Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 4175

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Revised

HONEYCOMB CORE, ALUMINUM ALLOY
2.5Mg - 0.25Cr (5052-H191)

1. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.

2. FORM: Blocks, slices, or other configuration as ordered.

3. APPLICATION: Primarily for use in fabricating sandwich constructions for structural applications.

4. MATERIAL: The core shall be made of aluminum alloy foil conforming to AMS 4004. The thickness shall be as specified on the drawing or purchase order. The adhesive system used for node-to-node attachment shall be left to the core manufacturer's discretion unless specified on the drawing or purchase order.

5. CONDITION: Core shall be clean and free of contamination and shall be supplied in the expanded form unless otherwise specified.

6. TECHNICAL REQUIREMENTS:

6.1 Designation: Core shall be designated according to the following numbering system:

a. Nominal density (lb per cu ft)
b. Cell size (in.)
c. Foil thickness (ten-thousandths in.)
d. "P" for perforated or "N" for nonperforated
e. Alloy
f. Adhesive, option of the supplier, unless otherwise specified

Example: Core with a nominal density of 3.1 lb per cu ft with a 1/4 in. cell size, 0.0020 in. foil thickness, nonperforated, made of AMS 4004 alloy, and bonded with required adhesive shall be numbered as follows:

3.1 - 1/4 20N (5052) (XXXX)

6.2 Cell Configuration: The core shall consist of sheets of aluminum alloy foil bonded together such that cells approximately hexagonal in shape are formed, when fully expanded (See Fig. 1).

6.3 Core Dimensions: Shall be as specified in Fig. 1 where,

T = Thickness, depth, or height dimension measured parallel to the core cell axis

L = Longitudinal or ribbon direction measured along the direction of a ribbon

W = Width measured normal to the ribbon direction

6.4 Perforations: When perforated core is specified, the perforations shall be approximately 0.005 in. in diameter and spaced to vent each cell into at least three adjacent cells at least once per 1/4 in. of core thickness. When thicknesses less than 1/4 in. are furnished, there shall be at least one perforation per cell into each of three adjacent cells.

6.5 Visual Imperfections: The following maximum requirements apply for imperfections observed in any randomly selected 12-in. diameter circle.

	Maximum Number for Cell Size, Inch, Shown				
Type of Imperfection	1/8	5/32	3/16	1/4	3/8
Mismatched Nodes	70	55	40	25	10
Loose Metal or Flakes (1)	35	28	20	12	5
Split Cell Walls	0	0	0	0	0
Buckled Cell Walls	0	0	0	0	0
Unbonded Nodes	2	2	2	2	2

(1) Flakes are excess metal attached to foil edges which do not interfere with measurement of core thickness.

6.6 Mismatched Nodes: The c/d ratio (See Fig. 2) of mismatched nodes shall be 0.00 to 0.25.

6.7 Mechanical Properties:

6.7.1 General: The mechanical properties of the core shall conform to the requirements of this specification and any additional requirements specified on the drawing.

6.7.1.1 Sampling: Unless otherwise specified, each block or 2% of the slices shall be sampled and tested during the production of a lot or block of core to assure that the requirements of this specification have been met. A lot shall be all of the slices cut from a single block.

6.7.2 Core Properties: The sandwich shear strength, compressive strength, and modulus shall meet the requirements specified in Table I when tested in accordance with 6.7.2.1 and 6.7.2.2.

6.7.2.1 Flatwise Compressive Strength: The test specimen shall be 5/8 in. thick with a cross sectional cut 3 in. x 3 in. ± 0.25. The test machine loading faces shall be approximately 4 sq in. in area. Spherical loading blocks, preferably the suspended self-aligning type, shall transfer the load at 0.002 in. per min. ± 0.0005. At least 6 specimens shall be tested for each material. The flatwise compressive strength shall be computed by dividing the maximum load by the cross sectional area of the specimen. The minimum individual values shall conform to the requirements of Table I, unless otherwise specified.

6.7.2.2 Sandwich Shear Strength and Shear Modulus of Core: Shall be determined in two directions by using a beam shear test. The test specimen shall be a fabricated 8 x 3 in. sandwich with 5/8 in. core and with facings of AMS 4049 aluminum alloy, varying in thickness with density as follows:

Core Density, lb per cu ft	Facing Thickness, Inch
Up to 5.00, incl	0.032
Over 5.00 to 6.30, incl	0.050
Over 6.30 to 7.80, incl	0.071
Over 7.80 to 10.00, incl	0.090

The specimen shall be positioned as in Fig. 3. The load rate shall be 0.0175 in. per min. ± 0.0025. Data shall be computed as follows:

$$S = \frac{P_{max}}{(H + T)\,W} \qquad F = \frac{Pa}{4f(H + T)W}$$

$$G = \frac{2\,P/M\,a\,T}{3W(H + T)^2\left(1 - \frac{23P\,Ma^3}{1296D}\right)} \qquad D = \frac{E(H^3 - T^3)}{12C}$$

where, S = Core shear stress (psi)
F = Facing stress (psi)
G = Core shear modulus (psi)
D = Flexural stiffness of sandwich
P = Total load, applied at 2 points located a distance of a/3 from each reaction
a = Span length (in.)
H = Total sandwich thickness (in.)
T = Core thickness (in.)
W = Sandwich width (in.)
M = Mid span deflection of sandwich (in.)
E = Flexural modulus of elasticity of facings (psi)
C = 0.91 for isotropic facings and 1.00 for most orthotropic facings
f = Face sheet thickness (in.)

6.7.3 Node Bond Strength: Shall not be less than 30 lb at 75 F ± 5 (23.9 C ± 2.8) and not less than 15 lb at 350 F ± 5 (176.7 C ± 2.8) when tested in accordance with 6.7.3.1.

6.7.3.1 Node Bond Strength: A 5/8 x 5 x 10 in. core slice shall be tested in a suitable core tension fixture by mounting, without causing cell distortion, at opposite ends of the "W" dimension (See Fig. 4) with round pins. Pins shall be as large as cell size permits and engage all cells of a continuous row. Opposite pins shall be in mirror image alignment at a distance as near to 8 in. as this mounting method permits. The fixture shall be slotted to allow horizontal pin movement. A steady loading rate of 1.00 in per min. ± 0.05 shall be maintained. In case of partial delamination at the minimum specified load, the delamination shall be less than 10% of the total stress section of the core slice. Specimens shall be brought to temperature equilibrium before testing; elevated temperature tests shall be conducted only after holding at the specified temperature for 15 min. ± 1.

6.8 Density: The core density shall be within ± 10% of the nominal specified density when tested in accordance with 8.6.

6.9 Flatness: Expanded core shall be capable of total facing contact with a flat surface under a uniform pressure without resulting in any damage that would cause core rejection.

6.10 Node-to-Node Attachment: Shall be accomplished by the use of a high quality adhesive that will not cause failure of the core to meet the requirements of this specification.

6.11 Double Foils: Expanded core slices which have double foils (two ribbons bonded together which cause uneven expansion in the "L" direction (Fig. 1)) shall be acceptable if the double foils are not more frequent than 1 in any 8 inches.

7. QUALITY:

7.1 Workmanship: The core shall be fabricated in accordance with the best commercial practices and shall be uniform in quality and free from imperfections detrimental to fabrication, appearance, or performance of parts.

7.2 Cleanliness: The core shall be free from corrosion, oil, or other contamination that will be detrimental to bonding.

7.3 Discoloration: A change in color of core material shall be acceptable provided the color change occurs on a line parallel to "L" (Fig. 1) This is indicative of a change in foil material where more than 1 foil coil is used in the manufacture of core block. All other discolorations of core material, such as spots, will be unacceptable.

8. TOLERANCES:

8.1 Core Thickness: Shall be ± 0.005 in. for machined slices up to 4 in. thick, ± 0.00625 in. for machined slices over 4 in. thick, and +0.25 in., -0.00 in. for raw block.

8.2 "L" and "W": Core length and width shall be the specified dimension +0.25 in., -0.00 in., unless otherwise ordered.

8.3 Cell Pitch: Shall be 1.733 times the nominal cell size + 20%, - 10%, measured by taking the average distance between 10 nodes along a ribbon for 6 different ribbons.

8.4 Average Cell Size: Shall be determined by taking the average distance between node bonds along the "W" dimension (Fig. 1) for at least 60 cells to be selected at random in groups containing 10 adjacent cells. The cell size of any 10 adjacent cells shall not vary more than ± 10%.

8.5 Ribbon Direction: All ribbons shall be parallel to each other within 10 degrees. The ribbon direction shall be determined by measuring the angle between one line through two nodes on the same ribbon ("L" direction), 12 in. apart, and another line in the principal ribbon direction (See Fig. 1).

8.6 Core Density: Shall be determined on blocks and slices from their weight and dimensions to an accuracy within 1%. Thickness shall be measured with an accuracy of ± 0.001 in. and length and width with an accuracy of ± 0.01 in. Measurements shall be made using a dial gage capable of applying 10 lb pressure over a 1.5 in. diameter area. Density shall be calculated in lb per cu foot.

9. REPORTS:

Unless otherwise specified, the vendor of the product shall furnish with each shipment three copies of a report stating that the material conforms to the requirements of this specification and, upon request, shall furnish copies of all qualification test reports. This report shall include the purchase order number, specification number, designation, size or part number, and quantity.

10. IDENTIFICATION:

Each piece of core material and each interior and exterior package shall have a tag attached giving the following information:

AMS 4175
ALLOY _____
CORE CLASSIFICATION _____
T x L x W _____
FOIL LOT NUMBER _____
MANUFACTURER'S NAME OR TRADE MARK _____
PART OR BLOCK NUMBER _____
PURCHASE ORDER NUMBER _____

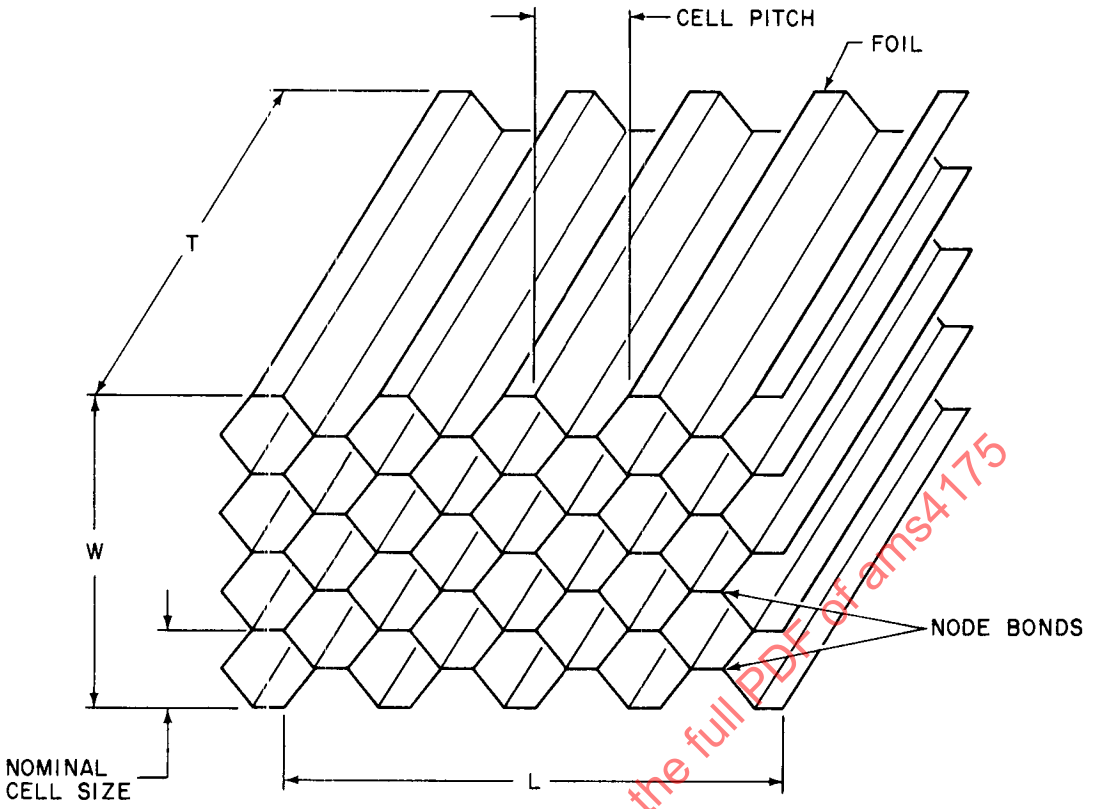
11. PACKAGING: The core shall be packaged to prevent any physical damage or corrosion during shipment and handling and shall be shipped flat unless contoured or formed shapes require special support.

12. APPROVAL: A vendor shall submit samples and certified conformance test results to the purchaser for qualification test and approval, unless such approval be waived. The same manufacturing procedures and processes shall be used for both sample and production materials. Written permission shall be obtained from the purchaser before making any process changes which could unfavorably affect material characteristics.

13. REJECTIONS: Material not conforming to this specification or to authorized modifications will be subject to rejection.

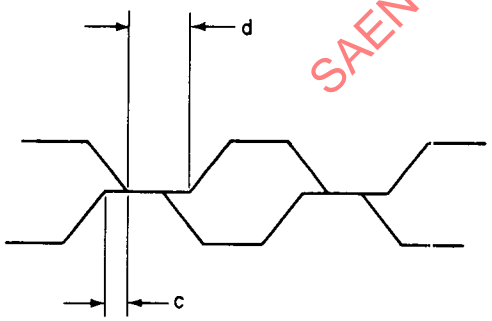
TABLE I

Nominal Core Dimensions			Sandwich Shear Strength, psi, min		Sandwich Shear Modulus, psi, min, avg		Compression Strength psi, min
Cell Size, Inch	Foil Thickness Inch	Density lb per cu ft	DIRECTION OF TEST W	L	W	L	T
	0.0007	3.1	85	140	16,000	31,000	200
1/8	0.0010	4.5	160	265	25,000	51,000	380
	0.0015	6.1	270	450	37,000	77,000	610
	0.0020	8.1	400	680	51,000	112,000	930
	0.0007	2.0	45	75	9,000	17,000	80
	0.0010	3.1	85	140	16,000	31,000	200
3/16	0.0015	4.4	155	255	24,000	50,000	360
	0.0020	5.7	245	410	34,000	70,000	550
	0.0025	6.9	325	540	42,000	91,000	730
	0.0030	8.1	400	680	51,000	112,000	930
	0.0007	1.6	30	55	7,000	13,000	50
	0.0010	2.3	50	90	11,000	21,000	110
1/4	0.0015	3.4	100	165	18,000	35,000	230
	0.0020	4.3	150	245	24,000	48,000	350
	0.0025	5.2	210	345	30,000	62,000	470
	0.0030	6.0	265	440	36,000	75,000	600
	0.0040	7.9	390	660	49,000	108,000	900
	0.0010	1.6	30	55	7,000	13,000	50
	0.0020	3.0	80	135	15,000	30,000	190
	0.0025	3.7	115	190	20,000	40,000	270
3/8	0.0030	4.2	145	235	23,000	47,000	340
	0.0040	5.4	225	370	32,000	66,000	510
	0.0050	6.5	300	500	39,000	84,000	670

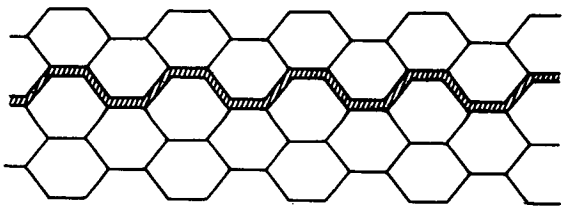


Honeycomb Core

FIGURE 1



MISMATCHED NODES



DOUBLE FOILS

Mismatched Nodes and Double Foils

FIGURE 2