Effect of Meta-Kaolin Clay on the Setting Time of Cement Grout

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Abstract: In this study, the effects of a meta-kaolin clay on the setting time, curing temperature and electrical resistivity 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) investigated as 0.6 and 1. Setting time was measured using the Vicat's needle apparatus Curing temperature and electrical resistivity were also monitored with respect to the setting time of the grout. Results showed that the curing temperature and electrical resistivity were not clear indicators of the setting time.

1 Introduction

Cement grouts have multiple applications and therefore there is continued interest in modifying the grout. Various studies have been in progress to modify and improve the composition of cement grouts to enhance the physical and chemical properties of the grout. With special qualities such as high water assimilation, good dilution resistance and good rheological behaviors, clay hardening grout have been in common use which had a composition of kaolinite clay and common silicate cement (Xinghua et al, 1997). Here, the gelling time of the clay hardening grout was studied with respect to varying the composition of the grout mix. Huang (2001) studied the changes in the properties such as viscosity, setting time, bleed, compressive strength and flexural strength of cement – fly ash grout on addition of polypropylene fiber and superplasticizer. Addition of the fibers decreased the setting time but the addition of superplasticizer increased the setting time. W/C ratio is a very important parameter that is to be considered during the application of cement grouts as they play an important role in the penetration ability of the grouts into the soil or penetrate the cracks in concrete.

2 Objective

The main objective of this study was to investigate the effect of meta-kaolin clay on the Setting time of the cement grouts with varying w/c ratios. Hence, the changes in the setting time and electrical resistivity with curing temperature were studied.

3 Materials and Experimental Program

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. Setting time of the cement grout was measured using the Vicat's needle apparatus (ASTM C 191). The typical variation of electrical resistivity with respect to time was also measured by observing the resistance of the sample using an ohm meter. The Resistivity was calculated using the formula, $\rho = R.A/L$ where R is the resistance (kilo-ohm), A is the cross sectional area (sq.m) and L is the length of the specimen between which the resistance was measured (m). The curing temperature was also measured using a thermocouple.

4 Results and Discussion

The Vicat needle test results are shown in Fig 1. Initial and final setting times of all the grout mixes are summarized in Table 1. From the setting times of cement grouts with w/c ratio 0.6:1 (GR-5, GR-6, GR-7 and GR-8) it was observed that the clay content in the grout mix with w/c ratio of 0.6 decreased the setting time of the grout. Addition of clay not only affected the initial and final setting time but also affected the time difference between the initial and final setting.

Table 2: Setting Time of Grout Mixes

Grout mix	Initial setting time (min)	Final setting time (min)	Difference (min)
GR-1	598	978	380
GR-2	646	1000	354
GR-3	611	833	222
GR-4	580	885	305
GR-5	500	586	86
GR-6	407	520	113
GR-7	360	517	157
GR-8	280	485	205

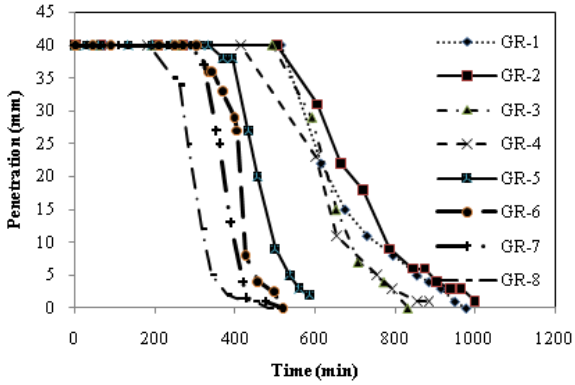

Fig 1: Setting Time Curves of the Grout Mix

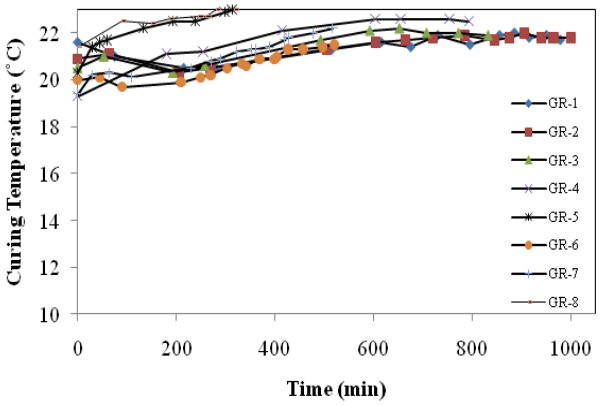

Fig 2: Curing Temperature Curve of the grout mixes

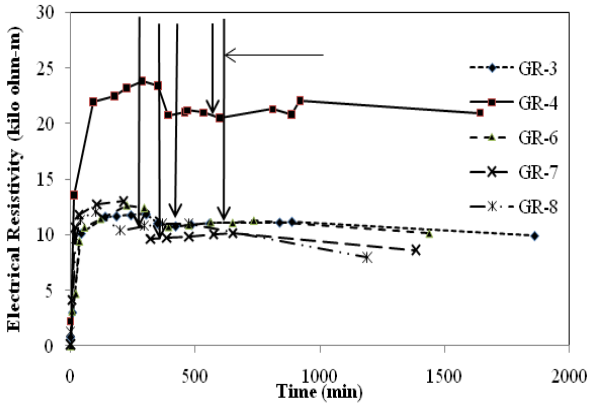

Fig 3: Variation of Electrical Resistivity of the Cement-Clay Grouts

Variation of curing temperature and electrical resistivity with time for various grout mixes are shown in Fig 2 and Fig 3 respectively. The maximum change in temperature during the process of curing varied from 1˚C to 3.3˚C. The maximum difference was observed during the setting of GR-5 and GR-8 grout mixes which was 3.3˚C and the minimum change of 1.1˚C was observed in GR-2 grout. For all the mixes, the resistivity peaked before the initial setting time. Addition of clay increased the electrical resistivity and the increase was influenced by w/c ratio. The maximum resistivity values of GR-3 and GR-4 were about 11 kilo ohm-m and 23 kilo ohm-m respectively consistently which made it hard to identify the initial setting time.

6 Conclusion

Based on the experiments conducted, following conclusions are advanced.

1. The initial and final setting time were affected by the addition of Meta-Kaolin clay. The difference (Final – initial) in setting time was also affected by the addition of clay.
2. The electrical resistivity peaked before the initial setting of the grouts. The resistivity was affected by the w/c ratio and the clay content.

8 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.

Xinghua, W., Quqing, G., (1997) “Study of a New Cheap Grouting Material: Clay Hardening Grout.”, Journal of Tunneling and Underground Space Technology, Vol 12, No 4, pp 497-502.