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CHANGING THE POSITION OF THE NEUTRAL LINE OF BEAMS MADE OF GLUED WOOD IN CONDITIONS OF OBLIQUE BENDING

Justyna SOBCZAK-PIĄSTKA[1], Andrii Pavluk[2], Svyatoslav S. Gomon[2], Petro Gomon[2], Sviatoslav Homon[2], Iryna Lynnyk[3]

[1)] Bydgoszcz University of Science and Technology, Faculty of Civil and Environmental Engineering and Architecture, prof. S. Kaliskiego Str. 7, 85-796 Bydgoszcz, Poland
[2)] National University of Water and Environmental Engineering, 33000 Soborna 11, Ukraine
[3)] O. M. Beketov National University of Municipal Economy in Kharkiv, 61002 Marshal Bazhanov Street, 17, Ukraine

Introduction

The practice of designing building structures in particular wooden shows that bending is one of the most common types of stress-strain state. The straight bend of the beams of glued wood is well-studied and represented today by scientific investigations. Oblique bending is a type of bending. It occurs when the direction of the load does not coincide with any of the main axes of the cross-section of the bending element. Oblique bended are elements of roofs beams which are supported by rafter legs a grid under the enclosing structures of the roof runways and joints between rafter structures bridges. etc. Moreover due to the anisotropy of wood the heterogeneity of its properties the presence of defects and damaging during the exploitation of wooden structures different grades of wood in the glued layers of beams all wooden bending elements in varied degrees are affected by the action of the oblique bending. The existing calculations of wooden elements are based on the fact that the work of the wood is taken elastic in particular the calculation formulas for straight and oblique bends. The purpose of this work is to study the motion of a neutral line of beams made of glued wood for the effects of one-time loads under oblique bend.

Material and Methods

The study of rain-fed timber beams was carried out on a pre-fabricated experimental plant. Tests of beams behind the oblique bend were carried out with the installation of the joints in the places of loading and on supports. Angles of inclination of beams to the horizontal plane were and . The beams BDK-1 and BDK-2 were tested on a corner of a slope; BDK-3 and BDK-4 - behind a corner.

The position of the neutral line of experimental beams from glued wood in conditions of oblique bend was found through the interpolation of indications of strain gauges located in the middle of the section of the beam along its perimeter with a step of 11÷15 mm. Establishing the position of the neutral line allows determining the area of the compressed and stretched beams zones calculated according to the formula and Figure 1 as for the rectangular shape of the section.

$$A = \frac{c+d}{2} \cdot b, \qquad (1)$$

where b – width of section of beam. cm;
c, d – the distance from the neutral line to the upper edge of the beam, cm.

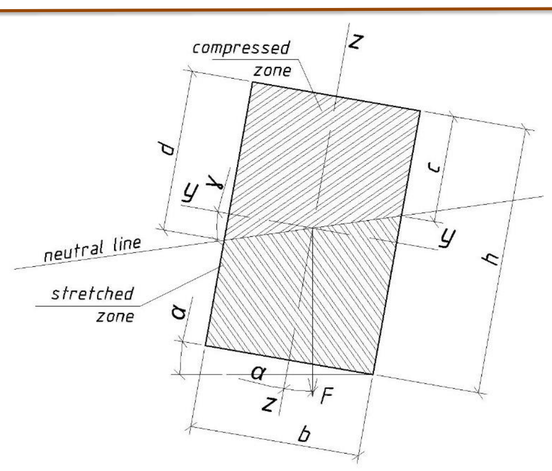

FIGURE 1. Determination the position of the neutral line and calculation the area of the compressed and stretched wood areas of the oblique bent beam of glued wood

Results

The neutral line changed its position at all loading levels which increased the area of the compressed zone of wood. At the same time there was a slight torsion of the neutral line which occurred due to increasing in the length of the area c with a decreasing in the length of the area d (Figure 1). The angle of the inclination of the neutral line to the horizontal plane is varying in the direction of a slight decrease. This suggests that the installed ties did not fully perceive the torque of the prototype. An insignificant turn of the neutral line can be explained by the local hardening of the wood of the joints in the places of loading and in the places of the apertures for the studs around which the twists of the joints were made during the increase of the load. In Figure 2 it is shown the position of the neutral line of beams BDK-1…BDK-4 at different load levels from 0.2M to M_{max}.

In order to compare the experimental values of the neutral line with the theoretical one in the conditions of the oblique bending, the calculation of the beam was performed using the finite element method. For this, the software package «Lira 9.6» was used. The location of the neutral line in the software complex was based on the stresses of the beam in the middle of its estimated span (Figure 3). According to the Figure 3 the neutral line in the software complex "Lira" does not change its position during the increasing in loading. Only tension growth in compressed and stretched zones is observed the same as with experimental data

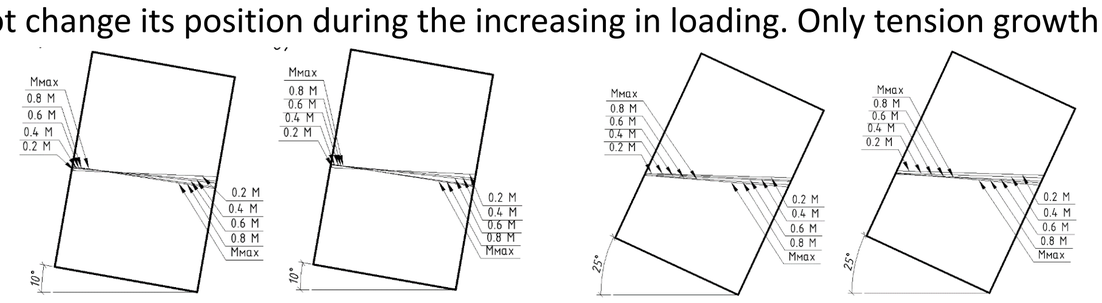

FIGURE. 2. . Changing the position of the neutral line at different load levels of glued beams: (a) BDK-1; (b) BDK-2; (c) BDK-3; (d) BDK-4

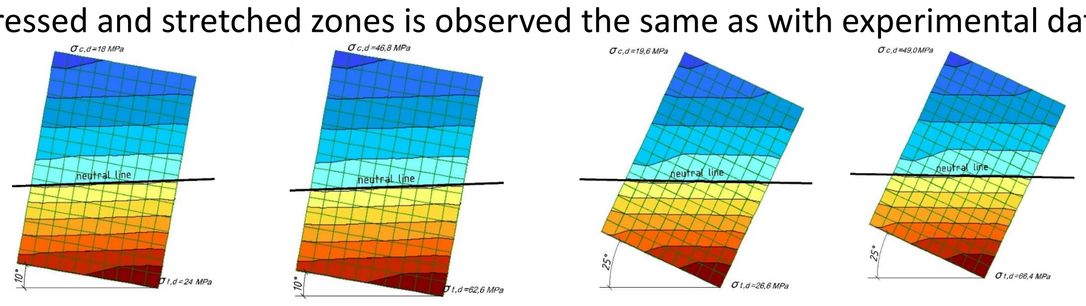

FIGURE 3. *The position of the neutral line at different load levels of beams at an angle of 10° and 25 °: at the load level $0{,}2F_{\max}$ and at the load level $0{,}8F_{\max}$*

Discussions & Conclusions

1. Conducting experimental and theoretical studies of glued beams in the conditions of oblique bend, the following conclusions can be drawn:
2. The neutral line of glued beams during the increase in load changes its position in the direction of increasing the area of the compressed section of the section.
3. The software complex "Lira 9.6" does not fully take into account the features of the work of wooden beams as during the increase in load only stress and deformation grow. whereas the neutral line is in one place.
4. Theoretical calculations by the formulas of the resistance of the materials show that the neutral line does not depend on the value of the external load and occupies a stable position according to a certain angle of inclination whereas in the real conditions, due to the elastic and plastic properties of the wood and the increase of the load, the neutral line for the oblique flexion changes its position.

Acknowledgements

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