ABSTRACT

The use of supplementary cementitious materials has become an integral part of high strength, high performance concrete mix design and high performance fibre reinforced concrete composites, which may be natural by-products or industrial wastes. Some of the frequently used supplementary cementitious materials (SCMs) are fly ash, silica fume (SF), Ground Granulated Blast Furnace Slag (GGBS), Rice Hush Ash (RHA) and Bagasse Ash (BA).

Bagasse ash, an agricultural waste, is classified as "a highly active pozzolan" because it possesses a very high amount of amorphous SiO_2 and a large surface area. Studies carried out on the performance of supplementary cementitious products with bagasse ash (BA), waste product of sugar industries are very important, which is intended to provide a possible solution to environmental concern related to waste management.

The possibility of utilizing bagasse ash as partial replacement of cement with various percentage of bagasse ash on the preliminary characteristics of cement paste and mortar were carried out. The various properties include Specific gravity, Normal Consistency (NC) of cement, Air content and Workability of mortar with different bagasse ash replacements. Setting times, Soundness and Shrinkage of cement pastes have been studied to ensure the pozzolanic and chemical reactions of bagasse ash. Additionally, the strength and durability properties of cement mortar have been studied at various bagasse ash replacements. Bagasse ash was varied from 0 % to 30 % at a constant increment of 5% by weight of cement.

Based on the test results obtained on strength and durability properties of cement mortar, the replacement level of bagasse ash up to 20% is considered for design of high performance concrete. High Performance Concrete of M60 grade is adopted with the different replacement levels of bagasse ash. The Mix Design for high performance concrete of M60 grade is done as per the method proposed by P.C.Aitcin. This method is simple and follows the same approach as ACI 211-1 standard practice for selecting proportion of normal, heavy and mass concreting. Ordinary Portland cement (OPC) was replaced at different levels of 0%, 5%, 10%, 15% and 20% by bagasse ash. The workability, strength & durability properties of high performance concrete with and without bagasse ash were investigated to obtain the optimum replacement percentage of bagasse ash in high performance concrete. The tests carried out on high performance concrete includes cube compressive strength, splitting tensile strength, flexural strength, saturated water absorption, sorptivity, porosity, impact test, alkalinity measurement, acid resistance, sea water resistance, water permeability , rebound hammer test and ultrasonic pulse velocity.

The test results indicate that the incorporation of bagasse ash up to 10% improves the properties of high performance concrete. By considering the results obtained in high performance concrete, experimental investigation was carried out on the high performance fibre reinforced concrete composites (HPFRCC) to assess the effect of the addition of steel (0.25%, 0.50% and 0.75%), polypropylene fibres (0.15%, 0.3% and 0.45%) and hybrid fibres (steel and polypropylene) at a total fibre volume fraction of 1.0% by volume of concrete on workability and strength-related properties of high performance fibre reinforced concrete utilizing bagasse ash. All the high performance fibre-reinforced concrete composite contained 10% bagasse ash to replace cement. Strength and Elastic properties such as compressive

strength, splitting tensile strength, flexural strength, modulus of elasticity and Poisson's ratio are determined.

An experimental investigation was carried out to study the behaviour of high performance fibre-reinforced concrete composites beams in flexure. The flexural test was done for beams with two point loading system till their failure. The behaviour of each beam was assessed with respect to initial crack, ultimate load, ultimate deflection, flexural strength, ductility and toughness. In the same way, investigation was conducted on short and slender high performance fibre-reinforced concrete composite columns. The behaviour columns were assessed with respect to initial crack, ultimate load and ultimate deflection. Thereby, optimum mix proportions were found for both columns and beams. The inclusion of fibres increased the failure load and ensured the ductile behaviour of the structural elements. The results demonstrated that adding hybrid fibres enhanced the mechanical properties as well as the structural behaviour of elements.

Behaviour of high performance fibre reinforced concrete composite exterior beam column joints under quasi-static loading was experimentally investigated. High performance fibre reinforced concrete composite joints were tested under positive quasi-static loading, and the performance of the joints was assessed with respect to load-deflection, displacement ductility, energy dissipation capacity and stiffness degradation. Outcome of the experimental study indicates that replacement of cement with bagasse ash improves the strength and ductility aspects of conventional specimen. The inclusion of fibres extended the failure load, and enhanced the ductile behaviour of the beam column joints, under quasi-static loading. The results also show that hybridization is a good preference for arresting minor cracks at different levels and improving the ductile behaviour of beam-column joints.

TOPSIS method is used to determine the optimum mixture proportion of bagasse ash blended cement mortar and high performance concrete. By considering the properties of different mix proportions and defining the quality with their levels, TOPSIS method is adopted. TOPSIS is one of the popular classical multi-criteria decision making (MCDM) method used to incorporate all determined performance attributes of the system into a single attributes. This method is trouble-free, flexible and easy to perform compared to other multi-criteria decision making methods. ABAQUS models were developed for beam in flexure, short column, slender column and beam column joint. The results obtained from experimental investigation for load carrying capacity and deflection values of structural elements were compared with analytical results and found to be reasonable.

From the detailed experimental and analytical investigation, it is thus accomplished that addition of bagasse ash as micro filler improved the properties of cement mortar and high performance concrete up to certain replacement percentages. Similarly, the inclusion of steel and polypropylene fibres in bagasse ash blended high performance concrete shows better results in strength and workability properties. The structural behaviour of High performance fibre reinforced concrete composites beams, columns and beam column joints indicates that addition of micro filler and fibres increases the load carrying capacity, energy absorption and stiffness degradation.

The results of experimental studies conducted on short and slender columns were discussed. The optimum fibre content was found out for superior load carrying capacity. For both short and slender column, the compressive strength indices were found. The influence of bagasse ash with different proportions of steel and polypropylene fibre shows improvement in structural behavior of short and slender columns.