

Newly Development on Sustainable Building Materials

Zongjin LI

Department of Civil and Environmental Engineering
The Hong Kong university of Science and Technology

ABSTRACT

To save natural resource and reduce carbon oxide gas releasing, and make cements more durable under some severe conditions, magnesium phosphate based cements have been developed recently. Comparing to PC, magnesium phosphate based cements have the following advantages and applications.

(1). Magnesium phosphate cement (MPC) can set rapidly and develop high strength at early stage. Its compressive strength can reach 12 MPa in one hour and 35 MPa in 6 hours See Figure 1. Hence it can be utilized as rapid repair materials for concrete structures, such as highway, airport runway, and bridge decks. By using MPC materials, the interrupt time of transportation can be greatly shortened. Therefore, the valuable time and resource can be saved

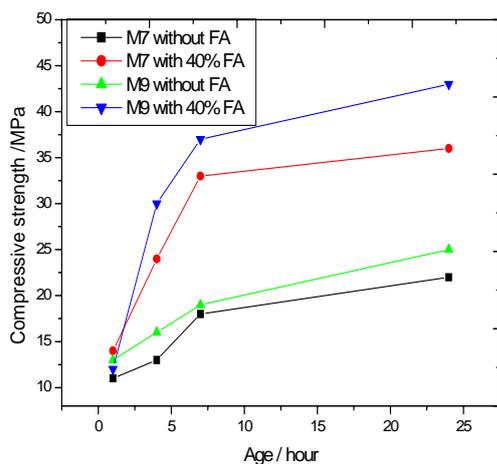
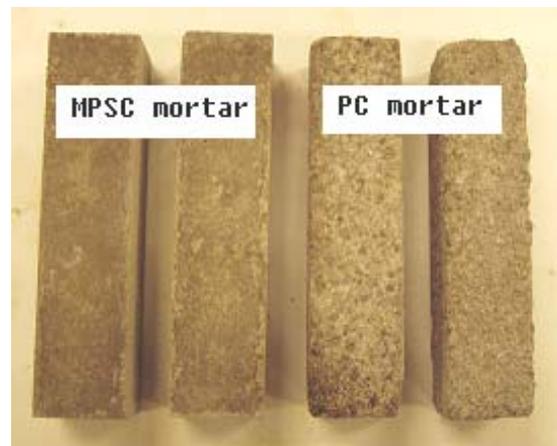


Figure 1 Ear-age strength of MPC concrete
(2). MPC can incorporate with lot of non toxic industrial waste, such as class F fly ash (FA) and translate it into useful binder. The

addition FA in MPC can over 40 % by mass of MPC, about two times comparing with PC. In addition, MPC can combine the FA which is not suitable incorporated in PC because of its high carbon content and other impurities. In the other words, PC only consumes so called good FA, but MPC can utilize FA with poor quality. Therefore, with respect to use recycling industrial waste, MPC will have more construction than PC. Besides FA, even acid blast furnace slag and red mud (the residual of alumina industry) can also be utilized in MPC at large amount. The two latter wastes are difficult utilized in PC concrete.

(3) The MPC has very good deicer freeze-thaw resistance. The experimental results of MPC mortar sample and Portland Cement mortar samples after 30 freezing-thawing (FT) cycles have shown that MPC samples are in good condition while the PC samples are damaged severely, see Figure 2.



Figures 2 Appearance of the MPC and PC mortar samples after 30 FT cycles

(4) MPC has good resistance to sulfate attack test. The compressive strength was determined after each following stages (I) After 3 days formed for MPC, 7 days for the PC mortar samples after they were molded, respectively; (II) the MPC mortars were immersed completely in solution of sodium sulfate (NS) and magnesium sulfate (MS) respectively, their concentration is 5 wt.%. MPC mortars were immersed 30 days in the two solutions; (III) The same samples set in normal condition for another 30 days; (IV) Afterwards, all the mortars immersed in the corrosive solutions for 60 days. (V) At last, those specimens were set in lab air for 90 days.

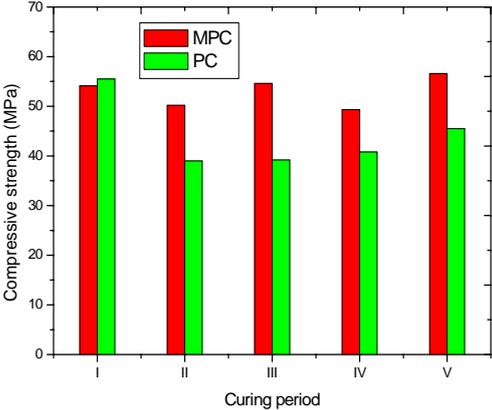


Figure 3 Compressive strength comparison for MPC and PC specimens

After immersing 30 days in the NS solutions, comparing with the strength at 3 day, the strength of MPC sample increased. But, after 30 days immersed in solution of MS, strength of CON decreased 7.2%. However, the strength loss of PC mortar is 29.4%, see Fig. 6. After then, the corroded samples set in normal condition (lab air), the strengths of MPC mortar increase continually, and surpass their strengths at 3d. However, the strength of PC sample basically did not recover anymore. This indicated that the microstructure of MPSC can recover when was separated from the attacking agents, however, the microstructure of PC had been damaged in the attacking agents. Then, these samples were immersed the sulfate solution again for another 30 day, respectively. The strength of MPC and PC decreased once more. However, after the specimens were put in lab air for another 90 days, the strength of MPC recovered much more (even catch up with the un-eroded specimens), the strength of PC mortar only recovered a little. From the results, it can be deduced that MPC sample has more resistance to NS attack than MS attack. In spite of which type of sulfate solution, MPC posses high salt attack resistance than PC mortar in the present research. Figure 3 shows the results of compression tests mention above .

(5) MPC has better volume stability than PC.

The length variation of specimen was measured as the volume variation of cement paste. The water to binder ratio of MPC and PC paste were 0.15 and 0.28 respectively. The test specimens was beams with size of 25x25x300 mm. The PMC paste was set in air after de-molded. The PC paste specimens were de-molded after one day, then were immersed in water for 6 days, after then, they were set in air for another 21 days. The test result was set forth in Table 1, it shows MPC paste is micro expansive. It indicates MPC paste does not produce shrink cracks as PC.

Table 1. Length change of MPC & PC paste

Specimen	MPC paste	PC paste
Curing procedure	After 28 days in lab air	From 7th day to 28th day set in lab air
Length change (%)	+0.0889%	-0.0689%