The effect of knot location on the load-bearing capacity of reclaimed timber beams

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Reclaimed timber is increasingly used in structural applications due to sustainability considerations and the growing demand for circular construction practices. However, its structural performance remains difficult to assess due to natural heterogeneity and the presence of defects such as knots, which significantly influence mechanical behaviour. Existing grading approaches, including visual sorting methods, already recognize the importance of knot size as a key parameter affecting timber classification and strength [1]. Nevertheless, the influence of knot location within structural elements remains less clearly quantified.

This study investigates the effect of knot location on the load-bearing capacity of timber beams subjected to four-point bending. An experimental campaign is conducted to determine the modulus of elasticity (MoE) and modulus of rupture (MoR) of reclaimed timber elements. A representative example of the failure mode observed during testing is shown in Fig. 1. The obtained results serve as a reference for the development and validation of a numerical modelling framework.

In parallel, a finite element model is being developed in Abaqus to simulate the bending response of timber beams. At the current stage, the model reproduces the behaviour of defect-free beams in the linear elastic range. The ongoing work focuses on incorporating knots as localized material disturbances, represented through variations in density, fibre orientation, or local stiffness reduction. The failure criterion is defined based on reaching a critical stress level, with consideration of appropriate strength hypotheses.

The proposed approach is intended to enable a parametric analysis of the influence of knot position and characteristics on beam capacity. Ultimately, the framework will be extended to include geometrically accurate models derived from three-dimensional scans of real timber elements, following previous work on lidar-based assessment of reclaimed timber [2]. This will allow for more reliable prediction of structural performance based on actual material geometry.

The presented work constitutes an initial step toward integrating experimental testing, numerical modelling, and advanced imaging techniques for the assessment of reclaimed timber structures.

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