Insulators Module 4

Part I

Dr. Suman Bhullar
AP,EIED
TIET,Patiala

Insulators

- Towers are at ground potential.
- Insulators are used to insulate tower from bare conductors.
- Ideal insulator must have following properties:
  - No pores or air spaces.
  - No impurity.
  - Perfectly homogenous material.
  - Leakage current through insulators should be minimum.
  - Able to withstand over voltage and normal working voltage.
  - Mechanically strong enough to bear conductor load.

Material for insulators

- Porcelain
  -- 20% silica
  -- 30% feldspar
  -- 50% clay
- Dielectric strength 120-280 kV/cm

- Toughened glass
- Glass is toughened to make skin more resistant to damage
- Dielectric strength 1200 kV/cm

Figure 4.1: Material for Insulators

Glass Insulators

Advantages:

- High dielectric strength
- Longer life
- High thermal shock resistant
- Lower coefficient of thermal expansion
- Greater mechanical strength under compression but tension is same as porcelain.
- Fault can be easily seen.

Disadvantages:

- Moistures are readily condensed on the surface.
- expensive than porcelain

Ratings of Insulators

Rated by three voltage

- Wor**king Voltage:** The voltage at which an insulator is designed to bear the steady state voltage.
- **Puncture voltage:** The voltage ta which flashover occurs through air surrounding the insulator.
- **Flashover voltage:** The voltage at which insulator breaks through between conductor and pin.

- Safety Factor = Flashover Voltage/ Working Voltage

Types of insulators

- **Pin type :** For transmission and distribution upto 33 KV .
- **String type insulator:**
  1. **Suspension type :** For voltage greater than 33 KV.
  2. **Strain type:** For dead ends, corner or sharp curve.
- **Shackle type:** For low voltage distribution lines & can be used either in a horizontal or vertical position.

Pin type Insulators

Figure 4.2: Pin Type Insulators

Pin type Insulators

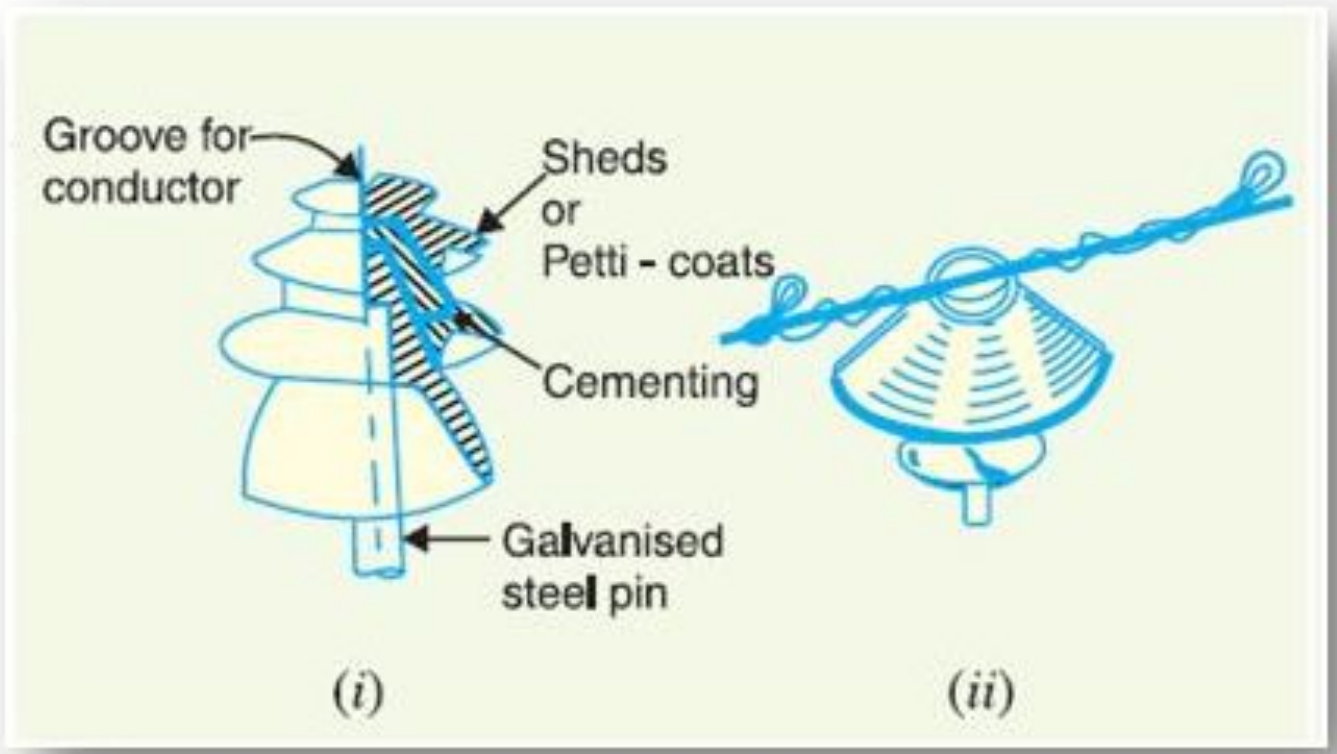


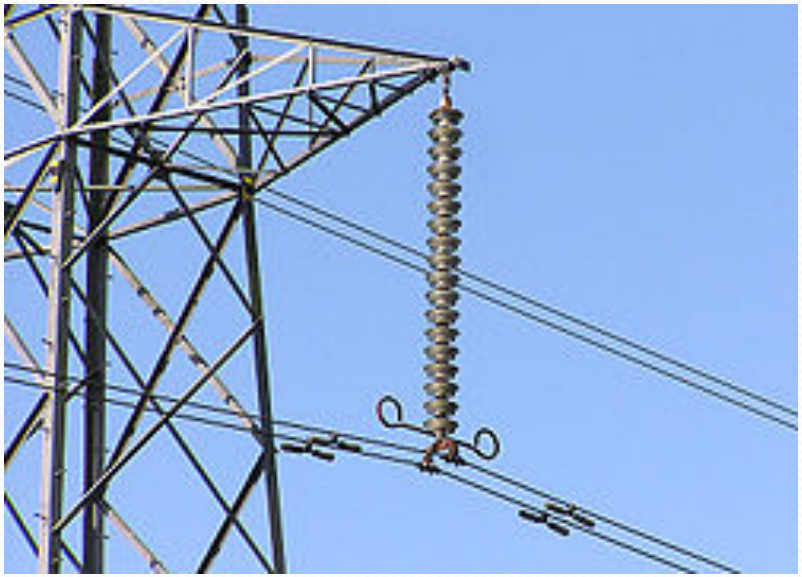
Figure 4.3: parts of Pin type insulator

Pin type Insulators

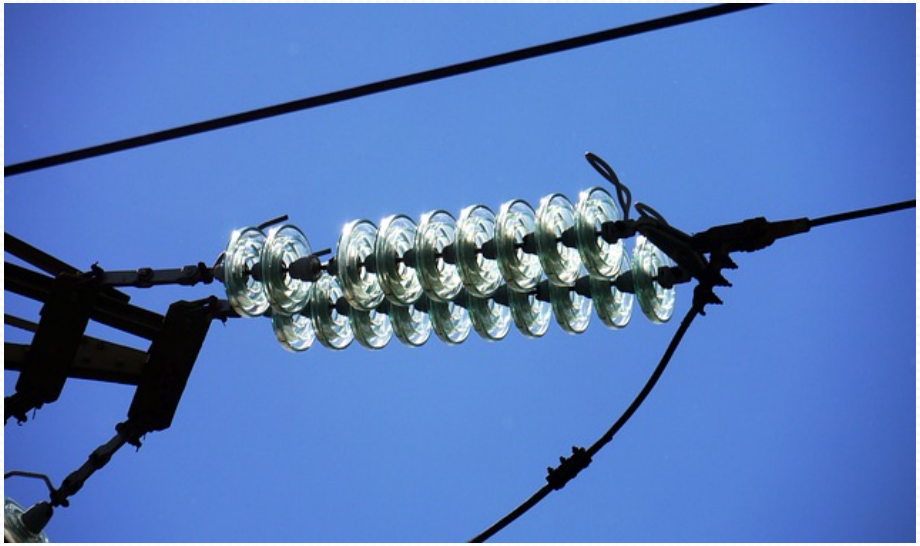
- Pin type insulator can be one part, two parts or three parts type, depending upon application voltage.
- Generally one part type insulator where whole pin insulator is one piece of properly shaped porcelain or glass is used in 11 kV lines.
- One, two or more rain sheds or petticoats are provided on the insulator body to provide lengthy leakage path.
- During rains the outer surface of the rain shed becomes wet but the inner surface remains dry and non-conductive.

String type Insulators

- String insulator consists of numbers of insulators connected in series to form a string.



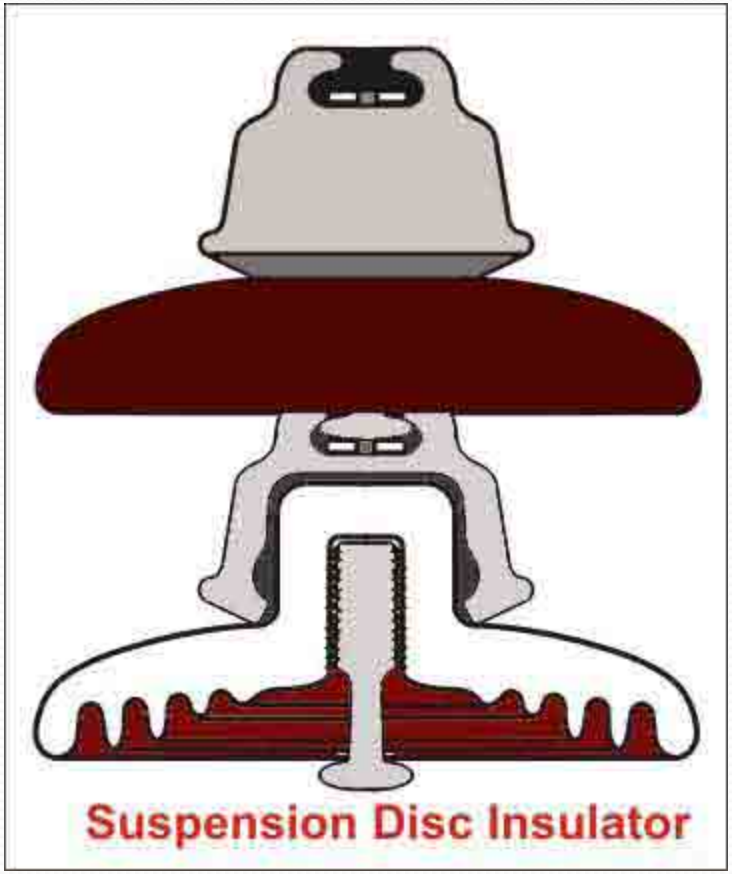
Suspension type



Strain type

Suspension type Insulators

- The conductor is suspended at the bottom end of this string while the other end of the string is secured to the cross-arm of the tower.
- Each insulator of a suspension string is called disc insulator because of their disc like shape.



Advantages of Suspension Insulators

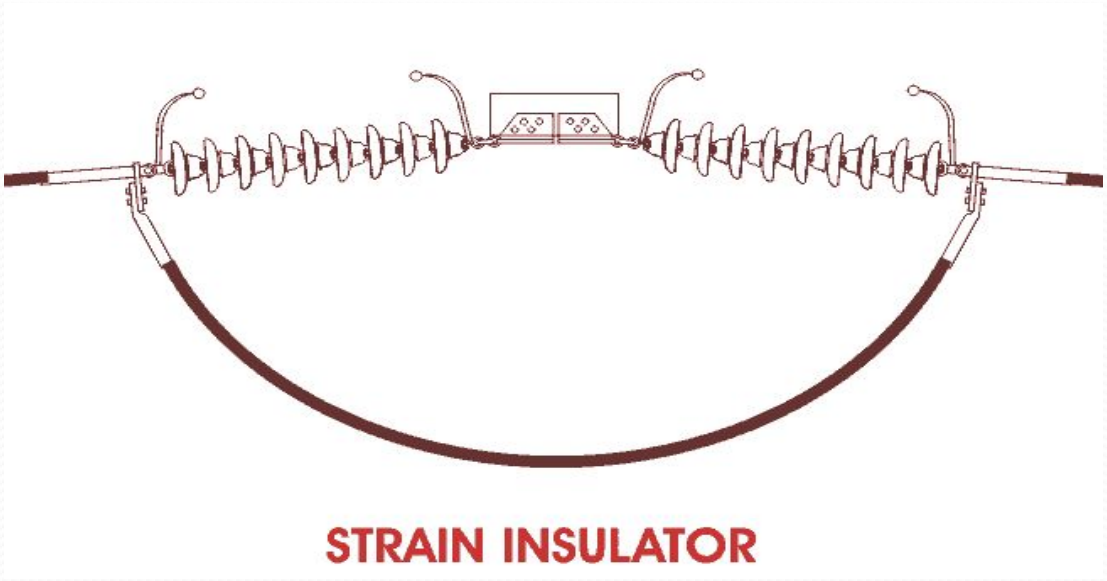
- Each suspension disc is designed for **11** kV, so by using numbers of discs, a suspension string can be made suitable for any voltage level.
- If any one of the disc insulators in a suspension string is damaged, it can be replaced much easily without replacing whole string.
- Mechanical stresses on the suspension insulator is less since the line hanged on a flexible suspension string.
- Flexible in extension of voltage rating by adding more units.

Disadvantages of Suspension Insulators

- Suspension insulator string costlier than pin type insulator.
- Suspension string requires more height of supporting structure than that for pin insulator to maintain same ground clearance of current conductor.
- The amplitude of free swing of conductors is larger in suspension insulator system, hence, more spacing between conductors should be provided.

Strain Insulator

- Exactly same as suspension insulator but placed in horizontal plane.
- Used to sustain extraordinary tensile load of conductor
- At dead ends, at sharp corners in transmission line.



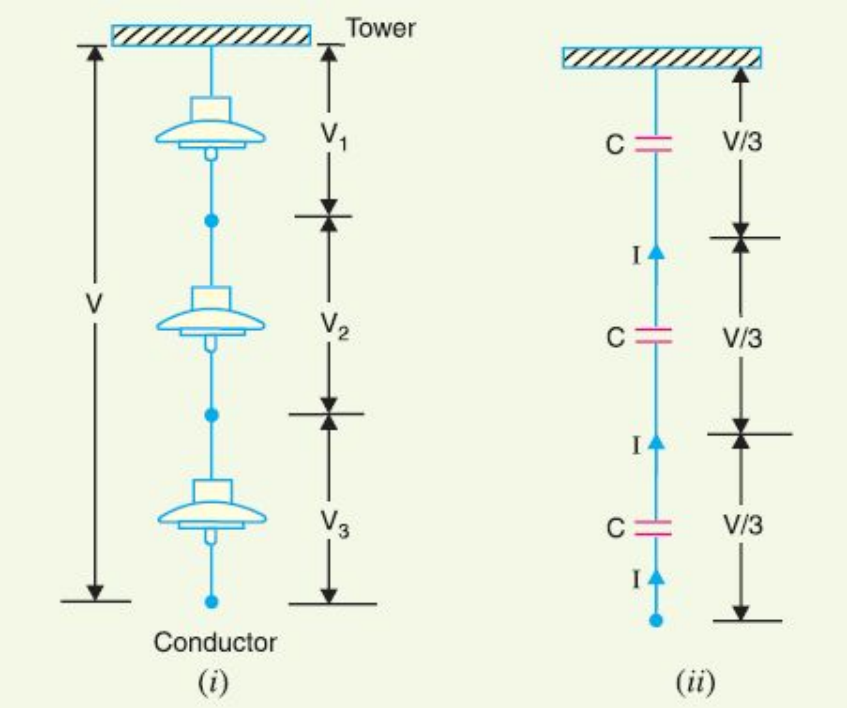
STRAIN INSULATOR

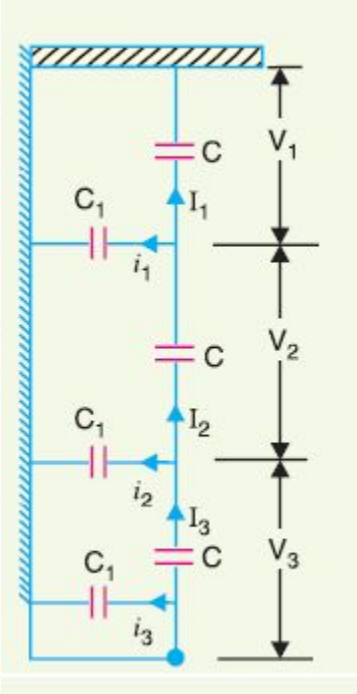
Insulators Module 4

Part II

Dr. Suman Bhullar
AP,EIED
TIET,Patiala

Potential distribution over a string of insulators



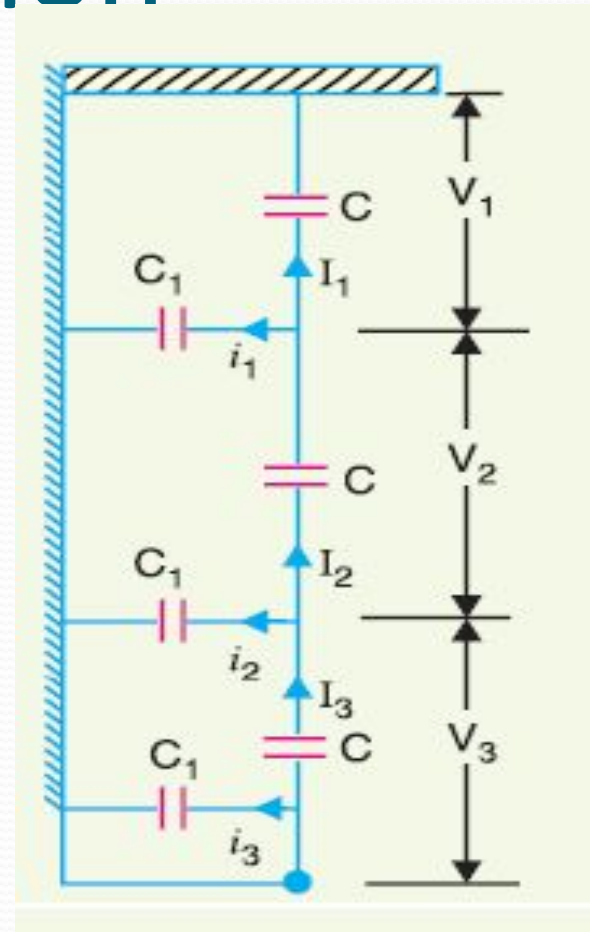


String efficiency

- Unequal distribution of voltage across string due to presence of shunt capacitance
- Disc nearest to the conductor is having more voltage across it
- Moving towards cross arms, magnitude of voltage keeps on decreasing

String efficiency=

Mathematical expression



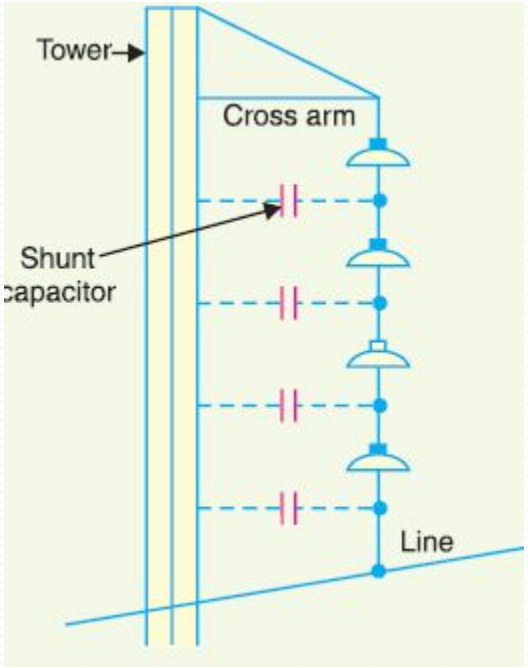
Insulators Module 4

Part III

Dr. Suman Bhullar
AP,EIED
TIET,Patiala

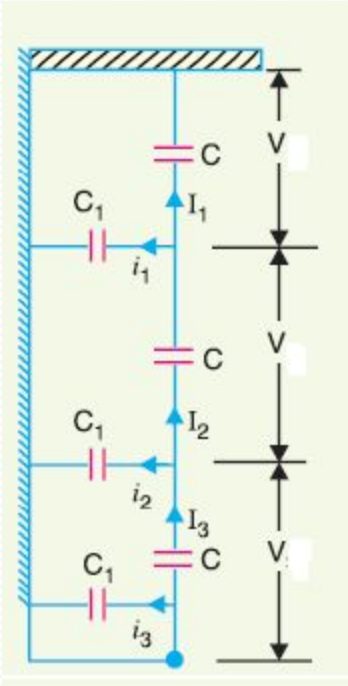
Methods to improve string efficiency

- By using longer cross arms- by reducing the value of K

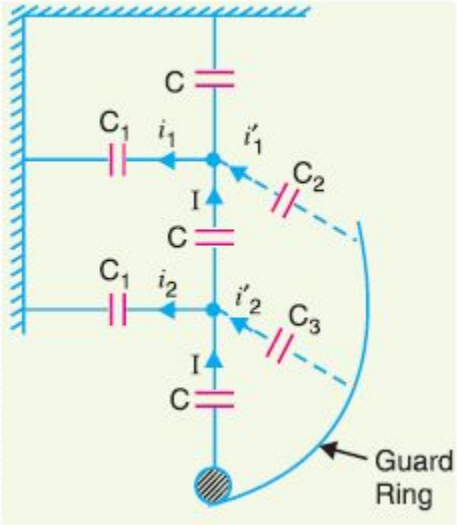


By grading the insulators

- Graded in the ring in such a way that the insulator nearest to disc has higher capacitance and capacitance goes on decreasing , moving towards cross arms
- Limitation-large number of different sized insulators are required for large string



By using guard ring



Grading rings and Arcing horns

Grading rings and arcing horns

Grading ring serves two purposes:

- Equal distribution of voltage across string of insulator
- When used in combination with arcing horns, it protects insulator from flashover

Insulators Module 4

Part IV

Dr. Suman Bhullar
AP,EIED
TIET,Patiala

Insulator Failure

- **Flashover voltage**
- **Mechanical stress**
- **Crack**
- **Porosity**
- Short circuit