Designation: D 4792 – ~~99~~00

Standard Test Method for Potential Expansion of Aggregates from Hydration Reactions[1]

This standard is issued under the fixed designation D 4792; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers the determination of potential volume expansion of dense graded compacted aggregates that contain components susceptible to hydration and consequent volume increase, such as the free calcium and magnesium oxides that occur in some industrial by-products.

1.2 The values stated in SI units are to be regarded as the standard. The inch-pound units in parentheses are for information purposes only.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 702 Practice for Reducing Samples of Aggregate to Testing Size[2]

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[1] This test method is under the jurisdiction of ASTM Committee ~~D-4~~ D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.51 on Aggregate Tests.

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D 75 Practice for Sampling Aggregates[2,3]
D 698 Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort (600 kN-m/m^3(12,400 ft-lbf/ft^3))[4]
D 1883 Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils[4]
D 2940 Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports[3]

3. Summary of Test Method

3.1 This test method consists of measuring the volume expansion of compacted specimens following the general procedures of Test Method D 1883. Compaction is based on maximum density determination using Test Methods D 698. To accelerate the hydration reaction, specimens are stored in water at 70 ± 3°C (158 ± 5°F) for a minimum of 7 days.

4. Significance and Use

4.1 This test method provides a procedure for determining the compliance of steel slags and other materials with specifications, such as Specification D 2940, that limit permissible expansion of base and subbase aggregates containing components subject to hydration.

4.2 This test method can also be used to evaluate the effectiveness of aging or other treatments for reducing the expansive potential of such materials.

4.3 Test results have not been correlated with field performance, and values obtained do not necessarily indicate expansion that may occur in service conditions.

5. Apparatus

5.1 *Molds, Spacer Disks, Expansion Measuring Apparatus, Stainless Steel Weights, and Dial Gages* conforming to the requirements of Test Method D 1883.

5.2 *Mixing Bowl, Straight-Edge, Scale, Filter Paper, Dishes*, etc. as required in Test Methods D 698 and D 1883.

5.3 *Water Storage Facility*—A water bath controlled at 70± 3°C (158 ± 5°F) or suitable tanks or buckets for submersion of the test specimens in an oven controlled so as to maintain that water temperature.

6. Sampling

6.1 To determine compliance with specifications, take field samples in accordance with Practice D 75 or the requirements of the project specifications.

6.2 Take samples for research or general evaluation purposes in a manner appropriate for the materials and purposes involved.

6.3 Keep samples at field moisture content until the time of the test by sealing in water-tight containers or plastic bags.

7. Preparation of Sample

7.1 Reduce the field sample to testing size in accordance with Practice C 702, obtaining two 18-kg (40-lb) portions.

7.2 Pass the samples through the 19.0-mm (¾-in.) and 4.75-mm (No. 4) sieves. If 10 % or more is retained on the 19.0-mm (¾-in.) sieve proceed to 7.2.1 for oversize correction.

7.2.1 Pass the material through a 75-mm (3-in.) sieve. Discard the material retained on the 75-mm (3-in.) sieve. The material passing the 75-mm (3-in.) sieve and retained on the 19-mm (¾-in.) sieve shall be replaced with an equal amount of material passing a 19-mm (¾-in.) sieve and retained on a 4.75-mm (No. 4) sieve. The material for replacement shall be taken from an unused portion of the sample.

7.3 Reseal one of the sample portions to maintain the field moisture and retain for expansion test specimens. Test the other portion for maximum density and optimum moisture.

8. Moisture-Density Relationship

8.1 Determine the moisture-density relationship in accordance with Test Method D 698, Moisture Preparation Method, except that the mold specified in Test Method D 1883 shall be used.

8.2 Use Method B or C depending upon the gradation of the sample, with oversize corrections as recommended in 7.2.1.

9. Expansion Test

9.1 Prepare three expansion test specimens from the sample set aside for this purpose, following the procedure in Test Method D 1883 for specimens to be soaked.

9.2 After placing the adjustable stem and perforated plate on the compacted specimens in the molds, add weights to produce a surcharge of 4.54 kg (10 lb), and submerge the molds and weights in water at 70 ± 3°C (158 ± 5°F). Allow free access of water to the top and bottom of the specimens, and maintain the temperature at 70 ± 3°C (158 ± 5°F) for the testing period.

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[2] *Annual Book of ASTM Standards*, Vol 04.02.
[3] *Annual Book of ASTM Standards*, Vol 04.03.
[4] *Annual Book of ASTM Standards*, Vol 04.08.

NOTE 1—The molds should be well coated with a rust preventative, such as 10W motor oil, whether they are constructed of corrosion-resistant metal or not.

NOTE 2—Excessive (more than 2.5 cm) evaporation of the bath water may necessitate the use of a cover over the water bath. This will reduce required water addition and variations in bath temperature.

9.3 After the specimens have been immersed in the hot water for 30 minutes to allow for thermal expansion of the test apparatus, take the initial dial gage measurements. These are the base readings from which the expansion will be determined.

9.4 Add heated water daily to keep the test specimens fully submerged. Make daily dial gage readings of specimen heights for a period of seven days, allowing at least 2 h to elapse between the addition of water and the measurement.

9.5 Measure and record the temperature of the water on a continuous or daily basis.

10. Calculation

10.1 *Percent Expansion (Volumetric)*—Calculate the percent expansion at each day's measurement by dividing the difference between the daily dial gage reading and the base reading by the initial specimen height (116.43 mm (4.584 in.)) and multiplying by 100.

10.2 *Rate of Expansion*—Plot the percent expansion (y-axis) versus the time in days (x-axis).

NOTE 3—Seven days is usually adequate to evaluate probable expansive behavior, with a pronounced decrease in the rate prior to this time. If the expansion rate has not dropped by seven days, the test may be continued to obtain additional data.

11. Report

11.1 The report shall include the following:

11.1.1 Identification of the sample by source and date,

11.1.2 Moisture content and percentages of material retained on the 19.0 mm (¾-in.) and 4.75-mm (No. 4) sieves as received,

11.1.3 Optimum moisture content, maximum density, the method used (B or C) and oversize correction made from Test Methods D 698,

11.1.4 Expansion data for each specimen and the average for three specimens from 10.1,

11.1.5 The plot of the rate-of-expansion for each specimen and the average of three from 10.2, and

11.1.6 A continuous or daily record of the temperature of the water bath.

12. Precision and Bias

~~12.1 Data are being developed by ASTM Subcommittee D04.51 for preparation~~

12.1 This data was obtained in a study of ~~precision statements for this test method.~~

~~12.2 This test method~~ variability using four and six laboratories and thus should be regarded as preliminary.

12.1.1 *Expansion of less than 0.5 %*—The average multi-laboratory coefficient of variation, when testing one specimen, has ~~no bias because the expansion values can~~ been found to be ~~defined only~~ 25 %, therefore the difference in results reported by different laboratories on samples of ~~a test method.~~

~~12.3 The test method can be sensitive to material variations within~~ the ~~samples. Stockpile evaluations~~ same material should not differ by more than 71 % of their average, nineteen times in twenty.

12.1.2 *Expansion of more than 0.5 %*—The average multi-laboratory coefficient of variation, when testing one specimen, has been found to be ~~made using appropriate statistical methods.~~ 18 %, therefore the difference in results reported by different laboratories on samples of the same material should not differ by more than 51 % of their average, nineteen times in twenty.

13. Keywords

13.1 aggregates; expansion; hydration reaction