DISSERTATION INFORMATION

INTRODUCTION

Dissertation title : **Resistance of Ultra-High Performance Fiber Reinforced Concrete Plates Under Impact Load**

Major : **Civil Engineering**

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ABSTRACT

Ultra-High Performance Concrete (UHPC) is a new material with many outstanding features, having a high capacity and being durable in an aggressive environment. The main contents of this study are the basic criteria for applications of structures subjected to special loads, impact loads, and explosive loads.

The UHPC composition is developed based on locally available raw materials. The concrete constituent is calculated and optimized by the packing density method and the experiment is investigated in both phases: aggregates and cement paste. Aggregates included sand, crushed stone CS-3, and crushed stone CS-5. The cementitious phase consists of cement, silica fume, silica powder, and blast furnace slag. The content of blast furnace slag at 20% by weight of cement enhanced the development strength at an early age with f_{c_7d} approximately 90% f_{c_28d}. The compressive strength reaches 130-150 MPa, the flexural tensile strength is 12÷29 MPa, and the uniaxial tensile strength is 7-8MPa. In addition, the microstructure of hardened cement paste was observed by Scanning Electron Microscope (SEM) with various resolutions, and the multilayered structure of the C-S-H crystal was seen at 10,000× and 15,000×. This study has contributed to the UHPC composition, using blast furnace slag to partially replace silica powder not only improves the quality of

concrete but also reduces minimizes products and minimizes their negative impact on the environment.

An experimental program was conducted to evaluate the mechanical properties of the UHPC mixture with the proportions of steel fibers 0%, 1.0%, 1.5%, 2.0%, and 2.5% by volume of concrete, respectively. Uniaxial compression tests, RILEM beam bending tests, and direct tensile tests have been carried out with a total of more than 120 samples of all types. The results show that the compressive strength is about 118÷151 MPa, the flexural tensile strength is 9÷29 MPa and the direct tensile strength is 7 ÷ 8 MPa. Increasing steel fiber content in the concrete enhances the absorption and spread of energy in UHPC.

UHPC plates of size (500×500×80) mm with a steel fiber content of 1.0%, 1.5%, and 2.0% respectively were fabricated to evaluate the behavior of the plate under impact load. The behavior of the plate subjected to impact load with some cylindrical masses of 16kg, 25kg, and 33kg. The quantities of acceleration and deformation were measured and observed during the test process. The results show that the shock absorption area increases, and the crack width on the plate surface decreases with increasing the steel fiber content and the compressive strength of concrete. It can be seen that the content of steel fiber is an important factor in reducing the crack width and significantly affects the bearing capacity of the slab compared to the compressive strength and reinforcement in the slab.

The analysis by numerical simulation has been performed by Explicit Dynamic in ANSYS-AUTODYN software. A full 3D plate structure model is established, and UHPC is described by the RHT constitutive model for concrete with parameters based on experimental results from Chapter 4. Some parameters are calibrated according to the compression testing results on the cylindrical sample. The simulation results show a correlation of the trend between the experiment and the simulation. In addition, the stress propagation in the plate can be observed by numerical model and the failure area of the concrete can be predicted when subjected to impact loads.

The results of the dissertation have successfully developed a set of UHPC concrete compositions that can be applied immediately in construction, with reasonable prices and

complete parameters for designability according to some current standards. A method of measuring stress-strain in the direct tensile test of concrete has been proposed, which improves the stability and accuracy of the measurement. The basic behavior of the UHPC plate subjected to impact loads has been investigated by the experiment program and numerical simulation. The correlation between the model and the experiment is determined, which is also a premise for the development of further studies.

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