Mechanical Behavior of Chopped Graphite Fiber Reinforced Polyester Polymer Concrete

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Abstract

Behavior of polymer concrete (PC) with chopped graphite fiber was investigated using nondestructive and destructive testing techniques. The effect of up to 6% chopped graphite fiber on the unit weight, elastic modulus, shear modulus, Poisson's ratio, flexural strength, splitting tensile strength, compressive strength, porosity, fracture parameters of polymer concrete were investigated. Impact resonance and pulse velocity methods were used to determine the nondestructive properties. Fracture parameters were determined using four-point bending test and by varying the notch-to depth ratio from 0.2 to 0.7. The splitting strength and compressive strength of PC were investigated using splitting tension test and compression test, respectively.

1. INTRODUCTION

Polymer concrete (PC) is formed by polymerizing a mixture of monomer and aggregates. High strength, chemical resistance, and ductility of polymer concrete make it an attractive material for construction and rehabilitation of civil infrastructure. PC properties can be improved greatly by adding fibers. There have been recent studies on incorporating glass, steel, polypropylene fibers in polymer concrete, but the effect of chopped graphite fiber on polymer concrete has not been investigated.

2. OBJECTIVE

The purpose of this study is to compare the behavior of PC with and without chopped graphite fiber using destructive and nondestructive tests.

3. MATERIALS AND EXPERIMENTS

The constituents of polymer concrete were polyester resin (14%) and sand (86%). PC was reinforced with up to 6% chopped graphite fiber. Compression tests and splitting tension tests were performed using a 400 kips capacity Tinius Olsen universal testing machine in displacement control mode (Fig. 1). Flexural tests were performed using a 50,000 pounds capacity Instron testing machine in displacement mode (Fig. 2). Pulse velocity and impact resonance test were performed according to ASTM C 597 and C 215 respectively. CIGMAT standard (CIGMAT PC1-99) for making polymer concrete and fiber reinforced polymer concrete was used.

4. RESULTS AND CONCLUSIONS

Based on the experimental study the following conclusions can be drawn:

1. Impact test results were sensitive to the notch-to-depth ratio. Notch does not have a significant effect on the pulse velocity test results.

2. Addition of graphite fiber of 3% and 6% to PC increased the mean K_{IC} values of PC by 25% and 44%, respectively. Addition of 3% and 6% graphite fiber increased nominal J_{IC} of PC by 125% and 260%, respectively. And correction in crack length resulted in 250%, 440% and 560% increasing in the K_{IC} values of PC, 3% and 6% GrFPC, respectively. The increasing in K_{IC} values may be caused by the crack extension at peak load.

3. Notch on specimen can greatly decrease the modulus of elasticity and shear modulus of PC and GrFPC calculated from impact resonance test results. However, the modulus of elasticity (calculated from pulse velocity test results) will not be affected. The damping ratio of PC and GrFPC increased significantly beyond a notch-depth ratio of 0.5.

4. Graphite fiber used in this study does not significantly affect the flexural strength of PC. But it will increase the mean K_I and J_I values of PC greatly.

5. The compressive strength and splitting tensile strength of polyester PC were 52 MPa (7,547 psi) and 6 MPa (871 psi), respectively. The result show that fiber addition did not have a significant effect on the compressive strength of PC, but failure strain of PC increased by 50% when 6% fiber was added to PC. However, addition of 3% and 6% graphite fiber increased the splitting tensile strength of PC by 90% and 150%, respectively.

5. ACKNOWLEDGEMENT

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6. REFERENCES

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Fig.1 Compression test

Fig.2 Flexural test