Non-Destructive Compressive Modulus of Fiber Reinforced Polymer Concrete

Kallol Sett and C. Vipulanandan

Center for Innovative Grouting Materials and Technology (CIGMAT)
Department of Civil and Environmental Engineering
University of Houston, Houston, TX 77204-4003

ABSTRACT

Impact resonance and pulse velocity methods were used to determine the dynamic compressive Young's modulus of polymer concrete system with glass fibers (GFRPC) and with carbon fibers (CFRPC) and the results were compared with their respective static properties. Fiber contents were varied up to 6% by weight for both GFRPC and CFRPC systems to study the sensitivity of non-destructive methods to fiber addition. Dynamic Young's moduli obtained from the pulse velocity method for both GFRPC and CFRPC systems were within 10% of their respective static moduli; whereas those from the impact resonance method showed larger variation. The effect of shape of the specimens on the dynamic compressive modulus of GFRPC and CFRPC systems was also studied.

1. INTRODUCTION

The impact resonance method and the pulse velocity method are two of the most commonly used non-destructive testing methods for construction materials. The dynamic properties determined by the impact resonance method are in general, dependent on the shape of the specimen. In contrast, the pulse velocity method has the advantage that, generally, it does not depend on the shape of the specimen[1].

2. OBJECTIVE

The overall objective of this study is to investigate the use of the impact resonance method and the pulse velocity method to determine the dynamic compressive Young's modulus of GFRPC and CFRPC systems. The specific objectives are a) to study the sensitivity of impact resonance and pulse velocity method to fiber addition for GFRPC and CFRPC system b) to compare the dynamic and static compressive Young's modulus and c) to study the shape effect of the specimen on the dynamic compressive Young's modulus.

3. MATERIALS AND TESTING PROGRAM

Pulse velocity and impact resonance tests were performed on both prismatic and cylindrical specimens. The size of the cylindrical and prismatic specimens used for non-destructive tests were 200 mm in length X 60 mm in diameter and 300 mm X 50 mm X 50 mm respectively. The cylindrical specimens used for the destructive cylinder tests were 100 mm in length and 38 mm in diameter. Fiber content for both the matrices was varied up to 6% by weight. Based on workability, polymer content for GFRPC system and CFRPC systems were determined to be 18% and 20% by weight respectively.

Pulse velocity tests were performed as per ASTM C 597. Lead zirconate titanate ceramic transducers having a natural frequency of 150 kHz were used to pass longitudinal waves through the specimens. Commercially available grease was used to provide good coupling between the specimens and the transducers. Impact resonance tests were performed as per ASTM C215. CIGMAT PC 5-02 was followed for the destructive cylinder test.

4. TEST RESULTS AND CONCLUSIONS

Based on non-destructive and destructive tests performed on over twenty-five GRRPC and CFRPC specimens, the following can be summarized:

a) Pulse velocity and impact resonance method were sensitive to fiber addition and can be used to characterize GFRPC and CFRPC systems.
b) Dynamic compressive Young's moduli obtained from the pulse velocity method for both GFRPC and CFRPC systems were within 10% of their respective static moduli; whereas those from the impact resonance method showed larger variations.
c) While the pulse velocity method was independent of specimen shape, the impact resonance method was dependent on specimen shape, with prismatic specimens yielding compressive moduli closer to their static moduli both for GFRPC and CFRPC systems.

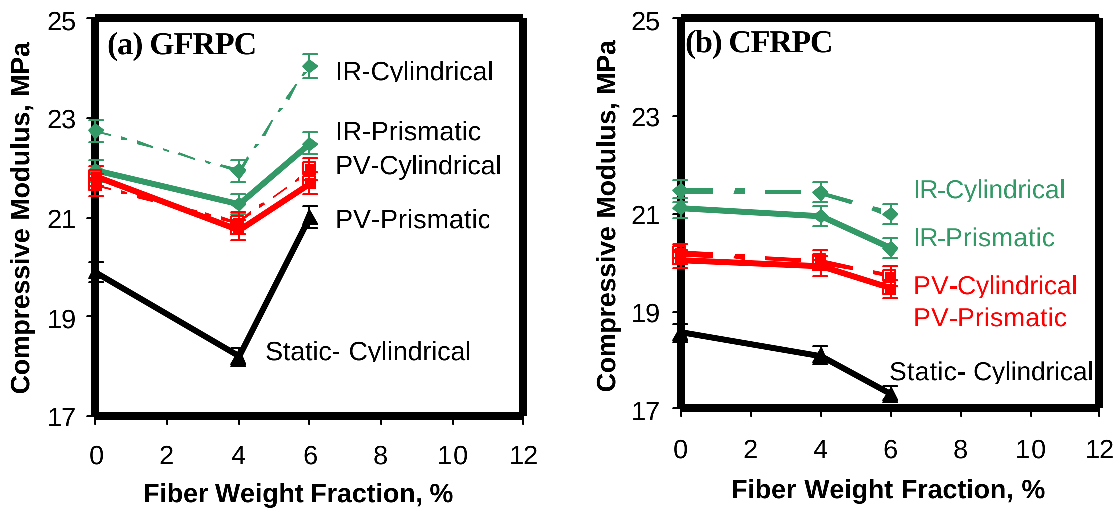

Figure 1 Comparison of dynamic and static compressive modulus of (a) GFRPC system and (b) CFRPC system

5. ACKNOWLEDGEMENT

This research work is being supported by the National Science Foundation (CMS-9634685) and the Advanced Research Program (ARP) of Texas.

6. REFERENCES

1) Mantrala, S.K. and Vipulanandan, C., "Nondestructive Evaluation of Polyester Polymer Concrete", ACI Materials Journal, V. 92, No. 6, November-December 1995, pp 660-668.
2) Obert, L. and Duvall, W.I, "Discussion of Dynamic Methods of Testing Concrete with Suggestions for Standardization", Proceedings of ASTM, V. 41, 1941, pp. 1053-1070.
3) ASTM C 215-97e1, "Standard Test Method for Fundamental Transverse, Longitudinal and Torsional Frequencies of Concrete Specimens." Vol. 04.02.
4) ASTM C 597, "Standard Test Method for Pulse Velocity Through Concrete." Vol. 04.02.

CIGMAT PC 5-02, “Standard Test Method for Compressive Properties of Polymer Concrete”.