## PROPORTIONING THE MATERIALS OF MORTARS AND CONCRETES

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large proportion of the structures now existing fall short of the ideal mainly for two reasons:—

1. Not all of the factors influencing the strength, hardness, durability and other physical properties of mortars and concretes are known and have not, therefore, been given due consideration.

2. Infallibility is not an attribute of the human mind, and, in consequence, defective structures are built, which, like chains, are no stronger than their weakest parts.

As regards strength alone, there is a most remarkable lack of "team play" between the designer on the one hand and the construction superintendent on the other. This lack of co-ordination arises most commonly from the restricted field over which each may claim, "I am monarch of all I survey." The average designer thinks in terms of pounds of compressive or of tensile stress rather than in terms of the materials to be used in the actual construction. Too frequently he clings tenaciously to the notion that a given mix will develop a given strength at an age of 28 days. For example, he assumes that a 1 : 2 : 4 mix, proportioned by the commonly used volume method, will develop a compressive strength of 2,000 lbs. per sq. in., while, as a matter of fact, the 1 : 2 : 4 mix actually used in the work he designs may attain a strength of from 1,200 to 3,000 lbs. per sq. in. or over. He rarely realizes that in ordinary concretes of, say, 1 : 2 : 4 mix the actual cement content per cubic yard of finished concrete varies widely, due to the character and quality of the aggregates, to the consistency of the mix and to field methods and operations of mixing and placing. The average field superintendent commonly thinks in terms of bags and barrows, batches and bulks. He measures strength by the "ring" of the concrete under the blows of a hammer, which indicates that the form work can safely be removed. To him efficiency and excellence are gauged and measured not by ultimate results, but by a day-to-day standard involving an intimate combination of time, volume and payroll rather than by standards of strength, reliability and permanence.

The securing of greater uniformity in results approaching more closely the ideal, demands that a great amount of work be done—work not only of an educational, but also of an experimental and creative kind—involving the training of the workman and of his foreman to a different conception of their duties, that they may become more expert and efficient; the consigning to a merited oblivion of time-honored practices and methods, unproductive of desired results; and the development and adoption of new methods and practices founded upon rational and scientific principles. This is, indeed, no menial task.

The maximum economy consistent with strength and durability will be realized when the designer can so proportion the several parts of a structure that all will theoretically be worked to equal efficiencies, and those the maximum safe ones; and the superintendent of construction can so erect the structure as to conform to the conditions assumed in the design.

There is ample evidence that in order to bring mortars and concretes to the highest standards of excellence as structural materials our efforts must be directed more specifically toward the development of a more thorough knowledge of their component materials and the improvement of field methods and practices. The suggested investigation of available aggregates with a view to determining their values as materials for the making of mortars and concretes, preliminary to the designing of a proposed structure, properly deserves further consideration.

Extended examinations cannot economically be made in connection with structures of minor importance involving comparatively small total expense. In such cases a liberal use of cement is doubtless more economical. However, there should be a certain amount of investigation. The justification of expense in connection with structures of greater magnitude, involving large quan-

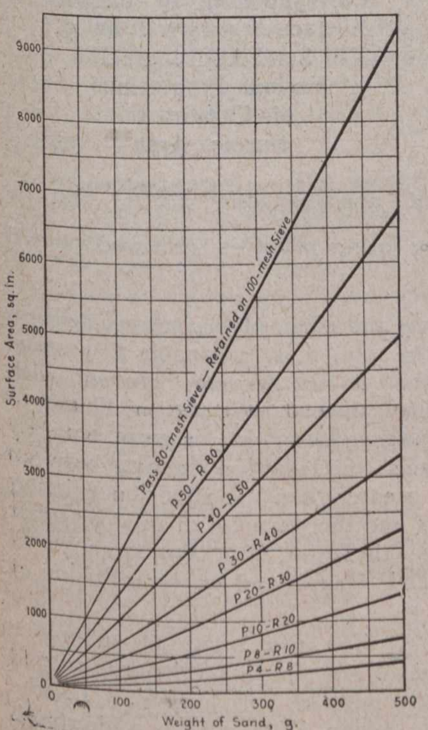


**Fig. 21—Surface Areas (sq. in.) Corresponding to Various Weights of Sand Aggregate (g.)**

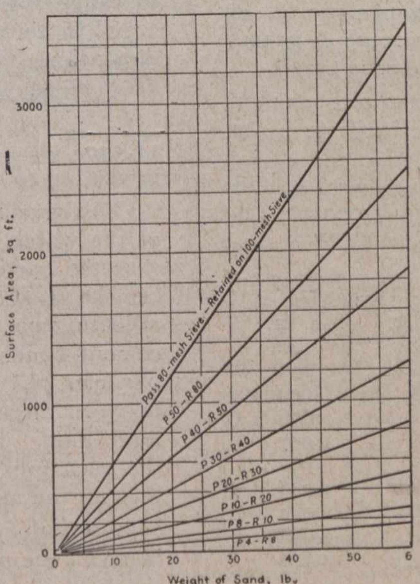


**Fig. 22—Surface Area (sq. ft.) Corresponding to Various Weights of Sand Aggregate (lb.)**

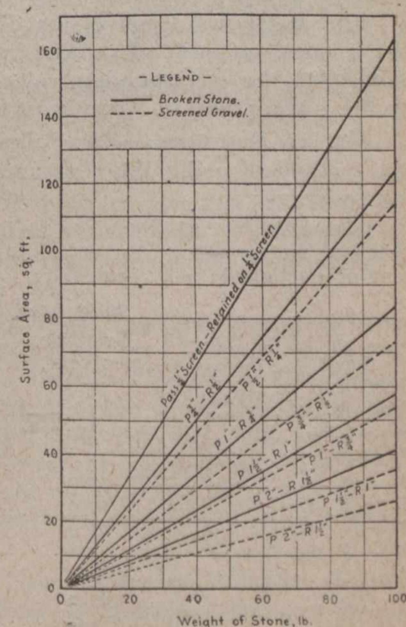


**Fig. 23—Surface Area (sq. ft.) Corresponding to Various Weights of Stone Aggregate (lb.)**