# MINIMASS: a new approach for low-carbon, low-cost 3D printed concrete beams

**Andy Coward**

*Net Zero Projects Limited, London, UK*

**Jesper Harrild Sørensen**

*Technical University of Denmark, Copenhagen, DK*

**Contact:** andyc@netzeroprojects.co.uk

## Abstract

The construction industry is beset by two well-known problems – high carbon footprint and low productivity growth. 3D printing of concrete offers the potential for massive improvements in both those areas, if real structural uses can be found. This conference paper describes a new and innovative design method for creating 3D printed concrete beams, using external post-tensioning to provide bending and shear capacity. The results offer reductions of up to 70% of the embodied carbon compared to a similarly performing precast concrete beam, with the potential for up to 50% reduction in material costs. A series of physical prototypes have been built, with large-scale load testing carried out at the Technical University of Denmark (DTU) in Copenhagen, the results of which are presented herein.

**Keywords:** 3D printed concrete; beams; post-tensioning; long-span structures.

## 1 Introduction

Cost and carbon in construction are prominent discussion points throughout the industry at the current time. The highly competitive and highly fragmented nature of the industry means that the question of cost will always be the primary driver for project developments. However, more and more countries and authorities are introducing and enforcing climate targets as a way to push development towards a more sustainable future. In the absence of a global agreement on carbon pricing, this targets-led approach could be the way in which the industry becomes more sustainable. Given that the industry is responsible for 11% of total global carbon emissions (2019), rising to 39% when operational emissions are included [1], there is an urgent need for lower carbon solutions.

Materials suppliers, for example the Global Concrete and Cement Association (GCCA), are setting targets and creating roadmaps [2] for de-carbonising supply chains. That is crucial work which will need to be supported over the coming years and decades. However, what if there are ways to significantly reduce both cost and carbon through better design? The GCCA Roadmap suggests that 22% of the savings required to reach net-zero will come from “efficiency in design and



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