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Discussion

Reply to the discussion of the paper "The occurrence of two-tone structures in room-temperature cured cement pastes"☆

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We thank Dr. Detwiler for her interest in the original paper and for her useful discussion. We appreciate her concurrence that the conclusion of the paper is in fact valid, and that indeed two-tone structures are not in themselves indications that the paste or concrete in which they are found has been exposed to curing at high temperature.

The works of Kjellsen et al. [1,2] cited by Dr. Detwiler are extremely interesting, and it is evident from their work that the temperature of early hydration does influence microstructure.

However, the context of our original argument had to do not with whether pastes cured isothermally at high temperature developed two-tone microstructure—obviously, they do—but whether a concrete of unknown provenance could reliably be assessed as having undergone high temperatures solely on the basis of a finding that a two-toned structure exists in it. We concluded that it could not, since two-tone microstructural characteristics develop in certain pastes and concrete without high temperature exposure.

Dr. Detwiler provides some useful suggestions as to auxiliary or supplementary features that might be helpful in assessing a given case. As she indicates, the morphology of the calcium hydroxide can be of some value in such an attempted assessment. However, it is well established that the morphology of calcium hydroxide may be strongly influenced by factors other than temperature; for example, the use of various chemical admixtures. In examining concrete of unknown provenance it is usually difficult to know what admixtures might have been used.

As Dr. Detwiler indicates, the paste pore structure is also sensitive to hydration temperature, and in principle an assessment of pore structure might provide helpful supplementary information. However, in addition to temperature, pore structure also is sensitive to water:cement ratio (often unknown), and again, to admixtures, especially superplasticizers. Thus pore structure seems also to be of limited help in deciding whether a given concrete has been exposed to high temperatures.

The third supplementary features suggested Dr. Detwiler, the thickness of hydration shells, may be helpful but it too may be ambiguous. If, as indicated, "the specimens hydrated at varying temperatures have hydration shells most closely resembling those of specimens hydrated isothermally at the final curing temperature," the thickness of hydration shells in concretes undergoing limited high temperature exposure followed by additional hydration under field conditions might be expected not to provide much clarification.

Thus it appears that even with the aid of the suggested supplementary features, it may be difficult to decide unambiguously whether or not a given concrete exhibiting a two-tone structure has in fact had early high temperature exposure.

Dr. Detwiler is certainly correct in her observation that the silica fume Portland cement-paste cited in our paper should have been expected to contain undispersed agglomerates of silica fume. The pastes in question were prepared for another study, and were meant to provide the basis for a comparison with other pastes not containing silica fume treated in an identical manner (i.e., mixed according to ASTM C 305 paste mixing procedure). This certainly would not be expected to disperse silica fume agglomerates.

Finally, we thank Dr. Detwiler for calling attention to the paper by Hearn at al. [3] which provides another illustration of two-toned structure in ambient-cured hydrated cement systems.

References

[1] K.O. Kjellsen, J.R. Detwiler, O.E. Gjørv, Backscattered electron imaging of cement pastes hydrated at different temperatures, Cem Concr Res 20 (2) (1990) 308–311.
[2] K.O. Kjellsen, R.J. Detwiler, O.E. Gjørv, Development of microstructures in plain cement pastes hydrated at different temperatures, Cem Concr Res 21 (1) (1991) 179–189.
[3] N. Hearn, R.J. Detwiler, C. Sframeli, Water permeability and microstructure of three old concretes, Cem Conu Res 24 (4) (1994) 633–640.

☆Cem Concr Res 28 (1998) 1237–1243.

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