Dyckerhoff

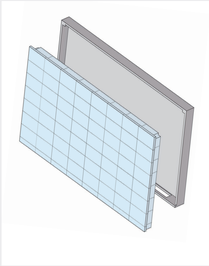
[H]house

[H]house Façade Elements - Demonstration of the Concept

[H]house - Healthier Life with Eco - Innovative Components for housing Constructions

The project has developed a variety of new multifunctional and flexible building components for a healthier indoor environment. The developed systems are suitable for new buildings and renovation. H-House solutions are durable, energy efficient and affordable. They are suitable for different applications and environments and cover aspects of long service life, reduced maintenance and long-term improvement of energy efficiency. This demonstrator is focused on the building envelope and the development of sandwich façade elements consisting of ultra high performance concrete (UHPC) and autoclaved aerated concrete (AAC). The approach on the material level is an optimization of the cementitious binder by means of an increased amount of supplementary cementitious materials (SCM) and an additional functionalization of the UHPC element surfaces.

UHPC Façade Elements



The resulting UHPC composite elements offer a number of advantages like reduced thickness and weight or improved durability. Fire safety is assured through the use of integrated insulation based on non-combustible autoclaved aerated concrete insulation boards (Multipor® from Xella). Due to the special structure of the mineral insulation, the AAC core of the elements has a remarkable low thermal conductivity (λ_D) of 0.042 W/(m·K).

◀ Drawing of UHPC-AAC half-panels (drawing: BAM)

UHPC Cementitious Binder

The aim of the binder development was the highest possible replacement of Portland cement clinker by SCM's within an UHPC mix design and a minimum strength requirement of 100 MPa. The resulting binder composition is named **[H]house Compound 5941** and available in grey and white. With less than 55% Portland cement clinker, the embodied energy of the developed binder system is greatly reduced. The following table shows the most essential figures of the LCA.

◀ Composite element section (drawing: BAM)

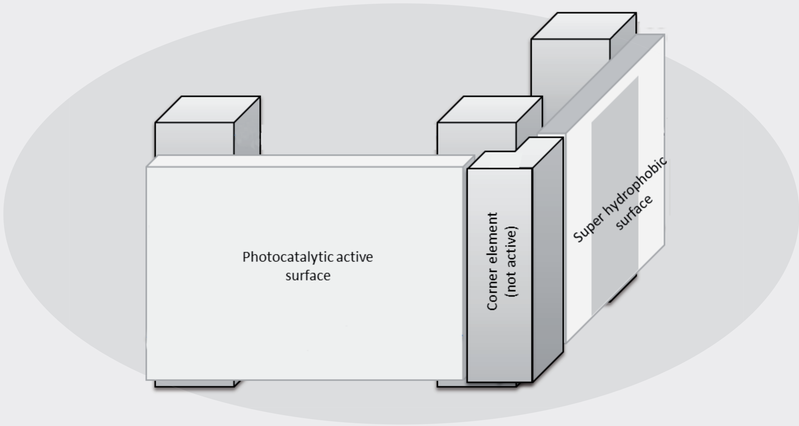
Material / building component	Non-renewable energy	Global warming potential GWP
UHPC-AAC half panel	1308 MJ/m² wall	118 kg CO_2 eq./m² wall
Conventional solution (cladding/mineral wool)	1586 MJ/m² wall	123 kg CO_2 eq./m² wall
Saving of energy and CO_2	278 MJ/m² wall	5 kg CO_2 eq./m² wall

▲ Table with life cycle impacts of UHPC-AAC half panel v/s conventional, non-combustible cladding. Functional unit: 1m² of non-loadbearing façade in refurbished building in Berlin (Germany), considered life span of components= 55 years; the benefit of UHPC-AAC half panels with respect to the conventional solutions increases with aging wiev to de limited life span of mineral wool (LCA performed by CYCLECO)

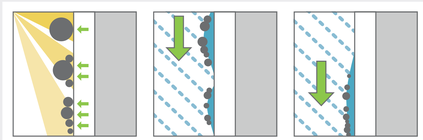
Surface Functionalization I

The granulometric optimization of **[H]house Compound 5941** and an advanced casting technique allows a micro-structuring of the concrete surfaces. The application of water-repellent agents directly on the textured mould leads to super hydrophobic concrete surfaces.

◀ Super hydrophobic surface of the elements (photo: BAM)



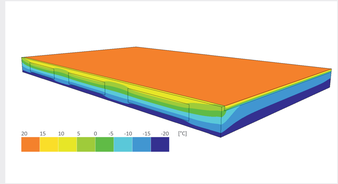
Surface Functionalization II



By addition of titanium dioxide (TiO_2) to the concrete multifunctional surfaces with photocatalytic and self-cleaning properties are possible.

▲ Self-cleaning effect of photocatalytic active surfaces (source: Roswag)

Thermal Performance



H-House aims to improve the energy efficiency of the building envelope by reducing the heat transmission coefficient (U-value) of the façade elements. The thermal conductivity (λ) of the materials was measured in accordance to EN 12664 using the Guarded Hot Plate method.

▲ Heat transfer profile of UHPC-AAC composite element calculated according to EN ISO 6496 applying 3D Physibel software (source: ITB)

Element	U-Value
H-House target value (low energy house)	0.15 W/(m²·K)
Conventional solution (cladding/mineral wool)	0.18 W/(m²·K)
UHPC-AAC half panel	0.15 W/(m²·K)

▲ Table with heat transmission coefficients of UHPC-AAC half panel v/s conventional, non-combustible cladding.
U-value calculation based on UHPC-AAC half panel with a total thickness of 30 cm and cladding with mineral wool insulation of 22 cm thickness and 4 connectors /m² (thermal properties measured and calculated by ITB)

Project Framework

H-House is a collaborative research project and has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no.608893.

Runtime: September 2013 to August 2017
Consortium: 12 partners from 4 EU countries
Coordinator: CBI Swedish Cement and Concrete Research Institute
Homepage: http://www.h-house-project.eu

Demonstration Object

The development and implementation of the demonstrator concept was realized by project partner Dyckerhoff, a member of the Buzzi Unicem Group:

Dyckerhoff GmbH
Wilhelm Dyckerhoff Institute for Building Materials Technology
Dyckerhoffstr. 7
D-65203 Wiesbaden, Germany

BAM · ITB Instytut Techniki Budowlanej · AERCRETE · CYCLeco · Roswag Architekten · AEROGEL · FASADA · STRÄNGBETONG · Xella · Mostostal · Dyckerhoff