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PRODUCTION AND EVALUATION OF COMPOSITES CONSISTING OF WOVEN FABRICS WITH INTEGRATED PRISMATIC SHAPED CAVITIES

R. Geerinck[1], I. De Baere[1], G. De Clercq[2], W. De Corte[3], K. De Clerck[2], J. Ivens[4], J. Degrieck[1]

[1]Department of Materials science and engineering
Ghent University, Technologiepark-Zwijnaarde 903, 9052 Zwijnaarde, Belgium
Email: Ruben.Geerinck@UGent.be, Ives.DeBaere@UGent.be, Joris.Degrieck@UGent.be

[2]Department of Textiles
Ghent University, Technologiepark-Zwijnaarde 907, 9052 Zwijnaarde, Belgium
Email: Geert.DeClercq@UGent.be, Karen.DeClerck@UGent.be

[3]Department of Structural engineering
Ghent University, Technologiepark-Zwijnaarde 904, 9052 Zwijnaarde, Belgium
Email: Wouter.DeCorte@UGent.be

[4]Department of Metallurgy and Materials Engineering
KU Leuven, Kasteelpark Arenberg 44 bus 2450, 3001 Leuven, Belgium
Email: Jan.Ivens@mtm.kuleuven.be

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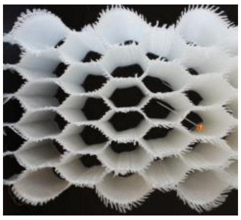
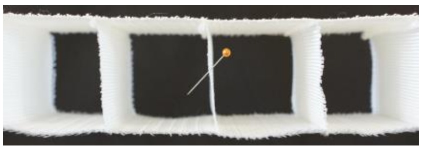
ABSTRACT

There is a lot of interest in complex 3D woven fabrics for composites because they can lead to special mechanical properties and applications. The two main advantages are the improved resistance against delamination and the reduction of manual labour. Since the fabrics are produced in one single run, a stacking sequence is not needed as this is already implemented at the weaving loom and all the different layers are connected to each other to improve the resistance against delamination. Another advantage is that there are open cavities in the fabric and thus in the composite. These can be used for utilities, insolation… This work focusses on the production and processing of woven fabrics with integrated prismatic shaped cavities.

Within these woven fabrics with integrated prismatic shaped cavities two categories can be defined (Figure 1). The first category has profiled surfaces (Figure 1a), the second has flat surfaces (Figure 1b). The connections between the surfaces of the fabrics can differ from Figure 1.



a) Profiled surfaces



b) Flat surfaces

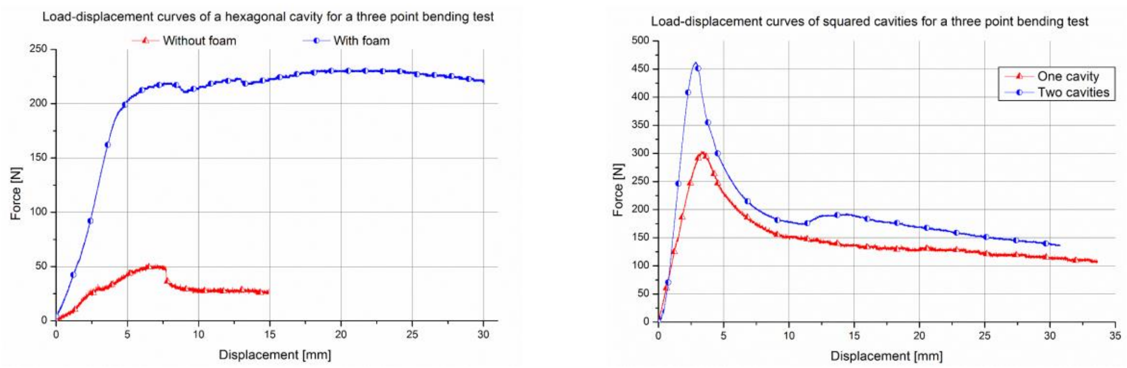
Figure 1: Woven fabrics with integrated prismatic shaped cavities.

Both types of woven fabrics with integrated prismatic shaped cavities are produced at industrial speed on a standard loom with minor adaptations and have a width of 1.5m. In comparison to Mountasir et al. [1] this production process is continuous process with less adaptations.

The composite production has been optimized for the two woven fabrics in Figure 1 with a polyester resin. The samples are produced via hand lamination and then opened with a special developed mould. For the woven fabrics with prismatic shaped cavities with profiled surfaces (Figure 1a) the mould consists out of square metal bars with the same dimensions as the upper horizontal layer of the hexagon. After impregnation

the metal bars are inserted in the fabric in the top and bottom hexagons. The bars are held at the right distance of each other to create regular hexagons as cavities. The method for the second type, woven fabrics with integrated prismatic shaped cavities with flat surfaces is slightly different. Here metal bars are inserted to clamp the vertical connection. In this way the connection does not display any S-curvatures. To prevent the resin from sagging during the production and curing, a polyester resin with a high thixotropic behaviour has been chosen. Samples up to 1.5m have been produced using this method. For the composites made out of a woven fabric with integrated prismatic shaped cavities with profiled surfaces also foamed specimens have been produced. The used foam is a two-component PUR foam with a density of 75kg/m³.

As first initial tests, three point bending tests have been performed for quality control of the production process and for the ease of interpretation of the results. Larger panels made out of these fabrics will also be most likely subjected to bending. The bending tests on the composites of the woven fabrics with integrated prismatic shaped cavities with profiled surfaces are conducted on a single hexagonal cavity. Both an unfilled and a filled hexagonal cavity have been tested in bending (Figure 2a). The specimen without foam will fail due to local indentation at the indenter. The specimen with foam reaches much higher forces as the foam prevents local indentation at lower forces. This specimen first goes in bending before local indentation starts at higher forces. Two bending tests have been performed on composites made out of a woven fabric with integrated prismatic shaped cavities with flat surfaces. The first one is on a single square cavity, the second one is on two square cavities, both without foam (Figure 2b). Both specimens fail due to local indentation at the indenter. The specimen with two cavities shows a higher peak force, an increase of 50%, before local indentation starts. This is due to the fact that this specimen has three vertical connections between the outer layers in comparison to the specimen with a single cavity that only has two vertical connections.



a) Profiled surfaces b) Flat surfaces

Figure 2: Bending tests of woven fabrics with integrated prismatic shaped cavities

The presented woven fabrics with integrated prismatic shaped cavities are divided into two groups: profiled surfaces and flat surfaces. Within these two groups several geometries are produced of which only two were illustrated here. The production process of one composite of each group has been optimized. Three point bending tests have been performed on a filled and unfilled hexagonal cavity and on one and two unfilled square cavities. All specimens fail due to local indentation at the indenter. The foamed hexagonal cavity reaches higher forces as the foam prevents local indentation at lower forces. These first tests show very promising results and further investigation will be performed to fully understand these textile structures and this new material combination.

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