Pergamon

Cement and Concrete Research, Vol. 28, No. 3, pp. 469–470, 1998
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0008-8846/98 $19.00 + .00

PII S0008-8846(97)00273-1

DISCUSSION

A REPLY TO THE DISCUSSION OF THE PAPER "A PROPOSED MECHANISM FOR THE GROWTH OF C-S-H DURING THE HYDRATION OF TRICALCIUM SILICATE,"* BY JOHN BENSTED

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(Received December 19, 1997)

Introduction

I wish to thank Dr. Bensted for his very kind remarks about my recent paper, and for taking the time and effort to prepare a rather detailed discussion of the subject of alite hydration. I am certainly in complete agreement with him over the complexity of alite hydration in Portland cements. In fact, this is one reason why I restricted my paper to the hydration of "tricalcium silicate," assuming, for simplicity, that one should attempt first to understand the reactions in the three-component system CaO-SiO_2-H_2O before extrapolating to real-world Portland cements. I also restricted my discussion principally to the acceleratory phase of C_3S hydration, which corresponds to something less than the first day of hydration in typical Portland cement concrete. Dr. Bensted correctly points out the potential for variation in the inherent "reactivities" of different preparations of C_3S and alite, due to crystal defects and impurity ions, and also to the effects of aging in humid air. I am quite sure that such differences can have a major influence on the rate of the dissolution process at the C_3S-water interface, and they may also play an important role in dictating the "stability" or perhaps the "strength of adhesion" of the protective coating that apparently forms on this surface very early during the hydration process, and which keeps the liquid phase far from saturation relative to the underlying anhydrous C_3S even at very early ages (1,2). However, if one believes, as I do, that the growth of a relatively stable but X-ray amorphous C-S-H phase is what dictates the kinetics during the period of steady but accelerating hydration of C_3S (which, in a Portland cement concrete, would be equivalent to the period of placing, setting and very early strength development,) and which begins "after" the initial period of rapid dissolution, then it seems reasonable to separate these two issues, as I have suggested in the past (2). This can be done if it is assumed that the "reactivity" of the anhydrous phase determines how much "excess" C-S-H is formed very early on in the reaction (during the initial period of rapid dissolution), before a relatively stable coating is formed on the C_3S surfaces. The more C-S-H formed at this initial stage, the more growth sites will exist for the initiation of the acceleratory stage, which will then amplify the effect of the early-age reactivity.

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[1] Cem. Concr. Res. 27, 665–672 (1997).

I again thank Dr. Bensted for bringing up these complex issues, and for providing a reminder to the scientific research community that the mechanisms of cement hydration are still far from well-understood. Clearly, much more basic scientific research needs to be done before we can say that we really understand all of the relevant processes at the atomic level.

References

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