



BOCA ENGINEERING CO.

STRUCTURAL TECHNOLOGIES · DESIGN · TESTING · CODE EVALUATION

INTERNATIONAL BUILDING CODE ENGINEERING EVALUATION REPORT

Date	Nov 30, 2020
File No.	0068-1-4
For	Stronghold Insulation Systems, Inc.
Address	P.O. Box 351, Pelican Rapids, MN 56572

Subject

Stronghold Insulated Concrete Form (ICF) System

Evaluation Scope

This report is provided to assist registered design professionals and building officials in the United States with determining compliance to the performance objectives in the named building codes.

The product(s) described herein have been evaluated to 2018 and 2015 International Building Code (IBC) and International Residential Code (IRC).

CSI DIVISION: 03 00 00 CONCRETE
SUBDIVISION: 03 11 19 Insulating Concrete Forming

CODE SECTIONS AND STANDARDS:

<u>IBC Section</u>	<u>Property</u>	<u>Referenced Standard or Code Section</u>	<u>Year ('18 Ed.)</u>
703.2	Fire Resistance Ratings	ASTM E119	2016
703.3	Fire Resistance Ratings	IBC Section 721	2018
803.1.2	Room Corner Fire Test	NFPA 286	2015
1403.3	Exterior Cladding Strength Attachment	IBC Ch 16	2018
Ch 16	Structural Design	ASCE 7	2016
Ch 19	Concrete Construction	ACI 318	2014
1903.4	Standard Specification for ICF	ASTM E2634	11(2015)
2603.2	Labelling, Foam Plastic Insulation	-	-
2603.3	Surface Burning Characteristics	UL 723	2008
2603.4	Thermal Barrier	-	-
2606.4	Self-Ignition Temperature, Thermoplastic ties	ASTM D1929	2016
2606.4	Rate of Burn, Thermoplastic ties	ASTM D635	2014
Ch 35	Physical Properties of Foam Plastic Insulation	ASTM C578	2015



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STRUCTURAL TECHNOLOGIES · DESIGN · TESTING · CODE EVALUATION

IRC Section	Property	Referenced Standard or Code Section	Year ('18 Ed.)
R302	Fire Resistance Ratings	ASTM E119	2016
R302	Fire Resistance Ratings	IBC Section 721	2018
R302.9.4	Room Corner Fire Test	NFPA 286	2015
R316.2	Labelling, Foam Plastic Insulation	-	-
R316.3	Surface Burning Characteristics	UL 723	2008
R404	Concrete Foundation Walls, Prescriptive Installation	Tables R404.1.2(1) – R404.1.2(4), R404.1.2(8)	2018
R404.1.3.3.6.1.5	Standard Specification for ICF	ASTM E2634	11(2015)
R608	Concrete Exterior Walls, Prescriptive Installation	Tables R608.3, R608.6(1), R608.6(4)	2018
R608.4.4	Standard Specification for ICF	ASTM E2634	11(2015)
R702.3.4	Thermal Barrier	-	-
R703.3.2	Exterior Cladding Strength Attachment	Table R301.2(3)	2018
Ch 44	Physical Properties of Foam Plastic Insulation	ASTM C578	2015

1. Only the applicable reference standards and code sections cited in the main body text are listed. (-) indicates that the main body text covers the full explanation of the objective.

Compliance Statement: Stronghold ICF, installed as described in this report, has demonstrated compliance with the listed sections of the 2018 and 2015 International Building Code (IBC) and International Residential Code (IRC). Design and performance information can be found in Section 2 of this report.

This report has been prepared and reviewed on behalf of Boca Engineering Co. by:

Christopher Bowness, P.Eng., P.E.

2020-11-30

Date



Evaluation

1.0 PRODUCT DESCRIPTION:

- 1.1 **Stronghold ICF FX and KD Series** are permanent concrete forms for preparing above or below grade concrete walls, consisting of two panels of expanded polystyrene (EPS) foam plastic joined by thermoplastic cross ties, leaving an open cavity for placing reinforcing and concrete. Foam plastic panels are 1.45 pcf nominal density, 2.75-in thick, and the concrete wall thickness is 4, 6, 8, 10 or 12 inches.
- 1.2 **Stronghold ICF FX Series** are with fixed end cross tie webs and a fixed open cavity.
- 1.3 **Stronghold ICF KD Series** are with hinged cross tie webs where the cavity folds the EPS panels flat for shipping and at installation folds open and locks to make the open cavity for concrete.

2.0 TECHNICAL EVALUATION:



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2.1 INSTALLATION

- 2.1.1 Stronghold ICF shall be installed in accordance with the jurisdictional Building Code and manufacturer's installation instructions, subject to the Limitations in Section 3, and as described in Section 4 of this report.
- 2.1.2 Materials integral to this building system as supplied on jobsites are to comply with the respective Code sections and materials and installation standards. Those materials as described in this report include concrete, reinforcing steel, interior ½" gypsum, and fasteners for interior and exterior finishes.
- 2.1.3 In areas of heavy termite presence, Termite Protection may be required by the local jurisdiction in accordance with IBC 2603.8 or IRC R318.4.
- 2.1.4 Footings for foundation walls are required as prepared in accordance with IBC Ch 18 or IRC R403.
- 2.1.5 Foundation site preparation, damproofing and backfill are to comply with IBC Ch 18 or IRC Ch 4.
- 2.1.6 Exterior wall water-resistive barrier, penetrations, flashings, and claddings are to comply with IBC Ch 14 or IRC R703.

2.2 CODE SECTIONS REVIEW:

IBC Section Description

703.2 **Fire Resistance Ratings**
See section 4 of this report.

703.3 **Fire Resistance Ratings**
See section 4 of this report.

803.1.2 **Room Corner Fire test**
A representative room assembly constructed with Stronghold ICF, covered with interior finish of ½-inch Gypsum board of materials and installation in accordance with IBC 2603.4 and 2508 and IRC 702.3, was tested to NFPA 286 and found to meet the Code requirements.

1403.3 **Exterior Cladding Strength Attachment**
The cladding design pressures for respective building applications are calculated by IBC 1609, or found in IRC Table R301.2(2).
Cladding attachment with fasteners through the EPS into the solid concrete wall are designed by IBC 1609 or installed in accordance with IRC R703.17.
Cladding attachments in to the ICF Plastic Cross Tie Flange have the following strength values:

Fastener Type ¹	Allowable Lateral Force (lbs) ²	Allowable Withdrawal Force (lbs) ³
#6 coarse thread drywall screw	53	40
#10 Wood Screw	76	43

1. Fasteners must be of sufficient length to pass through the cladding and any backing, and 1-inch past the outside surface of the EPS which provides for the tip of the fastener to penetrate a minimum ¼-inch through the back of the plastic web flange, with minimum edge distance of ½-inch.
2. Allowable Lateral Force is the ASD design resistance force of the individual fastener after safety factor of 6 applied per ASTM E2634. Lateral forces are in the direction perpendicular to the fastener, also referred to as fastener shear forces.



3. Allowable Withdrawal Force is the ASD design resistance force of the individual fastener after safety factor of 5 applied per ASTM E2634. Withdrawal forces are in the direction parallel to the fastener, typically from wind pressure acting on the cladding.

Ch 16 / Ch 19 Structural Design, Concrete Construction

For building applications where the IBC presides, the design, materials, and installation provisions of IBC Ch 16 and Ch 19 in accordance with ASCE 7 and ACI 318 are to be applied to Stronghold ICF Concrete Construction of foundation and above grade walls.

Also refer to Boca Engineering Co. report 0068-2-4 “Stronghold ICF Structural Guideline (USA)” for recommended design and installation methods in compliance with ACI 318.

1903.4 Standard Specification for ICF

Stronghold ICF has been tested to and complies with ASTM E2634, Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems.

2603.2 Labelling, Foam Plastic Insulation

See section 5.0 and 7.0 of this report.

2603.3 Surface Burning Characteristics

IBC 2603.3 and IRC316.6 require that foam plastic insulation tested to UL 723 achieve a maximum Flame Spread Index of 75 and Smoke Development Index of 450. Stronghold ICF produced of EPS was tested to UL 723 and achieved the ceiling Flame Spread Index of 0 and Smoke Development Index of 5, meeting the IBC and IRC requirements.

2603.4 Thermal Barrier

An interior finish thermal barrier of ½-inch gypsum is to be installed over Stronghold ICF and fastened to the flange of the plastic web ties with No. 6 drywall screws minimum 1-5/8-inch at 16-inch o/c horizontally and 12-inch o/c vertically. A representative interior room assembly was tested to NFPA 286 to validate that the ½-inch gypsum thermal barrier stays in place for 15-minutes under fire conditions and that the criteria of IBC 803.1.2 and IRC R302.9.4 is satisfied. Gypsum board materials and installation must adhere to IBC 2603.4 and 2508 and IRC 702.3. In attics and crawlspaces where entry is made only for service of utilities, under IBC 2603.4.1.6, the gypsum thickness may be reduced to 3/8-inch.

2606.4 Self-Ignition Temperature

Stronghold ICF thermoplastic web ties have been tested to ASTM D1929 and have a self-ignition temperature of greater than 650°F.

2606.4 Rate of Burn

Stronghold ICF thermoplastic web ties have been tested to ASTM D635 and are a Class CC2.

Ch 35 Physical Properties of Foam Plastic Insulation

As referenced in IBC CH 35 and IRC Ch 44, Stronghold ICF has been tested to ASTM C578 standard specification for foam plastic and is classified as Type II EPS.



<u>IRC Section</u>	<u>Description</u>
R302	Fire Resistance Ratings Same as this report commentary to IBC 703.2.
R302.9.4	Room Corner Fire Test Same as this report commentary to IBC 803.1.2.
316.2	Labelling, Foam Plastic Insulation Same as this report commentary to IBC 2603.2.
R316.3	Surface Burning Characteristics Same as this report commentary to IBC 2603.3.
R404	Concrete Foundation Walls, Prescriptive Installation For building applications where the IRC applies, Stronghold ICF concrete walls are to be installed in accordance with Tables R404.1.2(1) – R404.1.2(4) or R404.1.2(8) for foundation walls, and Tables R608.3, R608.6(1), R608.6(4) for above-grade exterior walls. Also refer to Boca Engineering Co. report 0068-2-4 “Stronghold ICF Structural Guideline (USA)” for recommended design and installation methods in compliance with R404 and R608.
R404.1.3. 3.6.1.7	Standard Specification for ICF Stronghold ICF has been tested to and complies with ASTM E2634, <i>Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems</i> .
R608	Concrete Exterior Walls, Prescriptive Installation See commentary to IRC R404.
608.4.4	Standard Specification for ICF See commentary to IRC R404.1.3.3.6.1.7.
R702.3.4	Thermal Barrier Same as this report commentary to IBC 2603.4.
R703.3.2	Exterior Cladding Strength Attachment Same as this report commentary to IBC 1403.3.
Ch 44	Physical Properties of Foam Plastic Insulation Same as this report commentary to IBC Ch 35.

3.0 LIMITATIONS:

- 3.1 This Evaluation is for the base code requirements of the building system as addressed in this report. In some building applications, additional performance objectives may be required by Code which must be addressed in the building design for those specific cases.



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STRUCTURAL TECHNOLOGIES · DESIGN · TESTING · CODE EVALUATION

- 3.2 Design calculations, drawings, and special inspections are to be furnished for building projects by registered professionals as required by the respective jurisdictional authorities and Codes.
- 3.3 Fire Blocking and draftstopping shall be installed in concealed locations as specified in IBC 718 and IRC 302.

4.0 FIRE CLASSIFICATIONS AND RATINGS:

4.1 IBC 703.2, IBC 703.3, IRC R302: Fire Resistance Ratings

IBC 703.2 and IRC 302 specify that walls required to be of Fire-Resistance construction (1 hr, 2 hr, etc.) are to be qualified by assembly testing to ASTM E119, or, by any of six ways listed in IBC 703.3. Stronghold ICF walls may be designed and installed by three of the code-conforming methods:

- a. Stronghold ICF has been tested to ASTM E119 for a custom fire-resistance rating construction detail:
 Concrete thickness: Min. 6-inch (may substitute with 8-inch, 10-inch, 12-inch ICF form)
 Concrete Weight: Normal, Nominal 150 lb/ft³
 Concrete Compressive Strength: Min. 3000 psi
 Steel Reinforcing: Optional, to structural design requirements
 Load-bearing: Applies to non-bearing and load-bearing walls
 Duration: 3-hr rating
- b. Design professionals and Code officials may use standard details for fire-resistant rated concrete walls formed with Stronghold ICF by following IBC 703.3(2): Prescriptive designs of fire-resistance-rated building elements, components or assemblies as prescribed in Section 721, reference Table 721.1(2) item 4-1.1 Solid Concrete. Quick reference for use of this table with the applicable Stronghold ICF Forms,

Construction ^{1,2}	Minimum ICF Core Cavity Thickness (in)			
	4 hrs	3 hrs	2 hrs	1 hr
Siliceous aggregate concrete.	8"	8"	6"	4"
Carbonate aggregate concrete.	8"	6"	6"	4"
Sand-lightweight concrete.	6"	6"	4"	4"
Lightweight concrete.	6"	6"	4"	4"

- 1. Based on IBC Table 721.1(2) item 4-1.1.
- 2. Concrete wall construction, with horizontal and vertical reinforcement as required, shall be in accordance with IBC Ch 19.

or,

- c. IBC 703.3(3): Calculations in accordance with Section 722.

4.2 Summary of flammability classifications found by testing to code referenced standards:

UL 723: Ceiling value Flame Spread Index (FSI): < 25, Smoke Developed Index (SDI): < 450
 ASTM D635: Burning Rate: < 2.5 in/min, Class CC2
 ASTM D1929: Self-Ignition Temperature: > 650 °F



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5.0 QUALITY ASSURANCE ENTITY:

The products evaluated in this report are surveyed at the approved manufacturing locations with third-party quality assurance inspections and product certification labeling by Intertek.

6.0 MANUFACTURING PLANTS:

Manufacturing and labeling location(s): Watertown SD, Ottawa OH, Post Falls ID, Jerome ID, Edmonton AB.

7.0 LABELING:

Labeling shall be in accordance with the requirements of IBC 2603.2 and IRC R316.2, and the Accredited Quality Assurance Agency.

8.0 EVALUATION RENEWALS:

This Evaluation Report expires Dec 31, 2021, subject to renewal. Up to the renewal date, the report is valid until such time as the named product(s) changes, the Quality Assurance Agency changes, or provisions of the Code that relate to the product change.

9.0 REFERENCE TESTING AND EVALUATION DOCUMENTS:

<u>Entity</u>	<u>Entity Accreditation¹</u>	<u>Standards</u>	<u>Report No.</u>	<u>Issue Date</u>
Intertek	TL-274	NFPA 286	103802777COQ-009R2	2019-05-14
Intertek	TL-274	UL 723	103802777COQ-007	2019-03-13
Intertek	TL-274	ASTM D635	103802777COQ-004a	2019-05-01
Intertek	TL-274	ASTM C578	103802777COQ-003REV	2019-05-10
Intertek	TL-274	ASTM D1929	103802777COQ-004b	2019-06-11
Intertek	TL-274	ASTM E2634	103802777COQ-004	2019-08-28
Intertek	TL-143	ASTM E119	g103851054-sat-001r0	2020-02-19
Intertek	AA-647	QA Inspections	51355	2020-09-24
Intertek	PCA-101	Certification	51355	2020-09-24

1. Testing, certification, evaluation, and inspection agencies referenced have been verified to be accredited by the International Accreditation Service (www.iasonline.org) for the applicable scope, in good standing on the date of the evaluation, in accordance with ISO 17025 and ISO 17020 international standards for testing and inspection bodies.

10.0 CERTIFICATION OF INDEPENDENCE:

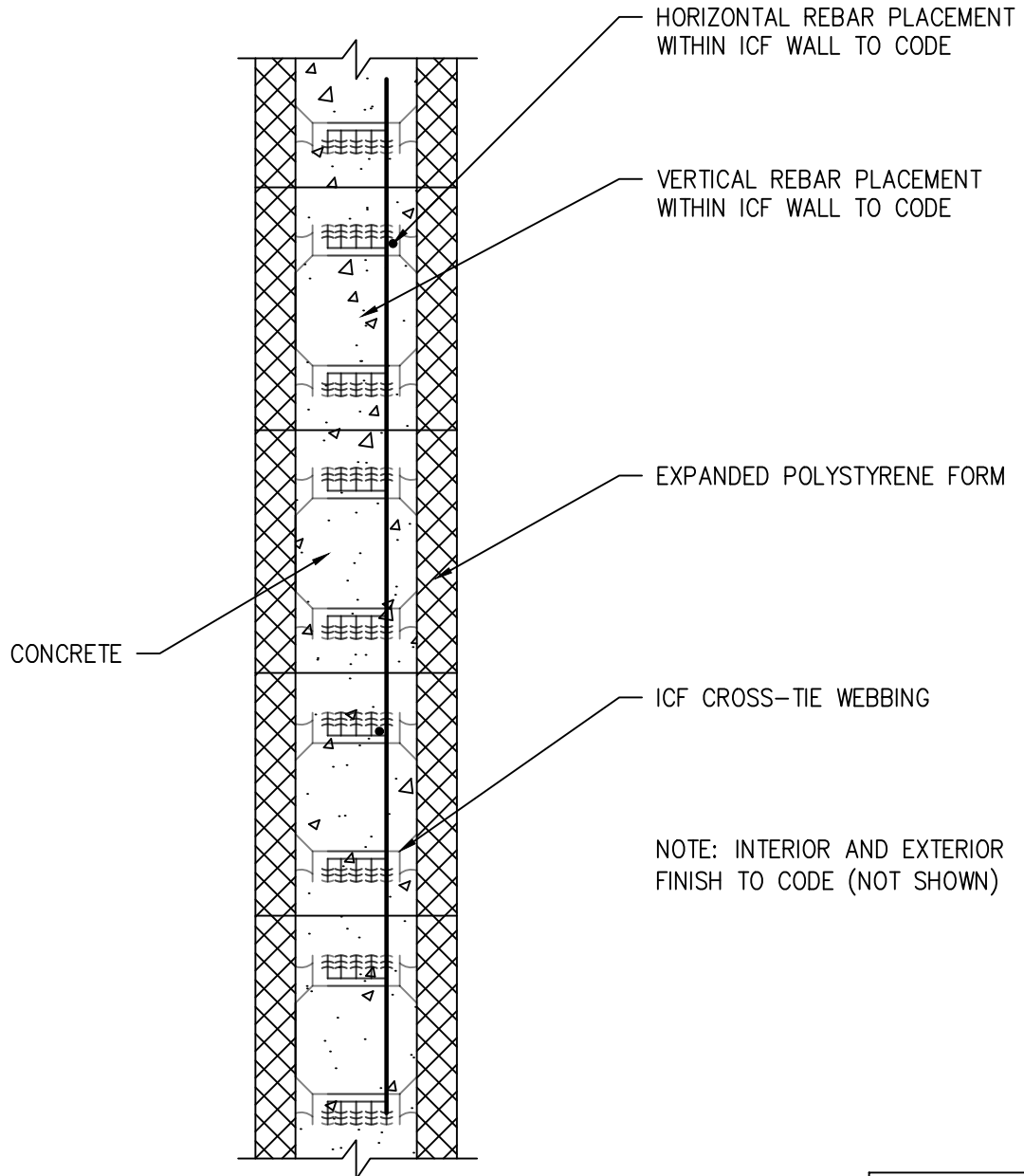
1. Boca Engineering Co., its employees and shareholders, do not have, nor do they intend to or will acquire, a financial interest in any company manufacturing or distributing products that they evaluate.
2. Boca Engineering Co. is not owned, operated, or controlled by any company manufacturing or distributing products that they evaluate.

11.0 EVALUATION REPORT TERMS:

This report is a general evaluation of the building code section requirements as identified and applies only to the samples that were evaluated. The evaluation report, including any drawings, do not imply that the signatory Engineer is the Designer of Record of any project for which this Evaluation Report is used.

ATTACHMENTS:

1. Typical Cross Section Diagram _____ (pg 8)
2. Stronghold ICF Materials Properties _____ (pg 9)



TYPICAL CROSS SECTION OF ICF WALL



DRAWING FOR STRONGHOLD INSULATED CONCRETE FORMS ENGINEERING EVALUATION REPORT – NOT FOR USE AS CONSTRUCTION DESIGN DOCUMENTS

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CLIENT: STRONGHOLD INSULATION SYSTEMS INC.	PROJECT: STRONGHOLD INSULATED CONCRETE FORM (ICF) IBC 2018 EVALUATION REPORT	TITLE: TYPICAL ICF WALL DETAIL
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ATTACHMENT 2: STRONGHOLD ICF MATERIALS PROPERTIES TESTING VALUES

Table 1: Stronghold ICF Physical Property Values as per ASTM E2634 and ASTM C578				
Standard	Properties	Test Requirement ¹	Compliance	
ICF Block (EPS)				
UL723	Surface Burning Characteristics (Ceiling only)	Flame Spread Index	≤ 75	Pass
		Smoke Development Index	≤ 450	Pass
ASTM C578	Specification for Rigid, Cellular Polystyrene Thermal Insulation	Type II	Pass	
ASTM D1621	Compressive resistance at yield or 10 % deformation (psi)	≥ 15 psi	Pass	
ASTM C518	Thermal resistance per 1.00-in., F·ft ² ·h/Btu @ 75 ± 2°F	≥ R4/inch (5.5-in EPS = R22)	Pass	
ASTM C203	Flexural strength (psi)	≥ 35 psi	Pass	
ASTM E96	Water vapor permeance of 1.00-in. (25.4-mm) thickness, max, perm (ng/Pa·s·m ²)	≤ 3.5 perm	Pass	
ASTM C272	Water absorption by total immersion, max, volume %	≤ 3 %	Pass	
ASTM D2126	Dimensional stability (change in dimensions), max %	≤ 2 %	Pass	
ASTM D2863	Oxygen index, min volume %	≥ 24 %	Pass	
ASTM D1622	Density (lb/ft ³)	≥ 1.35 lb/ft ³	Pass	
Cross Tie Web and Flange				
ASTM D635	Burn Rate (in/min)	≤ 2.5 in/min	Pass	
ASTM D1929	Ignition Temperature	≥ 650 F	Pass	
ASTM D1761	Fastener Allowable Shear ²	#6 coarse thread drywall screw	53 lbs	Pass
		#10 Wood Screw	76 lbs	Pass
ASTM D1761	Fastener Allowable Withdrawal ²	#6 coarse thread drywall screw	40 lbs	Pass
		#10 Wood Screw	43 lbs	Pass
ASTM E2634	Gypsum Wallboard Attachment	Time to seat	≤ 2 s	Pass
		Observation	No screw spinout	Pass
ASTM D638	Cross Tie Tensile Strength	≥ 675 psf of tributary wall area pressure	Pass	
ASTM D732	Cross Tie Shear Strength	≥ 1206 psi	Pass	
ICF Concrete Wall³				
NFPA 286	Fire Test, 15-minute Room Corner	Pass	Pass	
ASTM E119	Fire Resistance	3 HR, Load-Bearing	Pass	

1. Where the specification standard lists a required property value, testing has met or exceeded that value, and table lists the specification. Where the specification standard has no set value limit for a property test, the test result is shown.
2. ASD allowable design values of fastener test after safety factor applied are shown. See evaluation report for further description.
3. Wall assembly tests results are dependent on installation components and environmental conditions consistent with tested details. See Stronghold's document library of Engineering and Certifications reports for further details.

- END -