ABSTRACT

Ordinary Portland cement is the most popular binder material for producing concrete. The usage of cement is ever increasing due to its ability to gain early strength as well as prolonged strength gain. However, it is energy intensive and also consumes large amount of natural materials for its production. Further, production of every one ton of cement releases about 1 ton of CO$_2$ in to atmosphere promoting global warming and deterioration of ecosystem. More so, the performance of concrete in terms of durability is also a major concern when exposed to aggressive environment.

The development of geopolymer concrete (GPC) is an important step towards the production of eco-friendly concrete. It is an inorganic alumina-silicate compound synthesized from geological material or industrial by-products such as fly ash, slag, GGBFS, rice husk ash etc. The effective usage of industrial by-products can address the environmental pollution issues. Also, the geopolymer concrete is expected to be more durable than conventional concrete due to the absence of Ca(OH)$_2$. Hence an attempt has been made in the present work to study the effect of the blend of metakaolin(MK) and bottom ash (BA) as source material on the performance of GPC.

The materials such as meta-kaolin (MK), bottom ash (BA), fine aggregate, coarse aggregate, sodium hydroxide, sodium silicate and cement have been used in the present work to make geopolymer mortar (GPM), geopolymer concrete (GPC) and control concrete. Several trial mixes have been made to arrive at the optimum mix proportion for GPM to impart maximum strength. Further, the GPC mix proportion was made based on the
GPM mix with maximum strength and also the guidelines prescribed by Rangan. The specimens of GPM and GPC were cast and cured at ambient temperature. Also, M 30 grade control concrete was made using OPC and cured in water. The GPC and control concrete specimens were tested for compressive, split tensile, flexural strength and modulus of elasticity. Also, XRD, SEM and EDAX studies were carried out to analyse element/ mineral compounds present, microstructure and morphological characteristics of GPC to substantiate the strength development. Further, durability of GPC in terms of sulphate resistance, acid resistance, chloride resistance etc. has also been evaluated. Finally, an attempt has been made to study the suitability of GPC as paver blocks and in future the performance of geopolymer concrete can be carried out in structural concrete behavior.

It is evident from the result that equal proportion of source material with liquid to binder ratio 0.5 has yielded highest compressive strength of 78.24 MPa at the age of 28 days in ambient curing. Further, compressive strength of bBM50 mortar is about 47% higher than the mortar made with 53 grade OPC at the age of 28 days. Further, the early strength gain of GPM is remarkably higher than cement mortar. Also, the MK-BA GPC has demonstrated 49% higher compressive strength than the conventional concrete at the age of 28 days. More so, the early as well as later strength gain of GPC is remarkably higher than the cement concrete. The strength is due to densification of microstructure over a period of time due to the formation of more and more crystalline phases in the geopolymer concrete. Further, the durability of geopolymeric concrete in terms of sulphate resistance, chloride resistance, acid resistance, water absorption etc. is remarkably higher than the conventional concrete. Also, the paver blocks made of GPC satisfies all the requirements specified by BIS 15658:2006 and found superior to cement concrete paver blocks.