An insight to the basics of Conductors and Insulators

Objective

To determine the basics of conductors and insulators.

Theory:

Electrical energy is generated in large hydro-electric, thermal and nuclear power stations which are located far away from the load centers. This necessitates an extensive power supply network between generating stations and the consumer's loads.

- This network is divided into two parts:
- ❖ Transmission system
- ❖ Distribution system

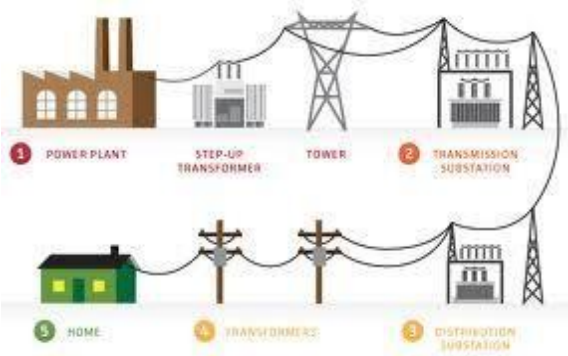

Fig: (a) Transmission and Distribution System

Power Cable

A cable is defined as an assembly of conductors and insulators used for the transfer of power in densely populated urban areas. Cables are mostly laid under the ground in order not to disturb the land beauty and to avoid using the land for power transmission purposes.

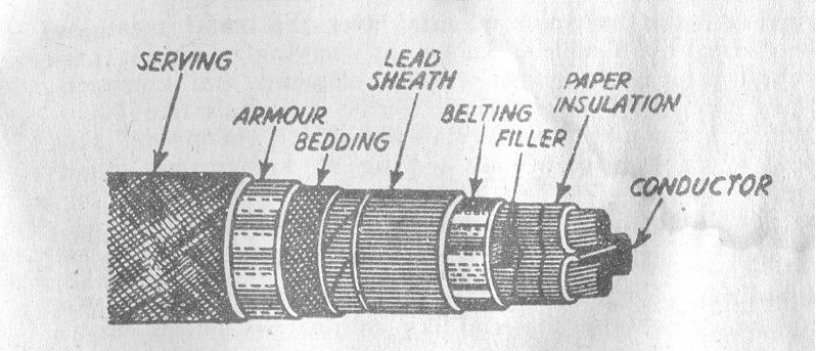

Fig: (b) Power Cable

PARTS OF CABLE

A cable is composed of the following parts;

Core

All cables either have a central core (conductor) or a number of cores made of strands of Copper or Aluminum conductors having highest conductivity. Conductors are stranded in order to reduce the skin effect.

Insulation

It is provided to insulate the conductors from each other and from the outside periphery. The common insulating materials are Poly Vinyl Chloride (PVC) and Polyethylene.

Metallic Sheath

Metallic Sheath protects the cable against the entry of moisture.

Bedding

In order to protect the metallic sheath from injury, bedding is wound over it.

Armoring

Armoring provides mechanical strength to the cable.

Serving

A layer used to protect the armoring.

Overhead Lines

The three-phase transmission and distribution system consists of overhead lines and underground cables. Because of cost consideration, the transmission system is generally overhead.

- The overhead line conductor material should have:

✓ High tensile strength

✓ Low resistivity

Conductor materials

The two most common conductor materials are: Hard drawn copper and aluminium. Hard drawn copper has very high conductivity good tensile strength and weather resisting properties.

Fig: (c) Hard drawn copper

ACSR (Aluminium Conductor Steel Reinforced) conductor comprises hard drawn aluminium wires stranded around a core of single or multiple strand galvanized steel wire. Aluminium provides conductivity while steel provides necessary mechanical strength. All the transmission lines use ACSR conductor.

Fig: (d) ACSR conductor

Aluminium has the following advantages over copper:

a. Lower cost

b. Lesser weight

c. Larger diameter

However, the tensile strength of aluminium is lower than copper. Therefore an All Aluminium Conductor (AAC) is rarely used except for low voltage distribution lines of short spans.

Fig: (e) All Aluminium Conductor (AAC)

Types of Towers

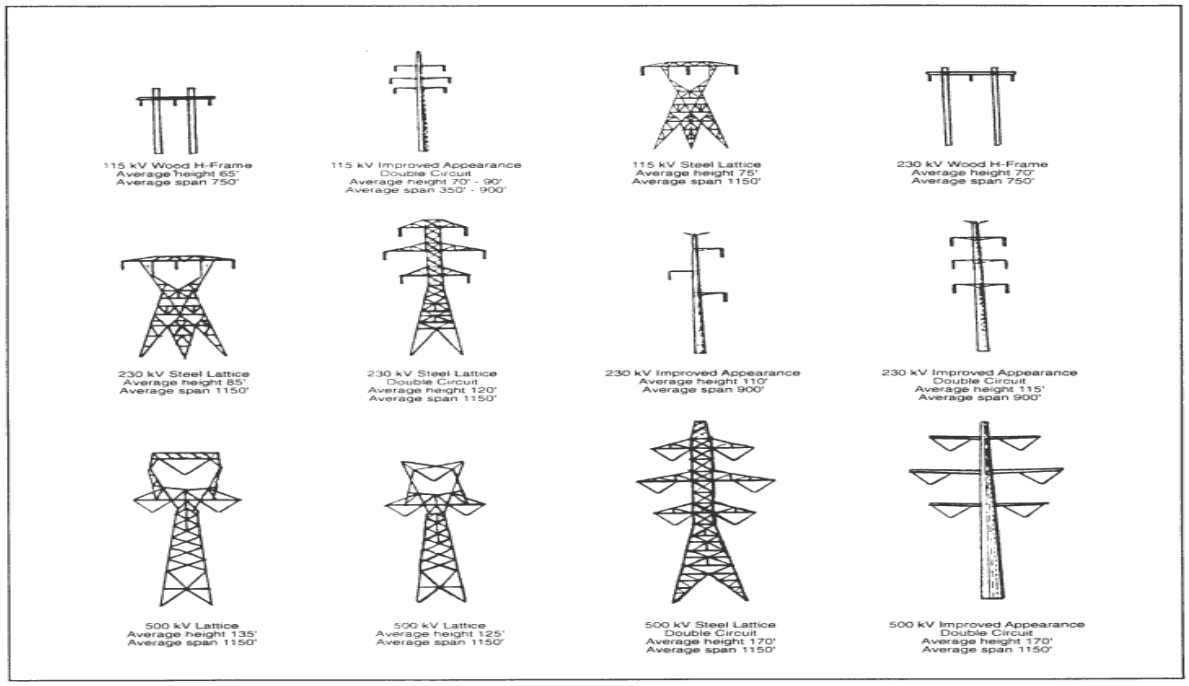

Fig: (f) Different types of Towers

Insulator materials

To provide necessary clearance between conductors and metal works, the conductors are attached to insulators. It provides mechanical support for the conductor.

- The most suitable materials for insulators are:
- Toughened glass
- Porcelain

Toughened glass

It is achieved by rapidly cooling the glass insulator after shaping and then allowing the interior to cool slowly. It can withstand great tension. Glass is cheaper than porcelain in simpler shapes. It is used very rarely. Used for lines below 25kV with short spans.

Fig: (g) Toughened glass

Porcelain

Mechanically stronger than glass. It is less affected by changes in temperature. It is most commonly used material for manufacturing of insulators.

Fig: (h) Porcelain

Types of Insulators

- Pin type insulators
- Suspension type
- Post type
- Strain insulators

Pin type insulators

It is small, simple in construction and cheap. It is used on lines up to 11kV.

Fig: (h) Pin type insulators

Suspension type insulators

It is used for lines above 33kV. Also known as disc or string insulators. It consists of porcelain discs mounted one above the other. The conductor is suspended below the point of support by an insulator string. Mechanical stresses are reduced.

Fig: (i) Suspension type insulators

Post Insulators

They are used for supporting bus bars and disconnecting switches in sub-stations. In extra high voltage sub-stations, polycon post insulators are used. Similar to pin insulator but has a metal base and metal cap so that more than one unit can be mounted in series.

Fig: (j) Post Insulators

Strain Insulators

They are special mechanically strong suspension insulators. Similar to suspension type insulators. Used to take the tension of the conductors at the line terminations and at portions where there is a change in direction of line.

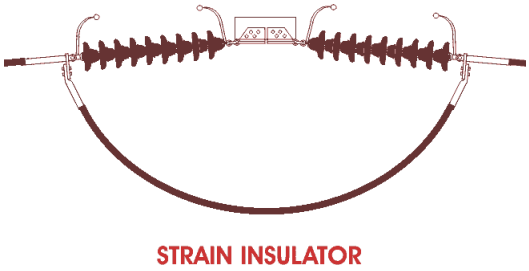

Fig: (k) Strain Insulators

Lab Task:

Q1: Why do we use ACSR conductors for transmission not in distribution?

Q2: Mostly Aluminum is used in transmission system as a conductor, why not Cu as a conductor?

Q3: Why are electrical insulators important?

Q4: Write down the source of heat generated in the power cable.

Q5: What will happen when the lead sheath of the power cable is damage?

Teacher remarks:

Obtained Marks:_____/ 10