

Resistance of Direct Fixings of Sandwich Panels under Cyclic Loading

The resistance of direct (visible) fixings of sandwich panels is regulated in Germany in the general type approval Z-14.4-407. The static pull-through resistance is determined on steel sheet strips. Cyclic loads are taken into account by a reduction factor $\alpha_{cycl} = 0.67$. Tests on steel sheet strips reflect the actual behaviour of a sandwich element only to a limited extent.

The aim of the research project was to determine the reduction of the resistance of direct fixings under cyclic loading on the basis of a comprehensive test program and, if necessary, to improve it compared to the current approval practice. For this purpose, pull-through tests according to prEN 14509-2 were carried out and evaluated on small-scale sandwich specimens from various manufacturers, core materials, element depths, face sheet thicknesses and with fixings from various manufacturers on the mid and end support.

The elements with PUR/PIR core layer showed a vulnerability to fatigue cracks in the face sheet, which was presumably caused by pre-damage of the material due to work hardening when the lining was formed. The elements with a mineral wool core showed a more favourable behaviour towards cyclic loading. A clear dependence of the factor α_{cycl} on the face sheet thickness, the core height and a support thread at the screw head was not determined. In the tests with screw positions close to the edge of the specimen ("end support", edge distance $e = 20/40$ mm), the reduction factor increased with increasing edge distance. The screw position in a top or bottom chord of the lined face sheet significantly influenced the cyclic load bearing capacity. On the mid support tests, smaller load bearing capacities were determined in top chord, on the end support in the bottom chord. It can be assumed that in the cases mentioned, larger stress peaks occur at the transitions of the lining, which can increase the damage or the crack growth in the face sheet.

In summary, the results of the research project show that the cyclic resistance of direct fixings of sandwich panels is influenced by a several factors which cannot be adequately taken into account by tests on steel sheet strips. The cyclic reduction factors determined differ regarding the core material and the screw position in the element. The specification of a general reduction factor is not expedient and uneconomical due to the numerous influences. A differentiation of the factor is recommended.

	PUR/PIR-foam	Mineral wool
Position	α_{cycl}	α_{cycl}
Mid support	0.8	1.0
Edge distance $e = 20$ mm	0.6	0.7
Edge distance $e = 40$ mm	0.7	0.9

The static pull-through resistance determined on steel sheet strips is usually bigger than the resistance determined on small-scale sandwich specimens. A final reference of the results to the current approval practice cannot be carried out due to a lack of comparative tests on steel sheet strips. The assumption that the previous approval practice leads to a conservative cyclic resistance cannot be confirmed, regarding the end support tests.