CASE STUDY

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The Challenge

Decarbonisation of reinforced concrete constructions is one of the primary objectives of any route maps developed for achieving net-zero industrial emission goals. The excellent properties and the significant volume of concrete used worldwide indicate that its large-scale replacement is not feasible. There is, therefore, a need for the development of solutions that allow for significant reduction of the embodied carbon of concrete constructions using existing technologies.

The application of emerging non-metallic textile grids to the reinforcement of concrete, the so-called Textile Reinforced Concrete (TRC), is one of the most effective strategies for achieving this urgent need. TRCs are several times lighter and stronger than reinforced concrete. The non-metallic nature of textiles eliminates the corrosion problem and allows for reducing the concrete cover thickness to nearly zero. These combinations allow the development of ultra-low-carbon light-weight concrete components that are more durable and have longer service life than traditional steel reinforced concrete. However, there is a lack of awareness, knowledge of performance, confidence, and guides for the industrial use of TRCs, hindering their application and uptake in the UK construction sector. Aiming to establish the foundations of upscaling TRCs to industrial applications, this project was centred around understanding the performance indicators of the TRC composites for precast manufacturing, and addressing the technical and non-technical barriers against their uptake in the UK construction sector.

Innovation Launchpad Network+

Innovation

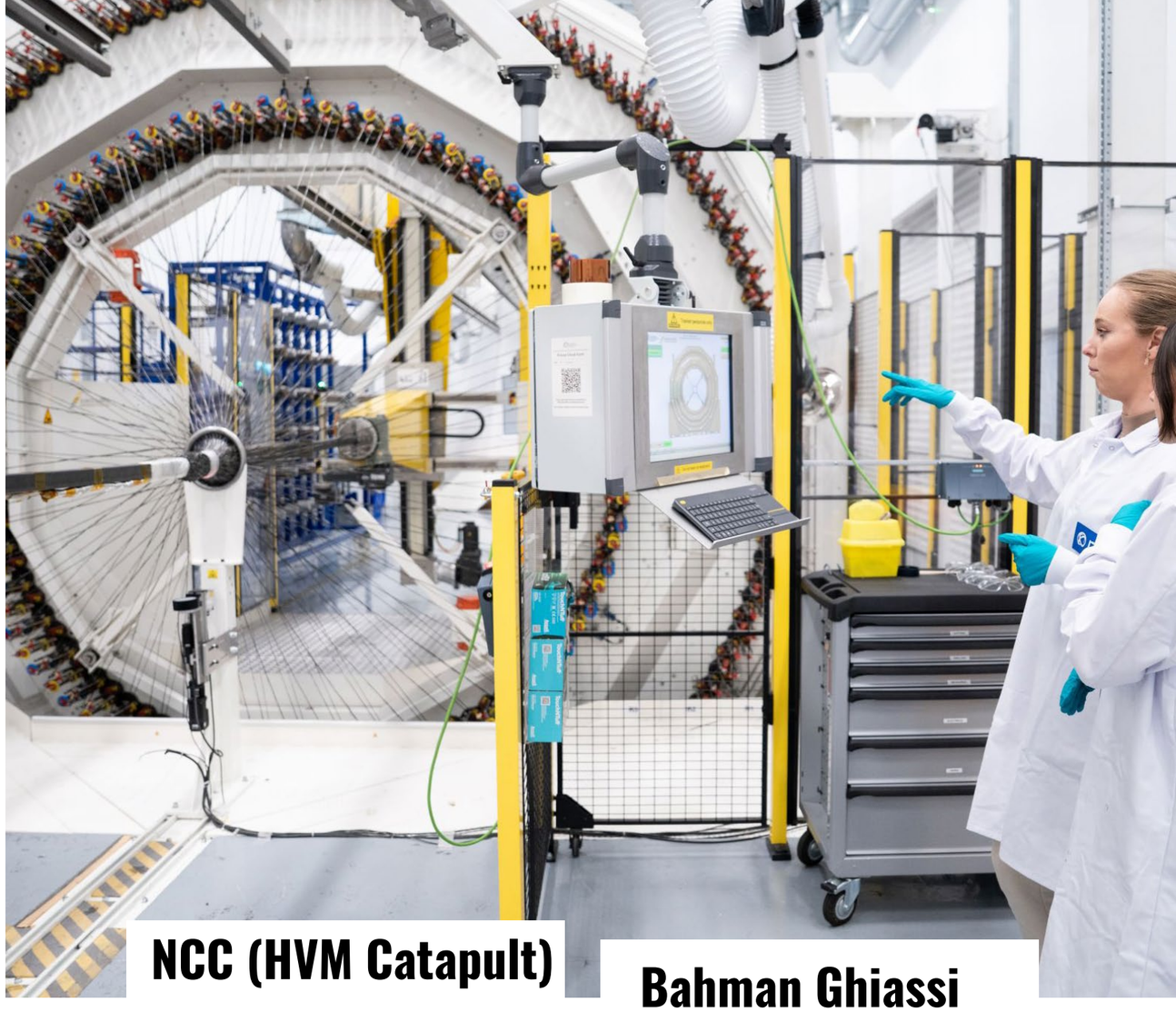
This project involved rigorous experimental assessment of how structural components made of TRCs behave under mechanical. This involved a large experimental campaign across scales, significantly leveraged by the in-kind support of Dr. Ghiassi's research group. This was followed by an assessment of the potential impact of TRCs on the embodied carbon, economy and longevity of reinforced concrete products or applications. Another key pillar of this project was focused on increased awareness and establishing collaborations with industrial partners including materials producers, pre-cast manufacturers, and consultants, through workshops and outreach events.

Result

TRC composites present a great opportunity for rapid decarbonisation of concrete infrastructure using existing technologies. TRC components can be lighter, stronger and more durable than their steel-based reinforced concrete counterparts. Application of non-metallic technical textiles to the reinforcement of concrete infrastructure eliminates the risk of corrosion, one of the most significant causes of deterioration in RC structures. This increases the service life and longevity of our infrastructure and also allows releasing durability-based code criteria for the protection of concrete elements against reinforcing steel corrosion. The application of non-metallic textile reinforcements is also associated with reduced reinforcement transportation and meshing costs and energy demand.
Currently, there are no TRC production facilities in the UK, but with design and production guidance to be drafted soon, it is expected that relevant specifications and use opportunities will increase. TRCs could be an enabler for sustainability and productivity improvement for the UK reinforced concrete products and can support Modern Methods of Construction (MMC) and minimisation of waste in constructions.

Impact

Compared to traditional reinforced concrete constructions, TRC composites can enable >50% materials saving (including cement, aggregates, water, and reinforcement) and 30-60% reduction of embodied carbon in the whole value chain of reinforced concrete constructions, while increasing the service life to >120 years.
TRCs can be used for the manufacturing or strengthening/repair purposes across a wide range of areas and sectors including constructions, transport infrastructure, energy infrastructure, and water infrastructure. This indicates the potential of these composites in enabling a significant reduction of the construction-related embodied carbon across the whole sector.



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"Textile reinforced concrete has the potential to be a game-changing technology for the built environment, delivering improvements in durability, material efficiency and sustainability. This project also demonstrated the value of cross-sector innovation. As the work progressed, we started exploring how advanced composites technologies, including textile fibre placement, could further enhance TRC through optimised reinforcement strategies and greater design flexibility. This creates an exciting pathway for future innovation, particularly in applications that demand both high performance and non-combustible material solutions." **- Dr Kaloyana Kostova, Engineering Capability Lead, NCC.**

ncc innovating for industry

Bahman Ghiassi

To date, efforts on decarbonisation of reinforced concrete constructions have been mainly focused on cement alternatives, neglecting the significant role reinforcement can play in this journey. This project addressed the above, and investigated the potential impact of replacing steel bars with non-metallic reinforcements on the embodied carbon, economy, and longevity of reinforced concrete and demonstrated significant benefits could be readily achieved in a wide range of construction and infrastructure product set.

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