NEW CONCERN OVER ALKALI-AGGREGATE REACTION[1)]

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There are three reasons why there is new concern over alkali-aggregate reaction:

1. The simple cheap precaution of specifying "low-alkali cement", and obtaining it at no increase in price over cement not required to be low-alkali, will no longer be widely available.
2. Aggregates not previously regarded as reactive are being found to have reacted in concrete in old structures and to be associated with significant cracking and damage
3. Serious early damage to concrete structures has occurred in places where it was previously unknown, especially in north Germany.

This justifies a re-examination of the state of knowledge and the state of the use of knowledge in this area.

All aggregates are reactive. They differ only in the kinds of reactions in which they participate, the degree to which and the rate at which the reactions proceed, and the effects. The reactic discussed here are those that can and have caused sufficient damag to concrete to result in somebody having to spend a lot of money he hadn't intended spending.

Concrete can become sufficiently damaged to be of concern only if one or the other of two circumstances exist: either the specifications covering its production were defective or these speci-

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fications were not complied with. In those cases where significant damage takes place, it is thus important to establish which of these circumstances existed so that one can establish first who shall bear the repair cost and second how recurrence can be avoided.

The Corps of Engineers has persisted, as a matter of policy, for the last 25 years or so, in requiring individual study and decisions about the need for precautions for each aggregate source for each project. We have never required low-alkali cement for all concrete in a large area, such as an entire state, simply to avoid having to bear the cost of aggregate testing. Some other agencies have done so.

With the need on the part of cement manufacturers to comply with regulations regarding air quality, it is now no longer economically feasible to waste kiln dust in order to keep down the alkali content of cement. With a need on the part of cement manufacturers to use more efficient cementmaking equipment to reduce the quantity of energy consumed per unit of product produced, the alkali content of cements will increase. It may be expected that cement produced so as not to contain more than 0,6% alkalies calculated as sodium oxide will no longer be available from some producers and will be available only at a premium price from most other producers.

What is needed - and possibly no additional research results are required - is a multivariate analysis of data relating to the laboratory tests for alkali-silica reaction.

Current criteria employed in the USA that provide a basis for separating aggregates into "reactive" and "non-reactive", while generally effective in preventing recurrences of catastrophic destruction of concrete structures, are now seen to be inefficient in two ways. First, they have caused more severe precautions to have been taken (limiting calculated cement alkalies to 0,60% Na_2O equivalent when a higher maximum would surely have been "safe") than were justified. Second, they have failed to preclude the occurrence of alkali-silica reaction from occurring in some cases

to a sufficient degree to have caused notable cracking when aggre
gates classed as "non-reactive" were used with cements containing
more than 0,60% Na_2O equivalent.

It is concluded that new research, or a re-interpretation of the
results of previous research, is needed to better characterize
the relevant parameters:

a. Degree and rate of aggregate reactivity.

b. Influence of concrete mixture proportions, especially unit cement content.

c. Influence of environment of service of the concrete.

d. Influence of dimensions of structures.

If these parameters were better understood, one could develop th
sort of prescription for safe structural behavior that would ser
efficiently to prevent damage to concrete from reactions between
aggregates and alkalies. This prescription might be a sort of
nomograph where one selected a point on a scale of low to high
aggregate reactivity, a point on a scale of cement content, a
point on a scale of structural dimensions, a point on a scale of
environmental exposure (temperature, moisture), and by connectin
these one could be directed to a point on a scale of degree of
precaution to take. Then one could work from the other side of
coin, taking the type and amount of slag or pozzolan in the ceme
itious medium, the $Na_2O:K_2O$ ratio in the cement, the water-solub
to total alkali ratio, and finally establish the limit on alkali
the cement appropriate for the concrete to be used in a given
structure, in a given location, to be constructed with aggregate
from a given source.