

Characterisation of the flow properties of green concrete for 3D printing

Introduction

Digital production of concrete structures using 3D printing is a technology with huge prospects since it could potentially create concrete structures faster, better and at less cost, while securing a safer working environment at construction sites. The most common concrete printing method is extrusion-based 3D printing where concrete is pumped via a hose through a nozzle to print layer by layer in two dimensions until the three-dimensional concrete structure is complete. New progress in this 3D concrete printing method has rendered the technology more useful to industry, but challenges are yet to be overcome to achieve a true commercial breakthrough:

- Concrete for 3D printing consumes two to three times more cement compared to concrete used for conventional structures, which increases the concrete price.
- The high cement content is also a burden to the environment since cement emits CO₂ during production.
- For 3D printing, the concrete must be thick enough to bear the load of the new layers printed on top of it, and thin enough for it to be pumped through the hose and to avoid porosity between layers.

Research project at DTU, Department of Mechanical Engineering

The purpose of this research is to overcome the listed challenges by developing a geopolymer concrete with the right flow properties for 3D printing purposes. The geopolymer is an environmentally friendly bonding agent that replaces cement in concrete. The bonding agent is the 'glue' that ties together the sand and aggregate in the concrete. The geopolymer is made of fly ash, which is a powerplant waste product.

Donation by COWIfonden

COWIfonden's donation enabled the purchase of a high-tech instrument that makes it possible to characterise the flow properties of the geopolymer concrete and thereby quantify which flow properties result in the best possible prints/concrete structures. This will be a very significant step towards making 3D concrete printing more relevant to industry and making concrete structures greener.