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DETERMINATION OF CONSTITUTIVE MECHANICAL BEHAVIOR OF PRECIOUS SAMPLES FROM LARGE WOODEN STRUCTURES OF CULTURAL HERITAGE

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In order to predict the mechanical behavior of large wooden structure of cultural heritage, it is necessary to test small samples all the way to the point of failure. Larger members can generally not be dismantled for testing. Mechanical tests usually induce some kind of irreversible deformation, i.e. damage, or even ultimate failure. Only small samples from non-critical parts of the structure can therefore generally be spared. Due to the preciousness of the material, necessitating small samples, some particular challenges arise. 1. The samples may not be representative. 2. Imprecision in machining induces non-linear load-displacement relations, e.g. non-parallel surfaces in compression of cubes. 3. Effects of barreling in compression. 4. Unreliable identification of shear moduli. These problems have been addressed in a project together with the Swedish Maritime Museums, hosting the 17th century man-of-war Vasa. Micromechanical homogenization has been used to deal with the variability in density, anisotropy and material stabilization. Finite elements simulations allow reducing the unwanted effects of barreling and non-ideal cubic geometry of the specimens. Ultrasonic resonance techniques permit to identify all parameters in the orthotropic stiffness tensor, including shear which otherwise would require larger and specially designed samples.