

# Discussion

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## The use of small specimens for measuring autoclave expansion of cements\*

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**Contribution** by V. S. Ramachandran, R. F. Feldman and P. J. Sereda

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Any simplification of a test method is useful and Mr Rehsi and Dr Majumdar have succeeded in reducing twenty-five-fold the amount of sample required for measuring the autoclave expansion of cement. This is confirmed by the good correlation of their results obtained from the small specimens with those obtained from the standard specimens.

In view of this it is necessary to draw attention to the fact that a prior paper<sup>(1)</sup> (not referenced by the authors) describes a test method for measuring the autoclave expansion of lime and cement with varying amounts of MgO which uses specimens smaller than those used by the authors and less than 1/100 of the size required in the standard method. The specimens weighed 2 to 3 g, were in the shape of 0.07 in. thick discs 1.25 in. in diameter and were made by compacting the fine powder in a steel mould at a pressure of 16,000 lb/in<sup>2</sup>. This shape of specimen gives greater sensitivity (maximum length for given weight).

Correlation with the standard bar test was excellent; an abrupt expansion occurred on the plot of MgO content versus expansion above 6% MgO. (Although the MgO was added to the cement rather than being present in the clinker, this should not alter significantly the correlation given.) In addition to the small size of specimen and good correlation obtained, there are several advantages in the method in comparison with

the one described by Mr Rehsi and Dr Majumdar. Some of these are listed below.

- (1) No mixing with water and pre-curing are required.
- (2) The total time for making compacts is much less than that required for the cement or lime bars because the latter require mixing, consistence testing and curing.
- (3) The compacts provide reasonable accuracy and reproducibility.
- (4) The autoclave expansion of the compact is about two-and-a-half times that of the bar. This results in a more sensitive test.

It may be stated in conclusion that a test which uses small specimens for measuring autoclave expansions due to MgO in limes or cements already exists, and this is in several ways superior to that of the authors.

### Reply by the authors

The  $\frac{1}{2}$  in. cube method of testing the soundness of cement was developed in connexion with our work<sup>(2)</sup> on high magnesia Portland cements containing as much as 15% MgO. This work has confirmed the earlier Czechoslovak conclusions that such cements are unsatisfactory on their own but, when mixed with adequate quantities of a suitable pozzolanic material such as pulverized-fuel ash, they pass the ASTM autoclave expansion test. It is quite likely that, in countries where reserves of low magnesia limestones are limited, a mixture of high magnesia cement plus p.f.a. will be

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used industrially in the near future. Such is the case already in Czechoslovakia.

With this objective in mind, we wished to try out a small-scale method which would (a) approximate the conditions recommended by the present standard as closely as possible, (b) be simple in conception as well as in operation, suitable for industrial laboratories, and (c) be able to deal with combinations of cement and various pozzolanic materials. Our experience with the  $\frac{1}{2}$  in. cube method so far has shown it to be quite adequate from these points of view and it has the advantage of using simple equipment already provided for other tests. Wet mixing and curing enable the specimens to be sufficiently rigid, and excessive caution is not required in handling them before autoclaving. The sensitivity of the method is very similar to that of the standard, so that calibration has not been necessary for each mixture. In our particular problem, the  $\frac{1}{2}$  in. cube method offered an extra advantage. The autoclaved cubes could be readily used for measuring the compressive strength of the cement plus p.f.a. mixtures. This has given us vital information regarding the mechanism of stabilization of high magnesia cements by pozzolanic materials.

We think that the method described above by Ramachandran et al. for measuring unsoundness in lime due to MgO is a very elegant one and the omission of any reference to this work in our paper is regretted. The press and die used are not, however, standard equipment, and the strength figures obtained from the discs are relative and not easily related to standard strengths. Since p.f.a. is known to compact poorly because of the spherical nature of its particles (and in our work we have had occasionally to add 50% or more by weight of p.f.a. to make the cement volume stable), it would have been interesting to see whether suitable compacts of this combination material could, in fact, be prepared. As the relative proportions of cement and p.f.a. vary with the amounts of MgO in the cement, presumably all compacts would have to be of a standard porosity.

#### REFERENCES

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1. MINISTRY OF PUBLIC BUILDING AND WORKS. *Building Research Station 1967*. London, H.M. Stationery Office, 1967. p. 20.