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Discussion

Reply to the discussion by W. Hime and L. Backus of the paper "Redefining cement characteristics of sulfate-resistant Portland cement"☆

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The discussion from Hime and Backus is interesting, but is not really related to the research conducted. It is an interesting proposal to conduct additional research, but looks to verify a preconceived conclusion. The research presented in the paper was not conducted to "determine the relationship between sulfate attack and C_3A content," but rather to identify specific cement characteristics that are related to the expansion of concrete due to sulfate attack. This is stated in the first sentence of the abstract. In fact, the paper points out that iron compounds have a stronger role in sulfate resistance than C_3A has in sulfate attack.

As for the comment that in the 21st century we should realize that classic sulfate attack is related to "C_3A that has not already formed ettringite," this is a simplistic half-truth of more a complicated chemical system. It ignores the transformation of existing monosulfoalunimate or the role of calcium hydroxide in the formation of ettringite. Most investigators of the sulfate mechanism and the mitigation of sulfate attack have long recognized the innocuous existence of monosulfoaluminate and ettringite in hardened concrete. These are not typically considered part of the sulfate attack mechanism, as they form during the plastic or fresh state of concrete. It is the effect of different cement characteristics on the expansion of concrete that occurs due to long-term exposure to external sulfates that most frequently concerns design engineers. This is the subject of the research and paper.

The discussion of historic cement is also not particularly relevant since we no longer manufacture cement in a vertical kiln or with design strengths of 1500 psi. These were the manufacturing conditions in the 1880s. Cements are manufactured in highly optimized kilns which must consider sulfur emissions in air pollution control, setting times for multiple clients, ASTM specifications, strength development for multiple clients, access to raw materials and much more.

The discussers propose an equation for the prediction of sulfate expansion. We urge them to conduct a series of redundant experiments with multiple cements that could be added to the volume of work presented by our research and that of others to verify their idea. We would be happy to cooperate with them on such a study. The full set of data from our study is available from NCHRP.

☆ Cem Concr Res 32(8) (2002) 1239–1246.

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