B.T. innovation GmbH, 39116 Magdeburg, Germany

Glass fibre reinforced plastic spacers minimise thermal bridges in core-insulated double walls

Core-insulated double walls are a widely used product that can be manufactured economically and in high quality. The trend is increasingly towards construction with as few thermal bridges as possible and the optimisation of the insulation values of the walls. A large number of possible thermal bridges can be eliminated with shear connectors made of glass fibre reinforced plastic (GRP), which is barely thermally conductive. Spacers are frequently used in addition in order to ensure dimensional accuracy with regard to wall thicknesses. As a consequence it can also be spacers made of GRP with which further thermal bridges can be eliminated.

The GRP spacer developed by B.T. innovation GmbH has a wound surface profile, which ensures optimised integration in the concrete. The contact surface has been kept as small as possible by means of partially sharpening the ends so that the rods are inconspicuous in the finished wall structure and a visually perfect result is achieved. Nonetheless, they offer sufficient stability to minimise the shifting of the first shell relative to the second shell during the production process.

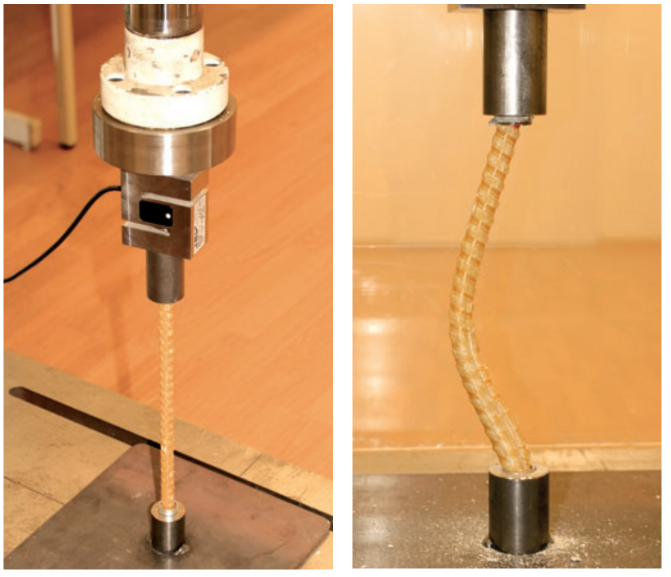

Fig. 1: GRP spacer clamped in the test press. a) before being loaded and b) during the application of pressure. In b) the rod exhibits strong bending, which led to the interlaminar shear failure of the glass fibres.

Tested for use in the precast plant

The bearable load is the characteristic value required for the use of spacers in the precast plant. In order to determine this load, 10 rods of the same length of specially manufactured GRP spacers were clamped individually in a test press and the tolerable compressive load was determined. The rod was clamped in two sleeves and a compressive load of 6 tonnes was applied with a continuous feed of 20 mm / minute. Two failure criteria were defined: bending and compression. As soon as the rods begin to bend or compress at the contact surfaces, they can no longer secure the distance as desired. The value upon occurrence of the failure criteria was recorded in each measurement. The highest and lowest measured values

Tab. 1: Determined tolerable load of a GRP spacer. From 10 measured values, the highest and lowest measured values were discarded and the mean value was determined from the remaining eight measured values and rounded down to the next smaller natural number.

Length [mm]	300	360	400	440	500
Load [kN]	10	8	7	6	6

were discarded and the mean value was determined as a characteristic load from the remaining eight values and rounded down to the next smaller natural number. Rods with lengths of 300 mm, 360 mm, 400 mm, 440 mm and 500 mm were used in this test series.
As expected, the GRP spacers with a length of 300 mm exhibit the highest tolerable load capacity. Deflection of the rod is only observed at very high loads well above 10 kN. The failure criterion in this measurement series is the compression of the glass fibre reinforced plastic at one contact point with an applied tamper head of 15 kN, which is clearly indicated by a sudden drop in the measured force (fig. 1; 1). If the load is increased still further, the second contact surface also fails at around 10 kN (fig. 1; 2.). The lower load value in comparison with the failure value for the first contact point is attributable to prior damage to the contact surface occurring in the course of the increased load. In the further course, interlaminar shear failure (fig. 1; 3.) sets in, leading to breakage of the glass fibres (fig. 1; 4.).
The measurement curve of the GRP spacer 360 resembles that of the 300 mm rod; however, the loads begin to act negatively on the rod at an earlier stage here. In addition, the rod already starts to bend at a mean load of 8 kN. The measuring curves become increasingly smooth with an increasing rod length of 400 – 500 mm. The failure of the glass fibres at the contact points becomes less dominant and only takes place later, after the start of bending. A jagged curve with sudden failure of the contact points is barely detectable. As the load increases the deflection is advanced to interlaminar shear failure or breakage of the glass fibres.
For a further experiment a very short rod was subjected to a compressive load that was successively increased from 1 kN to 11 kN in 1 kN steps, holding the load for 5 minutes at each pressure step. This was done in order to determine the compressive load at which the ends begin to fray (fig. 3 a-e). The first fibres began to fray minimally at the edge from 4 kN (fig. 3 b). This condition remained stable up to a load

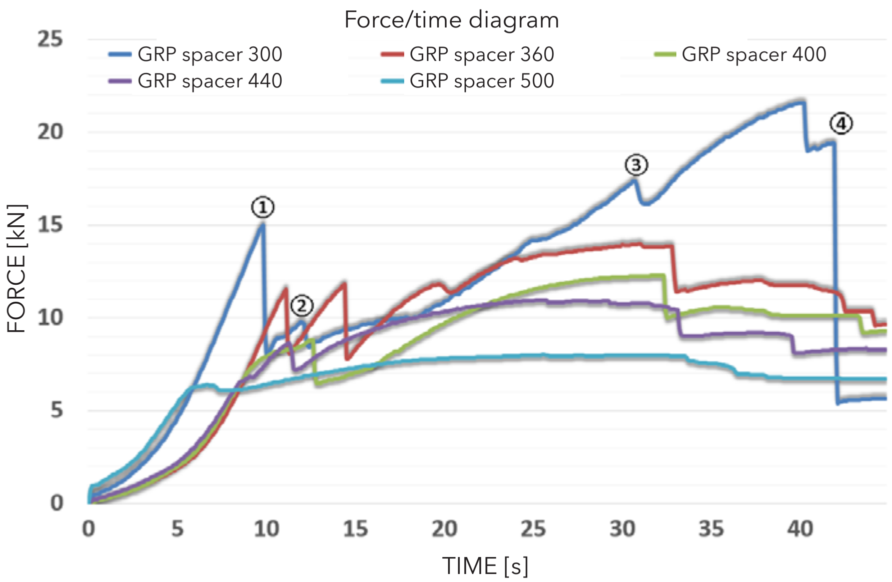

Fig. 2: Force/time diagram. Pressure was applied to the GRP spacers by means of the test press and the course was measured. On the basis of the GRP spacer 300, various states are visible during the test. ① the glass fibres of one contact surface yield; ② the glass fibres of the second contact surface yield. ③ interlaminar shear failure. ④ breakage of the glass fibres. The GRP spacers 500 directly exhibit bending of the GRP rods without there being any major damage to the contact surfaces.

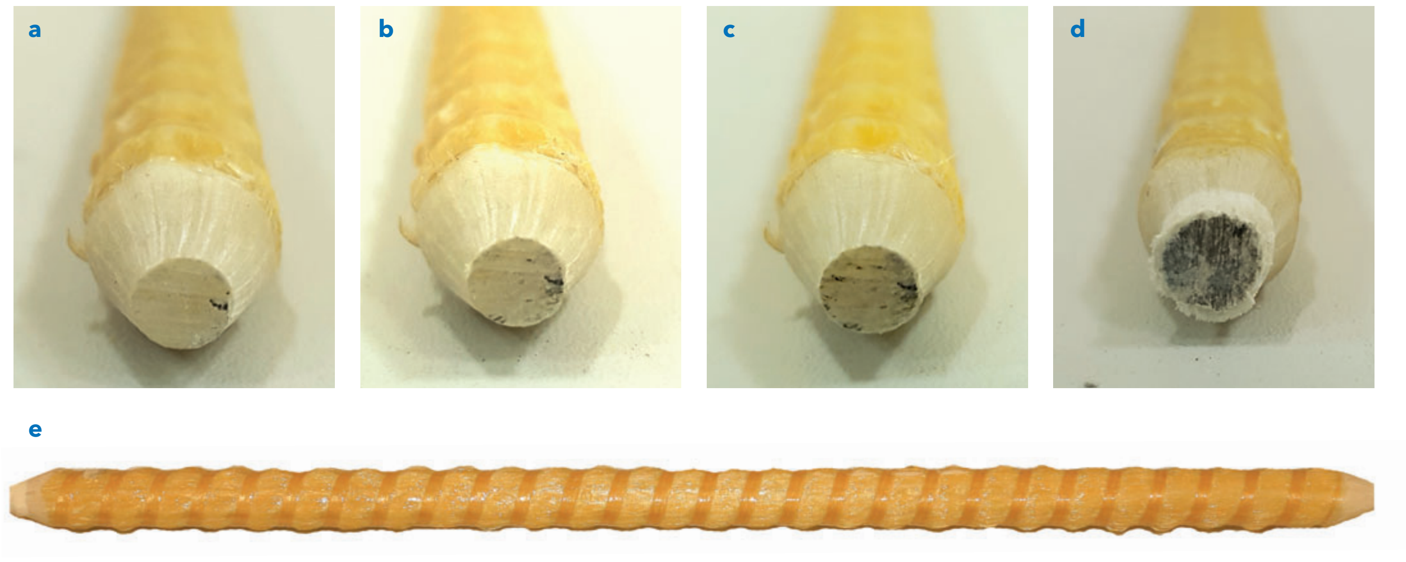

Fig. 3: Behaviour of the contact point under the influence of a compressive load. a) before; b) 4 kN; c) 10 kN; d) 11 kN; e) rod after loading to 11 kN exhibits one fully intact contact point and one compressed contact point.

of 10 kN (fig. 3 c); from 11 kN one partly sharpened end was compressed with an audible cracking sound (fig. 3 d). Since all GRP spacers with a length exceeding 360 mm begin to bend before that, the compression of the rod is the less important failure criterion

Finally, the punching shear behaviour of the rod was examined. To do this, halved GRP spacers were embedded in 7 cm-thick concrete of strength class C30/37. After the final strength of the concrete was reached, the rods were pushed through the concrete by means of the test press.

In each case the shape of the rod was unimpaired and it was pushed through the concrete at a mean value of around 12 kN. This value is higher than the tolerable loads listed in Table 1 and therefore doesn't represent a dominant failure criterion in use. A wall structure with a shell thickness of 7 cm has a weight of 1.7 kN per m² at a density of 2.5 t/m³, which means that one is on the safe side with one rod per square metre when using the GRP spacers. ■

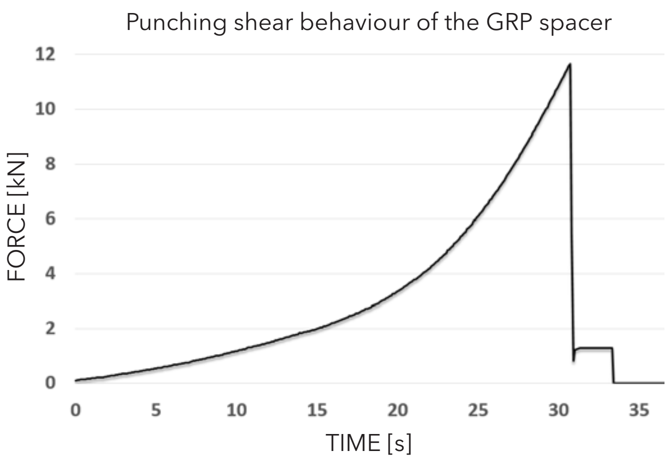

Fig. 4: Examination results for the evaluation of the punching shear behaviour of GRP spacers

FURTHER INFORMATION

BT innovation

B.T. innovation GmbH
Sudenburger Wuhne 60
39116 Magdeburg, Germany
T +49 391 73520
F +49 391 735252
info@bt-innovation.de
www.bt-innovation.de