Analysis of ancient timber structures performance capacity

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Abstract The evaluation of the residual performance capacity of existing wooden structures represents the first step to ensure structural efficiency and safety in the field of conservation and safeguard of historical heritage. To carry out restoration interventions and implement reliable numerical analysis models, a careful characterization of the material is required, that can be performed by means of widespread non destructive tests to compare with mechanical standardized laboratory tests, even only for few sacrificial specimens. The work presents an investigation procedure set up for a simple and reliable evaluation of the conservation condition of existing timber structure, applied to different real study cases, showing the results and the different investigation steps exploiting combined non destructive tests together with mechanical standardized laboratory tests on structural elements and clear wood specimens.

Keywords wooden structures, mechanical identification, structural assessment

1. INTRODUCTION

The conservation and safeguard of historical heritage always imply the problem of ensuring structural efficiency and safety. For this purpose accurate numerical simulations try to predict collapse and security margins of each structure, but an accurate and often not easy identification of the mechanical characteristics is necessary to reach a reliable model of the real structure.
Different type of laboratory tests are by now standardized to give physical and mechanical properties of each material, but only non-destructive tests (NDTs) are compatible with the demand of conservation. The problem of non-destructive tests is exactly the lack of standardization that implies uncertainty of the results, besides the most part of non destructive test is useful to determine physical but not mechanical characteristics, so each method has to be compared or combined to obtain reliable results. In the case of wood the identification of the mechanical characteristics turns out particularly difficult because of the great influence of botanic species, defects, degradation and of the heterogeneous and anisotropic microstructure of the material. However it represents a fundamental action to evaluate structural efficiency and safety and also to design restoration interventions.

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2. MECHANICAL IDENTIFICATION METHOD

The work presents a proposal of a mechanical identification method, concerning wide combined NDTs to carry out in situ and some focused laboratory tests, based on correlations between the parameters assessed by means of the different kind of tests.

3. APPLICATIONS

The method has been applied during an experimental campaign on wooden trusses in a XVIIth century building in *S. Lorenzo ad Septimum abbey* in Aversa (Caserta, Italy) and then carried out in other two interesting study cases: the trusses of *Citroniera and Grande Scuderia* in the Royal Palace of Venaria Reale (Turin, Italy) and the trusses of a part of the roof belonging to *Real Albergo dei Poveri* in Naples. The results reported below, as an example of the surveying procedure, are referred to the first application (*S.Lorenzo ad Septimum abbey*) on chestnut XVIIth century trusses.

4. MECHANICAL TESTS

Structural elements checked by mechanical destructive tests have been tested in original structural size according to specific UNI EN code and then reduced to clear wooden specimens according to UNI and ISO standard to test under static bending, tension, compression and shear, to evaluate elastic and strength parameters.

5. CONCLUSIONS

Mechanical laboratory tests are the more reliable way to identify the characteristics of the material and play an important role also in the calibration of non destructive tests to obtain consistent results.
A careful visual and instrumental inspection is always necessary to discover defects and critical zone and to rightly use mechanical parameters, coming from tests on clear wood specimen, aimed to an accurate identification of the material for structural analysis.
These results more clearly put into evidence the importance of a careful characterization of the material by means of a wide campaign of NDTs calibrated by means of mechanical standardized laboratory tests, even only for few sacrificial specimens, to reach an accurate modelling of the material for the evaluation of the conservation condition, the stress state and the residual performance capacity of existing structures.

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