Mechanical characterization of old chestnut beams

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Abstract The main objective of this work is to evaluate by non-destructive techniques seven old Chestnut beams. For that, after the geometric assessment and the detailed visual inspection that allowed to strength grade the beams, a series of non-destructive tests was setup. In a first step, non-destructive bending tests, under the elastic limit, were performed to quantify the modulus of elasticity in bending (MoE) of the seven beams. Then, Resistograph® and Pilodyn® tests were done to assess the superficial decay and to have a more clear idea of voids dimensions. Then, two beams were tested in bending until failure to evaluate the bending strength. In a second step, end parts were cut from the beams, one per end of the beams, to perform Resistograph®, Pilodyn® and ultrasound tests, to quantify the density of the beams and to extract meso-specimens to be used on tension parallel to the grain tests.

Keywords visual inspection, evaluation, NDT, chestnut beams

1. GEOMETRIC ASSESSMENT AND EXPERIMENTAL CAMPAIGN

The beams used in this work were recovered from an old factory in Guimarães that was partially demolished for the construction of a Museum. Beams are made of Chestnut (*Castanea sativa Mill*) with lengths between 3,6m and 5,6m. Their cross-section is defined by the trunk geometry and therefore, significant variability in the cross-section dimensions exists.
In order to have an adequate report of those variabilities, a detailed geometric assessment of the beams was performed. Every 40 cm, each beam was marked, named and the cross-section measured. Those cross-sections were used also in the non-destructive tests conducted and reported in following items.

1.1. Moisture content and density

The moisture content of the beams was evaluated through two methods: based on three readings of a thermo hygrograph following the measuring scheme of UNI 11035-1:2003; and, using the oven dry method suggested by UNI EN 13183-1:2003. Density has calculated following the NP 616:1973 prescriptions, dividing the mass by the volume of those small specimens.

1.2. Pilodyn®

For all beams, in each section used for the geometric assessment, the penetration depth obtained through the Pilodyn® in 2 faces was measured, in a total of 156 tests. Tests results vary between 5 and

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14 mm conducting to average values of 9 or 10 mm for all beams. Based on a correlation between the depth penetration and the density values of defect-free chestnut specimens proposed by (Feio, 2006), a prediction of the density of each beam was performed.

1.3. Resistograph®

The main objective of using this technique was not to predict mechanical properties but to complete the information given by the other non-destructive tests realized. In particular, the evaluation of the deterioration level and the voids existing inside the beams, and for that, not visible, were the main purpose of the use of Resistograph®.
For that, 3 sections, among the ones defined in the geometric assessment task, of each beam were used to collect Resistograph® charts. Moreover, two more Resistograph® tests were performed in each end part of the beams.

1.4. Bending tests

Static bending tests were conducted in accordance with the four-point loading method proposed by EN 408:2003. Each test was composed by three quasi-static loading cycles below the elastic limit, under a displacement rate of 0,125mm/s until a maximum deflection of 50mm. The MoE of the chestnut beams was assumed equal to the local modulus of elasticity in bending ($E_{m,l}$) defined by this standard. Then, after those bending tests under the elastic limit, destructive bending tests were performed loading beams B4 and B5 until failure. The objective was to quantify the bending strength (f_m) of the chestnut beams.

1.5. Ultrasound

Ultrasound test were performed on the end parts removed from the beams. In each end part, both indirect and direct methods were applied.

1.6. Tension tests

Tension tests were performed on meso-specimens removed from the end parts of beams 2, 3, 4, 5, 6 and 7. From each of these beams, a total of 4 meso-specimens were used to study the tension properties, stiffness and resistance, in the grain direction.

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