ARYAN SCHOOL OF ENGINEERING & TECHNOLOGY

BARAKUDA,PANCHAGAON,BHUBANESWAR,KHORDHA-752050

LECTURE NOTE

SUBJECT NAME- **ELECTRICAL INSTALLATION AND ESTIMATING**

BRANCH – ELECTRICAL ENGINEERING

SEMESTER – 6TH SEM

ACADEMIC SESSION - 2022-23

PREPARED BY – AJIT KU. PANDA

R.C.C.B - Residual current circuit Breaker.
E.L.C.B - Earth leakage circuit Breaker
M.C.C.B - molded case circuit Breaker
T.P.I.C - Tripple pole Iron clad
D.P.I.C - Double pole Iron clad
R.C.C - Rainforced cement concrete
M.C.B - miniature circuit Breaker
O.C.B - oil circuit Breaker
A.C.S.R - Aluminium conductor steel rainforced.
C.T.S - cap type sheathed
T.R.S. - Tough rubber sheathed
C.V.T - constant voltage transformer.
C.F.L - compact flurescent 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 repturing cartiaged
I.C.D.B Iron clad ~~Double pole~~ distribution board
I.C.T.P - Iron clad tripple pole
L.A. - Lightening arrhester
O.L.T.C - over load triping coil.
P.I.L.C - paper insulated load 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 electrefication corporation

M.C.C.B - Molded case circuit Breaker

T.P.N.M.C.B - Tripple pole with neutral miniature circuit Breaker

E.C.C - Earth continuity conductor

R.S.J - Rolled steel joint.

P.C.C - Plane cement concrete

Wire & Cables

wire

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

Cables

→ 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.

Q/ 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 streching or bending.

(iv) Flexibility.

The conductor should be sufficient flexible to withstand the installation stresses without be 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 temprature and dampness. It is again devided into annealed copper and hardrawn copper.

→ Generally Aluminium is used due to it's lite in weight and chipper 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 perchha
(vii) varnish cambric
(viii) AE insulation.

These are the reputed insulation used in various purpose.

wireing systems

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

system of distribution

(i) distribution system

→ This system of wireing is generally adopted for consumers of domestic installation.
→ The ~~future~~ fuse of various sub-short ckt are

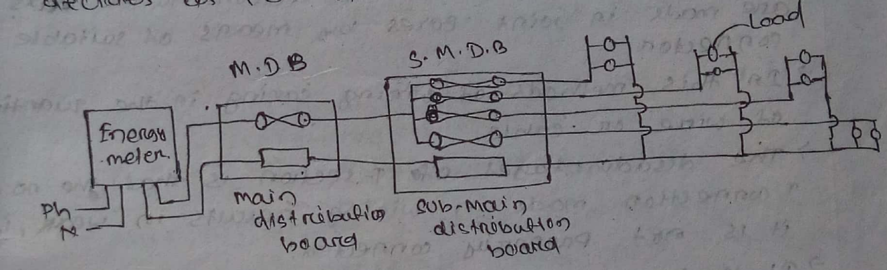
grouped together and placed together to near of main switch is known as distribution system.

→ inside the box of ironsheet or hardwood a copper strip is known as busbar and nutrallink is fixed.

→ for one circuit one phase wire is taken from the bus-bar 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 safe cable and to prevent voltage drop.

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



(Distribution board)

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 wireing has following drawbacks.

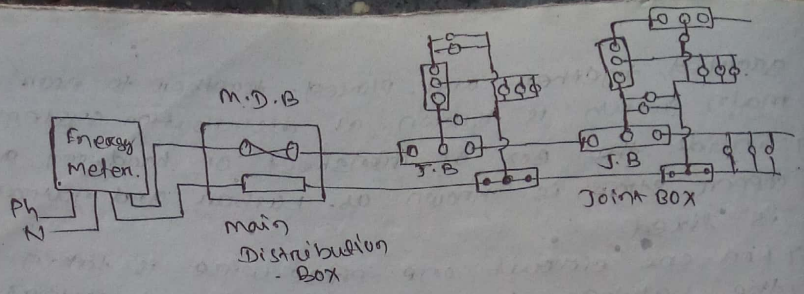
(i) The voltage across all the lamps doesn't remain the same.

(ii) The load in the last branch will have list voltage across them.

(iii) A number of joints are involved in every circuits.

(iv) Fuses are scattered.

(v) fault repairing is not so easy.



(Tree-system of wiring)

Methods of wiring

There are 2 methods of wiring. such as
(i) joint Box system (Tree system)
(ii) Loop-in system

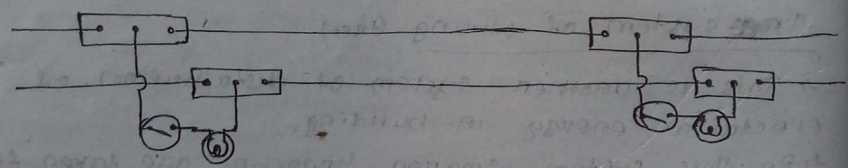
(i) joint Box system

→ In joint Box system the connections to the loads are made in joint Boxes by means of suitable connector.

→ In this methods of wiring saving in the quantity of wire or cable.

→ The disadvantages 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 connections for Appliances for parallel.

→ In this wiring the phase or line conductor are looped either in switch board or Box and nutrals are looped either in switch board or from light or fan.

→ The line or phase never be looped from light and fan.

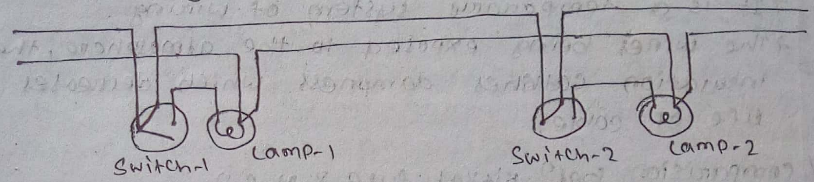
Advantages

→ 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) Flexible conduit wiring

Cleat wiring:

In this system of internal wiring the cables are supported bet" 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 30c.m to 60c.m. 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 VIR or PVC cables.

Advantages:

→ It is cheapest form of internal wiring.

→ The installation and dismetaling is easy and quick.

→ The inspection, alternation 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) Comparision betn Kitkat fuse & M.C.B.

Fuse	M.C.B
→ The fuse wire melts on excessive current flow.	→ It operates to cut off the ckt even on small overload current flow.
→ The fuse wire available at the time of rewiring may not be at standard rating	→ These are available in standard rating and we have to kept ready on demand.
→ It melts on 50%–100% excessive overload	→ It operates on just 5%–15% excessive overload.
→ The fused fuse wire has to be located amongest other alive units.	→ The switching knob provides direct indication on faulty ckt.
→ It cheapest source of protection so far as initial installation cost is concern	→ 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 VIR or P.V.C. or any other insulated cable.
→ The casing consist of 'U' 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 13 mm × 4 mm wooden screw.
→ The distance betn the two screw is of 15 cm
→ Two or three cables of same polarity run into one groove. No opposite polarity cables 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 6.5c.m in order to keep the casing dry at the back.

→ The wooden gattis on which the casing is screw by means of 32mm x 80mm wooden screws are fitted into walls or ceiling at interval not exceeding 90c.m. for sizes of casing capping upto 64mm and not exceeding 60cm for sizes more than 64mm

Advantages.

→ It is chip in cost as compare to conduit system of wiring.

→ As the phase and nutrals are placed in separate groove the shot ckt 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 cashing 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 residensial or in office building the cables are carried on the seaon teak wood batten which is banish coated and thickness is not less than 13mm

→ The battens are fixed on wall by means of wooden plug at a distance of 30c.m to 60c.m 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 nails.

→ Width of the batten depends upon the no of conductor carried on it.

These are various batten sizes like 13mm x 13mm for two conductor and 19mm x 13mm for 3 conductor 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 chiper in cost.
→ It's appearance is quite good.
→ fault location and fault removal is due to wires are vissible.
→ It's life is sufficiently long.

Disadvantages.

→ It is not suitable for dampwalls where the wiring is exposed to sun and rain.
→ There is a risk of fire as the wooden batten ~~make as 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 TRS or PVC with an outer covering of sheath of lead aluminium alloy.
→ The thickness of leads sheath is 1mm – 1.5mm.
→ It provides against protection of mechanical injury dampness and atmospheric corrosion.
→ The cables are placed on the teeth wood batten same as that of batten wiring.
→ The outer sheath of the lead is connected with earthwire to prevent the lead sheath becomming electrically live.
→ The earthwire made to run byside 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 occure.
→ 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 still or PVC pipe known as conduit.
→ The conduit wiring are 3 types.
(i) surface conduit.
(ii) flexible conduit.
(iii) consiid conduit.

Surface conduit wiring.

→ In this system of wiring conduit is placed on the surface of the wall by means of conduit shaddles.
→ 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 housewiring and where as 30mm and above are used for power wiring.

Consild 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 mechanical 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 ckts, where as ordinary conduit pipe of lite gauge and black enamel where as ordinary conduit pipe is preffered for consild system of house wiring.

Flexible conduit

- The flexible conduit or pipe which can be bent or twist without change it's time and diameter.
- It is used where the straight run of rigit conduit is not possible.
- The purpose of flexible conduit to provide mechanical protection to cables been rigit conduit and machines or other object.
- The flexible conduit used for connecting rigit conduit with machine terminals incase of motor wiring, in case of motor wiring energy meter, ~~in case of~~ ~~met~~ ~~inda~~ main switch industrial and domestic wiring.

Advantages.

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

Disadvantages.

- It is costlier system of wiring.
- Highly skilled workmen is required.
- Replacement of deffective 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

seen 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 dinomenator indicates diameter of each strand.

* Minimum size of conductor.

→ The minimum size of copper conductor for household is 1mm² or 1/1.12 mm, & aluminium conductor for household is 1.5 mm² or 1/1.40 mm diameter
→ The minimum size of copper conductor for power wiring for 4mm² or 1/2.24 mm may be used.

* Voltage drop

→ Before deciding the proper size of cable to be used in a ckt the consideration must be given to the voltage drop.

→ voltage drop (domestic) = $\left[\frac{\text{declared voltage} \times 2}{100}\right] + 1$

= 2% of declared voltage + 1

→ voltage drop for (industrial) ~~drop~~

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

= 5% of declared voltage

Ex:- Calculate the size of the wire for a sub-ckt consist of 10 light points on 800 watt. The supply voltage is 230V, 50Hz.

Ans:- declared voltage = 230V.
Power = 800W, assume $\cos\phi = 1$

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

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

From the conduction chat for the current 3.47 A we may select 1 mm² or 1/1.12 mm dia pvc insulated single core cable of a current up to 5 A.

Q/ A small house is to provided with single phase connection. The total length of wire from main switch onward to electrical points is 40meter (both phase & netral). If the load in the house is only 5A, determine the size of the conductor to be installed to the energy meter and main switch. The declared supply voltage taken of 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 15meter.

Ans

The permissible voltage drop = 2% of declared voltage + 1

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

Reffering to the conduction table the minimum size of aluminium conductor is 1.5mm² or 1/1.40mm dia having current carrying capacity of 10A used for installation of energy meter & main switch.

lets us calculate

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

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

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

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

This size is not suitable as it is more voltage drop than the permisible value.

Now consulting the next table let's take next higher size of the conductor is 2.5mm² or 1/1.80 dia aluminium condu^n. This wire has current carrying capacity of 15A and voltage of 2.5 m for 1V drop.

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

$= 5.33\,V$.

~~30, 1 feet conductor~~

The voltage drop is still higher than the permissible voltage drop therefore next higher size of 4mm² 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 40 mt + 30 mt = 70 mt
- 30 mt for (both phase & nutral)

Refferent to the same table if a cable size 6mm² or 1/2.80 mm is used then voltage drop of 27A

Chard current $= \frac{70}{3.4}$

V.drop for 5A $= \frac{70}{3.4} \times \frac{5}{27} = 3.81\,V$

~~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 energymeter should be easily accessible to meterreader to maintain privacy of household people. as the meter reader will visit every month for reading.

(ii) energy meter, main-switch and main distribution board close to eachother.

(iii) weather proof cable is selected for service connection.

(iv) the wires for wiring connection to mainswitch and distribution board should be of required rating based on total load requirement in building because these were 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 or T.R.S wire are used for batten system of wiring.

(vii) P.V.C. insulated wire are used for conduit wiring.

(viii) The height of the switchboard is 1.5meter 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 housewiring 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 all 3pin plugs and socket outlets are connected permanently to earthwire.

(xiii) In bathroom the height of the socket outlet should not be less than 1.5meter in any case.

(xiv) All ceiling fans are to be hung 2.75meter from the floor.

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

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

(xvii) 14 SWG G.I. wire is used as earthwire for house wiring beyond mainswitch.

(xvii) 8 S.W.G. G.I. wire are used beyond mainswitch upto earth electrode buried deep in earth.

(xviii) use G.I. 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 3.5meter and for large halls may be taken as 4m.

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

(xxi) If the height of the ceiling is assumed to 4meter then the height of the horizontal run is 3meter from floor or 1meter from the ceiling.

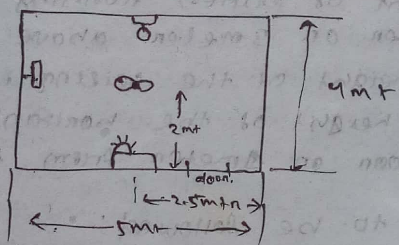
<u>Sequency to be followed</u>:-

(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~~ nutral wire.
(ix) calculation of length of earthwire.
(x) Preparing material list.

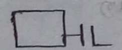
Batten or CTS/TRS wiring:-

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 fluosecent tube and 1 5Amp socket outlet. Each of the point is controlled by it's 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. Assume batten system of wiring.

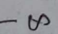
Ans:-



Symbol used:-

(i) main switch = 

(ii) switch board w/o switch = 

(iii) fan — 

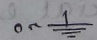
(iv) Bulb — 

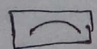
(v) 3 pin plug socket - 

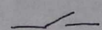
(vi) F.L. Tube - 

(vii) phase wire - ——————

(viii) Nutral wire - - - - - -

(ix) Earth wire - ━━━━━ or 

(x) Regulator :- 

(xi) ~~swit~~ 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 floor 0.5 meter from ceiling
→ height of switch board from floor = 1.5 meter

→ Location of mainswitch from the adjacent wall = 0.5m
→ light & tube point from the ceiling = 1 metre 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.
(5×4)mt	Fan	1	60	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 I.E rule there is a provision for 1 ckt is 10 points and 800 watt

In this case we use 1 ckt because the points 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)

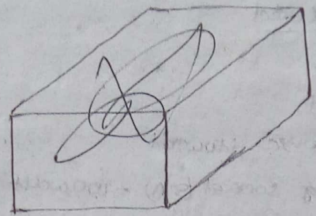
$P = V \cdot I \cos\phi$

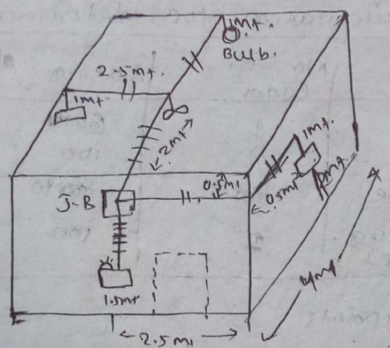
$I = \frac{P}{V\cos\phi} = \frac{300}{230} = 1.304A.$

we know that the short ckt current is 1.5 times of the full load current, so $I = 1.5 \times 1.30 = 1.95 \simeq 2A$

reffering to the conductor chart for this current we may use 1 mm² or 1/1.12 mm dia pvc insulated copper conductor single core cable.

Calculation the length of Batten





MS → J.B. → 2 wires (13×13 mm)

batten → 1+(0.5) wall clearance + 0.5+2.5 = 4.5 mt

J.B → S.B → 5 wires (31×13) mm.

length → 1.5 mt

J.B → fan → 4 wire (25×13) mm.

length → 0.5+2 = 2.5 mt.

Fan → F.L. Tube → 2 wire (13×13) mm.

length → 2.5+1 = 3.5 mt.

Fan → Bulb → 2 wire (13×13) mm.

length → 2+1 = 3 mt.

total length of 13×13 mm batten = 4.5+3.5+3 = 11 mt.

along 10% excess towards cutting and wastage

= 11 mt + 10% of 11 mt = 12.1 ≃ 12 mt.

total length of 25×13 mm batten = 2.5 mt.

along 10% excess towards cutting and wastage

= 2.5 + 10% of 2.5 = 2.75 ≃ 3 mt

total length of 31×13 mm batten = 1.5 mt.

along 10% excess = 1.5 + 10% of 1.5 = 1.65 ≃ 2 mt.

size of batten	total length of batten.
(13×13)mm.	12mt.
(25×13)mm.	3 mt.
(31×13) mm	2 mt.

Calculation of length of conductor for both phase & neutral.

in 13×13mm batten 2 wires = 11×2 = 22mt.
in 25×13mm batten 4 wire = 2.5×4 = 10mt.
in 31×13 mm battem 5 wire = 1.5×5 = 7.5 mt.
total. length of conductor = 22+10+7.5 = 39.5 mt.
allow 15%. toward cutting & wastage = 39.5×15/100 = 45.425mt. ≃ 45.5mt.
the total length of phase & neutral ware is 45.5mt.

Calculation of gutties

The total length of batten including (13×13)mm, (25×13)mm and (31×13)mm is 11+2.5+1.5 = 15mt.
the distance betn two adjacent gutties = 45cm.
no of gutis = total length batten / distance betn two adjacent gutties = 1500/45 = 33.33
allow 10%. extra. = 33.33+3.33 = 36.67 ≃ 37. Nos.

Calculation of link clips.

The distance between two link clips is 10cm.
No of link clips = Length of the batten / distance betn two link clips
= 1500/10 = 150cm.

for 2 wire the size of link clips is (1×38)mm used in (13×13)mm batten. The length of the (13×13)mm batten = 11m
No of link clip = 11.00/10 = 110 no ~~link clips~~
for four wire 2×38 mm size link clips is used of the length of 2.5m of batten (25×13)mm.
No of link clips of (1×38)mm = 250×2/10 = 50 no
for five wires the batten size is (31×13)mm and the link clips are used (1×38)mm and (1×50)mm.
Thus the length of (31×13)mm batten is 1.5m
the length of (31×13)mm link clips = 150/10 = 15 no
Therefore the no of (1×38)mm

The no of (1×50)mm link clips = $\frac{150}{10}$ = 15 no

The total no of (1×38)mm link clips = 110+50+15 = 175 no

Allow 10% extra = 175 + 17.5 = 192.5 ≃ 193 Nos.

Total no of (1×50)mm link clips = 15 no

Allow 10% extra = 15 + 1.5

= 16.5 ≃ 17 Nos.

Size of link clips	No of link clips.
(1×38) mm	193
(1×50) mm	17

Calculation of ECC :-

According IE rule, 14 SWG G.I. wire is used as earth ~~continuousta~~ continuity conductor. The length of the ECC is from main switch to switch board socket = 1+0.5 (wall crossing) +0.5+2.5+1.5 = 6mt

Allow 15%. extra = 6+0.9

= 6.9 ≃ 7 mt.

Total length of ECC = 7mt.

Material list

SL NO	Description	Specification	Quantity	Unit
1	D.P.I.C. mainswitch	16A., 250V grade	1	No.
2	Phase and Neutral wire	1mm² or 1/1.12 mm. dia PVC insulated single core copper conductor	45.5	mt.
3	Earth continuity conductor	14 SWG G.I wire	7	mt.
4	Batten	(13 × 13) mm.	1.2	mt
		(25×13) mm	3	mt
		(31×13) mm	2	mt
5	link clips	(1×38) mm	193	No.
		(1×50) mm	17	No
6	wooden Gutties including Batten, mainswitch, switch Board, junction box, Tube Light and Bulb point, sealing ros	(38×38) mm at bigger end and (25×25) mm at smaller end with 6.5cm long.	37+18 = 55	No

7	Switch tumbler type	5 A single way switch	4	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	(25 x 13) cm.	1	No
12	switch Board	(10x10) cm	1	No
13	Angle Holder		1	No
14	wooden screw for batten to fix with gutties	25 mm	55	No
15	wooden screw for Board	40 mm	18	No.
16	Earthing thimble		1	Set.
17	fan regulator		1	No.
18	cement, sand and concrete		As per req	

Workshop wiring

→ The power circuits are require for heater, coolers, Refrigirator, Air conditioner and other similar loads.

→ Power circuits are also required for motor, generators 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 pipes.

→ The armoured cable shall be used is under ground power wiring

→ The single core wire used for power wiring to motor shall be enclosed is G.I. conduit of appropriate site.

→ wooden guties or plug shall not be used for mounting of iron clad switch, control or distribution board.

.... AFTER 2 pages

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 meter.
- height of the plinth from pumpset 0.25 meter.
- height of the plingth for induction motor equal to 0.5 meter.
- Distance of motor from two nearest wall (min) equal to 1 meter.

Q) A small workshop of size 10m x 6m x 6m is under constructed. It is required to provided 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 induct motor for an automatic tool manufactur machine.
(iv) 1 drilling machine driven by a 1-Φ, 1 H.P. motor.
(v) 1 grinding machine driven by a 0.5 H.P. 1-Φ motor.
(vi) prepared a complete estimation in the following sequency.

(i) draw installation plan.
(ii) showing the location of machine main switch & power distribution board, motor control board etc.
(a) path of power wiring to each motor.
(B) Single line diagram starting from energy meter.
(C) draw wiring diagram of main board including earth wire connection, showing connection of 1-Φ and 3-Φ energy meter, main switch, distribution board.
(d) selection of important material & calculate the length of wire, condut, earth wire etc. prepare material table with full specification of each item.

Ans

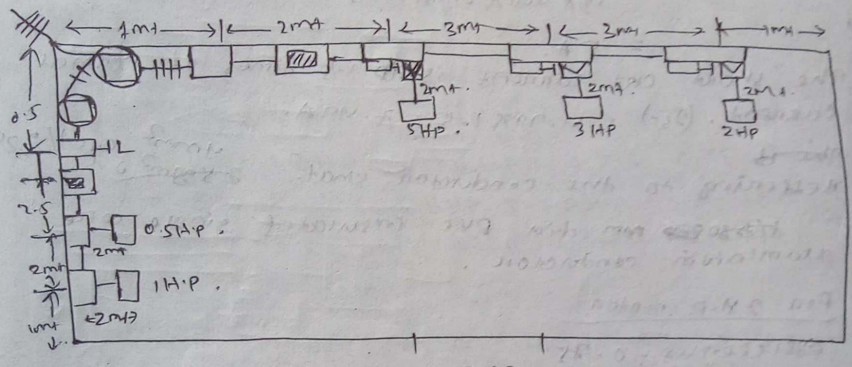
Assumption

→ height of the main switch, motor control switch 1.5 m from floor.

→ height of horizontal run level from the floor 2.5m.

→ height of the plinth for 3-Φ and 1-Φ motor equal to 0.5m.

→ height of the drilling machine is 1.5 meter.



INSTALLATION PLAN

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

(1) Line voltage = 400V

efficiency of motor = 0.8

p.f = 0.85

$$\text{Load current } (I_L) = \frac{\text{rated H.P.} \times 735.5}{\text{efficiency} \sqrt{3} \times \text{line voltage} \times \text{P.f}}$$

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

The short-ckt current is 1.5 times that of normal current. (Isc) = 1.5 × 7.8 = 11.7 Amp.

refference to the conductor chat for the wiring the 6mm² or 1/2.80 aluminium single core cable is selected for 5H.P. motor.

For 3H.P motor:

Efficiency = 0.75

$I_L = \frac{3 \times 735.5}{\sqrt{3} \times \text{line volt} \times \text{p.f} \times \text{efficiency}}$

$= \frac{3 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.75}$

= 5 A.

The short ckt current is 1.5 times of normal current. (I_{sc}) = 4.99 × 1.5 = 7.49 A.

Reffering to the conductor chart. 4 mm² or 1/2.24 mm ~~2.5 mm² or~~ 1.

~~1/1.80~~ mm dia PVC insulated single core aluminium conductor.

For 2H.P. motor

efficiency = 0.75

load current I_L = $\frac{\text{rated BHP} \times 735.5}{\sqrt{3} \times \text{line volt} \times \text{p.f} \times \text{efficiency}}$

$= \frac{2 \times 735.5}{\sqrt{3} \times 400 \times 0.85 \times 0.75} = 3.33\text{ A}$

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

Reffrence to the conductor chart the above current 4 mm² ~~1.5 mm²~~ or 1/2.24 ~~1/1.80~~ mm dia PVC insulated single core aluminium cable are used.

~~For 1 H.P motor~~

Selection the mainswitch and distribution board.

The total current in 3 motors is = 7.81 + 5 + 3.33
= 16.159 A.

Assuming 50% overload on all motors.

The total current run = 16.12 × 1.5 = 24.18 A

Reffering to the conductors chart for above current 16 mm² for 7/1.70 mm PVC insulated aluminium single core cable is used for main switch & distribution box.

Impordant rules.

The rag bolt used for this purpose.

→ The length of flexible conduit for connection between for terminal box for motor & stator 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 bellow 1BHP = 0.5 to 0.65

→ for betn 1BHP & 2BHP = 0.7 to 0.75

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

→ for large size of motor efficiency 0.9

Starter for motor.

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

→ The star-delta starter is also used for motor beyond 7.5 HP up to 25 HP motors.

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

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

* 1 BH.P = 735.5 watt (metric)

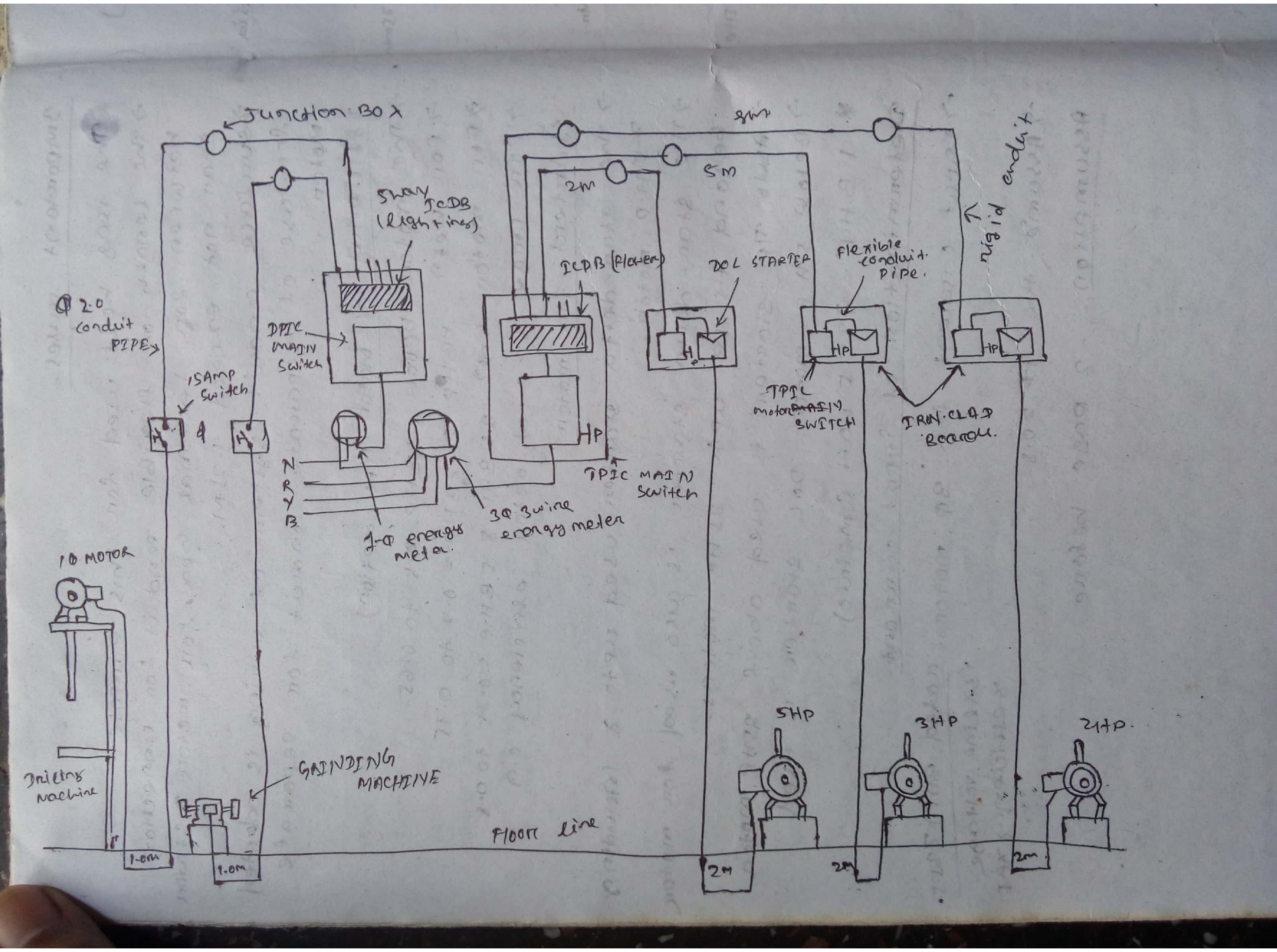
Determination of input current.

→ Input current for 3φ motor = $\dfrac{\text{rated BHP} \times 735.5}{\sqrt{3} \times \text{line voltage} \times \text{efficiency} \times \text{P.F}}$

→ Assume the P.F = 0.8.

Assumption ... 2 page before

↩


Junction Box
5way ICDB (lighting)
ICDB (Power)
DOL STARTER
Flexible conduit pipe.
rigid conduit
2m
5m
DPIC MAIN Switch
ISAMP Switch
N
R
Y
B
1-Φ energy meter.
3Φ 3wire energy meter
TPIC MAIN Switch
TPIC motor SWITCH
IRON CLAD
HP
5HP
3HP
2HP.
GRINDING MACHINE
Drilling Machine
1Φ MOTOR
Floor line
1.0m
2m
2m
2m

Selection the rating of TPIC main switch.

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

Selection of the rating of TPIC motor switch.

For 5 H.P. motor a TPIC motor switch of 32 Amp rating 500V grade should be selected. For 3H.P and 2H.P. motor a TPIC motor switch of 16 Amp rating 500V grade should be selected.

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

For 5HP motor

For main distribution board to 5HP motor.

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

~~for cutting and wasting 10% extra =~~

From M.d.b to 3HP motor.

~~Total PIPE~~ 2/ along the horizontal run = 5 mt. (all are same as before)

so total PIPE = 8.5 + 3 = 11.5 mt (1+5+1+1.5+0.25+2 + 0.25+0.5)

From m.d.b to 2 H.P. motor

2/ along the horizontal run = 8 mt.

so total PIPE = 11.5 + 3 = 14.5 mt. (1+8+1+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 = 38 mt.

Therefore total conduit PIPE is 38 mt

Calculation the length of 15mm dia conduit

From the motor control board to motor. (earth wire)

for same length of pipe for 3 motors = 9×3 = 27mt.
allow 10% extra = 27+10% = 29.7 mt ≃ 30mt.

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

From energy meter to main switch = 0.5 mtr
From mainswitch to distribution box = 0.25 mtr.
from distribution box to conduit box = 0.25 mtr ×3 = 0.75mtr
conduit mouth to motor switch = 0.25×3 = 0.75 mtr.
motor switch to starter = 0.5×3 = 1.5 mtr.
starter to conduit mouth = 0.25×3 = 0.75 mtr.
conduit mouth to motor terminal = 0.25×3 = 0.75mtr.
total length of flexible conduit = 0.5+0.25+0.75+0.75+1.5+0.75+0.75 = 5.25 mtr.

allow 10% extra = 5.25+10% = 5.75 ≃ 6 mtr

Calculation the length of wire for 5H.P. motor
length of conductor = length of rigid conduit + length of flexible conduit for 5HP
= 8.5+0.25+0.25+0.5+0.25+0.25 = 10

length of 3 conductor = 10×3 = 30mtr
allow 15% extra toward excess = 30+10% = 35mtr.
The length of 6mm² or 1/2.80 mm dia conductor for 5mm conductor is 35mtr.

for 3HP and 2H.P. motor.

length of wire = length of rigid conduit for 3H.P. and 2H.P.
+ 2×(0.25+0.25+0.5+0.25+0.025)
= 11.5+14.5+3 = 29 mtr,
length of 3 conductor = 29×3 = 87mtr.
allow 15% extra = 87+15% ≃ 100mtr.

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

Calculation length of E.C.C. & S.W.G for 3phase motor
length of conductor = length of 15mm dia conduit = 27mtr
allow 15% extra = 27+15% = 31.05 ≃ 31mtr.

Total leng
Calculation
1-Φ motor
Phase volta
Efficiency o
5 H(
The short
Referencing
rating 1.5mm or
selected.
for 1H.P.
Load c
Short.
referencing
rating 1.5
aluminiu
Selection the
The total
allow 50%
referring to
or 1/1.80 mm
Selected.
Selection the
The max
It is there
of 30 Amp
main switch.
Selection of
16Amp 1-way
control swit

Total length of E.C.C. of 8 S.W.G. = 31 mtr.

calculation of load current and size of conductor for 1-Φ motor

Phase voltage = 400/√3 = 230 V

Efficiency of the motor η = 0.5

P.f = 0.85

load current = rated BHP × 735.5 / (voltage × p.f × efficiency)
(0.5 / 0.85 0.5)

= 3.79

The short ckt current is 1.5 times of normal current.

= 1.5×3.79 = 5.61

Reffereing to the conductor chat for the above current rating 1.5mm or 1/1.40mm dia PVC insulated aluminium conductor may be selected.

For 1 H.P. motor:

~~Load cur~~ P.F = 0.85

load current = 735.5 × 1 / (231 × 0.7 × 0.85) = 5.35

Short ckt current = 1.5 × 5.35 = 8 Amp

Reffereing to the condr chat for the above current rating 1.5 mm² or 1/1.40 mm dia single core PVC insulated aluminium condn may be selected.

Selection the size of conductor for mainswitch & distribution board

The total current in two motor is 3.74 + 5.35 = 9.09 A

allow 50% for overload current = 9.09 + 4.5 = 13.63 A.

reffering to conductor chat for above current 2.5mm² or 1/1.80 mm dia PVC insulated single core cable may be selected.

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

The maxm demand will be 13.63 Amp

It is therefore suggested that a DPIC main switch of 30 Amp rating 250 volt grade should be used as 1-Φ main switch.

Slection of rating ~~of motor control 1-Φ way switch~~

16 Amp 1-way switch with 16 Amp socket should be used as control switch for 1-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) + 2.5 m (along the H.R) + 1 (upto motor switch) + 1.5 (upto floor) + (depth of trench) 0.25 + 1 mtr (along the trench) + 0.25 (depth of trench) + 0.5 (plinth height) = 8 mtr

For 1 H.P motor

From M.D.B to 1 H.P. motor = 1 + 4.5 + 1 + 1.5 + 0.25 + 1 + 0.25 + 1.5 (height of plinth) = 11 mtr

Total conduit = 11 mtr + 8 mtr = 19 mtr

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

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

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

Total length of conductor = 2 × total length of conduit for 1-Φ motor.

= 2 × 19 = 38 mtr.

allows 15% extra towards westage & cutting = 15% + 38 = 43.7

Calculate the length of 8 S.W.G. earth line for 1-Φ motor

The total length of conductor = 2 × total length of conduit pipe.

= 2 × 19 = 38 mtr.

allow 15% extra = 38 × 15% = 43.7 mtr.

Therefore total length of 8 S.W.G. conductor is 43.7 m

Calcula of 20mm dia flexible conduit.

Length of flexible conduit: ~~energy met~~

energy meter to D.B = 0.5 mtr.

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

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

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

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

~~terminal box to~~ total length = 2.5 mtr

allow 10% extra = 2.75 ≃ 3 mtr.

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

Material analysis.

SL.No	Description	Specification	Quantity	Unit
01	T.P.I.C main switch	45A, 500V grade	1	No
02	T.P.I.C motor switch	32A, 500V grade	1	No
03	T.P.I.C motor switch	16A, 500V grade	2	No
04	I.C.D.B (power) for 3 motors	45A, 500V grade	1	No
05	Heavy gauge conduct of size of 3-Φ motor	25mm dia black enamel	38	Mtr
06	conduit accesories for 25mm die			
	conduit bends		12	No.
	conduit junction box		3	No
	conduit socket to connect 2 pieces conduit		10	No
	conduit saddel to hold conduit with wall		70	No
	G.I. conduit for earth wire (15mm dia)			
07	conduit accesories (15mm)			
	conduit bends		6	No
	conduit socket		3	No.
	conduit saddle		55	No
09	flexible conduit for 3Φ motor (25mm) dia		6	No
10	I.C.D.P for mounting main switch I.C.D.P power	45 x 60 cm²	1	No
11	I.C.D.P for mounting motor switch & starter.	30 x 30 cm²	3	No
12	PVC insulated Aluminium cond^n 1-core for wiring mainboard	7/1.70 mm dia or 16 mm²	5	Mtr
13	P.V.C. insulated 1-core aluminium conductor for wiring 5H.P. motor	6mm² or 1/2.80 mm dia	35	Mtr
14	Same for 2H.P & 3H.P motor.	4mm² or 1/2.24 mm dia	100	Mtr
15	G.I. earth wire for both 1-Φ and 3Φ motor	8 SWG. G.I	75	Mtr
		30 Amp	1	No
16	D.P.I.C. (lighting) main switch	30 Amp, 250Volt grade	1	No
17	I.C.D.B. (lighting)		2	Sets
18	1-way switch & socket for 1-Φ motor	16 Amp		
19	heavy gauge conduit for 1-Φ motor	20mm dia black enamel	21	Mtr
20	conduit accesories (20mm dia)			
	conduit bends		8	No
	conduit junction box		3	No.

	conduit socket		5 Nos
	conduit saddle.		35 Nos
21	Aluminium condr for wiring the main board for 1-ϕ motor	2.5mm² or 1/1.80 mm dia	2 Mtr.
22	1 core wire for wiring 1-ϕ motor	1.5mm² pvc insulated Aluminium cnr.	45 Mtr.
23	IRON clad Board for mounting main switch	30cm x 45cm	1 No
24	I.C.D.P for motor switch & socket for 1-ϕ motor with bakelite sit-	15 cm x 15cm.	2 Nos.
25	flexible conduit	20 mm dia	3 Mts
26	RACK bolts with nut for fixing Iron clad board with wall	12mm dia 150 mm long	8 Nos
27	bolt with nut for main switch of 3-ϕ motor switch & starter	10mm dia 50 mm long	40 Nos
28	G.I. thimble with nut & Bolt for connecting earth wires for mainswitch connecting starter.		40 Nos
29	Rack bolt for fixing switch board		100 No
29	Plugs for welding conduit with wall		
30	fixing saddle with wall	25mm long	100 Nos
31	earthing set with complete arrangement		2 Sets
32	caution plane danger	440V	1 No
33	shock treadment chart		
34	cement concrete sand		

18-11 CST-1

Service connection

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

Metreboard or service board.

The service line is provided with kitkat fuse before it enters to the energymeter for protection of meter agains extra high voltage or line surge. The board on which the cut-out nutral link and the metre are fixed is called service board

Service conductor.

The service connection are given either by bare conductor from nearest pole to the consumer primises 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

Voltage	Across	Along	Else where
Low and medium voltage line	5.795mt	5.49mt	—
For high voltage line	6.1mt.	5.79mt.	—
For low, medium and high voltage upto and including 11KV	—	—	4.575mt if bare 3.965mt if insulated
Above 11KV			5.185 mt
For extra high voltage			5.185 mt plus 0.305m for every 33KV

Q. Prepare a list of material for a service connection ~~for a sing~~ of single storied building at 230V, 1-ϕ load of 5KW. This supply is to be taken from the nearest pole situated at 20mt 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 ≃ 5.8mtr
height of the energymeter = 2mtr from the floor

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

~~Loa~~ ~~calculation of load current~~.

current calculation & selection of cable.

Voltage = 230V.

P.f = 1 (assume)

P = 5KW.

$P = VI\cos\phi$

$I = \frac{P}{V\cos\phi} = \frac{5\times10^3}{230\times1} = 21.74$ Amp

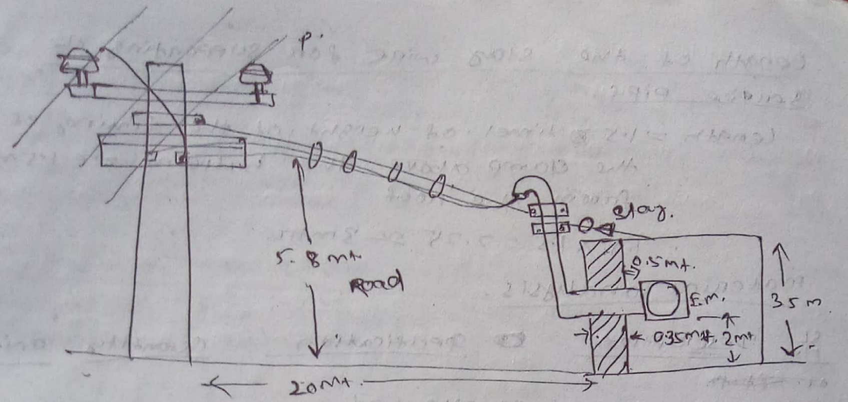
diversity factor = 60% because all the electrical points installed in house are never used at one time

$I = 21.74\times\frac{60}{100} = 13.044$ 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-ckt current is 1.5 times of normal value.

$= 13.04\times1.5 = 19.56$ A.

Reffering to the conductor chart for above current rating 4mm² or 1/2.24mm dia PVC insulated twin core aluminium cable is used.



Calculation the length of G.I. PIPE. of 20mm dia.

Service pipe length = minm ground clearance + top clearance and bend + wall thickness − minm higher of meter board from the floor

$= 5.8 + 1 + 0.35 - 2 = 5.15$ mtr.

Calculation of length of support of G.I. 8 S.W.G.

The length of 8 S.W.G. G.I. wire = span length + 2% sag + 1 mtr at the pole + 1 mtr at the pipe.

$= 20 + (0.02 \times 20 = 0.4) + 1 + 1 = 22.4 \simeq 23$ mtr.

Calculation the length of weather proof cable.

Span length + 2% sag + service pipe line + mtr Chains + 1m at the pole + 1m at the service pipe

$= 20 + 0.04 + 5.15$ mtr $+ 0.5 + 1 + 1 = 28.05$ mtr $\simeq 28$ 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 $= 5.15 - 1 + 0.5 = 4.65$ mtr.

Extra 15% extra $= 4.65 \times 1.15 = 5.35$ 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 = $\frac{\text{length of cable in cm}}{20}$

$= \frac{100 \times 20 + (0.02 \times 20)}{20} = \frac{2040}{20} = 102$ Nos.

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

Length of the stay wire for supporting the service pipe.

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

$= 1.5 \times 1.5 = 2.25 \simeq 3$ mtr.

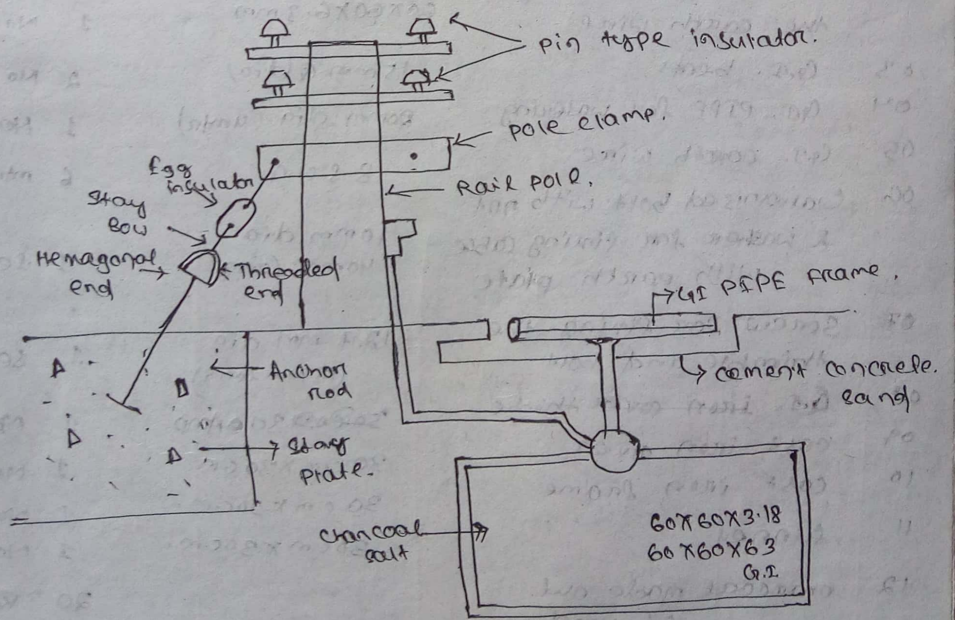
Material analysis.

SL No	Description	Specification	Quantity	Unit
	At the line support or pole end.			
01	Clamp for bearer wire at the pole end	—	1	set
02	bolt with nut and washer for above clamp	—	2	Nos.
03	teak wood board for kit kat fuse	100 x 100 cm	1	No
04	Kit Kat fuse porcelain type	16A, 250V	1	sets
05	wooden screw for using kitkat fuse	4mm dia x 25mm long	2	Nos.
	for span length.			
01	G.I bearer wire as service support	8 S.W.G.	23	mtrs
02	weather proof cable alumin twin core cable.	4mm² or 1/2.24mm dia	28	mtrs.
03	aluminium clips	7.5 cm.	102	Nos.
	at the service support.			
01	GI at service pipe	20mm Dia 5.5m long	1	sets.
02	GI Eb bow	20 mm. dia	2	Nos.
03	Pipe clamp to fix the stay wire & for fixed the bearer wire		2	Nos.
04	GI pipe shadele	20mm dia	4	Nos
05	bolt to bolt the conduct shades with wall	15mdia 150 mm long	8	Nos
06	Stay 7/10 SWG	7/10 SWGI	3	mts
07	stay bow		1	Nos
08	stay rod both & stay buckle & stay plate		1	set

09	stay insulator		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 capable of reading 9999.9		1 No.
14	earthing thimble		1 No.
15	Nut bolt for fixing energymeter with main board	10mm dia 50mm long	4 No
16	concrete & cement		As per req.

Stay arrangement

Q1 A pole of overhead high transmission of 11kV 3-Φ 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

Material list of pole stay connection:-

SL No	NAME	SPECIFICATION	Quantity	Unit
01	Rail pole	9mtr	1	No
02	Anchor rod	16mm φ m.s rod 1600mm long	1	No
03	Anchor plate	150mm x 150mm x 6mm (thick)	1	No
04	I. bolt with hexagonal nut	20mm φ	1	No
05	Stay bow or turn buckle	60mm φ m.s. rod approximately 900mm long	1	No
06	Stay insulator		1	No.
07	thimble		1	No.
08	Stay wire	7/8 SWG G.I.	8	Mtr.
09	concrete for stay	1:2:4 (0.5 mtr³)	As per req.	

Material for pole earthing.

SL No	NAME	SPECIFICATION	Quantity	Unit
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. bents	15mm φ (dia)	2	No
04	G.I. PIPE for watering	20mm dia (4mtr)	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	10mm dia 40mm long	1	set
07	Screw for fixing the thimble and bolt	12.7 mm dia (15mm long)	1	set
08	G.I. ~~iron cover~~ thimbe	~~30 Amp~~ 30 Amp	1	No
09	cast iron cover	30 c.m x 30 c.m	1	No
10	cast iron frame	30 c.m x 30 c.m.	1	No.
11	funnel	30 c.m x 30 c.m.	1	No
12	charcoal made out of wood		20	kg
13	common salt		15	kg
14	cement concrete sand	1:2:4	As per req.	

Overhead line.

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

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

(a) ± 5% of the declared L.T. voltage and

(b) ± 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 cond^n 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 metalic 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 1/6th of the pole is to be buried in the ground. In the case of normal soil condition the depth of the pole in ~~(vii) The cam of the norm~~ the depth of soil in earth earth is subject to condition of soil in earth. i.e if soil is hard the depth can be reduced.

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

(viii) If the overhead line passes above the road, Railway line, school, park, playground or the place for public utilities the guard were should be provided as per specification let down for each of the above place.

(ix) At each support the conductor should be bound with insulators with the help of binding wires so that the conductor withstand wind pressure.

(x) Jumper of proper size should be used.

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

(xii) The wooden poles are roofed before installation by providing 45° metalic slanting cap on the top of the pole to avoid snow or ice standing on the top of the pole in snow bound area.

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

(xiv) The spacing betn the conductor should be maintained as per table below.

SL No	Working voltage	Spacing bet conductor formation		Spacing below conductor and supporting structure formation.
		vertical formation	Horizontal formation	
1	Low tension	38 cm.	46 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.	1.96 m	3.23 mt	76 cm.
5	110 KV.	3.13 m	4.96 m	1.07 mt
6	132 KV.	3.66 mt	4.87 mt	1.30 mt

(xx) 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 800 mtr in 3-Ø, 5 wire system. The span length is 47 mtr use A.A.C. for the distribution of total load for 75 KW to 50 consumer. 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 as per R.E.C. specification use R.S.J. pole.

Ans

Given data 3Ø, 5 wire system.

distance = 800 mtr.

span length = 47 mtr

load = 75 KW.

assume voltage = 415 V.

P.F = 0.85

no of consumer = 50

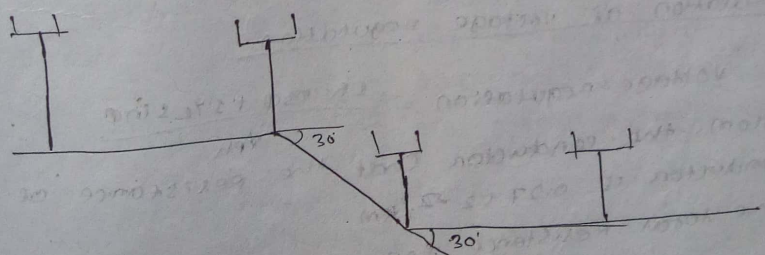
deviation point = 2

deviation angle = 30°

Street light in each pole.

use A.A.C. in distribution.

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



total tension point = 4

so that total tangent point = 18 - 4 = 14.

calculation of load current and selection of conductor size

$P = 75\ KW$

$V = 415\ V$ (assume)

$P.F = 0.85$

$$P = \sqrt{3}\, V_L\, I_L \cos\phi$$

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

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

As per R.E.C. specification for the current rating of 122.7 A we may select 100 mm^2 or 7/4.39 mm dia A.A.C. conductor for phase wire and in 3-ϕ system the nutral wire is the half of cross section of phase wire. so that we select 50 mm^2 or 7/3.10 mm dia A.A.C. conductor for nutral wire.

selection the size of conductor for street light.

no. of poles ~~equal to~~ no. of street light = 18

assuming sodium vapour lamp each of 70 watt

Total wattage = 18 × 70 = 1260 watt.

$$P = VI\cos\phi$$

$$V = 240V.$$

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

min^m size of the conductor for street light 25 mm^2 or 7/2.21 mm dia A.A.C. is used.

calculation of voltage regulation.

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

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

The total resistance for 0.8 km is = 0.2752 × 0.8

= 0.22 Ω

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

~~$I_L = 122.75$~~ $I_{ph} = I_L = 122.7A$

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

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. ±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 condu^n^ per km = 290 kg/km. = 0.29 kg/mtr

Safety factor for R.S.J. pole = 2

tension = $\frac{\text{Ultimate stress}}{\text{safety factor}}$

from the condu^n^. chart the ultimate stress = 15.96 K.N.

tension = $\frac{15.96 \text{ KN}}{2}$ = 7.98 KN.

9.8 N = 1 kg.
1 N = $\frac{1}{9.8}$ kg.
15.96 KN = $\frac{15.96 \times 10^3}{9.8}$ = 1628.57.

tension = $\frac{1628.5}{2}$ = 814.

Sag = $\frac{WL^2}{8T}$ = $\frac{0.29 \times 47^2}{8 \times 814.3}$ = 0.098 M.

Calculation of pole height.

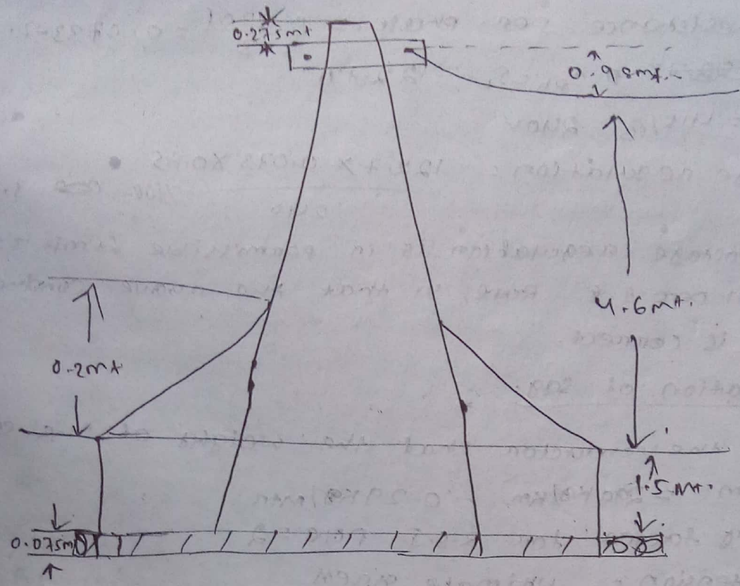
The height of pole = min^m^ plantation depth + ground clearance + sag + top clearance.
= 1.5 + 4.6 + 0.098 + 0.275 = 6.473 mtr.

The min^m^ height of the pole = 8 mtr of RSJ or P.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 × 0.4
= 0.16 m²



total length of cement concrete = 0.075 + 1.5 + 0.2
= 1.77 mtr.

total volume = 1.75 × 0.16 = $0.284 m^3$ for each pole.

for 18 no of pole = 0.284 × 18 = $5.112 m^3$

Calculation the volume of cement concrete for stay wire.

The volume of stay wire = 0.3×0.3×0.3 = $0.027 m^3$
for pole stay wire

for 4 no. of pole = 0.027×4 = $0.108 mtr^3$

The total volume of cement concrete = 0.108 + 5.112
= $5.22 m^3$

Material analysis for tangent pole.

SL NO.	Description	Specification	Quantity/pole	no of pole	total
01	cross arm	75mm×40mm ×5mm×1110mm long.	1	14	14
02	Back clamp.	40mm×6mm as flat suitable for pole	1	14	14
03	Bolt with nut and washer	16mm dia 50mm long	2 set	14	28 set
04	pole top bracket	50mm×8mm thick.	1	14	14
05	Bolt with nut and washer bracket.	16mm dia 50mm long	2 set	14	28 set

	earthing lead	8 SWG GI.	3mtr.	3	9mtr.
06	Pin type insulator	LOW tension.	5.1410	14	70.
07	binding wire for insulator.	aluminium conductor 4.3 mm dia	200gm	14	2800gm.
08	Pipe earthing set with complete accesories	14mm ⌀ G.I. PIPE of 2.5m length.	1set		3 No.
09	Street light fitting made of GI. ~~wire~~ pipe with ~~concrete~~. set. complete.		1set	14	14set

For angle ~~rotat~~ 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 Nos.
03	Bolt with nut & washer.	16mm dia, 50mm long.	2set	2	4sets.
04	Pole top bracket	50mm x 8mm thick.	1	2	2 Nos.
05	Bolt with nut & washer for bracket.	16mm dia 50mm long.	2set	2	4sets.
06	Sackle insulator.	L.T.			
07	U clamp and D clamp	ms clamp 40mm x 60mm	10	2	20
08	bolt with nut & washer with U clamp	16mm dia 50mm long	10	2	20
09	PIPE earthing with comple set.	14 mm dia GI PIPE of 2.5 m length	1set	2	2set
10	earthing lead	8 SWG GI wire 3mtr length	3mtr	2	6mtr
11	Street light fitting.		1set	2	2set
12	Stay wire with complete set.	GI stay wire 7/3.15 mm with complete accesori	1 set	2	2set.

For end point.

01	cross arm	75 mm x 40 mm x 5mm 1110 mm long	2	2	4 Nos.
02	Back clamp for above.	40mm x 6mm as flat suitable for the pole.	2	2	4 Nos.
03	Bolt with nut & washer.	16mm dia, 50mm long	4 set	2	8 sets

04	Pole top Bracket	50mm×8mm thick.	1	2	2 Nos
05	Bolt with nut and for Bracket.	50mm long 16mm dia	4	2	8 Nos
06	Sackle insulator	L.T.	10	2	20 Nos
07	U clamp or D clamp	ms flat 40mm×6mm.	10	2	20
08	Bolt with nut and washer	16mm dia, 50mm long.	10	2	20
09	Pipe earthing set	14mm dia G.I. pipe of 2.5mtr. length	1 set	2	2 set.
10	earthing lead	G.I. wire of 8 SWG.	3mtr	2	6mtr
11	street light fitting		1 set	2	2 set
12	stay wire with complet accessories.	GI wire 7/10.	1 set	2	2 set

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 Nutral	$50mm^2$	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 sand	1:2:4			$5.22\ m^3$

08

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 107 Mtr. There may be 1 deviation point at 22°. calculate height of the pole and no. of pole. determine the size of conductor, voltage regulation of line Receiving end voltage According to I.E. Rule calculate the sag assuming wind zone 75Kg/m² assuming Reactance 0.31 Ω per KM and prepare a complete material chart for above purpose.

Ans

Given data

3Φ, 11KV, H.T. Line

distance = 8Km = 8000mtr

voltage = 11KV = 11×10^3 V

Power = P = 300KW

Deviation angle = 22°

Deviation Point = 1

P.f = cos Φ = 0.85

Span = 107mtr.

Wind zone = 75Kg/m^2

Reactance = 0.31 Ω/Km.

Calculation no of poles.

$$\text{Total no of pole} = \frac{\text{total distance}}{\text{span length}} + 1$$

$$= \frac{8000}{107} + 1 = 75.7 \simeq 76$$

For double pole structure there are 3 extra pole required

So total no of pole = 76 + 3 = 79

According to the R.E.C. rule standard R.S.J. pole is used at double pole structure and P.C.C. pole are used at tangent location.

The total no of PCC pole = 73

RSJ pole for double pole structure = 6.

Calculation of load current and size of conductor.

$P = 300KW = 300\times10^3 W$.

$V = 11KV = 11,000V$.

$\cos\phi = 0.85$

$P = 300\times10^3 = \sqrt{3}\times11\times10^3\times I_L\times0.85$

$$I_L = \frac{300\times10^3}{\sqrt{3}\times11\times10^3\times0.85} = 18.52\ A.$$

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

calculation of sag.

weight of the wind pressure = $75\,kg/m^2$

from the conductor chat the approximate diameter of the conductor $6.33\,mm = 6.33 \times 10^{-3}\,m$

total wind pressure $= 75\,kg/m^2$

total wind pressure $= 75\,\frac{kg}{m^2} \times 6.33 \times 10^{-7}\,m$

$= 0.47\,kg/m$.

from the conductor chart weight of conductor = $85\,kg/km = 0.085\,kg/m$

Net weight $= \sqrt{w_p^2 + w^2}$

$= \sqrt{0.47^2 + 0.085^2}$

$\approx 0.48\,kg/m$.

~~tension (T) =~~

from the conductor chart the ultimate strength = $7.61\,KN$

$= \frac{7.61 \times 10^3}{9.81} = 775.74\,kg$

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

$= \frac{775.74}{2} = 387.8\,kg$.

$Sag = \frac{wl^2}{8T} = \frac{0.48 \times 107^2}{8 \times 387.8} = 1.76\,mtr$.

Calculation height of pole.

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

$= 1.5 + 4.6 + 1.75 + 0.27 = 8.12 \simeq 8\,mtr$.

the standard size of pole 8 mtr is used

calculation for Receiving end voltage.

$V_S = V_R + \sqrt{3}\,(I R_a \cos\phi + I X_L \sin\phi)$ ① (∵ 1 com)

From the conductor chat the resistance at $20^\circ C$ is $1.39\,\Omega/km$

total Resistance for 8 km $= 1.39 \times 8 = 11.12$.

Reactance for 8 km $= 0.31 \times 8 = 2.48\,\Omega$

Voltage reg =

The volta...
for
So the a...

volume ...

As per ...
Provided
The ...

Total ...

Total vo...
for 79...

calculat...

The vol...

Total vol...
Total vol...
Stay = 0...

Material ...

SL NO	Name ...
01	P.C.C. ... tange...
02	R.S.J.
03	V cross... for ...
04	Stay cla... double ...

$V_R = V_S - \sqrt{3}(I_a R_a \cos\phi + I_a X_L \sin\phi)$

$V_R = \frac{IR \cos\phi + IX_L \sin\phi}{V_{ph}}$ $= 11\times10^3 - \sqrt{3}\times 18.52 \times (11.15\times0.85 + 2.48\times0.526)$

$= \frac{18.52(11.12\times0.85 + 2.48\times0.526)}{6350.8}$ $= 10.65KV.$

$\text{Voltage reg} = \frac{V_S - V_R}{V_S}\times100 = \frac{11\times10^3 - 10.65\times10^3}{11\times10^3}\times100$

$= 3.18\%.$

The voltage regulation is in permissible limit ±12.5% for H.T. line as per I.E. rule.

So the above conductor size is correct.

Volume of cement concrete.

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

The area of cross section of the concrete pad

$= 0.4\times0.4 = 0.16 m^2$

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

$= 1.775 m$

Total volume $= 1.775\times0.16 = 0.284 m^3$

For 79 pole $= 0.284\times79 = 22.43 m^3$

Calculation the volume of cement for stay

The volume of staywire $= 0.3\times0.3\times0.3 = 0.027 m^3$ /pole

Total volume of 6 stay $= 0.027\times6 = 0.162 m^3$

Total volume of cement concrete for both pole and stay $= 0.0162 + 22.43 = 22.6 m^3$

Material list.

Sl No	Name of Item	Specification	Quantity/pole	No. of pole	Quantity
01	P.C.C. Pole for tangent location	8 mtr	1	73	73 Nos.
02	R.S.J. Pole	8 mtr.	1	6	6 Nos
03	V cross arm for tangent location	75 × 210 mm	1	73	73 Nos
04	Stay cross arm for double pole structure	75×410 mm MS channel	2	3 double pole structure	6 Nos.

05	back clamp for 'V' cross arm	(50×8) mm	1	73	73 Nos
06	bolt with nut and washer	16 mm dia 15 mm long	2 set	73	146 Nos
07	bolt with nut and washer from straight cross arm.	16 mm dia 50 mm long.	4 set	3	12 set.
08	pole top bracket for tangent location	50×8 mm	1	73	73 Nos
09	bolt with nut and washer for pole top bracket.	16 mm dia 50 mm long.	2	73	146
10	pin insulator.	11 KV.	3	73	219
11	disc insulator	11 KV	6	3 dp struct	18
12	Pipe earthing set with complete accessories	G.I. pipe of 140 mm dia 2.5 m long.	2 set.	3 dp struct	6 set
13	Earthing lead	8 SWG GI	6 m/dp struct.	3 dp st	18 mtr
14	stay wire with complete accessories for dp structure	7/3.11 mm dia.	2 set	3 dp st	6 set.
15	clamp for stay wire	ms flat for 20mm × 6mm thickness	2 set	3 dp st	6 set.
16	Bolt with nut and washer.	16 mm dia, 50 mm long	2 set	3 dp st	6 set.
17	Binding wire of aluminium	4.39 mm dia 200 gm	200 gm	73	14.6 kg
18	ACSR conductor.	7/2.11 mm dia			24556 mtr
19	Red oxide paint				As per req
20	Aluminium oxide paint				As per
21	danger plate		1	76	76
22	Anti climbing device				As per req
23	cement concrete sand	1:2:4			22.6 m³

SUBSTATION:-

There are two types of substation.

(i) pole - mounted substation

(ii) plinth-mounted substation.

→ Upto 125 KVA pole-mounted substation is done.

→ Above 125 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/(433-250) V the double pole structure should be provision of Air-break switch, lightening arrester, Hg fuse, LT 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.T. side.

$V = 11 KV = 11 \times 10^3$

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

taking short-ckt current 50%.

$I = 3.93 \times 1.5 = 5.9 A.$

Calculation of current in L.T. side.

$V = 11 KV,$

$I_L = \frac{75 \times 10^3}{\sqrt{3} \times 433} = 100 A.$

taking 1.5 times for short-ckt.

$I = 100 \times 1.5 = 150 A.$

Selection of ACSR conductor.

From the conductor chart for the current rating of 5.99 A we may select 20 mm² or 7/2.11 mm² ACSR conductor is selected for H.T. connection.

Selection of cable for L.T.

From the conductor chart we may select 95mm² or 19/2.50mm dia 3-core cable for L.T. connectio[n]

Material analysis.

SL NO	Description	Specification	Quantity	Unit
01	T/F	11KV/433-250V. 75KVA.	1	No.
02	RSJ or PCC pole.	9mtr or 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 or 40mm dia G.I Pipe	1	No
05	horn-gap fuse	3-Φ, 11KV; complete set	3	Nos
06	ACSR conductor for H.T. side.	30mm² or 7/2.11mm dia	As per req	
07	L.T. Cable	95mm² or 19/2.50mm dia	As per req	
08	L.T. C.B. oil filled	~~oil filled~~ 433V, 100A.	3	Nos
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.G. fuse and A.B. switch.	75mm X 40mm X 2800mm long.	4	N[os]
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	75 X 40 X 2800mm long	2	Nos.

14	Platel for fixing the cross arm for HG fuse.	40mm x 6mm made of from M.S. flat	As per req.
15.	Bracket unit end 'D' clamp for operating handle of A.b switch.	35x35x35 mm² thickness.	4 sets.
16	M.S. Pole with nut & washer.	10mm dia	As per req.
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.	Alumin. cond.	500gm.
22	Danger board	As per BIS.	1 NO.
23	Anticlimbing device		As per req.
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 & stay	1:2:4	

Q/ For 38 no of fan and light point in a Residencial building described which type of B.D.B will be selected.

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 ration 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 I.E. rule short ckt current is 1.5 time of normal current, so that $I_{sc} = 13.12 \times 1.5 = 19.68A$.

Current calculation for L.T.

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

The short ckt current is 1.5 times of the full-load current. $= 360.84 \times 1.5 = 541.2A$.

Selection of conductor for H.T.

We may select from the conductor chart 20mm² or 7/2.11 mm ACSR conductor is selected.

Selection of conductor for L.T.

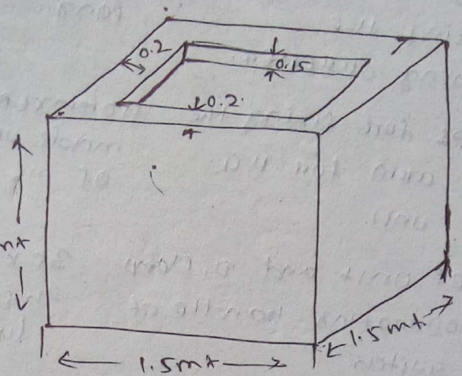
We may select 400mm² or 61/3 mm dia aluminium conductor for the current rating of 541.2 A.

Calculation of the volume of cement concrete for plinth

The outer volume = length × breath × height
$= 1.5 \times 1.5 \times 1.5 = 3.375 m^3$

inner vaume $= 1.1 \times 1.1 \times 1.35 = 1.6335\ m^3$

total volume of plinth = outer volume − inner volume
$= 3.375 - 1.6335 = 1.7415 m^3$



Material list.

SL NO	Description	specification	Quantity	Units
1	Distribution T/F	(11/0.4) KV, 250KVA	1	NO.
2	RSJ pole or 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 fill type 400V, 360A	3	Nos.
9	ms. channel cross arm for H.G. fuse 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 lightning arrester.	75x40x2800 mm long	2	No.
12	Clamps for fixing the cross arm for H.G. fuse unit.	40mmx6mm made up of ms flat		As per req.
13.	Braket unit and D. Clamp for operating handle of AB switch	35 x 35 x 35 mm thickness (4 set)	16	no
14	mesh bolt with nut and washer.	10mm Φ 20 mm Φ		As per req.
15.	Earthing set complete.		1	set
16.	GI earthing ~~strip~~	8 SWG.	50	mtr
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.	Jumper wire	AAC		As per
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.