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PRODUCTION OF ULTRA HIGH STRENGTH CONCRETE USING LOCAL MATERIALS AND ITS APPLICATION IN AXIALLY LOADED COLUMNS

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ABSTRACT

The development of Ultra High Strength Concrete (UHSC) started late in the 20th century by modifying some of the existing rules for designing concrete composition and selecting materials in High Strength Concrete (HSC) types. Beside ultra-high compressive strength (up to 200 MPa), UHSC also have considerably improved tensile strength, stiffness and durability compared to other concrete types. Therefore, they are also called ultra high performance concretes (UHPC). Ultra high strength concrete (UHSC) finds wide use in tall buildings, bridges, airports, power plants etc.

This research work investigates the production of UHSC using different local materials in Egypt, studies the different fresh and hardened properties of the produced concrete. It also investigates the behavior of columns cast with the produced concrete under axial loads. In addition, the research includes a theoretical study for predicting the behavior of concrete columns cast with ultra high strength concrete and comparing it with the experimental results.

An experimental program consists of three phases is designed. The first phase is designed to study the ability to produce Ultra High Strength Concrete (UHSC) using different locally available materials in Egypt. In this phase, a total of seventy two mixes are used to produce UHSC and to study the effect of different variables such as cement type and content, silica fume content, coarse aggregate type and content, fine aggregate type and content, existence of quartz powder, existence of steel fiber, and water to binder ratio on the compressive strength.

Phase two is designed to investigate the different fresh and hardened properties such as slump flow, compressive strength, flexural strength, indirect tensile strength , abrasion, length change, absorption, permeability and modulus of elasticity, of one selected mix of phase one, which has the highest compressive strength and compare it with a high strength concrete mix properties.

Phase three is designed to study the behavior of thirteen concrete columns manufactured from produced UHSC subjected to axial loading. The modes of failure and longitudinal compressive strains are studied. The parameters studied in this phase are concrete strength, longitudinal steel ratio, stirrups volumetric ratio, steel fiber content and column aspect ratio (L/d).

From the adopted experimental program in Phases one and two, ultra high strength concrete is successfully produced using local available materials in Egypt of strengths up to 150 MPa. The experimental results show that UHSC exhibits extraordinary mechanical properties compared to normal or high strength concretes. UHSC also has excellent resistance to abrasion, lower water absorption and water penetration. Phase three demonstrates the behavior of short UHSC columns under axial load and a theoretical prediction of the deformational behavior for these columns is developed. A design equation for designing short UHSC columns is presented.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES