Repair connection with wooden wedged dowels: preliminary experimental laboratory tests and FEM model for the description of the mechanical behaviour.

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ABSTRACT

The present paper will present the first steps of the research project by the title "Repair connection with wooden wedged dowels. New and alternative repair method that meets the demands of Monument Protection of built substance's gentle care and material fairness". The project aims to develop guidelines for static-constructive use of wood-wood repair joints with wooden wedged dowels. The research project is funded by the ZukunftBau research initiative of the Federal Institute for Research on Building, Urban Affairs and Spatial Development (BBSR, BMI) in the cluster "innovations for existing buildings". In the research project, the first steps for the description of the mechanical model for the wooden wedged dowels have been approached: in deepened research of current literature about wooden dowels and existing examples of wooden wedged dowels in heritage buildings have been analyzed; more, preliminary laboratory tests and FEM simulations have been implemented.

In this paper, the results of the preliminary laboratory tests and the parallel development of a FEM model with the aim of description of the deformation behavior of the wooden wedged dowels for the most used wooden species will be presented. The main aims are: a) analysis of the distribution of the strains / deformations in the *dowel* and in the connected *building components* when inserting the *wedge*; b) analysis of the risk of opening of cracks in the material; c) distribution of stresses in the *dowel* and in the *connected building elements* thanks to the support of FEM modeling calibrated on the experimental results.

Geometric parameters of the *wedged dowel,* as well as the density of both the *wedged dowel* and the *connecting building components* significantly influence the deformation behavior of the connection. First, for both the laboratory tests and FEM simulations two geometric configuration for the *wedge* and the *dowel* has been chosen. The choice of the geometric parameters was done in agreement to practical experience and research experience. Second, wooden species' combinations were also chosen in agreement to the practical experience. On one side, for the experimental tests, representative combinations of density were chosen: oak and spruce (characteristic timber density) for the *building element*, and oak (characteristic timber density) for both the *wedge* and the *dowel*. On the other side, for the approximation of the deformation behavior in real context, in which the wooden species both in the repair connection and in the wooden wedge dowel can cover a wide range of densities, a FEM model calibrated on the experimental results has been prepared. Here, for the *wedged dowel* and the *building components* have been chosen wooden properties that depict all strength classes' for soft and hardwood; therefore, the combinations of the different strength classes for the different connection components, covers all the possible densities' combinations in the connection.

The experimental tests have been evaluated thanks to non-destructive inspection techniques: optical sensors for detection of displacements on the specimen's surface, and computer tomography (CT) for detection and localization of internal cracks.

Thanks to the evaluation of deformation's behavior in the proposed geometrical and material combinations of *wedge, dowel* and in the *connected building elements* has been possible to understand the general framework of deformation behavior and failure modes for different combinations of timber density of the connection's components.