INFLUENCING PARAMETERS ON THE EXPERIMENTAL DETERMINATION OF THE WITHDRAWAL CAPACITY OF SELF-TAPPING SCREWS

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**ABSTRACT:** Self-tapping screws are simple and economical fasteners and therefore widely used in contemporary timber engineering, especially for joints in wide span glulam truss systems, for line connections in multi-storey “timber towers” in cross laminated timber or as reinforcements. Due to the fact that these screws – if axially loaded – show a quasi-brittle failure mode with low ductility and deformation and consequently without advance warning, the determination of the different resistances against steel or withdrawal failure – commonly done by tests – has to be carried out very accurately. This paper focuses especially on the specifications given for the determination of the withdrawal capacity following the test standard EN 1382.

Fixed boundary conditions in this standard are i.e. (i) the position of the fastener relative to the annual ring orientation (radial vs. tangential), (ii) the angle of the screw axis to the sample’s surface (90°), (iii) the distance of the screw axis to the supporting (minimum three times the diameter), (iv) the loading rate (time to failure in between 90 ± 30 s) and (v) the type of loading (monotonic). Other parameters which are not ruled in EN 1382 in detail but also may have an influence on the bearing resistance of axially loaded self-tapping screws are (i) the load and support conditions (push or pull), (ii) the shape and direction of the load path in the sample (push, pull or pile), (iii) the test preparation (with or without pre-drilling) and (iv) the climate conditions (moisture content and temperature).

Varying all of the mentioned influencing parameters for angles of 0° and 90° between screw axis and grain direction, which was performed the first time in this dimension, more than 3000 tests determining the withdrawal parameter \( f_{\text{ax}} \) of an axially loaded self-tapping screw, were carried out, statistically analysed and compared with literature and mechanical models. In this paper we concentrate on differences between analysed configurations and the influence which results by varying their parameters on requirements as given in EN 1382. First results indicate that

- the loading and supporting (± 3% on average in reference to push-pull tests),
- the angle between the sample’s surface and the screw axis, and
- the position of the screw to the annual ring orientation

influence the withdrawal capacity in a minor way, whereas

- the loading rate (especially “impact loads”: increase of 17%, referred to 90 s),
- the distance of the screw axis to the support,
- the moisture content of the samples at the time of testing as well as their history in climatic conditioning, and
- the test preparation (with and without pre-drilling)

show a significant impact on \( f_{\text{ax}} \) in several cases. Our analysis allows to give proposals for the adjustment of existing rules given in EN 1382 or even to cancel too strict regulations. Moreover, the possibility to add additional specifications, e.g. various types for loading and supporting, will be outlined.

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