Designation: E2634 – 17

Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems[1]

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 (ε) 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; foundations; 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.*

1.7 *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]

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

C390 Practice for Sampling and Acceptance of Thermal Insulation Lots

C475/C475M Specification for Joint Compound and Joint Tape for Finishing Gypsum Board

C578 Specification for Rigid, Cellular Polystyrene Thermal Insulation

C645 Specification for Nonstructural Steel Framing Members

C1002 Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs

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

C1396/C1396M Specification for Gypsum Board

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/D1622M 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/E8M Test Methods for Tension Testing of Metallic Materials

[1] This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.21 on Serviceability.

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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.

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
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:*[3]
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[4]
UL 1715 Fire Test of Interior Finish Material[5]
NFPA 286 Method of Fire Test for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth[6]
AISI NAS-01 North American Specification for the Design of Cold-formed Steel Structural Members, including 2005 Supplement[7]
ANSI/ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings[8]

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

[3] Available from International Organization for Standardization (ISO), ISO Central Secretariat, BIBC II, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, http://www.iso.org.
[4] Available from American Concrete Institute (ACI), 38800 Country Club Dr., Farmington Hills, MI 48331-3439, http://www.concrete.org.
[5] Available from Underwriters Laboratories (UL), 333 Pfingsten Rd., Northbrook, IL 60062, http://www.ul.com.
[6] Available from National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02169-7471, http://www.nfpa.org.
[7] Available from American Iron and Steel Institute (AISI), 25 Massachusetts Ave., NW, Suite 800, Washington, DC 20001, http://www.steel.org.
[8] Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, http://www.ansi.org.

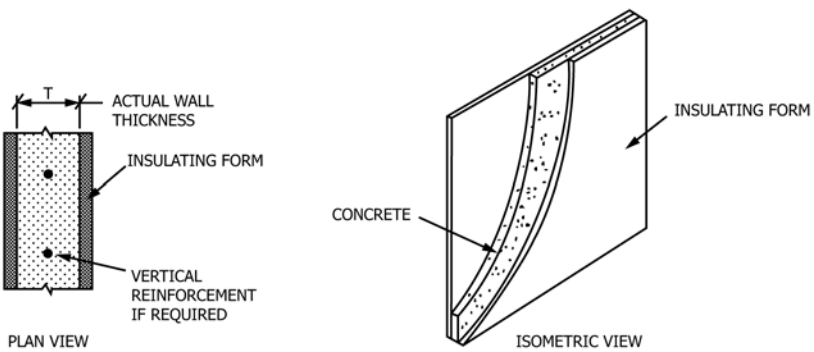

FIG. 1 Flat Wall ICF, Wall Assembly

core wall where the concrete design is in accordance with accepted design standards such as ACI 318.

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 of 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 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/D1622M of each grade and each 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 Type per supplier resin grade (base formula).

6.1.3.2 *Exception*—Thermal resistance tests need only be conducted at 23.8 ± 2.8 °C (75 ± 5 °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 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 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 Type per supplier resin grade (base formula).

6.1.4.2 *Exception*—Thermal resistance tests need only be conducted at 23.8 ± 2.8 °C (75 ± 5 °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/D1622M of each grade and each 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 noncombustible 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 °C (662 °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:

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

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/E8M 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^2 (675 lb/ft^2) 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 minimum shear strength of the plastic material determined from Test Method D732 shall be greater than the value calculated by multiplying the web tributary area by the minimum shear strength of the cross tie assembly and dividing by the minimum vertical cross sectional area of the portion of the cross tie that passes through the concrete cavity. Fig. 2 indicates the tributary area associated with the web cross sectional area that is subjected to the shear strength.

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 min 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^2 (10 764 ft^2).

6.3.2 *Gypsum Wallboard Attachment Test*—The ICF system shall be tested in accordance with the test method contained in Annex A1 and meet the requirements.

7. Dimensions and Permissible Variations

7.1 The length of the ICFs shall be within ±4.2 mm⁄m (0.05 in.⁄ft) of the intended length.

7.2 The height of the ICFs shall be within ±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 ±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^2 (1 per ft^2) 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 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 of the standard manufactured product, including typical color. Test specimens of products shall be sampled at the manufacturing facility by an accredited testing laboratory or accredited inspection agency. Instead of sampling at the manufacturing facility, a sampling at a warehouse or distribution center is permitted, provided the testing laboratory or quality agency samples the materials and correlates the sampled materials with the finished product specification.

10. Number of Tests and Retests

10.1 *General*—Any time significant changes, to manufacturing process or material specifications that affect the physical properties or system qualification requirements, occur qualification tests related to the significant change shall be required.

10.2 *Testing*—Qualification tests shall be conducted or witnessed by a quality agency as defined in 12.1. All test results are to be certified by the quality agency.

10.3 *Sample Size*—Where the number of test specimens is not specified in the applicable test method or this specification, a minimum of three specimens shall be tested.

11. Specimen Preparation

11.1 *Test Specimens*—Materials and fabrication procedures of specimens shall be as typical of intended production as can be obtained at the time of manufacturing qualification specimens. Tests in accordance with this specification shall be conducted on intended thicknesses and densities of representative specimens unless noted otherwise.

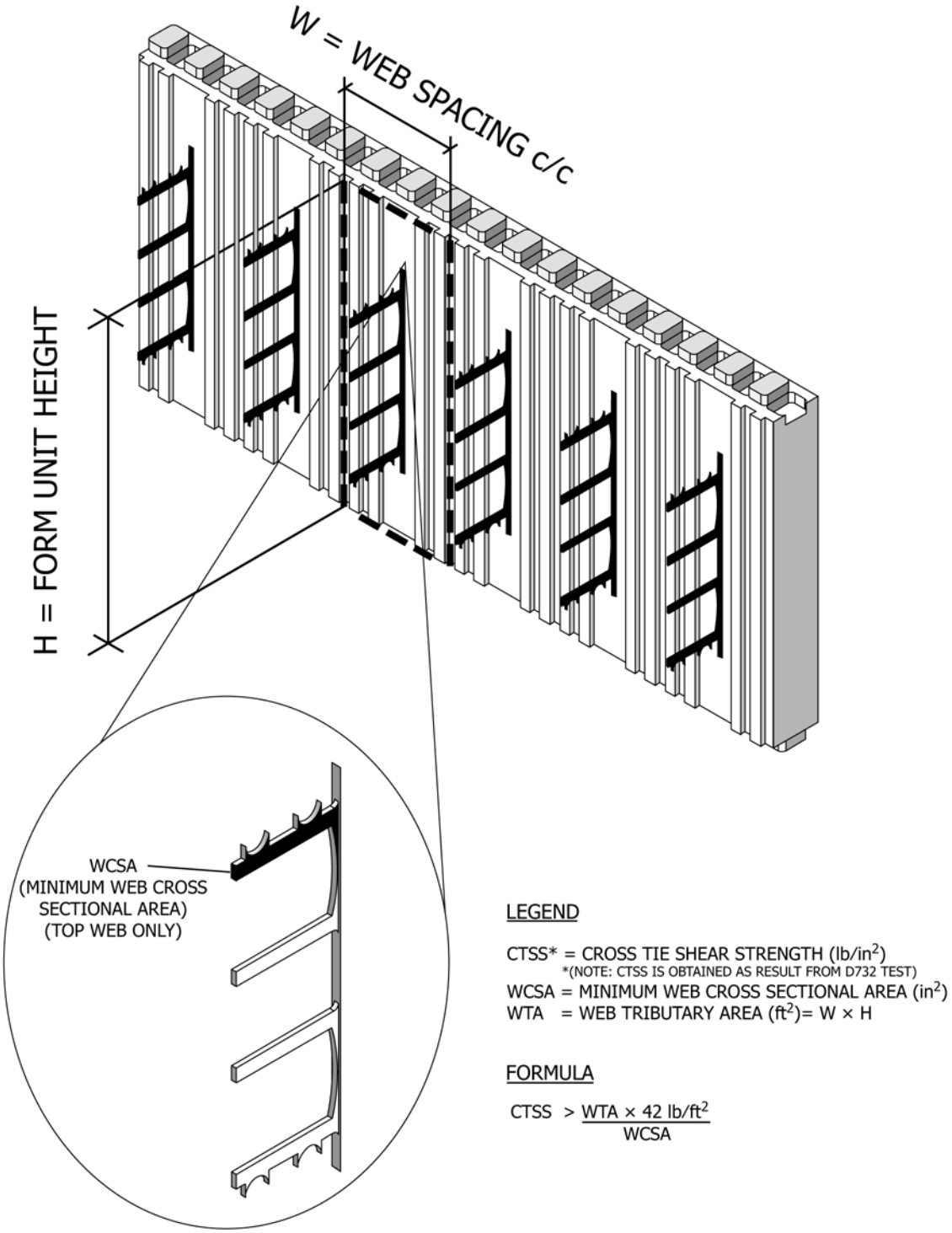

FIG. 2 Tributary Area Associated with the Web Cross Sectional Area that would be Subjected to the Shear Strength

12. Independent Inspection and Certification

12.1 A quality agency shall be retained by the ICF System owner for the purpose of certifying the ICF for compliance with this Specification, through monitoring of the quality assurance and the production process on a random unannounced basis. The quality agency shall establish or approve and monitor procedures for quality assurance.

13. Quality Control Manual

13.1 A quality control manual subject to the approval of the quality agency, shall be written and maintained by the ICF System owner manufacturer for each product and for each manufacturing facility. This quality control manual shall include provision for quality assurance.

14. Quality Assurance

14.1 *Quality Assurance in Quality Control Manual*—This portion of the quality control manual shall include subject matter necessary to the quality-assurance program including the following:

14.1.1 Material Specifications, including incoming material inspection and acceptance requirements.

14.1.2 Quality assurance, inspection, testing, and acceptance procedures.

14.1.2.1 Sampling and inspection frequencies shall be devised to encompass all variables that affect quality of the finished product. Increased frequencies shall be used in connection with new or revised facilities. A random sampling scheme shall generally be used for specimen selection.

14.1.3 Procedures to be followed upon failure to meet specifications or upon out of control conditions shall be specified. Included shall be re-examination criteria for suspect material and material rejection criteria.

14.1.4 Finished product marking, handling, protection, and shipping requirements as they relate to the performance quality of the product shall be defined.

14.2 *Inspection Personnel*—All manufacturing personnel responsible for quality control shall demonstrate to the quality agency that they have knowledge of the inspection and test procedures used to control the process of the operation and calibration and the maintenance and interpretation of quality control records.

14.3 *Record Keeping*—All pertinent records shall be maintained on a current basis and be available for review by the quality agency personnel. As a minimum, such records shall be kept for a minimum of two years and shall include:

14.3.1 All inspection reports and records of test equipment calibration, including identification of the personnel carrying out the tests.

14.3.2 All test data, including retests and data associated with rejected production.

14.3.3 Detail of any corrective actions taken and the disposition of any rejected production resulting from tests or inspections.

14.4 *Quality Assurance Testing:*

14.4.1 Testing equipment is to be properly maintained, calibrated, and evaluated for accuracy and adequacy at a frequency satisfactory to the quality agency.

14.4.2 *Required Tests*—The following shall be considered to be the scope of a minimum testing program:

14.4.2.1 The flexural strength and density test described in 6.1.3 shall be used for the quality assurance of the EPS at a frequency as stated in the quality control manual.

14.5 *Process Control:*

14.5.1 Data from the tests of 14.4 shall be evaluated prior to shipping material represented by the sample. The control levels selected shall be consistent with current design values and intended use of the material.

14.5.2 When the results of testing described in 14.4.2.1 indicates that the material properties are below the control level, the associated portion of production shall be subject to re-examination in accordance with acceptance procedures of 14.1.3.

15. Qualification and Quality Assurance of ICF Components Manufactured by Others

15.1 *Producers Responsibility*—When the facility manufacturing an ICF System purchases material which would require qualification and quality control under the provision of this specification, the manufacturing facility shall be responsible for assuring that, as a minimum, such material conforms to the requirements of Sections 6, 7, and 8 of this specification.

15.2 *Record Keeping*—The ICF System owner shall retain a third party quality agency. The manufacturing facility shall obtain and maintain records of certification from the quality agency showing that the components supplied conform to the requirements of this specification.

15.3 *Component Identification*—All such components shall be appropriately marked as agreed upon by the component supplier and ICF System owner.

16. Product Marking

16.1 The ICFs shall be clearly and properly identified by classification, company name, plant location or number, quality agency name or logo, and a means for establishing the date of manufacture.

16.2 The cross ties, if provided separately, shall be identified with the ICF manufacturers name or logo, or both.

17. Packaging and Package Marking

17.1 The ICFs and components shall be packaged for shipment with suitable protection to prevent damages during shipping and handling.

18. Keywords

18.1 buildings; concrete; concrete formwork; insulating concrete forms; insulating concrete form systems

ANNEX

(Mandatory Information)

A1. PENETRATION TEST THROUGH GYPSUM WALLBOARD

NOTE A1.1—This test procedure for screw penetration was based on Section 10 of ASTM C645 Standard Specification for Nonstructural Steel Framing Members.

A1.1 Gypsum Wallboard Attachment Test

A1.1.1 *Significance and Use*—This test method provides a procedure for evaluation of the performance of screw attachment to the cross-tie flanges to pull the head of a screw below the surface of gypsum wallboard. It shall be used to determine compliance with this specification. The degree of performance of this test method has not been determined.

A1.2 Apparatus

A1.2.1 Provide the following:

A1.2.1.1 *Power-driven Drill Screw Gun,* capable of 4000 rpm (free spindle speed) with a depth-sensitive nose piece, supplied with a screw driving bit to fit the screw used in the test.

A1.2.1.2 *Stop Watch,* capable of being read to the nearest 0.1 s.

A1.3 Required Materials

A1.3.1 *Gypsum Wallboard*—Specification C1396/C1396M, Type X, 15.9 mm (⅝ in.) thick.

A1.3.2 *Screws*—Specification C1002, Type S, minimum 50.8 mm (2 in.) long.

A1.3.3 *Paper Joint Tape*—Specification C475/C475M.

A1.3.4 *ICF*—For factory assembled forms the complete unit, for site assembled forms the number of EPS panels and cross tie assemblies required to assemble test samples in accordance with A1.5.1 and A1.6.1.

A1.4 Sampling

A1.4.1 One representative sample shall be selected from each bundle or package of Required Materials (A1.3), but not more than ten samples from any one shipment for testing.

A1.5 Specimen Preparation

A1.5.1 Each ICF unit sample (A1.3.4) to be tested may be cut into test specimens not less than 460 mm (18 in.) long. Minimum height shall be in accordance with A1.5.1.1.

A1.5.1.1 Factory pre-assembled ICF units shall be one full unit in height. ICFs requiring site assembly shall be of sufficient height to achieve the full assembly of the cross ties and EPS panels.

A1.5.1.2 For those ICF systems where the cross ties are inserted into molded recesses at the horizontal joints of the EPS panels, two panels shall be assembled with cross ties so that the cross ties are properly in place in each test sample.

A1.5.2 Cut and discard 300 mm (12 in.) strips from around the perimeter of each full sheet of gypsum wallboard (A1.3.1) to be used for testing. For each test specimen required for the attachment test, cut one square piece measuring 150 ± 2 mm (6 ± 1/16 in.) from the remaining gypsum wallboard (A1.3.1) to be used for testing.

A1.5.3 For each test specimen required for the attachment test, cut four square pieces of paper joint tape measuring 50 ± 1 mm (2 ± 1/32 in.).

A1.5.4 For each test specimen required for the attachment test, supply one screw.

A1.5.5 Each test specimen shall consist of one square piece of gypsum board centered and placed over an ICF cross tie in the ICF unit, four square pieces of paper joint tape centered on the square gypsum board, one screw centered in the paper joint tape.

A1.6 Procedure

A1.6.1 It is acceptable to conduct the attachment test on ICF samples of less than their full length, however, the sample shall have three complete cross ties or cross tie assemblies and be assembled in accordance with A1.5.1.1.

A1.6.2 Prior to performing the attachment test, set the depth of the nose piece on the screw gun by driving several screws through a piece of gypsum wallboard without the paper joint tape placed on top, allow the screws to be driven slightly below the surface of the gypsum wallboard without breaking the gypsum wallboard's face paper.

A1.6.3 Place the components (ICF with cross ties, gypsum wallboard and paper joint tape) on a rigid, flat surface prior to assembling them.

A1.6.4 Center and place the square piece of gypsum wallboard on top of a cross tie in the ICF.

A1.6.5 Center and place the four square pieces of the paper joint tape on top of the square piece of gypsum wallboard.

A1.6.6 Drive the screw through the center of the paper joint tape, using the screw gun, while applying a force (dead weight and applied force) of not greater than 133.5 N (30 lbf). See Fig. A1.1.

A1.6.7 Drive the screw until the nosepiece of the screw gun has either (*1*) stopped and seated the screw, or (*2*) the screw spins out. Record if the screw has spun out or if it exceeds 2 s to seat the screw in the gypsum wallboard, or both.

A1.7 Number of Tests and Retests

A1.7.1 A sample consisting of five test specimens of cross ties shall be tested.

A1.7.2 When failures occur a maximum of seven test specimens is allowed.

A1.8 Interpretation of Results

A1.8.1 Failure is defined as either:

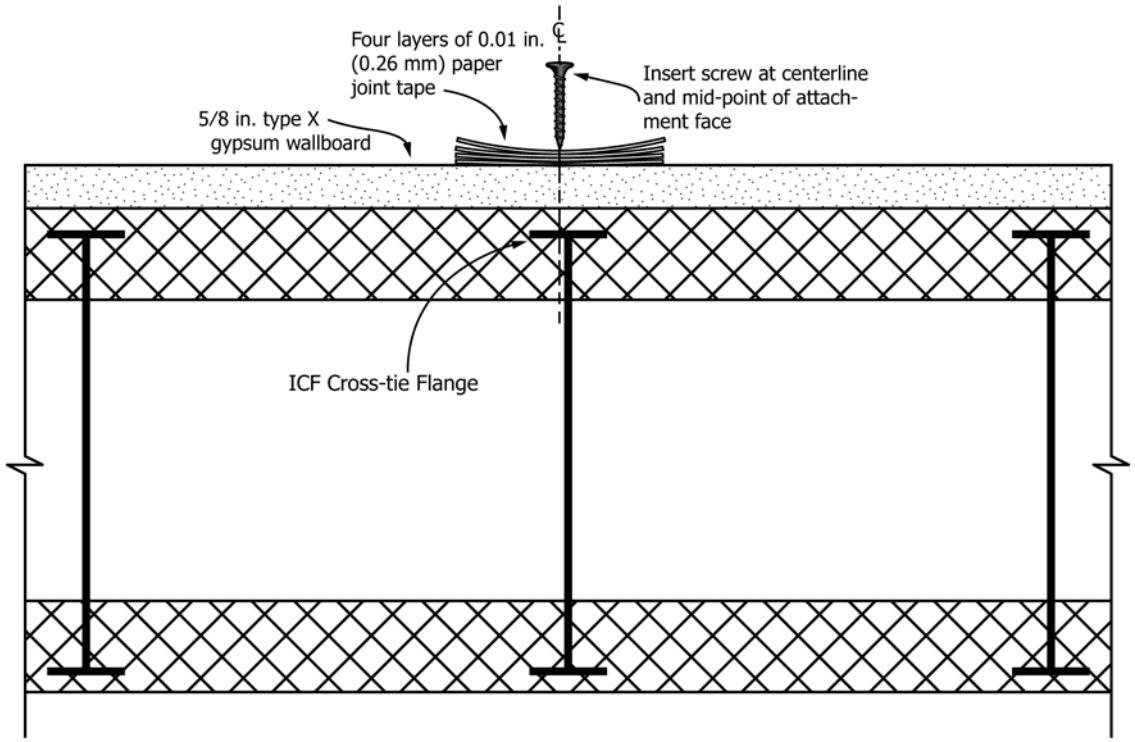

FIG. A1.1 Penetration Test Setup

A1.8.1.1 A screw that has exceeded 2 s to seat into the gypsum wallboard, or

A1.8.1.2 A screw that has spun out.

A1.8.2 If more than one of the test specimens fails to meet the requirements, then the sample has not met the requirements.

A1.8.3 When two of the five test specimens fail to meet the requirements, two additional test specimens shall be chosen for retesting. If either of the additional test specimens fails, the sample has failed to meet the requirements of this test.

A1.9 Report

A1.9.1 Report shall indicate the total number of test specimens tested and the number of specimens meeting the requirements.

A1.10 Precision and Bias

A1.10.1 No statement is made about either the precision or bias of this test method since the result merely states whether or not there is a conformance to the criteria for success specified in the procedure.

APPENDIX

(Nonmandatory Information)

X1. COMPLIANCE WITH APPLICABLE BUILDING CODES

INTRODUCTION

The purpose of the additional nonmandatory testing is to demonstrate compliance with respective sections of the applicable building codes where required.

X1.1 ICFs installed exposed in an attic or crawl space without a covering applied to the attic or crawl-space side of the EPS. The EPS shall be protected as set forth in the applicable code, with permissible variations from the code specifications in attics and under floor areas justified by diversified testing. The minimum thickness of the complete assembly of EPS, cross tie material, and concrete shall be tested. The ICF wall assembly shall exhibit a longer time frame

for both the flames exiting the test structure and the burn through of the floor/ceiling assembly than that permitted in the applicable code.

X1.2 *Water Penetration*—The minimum thickness complete assembly of EPS, cross tie material, and concrete shall be tested in accordance with Test Method E331, modified as follows; the test shall be extended for 2 h; water flow rate shall be equivalent to 205 mm (8 in.) of rain per hour; and the pressure differential shall be 0.72 kN/m^2 (15 psf). There shall be no water leakage visible through the assembly.

X1.3 *Air Infiltration*—The minimum thickness complete assembly of EPS, cross tie material, and concrete shall be tested in accordance with Test Method E283. The maximum air infiltration shall be 8.8×10^{-4} L/s/m^2 (0.02 cfm/ft^2).

X1.4 Thermal Performance

X1.4.1 The minimum thickness and minimum EPS density of the complete assembly of EPS, cross tie material, and concrete shall be tested in accordance with Test Method C1363 where applicable; or

X1.4.2 Thermal performance calculations in accordance with ANSI/ASHRAE 90.1 based on EPS testing in accordance with 6.1.3.2 or 6.1.4.2 is also permissible.

X1.5 *Air-Borne Sound*—The sound transmission class (STC) of the complete assembly to be recognized shall be tested in accordance with Test Method E90. The minimum STC ratings shall be consistent with the applicable building code.

X1.6 *Fire-Resistive-Rated Construction*—The complete ICF wall assembly including EPS, cross tie material, and concrete shall be tested in accordance with Test Methods E119. Testing shall be conducted for each thickness of wall assembly being recognized, unless the Fire resistance rating from the lesser thickness of the assembly is assigned to the wider assemblies. The minimum fire resistance ratings shall be consistent with the respective section of the applicable building code.

X1.7 *Qualification for Use in Non-Combustible Construction*—Recognition for use in noncombustible construction ICF solid concrete walls covered with exterior insulation and finish systems (EIFS) lamina, exterior plaster, cemetitious exterior wall coating (one-coat stucco), or brick veneer may be based on EIFS incorporating steel framing and gypsum coating justified for noncombustible construction.