Zukunft Bau

Titel

„ 3dTEX – Textile Lightweight Wall Elements“

Anlass/ Ausgangslage

Prefabrication and lightweight design are as essential in the improvement of quality and sustainability in architecture as they are already in automotive and aircraft production. 3dTEX shows, how these aims are achieved through a new combination of textile and foam technologies. Contrary to classic textile membrane structures, the project proves how foamed textiles can become wall elements with integrated insulation and load bearing structures.

Gegenstand des Forschungsvorhabens

The focus of the project is on spacer fabrics. They are used as a lost formwork for light wall elements. Spacer fabrics are multi-layer interconnected textiles that are produced in one work process. Their surfaces are linked by pile threads at a specifically defined distance. By arranging and spacing their textile layers, and thereby using their structural cavities and combining them with other materials, spacer fabrics can potentially integrate into and perform an exterior wall element’s main functions such as insulation and load-bearing. In contrast to pure membrane constructions, that offer no insulation for either cold or warm climate, spacer fabrics in combination with porous materials offer solutions for absorbing tensile and compressive forces and have good insulating properties. 3dTEX is suitable for industrial prefabrication for self-supporting, thermal bridge-free, insulating single and multilayer components as well as for in-situ production, depending on the chosen foam technologies.

In a first step, current comparable product developments and findings from research about technical textiles and foams were evaluated. Potentially promising spacer fabrics for initial prototypes were identified and materials research about fibre and foam materials was listed and evaluated in a diagrammatic form. In the product area of foamed textiles there is currently one variation of foamed spacer fabrics, used for so called big bags in order to have a strong envelope that is utilized for the transport of viscous material. The research projects about foamed textiles that had been undertaken unit now focused on multi-material elements and moulding tools processes for the production of automotive parts.

The evaluation of the research led to the production of first demonstrators of the size 30 cm * 30 cm. They are made by using standard spacer fabrics (used as mattress covers) and by using standard building in-situ foams. The objective was to find out how the spacer fabrics behave when used as a lost formwork. One could see, that the foam behaved “lazy” in terms of expansion. This means, the pile threads act as a simple barrier as long as the foam can easily spread in other directions. Also, the foam only penetrates the surface if the internal pressure in the spacer fabric is too high. Over all, the design evolving by foaming the spacer fabrics, is similar to architectural elements created from pneumatic structures. Furthermore, the first demonstrators showed that warp-knitted spacer fabrics with a rather elastic behavior are better suited for complex 3D geometries than woven spacer fabrics. The latter are less drapeable and therefore better suited for planar elements. However, woven spacer fabrics can be produced as multilayer structures in contrast to warp-knitted spacer fabrics, and potentially become multilayered, e.g. rear-ventilated building skins.

Interim results showed that a variety of parameters needs to be considered and has to be put into relation: Those are textile technologies such as warp-knitting and weaving in correlation with foam technologies (including mechanical, physical and chemical processes). As both technologies allow the use of a wide variety of materials this becomes a third and decisive parameter which comes together with the question of the making of the final foamed textile. There are basically two options, either work with slow or fast expanding foam recipes, or use either expanded or pre-expanded particle foam. For the use of pre-expanded particle foam, inelastic textiles such as woven spacer fabrics are needed. They are strong enough to withstand the pressure that is built up for the final expansion of the foam. For the use of already expanded particle foams, warp-knitted elastic spacer fabrics are suitable. On the other hand they are not useful for slow expanding foams due to their rather perforated surfaces. Parallel the research about potential materials was evaluated. By comparing relevant material properties, the aim was to define potential material combinations of fibers and foams that would allow having a mono material with maximum recycling options and good mechanical and building physical properties.

Finally tests with specifically made textiles with varying textile geometries have been undertaken. They were combined with different foam technologies, including in-situ as well as particle foams. It showed that for the final demonstrators in a size of 80 cm * 80 cm a one layer warp-knitted spacer fabric would be suitable, filled with expanded particle foam. As a second option a two-layer woven spacer fabric was developed to be filled with in-situ foam.

Fazit

The goal was to adapt 3D-textile technologies like spacer fabrics for facade elements. The results show that depending on the chosen material combination, structurally differentiated, gradient mono-materials and semi-finished, textile-based, light building elements evolve with programmable building physical, mechanical and design options. The finished demonstrators developed from two- and three layer spacer textiles and filled with either particle foam or in-situ foam become one layer or two-layer wall elements, the latter including a rear-ventilation zone. In perspective textiles e.g. from basalt fibers filled with foamed concrete will be sustainable elements, functionalized further with energy producing, light emitting and temperature amplitude regulating fibers.

Eckdaten

Kurztitel: 3DTEX

Forscher / Projektleitung: Prof. Dipl.-Ing. M.A. Claudia Lüling

Gesamtkosten: 138.396,27 € €

Anteil Bundeszuschuss: 77.842,57 €

Projektlaufzeit: 15 Monate

BILDER/ ABBILDUNGEN:

5 - 7 Druckbare Bilddaten als **eigene Datei** (*.tif, *.bmp, ...) mit der Auflösung von mind. 300 dpi in der Abbildungsgröße (z.B. Breite 10 - 20cm). Bilder frei von Rechten Dritter.
Bildnachweis jeweils:

Picture 1: Textile formwork: one layer warp-knitted spacer fabric and two-layer woven spacer fabric

Picture 2: Light wall element from foamed warp-knitted spacer fabric: framework foamed, areas inbetween partwise foamed/non-foamed

Picture 3: Light wall element from foamed warp-knitted spacer fabric, side view

Picture 4: Light wall elements from foamed two-layer woven spacer fabric: assembled with velcro

Picture 5: Detail: light wall element from foamed two-layer woven spacer fabric

Picture 6: Experimental student work FRA-UAS: bent roof element from foamed spacer fabric

Picture 7: Experimental student work FRA-UAS: folded building skin from foamed spacer fabric