



ELECTRICAL INSTALLATION ESTIMATION
SEC-A

BRANCH- ELECTRICAL ENGG
Lecture name- Anil Ku. Sahoo

SWAMI VIVEKANANDA SCHOOL OF ENGG AND
TECHNOLOGY, MADANPUR



①

General Principles of Estimating

✓ Assessment of quantities of different items & their cost to plan the amount required for executing a work before actually carrying out the work.

Before tender; estimate is made out by a person called Estimator.

* Estimation for internal wiring

① Complete specification, ~~se~~ type of wiring to be adopted & quality of material to be used.

② Complete schedule of the points to be wired for with their switches & sched fittings

③ Position of main switchgear & distribution board.

④ State & construction of building, the distance of the job from the main office, time available to complete the job.

* Characteristics of an Estimator

① Shld have knowledge a catalogue's library & price list of all products of his own organization & associated items

② He shld keep continual attention to keep up to date prices & related info.

③ Shld have knowledge of labour

Electrical schedule

- ✓ It is the list or plan of building which provides us the info regarding the number of points, in each room of a building under estimation.

Catalogues

- ✓ A list of items details which helps up to date the estimator save time while making a judicious decision useful for his work.

Good estimating knowledge

With update knowledge of

- ① Availability of product
- ② Source of production & vendor selection.
- ③ New product & their quality.
- ④ Price of product & discount.

Contingencies

- This amount is provided to cover the unforeseen expenditure such as extra cost on account of delay in delivery, minor accident & unexpected variation from the plan of estimating department.

Expressed as % of total cost &

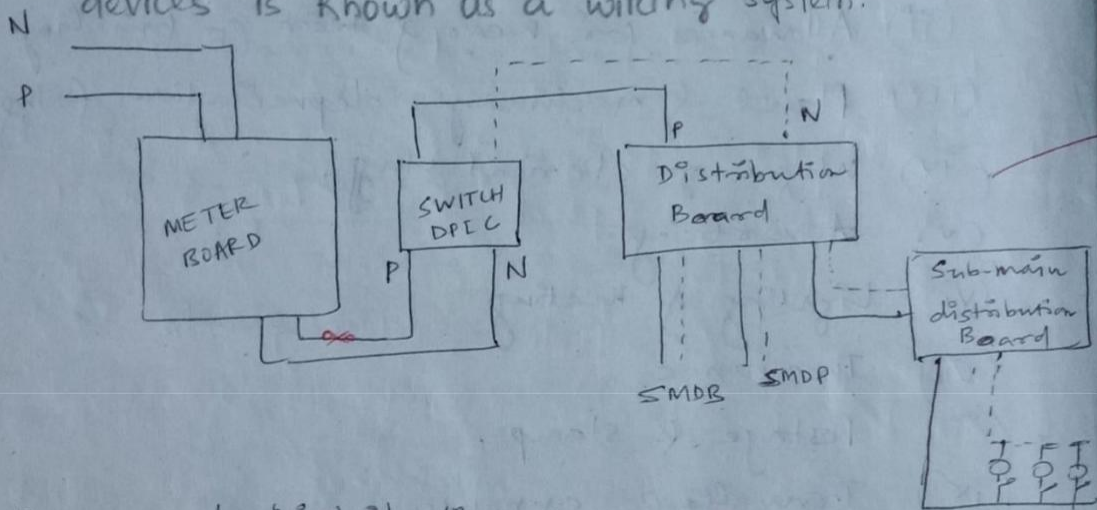
(labour + material)

↳ Additional expenses compensated by contingencies during natural calamities

Wiring System

→ A n/w of wires connecting various accessories for distribution of EE energy from supplier meter board to ~~near~~ numerous electrical consuming devices such as Lamp, fan & other etc; through controlling & safety devices is known as a wiring system.

(19)

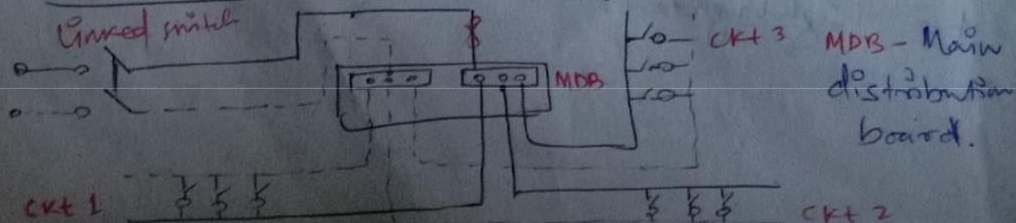


Internal Distribution of Electrical Energy

As per Indian Standard

- (i) Maximum ^{number of} points of light, fan, 5A socket in one circuit can be 10.
- (ii) Maximum load can be connected in 800 W.
- (iii) In case of more load & or powers are required; then it is to be done by having ~~one~~ more than one circuit.

(A) Distribution board System

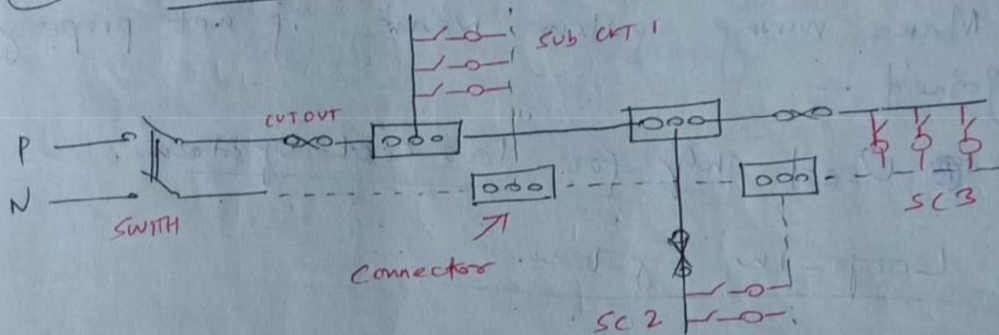


In large buildings

* If ~~X~~ distribution board is used, then loads would be in large distance as a result \downarrow voltage drop happens.

* To avoid such ~~inst~~ occurrence, sub-distribution board is connected to MDB. SMDB installed near the load.

(B) Tree system



→ Earlier days such system were adopted. Due to following drawbacks, obsolete system

(i) Voltage across all lamps not same. Last branch has least voltage due to drop.

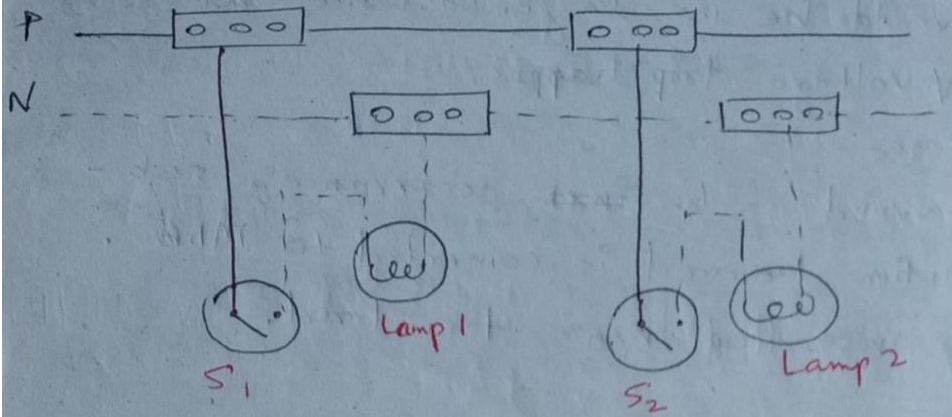
(ii) Fuses are scattered.

(iii) Numbers of joints are involved in circuits.

(iv) In case of fault all joints have to be located.

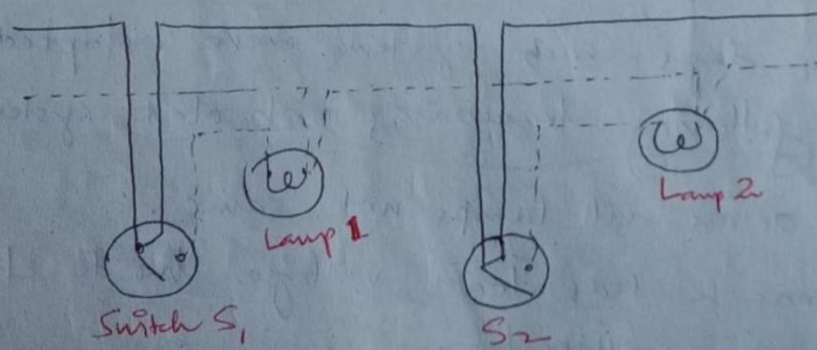
METHODS OF WIRING

I Joint Box or Tee system



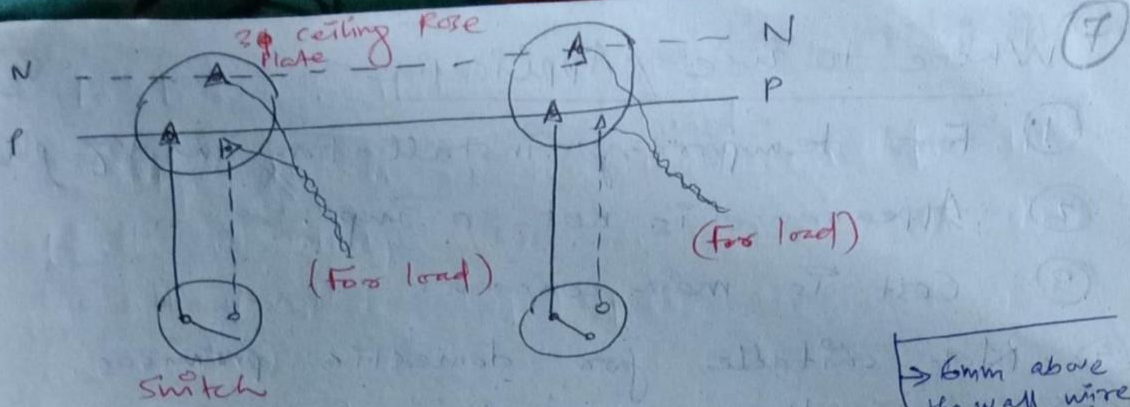
- Saving cable/wire but extra joints boxes ^{cost of} boxes required.
- Make wiring system weak if not properly joined.
- Used only for "low cost system".

II Loop-in System



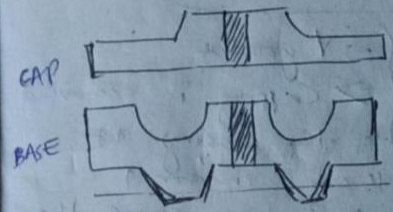
- * Advantages -
 - (i) Joint box are not required.
 - (ii) Fault location is easy; as no joints are concealed beneath floors or in roof space.

- * Disadvantages -
 - (i) length of wire is more, voltage drop ↑.

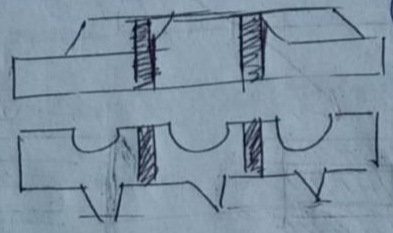


SYSTEMS OF WIRING -

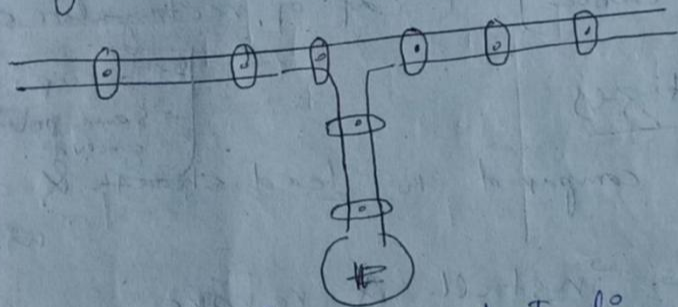
I Cleat Wiring



Two grooves



Three grooves



- 6mm above the wall, wire is held.
- Screw 38mm
- Interval 30 cm - 60 cm of cleat.

→ For VIR (Vulcanized Indian Rubber) & PVC (Polyvinyl chloride) cables.

→ Made up of porcelain.

Advantages

- ① Cheapest
- ② Installation & dismantling is easy & quick.
- ③ Material is recoverable after dismantling
- ④ Inspection can be made quickly.

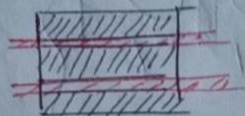
Disadvantage

- ① Not good looking;
- ② ~~More~~ less durable.

Where to use / Application

- ① For temporary installation in dry places.
- ② Appearance is not so imp.
- ③ Cost is main concern.
- ④ Not suitable for domestic premises.
- ⑤ Low voltage ~~used~~ (250 volt)

II Wooden casing & capping wiring



[Groove for cable]

[Cap of rectangular shape]

- V groove
- Capping is screwed to the casing at 15 cm intervals
- 3.2 mm above the wall casing is fixed

* Advantages

- (i) Cheap compared to lead sheath & conduit wiring.
- (ii) Easy to install & remove.
- (iii) Good insulation for conductor; as they are wide apart.

(iv) ~~Moisture proof~~

(v) Easy to inspect.

Disadvantages

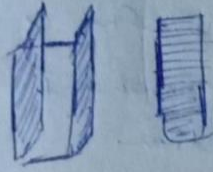
(i) Risk for fire hazard.

(ii) Labor cost is higher.

(iii) Used on surface & cannot be concealed in plaster.

- To keep it dry
- Same polarity in one groove

Due to a large cost of ~~teak~~ wood; PVC casing & capping is being used.



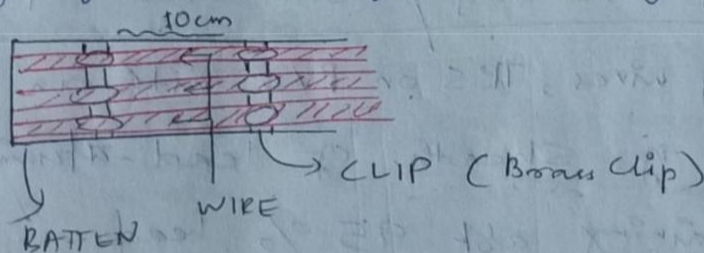
Casing Capping

III COTS or TRS wiring → Tough Rubber sheathed

→ Cab Tyre sheathed

→ 1, 2, 3 core cable are used.

→ chemical, steam, water, proof but slightly affected by lubricating oil.



→ Batten width is depend upon the nos of conductor it carries; (Table 2.2)

→ at least 10mm

→ Batten is fixed on wall with SCREW at an interval of 75cm.

→ Brass clip are provided at interval of 10cm horizontally & 15cm in vertical runs.

Advantages

- (i) Installation easy & quick.
- (ii) Life is long.
- (iii) Within certain limit it is fire proof.
- (iv) ...

Disadvantages

- (i) Good workmanship is required for TRS.
- (ii) For open outdoor wire prone to sun & rain such scheme is not recommended as it may depreciate insulation.

* Application

- Low voltage app.
- For lighting purpose.
- Can't be used in damp place of workshop as it may get mechanically injured.

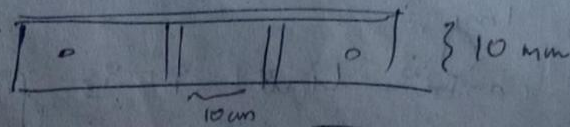
IV Lead Sheathed / Metal Sheathed Wiring

Insulated wires, TRS or PVC with an outer covering of sheath of lead-aluminium alloy containing abt 95% lead.

→ It provides mechanical protection & damp protect against dampness & atmospheric corrosion.

→ The lead covering is electrically continuous & ~~is~~ connected to the earth at the point of entry.

→ Placed on wood batten; well ~~is~~ varnished. > (10mm)



Advantages

- ① Mechanical protect against injury.
- ② Easy fix.
- ③ Damp & corrosion protect.
- ④ Can be used in rain & sun exposed area.

Disadvantages

- ① Costlier than TRS.
- ② Chemical corrosion may occur.
- ③ In case of damaged insulation, it may give shock.
- ④ Skilled labor & proper supervision is required.

⑤ Conduit Wiring.

- Initially, steel conduit were used but nowadays PVC conduit are employed.
- Cheap cost, labor time save, light weight,
- Resistant to Acid, Alkali, Oil & moisture.
- Can be buried in lime or cement without ill effects.
- PVC not suitable for location prone to fire hazard.
- Size 12mm, 16, 19, ~~25mm~~, 25mm, 31mm, 38mm, 50mm.

Advantage

- ① Mechanical & fire hazard protection
- ② Water proof.
- ③ Easy maintenance.

Disadvantages

- (i) Costly
- (ii) Its erection ~~is~~ requires time
- (iii) Experienced & high skilled labour required for job carrying out the job.


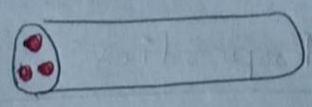
Application

- (i) Where considerable dust is present such as textile mills, sawmills, glass mills.
- (ii) Damp situation
- (iii) Residential & public buildings.
- (iv) Places where documents are kept such as record room.

* CHOICE OF WIRING SYSTEM

- (i) Safety.
- (ii) Durability - Time of lasting.
- (iii) Appearance
- (iv) Mechanical protection
- (v) Permanency
- (vi) Accessibility.
- (vii) Initial cost
- (viii) Maintenance cost.

Wiring Materials & Accessories (13)

WIRE	CABLE
<p>① Single wire may be bared or covered with insulation.</p> 	<p>① Multiple wires covered with insulation</p> 

* Cable consist of three parts

- (i) Conductor / core :- Metal strand
- (ii) Insulator / dielectric :- Avoid leakage current.
- (iii) Protective covering :- From mechanical damage.

* CONDUCTOR MATERIAL USED FOR

Aluminium	Copper
<p>(i) Cheaper</p> <p>(ii) Conductivity low (60%) \nearrow \neq copper</p> <p>(iii) $\rho = 2.87 \times 10^{-8} \Omega\text{-m}$ ($R = \rho / lA$) @ 20°C</p> <p>(iv) Used in distribution system. ACSR.</p> <p>(v) House wiring High resistance,</p> <p>(vi) Not easily solderable</p>	<p>(i) Costlier</p> <p>(ii) Conductivity $\uparrow\uparrow$</p> <p>(iii) $\rho = 1.786 \times 10^{-8} \Omega\text{-m}$</p> <p>(iv) Mechanically strong hard, strong durable ductile.</p> <p>(v) Resistive to oxidat corrosion, pitting.</p> <p>(vi) Withstand dampness</p>

INSULATING MATERIAL

To prevent leakage current from the conductor.

It should be highly resistive to the flow of electric current through it.

* Properties

- (i) High ρ
- (ii) High flexibility
- (iii) $\uparrow\uparrow$ dielectric strength.
- (iv) Non-inflammability
- (v) Non-hygroscopic (Non-retaining water)
- (vi) Resistive to moisture, acid & alkali.
- (vii) Resistive to high temperature without much deterioration.

* Type

(1) RUBBER :-

- * Relative permittivity $\cong 2$ to 3.
- * Dielectric strength = 30 kV/mm.
- * Absorb moisture, may swell when heated with 60°C or 70°C .

Ability of storing electrical energy in an field (external)

(2) VULCANIZED INDIA RUBBER (VIR)

- Does not absorb moisture, water-proof
- Sulphur content - attack copper.
- To avoid this above; a pure rubber is coated on the conductor. OR the copper

(3) Impregnated Paper

- Cheap, low capacitance.
- High dielectric strength (30 kV/mm) ↑
- High insulation resistivity ($10^{15} \Omega\text{-cm}$)
- Ad → Can withstand high temperature without deterioration.

Dis → hygroscopic - moisture absorber.

(4) Polyvinyl chloride (PVC)

- Synthetic compound.
- Preferred over VIR in extreme condition.
- Mechanical properties is worse than Rubber (Elasticity & recovery from stretching).
- low cost;
As a result widely used.

(5) Silk & Cotton

- Used in low voltage cable
- Used for instruments & motor wiring.

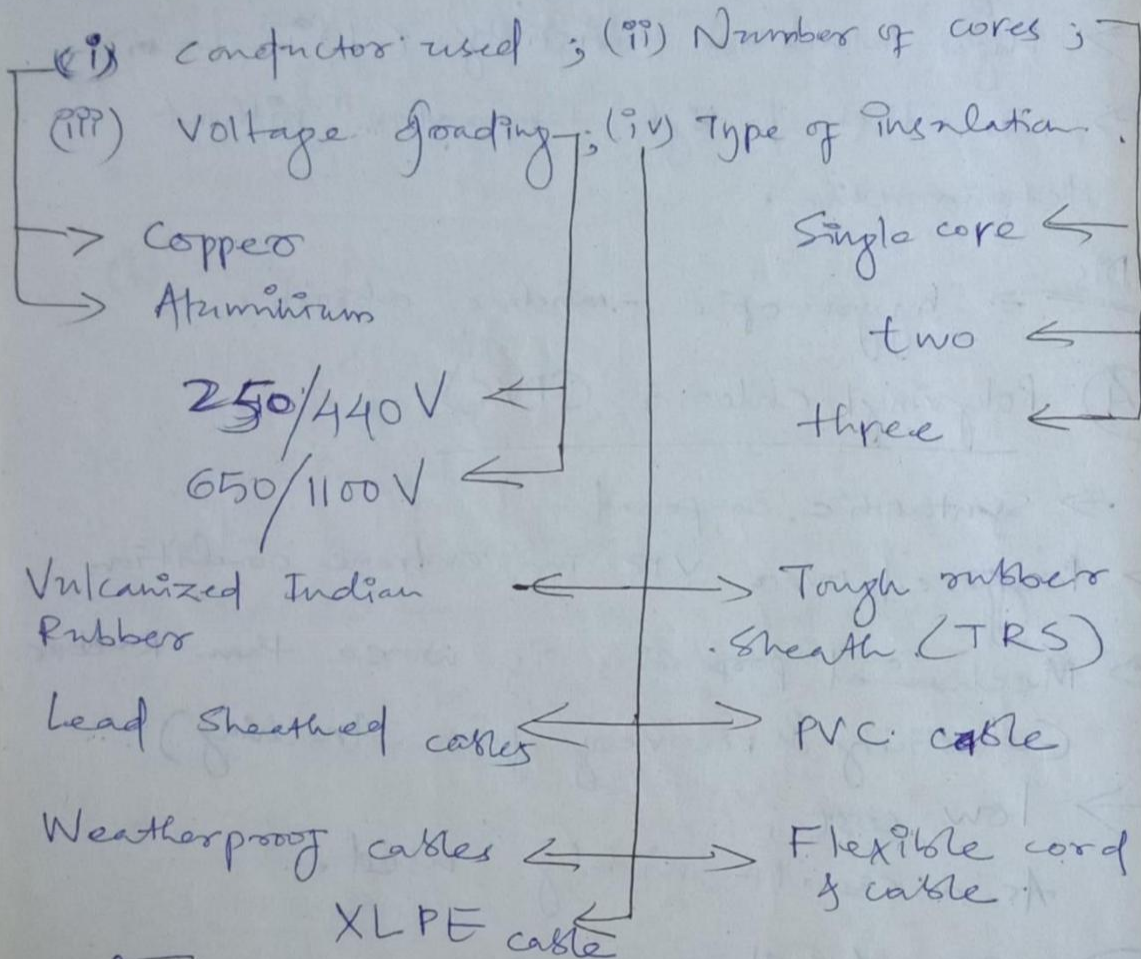
MECHANICAL PROTECTION

→ All insulating material are mechanically weak.

- Mainly used in ~~submarine~~ ~~underground~~ underground cable
or steel tape are provided

* Type of cables -

Wire \checkmark According to
are divided



[Cross-linked polyethylene]

① Vulcanized Indian Rubber :- Cable -

→ 240/415 Volt ; 650/1100 Volt

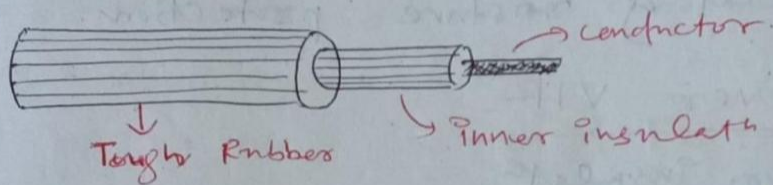
→ Thickness of rubber insulation \propto Voltage grading.

→ Copper wire is ^{coated with TIN} TINNED to provide protection against sulphur, ZnO in VIR.

→ Bitumen wax is provided on the rubber for moisture proof.

② Tough Rubber Sheathed (TRS) Cables (H)

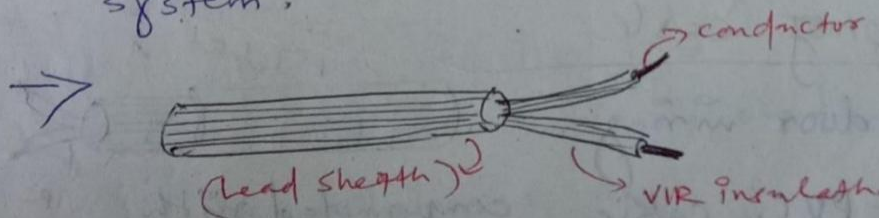
- 250/440V & 650/1100 volt grade.
- Used in TRS wiring.
- Same as VIR but provided with additional insulation & protection against tear & wear.
- Waterproof.



- 1 core, 2 core, 3 core cables available.
- ⊗ → cheap cost & lighter weight than ~~normal~~ ~~at~~ lead-alloy sheathed cable.

③ Lead Sheathed cable

- 240/440 volt grade.
- lead sheathed cable; cover with continuous sheath of lead.
- Protect against moisture, mechanical injury.
- Can be used ~~in~~ without casing & conduit system.



④ PVC (Polyvinyl chloride) Insulated cable

- can be used in casing-capping, battery & conduit wiring system.
- PVC is harder than rubber; does not require cotton taping & braiding for its mechanical & moisture protection.

PVC over VIR

- (i) better insulation
- (ii) better flexibility
- (iii) No chemical effect on conductor.
- (iv) Thin layer of PVC required for insulation.
- (v) Small diameter cable; size 14.

Disadvantages

Insulation resistance $<$ VIR.

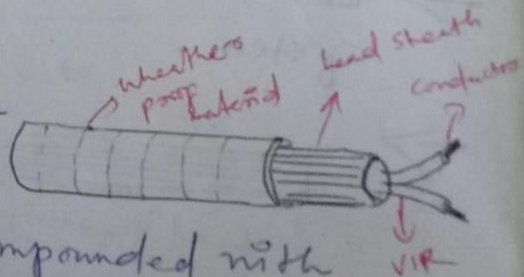
(but negligible under 600 V)

→ So; used frequently.

⑤ Water proof cable

→ for outdoor wiring.

→ VIR or PVC cable compounded with weather proof insulation.



(6) Flexible cord & cables

- Wire silk/cotton/plastic covered.
- It has tinned copper conductor, covered with plastic (for diff colors).
- Flexibility & strength obtained from number of strands of wires.
- X → Flexibility allow ~~is~~ consumer to have mobility.
- Must not be used in fixed wiring.
- Used for Household application

(7) XLPE cables

- Insulation made of polymers.
- The mechanical property of polymer depends on ~~depands~~ ^{eg.} Tensile strength, elongation elasticity & resistance against cold] depends upon chemical structure.

Advantages of XLPE over others

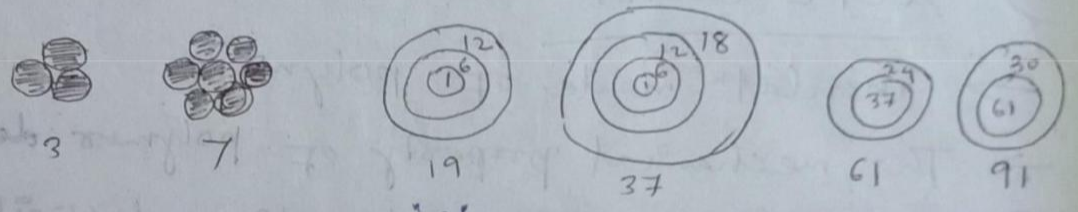
- (i) High current rating
- (ii) ↑↑ SC current rating
- (iii) Longer service life
- (iv) 130°C temp withstand for short time
- (v) Low dielectric loss.
- (vi) Excellent mechanical features improve protection against external effects.
- (vii) Resistant to, acid, alkali.

MULTI STRAND CABLE

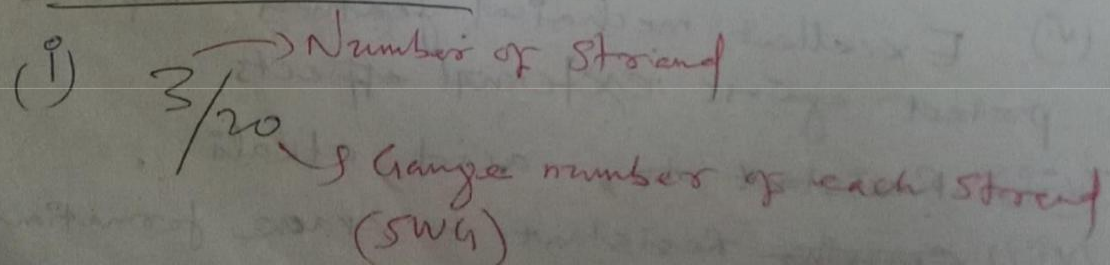
It has following advantage compared to single strand cable.

- (i) More flexible & durable * withstand incredible amount of vibration without breaking.
- (ii) Handled conveniently.
- (iii) Surface area is more; so heat radiating capacity is better.
- (iv) Skin effect is better as conductors are tubular; especially in high frequency.

→ 3, 7, 19, 37, 61, 91 → To obtain circular contour.
Numbers of strand



- Each layer has '6' strands more than the layer beneath it.
 - Alternative layers are spiralled in opposite direction. To prevent "BIRD AGING" when the conductor is bent.
 - 2% additional wire is required for spiralling.
 - Actual cross-section is 2% more.
- # Size of cable



(ii) $19/1.12 \text{ mm}$ → strands
→ diameter of each

(iii) 19.35 mm^2 → Total CS area of cable
for $19/1.12 \text{ mm}$ cable

$$\text{Skin depth } (\delta) \approx 503 \sqrt{\frac{\rho}{\mu_r f}}$$

ρ → resistivity
 $\mu_r f$ → frequency
→ relative permittivity

SWG = Standard wire gauge

Gauge → wire diameter.

$$LE = N\Phi$$



$$L = \frac{IN^2 A}{l}$$

* General Specification of cable -

(i) Size of cable in metric system.

Ex - $19/2.24 \text{ mm}$ (Number of strands & diameter of each strand in mm)

(ii) Type of conductor used (Al/Cu)

(iii) Number of core (1, 2 or 3).

(iv) Voltage grade (250/440 V or 650/1100 V)

(v) Type of cable with general specification description.
regarding insulation, shielding, armoring, braiding, etc.

Ex

$7/1.2$, Al, flat twin core, 650/1100V,

22

* Disadvantages of stranded conductor

- (i) Large diameter for same current carrying capacity as solid cable.
- (ii) Expensive
- (iii) Complex manufacturing
- (iv) Prone to corrosion.

* SOLID conductor

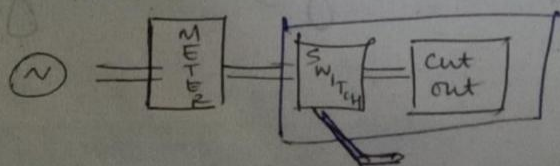
<u>Adv</u>	<u>Disadv</u>
→ Cheaper	→ No flexibility
→ Durable	→ Small diameter are sold.
→ Simple	→ At constant vibration, the cable tear/break.
→ Small diameter	
→ Not prone to corrosion	

Accessories

~~MAIN~~ MAIN SWITCH & DISTRIBUTION BOARD

* IER-50: a linked switch (which operate ^{simultaneously} on both phase & neutral wire)
to be provided just after meter board.

* Suitable cut out to be provided just after the linked switch.. (protect against over current)



For 1 ϕ , 2 Wire : DPIC (Double pole Iron clad)

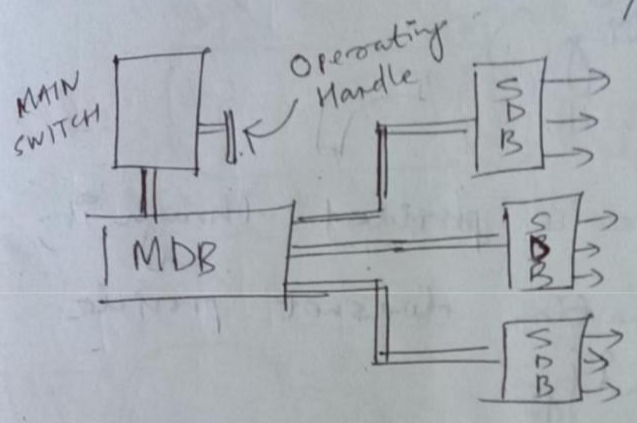
For 3 ϕ , 3 Wire : TPIC (Three pole Iron clad)

* IE Rule: 32

No fuse on neutral wire.

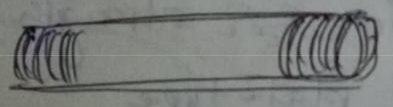
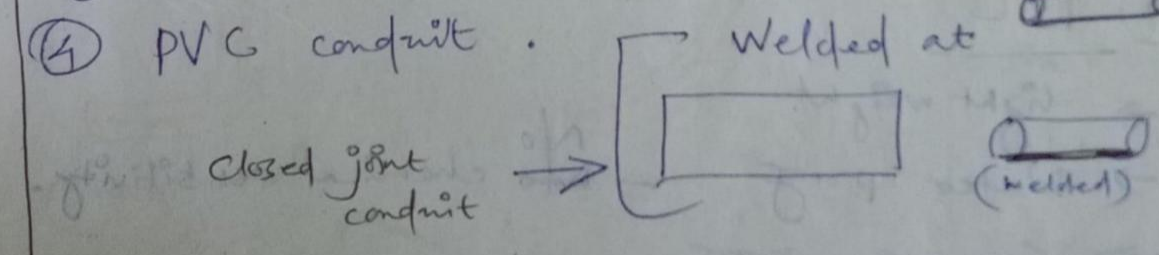
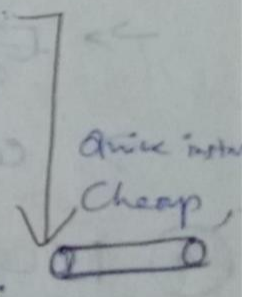
* Distribution board:

It is an assembly of parts; including one or more fuses / CB, arranged for distribution of ~~the~~ electrical energy from ~~the~~ MDB to circuits/SDB.



* CONDUIT

- ① Light gauge steel - plain conduit
- ② Heavy gauge steel - screwed
- ③ Flexible conduit
- ④ PVC conduit



Costly, tough, permanently installation

→ Threaded @ two end.

→ For joining

③ Flexible steel conduit

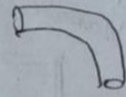
→ light gauged galvanized steel strips spirally wound & to some extent, interlock so as to form a tube.

→ Upto 250 m long conduit available.

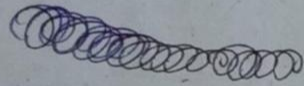
→ So; no interlocking is required.

(Hence; No threading)

No elbow is required.



→ A neutral wire is provided through it, as, spiral formation does not provide efficient continuity.



→ Efficient in vibration, case of

→ costly.

④ PVC

→ light weight

→ Water proof → No chemical sensitivity.

→ Corrosion proof

→ Insulation (high dielectric strength)

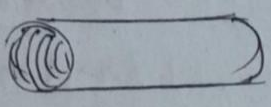
* Threaded type or plain type

Disadvantage

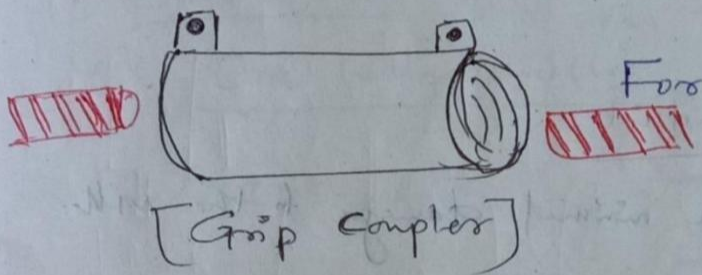
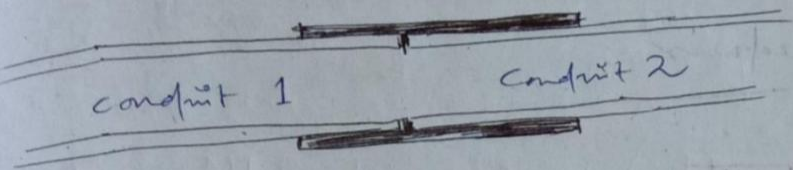
→ Separate earth wire need to be run.

* conduit accessories & fittings

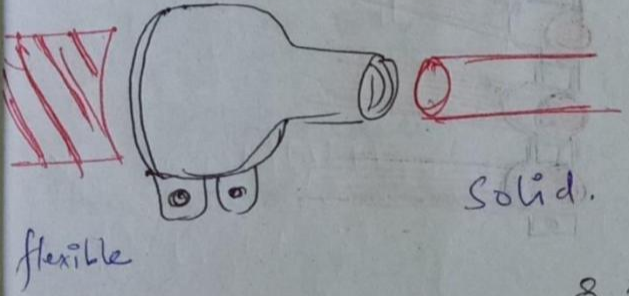
① Conduit coupler



for rigid conduit



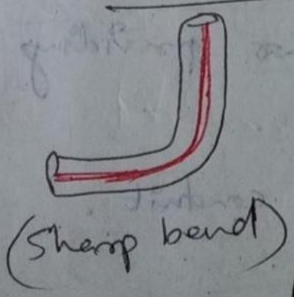
For flexible conduit



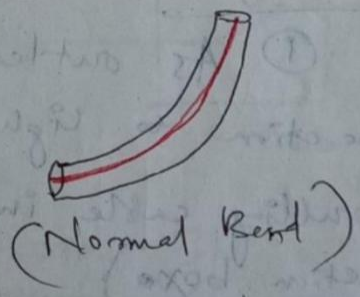
Solid.

flexible

② Bends, Elbows & Tees



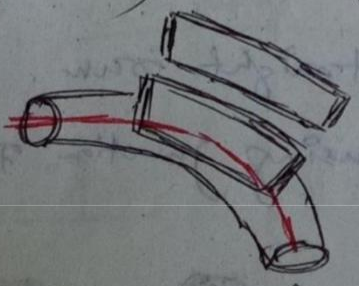
(Sharp bend)



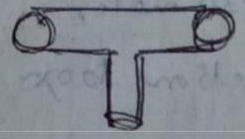
(Normal Bend)

ELBOW

- Short radius
- Sharp turn area.
- Neat wiring
- Inspection can be done



(Inspection Bend Elbow)



(Solid tee)

③ Conduit bashing -

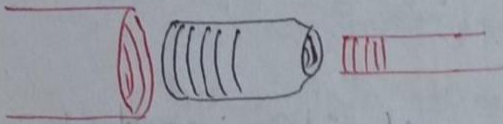


Male



Female

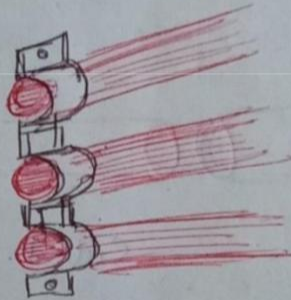
④ Conduit Reducer



⑤ Fixing of Conduit

fixing conduit with minimal damage to the wall.

CLIPS



⑥ Low Nuts

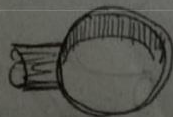
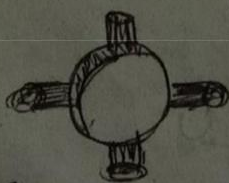
⑦ Conduit Boxes

Purpose (i) As outlet box for providing connection to light, fan.

(ii) For pulling cable into the conduit.
(inspection boxes)

At 30 meter in straight run.

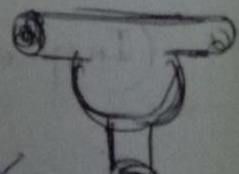
(iii) Junction box. Housing junction of cable.



Side entry



Back entry



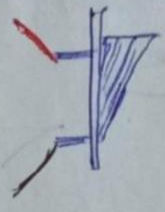
* LIGHTING ACCESSORIES

- ① Switches
- ② Ceiling Rose
- ③ Socket outlet
- ④ Plugs
- ⑤ Lamp holder

① Switch

(a) One way switch

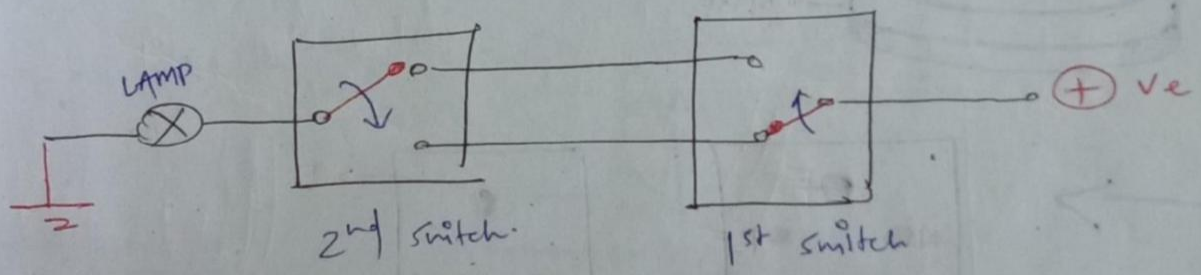
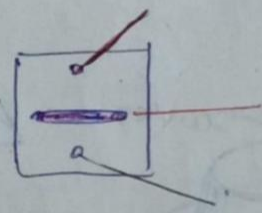
240V, 5-6A



(b) Two way switch

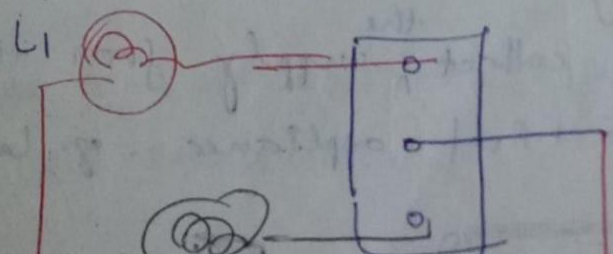
Stair case

Three/Four Terminals

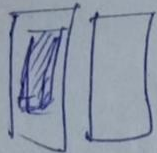


(c) Two way centre off

Centre off



(d) Double pole main switches



DPIC switch.

Combination of two one-way switch which can be operated simultaneously as the ON-OFF terminals.

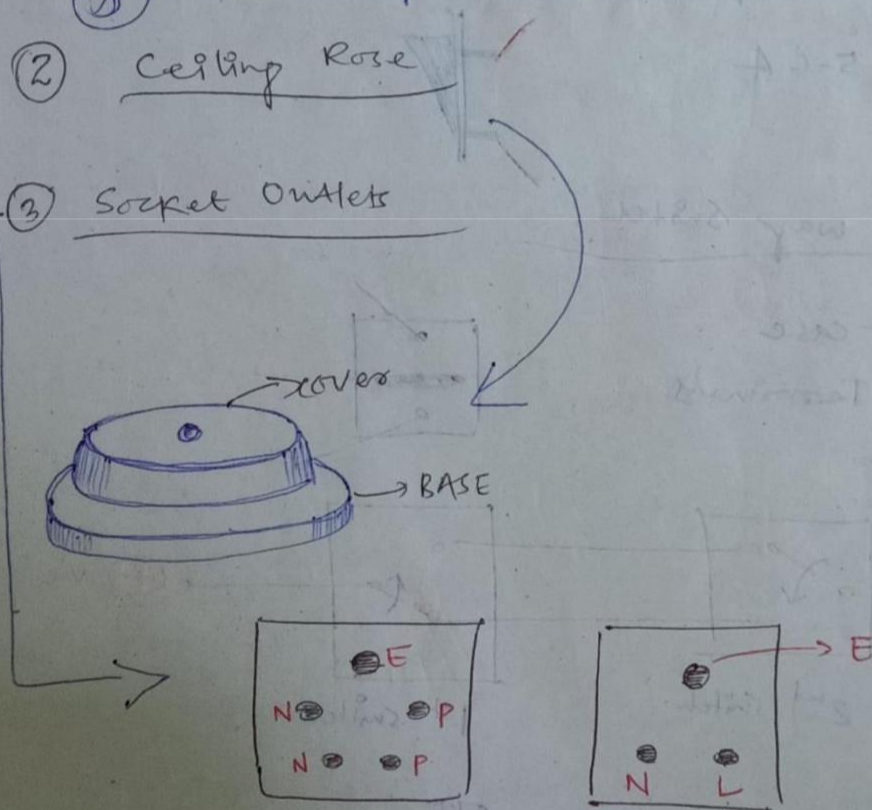
(e) Push button switch

Controlling electronic bell.

(f) Table lamp switch

(2) Ceiling Rose

(3) Socket Outlets



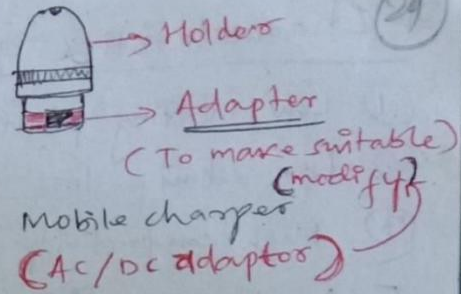
(4) Plug

It collect ^{the} supply from the socket outlet to electrical appliance. eg. lamp, fan, heater.



[3 pin plug]

5) Lamp holder



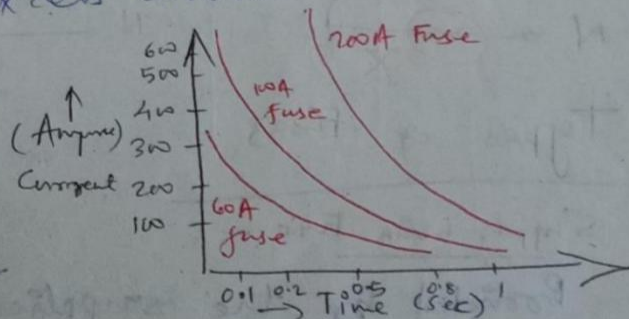
FUSES → Carry normal current safely
 → To break ckt for overcurrent (heating)
 It is the cheapest element that protect the electrical circuit under sc, excessive load, fault. over

Used for
 → Overload & short ckt protection upto 66 kV (HV)
 & 400V (in LV)

ACTION

→ Excessive current flow → heating → melt the wire
 (BREAK) disconnect the circuit from supply. ←
 Protect devices ←

→ The TIME of blowing of fuse depends upon magnitude of excess current.



Advantage

- (i) Cheapest protection
- (ii) No maintenance
- (iii) Automatic
- (iv) Range of operation high without noise, flame, gas or smoke.
- (v) Small size
- (vi) Inverse time-c².

Disadvantage

- (i) Re-wiring / replacement time time

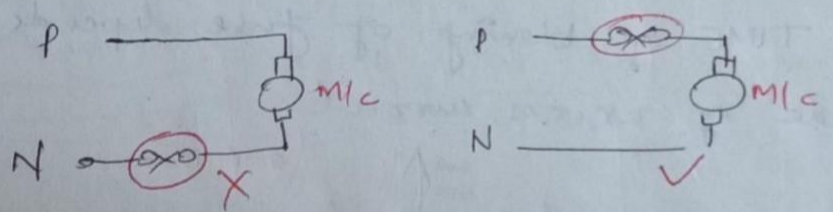
Characteristics of Fuse element

- ① Low melting point
- ② Low ohmic loss
- ③ High conductivity
- ④ Low cost
- ⑤ Free from deterioration due to oxidation.

Eg: - * Lead (37%) Tin (63%) - Upto 15A
 (∴ for I > 15A, diameter would be larger).

- * Copper tinned outside for I > 15A
 (Save from oxidation).
- * Zinc \checkmark for delay operation. not melt quickly for small overload
- * Silver is used inspite of having high cost.
- * Fuses are provided on live not neutral.

→ To ~~facilitate~~ facilitate maintenance to the "m/c or system" without shock.
 → If fuse is provided on the neutral, then the m/c is still in connection with the supply



* Types of fuses

① Supply main fuse -
 Provided by the supplier & is placed just after meter & sealed by him.
 Only authorized person would open & replace the fuse if it is ~~blown~~ blown out.

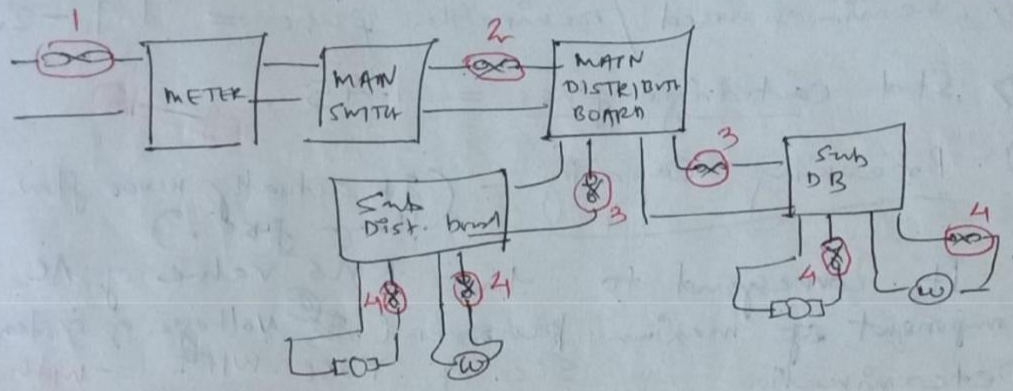
② Consumer main fuse -
 Placed just after main switch.

③ Sub-circuit fuse

A wiring system is divided into a number of sub-circuits & each are provided with a fuse.

④ Point fuse

In quality indoor wiring of building, each component gets a fuse of its own.



* Important Definition

① Fuse - ^{that breaks} system a ③ Fuse link - which need replacement

② Fuse wire - melting part

④ Current Rating - Specified by manufacturer. (RMS value of current a wire can carry without deterioration)

⑤ Fusing Current

→ Minimum current at which element melt.

→ More than "Current rating".

$$I \propto d^{3/2}$$

K → Fuse constant

depends upon

- (a) Type of material used
- (b) X-section area

- (c) Type of enclosure.
- (d) Type of surface.

⑥ Fusing factor -

Current Rating < fusing current < Breaking Capacity

$$F_f = \frac{\text{Minimum fusing current}}{\text{Current Rating of fusing element}} > 1$$

→ For less F_f ; it is prone to malfunction due to "action in ~~overload~~ ^{overload} for small time" which might not be dangerous.

→ Semi-enclosed / rewireable fuse = 1.9 - 2.0

→ Std cartridge fuse = 1.45



⑦ Breaking Capacity - (It actually never flows through fuse.)

It corresponds to the RMS value of AC component of maximum current & voltage of system.

* Determination of Size of FUSE-WIRE - without

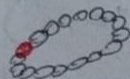
physically breaking / melting

① Maximum current rating of the circuit

② Current rating of the smallest cable

in ckt to be protected by fuse.

* "fuse" is the weak link in a circuit.



→ If a small appliance is connected to a sub-distribution board with comparably large fuse; then a local fuse to be provided for that appliance.

→ In a ckt where current is fluctuating, fuse wire is chosen such that it can carry momentary overload (e.g. motor)

→ For higher size cable (to minimize the

→ For normal lighting ckt;

Current rating of fuse = 3A

Minimum fusing current = 5A

(∵ cable can carry 5A).

∴ Fusing factor = $\frac{5}{3} = 1.67$.

<u>SWG</u> Standard wire gauge	<u>Diameter (mm)</u>	<u>Current Rating</u>	<u>Fusing watt (A)</u>
40	0.122	1.5 A	3
35	0.213	5 A	8
30	0.315	8.5 A	13
20	0.914	31 A	70
15	1.827	78	197

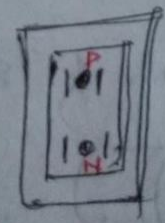
Fuse Unit

① Round type FU

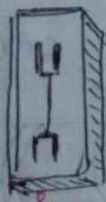
→ Porcelain/Bakelite box

② Kit-kat type

→ Semi-enclosed wireable fuse



Case



Fuse carrier

→ fusing current = 2 Rating current

→ Std rating of fuse wire are: 6, 16, 32,

* Disadvantages of Kit-kat type fuse

① Unreliable operation

• Possibility of ~~renewable~~ renewal by fuse wire of wrong size.

• Due to oxidation the fuse wire deteriorate.

• Length of wire varies results in alteration of rating.

② Lack of discrimination

A 50A fuse can't be discriminated from a 40A fuse but 80A fuse; (diameter of wire used)

③ Small time lag

④ Low capacity of breaking

⑤ No-current limiting features

⑥ Slow speed of operation

No mean of extinguishing the ARC that blows after fuse melt.

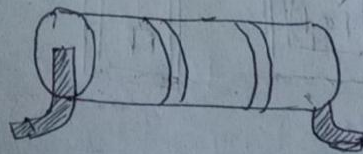
③ Cartridge type (Upto 600 Volt & 800A)

→ Enclosed type fuse.

→ Glass covered filled

with powder, sand, CaCO_3 , quartz (FILLER).

→ Filler cool down the arc & quench it.



④ HRC fuse

- High Rupturing Capacity.
- At generation station; High rating ~~fuse~~ current leads to high stress.
- Removable fuse is not advisable. So, HRC 500 MVA upto 66 KV & above

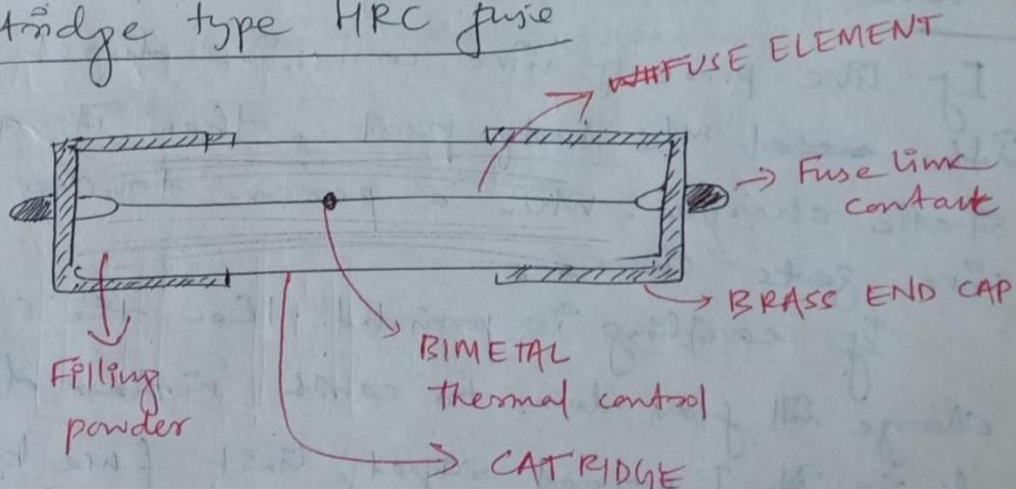
Advantages

- ① No maintenance.
- ② Quick operation & reliable.
- ③ Do not deteriorate with time.
- ④ Inverse-Time current I^2t .
- ⑤ Capable of clearing high & low current.

⊗ Disadvantage

- ① One time use
- ② Interlocking is not possible

Cartridge type HRC fuse



- ① Pre-Arcing: melting of silver elements
- ② Arcing operation: vaporization of elements

EARTHING

(36)

→ Connection of neutral point of a supply system / non-current carrying parts of electrical apparatus [metallic covering, covering of cable, earth terminal of socket outlet] to the general mass of Earth in such a manner that at all time immediate discharge of EE energy takes place without danger.

* Objective (उद्देश्य)

- ① ^{Potential of} No current carrying conductor should ~~have~~ ^{be} to a potential equal to earth other than insulation.
- ✓ ② To avoid electric shock to human beings
- ✓ ③ To avoid risk of fire due to Earth leakage current through unwanted path.

* If live part of wire comes in direct contact with ~~metal~~ M/C body part, then it accumulates static charge. When a person touches the wire gets shocks.

If earthing is provided then the static charge will flow down to earth without danger & if it exceeds safety limit fuse breaks.

Earthing

→ Dead part which does not carry current under

Grounding

→ Connecting the part which carry current under

* IS Specification Regarding Earthing of Electrical Installation

(i) Distance of Earth from building :-

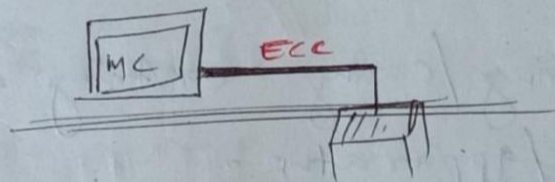
An earthing electrode shall not be situated within '1.5 m' dist from the building. (away atleast 1.5mtr)??

(ii) Size of Earth continuity conductor (ECC) :-

CS of ECC $\geq 2.9 \text{ mm}^2$ (14 SWG)

OR

~~Half~~ the ECC \geq half the installation conductor size.



(iii) Resistance of Earth :-

- Must be low enough to make RELAY operate on earth fault.

- It changes with ~~weather~~ weather (moisture of soil)

- No hard & fast rule for "R".

Large PS — 0.5 Ω

Major PS — 1.0 Ω

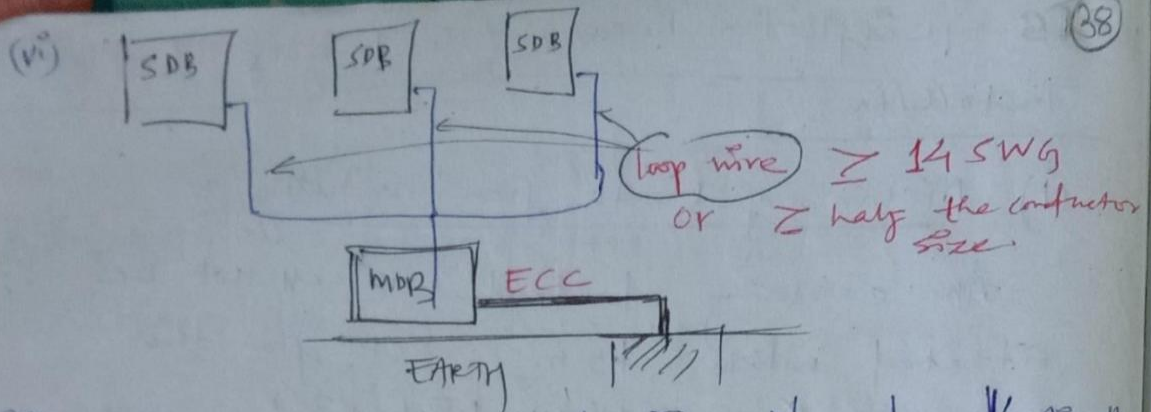
Small SS — 2.0 Ω

Other case — 5.0 Ω

ECC from electrode to M/C — 1.0 Ω ?

(iv) The earth wire of electrode will have same wire.

(v) Galvanised pipe of 130 mm diameter hold/carry ECC



(vii) The earth electrode is placed vertically such that it touches all the layers of earth. ?

* Point to be EARTHED :-

- (i) Earth point of 5-pin & 3-pin power plug socket.
- (ii) All metal covering/casing containing any electric supply line/apparatus.
- (iii) Metal casing of portable apparatus such as heater, soldering iron, drills.
- (iv) Casing of all generator, motor, etc.
- (v) The neutral conductor of 3 ϕ , 4w system shall be earthed ~~at~~ along the distribution line or at some specific location.
- (vi) Supply lines having ~~the~~ concentric cables, the external conductor should be ~~an~~ earthed ~~by~~.
- (vii) For DC 3-wire system, middle wire is earthed at the generating station.
- (viii) Pylon - steel tower carrying TNS line.
At every 1.61 km (mile)
- (ix) etc.

(A) Factor influencing Earth resistance

(89)

- ① Condition of soil
 - (a) Temperature of soil
 - (b) Moisture of soil
- ② Size & spacing of earth electrode
- ③ Depth at which electrode is placed.
- ④ Material of conductor
- ⑤ Quality of coal dust & charcoal in the earth electrode pit.

(#) Methods of reducing earth resistance of the system -

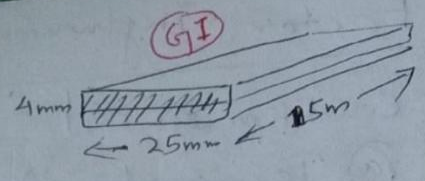
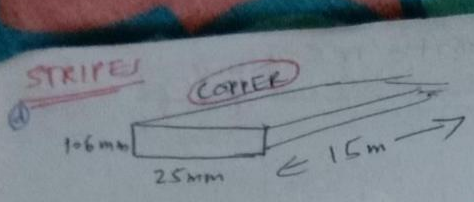
- ① Removing rust from the electrode/plate/pipe.
- ② In summer season; ^{wetting/}soaking charcoal bed with salt water.
- ③ Increase plate area
- ④ Inc. pit depth.
- ⑤ Inc. numbers of parallel electrodes.

(#) Methods of Earthing

① Strip/Wire Earthing -

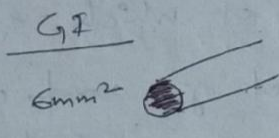
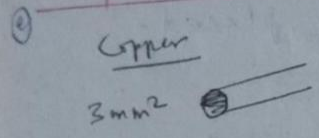
GI - Galvanized Iron

→ coating of "Zn" over iron/steel wire to prevent against "corrosion."

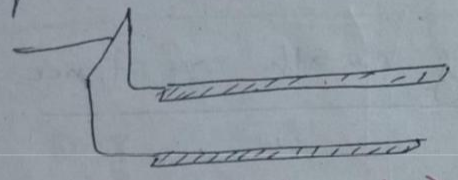


② Buried "horizontally" @ "0.5 m" depth.

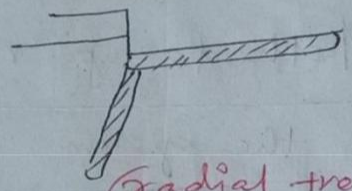
Wire/Round Conductor



⑥ The length should be sufficient to give the required earth resistance.



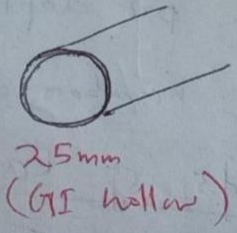
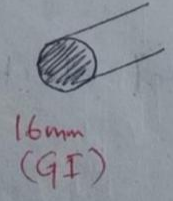
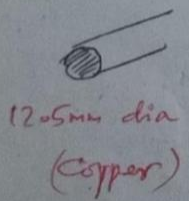
(parallel trench)



(radial trench)

③ Such type of earthing used in Rocky soil as excavation is not possible.

② Rod Earthing



→ Buried vertically atleast to 2.5 meters

→ More than one rod can be used to reduce earth resistance

→ Suitable for SANDY soil.

→ Cheap & no excavation is required.

→ Hammered down by pneumatic hammer

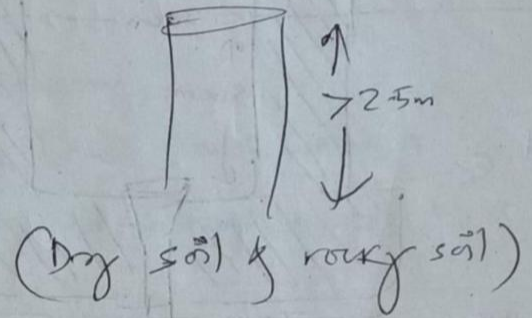
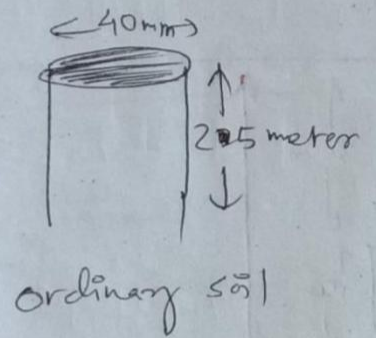


③ Pipe Earthing

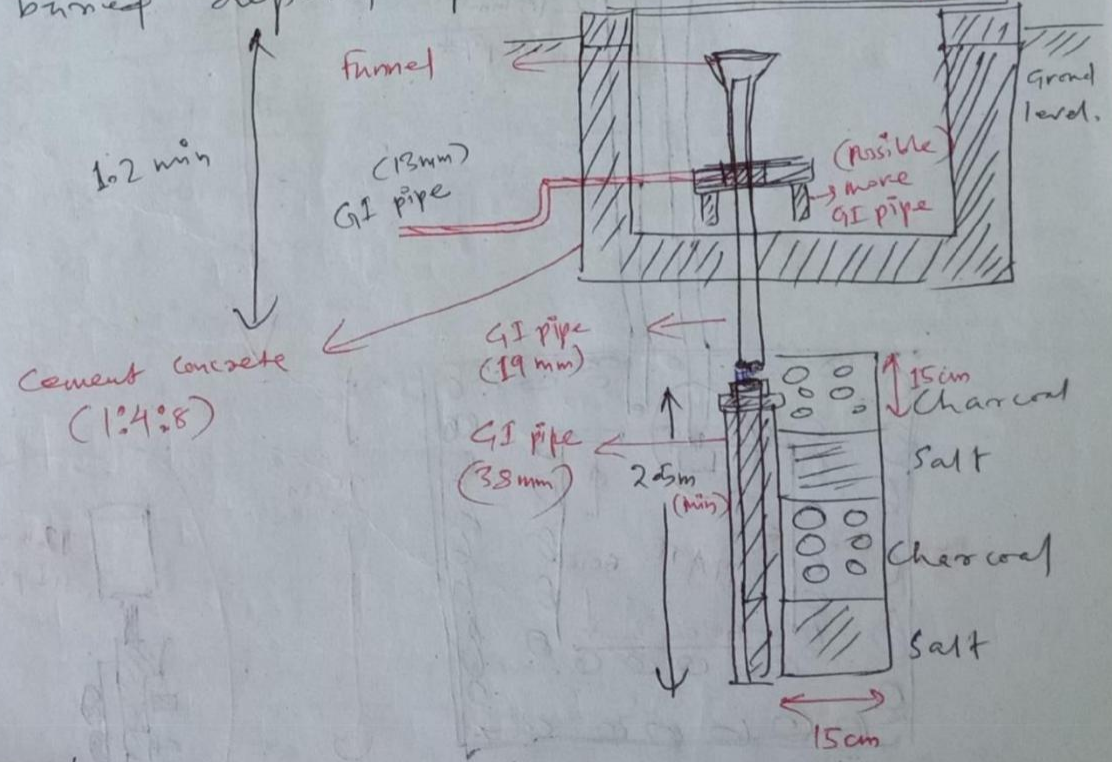
→ For earth with moisture condition.

→ GI steel pipe or perforated pipe placed upright permanently.

→ The size of pipe } Current rating
 Type of soil

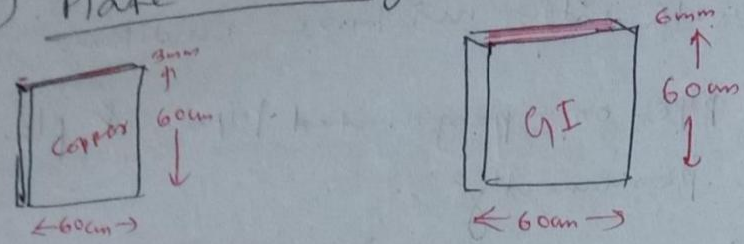


→ The depth at which pipe must be buried depend upon moisture level. ^(cost 4mm) CI cover

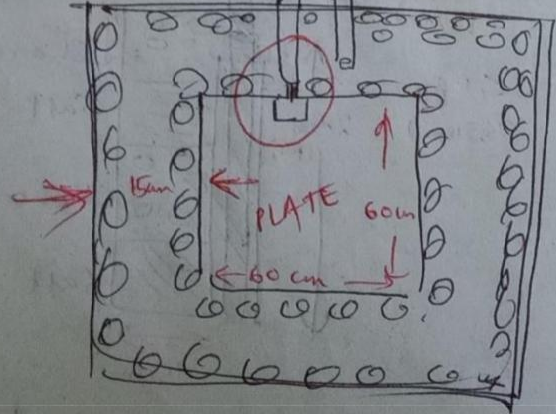
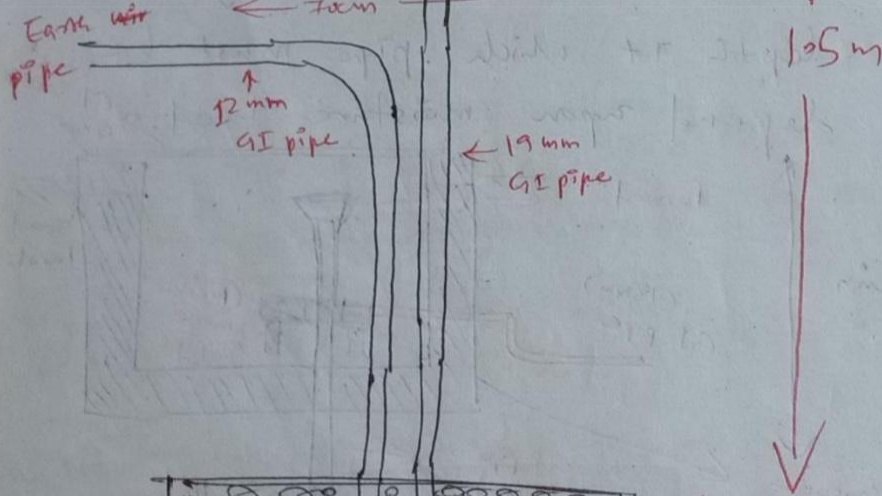
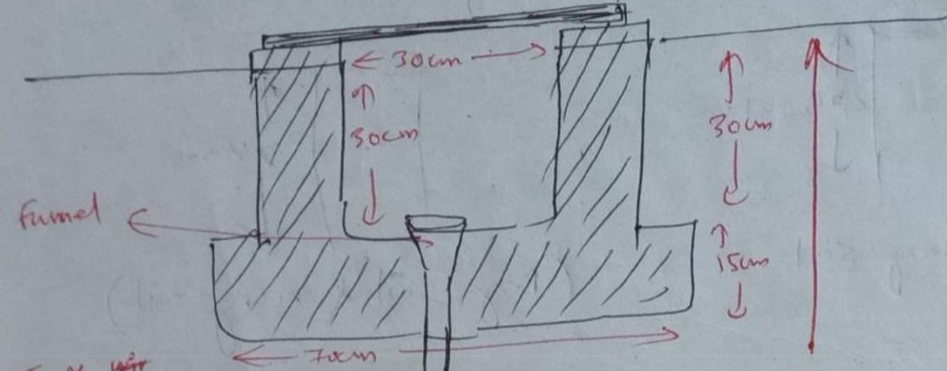


→ 3/4 bucket of water shld be poured to keep the soil moistured.

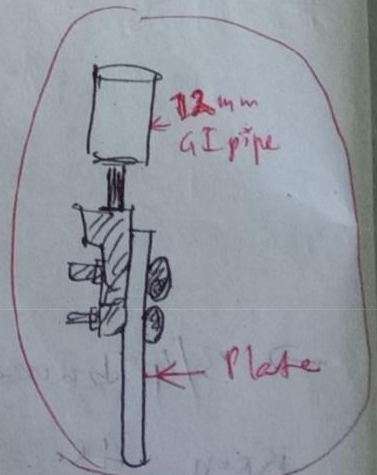
④ Plate Earthing



→ Placed atleast 3m below the ground vertically



90cm



LIGHTING ACCESSORIES SCHEME (43)

* Aim

- ① Promote work & activities carried on within the buildings.
- ② Promote safety of ppl. in using the buildy
- ③ Decorate, a pleasing environment conducive to interest & sense of wellbeing.

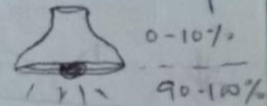
* How to achieve

- ① Plan brightness pattern
- ② Form & texture in the task area.
- ③ Controlling glare, stroboscopic effect & flicker
- ④ Color rendering (original color of object)
- ⑤ Lighting for movement.

* Type of lighting scheme - (Image back side)

(I) Direct lighting -

→ More than 90% of light made to fall directly on working space with deep reflector.



→ More efficient but

- Hard shadow
- Glare

→ Industrial & outdoor activities.

(II) Semi-direct lighting -

→ 60-90% of light made to fall on the working area & remaining illuminate the wall & ceiling.

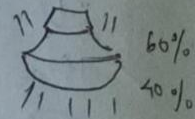
(44)

III Semi-Indirect lighting

→ 60-90% of total light flux thrown upward to the ceiling.

→ For soft shadow & glare free

→ Indoor light decoratⁿ.



IV Indirect lighting

→ More than 90% of total light is thrown upward, by inverted bowl reflector.

→ Ceiling act as light source, glare is reduced to minimum.

→ Softer illumination & more diffused.

→ Shadow is less prominent

→ Cinema hall, Hotel.

V General lighting

→ Equal illumination in all direction.

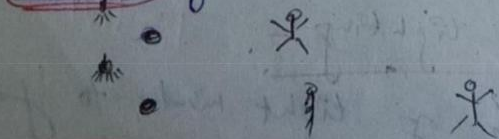
→ Made up of diffusing glass.

Design of lighting scheme

① Illumination level (Body color of obj is essential)

→ Necessary brightness is required by object.

→ (a) Size of object to be seen & its distance from observer



② Contrast between object & background

- Entrance/Hall → 100 (4)
- ① Living room → 300
- Dining room → 150 (3)
- ① Bedroom → 300
- Kitchen → 200 (2)
- Bathroom → 100 (4)
- ① Bathroom-mirror → 300
- Stair → 100 (4)
- Garage → 70 (5)
- ① Study → 300

Traffic

- Group A1 → 30 (imp route of heavy traffic)
- A2 → 15 (main road & mixed traffic)
- B1 → 8 (2nd road with considerable traffic)
- B2 → 4 (light traffic, 2nd road).

② Uniformity of illumination

- lack of uniformity → pupil/iris of the eye has to adjust more frequently → fatigue → productivity reduced.
- ~~loneliness~~ loneliness, gloom & unpleasurableness if wrong lighting (brightness).

③ Color of light

- Body color appearance is depends upon the incident light.
- The composition of light should be such that the color appears natural.

IV Shadow

- Formath of large & hard shadow cause fatigue to eyes.
- ~~Ab~~ No shadow is also not desirable
- Some shadow is required as it give shape to objects.

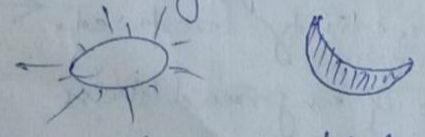
Hard & long shadow avoided



- (i) → large nos of luminaries mounted at height of 2.5 mtos.
- (ii) → Indirect lighting
 - Wide surface source light using globe over filaments.

V Glare

- may be direct / indirect (reflected)
- ~~Direct~~ light looking sun make eye discomfort but to moon (reflected plane).



- Placing light at a height, can be tolerated upto a limit.
- Metal reflectors for industrial lighting.

VI Mounting Height

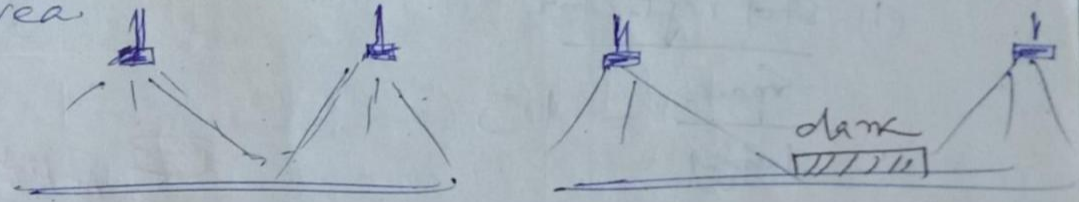
- Based on type of building & type of lighting.

- Bringing it down cause
 - (i) Non uniform lighting
 - (ii) Glare
 - (iii) less efficient of utilization

- Small room & high ceiling.
 - bulb with reflector is best.
- For indirect & semidirect lighting
 - Bulb placed far below the ceiling to give uniform light on ceiling.
 - 2.5 mtrs clearance betw luminary & the floor

(VII) Spacing of luminaries -

→ Correct spacing is imp bcz to provide uniform illuminatn. to do away with dark area



$$\left\{ \begin{array}{l} \frac{\text{Spacing}}{\text{Height}} = 1 \rightarrow \text{fluorescent light} \\ \phantom{\frac{\text{Spacing}}{\text{Height}}} = 0.6 \rightarrow \text{Tungsten lamp} \\ \phantom{\frac{\text{Spacing}}{\text{Height}}} = \frac{1}{2} \rightarrow \text{indirect lighting} \end{array} \right.$$

(VIII) Colour of wall -

→ Illuminatn of any room depends upon the colour of the wall & ceiling.

Factory lighting

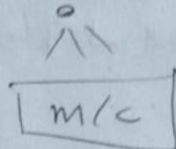
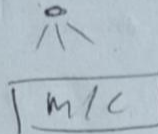
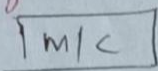
- Increase production
- Good visual environment for employee.
- reduce accident.

- Proper distribution of light
- ~~to~~ glare avoided.
- Avoid reflection from any polished surface

General lighting



Local lighting



Emergency lighting

→ Separate supply for emergency lighting.

(a) Industrial lighting fitting

(i) Std reflector

$$\frac{\text{Space}}{\text{height}} = 1.5$$

(ii) Diffusing fittings - (glare free)

Where highly polished articles is present



As light diffuses through a ~~concentrated~~ plastic / glass. concentrated.

(iii) Concentrating reflector

For high ceiling; wide angle reflector may ~~do~~ waste light.

(iv) Angle reflector

Doesn't provide illuminance in vertical plane.

(b) Maintenance

- Clean light fitting regularly.
- 2 a week or more for dirty environment.

(c) Types of lamp

→ Fluorescent ~~light~~ lamps for natural light colour, absence of glare, less heat than filament.

→ discharge lamp where "color rendering" is not important. Ability show natural color of object.

Street lighting

Objective

- Na-vapor lamp
- Mercury

① To make traffic & obstruction clearly visible to promote safety.

② To make street look attractive.


Principle

① Diffusion principle { road diffuse portion of light & appear bright.

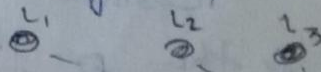
→ Direct light with uniform distribution.

→ 30° to 45° cut-off reflector are made to such that filament is not visible except from underneath.

② Specular reflect principle

→  reflector → wide angle of incidence

→ L_1, L_2 will make the object look darker/shadow & make



Method of producing light (2)

- (1) Arc betw two electrode
Arc lamp (Carbon Arc), Neon lamp.
- (2) Passing current through filament
Incandescent lamp (temperature) (Tungsten), Halogen
- (3) Discharge thru vapour/gas
 - Sodium-vapour lamp. (High voltage @ start to establish discharge)
 - Mercury Vapor lamp.
 - Fluorescent lamp
 - CFL

Reflection factor

$$\frac{\text{Reflected light}}{\text{Incident light}}$$

Law of Illumination (1)

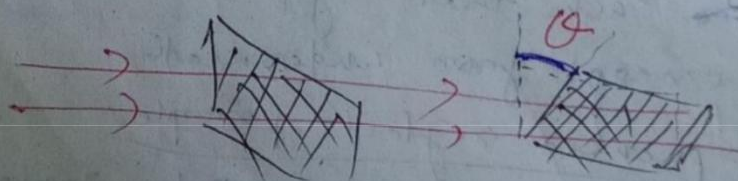
- Luminous intensity
- Dist. betw source & surface
- Direct of ray of light

(1) Inverse square law

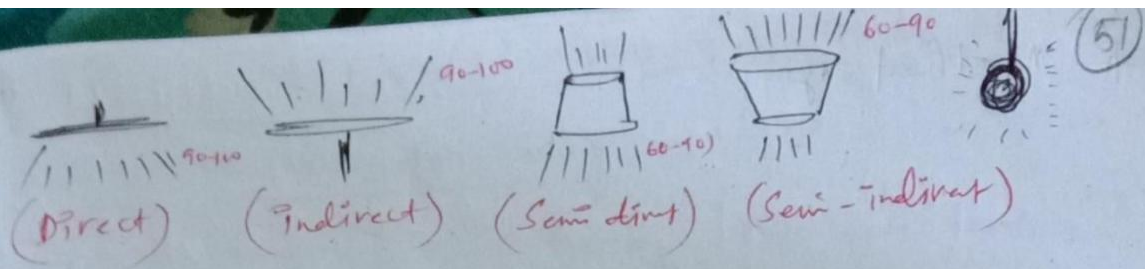
$$\text{Illumination} \propto \frac{1}{d^2}$$

d → dist betw source & surface

(2) Lambert's cosine law



Cosine angle of direct of ray of light
for the θ ~~area~~ to the surface



Utilization factor

$$UF = \frac{\text{lumen reached surface}}{\text{lumen emitted by source}}$$

0.5 to 0.8

Absorption by wall, ceiling, diffuser.

Depreciation factor

Due to the passage of time, dust deposition on wall & surface reduces the lumen.

1.3 to 1.6

Space-height ratio

$$S:H = \frac{\text{Space betw lamps}}{\text{height from the surface}}$$

(1 to 1.5)

Public Lighting Installation (18-136)

INTERNAL WIRING ESTIMATION (52)

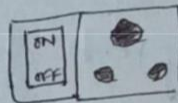
General rules for wiring

- ① Protectⁿ @ entry of cable by "two pole linked main switch" & "fuse".
"3 pole switch" for 3 ϕ supply.
No CB or fuse in neutral/earthed wire.
- ② Conductor size depends upon the load current.
- ③ Sub-ccts are connected to DB (dist. board).
- ④ Every line is protected by suitable rated fuse.
- ⑤ Switch board - 1.5m above the floor.

⑥ 3-pin socket outlet

Light & fan ckt \rightarrow 5A

Power sub-ckt \rightarrow 15A



- Controlled by individual switch, immediately adjacent
 - Shuttered/interlock sockets are used ~~to~~ where it is ~~not~~ accessible to children.
 - For higher rating ($>15A$) socket; a double pole switch is connected. (Table 8.2)
 - Socket outlet are placed 25 cm or 1.3 mtr above the floor level.
 - In bathroom No SO is provided below 1.3 mtr
- (X) 3-pin 15A SO provided in kitchen

⑦ Incandescent light lamps, ~~may~~ hung at height 2.5 mtr from floor level.

⑧ Ceiling fan at 2.75 mtr height.

⑨ Each sub-ckt has less than 10 point or

- (11) Every apparatus is provided with switch (53)
for isolation.
- (12) Light & fan wiring and power wiring are kept separated (bcz distinct wire gauge is used)
- (13) In 3 ϕ 4W installation, load is distributed equally on all the phases
- (14) Metal sheath & ~~and~~ conduit for all wiring & metal covering are to be properly earthed.
- (15) Each ^{Sub} Ckt is protected by separate fuse/CB.
- (16) After completion of installation are to be tested before energisation:

* Determinants of Number of point

(1) Light

- size of room, illumination level.
- luminous efficiency of the lamp to be used

(2) Fan

- size of room (Table 8.1)
- size of fan (3 Air-exchange per hour)

* Determinants of total load

- (1) CFL - 50W
- (2) Incandescent, fan, socket outlet → 50W

* Determination of sub-cst

(51)

- ① Number of point (if exceed 10 point then new SC)
- ② Load (if exceed 80W ; new SC)

* Determination of size of conductor

- ① Minimum size for mechanical reason

Copper wire $\geq 1/1.22$ mm (Number of strand / dia of each strand.)

Al wire $\geq 1/1.4$ mm²

Flexible cord $\geq 14/0.193$ mm

- ② Current carrying capacity

It should carry max current continuously without overheating.

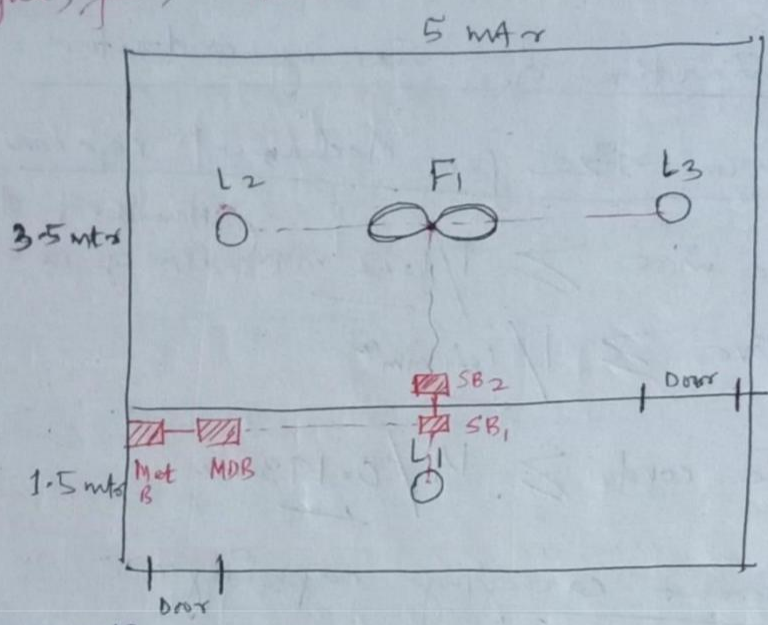
- ③ Voltage drop

Max allowed $V_{drop} = 2\%$ of V_{supply}

$V_{drop} = 5\%$ of V_{supply} (Power Wiring)

$[V_{drop} (AC) > V_{drop} (DC) \text{ } \because L, C]$

* Prepare one estimate for CBS wiring for small domestic installation of one room & one Verandah within $25m^2$ with given light, fan, socket.



Assumption ;

Taking $10 \text{ watts}/m^2$ of surface area as 9 min watts :

So; Total area = $5 \times 5 = 25 m^2$

Total wattage = $25 \times 10 = 250 \text{ watts}$

3 X 100 watt bulbs will be sufficient

One ceiling fan = $1 \times 60 \text{ watts}$

One socket in Verandah = 100 W

Two ~~two~~ sockets (One ~~power~~ ^{one power} + One light) in room.
 $\rightarrow \frac{100 + 100}{100 + 100} = \text{~~100 watts~~ } 1100 \text{ W}$

Total power consumption = $250 + 60 + 100 + 100$

$\Rightarrow P = \text{~~510 watts~~ } 510 \text{ W}$

Supply voltage = 240 V 1510

LIGHTING

$$\text{Lumen} = \text{Lux} * \text{Area}$$

(Luminous flux) (Illuminance)

$$\text{Illuminance} = \frac{\text{Luminous flux}}{\text{Area}}$$

Location	Lux
Entrance/Hall	100
Living room	300
Kitchen	200
Bathroom	100
Study	300

Lumen	Incandescent	CFL	LED
450	40W	10W	5W
800	60W	15W	7W
1100	75W	20W	10W
1600	100W	25W	18W
2600	150W	30-55 ^{40W}	26W

Ex 15m x 6m Hall

$$\text{Area} = 15 \times 6 = 90 \text{ m}^2$$

$$\text{for hall (Lux)} = 100$$

$$\text{Lumen} = 90 \times 100 = 9000$$

Choosing (100W - Incandescent bulb)

$$\text{for Nos of bulb} = \frac{9000}{100}$$

WIRING

58

few standards

- ① Switch board - 1.5 mtr above floor.
- ② Tube / bulb - 0.5 mtr below the ceiling.
- ③ Fan - on the ceiling.
- ④ Switchboard - (near door).
- ⑤ bulb = fan = socket (5A) \approx 60 W
- ⑥ Meter board to MDRB = 0.2 mtr.
- ⑦ Door = 1 mtr

Q. 5m x 4m x 3.5m room.

1 Lamp, 1 fan, 1 CF tube, 5A socket = 1

Draw wiring.

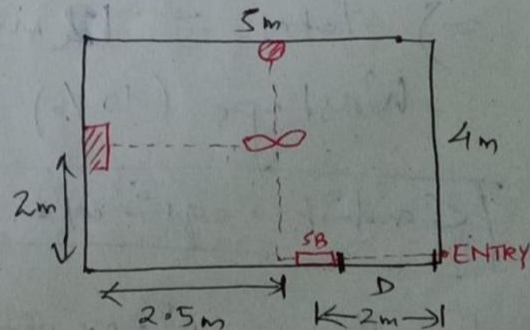
Calculate total wire & conduit.

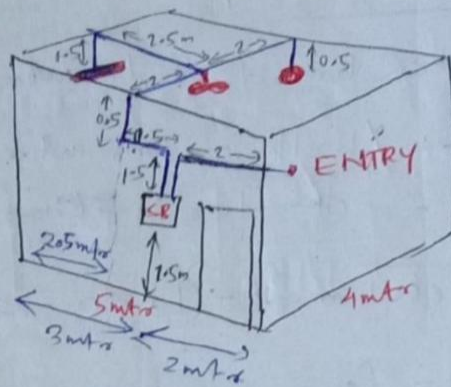
Prepare a list of material & their cost.

Ans

Few assumption

- (i) SB is placed 1.5 mtr above floor
- (ii) Tube/bulb are located 0.5 mtr below ceiling
- (iii) Horizontal Run (HR) from floor = 3 mtr.
(from ceiling = 0.5 mtr)
- (iv) Vertical Run (VR) = $3 - 1.5 = 1.5$ mtr.
(SB to HR height)





length of conduit

From entry point to SB = 2 mtr ✓

SB to HR = 1.5 mtr ✓

HR to take off point = 0.5 mtr ✓

take off to Fan = 0.5 + 2 = 2.5 mtr ✓

Fan to bulb = 2 + 0.5 = 2.5 mtr ✓

Fan to Tube = 2.5 + 0.5 = 3 mtr ✓

Total = 2 + 1.5 + 0.5 + 2.5 + 2.5 + 3

⇒ Total = 12 mtr

Wastage (10%) = 1.2 mtr

Conduit required = 12 + 1.2 = 13.2 mtr

length of phase wire

Entry to SB = 2 + 1.5 mtr = 3.5 mtr

SB to fan = 1.5 + 0.5 + 0.5 + 2
= 4.5 mtr

SB to bulb = 1.5 + 0.5 + 0.5 + 2 + 0.5
= 7 mtr

$$\text{Total wire} = 3.5 + 4.5 + 7 + 7.5$$

$$= 8 + 14.5$$

$$\boxed{\text{Phase} = 22.5 \text{ mtr}}$$

length of neutral wire

$$\text{Entry to SB} = 2 + 1.5 = 3.5 \text{ mtr}$$

$$\text{SB to fan} = 1.5 + 0.5 + 0.5 + 2 = 4.5 \text{ mtr}$$

$$\text{Fan to tube} = 2.5 + 0.5 = 3 \text{ mtr}$$

$$\text{Fan to bulb} = 2 + 0.5 = 2.5 \text{ mtr}$$

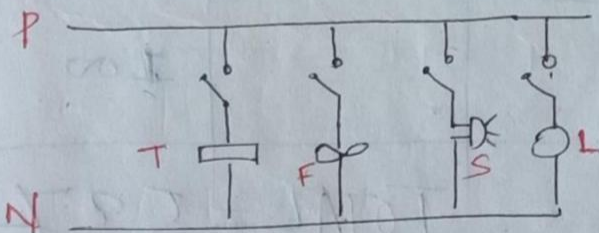
$$\text{Total neutral} = 3.5 + 4.5 + 3 + 2.5 = 8 + 5.5$$

$$\boxed{\text{Neutral} = 13.5 \text{ mtr}}$$

$$\text{Total wire} = P + N = 22.5 + 13.5 = 36.0 \text{ mtr}$$

$$15\% \text{ wastage} = 36 \times \frac{15}{100} = 5.4 \text{ mtr}$$

$$\boxed{\text{Grand total wire} = 41.4 \text{ mtr}}$$



Diameter of wire

$$\text{Total load} = 60 + 60 + 100 + 40 = 260 \text{ W}$$

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

$$I_{\text{line}} = \frac{240}{240} = 1.2 \text{ Amp}$$

$$\left[\frac{1}{1.4} \text{ mm Al} = 10 \text{ Amp (cheap)} \right]$$

Materials Required	Quantity	Cost
① Conduit pipe 20mm	14 mtr	12/mtr = 168
② PVC insulated 1.4mm Aluminium Conductor, 1 core	42 mtr	2/mtr = 84
③ Switch board (Iron clad) (20 X 25 cm ²)	1 No.	50
④ Conduit pipe (20mm) Accessories		100
⑤ Ceiling rose (Tube - fan)	2 No.	5
⑥ Lamp holder	1 No.	15
⑦ Screw		5
⑧ Bolt & Nut		10
⑨ Labour charge		100

TOTAL = 537

10% Extra

= 55

Grand total = 592

Q/ A room, verandah
(4x4) (4x3)

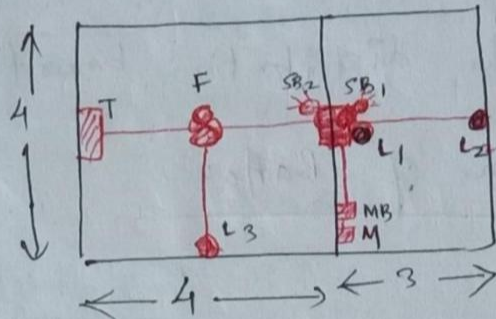
(62)

Design a suitable electrical w/w.

Prepare a list of materials required.

Meter & main switch are to be available.

(Batten wiring)



Load

Room : T, F, L₃, S (5A)

Verandah : L₁, L₂, S (5A)

7 points

Assume:

Height of ceiling = 3.5 m

HR from floor = 3 m

SB = 1.5 m

Meter & Main switch board = 0.5 m inside the wall.

Load calculation

$$\text{Lamp} = 3 \times 60 = 180$$

$$\text{Tube} = 1 \times 40 = 40$$

$$\text{Fan} = 1 \times 60 = 60$$

$$\text{Socket (5A)} = 2 \times 100 = 200$$

$$\text{Power} = 480 \text{ Watts}$$

$$I_{\text{phase}} = \frac{P}{V} = \frac{480}{240} = 2 \text{ A}$$

Selection of main switch

DPIC of 5Amp, 240V grade

Selection and rating of distribution board

Total points = 7

Total load = 480 W

No separate sub, ckt is required

So, No distribution board.

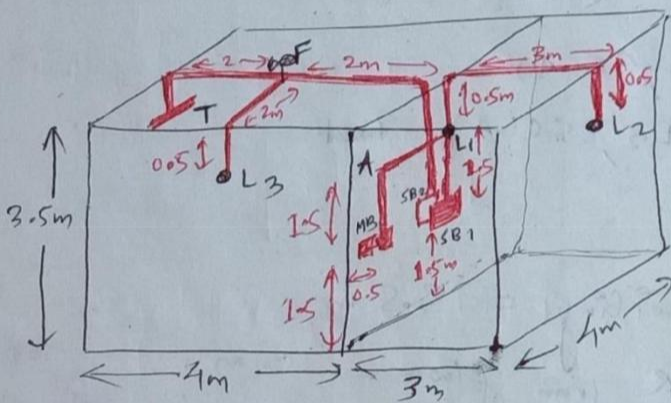
* Length of Batten

2W → 13 X 13 mm²

4W → 25 X 13 mm²

5W → 31 X 13 mm²

3W → ~~20~~ X 13 mm²



(i) Main switch board to ~~MB~~ L1 (Via A) [2 Wire]

$$= [1.5 + (2 - 0.5)] \text{ m} * 13 \text{ mm} * 13 \text{ mm}$$

$$= 3 \text{ m} * 13 \text{ mm} * 13 \text{ mm}$$

(ii) L1 to SB1 (2L + 1N = 5 Wire)

$$= 1.5 \text{ m} * 31 \text{ mm} * 13 \text{ mm}$$

(iii) L1 to L2 (1L + 1N = 2 Wire)

$$= ~~20~~ 4 \text{ m} * 13 \text{ mm} * 13 \text{ mm}$$

(iv) SB2 to Fan (3L + 1N = 4 wire)

$$= (2 + 2) \text{ m} * 25 \text{ mm} * 13 \text{ mm}$$

$$= 4 \text{ m} * 25 \text{ mm} * 13 \text{ mm}$$

Total length of batten size

$$13 \text{ mm} \times 13 \text{ mm} = 3 + 4 + 2.5 + 2.5 = 12 \text{ m}$$

$$25 \text{ mm} \times 13 \text{ mm} = 4 \text{ mtr}$$

$$31 \text{ mm} \times 13 \text{ mm} = 1.5 \text{ mtr}$$

Wastage 10%

$$13 \times 13 \text{ mm}^2 = 12 + 1.2 = 13.2 \text{ m} \approx 13 \text{ m}$$

$$25 \times 13 \text{ mm}^2 = 4 + 0.4 = 4.4 \text{ m} \approx 5 \text{ m}$$

$$31 \times 13 \text{ mm}^2 = 1.5 + 0.15 = 1.65 \text{ m} \approx 2 \text{ m}$$

* Length of wire

$$13 \times 13 \text{ mm}^2 \rightarrow 12 \text{ m} \times 2 \text{ W} = 24 \text{ m}$$

$$25 \times 13 \text{ mm}^2 \rightarrow 4 \text{ m} \times 4 \text{ W} = 16 \text{ m}$$

$$31 \times 13 \text{ mm}^2 \rightarrow 1.5 \times 5 \text{ W} = 7.5 \text{ m}$$

$$47.5 \text{ m}$$

~~A~~ crossing wall SB₁ to SB₂
 $= 2 \text{ W} \times (0.25 \text{ m}) = 0.5 \text{ m}$

$$48 \text{ m}$$

$$15\% \text{ wastage} = \frac{48 \times 15}{100} = 7.2 \text{ m}$$

$$\text{Grand total} = 55.2 \text{ mtr}$$

* Earth wire

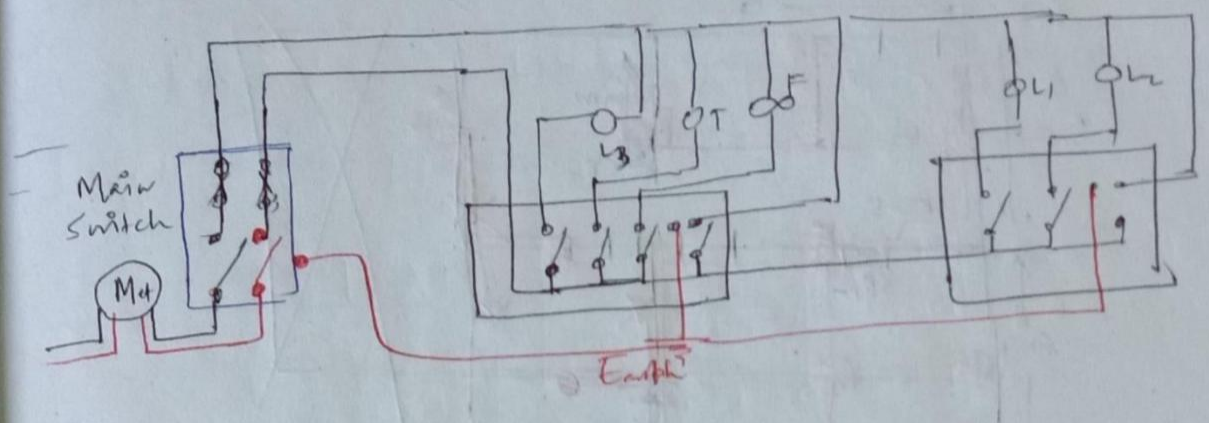
14 SWG of galvanized iron.

Installed on same batten.

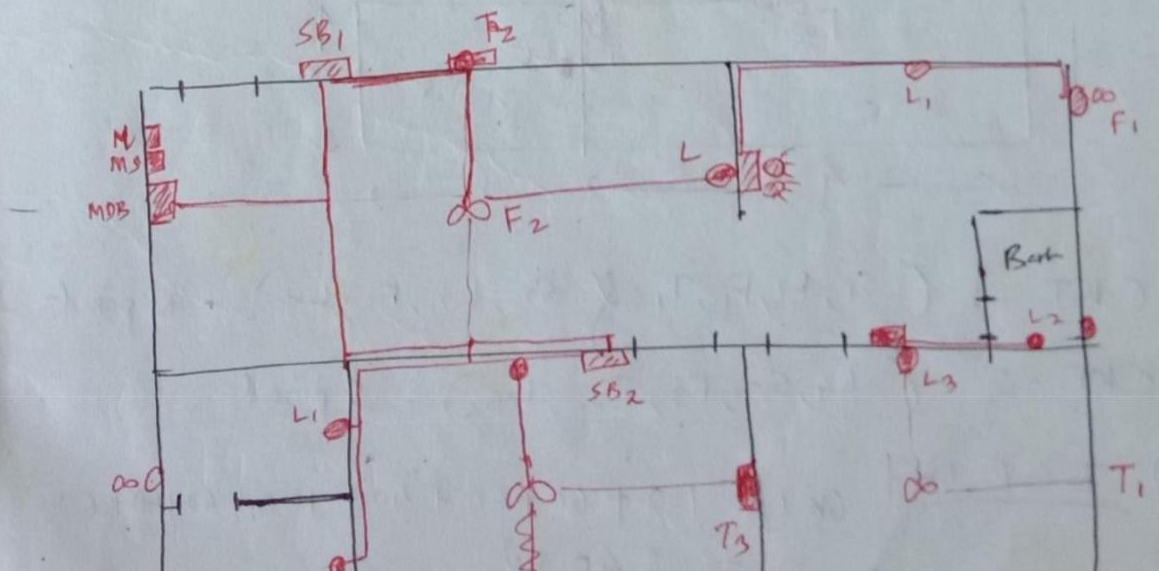
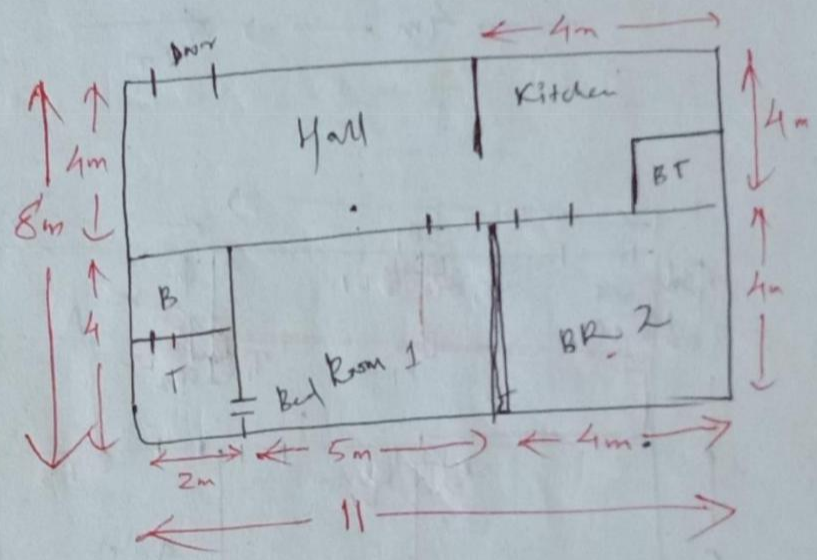
MS to SB₂ via SB₁

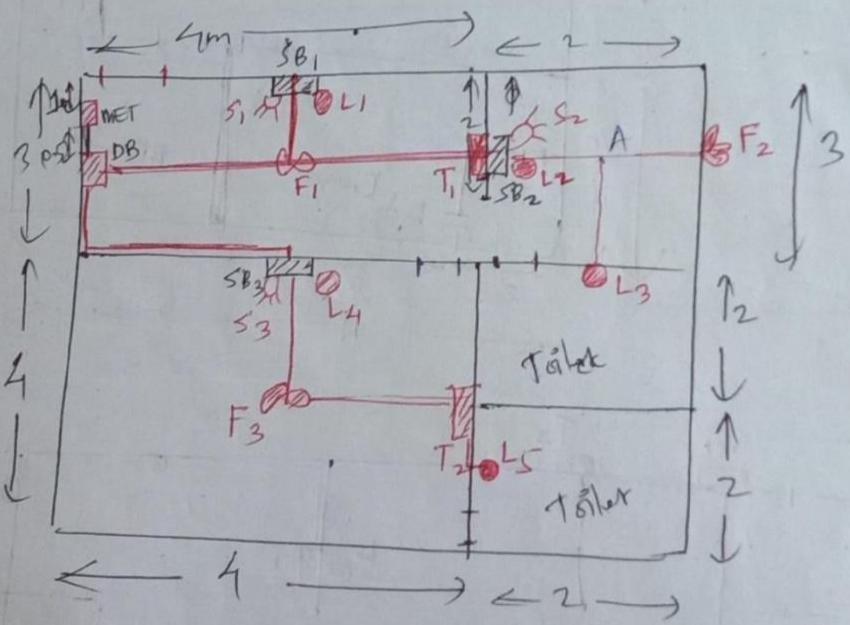
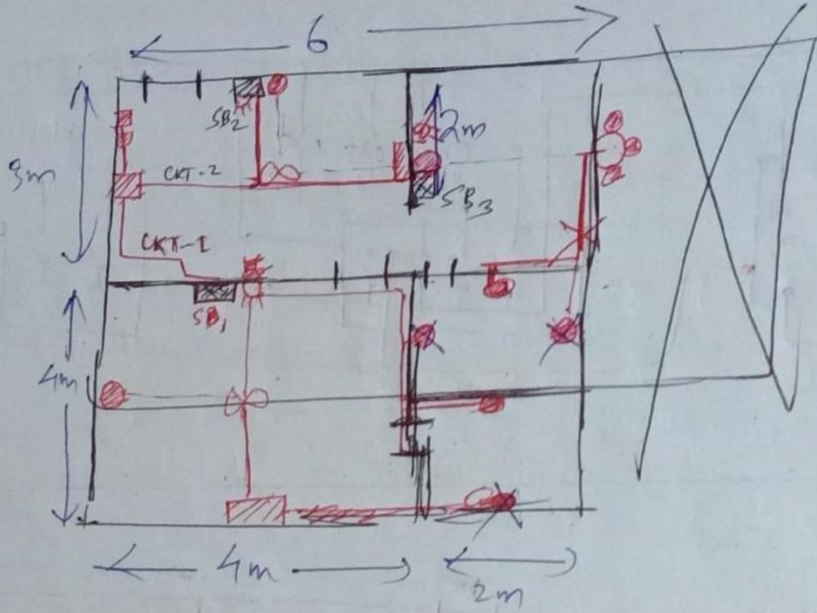
* Material Table

S No.	Specification	Qty
1.	DPIK (5A, 240V)	1
2.	meter board (30cm x 30cm)	1
3.	Batten	13m
	13 x 13 mm ²	5m
	25 x 13 mm ²	2 mtrs
4.	C.T.S wire 1.5 mm ²	56 mtrs
	(1/1.4 mm Al)	
5.	Earth wire (14 SWG GI)	5 mtrs
6.	Conduit pipe (20mm) wall crossing	0.25 mtrs
7.	Switch board cover (20cm x 20cm)	2
8.	Socket (5A, 3 pin)	2
9.	Switch (5A)	7
10.	Ceiling Rose (T & F)	2
11.	Lamp bracket & holder	2
12.	link clips (Al - 40mm long) 10 cm apart	300
13.	Nail to fix clips	50 gm



* Height = 3.5 mtr
Plan Lighting





CKT - 1 (S₁, L₁, F₁, T₁ & S₂, L₂, F₂, L₃) - 8 point
 CKT - 2 (L₄, S₃, F₃, T₂, L₅) - 5 point

15) Total load

$$\begin{aligned}
 CKT-1 &= 100 + 60 + 60 + 40 + 100 + 60 + 60 + 60 \\
 &= 540 \text{ W}
 \end{aligned}$$

$$I_{\text{phase}} = 3.6 \text{ Amp}$$

(68)

2 way, 240 Volt, 16A IC distribution board is used.

1/1.8 mm Al conductor, single core is used from meters to DB.

Few assypⁿ

$$\text{Height of ceiling} = 3.5 \text{ mtr}$$

$$\text{HR is below ceiling} = 0.5 \text{ mtr}$$

$$\text{SB at height} = 1.5 \text{ mtr}$$

$$\text{DB of meter at height} = 1.5 \text{ mtr}$$

$$\text{Bulb, Tube at height} = 0.5 \text{ mtr}$$

Add everywhere

Length of Conduit

$$\text{Meters to DB} = 0.5 \text{ m}$$

$$\text{DB to } F_1 = 2 \text{ m}$$

$$F_1 \text{ to } SB_1 = 1.5 \text{ m}$$

$$F_1 \text{ to } T_1 = 2 \text{ m}$$

$$SB_2 \text{ to } F_2 = 2 \text{ m}$$

$$A \text{ to } L_3 = 1.5$$

CKT-1

$$\text{DB to } SB_3 = 1.5 + 2 = 3.5 \text{ m}$$

$$SB_3 \text{ to } F_3 = 2$$

$$F_3 \text{ to } T_2 = 2$$

$$T_2 \text{ to } L_5 = 1 \text{ m}$$

CKT-2

$$VR = \underline{\underline{1.5}}$$

(IMP)

lb of meters

Length of phase wire

} metres to DB
~~NET~~ = $0.5 \times 2 = 1\text{m}$ (69)

i) For ckt 1.

- DB to SB₁ = 3.5 m
- SB₁ to F₁ = 1.5 m
- SB₁ to T₁ = 3.5 m

- ~~DB to~~
- F₁ to SB₂ = 2m
- SB₂ to F₂ = 2m
- SB₂ to L₃ = 1.5m

(ii) For ckt - 2

DB to SB₃ = 3.5

Overhead Installation

(70)

Q/o Estimate the materials required for 3p, 4w overhead distribution line of 1.25 km length. Connect 110 kW load at 400V distributed along the route.

Draw neat sketch diagram & list the materials required.

Ans

$$\text{Total load} = 110 \text{ kW}$$

$$\text{Supply Voltage} = 400 \text{ V}$$

$$\text{Length of line} = 1.25 \text{ km} = 1250 \text{ m}$$

Assuming 50 m span

$$\text{Nos of pole} = \frac{1250}{50} + 1 = 25 + 1 = 26$$

Nos of RCC pole required @ 50 m span are 26.

* Estn # CS of conductor

$$I_L = \frac{P}{\sqrt{3} V_L} = \frac{110 \times 1000}{\sqrt{3} \times 400 \times \eta \times \text{PF}}$$

(Let PF = 0.8 & $\eta = 0.85$)

$$\Rightarrow I_L = 233.5 \text{ Amp.}$$

$$I_{st} = 2 I_L = 467 \text{ A}$$

\therefore The choice of conductor is AAC

19/1x3.78mm

\rightarrow 468A range

Table 10-3
Page - 250

- Length of conductor (4w)

$$= 4 \times 1250 + 2\% \text{ sag}$$

$$= 5000 + \frac{2}{100} \times 5000$$

$$= 5100 \text{ m}$$

- Length of Earth wire

$$= 1250 + 2\% \text{ Sag}$$

$$= 1275 \text{ m}$$

PCC - Main Cement Concrete

Material required

	Items	Qty	Unit
1.	PCC Pole (9m)	26	Nos
2.	Alc conductor (19/3.78mm)	5100	m
3.	Earth wire (8SWG)	1275	m
4.	LT cable (4 core, 185mm ²)	15	m
	(Tf to Pole (nearest))		
5.	Erthing Set	2	Nos
			(Start & End)
6.	LT cable box for 4 core - 185mm ²	1	Nos
7.	Stay set	2 x 2 = 4	(2 on each pole)
8.	Pole foundation	26	Nos

Q/. Prepare an estimate of a distribution line with street lighting is to be distributed by 3 ϕ , 5W, 200 KVA, 0.8 PF over a distance of 2 km.

Calculate size of ACSR conductor & prepare a list of material used.

Ans. 5W = 3 ϕ + 1N + 1 for lighting + 1 Earth wire

$$\text{Length} = 2 \text{ km} = 2000 \text{ m}$$

$$\text{Pole} = \frac{2000}{50 (\text{span})} + 1 = 40 + 1 = 41$$

$$\text{height of pole} = 9 \text{ m}$$

$$\begin{aligned} \text{Total load} &= 200 \text{ KVA} \times 0.8 \\ &= 160 \text{ KW} \end{aligned}$$

$$I_L = \frac{160 \times 10^3}{\sqrt{3} (400) (0.8)} = 288.67 \text{ A}$$

$$I_{st} = 1.5 \times I_L = 433 \text{ A}$$

Conductor chosen from "Table 10.4" (Pg-251)

Panther (30/7 X 3.00) = 21 mm diameter

$$\begin{aligned} \text{The length of } 3\phi \text{ } 4W &= 4 \times 2000 + 2\% \text{ sag} \\ &= 8000 + 160 = 8160 \text{ m} \end{aligned}$$

Q/. A 1 km long overhead line
"Est. - 10.9" Page - 297

Data given :-

Length of line = 1 km = 1000 mtr

Average span = 50 mtr

$$\text{Nos of towers} = \frac{1000}{50} + 1 = 21$$

(RCC)
9 mtrs height

Length of ACSR (6/1 x 3 mm)

$$\begin{aligned} \text{required} &= 3 \times 1000 + 2\% \text{ sag} \\ &= 3000 + \frac{3000 \times 2}{100} \\ &= 3060 \text{ mtr} \end{aligned}$$

$$\begin{aligned} \text{Neutral wire length} &= 1000 + 2\% \text{ sag} \\ (6/1 \times 2.11 \text{ mm}) &= 1020 \text{ mtr} \end{aligned}$$

$$\begin{aligned} \text{Length of Earth wire} &= 1000 + 2\% \text{ sag} \\ (8 \text{ SWG}) \text{ GI} &= 1020 \text{ mtr} \end{aligned}$$

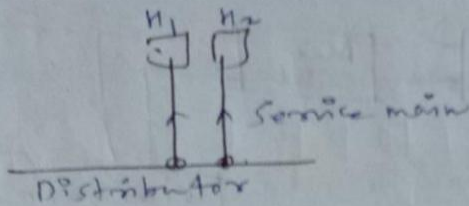
Materials

- ① RCC pole
- ② 7/3 mm ACSR
- ③ 7/2.11 mm ACSR
- ④ 8SWG GI
- ⑤ LI shackle Insulators = 21 x 4 = 84
- ⑥ Earthing set = 4

* Tee-off

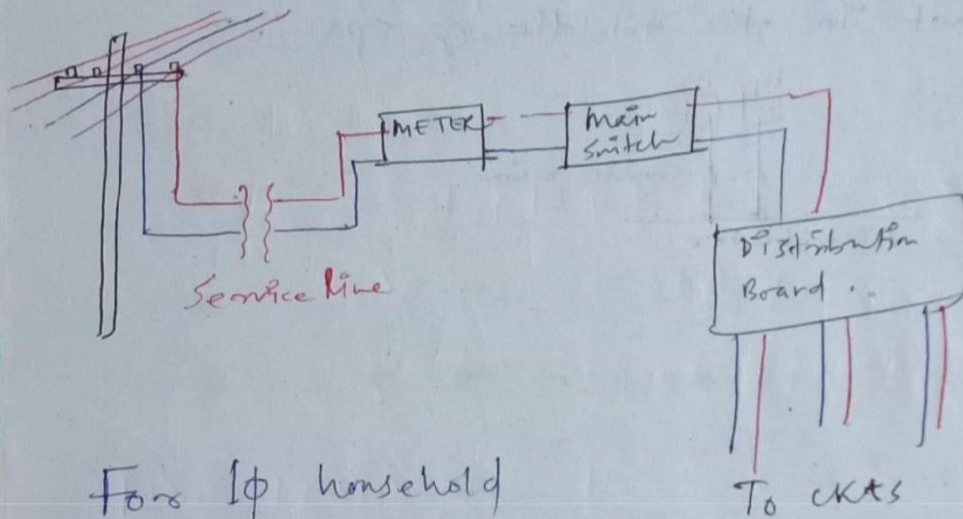
tee off is the ^{junction} ~~point~~ from ~~where~~ between distribution line & service main.

It ~~is~~ should be ~~near~~ near the pole & not in the middle of span.



Overhead Service Line

- Service line is the intermediate between distributor & consumer end.
- Weatherproof cables are used



For 1 ϕ household

3 wire live, neutral, Earth

For Workshop, factory.

5 wire = 3 ϕ , N, E

(I) Overhead SL

Copper - 10 SWG - 1 kW

AAC/ACSR - 8 SWG - 2.5 kW
(14 mm²) (Copper)

AAC/ACSR - Copper - 12 kW
(19.4 mm²) (6 SWG)

Weather proof / PVC cable are used.

(II) LT 3 $\frac{1}{2}$ core cable for underground SL.

* Method of installation

(i) High roof buildings

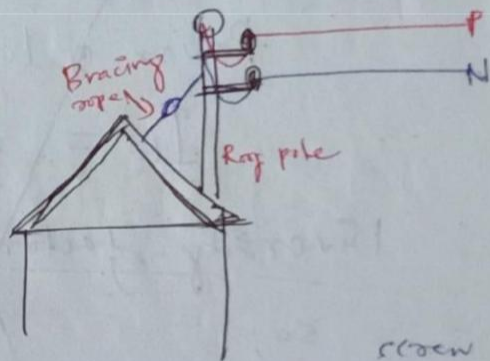
Service bracket is embedded on the wall at suitable height. Shankel type insulators are fitted on the wall.

Distance betⁿ insulator

∴ Vertical - 35 cm lateral - 30 cm ...

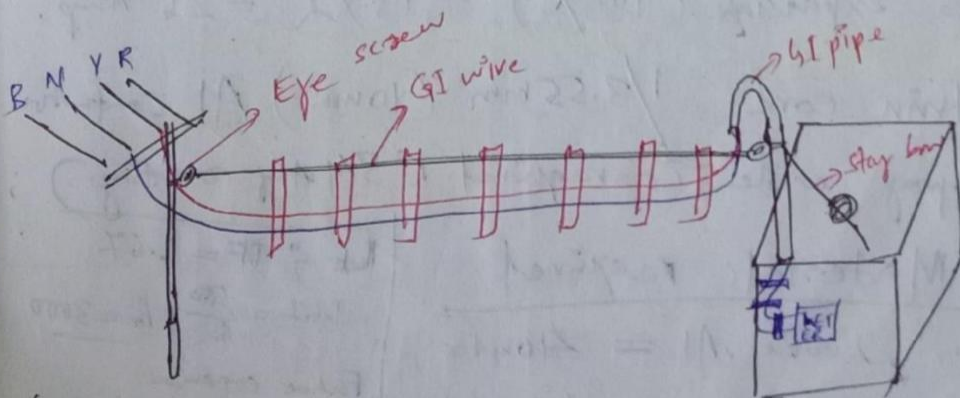
(ii) Low roof / 1 stored building

Service bracket can't be fixed on the wall. Roof pole is fixed on the top (within 3m) braced by steel rope

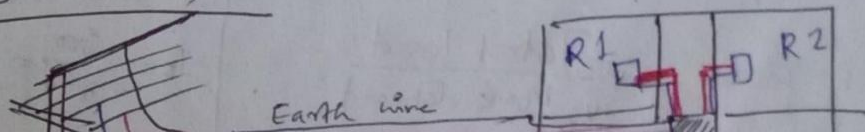


(iii) Weatherproof Cable

8 SWG GI wire Service pole to eye of bolt



(iv) Junction box



Q. Est 12.1 (Pg-333)

1 Store Building

$$V_s = 240 \text{ Volt}$$

$$\text{Load} = 5 \text{ kW}, 50 \text{ Hz}$$

Pole to meter = 20 meters
board

Assume

Height of building = 3.5 mtrs

SL received at height = 6 mt from floor.

$$\text{Electrical load} = \frac{50000}{800} = 5 \text{ Sub (ckt)} + 15 (15 \text{ Amp socket})$$

$$(X) = (4000 + 1000) \text{ Watts}$$

Selection of cable

Power of load = 5 kW.

$$I_L = \frac{5000}{240} = 21.7 \text{ Amp}$$

Diversity factor (60% used at a time)
of installed capacity

So;

$$I_d = 21.7 \times 0.6 = 13 \text{ Amp}$$

$$\text{future expansion (100\%)} = 13 \times 2 = 26 \text{ Amp}$$

So; Twin core $1/3.55 \text{ mm}$ (10 mm^2) Al conductor
Weatherproof cable is required (34 Amp rating)

* Materials required

$$10 \text{ mm}^2, 2 \text{ core Al} = 40 \text{ mtrs}$$

$$8 \text{ SWG, GI wire} = 40 \text{ mtrs}$$

$$\text{Diversity factor} = \frac{\text{Total load}}{\text{Max demand}}$$

$$\text{Let } DF = 1.67$$

$$1.67 = \frac{500}{I_m} \Rightarrow I_m = 3000$$

Future expansion

$$= 3000 \times 2 = 6000 \text{ W}$$

$$I_k = \frac{6000}{A_2} = 25 \text{ A}$$

Q/. Est 12.2 (Pg 334)

(78)

Double stored building
Load is 4kW, 240V, 50Hz
Separate meter for each floor
Pole - building = 12m
Service bracket - Service board = 10m

$$\text{Load} = 4\text{ kW}$$

1.6 diversity factor of 100% future growth

$$\text{Load} = \frac{4 \times 1000}{1.6} \times 2 = 5000\text{ W}$$

$$I_L = \frac{5000}{240} = 20.833\text{ A}$$

2-core $1/2.8\text{ mm}$ (6 mm^2) Al cable (27 rating)

* Material required

- 6 mm^2 - cable = $12 + 10 + 3 = 25\text{ meter}$
- Aerial fuse (32A) = 1
- GI pipe 50mm dia = 4 meter

Q/. Est 12.4 (Pg-337)

3ϕ , 37 kW, 415V, 50Hz

~~Structure~~ Structure - pole = 15m

$$\eta = 85\% \quad \text{PF} = 0.8$$

$$I_{\text{motor}} = \frac{37 \times 1000}{\sqrt{3} \times 415 \times 0.85 \times 0.8} = 75.7\text{ Amp}$$

$$I_{\text{st}} = 1.5 \times 75.7 = 113.6\text{ A}$$

Conductor \therefore $3\frac{1}{2}$ core, 35 mm^2 , 1100 Volt Al

Length of cable required

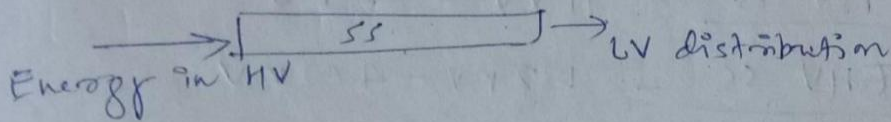
$$= \text{Pole} \rightarrow \text{ground} + \text{length along trench} \\ + \text{vertical run up to cable box + wastage}$$

$$= 6 + 15 + 2 + 3$$

$$= 26 \text{ meters}$$

SUBSTATION

(80)



Classification

(1) Nature of duties

(i) Step up (1°)

Generating station (11/220 kV)

(ii) 1° Grid SS

located @ suitable load centre along
1° transmission line.

2° is connected to 2° TL / 1° distribution line

(iii) Step down / distribution SS

11 kV / 415 Volt

located @ load centre.

1° dist line [SS] 2° distribution line.

(2) Basis of Service

(i) T/F substation

t/f are installed on each SS to step up or step down power.

(ii) Switching SS

→ For switching purpose.

→ Various TL are interconnected in SS.

(iii) Converting SS

AC to DC or DC to AC

③ Operating Voltage

- (i) HV SS - 11 KV - 66 KV
- (ii) EHV SS - 132 KV - 400 KV
- (iii) Ultra High Voltage (~~EHV~~ UHV) - > 400 KV

④ Basis of Design

① Indoor type

Within a building.
 11 KV - 33 KV.
 Surrounding with impurities. (metal covering gas dust)

② Outdoor type

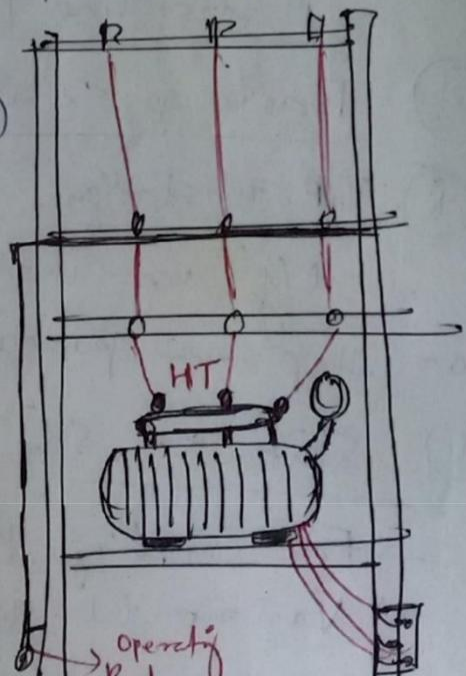
(A) Pole mounted

→ distribution of power in localities.
 Rating 25 KVA - 125 KVA upto 250 KVA

→ TPMS switch gear (Triple pole mechanically operated) switching 'ON' & 'OFF' of HT line.

→ LA (Lightning Arrestor) are installed over HT line to protect.

- 125 KVA - 2 pole
- 250 KVA - 4 pole



Ⓑ Foundation-mounted SS

82

- Above 250 KVA rating TF.
- Structured on the ground.
- Covered by fences.
- For 1^o & 2^o transmission (Bulk power).
- Very high voltage of operation.
- CB & f isolator are provided for maintenance.