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Composite Façade Elements with Self-Cleaning Surface made of Ultra-High-Performance Voncrete (UHPC)

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1 Introduction

Highly automated production plants and design methods based on Building Information Modelling (BIM) make the prefabrication of building elements very efficient. Within the European project [H]house the BAM and industrial partners developed self-supporting sandwich façade elements consisting of a thin shell of ultra-high performance concrete (UHPC) filled with an insulation of autoclaved aerated concrete (AAC) (Miccoli *et al*., 2015, Fontana *et al*., 2016). Sustainability of the façade elements was further increased by the optimization of the binder and adding self-cleaning properties to the surface based on the Lotus® effect.

2 Materials and Methods

While ensuring a minimum strength requirement of 100 MPa a binder composition named [H]house Compound 5941 based on the Nanodur® fine mix was developed which contains less than 55 % Portland cement clinker and results in a reduction of non-renewable energy and global warming potential (Deuse *et al*., 2018).

Due to the fineness and fine-tuned granulometry of the mixture a filigree microstructure can be imprinted into the concrete surface. To achieve a hydrophobic surface a hydrophobing agent was applied to the substrate before concreting and incorporated into the hardening concrete.

Based on structural and economic reasons the façade panels are designed as box shaped UHPC elements. Due to technical reasons the elements had to be manufactured in two concreting steps. In the following sections selected test results regarding different technological aspects during the upscaling process are presented.

3 Results

To identify the best surface treatment for an optimum bond between the two concreting sections, adhesive pull strength tests were performed at samples sized 30 x 30 cm according to DIN EN 1542. The results illustrate that after roughening the surface with a steel brush in one direction the loadbearing behavior corresponds to the monolithic reference. The system fails not in the joint as is the case without surface treatment but within the second layer (Figure 1).

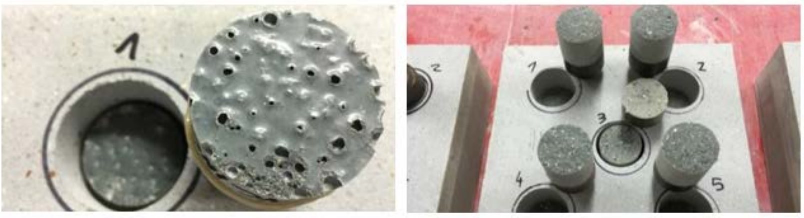

Figure 1. Failure in the joint due to “elephant skin” (left) and cohesion failure within the 2nd layer (right).

Within the upscaling process further test series were carried out to identify the best material for the formliner, the type and appropriate amount of the hydrophobing agent as well as the most efficient chronological sequence of the production method (Figure 2).

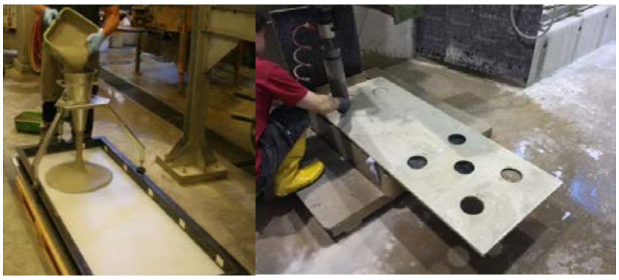

Figure 2. Concreting of test samples (left) and core extractions (right) to assess the self-cleaning properties.

The results illustrate that for achieving homogeneous and durable self-cleaning properties as well as a high quality of architectural concrete the production must be planned in detail. The best results can often be achieved with a moderate work effort or material use. The maximum adhesive pull strength was measured when roughening the surface only in one direction and not adding water. The best results regarding the homogeneity of the self-cleaning properties were determined for the application of the smallest amount of hydrophobing agent using a brush.

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