



Designation: E1091 – 21

Standard Specification for Nonmetallic Honeycomb Core for Use in Shelter Panels¹

This standard is issued under the fixed designation E1091; 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.

This standard has been approved for use by agencies of the U.S. 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 E864 and E874, and Specifications E865, E866, and E990. 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard. For conversion of quantities in various systems of measurement to SI units, refer to Practice E380.

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

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

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

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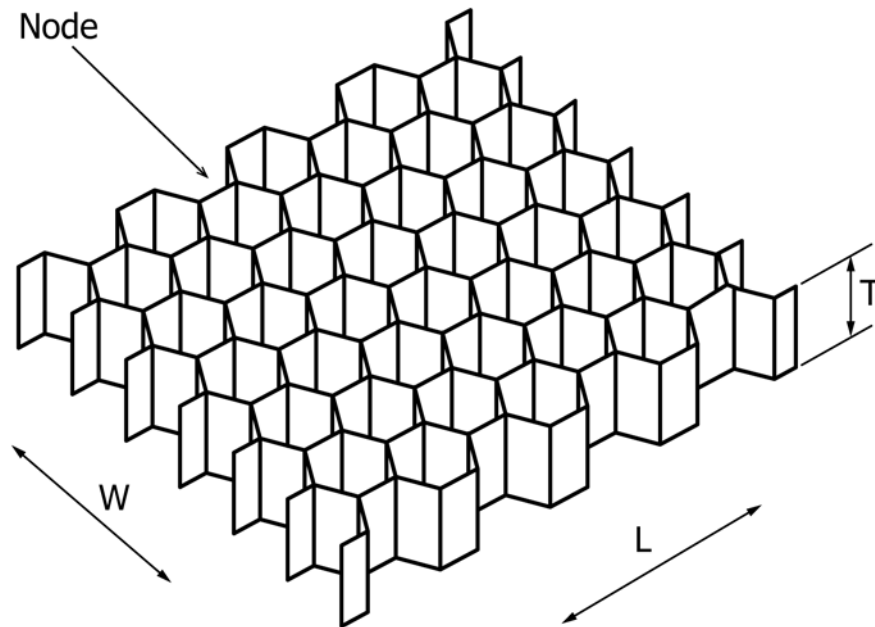
² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

- B209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- C177 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
- C366/C366M Test Methods for Measurement of Thickness of Sandwich Cores
- C481 Test Method for Laboratory Aging of Sandwich Constructions
- C518 Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
- E380 Practice for Use of the International System of Units (SI) (the Modernized Metric System) (Withdrawn 1997)³
- E631 Terminology of Building Constructions
- E864 Practice for Surface Preparation of Aluminum Alloys to Be Adhesively Bonded in Honeycomb Shelter Panels
- E865 Specification for Structural Film Adhesives for Honeycomb Sandwich Panels
- E866 Specification for Corrosion-Inhibiting Adhesive Primer for Aluminum Alloys to Be Adhesively Bonded in Honeycomb Shelter Panels
- E874 Practice for Adhesive Bonding of Aluminum Facings to Nonmetallic Honeycomb Core for Shelter Panels
- E990 Specification for Core-Splice Adhesive for Honeycomb Sandwich Structural Panels
- E1749 Terminology Relating to Rigid Wall Relocatable Shelters
- F501 Test Method for Aerospace Materials Response to Flame, with Vertical Test Specimen (for Aerospace Vehicles Standard Conditions) (Withdrawn 1998)³
- 2.2 *Federal Aviation Regulation:*⁴
 - FAR 25.853(a) Compartment Interiors
- 2.3 *Federal Standards:*⁵
 - FED-STD-191A Textile Test Methods
 - QQ-A-250/8 Aluminum Alloy 5052, Plate and Sheet
 - QQ-A-250/11 Aluminum Alloy 6061, Plate and Sheet

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Federal Aviation Administration (FAA), 800 Independence Ave., SW, Washington, DC 20591, <http://www.faa.gov>.

⁵ Available from DLA Document Services, Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil/>.



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

2.4 *Military Standards:*⁵

[MIL-STD-105 Sampling Procedures and Tables for Inspection by Attributes](#)

[MIL-STD-129 Marking for Shipment and Storage](#)

[MIL-STD-401 Sandwich Constructions and Core Materials; General Test Methods](#)

2.5 *TAPPI Standard:*⁶

[T 435-SU-68 Test Method for Hydrogen Ion Concentration of Paper Extracts, Hot Extraction Method](#)

2.6 *Other Publications:*

[Uniform Freight Classification](#)⁷

[National Motor Freight Classification](#)⁸

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of general terms related to building construction used in this specification, refer to Terminology [E631](#), and for general terms related to rigid wall relocatable shelters, refer to Terminology [E1749](#).

⁶ Available from Technological Association of the Pulp and Paper Industry (TAPPI), 15 Technology Parkway South, Suite 115, Peachtree Corners, GA 30092, <http://www.tappi.org>.

⁷ Available from RAILINC, 7001 Weston Parkway, Suite 200, Cary, NC 27513, <https://public.railinc.com/>.

⁸ Available from National Motor Freight Traffic Association, Inc. (NMFTA), 1001 N. Fairfax St., Suite 600, Alexandria, VA 22314-1798, <http://www.nmfta.org>.

3.2 *Definitions 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,

T = core thickness or depth, and

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.

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 in. by 10 in. (250 mm 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 $\pm 10\%$ of the manufacturer's specified density.

6.9 *Workmanship*—The honeycomb core material shall be free of excess resin accumulations (for example, runs and

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 \pm 0.5	7.0 \pm 0.5	7.0 \pm 0.5	6.0 \pm 0.5	6.0 \pm 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 °F \pm 2 °F (23 °C \pm 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 °F \pm 2 °F (23 °C \pm 1 °C), and 50 \pm 4 % RH.

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

^D After heating for 30 min at, and tested at, 176 °F \pm 5 °F (80 °C \pm 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 °F \pm 2 °F (23 °C \pm 1 °C) with loading blocks bonded directly to each side of core specimen having a minimum area of 9 in.² (5806 mm²).