

Abstract – Research Project
Block shear failure of timber members in the connection area of
axially loaded fully threaded screws

The present paper considers brittle failure modes in connections with screws loaded axially perpendicular to grain. The available test data are evaluated and compared with design proposals from Mahlknecht and Brandner for block shear, Meyer and Blass for row shear as well as with the approach only based on an effective number of fasteners n_{ef} . Even if an effective number of fasteners n_{ef} primarily incorporates the influence of uneven load distribution between the single screws in a connection, it obviously also compensates at least partly for brittle failure modes as block shear or row shear failure.

In order to expand the existing data basis, additional tests were performed at Versuchsanstalt für Stahl, Holz und Steine. These tests were used to check and modify existing design models as required.

The analytical model derived for glued-in rods taking into account row shear failure in connections with axially loaded fasteners arranged in rows parallel to grain and loaded perpendicular to grain also very well predicts the load-carrying capacity of similar connections with screws. This model may also be used for groups with several rows of screws, if the spacing a_2 perpendicular to grain is large.

The analytical model proposed by Mahlknecht and Brandner for block shear failure in connections with groups of axially loaded screws and load components perpendicular to grain was modified as follows:

- Shear planes perpendicular to the grain are not considered,
- Brittle failure is either caused by tension perpendicular to the grain in a plane defined by the screw tips or by rolling shear in planes defined by the outer screw rows, simultaneous load transfers via rolling shear and tension perpendicular to the grain are disregarded,
- The tension perpendicular to the grain capacity is determined according to the German national annex to Eurocode 5 (DIN EN 1995-1-1/NA),
- Rolling shear failure planes exceed the length of the connection parallel to the grain on each end by $0,75 \ell_{ef}$,
- It is considered that only a part of the load component perpendicular to the grain causes tension perp. to grain stresses or rolling shear stresses.

In order to verify the modified analytical model, ultimate test loads of axially loaded screwed connections are compared with the results of the model. The ultimate loads from the tests agree well with the model predictions. For the comparison, the model parameters screw tensile strength and withdrawal capacity were determined separately by tests. If block shear design is disregarded, the design of axially loaded screwed connections according to the screws' ETAs still leads to an adequate load-carrying capacity.

The results of the research project allow a simple design of connections with axially loaded screws and load components perpendicular to grain. The requirement of EAD 130118-00-0603 „SCREWS FOR USE IN TIMBER CONSTRUCTIONS“ regarding a block shear design may hence be fulfilled.