Nondestructive Evaluation Of Fiber Reinforced Polyester Polymer Concrete

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Abstract

Polyester polymer concrete reinforced with different types of fibers were characterized using the impact resonance and the pulse velocity methods. The effect of fiber type and content on the dynamic moduli, damping ratio, and pulse velocity were studied. Using the ultrasonic method, the pulse velocity in polymer concrete and fiber reinforced polymer concrete was measured at frequency of 150 kHz and the dynamic moduli of elasticity (Ep) was also determined from the pulse velocity and compared to the static moduli. The response of cylinders and prisms in the three fundamental modes of vibration, namely, longitudinal, transverse, and torsional, were investigated. From the longitudinal and transverse and torsional resonance frequencies the dynamic Young�s modulus of elasticity, the dynamic moduli of rigidity and dynamic damping ratio and Poisson�s ratio were determined. Fiber types investigated are PVC, polypropylene, glass and steel. Also the dynamic data obtained from the impact resonance and pulse velocity agreed.

1. Introduction

A fast, reliable and cost effective NDE method would be advantageous in the performance of polymer concrete in the laboratory as well as in the field. In this study, both impact resonance and ultrasonic pulse velocity method were used to investigate the effect of different fibers on the dynamic properties of polyester polymer. The measurements made nondestructively were compared with results obtained from destructive tests.

2. Materials and Experimental Procedure

The basic constituents of the polymer concrete (PC) were polyester resin (14%) and blasting sand (86%). PC was reinforced with steel fibers (6%) or non-metal fibers (1%, 3% or 6%). The fibers was added by the weight percentage of PC. The specimens were allowed to cure for one day at room temperature and then at 55-60 for another day. Two size of cylinders and one size of prism were used: small cylinder (1.5 " in diameter and 3 " in length) and large cylinder (2.5 " in diameter and 6.5 " in length) and prism (2.0"2.0"9.0"). Compression testing was performed using a 400 kip capacity Tinius Olsen universal testing machine in strain control mode. Pulse velocity and impact resonance tests were performed according to ASTM C 597-83 and C 215-91 respectively.

3. Experimental Results and Discussion

3.1 Uniaxial Compression (Static) Tests

The results of compressive testing show that PVC and polypropylene fibers did not significantly influence the compressive strength of the PC. Steel fibers gave the highest compressive strength. For fiberglass the compressive strength was 15% higher than that of PC. The compressive modulus of elasticity decreased due to the addition of PVC, polypropylene and glass fibers

3.2 Pulse Velocity

The dynamic elastic modulus Ep was calculated using and assuming Poisson's ratio as 0.2. It can be seen that among the four types of fibers steel fibers gave the highest velocity and highest Ep. PVC and polypropylene fibers gave the lowest velocities and Ep. Comparison of results from the large cylinders shows that the values of Ed for PVC fibers and polypropylene fibers were about 10 % and 19 % lower than those of PC. The data obtained from small cylinders and from large cylinders show the same tendency. The dynamic moduli of elasticity from small specimens were little larger than from large cylinders perhaps because the densities of small ones are little larger than large cylinders.

3.3 Impact Resonance Test

Dynamic modulus of elasticity Ed was calculated from both longitudinal and transverse resonant frequencies, and dynamic shear modulus Gd was calculated from tortional resonant frequency. From impact resonance test, it was observed that steel fibers gave the highest dynamic modulus and the PVC and polypropylene fibers gave the lowest dynamic modulus. The dynamic modulus obtained from longitudinal and transverse vibration were no more than 10% than the corresponding static modulus from compression test.

3.4 The Relationships of Pulse Velocity Test and Impact Resonance Test

The impact resonance tests were compared with the pulse velocity tests. when the frequency parameter (b) was equal to 0.8, the velocities from IR were very close to the pulse velocities. It should be noted that pulse velocity decreased when polymer fiber and glass fiber except for steel fiber, but the damping ratio increased from 0.7% to 1.1%.

4. Conclusions

1) PVC and polypropylene fibers did not significantly influence the compressive strength. Fiber addition decreased the compressive elasticity modulus with all fibers expect for steel fibers.

2) Among the four types of fibers investigated steel fibers gave the highest pulse velocity and highest pulse modulus of reinforced PC from pulse velocity test. PVC and polypropylene fibers gave the lowest pulse velocities and modulus.

3) The dynamic modulus from pulse velocity and Impact resonance test agreed well with the static modulus. The dynamic data also show that fiber addition decreased the elastic modulus with all fibers expect for steel fibers. Also the velocities from IR were very close to the pulse velocities.

5. Acknowledgment

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6. References

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