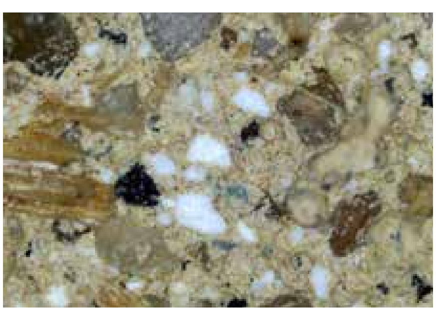
[H]house

HEALTHIER LIFE WITH ECO-INNOVATIVE COMPONENTS FOR HOUSING CONSTRUCTIONS

AEROGEL MODIFIED EARTH PLASTER

Due to their clay minerals, earthen plasters are recognised for their outstanding ability to adsorb and buffer humidity as well as to adsorb harmful substances and to reduce bad odours. In order to enhance such properties, aerogels are blended into earthen raw materials. The highly porous structure of aerogels offers a very large internal surface that provides excellent sorption performance for both moisture and airborne pollutants. The final product will balance interior humidity levels and make constructions more robust by reducing the prevalence of moisture damages such as mould growth.



▲ Mixing process of aerogel modified earth plaster
▶ Microscopic image of aerogel modified earth plaster specimen
▼ Compressive strength test of modified earth plaster specimen

INDOOR ENVIRONMENTAL QUALITY

Modern energy efficient and airtight buildings often demonstrate unforeseen shortcomings including poor indoor environmental quality. This can impact negatively on occupants' health. Special emphasis has therefore been placed on the investigation and selection of natural building materials, which exhibit low-level emissions (formaldehyde, VOCs, SVOCs and radon) for interior wall applications. Additionally, the sorption capacity of materials for airborne pollutants has been investigated for aerogel modified earth plasters.

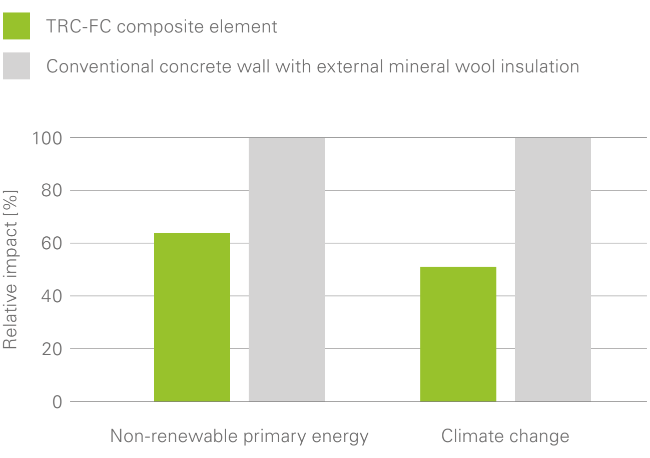
◀ Internal partition wall (earth plaster and earth dry board)
▲ Emission test chamber
▼ Interior fit-out with low emitting, hygroscopic materials

LIFE CYCLE ANALYSIS & COSTING

The sustainability of [H]house innovative components is of great concern to the project partners. In order to support the design of the composite elements, several variants have been compared according to the Life Cycle Assessment (LCA) methodology over the course of the project. Each material and design aspect was carefully selected taking into account stringent environmental criteria. Environmental impacts and costs of the innovative building components are estimated in comparison to conventional solutions.

Furthermore, the environmental datasets of the façade elements made of concrete will be available in the International Life Cycle Data (ILCD) format on the life cycle data network of the European Commission (http://eplca.jrc.ec.europa.eu).

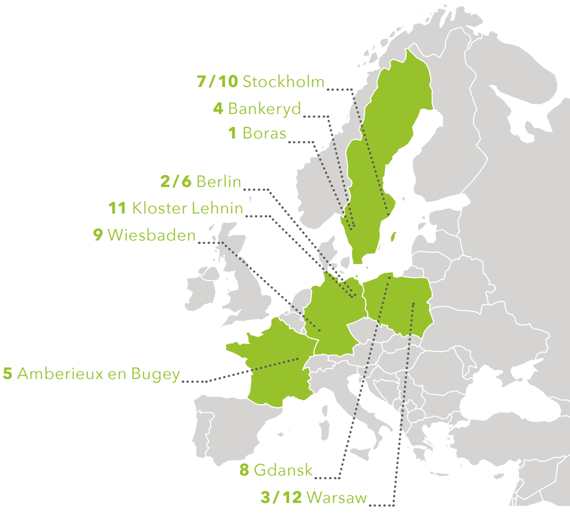
COMPARISON OF LOADBEARING WALLS FOR NEW CONSTRUCTIONS
U-value= 0.15 W/(m^2 K), Reference study period: 80 years
Life span: Conventional concrete: 80 years; Mineral wool insulation: 40 years
Life span: TRC-FC composite element: 80 years



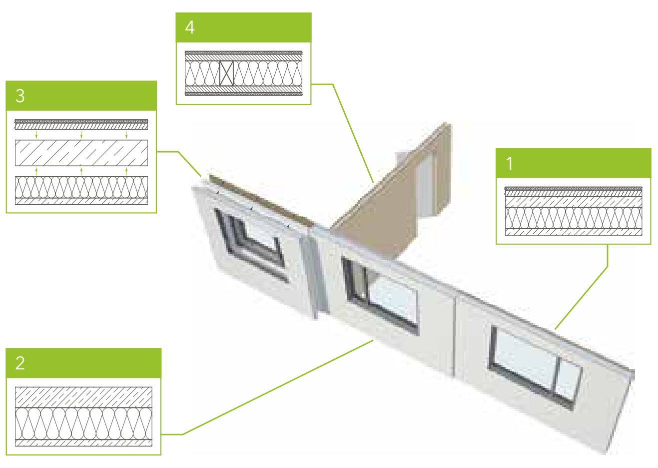
▶ Comparison of loadbearing walls for new constructions
▼ LCA assessment cradle to grave (Graphic: ©Cycleco / Photo: ©Consolis Strängbetong AB)

[H]house CONSORTIUM

1 CBI Swedish Cement and Concrete Research Institute (Sweden)
2 BAM Bundesanstalt für Materialforschung und-prüfung (Germany)
3 ITB Building Research Institute (Poland)
4 Aercrete Technology AB (Sweden)
5 Cycleco SAS (France)
6 Roswag Architekten (Germany)
7 Svenska Aerogel AB (Sweden)
8 PRE Fasada sp. z o.o. (Poland)
9 Dyckerhoff GmbH (Germany)
10 Strängbetong AB (Sweden)
11 Xella Technology and Research Centre (Germany)
12 Mostostal Warszawa SA (Poland)



www.h-house-project.eu



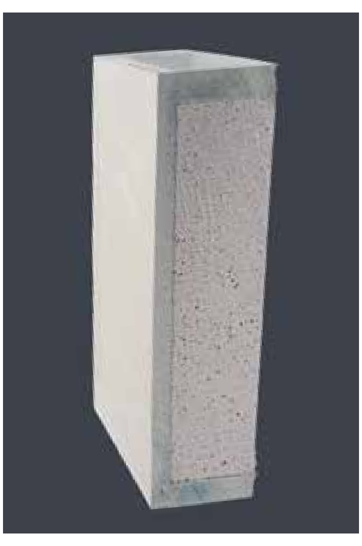
[H]house Healthier Life for Eco-Innovative Construction

The project will develop new eco-innovative materials with the aim to design innovative building components (internal and external walls) for a healthier indoor environment. The developed systems are suitable for new buildings and renovation. They are appropriate for a society where environmental awareness and a high degree of living comfort are both required and expected. [H]house solutions cover aspects of chemical and physical activity of the developed building materials, their embodied energy, suitability for different applications and environments, durability, cost-efficiency and long-term improvement of energy efficiency of buildings.

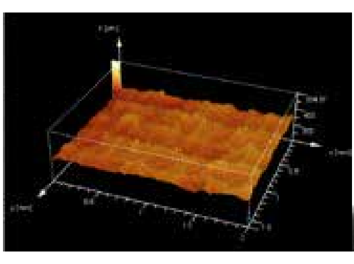
▲ Perspective real case scenario in urban context
▲ [H]house concept: External wall: UHPC composite element (1), TRC composite element (2), renovation (3); Internal wall: earth wood composite (4)
▶ Material composition

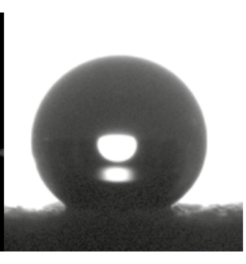
TRC AND UHPC FAÇADE ELEMENTS

TRC and UHPC composite elements offer a number of advantages. Steel reinforcement is replaced by a carbon fibre grid, thus significantly reducing thickness and weight whilst improving durability by avoiding corrosion. With less than 50% Portland cement clinker, the embodied energy of the binder system is greatly reduced. Fire safety is assured through integrated insulation based on noncombustible cementitious materials such as foam concrete (FC) and autoclaved aerated concrete (AAC).



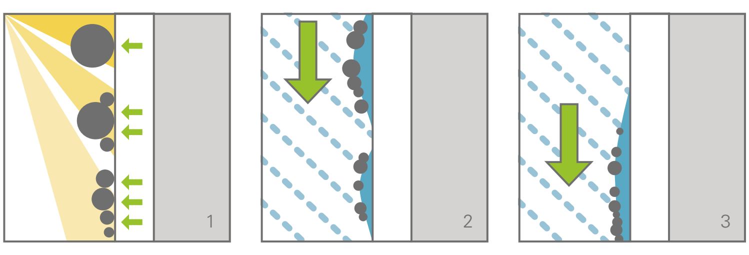
▲ 2D carbon reinforced concrete specimen
▲ UHPC-AAC composite element
◀ TRC panel production



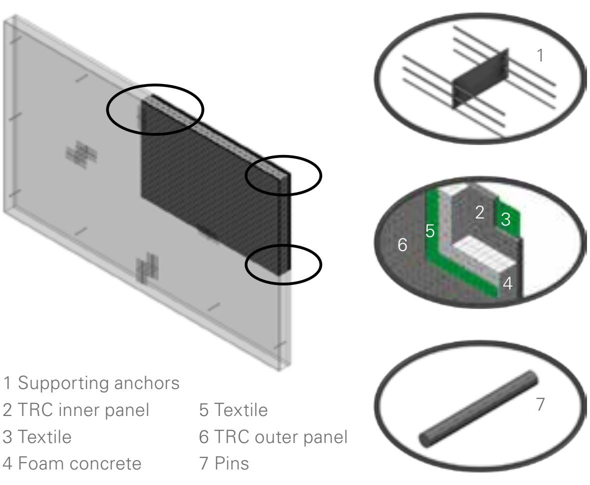


SURFACE FUNCTIONALISATION

Physical and chemical modification of the external concrete surfaces contributes to improved durability and reduced maintenance. Through micro-structuring of the concrete surfaces using a casting technique and water-repellent agents, superhydrophobic surfaces were created. This new method revealed higher efficiency and higher durability of the treatment leading to the application for a new patent. Bulk addition of titanium dioxide powder to the concrete or a simple method for coating the concrete surface, consisting of the application of titanium dioxide dispersion, allowed the development of photocatalytic and superhydrophilic properties.

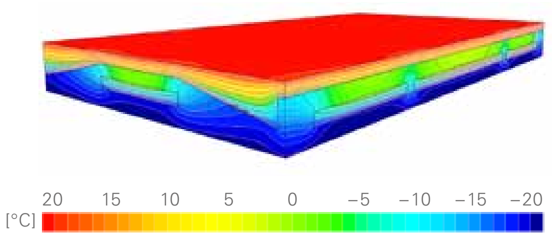


▲ Superhydrophobic UHPC surface
▲ Micro structured UHPC surface with water droplet
▶ Photocatalytic self-cleaning: (1) Decomposition of dirt activated by sunlight, (2–3) Decomposed dirt particles are easily detached and removed by rain water



NUMERICAL MODELLING

A multi-level structural analysis of Textile Reinforced Concrete (TRC) and Ultra-High Performance Concrete (UHPC) composite elements allowed a better understanding of the composite action of the composite elements leading to an optimisation of their design with regard to the thickness, number and location of connectors and anchorage systems. The reliable numerical strategy adopted represents a reasonable compromise in terms of accuracy of the element characteristics and the computational costs. The thermal performance of the components was specified through numerical modelling used to study 3D steady state heat transfer profiles according to EN ISO 6946. The influence of linear and point thermal bridges was also taken into account by applying 3D modelling according to EN ISO 10211.



▲ Flexural test of foam concrete (FC) sample
▲ TRC composite element numerical modeling
▶ 3D Thermal image of UHPC composite element with isotherms