

Load-carrying capacity of dowelled connections

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The fact, that the calculated load-carrying capacities of dowelled connections according to DIN 1052:2008 or DIN EN 1995-1-1:2010 (EC 5) are in part significantly lower than the corresponding values according to DIN 1052:1988 is intensely discussed among experts for a number of years. Assuming the calculation model of Eurocode 5 based on the Johansen theory being correct, connections designed according to DIN 1052:1988 would be unsafe.

This situation led to the present research project commissioned by DIBt. Here, the load-carrying capacity of dowelled joints was to be comprehensively studied and evaluated. For this purpose, altogether 1588 tests reported in seven different research studies were evaluated together.

The analysis of the short-term tests shows an overestimation of the load-carrying capacity according to DIN 1052:1988 by 20 – 25 %. Consequently, connections designed according to DIN 1052:1988 are below the reliability level required today.

The evaluations also show that load-carrying capacities according to Eurocode 5 are conservative and hence could be increased accordingly.

Based on bending and tensile tests with dowels sampled in companies during third party quality controls, a modified equation for the calculation of the yield moment M_y was derived, leading to higher calculated load-carrying capacities especially for large diameter dowels. The dowel bending and tensile tests also revealed that actual steel strength values in part significantly exceeded the corresponding nominal values.

For dowelled connections with a failure mode showing two plastic hinges per shear plane, an additional slenderness effect was observed, further increasing the load-carrying capacity of these connections in the order of 25 %.

The design rules in DIN 1052:1988 were derived based on tests, where the dowel steel strength was not determined. This means that both effects mentioned above, namely the surplus strength of the steel dowels and the slenderness effect, were implicitly included in the permissible loads according to DIN 1052:1988.

Considering the consequences of these three findings (modified equation for M_y , slenderness effect and steel over strength), the existing differences between the calculated load-carrying capacities according to DIN 1052:1988 and Eurocode 5, respectively, may be explained to a large extent. The obvious disagreement between the results according to both design codes becomes therefore lower than initially assumed.

The authors therefore see no need to check obviously non-damaged structures only because the calculated load-carrying capacity of dowelled connections according to DIN 1052:1988 seems too high according to today's knowledge. The verification of the structural safety in the context of the maintenance required by building legislation is considered sufficient to recognize in time possible damages in connections.