Effect of Curing Temperature on the Compressive Behavior of Smart Cement

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Abstract: In this study the effect of curing temperature on the behavior of smart oil well cement (OWC) was investigated. An LCR (inductance, capacitance, resistance) meter was used to measure the changes in the electrical properties with applied stress for the samples cured for six days under various temperatures. The results showed that curing at a higher temperature tended to increase compressive strength compared to the samples cured under normal room and refrigerator conditions and also the curing temperature had effect on the piezoresistivity of the smart cement.

1. Introduction: The properties of cementitious material considerably depend upon the temperature it is subjected to early on in its life, i.e., while curing (Obla et al. 2005). The effect of curing temperatures is continued to be the subject of a lot of researchers. In recent years, self-monitoring materials have become more popular, thus there is increasing interest in self-monitoring ability of the materials under different temperatures. The temperature effect on compressive strengths and self-sensing properties of smart OWC were investigated in this study for different curing scenarios.

2. Objective: The main objective of this study was to analyze the effect of curing temperature on the piezoresistive behavior and compressive strength of smart OWC.

3. Materials and Methods: OWC was used in this study with water to cement (w/c) ratio of 0.38. Conductive filler (0.075% by weight of composite) was used to develop the piezoresistivity. In order to characterize the effect of curing temperature, 2”x4” cylindrical specimens were prepared. Monitoring wires were embedded while preparing the specimen.

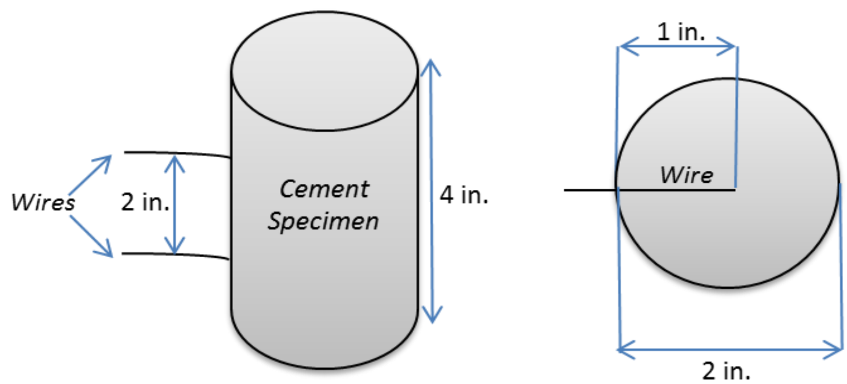

Figure 1: Schematic diagram of cement specimens

Cylinders were covered with plastic caps and specimens were subjected to different curing conditions such as curing in refrigerator at 20 F, normal room condition at 75 F and in an oven at 150 F, immediately after casting till the age of 6 days. Then the samples were de-molded and tested for compressive strength using a destructive testing method. In order to compare self-sensing properties with curing condition, impedance measurements were taken with AC signal with the frequency of 300 kHz between the wires for all the specimens during compression test.

4. Results and Analysis: The test data showed that the strength gains and sensitivities are different when variable curing temperatures are applied. The maximum stress attained during compressive loading is shown in Figure 2(a). The experimental results showed that the specimen subjected to high early temperature achieved the highest stress compared to other specimens at the age of 6 days. Specimen under high temperature curing attained a maximum stress of 3200 lb/inch^2 whereas the specimen cured under normal room condition reached a maximum stress of 1500 lb/inch2 and specimen with refrigerator curing reached a maximum stress of 1000 lb/inch2. Also figure 2(b) depicts the sensitivity of specimens cured under different temperatures when the stress level was 500 lb/inch^2. It has been seen that the temperature variation has also an impact on piezoresistivity.

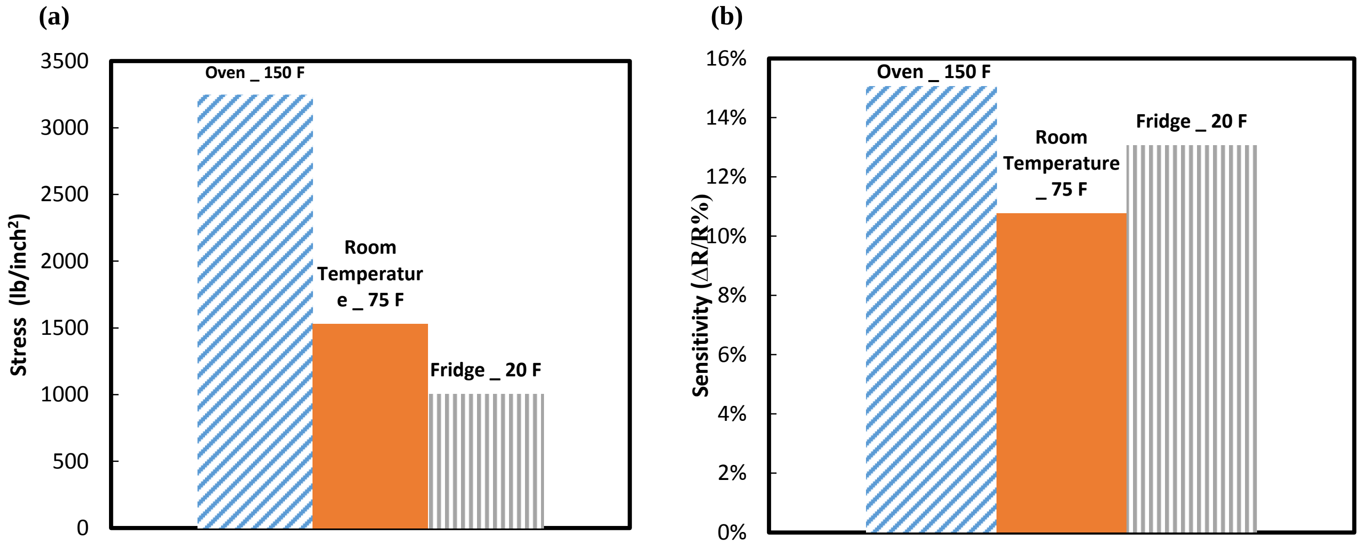

Figure 2: (a) Maximum compressive stress attained for samples cured under various temperatures, (b) Sensitivity of samples cured under various temperatures at 500 lb/inch^2

6. Conclusion: The study demonstrated the effect of curing test specimens in different temperatures. The curing temperature has affected the piezoresistive behavior and compressive strength of the smart cement. The cement specimen cured at higher temperature had higher compressive strength, which is more than three times that of refrigerator cured specimen and more than double that of normal room temperature cured specimen.

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8. References:

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