ANSI O5.1 Wood Pole Specification Update

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Abstract

The 2002 edition of ANSI O5.1, American National Standard for Wood Products-Specifications and Dimensions, was published after several years of test data evaluation and debate. The effort was catalyzed by the fact that the designated fiber stress values had been the same since the 1960's and yet a lot of subsequent, full-scale testing had occurred. The fiber stress values needed to be re-evaluated based on consideration of the additional test data.

A derivation of fiber stress values based on a combined data set of the ASTM (distribution) and EPRI (transmission) full-scale pole tests resulted in some changes in the standard. For the most part, distribution designs should remain the same while some transmission designs may call for higher class poles.

This paper will provide an overview of the fiber stress derivation that was used to re-evaluate the test data. The correlation will be shown between ANSI O5.1 2002 predicted pole strength and the test data.

Fiber Stress Derivation for ANSI O5.1-2002

Combining Test Data

This derivation started with the raw test data from all of the ASTM and EPRI pole tests in the ANSI database. It did not review all of the assumptions and adjustments explained in FPL 39 that were used to derive the existing designated fiber stress values in the 1960's. Rather than determining how the newer EPRI data affects the fiber stress values in FPL 39, this derivation began with the combined raw test data and made the following assumptions and adjustments.

1. No adjustment for load sharing
2. No adjustment for variability
3. No test data from small clears

All data combined for this derivation was from full-scale tests of green, untreated poles.

For poles that broke at the groundline, the modulus of rupture at the break point (MORBP) was equal to the modulus of rupture at the groundline (MORGL).

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For poles that broke above groundline, the MORBP was calculated using the actual circumference at the break point. Annex A of ANSI O5.1-1992 provides a formula that should be used to reduce fiber stress values for locations in the pole above the groundline. This formula was applied in reverse to project the actual MORBP to a MORGL.

The observed groundline stress is another value that comes into play when a pole breaks above the groundline during a test. This value is the fiber stress that was occurring at the groundline when the pole broke at a location above ground.

For poles that break above the groundline, it is important to note the difference between the theoretical projected fiber stress at the groundline and the observed groundline fiber stress.

The formula in Annex A was originally developed to account for a reduction in fiber stress at locations in the pole above ground. This was important for pole installations where the maximum stress point is likely to occur above ground. Applying the formula in Annex A in reverse to project a groundline stress from a known stress above ground is not how the formula was intended to be applied. However, the formula provides a rational method for estimating a true groundline MOR when only the true MOR at an above ground failure location is known. Since the Table 1 values in the ANSI standard are supposed to be true groundline MORs, and since the earlier data on distribution poles closely represented a true groundline MOR, the transmission data had to be reported on a similar basis in order for the data to be combined as measurements of the same material property, the actual groundline MOR. The derivation applied the formula in reverse in order to provide an estimate of actual groundline MOR, and if the resulting pole capacity correlated well with the test data, then designers would have a method to reliably project pole capacity.

The resulting projected fiber stress values at the groundline varied compared to the observed groundline stress due to actual pole geometry. In some cases, the projected values were higher than the observed and in other cases lower.

Class Oversize Adjustment

The class oversize is applied to the actual measured MOR calculated from the actual dimensions. This is the true material property. The average pole is going to be one-half of a class larger so the actual average strength will be midway between classes. Since all designs are based on the minimum dimensions, the design fiber stress value is multiplied by the oversize factor to account for the actual average oversize.

The adjustment factor is calculated by comparing the change in section modulus between the minimum dimension for a pole and the dimension that is one half of a pole class larger. The factor varies for species and between different classes. The factors that adjusted the test values ranged from 1.07 to 1.158.

Conditioning Adjustment
The test poles were not conditioned for treatment. However, utilities use poles that are conditioned and treated before going into service. Different conditioning methods affect pole strength to different degrees. Therefore, the test data needed to be adjusted to account for the effects of conditioning so that expected strength correlates with the test data.

The following factors adjusted the test data to account for the effects of conditioning during the treatment process.

Species	Conditioning	Factor
Southern Pine	Steam Conditioning	.85
Douglas-fir	Boultonizing	.90
Western Red Cedar	Air seasoning	1.0

Drying Factor for Taller Poles
For taller poles, the point of maximum stress is likely to be above the groundline. The MOR will increase above groundline due to drying to equilibrium conditions as compared to test results of green poles. The test data for poles taller than 50 feet was increased by 10% to account for this drying effect.

Results and Application

This derivation was found to result in a design methodology that has a good correlation with the test data (see examples in **Figures 1-3**). There is still some disagreement on the committee about some aspects of the derivation. However, consensus agreement was reached for the standard because the resulting designs are conservative in the vast majority of pole sizes.

Using the guidelines in ANSI O5.1- 2002, one simply needs to assume minimum dimensions, apply the load tree and determine the point of maximum stress. If the maximum stress point is at the groundline, the pole capacity is based on the Table 1 fiber stress and minimum pole dimensions. If the maximum stress point is above ground, adjust the fiber stress per the height adjustment equation and use the minimum dimension at that height.

These calculated pole capacities show a good correlation with the test data. Therefore, a designer can calculate pole capacity safely and without pole actual dimensions.

One other result of this exercise was the confirmation that pole capacity on taller poles changes depending on the height of the applied loads. An applied load two feet from the tip of a taller pole will cause the maximum stress point to occur above groundline. As the load point is applied at lower heights, the maximum stress point moves lower on the pole. The fiber stress is greater and the circumference is larger at the lower points on the pole so the ultimate pole capacity increases.

A Working Group has been formed within the Fiber Stress Subcommittee to determine if there is strong evidence for changes that might result in less conservative or more precise designs. The results of this work will be published in future documents.

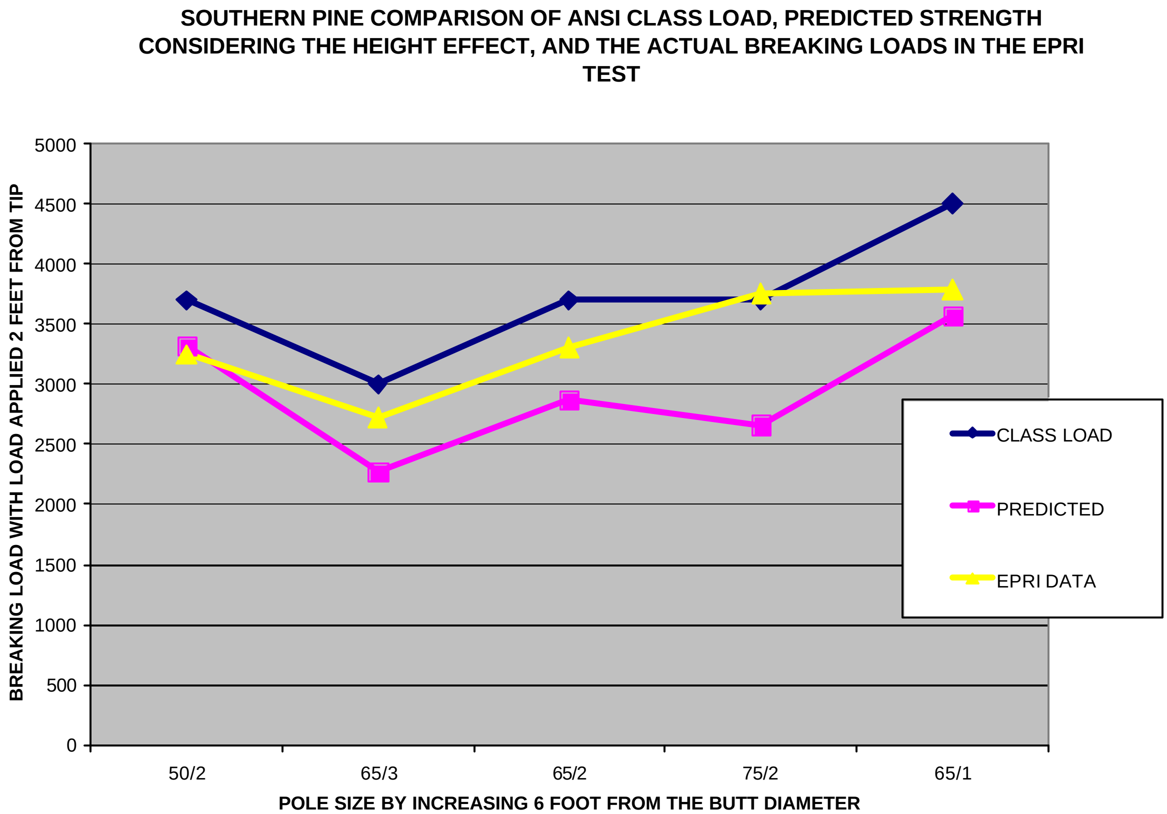

Figure 1

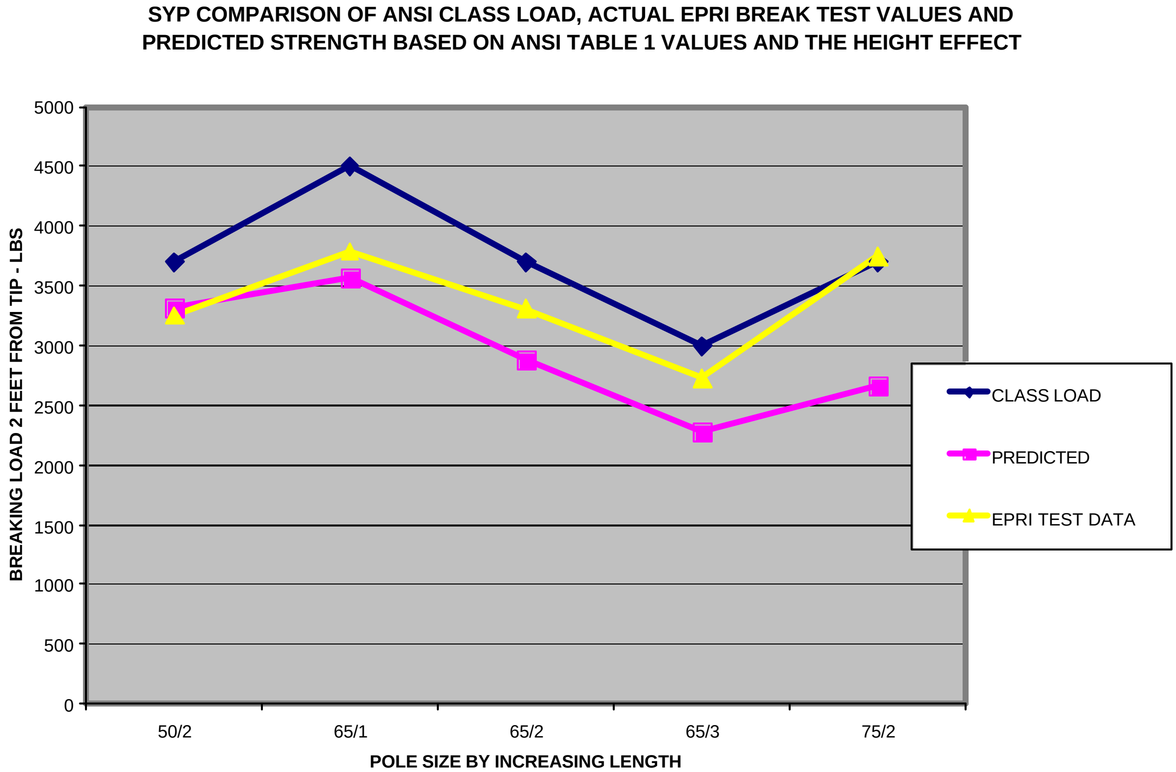

Figure 2

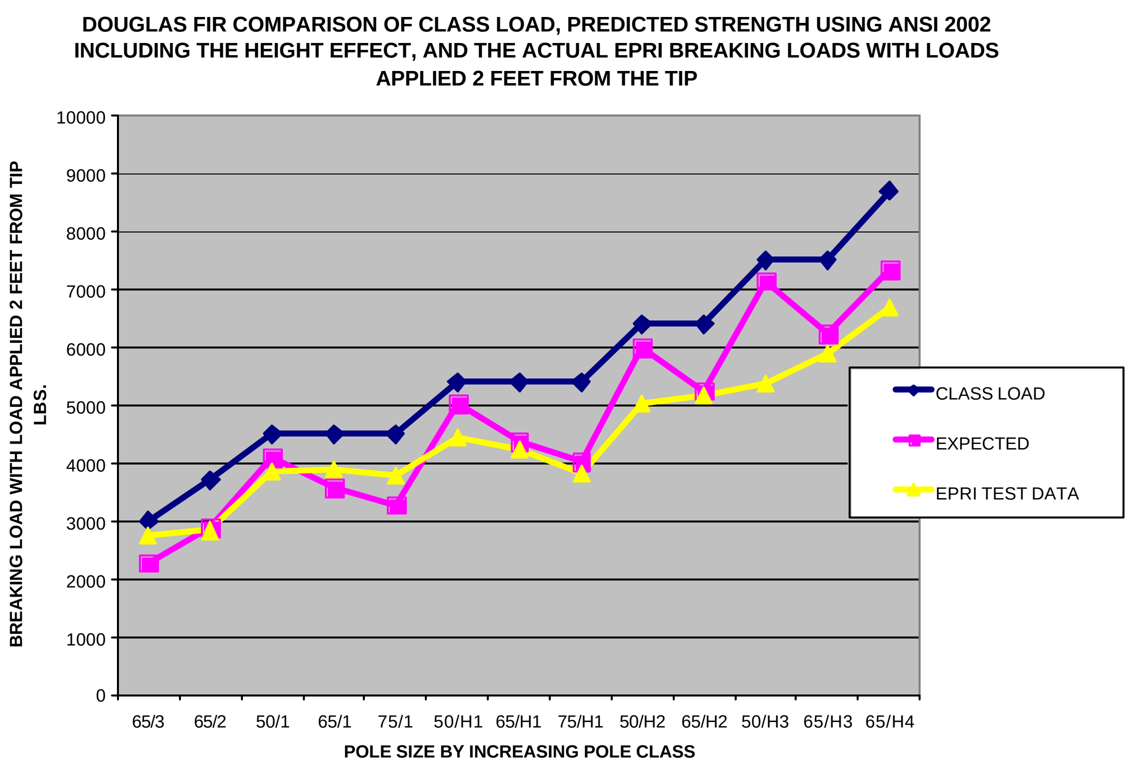

Figure 3