EFFECTS OF A HYDROGEL ON THE SELF-CURING PROPERTIES OF MORTARS

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Introduction

Curing is to maintain the moisture content in fresh concrete, which is important in developing the concrete microstructure, and achieving the desired engineering properties. Traditional curing methods of concrete such as moist curing and membrane curing are considered as external curing methods. These methods are not always convenient in some practical applications. Therefore, the concept of internal curing or "self-curing" has been proposed. Self-curing concrete is made by preparing concrete incorporated with self-curing agents, which is to reduce the water evaporation from concrete, and increase the water retention of concrete [1,2].

Two types of self-curing agents have been suggested [1-2]: (1) water-soluble polymers and (2) hydrogels. Water-soluble polymers can interact with water through hydrogen bonding, and decrease the water evaporation rate from concrete. Hydrogels are cross-linked polymers, which can absorb and retain large amount of water. They act as water reservoirs to release water gradually, supplement the water loss and increase the water retention of concrete compared to conventional concrete. In this study, an amphoteric hydrogel was prepared and evaluated as a self-curing agent. The water absorbency of this polymer in salt solutions was measured. The effect of the hydrogel on the water retention and compressive strength of mortars, and the crack sensitivity of cement pastes was determined and discussed.

Experimental

Materials
The materials used include Type I Portland cement, Ottawa sand, superplasticizer (SP) and hydrogel. Hydrogel is an amphoteric cross-linked polymer (PAC) which was prepared in our lab and contains ammonium cations and carboxylate anions when dissolved in water. SP is used to adjust the mortars reaching required fluidity.

Water Absorption Measurement
Certain amounts of PAC hydrogel were immersed in de-ionized water and in salt solutions. The water absorbency of the hydrogel was determined using a tea bag method.

Test of Mortars
Mortars with W/C=0.485 were made. Table 1 lists the mixture proportions of mortars. The spread diameter (SD) or fluidity of all tested mortars was controlled to be between 205 and 215 mm. Mortars were cast in cubic molds of 5×5×5 cm^3. The mortar samples were cured in the molds for 24 hrs, and then were de-molded and cured in air at room temperature. Their weights at 1-28 days were measured to determine the weight loss with time. Besides, compressive strength of mortars cured at 3-28 days was also measured.

Table 1 The composition of mortars*

	PAC (wt%)	PAC (g)	SP (wt%)	SD (cm)
M0	0	0	0.05	20.8
M1	0.1	0.74	0.07	20.6
M2	0.2	1.48	0.09	21.3
M3	0.4	2.96	0.13	21

* Cement: 740 g, Sand: 2035g, water: 359 g.

Cracking Test of Cement pastes
Cement pastes with W/C=0.35 were prepared and cast in molds having two concentric steel rings with diameter 150 and 300 mm and depth 25 mm, having ribs attached to provide crack initiation. After casting, the ring samples are positioned under air funnels. The opening between the paste surface and the funnel is 8 cm along the whole circumference of the outer ring. The standard test conditions are: wind velocity = 4.5 m/s, room temperature, and relative humidity=43±3%RH. After 1 day of drying, the ring samples are taken out of the rig and the

crack index (CI) measured as the average accumulated crack width around two concentric circles on the paste surface of the specimen.

Results and Discussion

Fig. 1 shows the amount of absorbed water is increased with absorption time, and then approaches a maximum and equilibrium value. The equilibrium value is of about 275 g/g in deionized (DI) water. Fig. 1 also shows the water absorbency of hydrogel in DI water is much higher than that in 0.1 M salt solutions. The decrease of water absorbency in salt solutions can be attributed to the reduction of osmotic pressure between the gel and the aqueous phase. In addition, the presence of cations from salt can shield the anions in the gel structure, and lower elsctrostatic anion-anion repulsions. Clearly, water absorbency of hydrogel in 0.1 M NaCl solutions is higher than that in a 0.1 M $CaCl_2$ solutions. Fig. 2 shows the weight loss or water loss increases with elapsed time quickly, and then approaches a constant value gradually. Mortars containing hydrogel lost less water than those without any polymer, indicating the hydrogel could impede water evaporated from inside of mortar to outside. Apparently, mortars containing greater amount of hydrogel show lower water loss.

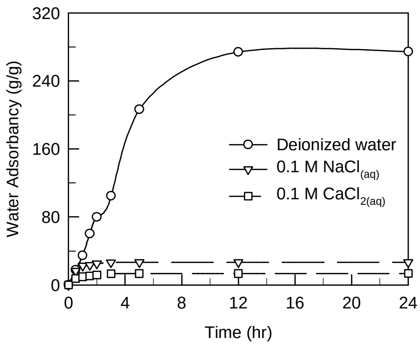

Fig. 1 Water absorbency of hydrogel versus time

Fig. 3 shows the effect of hydrogel content on the compressive strength of mortars cured at 3-28 days. The strength was found to increase with increasing hydrogel content. As hydrogel incorporated in mortars, the humidity and the degree the cement hydration inside the cementitious materials would increase; this promotes the strength growth. Fig. 4 shows less cracks on the surface of cement pastes with 0.1% PAC than those without any hydrogel. The CI value of the former is 0.13 mm and that of the latter is 0.55 mm. As the hydrogel could impede water evaporated from inside of materials to outside, it indeed reduces the crack sensitivity of the resulting pastes.

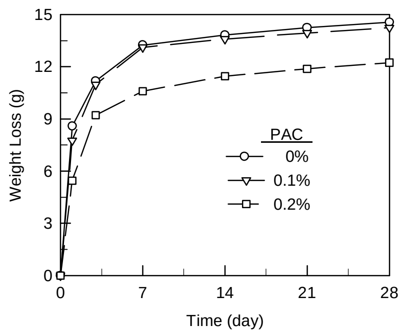

Fig. 2 The weight loss of mortars

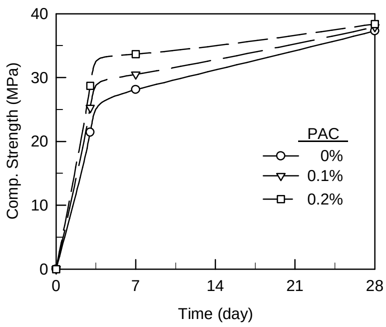

Fig. 3 The compressive strength of mortars

(a) (b)

Fig. 4 The surface appearance of ring pastes with (a) 0% PAC, and (b) 0.1% PAC.

Conclusions

The results indicate that the prepared hydrogel could absorb pure water up to 275 g/g. The water absorbency decreases with salt concentration and increasing ion charges. Mortars with hydrogel show lower water loss. Addition of proper amount of hydrogel could also improve the compressive strength of mortars and reduce the crack sensitivity of cement pastes.

References

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