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IMAGING THE MICROMECHANICAL RESPONSE OF WOOD IN STEEL-DOWEL CONNECTIONS

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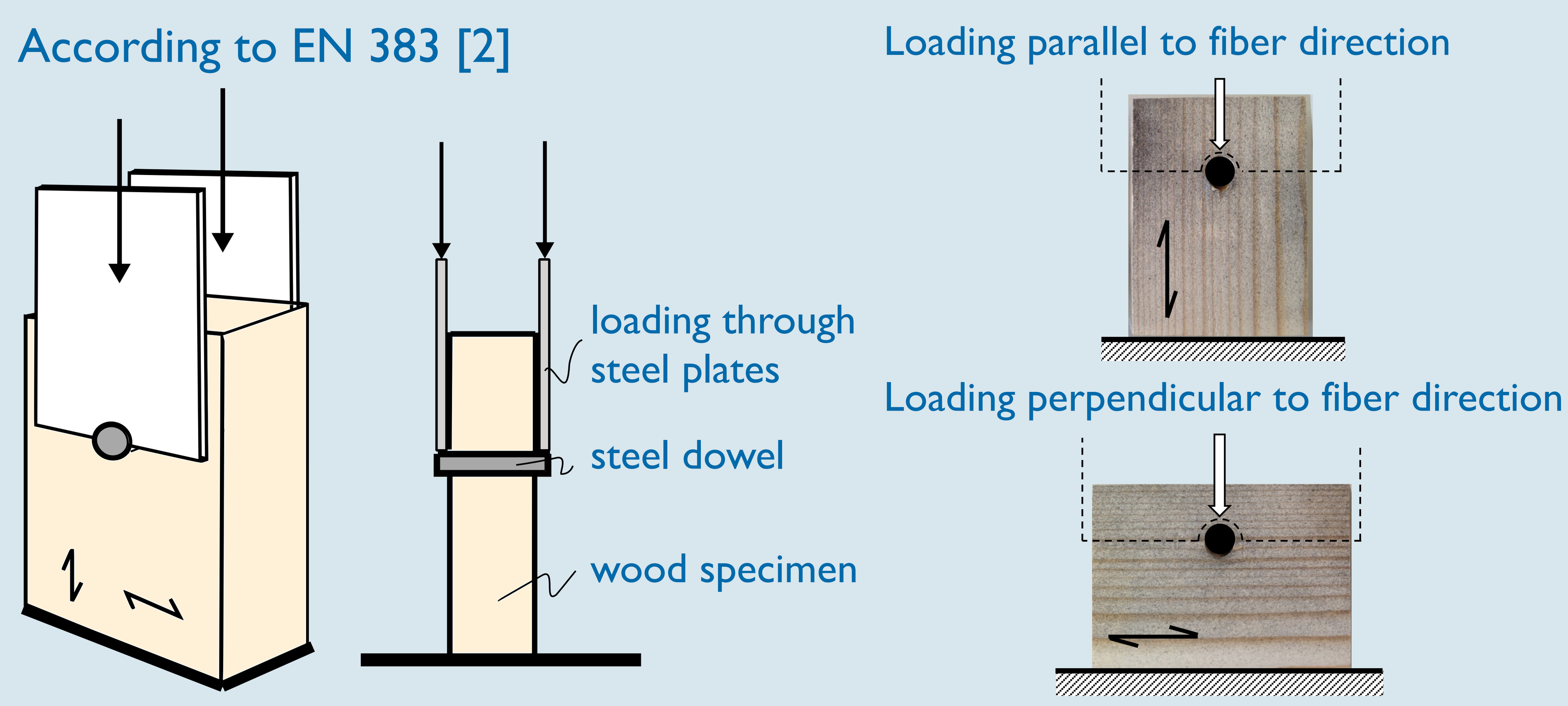
Motivation

WOOD STEEL-DOWEL CONNECTIONS

Dowel-type timber connections are widely used in timber engineering structures, due to their ease of application and their ability to transfer high loads. These types of connections act as compliant joints, allowing additional deformations between the structural elements when the joint is loaded. The aim of this study is to develop an integrated experimental procedure allowing an enhanced in-situ insight into the micromechanical interactions governing the global behavior of dowel connections during loading. The approach is to combine traditional embedment tests of steel-dowels in wood with innovative material micro-characterization and measurements based on advanced imaging technologies. The combination of these methods with numerical modeling is expected to bring the testing of complex assemblies to a new level of efficiency and knowledge by removing many limitations of the traditional experimental methods [1].

EMBEDMENT TESTS

According to EN 383 [2]

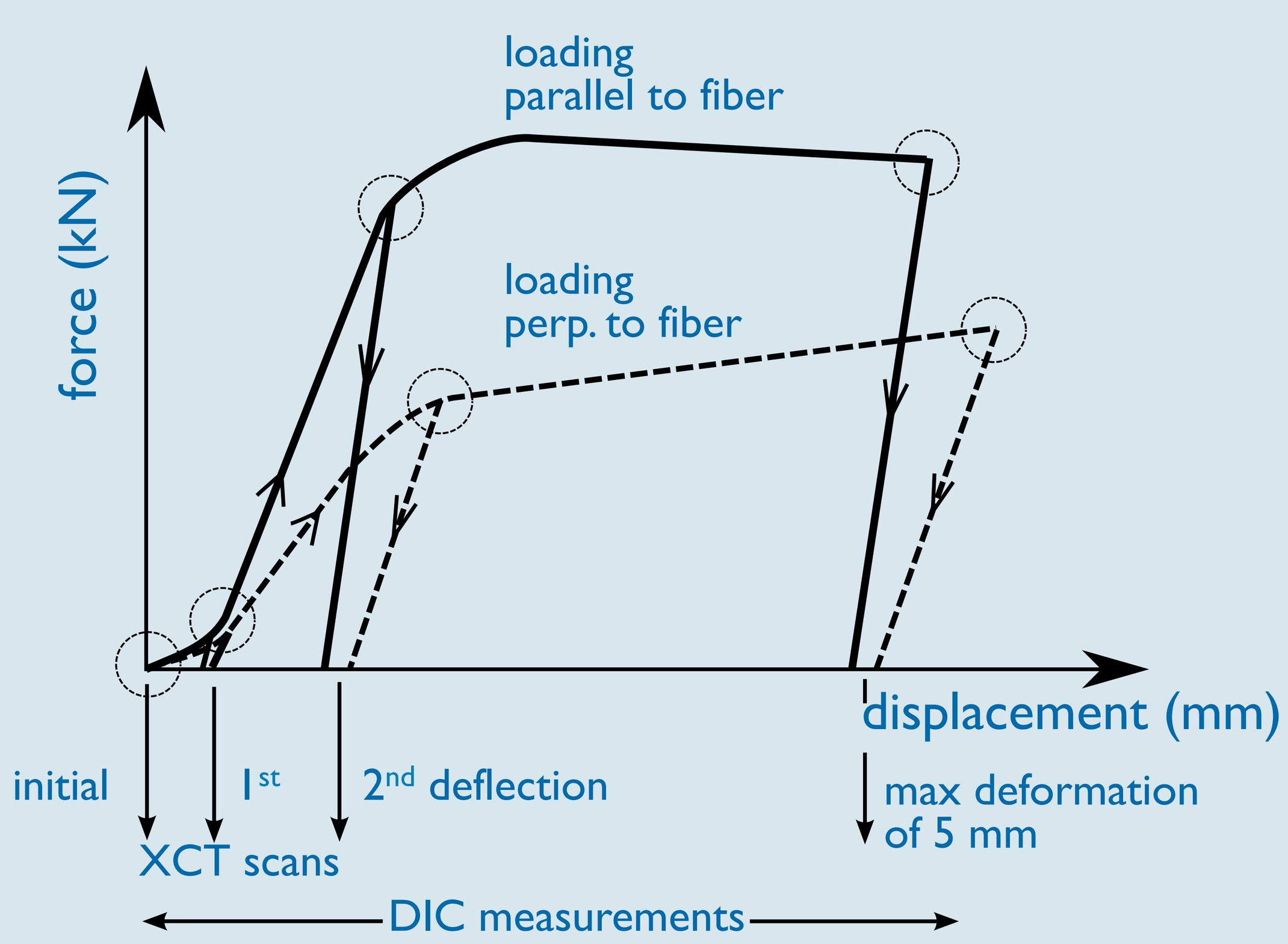


Methods – mechanical testing and integrative imaging techniques

TESTING PROCEDURE

Steel dowel embedment tests were performed on EN383 [2] spruce specimens with 12 mm boreholes. Displacements and strains below the holes were recorded via DIC method. Progress of the internal failure in wood was observed on XCT scans of the material surrounding the borehole physically extracted from the specimen before loading and at the first and the second inflection points of the load-displacement curves. The procedure continued until 5 mm global joint deformation was achieved.

LOAD-DEFORMATION BEHAVIOR WITH SAMPLING PROTOCOL

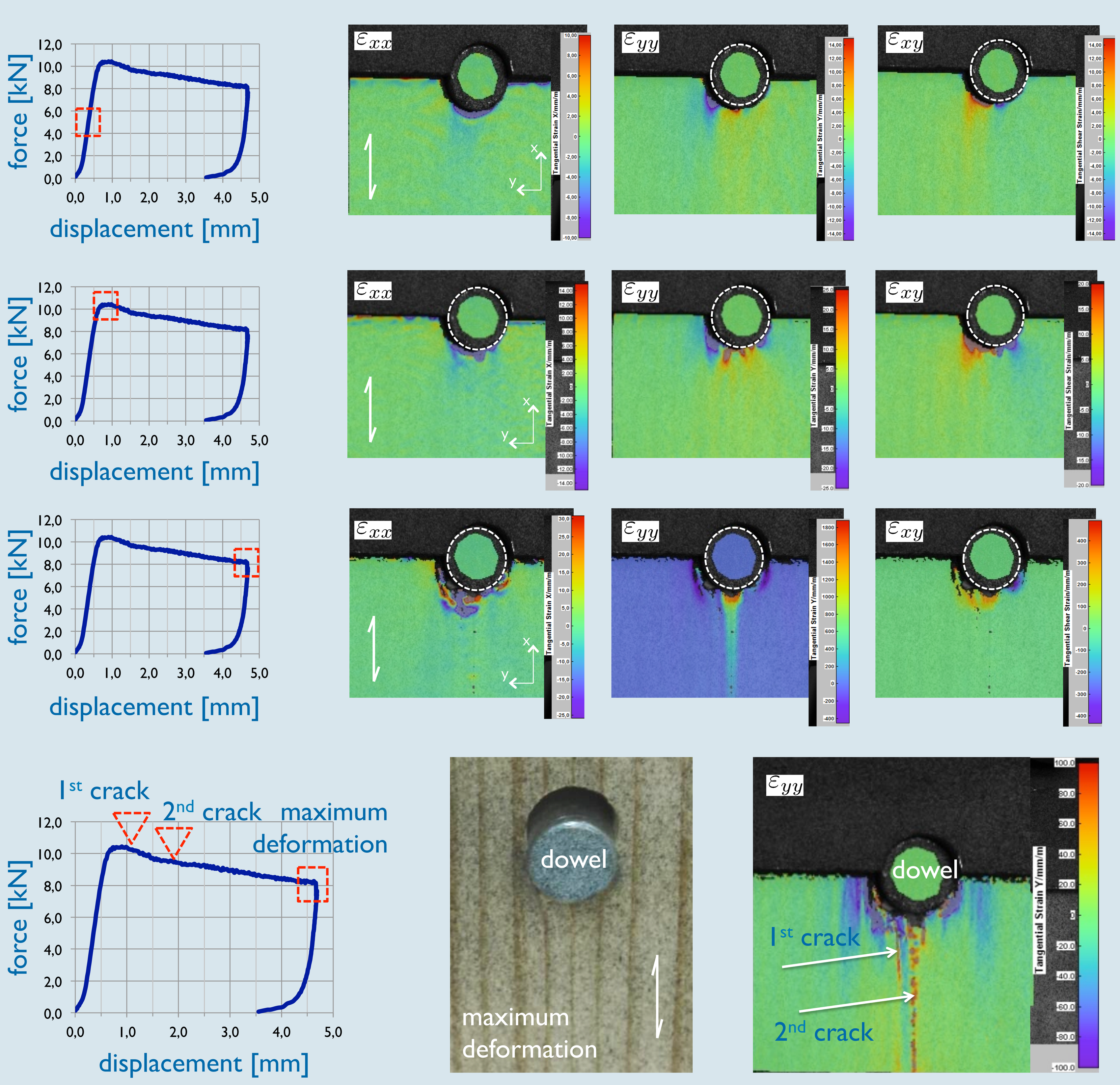


DIGITAL IMAGE CORRELATION (DIC)

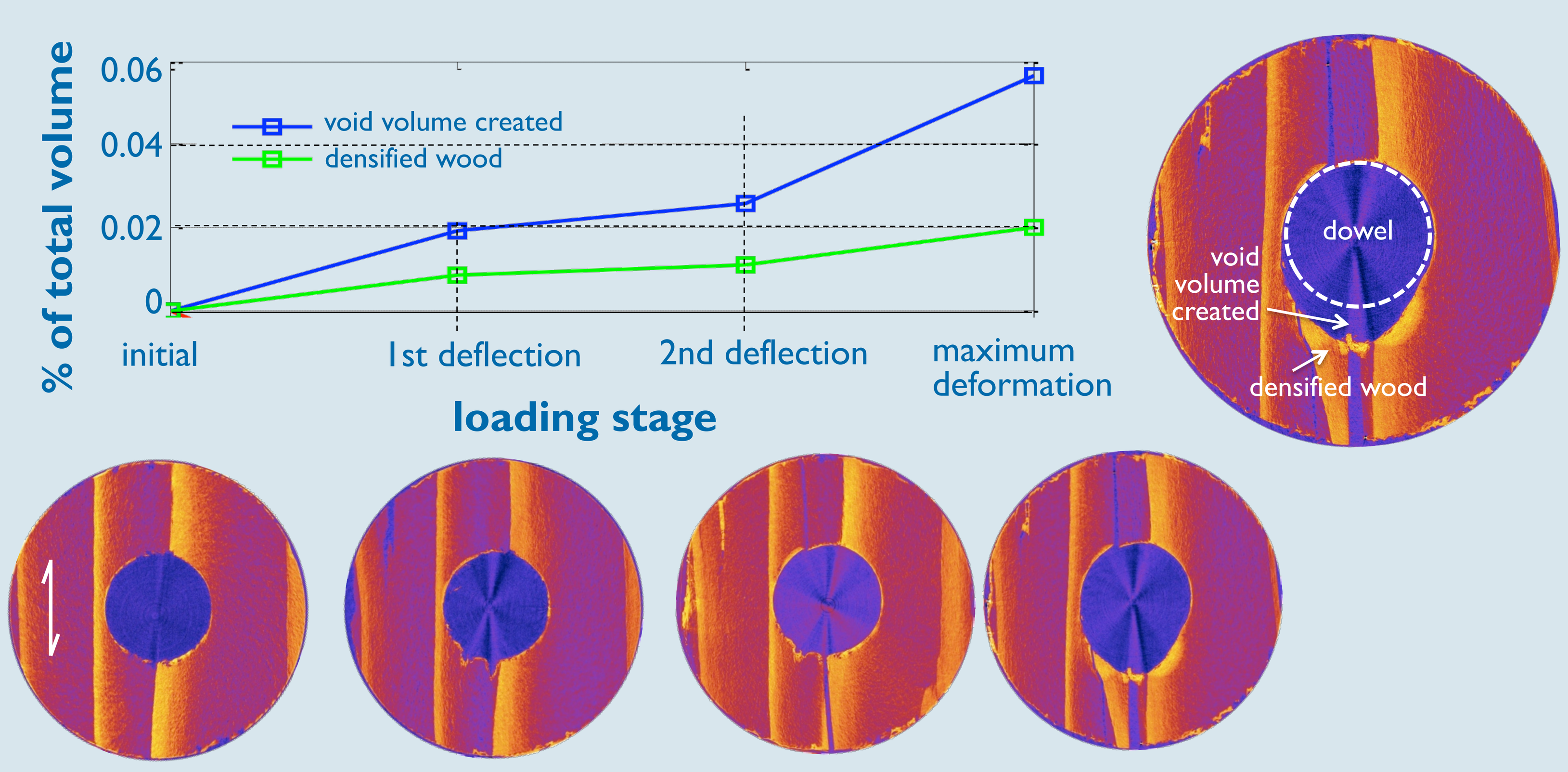
X-RAY COMPUTED TOMOGRAPHY (XCT)

Results – micromechanical response of wood

FULL-FIELD SURFACE STRAINS



INNER DEFORMATIONS



CONCLUSIONS

Digital image correlation (DIC) measurements highlighted strain concentrations in the contact region directly under the dowel. Particularly, the location of strains perpendicular to grain and shear strains as precursors for development of cracks could be visualized. Complementary CT data was found to be consistent with DIC results and reveals buckling and tearing of the cellular structure. These observations explain the challenges faced by the simulation attempts using conventional continuum mechanics models.

References:
[1] L. Muszyński, M.E. Launey: Advanced imaging techniques in wood-based panels research. in: Wood-Based Panels - An Introduction for Specialists. State-of-the-Art in Wood-Based Panels Research. COST Action E49 (2010), 177-201.
[2] EN 383:2007: Timber Structures – Test Methods – Determination of embedment strength and foundation modulus for dowel-type fasteners.

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