The rheology, mechanical and durability performance of 3D printable magnesium cement-based composites incorporating metakaolin and fly ash

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Abstract: Magnesium oxysulfate cement (MOSC) is one of the promising low-CO_2 alternate binder systems that could replace Portland cement in a variety of applications. In this study the feasibility of using MOSC for 3D printable concrete will be explored. we design 3D printable magnesium cement-based composites using magnesium oxide, magnesium sulfate, citric acid, water, and limestone coarse aggregates. Compared to OPC based materials, MOSC usually has a low water resistance, which hinders its wider application. In this study, In this context, various additives will be used to enhance the durability of MOSC, including fly ash, metakaolin, and hybrid use of fly ash and metakaolin. The influence of these additives on the performance of the MOSC will be assessed from the aspect of fresh properties, mechanical performance and durability. First, the time-dependent behavior of rheology of mixtures modified with different additives will be assessed, including dynamic yield stress, plastic viscosity, and static yield stress. Open time for the modified mixtures will be identified using flow table test and extrudability test. The compressive strength and drying shrinkage will be tested at varying air-curing ages, including 3, 7, 14, 21, and 28 days. The durability of modified mixtures will be assessed from the seawater resistance test with 14 days and 28 days. Then a comprehensive assessment will be carried out to determine the optimal dosage of the used additives in the system of magnesium cement-based composites from the aspect of dynamic yield stress, static yield stress, compressive strength, drying shrinkage, and seawater resistance.

Keywords: Magnesium oxysulfate cement, 3D concrete printing, Fresh properties, Compressive strength. Shrinkage, Water resistance.