Construction and Building Materials 34 (2012) 136–144

Contents lists available at SciVerse ScienceDirect

Construction and Building Materials

journal homepage: www.elsevier.com/locate/conbuildmat

A semi-destructive tension method for evaluating the strength and stiffness of clear wood zones of structural timber elements in-service

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ARTICLE INFO

Article history:
Received 3 November 2011
Received in revised form 10 February 2012
Accepted 25 February 2012

Keywords:
Semi-destructive
Assessment
Timber
Strength
Stiffness
Maritime pine
Chestnut

ABSTRACT

The paper presents a new semi-destructive method for obtaining a prediction of the tension parallel to the grain properties of clear wood of structural timber members. This method is less intrusive than other existing methods and consists in extracting four small specimens along the length of the timber members. The tension strength and stiffness obtained is intended to be used as input data for the assessment of timber members in situ. Since the method only provides information regarding clear wood, it will have to be used together with other non- or semi-destructive methods that could accommodate the effect of defects on the loss of clear wood properties. The validation of the method was carried out by a comparison with results obtained from a standard method used for determination of clear wood properties. The results show a good agreement between stiffness values but a medium agreement in the case of tension strength.

1. Introduction

The assessment of the structural performance of existing timber structures is strongly dependent on the capacity to evaluate in situ the physical and mechanical properties of timber elements. Current in situ evaluation is made through the visual assessment of the quality of timber elements (identifying the wood species and their features) having as reference a Visual Strength Grading Standard (VSGS). This procedure leads to the allocation of characteristic strength values or allowable stresses to the timber members. These values can then be modified taken into consideration the load and moisture history of the structure and also its status of conservation (biological and mechanical deterioration). This general process is followed by the Italian standard UNI 11119 [1]. This same standard makes reference to a possible use of non-destructive techniques (NDTs) but it does not indicate the available NDT and in what way they could assist in the definition of the mechanical properties of timber elements.

It is usually accepted that the application of VSGS and of structural design codes intended for new constructions assures over conservative serviceability and safety confidence levels [2]. This approach frequently leads to the demolition or to undertake heavy strengthening (often non-reversible) of timber structures even in cases where no deterioration signals exists and the structures are in service for more than 100 years. This result is critical for historic timber structures where the safety concerns balance with the principle of the conservation of cultural heritage.

The application of VSGS could also deliver unsafe characteristic values in some particular cases (adoption of VSGS developed for other wood species or from wood species with a different provenance) [3]. VSGS along with other available non-destructive methods evaluates the strength and stiffness indirectly by using the correlation between parameters as sound time-of-flight or knot's dimension and the mechanical properties of timber.

A procedure for the prediction of the bending behaviour of timber in service using different non-destructive methods was proposed [4]. This procedure applies the concept that assumes a timber member as a heterogeneous element composed of clear wood and weak wood zones (defined by the presence of knots) [5]. More recent results indicate the usefulness of having semi-destructive methods that could validate the results obtained from the usual non-destructive methods [3].

The need to get more reliable data on the real strength capacity of timber elements was the basis for the studies on semi-destructive or low-destructive methods carried out so far [6–9]. These methods do not estimate but instead actually measure the strength and stiffness of wood by destructive testing of small samples removed from the structural element.

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doi:10.1016/j.conbuildmat.2012.02.041