COST Action FP1101 Assessment, reinforcement and monitoring of timber structures

State of the Art Report

WG 1 / TG 2

COMBINE USE OF NDT/SDT METHODS FOR ASSESSMENT OF STRUCTURAL TIMBER MEMBERS

Editors:
José Saporiti Machado and Mariapaola Riggio

EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

EVALUATION OF THE INFLUENCE OF DEFECTS ON THE MECHANICAL PROPERTIES OF TIMBER THROUGH THE ANALYSIS OF MULTISCALE SPECIMENS, BASED ON NDT AND DT

Beatrice Faggiano, Maria Rosaria Grippa, Anna Marzo

Abstract

Abstract The research context. The work illustrated is part of the extensive experimental activity, developed within the Italian projects PRIN 2006 and DPC-RELUIS 2010-2013 and 2014 (B. Faggiano responsible of research unit) [1, 2, 3, STAR 1]. According to a defined investigation procedure, non-destructive (ND: hygrometric, sclerometric and resistographic) and destructive tests (D: compression and bending) on samples made of old chestnut wood were performed with the aim of obtaining reasonable ND-D correlations based on statistical elaborations for the prediction of wood density, stiffness and strength of the tested material..

The paper focus

The experimental activity was developed on multiscale specimens, such as structural timber and defect free clear elements, with the aim to evaluate the influence of natural defect patterns of material on both non-destructive parameters by sclerometric and resistographic tests and mechanical properties by compression and bending tests of timber.

Multiscale specimens and tests methods

The experimental campaign was developed on timber elements made of old chestnut wood (Castanea sativa Mill.), provided from roofing trusses of a masonry building of Naples, built up at the beginning of the 19th century. The investigations were carried out on both structural elements in actual and small dimensions (types SA and SS respectively) and defect-free (types DF) specimens with standard sizes, according to UNI EN 480 (2004) and UNI ISO 3789 and 3132 Italian codes (1985). Before the experimental tests, the conservation state of the selected samples was detected by checking wood defects and damage, such as longitudinal cracks due to shrinkage ring shakes, large isolated knots or knots groups. Ultrasonic (U), sclerometric (S) and resistographic (R) ND methods were used for SA and SS specimens, whereas compression (C) and bending (B) tests were performed on both S and DF elements. Fig. 1 summarises the multiscale specimens and tests types [3].

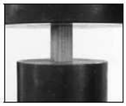
Actual dimensions (S_A)	Small dimensions (S_S)	Defect-free (DF)
 **Type S_A-C:** *Number:* 14 *Diameter:* 14-16 cm *Length:* ~ 90 cm *NDT:* H, U, S, R *DT:* C // grain	 **Type S_S-C:** *Number:* 20 *Size:* 5x5 cm *Length:* 30 cm *NDT:* H, S, R *DT:* C // grain	 **Type DF-C:** *Number:* 33 *Size:* 2x2 cm *Length:* 4 cm *NDT:* H *DT:* C // grain
 **Type S_A-B:** *Number:* 10 *Diameter:* 14-16 cm *Length:* 6D ~ 90 cm *NDT:* H, U, S, R *DT:* B	 **Type S_S-B:** *Number:* 24 *Size:* 4x4 cm *Length:* 76 cm *NDT:* H, S, R *DT:* B	 **Type DF-B:** *Number:* 35 *Size:* 2x2 cm *Length:* 40 cm *NDT:* H *DT:* B

Fig. 1. Multiscale specimens tested in the experimental campaign.

Experimental evidences

The results of compression tests parallel to grain show that the presence of extended natural defects on SA reduces of about three times the compression strength of the base clear material, being the stiffness properties nearly similar each other (Fig. 2a). Furthermore, the bending strength of DF samples is about twice than the same one of SA and SS elements. It is also apparent that the bending modulus of elasticity in clear wood is slightly larger than in structural timber (Fig. 2b) [1, 2, 3].

Concerning the influence of macroscopic defects on NDT parameters, it is observed that the presence of superficial layers of wood with low consistence increases of about 18% the penetration depth values by sclerometric test in transversal direction. Moreover, extended knots and internal more resistant parts produce an increment of the resistographic amplitude of about 40%.

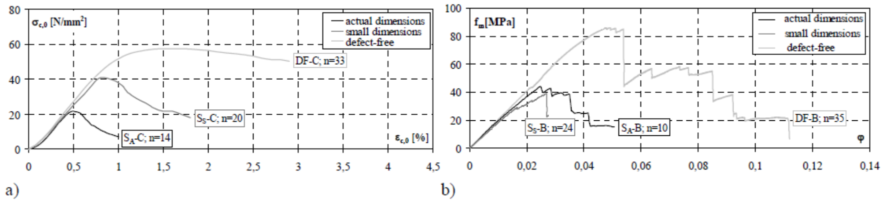


Fig. 2. Average curves: a) Stress ($\sigma_{c,0}$)-strain ($\varepsilon_{c,0}$) for C test; b) Strength (f_m)-middle rotation (φ) for B tests.

Acknowledgments

The research activity was developed within the Italian projects PRIN 2006 and DPC-RELUIS 2010-2013 and 2014..

References

[1] Faggiano B., Grippa M.R., Marzo A., Mazzolani F.M., 2011. “Experimental study for non-destructive mechanical evaluation of ancient chestnut timber”. Journal of Civil Structural Health Monitoring: Volume 1, Issue 3, page 103-112.

[2] Faggiano B., Grippa M.R., Marzo A., Mazzolani F.M., 2010. “Structural grading of old chestnut elements by compression and bending tests”. 11th World Conference on Timber Engineering (WCTE2010), Riva del Garda, Italy, 20-24 June.

[3] Faggiano B., Grippa M.R., Calderoni B., 2013, “Non-destructive tests and bending tests on chestnut structural timber”. 2nd International Conference on Structural Health Assessment of Timber Structures (SHATIS’13), Trento, Italy 4-6 September.