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Are Abrams' and Edwards' Theories Both Wrong?

Article Written Specially for "The Canadian Engineer," Stating Bureau of Standards' Opinion Regarding "Surface Area" and "Fineness Modulus" Methods of Proportioning Concrete—Methods Agree, Both Faulty, Claims Engineer in Charge of Bureau's Research

By G. M. WILLIAMS

Associate Engineer, U.S. Bureau of Standards

WHILE I am inclined to agree with R. B. Young's statement in the November 27th, 1919, issue of *The Canadian Engineer*, that the "surface area" and "fineness modulus" theories are in agreement in final conclusion, I further believe that both theories are faulty and the conclusions erroneous because of the disregard of the basic and fundamental requirement that concretes must have the same consistency or flowability to be comparable.

In Lewis Institute Bulletin No. 1, describing the fineness modulus theory, Professor Abrams states that for a given plastic condition of the concrete and same mix there is an intimate relation between the fineness modulus of the aggregate and the strength and other properties of the concrete. It is further stated that the grading of the aggregate may vary over a wide range without producing any effect on concrete strength so long as the water-cement ratio remains

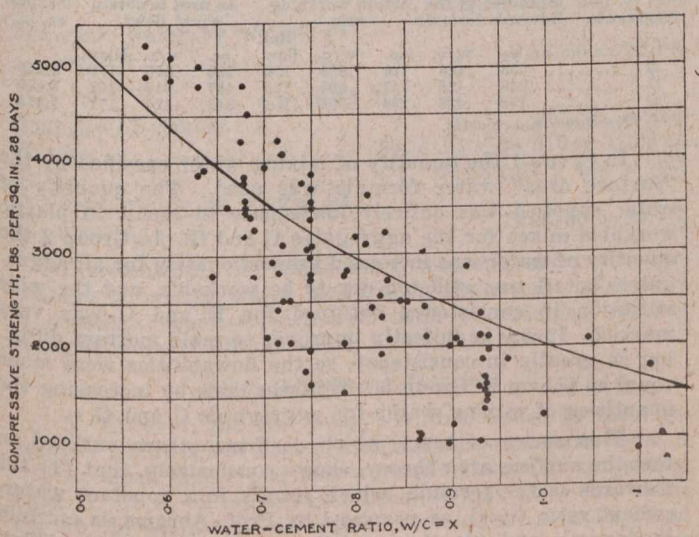

FIG. 1—TESTS OF MORTARS

Data from Table 5 of Technical Paper No. 58 issued by U.S. Bureau of Standards. The curve is platted from Prof. Abrams' formula, $S = 14{,}000/7^x$.

constant. Referring to the sieve analysis curves of the aggregates used, it is said that any other sieve analysis curve that will give the same total area below the curve corresponds to the same fineness modulus, and will require the same quantity of water to produce a mix of the same plasticity, and gives concretes of the same strength, so long as it is not too coarse for the quantity of cement used. In other words, the fineness modulus theory concludes that for given concrete materials, the strength depends upon one factor only,—the ratio of water to cement.

The surface area method of proportioning assumes as its basic principle that the physical properties are primarily dependent upon the relation of the volume of the cementing material to the surface area of the aggregate. It is further stated that the strength of the mortars are dependent upon the quantity of the cement in relation to the surface areas

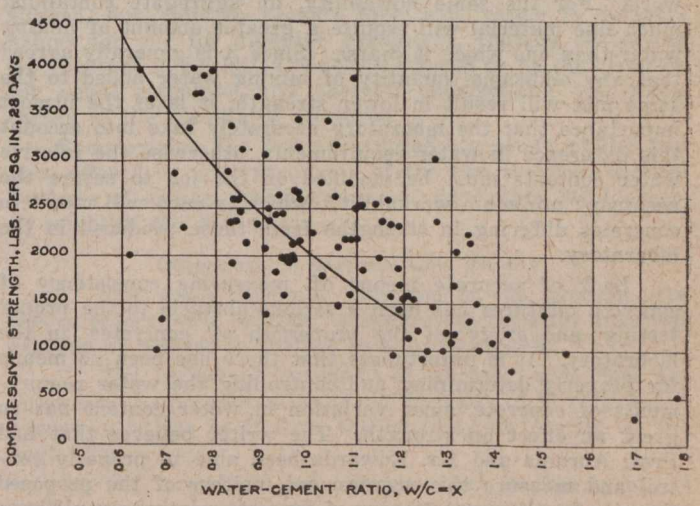

FIG. 2—TESTS OF CONCRETE

Data from Tables 8, 9, 10, 11 and 12 of Technical Paper No. 58 issued by U.S. Bureau of Standards. The curve is platted from Prof. Abrams' formula, $S = 14{,}000/7^x$.

of the aggregates, and the consistency of the mix. Also, that strengths of mortars of uniform consistency, containing sand aggregates of varying granular combinations are directly proportional to the quantity of cement they contain in relation to the surface area of the aggregate. Mr. Edwards states that "normal" uniform consistency mortars of varying cement content and of varying sand gradings were produced when the quantity of water used in the mix was made equal to that required to reduce the cement to a normal consistency paste, plus an amount equal to the surface area of the sand in square inches divided by 210. That is, water (cc.) = weight of cement (C) times percentage of water for neat normal consistency paste, plus total surface area of sand (sq. ins.) divided by 210.....(1)

The similarity of the two theories in final conclusion can be seen in a study of the water formula:—