The Effect of Hydrating Agents Upon the Strength of Concretes and Mortars

By SUMMERS & MIEHLS, C. E., 1917

In a series of articles in the Engineering Record, 1915, Nathan C. Johnson, Engineer of Tests for the Raymond Concrete Pile Co., of New York City, opens up a new field in the investigation of the apparent low dependable strength of concrete. By means of an extended system of microscopic examinations on concretes and mortars of various mixes, Mr. Johnson concludes:

(1) That the inferior strength is due to the groups of unhydrated cement scattered throughout the mass.

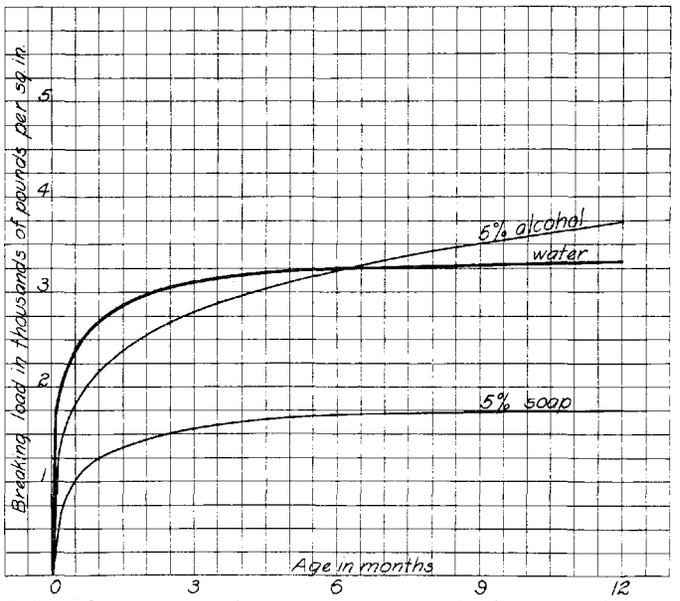
(2) That the surface tension of the water used in mixing is largely responsible for the unhydration of these particles.

(3) That the addition of a deflocculator to the water causes a dispersion of the cement groups that tend to form.

In addition to the microscopic examinations, Mr. Johnson conducted a series of actual tests, using with the mixing water certain chemicals designed to break the surface tension. And the results obtained apparently bore out the truth of the conclusions. But the tests were of comparatively short duration and conducted on mortar specimens only; and it was Mr. Johnson's desire that other investigators take up the question and by numerous experiments, aid materially in arriving at a logical conclusion.

It was with this end in view that the writers inaugurated their experiments. In order to make the tests as reliable as possible, it was decided to allow the period of testing to extend over one year. All tests of specimens under and including the age of three months were conducted by Messrs. Earhart, Holliday and Lutz, and reported in a thesis of 1916.

At this point the work was taken up by the writers, who conducted a parallel set of tests on specimens between the ages of three months and one year. All tests were conducted according to the specifications outlined by the American Society for Testing Materials; and by close association with their collaborators in the laboratory work, it was possible to secure uniform methods of handling and testing specimens. Owing to this uniformity the writers felt justified in using the data previously secured to make complete curves as shown in the diagram. (The tests covered specimens of various standard forms, and mixes, including 6″ cubes and 6″ x 12″ cylinders of mixes 1:2:4, and 1:3:6; and standard briquettes, 2″ cubes, and 6″ unit section beams of mixes 1:2 and 1:3. The curves given are representative, and the other tests showed a marked tendency to assume this general shape.)



The value of the proof of any theory lies in the thoroughness of observations and the extent of investigation. Consequently, only a limited amount of confidence can be placed in single observations of comparatively short duration as the foregoing of necessity were. For this reason, conclusions drawn from the meagre data obtained will depend to a large extent upon the element of personal equation in the interpretation of results as a whole; therefore the writers feel that these conclusions may be dissented from by observers of broader experience.

Our results seem to indicate that concrete mixed with a 5% solution of denatured alcohol tends to increase in strength with age as opposed to the general behavior of plain concrete which increases in strength up to a certain point and then maintains a constant value. Mortars mixed with the same solution, while not showing any marked increase in strength, at least showed no detrimental effects from such a mixture.

Concrete and mortar specimens mixed with a 5% solution of Ivory soap broke far below specimens mixed with water alone and showed a decided tendency to decrease in strength with age.

The fact that surface tension of the water was broken is evidenced by the action under crushing load of concrete specimens mixed with the alcohol solution. These specimens showed no signs of failure until a certain load was reached, at which

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time they broke much in the same manner as ordinary rock. This shows that the cohesion between the cement and the aggregates had been enhanced by the addition of alcohol; for no plain specimen was observed to break in the same manner. In the case of the soap solution, no definite conclusion can be drawn with regard to the breaking of surface tension; for, while such action might have taken place, the ill effects of the alkaline mixture more than counter-balanced it, thus giving rise to a weaker product.

Even granting an increase in the strength of concrete due to the use of alcohol, it is doubtful if its presence in the mixing water would be practicable because of the economic problem involved. However, it is to be hoped that further investigation will lead to the discovery of some substance which will produce the strengthening effect at a smaller cost.