Mechanical Performance of Ultra-High Performance Concrete for Bridge Applications

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Abstract

Ultra-high Performance Concrete (UHPC) is an upcoming type of cement composites, which now a days getting extensive attention and is particularly applied to bridge engineering area, on account of its superior mechanical performance and durability. With introduction of Ultra-High Performance Concrete, there is need to develop equation and relationship which can predict modulus of elasticity, flexural and split tensile strength of Ultra-High Performance Concrete using indigenous materials. The study is done by analysing experimentally obtained test results of a total 120 specimens for flexural strength, 120 specimens for split tensile strength and 100 samples for modulus of elasticity of concrete. Based on the experimental results an empirical equation is proposed for the prediction of modulus of elasticity, flexural and split tensile strength for strength range of 15 to 150 MPa and is compared with the empirical equations available in the different International standards.

Keywords: Ultra-high Performance Concrete (UHPC); Modulus of elasticity; Flexural Strength; Split tensile strength; Empirical equations

1. Introduction

The application of Ultra-high Performance Concrete (UHPC) are mainly in Bridge Girders, Decks, Piles, seismic columns and wind turbine towers etc. and require different performance characteristics. UHPC is a recently developed type of concrete which is desirable to be used in the construction of concrete members to improve design life, member strength and reduce the construction cost and weight. However, it needs more research to define its properties properly. The basic principles for the development of UHPC are [1, 2] (a) Minimizing composite porosity by optimizing the granular mixture through a wide distribution of powder size classes and reducing the water/binder ratio. (b) Enhancement of microstructure by post set heat treatment to speed up the pozzolanic re-action of Silica Fume and other ultrafine cementitious materials to improve mechanical properties. (c) Optimal usage of superplasticizer to reduce water/binder ratio and improve workability. (d) Improvement in homogeneity by eliminating coarse aggregate.

The modulus of elasticity is considered as a function of compressive strength of concrete and therefore, all the parameters that have influence on the properties of concrete should necessarily have its effects on the value of the modulus of elasticity [3]. There are different equations by current codes of practice and researchers for prediction of the modulus of elasticity. ACI 318-14 and EC2 express the modulus of elasticity in terms of the secant modulus, and they differ in their definitions [4]. The accurate and realistic value of the in situ tensile and compressive strengths of concrete distressed during service period for long time provide an important base for the evaluation of structures, especially for those, which are aged and needs repair or rehabilitation. In addition to high degree of variability in results, complexity, cost etc. involved in determination of tensile strength of concrete, it is important to develop realistic constitutive relationship between tensile strength and compressive strength of concrete [5-11]. The study is done by analysing experimentally obtained test results of a total 120 specimens for flexural strength, 120 specimens for split tensile

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