Pergamon

Cement and Concrete Research, Vol. 25, No. 5, pp. 1129-1130, 1995

0008-8846/95 $9.50+.00

A Discussion of the Paper "STUDIES ABOUT A SULFATE RESISTANT CEMENT: INFLUENCE OF ADMIXTURES" by M.T. Blanco, S. García, S. Giménez, F. Puertas amd T. Vázquez*

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The authors[1] have carried out a very interesting study on the sulphate resistance of a special white cement made from gypsum, fluorspar, limestone, kaolin, and sand which had undergone clinkerization at the realtively low temperature of 1350°C in a wet manufacturing process. The clinker proudced was not found to differ qualitatively much from conventional white Portland clinker, except for the presence of fluoroellestadite and sulpo- and fluoro-aluminates. Cements based upon the special clinker (surface area 437 m^2/kg) with 20% pulverized fly ash (Type F) addition and with 10% limestone filler addition were compared for sulphate resistance in 4.4.% wt. Na_2SO_4 solution and in artificial seawater (ASTM D1141) with the parent cement having no additions. The durability up to 18 months was examined by the Koch-Steinegger method.[2]

Although the compressive and flexural strengths of the cement mortars were lower in the sodium sulphate and seawater solutions in comparison with the mortars in deionized water, these cements exhibited good resistance to sulphate attack. Such sulphate resistance can be attributed to the low C_3A (aluminate phase) content, as indicated.[1]

The cement with 20% fly ash gave better compressive and flexural strengths at 180 days and beyond in both water and the sodium sulphate solution, which could be attribtued to the pozzolanic effect given by the fly ash additive. However, lower compressive strengths were observed in the seawater. Certainly there are morphological differences present when the mortars are stored respectively in seawater and in sodium sulphate. In seawater, decreases in the levels of portlandite $Ca(OH)_2$ found are likely to be due to increases in the gypsum $CaSO_4 2H_2O$ and brucite $Mg(OH)_2$ contents, which would facilitate expansion and some destruction of the calcium silicate hydrate C-S-H gel, as suggested,[1] before the onset of sufficient hydration of the fly ash with consequent further formation of C-S-H in the hydrating system, that would be unable to compensate fully for such expansion and destruction.

The cement with 10% limestone filler gave appreciably lower flexural strengths in the sodium sulphate solution than in the absence of the limestone, whereas the corresponding compressive strengths did not show any clear-cut long term trend. As pointed out,[1] the limestone filler modifies the paste microstructure such that topochemical growth of $Ca(OH)_2$ upon $CaCO_3$ crystals might occur and hence facilitate access of SO_4^{2-} ions to form gypsum expansively.

It would be of interest to conduct similar experiments with this special white cement at low temperatures ca. 0° to 5°C to find out to what extent, particularly when limestone filler is present as an additive, that the formation of thaumasite, the non-binding calcium carbonate silicate sulphate hydrate $CaCO_3.CaSiO_3.CaSO_4.15H_2O$ or $Ca_6[Si(OH)_6]_2(CO_3)_2(SO_4)_2 24H_2O$,[3] can arise and

*CCR 24(6) 1177-1184 (1994)

lower the sulphate resistance of the mortar specimens in both sodium sulphate and seawater. After all, it has been pointed out[4] that with regard to the destruction processes affecting cement pastes in sulphate media, above 20°C formation of ettringite is decisive, whilst below 10°C, formation of thaumasite increasingly plays a determining role; not only is control of transformations in the aluminate phases a necessary condition for avoiding destructive sulphate attack, but at lower temperatures control of transformations in the silicate phases is also necessary. Also, even at ambient temperature cements with high C_3S levels (about 60%) have been found to be more prone to sulphate attack than those of lower C_3S content when both types have relatively low C_3A contents; for better sulphate resistance C_3S and C_3A should both be addressed.[5]

Without doubt, the series of experiments undertaken by Drs. Blanco et al.[1] form part of a very useful investigation into the properties of the special white cement produced under lower energy conditions than for conventional white Portland cement. Their results demonstrate the good sulphate resistance obtained for the cement by itself and also in the presence of pulverized fly ash and limestone additives.

References

1. M.T. Blanco, S. García, S. Giménez, A. Palomo, F. Puertas and T. Vázquez, Cem. Concr. Res. 24, 1177 (1994).
2. A. Koch and H. Steinegger, Zem.-Kalk-Gips 13, 317 (1960).
3. J. Bensted, Cemento 85, 3 (1988).
4. F.F. Alksnis and V.I. Alksne, 8th Int. Congr. Chem. Cem., Rio de Janeiro 5, 170 (1986).
5. D. Dimic and S. Drolic, 8th Int. Congr. Chem. Cem., Rio de Janeiro 5, 195 (1986).