



Withdrawal Properties of Threaded Rods Embedded in Glued-Laminated Timber Elements

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Summary:

There is a complete lack of guidelines for the estimation of the withdrawal stiffness of threaded rods with larger diameters. Moreover, Eurocode 5 imposes a limitation to the angle between the rod-axis and the grain direction ($\alpha = 30^\circ$) without taking into account that splitting may be prevented by reinforcement. The lack of knowledge of proper design, documentation of mechanical behaviour, design guidelines and design codes for threaded rods are barriers for the development of timber connections with these fasteners.

The withdrawal properties (capacity and stiffness) of axially loaded threaded rods were investigated in the present thesis by use of experimental, analytical and numerical methods. An overview of the background information and research on withdrawal of screws and threaded rods is presented in Part I of the present thesis. Part II consists of 4 appended papers where the findings of this Ph.D. project are presented. Part III consists of 3 appendices where some analytical remarks together with the detailed experimental and numerical results are presented. According to experimental observation, the specimens exhibited high withdrawal capacity and stiffness (without initial soft response). Based on the experimental results, the necessary input parameters for the analytical method were quantified. In particular, simple expressions for the mean and 5%-percentile withdrawal strength, the shear stiffness and the brittleness were developed. In general, the analytical estimations and the experimental results were in good agreement. Numerical estimations overestimated stiffness especially for small angles and short embedment lengths; however this overestimation was smaller in the case of longer rods. Finally, the experimental results from tests with pairs of rods showed that the effectiveness per each rod was quite high, despite the fact that rods were placed with small edge distances and spacings.

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