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A Reply to a Discussion by John Bensted of the Paper "MECHANISM OF EXPANSION IN HARDENED CEMENT PASTES WITH HARD-BURNT LIME"*

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Formation of calcium hydroxide may cause either expansion or no expansion. It is universally accepted that calcium hydroxide from hydration of calcium silicates does not cause any expansion in cement pastes. However, calcium hydroxide formed by hydration of free lime in hardened cement pastes generally gives rise to much or less expansion, depending upon composition of pore solutions, strength of cement pastes etc. It does not seem that this difference is due to differences in the precise rate and extent of crystal growth development associated with impurities in calcium hydroxide.

Hard-burnt free lime enclosed in cement clinkers may differ from one cement to another. Consequently, it may hydrate in a distinct rate and bring about different expansion in cement pastes. However, the free lime used by the authors was derived from a pure limestone by calcining at 1400℃ [1]. The free lime incorporated in different cement pastes was identical. Its hydration rate might not be closely related to the degree of clinker burning in cement kilns as suggested by Dr. John Bensted[2].

Calcium hydroxide may be an impure compound with small amounts of silica oxide and other components in the structure or in inclusions as indicated by Bensted and Taylor[2,3]. However, calcium hydroxide from the same free lime in the investigated different Portland cement-based pastes, especially in the same kind of cement pastes with different alkalis[1], may contain analogous impurities because the pore solutions of these cement pastes are all composed of K^+, Na^+, Ca^{2+}, OH^-, AlO_2^-, SO_4^{2-} and SiO_4^{4-} ions etc. Therefrom, the influence of the included impurities on growth of calcium hydroxide from the free lime may not be the main cause for the distinct expansion characteristics of free lime in cement pastes. For better understanding of hydration and expansion of free lime, however, it is probably needed to further investigate the impurities in calcium hydroxide formed by the free lime in the studied systems and the influence of these impurities on the exact level of expansion although most of calcium hydroxide in cement pastes may grow into crystals[3].

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White Portland cements contain less ferrite phase than ordinary Portland ones. Thus, ordinary Portland cements tend to mop up more calcium hydroxide from hydration of calcium silicates and/or added free lime to form AFt phase during the hydration process of ferrite than white Portland cements. If calcium hydroxide from free lime is consumed by ferrite during its hydration as proposed by Bensted[2], calcium hydroxide available for expansion in ordinary Portland cement pastes will be smaller than that in white Portland ones. As a result, free lime in ordinary Portland cement pastes will cause a smaller expansion than that in white Portland cement pastes. However, the experimental results did not fellow this suggestion[1].

References

[1] Deng Min, Hong Dongwen, Lan Xianghui and Tang Mingshu, Mechanism of expansion in hardened cement pastes with hard-burnt free lime. Cement and Concrete Research, **25**(2), 440-448, 1995

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[3] Taylor H.F.W., Cement Chemistry, Academic Press, London, 126, 1990