1983

Tests at Philadelphia Electric Company Demonstrate that CCA Treated Distribution Poles Are Not Brittle

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Bending tests on 200 full-length SYP poles treated with CCA were performed by Philadelphia Electric Company in June 1982. The poles were placed in a test jig to simulate installation in six feet of earth and pulled one foot from the top to one-half of ultimate strength (1200 lbs. for Class 4 and 1850 lbs. for Class 2). Two hundred poles of various length and class passed this test without breaking. The modulus of elasticity (MOE) of each pole was calculated from deflection and circumference data.

Introduction

Philadelphia Electric Company (PECO) serves approximately 1,300,000 customers in an area of 2300 square miles in and around Philadelphia, Pa. PECO has 385,000 poles in service. These poles are predominantly southern yellow pine and are treated with both creosote and pentachlorophenol (Penta).

In 1980 PECO changed from Penta to chromated copper arsenate (CCA) treatment for its distribution poles and crossarms. Approximately 6000 CCA poles and 12,000 CCA crossarms were installed in 1980 and 1981. The poles were treated to 0.60 pounds retention using CCA type B or C. The change was based on expected savings from lower initial cost and longer life. Since that time, there have been continuing complaints from linemen about the difficulty of working on CCA poles because the CCA pole hardness prevents good penetration by climbing gaffs. The hard surface also quickly dulls drill bits and saws and makes it difficult to drive staples and lags. In addition, some poles were broken during unloading and, as a result, we required the vendors to deliver using trucks equipped with an unloading crane.

Early in 1982, a 35-foot, Class 5, CCA treated pole broke approximately eight feet from its tip while being hauled on a two-wheel pole dinky. The break appeared to be brittle and the light-weight condition of the pieces salvaged from the tip area suggested over-drying as a possible cause. Incipient breaks were not ruled out. However, this could not be positively determined as a cause. Because of these problems and the fact that the price advantage of CCA treated poles had disappeared, PECO decided to return to using Penta poles.

Our vendors asked to be permitted to deliver 1200 CCA treated poles ordered by us and held for delivery in their stock. The question of brittleness remained in our minds. To answer it, we decided to accept delivery on a quantity of these poles and proof test for brittleness / strength up to 50 percent of those delivered.

The Test

A test jig was built at one of our storeyards. It consisted of two 8″ × 8″ × ¾″ steel angles 12 feet long buried 8 feet deep and six feet apart in 4-foot diameter reinforced concrete caissons. In addition, each angle top was anchor-guyed to prevent movement. The test consisted of: (1) laying the pole on skid boards on the ground with its butt in the test jig; (2) measuring the circumference every 5 feet; (3) pulling the pole 1 foot from its tip to one-half of the ultimate strength of the pole (1200 lbs. for a Class 4 and 1850 lbs. for a Class 2); and (4) measuring deflection at the tip under one-half load. Half load was chosen because, under National Electrical Safety Code requirements for maximum loading, our poles in service will experience no greater load than this. (See Figures 1 through 6.)

During the month of June 1982, one-half of each arriving truck load of poles was tested. Poles were accepted into stock as each load was successfully tested.

Results

Brittleness—Two hundred poles were tested without breaking. These tested poles along with the remaining 1000 poles were accepted into stock and have been installed. Further shipments will be Penta treated. During the tests, there was no audible or visual evidence that the poles were cracking or splintering. Also, after the load was removed,

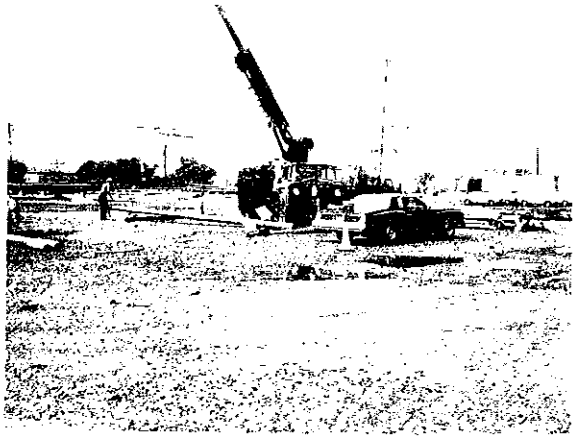

Figure 1.—General View of Test Area.

Figure 4.—Test #39
55′ Class 2
43.75″ Deflection at 1850 Lbs.

Figure 2.—Test Jig. Guyed 8 × 8 Angles Set in Concrete Caissons 6′ Apart and 8′ Deep.

Figure 5.—Test #93—Top View
40′ Class 2
33.5″ Deflection at 1850 Lbs.

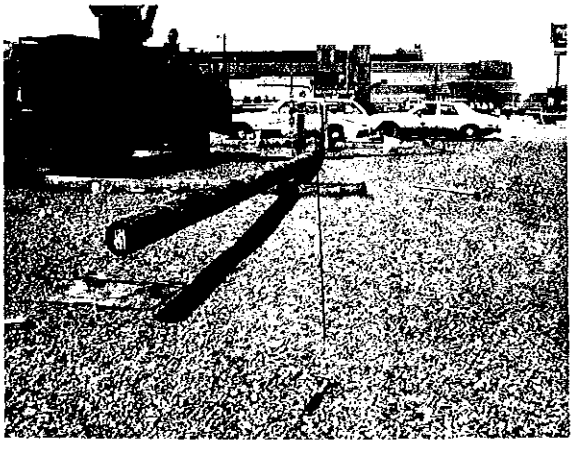

Figure 3.—Test #36
50′ Class 2
48.5″ Deflection at 1850 Lbs.

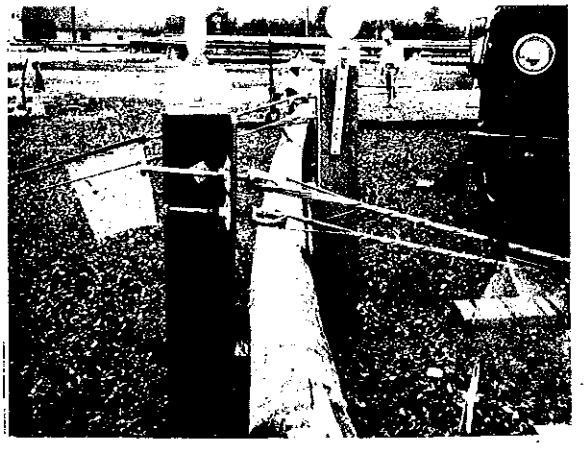

Figure 6.—Test #93—Bottom View
40′ Class 2
33.5″ Deflection at 1850 Lbs.

each pole was checked for permanent bending. There was none.

Modulus of Elasticity (MOE)—MOE is a measure of the stiffness of wood or the ability of the wood to resist permanent deformation due to bending. Data on untreated test specimens of various specie of SYP (1) gives values for MOE which range from 1.76×10^6 psi to 2.10×10^6 psi for moisture contents of 12 percent and from 1.39×10^6 psi to 1.60×10^6 psi for moisture contents of 81 percent. Data on CCA treated wood samples (2) with the specific gravities of approximately 0.5 produce values for MOE of between 1.96×10^6 psi and 2.26×10^6 psi.

A preliminary search failed to disclose published data for MOE on full-length tested CAA treated SYP poles.

The MOE of each pole tested was calculated using the following formula:

$$MOE = \frac{PL^3}{3DI}$$

Where:

MOE = Modulus of elasticity—psi
P = Load—pounds
L = Length—inches
D = Deflection—inches
I = Moment of initeria—inches^4
= .7854 R^4 where R = radius—inches

An in-house computer program used to calculate deflection of tapered steel transmission towers was modified to calculate MOE. A summary of calculated MOE values is shown in Figure 7. It shows that approximately 66 percent of the poles tested have a MOE which lies between 1.5 and 2.09×10^6 psi while 11 percent are lower and 23 percent are higher. The average for 200 tests is 1.87×10^6 psi. Unfortunately, no moisture content readings were taken. An estimate of moisture content can be made since all poles tested were between four months and 18 months old. Estimated moisture content was 25–30 percent.

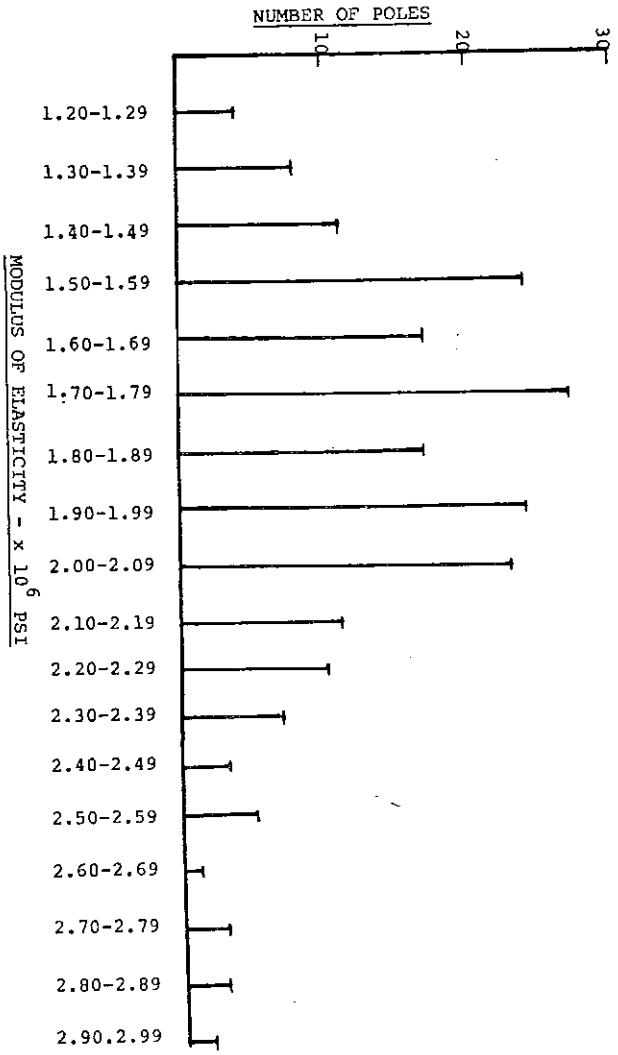

Figure 7.—Shows spread of modulus of elasticity (MOE) calculated from bending tests performed on 200 CCA treated SYP poles. Average MOE = 1.87×10^6 psi.

PECO will continue to use Penta treated poles until some method is found to make CCA poles less hard and easier to climb.

Summary

Bending tests performed on 200 full-length CCA treated SYP poles indicate that CCA poles are not brittle. Each pole was pulled to one-half of its ultimate strength without breaking.

Modulus of elasticity (MOE) calculations on each pole generally agree with published MOE test data on small wood samples.

References

1. U. S. Dept. of Agriculture Wood Handbook No. 72.
2. Effects of the MSU Process and High Preservative Retentions on Southern Pine Treated with CCA-Type C, M. W. Wood, W. C. Kelso, H. M. Barnes, Susmita Parikh.