Effects of Grading of Sands and Consistency of Mix Upon Strength of Concrete

Tests of Cylinders in Which Twelve Sands of Predetermined Gradings Were Used, Cylinders and Beams of Five Consistencies of Mix, and Cylinders for Which Time of Mixing Varied from One-Quarter to Two Minutes—Paper Presented at Last Annual Meeting of the American Society for Testing Materials

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THE rapid development and the wide application of plain and reinforced concrete in modern construction is without parallel in the history of materials. This change of status, from a minor material to one of first importance, has not been characterized by the degree of constructive criticism and conservatism which accompanied the adoption of iron and steel in the construction of bridges, buildings, and allied structures.

Laboratory experiments have multiplied to such an extent that the available data so produced are greater than those existing for any other single construction material. Engineers have sifted, culled and graded this information, and from it have evolved our modern practice in plain and reinforced-concrete design. Concrete has thus been studied mainly as a single material rather than as a combination of constituent materials and mechanical operations; each of which, taken individually, exerts a distinct influence upon the character of the combined product.

A definite knowledge of all the factors which tend to produce widely varying results, affecting the strength and permanence of structures composed wholly or in part of concrete, in the opinion of the author, is necessary to a thorough understanding of the full range of its usefulness. This necessarily involves not only the properties, selection and proportioning of the materials, but also the amount of water to be used, the method and thoroughness of mixing, the manner of placing, the temperature of seasoning, and various other factors affecting the practical operations involved in field construction. In former years the quality of the cement was considered as paramount in the production of concrete, but in the past few years the importance of the careful selection of other materials and of the field conditions attending the mixing, placing, etc., has been more generally recognized. However, aside from the limited investigations of a few individuals, very little information is available.

This paper presents the results of three series of tests made by the City of Toronto, Department of Works, in 1916, under the direct supervision of the writer.

Object and Scope of Tests

The tests were undertaken with the object of securing information relating to (1) the influence of the grading of sand, (2) the effect of the consistency of mix upon the strength and physical characteristics of the concrete produced, and (3) the effect of varying the time of mixing.

In so far as consistent with available facilities, the proportioning of concrete materials, the mixing of the concrete, and the preparation of test specimens were to be carried on under conditions which duplicated those usually accompanying actual field construction work under good supervision.

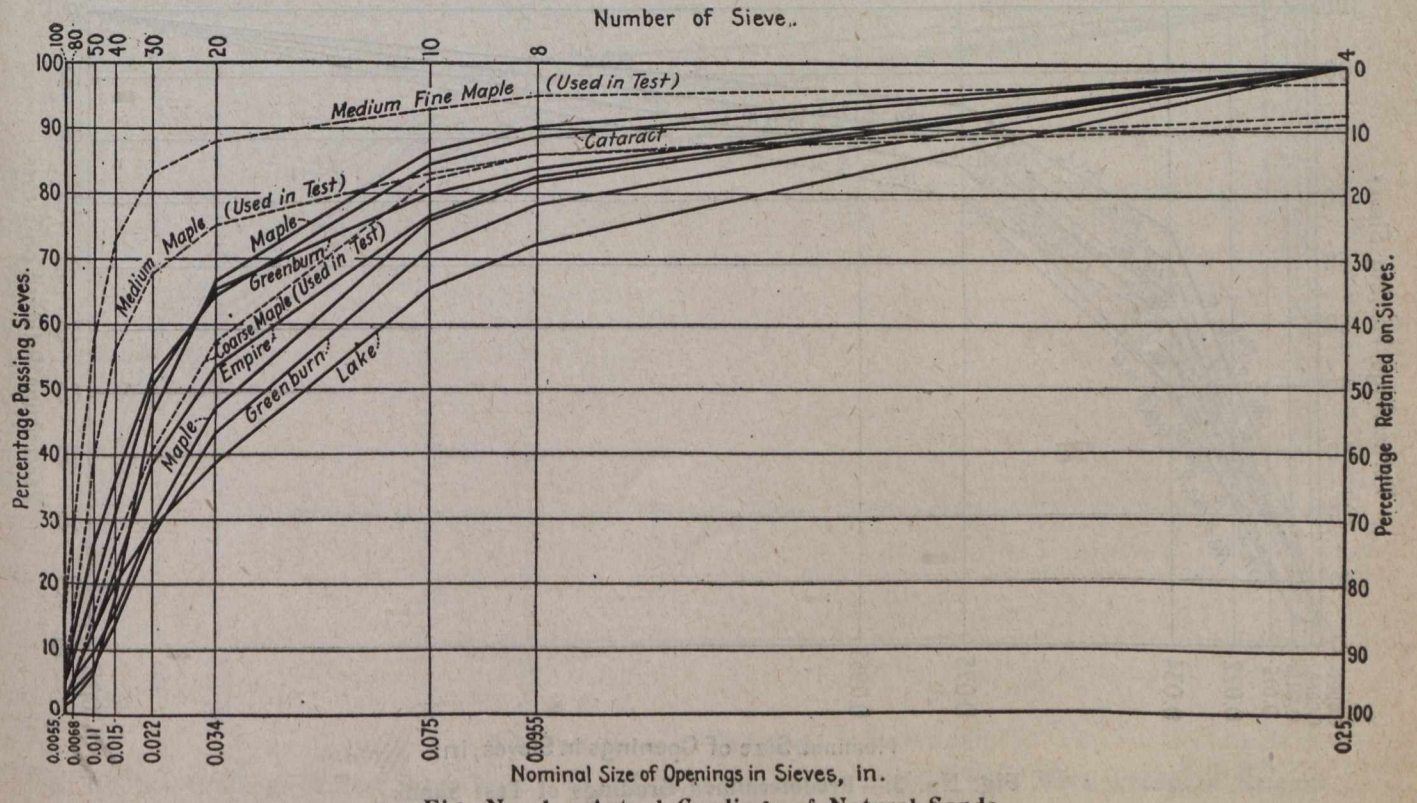

Fig. No. 1.—Actual Gradings of Natural Sands