Effect of Meta-Kaolin Clay on the Bleeding and Flowability of the Cement Grout

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Abstract: In this study the effects of Meta-Kaolin clay on the bleeding and flow-ability characteristics of cement grouts were investigated. Amount of clay used, varied up to 10% by weight of cement in the grout. The water-cement ratio (w/c ratio) varied from 0.6 and 1. Flow-ability was measured using the Marsh funnel cone viscometer.

1 Introduction

Cement grouts have numerous applications. Various studies have been in progress to modify and improve the composition of cement grouts to enhance the groutability of the cement grout. Huang (2001) studied the changes in the properties of cement – fly ash grout on addition of polypropylene fiber and superplasticizer. Viscosity, setting time, bleed, compressive and flexural strengths and resistance of the grout to sulfate attack have been studied. W/c ratio is a very important parameter that is to be considered. Akbulut and Saglamer (2002) studied the effect of w/c ratio in predicting the groutability. In general groutability increased on increasing w/c ratio but the increase in w/c ratio resulted in the increase in permeability of the grouted soil and decreased the strength.

2 Objective

The main objective of this study was to investigate the effects of Meta-Kaolin clay on the bleeding and the flowability of the cement grouts with varying w/c ratios.

3 Materials Required and Experimental Program

Bleeding tests were performed on the grout to check the stability of the various mix proportions. The volume of bleed water was noted by observing the solid-liquid interface. To measure the bleeding capacity, the grout mixes that were prepared were poured into 100 mL graduated cylinders and the readings were noted at regular intervals for a period of 2 hours. Bleeding was calculated by expressing the volume of water that separated out of the original volume of the grout sample. The time of efflux was measured using the Marsh funnel viscometer. The time taken for 950 mL (32 oz) of the freshly prepared cement grout to pass through the 5 mm diameter orifice of the funnel was measured. The time of efflux is an indication of the measure of flow-ability of the grout. ASTM specified Type I/II Portland cement was used. Commercially available Meta-kaolin clay which had 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.

4 Results and Discussion

Bleeding observed in various grout mixes are shown in Fig 1. It was observed that addition of clay reduced the bleeding in the cement grout for w/c ratios investigated. It can be seen in Fig 2a that GR-1 had a bleeding as high as 20% which was reduced to 11%, 5% and 1% with the addition of 3%, 5% and 10% of the clay (GR-2, GR-3 and GR-4 mixes) respectively. Reducing the w/c ratio from 1 to 0.6 reduced the bleeding from 20% to 3%. Addition of 3%, 5% and 10% clay further reduced the bleeding in the grout. GR-5 had a bleeding capacity of 3% but with the addition of 3% clay (GR-6), the bleeding was reduced to 0.5% which further was reduced to 0.2% and 0% with the addition of 5% and 10% clay (GR-7 and GR-8) respectively.

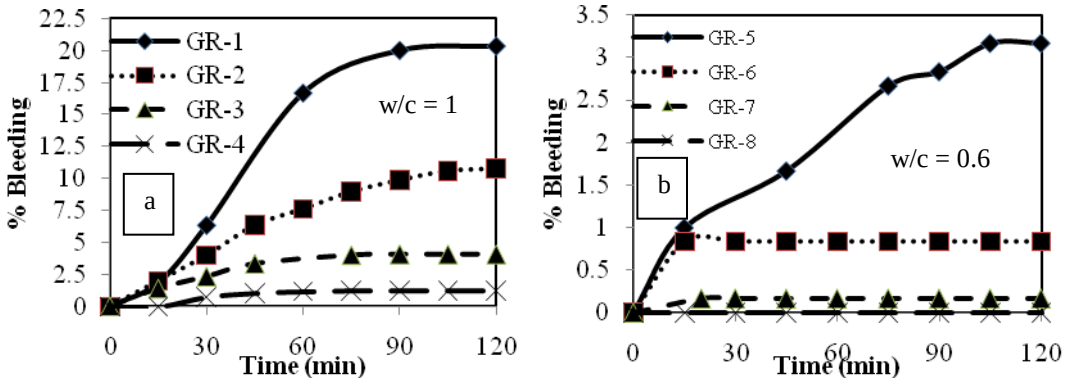

Fig 1: Variation of Bleeding Capacity of Cement-clay grouts with w/c ratio of 1 and 0.6

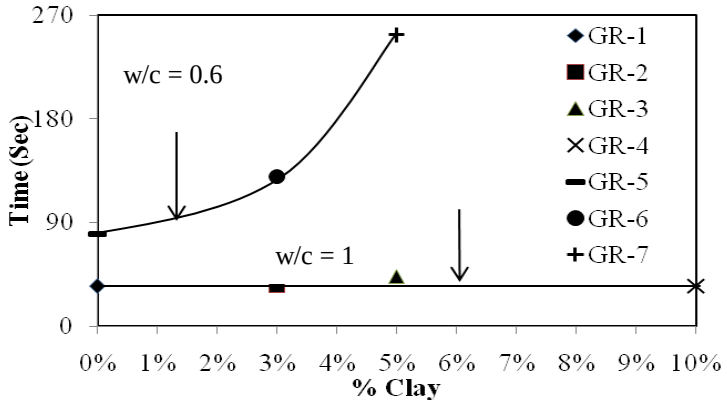

Fig 2: Effect of Clay Content on Time of Efflux of the cement grout

Variation in the flowability with the addition of clay is shown in Fig 2. It was observed that the grout mixes with w/c ratio of 1 have a very low time of efflux than the grout mixes with w/c ratio of 0.6. The time of efflux increased with the addition of the amount of clay in the grout mixes with w/c ratio of 0.6. However, there was no significant change in the case of mixes with w/c ratio of 1. GR-1 and GR-4 had a time of efflux of 35 seconds and GR-2 had a time of efflux of 36 seconds. GR-3 had a slightly higher value of 43 seconds. Cement grout with w/c ratio of 0.6 and with no clay content (GR-5) had a time of efflux of 80 seconds which was more than double the time of GR-1. GR-7 which had a w/c ratio of 0.6 had a very high time of efflux value of 253 seconds with 5% clay. GR-6 with 3% clay content had a time of efflux of 130 seconds.

6 Conclusion

Based on the experiments conducted, following conclusions were advanced.

1) Addition of clay up to 10% decreased the bleeding capacity of the cement grouts with w/c ratio of 0.6 and 1.
2) The flowability of the grout with w/c ratio of 0.6 was affected by the addition of clay. That was not the case with grout with w/c ratio of 1.

7 References

Huang, W., H., (2001) "Improving the Properties of Cement-Fly ash Grout Using Fiber and Superplasticizer." Journal of Cement and Concrete Research, Vol 31, No 7, pp 1033-1041.

Akbulut, S., Saglamer, A., (2002) "Estimating the Groutability of Granular Soils: A New Approach." Journal of Tunnelling and Underground Space Technology, Vol 17, No 4, pp 371-380.