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TRANSMISSION LINE CHARACTERISTICS

MECHANICAL CHARACTERISTICS OF COPPER AND ALUMINUM WIRES FOR ELECTRICAL TRANSMISSION LINES—SOME USEFUL TABLES, FORMULAS AND CHARTS.

By E. MAERKER, A.Sc.,
Designing Structural Engineer, Toronto.

VARIOUS tables and charts pertaining to electric transmission line wires have been compiled by different authors from time to time. These tables and charts enable the engineer in the field, when stringing the wire, to allow a certain tension at the prevailing temperature in order that the tension may not become excessive at some lower temperature and maximum loading; and on the other hand, to prevent the sag from becoming too great at some high temperature, which might reduce the clearance from ground to lowest point of wire beyond the specified limit.

In order to obtain a clear picture of how different temperatures and various loadings affect the tension and

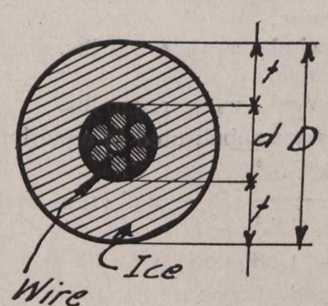

Fig. 1.

sag in the wire, Charts I. and II. have been constructed, the former for copper wire and the latter for aluminum.

These diagrams are easily constructed and the values are read off directly, eliminating all shifting about on the paper with straight-edges, as would be the case with parallel-scale types and others. The following diagrams are based on the parabolic law, as no appreciable error is introduced by doing so, providing the span is within reasonable limits.

The loading on the wire depends, of course, on the climatic conditions. However, in temperate zones an ice loading of ½ inch in thickness at 0° F. in conjunction with a wind pressure of 8 lbs. per square foot of projected area of the wire, corresponding to a 70-mile indicated wind velocity, or 55.2 actual, is usually recommended as maximum loading.

To obtain the weight of ice per foot of wire, the author has derived the following formula, which will undoubtedly be of some value.

Taking the ice as 57.3 lbs. per cu. ft., we have for W, the weight of ice per foot of wire:

$$W = \frac{\frac{D^2\pi}{4} - \frac{d^2\pi}{4}}{144} \cdot 57\cdot3 = \frac{57\cdot3\cdot\pi}{4\cdot144}(D^2 - d^2)$$

Substituting $d + 2t = D$, we have:

$$W = \frac{57\cdot3\cdot\pi}{144}\cdot(dt + t^2) = \frac{5}{4}\,t\,(d + t) \qquad (1)$$

where t denotes the thickness of the ice coating, and d the diameter of the wire; all values being in inches.

Combining the weight of the wire plus the ice with the wind, the resultant force acting on the wire is thus obtained, which forms the basis to all further calculation.

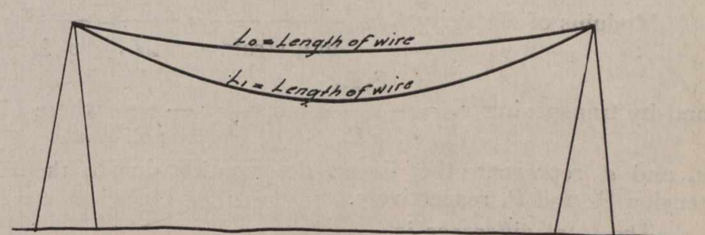

Fig. 2.

Development of Equations.

Let a denote the area of the wire in square inches.

- w_0 " the resultant force per foot of wire under maximum loading at 0° F., in lbs.
- $w_1 w_2 w_3$ " the resultant force per foot of wire under different loading, in lbs.
- l " the span in feet.
- S_0 " the sag at midspan under maximum loading at 0° F., in feet.
- S_1 " the sag at midspan under different loading, in feet.
- P_0 " the pull or tension in the wire under maximum loading at 0° F., in lbs.
- P_1 " the pull or tension in the wire under any loading or at any temperature, in lbs.
- L_0 " length of wire at maximum loading at 0° F., in feet.
- L_1 " length of wire at any other loading and other temperature.
- α " coefficient of linear expansion.
- t " temperature in degrees of Fahrenheit.
- E " Modulus of elasticity in lbs. per sq. in.