



Designation: D8444/D8444M – 24

Standard Specification for Fiber Reinforced Polymer Dowel Bars for Load Transfer Between Concrete Slabs¹

This standard is issued under the fixed designation D8444/D8444M; 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 specification covers glass fiber reinforced polymer (GFRP) dowel bars, provided in cut lengths and having a smooth surface so that when embedded in concrete, the expansion and contraction of concrete along the longitudinal axis of the dowel is not inhibited. A dowel bar, commonly referred to as a dowel, acts as a shear transfer device between concrete slabs. In addition, GFRP dowel bars are electromagnetically transparent, lightweight compared to steel, and non-corroding. Dowels covered by this specification shall meet the requirements for geometric, material, mechanical, and physical properties described herein.

1.2 Dowel bars produced according to this standard must meet the requirements using the test methods referenced in [Table 1](#). Quality control and acceptance of production lots of dowel bars must meet the requirements using the test methods referenced in [Table 2](#).

1.3 The text of this specification references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables) shall not be considered as requirements of the specification.

1.4 The following dowel bars are not covered by this specification:

1.4.1 Dowel bars made of more than one load-bearing fiber reinforcement type (that is, hybrid FRP).

1.4.2 Dowel bars having an external surface treatment, coating or bond-breaking agent added after production.

1.4.3 Dowel bars having an external surface enhancement for bonding with concrete (that is, bars intended for concrete reinforcement).

1.4.4 Dowel bars with geometries other than solid, round cross sections.

1.5 This specification is applicable for either SI (as Specification D8444M) or inch-pound units (as Specification D8444).

¹ This specification is under the jurisdiction of ASTM Committee D30 on Composite Materials and is the direct responsibility of Subcommittee D30.10 on Composites for Civil Structures.

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1.6 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.6.1 Within the text, the inch-pound units are shown in brackets.

1.7 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.8 *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

[C31/C31M Practice for Making and Curing Concrete Test Specimens in the Field](#)

[C39/C39M Test Method for Compressive Strength of Cylindrical Concrete Specimens](#)

[C192 Practice for Making and Curing Concrete Test Specimens in the Laboratory](#)

[C904 Terminology Relating to Chemical-Resistant Nonmetallic Materials](#)

[D570 Test Method for Water Absorption of Plastics](#)

[D578/D578M Specification for Glass Fiber Strands](#)

[D792 Test Methods for Density and Specific Gravity \(Relative Density\) of Plastics by Displacement](#)

[D2584 Test Method for Ignition Loss of Cured Reinforced Resins](#)

[D3171 Test Methods for Constituent Content of Composite Materials](#)

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.

TABLE 1 Property Limits and Test Methods for Qualification^A

Property	Limit	Test Method
Mean Glass Transition Temperature	≥100 °C [212 °F] (DSC) or ≥110 °C [230 °F] (DMA)	Test Method E1356 (DSC) or Test Method D7028 (DMA)
Mean Degree of Cure	≥95 %	Test Method E2160
Mean Measured Cross-Sectional Area	Table 3	Test Method D7205/D7205M , subsection 11.2.4.1
Mean Transverse Shear Strength	≥160 MPa [23 200 psi]	Test Method D7617/D7617M
Mean Apparent Horizontal Shear Strength	≥50 MPa [7250 psi]	Test Method D4475
Moisture Absorption in 24 h	≤0.25 % in 24 h at 50 °C [122 °F]	Test Method D570 , subsection 7.4
Moisture Absorption to Saturation	≤1.0 % to saturation at 50 °C [122 °F]	Test Method D570 , subsection 7.4
Alkaline Resistance	>80 % of the initial mean Apparent Horizontal Shear	Subjected to Test Method D7705/D7705M Procedure A for 90 days followed by Test Method D4475
Mean Bond Strength	Table 3	Annex A1

^A For the determination of each of the property limits, at least 24 samples shall be obtained in groups of eight or more from three or more different production lots. The mean properties shall satisfy the limits.

TABLE 2 Property Limits and Test Methods for Quality Control and Acceptance^A

Property	Limit	Test Method
Fiber Mass Content	≥70 %	Test Method D2584 or Test Method D3171
Glass Transition Temperature	≥100 °C [212 °F] (DSC) or ≥110 °C [230 °F] (DMA)	Test Method E1356 (DSC) or Test Method D7028 (DMA)
Degree of Cure	≥95 %	Test Method E2160
Measured Cross-Sectional Area	Table 3	Test Method D7205/D7205M , subsection 11.2.4.1
Transverse Shear Strength	≥160 MPa [23 200 psi]	Test Method D7617/D7617M
Apparent Horizontal Shear Strength	≥50 MPa [7250 psi]	Test Method D4475
Moisture Absorption in 24 h	≤0.25 % in 24 h at 50 °C [122 °F]	Test Method D570 , subsection 7.4

^A For the determination of each of the property limits, five random samples shall be obtained from each production lot. The mean value shall satisfy the property limits.

D3878 Terminology for Composite Materials

D4475 Test Method for Apparent Horizontal Shear Strength of Pultruded Reinforced Plastic Rods By the Short-Beam Method

D7028 Test Method for Glass Transition Temperature (DMA T_g) of Polymer Matrix Composites by Dynamic Mechanical Analysis (DMA)

D7205/D7205M Test Method for Tensile Properties of Fiber Reinforced Polymer Matrix Composite Bars

D7617/D7617M Test Method for Transverse Shear Strength of Fiber-reinforced Polymer Matrix Composite Bars

D7705/D7705M Test Method for Alkali Resistance of Fiber Reinforced Polymer (FRP) Matrix Composite Bars used in Concrete Construction

D7913/D7913M Test Method for Bond Strength of Fiber-Reinforced Polymer Matrix Composite Bars to Concrete by Pullout Testing

E4 Practices for Force Calibration and Verification of Testing Machines

E1356 Test Method for Assignment of the Glass Transition Temperatures by Differential Scanning Calorimetry

E2160 Test Method for Heat of Reaction of Thermally Reactive Materials by Differential Scanning Calorimetry

E2658 Practices for Verification of Speed for Material Testing Machines

2.2 Other Documents:

ACPA M253 Standard Method of Test for Dowel Bars for Concrete Street and Highway Pavement³

AASHTO R 39 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory to the references⁴

3. Terminology

3.1 Definitions:

3.1.1 Terminology **C904** defines terms relating to chemical-resistant nonmetallic materials. Terminology **D3878** defines terms relating to high-modulus fibers and their composites.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *commercial grade material, n*—a material formulated for and used in industrial (not consumer) applications.

3.2.2 *dowel, n*—a straight element with a solid, round cross-section, having a smooth as produced surface that extends into adjoining portions of a concrete construction, as an expansion or contraction joint in a pavement slab, so as to transfer shear loads.

3.2.3 *mean property, n*—a value provided by the manufacturer less than or equal to the mean of the samples tested according to a specified method.

3.2.4 *measured cross-sectional area, n*—the average cross-sectional area of a representative dowel, including imperfections, as measured according to Test Method **D7205/D7205M**, 11.2.4.1.

3.2.5 *nominal cross-sectional area, n*—a standard cross-sectional area of a dowel, as described in **Table 3**.

³ Available from American Concrete Pavement Association, 9450 W Bryn Mawr Ave #150, Rosemont, IL 60018, <https://www.acpa.org>.

⁴ Available from American Association of State Highway and Transportation Officials (AASHTO), 555 12th St., NW, Suite 1000, Washington, DC 20004, <http://www.transportation.org>.





TABLE 3 Geometric Property Requirements

Dowel Bar Size mm [in.]	Nominal Dimensions		Measured Cross-Sectional Area Limits mm ² [in. ²]		Bond Strength
	Diameter mm [in.]	Cross-Sectional Area mm ² [in. ²]	Minimum	Maximum	Maximum limit MPa [psi]
M16 [5/8]	15.9 [0.625]	198 [0.307]	188 [0.290]	241 [0.374]	1.17 [169]
M19 [3/4]	19.0 [0.750]	285 [0.442]	270 [0.420]	342 [0.530]	0.98 [141]
M22 [7/8]	22.2 [0.875]	388 [0.601]	368 [0.571]	465 [0.722]	0.83 [121]
M25 [1]	25.4 [1.000]	507 [0.785]	481 [0.746]	608 [0.942]	0.73 [106]
M32 [1 1/4]	31.7 [1.250]	792 [1.227]	752 [1.166]	950 [1.437]	0.58 [84.8]
M38 [1 1/2]	38.1 [1.500]	1140 [1.767]	1083 [1.679]	1368 [2.121]	0.49 [70.5]
M41 [1 5/8]	41.3 [1.625]	1339 [2.074]	1297 [2.011]	1430 [2.22]	0.45 [65.1]
M44 [1 3/4]	44.5 [1.750]	1555 [2.405]	1490 [2.310]	1715 [2.659]	0.42 [60.4]
M50 [2]	50.8 [2.000]	2027 [3.142]	1944 [3.014]	2235 [3.464]	0.36 [52.9]

3.2.6 *nominal dowel diameter, n*—a standard diameter of a dowel, as described in [Table 3](#).

3.2.7 *production lot, n*—determined by the manufacturer, as any batch of dowel bars produced from start to finish under continuous production run, with the same defined collection of constituent materials used in the same proportions without changing any production parameter (for example, cure temperature or speed of production).

3.2.8 *rehearing, n*—retesting or requalifying on a new set of specimens from the same production lot that has previously failed, by a third part not involved with the original testing.

3.2.9 *size designation, n*—corresponding to the dowel bar nominal diameter designation in [Table 3](#).

3.2.10 *test, acceptance, n*—an optional test, specified by and completed under the supervision of the purchaser, to verify that the material provided for a given project meets the requirements of the specification.

3.2.11 *test, qualification, n*—a test completed under the supervision of the manufacturer to ensure conformance of material to the requirements of a specification.

3.2.12 *test, quality control, n*—a test completed on each production lot of material, under the supervision of the manufacturer, to ensure that the process of manufacturing the product remains under control.

4. Ordering Information

4.1 The purchaser is responsible for specifying all requirements that are necessary for material ordered to this specification.

4.2 Orders for dowel bars under this specification shall contain at minimum the following information:

- 4.2.1 Name of the GFRP dowel bar material (manufacturer's description),
- 4.2.2 Quantity of each individual dowel,
- 4.2.3 Dowel nominal diameter (size), as given in [Table 3](#),
- 4.2.4 Dowel length, meeting requirements in [9.2](#), and
- 4.2.5 ASTM specification number and year of issue.

4.3 The purchaser shall have the option to specify additional requirements as necessary, including but not limited to, the following:

4.3.1 Copy of the report of the quality control tests, as given in [Table 2](#),

4.3.2 Requirements for inspection as indicated in [Section 12](#),

4.3.3 Special packaging requirements,

4.3.4 Production lot or acceptance report, and

4.3.5 Other requirements, if any.

NOTE 1—Descriptive dowel list part numbering can be helpful in communicating the designer's intent to the fabricator, supplier, placement of the dowels, procurement, and job site inspection. An example of descriptive part numbering for FRP dowels is shown in [Appendix X1](#).

5. Constituent Materials and Manufacture

5.1 *Reinforcing Fibers*—Glass fibers shall be boron-free in the form of continuous unidirectional rovings conforming to Specification [D578/D578M](#).

5.2 Matrix Resins:

5.2.1 Vinyl ester or epoxy thermoset resin systems are permitted, provided the finished dowel bar product meets the physical and durability requirements of this specification.

5.2.2 The base polymer in the resin system should not contain any polyester.

5.3 Manufacturing Process:

5.3.1 Process or material modifications are not permitted during the production of a single production lot.

5.3.2 The manufacturer shall document the process used and report the date(s) of production and quantity of material produced in the production lot.

5.3.3 The manufacturer shall maintain a documented quality control plan that details the activities of the process monitoring, production inspection, and record keeping. The plan shall be made available to customers upon request.

5.3.4 The manufacturer shall use all tests in [Table 2](#) as part of the quality control process. A record of these quality control tests shall be kept for each lot of material and shall be made available to the purchaser upon request. The manufacturer may use other tests as part of internal quality control processes. Results from such tests are not required to be reported.

5.3.5 The as-produced dowel bar shall be evaluated as per this specification, where no surface treatments, coating or bond-breaking agent shall be added after the manufacturing process.

6. Physical Properties

6.1 *Fiber Mass Content*—The fiber mass content shall be determined by Test Method [D2584](#) or [D2584M](#).

