DESTRUCTIVE TESTING

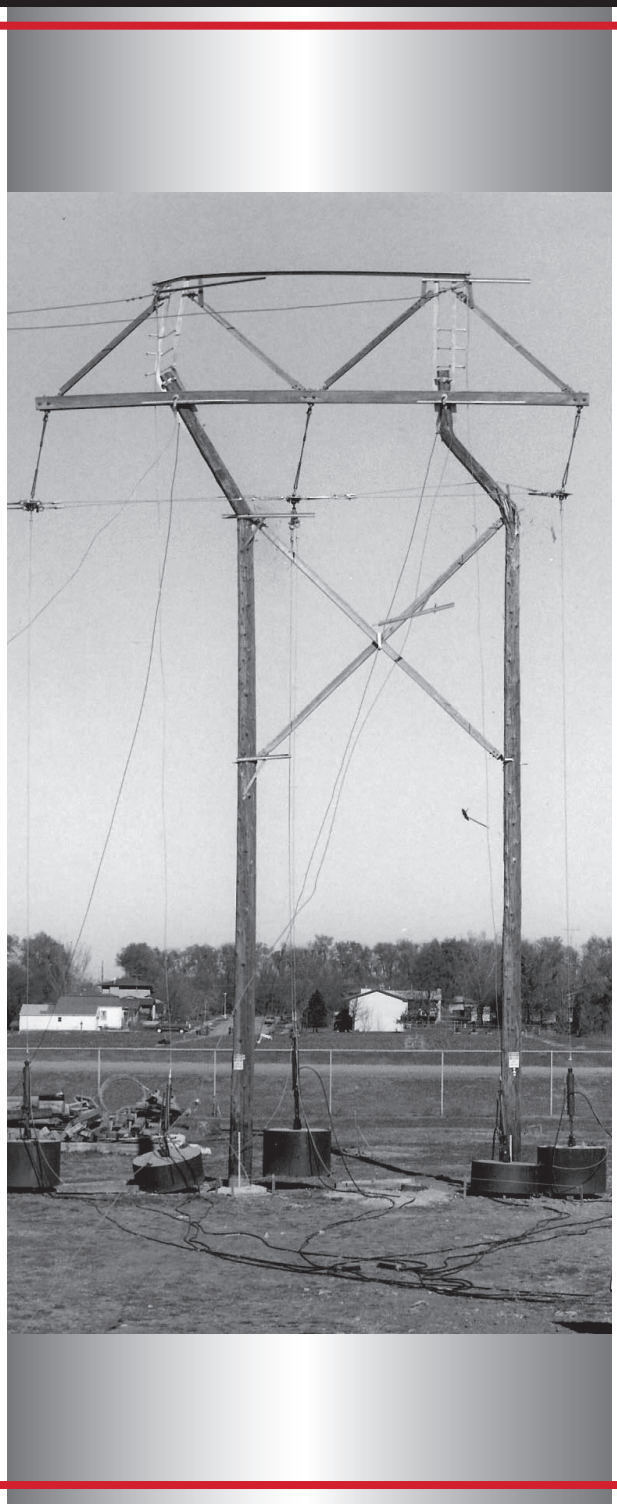
OF AGING WOOD POLE H-FRAME STRUCTURES

Full-scale structure tests have verified that the engineering and manufacturing processes done over a half century ago have stood the test of time. These tests also verified the expectation of a 50 to 75 year service life for wood H-frames.

Several of the structures tested were able to support the loads required by the current NESC code requirements after reaching twice their expected design life.

Two separate series of tests were performed on two groups of structures. The first group consisted of on-site testing of nine 115 kv structures near Kearney, Nebraska. These tests were conducted in cooperation with Nebraska Public Power District (owner of the 115 kv line) and Engineering Data Management of Fort Collins, Colorado. The second set of tests were performed on five structures provided by Wisconsin Power & Light Company. These vintage 115 kv structures were removed from service, disassembled, and shipped to our test facility in Seward, Nebraska. The condition when disassembled was noted carefully, and the structures were accurately reassembled to replicate the condition they were in at the time of removal.

The test data generated and a summary of the results are included in the following pages.



HUGHES BROTHERS

210 N. 13th Street • Seward, Nebraska 68434 • 402-643-2991 • www.hughesbros.com

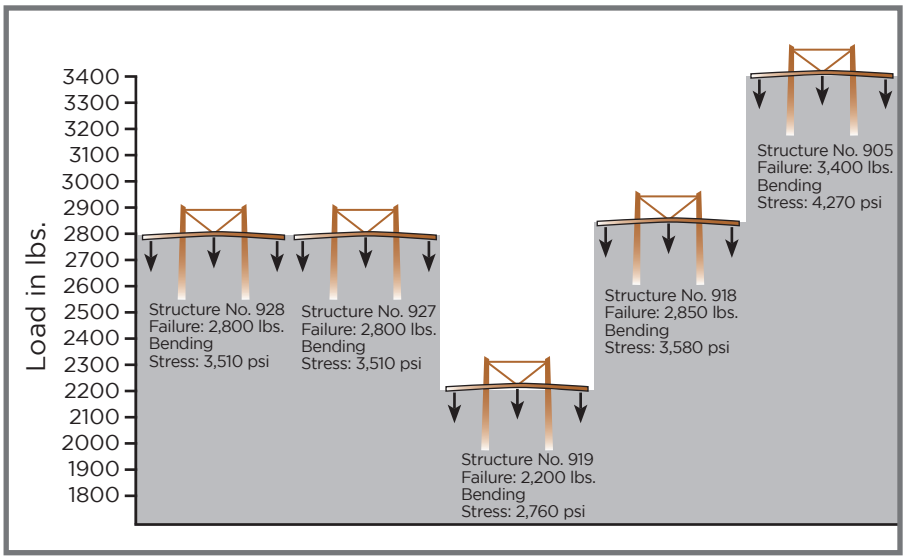
NEBRASKA PUBLIC POWER DISTRICT

115 KV TESTS Structures in Service since 1936

Crossarm Tests

Five of the structures crossarm assemblies were first tested vertically to NESC “Heavy” loading requirements. Each arm was reinforced with stainless steel bands after initial failure so they would not have to be replaced for the structure tests.

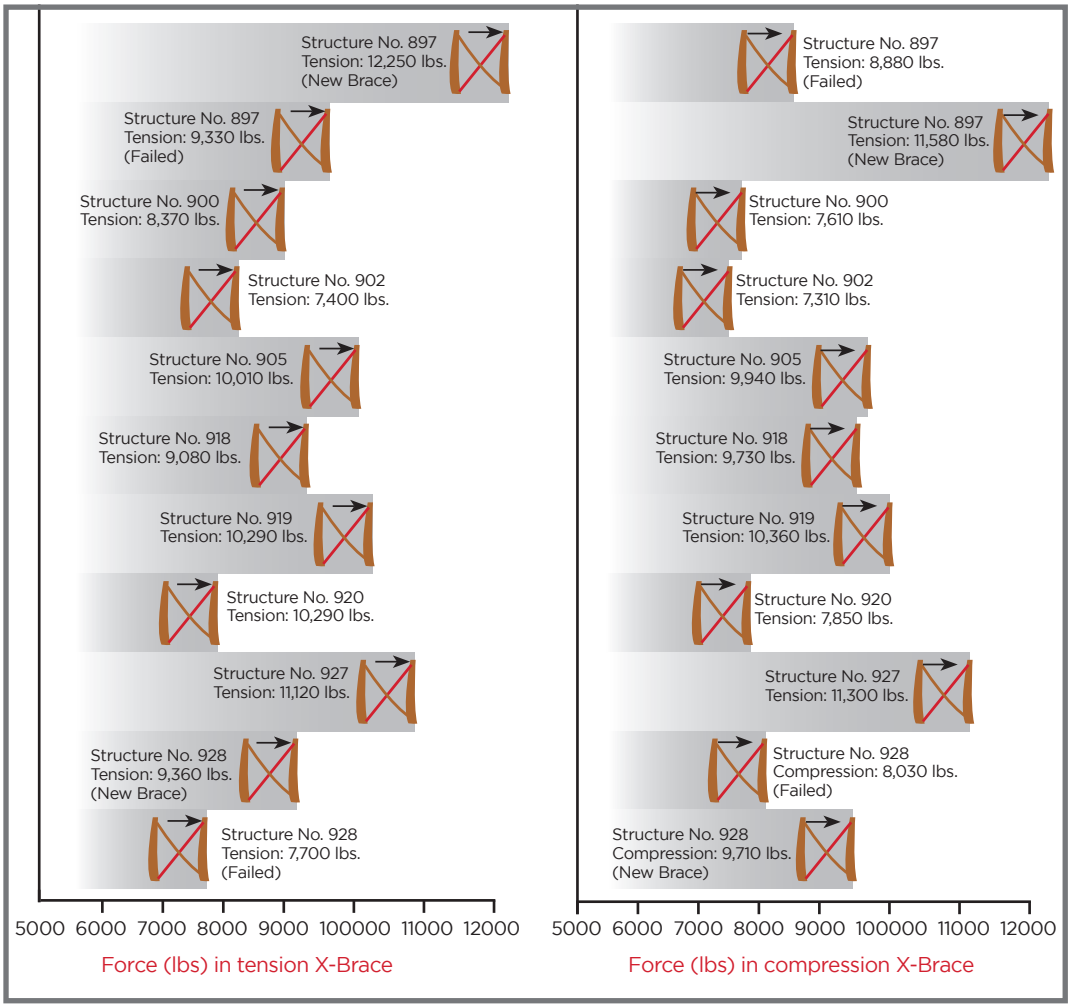
The sample size was small, but the testing showed that the crossarms still have sufficient strength to support the NESC Heavy loads with an OCF of 2.2. The average failure stress after 60 years of service was about 50% lower than new Douglas fir arms.



X-Brace Results

The axial tension and compression forces in the X-braces at the time of structure failure were also calculated and are tabulated as shown. In two of these cases the X-brace failed before the poles, and they were replaced with new X-braces so the structures could be tested further.

The original X-braces had a 3-3/8 x 4-3/8 cross section, which is not a recommended size for this pole spacing. Weathering reduced this section by about 1/16” on all faces, resulting into an approximate 12-13% reduction in buckling capacity. The X-braces performed adequately in spite of the weathering and loosening of some hardware.

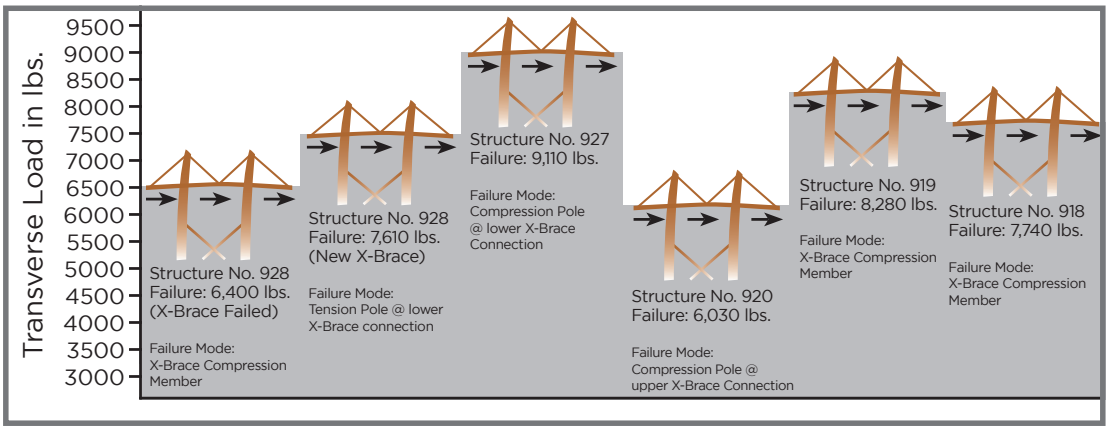


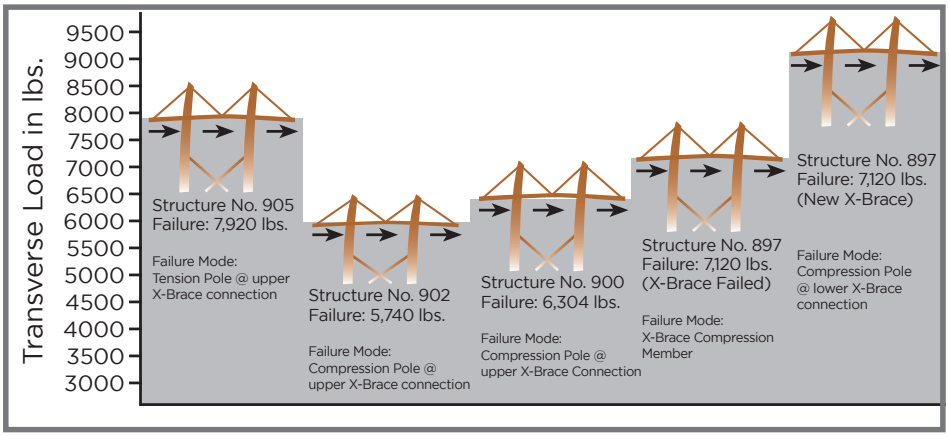
STRUCTURE TESTS

NPPD 115 KV STRUCTURES

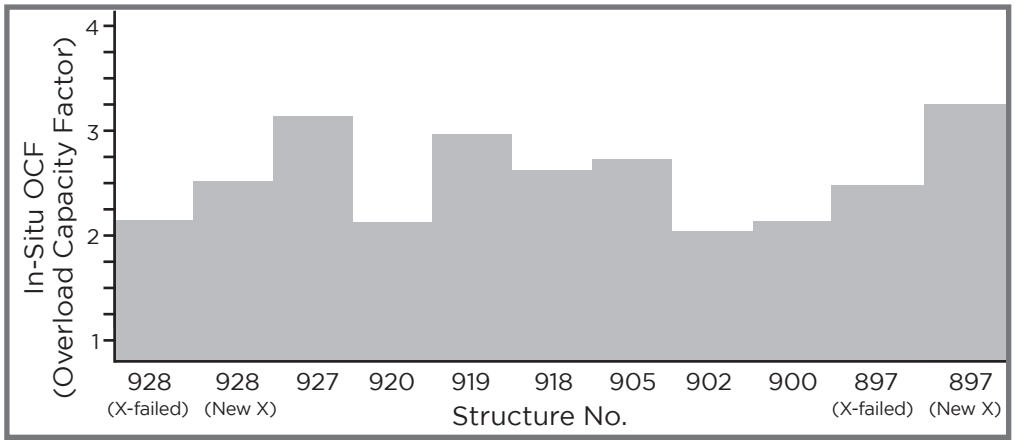
The results of the combined transverse and vertical load tests are tabulated below. Based on an original designated fiber stress of 6,000 psi for new western red cedar poles the structures should have failed near 11,680 pounds. The “at replacement” failure load should have been about 7,820 pounds. These loads were calculated based on ANSI minimum pole dimensions.

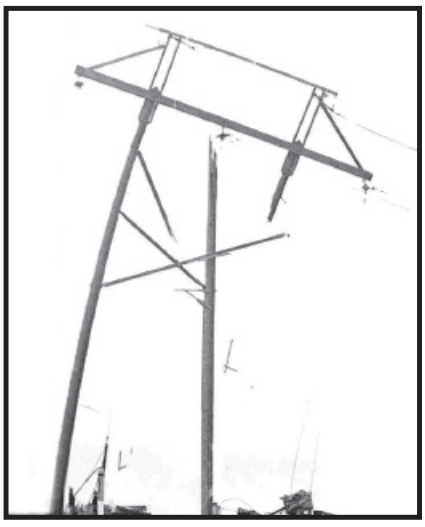
Transverse Loads & Failure Mode





In-Situ OCF





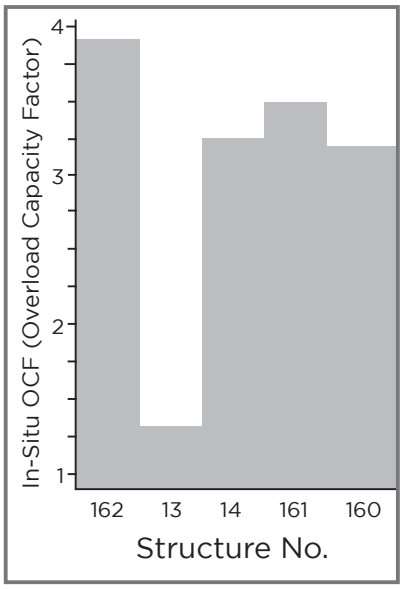
The structures performed well considering their age. The average failure load was only 5% below NESC “at replacement” requirements.

WISCONSIN POWER AND LIGHT

138 KV TESTS Structures in Service since 1939

The structures tested for Wisconsin Power and Light were removed from service, disassembled and shipped to Hughes Brothers testing facility. They were then reassembled exactly as they were found in service. Some structures were reframed with loose hardware, or even missing hardware, such as no X-Brace clamp on structure number 13.

In-Situ OCF



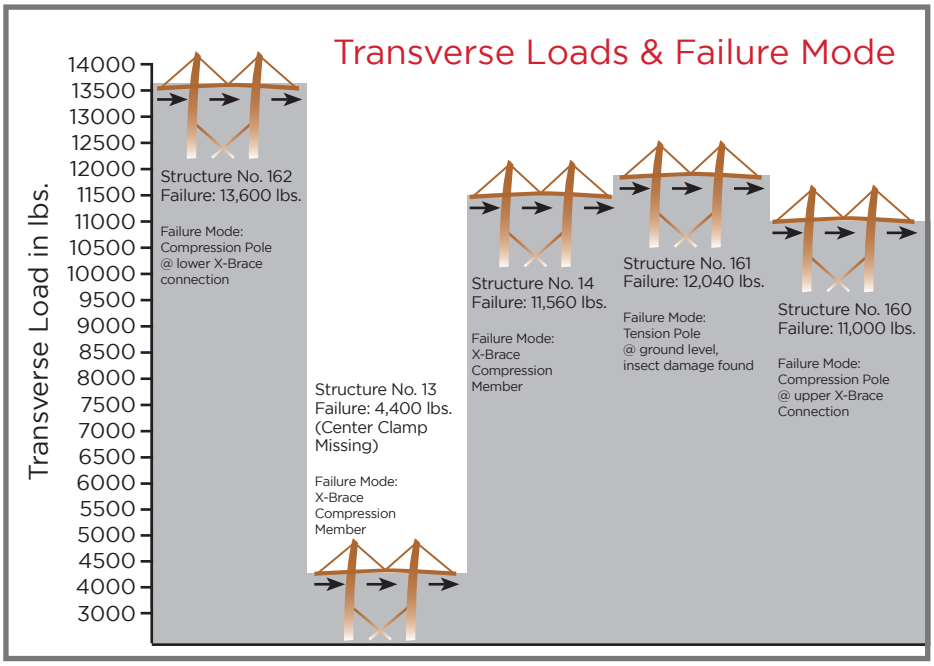
Structure Tests

The results of the combined transverse and vertical load tests are tabulated below. Based on an original designated fiber stress of 6,000 psi for new western red cedar poles, the structures should have failed near 13,900 pounds. The "at replacement" failure load should have been about 9,270 pounds. These loads were calculated based on ANSI minimum pole dimensions.

Crossarm Tests

One crossarm was tested vertically with a series of loads that included:
NESC Heavy loads with no OCF (1,300 lbs. per phase)
NESC Heavy loads with an "at replacement" OCF of 2.2 (2,800 lbs. per phase)
A final load corresponding to 1.6 inches of radial ice (3,900 lbs. per phase)
The crossarm held all of the loads without failure.

The tests for Wisconsin Power and Light show that simple maintenance such as tightening bolts or replacing missing hardware can increase the life of the structures significantly. The average failure load of these structures, even considering the missing center clamp, was well over the "at replacement" requirements.



Conclusion

Independent studies have shown repeatedly that wood structures are less costly and more reliable than their steel counterparts. These studies have shown that the original reliability of wood structures can be maintained at a nearly constant level through a wood pole management program. These tests verify that even with minimal maintenance, wood framing is here to stay.