Proportioning of Oil Shale Ash for Sustainable 3D Printable Mortars

Maris SINKA, Alise SAPATA, Ella SPURINA, Liga PUZULE, Genadijs SAHMENKO
3D concrete scientific laboratory, Institute of Materials and Structures, Riga Technical University

Introduction

To achieve optimal strength and printability, mortars used in 3D printing typically contain high proportions of cement, resulting in high carbon footprint.

The use of alternative supplementary cementitious materials such as oil shale ash (OSA) could reduce the environmental impact of mortars used in 3D printing.

It would also allow to repurpose waste from power plants in the Baltic states, where oil shale is intensively utilized.

Materials and Methods

The used mixtures contained varying amounts, ranging from 0% to 40%, of OSA from power plants in Narva, Estonia, used as a substitute for cement.

3D printing was carried out on a gantry type printer with batch type print-head. Mechanical and durability properties were measured for 3D printed and cast samples.

Life cycle assessment was performed to calculate carbon emissions from the developed composite.

Results and Conclusions

Replacement of 10% of cement mass with OSA does not significantly reduce the compressive strength of concrete.

Replacing up to 10% of cement with OSA can improve frost resistance compared to concrete with no OSA, making it suitable for XF4 environments.

Mortars containing up to 10% OSA have a reduced environmental impact, emitting 5% less carbon emissions compared to mortars without OSA.