NEW WOODEN POLES GRADING USING NON-DESTRUCTIVE TECHNOLOGY

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ABSTRACT

This article deals with the non-destructive grading of new-wooden poles, before their installations as supports of overhead lines by telecom or power companies.

Variability and uncertainties amplify risks in installing originally weakened poles. The probability to have a decayed or broken wood pole within the 10 years following its installation increases strongly from the last decade. The latest outcomes show that approximately 8% of Spruce and Fir new poles have critical mechanical properties.

LUXPOLE is a concept for new-wood pole grading. By using ultrasonic technique, the initial mechanical properties are estimated and the weakest poles are purged. Furthermore, the strongest poles can be identified and reserved for specific uses (difficult access, angle position…) In other terms, this method grades the new wooden poles in three classes:

1. *S: The weakest poles: to be rejected for overhead lines support use*
2. *L: The common poles: the initial mechanical properties are good enough for the pole to be used in an overhead network*
3. *XL: The strongest poles: poles with high mechanical performances for specific uses*

The customer by receiving graded poles has the confirmation that the poles can be used sustainably in the networks. In other terms, LUXPOLE gives the guaranty that no weak poles will be installed and even more: the best poles can receive extended life time expectancy.

INTRODUCTION

The selection of wood poles used as supports for telecom or power overhead lines is visually operated.

National or companies standards define the wood poles mechanical classes based, for each species, on some material singularities (knots, slope of grain, annual rings…) and intrinsic properties (length, diameter, weight…).

If this visual grading can be considered as a first approach for wood poles grading, this method is subjective and is not sufficient for the overhead lines asset management.

Indeed, due to the large variation of wood mechanical properties within a same species, a subjective grading can let some weak components to be installed in a network. By snowball effect, a weak component can be fatal to the entire network, causing many technical, human or financial troubles.

After 15 years' experience of non-destructive technologies for both new and in-field wood poles, CBS-CBT can present the advantages of selecting the best poles to be installed in the networks in terms of maintenance costs and reliability aspect.

WOOD MATERIAL

Wood is produced by the forests and its growing conditions affect strongly its mechanical performances.

Even from a same species, the mechanical properties can vary from 1 to nearly10. Concerning the wood poles, this variation can be confirmed thanks to destructive tests presented by the figure 1.

240 new wooden poles from the same species (Spruce-Fir) have been broken until failure (Cantilever protocol). If the lowest mechanical property is around 10 N/mm^2, the strongest one is up to 80 N/mm^2.

Figure 1 shows the allowable strength limits for both, Switzerland (15N/mm^2) and France (18.3N/mm^2). The figure underlines the fact that some new wooden poles are weaker than the codes expected values.

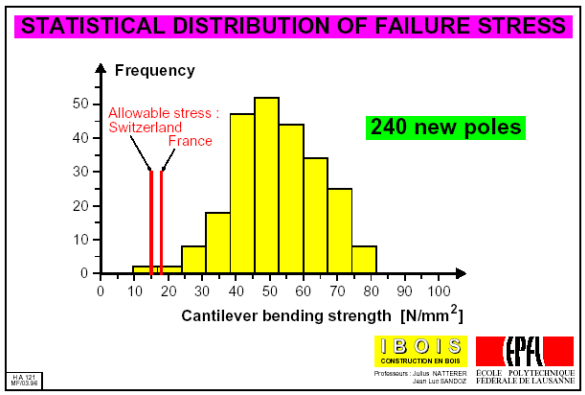

Figure 1: 240 new wooden poles tested until failure to determine the Cantilever bending strentgh (Spruce and Fir). IBOIS database, Swiss Federal Institute of Technology, Lausanne

NON DESTRUCTIVE TECHNIQUE FOR NEW WOOD POLES GRADING

In order to evaluate the initial mechanical properties of new wooden poles, a non-destructive technique using ultrasonic can be used.

This method, developed in the 80ies, has been transferred into the Sylvatest Duo technology.

Thanks to two transducers, an emitter and a receiver, the ultrasonic velocity is measured and is translated into mechanical performances.

Figure 2 presents the concept of the ultrasonic measurement for a new wood pole.

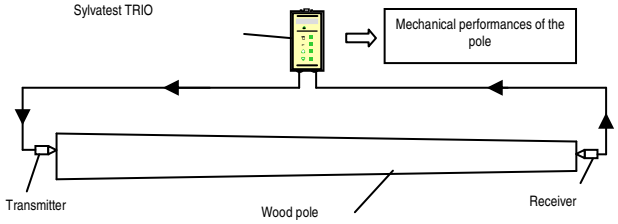

Figure 2: Concept of the ultrasonic measurement for a new wooden pole. One emitter and one receiver: measurement of the time of flight of ultrasonic waves.

The correlation between the measured ultrasonic velocity and the mechanical properties has been obtained, for each species, by destructive tests as illustrated by the figure 3. The coefficient of determination is r^2=0.6.

The measurements can be made before or after pole's impregnation.

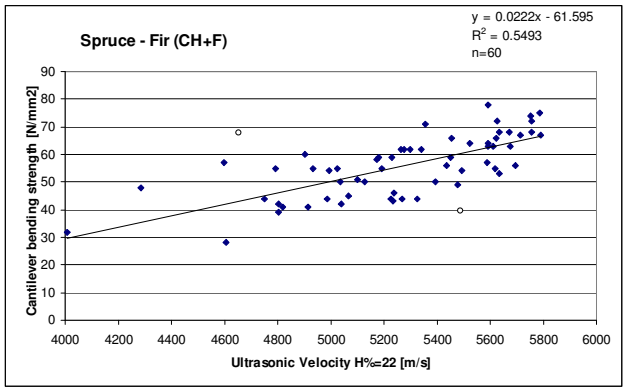

Figure 3: Non-destructive evaluation of new wood poles mechanical properties. Sylvatest Trio technology. Ultrasonic velocity vs. Cantilever bending strength. Spruce-Fir. Left: destructive tests in laboratory.

Figure 4 presents the evaluation of the quality of a wood poles stock in Germany (Spruce and Fir, salts treatment).

Figure 4: New-wooden-poles quality evaluation using Sylvatest Duo. Inspection in Germany (Fir-Spruce).

153 poles have been measured with the Sylvatest TRIO technology, and the results presented by the figure 5 show clearly the wood poles mechanical distribution. If many poles are excellent (category A) and others are good (category B), some of them are weak (category C).

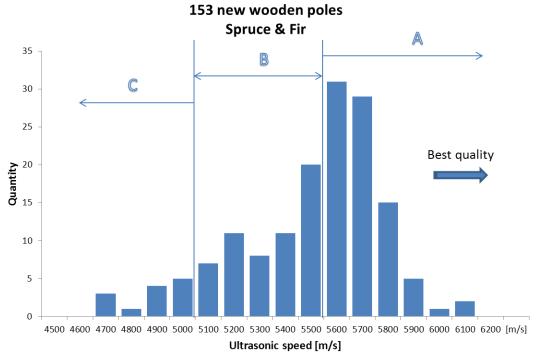

Figure 5: New-wooden-poles quality evaluation using Sylvatest Trio. Category A: excellent poles; category B: good poles; category C: weak poles. Spruce-Fir, Germany

This expertise confirms the fact that some new wood poles are weak even before their installation in the field.

The consequences of installing weak wood poles in the field can be high for the following reasons:

- A new wood pole is expected as a strong pole: the inspection is delayed
- A weak pole can destroy an entire overhead line by snowball effect (figure 6)
- Changing a pole is expensive
- The maintenance of weak poles is more expensive than for strong poles.

Figure 6: Consecutive poles broken by snowball effect. Canada.

Thanks to the Sylvatest TRIO technology, it's then possible to know the quality of a wood poles stock. This is the LUXPOLE concept.

Three classes are established:

1. S: The weakest poles: to be rejected for overhead lines support use
2. L: The common poles: the initial mechanical properties are good enough for the pole to be used in an overhead network
3. XL: The strongest poles: poles with high mechanical performances for specific uses

CASE STUDY

This case study has started in 1992, in Switzerland. 52 new wooden poles had to be installed for a medium voltage overhead line. Among these 52 new wooden poles, 33 of them have been selected thanks to the non-destructive technology based on ultrasound, and the 19 others were selected according to the habitual visual grading as illustrated by the figure 7.

The poles are Spruce and Fir poles, with CCB treatment.

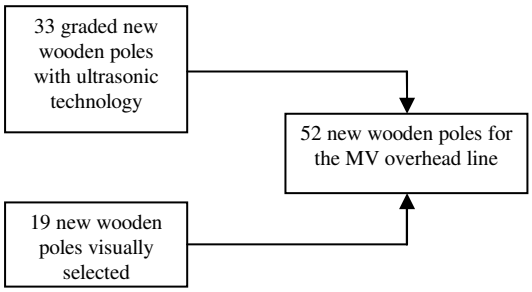

Figure 7: Selection of 52 new wooden poles for a MV overhead line construction: 33 poles are graded thanks to the ultrasonic non-destructive method, 19 poles are visually selected.

13 years later, the residual mechanical performances of those poles have been evaluated, thanks to the non-destructive technology Polux [1].

The results are presented by the figure 8 for all the poles and by figure 9 which focuses on the graded poles.

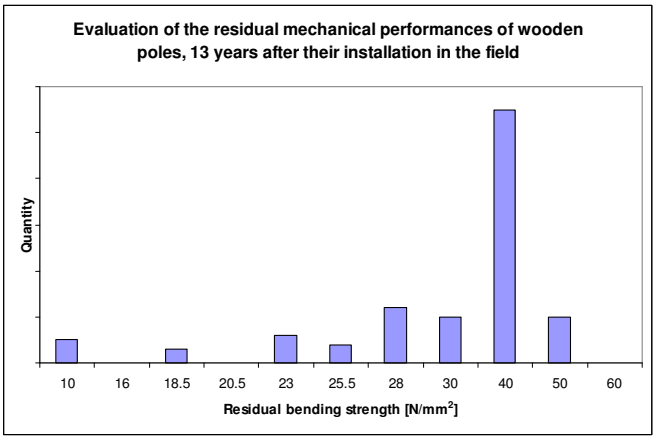

Figure 8: Non-destructive evaluation of residual mechanical bending strengths of wooden poles, 13 years after their installation in the field. Spruce-Fir, CCB Switzerland. All the poles.

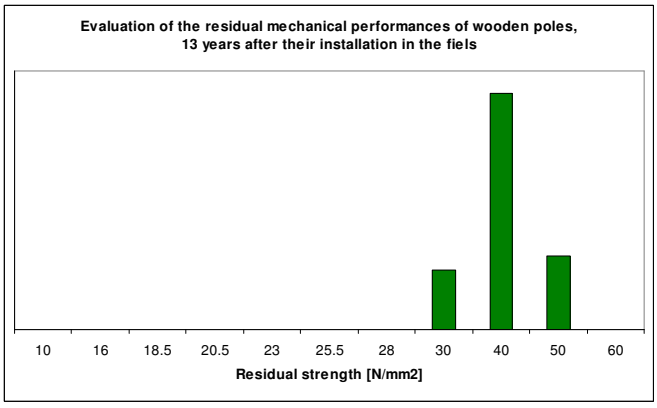

Figure 9: Non-destructive evaluation of residual mechanical bending strengths of wooden poles, 13 years

after their installation in the field. Spruce-Fir, CCB Switzerland. Poles graded with the ultrasonic non-destructive method.

The distribution of the poles residual mechanical performances is typical for in-field wood poles. Nevertheless, it can be noticed that some poles are weaker than the Swiss allowable limit (15 N/mm^2), already only 13 years after their installation in the field.

The most interesting conclusion to be noticed is the following: all the poles graded with ultrasound are among the best ones: the minimal value is 32 N/mm^2, and the maximal one is 42 N/mm^2.

This means that among the whole poles sampling, all the poles graded with the ultrasonic non-destructive method are still excellent 13 years after their installation in the field.

Among the visually graded poles, some of them are still good, or excellent. But, in the overhead line, the weakest poles all come from the visually graded method.

CONCLUSION

After many years of experience concerning both in-field and new wooden poles, CBS-CBT can now answer to many concerns about this overhead line component.

The advantages of non-destructive grading for new wooden poles are multiple and can be listed as follow:

- Objective evaluation
- Knowledge of the initial mechanical performance of a structural element used for overhead lines
- The initially weak poles are not installed in the networks: snowball effects are strongly reduced
- The poles life time expectancies can be extended
- The maintenance costs are lower: less poles need to be changed, the interval between two controls can be extended
- The entire network reliability is optimized
- Longer spans could be applied between the best poles: valorisation of the wood pole

LUXPOLE grading affects then the security, the maintenance and the reliability of the networks by reducing the costs and optimizing the poles. This can be then considered as a real networks asset management.

As a structural component, the new wood pole will follow the new standards applying for constructive elements: in 2012, any structural component must receive a CE marking in which the strength class must appear. Thanks to the ultrasonic non-destructive technology, one can give a strength class based on the three categories (S, L and XL) and compared to the official classes established in the relevant standard: EN338.

An example of this marking is proposed by the figure 10.

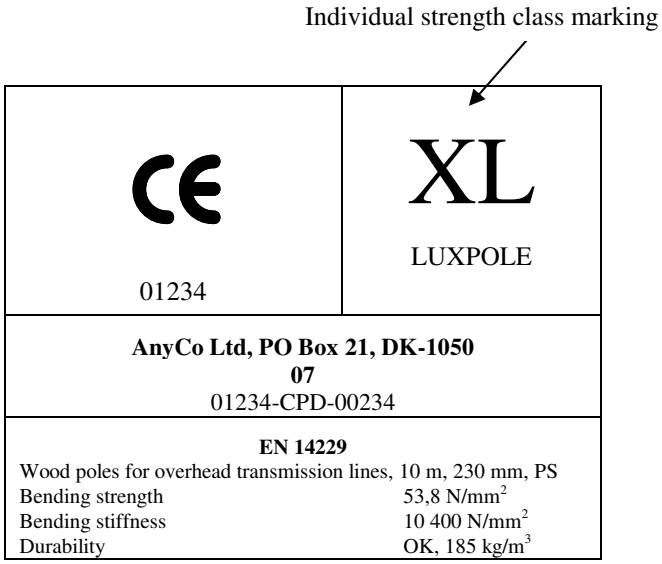

Figure 10: CE marking proposition for new wood poles including strength class obtained by the ultrasonic non-destructive method.

REFERENCES

[1] Sandoz; Benoit, 2005, "New technologies for wood poles quality assessment", *Proceedings CIRED 2005*, Paper 63.