# Customised Fibre Panels: A New Tool for Architectural Applications

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## ABSTRACT

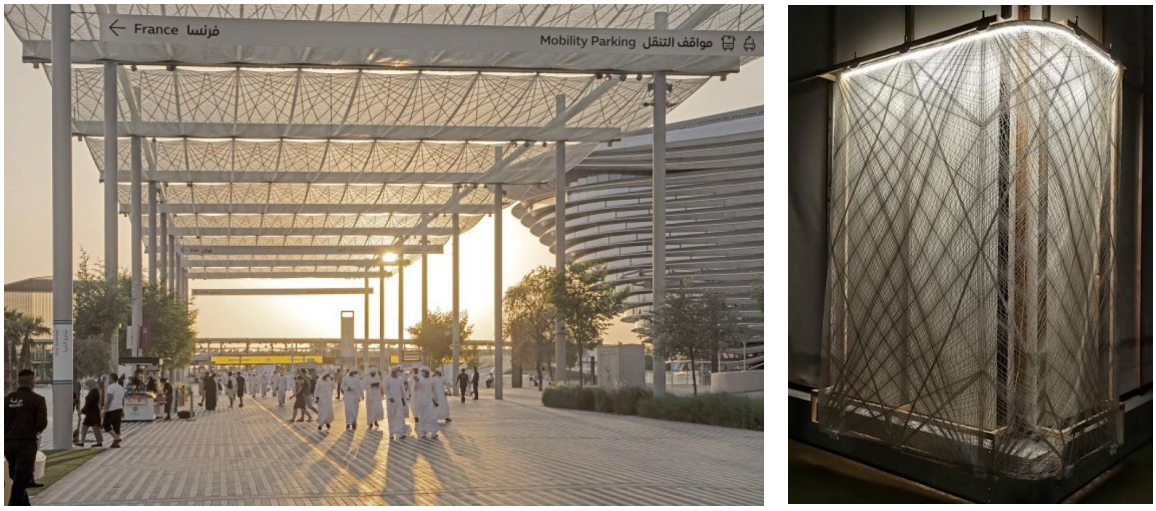


*Figure 1: Shading glass fibre system for the World Expo 2020 Dubai (left, © Andreas Keller, Altdorf) Mock-up for a glass fibre facade element installed at the D1244 Tower, University of Stuttgart (right, © ILEK)*

Digitally based design and fabrication methods allow for a new generation of fibre based systems in architecture. Instead of the classical warp and weft weave it is now possible to use customised designs, where the fibre layout is governed by mechanical criteria (i.e. main stress trajectories), performance targets (i.e. shading performance), aesthetical qualities and fabrication constraints. The synthesis of these criteria into an overall design is achieved through parametric methods, allowing for an iterative process which addresses specific design targets and production constraints.

Two case studies highlight how this approach can be used in research and in practical projects alike. For the World Expo 2020 in Dubai, Werner Sobek developed an innovative 52,500 $m^2$ large shading roof systems connecting all country pavilions on the exhibition grounds [1]. The use of customised glass fibre panels allowed for the creation of very light panels. The layout of these panels was optimised in order to concentrate the glass fibres along the main stress trajectories within the panels. At the same time, the panels were to guarantee an efficient shadowing and sufficient air circulation for the walking paths. Each panel covers a field of 22x12 $m^2$ and can be retracted mechanically (e.g. in case of strong winds or in the evening hours). No pretension was needed. Moreover, the possibility of varying the density of the fibres allowed for an integral design where no additional edge belts or secondary beams are needed, thus leading to a minimal and elegant shading architecture.

A similar approach was used for the facade design at the ground floor of the adaptive demonstrator tower D1244 [2], located next to ILEK at the University of Stuttgart. The 36.5 m tall high-rise building was built as part of the Collaborative Research Centre (CRC) 1244 "*Adaptive Skins and Structures for the Built Environment of Tomorrow*". It is to demonstrate the potential of adaptive structures and facades for reducing the ecological footprint of the built environment. The first results demonstrate how this approach can indeed radically reduce the consumption of natural resources, the production of greenhouse gas (GHG) emissions and the generation of waste by our buildings [3].

Several facade systems are planned to clad the different floors of the tower, showcasing the different strategies to be used to improve the ecological footprint of buildings by engaging adaptive technologies. Some of them are already under development [4,5] and demonstrate the contribution that the textile industry can play in the oncoming transformation process to a more sustainable built environment. For the facades at the ground floor of D1244, a movable translucent glass and basalt fibre facade was designed to showcase the adaptive structural systems located at the ground floor, while protecting them from rain and uncontrolled access. Moreover, the parametrically based design process served as a test for the integral design methods developed jointly by architects, civil and mechanical engineers within the CRC 1244 to improve the design of adaptive buildings [6]. The facade is currently under construction.

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