

CHARACTERISTIC OF DAMAGE TO THE STRUCTURAL ELEMENT BY CREATING ITS “DEGRADATION PROFILE”

J. Frankl^{*}

Abstract: *This paper presents results of experimental establishment of the extent of damage and changes in strength of a wooden structural element (a rafter base) through the creation of its "degradation profile." The tested part of the structural element was divided into segments by the means of a regular network from which standard test specimens were made with dimensions of 20x20x30 mm on which strength tests under compression along the fibres of wood were carried out. Readings were divided, according to the decrease in the property observed against the values of healthy (undamaged) wood, into 4 quality groups and then transferred back to the network of segments. A graphic model description of the shape and course of degradation of wood caused by wood-destroying fungi was created, marked as the "degradation profile of an element".*

Keywords: *Wood, Timber, Wood-destroying Fungi, Degradation profile.*

1. Introduction

Among the most important biological pests of wood are wood-damaging fungi. There is a considerable amount of information available about their morphology and principles of their destruction effect on wood (Schmidt 2006). Information on the changes in mechanical properties of wood due to their effects is available mainly based on experiments conducted under laboratory conditions (Singh 1994). Relatively little attention has been so far paid to the effects of wood-damaging fungi on changes in mechanical properties of wood under real conditions of actual structures.

The performed experiment was aimed at detecting the decrease in mechanical properties - compression strength along the fibres in wood samples prepared from a structural element (the bottom part of a rafter) damaged by the activities of wood-damaging fungi in a roof frame structure of a real building.

What was chosen for the experiment was the bottom part (the base) of a rafter from a roof beam structure of a historic building in the centre of Prague. The rafter base was damaged by wood-damaging fungi (brown rot). At the time of the survey of the quality condition of wood elements and the realization of repairs, wood-damaging fungi were in a non-active stage.

2. Methodology:

Part of the rafter, separated for experimental tests, was 60 cm long with a cross section of 12 x 15 cm. The damage by wood-damaging fungi observable with the naked eye covered the distance of approx. 40 cm from the end of the element. It was mostly of superficial nature which passed from the top surface of the element to the core (central) sections due to the activities of the fungi of the *Gloeophyllum* genus.

With regards to the required size of the test specimens, the dimensions of the tested wooden element and the technological capabilities (handling and woodworking machines), the division of the element "roughly" into a regular network of 12 x 5 x 4 segments of the size of approx. 45 x 25 x 25 mm was selected. More exact test samples of the required size of 20 x 20 x 30 mm were then made from individual segments, where possible. The difference in the sizes of segments and test samples

^{*} Ing. Jiří Frankl, Ph.D.: Institute Theoretical and Applied Mechanics, v.v.i., Academy of Sciences of Czech Republic, Prosecká 76; 190 00, Prague; CZ, e-mail: frankl@itam.cas.cz

covered losses during the processing (offcut) and allowed to partly offset the natural wood defects (knots, cracks).

In test samples prepared from individual segments, a test of the limit of compression strength in the direction of fibres was performed. The test was performed using the Testatron load testing apparatus as per the CSN 490110 Czech National Standard.

The force at the limit of strength was measured using the load testing apparatus (F_{\max}). The compression strength was then calculated using formula (1), whereby σ is compression strength, F_{\max} is the force at the strength limit and a , b are dimensions of the loaded surface.

$$\sigma = F_{\max} / a * b \quad (1)$$

In test samples prepared from individual segments of part of the rafter, the limits of compression strength of the wood in the direction of the fibres were ascertained as ranging from 31.7 to 2.9 MPa. The interval of values of the limit of strength was, for simplification purposes and in order to provide a graphic depiction of the degradation profile of the element, divided into four groups according to the degree of damage or rather the size of the change in the mechanical property under review. The division into groups is clear from Tab. 1.

Tab. 1: division of the damage of the elements by wood-damaging fungi into five groups depending on the change (drop) in the monitored mechanical property.

| wood | decrease in property (tentative) | limit in compression strength in the direction of fibres |
|--------------------|-------------------------------------|---|
| | [%] | [MPa] |
| sound | 0 – 10 | 31,7 – 28,5 |
| damaged | 10 – 40 | 28,5 – 19,0 |
| strongly damaged | 40 – 70 | 19,0 – 9,5 |
| completely damaged | 70 – 100 | 9,5 – 0 |

Based on this division, a degradation profile was prepared, i.e. the graphic depiction of the changes in the wood strength due to degradation by wood-damaging fungi in individual parts of the base part of the rafter. The drawing of the degradation profile in longitudinal sections of rafters (in the pre-selected network of 12 x 5 x 4 segments) is shown in full text - Fig. 5.

3. Conclusions

From the results of the tests of compression strength of wood and from the processed degradation profile, what is clear is a significant spread of values of strength of wood in individual segments of the element under review. This spread corresponds to the macroscopically observable accompanying phenomena of destruction caused by cellulosevorous wood-damaging fungi (darkening of wood, fissures, disintegration into minuscule particles). The results show that the transition zone between the heavily damaged timber (with a decrease in strength by more than 50%) and healthy wood is relatively narrow and varies in the order of millimetres. The degradation profile of the damaged element reveals changes in shape and considerable reduction of the effective cross section (of sound wood) in the element at the place it was deposited on the top plate.

Acknowledgement

The paper was prepared with the support of a grant of the Grant Agency of the Czech Republic, Grant No. P105/11/P628.

References

- Schmidt O. (2006) Wood and Tree Fungi. *Springer Verlag*, Berlin, Heidelberg, Germany, ISBN 3-540-32138-1
Singh J. (1994) Building mycology – Management of decay and health in buildings. (1994), *E & FN Spon*, UK