Effect of Microwave Heating on the Piezoresistivity of Smart Cement

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Abstract: In this study, the effect of microwave heating on the short term piezoresistivity behavior of smart cement was investigated. Microwave heating for 10 seconds improved the piezoresistivity by 28% at ultimate compressive strength and reduced the compressive strength of smart cement cured for one day by 35%.

1. Introduction: Safety of concrete structures is an important problem being paid attention to at all times in civil engineering field. Therefore, it is necessary to take reasonable measures to monitor the state of concrete structures. Cement-based material containing electrical fillers (carbon fibers or carbon black), which has favorable piezoresistivity to sense stress/strain in it (Baoguo & Ou, 2007). Strain monitoring by piezoresistance changes in conductive filler bundles and CFRP specimens is a very efficient technique to get immediate information on the state of stresses and damage inside the structures (Kalashnyka, et al., 2016). This study was carried out to analyze the piezoresistivive change of modified cement after heated on the microwave.

2. Objective: The overall objective was to investigate the effect of microwave heating on the piezoresistive behavior of regular and modified (with conductive filler) class H oil well cement.

3. Materials and Methods: This experiment was designed to obtain the piezoresistivity change on modified cement specimen after 10 seconds of microwaving. Water and cement in the weight ratio 0.38 were mixed by blender to form a cement paste. 0.04% of short conductive filler was added in the cement paste. Two cement specimens were casted with addition of conductive filler and another two were casted without conductive filler to compare the change in the piezoresistivity.

Plastic polyethylene cylindrical molds of 50 mm in diameter and 100 mm in length were used to prepare the cylindrical specimens. Flexible wires were embedded into the specimen during preparation and were used for measuring the resistance directly using the LCR meter at a frequency of 300 kHz. The longitudinal spacing between each two leads was 50 mm. Uniaxial compression test was conducted on the 0.04% conductive filler-cement samples after one day. Resistance measurements were taken while loading.

4. Results and Discussion: The impedance values were flatened at high frequency as shown in the Figure 1. So the test results fell into the case 2 of impedence spectroscopy model (Vipulanandan.C & Prasanth.P, 2013). The control and heated specimens were then analysed for resistivity change. Determined resistivity change from the resistance measurements were ploted with applied stress are shown in Figure 2. In order to represent the piezoresistive behavior of one day cement p-q model was used (Vipulanandan.C & Mebarkia.S, 1990).

The results of these experiments showed that microwave heating for 10 seconds using an output power of 1.5 kW lowered the one day ultimate compressive strength of cement and modified cement to 85% and 70% of its original value respectively. Microwave heating was not shown any significant piezoresistive change in the control cement(0.00% C.F) specimens. Upon investigating the resistivity change in between both modified cement(0.04% C.F) specimens, resistivity change of microwaved specimen was higher by 20% than the other at the ultimate compressive strength.

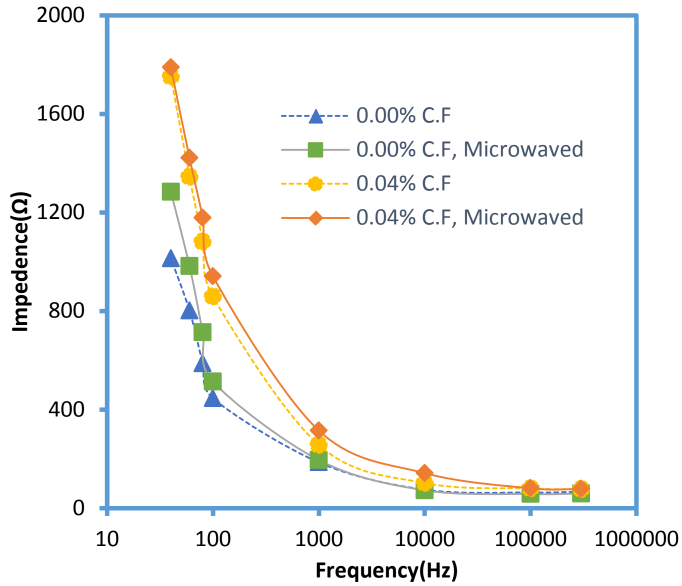

Figure 2: Impedance Behavior of cemen with frequency

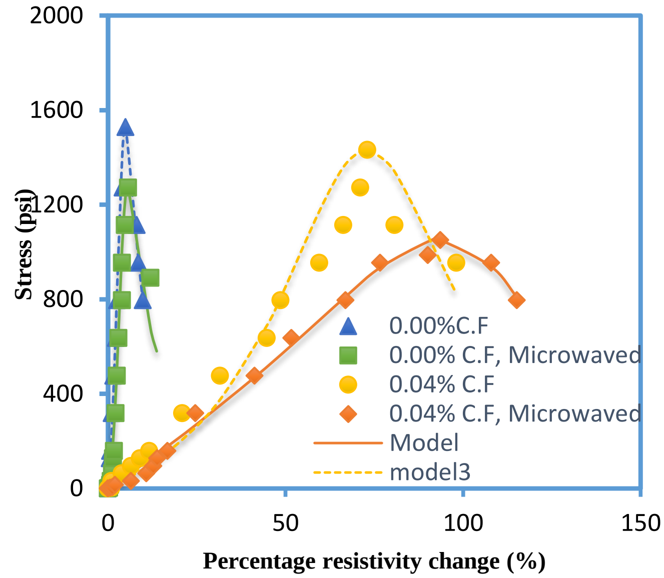

Figure 2: Piezoresistive behavior of the smar cement after 1 day of air curing

5. Conclusion: The resistivity change of modified cement (0.04% C.F) at the ultimate compressive strength increased by 28% after microwave heating. Also 35% reduction in compressive strength was identified after microwave heating. The p-q model strongly correlated the compressive strength with resistivity change of smart cement with coefficient of correlation (R^2) up to 0.94.

6. Acknowledgements:

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7. References:

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