Investigation of admixtures and water uptake of lightweight aggregate effect on the rheological behaviour of mortar mixes for 3D printing

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Developing a suitable concrete formulation for 3D printing can be challenging due to the number of parameters involved in the printing process, such as the system's specifications, the design choice, and the material's rheological behaviour. To tune the mixes' rheology for 3D printing, researchers often employ admixtures such as superplasticizers and viscosity modifying agents (VMAs). However, the rheological aspects of the mix change when lightweight aggregates are also incorporated due to an increase in effective water content caused by the uptake of water by the aggregates' rough surface. Nevertheless, to date, it is unclear to what extent the admixtures content and the water uptake of these aggregates affect the rheological behaviour of 3D printed concrete with lightweight aggregates. This study examines the influence of two admixtures: a superplasticizer (0 - 0.10%wt) and a viscosity modifying agent (0.05 - 0.45%wt), in addition to the uptake of water when using cork granules (100 - 200%wt) as a fine aggregate replacement, on the rheological profile of the mortar. Based on full factorial designed experiments, the rheological behaviour of eco-mortars with Granulated Blast Furnace Slag (GBFS) cement and cork granules is assessed by measurements of plastic viscosity and yield stress with varying admixtures and water uptake content. This work offers insights into what extent a superplasticizer, a viscosity modifying agent, and the water uptake of a lightweight aggregate can influence the rheological behaviour of a lightweight aggregate mortar for 3D printing. The response surface method allows for determining the significant factors' optimal settings.