Effect of Meta-Kaolin Clay on the Strength Characteristics of the Cement Grout

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Abstract: In this study the effects of meta-kaolin clay on the strength characteristics of cement grouts was investigated. Up to 10% by weight of cement of clay was used in the grout. The water-cement ratio (W/C ratio) investigated was 0.6 and 1. Pull-out strength and compressive strength of the cement grout showed notable variations with the addition of clay in the grout mix. Interface shear type failure was observed with pull-out tests.

1 Introduction

Several different grout formulations with Portland cement and pulverized fuel ash, sea water, powdered chalk, bentonite and sodium silicate at different proportions are in use since mid 1970's for filling the voids in the foundations of offshore concrete gravity platforms (Domone, 1988). The pull-out load capacity of fully grouted rock bolt was studied by Kilic et al, (2002). The rebars were grouted into basalt blocks with cement mortar. The bond strength was obtained by dividing the load by the surface area of the grouted bolt bar. Maalej et al, (2007) studied the strength of cement grouted soils. Triaxial tests were conducted under constant confining pressure for the cement grouted soil samples. The w/c ratio was varied between 0.1 and 0.2. The strength decreased on increasing with the confining pressure.

2 Objective

The main objective of this study was to investigate the effects of meta-kaolin clay on the mechanical properties of the cement grouts with varying w/c ratios. Hence, the changes in the pull-out strength and compressive were studied.

3 Materials Required and Experimental Program

ASTM specified Type I/II Portland cement and Commercially available Meta-kaolin clay which with a coefficient of gradation (Cc) of 0.85 and coefficient of uniformity (Cu) of 3.68 and d_{50} of 0.0019 mm was used in this study. The samples were cured for a period of 14 days and then the pullout strength of the sample was measured by dividing the pull-out load taken by the specimens by the area of cross section of the failure surface. The 7 day Compressive strength of the cement grout was measured using a 38 mm diameter and 102 mm high cylindrical sample. The samples were prepared using Teflon molds with a diameter of 1.5 in. (38 mm) and height of 4 in. (1012 mm). The strain rate was kept constant at 10%/hour. The test was conducted until the sample completely failed.

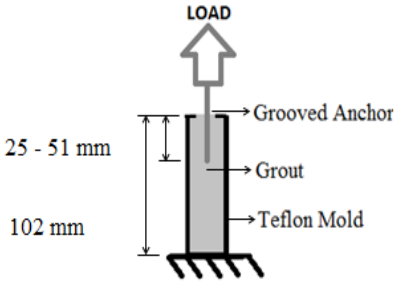

Fig 1: Schematic Diagram of Pull-out Strength Test

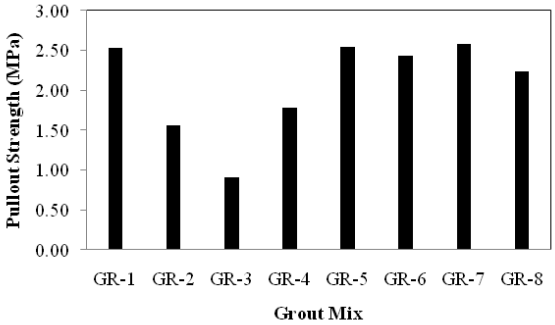

Fig 2: Variation of Pull-out Strengths of cement-Clay Grout Mixes

4 Results and Discussion

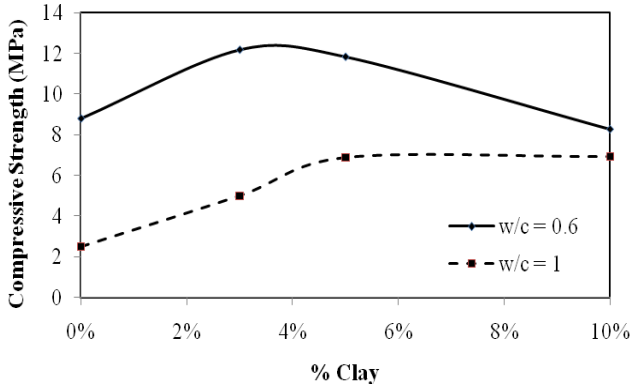

Fig 3: Variation of Compressive Strength of the Cement-Clay Grout Mixes

The variation of pull-out strength after 14 days of curing for various grout mixes are shown in Fig. 2. The dominant failure was interface shear. For the grout with w/c ratio of 1, the pullout strength reduced with the addition of clay. The pull-out strength was about 2.5 MPa for both grout mixes GR-1 and GR-5 respectively. The pull-out strength was not influenced by the clay content in the grout mixes with w/c ratio of 0.6.However, The average pull-out strength for cement grouts with w/c ratio of 1 varied from 0.9 MPa to 2.5 MPa.

The variation of Compressive strength of the cement grout with the addition of clay is shown in Fig 3. It was observed that up to an addition of 5% clay, the compressive strength of GR-1 increased to 6.9 MPa and then became stable on further addition of clay. However, the strength of GR-5 which was 8.8 MPa increased with the addition of 3% clay in the grout to 12.2 MPa and on further addition of clay the strength was reduced to the 8.2 MPa. The strength of grout mixes with w/c ratio of 0.6 had a higher strength than those with w/c ratio of 1.

6 **Conclusion**

The effect of adding varying quantities of clay to the cement grout was investigated. Based on the experiments conducted, following conclusions were advanced.

1 The general failure during the pull-out strength was interface shear. The pullout strength of the cement grout decreased with the addition of clay for the grouts with w/c ratio of 1. The changes were minimal for grouts with w/c ratio of 0.6.
2 The addition of clay affected the compressive strength of the cement grout. Grouts with w/c ratio 0.6 had a higher strength than grouts with w/c ratio 1.

8 References

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