

# A Figure of Merit for Fly Ash Replacement of Portland Cement

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## ABSTRACT

The replacement of Portland cement by fly ash produces competing effects: it contributes C-S-H gel through the pozzolanic and alkali-activated reactions, but it also dilutes the contribution of the main Portland cement reaction. The relative importance of these individual effects depends on the chemical composition of the glassy phase of the fly ash. All of them must be taken into account in proportioning the fly ash/cement mix. Therefore, a figure of merit for fly ash replacement has been developed. Given a fly ash chemical composition, and a specified replacement factor, the algorithm for computing the individual C-S-H contributions is:

1. Use all CaO in the fly ash to produce C-S-H by alkali-activation.
2. Use any remaining SiO<sub>2</sub> to make C-S-H by the pozzolanic reaction.
3. Reduce the C-S-H produced by the main cement reaction by the dilution factor, adjusted for the difference in densities between the fly ash and cement
4. Sum the individual C-S-H contributions
5. Divide the sum by the C-S-H contribution of the undiluted cement reaction to yield the figure of merit (FOM)

If the FOM is greater than unity, then the replacement should provide a beneficial effect, i.e. more C-S-H gel. If it is less than unity, then the fly ash replacement would degrade the performance of the concrete. This algorithm can be iterated using different replacement factors to find the optimum value. An example of this approach is presented using a typical lignitic-type (Class C) fly ash and a bituminous-type (Class F) one.

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