ABSTRACT

High-performance concrete is fast getting acceptability for a wide range of applications in the construction of concrete structures. It is a tailor made material for specific applications and having advantageous properties like high strength, high durability and high constructability as compared to the conventional type of normal strength concrete. To produce such a high performance concrete, mineral admixtures like silica fume, metakaoline and fly ash on the one hand and superplasticizer on the other hand used along with normal ingredients. The use of mineral admixtures in concrete enhances its properties regarding strength, durability, workability and economy. They act as pozzolanic materials as well as micro fillers; thereby the microstructure of hardened concrete becomes denser and stronger. Superplasticizers being surfactant in nature, help to disperse the cement particles in the mix and thus enhance the fluidity of the mixes at low water binder ratio.

The scope of the present study is to investigate the effect of mineral admixtures such as silica fume, metakaolin and fly ash towards the performance of HPC. An effort has been made to focus on the mineral admixtures towards their pozzolanic reaction, contribution towards strength properties, durability studies, mix proportioning, self-compactability and toughness characteristics.

The strength characteristics such as compressive strength, tensile strength and flexural strength were investigated with different water binder ratios (w/b) at different ages to find the optimum replacement of mineral admixtures. The compressive strength of HPC with mineral admixtures at the replacement levels of 0%, 5%, 10% and 15% were studied at 3 days, 7 days, 28 days, 56 days and 90 days of curing. The strengths were compared...
and the optimum replacement level of each mineral admixture was arrived at. The tensile strength and flexural strength of HPC were obtained at the same replacement levels of mineral admixtures at 28 days curing. Equations were developed to obtain tensile and flexural strengths in terms of characteristic strength.

The durability studies such as permeability, corrosion resistance, plastic shrinkage and impact strength for the concrete incorporated with mineral admixtures were carried out. Further, the drying shrinkage and alkali silica reaction tests were carried out for the mortar incorporated with mineral admixtures. Accelerated corrosion test was conducted to study the role of mineral admixtures against corrosion of reinforcement.

The efficiency factors for silica fume and fly ash with different replacement levels at 7 days and 28 days were obtained. A simple mix design procedure was presented by considering those efficiency factors. The same mix design was done using Visual Basic programming. The mix proportion can be obtained for HPC ranging from 60 MPa to 100 MPa. The proposed mix design was verified experimentally.

A simple mix design procedure was proposed for developing self-compacting high strength concrete with silica fume, metakaoline and fly ash and its self compactability has been verified as per Japan Society of Civil Engineers (JSCE) specifications. Also for the developed self compacting concrete, the compressive strength and tensile strength were determined experimentally.

The toughness of HPC with and without mineral admixture and glass fiber was investigated experimentally by conducting flexure test on beams. A generalized finite element model was developed using ANSYS software from the experimental
investigations so as to arrive at the load-deflection curve for any concrete mix just by giving its Young’s modulus value.

From the studies conducted, it was observed that silica fume and play a vital role in improving the strength of concrete particularly at early ages. From the durability point of view, all the three mineral admixtures perform well. But the drying shrinkage was more in silica fume mortar than in metakaoline and fly ash mortar. For its remedy, alteration at gradation of fine aggregate or addition of glass fibers is recommended.