Piezo-resistive Behavior of Smart Cement under Splitting Tensile Loading

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Abstract
Piezo-resistive behavior of smart cement with varying conductive filler content under splitting tensile loading was investigated. Conductive fillers content was varied from 0.05-0.15% of total weight and was used to prepare the cement specimens. Splitting tensile test was done after 28 days of curing. The highest piezo-resistivity obtained was 14% for conductive filler content of 0.15% and the corresponding splitting tensile strength was 555 psi.

1. Introduction

Tensile strength is an important parameter when durability of structures is considered (Oluokun et.al, 1991). It is essential to investigate tensile behavior and monitor its long term stability. Monitoring electrical resistivity change in a material due to mechanical stress/strain (Piezo-resistivity) is a technique which can be used in any structure to monitor throughout its lifetime (Vipulanandan, 2014).

2. Objective

The main objective was to investigate the piezo-resistive behavior of smart cement with varying conductive filler content under splitting tensile loading.

3. Materials and Method

Class H cement was used. Conductive fillers content was varied from 0.05-0.15% of total weight. Water to cement ratio was 0.38. Cylindrical molds were used with the height of 4 inches and the diameter of 2 inches. Specimens cured at room temperature for 28 days.

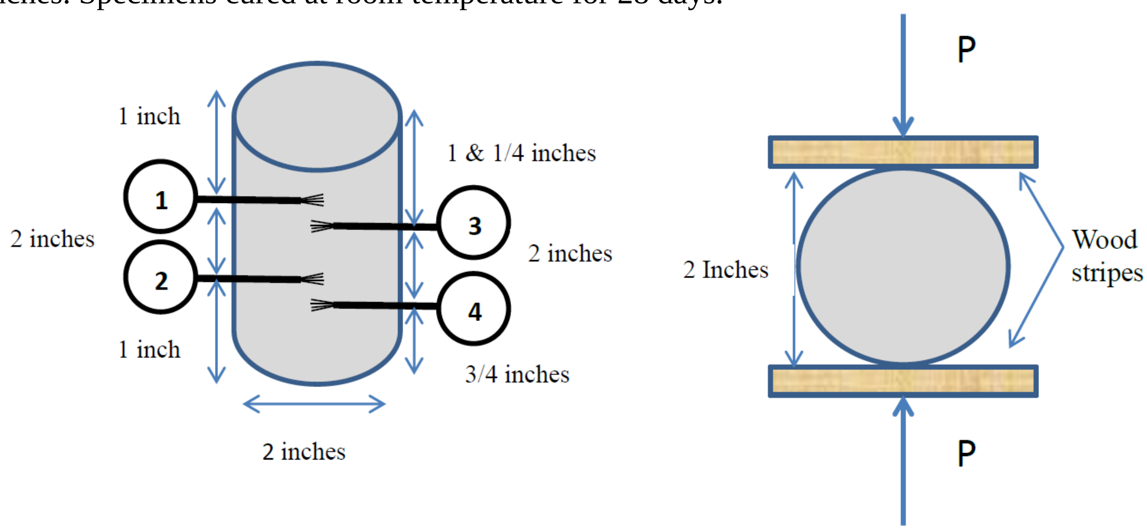

Figure 1: Schematic diagram of specimen configuration and test method

4. Results and Discussion

As shown in Figure 2 and 3, the experimental results obtained for two different wire configurations. The highest piezo-resistivity obtained between the wires 1 and 4 was 14% whereas the highest piezo-resistivity obtained between the wires 2 and 4 was 9 % for the same stress. The variation in piezo-resistivity has occurred between two wire configurations due to the variation of the distance between these wires. Due to the increment in the conductive filler content, piezo-resistivity and the splitting tensile stress have been increased.

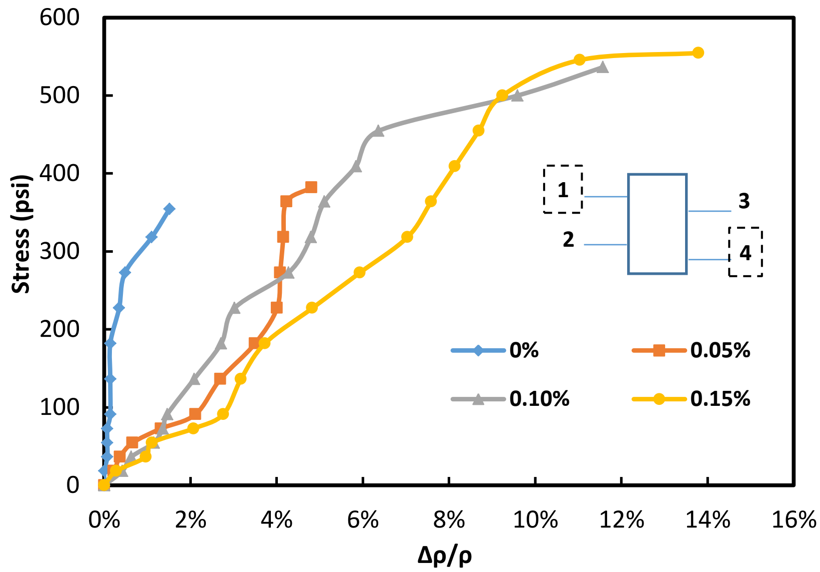

Figure 2: Splitting tensile stress vs Piezo-resistivity

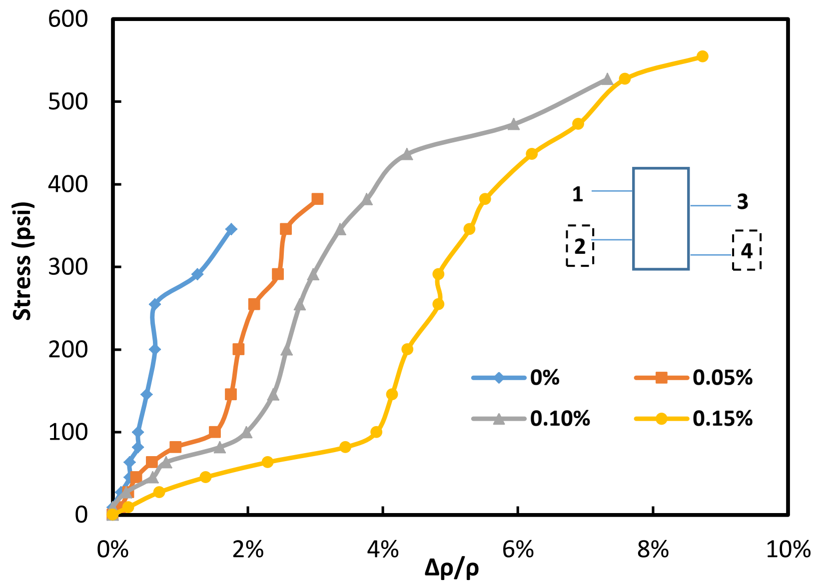

Figure 3: Splitting tensile stress vs Piezo-resistivity

5. Conclusion

Piezo-resistivity and splitting tensile strength increased with increment of conductive filler content. Highest piezo-resistivity obtained is 14% and corresponding splitting tensile strength was 555 psi.

6. Acknowledgements

This study was supported by the Center for Innovative Grouting Materials and Technology (CIGMAT) and Texas Hurricane Center for Innovative Technology (THC-IT), University of Houston, Houston.

7. References

1. C. Vipulanandan, (2014). "Development of smart cement for real time monitoring of ultra-deep-water oil well cementing applications", *CIGMAT-2014 Conference & Exhibition*, 1-16.

2. F. A. Oluokun, E. G. Burdette, and J. H. Deatherage, (1991). "Splitting tensile strength and compressive strength relationship at early ages", *ACI materials journal*, Vol-88, 115-123.