Moisture Healing Efficiency of Polymer Modified Smart Cement

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Abstract: In this study, self-healing of cement is achieved through a polymer. The effectiveness of this polymer additive into cement is studied. Various tests such as compressive test, ultrasonic pulse velocity and EIS studies of the specimen is done to evaluate the efficiency of the self-healing cement.

1. Introduction

Self-Healing capability of the cement is achieved by several researchers by addition of polymers, hollow fiber, expansive agents and bacteria healing agents [1]. In these methods, expansive healing agents are suitable for oil well cement. The disadvantage of these self-healing agents is that they do not have repeated self-healing [2]. As such, new agents need to be developed to improve the self-healing capacity of cement sheaths.

A new polymer is studied and tested for self-healing capacity in cement. In order to verify the self-healing capacity of the polymer modified cement pulse velocity test, compressive strength and electrical resistivity test on the sample is conducted. The compressive strength method evaluates the self-healing capacity by measuring the regained the compressive strength of specimen. Ultrasonic pulse velocity test is done to assess the strength and integrity of normal cement and repaired cement sample. Additionally the electrical resistivity of the healed specimen is compared with a broken specimen to measure the healing efficiency.

2. Objective.

The main objective of this to evaluate the self-healing efficiency of the polymer modified cement.

3. Materials and Methods.

The materials include Class G oil well cement, conductive filler and polymer. Dry mixing of conductive filler and polymer is done. Initial resistivity of the specimen is measured and the change of resistivity of the specimen over time is monitored.

Table 1: Composition of prepared samples.

Sample	Cement(Class H)	Conductive Filler(gm)	Polymer Added(gm)	Water(mL)	Resistivity(Ωm)
1	350	0.1	0	140	1.00
2	350	0.1	3	140	1.05
3	350	0.1	6	140	1.07
4	350	0.1	9	140	1.12

Cement slurries were prepared according to API standards with a water to cement ratio of 0.4. Four cement specimen were prepared for each test. After mixing, the mortar was casted into the cylindrical molds with height of 4 inches and diameter of 2 inches, in which, two conductive wires were embedded 2 inches far from each other to measure the piezo resistivity of the specimens.

4. Results and Discussion.

The specimen is cracked vertically and horizontally as shown in the figure. Then the specimen is allowed to heal. The impedance curve of the specimen before and after healing is measured. From the impedance curve, we can conclude that the polymer modified smart cement has self-healing properties.

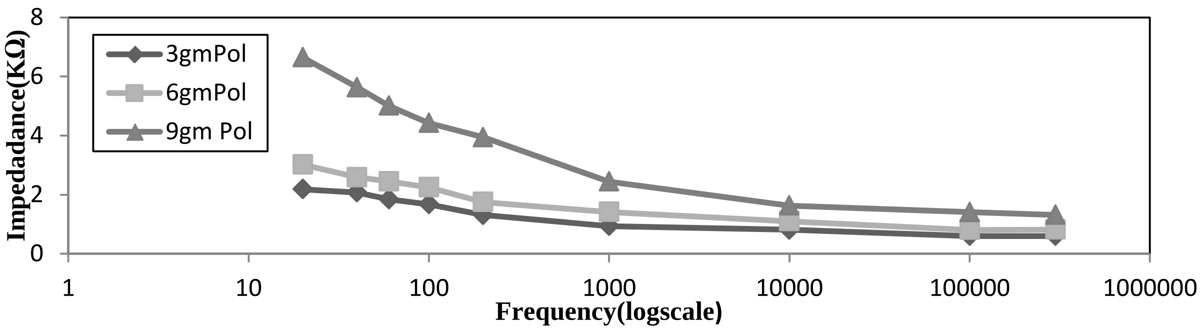

Fig 1: EIS curve of uncracked specimens.

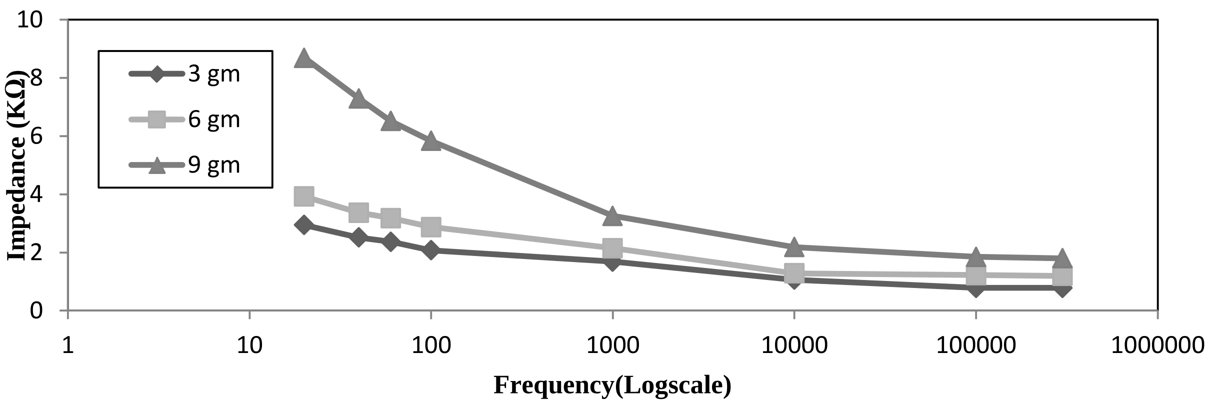

Fig 2: EIS curve of self-healed specimens.

Change in impedance curve for moisture healed specimen is observed compared to undamaged specimen. Slight increase in impedance curve indicates the healing effect of polymer inside specimen.

Ultrasonic Pulse velocity test is done on the cement specimens before healing and after healing. Higher velocity indicate good quality and continuity of the material, while slower velocities indicate cement with cracks and voids. An decrease of around 20% is observed in pulse velocity is observed in the healed sample compared to undamaged sample.

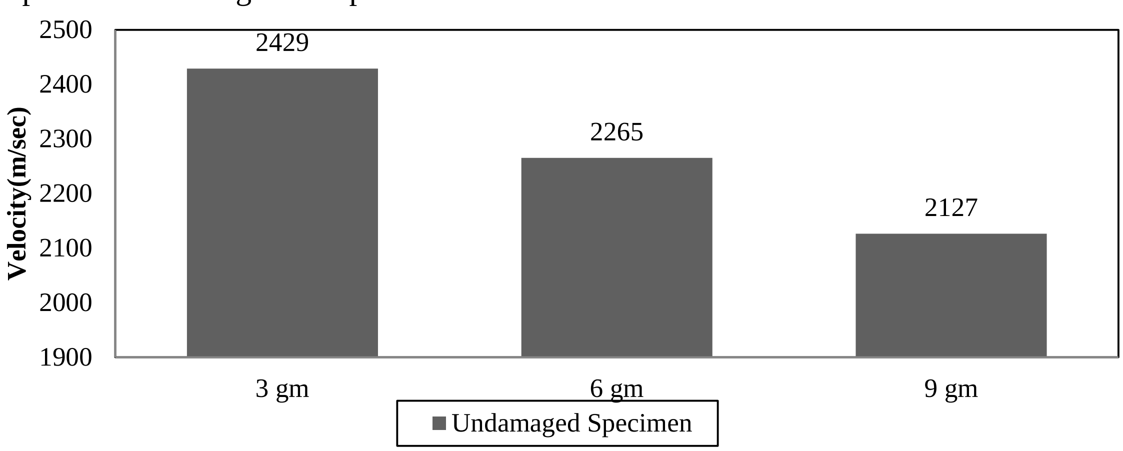

Fig 3: Ultrasonic pulse velocity of undamaged specimen.

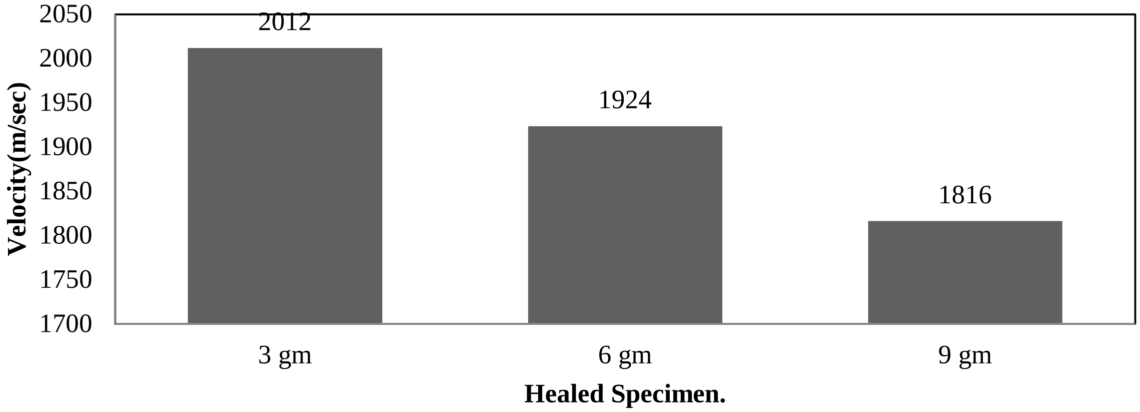

Fig 4: Ultrasonic pulse velocity of healed specimen.

5. Conclusion: Smart cement modified by polymer has moisture healing capacities. The integrity of the specimen is achieved by putting the cracked samples in moist environment.

6. Acknowledgements:

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7. References.

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