & verandah in batten system of wiring. Prepare a list of material with complete specification for the building which plan is given in fig. Assume other necessary data.



Assume data

Total height of ceiling = 3.5m

Height of meter & main switch from floor = 2m

Height of horizontal run from floor = 3m

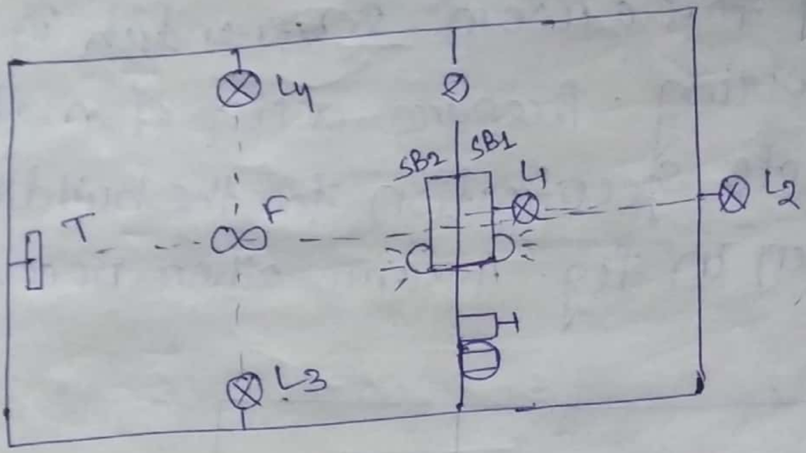
Height of switchboard from floor = 1.5m

Location of energy meter & main switch = 0.5m inside verandah wall.

All dimensions are in m.

Since it is a room with verandah ~~three tube~~ light points one fan & one 5A socket all to be installed in the room. Two lamp points & socket outlet is installed in the verandah.

Installation plan



Calculation of Load

Lamp - 4 × 60 = 240 W

Fan - 1 × 60 = 60 W

Tubelight - 1 × 40 = 40 W

Socket - 2 × 100 = 200 W

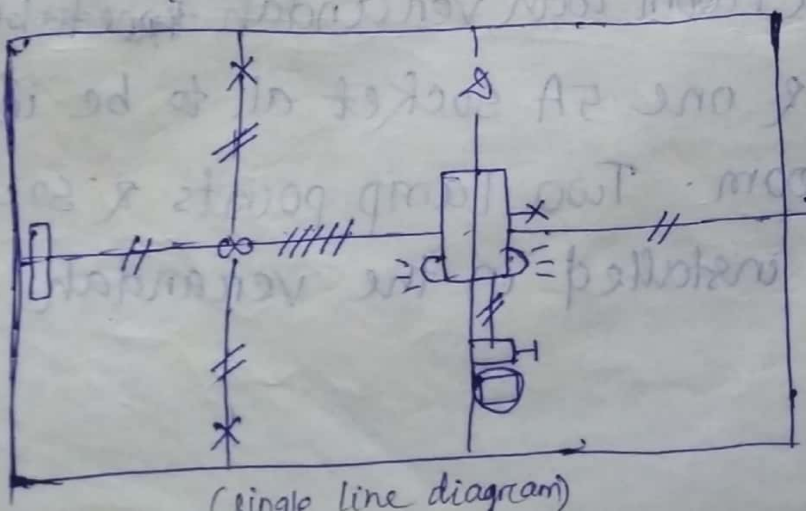
Total - 540 W

Assuming the supply voltage to be 230V :

Load current (I) = $\frac{P}{V} = \frac{540}{230} = 2.34$ Amp.

from the table the conductor of size 1/1.12 mm or 1.0 mm² of rating 5A is choosen.

A DPIC main switch of 5A rating 250V grade is selected.



(single line diagram)

calculation of batten

from main switch to HR above SB_1 = 2m (13mm X 13mm)

HR to SB_1 = 1.5m (25mm X 13mm)

HR to L_2 = 4m (13mm X 13mm)

wall thickness = 0.5m conduit

HR to SB_2 = 1.5m (37mm X 13mm)

HR to fan = 2.5m (31mm X 13mm)

fan to L_3 = 2.5m (13mm X 13mm)

fan to L_4 = 2.5m (13mm X 13mm)

fan to T = 2.5m (13mm X 13mm)

Total length of batten of size = 13mm X 13mm
= 13.5m + 10% wastage
= 13.5 + 1.35
= 14.85 = 15m.

25mm X 13mm = 1.5m + 10% wastage
= 2m

31mm X 13mm = 2.5m + 10% wastage
= 2.5 + 0.25
= 2.75 = 3m.

37mm X 13mm = 1.5m + 10% wastage
= 2m.

Total = 22m ~~+15% wastage~~

Calculation of phase wire

Ms to HR above switch board = 2m

HR to SB_1 = 1.5m

SB_1 to L_1 = 1.5m

SB_1 to L_2 = 5.5m

wall thickness = .5m

HR to SB_2 = 1.5m

SB_2 to fan = 4m

SB_2 to L_3 = 6.5m

SB_2 to T = 6.5m

SB_2 to L_4 = 6.5m

Total = 36 + 15% wastage

= 36 + 5.4

= 41.4

= 42 m

Calculation of neutral wire

Ms to HR above SB_1 = 2m

HR to SB_1 = 1.5m

HR to L_2 = 4m

wall thickness = 0.5m

HR to SB_2 = 1.5m

HR to fan = 2.5m

fan to L_3 = 2.5m

5

Fan to L_4 = 2.5m

Fan to T = 2.5m

Total = 19.5 + 15% wastage

= 19.5 + 2.92

= 22.4 ≅ 23 m

calculation of earthwire of size 14SWG GI

MS to HR = 1m

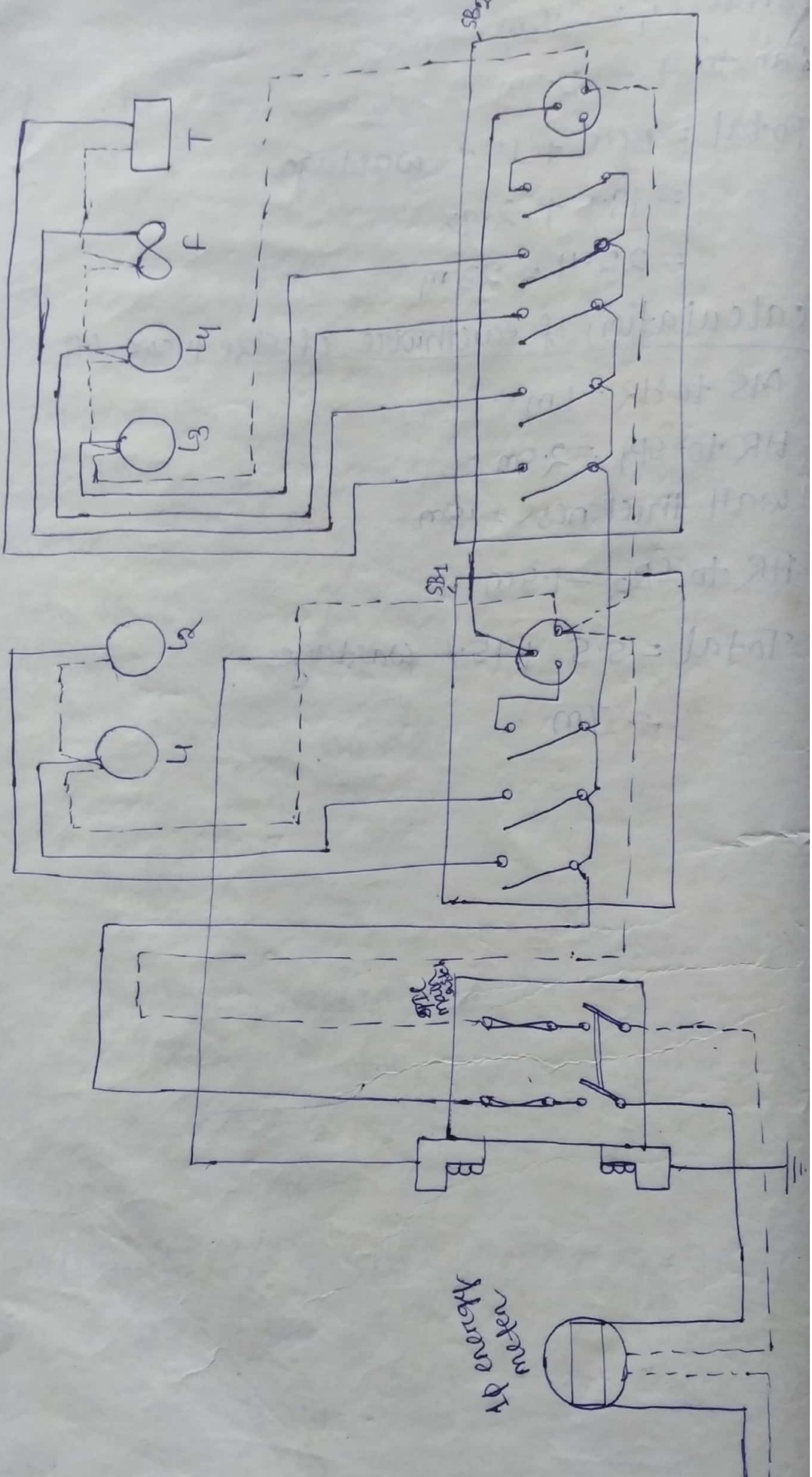
HR to SB_1 = 2.5m

wall thickness = .5m

HR to SB_2 = 1.5m

Total = 5.5 + 15% wastage

= 7m


SB2
T
F
L4
L3
L2
L1
SB1
1Φ energy meter

Matercial list

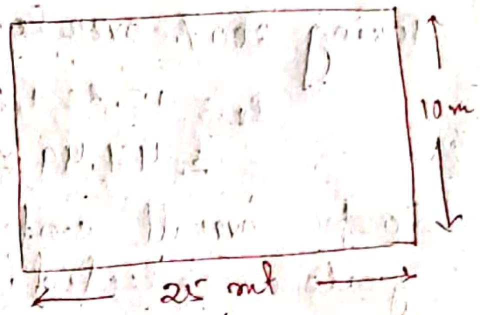
Sl.No.	Name	specification	Quantity
1.	DPIC	5A, 250V	1no.
2.	switch board		3no.
3.	Batten	13mm x 13m	15m
		25mm x 13mm	2m
		31mm x 13mm	3m
		37mm x 13mm	2m
4.	phase wire	1/1.12mm or 1.0mm^2	42m
5.	Neutral wire	11	23m
6.	Earth wire	14SWG GI	7m
7.	switch	5A	8no.
8.	socket	5A, 3pin	2no.
9.	ceiling rose	–	2no.
10.	Teak wood round block	10mm	4no.
11.	water tight fitting for lamp outside the verandah	–	1no.
12.	lamp holder	–	4no.
13.	Teak wood plug at 0.75m interval +20% wastage	–	5
14.	link clip (10 cm apart)		
15.	Earthing set (Pipe earthing)	–	1set

Q:- In a workshop of size 25 X 10 m, the plan of which is given below, a 10 BHP, 400V, 3Ø Induction motor is to be installed. The service connection is received in one corner of the workshop:

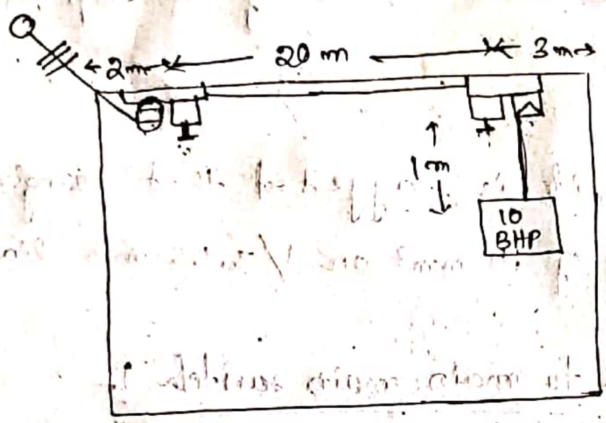
(i). Draw the installation plan showing location of main switch, motor & motor controll equipments.

(ii). Draw Wiring diagram & single line diagram.

(iii) Make a material list.



Ans:-



Assumptions:-

1. Height of motor main switch, main switch, starter = 1.5 mt from floor.
2. Height of H.R. from floor = 2.5 mt.
3. The motor will be installed 0.5 mt above the floor.
4. Two earth wire run side by side for earthing the motor & the non current carrying metal parts.
5. Power factor is 0.8 & efficiency is 85%.

Calculation of load current:-

$$I/p \text{ current} = \frac{I/p \text{ power}}{\sqrt{3} \times V_L \times \cos\phi}$$

$$I/p = \frac{O/P}{\eta} \Rightarrow I/p = \frac{10\ BHP}{0.85} = \frac{10 \times 746}{0.85} = 8776.47 \text{ watt}$$

$$\Rightarrow I_L = \frac{8776.47\ W}{\sqrt{3} \times 400 \times 0.8} = 15.83 \text{ Amp}$$

Selection of motor main switch:-

Taking 50% overload in motor the I/p current becomes

$= 15.83 + 50\%$ of 15.83

$= 23.75 \simeq 24$ Amp.

(2)

So for motor it is suggested that a TPIC main switch of 32 Amp, 440 V grade is selected.

Selection of main main switch:-

For this we need to consider all the loads or future extensions.

Taking 200% over load as future extension

$I_L = 15.83 + 200\%$ of 15.83
$= 47.49 \simeq 48$ Amp.

So for overall controll a TPIC main switch of 60 Amp, 440 V grade is selected.

Selection of wire for motor:-

According to the table 18.3, it is suggested that single core, PVC insulated, Aluminium conductor of $10\ mm^2$ or $1/3.55$ mm dia conductor is selected.

Selection of wire from Energy meter to main main switch:-

As the total load current is 48 Amp, from table it is suggested that single core, PVC insulated, Aluminium conductor of $25\ mm^2$ or $7/2.24$ mm dia conductor is selected.

Selection of size of conduit:-

25 mm diameter heavy gauge conduit used to enclose 3 wires.
31 mm " " " " " " 6 wires.

Length of 25 mm dia rigid conduit:-

From main main switch to motor switch = 1 mt + 20 mt + 1 mt = 22 mt.

taking 10% wastage = 22 + 2.2 = 24.2 ≃ 25 mt

Length of 31 mm dia rigid conduit:-

From motor starter to floor level = 1.5 mt.
from floor to trench = 0.25 mt
Along the trench = 1 mt
from trench to floor level = 0.25 mt
from floor to foundation = 0.5 mt
= 3.5 mt

Taking 10% wastage = 3.5 + 0.35 ≃ 4 mt.

Length of 25 mm dia flexible conduit :-

From energy meter to main switch = 0.5 mt
From main main switch to conduit mouth = 0.25 mt
From conduit mouth to motor MS = 0.25 mt
From motor main switch (MS) to starter = 0.5 mt
1.5 mt

Taking 10% wastage = 1.5 + 0.15 ≃ 2 mt.

Length of 31 mm dia flexible conduit :-

From starter to conduit mouth = 0.25 mt
from motor foundation to motor terminals = 0.5 mt
0.75 mt

Taking 10% wastage ≃ 1 mt

Length of 25 mm² conductor :-

From energy meter to MS = 1 mt × 3 wires = 3 mt

Length of 10 mm² conductor :-

From main switch to motor main switch = 22 mt × 3 wires = 66 mtr
From motor MS to starter = 0.5 mt × 3 wires = 1.5 mt
From starter to motor foundation = 3.5 mt × 6 wires = 21 mt
from foundation to motor terminal box = 1 mt × 6 wires = 6 mt
94.5 mt.

Taking 15% wastage = 94.5 + 15% of 94.5
= 108.67 mt ≃ 109 mt

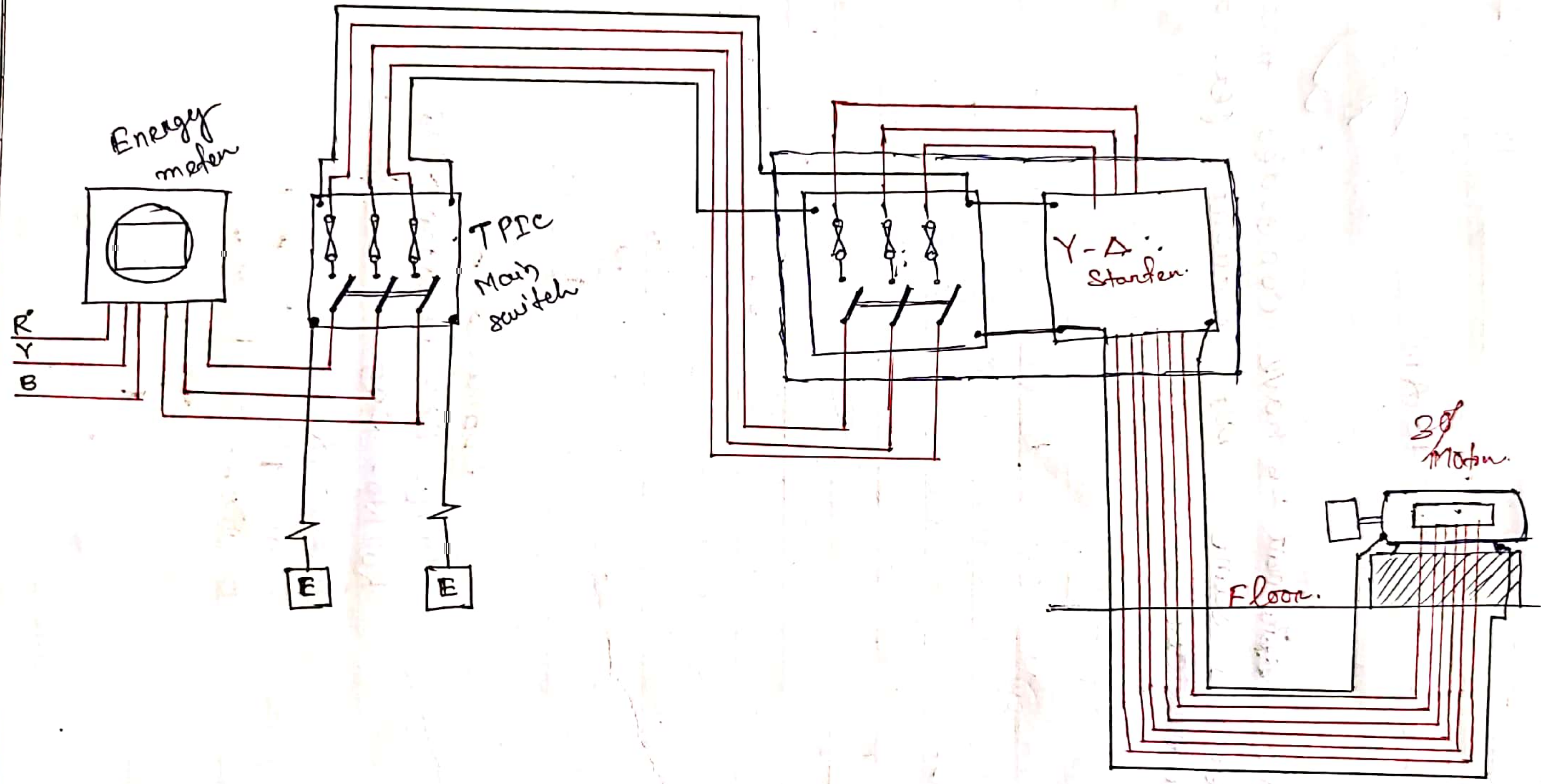
Length of earth wire of 8 SWG (GI) :-

Length of earth wire = 2 × length of rigid & flexible conduit
= 2 × (22 + 3.5 + 1.5 + 0.75)
= 2 × 27.75
= 55.5 mt ~~[illegible]~~

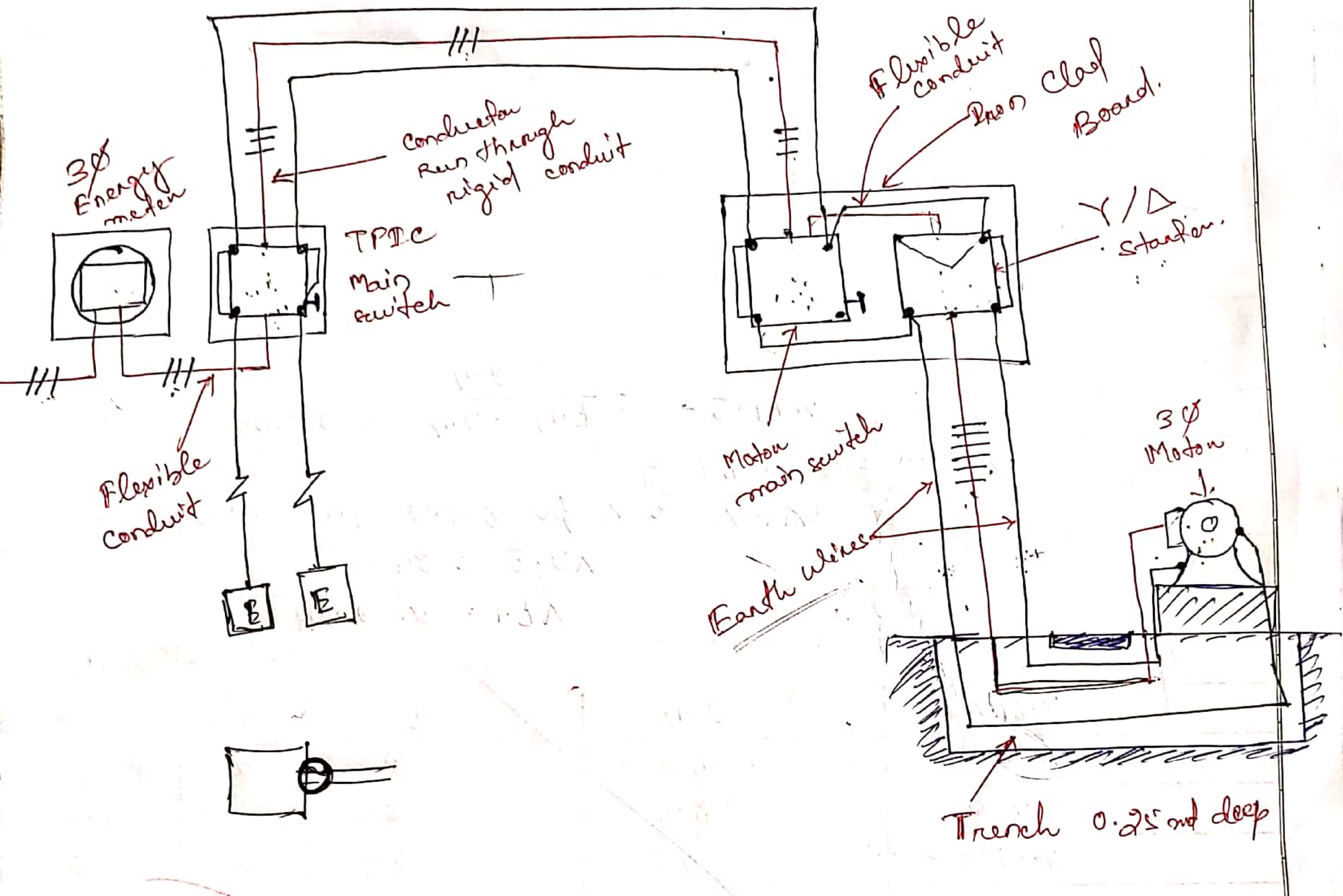
Taking 10% wastage = 55.5 + 5.55 = 61.05 ≃ 61 mt.

Material list :-

Sl No.	Name	Specification	Quantity
1.	TPIC Main Switch	60 Amp, 440V grade	1 Nos.
2.	TPIC Main switch	32 Amp, 440V grade	1 nos.
3.	Heavy gauge conduit	25 mm dia	25 mt
	Conduit accessories :- conduit bends	for 25 mm dia	2 nos.
	Conduit sockets (to joint)	—	4 nos.
	conduit saddle @ 1no/mt	—	25 nos
4.	Heavy gauge conduit	31 mm dia	4 mt
	conduit bends	—	2 nos.
	conduit sockets	—	2 nos.
	Conduit saddle	—	4 nos
5.	Flexible conduit	25 mm dia	2 mt
6.	Flexible conduit	31 mm dia	1 mt
7.	Conductor	25 mm^2 or 7/2.2 mm, Al, single core, PVC insulated	8 mt
8.	Conductor	10 mm^2 or 1/3.55 mm Al, single core, PVC insulated	111 mt
9.	Galvanised earth wire	8 SWG	61 mt
10.	Iron clad board for mounting MS	30 cm x 45 cm	1 nos.
11.	Nut & Bolt for fixing board	12 mm dia 150 mm long	8 nos.
12.	Iron clad board for fixing motor switch & starter	60 cm x 45 cm	1 nos.
13.	Nut & Bolt for fixing	10 mm dia 150 mm long	12 nos.
14.	Caution plate	danger 440V	1 nos.
15.	Shock treatment chart	—	1 nos
16.	Earthing set complete	—	2 nos.



(Wiring Diagram)



(Single line diagram)

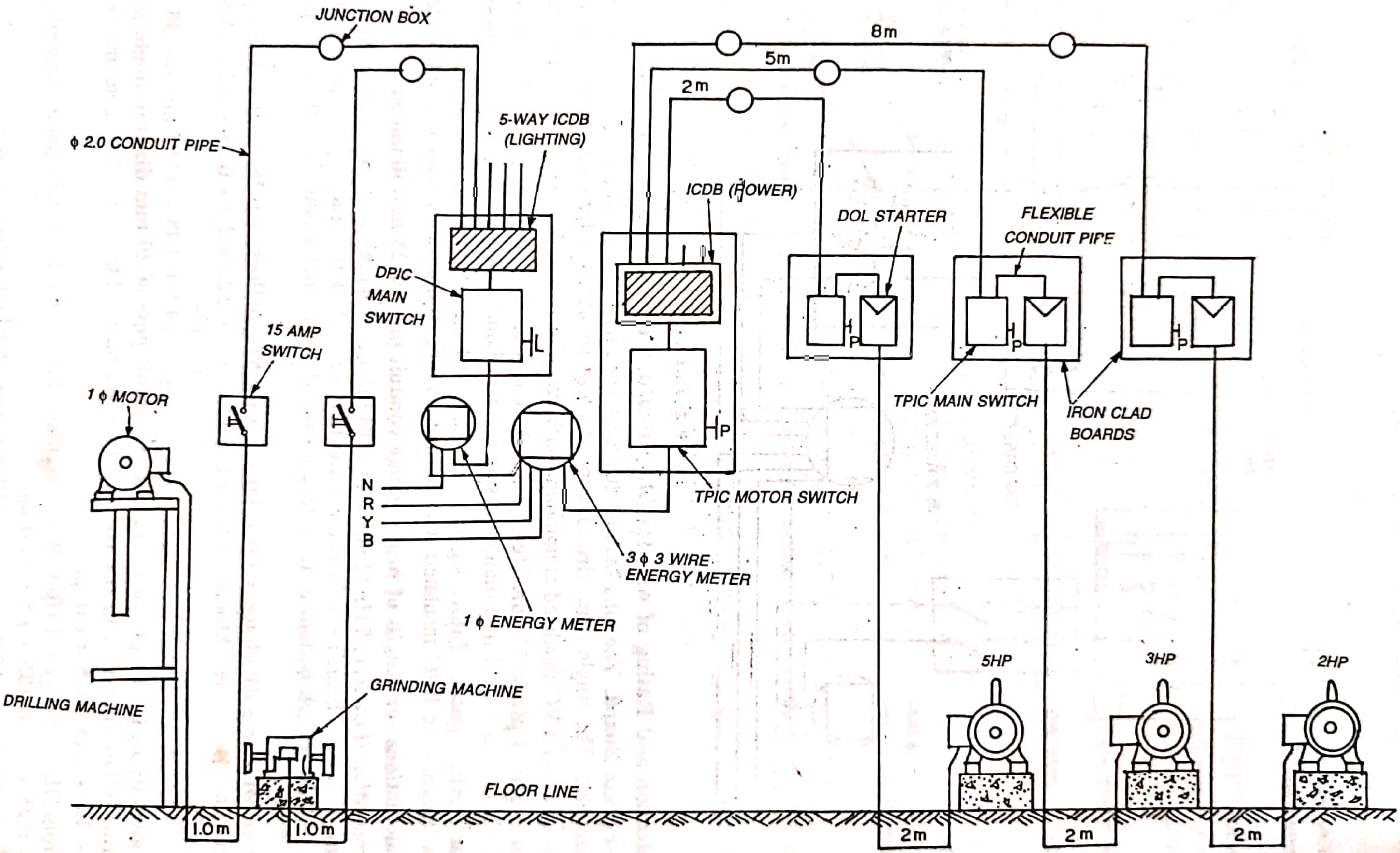


Fig. 18.16. Single Line Diagram.

①

Q1- A small workshop of size 10m × 6m × 4m is under construction. It is required to be provided with the following electrical power connections for motors.

(i) One 5 HP, 3φ motor

(ii) One 3 HP, 3φ motor

(iii) One 2 HP, 3φ motor

(iv) One drilling machine driven by a 1φ 1 H.P. motor.

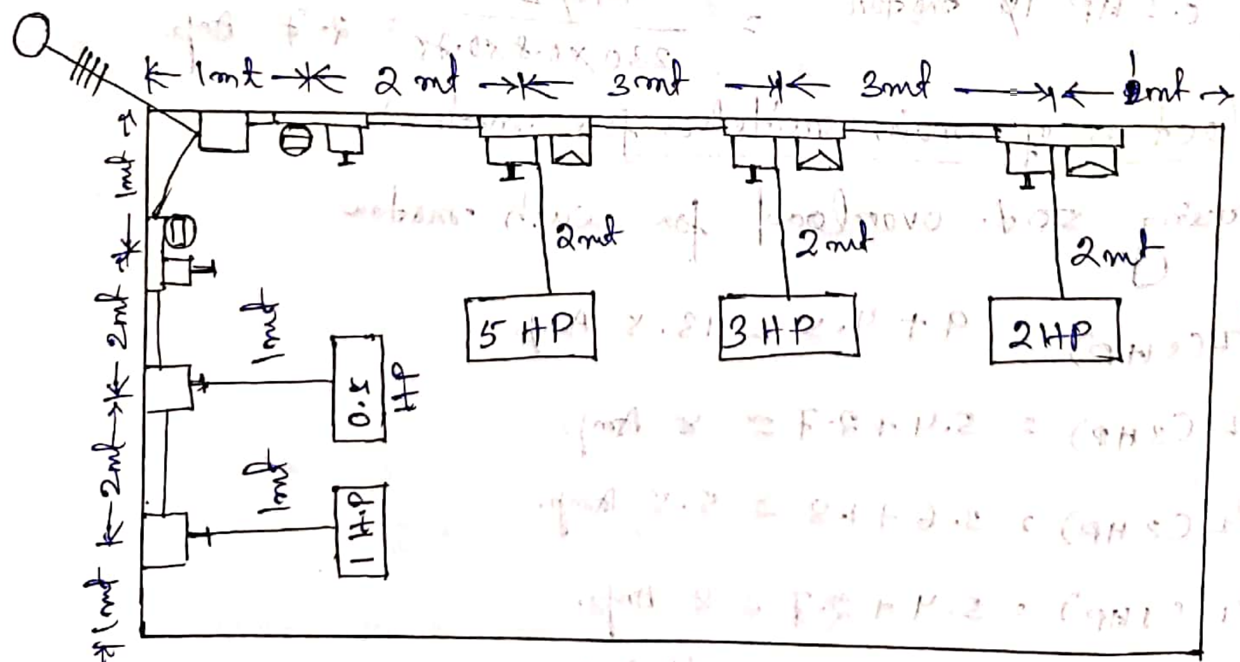
(v) One grinding machine driven by a 1φ 0.5 HP motor.

(a) Draw the installation plan showing location of machines, main switch, power distribution board & motor control board.

(b) Draw the single line diagram.

(c) Prepare a material list.

Answer:-



(Installation Plan)

Assumptions :-

(i) Height of main switch & control switch – 1.5 mt

(ii) Height of horizontal run – 2.5 m from floor.

(iii) Height of all motors except drilling machine – 0.5 m

(iv) Height of drilling machine – 1.5 m from floor.

(v) Assuming power factor 0.8 & efficiency 75%.

Calculation of load current :-

For 5 HP motor $= \frac{5 \times 746}{\sqrt{3} \times 400 \times 0.8 \times 0.75} = 8.97 \simeq 9$ Amp

For 3 HP motor $= \frac{3 \times 746}{\sqrt{3} \times 400 \times 0.8 \times 0.75} = 5.38$ Amp.

For 2 HP motor $= \frac{2 \times 746}{\sqrt{3} \times 400 \times 0.8 \times 0.75} = 3.6$ Amp

For 1 HP 1ϕ motor $= \frac{746}{230 \times 0.8 \times 0.75} = 5.4$ Amp

For 0.5 HP 1ϕ motor $= \frac{746/2}{230 \times 0.8 \times 0.75} = 2.7$ Amp.

Selection of main switches for motor :-

Taking 50% overload for each motor

I_L (5 HP) = 9 + 4.5 = 13.5 Amp

I_L (3 HP) = 5.4 + 2.7 ≃ 8 Amp.

I_L (2 HP) = 3.6 + 1.8 ≃ 5.5 Amp.

I_L (1 HP) = 5.4 + 2.7 ≃ 8 Amp.

I_L (0.5 HP) = 2.7 + 1.3 ≃ 4 Amp.

~~From the table~~

→ For 5 HP motor, it is suggested that a TPIC main switch of 16 Amp, 440 V grade is selected.

→ For 3 HP motor, it is suggested that a TPDC main switch of 10 Amp, 440 V grade is selected.

→ For 2 HP motor, it is suggested that a TPDC main switch of 10 Amp, 440 V grade is selected.

→ For 1ϕ, 1 HP motor, it is suggested that a DPDC main switch of 10 Amp, 250 V grade is selected.

→ For 1ϕ, 0.5 HP motor, it is suggested that a DPDC main switch of 6 Amp, 250 V grade is selected.

Selection of main switch for overall controll:-

For 3ϕ $I_L = 13.5 + 8 + 5.5$
$= 27$ Amp.

For 1ϕ $I_L = 8 + 4 = 12$ Amp.

→ For 3ϕ overall controll, it is suggested that a TPDC main switch of 32 Amp, 440 V grade is selected.

→ For 1ϕ overall controll, it is suggested that a DPDC main switch of 16 Amp, 250 V grade is selected.

* A distribution board of 60 Amp is selected.

Selection of conductor:-

* According to table 18.1, for 5 HP motor, it is suggested that single core, PVC insulated, Al conductor of 6 mm^2 or 1/2.80 mm dia is choosen.
* According to table for 3 HP & 2 HP motor single core, PVC insulated, Aluminium Conductor

of 4 mm² or 1/2.24 mm dia is selected.

* For 1ϕ motor from table 12.2 it is suggested that 1.5 mm² or 1/1.40 mm single core, PVC insulated Aluminium conductor is selected.

Selection of wire from energy meter to main switch:-

* For 3ϕ current rating is 27 Amp, so 10 mm² or 1/3.55 mm, Al conductor, single core, PVC insulated is used.
* For 1ϕ current rating is 12 Amp, so 2.5 mm² or 1/1.80 mm single core, PVC insulated, Al conductor is selected.

Size of selection of conduit:-

* 25 mm dia heavy gauge conduit is used to enclose 3ϕ conductors.
* 20 mm dia heavy gauge conduit is used to enclose 1ϕ conductors.

Length of 25 mm dia rigid conduit:-

* **From DB to 5 H.P motor:-**

From DB to H.R = 1 mt

Along the H.R = 2 mt

H.R to motor controll. = 1 mt.

Starter to floor level = 1.5 mt.

Floor to the trench = 0.25 mt

Along the trench = 2 mt.

trench to floor level = 0.25 mt

floor to motor foundation top = 0.5 mt

Total = 8.5 mt.

* From DB to 3 H.P motor = 1 + 5 + 1 + 1.5 + 0.25 + 2 + 0.25 + 0.5 = 11.5 mt.

* From DB to 2 HP motor :- 1 + 8 + 1 + 1.5 + 0.25 + 2 + 0.25 + 0.5
= 14.5 mt.

Total length = 8.5 + 11.5 + 14.5 = 34.5 mt.
Taking 10% wastage
= 34.5 + 3.45 = 37.95 ≃ 38 mts.

<u>Length of 20 mm dia rigid conduit :-</u>

From DB to 0.5 HP motor :- 1 + 2 + 1 + 1.5 + 0.25 + 1 + 0.25 + 0.5
= 7.5 mt.

From DB to 1 HP drilling machine -
1 + 4 + 1 + 1.5 + 0.25 + 1 + 0.25 + 1.5
= 10.5 mt.

Total = 10.5 + 7.5 = 18 mt
Taking 10% wastage = 18 + 1.8 ≃ 20 mt.

<u>Length of 25 mm dia flexible conduit :-</u>

From energy meter to main switch = 0.5 mt.
MS to conduit mouth of 5 HP motor = 0.25 mt
" " " " " 3 HP " = 0.25 mt
" " " " " 2 HP " = 0.25 mt

Conduit mouth to motor MS of 5 HP motor = 0.25 mt
" " " " " 3 HP " = 0.25 mt
" " " " " 2 HP " = 0.25 mt

Motor MS to starter of 5 HP " = 0.5 mt
" " " " 3 HP " = 0.5 mt
" " " " 2 HP " = 0.5 mt

From conduit mouth to motor terminal of 5 HP = 0.5 mt.

" " " " " " 3 HP = 0.5 mt

" " " " " " 2 HP = 0.5 mt

Total = 5 mt

Taking 10% wastage = 5 + 0.5 ≃ 5.5 mt.

<u>Length of 20 mm flexible conduit:-</u>

From energy meter to Main switch = 0.5 mt

Main switch to conduit mouth of 1 HP = 0.25 mt

" " " " " 0.5 HP = 0.25 mt

Conduit mouth to motor MS of 1 HP = 0.25 mt

" " " " " of 0.5 HP = 0.25 mt

Conduit mouth to motor terminal of 1 HP = 0.5 mt

" " " " " 0.5 HP = 0.5 mt

Total = 2.5 mt

Taking 10% wastage = 2.5 + 0.25 ≃ 3 mt.

<u>Length of 6 mm^2 conductor for 5 HP:-</u>

From DB to motor foundation = 8.5 mt × 3 wires

= 25.5 mt

motor foundation to motor terminal = 1 mt × 3 wires

= 3 mt

∴ Total = 25.5 + 3 = 28.5 mt

Taking 10% wastage = 28.5 + 2.85

= 31.35 ≃ 32 mt.

Length of $4 mm^2$ conductor for 3HP & 2HP motor :- (7)

From DB to motor foundation of 3 HP = 11.5 × 3 wires
= 34.5 mt

" " " " " 2 HP = 14.5 × 3 wires
= 43.5 mt

motor foundation to motor terminal (3 HP) = 1 mt × 3 wires
= 3 mt

" " " " (2 HP) = 1 mt × 3 wires
= 3 mt

Total = 34.5 + 43.5 + 3 + 3 = 84 mt

Taking 10% wastage = 84 + 8.4 = 92.4 ≅ 93 mt.

Length of $1.5 mm^2$ conductor for 1∅ motor :-

From DB to motor foundation of 0.5 HP = 7.5 × 2 wire
= 15 mt

" " " " " of 1 HP = 10.5 × 2 wire
= 21 mt

foundation to motor terminal = 1 mt × 2 wires
= 1 mt × 2 wires

Total = 15 + 21 + 2 + 2 = 40 mt.

Taking 10% wastage = 40 + 4 ≅ 44 mt.

Length of $10 mm^2$ conductor :-

From Energy meter to MS : 1 mt × 3 wires
= 3 mt

Taking 10% wastage = 3.5 mt.

Length of $2.5 mm^2$ conductor :-

From energy meter to MS = 1 mt × 2 wires
= 2 mt

Taking wastage as 10% ≅ 2.5 mt

Length of earth wire of 8 SWG (G.I.) :- (8)

As per I.E rule each 3ϕ & 1ϕ motor will be connected with two earth wires independently.

For 5HP motor = 2 × length of rigid & flexible conduit

$= 2 \times (8.5 + 0.25 + 0.25 + 0.5 + 0.5)$

$= 2 \times 10$

$= 20$ mt

For 3 HP motor $= 2 \times (11.5 + 0.25 + 0.25 + 0.5 + 0.5)$

$= 2 \times 13 = 26$ mt

For 2 HP motor $= 2 \times (14.5 + 0.25 + 0.25 + 0.5 + 0.5)$

$= 2 \times 16 = 32$ mt

For 1 HP motor $= 2 \times (10.5 + 0.25 + 0.25 + 0.5 + 0.5)$

$= 2 \times 12 = 24$ mt

For 0.5 HP motor $= 2 \times (7.5 + 0.25 + 0.25 + 0.5 + 0.5)$

$= 2 \times 9 = 18$ mt

Total $= 20 + 26 + 32 + 24 + 18 = 120$ mt

Taking 10% wastage $= 120 + 12 = 132$ mt.

Scanned with CamScanner

Material List

SL No.	Name	Specification	Quantity
1.	TPIC main switch	32 Amp, 440V	1 No.
		16 Amp. 440V	1 No.
		10 Amp, 440 V	2 Nos.
2.	DPDC main switch	16 Amp. 250 V	1 Nos.
		10 Amp, 250 V	1 Nos.
		6 Amp, 250 V	1 Nos.
3.	Heavy gauge conduit	20 mm dia	20 mt
	Conduit accessories –		
	Conduit Bends	20 mm	8 nos.
	Conduit Sockets	–	4 Nos.
	Conduit Saddle	–	20 nos.
4.	Heavy gauge conduit	25 mm	38 mt
	conduit bends	25 mm	12 nos.
	Conduit Sockets	–	6 Nos.
	Conduit Saddle	–	38 nos.
5.	Flexible Conduit	20 mm	3 mt
		25 mm	5.5 mt
6.	Conductor	6 mm² or 1/2.80 mm AL conductor, PVC insulated, single core	32 mt
		4 mm² or 1/2.24 mm AL conductor, PVC insulated, single core	93 mt
		1.5 mm² or 1/1.40 mm single core, AL conductor	44 mt

		10 mm^2 or 1/3.55 mm AL, PVC insulated	3.5 mt
		2.5 mm^2 or 1/1.80 mm single core, AL conductor	2.5 mt
7.	Galvanised earth wire	8 SWG	132 mt
8.	Iron Clad board for mounting MS. (3ϕ)	30 cm x 45 cm	1 Nos.
9.	Nut & Bolt for fixing	12 mm, 150 mm long	4 nos.
10.	Iron clad board for fixing motor starter & main switch	60 cm x 45 cm	3 nos.
11.	Nut & Bolt for fixing	10 mm, 150 mm long	36 nos.
12.	Iron Clad board for mounting MS (1ϕ)	30 cm x 45 cm	1 Nos.
13.	Nut & Bolt for fixing	10 mm, 150 mm long	4 nos.
14.	Iron clad board for mounting motor main switch	30 cm x 30 cm	2 nos.
15.	Nut & Bolt for fixing	8 cm, 100 cm	8 nos.
16.	Caution Plate	danger 440V	3 nos.
		danger 250V	2 nos.
17.	Shock treatment chart	–	1 Nos.
18.	Earthing set complete	–	10 nos.
19.	Labour charges.		

Over-head transmission System :-

The main components of over head lines are

1. Supports
2. Cross arms & Clamps
3. Insulators
4. Conductors
5. Stays
6. Lightning Arrester
7. Guard wires
8. Phase plate
9. Bird Guards
10. Danger plate
11. Barbed Wire

Line Supports :-

The fun of line support is to support the conductors. The line supports are of various types including wood, steel, reinforced concrete poles & steel towers.

Wooden poles :- These are used for voltages upto 22 kV & for short spans upto 60 meters.

Steel poles :- These are used for voltages upto 33 kV & for spans upto 50 - 80 meters.

RCC poles :- These poles are extensively used on 11 kV & low tension lines. It is used for longer spans 80-200 meters.

Steel towers :- These towers are used for transmission purposes at 33 kV 66 kV & above. These are used for spans 300 mts or more.

Cross arms & Clamps :-

Line supports used to keep conductors at a safe distance from ground where as the fun of cross arms is to keep the conductors at a safe distance from each other. Cross arm is fitted to the pole top by means of brackets known as pole brackets. These are of various types such as MS channel, angle iron & wooden. Usually the lengths are

1.5 m × 125 mm × 125 mm for 11 kV for wooden
2.1 m × 125 mm × 125 mm for 33 kV for wooden & so on.

Insulators :-

The most used insulators are Pin type, Suspension type, Strain type, Shackle type & Stay insulators.

Conductors :-

The most used conductor materials are Hard drawn Copper, Aluminium, Galvanised Steel, Cadmium Copper etc.

Stays!-

It is provided on over head line supports at angle & terminal positions. The theoritical angle betn stay & pole should be 45°, but it is not always possible so it is designed on a minimum angle of 30°.

An egg type strain insulators is inserted in the guy wire for safety. It isolates stay wire electrically from metal parts.

Lightning Arrester!- It is used to discharge excessive voltages built upon the line, to earth, due to lightning.

Guard Wires!- It is provided below power lines for protection of telecommunication line, safety of road, railway line & roof tops etc.

Phase Plate!- On each pole of tower, phase plate indicating the different phases (Red, Yellow, Blue) are provided.

Bird Guards!- A stick of ebonite is fixed near the insulator on the cross arm to prevent flashover due to bird sitting on the conductors.

Danger Plate!- It is provided on each pole, as a warning measure indicating the working voltage. It is provided at a height of about 2.5m from the ground.

Barbed Wire!- It is placed on a pole at a height of about 2.5m from the ground for at least 1meter. This prevents climbing by unauthorised persons.

Factors affecting height of pole:-

The minimum height of pole depends upon

(i) The minimum clearance of the lowest conductor from ground.

(ii) The number of conductors to be carried & minimum vertical clearance betn them.

(iii) The length of the pole to be buried in the ground (about 1/6 th).

Factors affecting the size of conductor for overhead line:-

The factors are

(i) Line working voltage.

(ii). Length of transmission line.

(iii) Power to be carried.

(iv) Power factor of the load.

Conductor Configuration:-

There are several conductor configuration are possible but three configuration are most common i.e.

(i) Horizontal configuration

(ii) Vertical configuration

(iii) Triangular configuration.

Conductor Spacing:-

A commonly used formula is employed for determination of spacing of conductor is given by

$$\text{Spacing} = \sqrt{S} + \frac{V}{150} \text{ meters}$$

where S = Sag in meters

V = line voltage in KV.

Line voltage in KV	0.4	11	33	66	132	220	400	765
Spacing in meters	0.2	1.2	2.0	2.5	3.5	6.0	11.5	14

Span length:-

Span length is the distance betn two adjacent poles.

The usual span lengths are

(i) For wooden pole = 40-50 mt.

(ii) For steel tubular pole = 50 - 80 mt

(iii) For RCC pole = 80 - 200 mt

(iv) For steel towers = 200 - 400 mt & above.

Jumper:-

→ The short length of conductor used to connect the line conductor on one side of terminal pole to line conductor on the other side of the terminal pole is known as jumper.

→ A jumper is made of the same material & has the same current carrying capacity as that of line conductors.

Q1:- An overhead 11 KV, 50 H_z transmission line has to be erected using 27 kg, 10 meter long steel poles & copper wire of size 3/2.642 mm, with an average span of 150 meter. Make a list of material required for one kilometer.

Answer:-

Length of the line = 1 km = 1000 mt

Span length = 150 mt

So No. of poles = $\frac{1000}{150} + 1$ = 8 nos.

Length of 3/2.642 mm conductor for phase wire

= 3 times of length of line + 2% sag

= $3 \times 1000 + \frac{2}{100} \times 3000$

= 3000 + 60 = 3060 mt ≃ 3.06 km.

From the table 3/2.642 mm copper conductor weights 149.1 kg/km

Hence weight of conductor required =

149.1 × 3.06 = 456.25 kg ≃ 457 kg.

Length of 8 SWG GI earth wire

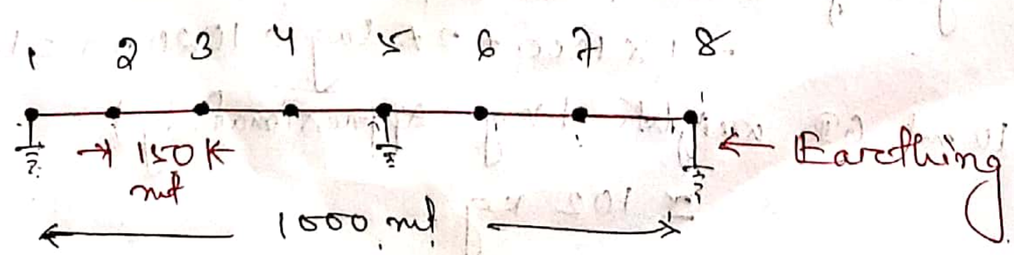
= 1 × 1000 + 2% sag = 1020 mt = 1.02 km

(10 mt GI weights 1 kg Approximately)

≃ 102 kg

Material List

Sl.No.	Name	Specification	Quantity
1.	Rail Poles	10 mt long, 27 kg	8 nos.
2.	Cross arms	1000 mm × 1000 mm × 1.5 mt	8 nos.
3.	Pin Insulator	11 KV	7×3 = 21 nos.
4.	Disc Insulator with dead end clamp	11 KV	1×3 = 3 nos
5.	Insulator bracket for top pin insulator	–	7 nos.
6.	Phase wire	3/2.642 mm copper conductor	457 kg
7.	Earth wire	8 SWG	102 kg
8.	Earth wire clamp (to hold earth wire)	–	8 nos.
9.	Binding wire @ 200 gm for each insulator	14 SWG copper wire	4.8 kg
10.	Lightning Arrester	11 KV	1 nos.
11.	Danger plate with clamp	11 KV	1 nos.
12.	Barbed wire @ 2 kg/pole	–	16 kg
13.	Earthing set complete	–	3 set
14.	Stay set complete @ 1 no/pole	–	8 nos.



(Single line diagram)

Q - 2

Q:- In a city, an overhead line of 400 V, 3ϕ, 50 Hz is to be erected along a straight route on steel tubular pole. The length of the line is 500 mt & terminates at this end. The span betn adjacent pole is 50 mt. The street light conductors are also supported on the same pole. Estimate the quantity of material required. Other details are :-

(i) ACSR conductor for phase, neutral & street light of size 6/1 × 2.11 mm.

(ii) Earth wire 7/16 SWG GS or 8 SWG GI

Answer :-

Length of line = 500 mt.

Length of span = 50 mt

No of poles = $\frac{500}{50} + 1 = 11$ nos.

Length of ACSR conductor = 5 × 500 + 2% sag

3 phase wire, 1 Neutral wire
1 Street light

= 2500 + 50 = 2550 ≃ 2.55 km.

Weight of conductor of 6/(1 × 2.11) mm = 85 kg/km

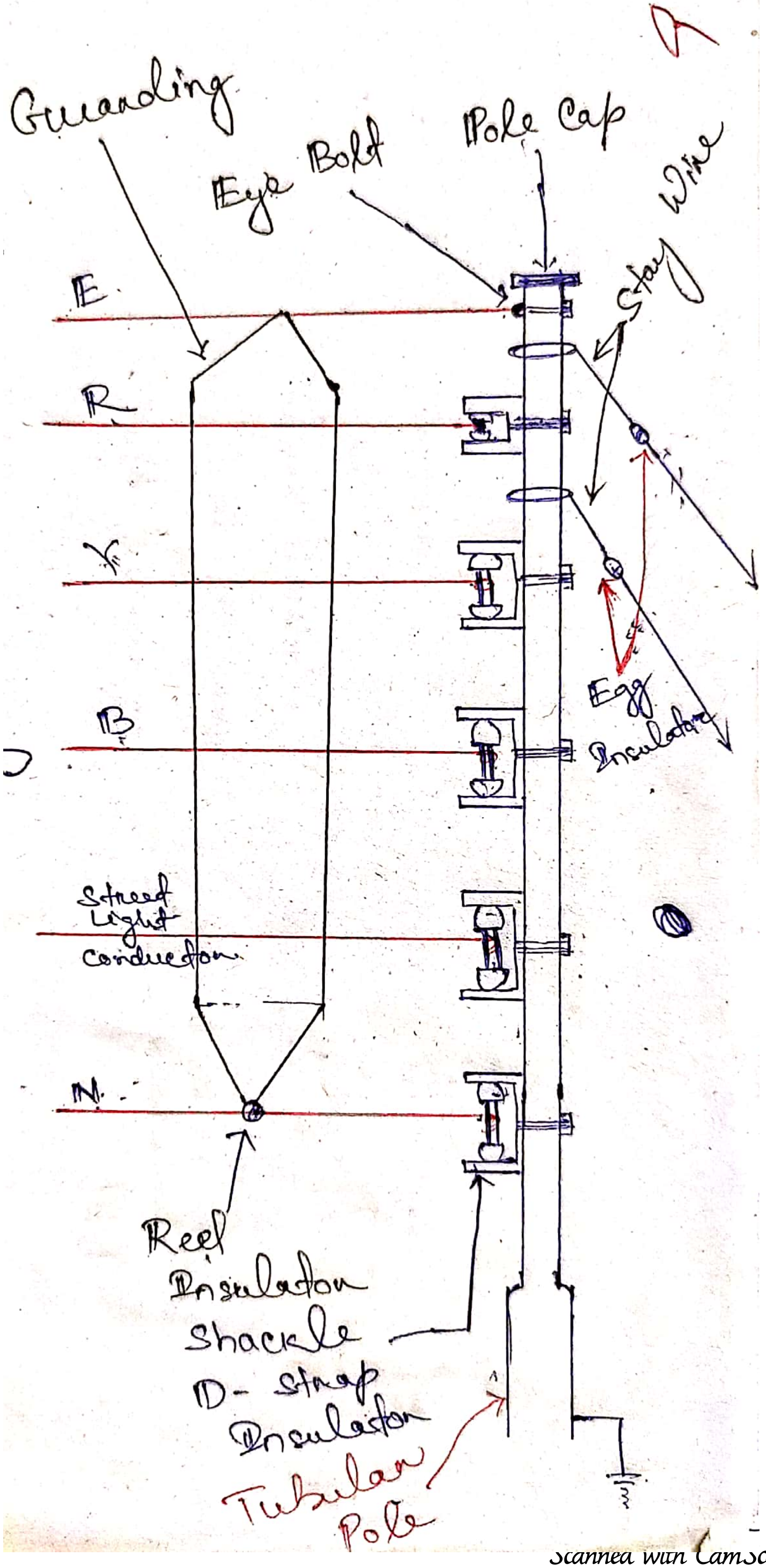
Total weight = 85 × 2.55 = 216.75 ≃ 217 kg.

Length of 8 SWG earth wire

= 500 + 2% sag = 510 mt ≃ 51 kg.

Material List

Sl No	Name	Specification	Quantity
1.	Steel tubular pole	9 mt long	11 nos.
2.	ACSR conductor	Squirrel 6/1×2.11mm	217 kg
3.	Earth wire	8 SWG GI	51 kg.
4.	Insulator @5/pole	D-strap shackle	55 nos.
5.	Eye bolt/Earth wire Clamp	15mm dia 200mm long	11 nos.
6.	Nut & Bolt for fixing D-strap insulator	"	55 nos.
7.	Guard wire (15 places Approx)	7/16 SWG	15 nos
8.	Binding wire @ 200gm	14 SWG	11 kg.
9.	Reel Insulator	–	15 nos.
10.	Stay set complete (1 on each pole & 2 on terminal)	–	13. nos.
11.	Earthing set complete	–	4 nos.
12.	Street light fittings complete with tube & fittings	–	11 nos.

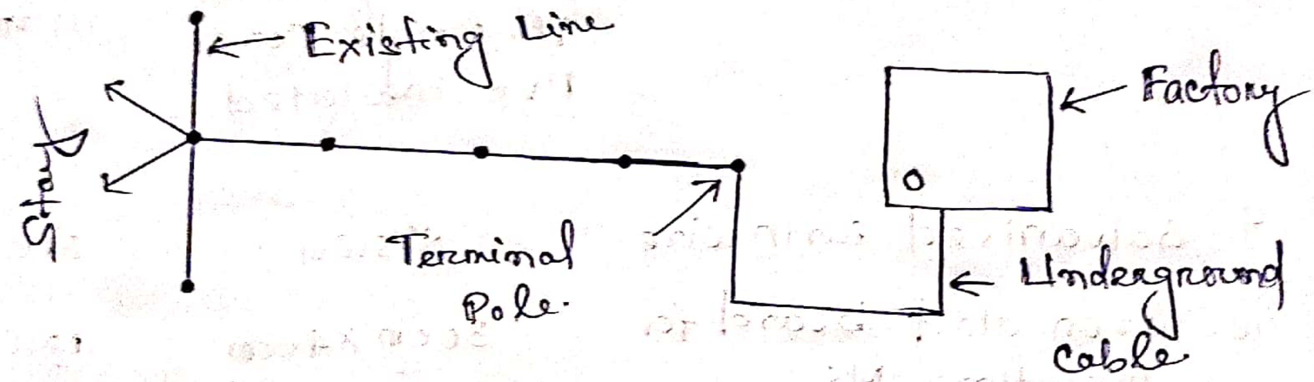

Guarding
Eye Bolt
Pole Cap
Stay Wire
E
R
Y
B
Street Light conductor
N
Egg Insulator
Reel Insulator
Shackle
D- strap Insulator
Tubular Pole

Q-3

Q:- A factory has 75 HP power load for motors & 10 kW light & fan load. The supply is to be given from a nearby 3ø, 4 wire distribution line which is 200 mt from factory. Prepare a list of material for erecting the line & for giving a connection to the factory. The line is to cross a 10 mt wide road. The connection to factory is to be given through underground cable.

Answer:-

Assuming the span to be 50 meters.



→ Length of the line = 200 mt

Span length = 50 mt

No of pole = $\frac{200}{50}$ = 4 nos (As there is existing line / Pole)

→ Load in the factory = 75 HP, Power factor = 0.8

Assuming line voltage = 400 V, Efficiency = 90%.

$$I_L = \frac{75 \times 746}{\sqrt{3} \times 400 \times 0.8 \times 0.9} = 112.16 \simeq 112 \text{ Amp.}$$

→ Light & fan load = 10 kW.

Assuming line voltage = 230 V

$$I_L = \frac{10 \times 10^3}{230} = 43.47 \text{ Amp} \simeq 44 \text{ Amp.}$$

→ As the light & fan load to be distributed along the 3 phases, the load current reduced to 44/3 ≈ 15 Amp

→ Hence total current to be drawn = 112 + 15 = 127 Amp

→ From the table 21.3, for overhead conductor ACSR weasel conductor of size 6/1 × 2.59 mm having current carrying capacity 150 Amp. is selected.

→ From the table 12.5, the weatherproof underground cable of size 50 mm² or 19/1.80 mm aluminium conductor; paper insulated, mass impregnated, lead covered 158 Amp rating, 1100 V grade is selected for underground connection from nearest pole to the energy meter.

→ Length of ACSR conductor of 6/1 × 2.59 mm = 3 × 200 + 2% sag
= 600 + 12 = 612 mt
= 0.612 km

Weight of 1 km ACSR conductor = 128 kg.

Total weight required = 0.612 × 128 = 78 kg.

→ Length of ACSR conductor of 6/1 × 2.11 mm for neutral wire = 1 × 200 + 2% sag
= 200 + 4 = 204 mt
= 0.204 kmt.

Total weight required = 0.204 × 85 ≈ 18 kg.

→ Length of 8 SWG GI for earth wire = 1 × 200 + 2% sag
= 204 mt ≈ 20 kg.

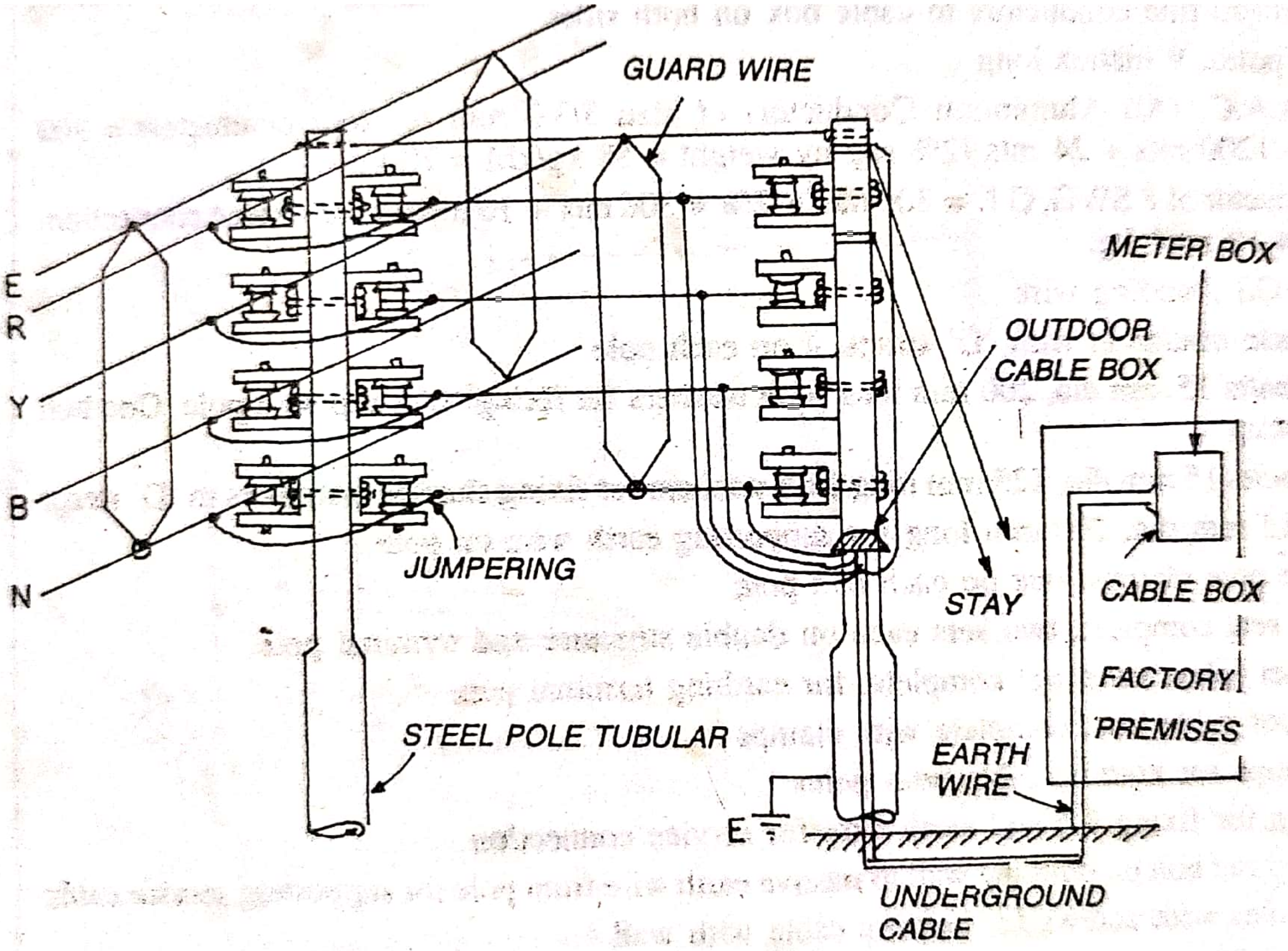
→ Length of underground cable of 50 mm²
~~[struck out]~~ From pole to ground ≈ 5 mt
Along the road = 10 mt
From ground to meter ≈ 5 mt

Total = 10 + 5 + 5 = 20 mt

Taking 10% wastage = 20 + 2 = 22 mt.

Material List.

Sl.No	Name	Specification	Quantity
1.	Rail poles	10 mt long	4 nos.
2.	Shackle Insulator @ 4/Pole	D - Strap	4x4 = 16 16 + 4 = 20 For existing Pole.
3.	Nut & Bolt for fixing insulator	15 mm dia. 200 mm long	20 nos.
4.	Eye bolt/Earth wire Clamp	15 mm dia 200 mm long	5 nos.
5.	Phase wire	6/1 x 2.59 mm.	78 kg.
6.	Neutral wire	6/1 x 2.11 mm	18 kg
7.	Earth wire	8 SWG GI	20 kg
8.	Underground cable	50 mm²	22 mt
9.	Binding wire @ 200gm	14 SWG	4 kg.
10.	Cable Clamp for holding cable with pole	–	4 to 5 nos.
11.	Cable box with fittings.	–	1 Nos.
12.	Guard wire	7/16 SWG	4 nos
13.	Reel Insulator	–	(Approx)
14.	Stay wire set complete	–	4 nos.
15.	Earthing set complete	–	5 nos.
16.	Labour charges		1 set.


GUARD WIRE
E
R
Y
B
N
METER BOX
OUTDOOR
CABLE BOX
JUMPERING
STAY
CABLE BOX
FACTORY
PREMISES
STEEL POLE TUBULAR
EARTH
WIRE
E
UNDERGROUND
CABLE

Service Connection :-

Q:- Prepare a list of material & estimate for providing service connection to a single storey building at 230 V, 1 ∅, 50 Hz having a light & fan. load of 5 KW. The supply is to be given from an overhead line 20 m away from that building.

Ans :-

Assumption :-

1. Height of ground floor = 3.5 mt
2. Service connection received at the height of 6 mt from floor.

Calculation of weatherproof conductor :-

→ Total connected load = 5 KW = 5000 watt

$$\text{Total current in Amp} = \frac{\text{Watt}}{\text{Volt}} = \frac{5000}{230} = 21.7 \text{ Amp}$$

→ taking diversity factor = 60 % (as all connected load is not used at a time)

→ $I_L = 21.7 \times 60\% \simeq 13$ Amp

→ Taking additional 100 % load as future extensions we have $I_L = 13 \times 2 = 26$ Amp (Approx)

→ From the table 12.4, it is suggested that a weatherproof cable of size 1/3.55 mm or 10 mm², twin core, PVC insulated, aluminium conductor to carry a load of 34 Amp is selected.

→ As bare conductor is used from supplier's pole to insulators on the building, it is suggested that a G.I. wire of 8 SWG may be used for bare conductor.

Calculation of 8 SWG GI wire:-

Length from house to pole = 20 mt × 3 wires → {Phase wire, Neutral wire, Earth wire}

= 60 mt

Taking wastage 10% = 60 + 6 = 66 mt.

Length of 10mm² weatherproof cable:-

From bare conductor to GI pipe mouth = 0.5 mt

Along the 50 mm GI pipe = 3 mt

From pipe to meter board = 1 mt + 1 mt.

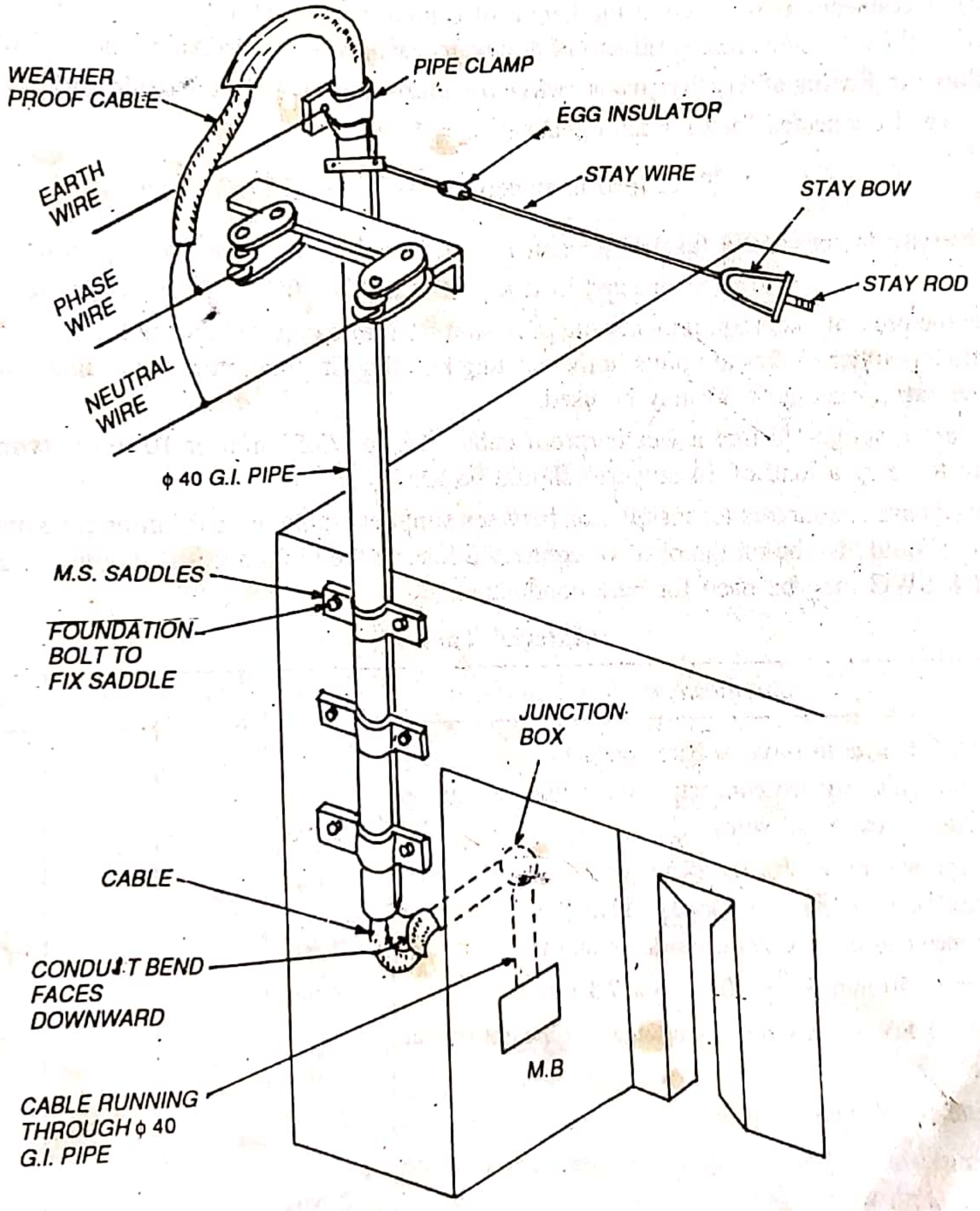
Total = 5.5 mt + 10% wastage

= 5.5 + 0.55 ≃ 6 mt.

Material list

Sl No.	Name	Specification	Quantity
1.	GI wire to serve as bare conductor	8 SWG	66 mt
2.	Weatherproof cable	1/3.55 mm or 10mm² PVC insulated, twin core, Aluminium Conductor	6 mt
3.	GI pipe	50 mm dia	3mt + 2mt = 5mt
4.	Earth wire running along G.I pipe upto meter board	8 SWG	6 mt
5.	Pipe ~~bends~~ bends	50mm dia	3 nos.
6.	Pipe Clamp to fix stay wire & earth wire	50mm dia	2 nos.

7.	GI pipe saddles	50mm dia	4 nos.
8.	Nut & Bolt to fix saddles on the wall	15mm dia 150 mm long	8 nos.
9.	L.T. shackle Insulator with 'U' clamp & fittings	–	4 nos. (2 at pole & 2 at service bracket)
10.	Angle iron service bracket to hold insulators	50 mm X 6 mm X 60 cm	2 nos.
11.	Iron clad meter board & fittings	25 cm X 30 cm	1 nos.
12.	Wooden bushing	50 mm dia	1 nos.
13.	Earthing thimble to hold earth wire with meter board	–	1 nos.
14.	Stay set		
	Stay bow	–	1 nos.
	Stay wire	7/10 SWG GI	8 mt (Approx)
	Stay rod with fittings	–	1 nos.
	Stay insulators	–	1 nos.
15.	Aluminium clip 75 mm long to hold earth wire with pipe	–	10 nos (Approx)


WEATHER PROOF CABLE
PIPE CLAMP
EGG INSULATOR
STAY WIRE
STAY BOW
STAY ROD
EARTH WIRE
PHASE WIRE
NEUTRAL WIRE
ϕ 40 G.I. PIPE
M.S. SADDLES
FOUNDATION BOLT TO FIX SADDLE
JUNCTION BOX
CABLE
CONDUIT BEND FACES DOWNWARD
CABLE RUNNING THROUGH ϕ 40 G.I. PIPE
M.B

Q1:- Prepare a list of material required for giving service connection to a double storeyed building having two energy meters. The supply is to be given at 230 V, 1Ø, 50 Hz having a load of 5 kW on each floor. The supply is to be given from overhead line 20 meters away from the building. Also draw the diagram.

Ans !-

Assumptions !-

1. Total height of ground floor = 3.5 mt
2. Total height of first floor = 7 mt.
3. Service connection received at a height of 6 mt from floor.
4. Height of ground floor meter board = 1.5 mt
5. Distance betn ground floor meter board to first floor meter board = 3.5 mt
6. Single phase supply is given to each floor.

Calculation of weatherproof conductor !-

→ Total connected load = 5 kW = 5000 W (as separate 1Ø connection to be given to each floor).

→ $I_L = \frac{5000}{230} = 21.7$ Amp

→ taking diversity factor = 60% (as all connected load is not used at a time)

→ $I_L = 21.7 \times 60\% \simeq 13$ Amp

→ Taking additional 100% load as future extensions.

we have $I_L = 13 \times 2 = 26$ Amp (Approx)

→ From the table 12.4, it is suggested that a weather-proof cable of size 1/3.55 mm or 10 mm^2, twin core, PVC insulated, aluminium conductor to carry a load of 34 Amp is selected.

→ As bare conductor is used from supplier's pole to insulators on the building, it is suggested that a ~~[illegible]~~ hard drawn bare copper conductor of size 3/1.62 mm to carry a load of 52 Amp is selected. from table 21.2.

→ 8 SWG wire may be used for earth wire.

<u>Calculation of bare conductor :-</u>

Length from house to pole = 20 mt × 2 wire → Phase, Neutral

= 40 mt

Taking wastage 10% = 40 + 4 = 44 mt = 0.044 km

Weight of conductor = 131.4 × 0.044

= 5.78 kg ≃ 6 kg.

<u>Length of 8 SWG GI wire :-</u>

Length from house to pole = 20 mt

From angle iron to meter on first floor = 1 mt + 1 mt + 0.5 mt

From angle iron to meter on ground floor = 1 mt + 3.5 mt + 0.5 mt

Total = 20 + 1 + 1 + 0.5 + 1 + 3.5 + 0.5 = 27.5 mt

Taking 10% wastage = 27.5 + 2.75 mt

= 30.25 mt

≃ 30 mt

Length of 10 mm^2 weatherproof cable :-

From insulator to wall = 1.0 mt + 1.0 mt (For both meters)

Wall to energy meter on first floor = 2 mt.

Wall to energy meter on ground floor = 1 + 3.5 + 1 mt

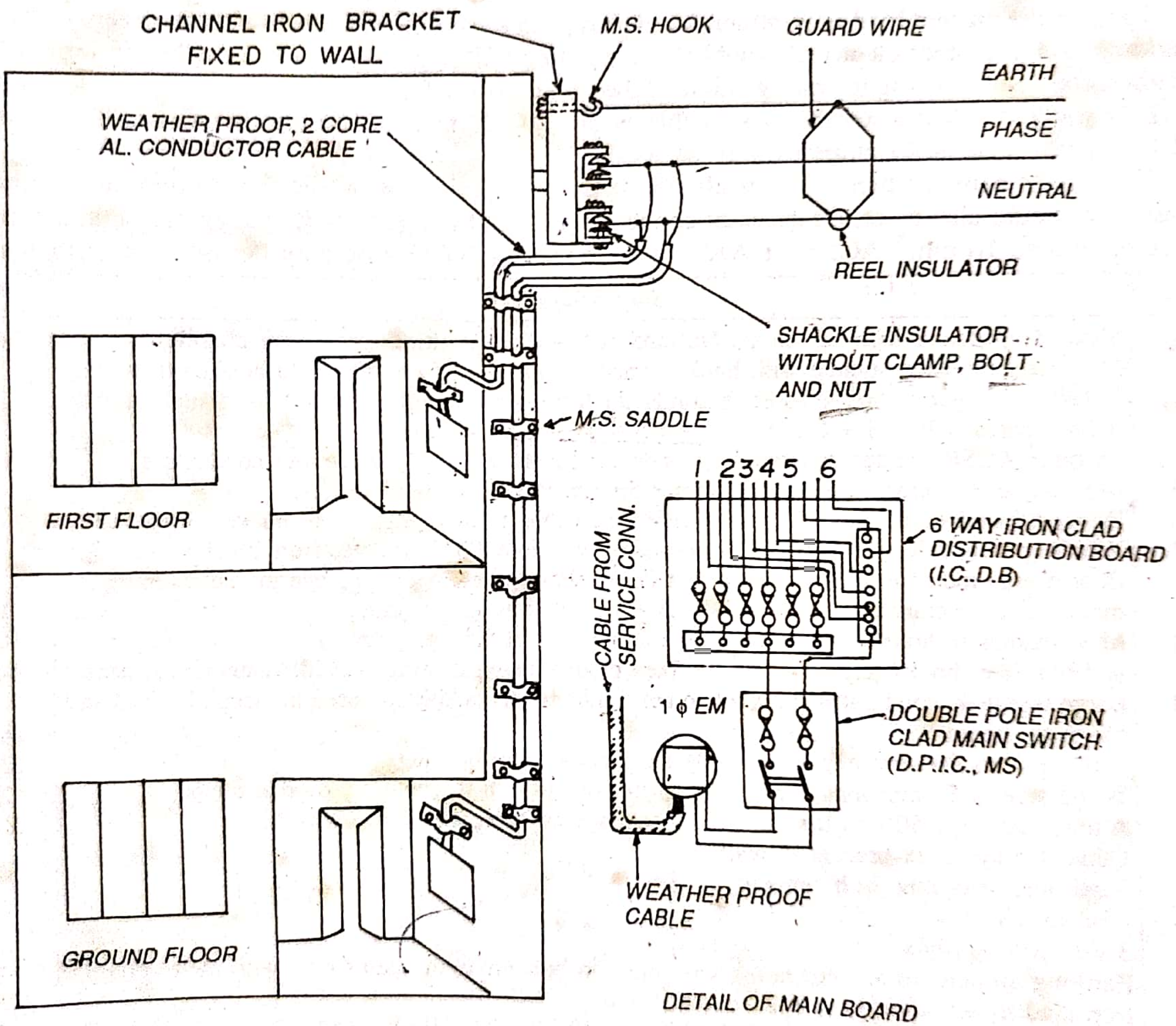
Total = 2 + 2 + 5.5 = 9.5 mt

Taking 10% wastage = 9.5 + 0.95 ≃ 10.5 mt

Material List :-

Sl. No.	Name	Specification	Quantity
1.	Shackle Insulator with Nut & Bolt & 'U' clamp	–	4 Nos (2 on each side)
2.	Mild steel spindle with hook to hold earth wire	15 mm dia 150 mm long	1 Nos
3.	Bare Conductor	3/1.62 mm hard drawn Copper	44 mt or 6 kg.
4.	Weatherproof Cable	1/3.55 mm or 10 mm^2 twin Core, PVC insulated Aluminium conductor	10.5 mt
5.	Earth Wire	8 SWG	30 mt.
6.	MS Angle Iron Bracket to hold insulator & earth clamp	50 mm × 50 mm × 1 mt	1 Nos.
7.	Hooked foundation bolt to hold the iron bracket on the wall	25 mm dia 300 mm long	1 Nos.

SL No	Name	Specification	Quantity
8.	MS saddle to hold weatherproof cable on the wall	-	14 nos (Approx)
9.	Wood screw to ~~hold~~ fix saddles	30 mm	30 Nos (Approx)
10.	Aluminium clips to hold earth wire	50 mm	20 nos. (Approx)
11.	Reel insulator	-	1 No.
12.	Iron clad meter board	25cm x 30 cm	2 Nos.
13.	Nut & Bolts to hold meter board with wall	10 mm dia 150 mm long.	8 nos.


CHANNEL IRON BRACKET FIXED TO WALL
M.S. HOOK
GUARD WIRE
EARTH
PHASE
NEUTRAL
WEATHER PROOF, 2 CORE AL. CONDUCTOR CABLE
REEL INSULATOR
SHACKLE INSULATOR WITHOUT CLAMP, BOLT AND NUT
M.S. SADDLE
FIRST FLOOR
1 2 3 4 5 6
6 WAY IRON CLAD DISTRIBUTION BOARD (I.C..D.B)
CABLE FROM SERVICE CONN.
1 φ EM
DOUBLE POLE IRON CLAD MAIN SWITCH (D.P.I.C., MS)
WEATHER PROOF CABLE
GROUND FLOOR
DETAIL OF MAIN BOARD

Q:- A 3 phase 4 wire underground service connection is to be given to a newly laboratory block of a Polytechnic from an existing 400/230 V, 3Ø, 4 wire, 50 Hz overhead line. The distance of the main board from service pole is 15 meters. Estimate the quantity of material. The total single phase and 3 phase load in laboratory is about 150 Amp.

Answer:-

→ Total load in building = 150 Amp
Diversity factor = 60%

→ Actual current = 150 × 0.6 = 90 Amp

→ For giving this underground service connection a weatherproof, mass impregnated, lead covered 1100 volt grade, 25 mm² or 7/2.24 mm, aluminium conductor having current carrying capacity of 107 Amp is selected from table 12.5.

Length of cable required:-

Along the pole upto ground = 6 mt.

Along the trench = 1.0 + 15 + 1.0 = 17 mt.

Vertical run along the wall upto cable box = 2 mt.

Total = 6 + 17 + 2 = 25 mt

Taking wastage 10% = 25 + 2.5
= 27.5 mt.

Material List

Sl.No.	Name	Specification	Quantity
1.	Underground Cable	25 mm^2, 1100 V, Al conductor, lead covered	27.5 mt.
2.	LT cable box (Outdoor type)	–	1 No.
3.	M.S. Channel to hold Cable box	76 mm x 38 mm x 1 mt	1 No.
4.	G.I. pipe (from cable box to trench)	–	6 mt
5.	Pipe Clamp to hold the cable	–	6 nos.
6.	G.I. earth wire	6 SWG	20 mt.
7.	G.I. bends	38 mm dia	2 nos.
8.	3/1.06 mm, PVC wire @ 5 mt. either end for connection	–	10 mt
9.	Iron Clad meter board	45 cm x 30 cm	1 Nos.
10.	Iron clad fuse unit	150 Amp.	Set of 3 fuse
11.	Nut & Bolt for fixing the DC board	15 mm dia 150 mm	4 nos.

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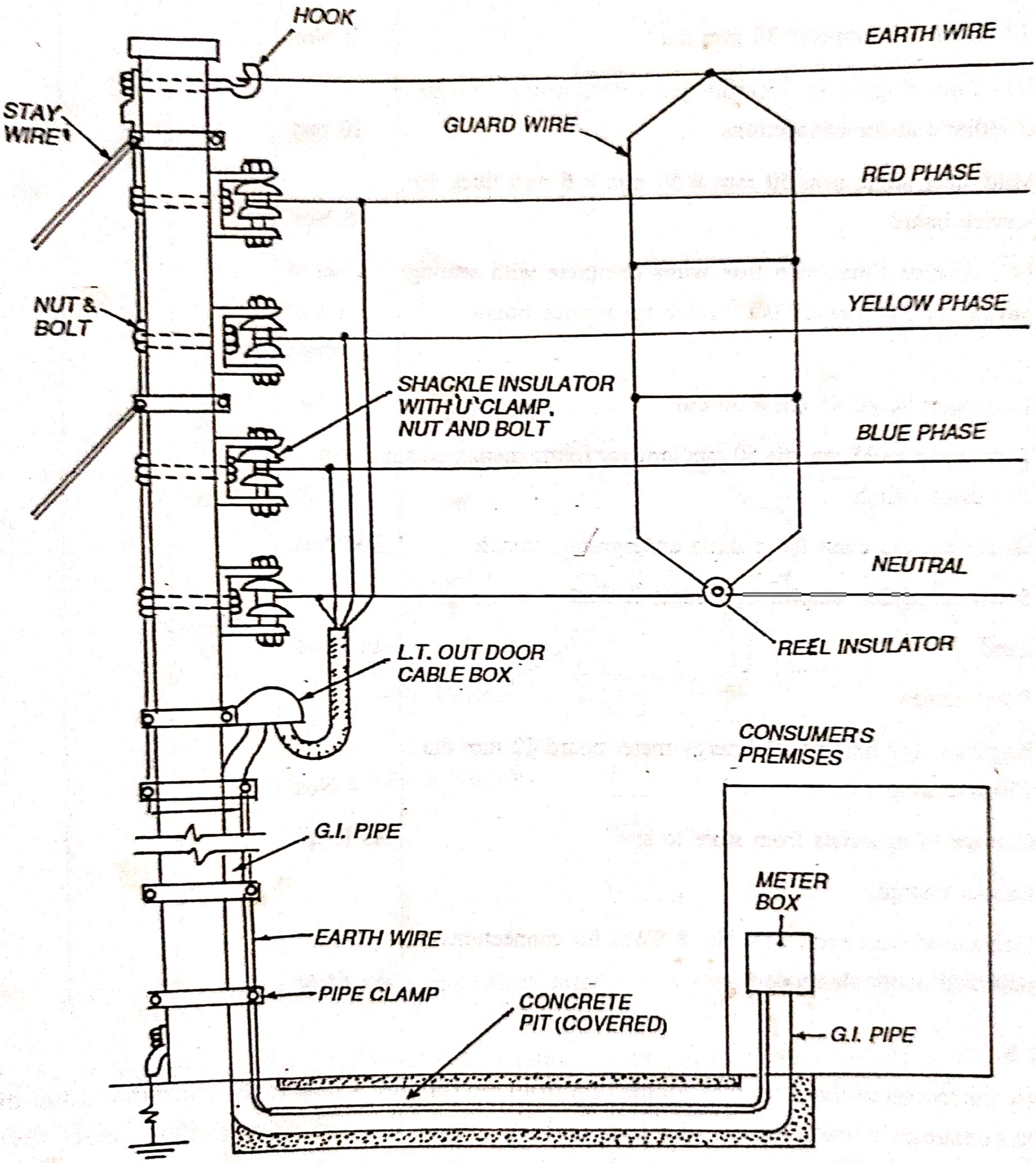
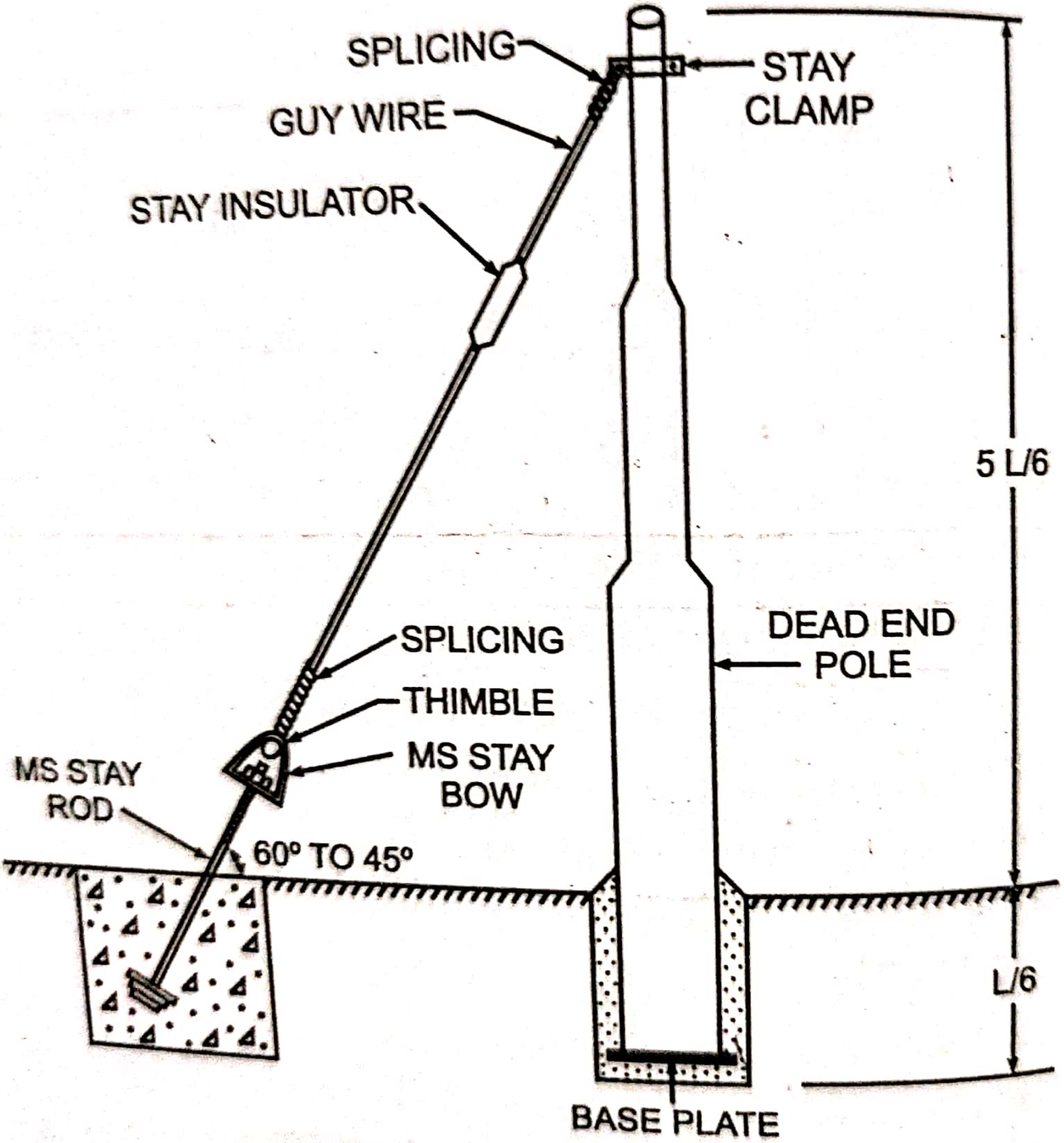

HOOK
EARTH WIRE
STAY WIRE
GUARD WIRE
RED PHASE
NUT & BOLT
YELLOW PHASE
SHACKLE INSULATOR WITH 'U' CLAMP, NUT AND BOLT
BLUE PHASE
NEUTRAL
REEL INSULATOR
L.T. OUT DOOR CABLE BOX
CONSUMER'S PREMISES
G.I. PIPE
METER BOX
EARTH WIRE
PIPE CLAMP
CONCRETE PIT (COVERED)
G.I. PIPE

Fig. 20.5

A pole for an overhead 11 kV, 3-phase, 50 Hz line is required to be earthed and a stay is to be provided. Make a neat sketch showing how it should be done. Prepare a list of materials required and estimate the cost. [*B.T.E. U.P Electrical Design, Drawing and Estimating-II 1997*]

S. No.	Description of Material With Complete Specifications	Quantity Required	
		Quantity	Unit
A	**EARTHING (Pipe Earthing)**		
1.	25 mm diameter GI pipe	2.5	m
2.	19 mm diameter GI pipe	1.5	do
3.	12 mm diameter GI pipe	4.0	do
4.	GI wire 6 SWG	12 (1.2)	do kg
5.	GI lugs	2	nos
6.	10 mm diameter, 32 mm long GI bolts and nuts	2	nos
7.	16 mm diameter, 40 mm long GI bolts, nuts and washers	2	do
8.	12 mm diameter GI bends	1	do
9.	30 cm square cast iron frame	1	no
10.	30 cm square cast iron cover	1	do
11.	Funnel with wire mesh	1	do
12.	Charcoal	10	kg
13.	Common salt	10	do
14.	Cement concrete 1 : 4 : 8	0.15	m^3
B.	**STAYING**		
1.	MS anchor plate 45 cm × 45 cm × 6.0 cm (not galvanised)	1	no
2.	MS stay rod 16 mm diameter and 2.42 m long	1	do
3.	Stay bow made of MS rod 12 mm diameter	1	do
4.	Stay insulator	1	do
5.	Stay wire (7/8 SWG GI wire)	7.5 (4.5)	m kg
6.	Stay clamp	1	no
7.	16 mm diameter, 76 mm long bolts and nuts for fixing	2	do
8.	MS thimbles	2	do
9.	Cement concrete 1 : 4 : 8	0.2	m^3


SPLICING
GUY WIRE
STAY INSULATOR
STAY
CLAMP
5 L/6
DEAD END
POLE
SPLICING
THIMBLE
MS STAY
BOW
MS STAY
ROD
60° TO 45°
L/6
BASE PLATE

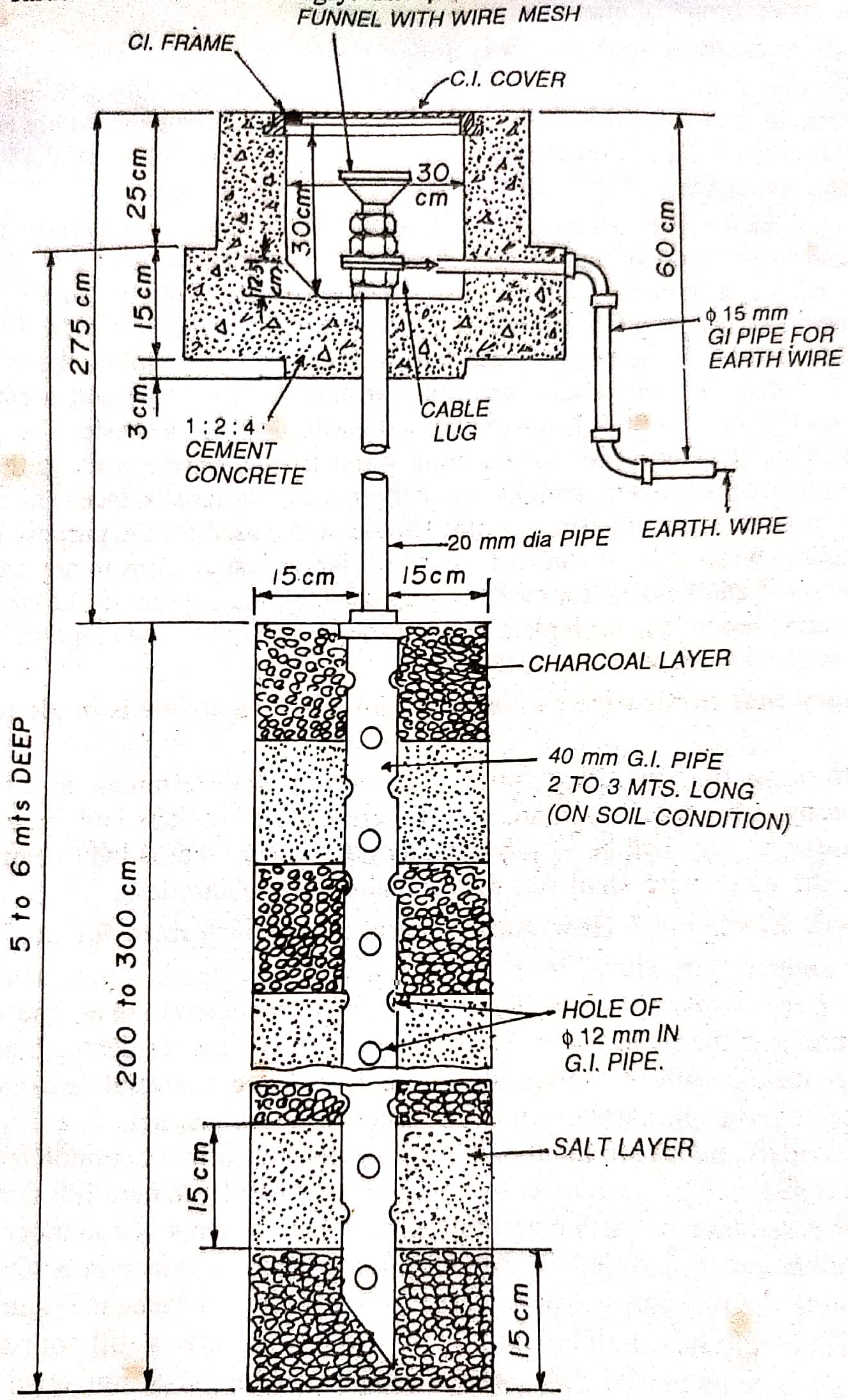
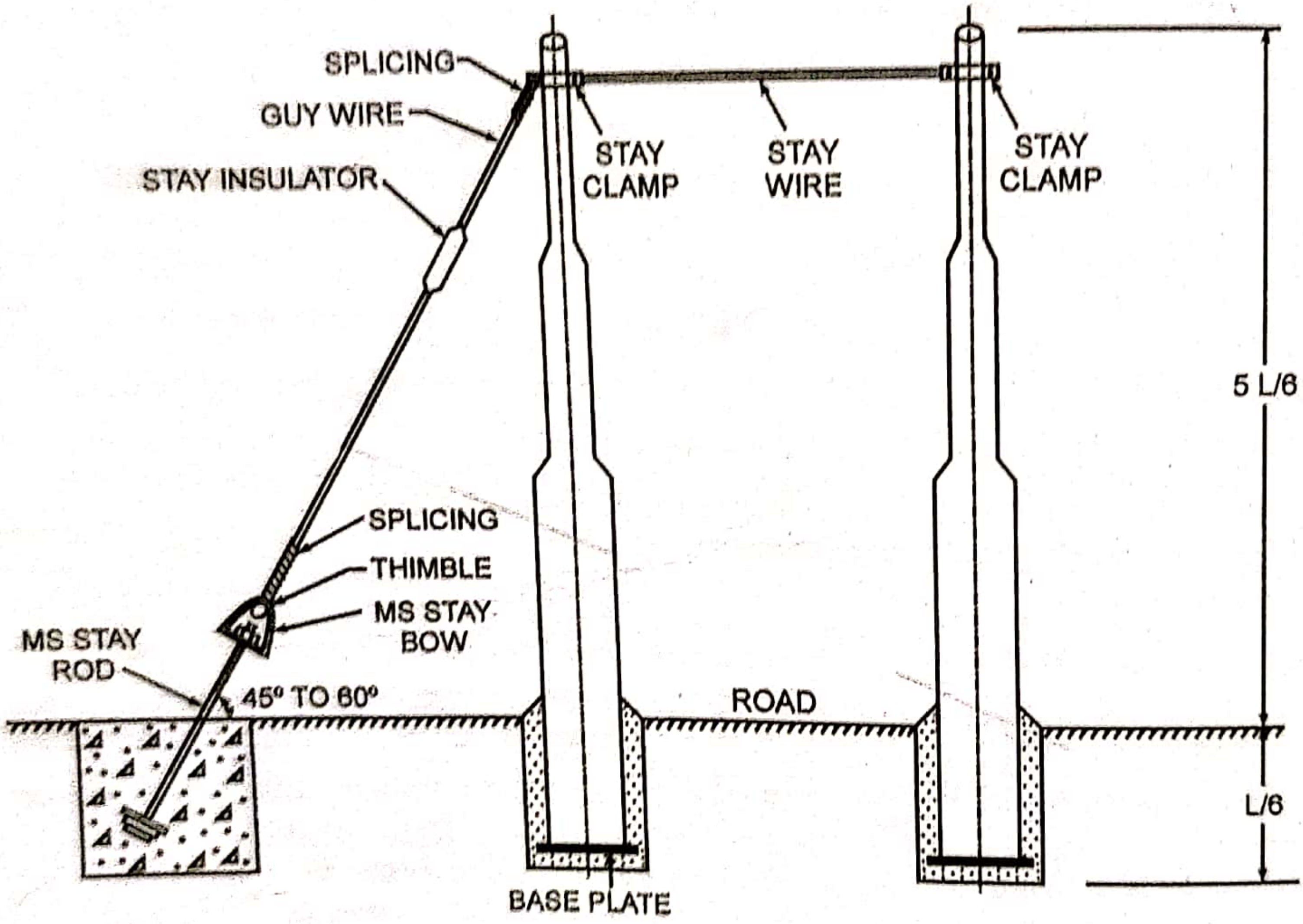


Fig. 14.2. Pipe Earthing

A pole for an 11 kV, 3-phase, 50 Hz overhead line is situated on the bank of the road where there is no front and back for fixing the stay in the ground. This pole is to be earthed and a stay is to be provided. Prepare a list of material required and also the total cost of erection.

S. No.	*Description of Material With Complete Specifications*	*Quantity Required*	
		Quantity	*Unit*
A	**EARTHING (Pipe Earthing)**		
1.	2.5 mm diameter GI pipe	3	m
2.	19 mm diameter GI pipe	2	do
3.	12 mm diameter GI pipe	4	do
4.	GI wire 6 SWG	13 (1.3)	do kg
5.	GI lugs	2	nos
6.	10 mm diameter, 32 mm long GI bolts and nuts	2	nos
7.	16 mm diameter 40 mm long GI bolts and nuts	2	do
8.	12 mm diameter GI bends	2	do
9.	30 cm square cast iron frame	1	do
10.	30 cm square cast iron cover	1	do
11.	Charcoal	10	kg
12.	Common salt	10	do
13.	Funnel with wire mesh	1	do
14.	Cement concrete 1 : 4 : 8	0.15	m^3
15.	Sundries to complete the job provision		


SPLICING
GUY WIRE
STAY INSULATOR
STAY CLAMP
STAY WIRE
STAY CLAMP
5 L/6
SPLICING
THIMBLE
MS STAY BOW
MS STAY ROD
45° TO 60°
ROAD
L/6
BASE PLATE

B STAYING (FLYING) OF 11 kV OVERHE

S. No.	*Description of Material With Complete Specifications*	*Quantity Required*	
		Quantity	*Unit*
1.	PCC poles 9 metre long	1	no
2.	MS anchor plate 45 cm × 45 cm × 6.0 cm (not galvanised)	1	do
3.	MS stay rod 16 mm diameter and 2.42 m long	1	do
4.	Stay bow made out of MS rod 13 mm diameter	1	do
5.	Stay insulator	1	do
6.	Stay wire (7/8 SWG GI wire)	17	kg
7.	Stay clamps	2	nos
8.	16 mm diameter, 76 mm long bolts and nuts	4	do
9.	MS thimbles	2	do
10.	Sundries to complete the job provision		