NORTH AMERICAN
WOOD POLE COUNCIL

A Discussion of "Wood Equivalent" Poles and the 2002 National Electrical Safety Code

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INTRODUCTION

Utility poles constructed of materials other than wood are now being aggressively marketed for use in distribution applications. Although steel and prestressed concrete poles have been used for many years for transmission applications, these products are now being used on a broader basis in distribution pole applications. Whereas it is common practice to design transmission structures individually, distribution line designs have typically been based on a range of standard pole sizes. This allows for poles to be inventoried and allows repair and new construction to proceed without the delays inherent in a custom design and fabrication scenario. Historically, virtually all distribution poles were wood, and wood poles have been manufactured to distinct class sizes established by the American National Standards Institute (ANSI) specification for wood poles, presently known as ANSI 05.1.[1] In order to improve marketplace acceptance, non-wood distribution poles have been marketed as "wood equivalent" pole classes. Because the National Electrical Safety Code (NESC)[3] applies different strength and overload factors to poles of different materials under different controlling design conditions, there can be no true "wood equivalent" pole. A non-wood distribution pole designed for equivalence, for instance, to meet the requirements of NESC Grade B under a transverse wind load condition, will not be equivalent under the requirements of NESC Grade C, which controls the safety of most distribution pole designs.

Since most non-wood distribution poles are manufactured for "equivalence" based on NESC Rule 250B Grade B Transverse Wind Load design situations, yet most distribution lines are subject to the provisions of NESC Grade C, there has been confusion in the field concerning how to utilize these poles in Grade C designs based on wood. Contrary to reports coming from the field, the changes made in the 2002 version of the NESC did not make it acceptable to use a Grade B "wood equivalent" pole in Grade C lines designed on wood pole classes, or in any other wood pole designs not controlled by NESC Rule 250B Grade B Transverse Wind Loading criteria.

DISCUSSION

The "wood equivalent" pole has been the subject of discussion in several earlier documents.[(2)(4)(5)] Changes made in the 2002 edition of the National Electrical Safety Code, C2-2002, altered the strength relationship between wood and metal or prestressed concrete poles under one of the NESC load conditions. This load condition is Grade C, Transverse Wind Load, Not at Crossings, for which the overload factor for metal and prestressed concrete structures was reduced to 1.75, the same as for wood poles. This means that metal and prestressed concrete poles now have overload factors equal to wood in all transverse wind load conditions. However, the strength factors for wood change with the grade of construction, so a "wood equivalent" pole under Grade B Rule 250B is not a "wood equivalent" pole under Grade C Rule 250B, or under Rule 250C Extreme Wind, load conditions.

There are 14 different load conditions for which the NESC provides overload factors and strength factors. In many cases the overload and strength factors vary between wood and non-wood materials, and the ratio of the combination of the two values represents the "wood equivalent" design condition for non-wood materials. Table 1 presents the overload factors and strength factors for the Transverse Load Condition and Table 2 presents the overload and strength factors for the Other Load Conditions. An examination of these tables reveals that there are five different ratios of required non-wood design strength relative to the wood design strength. It must be remembered that in some cases the controlling design is transverse load, and in others, it may be another load condition such as vertical loading. A non-wood pole designed to be a "wood equivalent" pole under a transverse load would not be a "wood equivalent" pole if vertical loading was the controlling criteria. For example, even though the relative strength ratio in Table 1 is 0.65 for the transverse load condition of Grade B Rule 250B, Combined Ice and Wind Load, and it is also 0.65 in Table 2 for Grade B, Vertical Load, the "wood equivalent" pole would not be the same in each case. In the first case, the non-wood pole would have to be designed to 65% of the ANSI wood pole transverse strength, and in the second case, the non-wood design would have to be to 65% of the column loading strength of the ANSI wood pole. These are not the same design point, and the effect would be different depending upon the non-wood material used for the pole. In other words, the relative transverse load strength versus column loading strength of poles varies by material and method of construction. A thin-walled steel pole, a prestressed concrete pole, and a wood pole all designed to have the same transverse load capacity would normally each have a different column loading capacity.

Some pole designers and users feel that it is counterintuitive that a "wood equivalent" steel or prestressed concrete pole designed for equivalence in Grade B, which is the more conservative design condition, cannot be used as a substitute for wood in a Grade C design based on wood. The reason is that wood is penalized in Grade B designs because of its perceived higher variability of strength. That is why the wood strength factor is only 0.65 in Grade B designs. However, in Grade C, the wood strength factor is 0.85 and under Rule 250C Extreme Wind the strength factor is 0.75. Therefore, a "wood equivalent" pole of steel or prestressed concrete would have to be designed to 85% of the ANSI 05.1 wood pole transverse strength to be suitable for substitution for wood in a transverse load Grade C design and 75% of the ANSI strength in a situation controlled by Rule 250C Extreme Wind. Most thin-walled steel poles are designed to 65% of the ANSI transverse strength, and therefore, it should be clear that those poles could not be substituted for wood poles in NESC Grade C or Rule 250C transverse load situations.

Under each of the potentially controlling design conditions shown in Tables 1 and 2, a different "wood equivalent" pole may be required. For these reasons, the concept of a "wood equivalent" pole is fundamentally flawed. It is imperative that users of non-wood poles employ them in accordance with the requirements of the NESC. Failure to meet the requirements of the NESC could have serious consequences. However, many non-wood distribution pole manufacturers only produce "wood equivalent" poles that are manufactured to be equivalent in an NESC Grade B Rule 250B Transverse Wind Load design. This creates potential problems in misapplication of the product, because NESC Grade C Rule 250B, or Rule 250C Extreme Wind are the criteria applicable to most utility structures. A non-wood distribution pole manufactured to be a "wood equivalent" pole under an NESC Grade B Transverse Wind Load cannot be used as a direct substitute for wood in a Grade C Transverse Wind Load situation, which governs most distribution pole installations. Use of the Grade B "wood equivalent" pole in anything other than an installation governed by transverse wind loads under Grade B Rule 250B of the NESC may result in conditions not in compliance with the NESC.

SUMMARY & CONCLUSIONS

It is clear that due to: the differences in relative strengths inherent in poles manufactured of different materials by different methods; the many different permutations of possible controlling load configurations in the NESC; and the different load and strength factors assigned to different materials under different load conditions in the NESC; there can be no universally applicable "wood equivalent" pole made from steel, prestressed concrete, or other non-wood material. The corollary to this statement is equally true, a wood pole cannot be used as a replacement for a steel or prestressed concrete pole without a thorough evaluation of all of the design loads and the proper application of the appropriate overload and strength factors for wood.

The line design engineer or utility company must have a complete understanding of the basis for the "wood equivalent" pole design in order to avoid misapplication of the product in situations for which it was not designed. A misapplication could result in construction not meeting the minimum requirements of the NESC. Since there may be statutory or regulatory provisions requiring utility construction to meet the minimum standards of the NESC, there could be substantial risk associated with any failure to fully comply with the code requirements.

The line designer does not need to use the "wood equivalent" pole concept in order to effectively utilize non-wood poles. Use of the actual design strength and the appropriate overload and strength factors for the material of construction under the controlling load condition and grade of construction specified in the NESC will ensure that the design meets the NESC code requirements.

As described in the earlier discussion, the 2002 edition of the NESC did make one minor change to the overload factor for steel and prestressed concrete in Table 253-1, for the Grade C Transverse Wind Load, Not at Crossings, design condition. This change did not make it acceptable to employ "wood equivalent" poles designed for equivalence under NESC Grade B Transverse Wind Load as replacements for wood in NESC Grade C Transverse Wind Load, NESC Rule 250C Extreme Wind, or any other controlling design conditions.

Table 1

	Transverse Load Conditions					
	Extreme Wind Rule 250C	**Grade B Combined Ice & Wind Rule 250B**	**Grade C Combined Ice & Wind at Crossings Rule 250B**	**Grade C Combined Ice & Wind Not at Crossings Rule 250B**	**Wire Tension Grade B**	**Wire Tension Grade C**
Wood overload factor (Table 253-1)	1.0	2.5	2.2	1.75	1.65	1.3
Wood strength factor (Table 261-1A)	0.75	0.65	0.85	0.85	0.65	0.85
Steel & prestressed concrete overload factor (Table253-1)	1.0	2.5	2.2	1.75	1.65	1.1
Steel & prestressed concrete strength factor (Table261-1A)	1.0	1.0	1.0	1.0	1.0	1.0
Ratio of required steel or prestressed concrete strength to ANSI wood pole strength	0.75	0.65	0.85	0.85	0.65	0.72

Table 2

	Other Load Conditions							
	Vertical Load Grade B	Vertical Load Grade C	Longitudinal Load at Crossings Grade B in General	Longitudinal Load at Crossings Grade B at Dead Ends	Longitudinal Load at Crossings Grade C at Dead Ends	Longitudinal Load Elsewhere Grade B in General	Longitudinal Load Elsewhere Grade B at Dead Ends	Longitudinal Load Elsewhere Grade C at Dead Ends
Wood overload factor (Table 253-1)	1.5	1.9	1.1	1.65	1.3	1.0	1.65	1.3
Wood strength factor (Table 261-1A)	0.65	0.85	0.65	0.65	0.85	0.65	0.65	0.85
Steel & prestressed concrete overload factor (Table253-1)	1.5	1.5	1.1	1.65	1.1	1.0	1.65	1.1
Steel & prestressed concrete strength factor (Table261-1A)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ratio of required steel or prestressed concrete strength to ANSI wood pole strength	0.65	0.67	0.65	0.65	0.72	0.65	0.65	0.72

REFERENCES

1. American National Standards Institute. 2002, ANSI-05.1-2002. ANSI, New York, NY.
2. Dagher, H. J. 2000. Reliability of Poles in NESC Grade C Construction. Paper prepared for the American Iron and Steel Institute, Orono, ME.
3. Institute of Electrical and Electronics Engineers, Inc. 2002. National Electrical Safety Code C2-2002. IEEE, New York, NY.
4. Rollins, H. M. 1998. The Effect of Material Strength Variabilities on the Development of Equivalent Overload Factors. Paper presented at the NESC Subcommittee 5 meeting, October 20, 1998. Piscataway, NJ.
5. Rollins, H. M. 2001. A Discussion of "Wood Equivalent" Poles, North American Wood Pole Coalition Technical Bulletin. NAWPC, Vancouver, WA.

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