Zukunft Bau Short Report

Title

Development of lightweight profiles and components for usage in the textile building shells and window technology

Initiative / origin

Fibre reinforced plastics (FRP) present up till now little considered advantages in the production and construction of civil engineering, for example resistance against corrosion, durability and a low consumption of energy during manufacture. Through the development and construction of profiles the application of composites in supportive structures for modular multilayer textile building shells and window technology should be demonstrated.

Subject of the research project

In addition to manufacturing the focus was directed on developing a construction guideline for sizing and scaling from fibre reinforced plastic profiles for use in the building industry. The methods known in steel engineering are not easily transferable to meet the necessities of the technology for fibre reinforced plastic. Considering actual research results from aircraft and vehicle construction constructive nomenclatures were used to create a new material oriented philosophy to cope with the transition of fibre reinforced plastics into civil engineering.
The requirements necessary for the plastic profiles that could be used in textile building shells and window technology were analysed and hand in hand with industrial partners a supportive profile for textile building shells was developed (Fig. 1). The adaptable multilayer textile building shells are constructions of flexible high performance materials such as fabrics, knitted fabrics and films that create the outer casing under accordance with all the requirements needed. Parallel to this profiles for fibre reinforced plastic window frames were developed.
The profiles and their sizing and scaling were canalised and calculated using the Finite Element Method (FEM), (Fig. 2). Consequently the necessary tools were constructed and produced by an industrial partner. The interim result was the construction of a mock up for exhibition presentations (Fig 3).
Economical and effective construction of fibre reinforced plastic profiles was possible due to the Faserinstitut Bremen incorporated pultrusion technology in the region of process technology. These can be produced in nearly every cross-section desired. Due to the fast production speed the profiles are significantly less costly in comparison with traditionally produced fibre compound components. For the pultrusion, suitable materials were chosen and production tests were carried out. Samples were taken from the finished components and put through optical and destructive tests.
The detailed planning and construction of functional prototypes with the integration of a multilayer textile casing followed (Fig. 4). Examina-

tion of the diverse mechanical characteristics for these prototypes were implemented. For this the configuration and expansion of the test methods for the fibre reinforced plastic profiles on an existing test machine was necessary. Parallel to this the construction of samples to use as connectors to the multilayer systems and demonstration objects for the project developed Window frame profiles took place (Fig 5).
In future, through the development of fibre reinforced plastic profiles and components it will be possible to construct supportive structures for modular multilayer building cases and for usage in the window technology. In comparison to traditional materials these materials are characterised through a significant weight reduction. Light weight fibre reinforced plastic structures can be assembled as complete modules and thereby allow for a structured and efficient work flow. A further decisive advantage is the possibility to create low thermal bridging constructions.
The research results contribute substantially to show the future potential, bring the development to maturity and verify the practicability and functionality.
Within the projects research, significant aspects for the application of fibre reinforced plastic profiles such as the problems caused through complex cross-sectional geometry could be clarified. There are however still further unsolved questions. Particularly concerning the strengthening of the profiles through orthogonal to the pultrusions axis inserted fibre reinforcements which are necessary for the static functionality. As soon as this problem is solved, all structural requirements on the profiles will be complied.

Conclusion

The aim of this research project was the development of profiles from light weight fibre reinforced plastic and the usage of these materials in the architecture of civil engineering.
Profiles were developed for the region of multilayer textile building cases, the mechanical characteristics in simulation procedure were calculated and constructed through a pultrusion technique. Finally demonstrations for the textile building cases were built and put on show for the public. In a further activity novel profiles for very slim but mechanically stiff window frames were designed and constructed as mock ups.

Key data

short title: PROFAKU /
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FIGURES :

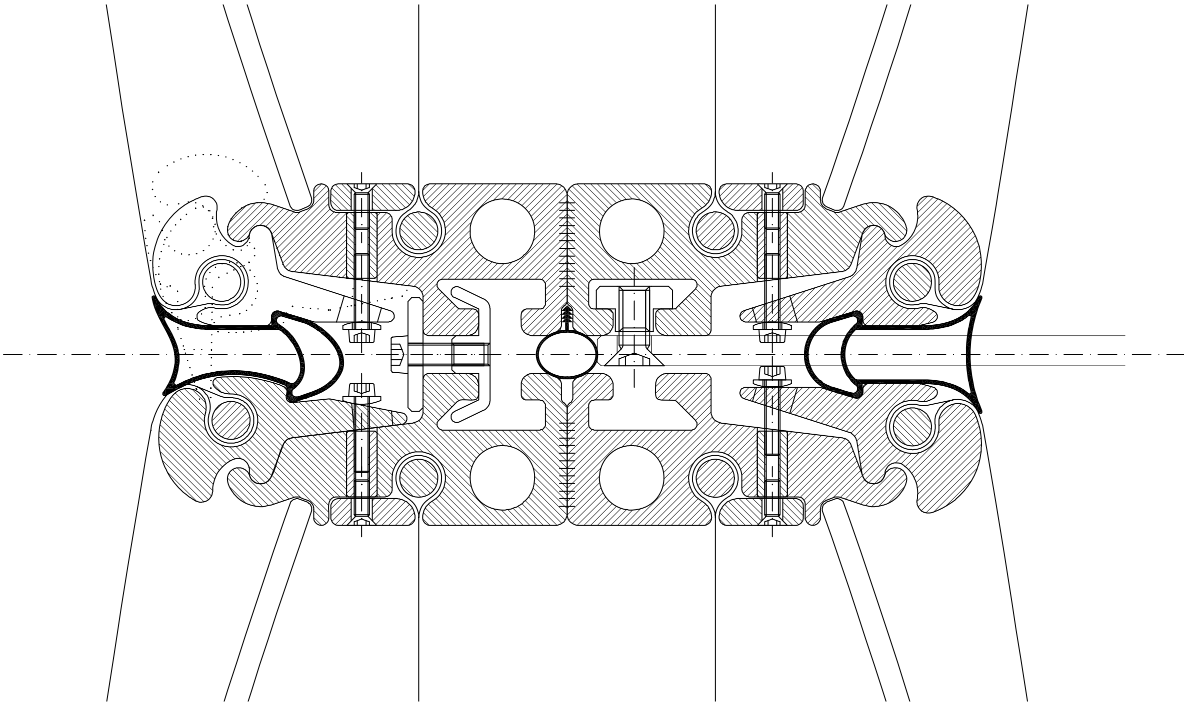

Fig. 1: Cross section of two building case frames in mounted state

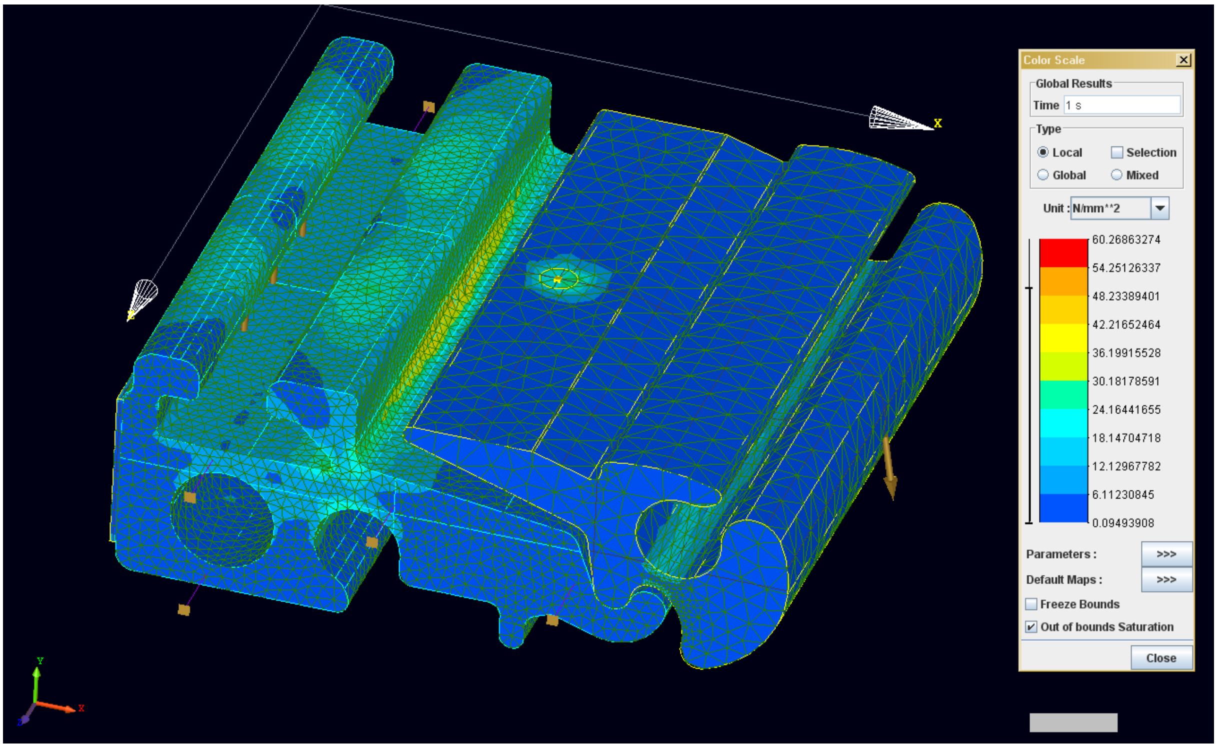

Fig. 2: Finite Element Method simulation of a frame segment with screwed clamp profile

Fig. 3: Mock up of a textile building case

Fig. 4: Demonstration of two building case segments (Height 3m, Width 2,4m)

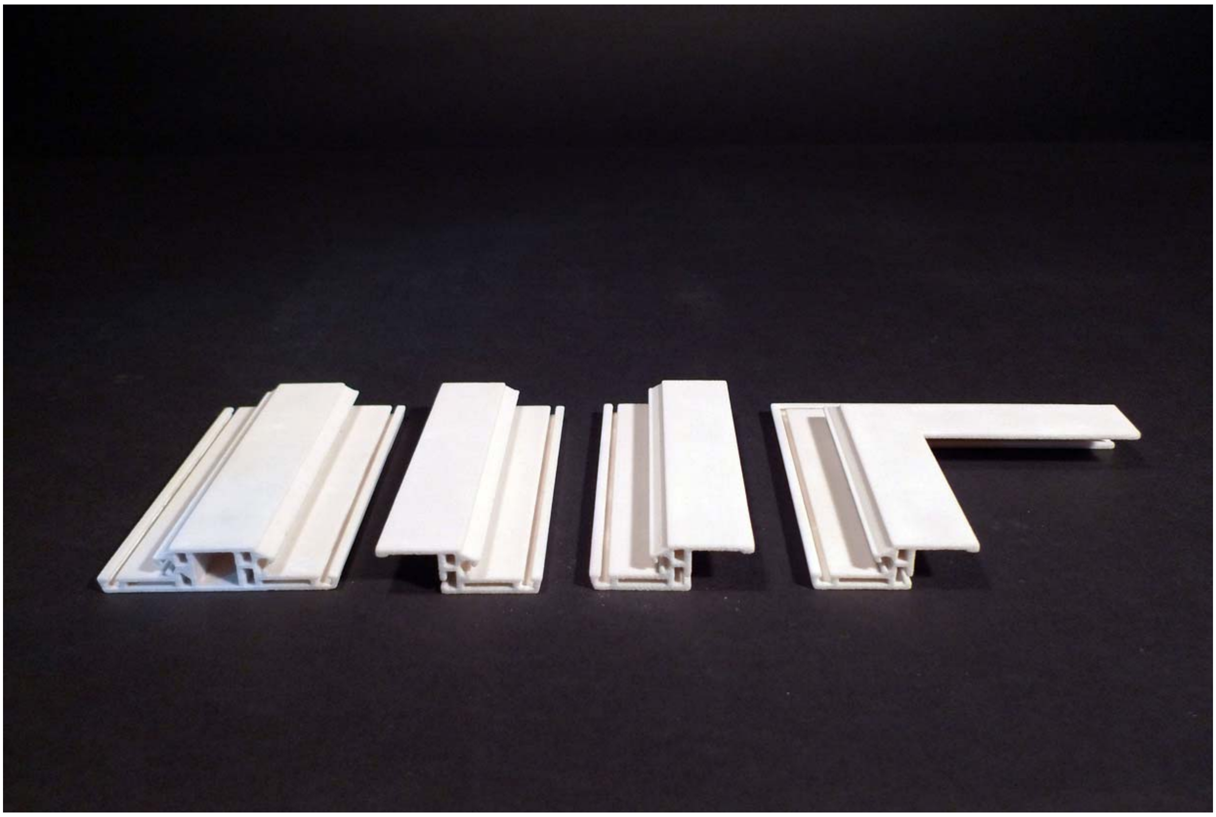

Fig. 5: Mock ups of ultra slim window frame profiles created from rapid prototypes