CHAPTER-1

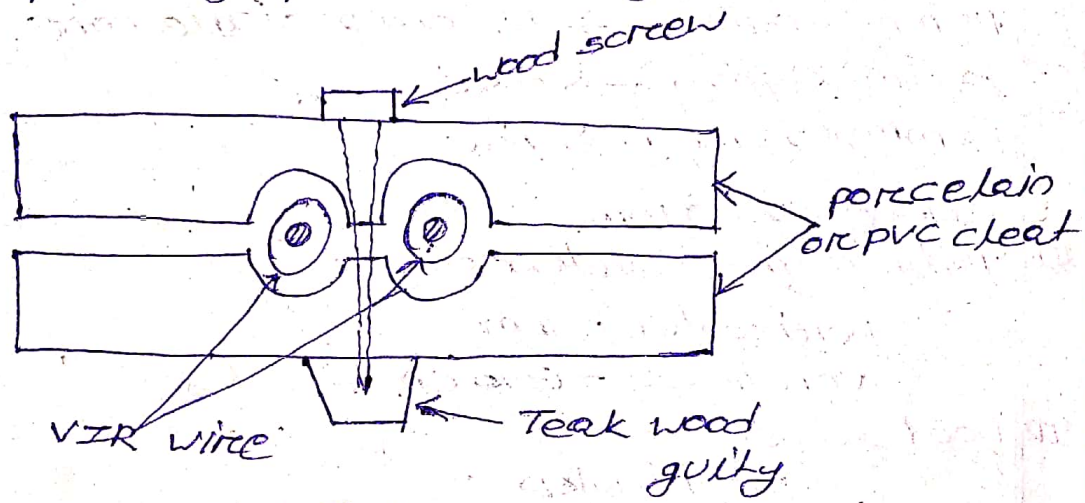
DOMESTIC OR INTERNAL WIRING

→ There are 5 types of domestic or internal wiring.

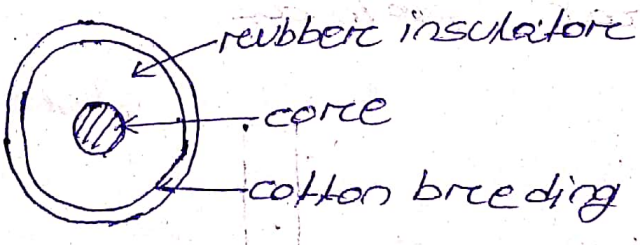
1. cleat wiring
2. casing caping wiring
3. CTS or TRS or Batten wiring
4. Lead sheathed wiring
5. conduit wiring / pipe wiring.

1. CLEAT WIRING

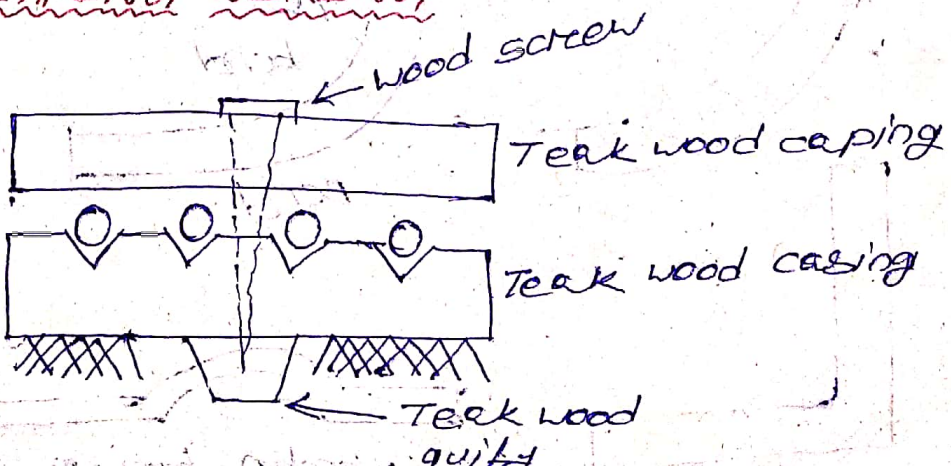
→ In this type of wiring is used temporary wiring like camp wiring, product wiring etc.



VIR → Vulcanization Indian rubber



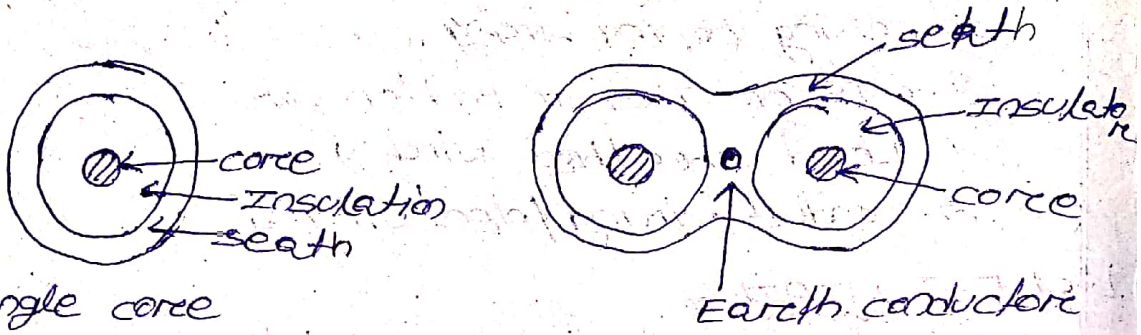
2. CASING CAPING WIRING



→ Life span is 20 years

3. CTS (cap type seath) OR TRS (Through Rubby seat) OR BATTEN WIRING

i. WIRE



(ii) Batten size

13 mm X 13mm → 1T or 2 single core

13 mm X 19mm → 3SC

13 mm X 25mm → 4SC

1inch = 25.2mm

iii guilty to guilty distance

Horizontal = 1m

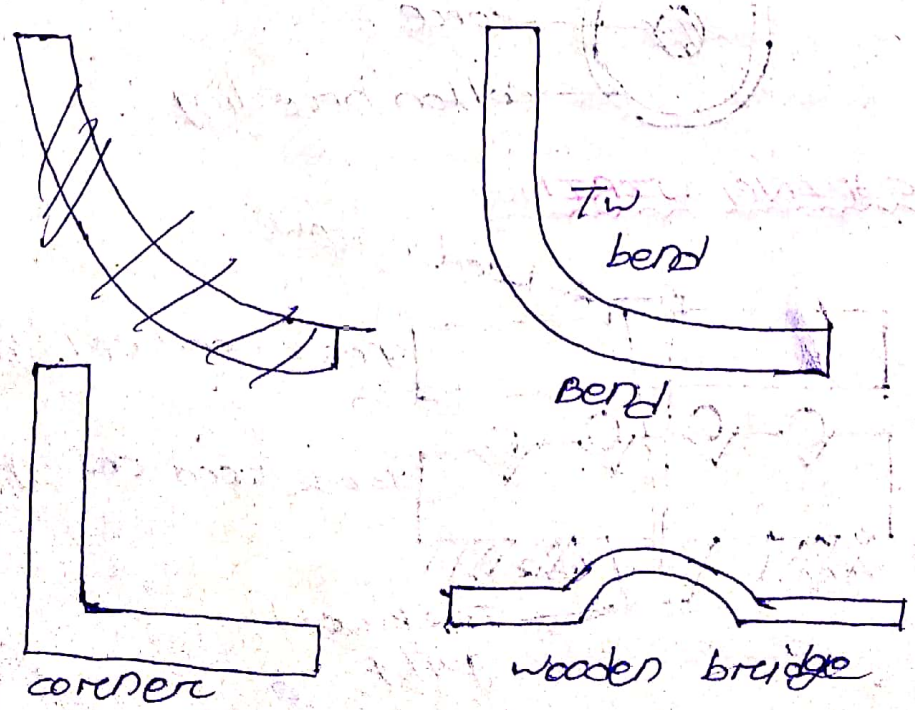
vertical = 60 cm

iv Wood screw

= 19mm NKP

NKP = Normaly plaincut

PKP = project plain cut



(v) Link clip

tin , 25mm (2 single core)

38 mm (3 single core)

vi) Link clip to link clip distance

Horizontally = 10cm

vertically = 15cm

vii) Running earth wire

CU → 14-18 SWG

GI → 14 SWG

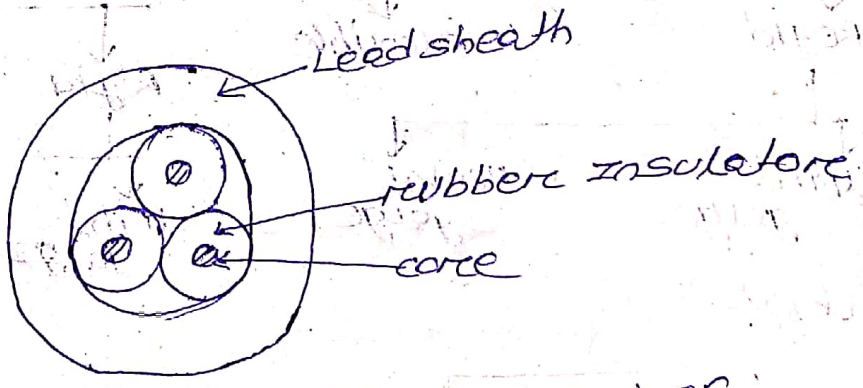
SWG → standred wire Gauge

→ overal life span is 15 years

4. LEAD SHEATHED WIRING

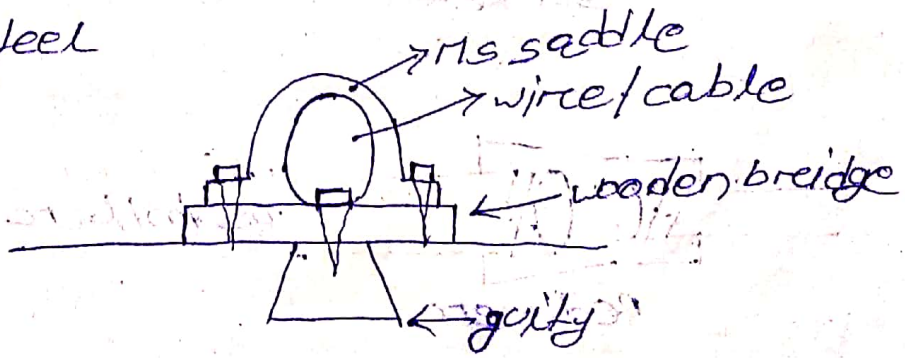
→ In this type of wiring used in railway platform, stadium, plant store yard

→ Life span is 15 to 20 year

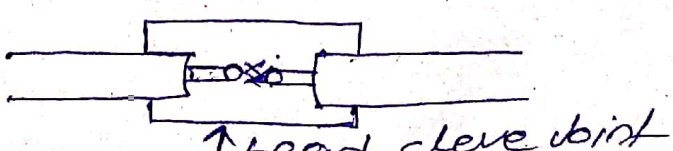


water proof & shock proof

MS = Mild steel



→ Maximum span 1m

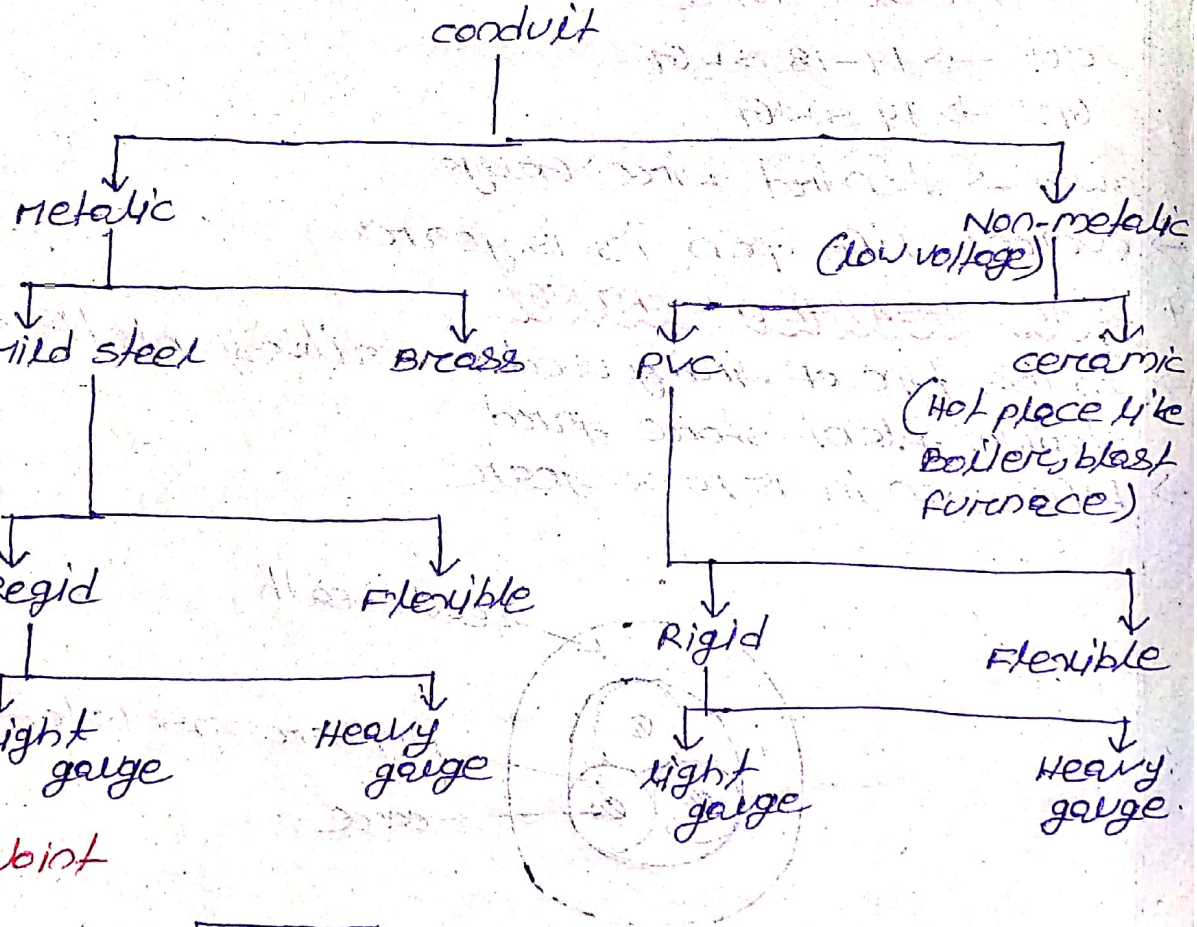


5. CONDUIT WIRING

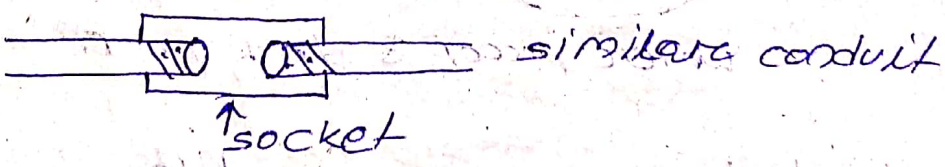
→ Always single core PVC or VIR wire is used

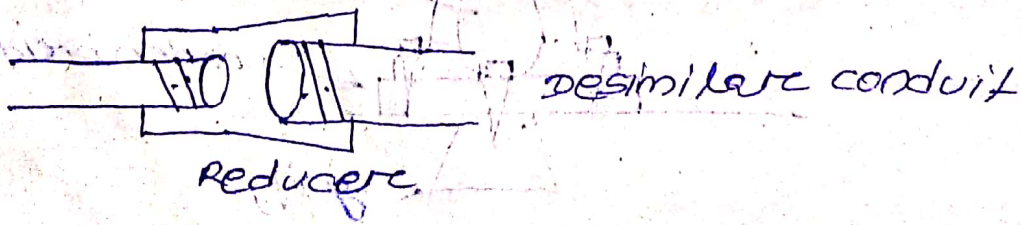
→ Basically two types

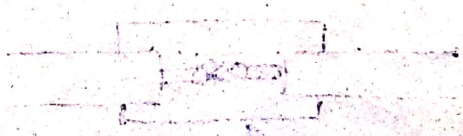
1. surface conduit wiring
2. concealed conduit wiring

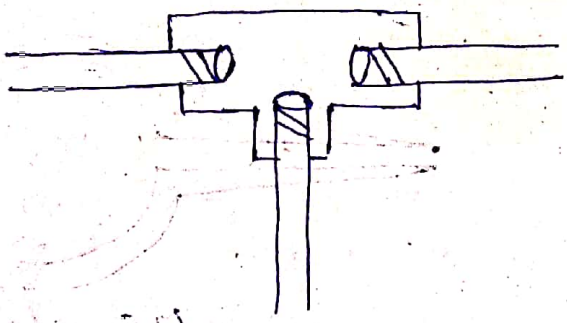


→ Joint

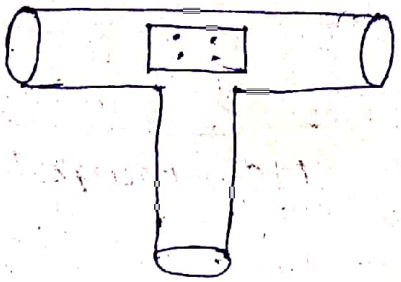






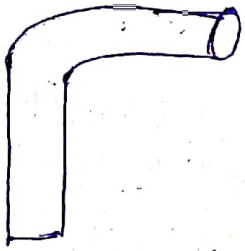


Normal Tee

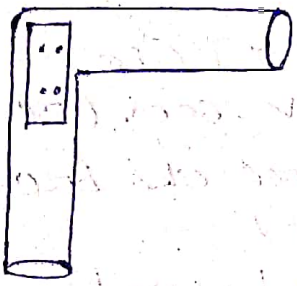


Inspection Tee

→ Bend

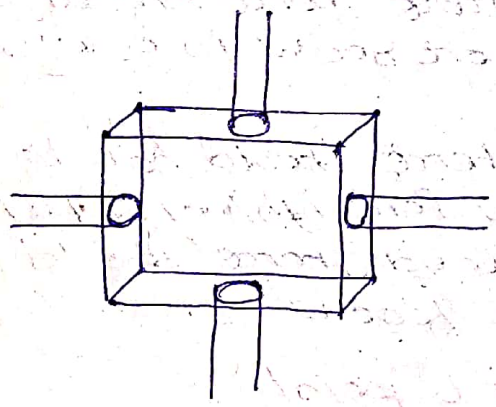


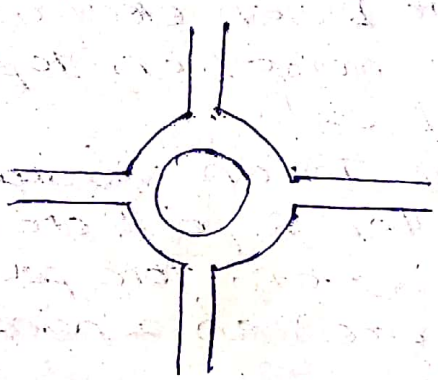
MS bend elbow



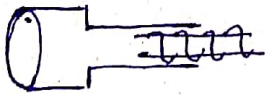
Inspection elbow

→ MS BOX





→ Flexible conduit end connector



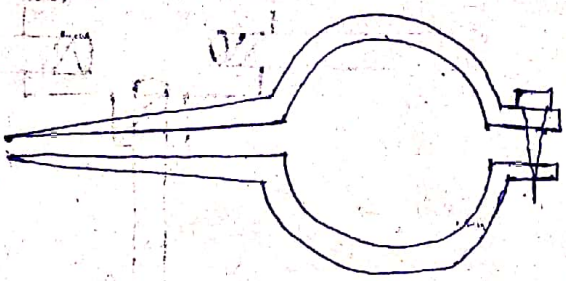
→ conduit size

→ 13mm conduit for two single core wire of light and fan ckt

→ 19mm conduit for minimum size for power ckt

→ Maximum distance 45cm

MS creampet



MS clamp

→ chemical, Fire, Moisture, shock proof
→ Tolerate maximum mechanical pressure
→ Main switch
  - 250V, 16-32A (1φ)
  - 500V, 550V, 600V (3φ)
→ MCB (Miniature ckt breakers)
→ switch boxed
  i. Teak wood
  ii. MS & Mica plate
→ As per Indian electricity rule there should not be more than 10 point or 800W in a ckt or sub ckt.
→ As per Indian standard there should not be more than 8 point or 500W for light and fan ckt load and for power load there should not more than 2 point or 1000W
→ wattage of some electrical point.

1. Incandescent lamp - 100W, 200W
2. Fluorescent lamp - 40W
3. ceiling fan - 60W
4. Exhaust fan - 100W
5. Water light lamp - 100W
6. ordinary plug ckt - 60W/100W
7. calling bell - 40W
8. power shocket - 1000W

→ Main switch to Master distribution board (MDB)
→ Main ckt
→ Main switch to Branch distribution board → sub. Main ckt
→ Branch distribution board to intermediate board → sub ckt
→ Minimum 5A fuse is required in every sub ckt
→ ICBDB → Iron clad Branch distribution board
→ Junction BUS Minimum size 10 CM × 10 CM = 4" × 4"
" = Inch
→ switch Board → switch, shocket, Fan regulator, Fuse, indicator.
→ different type of switch
→ single way → pendent
→ Double way → selector
→ Flush type → Tumbler
→ Toggle → 5A → ordinary ckt
→ push Button → 16 A → power ckt
→ socket.
2 pin, 3 pin, 5 pin
ordinary socket = 5A
power socket = 16A

RULES REGARDING ELECTRICAL WORKS

→ All the works related to generation, transmission, distribution and utilisation should confirm indian electricity act 1910 and indian electicity rules 1956
→ All the workers engaged from the concerned electrical work must have be Authority/licence from electrical inspector/electrical inspector general
→ consumption of electrical power should be commenced only after approval only electrical inspector in conform ISI standred.

→ All the electrical works should be supervised by competent engineer or a licenced contractor for this purpose.

→ After competion of each work all the test should be carried out in the prescribed manner and should be submitted to the electrical inspector in the prescribe manner/ perform signed by both contractor and supervisor.

→ For any electrical work a single person shall not engage at any time, a licence helper must be required to carry out electrical works.

→ When works in order light condition is carried out it is the duty of supervisor and incharge engineer to all the safety rule are strictly followed

SOME RULE REGIARDING HOUSE WIRING/INTERNAL WIRING

→ All the domestic installation should be low voltage system only.

→ power ckt or heating ckt should be separate.

→ Light & Fan should be conected separately.

→ Any electrical conection should be clearly inspectable.

→ The main ckt or the metal board should be located at the place which is easyly accessable without any barrier.

→ The total load point should be uniformly distributed so that the maximum voltage drop should not exceed 2% +1 of the declard voltage.

→ All the equipments and electrical assories used in electrical ckt should confirmed standard frequency.

→ All the electrical system should be atlist 23cm (9 inch) below the celing.

→ The batten or conduit height should be at list 2.5m from floure for surface wiring and at list 1.5m for concealed wiring.

→ The height of the switch board should be at list 1.23m (4 feet) from the flare.

→ When wiring is carried out to ancilliary building through open space the wiring should be carried out either with GI pipe or wheather proof wire and GI bearer wire at minimum height of 2.5m.

→ The minimum height of celing fan or any pentant connection should be at 2.5 m height from the flare.

→ The current rating of the selected conductors should be taken with a factor of shefty at list 1.4 for light and fan ckt 1.5 for power ckt.

→ For industrial wiring the factors of shefty is 2.

→ The minimum cross sectional area for light and fan ckt should be 1mm² copper or 1.5mm² Aluminium. For power ckt 1.5mm² cu and 2.5mm² AL.

→ The wires used for low voltage system should be up to 250V grede insulation and Midium voltage system should be 550volt-grade

→ The selected conductors should be confirem requir-ed current rating of insulation minimum conduct-or size and voltage drop limitation.

→ The pendant conection like tubelight and fan. etc silk breded flexiable twisted wire of 0.5mm² cross section should be used.

→ For eech section of the building separate Master control should be provided.

→ The switches used should be placed in live wire or phase conductor.

→ The first switch at the entrance should be of a light point of the room and the first switch board should be place left side of the entrance.

→ The switches placed in a switch board can be connected in looping if the belong to some sub-ckt.

→ The running earth should be provided to each metalic component of the electrical ckt by 14 (GI) SWG or 18 (Cu) SWG.

→ When metalic boxes are used with conduit wiring check & lock noughts should be provided.

→ For industrial wiring separate earth connection should be taken with minimum 10 SWG HDBC (Hard drawn Bed copper) conductor seperately.

→ The switch board should not be located near stoves, inside the branch room and damp places or near washing machine.

→ The power wiring if a panel is required the clearance from the wall should be atlist 76cm ($30\frac{29.92}{}$ inch) or the wiring should be taken in the ground of the floor.

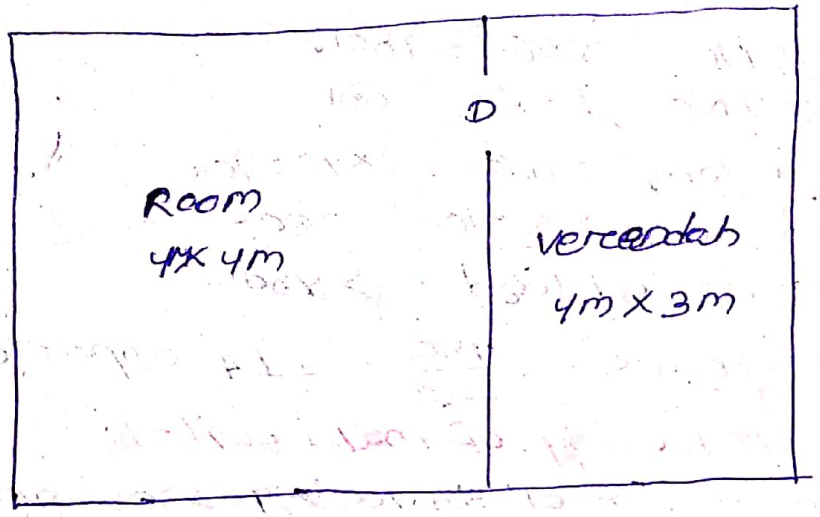
→ For motor connection a main switch will be provided with in 2 meter of operation. All the motor connection should be carried out separately with there control from a suitable bus-bare.

→ The maximum earth resistance for a domestic insulation from any point to the earth should not be make than 5Ω. where as power and industrial wiring it should be more than 2Ω.

CHAPTER-3

PROBLEM-1

A room and a verandah, the plan of which is given below is required to be provided with electrical wiring. Mark the location of the energy meter, main switch and switch board and electrical points suitable and draw the installation plan showing supply path to each point and wiring diagram. calculate the total length of wire required for wiring the room and verandah in batten system of wiring. prepare a list of material with which complete specification of each item with approximate cost.

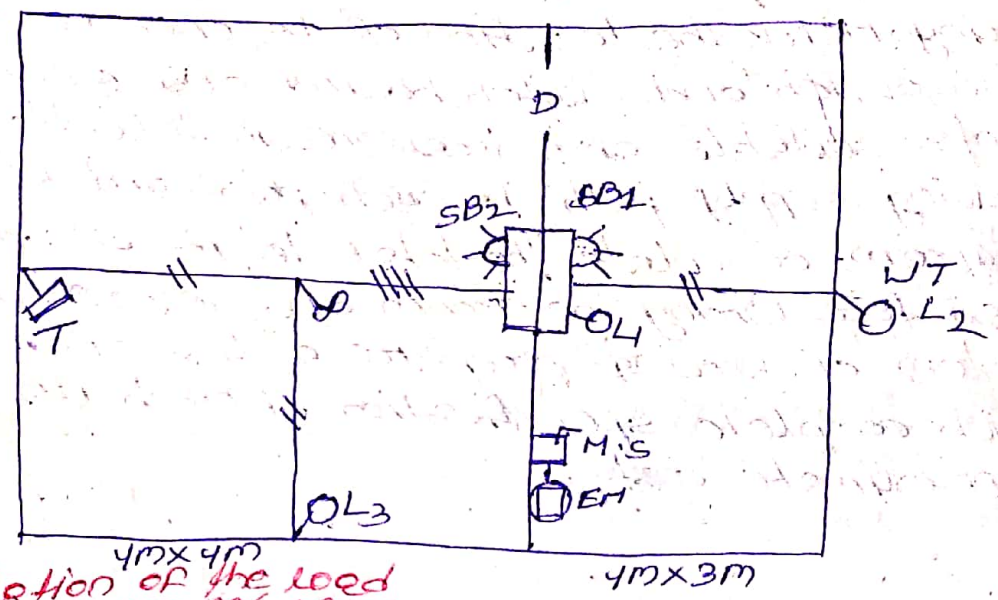


solution

Assumption

a. Total ceiling height = 3.5 mt
b. Height of the H.R (Horizontal Run) from flour = 3 mt
c. Height of B.S.B from flour = 1.5 mt
d. Location of the energy meter and main switch board is equal to 0.5m inside verandah or room wall.
e. All dimensions are meter.

Installation plan



calculation of the load

Lamp → 3 No – 3 × 60 = 180W

Fan → 1 No – 1 × 60 = 60W

Flourescent lamp → 1 No → 1 × 40 = 40W

Socket → 2 No → 2 × 100 = 200W

Total connected load → 480W

Load in Amperes = $\frac{480}{230}$ = 2.1A approx.

selection of rating of main switch

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

~~The distribution bo~~

selection of rating of distribution board.

The distribution board always on the basis of no. of points. Hence there is only 7 load points hence distribution board.

calculation for length of batten

From main board to H.R = 1.5m = 13mm × 13mm 2 wires

From H.R above main board to L_1 = 1.5m = 13mm × 13mm 2 wires

From H.R to SB1 = 1.5m ~~= 13mm × 13mm~~

= 31mm × 13mm 5 wires

13.01.20

From SB2 to H.R = 1.5mt = 25mm x 13mm 4 wires

From L1 to L2 = 0.5 + 3 + 0.5 = 4mt = 13mm x 13mm 2 wires

From H.R above SB2 to Fan = 0.5 + 2 = 2.5mt

= 25mm x 13mm 4 wires

From Fan to L3 = 2.5mt = 13mm x 13mm = 2 wires

From Fan to tubelight = 2.5mt = 13mm x 13mm 2 wires

→ Total length of batten size.

13mm x 13mm = 1.5 + 1.5 + 4 + 2.5 + 2.5 = 12mt

25mm x 13mm = 1.5 + 2.5 = 4mt

31mm x 13mm = 1.5mt

→ Taking 10% for wastage on joints the total length of batten of various size will be

13mm x 13mm = 12 + 1.2 = 13.2 ≅ 13mt

25mm x 13mm = 4 + 0.4 = 4.4 ≅ 5mt

31mm x 13mm = 1.5 + 0.15 = 1.65 ≅ 2m

→ calculation for length of aluminium conductor VIR wire of size 1.5mm²

→ Wires on batten size

13mm x 13mm = 12 x 2 = 24mt

25mm x 13mm = 4 x 4 = 16mt

31mm x 13mm = 1.5 x 5 = 7.5mt

Total length of wire on batten = 47.5mt

Wire in conduits at wall crossing is equals to 2 wires x 0.25mt = 0.5mt

→ Total length of the wire taking 15% wastage

= 48 + 7.2 = 55.2 ≅ 55mt

calculation for length of the earth wire.

→ The earth wire of 14SWG GI is uninsulated and installed along with other wire same batten

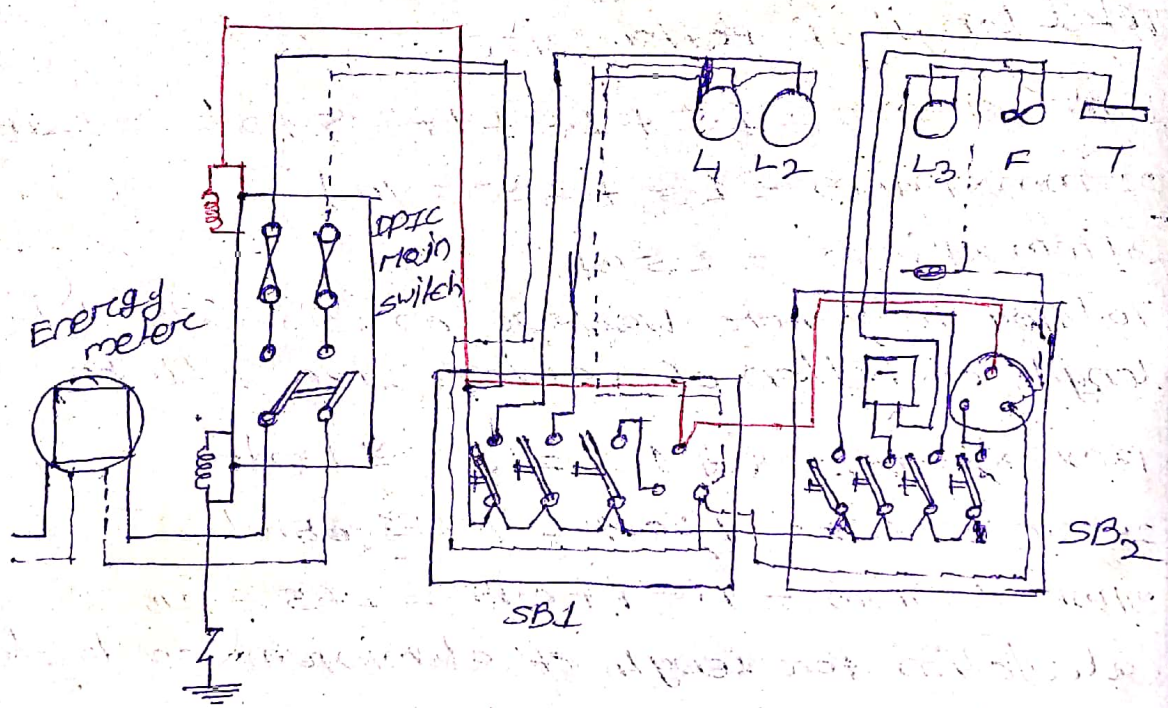
→ From M.S to SB_2 through SB_1

$= 1.5 + 1.5 + 1.5 + 0.25$

$= 4.75$

Taking 10% on wastage of earth wire

$= 4.75 + 0.75 = 5.22 \cong 5mt$



MATERIAL TABLE

SL.NO	specification	quantity
01.	DPIC Main switch 5A rating 250V grade with fuse and NL (Neutral link)	01 NO.
02.	Teak wood main box 30cm×30cm (12inch×12inch) For enclosed energy meter and main switch	01 NO.
03.	Teak wood main board frame shutter with locking arrangement for covering main board.	01 No.
04.	Teak wood batten size	
	13mm×13mm	13 mt
	25mm×13mm	5 mt
	31 mm×13mm	2 mt
05.	CTS wire of size 1.5mm2 or 1/2.24mm die. single core 250V grade.	55 mt

06.	Earth wire 14SWG, GI.	5m/t
07.	conduit pipe 20mm dia, black enamel, at wall crossing.	0.25m/t
08.	Teak wood switch board concealed type with bakelite sheet.	
	20cm x 10cm	1NO.
	20 cm x 25cm	1NO.
09.	Flush type switch 5A rating one way	7NOS
10.	Flush shacket 5A rating 3 pin	2NOS
11.	ceiling rose, 2 plate, bakelite for tubes and fans	2NOS
12.	Teak wood round block, 10mm diameter	4 NOS
13.	water light fittings for lamp outside the verandah.	1NO.
14.	Teak wood guttis	1450/45 = 25NOS
15.	Brass lamp brecket with holders	2NOS
16.	Link clips 40mm long	5500/2x10 = 300NOS
17.	Black enamel nails to fix link clips with batten	100gms
18.	wood screws 25mm long to fix batten with guttis	25NO.
19.	wood screws 25mm for fixing bakelite sheeth with switch board	24NOS
20.	Earthing thimbles 5A rating for fixing earth wire to main switch and distribution board.	2NOS
21.	Earthing set complete (pipe earthing) with pipe, earth wire, charcoal, salt, thimble, nut bolt etc.	1set

CHAPTER-4

WORKSHOP/SMALL INDUSTRIES WIRING

Q

The workshop of size 10m x 6m x 4m is under construction. It is required to be provided with following electrical connection for Motors

1. one 5HP 3Φ Motor
2. one 3HP 3Φ Motor
3. one 2HP 3Φ IM
4. one 1HP 1Φ Drilling M/c
5. one 0.5HP 1Φ Grinding M/c

a. Draw Installation plan
b. Draw single line diagram
c. Draw wiring diagram
d. calculate length of conduit wire, earth wire and prepare material table.

Ans

ASSUMPTION

→ Height of M.S, Motor switch & control switch from floor = 1.5mt
→ Height of H.R from floor = 2.5mt
→ Main distribution board is 1mt from the nearest corner of the wall.
→ Height of all Motor except drilling machine Motor is 0.5mt above floor.
→ Height of drilling machine is 1.5mt above the floor.
→ Assume efficiency of 3Φ Motor is 0.75 and P.F = 0.8

CALCULATION OF LOAD IN AMPER

$$I_L \text{ For 5HP Motor} = \frac{5 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.75}$$

$$= 8.84 \cong 9A$$

$$I_L \text{ For 3HP Motor} = \frac{3 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.75}$$

$$= 5.30 \cong 5A$$

$$I_L \text{ For 2HP Motor} = \frac{2 \times 735.5}{\sqrt{3} \times 400 \times 0.8 \times 0.75} = 3.53 \cong 3.5A$$

Total current in Ampere for 3 No. of 3 H.P Motors = 9+5+3.5 = 17.5A

Assuming 50% over load on all motors the total current drawn = 17.5 + 8.75 = 26.25A

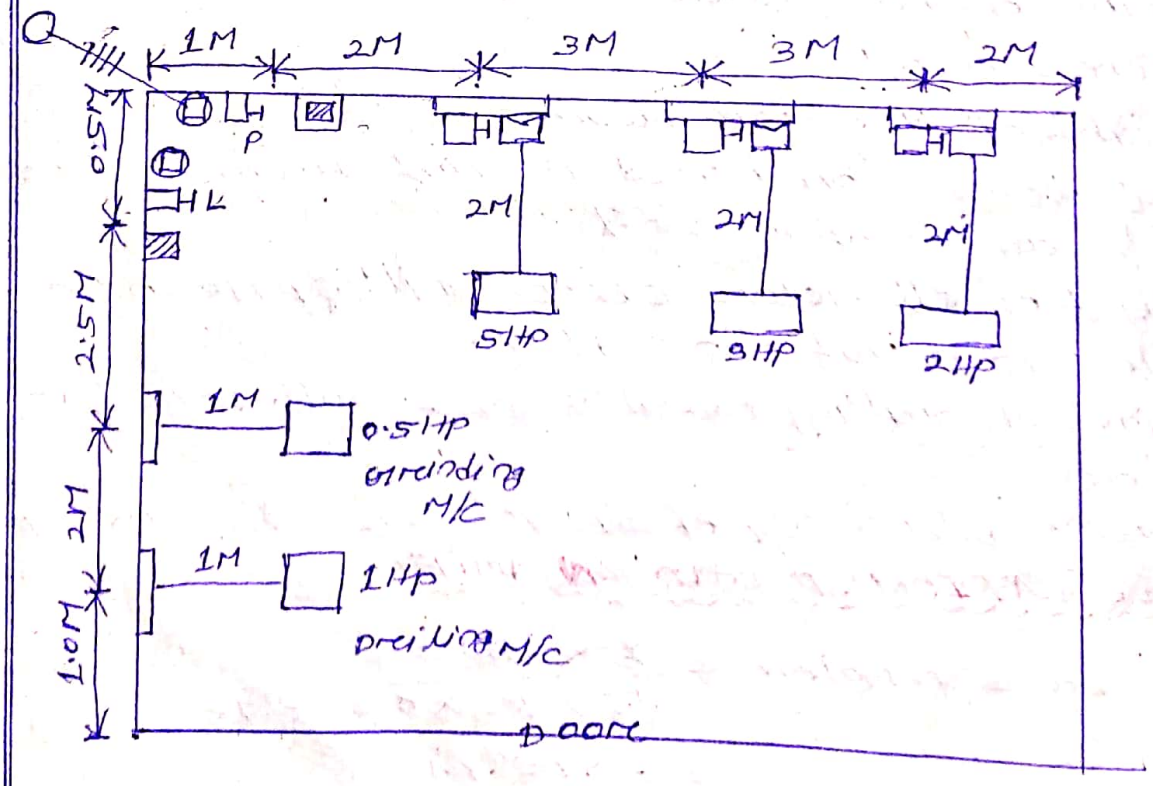
selection Rating of TPIC MAIN SWITCH

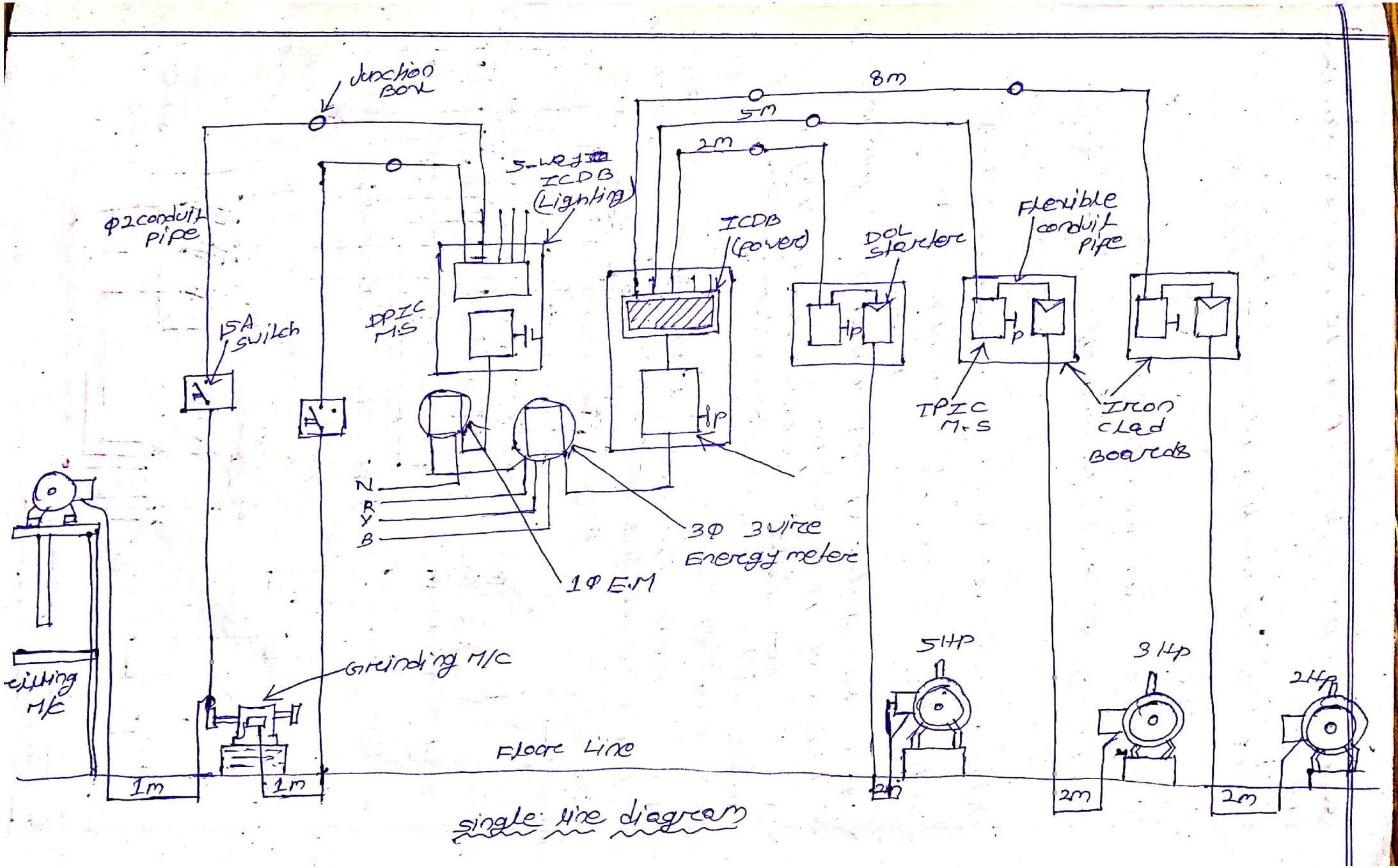
A TPMCB of 45A rating 500V greede should be used as main switch

selection Rating of TPIC MOTOR switch

The heighest load current will be drawn by 5HP Motor i.e 9A adding 50% for over load i.e 13.5A. So TPIC Motor swithc of 32A rating 500V greede should be selected at Motor switch for other remaining 3Φ Motor 16A rating 500V greede TPMCB Main switch should be selected.

INSTALLATION PLAN (First)





Selection and rating of DP 1Φ main switch for 1Φ load.

I_L of 1Hp 1Φ drilling M/c $= \frac{1 \times 735.5}{230 \times 0.8 \times 0.8}$

$= 5A$

Adding 50% over load $= 5 + 2.5 = 7.5A$

I_L of 0.5Hp 1Φ ~~drill~~ grinding M/c $= \frac{0.5 \times 735.5}{230 \times 0.8 \times 0.8}$

$= 2.49 \cong 2.5$

Adding 50% over load $= 2.5 + 1.25 = 3.75A$

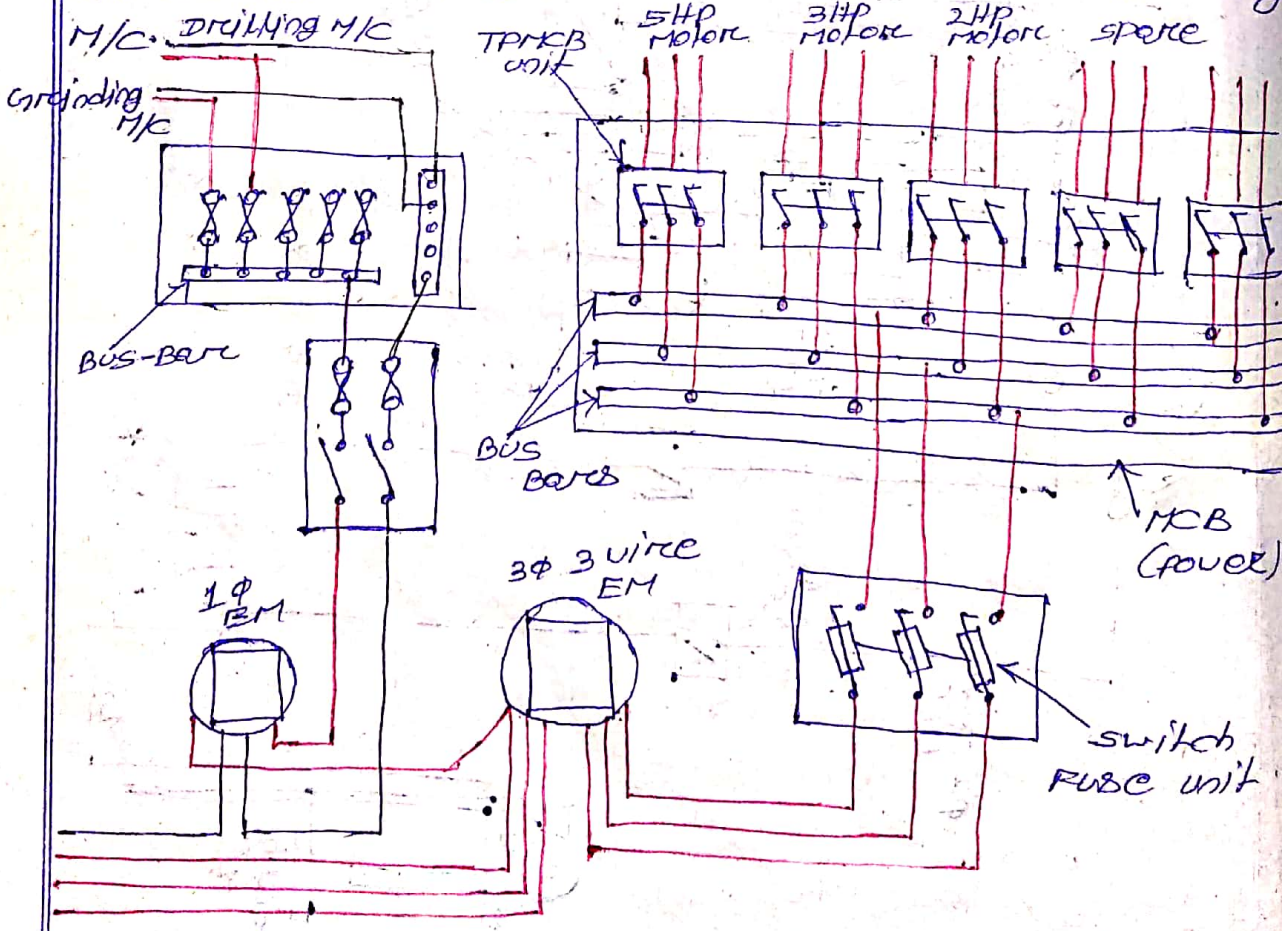
Total load of 1Φ Motor $= 7.5 + 3.75A$

$= 11.25A$

→ DPIC main switch of 30A rating 250V grade to be selected as main switch.

→ A DPIC ~~main~~ ~~Motor~~ main switch of 15A rating 250V grade will be used as the motor switch of 1Hp drilling M/c.

→ A DPIC main switch of 5A rating 250V grade will be used as the motor switch of 0.5Hp grinding M/c.



wire for wiring

selection rating of Main board, 5Hp Motor, 3Hp Motor

Total load current with 50% over load for all 3φ Motors is 26.25A, so single core 'Al' conductor of size 10mm² or 1/3.55mm dia will be selected for this connection.

For 5Hp 3φ Motor

Total load current with 50% over load of 5Hp Motor is 13.5A so single core pvc insulated Al conductor of size 4mm² or 1/2.24mm dia will be selected for this connection.

For 3Hp 3φ Motor & 2Hp 3φ Motor

single core pvc insulated 'Al' conductor of size 2.5mm² or 1/1.80mm dia will be selected for the connection.

calculation for length of heavy gauge conduit pipe of 25mm dia.

From MDB to 5Hp Motor

$= 1+2+1+1.5+0.25+2+0.25+0.5$

$= 8.5m$

From MDB to 3Hp Motor

$= 1+5+1+1.5+0.25+2+0.25+0.5$

$= 11.5m$

From MDB to 2Hp Motor

$= 1+8+1+1.5+0.25+2+0.25+0.8$

$= 14.5m$

Total length of 25mm dia conduit

$= 8.5+11.5+14.5 = 34.5m$.

Total length of conduit taking 10% wastage

$= 34.5+3.45 = 37.95 \cong 38m$

calculation for length of heavy gauge conduit Pipe of 20mm dia for 1φ Motor

From 1φ MDB to 0.5Hp grinding M/c

$= 1+2.5+1+1.5+0.25+1+0.25+0.5 = 8m$

From MDB to 1Hp drilling M/C

$= 1 + 4.5 + 1 + 1.5 + 0.25 + 1 + 0.25 + 1.5$

$= 11$ mt.

Total length of the conduit 20mm dia $= 19$ mt

Total length of conduit taking 10% weastage

$= 19 + 1.9 = 20.9 \cong 21$ mt

calculation for length of wire of size 4mm² or 1/2.24mm dia for 5Hp Motor. 2.5mm2 or 1/1.80mm dia for 3Hp and 2Hp Motors.

$= 8.5 \times 3 = 25.5$ mt.

Taking 15% weastage $= 25.5 + 3.825$

$= 29.325 \cong 30$ mt

or

3Hp 2Hp $= (11.5 + 14.5) \times 3 = 78$ mt

Taking 15% weastage $= 78 + 11.7 = 89.7 \cong 90$ mt

calculation for length of wire of size 2.5mm² or 1/1.80mm dia for both the 1φ Motors.

$= (11 + 8) \times 2$

$= 19 \times 2 = 38$ mt

Taking 15% wastage $= 38 + 5.7 = 43.7 \cong 44$ mt

calculation for 8 S.W.G earth wire of GI for 3φ Motors & 1φ Motors.

Total length of earth wire

= Total length of conduit pipe (For both 3φ & 1φ Motors) × 2 wires + 10% weastage

Total length of earth wire

$= 34.5 + 19 = 53.5$

$= 53.5 \times 2 = 107$ mt

$= 107 + 10\%$ weastage

$= 107 + 10.7 = 117.7 \cong 118$ mt

calculation for length of 15mm dia. GI pipe to enclose from motor control board to motor but the 3φ motors only

From motor control board to 3φ motors

$= 1.5 + 0.25 + 2 + 0.25 + 0.5 = 4.5 \times 2$ pipe

$= 9$ mts

same length of pipe each three phase motors

$= 3 \times 9 = 27$ mt.

Taking wastage 10% $= 27 + 2.7 = 29.7$ mt

$= 30$ mt.

MATERIAL TABLE=

Sl No:	SPECIFICATION	QUANTITY
1.	TPIC, main switch, 45amps rating, 500 volts grade with built in H.R.C FUSES.	1 NO.
2.	TPIC, motor switch, 32A rating, 500 volts grade with fuses	1 NO.
3.	TPIC, motor switch 16A rating, 500 V grade with fuses.	2 NOS
4.	Iron clad Distribution Board ICDB(power) for 3 motors 45A rating 500 volts grade with built-in-copper bus bares and fuses	1 NO
5.	Double pole Iron clad DPIC(lighting) main switch of 30A rating 250 volts grade as single phase main switch.	1 NO.
6.	~~Iron clad~~ ICDB(lighting) 6 way, with neutral link, 30A rating 250v grade	1 NO.
7.	ISA one way switch and shocket combined for 1φ motors	2 sets
8.	Heavy gauge conduit of size 25mm dia black enamel for 3φ motor	38 mts
9.	Heavy gauge conduit of size 20 mm dia. black enamel for 1φ motor	21 mts
1.		

S/No.	SPECIFICATION	QUANTITY
10.	a. conduit accessories for 25mm dia conduit:	
	conduit bends	12 Nos
	conduit junction boxes to facilitate putting of wires in conduits	3 Nos
	conduit sockets to connect two pieces of conduits	10 Nos
	conduit saddles to hold conduit with wall	30 Nos
	b. conduit accessories for 20mm dia conduit.	
	conduit bend	8 Nos
	conduit junction boxes	2 Nos
	conduit shocket.	4 Nos
	conduit saddles	15 Nos
11.	GI pipe of 15mm diameter for earth-wires to motor frames for 3φ motors. conduit accessories for 15mm dia G.I. pipe:	
	conduit bends	6 Nos
	conduit sockets	3 Nos
	conduit saddles	10 Nos
12.	pvc insulated, single core aluminium conductor wire of size ~~7/1.4mm~~ 1/3.55 mm dia or 10mm2 for wiring the main board.	5mts
13.	pvc insulated single core 'Al' conductor wire of size 4mm2 or 1/2.24mm dia for supply to 5HP motor	30mts
14.	pvc insulated, single core 'Al' conductor wire of size ~~4mm2 or~~ 2.5mm2 or 1/1.80 mm dia for 3HP and 2HP motors	90 mts
15.	10mm2 or 1/3.55mm dia 'Al' conductor pvc insulated wire for wiring main board for 1φ	2 mts

Sl.No	SPECIFICATION	QUANTITY
16.	2.5 mm² or 1/1.80 mm dia. 'Al' conductor pvc insulated, single core wire for wiring the 1ϕ motors.	44 mts
17.	Galvanised Iron (GI) earth wire 8 SWG for earthing motors MB etc	118 mts
18.	Iron clad board for mounting main switch, and ICDB 'power' of size 45cm x 60cm	1 NO.
19.	Iron clad board for mounting 1 ϕ main switch and ICDB 'lighting' 30 cm x 45 cm	1 NO.
20.	Iron clad board for mounting motor switch and starter of size 30cm x 30cm	3 Nos.
21	Rag bolts with nuts for fixing iron clad boards with well 12mm dia 150mm long four bolts for each board.	8 Nos
22.	10mm dia., 50mm long bolts with nuts to hold both main switches, distribution boards, 3ϕ motor switches and starter with iron clad board	40 Nos
23.	GI thimbles with nuts and bolts for connecting earth wires with main switches DB's motor switches ~~starters~~ starters etc	40 Nos
24.	Flexible conduit 25mm dia. 1.5 mt for each motor approximately plus conduits required for main board.	5 mts
25.	Flexible conduit of 20mm dia for both single phase motors.	2 mts
26.	Flexible conduit attachement with lock nuts for 25mm dia. pipe.	18 Nos
27.	Flexible conduit/couplers screwed on one side to fix rigid conduit with flexible conduit 25mm dia	12 Nos
28	Flexible conduit attachement with lock out for 20mm dia. conduit,	2 Nos
29.	Flexible conduit ~~attachement with lock nuts for 20mm dia conduit~~ coupler screwed on side	2 Nos

Sl.No.	SPECIFICATION	QUANTITY
30.	15cm x 15cm iron clad deep switch boards with bekalite covers for fixing 15A switch socket set	2 NOs
31	Reg bolt for fixing switch board with wall 10mm dia. 150 mm long 2 each	4 NOs
32.	Teak wood plugs (gutties) large size for holding conduits with wall with conduit saddles	100 Nos
33	wood screws 25mm long for fixing saddles with wall	100 Nos
34.	caution plate (danger 440 volts)	1 NO.
35.	shock treatment chart	1 NO.
36.	Earthing set complete	2 sets
37	civil engg work	
38	Labour charges for civil engg.	
39.	Transport of material including earthing material to site.	
40.	Labour charges for wiring	
41	including supervision charge	

CHAPTER-5

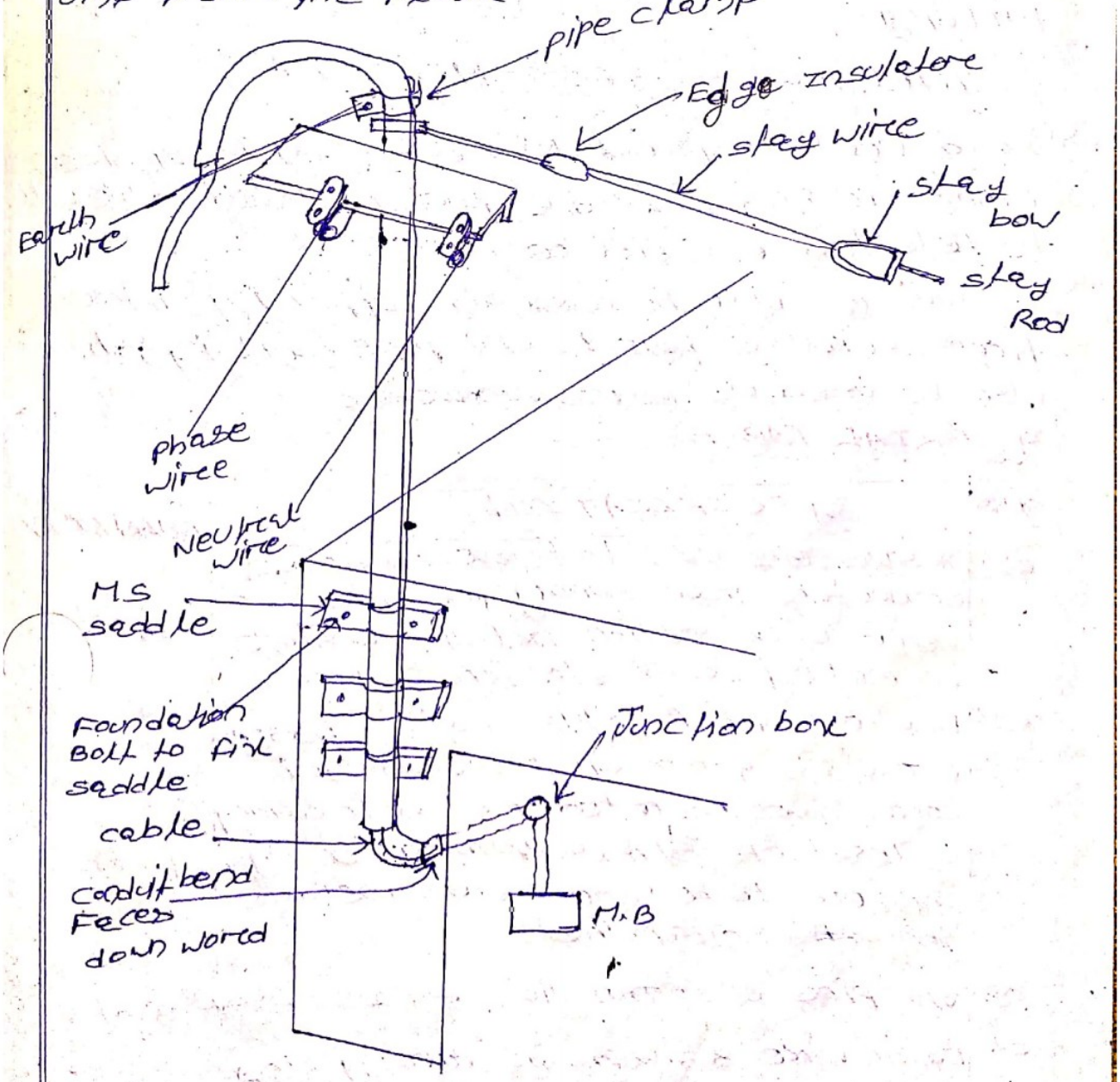
SERVICE CONNECTION TO A SINGLE STARE BUILDING

Q// A single storeyed building is to provided with 1Φ 230V 50Hz supply force a 5kW load distance of the service pole in 20mt from the building, prepare the list of material and suitable material.

Ans

ASSUMPTION

1. Height of the ground floore = 3.5mt
2. service connection receive at the height of 6mt from the floor



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selection and Rating of weather proof twin core 'Al' conductor cable and line conductor.

→ Total connected load 5 kW.

Total load in A $= \frac{5 \times 1000}{230} = 21.7A$

Diversity Factor = 60%.

Total average load is used

= Total connected load × 60%.

= 21.7 × 0.6

= 13A.

→ Adding 50% load for feature extinction of the building.

Total load = 13 + 6.5 = 19.5 ≅ 20A

→ So a weather proof twin core cable of size 6mm² or 1/2.80mm dia pvc insulated cable will be selected as service wire.

→ 8 SWG GI will be used as supporting wire from service pole to GI pipe (building) which also be used as earth conductor.

MATERIAL TABLE

S.NO	SPECIFICATION	QUANTITY
01.	8 SWG, G.I wire to serve as earth conductor from supply pole upto base service connection including wastage on making joints etc. for 3 wires	25 mts
02.	weather proof cable of size ~~1/3.55mm~~ ~~or~~ 1/2.80mm dia or 6mm² twin core, pvc insulated. rated to carry a load of ~~30~~ 24 A, assuming energy meter to be one metere inside the ~~veranda~~ verandha.	4 mts
03.	GI pipe of 50mm dia = 5 + 2.5 = 7.5m	8 mts
04.	Earth wire 8 S.W.G, GI running along G.I. pipe upto meter board.	6 mts

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Sl. No	SPECIFICATION	QUANTITY
05.	Pipe bend for 50mm dia pipe.	
6.	Pipe clamp (for 50mm dia pipe) to fix stay wire and one for fixing earth wire.	2Nos
7.	GI pipe saddles for 50mm dia pipe	4Nos
8.	Hooked bolt or hooked foundation bolts set in wall (to hold conduit saddle with wall) with 8 nuts, 15mm dia and 150mm long.	8 Nos
9.	L.T. shackle insulators with 'U' clamp, nuts and bolts and other fittings (2Nos. for pole and 2 Nos on service bracket)	4Nos
10.	Angle iron service bracket of size 50mm x 50mm x 6mm x 60cm long (M.S)	2Nos
11.	Bolt 15 mm dia 60mm long with nut (to hold mild steel angle iron with GI pipe.)	1Nos
12.	Iron clad meter board along with 4 No. Bolts and nuts of size ~~25cm x 30cm~~ 25cm x 30cm.	1 Nos
13	conduit bushings 50mm dia (wooden) for G.I pipe	2Nos
14.	stay wire 7/10 SWG GI.	1 m/s
15.	stay bow.	1No
16.	stay rod with bolts and stay buckle and stay plate of size 30cm x 30cm	1 set
17.	stay insulator	1No
18.	Lock nut for 50mm dia GI pipe (at service board)	1No
19.	pole clamp 60cm long 50mm x 50mm x 6cm for holding service bracket with pole	
20.	'A' clips 15 mm long to hold earth wire with pipe	1 Box
21.	cement	1 bag
22	sand	6 bag
23	Earthing thimble to hold earth wire with meter board 30 A rating with nut and bolt	1No.

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S/No	SPECIFICATION	QUANTITY
24.	4 Nos bolts 10mm dia 50 mm long with nuts fore fixing energy meter with nut and bolt.	4 Nos ~~4 Nos~~.
25.	2-way junction box fore 50mm dia pipes	~~1 No~~. 1 Nos

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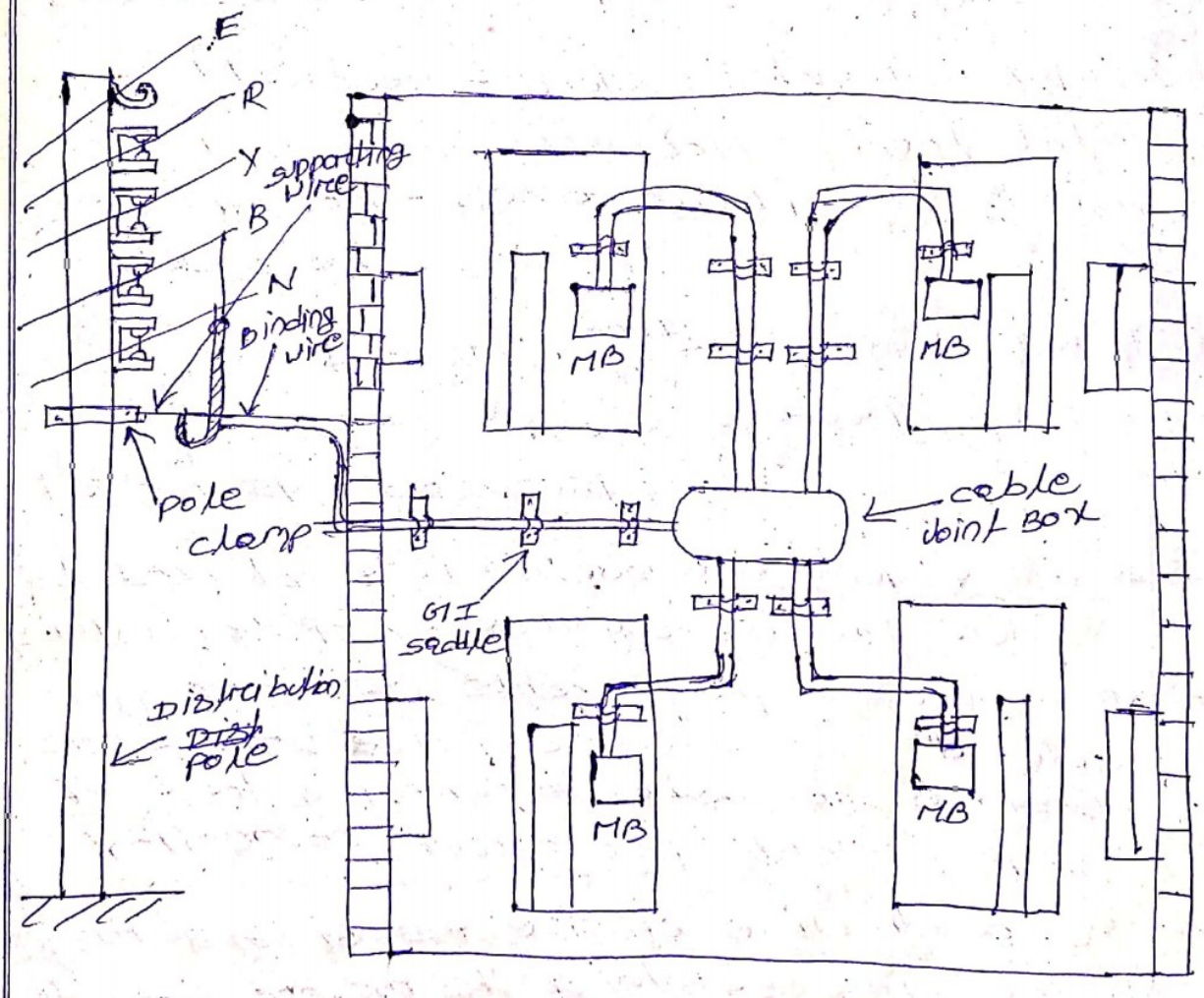
CHAPTER-6

SERVICE CONNECTION TO A ~~SINGLE~~ DOUBLE STARE BUILDING

Q/

A set of four govt. quarter (2 ground floor and 2 1st floor) is to be provided service connection near by service pole 30mts away from the building the supply is 1φ 230V. Draw the sketch of service connection to each house to single service connection and prepare the list of material table.

Ans



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ASSUME

1. Height of ground floor roof = 3.5 mts
2. service connection received at the height of 4mts above ground.
3. Assume electrical load in each house to be 3 light/fan sub ckt and 2-15A sub ckts.
4. ~~Eeno~~ Energy meters to be one meter inside verandah in each case.

Selection rating of weatherproof cable

Total connected load in each house = 3 sub ckt × 800 watts
= 2400 watts

2-15A sub ckts = 2 × 1000 = 2000 watt

Total load = 4400 watt.

Load in all the flourse couses = 4400 × 4
= 17600 watt

Load in Ampere = $\frac{17600}{230}$ = 76.5A

diversity factore = 60%
= 76.5 × 0.6 ≒ 45.9 ≅ 46A

→ As it is a govt: ecomodation it is not need to consider feature expansion of the building

→ so the weather proof cable, twin core, pvc insulated, 'A.L' conductor of size 25mm2 or 7/2.24 mm die rated to carry a load of 59A is suitable for servic connection.

→ The earth wire of size 8 SWG GI may be used for earthing the metere boards and also to serve as support wire. ~~also to~~

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MATERIAL TABLE

SL NO	SPECIFICATION	QUANTITY
01	7/2.24 mm, PVC insulated 'Al' conductor, twin core; 250 volts grade from pole to junction box	33 mts.
02	1/3.55 mm dia or 10 mm2 PVC insulated, 'Al' conductor twin core, 250 volts grade from junction box to four meter boards 4 mts. each connection + 10% vestage = 16 mt + 1.6 mt = 17.6 mts	18 mts
03	Earth wire, 8 SWG, GI from pole to junction box and from junction box to four energy meters individual	51 mts
04.	pole clamp of mild steel with two bolts and nuts	1 NO.
05	Mild steel hook 20cm long 15mm d'e to fix earth wire with wall	1 NO.
06.	conduit saddles at one metre interval approx	30 Nos
07	Teak wood plugs (guiths) large size (2 per saddle) + wastage	8 Nos
08.	wood screws 30mm long	120 Nos
09	Meter board of teak wood size 25cm × 30 cm	4 Nos
10.	Mild steel bolts 10 mm dia 150mm long for fixing energy meter with switch boards.	4 Nos
11.	Mild steel bolt with nuts 10cm d'e. 50mm long for for fixing energy meter with switch board.	16 Nos
12.	Earthing thimbles to hold earth wire with meter board 30 A rating nuts and bolts	5 Nos
13.	'Al' clips 75mm long to hold cable with support wire between pole clamp and wall or	1 box of 50, 3 mt
14.	Binding wire of 12 SWG, GI	
15	cast iron; 5 way cable junction box, meter light Earthing coil	1 No.

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CHAPTER-7

ESTIMATE OF MATERIALS FOR L.T DISTRIBUTION

Q//
A tubewell motor is to be provided with service connection from a DP structure having T/F 25KVA, 11/0.4 KV. The rating of the motor is 10Hp. the ~~distribution~~ DP-structure is 300mt away from tubewell. Draw a neat sketch and estimating material required

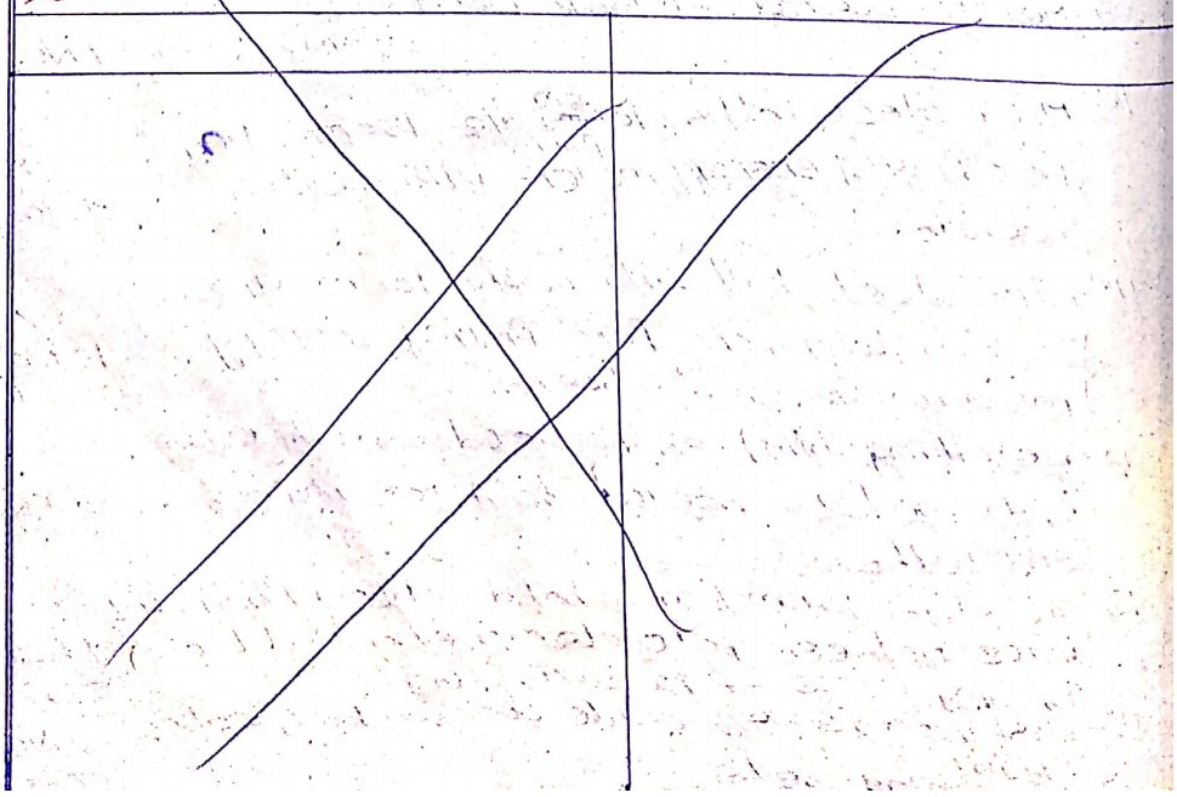
solution

$$\text{current required} = \frac{10 \times 746}{\sqrt{3} \times 400 \times 0.8 \times 0.9} = 15\,A.$$

→ since it is a small line of 300mt, the AAC of minimum size i.e Marthis of size 3/3.00mm stranded conductor my be used.

→ For service connection to the motor the LT 3½ core 'Al' conductor wheather proof cable size 6mm² will based from pole to energy-meter.

MATERIAL TABLE



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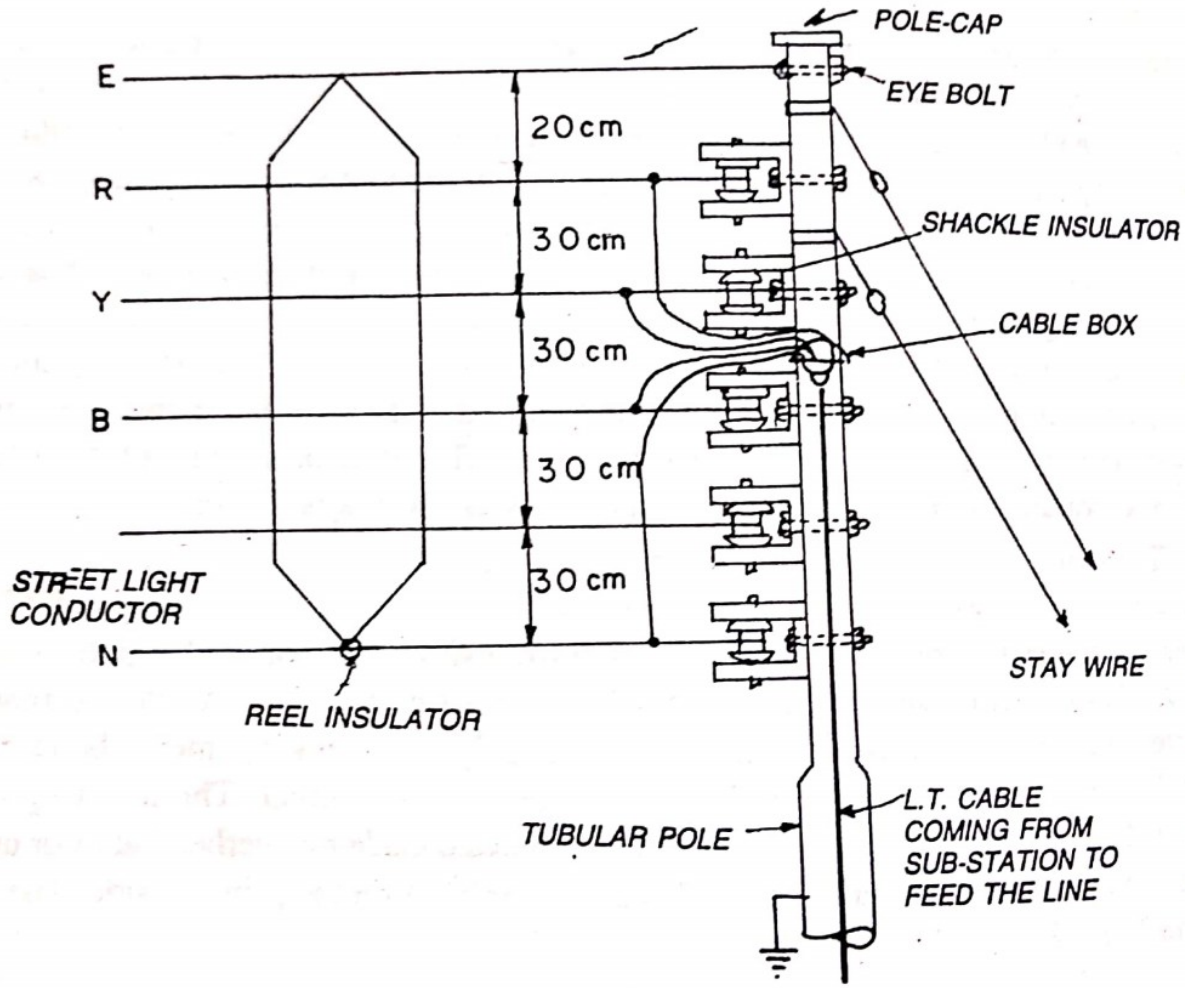

Fig. 22.2.

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MATERIAL TABLE

S. No.	SPECIFICATION	QUANTITY
1.	L.T. 3½ core, weather proof, 'Al' conductor cable of size 6mm² 660 volts grade	8 mts
2.	VIR, weather proof, single core cable of size 6mm² volts grade for loose connections from overhead line conductors to cable box on both sides.	8 mts.
3.	concrete poles, 9 meters long	6 Nos.
4.	Mark's A.A.C. of size 3/3.0mm for four conductors = 300 mts x 4 = 1200 mts + 24 mts (2% sag by weight 58 kg/km = 70 kg.	1224 mts or 70 kg
5.	Earth conductor of 8 SWG GI = 300 mts + 2% = 306 mts + 10 meters for service connection	316 mts
6.	14 SWG, GI, binding wire	3 kg
7.	L.T shackle insulators with 'D' straps, 4 on each pole.	28 Nos
8.	Nuts and bolts 15mm dia, 200mm long with washers for fixing 'D' strap with pole, one bolts for each strap	28 Nos.
9.	Nut and bolts 15mm dia, 125mm long with washers for fixing shackle insulators in 'D' straps	28 Nos
10.	Eye bolt 15mm dia, 200mm long for supporting earth wire on pole	4 Nos
11.	Earth wire pole clamps, one on each end pole	2 Nos
12.	stay wire sets complete, two sets each on double structure and terminal pole	4 sets
13.	Earthing sets (plate earthing) complete	1 set
14.	L.T. outdoor cable box, complete with clamps	2 Nos
15.	cable clamps for holding cable with poles	4 Nos.
16.	pole clamp for fixing 8 SWG earth wire for service connection	1 No.
17.	GI Hook or rag bolt on building wall to receive earth wire from pole for supporting service cable	1 No.

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S. No:	specification	quantity
18.	cable saddles with screws for holding cable with wall	5 Nos
19.	Aerial fuse, 30A rating on last pole	3 Nos
20.	surface type, teak wood meter board of size 30cm x 30cm complete with wooden plugs wood screws both for power meter and lighting meters	2 Nos
21.	kit-kat, 30A rating, 660 volts grade	3 Nos.
22.	kit-kat, 15A, ~~kwh, energy meter 25A~~ rating, 250V grede for 1 ϕ	2 Nos.
23.	3 ϕ, 3 wire, kwh, energy meter 25A rating	1 No
24.	1 ϕ, kwh, energy meter 25A rating	1 No.
25.	pole fondation for each pole with cement, concrete 0.5 cubic meter per pole for six poles	3 cu. mt.
26.	Number plate with clamps	6 Nos.
27.	sundries such as wooden plugs, screws thimbles, conduit pipe of 25mm dia for passing cable through wall, cement, sand etc.	

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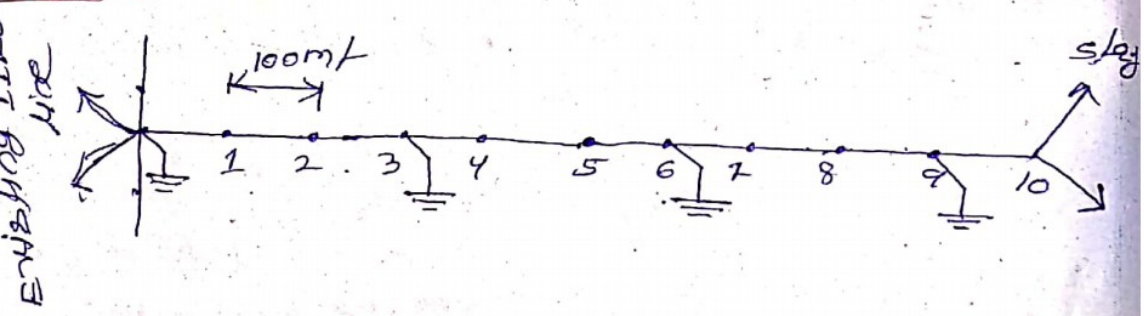
Q//
Estimate the quantity of material required for the construction of 1 km overhead line. The line is tapped from the existing 11kV line to feed a particular locality. The particulars of the important material to be used for the line to be erected are as follows.

a. size of conductor: ACSR 6/1 x 2.59 mm
b. Tubular pole or supports of 11 mt length
c. size of earth wire: GS (Galvanised steel) 8 SWG.
d. Average span = 100 mt
e. No. of earthing sets to be installed: 3 Nos

solution



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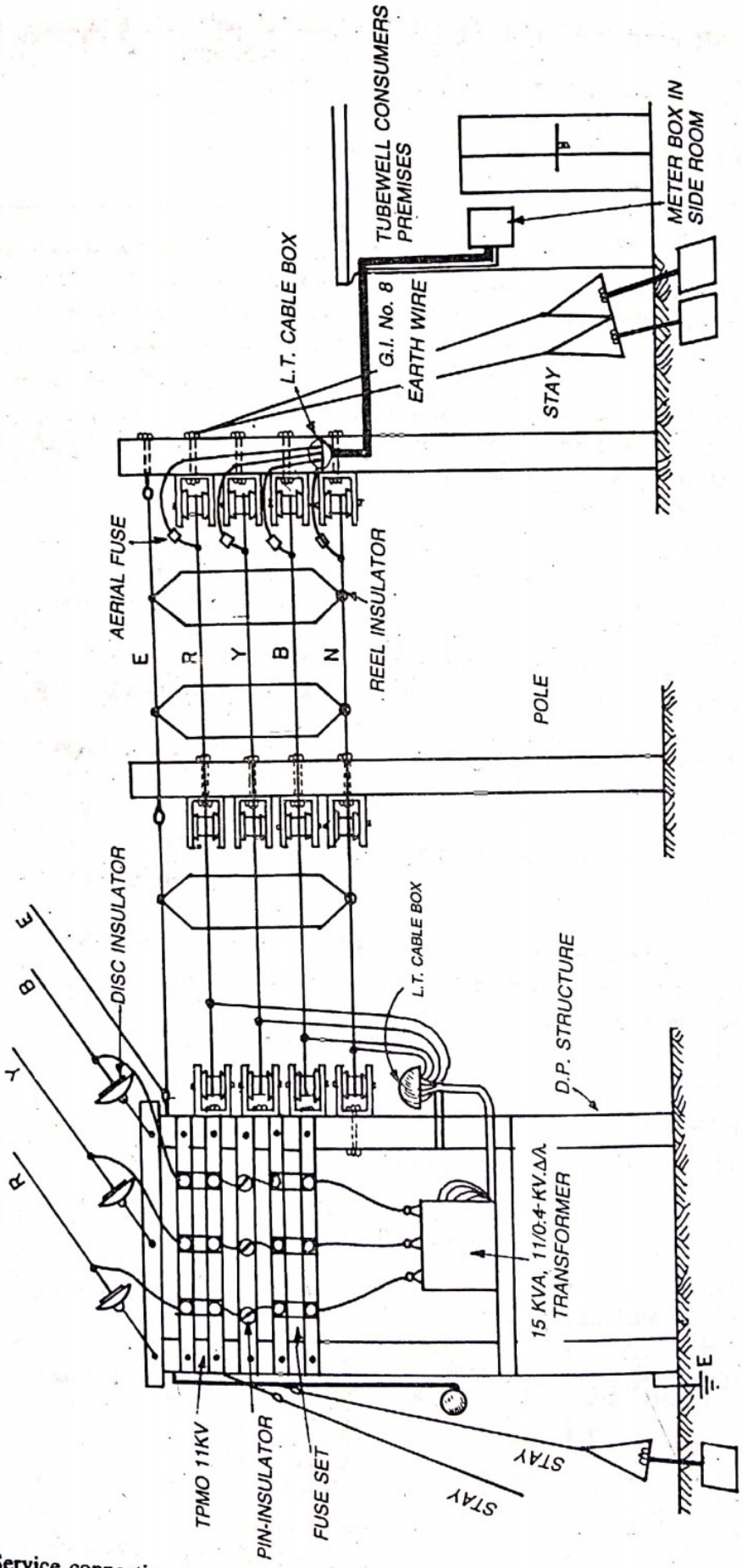

Fig. 22.4. Service connection to tubewell consumer by making LT line of four pole and cable service in open air.

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Material table

S. No.	specification	quantity
1.	Tubular line supports (poles) 11 mt long	10 Nos
2.	Material required for connection with existing line of 11 kV	
	i. MS channel for cross-arm 10cm x 5cm x 1.5mt	1 No.
	ii. H.T 11kV disc insulators with complet fittings	3 NOS
	iii. H.T, 11kV, pin-type insulators with pins and nuts to support dampers wires	2 NOS
	iv. stay complete with clamp, stay wire, egg insulator, stay rod, nuts, stay plate etc.	2 NOS
	v. concreting for ~~existing poles~~ stay rod	2 NOS
	vi. concreting for existing poles	1 Nos
	vii. Earth wire damp of mild steel (M.S)	1 No.
	viii. clamp for M.S channel	1 No.
	ix. Binding wire of 'AL' for dampers	1 kg.
3.	Fitting for H.T straight line supports.	
	i. pole cap of M.S (Mild steel)	10 NOS
	ii. stone pads for poles	10 NOS
	iii. Angle iron cross arms, 1 for each pole	10 NOS
	iv. cross arm clamps for fixing cross arms with pole	10 NOS
	v. 11kV, pin insulators, with pins and nuts	30 NOS
	vi. No. plate with clamps for fixing	10 NOS
	vii. Danger plate with clamp for fixing	1 NOS
	viii. Earth wire clamps	10 NOS
	ix. Barbed wire for anticlimbing for ~~fixing conductors~~ 10 poles, 1kg for each pole	10 kg
	x. Binding wire of 'AL' for fixing conductors over insulators, 200gms at each insulator for 30 insulators.	

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S. No.	specification	quantity
4	ACSR conductor 6/1 x 2.59 mm weasel = 1000 x 3 = 3000 meters sag allowance 1% = 30 mt, total length = 3030 mt	3030 mts
5.	GI earth wire of ~~size~~ size 8 SWG, length = 1000 mts (2% set) 20 mt = 1020 mts	1020 mts
6.	Material for 3 Nos, earthing sets	
	i. Earth plate GI of size 60cm x 60cm x 6.38 mm thick	3 NOS
	ii. GS earth wire 8 SWG, 10 mt for each set	30 mts
	iii. GI pipe for earthing wire 15mm dia (For 3 set)	30 mts
	iv. GI pipe for watering to reduce earth resistance (for all 3 sets) of dia 20 mm	30 mts
	v. Miscellaneous material of 3 sets.	As reqd.
7.	painting for poles	10 poles
8.	Labour charges	
9.	concreting of poles for 10 poles	
10.	other charges.	

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Rules & Specifications of overhead lines:-

1) The minimum breaking strength of conductor used in over head lines should not be less than 317.5 kg or 700 pounds (lbs). when the span is less than 50 ft or 15.4 m used for low voltage system the ultimate breaking strength can be more than 136 kg or 300 pounds.

2) When joints are carried on the conductor the joints should be such that the ultimate breaking strength of the joint should not be less than 95% of the conductor.

3) Factor of safety to calculate the tensile strength of the conductor for steel supports is 2, for mechanically processed RCC or PCC (Prestressed cement concrete) poles is 2.5, for hand maded RCC poles is 3, for wooden structure is 3.5.

4) The minimum factor of safety for stay wire is 2.5.

5) for calculating the factor of safety for conductor the wind pressure, ice loads etc should be taken into account.

6) minimum clearance of the conductor:—

Location	LT	HT	EHT
a) Ground clearance across the street or road.	5.8 M =(19')	6 M =(20')	6M + 1' for each 33 kV addition
b) Ground clearance along street.	5.5 M =(18')	5.8 M =(19')	19' + 1' for each 33kV addition
c) Ground clearance else where	4.57 M=(15')	11 kV → 15' 33kV → 17'	17' + 1' for each 33 kV addition
d) clearance betn conductor of different line	4' (1.23 M)	11 kV → 6'(1.83m) 33kV → 8'(2.5m)	10' (3.05 M)
e) clearance from top of the building.	8'(2.44 M)	12'(3.69 M)	12' + 1' for each 33kV addition
f) Horizontal clearance from building.	4'(1.23M)	11kV → 4' 33 kV → 6'	6'+6' for each 33 kV addition.

7) The span length bet" the poles should be calculated taking account of sag, ice load, wind load, as specified by the state Govt. and approval of the electrical inspector. For LT lines the span should not be more than 220' (67 M) at any time without approval of electrical inspector.

8) When the lines are crossing the railway lines, telephone lines, canals, rivers etc permission has to be taken from concerned authority and clearance should be made as per their requirement.

9) When the line crosses a railway, road, canals, any other electrical lines a guard wire with minimum ultimate breaking strength of 635 KG or 1440 pounds connected to earth of both ends should be provided.

10) When the line is carried with continuous earth conductor minimum 4 earth connections are to be made for each mile (1.6 KM). When there is no continuous earth wire each support is to be efficiently earthed.

11) For each end of the over head line suitable lightning protection system should be provided with independent earthing.

12) For each metalic structure an indicating board (Danger board) should clearly indicate the system voltage in regional & national language.

13) When steel poles are used minimum 15 cm thick bed of 1:3:6 cement concrete is to be provided.

14) The minimum cross section of cross arm should not be less than 50mm x 50mm x 6mm ms channel.

15) The D-clamp or U-clamp used for fixing the cross arm should be made with minimum 50 mm x 6mm MS flat.

16) Maxm voltage regulation allowed in OH lines is ±6% for LT lines and ± 12.5% for HT & EHT lines.

Rules & specification for stay wire :-

1) The minimum size of stay wire is 7/10 SWG GI.
2) stay plate size is 30 cm X 30 cm X 6 mm
3) Minimum length of Anchor rod / stay rod is 6' or 1.8 m. minimum diametre is 19 mm for HT
16 mm for LT.
4) Turn buckles should be provided to tighten the stay.
5) Each iron component like structure, cross arm etc should be coated with red oxide primer before erection and two coats of paint (aluminium oxide) after erection.

SUB-STATION

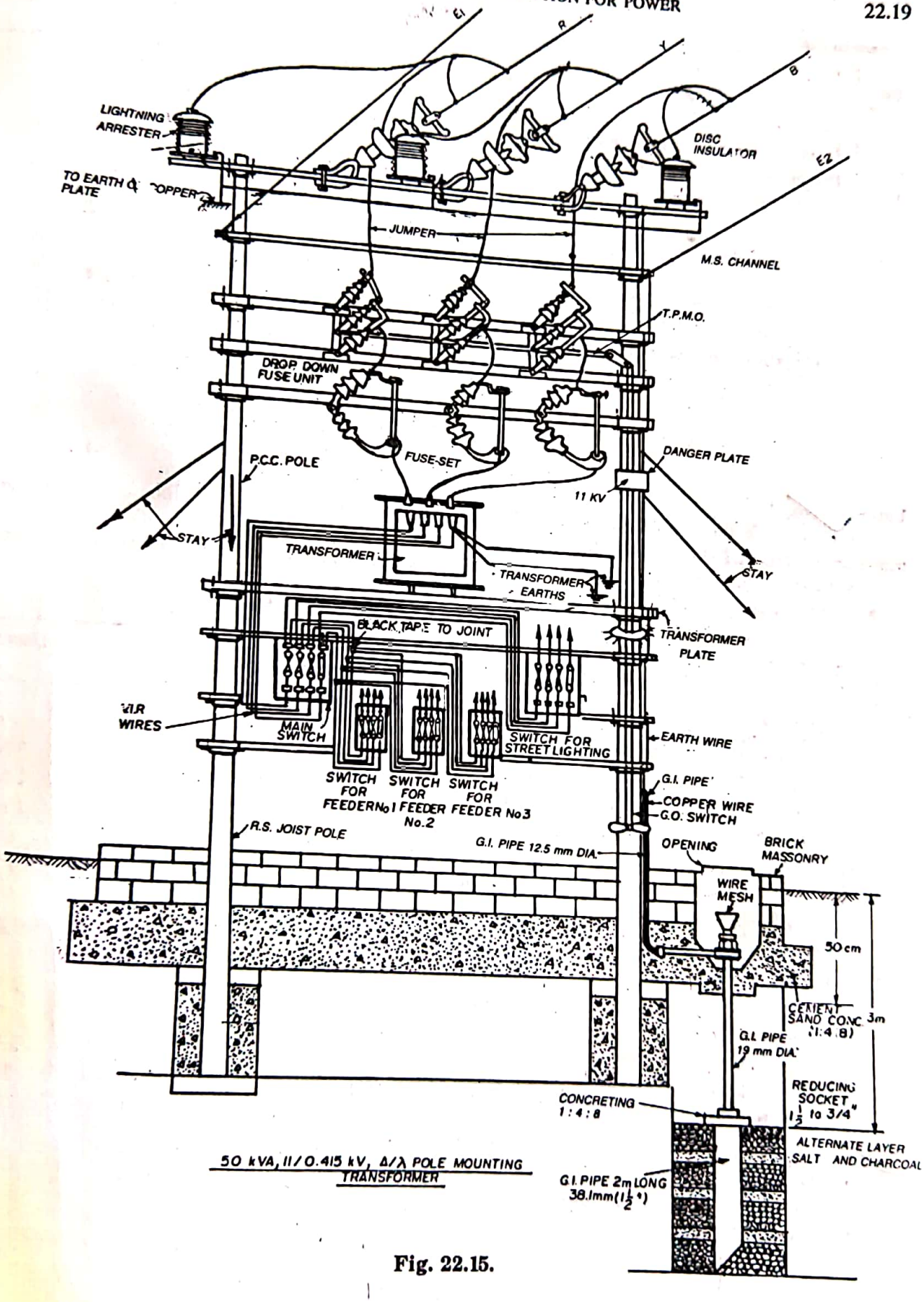
Estimate No. 8 :

Estimate the cost of a pole mounted sub-station of capacity 50 kVA transformer of rating 11/0.4 kV. The H.T. line is available about 50 metres from the proposed site. Also make a neat sketch of the pole mounted sub-station.

Solution. The connection diagram for pole mounted sub-station is shown in figure 22.15.

Schedule of Material with Cost

S. No.	Description of Material	Quantity	Rate	Amount	Remarks
1.	**Material for H.T. connection with main line**				
	(*a*) M.S. channel 10 cm × 5 cm × 1.5 mts	1 No.	80-00 each	80-00	
	(*b*) H.T. 11 kV disc insulators with fittings	3 Nos.	75-00 each	225-00	
	(*c*) 11 kV pin type insulators with pins	2 Nos.	45-00 each	90-00	
	(*d*) Stay sets complete	2 Nos.	310-00 each	620-00	
	(*e*) Concreting of existing line	1 No.	120-00 each	120-00	
	(*f*) Earth wire clamp	1 No.	25-00 each	25-00	
	(*g*) Tee clamp for M.S. channel	1 No.	20-00 each	20-00	
	(*h*) Binding wire (aluminium)	500 gms.	60-00 kg	30-00	
2.	Conductor ACSR gopher 6/1 2.36 mm diameter : length 50 × 3 = 150 mts sag allowed 1% = 1.5 mt. Total length of conductor required	151.5 mts or 16 kg	60-00 kg	960-00	
3.	Galvanised steel wire of 8 SWG = 50.5 mts or 6 kg	6 kg.	25-00 kg.	150-00	
4.	R.S. joist 175 mm × 100 mm × 10 mts long	2 Nos.	800-00 each	1600-00	
5.	Fittings on H.T. double pole structure for pole mounted sub-station				
	(*i*) Stone pad	2 Nos.	14-00 each	28-00	
	(*ii*) Sub-station plate	1 No.	12-00 each	12-00	
	(*iii*) M.S. channel 100 mm × 50 mm × 8 mm × 2.65 mts long	1 No.	100-00 each	100-00	
	(*iv*) Eye bolt	3 Nos.	25-00 kg.	25-00	
	(*v*) Dropper angle iron 75 mm × 75 mm × 8 mm × 2 mts long	1 No.	80-00 each	80-00	
	(*vi*) Stay complete	2 Nos.	310-00 each	620-00	
	(*vii*) 11 kV disc insulators with fittings	3 Nos.	75-00 each	225-00	
	(*viii*) 11 kV pin type insualtors with pins	3 Nos.	40-00 each	120-00	
	(*ix*) Binding wire 500 gms	500 gms	60-00 kg	30-00	
	(*x*) Number plate with clamp	1 No.	12-00 each	12-00	
	(*xi*) Danger plate with clamp	1 No.	12-00 each	12-00	
	(*xii*) Barbed wire	5 kg.	25-00 kg	125-00	
	(*xiii*) Earthing complete	1 set	1300-00 set	1300-00	
	(*xiv*) Jumper wire for Jumpering 1.1 kg	11 mts	60-00 kg	66-00	
	(*xv*) Nuts and bolts of sizes as required	18 Nos.	30-00 kg	90-00	
	(*xvi*) Concreting of poles	2 Nos.	120-00 each	240-00	
	(*xvii*) T.P.M.O. switch	1 No.	1400 each	1400-00	
	(*xviii*) Painting of poles and other attachements	2 litres	80-00 Lt.	160-00	



50 kVA, 11/0.415 kV, Δ/λ POLE MOUNTING TRANSFORMER

Fig. 22.15.

S. No.	Description of Material	Quantity	Rate	Amount	Remarks
	(xix) Fuse set	1 set	125-00 set	125-00	
	(xx) Fabrication of some parts such as clamps etc.	L.S.	200-00 L.S.	200-00	
6.	Transformer 50 kVA 11/0.4 kV	1 No.	42000 each	42,000-00	
7.	TPICN (Triple pole Iron Clad and Neutral) main switch 100 amperes rating	1 No.	500-00 each	500-00	
8.	Earthing for transformer	1 No.	1300-00 set	1300-00	
9.	Lightning arresters one set of three	one set	1200-00 each	1200-00	
10.	Cartage of material from store to site	L.S.	250-00 L.S.	250-00	
11.	Labour charges @ 3500-00/	—	3500-00 L.S.	3500-00	
12.	Contingencies on cartage and labour charges	—	—	120-00	

Total Rs. 57760/-
11% overhead and supervision charges Rs. 6353/-
Grand total estimated cost Rs. 64113-00
Say Rs. 64120-00

Estimate No. 9 :

Prepare an estimate for erecting a 500 kVA 11/0.4 kV sub-station by installing an outdoor type transformer. The H.T. line is available just outside the sub-station premises.

Solution. The connection diagram for the out-door sub-station is shown in figure. Assuming that the 11 KV line (existing) is 25 metres away from the sub-station.

Schedule of Material required for 11/0.4 kV outdoor sub-station.

S. No.	Description of Material	Quantity
1.	**H.T. connection with main line**	
	(i) M.S. channel 100 × 50 mm × 1.5 mt long	1 No.
	(ii) H.T. 11 kV disc insulators with fittings	3 Nos.
	(iii) Pin type insulator with pin for 11 kV	2 Nos.
	(iv) Pole stay complete with fittings	2 Nos.
	(v) Concreting of existing pole	1 No.
	(vi) Earth wire clamp for holding earth wire with pole	1 No.
	(vii) Tee clamp for M.S. channel	1 No.
	(viii) Binding wire of aluminium	500 gms.
2.	**Fittings for double pole structure**	
	(i) Stone pad for placing below the pole while erecting pole	2 Nos.
	(ii) Fuse set complete (of the proper rating)	1 set
	(iii) Lightning arrestors	3 Nos.
	(iv) M.S. channel 10 cm × 5 cm × 8 mm × 2.65 mt long	1 No.
	(v) Eye bolt	3 Nos.
	(vi) Dropper angle iron 75 cm × 75 cm × 8 mm × 2 mt long	1 No.
	(vii) Stay complete with attachements	2 Nos.
	(viii) 11 kV disc insulators with fittings	3 Nos.
	(ix) Pin type insulators of 11 kV rating	3 Nos.

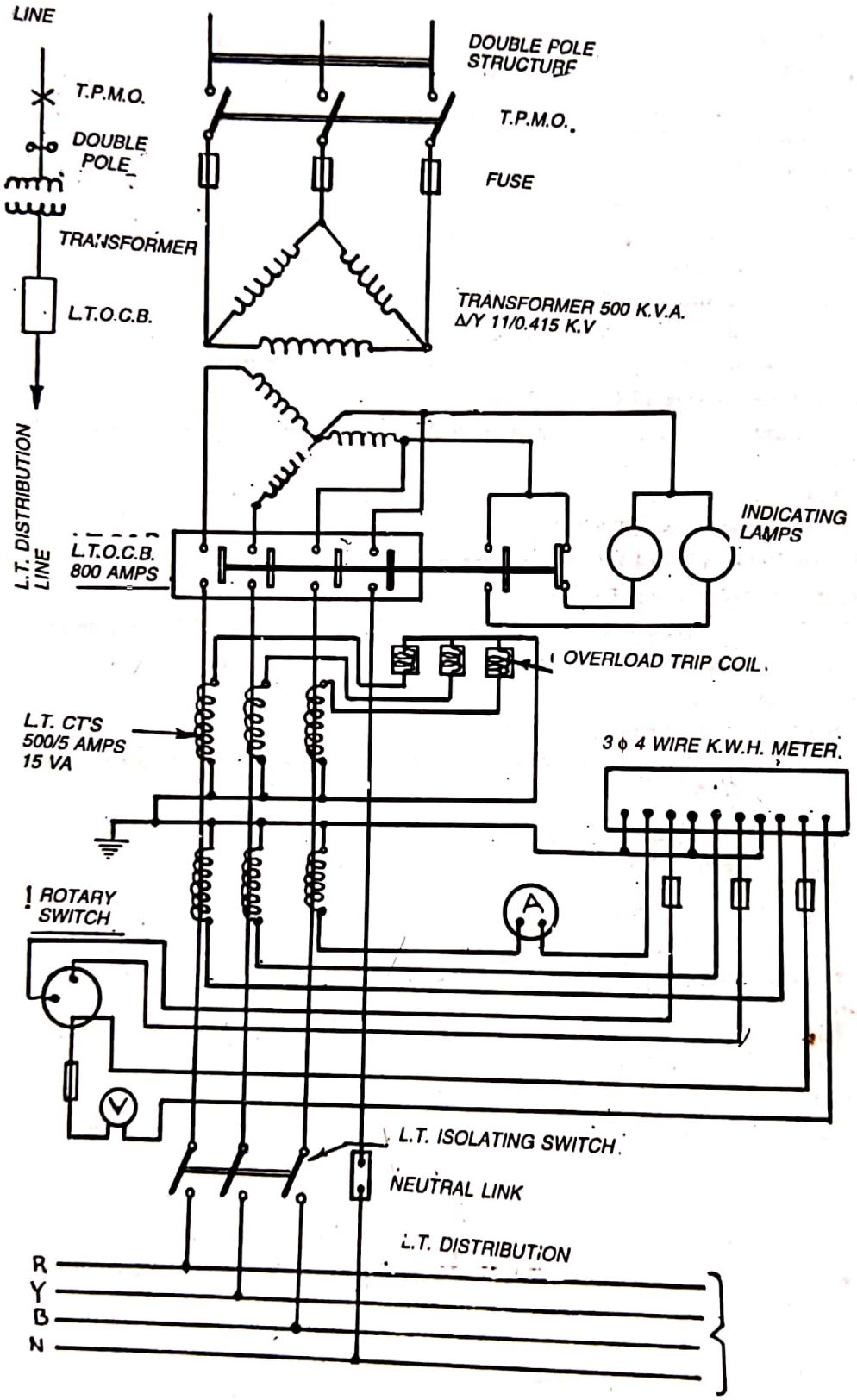


Fig. 22.16.

S. No.	Description of Material	Quantity
	(x) Binding wire 500 gms	500 gms
	(xi) Danger plate with clamp and fittings	1 No.
	(xii) Barbed wire	5 kg.
	(xiii) Earthing set complete	1 No.
	(xiv) Jumpering	11 mts
	(xv) Nuts and bolts of various sizes	18 Nos.
	(xvi) Fabrication of some parts	L.S.
	(xvii) Concreting of poles	2 Nos.
	(xviii) Triple pole, mechanically operated switch	1 No.
	(xix) Painting of poles *i.e.* paint required	2 litres
	(xx) Number plate with clamp	1 No.
3.	R.S. Joist 10 metres long 17.5 cm × 10 cm	2 Nos.
4.	ACSR conductor wesel size 6/1/2.59 mm length 25 × 3 = 75 metres from existing line to H type poles	75 mts
5.	Galvanised steel earth wire for H.T. line 25 mts or 2.5 kg	2.5 kg.
6.	Plinth for transformer and L.T. OCB	As reqd.
7.	Transformer 500 kVa 11/0.4 kV delta/star connected	1 No.
8.	Earthing sets complete (Plate Earthing)	2 Nos.
9.	LT, OCB, 800 amperes, complete with ammeter and voltmeter, kWh meter, C.T.'s and metering	1 No.
10.	VIR cable, 11000 volts rating	40 mts
11.	Copper lugs 800 amperes	8 Nos.
12.	L.T. Cubical for OCB of size 1.25 m × 1.25 m × 2 m.	1 No.
13.	Miscellaneous items such as kerosene oil, empire tape, solder, aluminium, aluminium flux, cotton waste	L.S.
14.	N.L. (Neutral Link made of copper)	L.S.
15.	Pole fencing with gate	L.S.
16.	Transport of material from store to work site	L.S
17.	Labour charges	L.S.
18.	Contingencies at the rate of 3% of item 16, 17.	

Estimate No. 10 :

Estimate the cost of indoor type 11/0.4 kV sub-station to be erected in city. The capacity of sub-station is 1000 kVA and the maximum demand is 800 kVA which have to be distributed in four circuits.

Solution. The electrical connection for the sub-station is shown in Fig. 22.16. There are four distribution circuits in the sub-station, and each may be assumed to be rated at 200 kVA.

Assume that the existing H.T. line from where connection to the transformer are to be given, is just close to the sub-station.

(1) The size of L.t. Unit box and cable for each 200 kVA, LT distribution circuit :

$$\text{Maximum load} = 200 \text{ kVA}$$

$$\text{Line voltage} = 400 \text{ volts}$$

$$\text{Current required} = \frac{200 \times 1000}{\sqrt{3} \times 400} = 288 \text{ amperes}$$

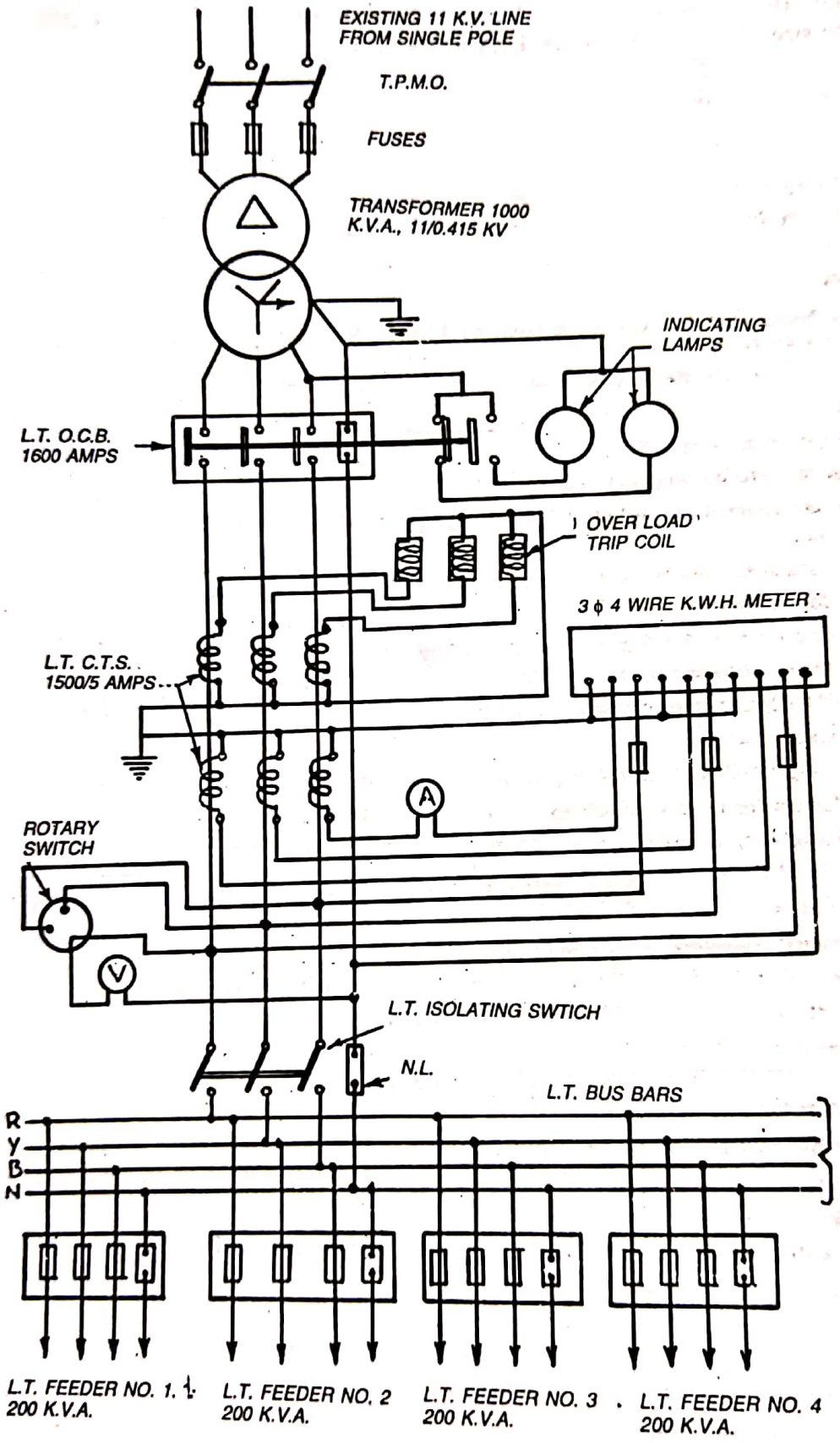


Fig. 22.17. Connection diagram for indoor type sub-station.

Therefore 300 ampere unit box, three phase with neutral will be provided on each circuit. The size 4 core cable 185 mm will be selected from unit boxes to terminal test block on pole.

(2) The size of H.T. cable for 100 kVA transformer.

Line voltage = 11000 volts

Therefore current required on primary side of the transformer

$$= \frac{1000 \times 1000}{\sqrt{3} \times 11000} = 52.4 \text{ amperes}$$

So, the size of 11 kV 3 core H.T. cable 25 mm will be provided from single pole to transformer.

(3) The size of VIR required from transformer to OCB.

The size of VIR cable single core 625 mm will be provided as the load on secondary side of transformer is 1440 amperes.

Schedule of material with cost for 11/0.4 kV, 1000 kVA Indoor Sub-station

S. No.	*Description of Material*	*Quantity*	*Rate*	*Amount*	*Remarks*
1.	Swtich gear room 6 mt × 6 mt	—	L.S.	35000-00	
2.	**Fittings for existing terminal pole**				
	(*i*) M.s. channel cross arm 100 mm × 50 mm × 1.5 mts long	1 No.			
	(*ii*) 11 kV disc insulators with fittings	3 Nos.			
	(*iii*) Stay complete	2 Nos.			
	(*iv*) H.T. outdoor cable box complete with compound, mounting plate and jointing material	1 No.			
	(*v*) G.I. pipe 75 mm diameter	3 mts.			
	(*vi*) Cable clamps	1 No.			
	(*vii*) G.I. pipe clamps for holding the pipe	2 Nos.			
	(*viii*) Barbed wire for anticlimbing	2 kg.			
	(*ix*) Concreting of existing pole	1 No.			
3.	11 kV, H.T. cable, 3 core 2.5 mm dia., from pole to 11 k.V.	30 mts			
4.	Laying of cable	14 mts			
5.	11 kV Panel consisting of T.P.M.O. and metering arrangement etc.	1 No.			
6.	Transformer 11/0.4 kV, 1000 kVA delta/star, 50 cycles/second				
7.	Right angle cable box to be fitted in 11 kV panel with compound material	1 No.			
8.	Cable VIR 625 mm double leads for connections in panel board etc.	80 mts.			
9.	Copper lugs 1000 amps for connections in panal etc.	28 Nos.			
10.	Jointing material for lungs	L.S.			
11.	L.T., OCB, 1600 amps, complete with ammeter, voltmeter, energy meter with maximum demand meter, CT's, P.T.'s 3 NOS, operated trip coils and under voltage release etc.	1 No.			
12.	Earthing of transformer and L.T. OCB (G.I. pipe earthing)	3 Nos.			
13.	L.T. Unit box, 300 amperes, 660 volts grade	4 Nos.			
14.	L.T., Terminal Test Block (T.T.B.) on outgoing panel	4 Nos.			

S. No.	Description of Material	Quantity	Rate	Amount	Remarks
15.	Wiring in sub-station for light and fan including one single phase energy meter, 50 c/s, 2.5 amps	L.S.			
16.	Ceiling fan for sub-station	1 No.			
17.	Miscellaneous expenses such as empire tape, kerosene oil, solder aluminium, cotton waste, nuts and bolts etc.	L.S.			
18.	Labour charges for the above work	L.S.			
19.	Cartage charges from store to site	L.S.			
20.	Contingencies 3% on Labour and cartage				

Total Rs.
11% overhead and supervision charges Rs.
Grand Total estimated cost Rs.
or Say Rs.

Note : The rates of various items have not been given in this estimate.

Take this exercise as a project work. The students are advised to go to nearest sub-station, study the transformer parts thoroughly and prepare the estimate.

Estimate No. 11 :

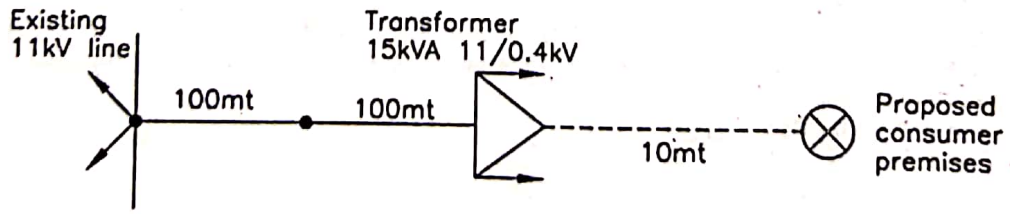
A 15 kVA, 3 phase transformer is to be installed giving supply to a rural tubewell for the consumer. The transformer is placed on a structure fabricated by use of two poles on which the 11 kV lines also terminate and the substation is required to be pole mounted type. Make a neat sketch of the same and prepare a material schedule required for the work. The cost of service connection may be mentioned after going through the market for the material cost. Prepare the list of material with full specification of each item.

Solution. Assumptions

(*i*) The existing line is 200 metres from proposed tubewell.
(*ii*) The load of consumer is 10 H.P.
(*iii*) The cable service will be provided from double pole structure (pole mounted sub-station) to consumer's premises.
(*iv*) The approximate length between transformer and consumer's premises is 10 metres in all.
(*v*) R.S. joist will be provided for single and double pole structure.

Calculation of current. Current to be supplied by secondary side of transformer

$$= \frac{15 \times 1000 \text{ W}}{\sqrt{3} \times 400} = 22 \text{ Amps.}$$



Schedule of Material for 200 mts 11 kV Line

S. No.	Description of Material with Full Specifications	Quantity
1.	**H.T. connection with main line :**	
	(*a*) M.S. channel 10 cm × 5 cm × 1.5 m long	1 No.
	(*b*) H.T. 11 kV disc insulators with fittings	3 Nos.
	(*c*) 11 kV pin insulators with pins	2 Nos.
	(*d*) Stay complete (with stay wire, clamps, stay bow, stay rod etc.)	2 Nos.
	(*e*) Earth wire clamp complete with nuts and bolts	1 No.
	(*f*) Tee clamp for M.S. channel with nuts and bolts	1 No.
	(*g*) Binding wire of aluminium for jumpering	1 kg.
2.	**R.S. joist 10 metres long (one for single pole and 2 for double poles 175 mm × 100 mm**	3 Nos.
3.	**Double pole structure for transformer**	
	(*a*) Stone pad	2 Nos.
	(*b*) Sub-station plate	1 No.
	(*c*) Mild steel clamps	2 Pairs
	(*d*) M.S. channel 100 mm × 50 mm × 8 mm × 2.75 m long	3 Nos.
	(*e*) Eye bolts	3 Nos.
	(*f*) Dropper angle iron 75 mm × 75 mm × 8 mm × 2 m long	1 No.
	(*g*) Stay complete	2 Nos.
	(*h*) 11 kV disc insulators with fittings	3 Nos.
	(*i*) 11 kV pin insulators with pins	3 Nos.
	(*j*) Binding wire	500 gms
	(*k*) No. plate with clamp and danger plate with clamp	1 each
	(*l*) Barbed wire	5 kg.
	(*m*) Earthing complete	1 No.
	(*n*) Jumpering	11 mts.
	(*n*) Nuts and bolts 12 mm dia. 25 mm long 12 mm dia. 50 mm long	16+2=18 Nos.
	(*o*) TPMO (Triple pole mechanically operated) switch	1 No.
	(*p*) Fuse set	1 set.
	(*q*) Fabrication, pointing, concreting	As required
4.	**Fitting on straight line :**	
	1. Cross arm of angle iron	1 No.
	2. 11 kV pin insulators with pins	3 Nos.
	3. Clamp for R.S. joist	1 No.
	4. Earth wire clamp, danger plate, No. plate with clamps	1 each
	5. Barbed wire	2 kg.
	6. Stone pad = one, Barbed wire = 2 kg, Binding wire	As reqd.
5.	ACSR conductor 6/1/2.19 mm dia. = 200 × 3 + 1% (sag).	606 mts.
6.	Galvanised steel earth wire 7/16 = 200 × 1 + 1% sag 201 mts or	22 kg.
7.	Cable VIR from transformer to I.C.T.P. switch 6 mm 660 V grade	12 mts.
8.	ICTP switch, flat rag bolt, energy meter box, kWh meter 3ϕ 4 wire, 20 amp, kit kat fuse unit for light, single phase	1 each
9.	Cable 6 mm 3.5 core 660 V grade	10 mts.
10.	Kit kat 30 amps. 500 V grade	3 Nos.
11.	Rag bolts for meter box	4 Nos.
12.	Lightning arrester	1 set of 3