



Standard Specification for Corrugated Asbestos-Cement Sheets¹

This standard is issued under the fixed designation C 221; 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 corrugated asbestos-cement sheet products and lists accessories used in conjunction with application. Corrugated asbestos-cement sheets are designed for the following purposes:

1.1.1 To provide weather-resistant surfaces of roofs, walls, and other elements of buildings and structures, and

1.1.2 For decorative as well as functional uses in any area where a corrugated sheet may be advantageous.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

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 The following documents of the issue in effect on date of material procurement form a part of this specification to the extent referenced herein:

2.2 ASTM Standards:

C 150 Specification for Portland Cement²

C 595M Specification for Blended Hydraulic Cements²

D 2946 Terminology for Asbestos and Asbestos-Cement Products³

2.3 Federal Standard:

Fed. Std. No. 123 Marking for Domestic Shipment (Civilian Agencies)³

2.4 Military Standard:

MIL-STD-129 Marking for Shipment and Storage⁴

¹ This specification is under the jurisdiction of ASTM Committee C-17 on Fiber-Cement Products and is the direct responsibility of Subcommittee C17.03 on Asbestos-Cement Sheet Products and Accessories.

Current edition approved Sept. 10, 1998. Published March 1999. Originally published as C 221 – 49 T. Last previous edition C 221 – 91(1995) ^{ϵ 1}.

² *Annual Book of ASTM Standards*, Vol 04.01.

³ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁴ *Annual Book of ASTM Standards*, Vol 04.05.

3. Terminology

3.1 Definitions:

3.1.1 *density*—mass per unit volume, expressed in g/cm³(or lb/ft³).

3.1.2 *flexural strength*—the average breaking load in newtons per metre of width (or lbf/ft of width) of dried specimens loaded as simple beams on a 762 mm (30 in.) span with the load applied equally and simultaneously at both one-third points of the span.

3.1.2.1 *Discussion*—The flexural performance is defined as the moment capacity in N.m/m (or ft. lbf/ft) of width obtained from the product of flexural strength and span divided by 6.

3.1.3 *pitch*—the distance from center point to center point of adjacent crests of an asbestos-cement product of corrugated or grooved cross-section.

3.1.4 For additional definitions refer to Terminology D 2946.

3.2 Definitions of Terms Specific to This Standard: Description of Term Specific to This Standard:

3.2.1 *water absorption*—for the purpose of this specification, the increase in mass of the test specimen is expressed as a percentage of its dry mass after immersion in water for 24 h.

4. Classification

4.1 The asbestos-cement corrugated sheets furnished under this specification shall be manufactured to meet a minimum bending moment determined by loading equally and simultaneously at both one-third points of the test span. The types of asbestos-cement corrugated sheets manufactured are given in Table 1.

5. Materials and Manufacture

5.1 Corrugated asbestos-cement sheets, and accessory shapes except for filler strips, shall be composed of a mixture of asbestos fiber and hydraulic cement, as specified in Specifications C 150 and C 595, with not more than 1 weight % of organic fiber. The product may contain inert mineral pigments, mineral fillers, curing agents, and coatings, and shall be formed under pressure and cured.



TABLE 1 Flexural Strength Requirements

Type ^{A,B,C}	Minimum Bending Moment			
	Average of Test Specimens		Individual Specimens	
	N.m/m	(ft.-lbf/ft)	N.m/m	(ft.-lbf/ft)
A	2697	(606)	2207	(497)
B	3188	(717)	2697	(607)
C	3677	(827)	3188	(717)
D	6865	(1544)	5394	(1213)
E	7355	(1653)	6129	(1378)

^A Types A and B are available with a density of 1.40 g/cm³ and a pitch of 101.6 mm.

^B Types C and D are available with a density of 1.68 g/cm³ and a pitch of 106.7 mm.

^C Type E is available with a density of 1.4 g/cm³ and a pitch of 177 mm.

6. Physical Requirements

6.1 All measurements and tests necessary for determining the conformity of the asbestos-cement sheets with this specification shall be made in accordance with the test methods covered in Sections 10 to 14.

6.2 *Flexural Strength*—Flexural strength is the breaking load for the dried test specimens and is used to calculate the bending moment for conformance with 6.3.

6.3 *Moment Capacity* (bending moment)—The bending moment of this product as calculated in accordance with 12.4 shall not be less than as shown in 4.1.

6.4 *Water Absorption*—The average water absorption of the dried test specimens from the lot being tested shall not exceed 25.0 weight % for all types, when calculated in accordance with 13.1.

7. Dimensions, Weights, and Permissible Variations

7.1 *Length and Width*—Corrugated sheets are produced in nominal widths, lengths, and thicknesses, as specified by the manufacturer. The permissible variation in length and width shall be $\pm \frac{1}{4}$ in. (± 6 mm) for the specified dimensions.

7.2 *Thickness*—The thickness of a corrugated sheet may be expressed as the *overall thickness* as measured between two planes contacting the crests of corrugations on opposite sides of the sheet, or the *cross-sectional thickness* as determined in 14.2.

7.2.1 The permissible variation in thickness shall be ± 0.1 in. (± 2.54 mm) for overall thickness and ± 0.030 in. (± 0.76 mm) for the cross-sectional thickness.

7.3 *Pitch*—The nominal pitch as designated by the manufacturer is the linear distance between the mid-points of adjacent crests of the corrugations. The permissible variation for pitches on a single sheet or between sheets shall be ± 3.00 % of the nominal pitch.

NOTE 1—The typical corrugated asbestos-cement sheets are produced with a pitch of 107 mm (4.2 in.) and a width of 1.07 m (42 in.). Sheets are produced in lengths up to 3.66 m (12 ft). Consult the manufacturer for availability of products with other pitches.

8. Workmanship, Finish, and Appearance

8.1 *Workmanship*—All surfaces of the sheet shall be smooth or factory textured. The product shall be free of defects that impair erection, appearance, or serviceability. Ends and edges of sheet shall be solid.

8.2 *Color*—The color shall be the natural color of the asbestos-cement product or as agreed upon between the purchaser and the seller.

8.3 *Efflorescence*—Efflorescence that sometimes may appear on asbestos-cement sheets should not result in a permanent change in color and has no critical effect on physical properties.

9. Installation Accessories

9.1 The following accessories are used in conjunction with the corrugated products for installation, closing, and finishing. Details for the use and size of these accessories are available from the manufacturer:

9.1.1 Ridge rolls (half-round sections or two-piece adjustable pitch).

9.1.2 Battens.

9.1.3 Corner angles or corner rolls.

9.1.4 Louvre blades.

9.1.5 Filler or closure strips.

9.1.6 Fasteners (nonstaining corrosion-resistant metal).

9.1.7 Plastic lap cement.

9.1.8 Caulking compound.

10. Sampling

10.1 From each shipment or fraction thereof, representing a product of the same kind, a sample shall be obtained consisting of a number of sheets selected at random. The following table shows the number of sheets to be selected from shipments of various sizes:

Number of Sheets in Shipment	Number of Sheets to Be Selected as Sample
500 and under	3
501–1000	5
1001 to 1728	6
1729–2744	7
2745–4096	8
4097–5832	9
5833–8000	10

Additional sheets may be tested at the discretion of the inspector.

11. Test Specimens

11.1 Cut a test specimen 914 ± 3 mm ($36 \pm \frac{1}{8}$ in.) in length. Full width sheets are used for the flexural strength test, however, for sinusoidal corrugated shapes, three complete corrugations are adequate for the width. Specimens cut three corrugations in width are to be cut from the interior of the sheet in such a manner that no edge of the specimen shall be less than one corrugation from the original edges of the sheet. The length direction shall be parallel to the corrugations of the sheet. Do not test cracked or otherwise damaged specimens, but provide supplemental specimens.

12. Flexural Strength Test

12.1 *Definition*—Flexural strength is defined as the average breaking load, in newtons (or pounds-force) of dried test specimens, loaded as simple beams, with the load applied by loading equally and simultaneously at both one-third points of the span and tested by the method prescribed in 12.3.

12.2 *Significance*— Flexural strength is used to calculate the bending moment capacity for compliance with the requirements of 4.1.

12.3 *Procedure*—Dry each specimen to constant weight in a ventilated oven at a temperature of 100 to 105°C and cool to room temperature in an enclosure designed to prevent moisture pickup. Record the dry weight of each cooled specimen. Determine the flexural strength of each specimen by placing the specimen on supports that cannot exert longitudinal constraint [for example, rocker-type bearing edges or rollers with a 3-mm ($\frac{1}{8}$ -in.) minimum and 13-mm ($\frac{1}{2}$ -in.) maximum radius] and applying the load equally and simultaneously at both one-third points of the span through similar edges, bearing against the finished surface of the specimen. The test span shall be 762 ± 1.5 mm ($30 \pm \frac{1}{16}$ in.) and the load line and supports shall be parallel. Report the flexural strength as the average load, in newtons (or pounds-force) for all the specimens tested, calculated to a width of 1 m (1 ft).

12.3.1 *Loading Device Accuracy*—The loading machine may consist of any mechanically driven or hand-powered device that meets the following requirements. It shall be substantially built and rigid enough throughout so that the distribution of load to the specimen will not be affected appreciably by deformation or yielding of any part. It shall provide for continuous application of load at a uniform rate to have failure occur in 1 to 2 min. It shall provide a means for determining the load with an error not greater than 2 % of the breaking load.

12.3.2 *Break Point*— The failure point or break in the specimen shall occur within the middle third of the specimen. Any break beyond these limits indicates a defective specimen and the formulation for calculating the moment capacity is not applicable. Such a specimen shall not be included in the results.

12.4 *Moment Capacity*— Calculate the resisting or bending moment capacity of the specimen from the flexural strength per metre (or foot) of width as follows:

$$M = PL/6$$

where:

M = bending moment, N·m/m (or ft·lbf/ft) of width,

P = flexural strength, N/m (or lbf/ft) of width at failure, and

L = span, m (or ft).

13. Water Absorption Test

13.1 *Procedure*—Weigh one broken portion of each dry specimen used in the flexural strength test; then submerge for a minimum of 24 h in clean water at 15 to 27°C. Remove each specimen from the water, wipe with a damp cloth, and weigh separately on a balance with an accuracy of 0.5 %. Report the water absorption as the average value for all specimens tested. Calculate the water absorption value for each specimen as follows:

$$\text{Water absorption, mass \%} = [(W_s - W_d)/W_d] \times 100$$

where:

W_s = saturated mass, and W_d

W_d = dry mass.

14. Dimensional Measurements

14.1 *Significance*— These are routine measurements to determine whether the length and width of the individual units are as ordered, to ensure that they fit together properly in application, and to determine the uniformity of the specified thickness.

14.2 *Thickness*—Measure the thickness of each specimen at the crest and vale and at the flank (midway between the crest and vale) with a micrometer having a ball anvil and ball spindle ends approximately 3.2 to 6.4 mm ($\frac{1}{8}$ to $\frac{1}{4}$ in.) in diameter, or an anvil and spindle, each with a 30° taper and a 0.4-mm ($\frac{1}{64}$ -in.) flat at its end. Place the anvil or spindle of the ball-shaped or the tapered flat-end-shaped micrometers between the projections on the back of the sheet so as to measure the flat plane surface. The thickness of the crest and vale shall be the average of four measurements, two of which are on the crest (one at each end) and two of which are in the vale (one at each end). The thickness of the flask shall be the average of four measurements, two at each end of the test specimen.

14.2.1 The thickness readings obtained on each specimen shall be compared to the thickness agreed on between the purchaser and seller to determine compliance with Section 7.2.

15. Inspection

15.1 Inspection and certification of the material shall be as agreed upon between the purchaser and manufacturer as part of the purchase contract.

16. Rejection and Rehearing

16.1 If the sample fails to conform to any one of the requirements of this specification, a second sample from the same lot shall be prepared and tested. The results of the retest shall be averaged with the results of the original test to determine compliance with this specification.

16.2 If any individual specimen fails to conform to a requirement of this specification, two additional specimens from the same portion of the lot shall be prepared and tested for the property in question. The results of the retest shall be averaged with that of the original specimen to determine compliance with this specification.

16.3 Failure to conform to any one of the requirements of this specification, upon retest as prescribed in 16.1 and 16.2, shall constitute grounds for rejection. In case of rejection, the seller shall have the right to reinspect the rejected shipment and resubmit the lot after removal of the portion of the shipment not conforming to the specified requirements, provided this is done within 20 days after receipt of notice of the specific cause for rejection.

17. Packaging and Shipping

17.1 *Commercial Quantities*—Corrugated asbestos-cement roofing and siding is marketed on a basis of the following:

17.1.1 Per sheet of specified length, and

17.1.2 Supplementary and finishing pieces, accessories, fasteners, and cements, which may be quoted as extras, or included in the unit price.

17.2 *Commercial Packaging*—Corrugated sheets shall be packaged or protected so as to ensure acceptance by common

carrier. There is no standard package. This material is usually shipped in bulk, but may be crated if agreed upon between the purchaser and the manufacturer.

17.3 *Storage*—Corrugated asbestos-cement sheets should be piled on firm supports to keep the sheets level and flat.

18. Keywords

18.1 asbestos; asbestos-cement; sheeting; sheets

SUPPLEMENTARY REQUIREMENTS

The following supplementary requirements shall apply when material is supplied under this specification for U.S. Government Procurement.

S1. Packaging

S1.1 Unless otherwise specified in the contract, the material shall be packaged in accordance with the suppliers standard practice which will be acceptable to the carrier at lowest rates. Containers and packing shall comply with Uniform Freight Classification Rules⁵ or National Motor Freight Classification Rules.⁶ Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

⁵ Available from The Uniform Classification Commission, Room 1106, 222 S. Riverside Plaza, Chicago, IL 60606.

⁶ Available from National Motor Freight Inc., 1616 P. St., NW, Washington, DC 20036.

S2. Responsibility for Inspection

S2.1 Unless otherwise specified in the contract or purchase order, the manufacturer is responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract or order, the manufacturer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to assure that material conforms to prescribed requirements.

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org).