ABSTRACT

Self-compacting concrete (SCC) requires twice the amount of unit cement content in comparison to ordinary Portland cement (OPC) concrete. The environmental problems due to the usage of OPC increased day by day due to the emission of carbon dioxide (CO_2) ultimately resulting in global warming. The geopolymer concrete (GPC) concept was first proposed by Joseph Davidovits as environmentally friendly concrete based on the formation of binder after the reaction of an alkaline solution with silica and alumina content in a source material of geological origin. One of the biggest challenges in the field applicability of GPC is its very low workability due to the high viscosity of alkaline solution. The advantages of the self-compaction of SCC and the cohesive nature of GPC are combined to develop a revolutionary concept of self-compacting geopolymer concrete (SCGC). The main objective of this dissertation is to propose a methodology for the mix design of SCGC. Generally, the flow properties of SCC mainly depend on the self-compacting mortar (SCM). Therefore, to achieve the objective of proposing a mix design process for SCGC the mechanical properties of self-compacting geopolymer mortar (SCGM) were investigated in the first step. Fresh mechanical properties (flow deformability, flow speed (viscosity), and flow passing ability (blockage)) and hardened mechanical properties (dry density, compressive strength, young's modulus, and Poisson's ratio) are reported for SCGM and SCGC. The flow properties of SCGM and SCGC were investigated with the variation of different influencing parameters and compared with SCM and SCC, respectively. The impact of fly ash to sand ratio (FA/S), the volume of water to powder ratio (Vw/Vp), and the dosage of superplasticizer (Sp/P) were significant in respect of controlling the flow properties of SCGM and SCGC. The flow results indicated that the SCGC had comparatively high viscosity in comparison to SCC. The test results exhibited that the increase in Vw/Vp and Sp/P had a negative impact on the compressive strength of SCGM and SCGC. The compressive strength of SCGM and SCGC was mainly influenced by FA/S, sodium hydroxide (NaOH) molarity, and the curing temperature. The maximum compressive strength of 27 MPa and 37 MPa was achieved for SCGC having natural and silica sand, respectively. Finally, the mix design process for SCGC is proposed indicating different mixing conditions and influencing parameters.