



Designation: ~~E2634-08~~ Designation: E2634-10

## Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems<sup>1</sup>

This standard is issued under the fixed designation E2634; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification is intended to apply to Insulating Concrete Form (ICF) Systems that will act as permanent formwork for cast-in-place reinforced concrete beams; lintels; exterior and interior, above and below grade bearing and non-bearing walls; foundation; and retaining walls. The specification is restricted to ICF Systems with a resultant uniform monolithic concrete core.

1.2 Products covered by the specification consists of molded expanded polystyrene (EPS) insulation panels that are connected by cross ties to form the ICF System.

1.3 This specification identifies test methods appropriate for establishing ICF System performance in their primary function as a stay in place concrete forming system. The use of ICF Systems covered by this specification shall be regulated by building codes that address fire performance, structural performance or both. The fire performance of the material shall be addressed through standard fire test methods established by the appropriate governing documents. The structural performance must be addressed through design of concrete structures in accordance with the appropriate Code requirements.

1.4 Details of manufacturing procedures are beyond the scope of this specification.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are mathematical conversions to inch-pound units that are provided for information only and are not considered standard. For conversion to metric units other than those contained in this specification, refer to ~~IEEE/ASTM~~ ~~SI~~ ~~10~~.

1.6 *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:*<sup>2</sup>

C203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

C1363 Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus

D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position

D638 Test Method for Tensile Properties of Plastics

D732 Test Method for Shear Strength of Plastics by Punch Tool

D1622 Test Method for Apparent Density of Rigid Cellular Plastics

D1761 Test Methods for Mechanical Fasteners in Wood

D1929 Test Method for Determining Ignition Temperature of Plastics

D2863 Test Method for Measuring the Minimum Oxygen Concentration to Support Candle-Like Combustion of Plastics (Oxygen Index)

E8 Test Methods for Tension Testing of Metallic Materials

E84 Test Method for Surface Burning Characteristics of Building Materials

E90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

E119 Test Methods for Fire Tests of Building Construction and Materials

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<sup>2</sup> 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.

E283 Test Method for Determining Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen

E331 Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): the Modern Metric System

2.2 ISO/IEC Standards:<sup>3</sup>

ISO/IEC Guide 65 General Requirements for Bodies Operating Product Certification Systems

ISO/IEC Guide 17020 General Criteria for the Operation of Various Types of Bodies Performing Inspection

ISO/IEC Standard 17025 General Requirements for Competence of Test and Calibration Laboratories

2.3 Other Standards:

ACI 318 Building Code Requirements for Structural Concrete<sup>4</sup>

UL 1715 Fire Test of Interior Finish Material<sup>5</sup>

NFPA 286 Method of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth<sup>6</sup>

AISI NAS-01 North American Specification for the Design of Cold-formed Steel Structural Members, including 2005 Supplement<sup>7</sup>

ANSI/ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings<sup>8</sup>

### 3. Terminology

3.1 Definitions:

3.1.1 *cross ties*—plastic or metal bridging comprised of flanges and webs that hold the EPS panels at a prescribed distance and provide resistance to the concrete pressure. The flanges may be used as attachment points for interior and exterior finishing materials.

3.1.2 *expanded polystyrene*—a type of foamed plastic formed by the expansion of polystyrene resin beads in a molding process.

3.1.3 *insulating concrete forms (ICFs)*—a structural stay-in-place concrete forming system, consisting of opposing EPS panels, held parallel by means of cross ties and serves to provide insulating characteristics. See Fig. 1.

3.1.4 *quality agency*—a quality agency is defined to be one that: (1) Maintains accreditation as a Certification Organization in accordance with ISO/IEC Guide 65 and as an Inspection Agency in accordance with ISO/IEC Guide 17020. The scope of accreditations shall be consistent with the type of product being inspected. (2) Has access to the facilities and trained technical personnel to verify that the grading, bonding, workmanship, and other characteristics of the products as determined by inspection, sampling, and testing comply with all applicable requirements specified herein. (3) Has procedures to be followed by its personnel in performance of the inspection and testing. (4) Has no financial interest in, or is not financially dependent upon, any single company manufacturing the product being inspected or tested. (5) Is not owned, operated, or controlled by any such company.

3.1.5 *testing laboratory*—a testing laboratory is one that is accredited as complying with ISO/IEC Standard 17025. The scope of the laboratory's accreditation shall include the specific type of testing being performed.

### 4. Classification

4.1 ICF Systems addressed by this specification are those which produce a cast-in-place uniform monolithic concrete core wall where the concrete design is in accordance with accepted design standards such as ACI 318.

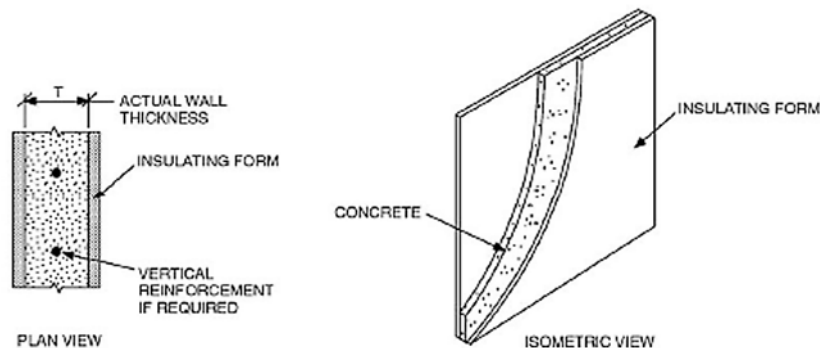


FIG. 1

<sup>3</sup> Available from International Organization for Standardization (ISO), 1, ch. de la Voie-Creuse, Case postale 56, CH-1211, Geneva 20, Switzerland, <http://www.iso.ch>.

<sup>4</sup> Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, <http://www.concrete.org>.

<sup>5</sup> Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062-2096, <http://www.ul.com>.

<sup>6</sup> Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, <http://www.nfpa.org>.

<sup>7</sup> Available from American Iron and Steel Institute (AISI), 1140 Connecticut Ave., NW, Suite 705, Washington, DC 20036, <http://www.steel.org>.

<sup>8</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

## 5. Materials and Manufacture

5.1 *EPS Panels*—All EPS panels are manufactured using molded EPS insulation, conforming to Specification C578.

5.2 *Cross Ties*—All components shall conform to manufacturing or performance standards as in accordance with 6.2. Cross ties that are susceptible to UV degradation shall have a minimum of 6 months' ultraviolet (UV) protection against degradation of physical properties.

NOTE 1—UV protection includes but is not limited to UV stabilizers, protective coverings, or other suitable means.

## 6. Physical Properties

6.1 *Expanded Polystyrene Qualification:*

6.1.1 These materials, including products into which recycled material is introduced, must comply with requirements in Specification C578, Table 1.

6.1.2 *Qualification to the Requirements of 6.1.3*—Data required in 6.1.1 must be submitted in accordance with either 6.1.3 or 6.1.4.

6.1.3 Where the resin supplier provides to the quality agency sufficient test data in compliance with 6.1.1 for each resin grade (base formula) and for each ~~Specification C578~~ Specification C578 Type intended for application use, the ICF System owner must provide reports of tests demonstrating compliance with flexural strength tested in accordance with Test Methods C203, Method I, Procedure B, and density requirements tested in accordance with Test Method D1622 of each grade and each ~~Specification C578~~ Specification C578 Type intended for application use for each recognized manufacturing plant/location.

6.1.3.1 *Exception*—Oxygen index tests in accordance with Test Method D2863 need only be conducted on one ~~Specification C578~~ Specification C578 Type per supplier resin grade (base formula).

6.1.3.2 *Exception*—Thermal resistance tests need only be conducted at  $23.8 \pm 2.8^\circ\text{C}$  ( $75 \pm 5^\circ\text{F}$ ).

6.1.4 Where the resin supplier does not provide, to the quality agency, sufficient test data showing compliance with all requirements of 6.1.1 for each resin grade (base formula) and for each ~~Specification C578~~ Specification C578 Type intended for application use, the ICF System owner must provide reports of tests to demonstrate full compliance with 6.1.1 for each ~~Specification C578~~ for each Specification C578 Type intended for application use at one manufacturing location.

6.1.4.1 *Exception*—Oxygen index tests in accordance with Test Method D2863 need only be conducted on one ~~Specification C578~~ Specification C578 Type per supplier resin grade (base formula).

6.1.4.2 *Exception*—Thermal resistance tests need only be conducted at  $23.8 \pm 2.8^\circ\text{C}$  ( $75 \pm 5^\circ\text{F}$ ).

6.1.4.3 *Exception*—Where products manufactured with any one of the resin grades (base formula) already quality under 6.1.4, the ICF System owner must provide reports of tests demonstrating compliance with flexural strength tested in accordance with Test Methods C203, Method I, Procedure B, and density requirements tested in accordance with Test Method D1622 of each grade and each ~~Specification C578~~ Specification C578 Type intended for application use for each recognized manufacturing plant/location.

6.1.5 *Surface Burning Characteristics*—The EPS shall be tested in accordance with Test Method E84 in the maximum thickness and density intended for use. The maximum Flame Spread Index shall be 75 and the maximum Smoke Development Index shall be 450.

6.1.5.1 *Exception*—The maximum Flame Spread Index shall be 25 when the product is intended for use in non-combustible construction.

6.2 *Cross Tie Qualification:*

6.2.1 *General*—These materials, including products into which recycled material is introduced, must comply with requirements of 6.2.2-6.2.6 of this specification which establish the base line properties of the cross ties.

6.2.2 *Rate of Burning*—Plastic Ties shall be tested in accordance with Test Method D635. The plastic shall meet minimum CC2 Classification as defined by Test Method D635, X2.1.2.

6.2.3 *Ignition Temperature*—Plastic Ties shall be tested in accordance with Test Method D1929, Procedure B. The minimum Ignition Temperature shall be  $350^\circ\text{C}$  ( $662^\circ\text{F}$ ).

6.2.4 *Fastener Capacity*—Shall be tested in accordance with modified Test Methods D1761 on a minimum of ten specimens.

6.2.4.1 Lateral Load Strength test specimens shall consist of full-thickness ICF panels, with the fastener for which recognition is sought, screwed into the cross-tie flange in a manner representative of the end-use configuration. The test shall be conducted with an eccentricity equal to the embedment depth of the cross tie below the surface of the EPS. Where cross ties are flush to the EPS no eccentricity is required. Pilot holes for screws shall not be predrilled into the specimen.

6.2.4.2 *Analysis:*

(1) *Plastic Cross Ties*—The allowable lateral load strength of the connection shall not exceed 75 % of the average proportional limit load, or the average ultimate load divided by a factor of 3.2, whichever is lower. The factor of 3.2 assumes a maximum coefficient of variation (COV) of 15 %. Where the COV is greater than 15 %, the allowable load shall be computed using the following equation:

$$F_{all} = F((1 - 2COV)/2.24) \quad (1)$$

where:

$F_{all}$  = allowable load, N,  
 $COV$  =  $s/F$  = coefficient of variation in a test series,  
 $s$  = standard deviation in a test series, and  
 $F$  = average ultimate load in test series, N.

(2) *Metal Cross Ties*—The allowable lateral strength of the connection shall be determined in accordance with AISI NAS-01, Chapter F.

6.2.4.3 *Withdrawal Load Strength (Plastic or Metal Cross Ties)*—Test specimens shall consist of full-thickness ICF panels, with the fastener for which recognition is sought, screwed into the cross-tie flange in a manner representative of the end-use configuration. Pilot holes for screws shall not be predrilled into the specimen.

(1) The ultimate load shall be determined for each test specimen.

(2) The allowable withdrawal load strength of the connection shall be determined based on the average ultimate load divided by a safety factor of 5.

6.2.5 *Cross Tie Tensile Strength*—The integrated cross tie assembly shall be tested in accordance with modified Test Method D638 for plastic cross ties and modified Test Methods E8 for metal cross ties. The minimum tensile strength of the cross tie assembly shall be equivalent to 32.3 kN/m<sup>2</sup> for metal cross ties. Modification of Test Method is to test the actual cross tie assembly with load rate of 25 mm (1 in.) per minute. The minimum tensile strength of the cross tie assembly shall be equivalent to 32.3 kN/m<sup>2</sup> (675 lb/ft<sup>2</sup>) of wall surface.

6.2.5.1 *Exception*—Where the manufacturer can substantiate satisfactory concrete formwork capability through analysis or testing, a reduced minimum tensile strength may be acceptable.

6.2.6 *Cross Tie Shear Strength*—The integrated plastic material utilized in the cross tie assembly shall be tested in accordance with Test Method D732. The minimum shear strength of the cross tie assembly shall be 40.82.0 kN/m<sup>2</sup> (225 lb/ft<sup>2</sup> (42 lb/ft<sup>2</sup>)) of surface area in contact with concrete.) of the tributary area of the form surface in contact with concrete. The minimum shear strength shall be calculated by multiplying the minimum vertical cross sectional area of the portion for the cross tie that passes through the concrete cavity by the test data from the Test Method D732 test. (See Fig. 2.)

### 6.3 System Qualification:

6.3.1 *Room Corner Fire Test*—The minimum thickness of the complete assembly of EPS, cross tie material, and concrete with thermal barrier attached, but excluding exterior finishing. The tested thermal barrier shall remain in place for a minimum of 15 minutes when tested in accordance with UL 1715 or NFPA 286 with the following conditions of acceptance applied to the NFPA 286 test method.

6.3.1.1 Additionally, during the 40 kW (2276 Btu/min) exposure, the interior finish shall comply with Item (1). During the 160 kW (9120 Btu/min) exposure, the interior finish shall comply with Item (2). During the entire test, the interior finish shall comply with Items (3) and (4):

- (1) During the 40 kW (2276 Btu/min) exposure, flames shall not spread to the ceiling.
- (2) During the 160 kW (9120 Btu/min) exposure, the interior finish shall comply with the following:
  - (a) Flame shall not spread to the outer extremity of the sample on any wall or ceiling.
  - (b) Flashover, as defined in NFPA 286, shall not occur.
- (3) The peak rate of heat release throughout the NFPA 286 test shall not exceed 800 kW (45 600 Btu/min).
- (4) The total smoke released throughout the NFPA 286 test shall not exceed 1000 m<sup>2</sup> (10 764 ft<sup>2</sup>).

## 7. Dimensions and Permissible Variations

7.1 The length of the ICFs shall be within  $\pm 4.2$  mm/m (0.05 in./ft) of the intended length.

7.2 The height of the ICFs shall be within  $\pm 1.6$  mm (0.06 in.) of the intended height.

7.3 Any mold ejection damage of the ICFs shall be limited to 4.8 mm (0.19 in.) indentation and 1.6 mm (0.06 in.) protrusion from the flat surface of the EPS.

7.4 The cross ties embedded in the EPS panels shall be spaced center to center within  $\pm 6.4$  mm (0.25 in.).

## 8. Workmanship, Finish, and Appearance

8.1 The EPS panels shall be free from defects in workmanship. Defects in the ICFs consist of, but are not limited to, the following:

8.1.1 The EPS panels shall have warping limited to 6.4 mm (0.25 in.) as measured at the center of the panel.

8.1.2 The total number of voids on the EPS panels shall not exceed the average of 1 per 0.093 m<sup>2</sup> (1 per ft<sup>2</sup>) with dimensions larger than 3.3 by 3.3 by 3.3 mm (0.13 by 0.13 by 0.13 in.).

8.1.3 The cross ties shall be properly formed and free from damage after molding.

8.1.4 The EPS panels shall have proper fit between the top and bottom interlocking mechanism.

8.1.5 The EPS panels dimensions shall conform to sections 7.1, 7.2, 7.3, or 7.4, or a combination thereof.

8.1.6 The EPS panels shall have no crushed or depressed areas on any surface exceeding 3.3 mm (0.13 in.) in depth on more than 10 % of the total surface area.

## 9. Sampling

9.1 Sampling of the test specimens shall be in accordance with Practice C390, where practical, and shall be truly representative