

Standard Specification for Glass Cullet Use for Soil—Aggregate Base Course

AASHTO Designation: M 318-02 (2015)



Technical Section: 1a, Soil and Unbound Recycled Materials

1. SCOPE

- 1.1. This specification covers processed glass cullet intended for use as a granular road base material. When properly processed and mixed with natural or crushed aggregate, hauled to and properly spread and compacted on a prepared grade to appropriate density standards, glass cullet can be expected to provide adequate stability and load support for use as road or highway bases. Material described in this specification is not intended to be used in treated or stabilized pavement layers. This specification is intended for use in conjunction with M 147 or with the requirements of the local jurisdiction specifying the properties of natural or crushed aggregate used in the base course. It is not intended for use in base courses in locations where surfacing will not be placed over the base.

Note 1—The engineer is advised to provide appropriate construction specifications to ensure that sufficient compaction is achieved so that further densification of the completed pavement from traffic loadings will be insignificant. The method requires compaction of the material at a suitable moisture content on a firm foundation of a short control strip by means of vibratory or other proven effective rollers or tampers, until no further increase in density results. Compaction requirements should ensure that the average density of the final base course is an appropriate percentage of the maximum density obtained for the control strip; for base courses, achieving on average 98 percent of the maximum control strip density is suggested.

- 1.2. The values stated in SI units are to be regarded as the standard. The English unit equivalents shown in parentheses may be appropriate, except with regard to sieve sizes and aggregate size as determined by the use of testing sieves, in which case the standard SI designation shown is the standard as required by ASTM E11-15.

2. REFERENCED DOCUMENTS

2.1. *AASHTO Standards:*

- M 146, Terms Relating to Subgrade, Soil—Aggregate, and Fill Materials
- M 147, Materials for Aggregate and Soil—Aggregate Subbase, Base, and Surface Courses
- R 58, Dry Preparation of Disturbed Soil and Soil—Aggregate Samples for Test
- T 2, Sampling of Aggregates
- T 11, Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
- T 27, Sieve Analysis of Fine and Coarse Aggregates
- T 88, Particle Size Analysis of Soils
- T 99, Moisture—Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop
- T 180, Moisture—Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop
- T 193, The California Bearing Ratio

- T 307, Determining the Resilient Modulus of Soils and Aggregate Materials

2.2. *ASTM Standards:*

- D2940/D2940M, Standard Specification for Graded Aggregate Material for Bases or Subbases for Highways or Airports
- D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- E11-15, Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. TERMINOLOGY

- 3.1. The definitions of "base course" and other soil—aggregate terms are given in M 146. The term "glass cullet" as used in this specification refers to a crushed glass container material that is screened and graded for potential use as a substitute material for soil—aggregate base courses.

4. ORDERING INFORMATION

- 4.1. *The purchaser or specifier shall include the following information in the purchase order or contract documents:*
- 4.1.1. Reference to this specification, including year;
 - 4.1.2. Grading to be furnished for the granular base;
 - 4.1.3. The percentage of glass cullet by mass in the granular base;
 - 4.1.4. The optimum moisture content and maximum density of the granular base; and
 - 4.1.5. Exceptions or additions to this specification.

5. PHYSICAL PROPERTIES AND DELETERIOUS SUBSTANCES IN GLASS CULLET

- 5.1. Glass cullet shall consist of broken food and beverage containers. China dishes, ceramics, or plate glass shall be limited to a maximum of 5 percent by mass of glass cullet. Refer to [Appendix X1](#) for further discussion of this topic.
- 5.2. Glass cullet shall be crushed and screened if necessary so that 100 percent of the glass cullet material passes the 9.5-mm (³/₈-in.) sieve.
- 5.3. Glass cullet shall be free of odor.
- 5.4. Container tops, paper, labels, food residue, foil, wood, and other deleterious materials shall be limited to a maximum of 1 percent by mass of the glass cullet, of which no more than 0.05 percent by mass of paper shall be permitted. Extraneous soil-like materials shall be limited to a maximum of 2 percent by mass of the glass cullet. Refer to [Appendix X3](#) for a discussion of methods to determine these percentages. Glass cullet shall be free of TV or other cathode ray tubes, fluorescent lightbulbs, and any toxic or hazardous materials as defined by the state or local jurisdiction, which the supplier shall certify.
- 5.5.

Glass cullet material shall be processed so as to limit the quantity of shard-like particles to less than 1 percent by mass as measured by ASTM D4791. Refer to [Appendix X4](#) for further discussion of this topic.

6. SOIL—AGGREGATE MATERIALS AND GLASS CONTENT

- 6.1. Glass cullet shall be combined with soil—aggregate material to form a blended material conforming to the requirements of M 147, ASTM D2940/D2940M, or the requirements of the specifying jurisdiction.
- 6.2. The supplier shall be permitted to use up to 20 percent by mass of glass cullet in composite glass cullet/soil—aggregate mixtures.
- 6.3. If the engineer wishes to use a combination of materials that exceeds the glass percentage limit indicated above, then reference should be made to the evaluation methods described in [Appendix X2](#).
- 6.4. The supplier shall ensure that composite material is uniformly blended.

7. METHODS OF SAMPLING AND TESTING

- 7.1. Glass cullet soil—aggregate composite shall be sampled and tested in accordance with the following standard methods of the American Association of State Highway and Transportation Officials, except as otherwise provided in this specification:
 - 7.1.1. R 58, Sample Preparation;
 - 7.1.2. T 2, Sampling;
 - 7.1.3. T 11, Elutriation;
 - 7.1.4. T 27, Grading;
 - 7.1.5. T 88, Particle Size Analysis;
 - 7.1.6. T 99, Moisture—Density Relationship;
 - 7.1.7. T 180, Moisture—Density Relationship.

8. KEYWORDS

- 8.1. Glass; glass cullet; recycled aggregate; recycled glass.

APPENDIXES

(Nonmandatory Information)

X1. CHINA DISHES, CERAMICS, PLATE GLASS, OR GLASS PRODUCTS IN EXCESS OF 5 PERCENT OF THE CONTAINER GLASS CULLET WEIGHT

- X1.1. If products such as nonbeverage container glass, glass-like products, or ceramics are processed to the specified glass cullet gradations presented above, there is no technical evidence to suggest that their use at levels in excess of 5 percent by mass of the container glass cullet will have an adverse effect on the properties of a granular base. Insofar as these glass products are introduced in percentages less than or equal to 5 percent by mass of the total glass cullet content, little impact is expected. If the engineer wishes to use higher percentages of nonbeverage container glass that meet all other requirements of this specification in the base course material, then one of the following laboratory tests or field evaluation tests and acceptance criteria is recommended:
- X1.1.1. *Validation by Use of California Bearing Ratio Testing*—The supplier should compare California Bearing Ratio test results (T 193) obtained from a control sample (consisting of natural soil—aggregate material normally used to comply with granular base specifications) and from the composite blend of glass product and natural soil—aggregate proposed for use on the project.
- X1.1.2. *Validation by Use of Resilient Modulus Testing*—The supplier should compare Resilient Modulus test results (T 292 and T 307) obtained from a control sample (consisting of natural soil—aggregate material normally used to comply with granular base specifications) and from the composite blend of glass product and natural soil—aggregate proposed for use on the project. Three tests for each condition shall be performed and the values averaged.
- X1.1.3. *California Bearing Ratio and Resilient Modulus Criteria*—If the California Bearing Ratio value for the glass product/natural soil—aggregate combination is equal to or greater than that for the control material, and if the average Resilient Modulus value for the glass product/natural soil—aggregate combination is equal to or greater than the average value for the control material alone, then the higher percentage noncontainer glass product aggregate may be permitted subject to further validation by field validation as defined in [Section X1.1.4](#).
- X1.1.4. *Validation by Field Demonstration Application*—The supplier shall show by construction of a test strip or introducing historical data that will demonstrate that higher percentages of nonbeverage container glass than those recommended in these specifications do not adversely affect the granular base design and performance by establishing periodic performance reviews (not less than annually) of the field application until such time that the engineer is satisfied with the results.

X2. GLASS CULLET IN EXCESS OF 20 PERCENT BY MASS OF THE COMPOSITE BLEND

- X2.1. Experience has shown that the use of less than 20 percent by mass of glass cullet in soil—aggregates produces an efficient combination where the properties of the combination are substantially equivalent to the natural soil—aggregate material alone. Little is known of the performance of combinations of greater than 20 percent by mass of glass cullet aggregate. If the engineer wishes to use higher percentages of glass cullet in the base course material, then the following performance acceptance criteria is recommended:
- X2.1.1. *Validation by Use of California Bearing Ratio Testing*—The supplier should compare California Bearing Ratio test results conducted on a control sample consisting of natural soil—aggregate material normally used to comply with granular base specifications to the composite blend of glass cullet and natural soil—aggregate the supplier wishes to use on the project.
- X2.1.2.

Validation by Use of Resilient Modulus Testing—The supplier should compare the results of Resilient Modulus testing on a control sample consisting of natural soil—aggregate material normally used to meet granular base specifications to the natural soil—aggregate material plus the percentage of glass cullet material that the supplier wishes to use on the project. Three tests for each condition shall be performed and the values averaged.

X2.1.3. *California Bearing Ratio and Resilient Modulus Criteria*—If the California Bearing Ratio value for the glass cullet/natural soil—aggregate combination is equal to or greater than that for the control material, and if the average Resilient Modulus value for the glass cullet/natural soil—aggregate combination is equal to or greater than the average value for the control material alone, then the higher percentage glass cullet combination may be permitted subject to further validation by field application as defined in [Section X2.1.4](#).

X2.1.4. *Validation during Field Application*—The supplier shall show by constructing a test strip or introducing historical data that will demonstrate that such higher percentages of glass aggregate than recommended in these specifications do not adversely affect the granular base design and performance by establishing periodic performance reviews of the field application until such time that the engineer is satisfied with the results.

X3. DETERMINATION OF PERCENTAGES OF DELETERIOUS MATERIALS

X3.1. It is recommended that percentages of deleterious materials be determined on a mass basis as described below or some equivalent alternative. In the mass method approach, a representative sample of the glass cullet is taken and dried to constant mass. The sample is then visually segregated into four categories: (1) glass, (2) paper, (3) other deleterious materials, and (4) soils. The percentage of each component may be determined by dividing the mass of the component by the mass of the total sample. Each value would then be multiplied by 100 to yield a percentage. The values so determined can be rounded to the nearest 0.1 percent.

X4. GLASS CULLET PROCESSING AND SAFETY

X4.1. The nature of crushed glass is such that certain crushing processes may generate particles that are elongated or exceptionally sharp, posing a potential safety hazard. Proper processing, which includes glass crushing, can produce a somewhat well-rounded glass particle that can be safely handled. As a result, it is recommended that glass used in granular base applications should be processed so that glass particles retained on a 4.75-mm (No. 4) sieve should not contain more than 1 percent by mass of particles so flat, elongated, or both that the ratio between the maximum and minimum dimensions of a circumscribing rectangular prism exceeds 5:1. Such an evaluation can be performed in accordance with ASTM D4791. These requirements are intended to ensure that the processed glass cullet will have a minimal amount (less than 1 percent) of long, narrow glass particles that may pose a safety hazard. More stringent requirements may be needed. The ratio is not to be used as a criterion for the evaluation of the engineering properties of glass cullet.
