



**University
of Victoria**

Graduate Studies

Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

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BASc (American University in Cairo, 2013)

**“Application of Impact Resonance Method for Evaluation of the Dynamic
Elastic Properties of Polypropylene Fiber Reinforced Concrete”**

Department of Mechanical Engineering

Wednesday, May 24, 2017

9:00 A.M.

Engineering Office Wing

Room 230

Supervisory Committee:

Dr. Rishi Gupta, Department of Civil Engineering, University of Victoria (Co-Supervisor)

Dr. Rodney Herring, Department of Mechanical Engineering, UVic (Member)

External Examiner:

Dr. Svetlana Brzev, Department of Civil Engineering, British Columbia Institute of Technology

Chair of Oral Examination:

Dr. Michelle Wiebe, Department of Curriculum and Instruction, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies

Abstract

For evaluation and quality control of concrete structures, the impact resonant frequency method is widely accepted for monitoring structure in-service properties and detecting structural damage. Common defects in concrete include consolidation problems during casting and development of micro-cracks. Monitoring the dynamic characteristics of concrete plays an essential role in detecting real-time and early stages of deterioration. Much research is focused on detecting large defects, however not much information is available on detection of minor defects in composites like fiber reinforced concrete. Change of elastic behavior when Polypropylene fibers are added as reinforcement is investigated. Destructive tests on structures in-service are not always feasible thus leaving non-destructive condition assessment methods as the only option. Amongst the various non-destructive tests available, vibrational tests provide a practical method to predict the dynamic moduli of structures (dynamic modulus of elasticity, dynamic modulus of rigidity and dynamic Poisson's ratio). The objective of this research to assess the dynamic elastic properties of Polypropylene Fiber Reinforced Concrete (PFRC) in correlation of induced cracks and common consolidation defects using a non-destructive testing method that relies on impulse excitation and stress wave propagation to measure changes in the resonant frequency when polypropylene fibers are added to concrete.

In the experimental program, two fiber sizes, macro and micro fibers, with various volume contents have been used for casting PFRC prisms and cylinders. Fundamental resonant frequencies were measured for all cylinders and prisms in the transverse and longitudinal directions. All measured frequencies are directly related to the low-strain dynamic modulus of elasticity. In addition, PFRC prisms were used to investigate the relationship between the dynamic modulus of elasticity and modulus of rigidity. Several batches of similar mixtures are used to investigate different parameters that affect the resonant frequency of concrete such as the water to cement ratio, curing condition and age. Results indicated a decrease in the resonant frequency and elastic properties with an increase of the fiber content or length. Micro fibers showed a higher dynamic elastic moduli when compared to macro fibers of the same mixture. Post cracked PFRC cylinders and flexural fractured prisms retained some of the resonant frequency with macro fibers exhibiting better elastic recovery compared to having a distinct difference between the macro and micro fibers prior to cracking.