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CEMENT AND CONCRETE RESEARCH

Discussion

Reply to discussion of the paper "Effect of aggregate particle size and composition on expansion of mortar bars due to delayed ettringite formation"[1]

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We thank Dr. G.M. Idorn for his comments on our paper [1]. The observation that deleterious expansion only occurred in our tests when quartz was used as aggregate in the mortar bars subjected to excessive heat curing might suggest that the deterioration of concrete subjected to curing at excessive temperature was due to the use of quartz aggregate rather than to the composition of the cement. However, other research [2] showed that, even in mortar bars made with quartz aggregate, deleterious expansion only occurred when ASTM type III (high early strength) cement was used.

In a recent publication [3] we examined the role of cement composition on the expansion of mortar bars cured in the same way as those in the earlier publication. In this research, to minimize the number of variables, the SO_3 content of the cements was kept constant at 4.5%, which is the average value of North American type III cements. Significant expansions were only observed in the tests in which cements with high C_3A contents were used. There appeared to be a pessimum C_3A content of about 10% leading to maximum expansion (Fig. 1).

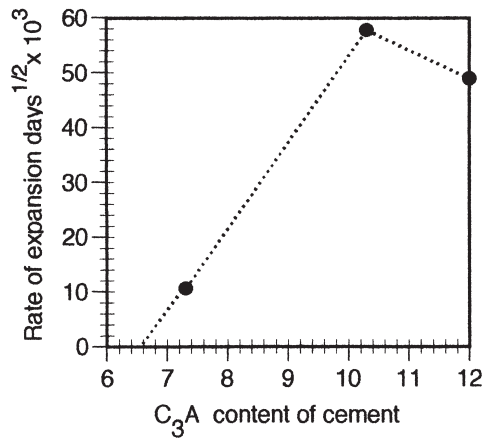

Fig. 1. Correlation between C_3A contents of cements and the rates of expansion of mortar bars subjected to accelerated heat curing [3].

Expansions also were observed to increase with increases in the alkali content of the cements. This research confirms that of many other authors who showed that expansion of mortar, or concrete, due to delayed ettringite formation, was strongly dependent on the composition of the cement. Therefore we cannot agree with Dr. Idorn's postulate that "the findings of our research do not justify obligations for the cement industry to develop new cement types which can prevent deleterious expansions in incorrectly steam-cured concrete," and we think that having read our second paper [3], he will agree with us.

We appreciate Dr. Idorn's recommendation that we should apply lengthwise thin-sectioning to the mortar bars to obtain additional information on the extent of microcracking and on the distribution of ettringite in the cracks and in the cement paste. This technique will be used in future investigations. However, mapping cracks and the spatial distribution of ettringite in the mortar lay outside the scope of the investigation under discussion. We are currently developing a nondestructive method for mapping cracks in the mortar bars using a nuclear magnetic resonance imaging technique that shows considerable promise.

References

[1] P.E. Grattan-Bellew, J.J. Beaudoin, V.-G. Vallée, Effect of aggregate particle size and composition on expansion of mortar bars due to delayed ettringite formation, Cem Concr Res 28 (1998) 1147–1156.
[2] Y. Fu, J.J. Beaudoin, Mechanisms of delayed ettringite formation in Portland cement systems, ACI Mater J July–August (1996) 327–333.
[3] P.E. Grattan-Bellew, J.J. Beaudoin, V.-G. Vallée, Delayed ettringite formation: effect of clinker particle size and composition on expansion of mortar bars, Materials Science of Concrete, Proceedings of The Sidney Diamond Symposium, August 1998, pp. 295–307.

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[1] Cem Concr Res 28 (1998) 1147–1156.

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