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Physical Properties of Mortars and Concretes

Review of Work Done by Other Investigators and Description of Experiments Performed for the Greater Winnipeg Water District—Use of Chemicals to Resist Alkali Action Abandoned After Trial in One of the District's Structures

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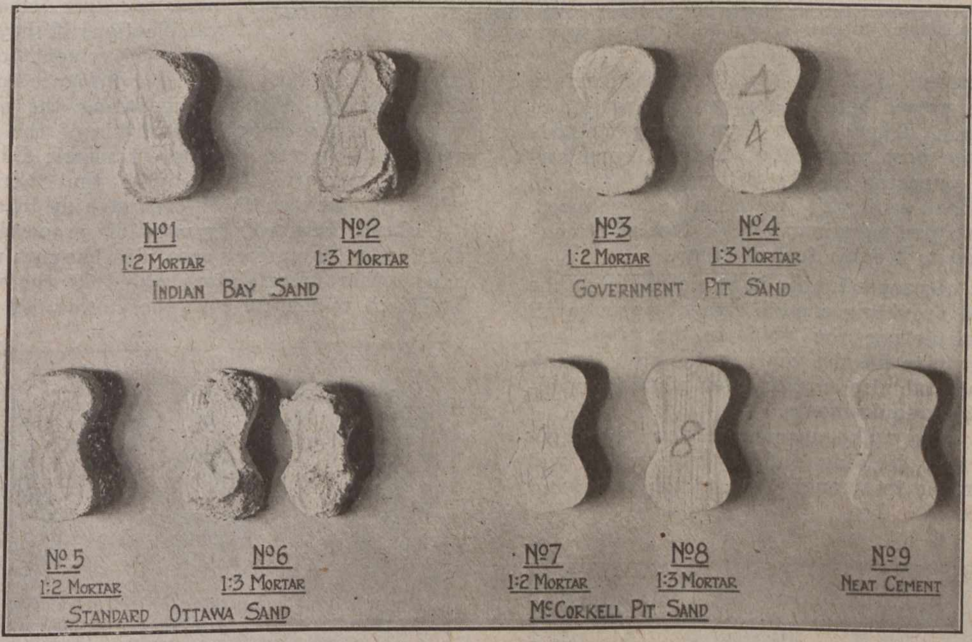
An enormous amount of work has been done on the investigation of the physical properties of cement mortars and concretes by various workers in all parts of the world. Outstanding among these are investigations made by Mr. Feret of Boulogne-sur-Mer, France, in 1892; those made by Messrs. Fuller and Thompson for the aqueduct commission of the city of New York, 1903 to 1905; those made by various workers at the Bureau of Standards and issued from time to time, which investigations are still being extended at the present time. Much information has been accumulated from these sources, a considerable amount of which is available in various textbooks on concrete. The most recent work published in connection with these studies has been made in the structural materials research laboratory of the Lewis Institute, Chicago, in cooperation with Portland Cement Association. A large staff of men are employed at the institute under the supervision of Prof. Abrams, who has already published in engineering journals in 1918, a large amount of interesting and apparently revolutionary information. His work so far has mostly dealt with the function of the water in concrete mixtures.

Working from a different point of view, Captain Lewellyn Edwards, supervisor of bridges of the city of Toronto, has reached certain conclusions regarding the influence of the surface area of aggregate on mortar and concrete mixtures.

In this paper it will only be possible to outline some of this work and point out some of the characteristics of various concrete mixtures.



Action of a 10% Solution of Sodium Sulphate on Various Mortars

Air briquettes cured 24 hrs. in moist closet and 48 hrs. in steam at 150 degs. F. kept in alkali solution for 3½ months.
No. 1 shows slight action at edges; No. 2, disintegration at ends; Nos. 3,4 and 5, no apparent action; No. 6, disintegrated; Nos. 7, 8 and 9, no apparent action.

Sand is usually considered to be the fine aggregate which will pass a screen having four meshes per linear inch. The work of Fuller and Thompson, above referred to, has shown that the term "sand" is a relative term and depends on the maximum size of stone used in the aggregate. They show that for a mixture of maximum density the stone portion of the aggregate should be graded according to a straight line and that the sand and cement portion of the mix corresponds to an elliptical curve. The junction between the straight line and the ellipse occurring at a point one tenth diameter of the maximum size of stone in the aggregate (Figure 1). The meaning of the term "sand" will therefore vary according to maximum size stone used in the aggregate.

In our work, in connection with the water district aqueduct, we have considered our maximum size of stone 1½ ins.; one tenth of this is .150. The nearest screen to this dimension is ⅛ in. In subsequent remarks, it will be understood that the term "sand" means material passing ⅛-in. screen.

The first procedure in testing a sand is to make a mechanical analysis of the sand. The sieves used in the water district's laboratory in the grading of a sand are the No. 10, No. 20, No. 40, No. 75, No. 100 and No. 200; the numbers referring to the number of meshes per linear inch. From such an analysis one familiar with sands can form an opinion as to its suitability or otherwise for concrete work and also make a close prediction as to the possible strength obtainable from mortars made from such sand.

The grading of a sand has a very marked effect on all its characteristics. Referring to Figure 2 (copied from