



Designation: D6932/D6932M – 21

Standard Guide for Materials and Construction of Open-Graded Friction Course Plant Asphalt Mixtures¹

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1. Scope

1.1 This guide covers the construction of open-graded friction course (OGFC) plant asphalt mixtures. End-use specifications should be adopted to conform to job and user requirements. Where applicable, Specification D3666 should be applied as a minimum for agencies testing and inspecting road and paving materials.

1.2 Asphalt OGFCs are placed as the final wearing course for highways and airfields.

1.3 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.4 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

- C29/C29M Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
- C88/C88M Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
- C127 Test Method for Relative Density (Specific Gravity) and Absorption of Coarse Aggregate

- C128 Test Method for Relative Density (Specific Gravity) and Absorption of Fine Aggregate
- C131/C131M Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
- C136/C136M Test Method for Sieve Analysis of Fine and Coarse Aggregates
- C1252 Test Methods for Uncompacted Void Content of Fine Aggregate (as Influenced by Particle Shape, Surface Texture, and Grading)
- D75/D75M Practice for Sampling Aggregates
- D140/D140M Practice for Sampling Asphalt Materials
- D448 Classification for Sizes of Aggregate for Road and Bridge Construction
- D946/D946M Specification for Penetration-Graded Asphalt Binder for Use in Pavement Construction
- D1461 Test Method for Moisture or Volatile Distillates in Asphalt Mixtures
- D2419 Test Method for Sand Equivalent Value of Soils and Fine Aggregate
- D2995 Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
- D3381/D3381M Specification for Viscosity-Graded Asphalt Binder for Use in Pavement Construction
- D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials
- D4791 Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
- D5821 Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
- D6114/D6114M Specification for Asphalt-Rubber Binder
- D6307 Test Method for Asphalt Content of Asphalt Mixture by Ignition Method
- D6373 Specification for Performance-Graded Asphalt Binder
- D6390 Test Method for Determination of Draindown Characteristics in Uncompacted Asphalt Mixtures
- D7064/D7064M Practice for Open-Graded Friction Course (OGFC) Mix Design

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

2.2 Other References:

TRB NCHRP Synthesis 284 Performance Survey on Open-Graded Friction Course Mixes
NCAT Report No. 2001-01 Design, Construction and Performance of New Generation Open-Graded Friction Courses
FAA-RD-73-197
FAA-RD-74-38

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *open-graded friction course (OGFC), n*—a special type of surface asphalt mixture used for reducing hydroplaning and potential for skidding, where the function of the mixture is to provide a free-draining layer that permits surface water to migrate laterally through the mixture to the edge of the pavement.

3.1.1.1 *Discussion*—Example gradings can be found in Appendix X1.

4. Significance and Use

4.1 This guide provides information to assist engineers with the design requirements and construction guidelines for paving an open-graded friction course (OGFC) surface layer. An OGFC is primarily used to improve the skid resistance and wear resistance of an asphalt pavement by providing an escape route for surface water beneath a moving wheel load. The asphalt mixture is typically produced with a low amount of fine aggregate particles and high air void content to provide a passageway of interconnected voids for moisture to drain away from the travelway. The film thickness of the asphalt and overall asphalt content are important for better stripping resistance and durability and aging properties.

NOTE 1—OGFCs may also be placed to reduce the tire-pavement interface noise and may also be placed to reduce the occurrence and severity of reflective cracking.

5. Types of Specification Information

5.1 Contract documentation for asphalt OGFC typically includes the following information:

5.1.1 Type of asphalt (for example, asphalt cement, polymer-modified asphalt, asphalt-rubber) and specification designation;

5.1.2 Grade of asphalt;

5.1.3 Quantity of asphalt required;

5.1.4 Type of aggregate (for example, crushed stone, crushed gravel, crushed slag, gravel, slag) specification designation;

5.1.5 Aggregate quality requirements (for example, coarse aggregate angularity, fine aggregate angularity, L.A. abrasion, soundness, water absorption, sand equivalent);

5.1.6 Size or sizes of aggregate to be furnished;

5.1.7 Quantity of additive, or anti-stripping agent, or both;

5.1.8 Quantity of open-graded mix; and

5.1.9 Special requirements.

6. Aggregate

6.1 Aggregate shall conform to Classification D448 except where noted in this guide.

6.2 *Size*—Aggregate should be as close to one size as is economically practical, preferably in the range of 12.5 to 4.75 mm [$\frac{1}{2}$ in. to No. 4], for OGFC with up to 25 mm [1.0 in.] in compacted thickness.

6.3 *Shape*—The ideal shape is cubical or angular. To achieve adequate angularity it is suggested that the coarse aggregate have at least 95 % one-fractured face and 90 % two-fractured face as measured by Test Method D5821. To help achieve a more cubical shape it is suggested that the coarse aggregate maximum amount of flat or elongated particles as measured by Test Method D4791 not exceed 10 % with a ratio of 5 to 1 in maximum dimension to minimum dimension. Rounded particles are not acceptable. The uncompacted void content (fine aggregate angularity-FAA) as measured by Test Methods C1252 should be 40 % or greater.

6.4 *Cleanliness*—It is important that the aggregate be clean. The sand equivalent value of the fine aggregate passing the 2.36 mm [No. 8] sieve according to Test Method D2419 should be at least 45 % or greater. It is recommended that the material to be tested be separated on the 2.36 mm [No. 8] sieve because of the coarse grading of the aggregate. It is also very important to remove any coatings or fines adhering to the coarse material.

7. Asphalt Binder

7.1 Asphalt cement shall conform to Specification D946/D946M, D3381/D3381M, or D6373.

7.2 When modified asphalt is used, it shall conform to Specification D6373.

7.3 When asphalt-rubber is used, it shall conform to Specification D6114/D6114M.

NOTE 2—The asphalt type and grade to be used depend on the type of construction, climatic conditions, amount and nature of traffic.

8. Composition of Open-Graded Mixtures

8.1 The asphalt content shall be determined in accordance with the owner's selection method or Practice D7064/D7064M.

8.2 The asphalt cement open-graded mixture will typically consist of 93 to 95 % aggregate and 5 to 7 % asphalt by weight of total mixture.

8.3 The modified asphalt open-graded mixture typically consists of 92 to 94 % aggregate and 6 to 8 % modified asphalt by weight of total mixture.

8.4 The asphalt-rubber open-graded mixture typically consists of 90 to 91.5 % aggregate and 8.5 to 10 % asphalt-rubber by weight of total mixture.

NOTE 3—Due to the open-graded nature of the asphalt mixture, it may be advisable to add 1 to 2 % cement or hydrated lime or a suitable anti-stripping agent to prevent stripping.

NOTE 4—The selected asphalt content should be checked by performing a suitable asphalt draindown test such as Test Method D6390. Draindown may be reduced by using cellulose or mineral fiber. Typically the dosage is in the range of 0.2 to 0.5 % by mixture mass as per the mix design procedure test results. Polymer-modified asphalt, asphalt-rubber, and warm mix asphalt mixes may not require fiber additives to obtain good performance or control draindown.

9. Production and Placement

9.1 Asphalt OGFCs should not be placed during periods of cold or wet weather, or both. The existing surface shall be warm, clean, and dry while paving the OGFC.

9.1.1 Typically the minimum air temperature should be 16 °C [60 °F] in the shade and rising and the minimum surface temperature should be 21 °C [70 °F] in the shade and rising before starting the operation. Open-graded asphalt mixtures placed 12.5 mm [0.5 in.] to 25 mm [1.0 in.] in thickness will cool very rapidly and thus a higher minimum air and surface temperature may be advisable. Thus, the specifying agency in setting the minimum air and surface temperature should consider their normal good paving practices and as a minimum the operation should not be permitted when the temperature falls below such normal agency temperature thresholds.

NOTE 5—The specifying organization may want to consider setting or designating paving seasons to ensure optimal paving conditions.

NOTE 6—Running a little bit of hot virgin aggregate through the paver and wasting it, just to warm all the placement equipment, is advisable if a contractor can do it. This will allow for less sticking of material to cool surfaces.

9.1.2 The operation should not be carried out in the rain or when rain is threatening.

9.1.3 The open-graded asphalt mixture should be placed as the final surface course with its edges exposed to ensure free draining at the edges. If it is placed in a curb and gutter section, it should be placed above the gutter.

9.1.4 The open-graded asphalt mixture is not a structural pavement layer and thus should not be expected to correct obvious pavement structural defects such as potholes or weak underlying pavement or foundation support. Some caution should be exercised in placing this mix on a surface that might be permeable or a cracked surface that would allow water to enter.

10. Method of Sampling and Testing

10.1 Calibrate asphalt distributors for proper application rate for tack coat using Practice **D2995**.

10.2 Sample asphalt materials according to Practice **D140/D140M** and test for conformance with the designated specification according to test methods indicated in that specification.

10.3 Sample all aggregates according to Practice **D75/D75M**. Test the aggregate according to the test methods listed in **6.3** and **6.4**, according to the following test methods, as necessary.

10.3.1 *Bulk Density of Aggregates*—Test Method **C29/C29M**.

10.3.2 *Sulfate Soundness*—Test Method **C88/C88M**.

10.3.3 *Specific Gravity and Absorption*—Test Method **C127** or **C128** as applicable.

10.3.4 *Resistance to Degradation*—Test Method **C131/C131M**.

10.3.5 *Sieve Analysis*—Test Method **C136/C136M**.

10.4 Samples of the open-graded asphalt mixture should be taken at the discretion of the engineer and tested for asphalt binder content using Test Method **D6307** and/or moisture content using Test Method **D1461** or by using methods as approved by the engineer.

10.5 Cores should be taken at the discretion of the engineer to verify the thickness of the open-graded asphalt mixture.

11. Construction Procedure

11.1 Patch potholes, fill cracks, and repair damaged areas in existing pavements.

11.2 The surface to be covered should be cleaned with a rotary broom or other approved means.

11.3 A tack coat should be applied to the paved surface before placement of the open-graded friction course asphalt mixture.

NOTE 7—For open-graded mixtures, the tack coat is typically a paving grade liquid asphalt applied at the rate of 0.4 L/m² [0.08 gal/yd²].

11.4 The temperature of the asphalt cement open-graded asphalt mixture during compaction should be at least 93 °C [200 °F].

11.5 The temperature of the modified asphalt cement open-graded asphalt mixture during compaction should be in the range of 93 to 135 °C [200 to 275 °F].

NOTE 8—It is advised that the supplier of the modified asphalt binder be consulted for the proper mixing and compaction temperature ranges to be used in the field.

11.6 The temperature of the asphalt-rubber open-graded asphalt mixture during compaction should be at least 135 °C [275 °F].

11.7 Compact the OGFC by using self-propelled rollers, either steel wheel or pneumatic, in the non-vibratory mode following immediately behind the laydown machine.

NOTE 9—When using modified asphalt binder or asphalt rubber binder, only use steel-wheeled rollers operated in static mode. Pneumatic/rubber tire rollers should not be used with OGFC produced using modified asphalt binder or asphalt rubber binder.

NOTE 10—The compaction equipment and method of rolling should be selected and done in such a manner that it does not fracture the aggregate or damage the asphalt mix.

11.8 It may be advisable to place a test section to determine an adequate rolling pattern (typically two to three passes) and to ensure adequate compaction.

12. Keywords

12.1 asphalt cement; asphalt rubber; modified asphalt cement; open-graded friction course