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Research Article

Assessment of Durability of Screw Jointed Wooden Elements-A Case Study

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Abstract

Nowadays, the timber structures built from round timber components are increasingly popular. Knowing the mechanical properties of the timber used and the determination of the carrying capacity of wooden elements joints are a necessity. This paper presents the results of static tests in traction of the screws used in wooden elements connections. The main aim of the tests is to verify the failure model in order to be able to prevent the destruction of the connections through reinforcing interventions.

Keywords: *Screws, wood, strength, mechanical tests*

1. Introduction

Generally, the assessment of the mechanical characteristics and allowed strains values in the joints of the wooden elements are made Screws, wood, strength, mechanical tests using T-shaped or L-shaped connections. The results obtained can be adapted both in the construction of furniture as well as in the construction of larger timber structures. In these cases is used a console like model to test the resistance of the connection. For massive wooden furniture structures, MDF or particle board furniture's, dove-tails or dowel joints are made a lot of tests (Tsai, 1997), (Chang, 2006). In some cases, when we deal with the visual evaluation of wood material we have to consider the fact that the evaluator must be a skilled and experienced professional (Uni 11035, 2005). Because of the large size of timber structures, tests with real-size structural elements are not frequently conducted. However, results which have been obtained can easily be homologated.

The woods are classified according to their mechanical characteristics in resilient classes of resistance, to make possible their interchangeability in the project and to enable design based on resistance (EN 338, 2009). With ever-growing demands for environmental protection, people are addressing ecological materials such as wood.

According to the National Forest Inventory 2004, the production of sawn timber is the main function in 78% of the forested areas (Agrotech, 2004). For better safety in the realization of projects it is advisable to use certified and tested products. However, sawn timber used in construction is characterized by the presence of structural defects (joints, cracks) and for this reason it is important to make a preliminary classification based on the sustainability classes (EN 384, 2010).

The evaluation and the methods used are defined in the European Standards, such determination of destructive strains (fm, 384) the modulus of elasticity in bending E(m, g, 384) and the density of the wood (Glos, 1999), (Deublein *et al*., 2010). Nowadays, the use of wood material is scientifically based and highly efficient (Giordano, 1981). Despite the use of various types of coupling elements such as nails, pins and staples for joining timber elements according to the case of use, the bonds between the elements of mass joints are realized with mechanical elements such as bolts and screws. In order to maximize the resistance of the joints, various tests must be carried out. In our concrete case, tests on the resistance in the pulling of the elements joined to the screws are performed.

2. Material and methods

According to UNI EN 1382: 2002, samples of 95 x 95 x 48 (L x b x h) mm (fig1) and TECFI TT02 screws (fig. 2) with diameter d = 6 mm are taken in consideration. The elements, obtained by Abies Alba mill wood, with density of 0.35 g/cm^3, with a humidity of 12%, have four sideways perpendicular to each other (EN 408, 2010). Tests are performed in a Controlab testing machine. It can measure the force applied at regular intervals, by means of a pressure transducer. . We measure the displacement of the sample during testing by means LVDT (Linear Variable Displacement Transformers) connected to the computer-controlled data

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acquisition system . It is worth mentioning that wood as an anisotropic material, at a certain point it presents different physical-mechanical characteristics in different directions (Giordano *et al*, 2003). The screw is introduced parallel to the direction of the fibers and perpendicular to the surface of the wood samples in a depth of 40 mm.

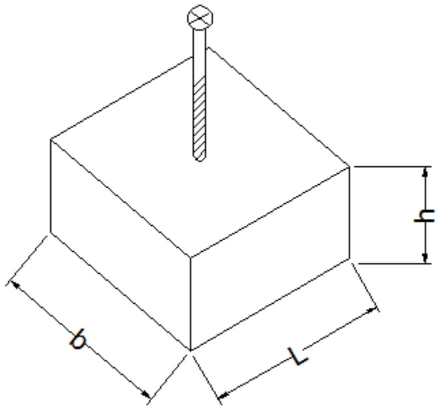


Fig. 1 Dimensions of the tested specimens

Fig. 2 Schematic representation of the screw

Screws used in tests have such features that make them suitable for use in structural elements. Their first part, with discontinuous fillets, helps to stamp the wood.

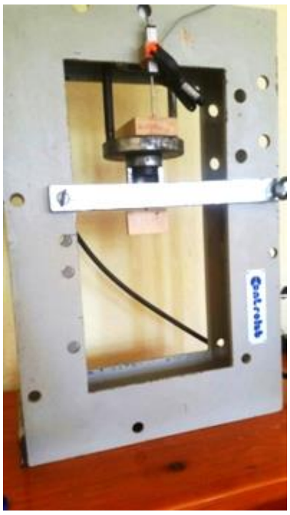


Fig. 3 Elements during tests

The second part is securing the bond strength by means of the flyer. The third part of the saw due to threading different from the second part guarantees greater resistance to strain. The end of the screw head, folded at the bottom, in the part that has contact with the wood, increases the resistance to rotation (which may arise due to the action of the washer, when used). Screw head geometry allows us to achieve fast and secure assembly of the elements. The picture below shows a sample during a test.

3. Test results

We tested 50 samples in total and the test results are showed in the Table 1.

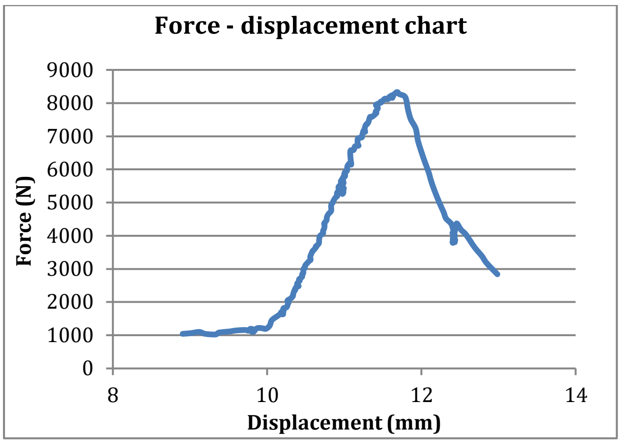
Table 1 The results of the tests

Sample number	F_{max}	T_{max}	S_{Fmax}	F_{mes}	Standard deviation	Median
	kN	s	mm	kN		kN
1	2	3	4	5	6	7
Samples	4,32	62	4.7	4.075	1.231	3, 11

Where we can see

1) Name samples from 1-50
2) The maximum force at which element destruction occurs
3) Time required to achieve this force value and the destruction of element
4) Maximum displacement of the element
   Average strength exercised during the test
5) Standard deviation
6) A characteristic value (corrected average force)

Below we present a graph to illustrate the test performance for the Sample 4. We can see there the force-deformation curve that demonstrates the application of force by given intervals, depending by the stroke of the Lucas cylinder.



Graphic 1 Force-displacement chart

Here can be seen a picture of a destroyed sample.

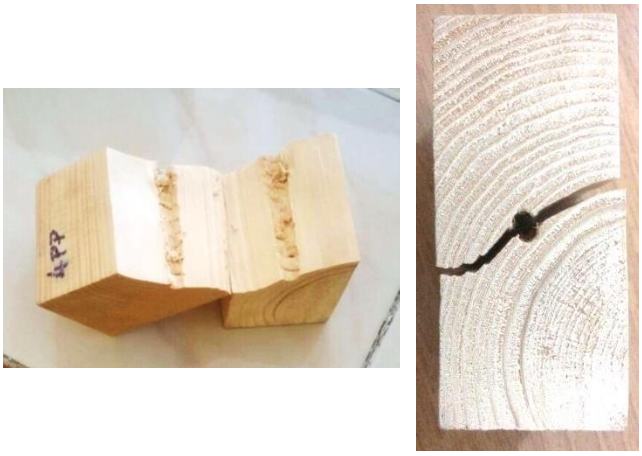


Fig. 4 Destroyed sample

During some tests the wooden joint is destroyed as a result of the destruction of the wooden elements. Even here deformation starts around the 4000N values of applied force. This deformation is noticed in the holes passing through the bolt and occurs in transversal compression, ie perpendicular to the fibers, in the parts 1 and 2. As a result of the insertion of the bolt into the wood, forces of transversal pulling are produced, perpendicular to the fibers. At first we have fibrous cleavage and then the destruction occurs parallel to the fibers following the weaker areas, the boundaries between the autumn and spring of the annual rounds and the parenchymal rays. In this area we have a bigger percentage of spring wood than autumn wood and we notice a change in the annual growth rate of wood (Thoma, 2013). In this area the annual rings begin to grow in width. In the longitudinal cut we have fiber deviation from the parallel direction to the axis of force exertion. Even in this cut, the destruction occurs by following the direction of the fiber.

4. Conclusions and Discussions

- From a look at the graphs obtained from the tests we observe a scaled curve performance. This is because the force is exercised by means of a hand-held piston, that is, manual. The pump should be recycled each time it goes to the bottom of the stroke. If the charging of the pump becomes fast, it causes to the graph a fluctuation of the curve, with a tendency to decrease.
- The various maximum values achieved are explained by the anisotropy of wood and the presence of defects such as joints, which are inevitable. Wood anisotropy also explains the different times needed for the destruction of the samples.
- Normally, depth of the threading of the drill on element has its effect. The deeper the thread on the wood, harder it is to get it out. An important factor to take in consideration is the proper torque used when driving screws.
- The tests performed for pulling resistance show a fragile behavior of the elements as outlined in the literature. That such links do not transmit strength, reinforcing this fact even by low resistance values.

References

Agrotech (2004), Albanian National Forest Inventory, Final Report. Tirana, Albania.

W.-S. Chang, (2006), On rotational performance of traditional Chuan-Dou timber joints in Taiwan, PhD dissertation of National Chen Kung University, Taiwan

M. Deublein, R. Steiger, J. Köhler (2010), Quality control and improvement of structural timber. The future of quality control of wood and wood products. COST Action E53 4-7th May 2010, Edinburgh COST Action E53

EN 338 (2009), Structural timber. Strength classes. European Committee for Standardization. Brussels.

EN 384 (2010), Structural timber. Determination of characteristic values of mechanical properties and density. European Committee for Standardization. Brussels.

EN 408 (2010), Timber structures. Structural timber and glued laminated timber. Determination of some physical and mechanical properties. European Committee for Standardization. Brussels

G. Giordano, (1981), Tecnologia del legno, vol. 1, UTET, Torino, Italia.

G. Giordano, A. Ceccotti, L. Uzielli, (2003), Tecnica delle costruzioni in legno, HOEPLI, Milano, Italia.

P. Glos, (1999), The great potential of wood as a building material of the next century. In: International RILEM Symposium on Timber Engineering.

H. Thoma, (2013). Il nodo puntone-catena nelle capriate lignee tradizionali. Aracne, Roma 2013.

Y-L, Tsai, (1997) "Investigation on the Materials used for Timber Construction of Historical buildings" ,Master dissertation, Department of Forestry, National Chung-Hsing University

UNI 11035 (2010), Structural timber. Visual strength grading for structural timbers. Ente Nazionale Italiano di Unificazione.