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Environmental benefits of textile-reinforced concrete demonstrated

A new concrete-reinforcement system, used by the LIFE INSU-SHELL[1] project, replaces steel rods with non-corrosive textile structures to reduce the amount of concrete needed in construction. This nearly halves the global warming potential of traditional steel-reinforced concrete which is the largest producer of CO_2 emissions in the building industry.

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The good mechanical properties and low cost of concrete have made it the world's most popular building material. However, although it can bear high pressure, it does not perform well at resisting 'tensile' forces; the vertical forces that tend to tear apart or split materials. As such, concrete requires reinforcement, which traditionally uses steel rods. In order to avoid corrosion of these steel rods, a minimal concrete layer of 3.5 cm is needed. This is not required from a structural point of view but to protect the steel.

However, the use of textile reinforcement made from non-corrosive materials, such as carbon and glass can reduce the required concrete material by up to 85%. This is known as Textile Reinforced Concrete (TRC).

Sandwich panels are a composite structure in which two stiff outer sheets are bonded to a lightweight core and are used in industrial and multi-storey buildings. The technology of sandwich panels made of TRC has been applied in laboratory research, but the INSU-SHELL project was one of the first to use it in a large-scale building project in Aachen, Germany. Using data collected from this project, the study assessed the structural, environmental and economic performance of TRC.

The panels were made of concrete reinforced with glass textiles and fixed to a rigid polyurethane foam core inside the 'sandwich'. The heat transfer was at a level far below the critical value of current regulations and the panels exceeded the demanded design values in terms of capacity to bear horizontal loads and tensile forces.

Using life cycle analysis, the study compared the global warming potential of the INSU-SHELL TRC sandwich panel to traditional steel-reinforced concrete panel. To make a fair comparison, the study compared TRC to a traditional wall panel with the same bearing capacity and heat transition per m^2 façade.

The INSU-SHELL façade weighs about 17% of the conventional façade and its energy consumption during production is just over 1000 MJ (megajoules) per m^2, which is just over half (54%) the energy consumption of traditional concrete design. In terms of environmental impact, the global warming potential of the INSU-SHELL façade is 69.34 kg of CO_2 equivalent per m^2 which is 47% of the global warming potential of its traditional counterpart.

The study estimated that the INSU-SHELL panel would cost €487.5 for 3 m^2, over twice as much as traditional concrete, which would cost €208.32 for the same amount. However, this high value is because this method of concrete reinforcement is in an early, prototype stage of its development. Once the production has been optimised, with standardised elements for mass production, the costs should fall. It should also be noted transport costs for INSU-SHELL are about a third of the costs for traditional concrete as it weighs much less. As future developments occur, such as vacuum insulation panels, the INSU-SHELL prototype has the potential to make even more financial and environmental savings.

1. www.life-insushell.de