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DIVISION: 03 00 00—CONCRETE
Section: 03 11 19—Insulating Concrete Forming

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REPORT SUBJECT:
Greenblock 2-4-2 Insulating Concrete Forms (ICFs)
Greenblock Fixed-Web ICFs
Greenblock G-BLOX ICFs

1.0 SCOPE OF EVALUATION

This research report addresses compliance with the following codes:

- 2009 *International Building Code® (IBC)*
- 2009 *International Residential Code® (IRC)*

The Greenblock 2-4-2, Fixed-Web and G-BLOX ICF systems have been evaluated for the following properties:

- Physical properties
- Surface-burning characteristics
- Attic and crawl space fire evaluation
- Exterior walls in Types I, II, III and IV construction

See Table 1 for applicable code sections related to these properties.

2.0 USES

The Greenblock 2-4-2, Fixed-Web and G-BLOX ICF systems are used as stay-in-place formwork for structural concrete load-bearing and nonload-bearing exterior and interior walls, concrete beams, lintels, foundation walls, and retaining walls. The forms may be installed in attics and crawl spaces without a covering on the interior side when installed in accordance with Section 4.3.2. The forms may be used in Types I, II, III, IV and V construction; when used in Types I, II, III or IV construction, installation must be in accordance with Section 4.9.

3.0 DESCRIPTION

3.1 General: Greenblock 2-4-2 ICFs consist of two 2-inch thick (51 mm) expanded polystyrene (EPS) foam plastic panels and injection-molded polypropylene plastic cross-ties that are inserted into the EPS panels at the job site. The cross-ties maintain the EPS panel facings at a clear distance of 4 inches (102 mm).

Greenblock Fixed-Web ICFs consist of two 2⁵/₈-inch (66.7 mm) thick EPS foam plastic panels with injection-molded

polypropylene plastic cross-ties that are embedded into the EPS panels at the time of EPS molding. The cross-ties maintain the EPS panel facings at a clear distance of 6 inches (152 mm) or 8 inches (203 mm).

Greenblock G-BLOX ICFs consist of two 2⁵/₈-inch (66.7 mm) thick EPS foam plastic panels and injection-molded polypropylene plastic cross-ties that are inserted into the EPS panels at the job site. The cross-ties maintain the EPS panel facings at a clear distance of 6 inches (152 mm), 8 inches (203 mm), 10 inches (254 mm), or 12 inches (305 mm).

Forty-eight-inch (1220 mm) long by 2⁵/₈-inch (66.7 mm) thick wide by 2-inch (52 mm) high EPS height adjusters and EPS end inserts (for wall terminations) are available for 6- and 8-inch Fixed-Web and G-BLOX ICF forms.

The Greenblock 2-4-2, Fixed-Web and G-BLOX ICF systems are flat ICF systems as defined in IRC Section R611.3. The following variants are available:

2-4-2 ICFs:	Straight 45-degree "shortie" angle 90-degree angle 90-degree "shortie" angle
Fixed-Web ICFs:	Straight 45-degree angle 90-degree angle Taper Top
G-BLOX ICFs:	Straight Brickledge

See Figure 1 for illustrations of the forms.

3.2 Foam Plastic Panels:

The EPS foam plastic panels have a nominal density of 1.5 pcf (23.2 kg/m³), a flame-spread index of 25 or less and a smoke-developed index of 450 or less when tested in accordance with ASTM E84. The foam plastic complies with Type II requirements when tested in accordance with ASTM C578.

3.3 Cross-ties:

The polypropylene cross-ties connect the EPS panels at a fixed clear distance. The cross-ties are molded or manually inserted into the EPS panels, have openings to permit concrete placement, and have slots to support horizontal steel reinforcing bars. The cross-ties are spaced horizontally at 6 inches (152 mm) on center. The plastic flange of the polypropylene cross-ties is used to attach exterior and interior finish materials. The nailing flanges for all products are 1.5 inches (38.1 mm) wide. G-BLOX ICF cross-tie flanges are 8 inches (203 mm) high and taper

from $\frac{3}{16}$ inch (4.8 mm) thick at the top to $\frac{1}{8}$ inch (3.2 mm) thick at the bottom. 2-4-2 ICF cross-tie flanges are $9\frac{1}{4}$ inches (235 mm) high and taper from $\frac{3}{16}$ inch (4.8 mm) thick at the top to $\frac{1}{8}$ inch (3.2 mm) thick at the bottom. Fixed-Web ICF cross-tie flanges are $10\frac{7}{8}$ inches (276 mm) high and are $\frac{3}{16}$ inches (4.8 mm) thick from top to bottom. 2-4-2 ICF cross-tie flanges are recessed $\frac{1}{2}$ inch (12.7 mm) below the outer EPS surface; the flanges for the G-BLOX and Fixed-Web are recessed $\frac{5}{8}$ inch (15.9 mm) below the outer EPS surface.

3.4 Concrete:

Concrete must be normal-weight concrete complying with the IBC, with a maximum $\frac{3}{4}$ -inch (19 mm) aggregate size. Concrete must have a minimum compressive strength of 3000 psi (21 MPa) at 28 days. Under the IRC, concrete must comply with IRC Sections R404.1 (foundation walls and retaining walls) and R611.5.1 (walls), as applicable.

3.5 Reinforcement:

Deformed steel reinforcement bars must have a minimum yield stress of either 40 ksi (276 MPa) or 60 ksi (413 MPa), depending on the structural design. Under the IBC, the deformed steel bars must comply with Section 3.5.3.1 of ACI 318 and IBC Section 1903. If construction is based on the IRC, reinforcement must comply with IRC Sections R404.1.2.3.7 (foundation walls and retaining walls) and R611.5.2 (walls).

4.0 INSTALLATION

4.1 General:

Design and installation of the Greenblock 2-4-2, Fixed-Web and G-BLOX ICF systems must comply with this report, the applicable code, and the manufacturer's published installation instructions, which must be available on the jobsite during installation.

4.2 Design:

4.2.1 IBC Method: Solid concrete walls must be designed and constructed in accordance with IBC Chapter 16 and 19, as applicable. Footings and foundations must be designed in accordance with IBC Chapter 18.

4.2.2 Alternative IBC Wind Design Method: Solid concrete walls may be designed and constructed in accordance with the provisions of Section 209 of ICC 600, subject to the limitations found in IBC Section 1609.1.1.1 in accordance with Exception 1 to Section 1609.1.1.1. Design and construction under the provisions of ICC 600 are limited to resisting wind forces.

4.2.3 IRC Method: Solid concrete walls, footings and foundations must be designed in accordance with IRC Sections R611 and R404.1.2, as applicable for flat wall systems.

4.2.4 Alternative IRC Methods: When used to construct buildings that do not conform to the applicability limits of IRC Sections R404.1.2 and R611.2, construction must be in accordance with the prescriptive provisions of the 2007

Prescriptive Design of Exterior Concrete Walls (PCA 100), or the structural analysis and design of the concrete must be in accordance with ACI 318, ACI 332 and IBC Chapters 16, 18 and 19.

4.3 Interior Finish:

4.3.1 General: ICF units exposed to the building interior must be finished with an approved 15-minute thermal barrier, such as minimum $\frac{1}{2}$ inch thick (12.7 mm) regular gypsum wallboard complying with ASTM C1396, installed vertically or horizontally, and attached to the cross-tie flanges with minimum $1\frac{1}{2}$ -inch-long (38.1 mm), No. 6, Type S, fine-thread gypsum board screws spaced a maximum of 12 inches (305 mm) on center vertically and a maximum of 16 inches (406 mm) on center horizontally. The screws must penetrate a minimum of $\frac{1}{4}$ inch (6.4 mm) through the flange. Gypsum board joints and screw heads must be taped and finished with joint compound in accordance with ASTM C840 or GA216. See Section 4.3.2 for installation details for crawl space applications without an ignition barrier on the interior face.

4.3.2 Attic and Crawl Space Installations: When the ICFs are used for walls of attic or crawl spaces, an ignition barrier complying with IBC Section 2603.4.1.6, or IRC Sections R316.5.3 or R316.5.4, is required, except when all of the following conditions are met:

- Entry to the attic or crawl space is only to service utilities, and no storage is permitted.
- There are no interconnected attic or basement areas.
- Air in the attic or crawl space is not circulated to other parts of the building.
- Under-floor (crawl space) ventilation is provided that complies with IBC Sections 1203.3 or IRC Section R408.1, as applicable.
- Attic ventilation is provided when required by IBC Section 1203.2 or IRC Section R806, as applicable.
- Combustion air is provided in accordance with IMC (*International Mechanical Code*) Section 701.
- The ICFs must have at least one label (described in Section 7.0) visible in every 160 square feet (15 m²) of wall area.

4.4 Exterior Finish

4.4.1 Above Grade: The exterior surface of the ICF must be covered with an approved wall covering in accordance with the applicable code or a current evaluation report. When the wall covering is mechanically attached to structural members, the wall covering must be attached to the flanges of the embedded cross-ties with fasteners, described in Table 2, having sufficient length to penetrate through the flange a minimum of $\frac{1}{4}$ inch (6.4 mm). The fasteners have an allowable fastener withdrawal and lateral shear strength as noted in Table 2.

The fastener spacing must be designed to support the gravity loads of the wall covering and to resist the negative wind pressures. The negative wind pressure capacity of the exterior finish material must be the same as that recognized in the applicable code for generic materials, or that recognized in a

current evaluation report for proprietary materials and must not exceed the maximum withdrawal capacity of the fasteners listed in Table 2.

4.4.2 Below Grade: Materials used to dampproof or waterproof basement walls must comply with the applicable code or be recognized in a current evaluation report, must be compatible with the EPS foam plastic, and must be free of solvent that will adversely affect the EPS foam plastic panels. Dampproofing, waterproofing and drainage requirements must comply with the applicable code. No backfill may be applied against the wall until the complete floor system is in place, unless the wall is designed as a freestanding wall that does not rely on the floor system for structural support.

4.5 Foundation Walls:

The ICF system may be used as a foundation stem wall when supporting wood-framed construction, provided the structure is supported on concrete footings complying with the applicable code. For jurisdictions adopting the IRC, compliance with Section R404 is required.

4.6 Retaining Walls:

The ICF system may be used to construct retaining walls, with reinforcement designed in accordance with accepted engineering principles, Section 4.2 of this report and the applicable code.

4.7 Protection Against Termites:

Where the probability of termite infestation is defined by the code official as "very heavy," the foam plastic must be installed in accordance with IBC Section 2603.8 or IRC Section R318.4, as applicable. Areas of very heavy termite infestation must be determined in accordance with IBC Figure 2603.8 or IRC Figure R301.2(6).

4.8 Fire-resistance-rated Construction:

Use in fire-resistance-rated construction is outside the scope of this report.

4.9 Use in Buildings Required to be of Types I, II, III and IV Construction:

4.9.1 General: Exterior walls constructed with the ICFs for use in buildings required to be of Type I, II, III or IV construction must comply with the applicable conditions cited in Sections 4.9.2 through 4.9.4.

4.9.2 Interior Finish:

4.9.2.1 Buildings of Any Height: The ICFs must be finished on the interior with an approved 15-minute thermal barrier, such as $\frac{1}{2}$ -inch-thick (12.7 mm) gypsum board, as required by the IBC. The gypsum board must be installed and attached as described in Section 4.3.1.

4.9.2.2 Alternate Interior Finish for One-story Buildings: For one-story buildings, the interior finish may be in accordance with

IBC Section 2603.4.1.4, provided all the conditions in that section are met.

4.9.3 Exterior Finish:

4.9.3.1 Buildings of Any Height: The ICFs must be finished on the exterior with materials described in Sections 4.9.3.1.1, 4.9.3.1.2 and 4.9.3.1.3. The ICFs must have at least one label as described in Section 7.0 visible in every 160 square feet (15 m²) of wall area prior to applying the wall covering.

4.9.3.1.1 Exterior Finish – EIFS and One-coat Stucco: EIFS and one-coat stucco wall coverings may be applied over the ICF, provided the wall covering system is recognized in a current evaluation report and is recognized for use in Types I, II, III and IV construction. The wall covering system must be installed in accordance with the respective evaluation report and the maximum mass per wall surface area [lbs/ft² (kg/m²)] qualified in the wall covering evaluation report must be greater than 0.361 lbs/ft² (1.76 kg/m²) (which is the max-tolerance mass of the EPS panel on the exterior side of the concrete wall). Acceptable EIFS wall coverings include the following:

- BASF Corporation Senerflex EIFS as described in ESR-1794;
- BASF Corporation Senturion EIFS as described in ESR-1794 (Greenblock 2-4-2 ICFs only);
- BASF Corporation Finestone Pebbletex EIFS described in ESR-2165 (Greenblock 2-4-2 ICFs only);
- BASF Corporation Finestone Pebbletex-D EIFS as described in ESR-2165
- Dryvit Outsulation EIFS as described in ESR-1232;
- Parex Watermaster EIFS as described in ESR-2562 (Greenblock 2-4-2 only);
- Sto Corp. StoTherm Essence as described in ESR-1720.

4.9.3.1.2 Exterior Plaster: Exterior plaster must comply with the applicable code, and the exterior plaster must be a minimum of $\frac{7}{8}$ inch (22.2 mm) thick. The lath must be attached to the flanges of the cross-ties with fasteners described in Section 4.4.1.

4.9.3.1.3 Exterior Finish – Brick Veneer: Anchored brick veneer must be attached to the flanges of the cross-ties with fasteners as described in Section 4.4.1. The 4-inch-thick (102 mm) brick veneer must comply with the IBC and must be installed with a minimum 1-inch (25.4 mm) air gap between the face of the exterior EPS panel and the brick. The brick must be installed with a steel shelf angle attached to the concrete and installed at each floor line and at the top of each window and door opening.

4.9.4 Fireblocking: Foam plastic on the interior side of exterior walls and on both sides of interior walls must be discontinuous at floor lines. The intersections of must be constructed to prevent the passage of flame, smoke and hot gases from one floor to another. Refer to the illustration in Figure 5.

4.10.2 IRC: For walls designed in accordance with Section 4.2.3 or PCA 100 (Section 4.2.4), special inspection is not required. When walls are designed in accordance with the IBC, as described in Section 4.2.4, special inspection is required as described in Section 4.10.1.

5.0 CONDITIONS OF USE

The Greenblock 2-4-2, Fixed-Web and G-BLOX ICF systems described in this research report comply with, or are a suitable alternative to what is specified in, those codes listed in Sections 1.0 and 2.0 of this report, subject to the following conditions:

5.1 The ICFs must be manufactured, identified and installed in accordance with this research report, the manufacturer's published installation instructions and the applicable code. The provisions in this report take precedence over the provisions in the manufacturer's instructions.

5.2 When required by the code official, calculations showing compliance with the general design requirements of the applicable code must be submitted to the building official for approval, except where calculations are not required under IRC Section R611.1. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.3 When required by the code official, calculations and details showing compliance with IRC Section R611.5.3 and R404.1.2.3.6 must be submitted, establishing that the ICFs provide sufficient strength to contain concrete during placement and the cross-ties are capable of resisting the forces created by fluid pressure of fresh concrete. The calculations and details must be prepared by registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.4 The ICFs must be separated from the building interior with an approved 15-minute thermal barrier, except for attic and crawl space construction as described in Section 4.3.2.

5.5 The plastic cross-ties must be stored indoors away from direct sunlight.

5.6 Special inspection must be provided in accordance with Section 4.10 of this report.

5.7 The forms are manufactured by Greenblock International, LLC in Orlando, FL and Colorado Springs, CO and are produced under a quality control program with inspections conducted by Intertek Testing Services NA, Inc. (AA-647).

5.8 The approval of building products is the responsibility of the Authority Having Jurisdiction.

5.9 Intertek Research Reports shall not be used in any manner that implies an endorsement of the product, material or system by Intertek.

5.10 The current status of any Intertek Research Report can be verified on the Intertek Directory of Certified Products (<https://whdirectory.intertek.com>).

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5.13 Intertek Research Reports shall not be used in any manner that implies an endorsement of the product, material or system by Intertek.

5.14 The current status of any Intertek Research Report can be verified on the Intertek Directory of Certified Products (<https://whdirectory.intertek.com>).

6.0 SUPPORTING EVIDENCE

6.1 Data in accordance with the ICC-ES Acceptance Criteria for Stay-in-place, Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete Walls (AC353), dated October 2012.

6.2 Intertek Warnock Hersey Listing Report "Greenblock Insulating Concrete Forms (Greenblock ICFs)" on <https://whdirectory.intertek.com>.

7.0 IDENTIFICATION

The Greenblock 2-4-2, Fixed-Web and G-BLOX ICF systems are identified by a marking bearing the report holder's name (Greenblock International, LLC), the product name, the manufacturing location, the manufacturing date, the Intertek Warnock Hersey mark, and the Intertek Research Report number (IRR-1016).

When use in an attic or crawl space without an ignition barrier, as described in Section 4.3.2, one label bearing the evaluation report number and the phrase "Acceptable for use in attics and crawl spaces" must be visible in every 160 square feet (15 m²) of exposed exterior wall area.

When use is in buildings required to be of Type I, II, III or IV construction, one label must be visible in every 160 square feet (15 m²) of wall area.

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TABLE 1 – PROPERTIES EVALUATED

PROPERTY	IBC SECTION	IRC SECTION
Physical properties	NA	R404.1.2.3.6.1 and R611.3
Surface Burning Characteristics	2603.3	R316.3
Attic and crawl space applications	2603.4.1.6 and 2603.9	R316.5.3, R316.5.4 and R316.6
Exterior walls in Types I – IV construction	2603.5	NA

TABLE 2 – ALLOWABLE WITHDRAWAL AND LATERAL CAPACITIES OF FASTENERS IN CROSS-TIE FLANGES

FASTENER ¹	ALLOWABLE LOAD CAPACITY (lbf)	
	Lateral	Withdrawal
1 ⁵ / ₈ -inch-long, No. 6 coarse-thread drywall screw	29.5	27.3
1 ⁷ / ₈ -inch-long, No. 6 coarse-thread drywall screw	23.5	28.0

For SI: 1 lb = 4.45 N, 1 inch = 25.4 mm

¹Fasteners must be of sufficient length to penetrate through the flange a minimum of ¼ inch

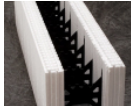
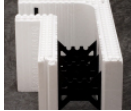


Type Image	Type Name
	Fixed-Web 6 in. Straight Fixed-Web 8 in. Straight
	Fixed-Web 6 in. 90° Fixed-Web 8 in. 90°
	Fixed-Web 6 in. 45° Fixed-Web 8 in. 45°
	Fixed-Web 6 in. Taper Top Fixed-Web 8 in. Taper Top

Figure 1 – GREENBLOCK FIXED-WEB ICF SYSTEM ILLUSTRATIONS



Type Image	Type Name
	G-BLOX 6 in. Straight G-BLOX 8 in. Straight G-BLOX 10 in. Straight G-BLOX 12 in. Straight
	G-BLOX 6 in. Brickledge G-BLOX 8 in. Brickledge G-BLOX 10 in. Brickledge G-BLOX 12 in. Brickledge

Figure 2 – GREENBLOCK G-BLOX ICF SYSTEM ILLUSTRATIONS





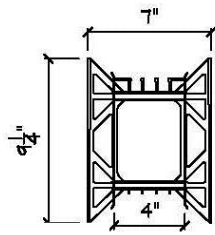
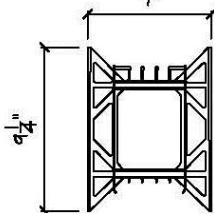
Type Image	Type Name
	2-4-2 Straight
	2-4-2 90-degree Universal
	2-4-2 90-degree Shortie
	2-4-2 45-degree Shortie

Figure 3 – GREENBLOCK 2-4-2 ICF SYSTEM ILLUSTRATIONS



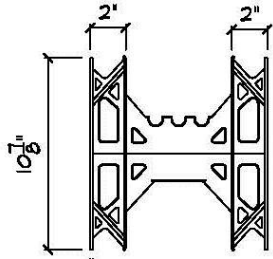
4" WEB (CORNER)

2-4-2

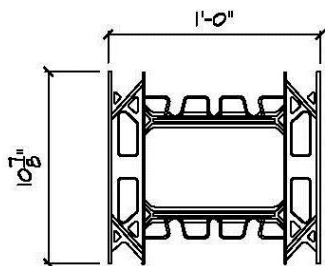


4" WEB (INSERT)

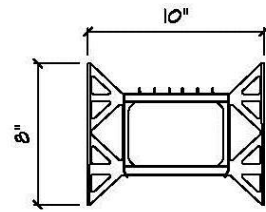
2-4-2



6" WEB (FIXED)

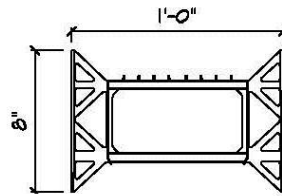


8" WEB (FIXED)



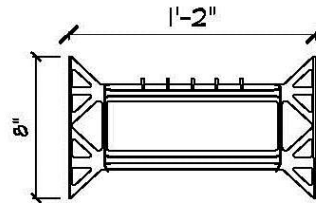
6" WEB (INSERT)

GBLOX



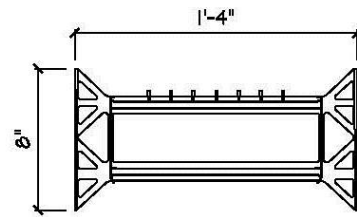
8" WEB (INSERT)

GBLOX



10" WEB (INSERT)

GBLOX



12" WEB (INSERT)

GBLOX

Figure 4 – Greenblock ICF System Web Connectors

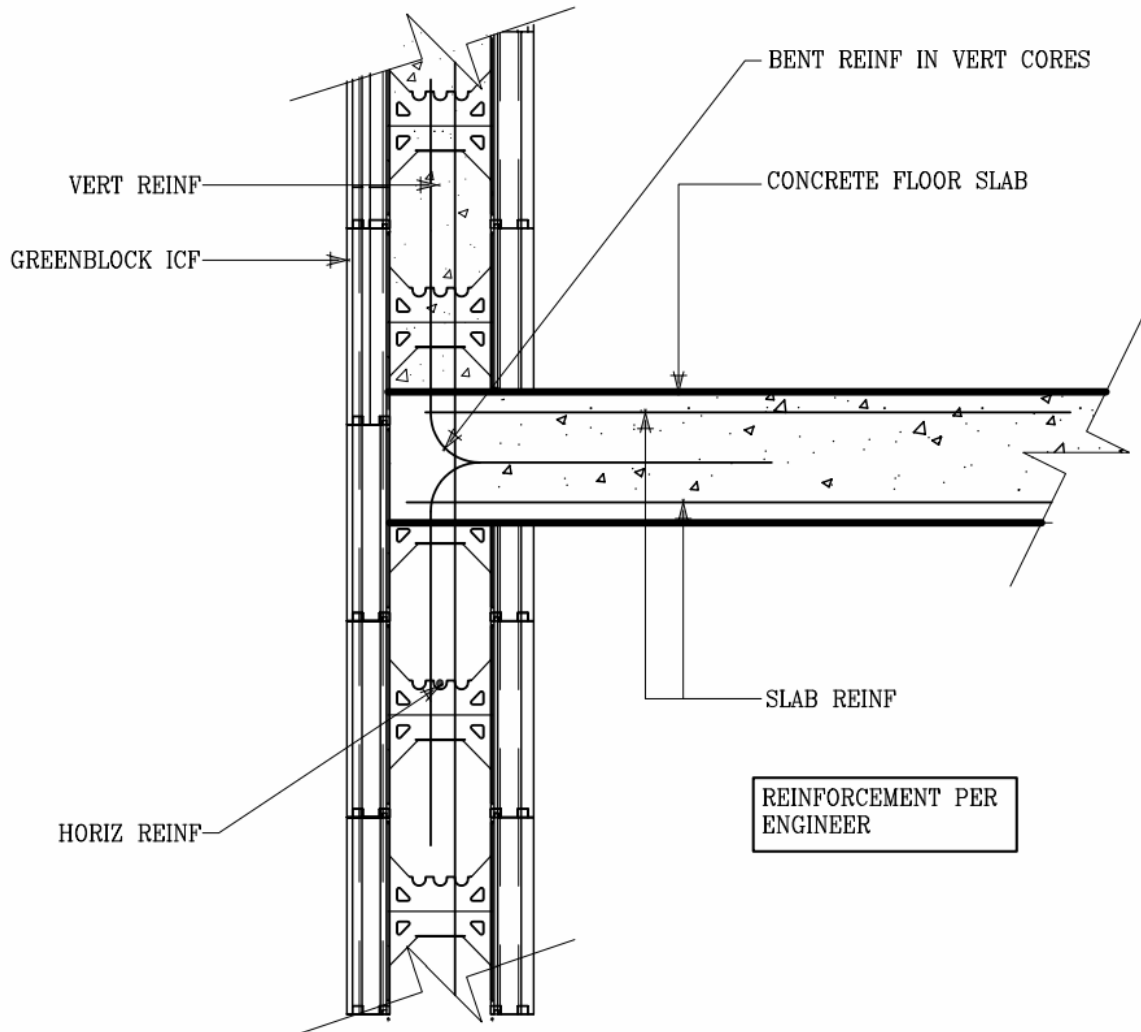


Figure 5 – Typical Wall-to-Floor Intersection for Types I, II, III and IV Construction