

ELECTRICAL INSTALLATION & ESTIMATING

(Diploma 6TH SEM)



Education for a World Stage

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R.C.B - Residual current circuit Breaker.
 F.L.C.B - Earth leakage circuit Breaker
 M.C.C.B - molded case circuit Breaker
 T.P.T.C - Tripple pole Iron clad
 D.P.T.C - Double pole Iron clad
 R.C.C - Reinforced cement concrete
 M.C.B - miniature circuit Breaker
 O.C.B - oil circuit Breaker
 A.C.S.R - Aluminium conductor steel reinforced.
 C.T.S - cap type sheathed
 T.R.S. - Tough rubber sheathed
 C.V.T - constant voltage transformer.
 C.F.L - Compact fluorescent lamp.
 B.I.S - Bureau of indian standard.
 B.O.T.U - Board of trade unit.
 D.B - Distribution box
 D.P - Double pole.
 D.P.D.T - Double pole double through
 D.P.S.T - Double pole single through
 H.P.M.V.L - High pressure mercury vapour lamp.
 H.R.C - High rupturing cartridge
 I.C.D.B - Iron clad ~~Double~~ pole distribution board
 I.C.T.P - Iron clad tripple pole
 L.A - Lightning arrester
 O.L.T.C - over load tripping coil.
 P.T.L.C - Paper insulated lead cover.
 S.D.B - sub-distribution Box
 S.M.S - sub-main ~~box~~ switch
 S.P.D.T - single pole double through
 S.V.L - Sodium vapour lamp.
 S.W.G - Standard wire gauge
 T.D.R - Time delay relay
 T.P.D.T - Tripple pole double through
 T.P.S.T - Tripple pole single through
 W.P.C - Wether Proof cable.
 P.C.C - pre sheath cement concrete
 T.P.M.O - Tripple pole mechanically operated switch
 R.E.C - Rural electrification corporation

M.C.B - Moulded case circuit breaker
T.P.N.M.C.B - Tripless pole with neutral miniature circuit breaker
E.C.C - Earth continuity conductor
R.S.J - Rolled steel joint
P.C.C - Plain cement concrete

Wire & Cables

Wire

→ A single conductor which may be bare or covered with insulation is known as a wire.

Cable

→ A several wire with insulation & standard together then is known as a cable.

→ The cable consists of 3 parts

(i) conductor or core

(ii) insulation

(iii) outer covering also known as protecting covering.

CHOICE OF CONDUCTOR.

The choice of conductor for a given application is done keeping in mind the following consideration.

(i) current carrying capacity.

The current carrying capacity of conductor size is the max^m current that it can carry without overloading and overheating.

(ii) Resistance & impedance.

The current size must have low resistance per unit length so that the losses are acceptable within the limits.

(iii) Mechanical strength

The conductor size used in cable must provide sufficient physical strength for insulation without stretching or bending.

(iv) Flexibility.

The conductor should be sufficient flexible to withstand the installation stresses without becoming brittle.

(v) Conductor configuration.

The conductor must have configuration that provides most efficient transmission of power.

Conductor Materials

→ The conducting material used for core of the conductor, generally the conducting material used for electrification purpose are copper and Aluminium.

→ Copper is used due to it's high mechanical strength, durable and ductile in nature. It can instant high temperature and dampness. It is again divided into annealed copper and harddrawn copper.

→ Generally Aluminium is used due to it's lite in weight and cheaper in cost as compare to other conducting materials.

Insulating Material

→ Various insulating material are used for safety purposes. These are as follows.

(i) Rubber

(ii) vulcanised indian rubber (V.I.R)

(iii) paper

(iv) poly vinyl chloride (P.V.C)

(v) cotton & silk insulation

(vi) Gutta percha

(vii) Varnish cambric

(viii) AF insulation.

These are the reported insulation used in various purpose.

Wiring systems

A network of wires connecting various accessories for distribution of electrical energy from supply energy meter to electrical consuming energy device such as fans, lights, and other appliances through controlling and safety devices is known as wiring system.

system of distribution

in distribution system

→ This system of wiring is generally adopted for consumers of domestic installation.

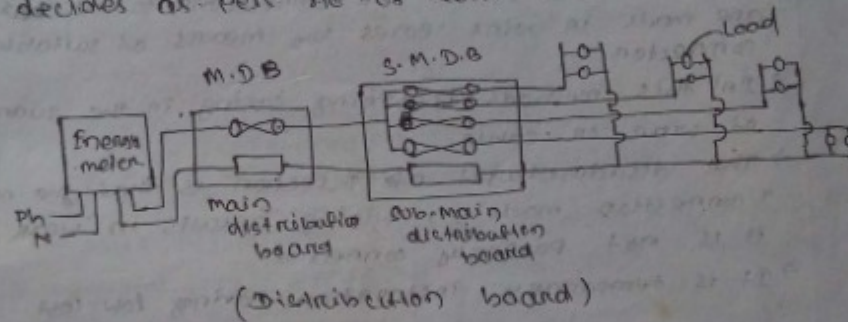
→ The future fuse of various sub-branches are

grouped together and placed together to near of main switch is known as distribution system. Inside the box of Ironsheet or hardwood a copper strip is known as busbar and neutral link is fixed.

→ For one circuit one phase wire is taken from the busbar through a fuse and neutral is taken from the neutral link.

→ The sub-distribution board are employed if the building is large and the no of load is more. To save cable and to prevent voltage drop.

→ The no of circuits and sub-circuits are decides as per no of load point to be wire.



Tree system of wiring (tree)

→ This is another system of distribution of electrical energy in building.

→ In this system smaller branches are taken from the main branch just like a tree. This system of wiring has following drawbacks.

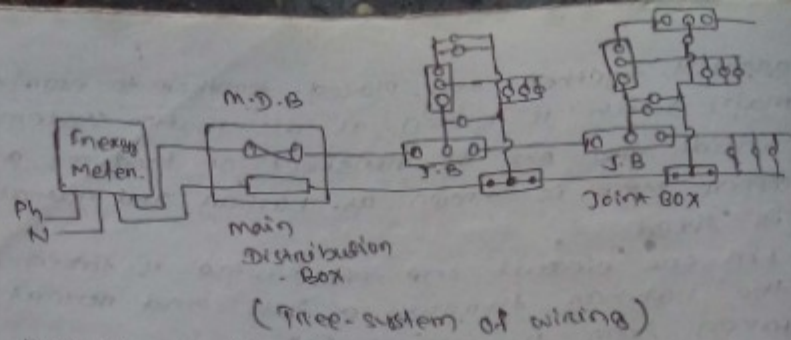
1) The voltage across all the lamps doesn't remain the same.

2) The load in the last branch will have less voltage across them.

3) A number of joints are involved in every circuit.

4) Fuses are scattered.

5) Fault repairing is not so easy.



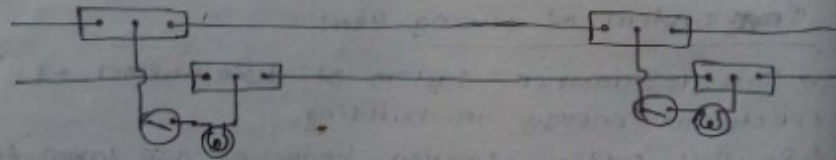
Methods of wiring

There are 2 methods of wiring, such as

- (i) joint box system (Tree system)
- (ii) Loop-in system

(i) joint box system

- In joint box system the connections to the loads are made in joint boxes by means of suitable connector.
- In this method of wiring saving in the quantity of wire or cable.
- The disadvantage of T-section is that the no. of T connection made in wiring results in weak, if it is not properly connected.
- It is temporary installation having low cost.



Loop-in system

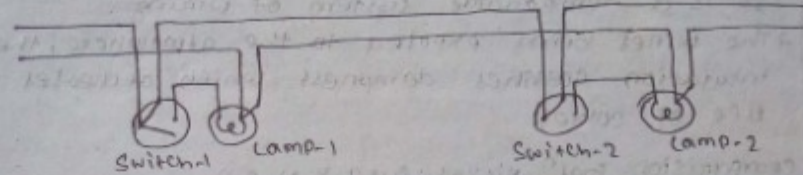
- This system of wiring is generally employed for connectors for appliances for parallel.
- In this wiring the phase or line conductor are looped either in switch board or box and output are looped either in switch board or from light or fan.
- The line or phase never be looped from light and fan.

Advantages

- joint boxes are not employed.
- The faults are easily inspected.

Disadvantages

→ The length of wire and cable is required more and voltage drop and power loss is more.



Types of internal wiring

There are following types of internal wiring, are used

(i) Cleat wiring

(ii) Casing capping wiring

(iii) CTS or TRS wiring

(iv) Lead sheathed or metal sheathed wiring

(v) Conduct wiring

(a) Surface conduct wiring

(b) concealed conduct wiring

(c) Fibre conduct wiring

Cleat wiring

In this system of internal wiring the cables are supported by porcelain cleat 10mm above the wall or ceiling.

→ The cleat are made of porcelain in 2 halves, the main part is base which is grooved to accommodate the cable and cap is put over it.

→ After placing cable the lower cleat and upper cover are screw on wooded plugged gutties, which is previously fixed into the wall or ceiling at a interval of 30cm to 60cm. apart.

→ The screw used are of size 38mm length.

→ Two wires shall not be placed in one groove of the cleat.

→ The cables which can be used in the system of wiring is VTR or PVC cables.

Advantages

→ It is cheapest form of internal wiring.

→ The installation and dismantling is easy and quick.

→ The inspection, alteration and addition is made easily.

Disadvantages.

- It's appearance is not good looking.
- It is a temporary system of wiring.
- The wires being exposed to the atmosphere, the insulation catches dampness which decreases the life of cable.

Q/ comparison betⁿ Kikkal fuse & M.C.B.

Fuse

- The fuse wire melts on excessive current flow.
- The fuse wire available at the time of rewiring may not be at standard rating.
- It melts on 50%-100% excessive overload.
- The fused fuse wire has to be located amongst other alive units.
- It cheapest source of protection so far as initial installation cost is concern.

M.C.B

- It operates to cut off the ckt even on small overload current flow.
- These are available in standard rating and we have to keep ready on demand.
- It operates on just 5%-15% excessive overload.
- The switching knob provides direct indication on faulty ckt.
- The initial cost is more but it is bearable keeping trouble free and self protection in view.

Wooden casing capping wiring.

- In this system of wiring the cables are either VSR or P.V.C. or any other insulated cable.
- The casing consist of 'W' set grooves and it is covered with the top by means of rectangular strip of wood is known as capping of same width as casing.
- The screw used to fix the capping with casing is of 13mm x 10mm wooden screw.
- The distance betⁿ the two screw is of 150mm.
- Two or three cables of same polarity run into one groove, no opposite polarity cable are run in same groove.

- The casing is usually placed 3.2mm apart from wall or ceiling by means of porcelain distance pieces of thickness not less than 6.5cm in order to keep the casing dry at the back.
- The wooden grid is on which the casing is screw by means of 32mm x 80mm wooden screws are fitted into wall or ceiling at interval not exceeding 90cm. for size of casing capping upto 64mm and not exceeding 60cm for size more than 64mm.

Advantages.

- It is cheap in cost as compare to conduit system of wiring.
- As the phase and neutrals are placed in separate groove the short circuit chance is min.
- It is easy to install and rewiring is economical.

Disadvantage.

- There is a risk of fire so it is not used where there is a risk of fire hazard.
- It can't be used in damp places.
- The casing is placed on wall which is not looking so good.

C.T.S. or T.R.S wiring or Batten type of wiring.

- It is suitable for low voltage installation in residential or in office building. The cables are covered on the seasoned teak wood batten which is borich coated and thickness is not less than 12mm.
- The battens are fixed on wall by means of wooden plug at a distance of 30cm to 60cm apart.
- The wires are used for batten wiring as C.T.S or T.R.S. type.
- The wires are placed on the batten by means of link clips which is already fixed on the batten with small nail.
- Width of the batten depends upon the no of conductor covered on it.

These are various batten sizes like 13mm x 13mm for two conductor and 11mm x 13mm for 3 conductors and so on.

→ The link clips are fixed at an interval of 10cm in case of horizontal run and 15cm in case of vertical run.

Advantages.

- It is easy to install and cheaper in cost.
- Its appearance is quite good.
- Fault location and fault removal is due to wires are visible.
- Its life is sufficiently long.

Disadvantages.

- It is not suitable for damp walls where the wiring is exposed to sun and rain.
- There is a risk of fire as the wooden batten ~~make a fire~~ may catch fire easily.

Application.

- It is generally used in domestic, commercial or industrial wiring except workshop wiring.
- It is used for low voltage installation.

Lead sheathed or metal sheathed wiring.

- In this system of wiring the cables used are insulated wires of TCS or PVC with an outer covering of ^{water} lead aluminium alloy.
- The thickness of lead sheath is 1mm - 1.5mm.
- It provides against protection of mechanical injury dampness and atmospheric corrosion.
- The clips are placed on the teeth ~~of~~ wood batten same as that of batten wiring.
- The outer sheath of the lead is connected with earth wire to prevent the lead sheath becoming electrically live.
- The earth wire made to run by side to side along with cable.

Advantages

- It can be used in places expose to sun and rain and damp places.
- It's life is long if proper earth continuity is maintain throughout.
- It provides protection against mechanical injury better than that TRS wiring.

Disadvantages

- It is costlier than TRS wiring.
- It is not suitable for places where chemical corrosion may occur.
- If proper earthing is not done, the insulation is damaged and the metal sheath get alive and give electric shock.

Application

- It is used in places expose to the sun and rain provided no joints is exposed. It also used in damp places.

Conduit wiring

- In the system of wiring the wires are placed inside the stl or PVC pipe known as conduit.
- The conduit wiring are 3 types.
 - (i) Surface conduit.
 - (ii) Flexible conduit.
 - (iii) Rigid conduit.

Surface conduit wiring.

- In this system of wiring conduit is placed on the surface of the wall by means of conduit saddles.
- This system of wiring is applied in industrial wiring. This system of wiring is not use normally in domestic wiring because it spoils the beauty of house.
- The minimum size of conduit is 12.7 mm which is not normally used.
- The 15mm, 20mm and 25mm are commonly used in house wiring and where as 30mm and above are used for power wiring.

conduit wiring

- In this case the conduit is placed inside the wall or ceiling in plaster at the time of construction of house.
- PVC cables are drawn into the conduit.
- The conduit should be electrically and mechanically continuous and connected to earth properly.
- The conduit should not be heavy gauge to avoid extra cost.
- Galvanised iron pipe is used in industrial electrification for power ckt. where as ordinary conduit pipe of size gauge and black enamel where as ordinary conduit pipe is preferred for conduit system of house wiring.

Flexible conduit

- The flexible conduit or pipe which can be bent or twist without change its size and diameter.
- It is used where the straight run of rigid conduit is not possible.
- The purpose of flexible conduit to provide mechanical protection to cable between rigid conduit and machines or other object.
- The flexible conduit used for connecting rigid conduit with machine terminals in case of motor wiring, in case of motor wiring energy meter, in case of ~~motor~~ main switch industrial and domestic wiring.

Advantages.

- It provides complete protection against fire and mechanical wiring.
- Longer life.

Disadvantages.

- It is costlier system of wiring.
- Highly skilled workmen is required.
- Replacement of defective wire is difficult.

Application

- It is mostly used in varnish and plant factory.
- It is also suitable for damp situation and also suitable for workshop and industrial wiring.

Conductor size calculation

See 1st page.

* Specification of cable.

A cable having 3 strands and each strand of diameter 0.736 mm can be termed as 3/0.736 mm. The numerator indicates the no. of strands in cable and denominator indicates diameter of each strand.

* Minimum size of conductor.

- The minimum size of copper conductor for household is 1 mm^2 or $1/1.12 \text{ mm}$, & aluminium conductor for household is 1.5 mm^2 or $1/1.40 \text{ mm}$ diameter.
- The minimum size of ^{copper} conductor for power wiring is 4 mm^2 or $1/22 \text{ mm}$ may be used.

* Voltage drop

- Before deciding the proper size of cable to be used in a circuit, the consideration must be given to the voltage drop.

$$\begin{aligned} \text{Voltage drop (domestic)} &= \left[\frac{\text{declared voltage} \times 2}{100} \right] + 1 \\ &= 2\% \text{ of declared voltage} + 1 \end{aligned}$$

- voltage drop for (industrial) drop

$$= \left[\frac{\text{declared voltage} \times 5}{100} \right]$$

$$= 5\% \text{ of declared voltage}$$

Ex:- calculate the size of the wire for a ^{sub} short-circuit consist of 10 light points on 800-watt. The supply voltage is $230 \text{ V}, 50 \text{ Hz}$.

Ans:- declared voltage = 230 V .

Power = 800 W .

assume $\cos \theta = 1$

$$I = \frac{P}{V \cos \theta} = \frac{800}{230 \times 1} = 3.47 \text{ A}$$

$$\text{Voltage drop} = \frac{\text{declared voltage} \times 2}{100} + 1 = \frac{230 \times 2}{100} + 1 = 5.6 \text{ volt.}$$

From the conductor chart for the current 3.47 A we may select 1 mm^2 or $1/1.12 \text{ mm}$ dia pre insulated single-core cable & of a current up to 5 A.

A small house is to be provided with single phase connection. The total length of wire from main switch onward to electrical points is 40 meters (both phase & neutral). If the load in the house is only 5 A, determine the size of the conductor to be installed to the energy meter and main switch. The declared supply voltage taken at the main switch is 200 V.

also decide the size of the conductor bet nearest pole & energy meter. The energy meter is at a distance of 15 meter.

Ans

The permissible voltage drop = declared voltage $\pm 1\%$

$$= \frac{2}{100} \times 200 \pm 1 = 5 \text{ V}$$

Referring to the conductor table the minimum size of aluminium conductor is 1.5 mm^2 or $1/1.40 \text{ mm}$ dia having carrying capacity of 10 A used for installation of energy meter & main switch. Let us calculate

for energy table it is given that there will be 1 V drop after every 2.3 meter for 10 A load.

$$\text{Voltage drop at } 10 \text{ A} = \frac{40}{2.3}$$

$$\text{Voltage drop at } 1 \text{ A} = \frac{40}{2.3} \times \frac{1}{10}$$

$$\text{Voltage drop at } 5 \text{ A} = \frac{40}{2.3} \times \frac{5}{10} = 8.69 \text{ V}$$

this size is not suitable as it is more voltage drop than the permissible value.

Now consulting the next table let's take next higher size of the conductor is 2.5 mm^2 or $1/1.50 \text{ mm}$ dia aluminium conductor. This wire has carrying capacity of 15 A and voltage of 2.5 m for 1 V drop.

$$\text{Voltage drop at } 5 \text{ A} = \frac{40}{2.5} \times \frac{5}{15} = \frac{\text{Given dist}}{\text{Chart dist}} \times \frac{\text{Given current}}{\text{Chart current}}$$

$$= 5.33 \text{ V.}$$

The voltage drop is still higher than the permissible voltage drop therefore next higher size of mm² or 1/2.24 mm should be used betⁿ energy meter & main switch.

- For cable to be installed betⁿ nearest pole & energy meter. The total length of cable to be used equal to 40m + 30m = 70m
- 30m for (both phase & neutral)

Referent to the same table if a cable size 6mm² or 1/2.80mm is used then voltage drop ~~will~~ be 27V

$$\text{Char'd current} = \frac{70}{3.4}$$

$$\text{v. drop} \cdot 5A = \frac{70}{3.4} \times \frac{5}{27} = 3.81 \text{ V}$$

General Guideline

General Guideline for internal wiring

- The General rules, which are to be kept in mind in executing the internal wiring are as under
- (i) The place selected for installation of energy meter should be easily accessible to meter reader to maintain favour of household people as the meter reader will visit every month for reading.
 - (ii) Energy meter, main switch and main distribution board close to each other.
 - (iii) Whether proof cable is selected for service connection.
 - (iv) The wires for wiring connection to main switch and distribution board should be of required rating based on total load requirement in building because these wires are to be withstand the entire load in the building.
 - (v) The conductor is used beyond distribution board in whole in the building of the same size i.e. 1.5mm² aluminium conductor or 1mm² for copper conductor.
 - (vi) C.T.s ~~are~~ ^{wire are} or T.R.s ~~are~~ ^{wire} used for battery system of wiring.
 - (vii) P.V.C. insulated wire are used for conduit wiring.
 - (viii) The height of the switchboard is 1.5 meter from the floor.
 - (ix) The height of main switch is 2m or approximately 0.25m above the switch board.
 - (x) The socket outlets in the house wiring should be installed from the switchboard along with other switches.
 - (xi) The socket outlets in office building is 0.25m above the floor.
 - (xii) The earth terminal of an 3 pin plug and socket outlets are connected permanently to earth wire.
 - (xiii) In bathroom the height of the socket outlet should not be less than 1.5 meter in any case.
 - (xiv) The ceiling fans are to be hung 2.75 meter from the floor.

(xv) The light wiring for one sub-ckt is 10. ~~to 1000 watt~~ 1000 watt or 800 watt.

(xvi) For power wiring there are two points - 3000 watt for one sub-ckt.

(xvii) 14 SWG G.T. wire is used as earthwire for house wiring beyond main switch.

(xviii) 8 SWG G.T. wire are used beyond main switch upto earth electrode buried deep in earth.

(xix) Use G.T. or copper thimbles are to be made where earth wire connection is to be made with main switch distribution board etc.

(xix) The height of the ceiling for normal residential ~~build~~ building may be taken as 3.5 meter and for large halls may be taken as 4m.

(xx) The height of batten running below the ceiling is 0.5 meter or 3 meter above the ~~floor~~ floor.

(xi) If the height of the ceiling is assumed to be 3 meter then the height of the horizontal run is 3 meter from floor or 4 meter from the ceiling.

Sequence to be followed:-

(i) Drawing installation plan

(ii) Symbol used

(iii) Assumption

(iv) Calculation of load in Amp

(v) Selection and rating of main switch

(vi) Selection & rating of main distribution board.

(vii) Calculation of batten or conduit pipe.

(viii) Calculation of length of phase and neutral wire.

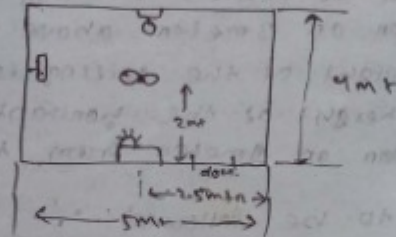
(ix) Calculation of length of earthwire.

(x) Preparing material list.

Batten on CTS/TRS wiring:-

Q/ The plan of a single room of size 5m x 4m is given below. The room is required to be provided with 1 lamp, 1 fan, 1 fluorescent tube and 1 5 Amp socket outlet. Each of the point is controlled by its individual switch. mark the location of the electrical point and draw the installation plan. also draw the wiring diagram, calculate the total length of the wire and other materials used and prepare complete material list. assume the supply is taken from Neighbour house, not assume batten system of wiring.

Ans:-



Symbol used:-

(i) main switch = HL

(ii) switch board
v/o switch =

(iii) fan =

(iv) Bulb =

(v) 3 pin plug socket =

(vi) F.L. Tube =

(vii) phase wire =

(viii) Neutral wire =

(ix) Earth wire = on

(x) Regulator :-

(xi) ~~single~~ single way switch =

assumption

→ The height of the room = 3.5 meter

→ height of main switch = 2 meter.

→ height of horizontal run = 3 meter. from door 0.5 meter

→ height of switch board from door = 1.5 meter

- Location of main switch from the adjacent wall = 0.5m
- Light & tube point from the ceiling = 1m from ceiling or 2.5m from floor

Assumption of Load

- ① fan = 60 watt
- ② lamp = 100 watt
- ③ fluorescent tube = 40 watt
- ④ three pin plug socket (5A) = 100 watt
- ⑤ Declared voltage = 230V.

Load current calculation for determination of conductor

Room Size	Name of Load	No. of Load	Rating	Total wattage.
(5x4)m ²	Fan	1	60W	60
	Lamp	1	100	100
	F.L. Tube	1	40	40
	3 pin plug socket	1	100	100
				300 watt

Total point & wattage = 4 points

From the above calculation of the load there are 4 points and 300 watt. According to I.E. rule there is a provision for 1 ckt is 10 points and 300 watt. In this case we use 1 ckt because the point and load wattage is in permissible limit. Hence there is no use of distribution box.

Selection of conductor size.

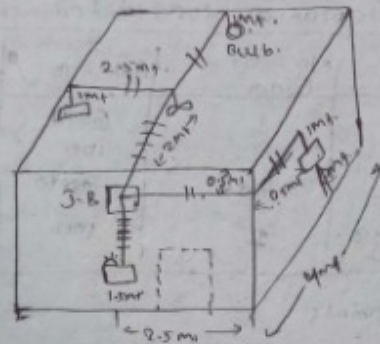
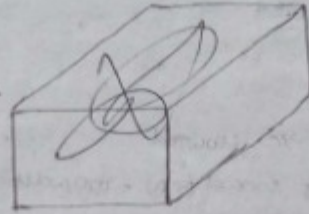
declared voltage = 230V,
total wattage = 300 watt
P.F. = 1 (assumed)

$$P = VI \cos \phi$$

$$I = \frac{P}{V \cos \phi} = \frac{300}{230} = 1.304 \text{ A}$$

We know that the value of short ckt current is 1.5 times of the full load current, so $I = 1.5 \times 1.304 = 1.95 \approx 2 \text{ A}$ referring to the conductor that for this current we may use 1 mm² or 1/1.12 mm dia pre insulated copper conductor single core cable.

Calculation the length of batten



MS $\rightarrow$ S.B. $\rightarrow$ 2 wire (13x13 mm)

batten $\rightarrow$ 1 (0.5) wall circumference $\rightarrow 0.5 + 2.5 = 4.5$ mt

S.B. $\rightarrow$ S.B. $\rightarrow$ 5 wires (31x13 mm)

length $\rightarrow 1.5$ mt

S.B. $\rightarrow$ Fan $\rightarrow$ 4 wire (25x13 mm)

length $\rightarrow 0.5 + 2 = 2.5$ mt

Fan $\rightarrow$ F.L. Tube $\rightarrow$ 2 wire (13x13 mm)

length $\rightarrow 2.5 + 1 = 3.5$ mt

Fan $\rightarrow$ Bulb $\rightarrow$ 2 wire (13x13 mm)

length $\rightarrow 2 + 1 = 3$ mt

total length of 13x13 mm batten $= 4.5 + 3.5 + 3 = 11$ mt

along 10% excess towards cutting and wastage

$= 11 \text{ mt} + 10\% \text{ of } 11 \text{ mt} = 12.1 \approx 12$ mt

total length of 25x13 mm batten $= 2.5$ mt

along 10% excess towards cutting and wastage

$= 2.5 + 10\% \text{ of } 2.5 = 2.75 \approx 3$ mt

total length of 31x13 mm batten $= 1.5$ mt

along 10% excess $= 1.5 + 10\% \text{ of } 1.5 = 1.65 \approx 2$ mt

Size of batten	Total length of batten
$(13 \times 13) \text{ mm}$	12 m
$(25 \times 13) \text{ mm}$	3 m
$(31 \times 13) \text{ mm}$	2 m

Calculation of length of conductor for both phase & neutral.

In $13 \times 13 \text{ mm}$ batten 2 wires = $11 \times 2 = 22 \text{ m}$.

In $25 \times 13 \text{ mm}$ batten 4 wires = $2.5 \times 4 = 10 \text{ m}$.

In $31 \times 13 \text{ mm}$ batten 5 wires = $1 \times 5 = 5 \text{ m}$.

Total length of conductor = $22 + 10 + 5 = 37 \text{ m}$.

allow 15% toward cutting & wastage = $37 \times \frac{15}{100} = 5.55 \text{ m}$

The total length of phase & neutral wire is 42.55 m .

Calculation of gutties

The total length of batten including $(13 \times 13) \text{ mm}$, $(25 \times 13) \text{ mm}$ and $(31 \times 13) \text{ mm}$ is $11 + 2.5 + 1.5 = 15 \text{ m}$.

The distance betⁿ two adjacent gutties = 45 cm .

No. of gutties = $\frac{\text{Total length batten}}{\text{distance betⁿ two adjacent gutties}} = \frac{1500}{45} = 33.33$

allow 10% extra = $33.33 + 3.33 = 36.66 \approx 37 \text{ Nos.}$

Calculation of link clips

The distance between two link clips is 10 cm .

No. of link clips = $\frac{\text{Length of the batten}}{\text{distance betⁿ two link clips}}$
 $= \frac{1500}{10} = 150 \text{ Nos.}$

For 2 wire the size of link clips is $(1 \times 38) \text{ mm}$ used in $13 \times 13 \text{ mm}$ batten. The length of the $13 \times 13 \text{ mm}$ batten = 11 m

No. of link clips = $\frac{1100}{10} = 110 \text{ No. link clips}$

For four wire $2 \times 38 \text{ mm}$ size link clips is used of the length of 2.5 m of batten $(25 \times 13) \text{ mm}$.

No. of link clips of $(1 \times 38) \text{ mm} = \frac{2500}{10} = 250 \text{ No.}$

For five wires the batten size is $(31 \times 13) \text{ mm}$ and the link clips are used $(1 \times 38) \text{ mm}$ and $(1 \times 50) \text{ mm}$.

Thus the length of $(31 \times 13) \text{ mm}$ batten is 1.5 m

Therefore the No. of $(1 \times 38) \text{ mm}$ link clips = $\frac{150}{10} = 15 \text{ Nos.}$

The no of (1x50)mm link clips = $\frac{150}{10} = 15$ no

The total no of (1x36)mm link clips = $10 + 50 + 15 = 175$ no

Now 10% extra = $175 + 17.5 = 192.5 \approx 193$ Nos.

Total no of (1x50)mm link clips = 15 no

Now 10% extra = 15 H.S.

= $16.45 \approx 17$ Nos.

Size of link clips	No of link clips.
(1x36)mm	193
(1x50)mm	17

Calculation of ECC:-

According to rule, 14 SWG G.T. wire is used as earth continuity conductor. The length of the ECC is from main switch to switch board socket = $1 + 0.5$ (wall opening)

$+ 0.5 + 2.5 + 1.5 = 6$ mt

Now 15% extra = $6 + 0.9$

= $6.9 \approx 7$ mt.

Total length of ECC = 7 mt.

Material list

Sl. No	Description	Specification	Quantity	Unit
1	D.P.S.C. main switch	16A, 250V grade	1	No.
2	Phase and Neutral wire	1mm ² or 1/16" mm dia pvc insulated single core copper conductor	45.5	mt.
3	Earth continuity conductor	14 SWG G.T. wire	7	mt.
4	Batten	(13x13)mm.	2	mt
		(25x13)mm	3	mt
		(31x13)mm	2	mt
5	Link clips	(1x36)mm	193	No.
		(1x50)mm	17	No
6	Wooden Gutteral including batten, main switch, switch board, junction box tube light and bulb point, sealing cap	(38x36)mm at bigger end and (25x25)mm at smaller end with 6.5cm long.	37 + 18 = 55	No

7	Switch tumbler type	5A single pole switch	1	No
8	Plug socket	5A, 100Watt	1	No
9	Ceiling Rose	2 plates type	2	No
10	Teak wood round junction box	10 cm dia	1	No
11	Switch board	(25x13) cm.	1	No
12	Switch board	(10x10) cm	1	No
13	Angle holder		1	No
14	Wooden screw for gutter to fix with gutters	25 mm	55	No
15	Wooden screw for board	40 mm	18	No
16	Earthing thimble		1	Set
17	Fan regulator		1	Req.
18	Cement, sand and concrete		As per req.	

Workshop wiring

- The power circuits are required for heater, cooler, Refrigerator, Air conditioner and other similar loads.
- Power circuits are also required for motor, generator, ventilation equipment, machine tool and other large loads.

Important rules

- Looping of conductor from one motor terminal block to the next motor terminal block.
- All the equipment used is power wiring shall be of iron clad conductor.
- All conductors shall be completely enclosed, is mechanically strong metal plate.
- The armoured cable shall be used is underground power wiring.
- The single core wire used for power wiring to motor shall be enclosed in G.I. conduit of appropriate size.
- Wooden gutters or plug shall not be used for mounting of iron clad switch, control or distribution board.

... AFTER a page

Assumption

- height of the main board from the floor equal to 1.5 meter
- height of the horizontal run from the floor equal to 4.5 meter.
- depth of the trench is ~~0.25~~ 0.25 meter.
- height of the plinth from pumpset 0.25 meter.
- height of the plinth for induction motor equal to 0.5 meter.
- Distance of motor from two nearest wall equal to 1 meter.

Q. A small workshop of size $10m \times 6m \times 4m$ is under construction. It is required to provide with the following electrical power connection for motor. The electrical connection to motor are to be taken along walls.

- (i) 1 5 H.P. 3- ϕ motor for lathe machine.
- (ii) 1 3 H.P. 3- ϕ motor for small lathe machine.
- (iii) 1 2 H.P. 3- ϕ induction motor for an automatic tool manufacturing machine.

(iv) 1 drilling machine driven by a 0.5 H.P. 1- ϕ motor.

(v) 1 grinding machine driven by a 0.5 H.P. 1- ϕ motor.

(vi) prepare a complete estimation in the following sequence.

(i) draw installation plan.

(ii) showing the location of machine, main switch, power distribution board, motor control board etc.

(iii) show path of power wiring to each motor.

(iv) single line diagram starting from energy meter.

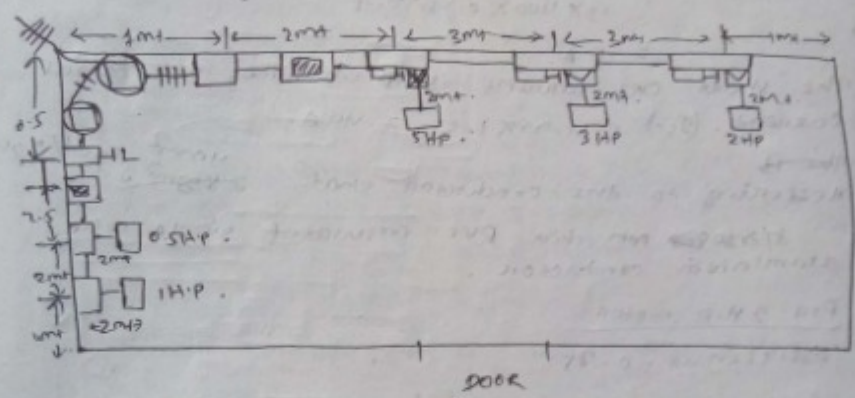
(v) draw wiring diagram of main board including earth wire connection, showing connection of 1- ϕ and 3- ϕ energy meter, main switch, distribution board.

(vi) selection of important material & calculate the length of wire, conduit, earth wire etc. prepare material table with full specification of each item.

Ans

Assumption

- height of the main switch, meter, control switch 1.5 m from floor.
- height of horizontal level from the floor 2.5 m.
- height of the length for 3-φ and 1-φ motor equal to 0.5 m.
- height of the drilling machine is 1.5 meter.



INSTALLATION PLAN

Calculation of load current and size of motor conductor for 5HP motor.

(i) line voltage = 400V
 efficiency of motor = 0.8
 P.F = 0.85
 load current (I_L) =
$$\frac{\text{rated H.P.} \times 735.5}{\text{efficiency} \times \sqrt{3} \times \text{line voltage} \times \text{P.F.}}$$

$$= \frac{735.5 \times 5}{0.8 \times \sqrt{3} \times 400 \times 0.85} = 7.8$$

The short-circuit current is 1.5 times that of normal current.
 $I_{SC} = 1.5 \times 7.8 = 11.7 \text{ Amp.}$
 reference to the conductor chart for the wiring the 6mm² or 1/2" aluminium single core cable is selected for 5HP motor.

For 3 H.P. motor:

Efficiency = 0.85

$$I_L = \frac{3 \times 735.5}{\sqrt{3} \times \text{line voltage} \times \text{P.F.} \times \text{efficiency}}$$
$$= \frac{3 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.85}$$
$$= 5 \text{ A.}$$

The short ckt current is 1.5 times of normal current. $I_{sc} = 4.99 \times 1.5 = 7.49 \text{ A.}$

Referring to the conduction chart $\frac{4 \text{ mm}^2}{2.5 \text{ mm}^2} \text{ or } 1/2.24 \text{ mm}^2$

~~1.5 mm~~ mm dia pvc insulated single core aluminium conductor.

For 2 H.P. motor

efficiency = 0.85

$$\text{load current } I_L = \frac{\text{rated 2 H.P.} \times 735.5}{\sqrt{3} \times \text{line voltage} \times \text{P.F.} \times \text{efficiency}}$$
$$= \frac{2 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.85} = 3.33 \text{ A}$$

$$I_{sc} = 1.5 \times 3.33 = 4.99 \text{ A}$$

Referring to the conduction chart the above current $\frac{4 \text{ mm}^2}{2.5 \text{ mm}^2}$ or $1/2.24 \text{ mm}^2$ mm dia pvc insulated single core aluminium cable one used.

For 1 H.P. motor.

selection the main switch and distribution board.

The total current in 3 motors is $7.49 + 5 + 3.33$

Assuming 50% overload on all motors. $= 16.15 \text{ A.}$

The total current $16.15 \times 1.5 = 24.18 \text{ A}$

Referring to the conduction chart for above current $\frac{16}{10} \text{ mm}^2$ for 1.7 mm pvc insulated aluminium single core cable is used for main switch & distribution box.

Important rules.

The rag bolt used for this purpose.

→ The length of flexible conduit for connection between for terminal box for motor & station shall not exceed 1.25m.

→ Surface conduit system of wiring is adopted for use of separate conduit for separate motor.

Efficiency of Motor (Assumption)

→ The motor below 1 BHP = 0.5 to 0.65

→ For betⁿ 1 BHP & 2 BHP = 0.7 to 0.75

→ For motor betⁿ 2.5 BHP & 5 BHP = 0.75 to 0.8

→ For large size of motor efficiency 0.9

Standard for motor.

→ The star-delta starter used upto & including 7.5 H.P motor.

→ The star-delta starter is also used for motor beyond 7.5 H.P upto 25 H.P motors.

→ Auto T/F starter is used above 25 H.P motor.

→ Below 5 H.P motor DOL starter is used.

* 1 B.H.P = 735.5 watt (metric)

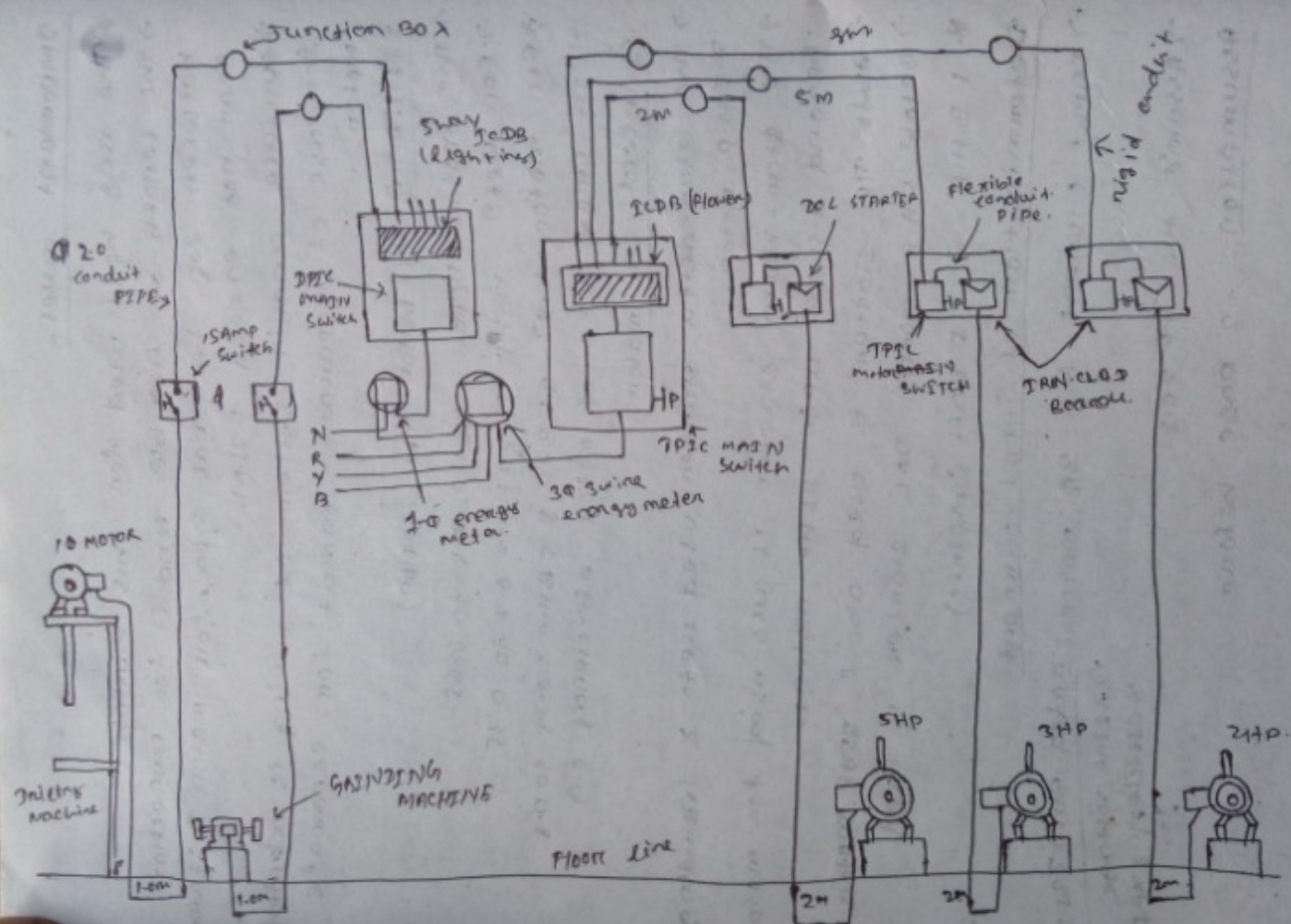
Determination of input current.

→ Input current for 3φ motor =
$$\frac{\text{rated BHP} \times 735.5}{\sqrt{3} \times \text{line voltage} \times \text{efficiency} \times \text{PF}}$$

→ Assume the PF = 0.8.

Assumption ... 2 page before

2



Selection the rating of TPSC main switch.

The max^m current demand for power load will be 24.18 A. It is therefore suggested that a TPSC main switch of 45A, 500V ^{grade} ~~grade~~ should be used as main switch.

Selection the rating of TPSC motor switch.

For 5H.P. motor a TPSC motor switch of 22Amp rating 500V grade should be selected. For 3H.P. and 2H.P. motor a TPSC motor switch of 16Amp rating 500V grade should be selected.

Calculation of heavy gauge conduit PPF of 25mm dia for 3-Ø motor.

For 5HP motor

For main distribution board to 5HP motor.

- 1/ M.d.b to horizontal run = 1mt
- 2/ along the horizontal run = 2mt.
- 3/ horizontal run to motor control board = 1mt.
- 4/ motor ^{standon} ~~control~~ board to floor level = 1.5mt.
- 5/ depth of trench = 0.25mt.
- 6/ along the trench = 2mt
- 7/ depth of trench = 0.25mt
- 8/ height of plinth = 0.5mt.
- 9/ total PIPE = 8.5mt.

~~For cutting and wastage for extra~~

From M.d.b to 3HP motor.

• Total PPF 2/ along the horizontal run = 5mt. (all are same as before)
So total PIPE = 8.5 + 3 = 11.5mt (1.5 + 1.5 + 0.25 + 0.25 + 0.5)

From M.d.b to 2HP motor.

2/ along the horizontal run = 8mt.
So total PIPE = 11.5 + 3 = 14.5mt. (1.5 + 1.5 + 0.25 + 2 + 0.25 + 0.5)
total length of conduit = 8.5 + 11.5 + 14.5 = 34.5
allow 10% extra for wastage = 34.5 + 10% of 34.5 = 38mt

Therefore total conduit PIPE is 38mt

Calculation the length of 15mm dia conduit
 From the motor control board to motor (earth wire)
 For same length of pipe for 3 motors = $9 \times 3 = 27 \text{ mtr}$
 allow 10% extra = $27 + 10\% = 29.7 \text{ mtr} \approx 30 \text{ mtr}$

Calculation the length of flexible conduit for 25mm dia flexible pipe.

From energy meter to main switch = 0.5 mtr
 From main switch to distribution box = 0.25 mtr
 From distribution box to conduit box = $0.25 \text{ mtr} \times 3 = 0.75 \text{ mtr}$
 Conduit mouth to motor switch = $0.25 \times 3 = 0.75 \text{ mtr}$
 Motor switch to starter = $0.5 \times 3 = 1.5 \text{ mtr}$
 Starter to conduit mouth = $0.25 \times 3 = 0.75 \text{ mtr}$
 Conduit mouth to motor terminal = $0.25 \times 3 = 0.75 \text{ mtr}$
 Total length of flexible conduit = $0.5 + 0.25 + 0.75 + 0.75 + 1.5 + 0.75 + 0.75 = 5.25 \text{ mtr}$
 allow 10% extra = $5.25 + 10\% = 5.75 \approx 6 \text{ mtr}$

Calculation the length of wire for 3HP motor
 length of conductor = length of rigid conduit + length of flexible conduit for 3HP
 $= 8.5 + 0.25 + 0.25 + 0.5 + 0.25 + 0.25$

length of 3 conductor = $10 \times 3 = 30 \text{ mtr}$
 allow 15% extra toward losses = $30 + 10\% = 35 \text{ mtr}$
 The length of 6mm² or 1/2.80 mm dia conductor for 5mm conductor is 35 mtr.
 for 3HP and 2HP motor.

length of wire = length of rigid conduit for 2HP and 3HP
 $+ 2 \times (0.25 + 0.25 + 0.5 + 0.25 + 0.25)$
 $= 11.5 + 14.5 + 3 = 29 \text{ mtr}$

length of 3 conductor = $29 \times 3 = 87 \text{ mtr}$
 allow 15% extra = $87 + 15\% = 100 \text{ mtr}$

The total length of 4mm² or 1/2.24 mm dia conductor for 3HP and 2HP motor is 100 mtr.

Calculation length of E.C.C. 8 SWG for 3 phase motor
 length of conductor = length of 15mm dia conduit = 27 mtr
 allow 15% extra = $27 + 15\% = 31.05 \approx 31 \text{ mtr}$

Total length
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It is then
 of 30 amp
 main switch.

selection of

16 amp 1-way
 control unit

Total length of E.C.C. of 8 SWG. = 31mtr.
calculation of load current and size of conductor for
1- ϕ motor

$$\text{Phase voltage} = 400/\sqrt{3} = 230 \text{ V}$$

$$\text{Efficiency of the motor } \eta = 0.85$$

$$\text{PF} = 0.85$$

$$\text{load current} = \frac{\text{rated BHP} \times 735.5}{\text{Voltage} \times \text{PF} \times \text{efficiency}}$$

$$= \frac{3.75}{0.85 \times 0.85}$$

The short cut current is 1.5 times of normal current.

$$= 1.5 \times 3.75 = 5.61$$

Referring to the conductor chart for the above current
rating 1.5mm or 11.40mm dia PVC insulated aluminium conductor may be
selected.

For M.P. motor:

$$\text{load current PF} = 0.85$$

$$\text{load current} = \frac{735.5 \times 1}{231 \times 0.7 \times 0.85} = 5.35$$

$$\text{short cut current} = 1.5 \times 5.35 = 8 \text{ Amp}$$

Referring to the conductor chart for the above current
rating 1.5mm² or 11.40mm dia PVC insulated aluminium conductor may be selected.

Selection the size of conductor for main switch & distribution

$$\text{The total current in two motor is } 3.75 + 5.35 = 9.1 \text{ A}$$

$$\text{allow 50% for overload current} = 9.1 + 4.5 = 13.63 \text{ A}$$

Referring to conductor chart for above current 2.5mm²
or 1/1.20 mm dia PVC insulated single core cable may be
selected.

Selection the rating of D.P.C. main switch.

$$\text{The max demand will be } 13.63 \text{ AMP}$$

It is therefore suggested that a DPCL main switch
of 20 AMP rating 250 volt grade should be used as 1- ϕ
main switch.

Selection of rating of motor control 1-way switch.

16 AMP 1-way switch with 16-AMP socket should be used as
control switch for 2 ϕ motor.

Calculation for length of heavy gauge conduit pipe
of 20mm dia for 1-φ motor.

for 0.5 HP motor

from M.D.B to 0.5 H.P. motor = 1 (D.B to H.R) + 2.5m
along the H.R + 1 (upto motor switch) + 1.5 (upto floor)
+ (depth of trench) 0.25 + 1m (along the trench) + 0.25
(depth of trench) + 0.5 (Plinth height) = 8mtr
for 1 HP motor

from M.D.B to 1 HP motor = 1 + 0.5 + 1 + 1.5 + 0.25 + 1 + 0.25
+ 1.5 (height of plinth) = 11mtr

total conduit = 11mtr + 8mtr = 19mtr

allow 10% extra = 19 + 10% = 21mtr

Therefore total length of 20mm dia conduit is 21mtr.

Calculation the length of 1.5mm² for both single
phase motor.

total length of conductor = 2X total length of conduit
for 1-φ motor.

$$= 2 \times 19 = 38 \text{ mtr.}$$

allow 15% extra towards wastage & cutting = 38 + 15% = 43.7

calculate the length of 8 SW.G. ^{earth} line for 1-φ motor

The total length of conductor = 2X total length of conductor
Pipe.

$$= 2 \times 19 = 38 \text{ mtr.}$$

$$\text{allow 15\% extra} = 38 \times 15\% = 43.7 \text{ mtr.}$$

Therefore total length of 8 SW.G. conductor is 43.7 -
actual of 20mm dia flexible conduit.

length of flexible conduit = 43.7 mtr.

conduit from D.B to 0.5 mtr.

distribution box to conduit mouth = 0.25 X 2 = 0.5 mtr.

conduit mouth to motor switch = 0.25 X 2 = 0.5 mtr.

motor switch to conduit mouth = 0.25 X 2 = 0.5 mtr.

conduit mouth to terminal box = 0.25 X 2 = 0.5 mtr.

terminal box to total length = 2.5 mtr.

allow 10% extra = 2.5 + 10% = 3 mtr.

Therefore total length of flexible conduit of 20mm dia
is 3 mtr.

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material analysis.

Sl. No	Description	Specification	Quantity	Unit
01	T.P.T.C main switch	45A, 500V grade	1	No
02	T.P.T.C motor switch	32A, 500V grade	1	No
03	T.P.T.C motor switch	16A, 500V grade	2	No
04	T.C.D.B (Power) for 3 motor	45A, 500V grade	1	No
05	Heavy gauge conduit approx size of 3-φ motor	25mm dia black enamel	38	mtr
06	conduit accessories for 25mm dia		12	No.
	conduit bends			
	conduit junction box		3	No
	conduit socket to connect 2 pieces conduit		10	No
	conduit saddle to hold conduit with wall		70	No
	G.S. conduit for earth wire (15mm dia)			
07	conduit accessories (15mm)		6	No
	conduit bends		3	No
	conduit socket		25	No
	conduit saddle			
09	flexible conduit for 3φ motor (25mm dia)		6	m
10	T.C.D.P for mounting main switch T.C.D.P power	45 x 60 cm ²	1	No
11	T.C.D.P for mounting motor switch & starter.	30 x 30 cm ²	3	No
12	PVC insulated Aluminium cond 7 core for wiring main board	7/1.70 mm dia on 16 mm ²	5	mtr
13	P.V.C. insulated 7-core aluminium cond for wiring 5hp motor	6mm ² on 1/2.80 mm dia	35	mtr
14	Same for 2hp & 3hp motor.	4mm ² on 1/2.24 mm dia	100	mtr
15	G.S. earth wire for both 1-φ & 3φ motor	8.5w.g. G.S	75	mtr
16	Double D.P.S.C. (lighting) main switch	30 amp	1	No
17	T.C.D.B. (lighting)	30 amp, 250V grade	1	No
18	2-way switch & socket for 3-φ motor	16 amp	2	sets
19	heavy gauge conduit for 2-φ motor	20mm dia black enamel	20	mtr
20	conduit accessories (20mm dia)		8	No
	conduit bends		3	No
	conduit junction box			

	conduit socket		5 Nos
	conduit saddle		25 Nos
21	Aluminium conduit for wiring the main board for 2.4 motor	25mm ² or 1/1.60 mm dia	2 mtr.
22	1 core wire for wiring 2.4 motor	1.5mm ² PVC insulated aluminium wire	45 mtr.
23	IRON clad board for mounting main switch	30cm x 45cm	1 No
24	J.C.D.P for motor switch & socket for 2.4 motor with bakelite sit.	15cm x 15cm	2 Nos
25	flexible conduit	20mm dia	3 mtr.
26	rack bolts with nut for fixing iron clad board with wall	12mm dia 150mm long	5 Nos
27	bolt with nut for main switch or 2.4 motor switch & standard	10mm dia 50mm long	40 Nos
28	G.I. thimble with nut & Bolt for connecting earth wires for main switch connecting standard.		40 Nos
29	Back bolt for fixing switch board		100 Nos
29	Plugs for welding conduit with wall		
30	fixing saddle with wall	25mm long	100 Nos
31	earthling set with some complete arrangement		2 sets
32	caution plate for 440v		1 No
33	specimen treatment chart		
34	cement concrete sand		

18-11-11

Service Connection

The overhead line or cable connecting the supply distributing to the consumer's premises is called service connection. The service connection terminates at the point, where the supply conductor entered the meter.

Meterboard or service board

The service line is provided with ~~even~~ with R.M.C.B. fuse before it enters to the energy meter, for protection of meter against extra high voltage on line surge. The board on which the cut-out, neutral link and the meter are fixed is called service board.

Service conductor

The service connection are given either by bare conductor from nearest pole to the consumer premises or by weather proof cable of aluminium or copper. The size of conductor depend upon the load of the consumer, and distance upto service pole. For voltage drop calculation to determine correct size of the service conductor.

Types of service connection

The service connection are of 2 types.

(i) overhead service connection

(ii) underground service connection

TABLE	Across	Along	Else where
Voltage	Across	Along	Else where
Low and medium voltage line	5.795 mt	5.49 mt	—
For high voltage line	6.1 mt	5.79 mt	—
For low, medium and high voltage upto and including 11 kV	—	—	4.575 mt if bare 3.965 mt if insulated
Above 11 kV	—	—	5.185 mt
For extra high voltage	—	—	5.185 mt plus 0.25 m for every 33 kV

Q1 Prepare a list of material for a service connection for a single of single storey building at 230V, 1- ϕ load of 5KW. This supply is to be taken from the nearest pole situated at 20m distance across from the building draw the service connection diagram and material selected for proper specification.

Ans:

Given data:

connected Load = 5KW

Supply voltage = 230V

distance = 20mtr

Location = Across the Road.

Assumption:

height of the building from the ground = 3.5mtr.

height of the overhead cable = 5.79 $\approx$ 5.8mtr

height of the energymeter = 2mtr from the floor.

As per the R.F.C. specification service support is G.I. PIPE of 20mm dia bend at the ~~rough~~ top

Calculation of Load current:

At

$I_{PB} =$

current calculation & selection of cable.

Voltage = 230V.

P.F = 1 (assumed)

P = 5KW.

$P = V I \cos \phi$

$$I = \frac{P}{V \cos \phi} = \frac{5 \times 10^3}{230 \times 1} = 21.74 \text{ A}$$

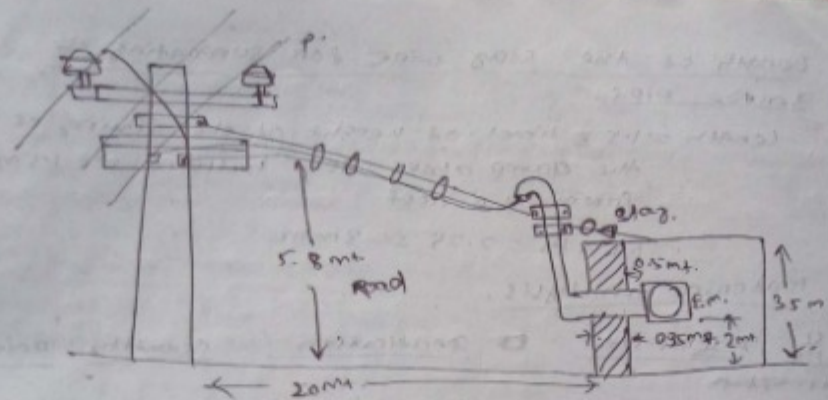
diversity factor = 60%. because all the electrical points installed in house are never used at one time

$$I = 21.74 \times \frac{60}{100} = 13.04 \text{ A}$$

To meet the present load requirement and provision for future requirement in event of expansion of building and any other electrical points in the existing building 50% of overload may be used. or the short-circuit current is 1.5 times of normal value

$$= 13.04 \times 1.5 = 19.56 \text{ A}$$

Referring to the conduction chart for above current rating 25mm² or 1/2 inch dia PVC insulated twin core aluminium cable is used.



Calculation the length of G.S. pipe of 20mm dia.

Service pipe length = min ground clearance + top clearance
and board + wall thickness - min height of meter board
from the floor

$$= 5.8 + 1 + 0.35 - 2 = 5.15 \text{ mtr.}$$

Calculation of length of support of G.S. B & S.W.G.

The length of 8 S.W.G. G.F. wire = span length + 24 sag
+ 1m at the pole + 1m at the pipe.

$$= 20 + 0.02 \times 20 + 1 + 1 = 22.4 \approx 23 \text{ mtr.}$$

Calculation the length of weather proof cable.

span length + 24 sag + service pipe line 1m
at the pole + 1m at the service pipe

$$= 20 + 0.04 + 5.15 \text{ mtr} + 0.5 + 1 + 1 = 28.05 \text{ mtr.}$$

Length of earth wire of 8 S.W.G. from the service
pipe to meter board = length of service pipe - top
clearance + meter clearance = $5.15 - 1 + 0.5 = 4.65 \text{ mtr.}$

$$\text{Extra 15\% extra} = 4.65 \times 0.15 = 0.6975 \text{ mtr.}$$

Calculation aluminium clips for binding service
cable with support wire.

length of each aluminium clip = 7.5 cm.
distance betn two clips = 20 cm.

therefore no of clips required = $\frac{\text{length of cable in cm}}{20}$

$$\text{span} = \frac{\text{span length } 20 + (0.02 \times 20)}{100 \times \frac{20}{20}} = \frac{20.4}{20} = 102 \text{ Nos}$$

The total length of aluminium wire required for
clip = $102 \times 7.5 = 765 \text{ cm} = 7.65 \text{ mtr.} \approx 8 \text{ mtr.}$

Length of the stay wire for supporting the service pipe.

Length = 1.5 times of height of the lining of the clamp above the building i.e. 1.5m from the roof.

$$= 1.5 \times 1.5 = 2.25 \approx 3 \text{ mtr.}$$

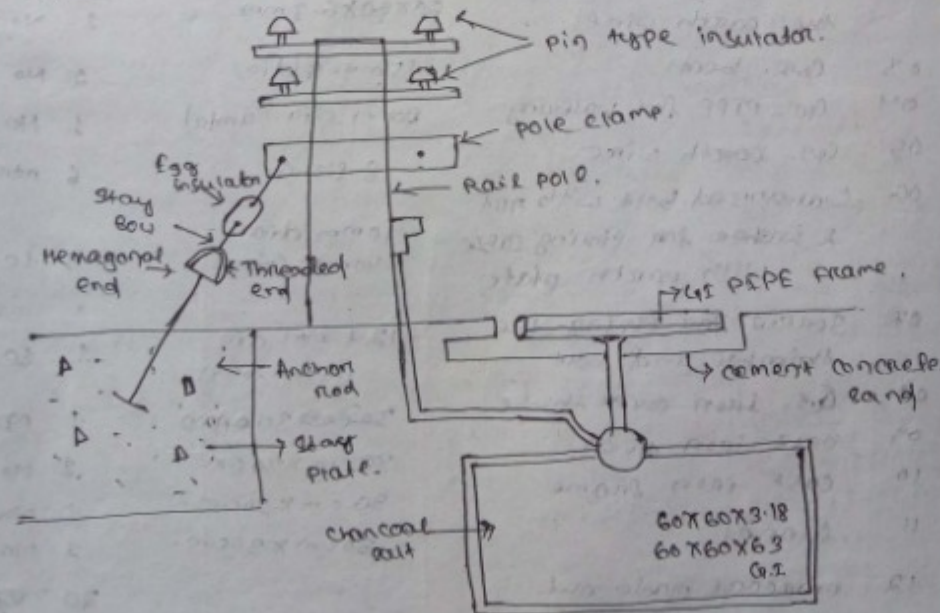
Material analysis.

SL No	Description	Specification	Quantity	Unit
<u>At the line support on pole end.</u>				
01	Clamp for beamed wire at the pole end		1	Set
02	Bolt with nut and washer for above clamp		2	Nos.
03	Lean wood board for kit kat pole	100x100cm	1	No
04	Kit Kat fuse Porcelain type	1KA, 250V	1	Set
05	Wooden screw for wing kit kat fuse	4mm dia x 25mm long	2	Nos.
<u>For span length.</u>				
01	G.I. beamed wire at service support	8 S.W.G.	23	mtr.
02	Weather proof cable (aluminum) cable	4mm ² or 1/2.25mm dia	28	mtr.
03	aluminium clips	7.5cm.	102	Nos.
<u>At the service support.</u>				
01	G.I. at service pipe	20mm dia 5.5m long	1	Set.
02	G.I.E.B. bow	20mm dia	2	Nos.
03	Pipe clamp to fix the stay wire & for lined the beamed wire		2	Nos.
04	G.I. pipe shackle	20mm dia	4	Nos.
05	Bolt to bolt the conduct shackle with wall	15mm dia 150mm long	8	Nos.
06	Stay 7/10 SWG	7/10 SWG	3	mtr.
07	Stay bow		1	Nos.
08	Stay nut both & stay wire & stay		1	Set

09	stay insulation		1 Nos.
10	earth wire	8SWG G.I.	5.5 mtr.
11	lock nut	20mm dia PIPE	1 Nos
12	Teakwood meterboard	350 x 200 c.m.	1 No
13	energymeter caposie of reading 999.9		1 No.
14	earthing thimble		1 No.
15	Nut bolt for fixing energymeter with main board	16mm dia 50mm long	4 Nos
16	concrete & cement		AS per req.

Stay arrangement

Q1. A pole of overhead high transmission of 11kV 3-Ø 50Hz, required to be an earth stay provided. make a neat sketch of the pole stay wire, stay plate and earthing and other component required. Prepare a complete list of material with proper specification.



SL No	NAME	SPECIFICATION	Quantity	Unit
<u>Material list of pole stay connection:-</u>				
01	Rail pole	Ø 25 mm	1	No
02	Anchor rod	16 mm Ø m.s rod 1600 mm long	1	No
03	Anchor plate	150 mm x 150 mm x 6 mm (thick)	1	No
04	5 bolt with hexagonal nut	20 mm Ø	1	No
05	Stay bow on turn buckle	Ø 6 mm Ø m.s. rod approximately 600 mm long	1	No
06	Stay insulator		1	No.
07	thimble		1	No.
08	Stay wire	7/8 SWG G.S.	8	Mtr.
09	Concrete for stay	1:2:4 (0.5 mtr ³)	As per req	

Material for pole earthing.

01	Earthing plate	60 x 60 x 3.18 mm	1	No.
02	G.I. PIPE for enclosing the earth wire	60 x 60 x 6.3 mm	1	No.
03	G.I. bolts	15 mm Ø (dia)	2	No
04	G.I. PIPE for watering	25 mm dia (umda)	1	No
05	G.I. earth wire	8 S.W.G.	6	mtr
06	Galvanised bolt with nut & washer for fixing cable with earth plate	10 mm dia 40 mm long	1	Set
07	Screw for fixing the thimble and bolt	12.7 mm dia (15 mm long)	1	Set
08	G.I. iron cover thimble	30 cm 30 cm Ø	1	No
09	cast iron cover	30 cm x 30 cm	1	No
10	cast iron frame	30 cm x 30 cm.	1	No
11	funnel	30 cm x 30 cm.	1	No
12	charcoal made out of wood		20	kg
13	common salt		15	kg
14	cement concrete	1:2:4	As per req.	

Overhead line

The following point should be taken into consideration while erecting overhead line

(i) The voltage at the tail end of the line should be within prescribed limit, which are

(a) $\pm 5\%$ of the declared L.T. voltage and

(b) $\pm 12.5\%$ of the declared of the H.T. and E.H.T. voltage

(ii) It should be mechanically strong enough to withstand stress during adverse weather condⁿ where ever required the stay wire should be provided at proper angle

(iii) continuous earthwire of proper size should be solidly earthed at the sub-station is to run or along the root of overhead line for reasons of safety the pole after every 5th span should be provided with earthwire connection. The joints of earthwire should be very carefully made so that the earth resistance is zero at every point.

(iv) All non-current metallic parts used in overhead line are to be solidly connected with earthwire since every 5th or 6th pole is independently earthed. The attachments of the pole should be solidly connected to pole.

(v) The clearance of the conductor from the ground and adjoining building should be in accordance with I.E. rule 77 and 79. (Before table)

(vi) Above $\frac{1}{16}$ th of the pole is to be buried in the ground. In the case of normal soil condition

(vii) ~~The cam of the beam~~ the depth of the pole in earth is subject to condition of soil in earth. i.e. if soil is hard the depth can be reduced.

(viii) For every overhead line of 6.6 kV and above anticlimbing device and danger plate should be provided.

iii) In the overhead line Poles above the road, Railway line, school, park, playground or the place for public utilities the guard wire should be provided as per specification let down for each of the above place.

(iv) At each Support the conductor should be bound with insulators with the help of binding wires so that the conductor with stand wind pressure.

(v) Jumper of proper size should be used.

(vi) The shackle or point should be provided after above 10 spans or as required for the purpose of Isolating the faulty Area.

(vii) The wooden poles are covered before installation by providing us metallic standing cap on the top of the pole to avoid snow or ice standing on the top of the pole in snow bound area.

(viii) The cost of overhead line should be as low as possible. for this purpose, the span of the line should be optimum.

(ix) The sagging between the conductor should be maintained as per table below.

SL No	Working voltage	spacing between conductor formation		Spacing below conductor and supporting structure formation.
		Vertical formation	Horizontal formation	
1	Low tension	3.8 cm.	4.6 cm.	15 cm.
2	6.6 KV or 11 KV.	76 cm.	1.14 m.	30.5 cm.
3	33 KV	1.22 m	1.53 m	61 cm.
4	66 KV.	1.26 m	3.23 m	76 cm.
5	110 KV.	3.13 m	4.96 m	1.07 m
6	132 KV.	3.66 m	4.87 m	1.30 m

(11) The structure of pole should be such that they must be mechanically strong with factor of safety to 2.5 to 3.

L.T. Distribution:-

prepare the material estimate the L.T. distribution system for a distance of 800mtr ~~km~~ in 3- ϕ , 5 wire system. The span length is 47mtr use A.A.C. for the distribution of total load for 75KW to 50 consumers. The split phase conductor is required for street light provide a on each of the pole system. calculate the size of the pole voltage regulation, concrete mixture used for ^{foundation} end point. The angle of deviation is 30° for both deviation point. assume P.F. 0.85. Each pole must be earthed at per R.E.C. specification use R.S.J. pole.

Ans

Given data 3 ϕ , 5 wire system.

distance = 800mtr.

Span length = 47mtr

Load = 75KW.

assume voltage = 415V.

P.F. = 0.85

no of consumer = 50

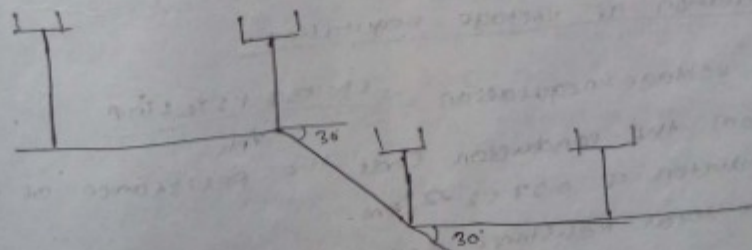
deviation point = 2

deviation angle = 30°

Street light in each pole.

use A.A.C. in distribution.

$$\text{no of pole} = \frac{\text{total distance}}{\text{span}} = \frac{800}{47} = 17.02 + 1 = 18.02 \approx 18$$



total tension point = 4

so that total tangent point = 18 - 4 = 14

calculation of load current and selection of conductor size

$$P = 75 \text{ kW}$$

$$V = 415 \text{ V (assume)}$$

$$\text{PF} = 0.85$$

$$P = \sqrt{3} V_L I_L \cos \theta$$

$$75 \times 10^3 = \sqrt{3} \times 415 \times I_L \times 0.85$$

$$\Rightarrow I_L = \frac{75 \times 10^3}{\sqrt{3} \times 415 \times 0.85} = 122.75 \text{ A}$$

As per A.E.C. Specification for the current rating of 122.7 A we may select 100 mm² or ϕ 11.3 mm dia A.A.C. conductor for phase wire and in 3- ϕ system the neutral wire is the half of cross section of phase wire - so that we select 50 mm² or ϕ 7.9 mm dia A.A.C. conductor for neutral wire.

Selection the size of conductor for street light.

no. of poles ~~each~~ no. of street light = 18

assuming sodium vapour lamp each of 70 watt

$$\text{Total wattage} = 18 \times 70 = 1260 \text{ watt}$$

$$P = VI \cos \theta$$

$$V = 240 \text{ V}$$

$$I = \frac{1260}{240 \times 0.85} = 6.17 \text{ A}$$

min size of the conductor for street light 25 mm² or ϕ 5.2 mm dia A.A.C. is used.

calculation of voltage regulation.

$$\text{voltage regulation} = \frac{IR \cos \theta + IX_L \sin \theta}{V_{ph}}$$

from the conductor chart the resistance of phase conductor is 0.2752 Ω /km

$$\text{The total resistance for 0.8 km is} = 0.2752 \times 0.8 = 0.22 \text{ } \Omega$$

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The Resistance per phase. = $\frac{0.2201}{3} = 0.0733 \Omega$.

$I = 122.75$ & $I_{ph} = I_L = 122.7 A$

$V_{ph} = 415/\sqrt{3} = 240 V$

Voltage regulation = $\frac{122.7 \times 0.073 \times 0.85}{240} \times 100 = 3.17\%$

The voltage regulation is in permissible limit i.e. $\pm 5\%$ as per I.E. Rule, so that the above conductor size is correct.

calculation of sag.

From the conductor chart the weight of the conductor per km = $290 \text{ Kg/km} = 0.29 \text{ Kg/mtr}$

safety factor for R.S.J. pole 22

Tension = $\frac{\text{Ultimate strength}}{\text{safety factor}}$

From the chart that the ultimate strength = 15.96 KN

Tension = $\frac{15.96 \text{ KN}}{2} = 7.98 \text{ KN}$

$9.8 \text{ N} = 1 \text{ Kg}$
 $1 \text{ Kg} = \frac{1}{9.8} \text{ mtr}$
 $15.96 \text{ KN} = \frac{15.96 \times 10^3}{9.8} = 1628.57$

Tension = $\frac{1628.57}{2} = 814.3$

Sag = $\frac{WL^2}{8T} = \frac{0.29 \times 42^2}{8 \times 814.3} = 0.098 \text{ mtr}$

calculation of pole height

The height of pole = min. plantation depth + ground clearance + sag + top clearance.

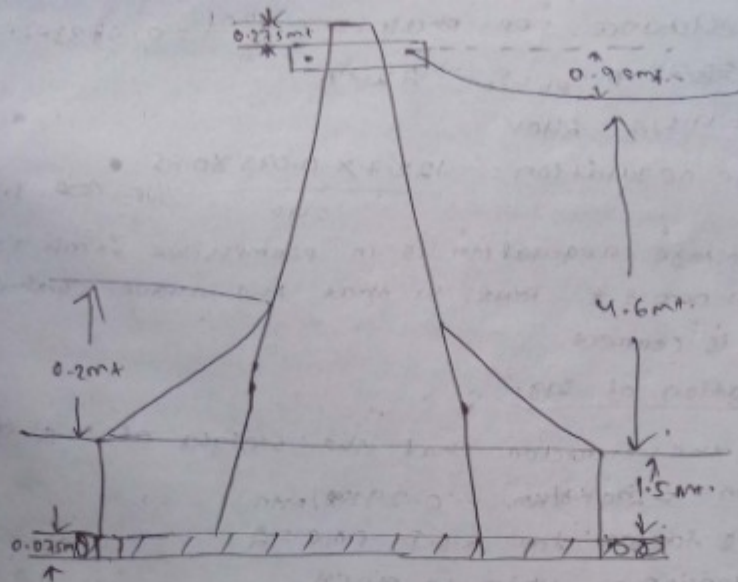
$= 1.5 + 0.6 + 0.098 + 0.275 = 2.473 \text{ mtr}$

The min height of the pole = 8 mtr of R.S.J. on R.C.C. pole.

calculation of cement concrete

As per I.E. rule for R.S.J. pole should be provided a concrete pad of 0.075 mtr .

The area of cross section of concrete = $0.4 \times 0.4 = 0.16 \text{ m}^2$



total length of cement concrete = $0.75 + 1.5 + 0.2$
 $= 1.77 \text{ mtr.}$

total volume = $1.75 \times 0.16 = 0.28 \text{ m}^3$ for each pole.

for 18 no of pole = $0.284 \times 18 = 5.112 \text{ m}^3$

calculation the volume of cement concrete for stay wire.

The volume of stay wire = $0.3 \times 0.3 \times 0.3 = 0.027 \text{ m}^3$
 for pole stay wire

for 4 no of pole = $0.027 \times 4 = 0.108 \text{ mtr}^3$

The total volume of cement concrete = $0.108 + 5.112$
 $= 5.22 \text{ m}^3$

material analysis for tangent pole.

Sl No.	Description	Specification	Quantity/pole	No of pole	Total
01	Cross arm	75mm x 40mm X 5mm x 110mm long	1	14	14
02	Back clamp.	10mm x 6mm as fixed suitable for pole	1	14	14
03	Bolt with nut and washer	16mm dia 50mm long	2 set	14	28
04	Pole top bracket	50mm x 8mm thick	1	14	14
05	Bolt with nut and washer bracket	16mm dia 50mm long	2 set	14	28

06	earthing lead	8 swg. wt.	3mtr.	3	amt.
06	Pin type insulator	LOW tension.	5.150	14	70.
09	binding wire for insulator.	aluminium conductor 43mm dia	200gm	14	2800gm.
08	Pipe earthing set with complete accessories.	14mm ϕ G.I. PIPE of 2.5m length.	1 set		3 No.
09	Street light fitting made of G.I. with pipe with complete set.		2 set	14	1 use

For angle ~~at~~ location.

01	cross arm.	75mm x 40mm x 5mm 1110mm long	2	2	4 nos.
02	Back clamp for above.	40mm x 6mm as flat suitable for the pole.	1	2	4 No.
03	Bolt with nut & washer.	16mm dia, 50mm long.	1 set	2	4 sets.
04	Pole top bracket	50mm x 8mm thick.	1	2	2 + 10.
05	Bolt with nut & washer for bracket.	16mm dia 50mm long.	2 set	2	4 sets.
06	Saddle insulator.	C.T.			
07	U clamp and D clamp	MS clamp 40mm 76mm	10	1	20
08	Bolt with nut & washer with U clamp	16mm dia 50mm long	10	2	20

09	Pipe earthing with complete set	14mm dia G.I. PIPE of 2.5m length	1 set	2	2 set
10	earthing lead	8 Swg. G.I. wire 3mtr. length	3mtr	2	6mtr
11	Street light fitting.		1 set	2	2 set
12	Stage wire with complete set.	G.I. stage wire 7/3.15 mm with complete accessories.	1 set	2	2 set

For end point.

01	cross arm	75 mm x 40mm x 5mm 1110mm long	2	2	2 C/NOL.
02	Back clamp for above.	40mm x 6mm as flat suitable for the pole.	2	2	2 sets
03	Bolt with nut & washer.	16mm dia 50mm long	1 set	2	2 sets

04	Pole top Bracket	50mm x 8mm thick	1	2	2.130L
05	Bolt with nut and for bracket.	50mm long 16mm dia	4	2	8.160L
06	Saddle Insulator	L.T. 4	10	2	20.60L
07	U clamp on D clamp	ms flat 20. 14mm x 6mm	10	2	2.0
08	Bolt with nut and washer	16mm dia, 50mm long	10	2	2.0
09	Pipe earthing set	14mm dia G.I. Pipe of 2.5m length	1 set	2	2.50L
10	Earthing lead	G.I. wire of 8 SWR	3mtr	2	6mtr
11	Street light fitting		1 set	2	2.1L
12	Stay wire with complete accessories.	G.I. wire 7/10	1 set	2	2.5L

Other Materials.

01	RSJ pole	8mtr.	18	18 Nos
02	AAC for 3-φ	100mm ²	0.8	3 wire 2.4 KM
03	AAC for Neutral	50mm ²	0.8	0.8 KM
04	AAC for street light	25mm ²	0.8	0.8 KM
05	Red oxide paint.			As per req
06	Aluminium oxide paint			As per req
07	Cement concrete and	1:2:4		5.22 m ³

Q. prepare and estimate and H.T. line for a distance of 8KM using A.C.S.R. conductor to transmit 300KW load at pf. 0.85. in 3φ 11KV electric pressure. The span is 107mtr. The may be 2 deviation point at 22'. calculate height of the pole and no. of pole. determine the size of conductor, voltage regulation of line Receiver end voltage according to D.F. Rule calculate the sag assuming wind zone 75kg/m assuming Reactance 0.31-2 per KM and prepare a complete material chat for above purpose.

Given data

30, 11KV. H.S. Line

distance = 8 Km = 8000m

voltage = 11KV = 11×10^3 V

Power = $P = 300$ KW

Deviation angle = 22°

Deviation point = 1

P.F. = $\cos \theta = 0.95$

Span = 107m

Wind zone = 75 kg/m^2

Reactance = $0.31 \Omega/\text{km}$

Calculation no. of Pole.

$$\begin{aligned} \text{Total no of pole} &= \frac{\text{Total distance}}{\text{Span length}} + 1 \\ &= \frac{8000}{107} + 1 = 75.7 \approx 76 \end{aligned}$$

For double pole structure there are 3 extra pole required

$$\text{So total no of pole} = 76 + 3 = 79$$

According to the R.E.C. wire standard R.S.J.

Pole is used at double pole structure and P.C.C.

Pole are used at tangent location.

$$\text{The total no of P.C.C. pole} = 73$$

R.S.J. pole for double pole structure = 6.

Calculation of load current and size of conductor.

$$P = 300 \text{ KW} = 300 \times 10^3 \text{ W}$$

$$V = 11 \text{ KV} = 11,000 \text{ V}$$

$$\cos \theta = 0.95$$

$$P = 300 \times 10^3 = \sqrt{3} \times 11 \times 10^3 \times I_L \times 0.95$$

$$I_L = \frac{300 \times 10^3}{\sqrt{3} \times 11 \times 10^3 \times 0.95} = 15.52 \text{ A}$$

From the conductor chart for the current rating of 18.5 we may select 20mm² or 7/2.11 mm dia ACSR Conductor

Calculation of sag.

weight of the wind pressure = 75 kg/m^2
from the conductor chart the approximate diameter
of the conductor $6.33 \text{ mm} \approx 0.00633 \text{ m}$

total wind pressure = 75 kg/m^2

$$\begin{aligned}\text{total wind pressure} &= 75 \frac{\text{kg}}{\text{m}^2} \times 6.33 \times 10^{-3} \text{ m} \\ &= 0.47475 \text{ kg/m}\end{aligned}$$

from the conductor chart weight of conductor =
 $0.5 \text{ kg/m} = 0.005 \text{ kg/m}$

$$\begin{aligned}\text{Net weight} &= \sqrt{w_p^2 + w^2} \\ &= \sqrt{0.47^2 + 0.005^2} \\ &= 0.48 \text{ kg/m}\end{aligned}$$

~~tension~~ =

from the conductor chart the ultimate strength =

$$\begin{aligned}&7.61 \text{ kN} \\ &= \frac{7.61 \times 10^3}{9.81} = 775.74 \text{ kg}\end{aligned}$$

Tension = $\frac{\text{ultimate strength}}{\text{safety factor}}$

$$= \frac{775.74}{2} = 387.87 \text{ kg}$$

$$\text{sag} = \frac{wL^2}{8T} = \frac{0.48 \times 10^2}{8 \times 387.8} = 1.76 \text{ mtr.}$$

Calculation of height of pole.

height of pole = plantation depth + ground clearance
+ sag + top clearance

$$= 1.5 + 4.6 + 1.75 + 0.27 = 8.12 \approx 8 \text{ mtr.}$$

the standard size of pole 8 mtr is used

Calculation for receiving end voltage.

$$V_s = V_R + \sqrt{3} (I R \cos \phi + I X_L \sin \phi) \quad @ 1 \text{ A cos } \phi$$

from the conductor chart the resistance at 20°C
is $1.39 \Omega / \text{km}$

$$\text{total resistance for } 8 \text{ km} = 1.39 \times 8 = 11.12$$

$$\text{Reactance for } 8 \text{ km} = 0.31 \times 8 = 2.48$$

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$$V_s = V_3 - V_3 (\frac{I_a R_a \cos \phi + I_a X \sin \phi}{V_{ph}}) = 11 \times 10^3 - \frac{11.15 \times 0.55 + 2.48 \times 0.52}{635} \times 10^3$$

$$= 10.65 \text{ kV}$$

$$\text{Voltage Reg.} = \frac{V_s - V_R}{V_s} \times 100 = \frac{11 \times 10^3 - 10.65 \times 10^3}{11 \times 10^3} \times 100 = 3.18\%$$

The voltage regulation is in permissible limit $\pm 12.5\%$ for H.T. line as per S.F. rule. So the above conductor size is correct.

Volume of cement concrete.

As per S.F. rule for P.C.C. or R.S.J. Pole should be provided a concrete pad of 0.075 m^2 .

The area of cross section of the concrete pad $= 0.4 \times 0.4 = 0.16 \text{ m}^2$

Total height of cement concrete $= 0.075 + 1.5 + 0.2$

$$= 1.775 \text{ m}$$

Total volume $= 1.775 \times 0.16 = 0.284 \text{ m}^3$

for 79 pole $= 0.284 \times 79 = 22.43 \text{ m}^3$

Calculation the volume of cement for stay

The volume of staywire $= 0.3 \times 0.3 \times 0.3 = 0.027 \text{ m}^3$ / Pole

Total volume of 6 stay $= 0.027 \times 6 = 0.162 \text{ m}^3$

Total volume of cement concrete for both pole and

stay $= 0.162 + 22.43 = 22.6 \text{ m}^3$

Material list.

S/L NO	NAME OF ITEM	SPECIFICATION	Quantity / Pole	No. of Pole	Quantity
01	P.C.C. Pole for tangent location	8mtr	1	73	73 Nos.
02	R.S.J. Pole	8mtr.	1	6	6 Nos.
03	V cross arm for tangent location	75 x 40 mm	1	73	73 Nos.
04	Stays cross arm for double pole structure	75 x 40 mm 16 channel	2	2 double pole structure	6 Nos.

05	lock clamp for LV cross arm	(50x8) mm	1	73	73 No
06	bolt with nut and washer	16mm dia. 15 mm long	2 set	73	146 No
07	bolt with nut and washer from straight cross arm.	16mm dia 50 mm long	4 set	3	12 set
08	pole top bracket for tangent location	50x8 mm	4	73	73 No
09	bolt with nut and washer for pole top bracket.	16mm dia. 50mm long	2	73	146
10	pin insulator.	11KV. It.	3	73	219
11	disc insulator	11KV	6	3 dp	18
12	PIPE earthing set with complete accessories	11KV. PEPE of 14mm dia 2.50m long.	2 set	3dp struct	6 set
13	Earthing lead	8.25m. GI	6m/ dp struct.	3dp str	18 mtr
14	stay wire with complete accessories for dp structure	7/3.11 mm. dia.	2 set	3dp str	6 set
15	clamp for stay wire	ms flat for 20mm x 6mm thickness	2 set	3dp str	6 set
16	Bolt with nut and washer.	16mm dia, 50mm long	2 set	3dp str	6 set
17	Binding wire of aluminium	4.39mm. dia 2mm	205m	73	1464
18	ACSR conductor.	7/2.11 mm. dia			2455h mtr
19	Red oxide paint			AS per	
20	Aluminium oxide paint			AS per	
21	ladders plate		1	76	76
22	Anti climbing device			AS per	
23	cement concrete sand	1:2:4			22.6m

SUBSTATION:-

There are two types of substation.

(i) pole-mounted substation.

(ii) plinth-mounted substation.

Upto 25 kVA pole-mounted substation is done.

Above 25 kVA plinth-mounted substation is done.

Q. prepare the material list for a pole-mounted substation using outdoor type T/F of 75 kVA stepdown oil cooled type. T/F 11 kV/(133-250) V the double pole structure should be provision of air-break switch, lightning arrester, H.V. fuse, L.T. C.B., etc. using channel iron platform for the T/F and angle iron for bolting the T/F.

Ans:-

Given data:-

Pole mounted substation

O/P of T/F = 75 kVA.

Current calculation for H.V. side.

$$V = 11 \text{ kV} = 11 \times 10^3$$

$$I_L = \frac{P}{\sqrt{3} V} = \frac{75 \times 10^3}{\sqrt{3} \times 11 \times 10^3} = 3.93 \text{ A.}$$

Adding short-circuit current 50%.

$$I = 3.93 \times 1.5 = 5.9 \text{ A.}$$

Calculation of current in L.T. side.

$$V = 250 \text{ V.}$$

$$I_L = \frac{75 \times 10^3}{\sqrt{3} \times 250} = 100 \text{ A.}$$

Adding 1.5 times for short-circuit.

$$I = 100 \times 1.5 = 150 \text{ A.}$$

Selection of ACSR conductor.

From the conductor chart for the current rating of 5.99 A we may select 20 mm² or 7/2.1 mm² ACSR conductor is selected for H.V. connection.

selection of cable for L.T.

From the conduction chart we may select 95mm² or 19/2.5mm dia 3-core cable for L.T. connection.

Material analysis.

Sl No	Description	Specification	Quantity	Unit
01	T/F	11KV/433-250V.	1	No.
02	AGS on PCC Pole.	75KVA 9mtr on 9mtr x 750mm x 100mm.	2	Nos
03	Lightning arrester	11KV	3	No
04	Air-break switch	Horizontal type. 3-φ, complete with operating handle on 40mm dia G.I. Pipe	1	No
05	horn-gap fuse	3-φ, 11KV; complete set	3	Nos
06	ACSR conduction for H.V. side.	30mm ² on 7/2.11mm dia	As per req	
07	L.T. Cable	95mm ² on 19/2.5mm dia	As per req	
08	C.T. C.B. oil filled	oil filled 433V, 100A.	3	No
09	m.s. channel for top cross arm and T/F base.	100mm x 50mm x 2800mm long.	4	No
10	m.s. channel for cross arm for H.V. fuse and A.B. switch.	75mm x 40mm x 2800mm long.	4	No
11	m.s. angle bolting the T/F	50mm x 50mm x 2800mm long.	2	No
12	m.s. angle cross arm for supporting the Bolt	35mm x 35mm x 460mm long.	2	Nos
13	m.s. channel for supporting lightning arrester	75x40x2800mm long	2	Nos

14	plate for fixing the cross arm for Hg fuse.	40mm x 6mm made of steel m.s. flat	As per spec.
15	Bracket unit end 'D' clamp for operating handle of A.B. switch.	35x35x35mm ³ thickness.	4 sets.
16	m.s. pole with nut & washer.	10mm dia	As per spec.
17	Earthing set complete	1 set	1 set.
18	G.I. earth	8 SWG.	As per.
19	Disc insulator.	11KV	3 Nos.
20	stay wire with complete set	7/10 SWG.	2 set.
21	binding wire of aluminium conduct.	1 set Alumin' cable	500gm.
22	Danger board	As per SIS.	1 No.
23	Anticlimbing device		As per spec.
24	jumper wire	AAC	As per.
25	Red oxide paint	any brand	As per.
26	Aluminium paint		As per.
27	cement concrete sand for pole & stays	1:2:4	

0/ For 38 no of fan and light point in a Residential building ~~as~~ prescribed which type of B.D.S will be required.

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Plinth mounted Substation

Q/ Prepare an estimate of material for a plinth mounted substation 11/0.4KV, 250KVA Δ/Y 50Hz out of substation.

Ans:-

Given data:- plinth mounted substation.

KVA rating of T/F = 250 KVA.

Current calculation for H.T.

$$S = \sqrt{3} V_L I_L$$

$$I_L = \frac{S}{\sqrt{3} V_L} = \frac{250 \times 10^3}{\sqrt{3} \times 11 \times 10^3} = 13.12$$

According to I.E. rule short circuit current is 1.5 times of normal current, so that $I_{sc} = 13.12 \times 1.5 = 19.68 \text{ A}$.

Current calculation for L.T.

$$I = \frac{S}{\sqrt{3} V_L} = \frac{250 \times 10^3}{\sqrt{3} \times 400} = 360.87 \text{ A}$$

The short circuit current is 1.5 times of the full-load current. $= 360.87 \times 1.5 = 541.2 \text{ A}$.

selection of conductor for H.T.

We may select from the conductor chart 20 mm^2 or $7/20 \text{ mm}$ ACSR conductor is selected.

Selection of conductor for L.T.

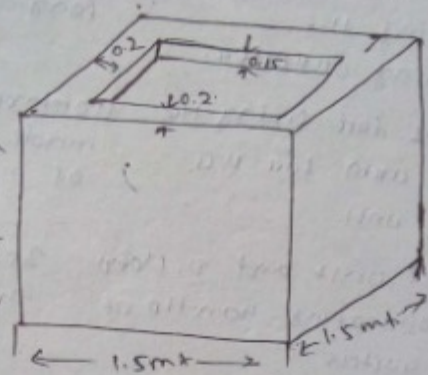
We may select 400 mm^2 or $61/3 \text{ mm}$ dia aluminium conductor for the current rating of 541.2 A .

calculation of the volume of cement concrete for plinth

$$\text{The outer volume} = \text{length} \times \text{breadth} \times \text{height} \\ = 1.5 \times 1.5 \times 1.5 = 3.375 \text{ m}^3$$

$$\text{inner volume} = 1.1 \times 1.1 \times 1.35 = 1.6335 \text{ m}^3$$

$$\text{total volume of plinth} = \text{outer volume} - \text{inner volume} \\ = 3.375 - 1.6335 = 1.7415 \text{ m}^3$$



Material list

<u>Sl No</u>	<u>Description</u>	<u>Specification</u>	<u>Quantity</u>	<u>Units</u>
1	Distribution TF	(110.4) KV, 250KVA	1	No.
2	R/S Pole on PCC pole	750mm x 100mm	2	Nos.
3	Lighting arrester	11KV	3	Nos.
4	Air break switch	3-Ø complete with operating handle of 40mm dia. GI pipe.	1	No.
5	Horn gap fuse unit	3Ø, 11KV complete set	3	No.
6	ACSR conductor for H-T cable.	20mm ² , 7/2.11mm	10	mt.
7	L-T cable	400mm ² , 61/3.00mm 3 core cable	10	mt.
8	L-T ckt breaker	oil sin type 400V, 360A	3	Nos.
9	ms channel cross arm for H.G. sub. unit AB switch	75mm x 40mm x 2800mm long	4	Nos.
10	ms angle cross arm for support the bolt	35 x 35 x 40mm	2	Nos.

11.	ms channel for supporting the righting arrester.	150x40x2000 mm long	2	No.
12.	clamps for fixing the cross arm for H.V. fuse unit.	40mm x 6mm made up of ms flat		As per req.
13.	Bracket unit and P. Clamp for operating handle of A.B. switch	35 x 35 x 35 mm thickness (1 set)	16	No.
14.	mesh bolt with nut and washer.	10mm ϕ 20mm ϕ		As per req.
15.	Earthing set complete.		1	Set
16.	G.I. earthing strapping	8 SWG.	50	mt
17.	Strain insulator with complete set.	11KV.	3	No.
18.	stay wire with complete set.	7/10 SWG	2	Set
19.	Binding wire of Aluminium conductor		500	gm
20.	Danger board with clamp	As per BIS	1	No.
21.	Number plate with clamp		1	No.
22.	Substation plate with clamp		1	No.
23.	Anticlimbing device			As per req.
24.	Jumpen wire	AAC		As per req.
25.	Red oxide paint.			"
26.	Aluminium paint.			"
27.	Volume of cement concrete of plinth.	1:2:4	1.74	mt ³
28.	for stay and pole.			As per req.