

Cement-free 3D printable concrete using construction and demolition waste achieved ~30 MPa compressive strength, proving it low-CO₂ alternative for sustainable construction.

Emissions were reduced by ~80-90% compared to conventional 3D-printable concrete, with most of the reduction coming from cement replacement.



Introduction

This research presents an innovative approach for utilizing **construction and demolition waste aggregates (CDWA)** in a **cement-free binder** suitable for **3D printing**, with the goal to **reduce CO₂ emissions** and **promote circular construction**.

Materials and Methods

Granulometric analysis, water absorption, and density of natural coarse aggregate (NCA) and CDWA (fr. 2/8mm) was studied to ensure compatibility.

Flexural and compressive strength was tested for both 3D printed and cast specimens for **six different series**. 3D printing was carried out using a gantry-type printer.



Fig. 1. 3D printing using following aggregates: NCA Sakret; CDWA CleanR; CDWA Getlini.

Three series of **cement-containing mixtures** were formulated using NCA and two types of CDWAs, with a binder composition of 60 wt% **cement**, 25 wt% **oil shale ash (OSA)**, and 15 wt% **metakaoline (MK)**.

Then, for each cement-containing mixture, a **corresponding cement-free mixture** was formulated, with binder consisting of 80 wt% OSA and 20 wt% MK.

Results and Conclusions

Particle size distribution was similar for all aggregates, ensuring **comparable packing densities** for all mixes and leading to **similar printability and water demand**.

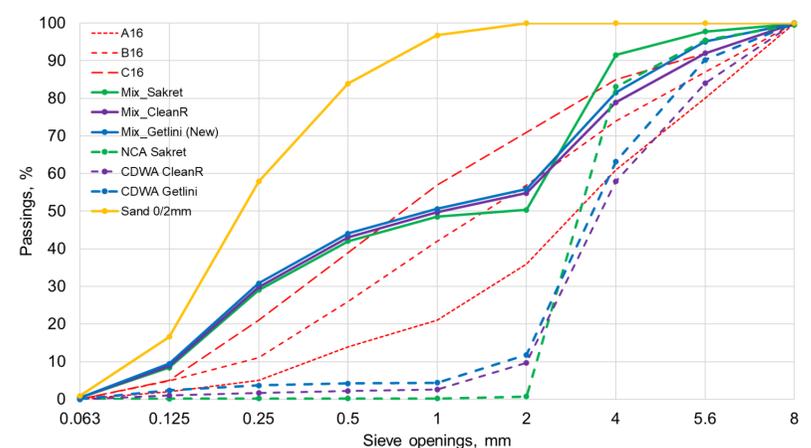


Fig. 2. Particle size distribution of used aggregates and mixtures.

Cement-containing mixes with CDWA reached relatively high compressive strength of **~50-65 MPa**.

Cement-free mixes reached compressive strength of **~30 MPa**, showing that OSA-MK can ensure **adequate structural performance without cement**.

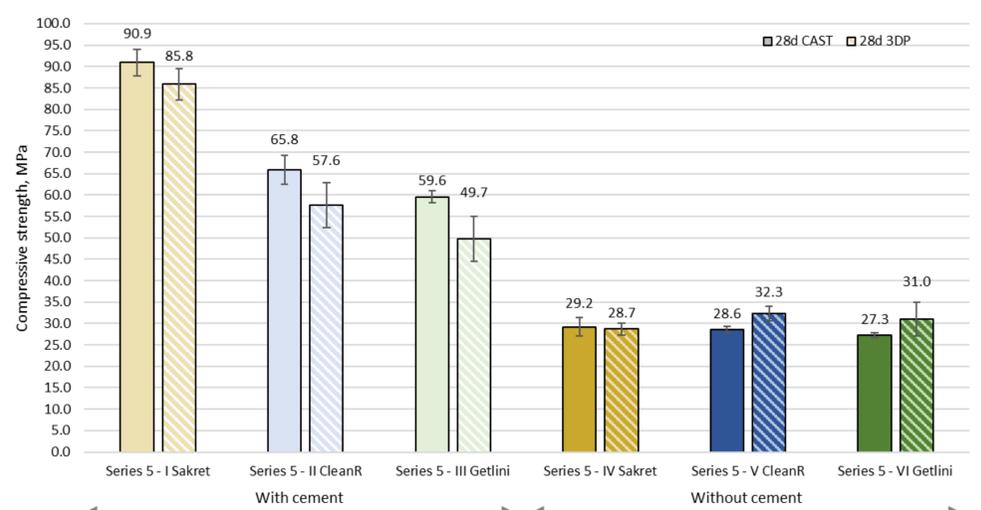


Fig. 3. Compressive strength test results.