

CONCRETE AND CONCRETE AGGREGATES

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SOUNDNESS TESTS OF AGGREGATES

The sodium sulphate test described in Bulletin No 1216 of the U S Department of Agriculture is in use at the laboratory of the Bureau of Public Roads, and also by several of the State testing laboratories. As mentioned in our report two years ago, this test is rather drastic. Material passing it is usually sound and durable, but users of the test have found that some aggregates which fail to pass it may make concrete of satisfactory durability. Hence, unfavorable behavior in this test should be taken as a warning that the aggregate may be non-durable, and should indicate that a more extended investigation into the durability of the material should be made prior to its use in important work.

The sodium chloride test experimented with to a considerable extent by the Bureau of Standards in testing the durability of limestone (see Proceedings of 4th Annual Meeting, Highway Research Board, page 111) has not proven very satisfactory. At the present time the Bureau is using a freezing and thawing test in its studies of the durability of building stones. In these tests small specimens are alternately frozen and thawed until disintegration occurs. The freezing temperature is maintained at 5° Fahr and the specimens are thawed in water at 70° Fahr. Two or four cycles are completed in one day. Some of the poorer limestones have been found to disintegrate in less than 100 cycles while the more resistant types require 2,500 or more. The Bureau attaches believe that stone for important work should withstand 300 cycles without visible evidence of disintegration.

In view of the indeterminate nature of the sodium sulphate test for soundness of rock, this test should be supplemented by freezing and thawing tests and by thorough examination of ledges and pieces of the rock in question, which have been exposed to the action of the elements over a considerable period of time. Where possible, examples of concrete of considerable age made from stone in question should be examined.

ACCELERATED SOUNDNESS TESTS OF CONCRETE

At the laboratory of the Hydro-Electric Power Commission of Ontario a limited number of 2-inch mortar cubes, varying in proportions from 1 2 to 1 7 (by weight) were recently subjected to over 600 alternations of freezing at 5° Fahr and thawing in pans

of warm water. Two alternations were carried out per day. At the conclusion of these tests most of the leaner mixes had disintegrated whereas the effect on the rich mixes was inappreciable.

A very large series of tests is now being conducted at the Bureau of Public Roads in which the effects of alternate freezing and thawing on the strength of concrete beams is being studied. Specimens which have been under observation longest have received somewhat over 60 cycles. The test pieces include aggregates of questionable character which have been carefully selected from various localities throughout the country. Results of these tests should be of great value in estimating the durability of concrete made from such material.

At the University of Wisconsin a limited investigation on the resistance to freezing and thawing of concrete made of certain aggregates much used in northwestern Wisconsin is now under way. In these tests the transverse strength, the crushing strength, the absorption and the expansion of the concrete will be measured. Variations in the grading of the material, in the proportion of the cement in the mix, and in the age of the test specimens are included in the program of tests.

At present, the alternate freezing and thawing test appears to be the best test for determining the durability of concrete to weathering. On account of the length of time required and the high cost of making this test, it is very desirable that some form of accelerated test for concrete be devised. Such an attempt is now being made at the University of Wisconsin. Believing that the sodium sulphate test if applied to concrete will bring about effects which are not normal in weathering, an attempt has been made to find a salt solution which will crystallize without causing dehydration. With this in mind, several organic salts and organic solvents have been tried without success. At present a search is being made for such a salt which has a melting temperature above room temperature and below the boiling point of water.

FIELD CONTROL OVER STRENGTH OF CONCRETE

One of the important conclusions which has been established by tests of experimental roads is that the modulus of rupture of concrete is a most important property in determining the strength of the road slab. An appreciation of this fact has led a number of State highway departments to use a transverse test for controlling in the field the quality of the concrete. In such tests two breaks may be made on each beam, and the modulus of rupture of the concrete is easily calculated. The portable testing equipment which

is used is quite simple, and the unit cost of testing is very much less than the cost of making crushing tests on samples taken in the field and shipped to the laboratory.

THE RELATION OF MODULUS OF RUPTURE OF CONCRETE TO CHARACTER OF CONSTITUENT AGGREGATES

Owing to the rapid growth in the use of the cross-bending test it seems likely that this test will supersede the crushing test as a method of field control for the quality of the concrete. Hence, the cross-bending test of plain concrete is likely to be a very important test and engineers should appreciate all the factors which affect the chief strength measure of this test, the modulus of rupture.

There has been considerable study made, notably by the Structural Materials Laboratory of the Portland Cement Association, to show the effects of the water-cement ratio, the grading of aggregate, proportion of cement, and age upon the modulus of rupture, but to date there is very little information correlating the effect of shape and surface condition of the constituent aggregate particles with the modulus of rupture of the concrete. From results of tensile tests of mortars which have been made, it appears that the shape of the aggregate particles has considerable effect on the tensile strength. Since the tensile strength is the most important criterion of the modulus of rupture, it would appear that shape might therefore materially influence the modulus of rupture. It seems important to the Committee that numerous tests to determine the effects of these factors on the modulus of rupture should be made. In making such tests, the relation of the transverse strength to the crushing strength should be determined. By so doing a suitable factor may be established for each aggregate so that the crushing strength of the concrete may be estimated from its modulus of rupture.

FIELD CONTROL OF CONCRETE MAKING—A STUDY OF LATE PRACTICE

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Research into the basic principles that control the quality of Portland cement concrete has been going on ever since this material came into general use. Practical application of the results of research, on a large scale, are comparatively recent. It is the purpose of this study to review some cases in which the actual concreting operation has been carefully controlled according to scientific