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Relation of Stone Aggregate Content to the Compressive Strength of Concrete

Tests Indicate that Addition of Twenty Per Cent. of Stone Reduces Strength of Mortar by Three Per Cent., while Forty Per Cent. of Stone Reduces It by Eleven Per Cent.—Stone Bears Same Relation to Concrete as Inert Extenders Bear to Paint

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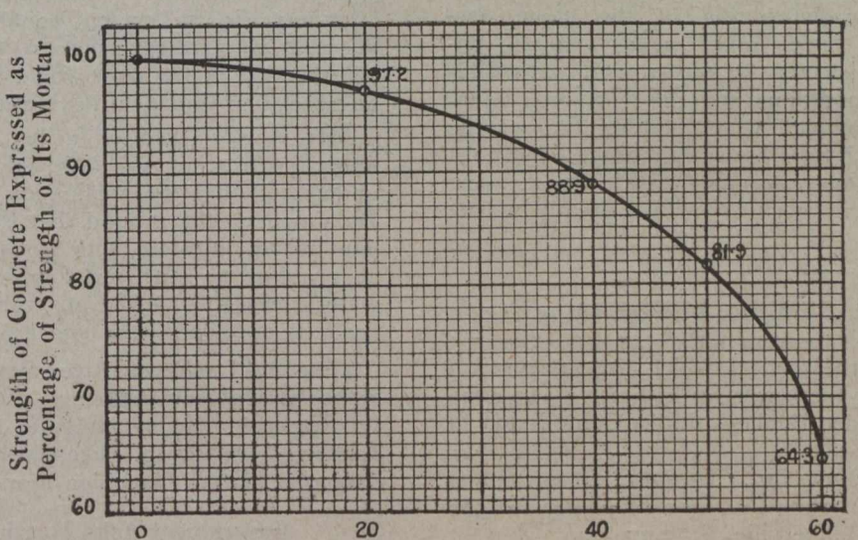
PAINT-MAKERS, in proportioning the materials of an economical paint mix, make use of certain inert materials commonly termed "extenders," since they serve the purpose of increasing the ultimate volume of paint produced per gallon of linseed oil or other vehicle material.

The use of a too great proportion of "extender" will very materially reduce the toughness, strength and other physical properties affecting the service value of the paint.

In a somewhat similar manner and for a like purpose, concrete-makers use inert stone aggregates as "extenders" in the production of economical concrete mixes, and upon the proportions used depends, in part, the ultimate strength of the concrete produced.

The test herein described was made with the object of obtaining information relating to the effect of varying the stone aggregate content of the concrete.



Relation of Stone Aggregate to Total Volume of Concrete, Per Cent.

All materials, except the water, were proportioned by volume reduced to a unit weight basis.

The unit weights assumed were as follows:—

One cubic foot of cement assumed at 100 lbs.

One cubic foot of sand (dry) assumed at 100 lbs.

One cubic foot of broken stone assumed at 90 lbs.

Five specimens were made for each mix, the usual test cylinders, 6 ins. in diameter by 12 ins. long, being used. These specimens were tested at an age of three months after having been cured in damp sand.

The grading of the sand was as follows:—

Sieve No. 4, 0.0% retained on sieve; No. 8, 14.0%; No. 10, 4.0%; No. 20, 14.0%; No. 30, 9.0%; No. 40, 11.0%; No. 50, 14.0%; No. 80, 20.0%; No. 100, 6.0%; No. 200, 6.0% retained and 2.0% passing.

The grading of the stone was as follows:—

1½" screen, 0.00%; 1", 20.00%; ¾", 30.00%; ½", 30.00%; ¼", 20.00%.

The water content was such as to produce a concrete in which the stones were thoroughly covered with a coating of sticky, semi-plastic mortar. All mixing was done by hand.

The cement-sand ratio of the mortar content was taken at 1:2, this being known to produce, for the sand used, a strong, reliable mortar.

The first set of cylinders made was composed of mortar only. The stone content of the succeeding sets was 20, 40, 50 and 60 per cent. of the total weight of mortar and stone aggregate combined. The quantities of these ingredients were therefore:—

First set, 160 lbs. mortar.

Second set, 128 lbs. mortar, 32 lbs. stone.

Third set, 96 lbs. mortar, 64 lbs. stone.

Fourth set, 80 lbs. mortar, 80 lbs. stone.

Fifth set, 64 lbs. mortar, 96 lbs. stone.

The average ultimate strengths obtained from the compression tests were as follows:—

First set (mortar), 3,380 lbs. per square inch.
Second set (20% stone), 3,284 lbs. per square inch.
Third set (40% stone), 2,999 lbs. per square inch.
Fourth set (50% stone), 2,769 lbs. per square inch.
Fifth set (60% stone), 2,175 lbs. per square inch.

The accompanying diagram was deduced from the above values and shows the relative strengths of the concretes expressed as percentages of the ultimate strength of the mortar alone; or, in other words, the strength-reducing effect of increasing the stone aggregate content of the mix.