Effect of Metakaolin on the Piezeresistivity Properties of Modified Oil Well Cement under Compression Test

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Abstract
The effect of 10% metakaolin additive on the modified oil well cement was investigated at room condition. Adding metakaolin enhanced the piezoresistive behavior of the cement under compressive loading, almost tripling the change in resistivity at the peak stress.

1. Introduction

Hydration of cementitious material is an important process for cement to develop mechanical strength and low permeability. Cement hydration involves chemical reaction between water and the anhydrous compounds present in the cement. As a result, the solid phase becomes highly connected and the material transforms from a viscous suspension of irregular shaped cement and other particles into a porous stiff solid. Cement hydration has been monitored with so many different ways using Vicat needle, strength, scanning electronic microscope (SEM), X-ray diffraction (XRD), (Andrew et al.2012, Cheung et al.2011, Brooks et al.2001). Metakaolin is refined kaolin clay that is fired (calcined) under carefully controlled conditions to create an amorphous aluminosilicate that is reactive (Ambrosia et al.1994). Like other pozzolans (fly ash and silica fume), metakaolin reacts with the calcium hydroxide (lime) byproducts produced during cement hydration. Metakaolin has been used in concrete to refine the pore structure of the cement paste matrix of concrete, also metakaolin increased resistance to acids and sulphates, reducing porosity and reduced chloride ion diffusivity. (Ambrosia et al.1994, Khatib et al.1996)

2. Objective

Effect of metakaolin on the piezoresistivity property of modified oil well cement under the compressive loading at room condition was investigated.

3. Materials and Methods

The cement was mixed with 10% metakaolin and then water was added. The water-to-cement ratio (including metakaolin) was 0.45 for both the metakaolin and control specimen. The cement mix was then placed in plastic cylinder mold of 2 inches in diameter and 4 inches in height. Each mold had 4 wires installed to measure the electrical resistance.

4. Result and Discussion

The change in the electrical resistivity for different frequencies was recorded. From the Fig.1 it can be understand that the effect of contact resistance reduced by increasing the frequency. Frequency of 300 kHz was chosen for conducting compressive test. As shown in Fig.2 fractional change in resistivity increased during compression test on 7 days old samples made with and without metakaolin. Control specimen showed value of 0.15 when the major crack initiate, while sample containing 10% of metakaolin showed the fractional change in resistivity of 0.42 which was approximately 200% higher than the control specimen. For both samples during major cracks sudden increase in the fractional change in the resistance were observed during compressive loading Fig. 2. Compression strength of the sample with metakaolin was increased by 40%.

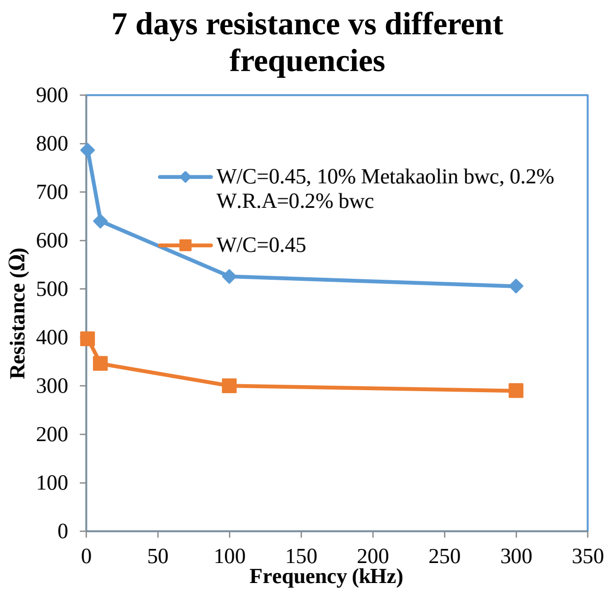

Fig.1. Change in the electrical resistance versus time for different frequency range with and without metakaolin

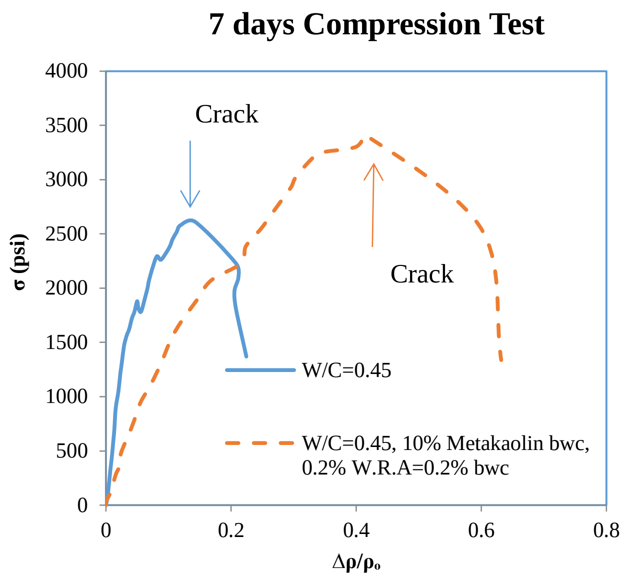

Fig.2. fractional change in resistivity versus stress under 7 day compression test

5. Conclusion

Addition of the 10% metakaolin to the modified oil well cement increased the fractional change in the resistivity at the peak stress by almost three times than the control specimen also results showed that addition of metakaolin increased the compressive strength of cement by 40%.

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7. References

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