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Discussion

A discussion of the paper "Delayed ettringite formation in heat-cured Portland cement mortars" by R. Yang, C.D. Lawrence, C.J. Lynsdale, J.H. Sharp☆

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The results presented by the authors in this well-researched paper [1] are interesting, but I have a concern that the expansions they observed may not be indicative of the performance of the cement in steam-cured concrete in the field. It would appear from the analysis of the cement used that it would fall into the ASTM Type I category. There are no reports in North America of deterioration of concrete in the field made with Type I cement due to delayed ettringite formation (DEF). Furthermore, Fu and Beaudoin [2] only observed expansion in mortars cured at 90°C when Type III cements were used. The concept that only Type III cements are susceptible to DEF is supported by Mcdonald [3] who used Kelham's [4] equation relating cement composition and fineness to expansion in mortars cured at 90°C, to calculate the DEF potential of 1994 North American Cements [5]. He only found one Type I cement of 71 that appeared to have a potential for DEF. Unfortunately, he did not list the composition of the cement. It was not possible to accurately calculate the DEF potential of the cement used by Yang et al. [1], because the fineness of the cement was not listed. However, assuming a surface area of 375 mg^2/kg, Kelham's equation yielded n expansion of −0.974%, indicating that the cement does not have DEF potential.

In a recent paper [6] we showed that expansion due to DEF in mortars cured at 90°C was related to the C_3A content of the cement, the SO_3/AI_2O_3 ratio, and to a lesser extent the fineness of the cement. Figure 2 of the above paper is shown replotted here as Fig. 1, to which has been added the rates of expansion calculated from the data of Yang et al. [1]. The rates of expansion at 56 and 365 days were calculated by replotting the data on a graph of percentage expansion vs. $days^{1/2}$. The rate of expansion is given by the slope of the line fitted to the points on the linear portion of the expansion curve. The rate of expansion at 1 year is apparently too high when compared to our data, but the rate at 56 days is too low since their mortars did not show appreciable expansion until almost 100 days of storage in water. In our tests the cement with a C_3A content of 7.4% showed no additional expansion after 800 days, although some ettringite was detected by X-ray diffraction. This raises the question, Does evaluation of the DEF potential of cements by laboratory curing at 100°C, as was done by Yang et al., yield results that would not be matched by steam-cured concrete in the field, because the curing temperature in the laboratory is too high? This is an important question for the precast concrete industry—there is a need to develop a reliable test of the DEF potential of cements.

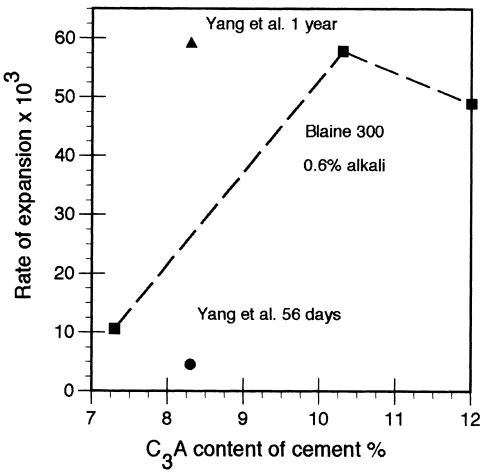

Fig. 1. Graph showing rate of expansion vs. the C_3A content of cements from Grattan-Bellew et al. [4]. The rates of expansion, obtained from the data of Yang et al. [1], after 56 and 365 days are shown on the graph.

References

[1] R. Yang, C.D. Lawrence, C.J. Lynsdale, J.H. Sharp, Delayed ettringite formation in heat-cured cement mortars, Cem Con Res 29 (1) (1999) 17–25.

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