



Designation: E 1091 – 03

Standard Specification for Nonmetallic Honeycomb Core for Use in Shelter Panels¹

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This standard has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This specification is for nonmetallic honeycomb core used in the manufacture of adhesively bonded sandwich panels for tactical shelters. The materials are intended for adhesive bonding to aluminum facings using materials and processes defined by Practices E 864 and E 874 and Specifications E 865, E 866, and E 990. This specification covers five main types of honeycomb for use in sandwich panels, Types I, II, III, IV, and V. Types I, II, and III honeycombs correspond to three honeycomb densities. Types IV and V are similar to Types II and III, respectively, but have lower performance requirements.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI units in parentheses are provided for information only. For conversion of quantities in various systems of measurement to SI units, refer to Practice E 380.

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:

B 209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate²

C 177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus³

C 366 Test Methods for Measurement of Thickness of Sandwich Cores⁴

C 481 Test Method for Laboratory Aging of Sandwich Constructions⁴

C 518 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus³

D 3951 Practice for Commercial Packaging⁵

E 380 Practice for Use of the International System of Units (SI) (the Modernized Metric System)⁶

E 864 Practice for Surface Preparation of Aluminum Alloys to be Adhesively Bonded in Honeycomb Shelter Panels⁷

E 865 Specification for Structural Film Adhesives for Honeycomb Sandwich Panels⁶

E 866 Specification for Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to be Adhesively Bonded in Honeycomb Shelter Panels⁷

E 874 Practice for Adhesive Bonding of Aluminum Facings to Nonmetallic Honeycomb Core for Shelter Panels⁷

E 990 Specification for Core-Splice Adhesive for Honeycomb Sandwich Shelter Panels⁷

E 1749 Terminology of Rigid Wall Relocatable Shelters⁷

F 501 Test Method for Aerospace Materials Response to Flame, with Vertical Test Specimen (For Aerospace Vehicles Standard Conditions)⁸

2.2 Federal Aviation Regulation:

FAR 25.853(a) Compartment Interiors⁹

2.3 Federal Standards:

FED-STD-191A Textile Test Methods¹⁰

QQ-A-250/8 Aluminum Alloy 5052, Plate and Sheet¹⁰

QQ-A-250/11 Aluminum Alloy 6061, Plate and Sheet¹⁰

2.4 Military Standards:

MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes¹⁰

MIL-STD-129 Marking for Shipment and Storage¹⁰

MIL-STD-401 Sandwich Constructions and Core Materials; General Test Methods¹⁰

2.5 TAPPI Standard:

⁵ Annual Book of ASTM Standards, Vol 15.09.

⁶ Annual Book of ASTM Standards, Vol 14.02.

⁷ Annual Book of ASTM Standards, Vol 04.11.

⁸ Annual Book of ASTM Standards, Vol 04.07.

⁹ Available from Federal Aviation Agency, Office of Aviation Safety, 800 Independence Ave., SW, Washington, DC 20591.

¹⁰ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

¹ This specification is under the jurisdiction of ASTM Committee E06 on Performance of Building Constructions and is the direct responsibility of Subcommittee E06.53 on Materials and Processes for Durable Rigidwall Relocatable Structures.

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² Annual Book of ASTM Standards, Vol 02.02.

³ Annual Book of ASTM Standards, Vol 04.06.

⁴ Annual Book of ASTM Standards, Vol 15.03.

T 435-SU-68 Test Method for Hydrogen Ion Concentration of Paper Extracts, Hot Extraction Method¹¹

2.6 Other Publications:

Uniform Freight Classification¹²

National Motor Freight Classification¹³

ANSI/ASQC Z1.4 – 1993, Sampling Procedures and Tables for Inspection by Attributes¹⁴

3. Terminology

3.1 Definitions—See Terminology E 1749 for definitions of terms used in this specification.

3.2 Descriptions of Terms Specific To This Standard:

3.2.1 block, *n*—a single production unit of honeycomb before slicing.

3.2.2 cell size, *n*—the average distance between node bonds, measured along the *W* direction (Fig. 1), for at least 60 cells, selected at random in groups containing 10 adjacent cells.

3.2.3 core material, *n*—a slice or sheet cut from a production block that is used in a honeycomb sandwich panel. The orientation of the cells in the honeycomb core material as produced is shown in Fig. 1. The honeycomb core materials exhibit anisotropic behavior, therefore the following notation is used:

L = ribbon direction or longitudinal direction of core,
W = expanded direction or transverse direction of core, and
T = core thickness or depth,

N = bonded portion of the honeycomb flat sheet material; the honeycomb cell's double wall.

3.2.4 first article, *n*—a sample sheet of honeycomb from the first lot produced.

3.2.5 lot, *n*—1000 ft³ (28.3 m³) or less of honeycomb of the same type produced during consecutive operating or working days using the same basic materials and operating conditions.

3.2.6 sheet, *n*—a slice of honeycomb cut from a production block.

4. Classification

4.1 Five types of nonmetallic honeycomb material are specified. Their required properties are given in Section 6 and in Table 1.

4.1.1 Type I—honeycomb for use in panels which are required to have a high load-carrying capability that could not be adequately met using any of the other types.

4.1.2 Type II—honeycomb for use in panels which are required to have a load-carrying capability that could not be adequately met by using materials of any of Types III, IV, or V.

4.1.3 Type III—honeycomb for general use in panels where the higher performances of Types I, II, and IV materials are not required.

4.1.4 Type IV—honeycomb similar to Type II but with slightly lower performance.

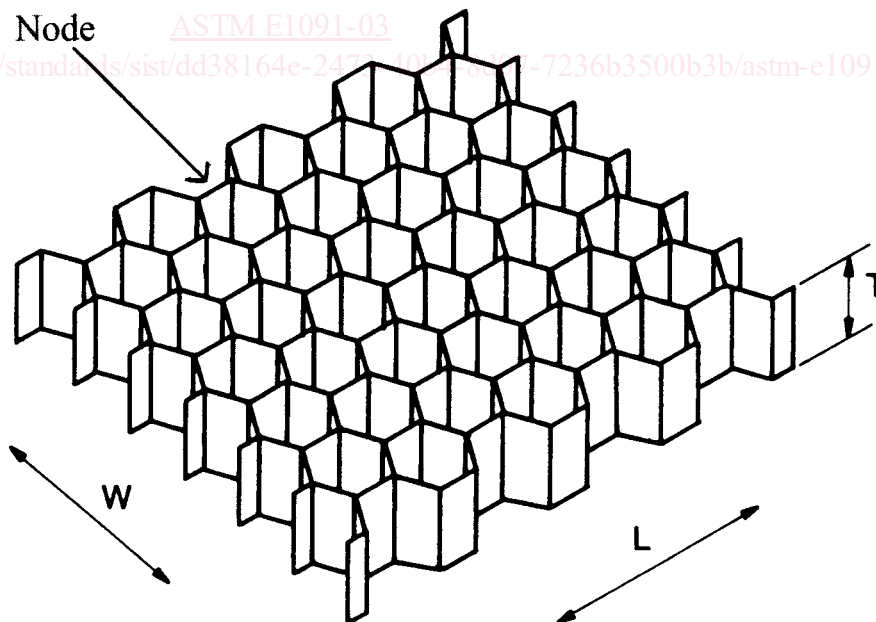
4.1.5 Type V—honeycomb similar to Type III but with slightly lower performance.

¹¹ Available from the Technical Association of the Pulp and Paper Industry, 1 Dunwoody Park, Atlanta, GA 30341.

¹² Available from the Uniform Classification Committee, Room 1106, 222 S. Riverside Plaza, Chicago, IL 60606.

¹³ Available from the American Trucking Associations, Inc., Traffic Department, 1616 P St., NW, Washington, DC 20036.

¹⁴ Available from the American Society for Quality Control, 611 E. Wisconsin Ave., Milwaukee, WI 53202.



L—Ribbon direction or longitudinal direction of core
W—Expanded direction or transverse direction of core
T—Core thickness or depth

N—Node is the bonded portion of the honeycomb flat sheet material; the honeycomb cell's double wall

FIG. 1 Orientation of Cells in Honeycomb-Core Material

TABLE 1 Honeycomb-Core Material Properties

Type	Type I	Type II	Type III	Type IV	Type V
Maximum density, lb/ft ³ (kg/m ³)	5.5 (88)	4.4 (70)	3.3 (53)	4.4 (70)	3.3 (53)
pH, pH units	7.0 ± 0.5	7.0 ± 0.5	7.0 ± 0.5	6.0 ± 0.5	6.0 ± 0.5
Compressive strength, ^A psi (MPa):					
Dry, min ^B	464 (3.20)	464 (3.20)	232 (1.60)	404 (2.79)	198 (1.37)
Wet, min ^C	406 (2.80)	232 (1.60)	116 (0.80)	163 (1.13)	98 (0.68)
At elevated temperature ^D	394 (2.72)	278 (1.92)	139 (0.96)	185 (1.28)	115 (0.79)
Cyclic aging, minimum	363 (2.50)	190 (1.31)	104 (0.72)	119 (0.82)	62 (0.43)
After fungus test ^E			See footnote ^E		
Shear strength, ^A psi (MPa):					
Dry, min					
TL core orientation ^B	218 (1.50)	218 (1.50)	116 (0.80)	180 (1.24)	85 (0.59)
TW core orientation ^B	130 (0.90)	116 (0.80)	65 (0.45)	113 (0.78)	57 (0.39)
Wet, min					
TL core orientation ^C	203 (1.40)	109 (0.75)	58 (0.40)	86 (0.59)	53 (0.37)
TW core orientation ^C	116 (0.80)	58 (0.40)	33 (0.23)	58 (0.40)	32 (0.22)
Flatwise tensile strength, min, ^F : psi (MPa)	406 (2.80)	406 (2.80)	231 (1.60)	306 (2.11)	231 (1.60)
Brittleness/Impact:					
Drop height, min, in (mm)	40 (1016)	30 (762)	20 (508)	30 (762)	20 (508)
Water migration resistance: 24 h, max, number of cells	3	3	3	3	3

^A Two-inch (51-mm) thick core with 0.05-in (1.3-mm) facings, tested at 73 ± 2°F (23 ± 1°C) unless otherwise stated herein. Shear tests shall be conducted with the core oriented in the TL and TW planes (Fig. 1).

^B At equilibrium with 73 ± 2°F (23 ± 1°C), and 50 ± 4 % RH.

^C After soaking in water at 70 ± 5°F (21.1 ± 3°C) for 48 h with perforated facings.

^D After heating for 30 min at, and tested at, 176 ± 5°F (80 ± 3°C).

^E Values for compressive strength shall be not less than 85 % of the dry compressive strength values for Types I, II, and III and 80 % for Types IV and V.

^F Tested at 73 ± 2°F (23 ± 1°C) with loading blocks bonded directly to each side of core specimen having a minimum area of 9 in.² (5806 mm²).

5. Ordering Information

5.1 *Procurement Documents*—Purchasers shall select any of the desired options offered herein and the procurement documents shall specify the following:

- 5.1.1 Title, number, and date of this specification.
- 5.1.2 Type of honeycomb required (see Section 4).
- 5.1.3 Dimensions required (see 6.4).
- 5.1.4 Cell size required (see 6.2 and 6.4).
- 5.1.5 Whether a first article sample is required (see 3.3).
- 5.1.6 Whether qualification is necessary (see 8.2.2).

5.2 When a first article sample is required, specific instructions shall be given regarding arrangements for examination, test, and approval of the first article.

6. Materials and Manufacture

6.1 *Materials*—Materials shall be as specified herein for the type ordered and shall comply with all provisions of this specification for this type.

6.2 *Configuration*—The honeycomb material (see Fig. 1) shall consist of a nonmetallic web material, suitably bonded so that in its final expanded form, a reasonably uniform cellular shape is developed. Unless otherwise specified, the cell size shall not exceed 0.5 in (12.5 mm).

6.3 *Flame Resistance*—The honeycomb core material shall meet the following requirements when tested as specified:

- 6.3.1 Average burn rate shall not exceed 4 in/min.
- 6.3.2 Self extinguishment within 15 s after removal of the 60-s applied flame.
- 6.3.3 Burning without flame shall not extend into undamaged area of core material.

6.4 *Dimensions*—Using the methods specified in 7.15, the length, width, and thickness dimensions of the honeycomb core (see Fig. 1) and the cell size shall be as specified.

6.5 *Dimensional Tolerances*—Unless otherwise specified, the dimensional tolerances of the honeycomb core material shall be as specified in Table 2. The cell size shall not vary more than 10 % from the specified dimension within any lot.

6.6 *Unbonded Nodes*—There shall be no more than one unbonded node within any 10 by 10-in (250 by 250-mm) area of the honeycomb core.

6.7 *Honeycomb Properties:*

6.7.1 *Physical and Mechanical*—The physical and mechanical properties of the honeycomb material shall meet the requirements listed in Table 1 when tested using the methods specified.

6.7.2 *pH*—When tested as specified, the pH of the honeycomb material shall meet the requirements listed in Table 1.

6.7.3 *Fungus Resistance*—When the fungus resistance is determined as specified, the compressive strength of the honeycomb shall meet the requirements listed in Table 1.

6.8 *Density*—The density of the honeycomb material, determined as specified, shall not exceed the values shown in Table 1 and shall be within ±10 % of the manufacturer's specified density.

6.9 *Workmanship*—The honeycomb core material shall be free of excess resin accumulations (for example, runs and sags), starved areas (for example, lack of resin) and foreign materials. The cell wall edges of the core shall be clean cut with no broken edges.

TABLE 2 Dimensional Tolerances

Dimensions	Tolerance, in (mm)	
	plus	minus
Length	2.0 (50.8)	0 (0)
Width	1.0 (25.4)	0 (0)
Thickness	0.010 (0.254)	0.010 (0.254)