BEST PRACTICE IN CONCRETE ROAD CONSTRUCTION.*

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THEORETICAL tests are fine. They are necessary to tell you what you should have as a final product. You proceed on the hypothesis they offer and then you have to wait until service and climatic conditions prove how far your hypothesis conforms to reality.

Tests for concrete materials have never been given their proper consideration, with the exception of cement, which has been tested with all the finesse of the art of testing. In general, little, if anything, has been done on the sands, which have been casually accepted if they looked good, or had ever been used before in a structure that would stand up. As for the stone or gravel, all kinds and conditions of both have been used with practically no tests at all.

Our work has shown that if we are to omit any of the tests, we might better take a chance with the cement, for of the last 455,000 barrels used only 1.4% failed to conform to the test of the American Society for Testing Materials. Fifty per cent. of these failures was due to flash set and fifty per cent. to failure on the 200-mesh sieve requirement. Had all this cement been used, that rejected for sieve requirement would have given good work, and that rejected for flash set would have been aged enough by the time it was placed in the work to give good results. There has been a far greater proportion of both sand and stone rejected for this kind of work.

Engineering skill presupposes judgment, so why not inject it into our problems? After priming ourselves with theory, let us apply it to practice. Let us make field tests that will parallel laboratory experiments; let us conduct our laboratories in such a way that their value may be significant to the man in the field, and so that their results may be checked up by him. Success of work depends upon the field man; in every case his personality helps determine the results. Put him in line with your tests, practices, etc., and his interest and co-operation will show most profitably in the work. All of our men, from the engineer in charge of the road up, are instructed in all the tests and methods of inspection and they complete them on every inspection of the work. We of New York State believe that our best results may be attributed to the *esprit de corps* engendered by this method.

Field Tests.—The principal tests which can be made in the field accurately enough for all practical purposes are:—

(1) Gradation tests for sand. Our field men are furnished with sand testers which have the ¼ in., the 20 and the 50 sieves. By using these they can be assured of getting a uniform product from the bank, for they would at once detect any change for the worse in the character of the material and would reject it. Each engineer is supposed to make a daily report of the gradations. A laboratory test, however, is essential to ascertain the presence of any deleterious matter in the sand.

(2) Test for loam and silt content in sand. This can be made in the field and checked up by the laboratory results.

For the loam test, an excess of water is added to a given quantity of sand in a glass graduate, the whole is well agitated and allowed to stand until the loam and silt has settled on top, when their percentage may be measured.

(3) Test for set. This is made by mixing the sand with cement and forming a pat with thin edges. By breaking the edges after 24 to 48 hours it may be determined how the material sets.

(4) Tests for stone and gravel. Field determinations of these materials can be made only for voids. Visual inspection should, of course, detect soft material and dirty aggregates. Such inspection on the road and at the quarry should be made constantly to know that the material is running uniform and is equal in quality to the original samples.

When we realize that nature never has two deposits alike, the importance of these tests in securing good work will be readily appreciated.

Laboratory Tests.—Laboratory tests of stone are so familiar to us all that I omit discussion of them here.

For gravel, however, we found that the rattler test in general use did not give a true abrasive value. Because of the rounded structure of the rattler, the first material that was abraded off formed a protective cushion that greatly decreased the subsequent wear upon the stone. To eliminate this condition a new pot of the same size and shape as the standard pot was designed but it is slotted at intervals to prevent cushioning by allowing the worn-off material to escape. Some of the better-known gravels which have proved successful in concrete pavements are used as standards of comparison with satisfactory results. We have also had promising results in using this pot to test slag, which in the old pot used to act the same as the gravel did.

Final Test of the Concrete.—Concrete from a batch mix is made up on the road into six-inch cubes two in number from every 500 cu. yds. of material. They are cured for 21 days in moist sand and then shipped into the laboratory and tested at 26 days. The results of these tests are given to the engineers on the work and the rivalry to have the highest test value produces good results. It is expected that these cubes shall go over 3,000 pounds per square inch compression, and if they do not we look for trouble. Of 504 cubes tested in 1916 only 13¼% were below 3,000 pounds and the determination of the defects were as follows:—

	1916.	1915.
Coarse aggregate coated	61.9%	35 %
Fine aggregate containing an excess of loam or made up of excessively fine-grained sand	25.7%	43.9%
Coarse aggregate, poor quality	6.2%	8.2%
Poor manipulation in making cubes..	6.2%	16.9%

These tests also show a grand average of 3,370 pounds compression for all 1:1½:3 mix cubes stone and gravel, while the average for the stone cubes is 3,380 pounds and the average for the gravel cubes is 3,080 pounds. Thus it is demonstrated from these tests that stone concrete is 11% stronger than gravel concrete. In comparing the two, it is fair to say that all gravels with a coating that ordinary washing will not remove should be rejected; while stone that retains much of the dust of fracture is bound to make weak concrete. This is especially true of all soft limestones, and of any stone that is crushed when it is wet.

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