Annals of Warsaw University of Life Sciences - SGGW
Forestry and Wood Technology № 92, 2015: 364-367
(Ann. WULS - SGGW, For. and Wood Technol. 92, 2015)

Influence of knots to mechanical stress grading of spruce wood timber

ALENA ROHANOVÁ
Faculty of Wood Sciences and Technology, Technical University in Zvolen

Abstract: *Influence of knots to mechanical stress grading of spruce wood timber*. Spruce wood timber is applied for wood engineering structures. Wood defects (knots, grain angle and other) have significant influence to its strength and elasticity and from it resulting grading into the equivalent strength class. The characteristic values are determined in EN 338. The experiment was oriented to the investigation of the defects influence to MOE of spruce wood timber. The recorded force-deformation diagrams were used for determination of the characteristic values and from it resulting grading into the equivalent strength class.

Keywords: spruce wood, wood defects, knots, modulus of elasticity, mechanical stress grading

INTRODUCTION

Wood is material with high variability of the physical and mechanical properties. Many factors can be reason of its variability. For instance density and defects of wood are very interesting from the viewpoint of the mechanical stress grading. The density influence to the mechanical properties is known. It can be applied as a direct proportional linear function. The influence of the wood defects is much more complicated and less investigated. Knots, which have dominant position in the softwood species, have negative influence to the mechanical properties especially.

The mechanically stress graded timber is preferred in the area of the wooden structures which have tendency of the intensive increasing at the present time. One of the most often applied method of the mechanical stress grading is application of the bending loading (ROHANOVÁ 2013, ROHANOVÁ – NUNEZ 2014).

From this point of view the non-destructive characteristics, i. e. modulus of elasticity (MOE) or the influence of knots to the modulus of elasticity, are very interesting. Afterwards the suitable grading of the timber, based on the known relationship of modulus of elasticity and modulus of rupture (MOR), for require aims is possible.

The aim the contribution is evaluation of the influence of the knots to the variability of MOE at the bending loading. This relationship is possible to apply at the quality evaluation of timber for the purposes of the wooden structural elements.

MATERIAL AND METHODS

The spruce wood timber of the regularised cross section 32×240 mm (2 pieces) and 32×220 mm (4 pieces) of the length 2 500 mm was tested. Specimens of the board length were tested to the 3-points bending test with the support span 1 000 mm. The specimens were conditioned to 12 % moisture content at the air condition humidity φ = 65 % and temperature t = 20 °C. This moisture content is required in the standard EN 384. Ten testing points were chosen on the each specimen in relation to the knots distribution, Fig. 1. Afterwards the specimens were loaded in these points as from the face (side) A as the face B. The loaded force F = 2 949 N was applied to the specimen with the breadth b = 240 mm and F = 2 703 N for the breadth b = 220 mm. The applied force was lower than the supposed proportional limit. Further the points with the highest and smallest deflection were chosen for the repeat loading to the ultimate limit. The recorded force-deformation diagrams are shown in Fig. 2 (for specimens S-1 and S-3). The deformations (in our case deflections) and forces determined from the force-deformation diagrams were applied for MOE calculation. The variability of MOE in the board length for specimens S-1 and S-3, taking in account the both faces (A and B), is shown in Fig. 3.

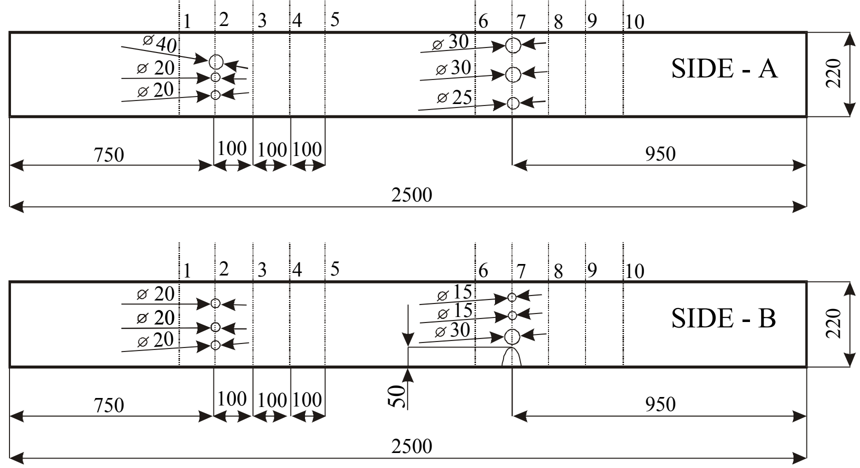

Figure 1. The data sheet for specimen - board No. 3. Method of the knots identification on the board faces (sides A, B) and the testing point arrangement in the board length.

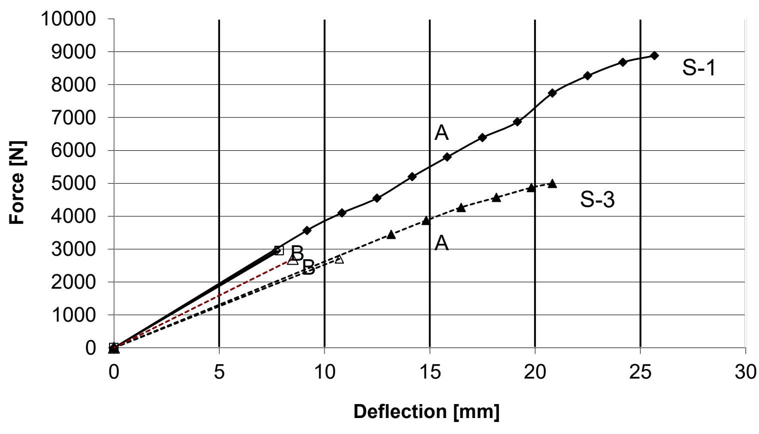

Figure 2. The force-deformation diagram in the selected point in the board No. 1 (S-1) and in the board No. 3 (S-3). A - loading to the face A - force-deformation curve in the point 2 (in S-1) and in the point 7 (in S-3) at the loading to the ultimate limit. B - loading to the face B, the points (force, deformation) at the loading to the assumed proportional limit in the point 2 (in S-1) and in the point 7 (in S-3).

RESULTS AND DISCUSSION

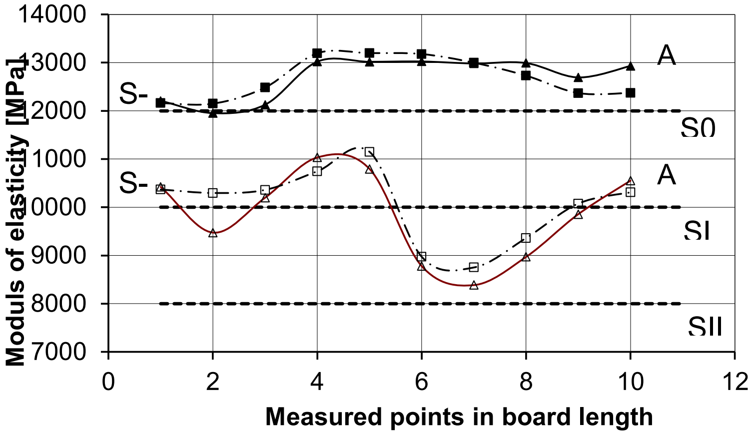

Figure. 3. The continuous variability of the modulus of elasticity in the tested points in the board length at the bending loading.

The negative influence of knots to MOE of the spruce wood timber results from the experimental tests. It is possible to states base on the Fig. 1, 2 and 3, which represent the specimens with the extreme results. The specimen with the highest MOE (S-1) and with the lowest MOE (S-3) were used for the result analysis. All figures is necessary to take into consideration at the evaluation as a complex. Fig. 1 represents a data sheet and gives information about the distribution of the identified knots. Fig. 2 gives information about the specimens reaction to the loading from the side A and B. The loading to the side A in both cases is represented with the force-deformation diagram into the ultimate limit. The loading to the side B is represented only with one point B which position is very closed to the diagram curve for the side A.

For final application of our results the Fig. 3 is most important. In the first, gives information about the continuous variability of MOE in the relation to the knots distribution as for loading to the side A as to the side B. In the second, base on the standards STN 49 1531, EN 1912 and EUROCODE 5 values of MOE for the qualitative classes S0, SI and SII we can do the evaluation of our specimens. The Fig. 3 enable to grade the tested specimens to the qualitative classes. S-1 into the class S0 (the best) and S-3 into the class SII (the worst). This diagram can be also applied for the weakest points determination (i. e. point No. 7 in the specimen S-3), what is the basement of the mechanical stress grading.

CONCLUSIONS

The results of the experimental tests give reliable information about the influence of knots to MOE of the spruce wood timber. The distribution of MOE in the board length is suitable information for application in the methods of the mechanical stress grading. It is the most suitable for methods with the bending application. This kind of grading is the most suitable for the timber applied in the wood structure elements. Base on the above mentioned knowledge, wood defect elimination and new longitudinal joining in the weakest points is possible to apply. For example, application of the fingers joins gives possibility of new grading into higher qualitative class.

REFERENCES

1. ROHANOVÁ A. 2013: Predikcia parametrov kvality smrekového konštrukčného dreva. Vedecká monografia. TU Zvolen 2013. 79 s. ISBN 978-80-228-2631-0.
2. ROHANOVÁ A., NUNEZ E. 2014: Prediction Models OF Slovakian Structural Timber. Wood Research, 2014, 59 (2).
3. STN 49 1531 Drevo na stavebné konštrukcie. Časť 1: Vizuálne triedenie podľa pevnosti. 2001.
4. EN 384, 2010: Structural timber. Determination of characteristic values oh mechanical properties and density.
5. EN 338, 2009: Structural timber. Strength classes.
6. EN 1912, 2012: Structural timber. Strength classes. Assignement of visual grades and species.
7. EUROKODE 5, 2008: Design of timber structures. Part 1-1: Common rules and rules for buildings.

Streszczenie: *Wpływ sęków na sortowanie wytrzymałościowe drewna świerkowego.* Drewno świerkowe jest wykorzystywane w konstrukcjach drewnianych. Wady drewna (sęki, odchylenie włókien, inne) mają istotny wpływ jego na wytrzymałość i sztywność, co determinuje przynależność do klasy jakości. Wartości charakterystyczne są określone postanowieniami normy EN338. Badania dotyczyły określenia wpływu wad na MOE drewna świerkowego. Zarejestrowana zależność między siłą a przemieszczeniem zostały wykorzystane do określenia wartości charakterystycznych oraz na ich podstawie do określenia odpowiedniej klasy wytrzymałości.

Corresponding author:

Doc. Ing. Alena Rohanová, PhD.
Technická univerzita vo Zvolene,
Drevárska fakulta
T. G. Masaryka 24,
960 53 Zvolen,
Slovakia
e-mail: rohanova@tuzvo.sk