

# REPORT OF COMMITTEE ON CHARACTER AND USE OF ROAD MATERIALS

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## THE CONTROL OF CONCRETE ON HIGHWAYS

The Committee on Character and Use of Road Materials, after giving consideration to the many subjects within their field, which have been brought into prominence within the past several years, consider that the Control of Concrete on Highways is a very important subject on which the available data and general good practices should be correlated

The report this year will take up some of the important features of concrete control. The subject was divided into six sections, and separate reports submitted by individual members to the entire committee for approval

The subsections of the report are:

- Portland Cement, Quality and Quantity Control,
- Fine Aggregates,
- Coarse Aggregates,
- Concrete Proportioning or Design of Concrete Mixtures,
- Some Present Practice in Curing of Concrete Pavements,
- Tests on Finished Concrete.

## PORTLAND CEMENT

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The standard specifications<sup>1</sup> for Portland cement quality, methods of sampling and tests, are generally used in highway specifications. Some highway departments have modified these standards by minor additions or omissions. Probably one of the main modifications is the addition of the following uniformity requirement in test results: "Samples of each lot shall be required to show practically uniform results in tests. Marked deviation from the uniform results may be

<sup>1</sup>Serial Designation C9-26, American Society for Testing Materials

considered cause for rejection, even though the test requirements may be otherwise fulfilled" This clause is found in the highway specifications in force during 1927 in the states of New York, Ohio, Pennsylvania, and others.

#### SAMPLING

Several methods for sampling are given in the standard requirements. These include two methods for sampling and testing from cars or warehouses, and three methods for sampling at the mills. Where large quantities of cement are shipped, some mills can and do assign special storage bins. Under this plan, samples are taken from these assigned bins, and the material tested before shipment. This procedure eliminates delays at destinations, and, if carefully supervised, assures a positive control, as under this system the assigned bins are locked and sealed after sampling, and the loading in cars is permitted only under the supervision of the inspector. This inspector seals the loaded cars and notifies the field engineer relative to name of producing company, designation of bin, from which the cement was sampled, and the amount in shipment. Duplicate copies of such shipping notices have been found to be of great assistance in checking the quantity of cement shipped to individual projects.

Where conditions are not favorable for bin sampling and storage, composite samples are taken from cars during or after loading, in accordance with the standard method.<sup>1</sup> Under the same conditions bulk cement is sampled by a grab method during loading, or by means of tubes or long-handled containers after loading.

Of the three methods for sampling bins at the mills, sampling from the conveyor delivering to the bins has merit for study of the uniformity of the product, but as a routine method of sampling it requires more time, and results in higher cost than either of the other methods used in sampling from filled bins. For example: In the average mill grinding 250 barrels of finished product per hour, the sampling operation at the conveyor for a 5000-barrel bin would require twenty hours.

In sampling from loaded bins, the selection of the tube method or the ball method at point of discharge depends on the shape and construction of the bins. In low bins the sampling tube is the most satisfactory, while in high, narrow bins or silos of small diameter the most efficient method is to sample at the discharge end. The more modern cement mills store the finished product in silos well suited for sam-

pling at points of discharge. The procedure is to use a cork ball for an indicator, which is placed on top of the cement above one of the points of discharge. The discharge gate is opened, and sampling is started immediately and continued at intervals until the ball passes the discharge opening. The number of balls used depends on the size of bin and the number of openings. The interval of sampling is regulated by the rate of discharge, so that the required number of samples are taken to represent the uniform run of the product. It has been found that the sampling at the point of discharge, when properly supervised, gives a more representative sample of the material shipped than does the sampling from the conveyor. It also has an advantage to the producer, in that it gives him an opportunity to ascertain the quality of the product before assigning a bin for sampling and testing. Where the amount of cement to be used warrants it, sampling should be done at the mills. This eliminates or reduces the time of storage at destination.

One paragraph of the standard specifications states "the sampling shall be done by or under the direction of a responsible representative of the purchaser." This is an important provision, and where the operation is handled directly by a highway department, great care should be taken to have proper supervision over inspectors assigned to this work. In cases where the sampling and testing of cement is let by contract to commercial testing organizations, an investigation should be made relative to their responsibility and the equipment and force which they have available for carrying out the standard methods.

#### TESTING

The testing of cement and the methods of procedure are well outlined.<sup>2</sup> To secure accurate results, the following precautions are absolutely essential:

Operators with experience should be assigned to this work.

Specified humidity and temperature conditions for the storage of test specimens should be maintained.

Testing machines should be calibrated periodically.

Care must be taken to avoid contamination of storage tanks where test specimens are cured.

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<sup>2</sup>Supplemental Manual of cement testing prepared by Committee on Cement of the American Society for Testing Materials. This Manual is not a part of the A S T M Standard Specifications C9-26.

A procedure which is helpful in maintaining standardized operations and conditions is periodic cooperative check testing on samples of cement by several laboratories

#### STORAGE

As dampness causes partial hydration and ultimate deterioration of cement, provision must be made to guard against it. The floors of cement storehouses should be raised off the ground sufficiently to prevent ground moisture coming in contact with the cement; the sides and roof should be properly insulated by moisture-proof lining, and air circulation should be minimized. Cement held in local storage over winter or for periods of three months at any time should be retested before its use is permitted for any concrete work.

#### QUANTITY

An efficient check on the amount of cement used is an important factor in quality control of concrete in designing concrete mixtures. A bag of cement (94 pounds net weight) is the unit in proportioning, therefore, the first check on cement quantity should be at the mills by the inspector, who should make occasional checks on the net weight of bags of cement as loaded.

Checks on the number of bags of cement used in proportioning batches of concrete can be provided by having inspectors held responsible for checking the number of bags of cement emptied into each batch. Adequate provisions should be made to prevent loss of cement in transit and handling. Where the cement is added at the skip of the mixer or at trucks waiting to dump into the mixer, inspection must be maintained at the cement stockhouse to record the number of bags taken to the work. An additional check must be made on this by the inspector at or near the mixer to record the amount actually added to a batch.

An operation which is likely to be carelessly controlled is the thorough emptying of cement sacks. On this subject J. T. Ellison, Chief Engineer of the Minnesota Highway Department, states "Our experience in cleaning cement sacks has shown that an average of one pound of cement is left in the sack"<sup>3</sup> This gives an idea of the loss of cement under well-controlled inspection, and gives an indication of what might occur with poor control. Careless supervision of this

<sup>3</sup> Best method of control and payment for pavement quantities, by J. T. Ellison, proceedings American Road Builders Association, page 301, 1927

operation gives at least false information on the amount of cement in the mixture, and there are possibilities of the shortage being sufficient to have an effect on the strength. The number of men assigned to this operation by the contractor should be enough to assure the thorough emptying of the sacks as far as practicable.

The amount of cement remaining in the so-called empty bags is given recognition by contractors, who have equipment for cleaning bags and reclaiming the cement for use in concrete work. This practice has not become common enough to have any standard procedure established relative to its control, but it can be readily seen that the practice might increase to such an extent that it would become an incentive to encourage careless emptying of sacks.

Bulk cement should be proportioned by weight

## FINE AGGREGATES

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### QUALITY

*Desirable Characteristics and Properties* In order that proper field control may be exercised over fine aggregate, a true appreciation must be had of the requisite qualities and their relative importance to the securing of a satisfactory concrete for road-building. The definition<sup>1</sup> tentatively adopted by the American Society for Testing Materials states:

"Fine aggregate shall consist of sand, stone, screenings, or other inert materials with similar characteristics, or a combination thereof having clean, hard, strong, durable, uncoated grains, free from injurious amounts of dust, lumps, soft or flaky particles, shale, alkali, organic matter, loam, or other deleterious substances"

For pavement construction, the inherent qualities which are of prime importance are uniformity, durability, and a reasonable degree of hardness and toughness. Hence, inspectors should be continually watchful to see that satisfactory standards in these qualities are maintained.

Although comprehensive test data on the effect of silt inclusions on the strength and wear resistance of concrete are lacking, the committee believes, from evidence furnished by the poor surfaces of pave-

<sup>1</sup>See A S T M Tentative Standards, Ser Des C33-26T