were pulled over without any difficulty. The soil yielded and the steel anchorages pulled out. Such designing, or lack of designing, is foolish.

The usual method of anchoring is to run an angle stub 5 to 8 ft. in the ground. This stub extends a foot or so above the ground level, and at the top are open holes for bolts to take the corner legs of the tower. At the bottom of the stub is a cross piece 3 or four ft. long of either channels or angles. This anchorage is placed in a hole dug in the ground and the hole refilled. For light lines with short spans and good soil, this may be sufficient for a time. For the usual long-span transmission line, the overturning moment due to the side wind pressure becomes much larger. A platform at the bottom of the angle stub can easily be designed to withstand the uplift, if the soil conditions are known.

Without any protection save a coat of galvanizing, corrosion is bound to set in at or near the ground level. The writer, a year ago, saw some towers in a cultivated field against the corner angles of which the soil had been turned in plowing. The galvanizing had nearly disappeared, though the towers had been erected but two years. There is trouble at no distant future for those towers. The anchorage should extend not less than a foot above the ground line and should be entirely encased in concrete; though a sleeve of concrete extending from the top to two or three feet below the ground line is sometimes used. Here at once a practical objection is raised. To get water and material at the site of the various towers of a transmission line, make concrete and properly set it, is difficult and expensive. Unless a strict supervision is exercised the work is sure to be slighted.

Thicker steel sections used for the anchorage will delay, but not prevent, failure from corrosion. It has been suggested that the anchor stubs be designed in two lengths, the upper length to be removable and thus replaced without tearing down the tower. A large line installed last year used a preservative paint instead of galvanizing their anchorages.

Life.—The life of a wooden pole is given, if of cedar, as from 15 to 20 years, and longer if preservatives are used. The life of a steel pole or tower cannot yet be definitely stated. It is only as far back as 1903 that the first high-tension transmission line was built in which steel towers were used exclusively. This was a line 101 miles long in Mexico, with towers about 450 ft. apart. The present practice of a multiplicity of light sections will not be conducive to long life. Sections 1/8 in. thick are very common—more of this thickness than of any other are used in the average tower. Towers made of such material, galvanized at the shop, bolted together in the field, and then left alone cannot last for a long term of years.

The use of unusually thin metal for compression values calculated in accordance with accepted formulas is to be criticized. In a number of tower tests, under the writer's observation, the failure was always in the 4 x 4 x 1/4-in. corner-angle leg. They were not good for their calculated value. This confirms Talbot & Moore in "An Investigation of Built-up Columns Under Load"* in which they write:

It would seem quite probable that, for columns of the same length and containing the same amount of metal, one which is of stocky form and in which the metal is distributed so as to resist local flexural and torsional action will be much stronger and more satisfactory than a column of more flimsy form, which has its metal spread in thinner sections, even though the slenderness ratio l/r of the former may be considerably more than that of the latter.

Important changes will take place in the direction of thicker material after some of the present lines fail, and the present policy of purchasing only what will answer for the immediate present is abandoned. There is no reason why a tower properly designed, inspected at regular intervals, painted when necessary, should not last 50 years, perhaps longer.

Examples of Towers.

Connecticut River Power Co.—The 917 towers for the line of the Connecticut River Power Co. were designed and built by the American Bridge Co. Of these towers, 862 are the standard, shown in Fig. 1. The specifications, drawn up by J. G. White & Co., call for the strength of these towers to be as follows:

The towers shall be designed for, and shall be guaranteed to stand, the following test loads without stressing any member beyond its elastic limit:

Insulator pins and grounded wire cap:

(1) At top of insulators for line conductors, 1,600 lb. in any direction perpendicular to pin axis. (2) At top of iron cap support for grounded wire, 1,400 lb. in any direction perpendicular to axis of support.

Supports for pins and cap.

(3) 1,400 lb. load in any direction on grounded wire cap and 1,600-lb. loads in any direction on line conductor insulators to be applied singly or in any combination to produce maximum stress in the supports.

Main tower structure:

(4) A load of 4,800 lb. in any direction at point A (Fig. 1), and no load at B and C.

(5) A load of 4,800 lb. in any direction at points A and B, together with a load of 1,400 lb. in any direction at point C.

In proportioning material the unit stresses were taken at 24,000 lb. per sq. in. net for tension and for compression.

$$\frac{24,000}{1 + \frac{l^2}{13,500\ r^2}}$$

Georgia Power Co.—Some towers designed and built by the American Bridge Co. for the Georgia Power Co. are shown in Fig. 2. Suspension insulators are used. There are 735 towers of the dimensions shown in cut carrying six line conductors of No. 0000 copper wire, and two 7/16-in. galvanized-steel-strand ground wires. The data drawn up for the Georgia Power Co. by the Northern Contracting Co., C. O. Lenz, chief engineer, from which the towers are designed follow:

The test load shall be: (1) A longitudinal pull of 4,300 lb. at right angles to the end of any one cross-arm. (2) A vertical load of 1,500 lb. at the ends of any or all cross-arms. (3) A load of 1,500 lb. pulling in any direction at the top of tower. (4) A load of 10,000 lb. pulling at right angles to the line or parallel to the cross-arms, that is, 2,500 lb. at each cross-arm. At the same time a pull parallel to the line or at right angles to the cross-arms of 8,000 lb., that is, 4,000 lb. in the same or opposite directions at each end of any single cross-arm or at one end of any two cross-arms.

Cross-arms are proportioned for combined loading (see section on "Loads" under "Towers" above) of Case 1, Case 2, and 1,250 lb. horizontal thrust at end of arm. The tower is proportioned for maximum combination of Cases (2) and (3), or (2) and (4). Unit stresses used are 25,000 lb. per sq. in. net for tension and for compression.

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