



Experimental evaluation of different strengthening techniques of traditional timber connections

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ABSTRACT

A series of monotonic and cyclic tests were performed on unstrengthened specimens, in order to characterize the original behavior of connections, representative of traditional timber trusses. Subsequently, connections strengthened with metal devices were tested under monotonic and cyclic loading. Test data of original connections has been gathered with the purpose of characterizing their behavior, in particular, the post-elastic response and the failure mode. Observing the behavior of strengthened connections under cyclic loading gave straight indications on the positive and negative characteristics of the different strengthening techniques analyzed.

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1. Introduction

The most common joint in existing timber roof structures is the “birdsmouth joint with a single tooth”, although geometry varies with joint location in the truss, and the joint bearing capacity is a function of skew angle, notch depth and length of the toe. The load transmission relies on direct contact and friction between the surfaces facing each other. Metal ties or fasteners are not meant to transmit forces directly; they are mainly used for positioning and maintaining the functionality of the joint in adverse or unpredictable conditions.

Common timber roof structures are usually modeled with perfect hinges at the extremities of each element. However, these joints offer a significant moment resistance and may be better classified as semi-rigid [1]. The lack of practical, though realistic models for the joints in old traditional timber structures generally leads to very conservative retrofits and upgrades to satisfy new safety and serviceability requirements. Moreover, the misunderstanding of the global behavior of traditional roof trusses can result in unacceptable stresses in the members as a consequence of inappropriate joint strengthening (in terms of stiffening) [2]. Joint strengthening can be done in a number of

possible ways, from simple replacement or addition of fasteners, to the use of metal plates, glued composites or even full injection with fluid adhesives. Each solution presents unique consequences in terms of the joint final strength, stiffness and ductility.

An international research program, including a Ph.D. program [3], has been developed by the authors with the purpose of investigating the monotonic and cyclic behaviors of traditional timber connections and identifying and evaluating suitable strengthening techniques using metal devices.

This research aims to analyze Portuguese traditional timber connections, and in its preparation and development, all observations and conclusions obtained in previous research of the team were taken into account [4,1,2].

2. Experimental campaign

An experimental research was carried out at the Laboratory of Structures of the University of Minho (Portugal), including monotonic and cyclic tests of full-scale traditional timber connections. A series of monotonic and cyclic tests were performed on unstrengthened specimens, in order to study the primary behavior characteristics of the connection, as well as its sensitivity to a few parameters. Subsequently, connections strengthened with basic metal devices were tested under monotonic and cyclic loading. The purpose of these tests was to uncover any advantages and deficiencies in the behavior of the connection and the device itself, as well as to determine a need for different types of strengthening. Tests on

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