RP1020

COMMERCIAL ADAPTATION OF CONSTRUCTION MATERIALS WITH LOW-EMBODIED-CARBON

Research Question

Carbon emissions from conventional concrete containing Portland cement (OPC) are second only to fossil fuels; up to 80% reduction in carbon emissions can be achieved using the Geopolymer concrete (GPC) (Figure 1). However; as a new engineering material, there are some concerns over the durability and long-term performance of geopolymer-based binders. Also, there is not a universal recipe to produce GPC yet.

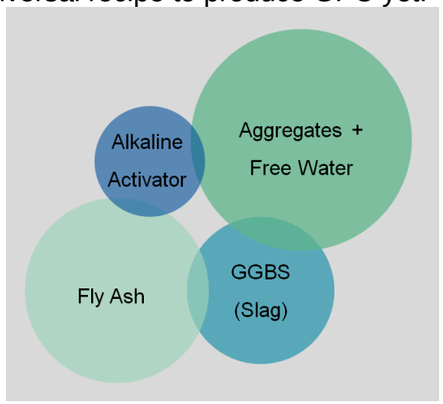

Figure 1: Geopolymer concrete constituents

Methodology

- Experimental as well as numerical studies are undertaken
- field data from GPC real-life constructions to be gathered
- a comprehensive handbook for GPC specification will be developed and published by Standards Australia

Results

Unlike the OPC, there is not a direct relationship between the mechanical strength and the durability properties of GPCs. Figure 2 demonstrates the 28th day compressive strength of geopolymer mortars. While increasing the molar ratio of SiO_2 to Na_2O (i.e. Ms) improves the compressive strength, it increases the risk of alkali leaching and efflorescence at the same time (Figure 3).

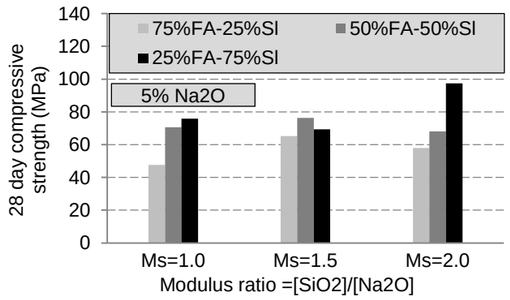

Figure 2: 28th day compressive strength of geopolymer mortar samples

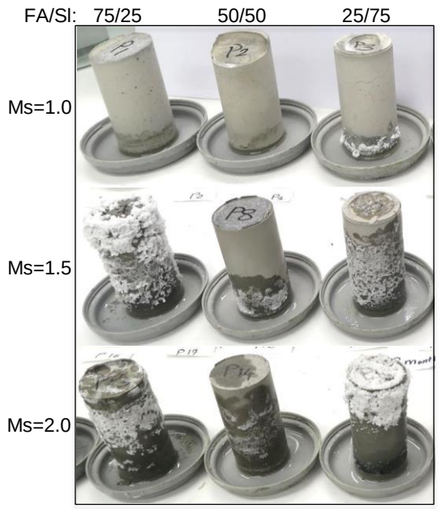

Figure 3: Effect of the precursor's proportion, and different modulus ratios on the efflorescence of geopolymer pastes, (one month exposure to water)

Alkali leaching in GPCs is considered as a major issue which leads to efflorescence and depassivation of the reinforcement by lowering the pH of the binder.

Conclusions

Developing geopolymer concrete mix designs is considered as a multi-objective design process; a lot of variables are involved and interacting with each other (Figure 4). This highlights the need for developing mixes which are specifically designed for the exposure conditions expected during the service life of the structure.

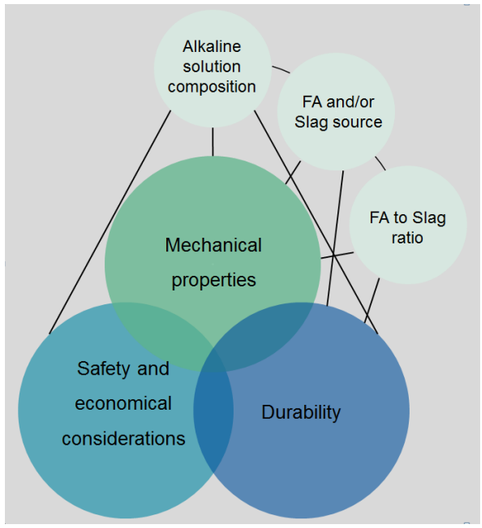

Figure 4: Interaction of different variables involved in production of GPC

Anticipated impacts

Geopolymer alternatives can achieve up to 80% reduction in carbon emission, depending on the type and amount of activators used.

The major barrier to geopolymer concrete adaptation is the lack of both standard specifications and knowledge related to its durability aspects.

For a relatively moderate uptake of 10% geopolymer/concrete replacement, for example, 640 thousand tonnes per annum less carbon will be emitted to the atmosphere per year from Australia alone. This uptake will not be realised without the development of production and design guidelines for engineers and practitioners approved through Standards Australia, which this project will deliver.

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