Mechanical design of overhead lines
Module 3

Part I

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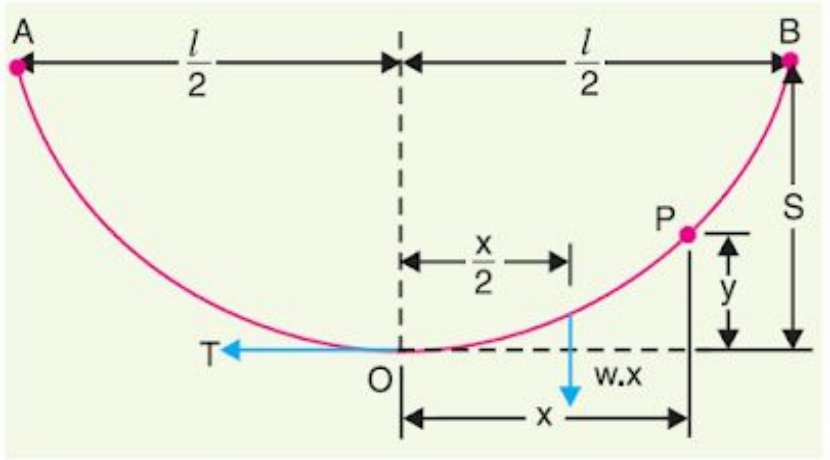
Tension and sag calculations

Topics to be covered

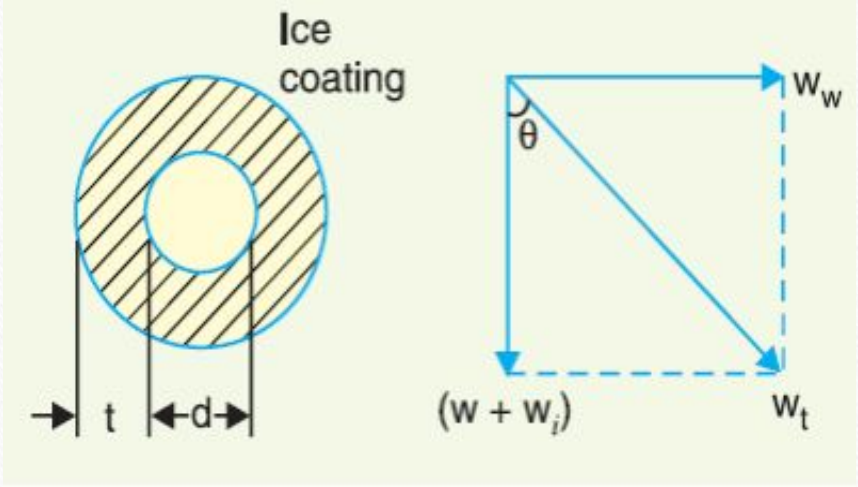
- Supports at same level ((i)parabola (ii) catenary curves)
- Effect of ice and wind
- Supports at different level
- Total length of conductor


A
$\frac{l}{2}$
$\frac{l}{2}$
B
P
S
$\frac{x}{2}$
y
T
O
w.x
x

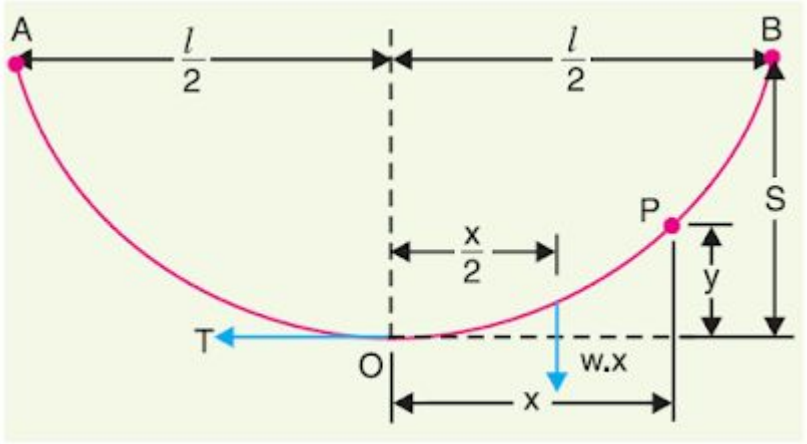
Effect of ice and wind

Factors should be taken into account while calculating sag

- wind pressure, fog, snow, a coating of ice in hilly areas



Total length of conductor



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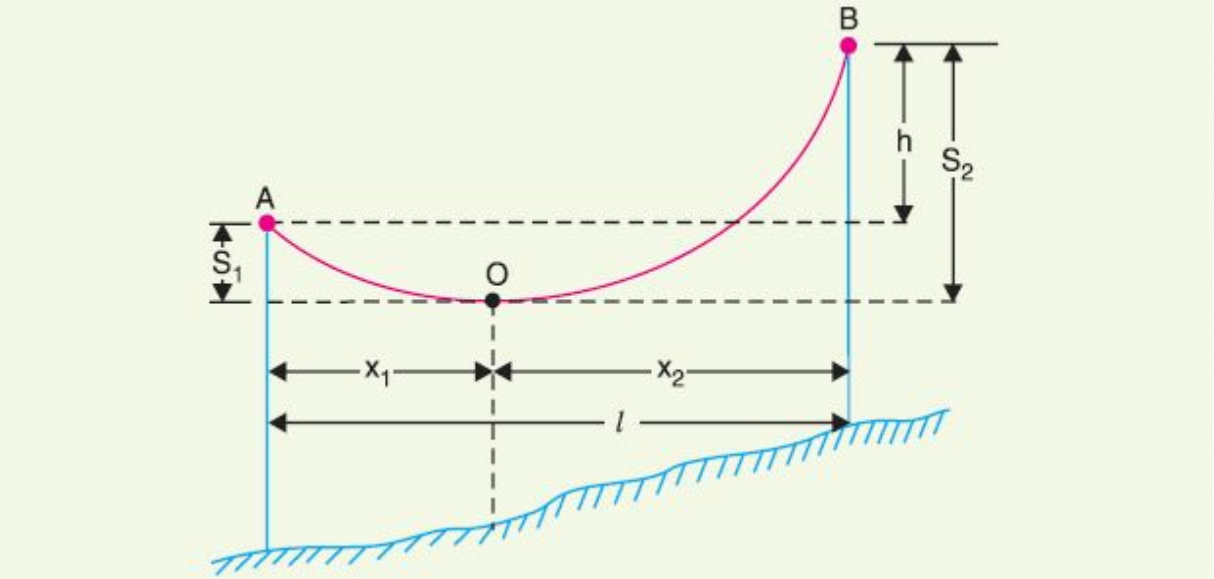
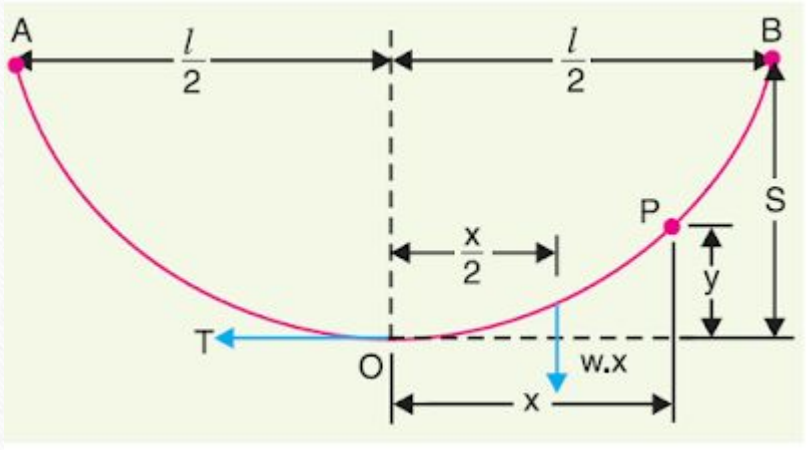
When the supports are of unequal height



Sag and tension calculations for catenary curve



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Module 3

Part III

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Topics to be covered

- Factors affecting sag
- Stringing chart
- Sag template
- Vibrations in conductors

Factors affecting Sag

- Value of sag should neither be pessimistic nor be optimistic. It should be optimum.

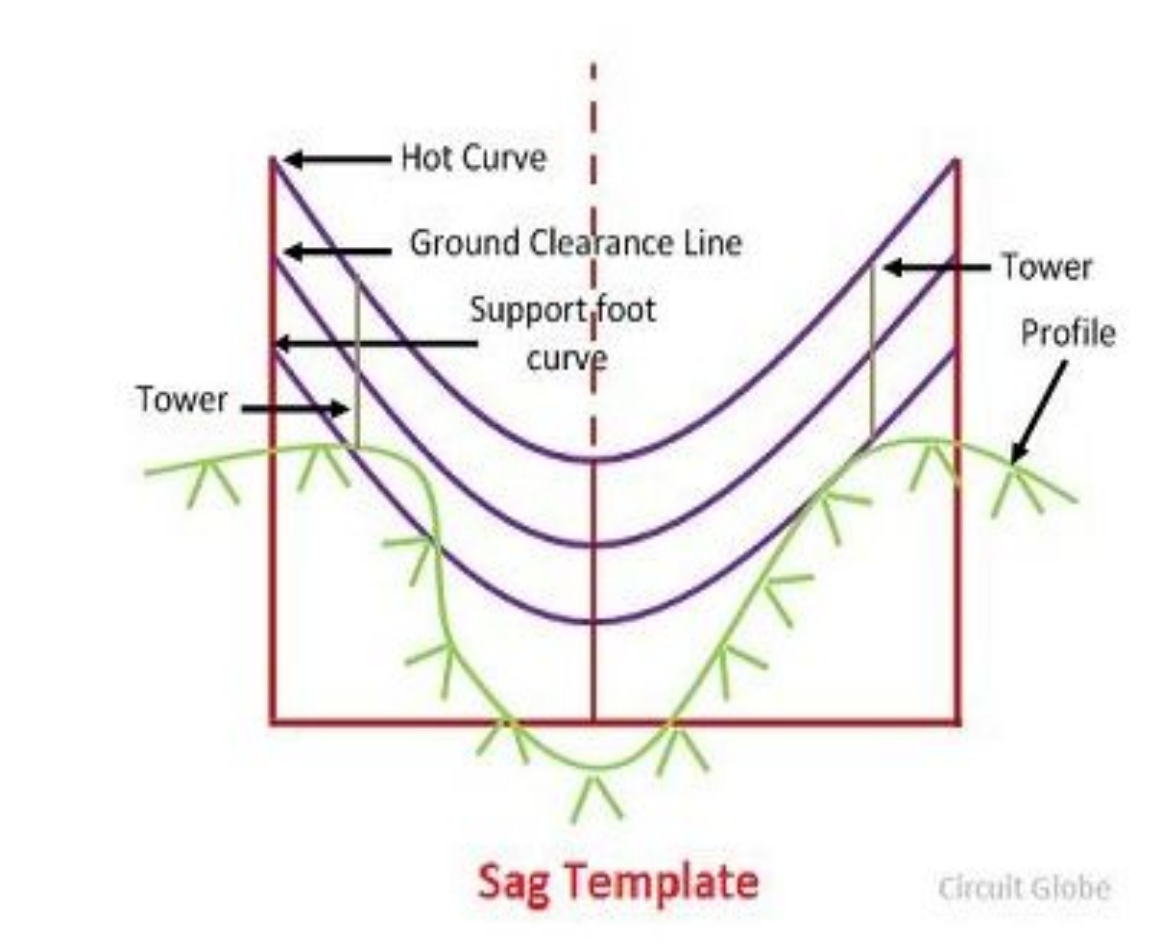
- Weight of conductor-sag is directly proportional to weight per unit length of conductor
- Span-sag is directly proportional to square of span
- Conductor tension or tensile strength-sag is inversely proportional to conductor tension
- Ground clearance-as per Indian Electricity Rules
- Temperature-reduction in temperature leads to reduced sag but under worst conditions, sag may increase

Stringing chart

- Very useful in the field for stringing the conductors and adjusting to conductors to the proper sag and tension.
- Sag must be calculated for worst conditions and ground clearance according to rules and regulations.
- Erection conditions are different as compared to various operating conditions and tension should be such that on loading there will be no infringement on the factor of safety.
- The two types of physical conditions i.e., worst conditions and erection conditions are taken for analysis .

Sag template

- The sag template is used for allocating the position and height of the supports correctly on the profile.
- The sag template decided the limitations of vertical and wind load. It also limits the minimum clearance angle between the sag and the ground for safety purpose.
- Sag template is a celluloid frame containing hot curve , cold curve and ground clearance of the cable between two towers for the particular span length.
- Approximated to be parabolic curve. Horizontal distances represent span length and vertical distances represent sag.


Hot Curve
Ground Clearance Line
Support foot curve
Tower
Tower
Profile
Sag Template
Circuit Globe

Preparation of sag template

- Curves are first drawn on a squared on the same scale as the line profile
- Selection of suitable scales
- Curves are then transferred to transparent celluloid
- Celluloid is then cut along the line of maximum sag, the hot curve

Vibrations in conductors

- Overhead line conductors may be subjected to vibrations in addition to normal swinging
- These vibrations cause alternating bending strains in the conductor, which are superimposed on the static tensile and bending strains.
- Vibrations spread via suspension and tension fittings and lead to problems such as shaking out of joints etc.

Aeolian Vibration

- Aeolian vibration is a low amplitude upto 2 cm to 5 cm (as much as conductor diameter) high frequency (5 to 150 Hz) phenomenon.
- **Aeolian vibration** is one of the most important problems in transmission lines because it represents the major cause of fatigue failure of conductor strands or of items associated with the support, use, and protection of the conductor.
- Conductor strand fatigue failures occur at the suspension clamps or at the clamps of the other devices installed on the conductor such as spacers, spacer dampers, dampers and other devices.

Aeolian Vibration

To solve these vibrations to devices are used:

- **Armour Rods or reinforcement:** In this scheme a spiral layer of small round rods and larger in diameter than conductor surrounds conductor.
- **Vibration dampers:** There are several designs but stock bridge damper is extensively used.
- It comprises of two hollow weights fixed at both end of short length of stranded steel cable suspended from conductor.

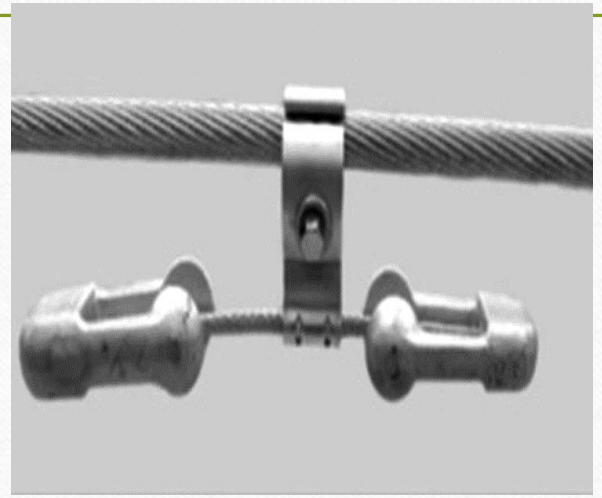
Galloping or dancing

- High amplitude and low frequency vibrations
- Occur mainly due to unbalanced physical loading on the conductors and at a speed of 30 to 80kmph
- As a result, phase conductors come in contact leading to flashover between conductors , burning of conductors, failure of cross arms etc.

Vibration damping

- Amplitude of vibration should be maintained at a value determined by dynamic strain which leads to significantly increase in the energy absorption of overall mechanical system.

Stock Bridge Damper



Advantages of vibration dampers

- Damping long span lengths
- Within the zone of coastal areas/exposure of wind energy plants
- In switchgear and external vibration problems