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DISCUSSIONS

A Discussion of the Paper "A STUDY OF THE HYDRATION AND SETTING BEHAVIOUR OF OPC-HAC PASTES"
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The authors(1) have clearly demonstrated that the impedance and capacitance response of the hydration of ordinary Portland Cement-high aluminate cement (OPC-HAC) pastes are sensitive to the combined effects of changes in ionic concentration in the liquid phase plus the paste microstructure as hydration ensues. Rapid increases in the impedance characterise the OPC-HAC pastes at 0-20 minutes and 300-450 minutes, with a maximum being observed after the second rapid rise. Ettringite was formed in these pastes at very early times and SEM and EDXA data attributed to the fast setting seen to ettringite formation. The decrease in which impedance after the second rapid increase at 300-450 minutes was attributed to calcium hydroxide from C_3S and C_2S hydration providing Ca^2 and OH^- ions for the pore solution. For the OPC-prehydrated HAC pastes the lack of rapid impedance rise could be attributed to a reduction in the quantity of ettringite crystals formed. The setting time delay was considered to be due to slow diffusion through a layer of preformed hydration products on unhydrated surfaces of CA particles.

OPC-HAC mixes have been around for a long time. Their properties are well known and they are particularly important for rapid setting repair mixes, such as the sealing of leaks in mortar or concrete and in expansive situations.(2,3) HAC-OPC mixes normally have lower setting and compressive strengths compared with HAC and OPC alone, and for certain mix ranges the setting is very short and flash set can arise. These mix ranges vary with particular OPC-HAC types and cannot be predicted without trial experiments. The HAC setting is accelerated by gypsum and its derivatives and calcium hydroxide from the OPC; the OPC setting is accelerated by reaciton of gypsum and its derivatives with CAH_{10}, C_2AH_8 and C_3AH_6 in particular from the HAC to give ettringite. The later strength of HAC-OPC mixes decreases progressively as HAC is replaced by OPC until a maximum is reached that is lower than for OPC alone. The strength developed over the first few hours is sometimes greater than for HAC alone, even though the later strength is lower. It is also important to remember that mix proportions giving the higher early strength (like 1 day) and the minimum later strength (like 28 days) can differ with different batches of OPC and HAC.

Sulphate resistance of OPC-HAC mixes can be important in various repair jobs. The actual sulphate resistance will depend upon the smoothness of hydration and setting, as well as water/cement ratio,(4) since these factors influence the microstructure developed. Irregular fast setting, for instance, gives a more heterogeneous microstructure, which will give more large pores and thus greater ingress of extraneous salts like sulphates into the structures. Examples quoted in Lea(2) showed that HAC-OPC mixes 5:95 and 20:80 by weight showed lower sulphate resistance than OPC alone, whilst HAC-OPC mixes 80:20 to 100:0 by weight had sulphate resistance that was comparable with that of the HAC itself.

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* CCR 24(4) 682 (1994)

The results obtained by the authors are a very useful indication of the value of the impedance-capacitance matrix for studying the hydration behaviour of complex systems like OPC-HAC mixes. Whilst I would agree that ettringite formation is the prime cause of fast set in most instances, it is not the sole cause. There are also contributions to the advent of fast set from simultaneous early formation of CAH_{10} and/or C_2AH_8, even though during the course of hydration these hydrates become largely superseded (depending upon the availability of sulphate) in the sulphated environment, and also from their conversion if present and if sufficiently rapid into the hydrogarnet C_3AH_6, which may itself only be a transient phase in such systems. This, of course, depends upon sulphate availability in these hydrating OPC-HAC systems that governs the extent of ettringite formation therein.(5) Notwithstanding these comments, the authors(1) are to be congratulated upon their application of the electrochemical impedance method to the difficult area of early hydration and setting of OPC-HAC mixes, including those in which the HAC had been prehydrated prior to mixing with OPC.

References

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