

# Discussion

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## Lightweight calcium silicate hydrate : some mix and strength characteristics\*

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Two comments may be made. (1) The authors show that very close control of lime/silica ratio and, to a lesser extent, of water/solids ratio is required to give maximum strength for a given silica flour and a given heating cycle. It might be expected that, in commercial practice where a wider range of particle size is normally employed, these ratios would be rather less critical. (2) The results would have been much more valuable had the chemical nature of the compounds formed been investigated, by X-ray or thermogravimetric methods. In the absence of such data, only speculation is possible as to the explanation of the results.

At the temperature of Taylor and Moorehead's work, four different compounds are readily formed—gyrolite, xonotlite, tobermorite and dicalcium silicate  $\alpha$ -hydrate. Of these, only tobermorite is specifically known to be cementitious, while dicalcium silicate  $\alpha$ -hydrate is certainly non-cementitious. Xonotlite would be expected to have cementing qualities, on account of its structural resemblance to tobermorite, but little is yet known of the properties of gyrolite.

A tentative explanation can be offered for the existence of an optimum lime/silica ratio for each grade of silica flour. The maxima in the curves in Figure 2 of the paper may correspond to maximum formation of the strongly binding tobermorite. At lower lime/silica ratio for a particular silica specimen, less tobermorite is formed, so that maximum strength is not achieved; at higher lime/silica ratio, some dicalcium silicate  $\alpha$ -hydrate may be formed, with a corresponding loss of strength.

In the case of the silica of highest specific surface,

almost complete reaction has probably taken place. For lower specific surfaces some larger and, hence, less reactive particles of silica will remain unreacted and the lime/silica ratio required to give maximum tobermorite formation in the period of autoclaving is correspondingly lower.

The further work promised by the authors should help to test these hypotheses and will be awaited with interest.

### Reply by the authors

(1) The range of particle sizes studied was confined to the requirements of lightweight calcium silicate hydrate, and no attention was paid to the requirements of dense autoclaved products such as sand-lime bricks. Within this range it was found that the lime/silica ratio required for maximum strength/weight ratio was governed by the grain size of the silica. The straight line relation between lime/silica ratio and specific surface area of the silica (Figure 3 of the paper) indicates that the effect of variations in the latter may be overcome by adjusting the lime/silica ratio to obtain the maximum strength.

(2) Since the paper was published, Dr W. F. Cole, of the Division of Building Research, C.S.I.R.O., has carried out X-ray diffraction and differential thermal analyses of some specimens typified by curve 3, Figure 2. Results by both methods have shown that the content of tobermorite was highest in specimens having the highest strength/weight ratio, which also contain some xonotlite. These results are in accord with the tentative explanation offered by Aitken and Taylor, but it is considered that the strength of lightweight calcium silicate hydrate is also influenced by such factors as the gap-grading of particles, the curing cycle, and the porosity of the manufactured product.