Zukunft Bau

Short report

Titel

Load bearing behavior of slender concrete sandwich panels with bar-shaped glass fiber reinforced polymer (GFRP) connectors under compressive load

Motivation

The positive influence of the external concrete layer and of the core layer on the stability of the whole sandwich panel cannot be taken into account because there is no engineer model available that would describe the load carrying behavior of the sandwich panel under compressive load. For high panels exposed to buckling risks, it would allow reducing the concrete layers' thickness and their reinforcement.

Description of the research project

The influence of the external concrete layer and of the core layer on the stability of sandwich panels was researched at the technical university of Kaiserslautern. The connectors used between the external concrete layer and the internal one were horizontal and diagonal bar-shaped glass fiber reinforced polymer (GFRP) connectors as well as steel lattice girders.

Numerous experimental tests with sandwich panels were realized to determine the influence of the different parameters on the load carrying behavior of the sandwich panels.

The high number of parameters having an influence on the load carrying behavior of the sandwich walls made it necessary to make a selection of the parameters that would be varied in the test program. The core layer was 60,140 or 200mm thick, the insulation type was either a flexible expanded polystyrene foam (EPS) or a rigid extruded polystyrene foam (XPS). Some test specimen also had no insulation. The connectors that were used for the specimen tests were GRFP bar-shaped connectors and in only one test specimen steel lattice girders.

The test specimens were 4,2m long and 0,8m wide. They were composed of a 10 cm thick internal concrete layer (slenderness ratio=145), a 6 till 20 cm core layer and a 7 cm thick external concrete layer. Parameters like the concrete compressive strength and its reinforcement were not varied. The load was applied only on the internal layer and was increased until the test specimen failed. Whereas the internal concrete layers alone, which served as reference test specimens all showed a stability failure, the sandwich walls failed when the maximum bearing capacity of there core layer was reached. The core layers failed at a load level that exceeded the critical load of the internal layer alone.

The test program showed as expected that the external concrete layer and the core layer always lead to a higher maximal load compared to the internal concrete layer alone. The test specimen with the biggest core layer stiffness had the biggest augmentation of their maximal load.

The specimen tests with XPS don't reach higher maximal loads than the ones with EPS. The explanation is that the bond between the XPS and the concrete fails before the higher shear resistance of the XPS can be exploited.

Although the internal as well as the external concrete layers were identical for all test specimens and only the core layers were varied, different failure mechanisms were observed. A lot of information could be obtained. The thickness of the insulation core layer also has an influence on the maximal load. The thicker the core layer is, the bigger the

inner lever arm is between the concrete layers, which generates a more pronounced sandwich carrying action and makes it possible to reach higher maximal loads. A condition is that the core layer is stiff enough to activate the external layer properly by big thicknesses.
Differential equations were adapted to the problem descripted in this research project. They can only be solved for simple sandwich configurations (continuous properties of the core layer). For more complicated configurations of the core layer, a finite element model would be necessary. It would also make it possible to let more parameters varied as within an experimental program in a laboratory.

Conclusion

Only the internal concrete layer is nowadays taken into account to dimension sandwich walls. The tests described in this paper have shown that a sandwich panel reaches a much higher maximal load than its internal concrete layer alone. The wall thickness being constant, it would be possible to increase the core layer's thickness and to reduce the concrete layers' thickness. In summary numerous information for a more economical dimensioning of sandwich walls were obtained.

Data

Kurztitel: Stabilität von Sandwichwänden

Forscher / Projektleitung: Dipl.-Ing. Pavis d'Escurac / Prof. Dr.-Ing.Pahn

Gesamtkosten: 162.161,97€

Anteil Bundeszuschuss: 94.641,97€

Projektlaufzeit: 20 Monate

Pictures/ Figures:

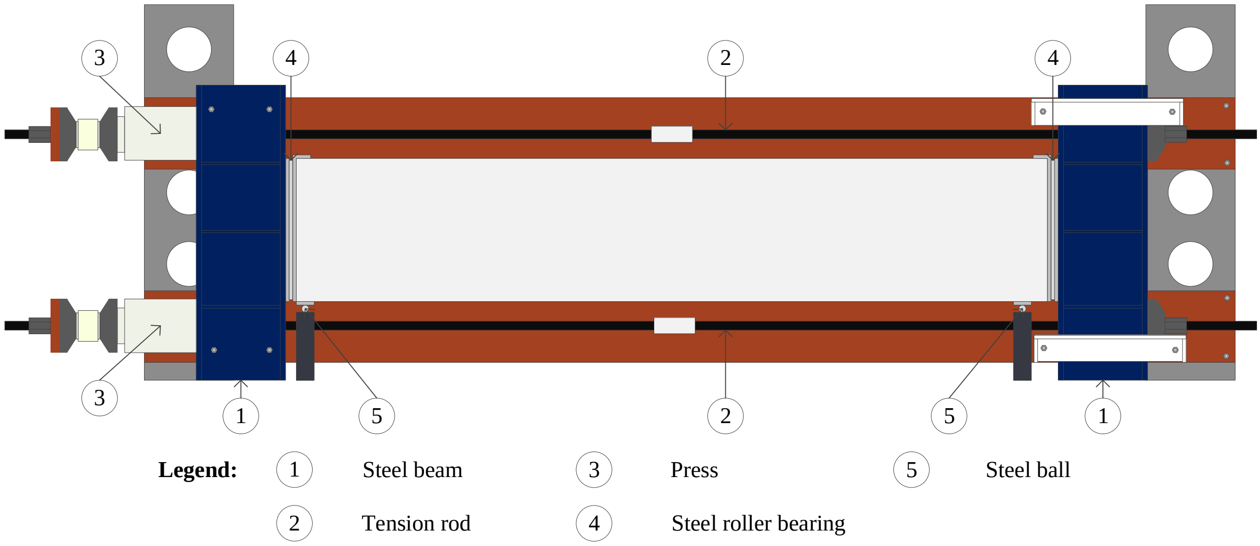

Bild 1: Test setup

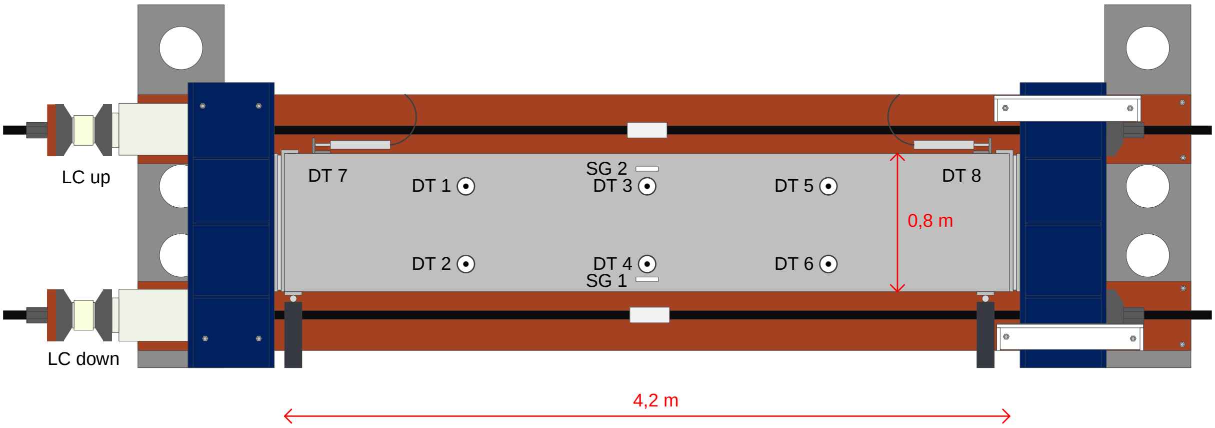

Bild 2: Measuring technique

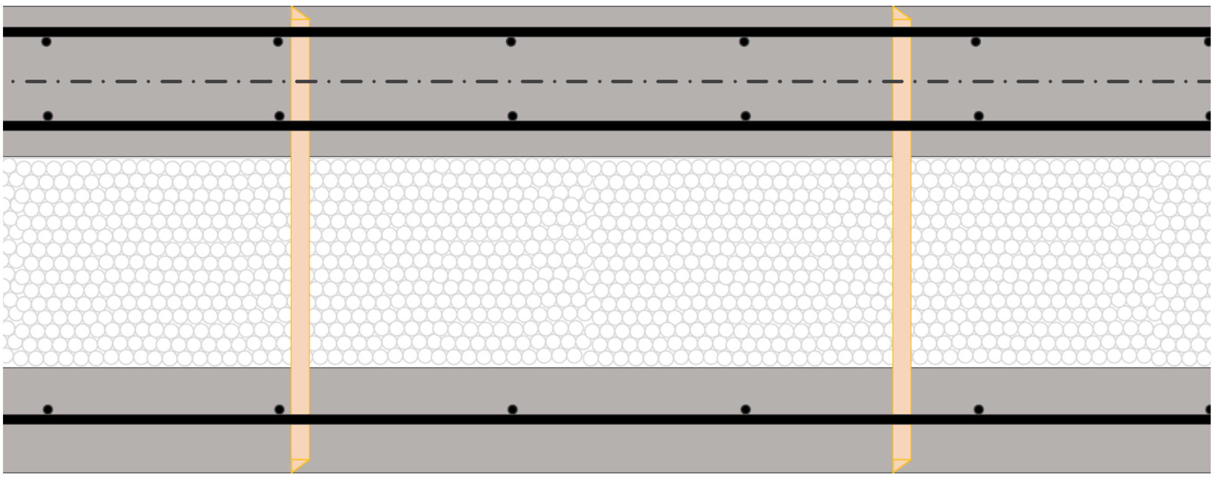

Bild 3: Test specimen with EPS and horizontal bar-shaped GFRP connectors

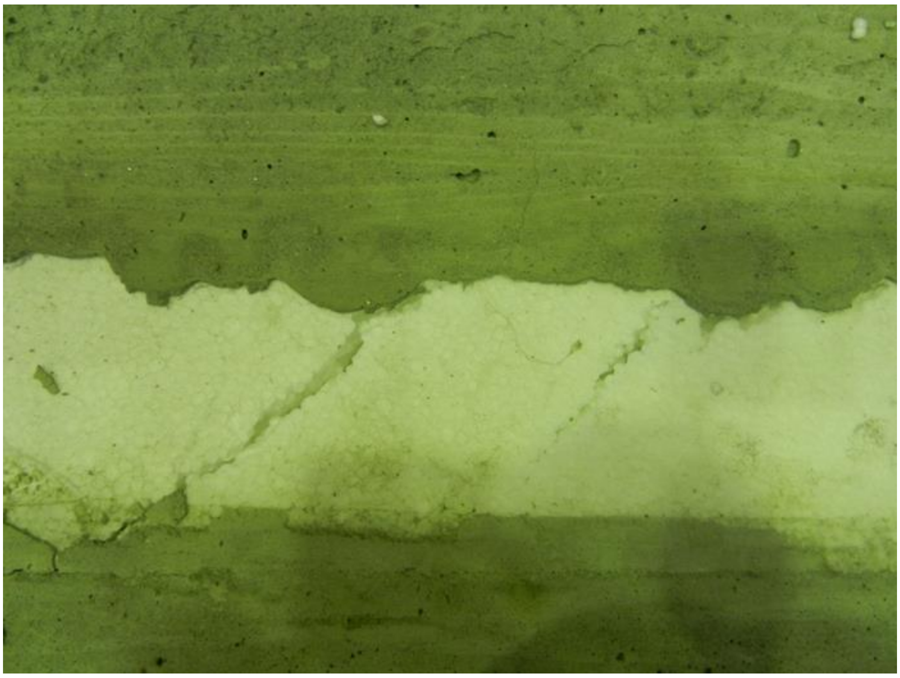

Bild 4: shear failure of the EPS

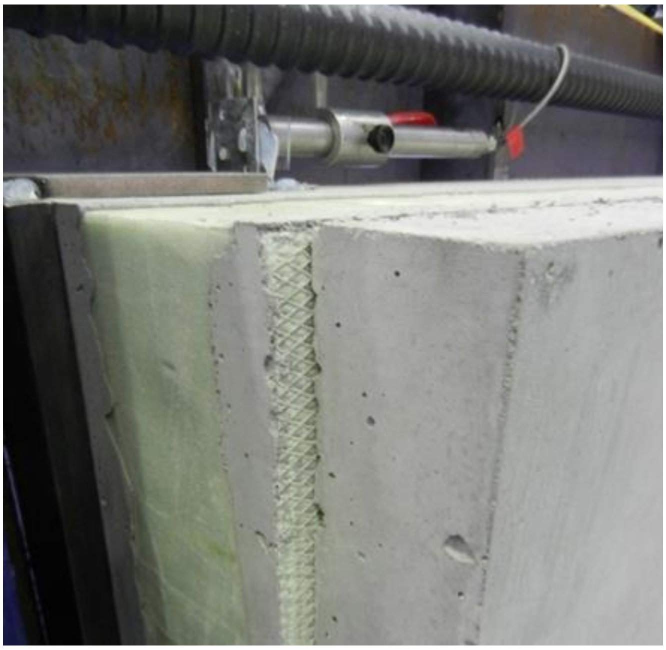

Bild 5: bond`s failure between the XPS and the external concrete layer

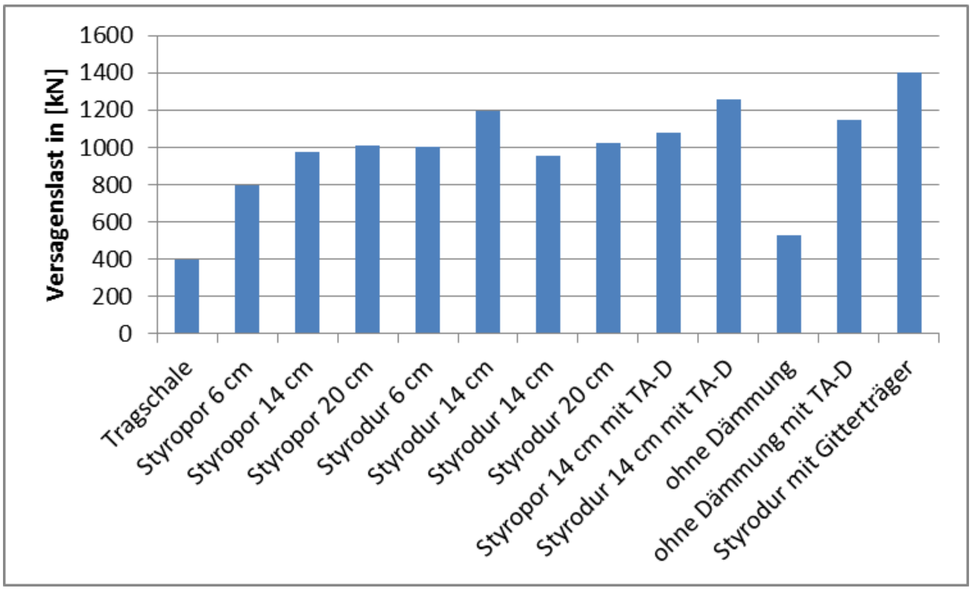

Bild 6: Test results