Effect of Biosurfactant on the Curing and Piezoresistive Properties of Smart Cement Grout

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Abstracts: The effect of Biosurfactant (BS) on the electrical resistivity during curing and piezoresistive properties of smart cement grout (water to cement ratio of 0.8) was investigated. BS of up to 1% was added to the smart cement grout and BS increased the initial, minimum, 24 hour resistivity, and longtime resistivity of the smart cement grout. Adding BS reduced the compressive strength of the smart cement grout after 1 and 7 days of curing. The piezoresistive response of the smart cement grout with 1% BS was also decreased after 1 day, and 7 days of curing.

1. Introduction: Cement grouts are commonly used to repair cracks in concrete structures and masonaries (Anagnostopoulos, 2014), to coat pre-stressed cables, to stabilize ground near tunnels, rehabilitative old defective masonaries in historical buildings and to repair cracked oil well cement sheath (Chun et al. 2008). Smart cement grout can be used to repair the structures and at the same time to monitor the repaired structures having piezoresistive properties (Vipulanandan et al., 2016). Biosurfactant is an environmentally acceptable dispersing agent (Mulligan, 2005). Whether the addition of biosurfactant to smart cement grout affects the curing and piezoresistive properties of smart cement grout that is required to monitor the life of the repaired cement has not yet been studied.

2. Objectives: Investigate the effect of biosurfactant on the electrical resistivity during curing and piezoresistivity of smart cement grout.

3. Materials and Methods: Smart cement grout was prepared using smart cement mixed with water-to-cement ratio of 0.8. The surfactant used in this study is the UH-Biosurfactant which was produced from used vegetable oil in continuously stirred batch reactors and Serratia.sp.bacteria. The samples were prepared by mixing the water with the cement and/or surfactant solution using standard mixers. After mixing, specimens were prepared using cylindrical molds with a diameter of 50.8 mm and a height of 101.6 mm. Two conductive wires were placed in all of the molds which were 50.8 mm apart. All specimens were capped to minimize moisture loss and were cured up to the day of testing for the piezoresisitivity under compressive loading. To determine the electrical resistivity, two probe method with fixed 2 electrical wires were used to measure the resistance. The resistivity (ρ) is defined as RA/L (where, R = measured resistance, A = area of the electrical flow, L = distance between the probe). The two probe test mold was first calibrated by determining the resistivity of the cement slurry with a direct resistivity measuring device and the corresponding resistance measurement by an AC resistance measuring device. Then from the resistivity relationship, the A/L ratio of the test mold was determined. This ratio was used to determine the resistivity of hardened cement.

4. Results and Discussion: **4.1 Resistivity:** The effect of Biosurfactant (BS) on the resistivity of the smart cement grout with curing time up to 28 days was determined and compared with that of smart cement grout only. The results showed that the initial resistivity (1.08 Ω.m) of the smart cement grout increased by about 12% with addition of 1% Biosurfactant and the resistivity after 24 hours of curing (2.16 Ω.m) increased by about 30%. The minimum resistivity of the smart cement grout was 1.04 Ω.m after 180 minutes and it increased to 1.16 Ω.m with addition of 1% Biosurfactant (a 12% increase). After 28 days of curing, the electrical resistivity of the smart cement grout was 9.37 Ω.m which increased to 14.2 Ω.m (a 50% increase) with addition of 1% Biosurfactant (Fig. 1).

4.2 Compressive Strength and Piezoresistive Properties: Addition of 1% BS reduced the compressive strength of smart cement grout by 17% and 15% after 1 day and 7 days of curing respectively. The piezoresistive response also showed similar trend with addition of BS. Addition of 1% BS reduced the piezoresistivity by 84% than that of smart cement grout after 1 day (Fig. 2). And after 7 days of curing, the piezoresistivity with addition of 1% BS decreased by 80% from that of smart cement grout (Fig. 3).

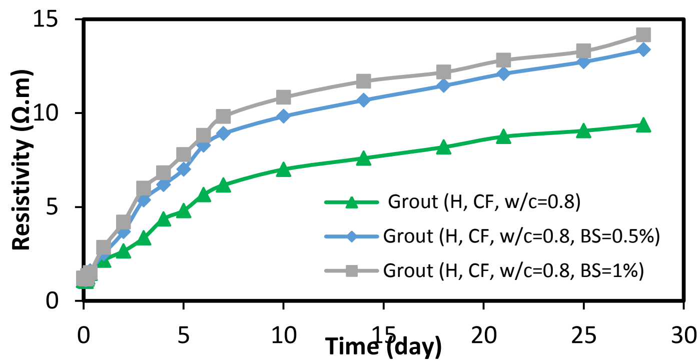

Figure 1. Curing resistivity of the smart cement grout with and without BS

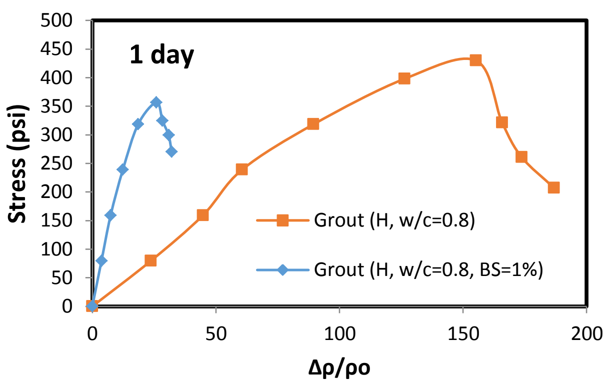

Figure 2. Compressive stress Vs piezoresistivity of smart cement grout with and without BS at 1 day

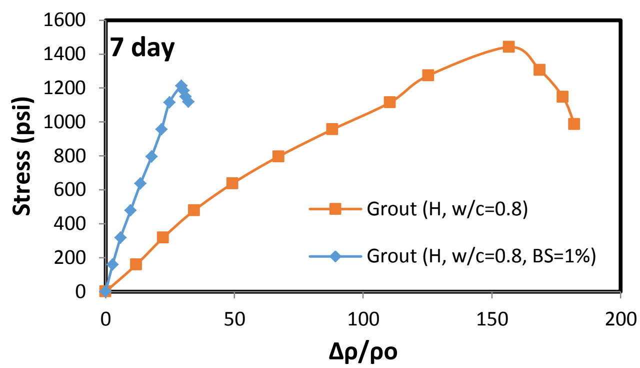

Figure 3. Compressive stress Vs piezoresistivity of smart cement grout with and without BS at 7 days

5. Conclusions: a) BS increased the initial, minimum and 24 hour resistivity of the smart cement grout. The addition of 1% BS increased the initial and minimum resistivity by 12%, and the 24 hour resistivity by 30%. The resistivity of the smart cement grout after 28 days of curing was increased by about 50% by addition of 1% BS. b) Addition of 1% BS reduced the compressive strength of smart cement grout by 17% and 15% after 1 day and 7 days of curing respectively. The piezoresistivity of the smart cement grout with 1% BS was decreased by 84% from that of smart cement grout after 1 day of curing and by 80% after 7 days of curing.

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7. References

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