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CLAY, AGGREGATE, AND CONCRETE

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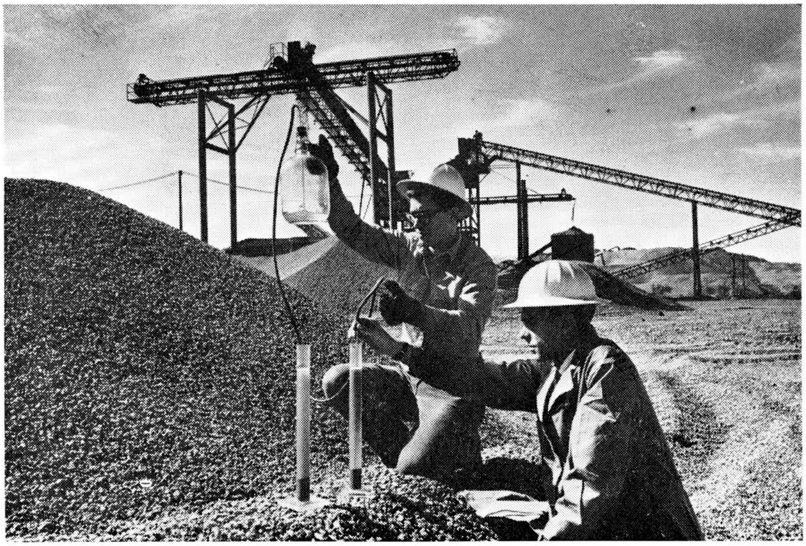

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Clay, Aggregate, and Concrete

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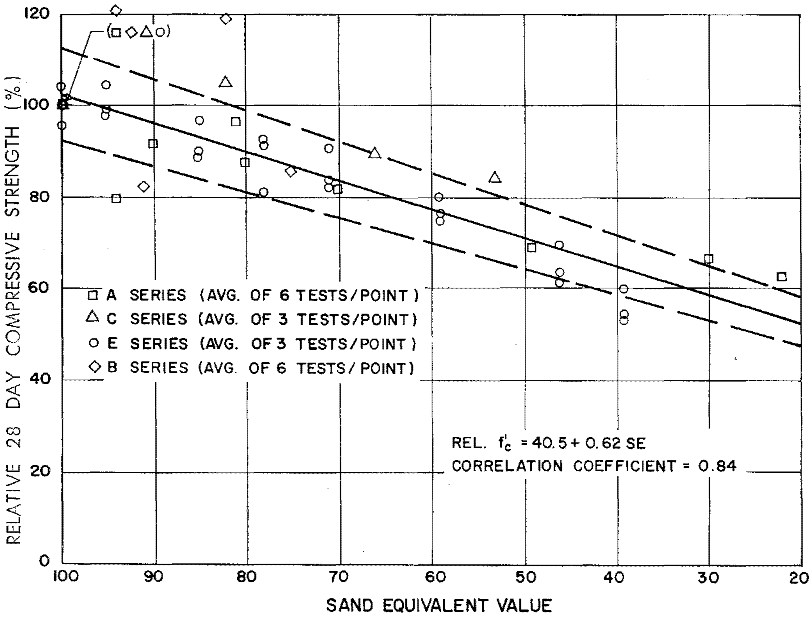
Specifications for concrete aggregates represent a compromise between the desire for a perfect material and the necessity for using materials that are economically available. In many instances the engineer is faced with the problem of writing a specification to limit a certain property and finds that sufficient information concerning that property, or how to measure it is not available. These encounters have resulted in the use of such phrases as "harmful amounts," "excessive amounts," or in the assignment of some arbitrary quantitative measure. As experience is gained these arbitrary quantitative measures have been adjusted first in one direction then in another, resulting in serious loss of confidence in some specifications. One of the examples of this type of specification is in the area of cleanliness of concrete aggregates.

This research included a study of the existing test methods (sand equivalent and loss by decantation) used to detect clay in concrete aggregates, and a study of the effect of various amounts of clay with various liquid limits on the strength, shrinkage, and freeze-thaw durability of concrete.

The sand equivalent test (shown in cover photo) makes use of a plastic cylinder and a solution of calcium chloride and glycerin to separate the clay fraction from the sand. The sample and solution are placed in the cylinder and agitated in a prescribed manner. The clay particles are then flushed up into the solution and allowed to settle for a given length of time. The result is a column of sand with a layer of clay on top. The sand equivalent value is defined as the height of the sand expressed as a percentage of the total height of sand plus clay.

The results of the research can be summarized as follows:

It has been found that the **activity** as well as the **amount** of the minus no. 200 mesh fraction of concrete aggregates affects the properties of concrete. Both activity and amount are reflected in the sand equivalent value but not in the loss by decantation. Clay contaminants in concrete aggregate affect concrete properties primarily through their effect on water demand. Concrete strength and shrinkage correlate to a high degree with sand equivalent values and to a slightly lesser degree with



Variation in 28-day compressive strength with sand equivalent values.

water-cement ratio indicating the possibility that the sand equivalent test indicates properties of the aggregate that are not accounted for solely by the aggregate's water demand in concrete.

The freeze-thaw durability of the concretes studied is also related to the sand equivalent value. Decreases in sand equivalent value bring about decreases in the freeze-thaw durability of the concretes, but, the mode of deterioration was different in the air entrained and non-air entrained concretes. The non-air entrained concretes exhibited structural failure as indicated by sonic modulus of elasticity determinations while the air entrained concretes showed a surface attrition reflected by loss in weight.

The need for sufficient processing to produce a relatively clean aggregate can best be emphasized by considering the quantitative effects on the properties of the concrete. The data developed indicate that for a given fine aggregate, as the sand equivalent value changes from 60 to 80, the concrete properties will exhibit the following changes.

1. Gain in 7-day compressive strength of 15%.
2. Gain in 28-day compressive strength of 16%.
3. Gain in 7-day modulus of rupture of 13%.
4. Gain in 28-day modulus of rupture of 12%.

5. Increase in durability (according to ASTM C290) of **non-** air entrained concrete of 60%.

6. Insignificant change in durability of air entrained concrete (air content approximately 5%).

7. Decrease in relative 28-day shrinkage of 17%.

8. Decrease in relative 120-day shrinkage of 15%.

9. Decrease in concrete mixing water demand of 9%.

Comparable changes in concrete properties are evident as the sand equivalent value changes from 80 to 100. The value of 100 denotes a completely clean fine aggregate.

The sand equivalent test does not tell everything that is needed to know the relative concrete making properties of different fine aggregates. Other factors such as degradation, elastic modulus, particle shape, fineness, etc. are of importance, but are comparatively difficult to determine. The sand equivalent test does predict the effect that the clay portion of a given aggregate will have on concrete making properties and is a very useful, rapid, field test for quality control of fine aggregate.