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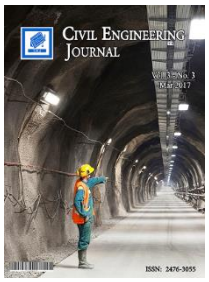

State of the Art: Mechanical Properties of Ultra-High Performance Concrete

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Abstract

During the past decades, there has been an extensive attention in using Ultra-High Performance Concrete (UHPC) in the buildings and infrastructures construction. Due to that, defining comprehensive mechanical properties of UHPC required to design structural members is worthwhile. The main difference of UHPC with the conventional concrete is the very high strength of UHPC, resulting designing elements with less weight and smaller sizes. However, there have been no globally accepted UHPC properties to be implemented in the designing process. Therefore, in the current study, the UHPC mechanical properties such as compressive and tensile strength, modulus of elasticity and development length for designing purposes are provided based on the reviewed literature. According to that, the best-recommended properties of UHPC that can be used in designing of UHPC members are summarized. Finally, different topics for future works and researches on UHPC's mechanical properties are suggested.

Keywords: Durability; Tensile Strength; Cracking; Fiber Reinforcement Polymer; Bond Properties.

1. Introduction

Concrete, along with steel, is the most widely used material in the construction of infrastructures. The reliable foundation provided by concrete makes it an appealing choice for traditionally non-concrete structures [1, 2], dams [3], pavement [4, 5] and bridges. However, the low tensile strength, flexural strength, and durability of concrete have been the main concern in designing of the elements. Therefore, the development of science and material in the recent decades has led to the production of Ultra-High Performance Concrete (UHPC). UHPC is a new class of concrete that exhibits remarkable mechanical and durability properties, as compared to the conventional concrete which is available commercially since 2000 [6]. The main components of UHPC which make UHPC properties special are an optimized gradation, fiber reinforcements, and its water to cementation ratio less than 0.25 which is less than conventional concrete [6, 7]. The special properties of UHPC cause the extensive interest in using UHPC in precast, pre-stressed, and field cast bridge connections. Bridge decks [8], movable decks [9], roof panels [10], precast piles and foundation of bridges on loose soils [11] are the structural elements that UHPC have been utilized to construct them.

Habel [12] demonstrated that UHPC has self-consolidation feature. This feature showed that UHPC could have a compressive strength over 150 MPa without applying any special curing during its casting. Moreover, the cost of UHPC mix design was investigated, and it was concluded that with the moderate cost it is possible to produce UHPC with enough workability [13]. Graybeal [14] investigated that the mixing procedure of conventional concrete can be implemented for UHPC mixing procedure. However, UHPC needed more input energy in its mixing procedure; therefore, ice should be used in the mixing of UHPC instead of water to produce no overheated mix.

The high energy absorption capacity is another unique feature of UHPC in high-rate loading which can prevent the collapsing of infrastructures during the earthquake and cycling loading [15]. To improve the energy absorption

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