plasticity and to give concrete of the same strength, so long as the aggregate is not too coarse for the quantity of cement used. This, he says, is because the fineness modulus simply reflects the changes in water-cement ratio necessary to produce a given plastic condition.

Mr. Edwards' method is based on the theory that for uniform plasticity and uniform strength, the cement varies

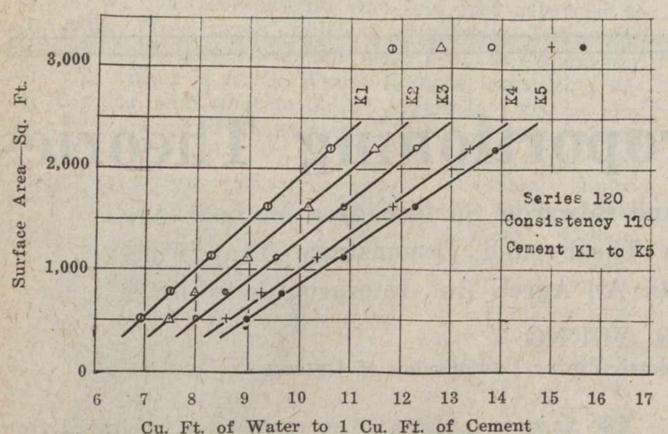

FIG. 4—RELATION BETWEEN MIXING WATER AND SURFACE AREA TO GIVE CONSTANT PLASTICITY (DERIVED FROM PROF. ABRAMS' TESTS)

as the surface area of the aggregate; and further that the quantity of water required to produce mortars of uniform consistency is a function of the water required to reduce the cement to a "normal" paste and of the surface area of the sand particles to be wetted.

In other words, Mr. Edwards claims a relation between strength and surface area, and between mobility and surface area and his tests support his theories so far as mortar mixtures are concerned. Later tests by the Hydro-Electric

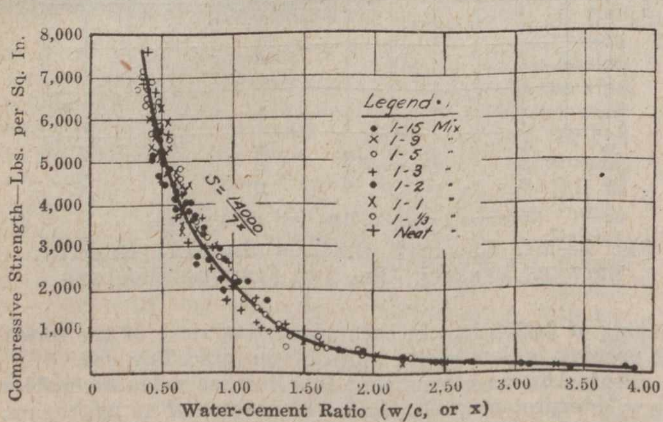

FIG. 5—PROF. ABRAMS' DIAGRAM SHOWING RELATION BETWEEN WATER-CEMENT RATIO AND STRENGTH OF CONCRETE

Power Commission of Ontario, under the direction of the writer, show that these conclusions are equally applicable to concrete mixtures.

Mr. Edwards obtains the surface area of an aggregate by counting and weighing some of each size of aggregate obtained in a sieve analysis, and from this data determining the average number of particles per unit weight for each size. Then, assuming these to be spherical, and knowing their specific gravity, he calculates the average volume per particle, the surface area per particle, and hence the total surface area per unit weight for each size of separation.

The surface area of any mixed material can be found by multiplying the surface area per unit weight of each size of separation by the weight of that size present in the material, and adding these. The value thus obtained is not the true surface area, for the latter cannot be obtained, as the particles are not true spheres, are variable in shape and have not smooth surfaces. However, this value undoubtedly bears a constant relation to the true surface area, and for all practical purposes is equally as useful.

The Bureau of Standards, Washington, D.C., made a limited series of tests to check the findings of these investigators. As a result the Bureau claims that the water-cement ratio is only an incidental relation of no direct value to the engineer in proportioning concrete, that a wide difference in strength is found with constant water-cement ratio and that there is no relation between surface area and strength. These conclusions directly contradict the findings of the two last-mentioned investigators.

At a later time, however, the Bureau makes this interesting statement: "Our tests indicate that for constant flow-

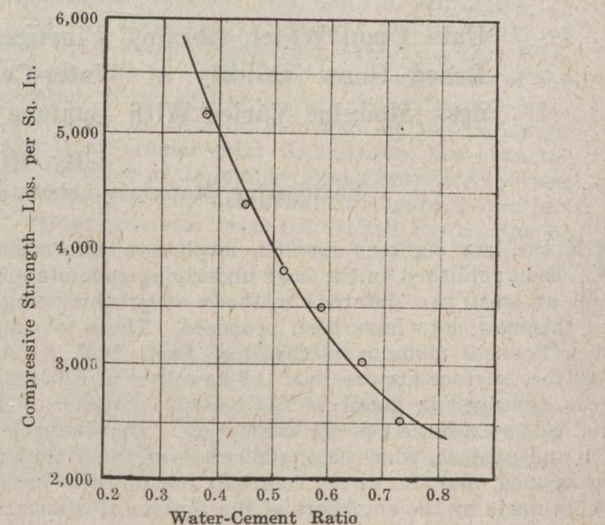

FIG. 6—RELATION BETWEEN WATER-CEMENT RATIO AND STRENGTH OF CONCRETE (PLATTED FROM MR. EDWARDS' TESTS)

ability the water required varies with the surface area of the aggregate."

Other investigators are working upon these different theories, although their results have not yet found their way into print. Prof. A. N. Talbot, of the University of Illinois, has said of his investigations, carried out upon concretes of one consistency and cement content:—

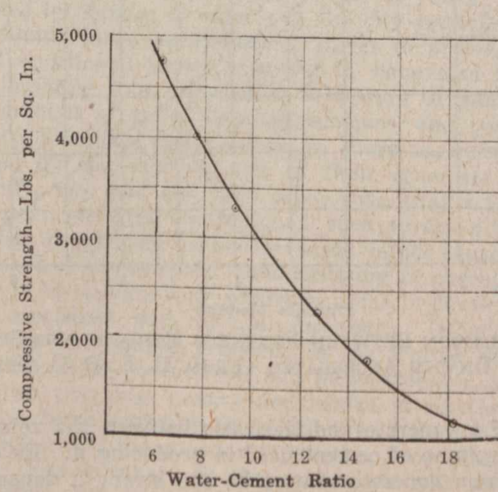

FIG. 7—RELATION BETWEEN WATER-CEMENT RATIO AND STRENGTH OF CONCRETE (PLATTED FROM BUREAU OF STANDARDS' TESTS)

"The tests indicate that for an aggregate having a given size of particles, the amount of mixing water required to produce a concrete of a given consistency, or mobility, is equal to a constant plus a term which is dependent upon the surface area. The tests show that the strengths of these con-