



Code Compliance Research Report CCRR-1060

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

REPORT HOLDER:
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REPORT SUBJECT:
Quad-Lock Insulating Concrete Forms (ICFs)

1.0 SCOPE OF EVALUATION

This Research Report addresses compliance with the following Codes:

- 2015, 2012, and 2009 *International Building Code®* (IBC)
- 2015, 2012, and 2009 *International Residential Code®* (IRC)

NOTE: This report references 2015 Code sections with [2012 and 2009] Code sections shown in square brackets where they differ.

Quad-Lock ICFs have been evaluated for the following properties:

- Physical properties
- Surface-burning characteristics
- Fire resistance
- Structural
- Use in Type V construction
- Exterior walls in Types I through IV construction
- Attic and crawl space fire evaluation

See Table I for applicable Code sections related to these properties.

2.0 USES

Quad-Lock Insulating Concrete Forms (ICFs) are used as stay-in-place formwork for structural concrete, loadbearing and non-loadbearing, below-grade and above-grade walls. The forms are used in construction of plain and reinforced concrete beams, lintels, exterior and interior walls and foundation and retaining walls in

Type V construction. The forms may also be used in Types I, II, III, or IV construction when installed in accordance with Section 4.10. The forms may be used in fire-resistance-rated construction, provided installation is in accordance with Section 4.9.

3.0 DESCRIPTION

3.1 General:

The Quad-Lock ICFs consist of two expanded polystyrene (EPS) foam plastic panels separated by injection-molded high density polyethylene (HDPE) cross-ties which are inserted into top and bottom edges of the EPS panels. Quad-Lock ICFs are shipped as components and are assembled on the jobsite.

The HDPE cross-ties maintain the EPS panels at fixed clear distances outlined in Section 3.3. Galvanized metal corner brackets are provided to reinforce corners, T-junctions and angles. Galvanized metal tracks are provided for optional use at the base and top of the walls to provide form alignment and resist concrete pressure. Metal wire top ties for optional use connect the panels with metal tracks at the top of the walls. See Figures 1 and 3 for illustration of the forms.

Quad-Lock forms are classified as a flat ICF wall system in accordance with IRC Section R608.3.1 [2012 - R611.3.1] [2009 - R611.3.1].

3.2 Foam Plastic Panels:

The EPS panels are 12 in. high, 48 in. long. Quad-Lock Regular Panels are 2-1/4 in. thick. Ultra Panels are 3-1/8 in. thick and Plus Panels are 4-1/4 in. thick. The Regular Panels have a nominal density of 1.9 pcf. Ultra and Plus Panels have a nominal density of 1.44 pcf. All panels have a flame-spread index of 25 or less and a smoke-developed index of 450 or less when tested in accordance with ASTM E84, and comply with ASTM C578 as Type II (for Ultra and Plus Panels) and Type IX (for Regular Panels). The EPS panels have pre-formed slots to receive tie flanges at both top and bottom edges and preformed interlock knobs to facilitate positioning of panels while stacking.



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3.3 Cross-Ties:

Quad-Lock HDPE cross-ties each consist of 4 tie flanges and two legs that span across the concrete cavity. The legs are joined to one another, 4 in. apart, to form a paired assembly. During assembly on-site, cross-ties are spaced at 12 in. on center along horizontal joints between panels, embedding half of each tie-flange into panels below. The panel above receives the upper half of tie flanges into molded slots at the bottom of the panel. The face of each tie flange is recessed from the outer face of EPS panels by 3/8 in. Legs of cross-ties have regular depressions along their top edge to assist in positioning horizontal reinforcing bars. Cross-ties are color-coded by length to assist in choosing the appropriate concrete cavity size. Tie color tints are black, blue, yellow, green, red, and brown. When used with Regular and Plus Panels cross-ties form cavities of 3-3/4 in., 5-3/4 in., 7-3/4 in., 9-3/4 in., 11-3/4 in., or 13-3/4 in.. When used with Ultra Panels, cross-ties maintain clear distances of 4 in., 6 in., 8 in., 10 in., and 12 in. Quad-Lock XT-Extender Ties are available to increase the standard wall widths by 12 in., and are tinted orange.

Optional ABS fastening strips are available to provide anchoring for exterior wall cladding or sidings. The ABS fastening strips are 1-1/2 in. wide by 10-7/8 in. tall, and are molded into the EPS panels every 12 in. on center.

Each flange is 1-1/2 in. wide by 4-7/8 in. high by 1/8 in. thick. Cross-tie flanges interlock with tops and bottoms of ABS fastening strips as each row is added.

3.4 Concrete:

Concrete must be normal-weight concrete complying with the applicable Code, and must have a maximum aggregate size of 3/4 in. for core thicknesses greater or equal to 7-3/4 in., and 3/8 in. for core thicknesses less than 7-3/4 in., and a minimum specified compressive strength of 2500 psi at 28 days for non-fire-resistance-rated construction, and 2900 psi for fire-resistance-rated construction. Under the IRC, concrete must comply with IRC Section R404.1 (foundation walls and retaining walls) and R608.5.2 [2012 - R611.5.1] [2009 - R611.5.1] (walls), as applicable.

3.5 Reinforcement:

Deformed steel reinforcement bars must have a minimum specified yield stress of either 40 ksi or 60 ksi,

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 R404.1.3.3.7 [2012 - R404.1.2.3.7] [2009 - R404.1.2.3.7] and R608.5.2 [2012 - R611.5.2] [2009 - R611.5.2].

4.0 DESIGN AND INSTALLATION

4.1 General:

Design and installation of Quad-Lock ICFs must comply with this report, the applicable Code, and the manufacturer's published installation instructions, which must be available at the jobsite at all times 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 Exception 1 of IBC Sections 1609.1.1 and 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 R608 [2012 - R611] [2009 - R611] and R404.1.3 [2012 - R404.1.2] [2009 - 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 R404.1.3 [2012 - R404.1.2] [2009 - R404.1.2] and R608.2 [2012 - R611.2] [2009 - R611.2], construction must be in accordance with the prescriptive provisions of the 2012 Prescriptive Design of Exterior Concrete Walls (PCA 100), or the structural analysis and design of the concrete must be in accordance with ACI 318 and IBC Chapters 16, 18 and 19.

4.3 Wall Construction:

The Quad-Lock ICF wall system must be supported on concrete footings complying with IBC Chapters 18 and 19, or IRC Chapter 4, as applicable.

Vertical reinforcement bars embedded in the footing must extend into the base of the wall system the minimum development length necessary for compliance with ACI 318, Chapter 12 (IBC) or IRC Section R611.5.1, as applicable. Vertical and horizontal reinforcement bars must have concrete protection in accordance with, and must be placed as required by, the design and the applicable Code. Additional reinforcement around doors and windows must be described in the approved plans. The panels must be installed according to the manufacturer's instructions, with the cross-ties placed in each row and spaced at a maximum of 12 in. on center. The ties must be vertically aligned in each row to support the interior and exterior finish materials. Placement of the panels must begin from any two corners proceeding to fill in between the corners to form an individual wall section.

Concrete quality, mixing, and placement must comply with IBC Section 1905 or IRC Sections R404.1.2.3 and R611.5.1, as applicable. Window and door openings must be built into the forms, with the same dimensions as the "rough stud opening" specified by the window or door manufacturer, prior to the placement of the concrete. Connections of concrete walls to footings, floors, ceilings and roofs must be in accordance with IRC Section R611.9, or be engineered in accordance with the IBC, whichever Code is applicable. Anchor bolts used to connect wood ledgers and plates to the concrete must be cast in place, with the bolts sized and spaced as required by design and the applicable Code. Details must be prepared to accommodate the specific job situation, in accordance with the applicable Code and the requirements of this report, subject to the approval of the Code official.

4.4 Interior Finish:

4.4.1 General: ICF units exposed to the building interior must be finished with an approved 15-minute thermal barrier, such as minimum 1/2 in. thick regular gypsum wallboard complying with ASTM C1396, installed vertically or horizontally and attached to the cross-tie flanges with minimum 1-5/8 in. long, No. 6, Type W, coarse-thread gypsum wallboard screws spaced 12 in. on center vertically and 12 in. on center horizontally.

The screws must penetrate a minimum of 1/4 in. through the flange. Gypsum board joints and screw heads must be taped and finished with joint compound in accordance with ASTM C840 or GA216.

4.4.2 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 and 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 Section 1203.4 [2012, 2009 – 1203.3] or IRC Section R408.1, as applicable.
- Attic ventilation is provided when required by IBC Section 1203 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 as described in Section 7.0 visible in every 160 square feet of wall area.

4.5 Exterior Finish:

4.5.1 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 Research Report. Under IRC, walls must be flashed in accordance with IRC Section R703.8. When the wall covering is mechanically attached to structural members, the wall covering must be attached to the flanges of the cross-ties or FS Strips with fasteners described in Table 3, having sufficient length to penetrate through the flange a minimum of 1/4 in.. The fasteners have an allowable fastener withdrawal and lateral shear strength as noted in Table 3.

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 3.

4.5.2 Below Grade: For below-grade applications, exterior wall surfaces must be dampproofed or waterproofed in accordance with IBC Section 1805 or IRC Section R406, as applicable. The material must be compatible with the ICF foam plastic units, and free of solvents, hydrocarbons, ketones, and esters that will adversely affect the EPS foam plastic panels. No backfill can 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.

4.6 Foundation Walls:

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

4.7 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.

4.8 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 [2012 - 2603.9] or IRC Section R318.4, as applicable. Areas of very heavy termite infestation must be determined in accordance with IBC Figure 2603.8 [2012 - 2603.9] or IRC Figure R301.2 (6).

4.9 Fire-resistance-rated Construction:

Walls constructed with Quad-Lock Regular form ICFs have fire-resistance ratings for bearing and nonbearing wall assemblies as shown in Table 2.

4.10 Installation in Buildings Required to be of Types I, II, III, and IV Construction:

4.10.1 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 4.10.2 through 4.10.4.

4.10.2 Interior Finish:

4.10.2.1 Buildings of Any Height: The ICFs must be finished on the interior with an approved 15-minute thermal barrier, such as 1/2 in. thick gypsum wallboard, as required by the IBC. The gypsum wallboard must be installed and attached as described in Section 4.3.1.

4.10.2.2 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.

4.10.3 Exterior Finish:

4.10.3.1 Buildings of Any Height: Except as allowed in Section 4.5.1, the ICFs must be finished on the exterior with materials described in Sections 4.10.3.1.1, 4.10.3.1.2 or 4.10.3.1.3. The ICFs must have at least one label as described in Section 7.0 visible in every 160 square feet of wall area prior to applying the wall covering.

4.10.3.1.1 Exterior Finish – EIFS and One-coat Stucco: EIFS and one-coat stucco wall coverings may be applied over the Quad-Lock ICFs, provided the wall covering system is recognized in a current Research 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 Research Report and the maximum mass of foam plastic per wall surface area [lbs/ft²] qualified in the wall covering evaluation report must be greater than 0.312 lbs/ft² (which is the mass of the EPS panel on the exterior side of the concrete wall). Acceptable EIFS wall coverings include the following:

- STO Corp., StoTherm Classic NexT EIFS, ICC-ES ESR-1748
- STO Corp., StoTherm Classic, StoTherm Essence, and StoTherm Premier Systems, ICC-ES ESR-1720
- BASF Corporation, Senerflex Wall System EIFS, ICC-ES ESR-1878
- BASF Corporation, Finestone Pebbletex System, ICC-ES ESR-2165
- BASF Corporation, AcroWall ES System, ICC-ES ESR-2164
- Dryvit Systems, Inc., Dryvit Outsulation System, ICC-ES ESR-1232.

Ignition properties in accordance with NFPA 268 must be provided to the Code official for the specific EIF system, as required by IBC Section 2603.5.7.

4.10.3.1.2 Exterior Finish – Brick Veneer: Anchored brick veneer must be attached to the exterior face of Quad-Lock ICF walls with approved masonry anchors extending into the concrete as required in the IBC. The 4 in. thick brick veneer must comply with the IBC and must be installed with a minimum 1 in. 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. The assembly satisfies the requirements for ignition under the exceptions to IBC Section 2603.5.7.

4.10.3.1.3 Exterior Finish – Plaster: Metal lath and exterior plaster or standard stucco shall comply with the requirements of the IBC and the exterior plaster must have a minimum thickness of 7/8 in. The lath shall be attached to the cross-tie flanges with fasteners as described in Section 4.4.1. The assembly satisfies the requirements for ignition under the exceptions to IBC Section 2603.5.7.

4.10.4 Fireblocking: For applications on buildings of any height, floor-to-wall intersections must be fireblocked in accordance with the IBC to prevent the passage of flame, smoke and hot gases from one story to another. The foam plastic on the interior side of the exterior walls and on both sides of interior walls must be discontinuous from one story to another. See Figure 4, Floor Connections for Type I - IV Construction (Typical). Details of typical floor-to-wall intersections must be shown on approved drawings.

4.11 Special Inspection:

4.11.1 IBC: Special inspection is required as noted in IBC Section 1705 [2009 - 1704] for placement of reinforcing steel and concrete, and for concrete cylinder testing.

When an EIFS wall covering is applied, special inspection is required in accordance with the evaluation report on the EIFS and with IBC Sections 1704 [2009 - 1704.1] and 1705.16 [2012 - 1705.15] [2009 - 1704.14 and 1704.12] is required.

4.11.2 IRC: For walls designed in accordance with Section 4.2.3 or PCA 100, 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 4.11.1.

5.0 CONDITIONS OF USE

The Quad-Lock Building Systems Ltd. Insulating Concrete Forms described in this Research Report comply with, or are suitable alternatives to, what is specified in those Codes listed in Section 1.0 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. In the event of a conflict between the manufacturer's instructions and this report, this report governs.

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 R608.1 [2012 - R611.1] [2009 - 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 R608.5.3 [2012 - R611.5.3] [2009 - R611.5.3] and R404.1.3.3.6 [2012 - R505.1.2.3.6] [2009 - 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 a 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.

5.5 Use of the ICF system in Types I, II, III, and IV construction must be as described in Section 4.10.

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

5.7 Special inspection must be provided in accordance with Section 4.11 of this report.

5.8 The Quad-Lock ICFs are manufactured in Surrey, British Columbia, Canada, and Villa Rica, Georgia, USA, under a quality control program with inspections by Intertek Testing Services NA, Inc. (AA-647).

6.0 SUPPORTING EVIDENCE

6.1 Reports of tests in accordance with ASTM E119 and ASTM E2634.

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

6.3 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), editorially revised October 2013.

6.4 Intertek Listing Report "[Quad-Lock Insulating Concrete Forms \(ICFs\)](#)".

7.0 IDENTIFICATION

The Quad-Lock Insulating Concrete Forms are identified by a label bearing the report holder's name (Quad-Lock Building Systems Ltd.), the manufacturing location, the lot number, the Intertek Mark, and the Code Compliance Research Report number (CCRR-1060).

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 of wall area.

When the forms are used in an attic or crawl space without an ignition barrier, the exposed inside face of the ICF must be labeled with the phrase "Acceptable for use in attics and crawl spaces". The label must be visible in every 160 square feet of wall area.

8.0 OTHER CODES

This section is not applicable.

9.0 CODE COMPLIANCE RESEARCH REPORT USE

9.1 Approval of building products and/or materials can only be granted by a building official having legal authority in the specific jurisdiction where approval is sought.

9.2 Code Compliance Research Reports shall not be used in any manner that implies an endorsement of the product by Intertek.

9.3 Reference to the <https://bpdirectory.intertek.com> is recommended to ascertain the current version and status of this report.

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TABLE 1 – PROPERTIES EVALUATED

PROPERTY	IBC SECTION	IRC SECTION
Physical properties	NA	R404.1.3.3.6.1 [2012 – R404.1.2.3.6.1] [2009 - R404.1.2.3.6.1]
Surface Burning Characteristics	2603.3 [2015 - 2603.4] [2009 - 2603.3]	R316.3
Fire resistance	703.2	R302.1
Structural	Chapter 19	Section R610
Exterior walls in Types I – IV construction	2603.5	NA

TABLE 2 – TWO, THREE, OR FOUR-HOUR FIRE-RESISTANCE-RATED WALL ASSEMBLIES⁴

WALL TYPE ¹	FIRE RESISTANCE	MINIMUM CONCRETE WIDTH	THERMAL BARRIER ^{3,4}	STEEL REINFORCEMENT ¹
Load Bearing ^{2,3,4,5,6} Max load 29,800 lbf/lin ft	2-Hour	3-3/4 in.	½ in. gypsum wallboard fastened 12 in. oc in field and 12 in. oc at perimeter	Vertical - #4 at 15-3/4 in. oc Horizontal - #4 at 12 in. oc
Load Bearing ^{2,3,4,5,6} Max load 29,800 lbf/lin ft	3-Hour	5-3/4 in.	½ in. gypsum wallboard fastened 12 in. oc in field and 12 in. oc at perimeter	Vertical - #4 at 15-3/4 in. oc Horizontal - #4 at 12 in. oc
Load Bearing ^{2,3,4,5,6} Max load 29,800 lbf/lin ft	4-Hour	7-3/4 in.	½ in. gypsum wallboard fastened 12 in. oc in field and 12 in. oc at perimeter	Vertical - #4 at 15-3/4 in. oc Horizontal - #4 at 12 in. oc
Nonbearing ^{3,4}	2-Hour	3-3/4 in.	½ in. gypsum wallboard fastened 12 in. oc in field and 12 in. oc at perimeter	Vertical - #4 at 15-3/4 in. oc Horizontal - #4 at 12 in. oc
Nonbearing ^{3,4}	3-Hour	5-3/4 in.	½ in. gypsum wallboard fastened 12 in. oc in field and 12 in. oc at perimeter	Vertical - #4 at 15-3/4 in. oc Horizontal - #4 at 12 in. oc
Nonbearing ^{3,4,5}	4-Hour	7-3/4 in.	½ in. gypsum wallboard fastened 12 in. oc in field and 12 in. oc at perimeter	Vertical - #4 at 15-3/4 in. oc Horizontal - #4 at 12 in. oc

¹Fire-resistance-rated wall assemblies are to be constructed using Regular panels as per Section 4.9

²Steel reinforcement is the minimum required for the design loads given.

³Concrete must be normal-weight concrete[(150-155 lb/ft³) with a minimum 2900 psi compressive strength.

⁴Fasteners to attach the gypsum wallboard thermal barrier must be 1-5/8-inch long No. 6, Type W, coarse-thread gypsum wallboard screws. See Section 4.3.1

⁵The wall assembly may be used as either an interior or exterior wall. When used as an interior wall, both sides of the form must be protected with gypsum wallboard.

⁶Design loads are based on 10-foot wall heights.

TABLE 3 – ALLOWABLE WITHDRAWAL AND LATERAL CAPACITIES OF FASTENERS IN CROSS-TIE FLANGES

Lateral (Shear) Strength Evaluation Summary		
Sample Designation		Allowable Lateral Strength (lb _r)
Substrate	Fastener Type ¹	
Cross-Tie Flanges	#9 Cement Board Fasteners	46
	#8 Drywall Screws	39
FS Fastening Strips	#9 Cement Board Fasteners	56

Withdrawal Strength Evaluation Summary		
Sample Designation		Allowable Withdrawal Strength (lb _r)
Substrate	Fastener Type ¹	
Cross-Tie Flanges	#9 Cement Board Fasteners	24
	#8 Drywall Screws	24
FS Fastening Strips	#9 Cement Board Fasteners	36

¹Fasteners must be of sufficient length to penetrate through the flange a minimum of 1/4 inch

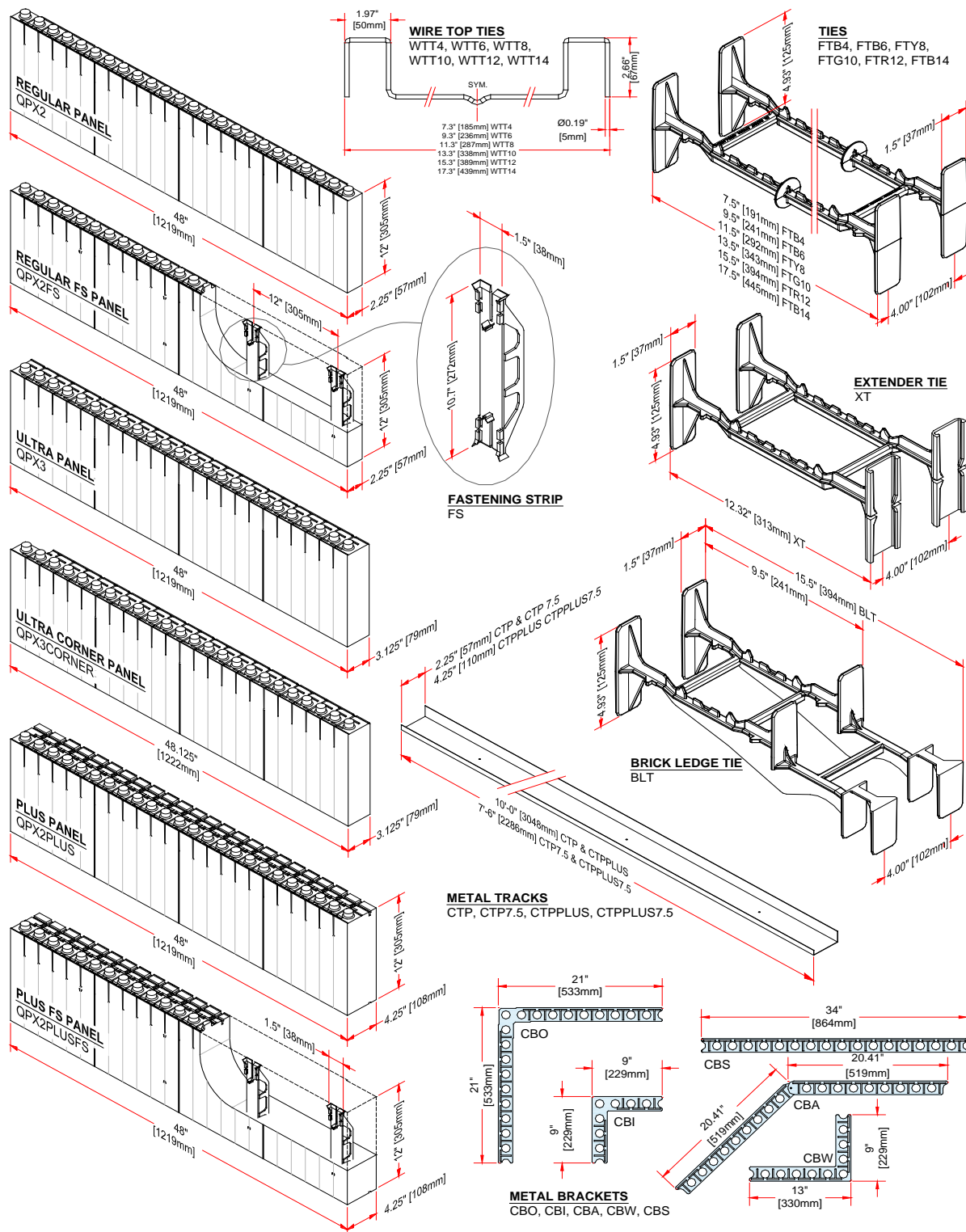


FIGURE 1 – QUAD-LOCK FORMS AND ACCESSORIES

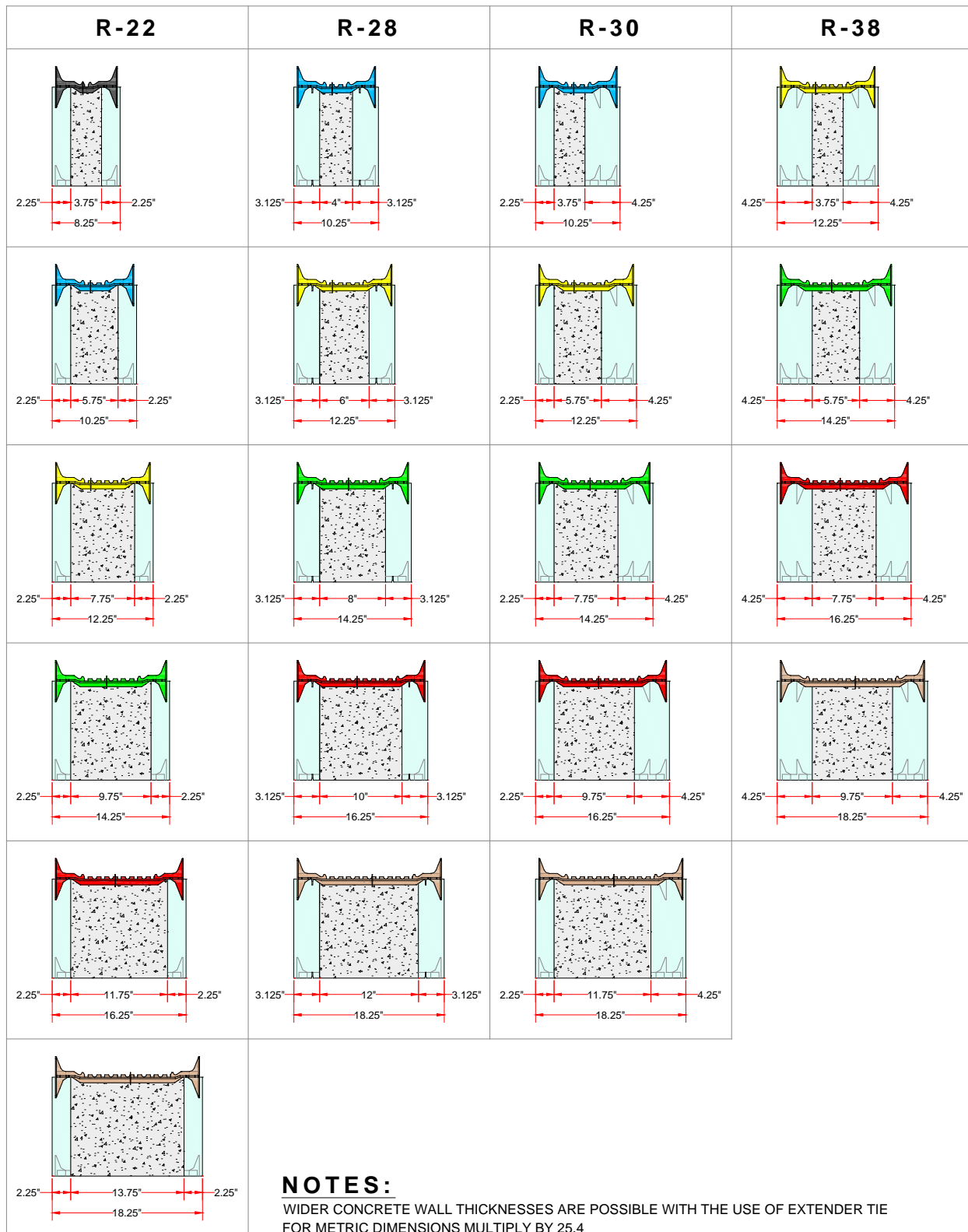


FIGURE 2 – QUAD-LOCK ICF WALL CONFIGURATIONS

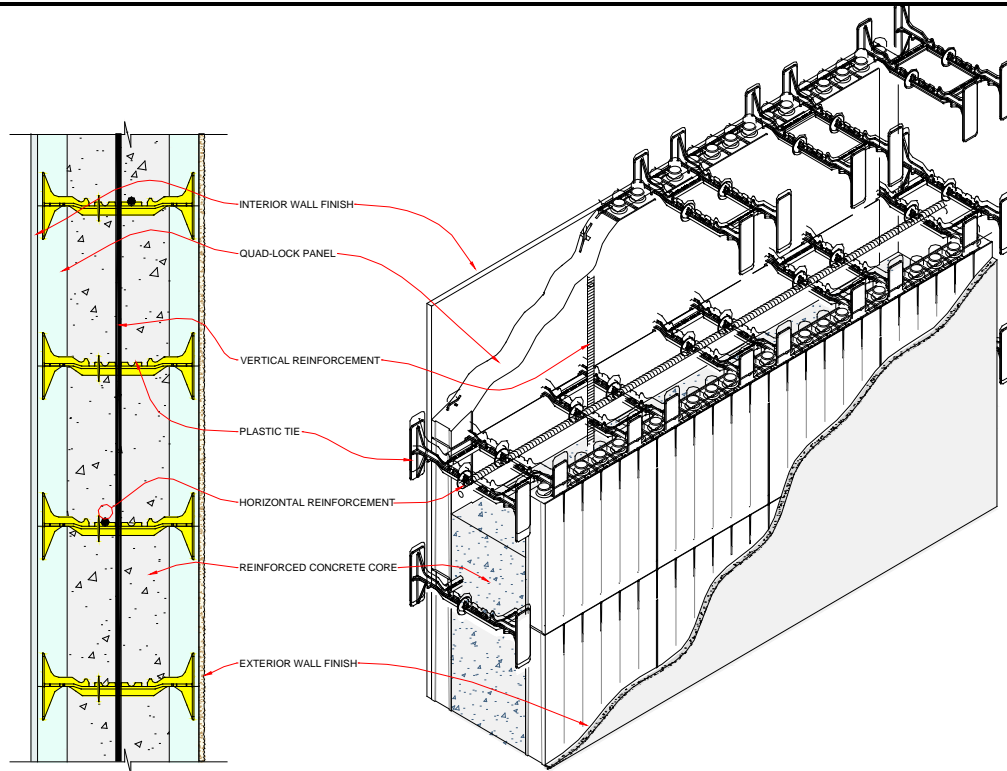


FIGURE 3 – QUAD-LOCK ICF WALL SYSTEM

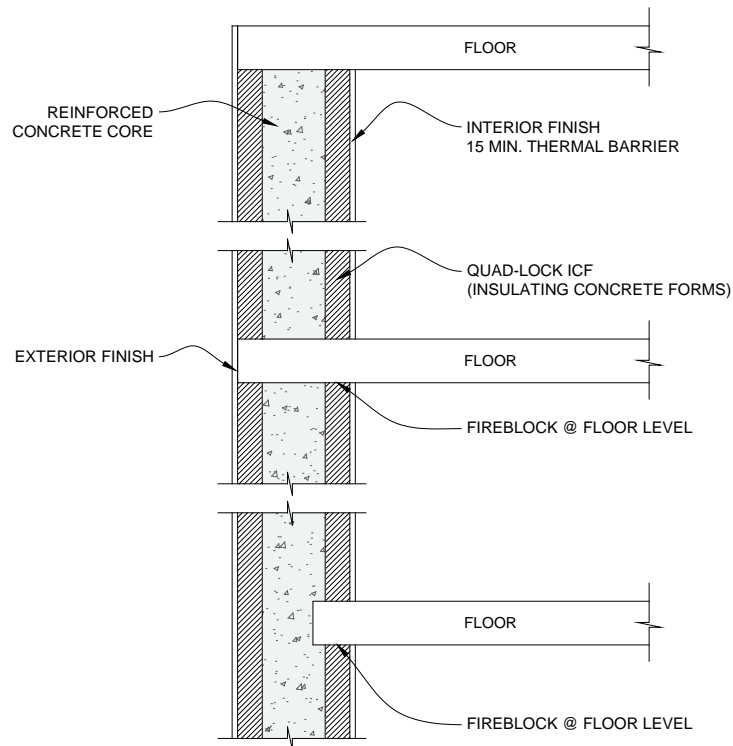


FIGURE 4 – FLOOR CONNECTIONS FOR TYPES I – IV CONSTRUCTION