

Synopsis

Thesis Title : Experimental and Analytical Investigations on Ultra High Performance Concrete

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The history of concrete has been centuries old, but still the mysticism behind the theories is not clearly understood. The conventional concrete still possess lot of problems regarding sustainability, durability and mechanical properties. Ultra High Performance Concrete (UHPC) has compressive strengths of more than seven times and tensile strength exceeding three times that of ordinary concrete, it sets itself as a current solution worldwide. For UHPC, there are design guidelines and recommendations in France, Japan, and Australia but there has been limited research and almost no application in India compared to developed nation. In context to Indian scenario there is need for resurgence of UHPC to acquire definition of the material, a basic understanding of the material structure, properties, and behaviour under loads and generation of processing structure property performance relationships. The project was conducted in three phases: Phase I was to identify present gaps available in the literature, Phase II - To conduct experimental studies based on the identification of gaps and Phase III – To develop analytical formulation based on experimental studies.

The present work focuses to develop a mix proportion for UHPC using indigenous material, with a proper curing methodology and then characterize the behaviour in compression and tension. UHPC for this project is considered to have compressive strength greater than 150 MPa, internal fibre reinforcement to ensure non brittle behavior, and high binder content with special aggregates. The constituents are cement, fine sand, silica fume, quartz powder, superplasticizer, a low water-cement ratio, and high-strength steel fibres. UHPC needs special curing in order to achieve its high performance, suitable curing methodology with a proper curing regime is evaluated. The curing regime included ambient air curing, water curing and hot air curing. The material properties are determined by conducting experiments to evaluate compressive strength, split tensile strength, flexural strength, residual strength, fracture energy and durability. As constitutive relationship of any concrete is the primary demand for development of design code, the relationship for UHPC under uniaxial compression is evaluated for varying reinforcement index. The obtained parameters are used to formulate and propose a new stress strain model for UHPC to predict the prepack and post peak behavior. The behavior of this concrete in tension is evaluated using three point bending tests for notched beam specimens. A bilinear tension softening model is evaluated to obtain tensile stress -crack width relationship using crack hinge model. An inverse analysis is carried out using MATLAB to compare and calculate the experimentally obtained load and crack mouth opening displacement with the analytical model.

The main research contributions from the project are -

- ❖ Curing Regime for UHPC using indigenous material was identified.
- ❖ Developed mix having target compressive strength more than 150MPa.
- ❖ Proposed an analytical model to evaluate of Stress Strain characteristics of UHPC under uniaxial compressive loading based on reinforcement index.
- ❖ Derived a bilinear tension softening model of UHPC by tensile stress versus crack width relationship.