DSA IR 19-6

FLAT WALL INSULATING CONCRETE FORM (ICF) CONSTRUCTION: 2025 CBC

Disciplines: All

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Division of the State Architect (DSA) documents referenced within this publication are available on the DSA Forms or DSA Publications webpages.

PURPOSE

This Interpretation of Regulations (IR) clarifies requirements, inspections, testing, and acceptance criteria for the use of flat wall insulating concrete forms (ICF) in cast-in-place concrete construction on projects under DSA jurisdiction.

SCOPE

This IR is applicable to flat wall ICF systems, which result in solid, flat reinforced concrete walls between insulation panels interrupted only by plastic or metal crossties. This type of ICF system is addressed in California Building Code (CBC) Section 1903A.3. This IR is not applicable to other ICF systems such as waffle grid, screen grid, and post-and-beam systems. Refer to the American Concrete Institute (ACI) Report on Design and Construction with Insulating Concrete Forms (ACI 560R) for further descriptions of different ICF systems.

ICF are, by nature, proprietary products with some degree of variation between different manufacturers. Additionally, new ICF products may result from future innovations unforeseen at the time of this writing. While this IR endeavors to address flat wall systems in a general sense applicable to products from multiple manufacturers, DSA will make the final determination of the applicability of this IR to any specific manufacturer's product.

BACKGROUND

Flat walls built with ICF systems are structurally designed and constructed similar to cast-in-place walls built using traditional removable forms. The wall assembly consists of reinforced concrete between two insulation panels that serve as formwork during concrete placement. The insulation panels are typically flame-resistant expanded polystyrene (EPS) material connected by plastic (i.e., polypropylene) or metal crossties. Depending on the specific product, flat wall ICF may be a block system, panel system, hinged system, or plank system. Refer to ACI 560R and specific product data for additional information.

ICF systems are commercially available to accommodate concrete wall thicknesses of 4, 6, 8, 10, and 12 inches with insulation panels ranging from 2-3/8 to 2-3/4 inches thick. In the commonly used block system, units are typically 12 to 24 inches tall, 48 to 96 inches long, and laid in running bond. The crosstie webs span the concrete core and connect to vertical crosstie flanges embedded within the insulation panels. The face of the flange is recessed from the outer face of the insulation panel, and the flange extends the full height of the wall to facilitate fastening of interior and exterior wall finishes. The crosstie webs are often designed to position and secure the horizontal steel reinforcement in the form cavity.

1. DESIGN

The design of flat wall ICF systems shall comply with the CBC, ACI Building Code Requirements for Structural Concrete (ACI CODE-318), and this section. In accordance with ACI CODE-318 Section 11.1.6, ICF walls are permitted in one- and two-story buildings only.

Refer to Sections 5 and 6 below for fire and life safety and access compliance requirements, respectively.

1.1 Evaluation Report

ICF systems shall be qualified by an evaluation report in accordance with *IR A-5: Product and Material Acceptance Based on a Valid Evaluation Report*.

1.1.1 The evaluation report shall document the compliance of the system with each of the following:

1.1.1.1 American Society for Testing and Materials (ASTM) E2634: Standard Specification for Flat Wall Insulating Concrete Form (ICF) Systems.

1.1.1.2 International Code Council Evaluation Service (ICC-ES) AC353: Acceptance Criteria for Stay-In-Place, Foam Plastic Insulating Concrete Form (ICF) Systems for Solid Concrete Walls.

1.1.2 The evaluation report shall qualify the system for use in the Seismic Design Category (SDC) of the project except as permitted in Section 1.3 below.

1.1.3 EPS panels shall comply with the requirements for foam plastic insulation per CBC Section 2603 and ASTM E2634.

1.2 Shear Strength

Crossties consist of webs that span horizontally across and interrupt the concrete core and vertical flanges embedded in the insulation panels on both sides. The structural engineer of record (SEoR) shall address the reduced shear strength resulting from the area of concrete displaced by the crosstie webs by calculating the percentage of effective concrete area in both the horizontal and vertical planes. The concrete area (A_{cv}) used to calculate shear strength per ACI CODE-318 Equation 18.10.4.1 shall be reduced by the most critical percentage.

1.3 Seismic Force Resisting System

The seismic design coefficients and factors given in American Society of Civil Engineers (ASCE) Standard 7: Minimum Design Loads and Associated Criteria for Buildings and Other Structures (ASCE 7), Table 12.2-1 for concrete shear wall systems are based on walls constructed with traditional formwork. Shear walls constructed with ICF have numerous closely spaced planes of discontinuity due to the presence of the crosstie webs; test data is lacking to demonstrate the equivalence of this construction with conventional shear walls. Consequently, concrete walls constructed with ICF and serving as the primary seismic force resisting system shall comply with one of the three design approaches set forth in this section.

1.3.1 ICF shear walls may be qualified for use as “special reinforced concrete shear walls” by the evaluation report. The report must document the compliance of the system with Section 3.2.3 (Item 8), Section 4.2.2.6, and all associated requirements of ICC-ES AC15: Acceptance Criteria for Concrete Floor, Roof and Wall Systems, and Concrete Masonry Wall Systems.

1.3.2 ICF shear walls may be designed as “special reinforced concrete shear walls” when approved by DSA as an alternative method of construction in accordance with California Administrative Code (CAC) Section 4-304. Prior to submission of the project and in accordance with Procedure (*PR) 18-01: Request for Alternate Design, Materials and Methods of Construction*, the project applicant shall submit and obtain DSA approval of a form *DSA 1-AMM: Request for Alternate Design, Materials and Methods of Construction*.

1.3.2.1 When substantiating test data is available, compliance with the Federal Emergency Management Agency (FEMA) publication, Quantification of Building Seismic Performance Factors: Component Equivalency Methodology (FEMA P-795), may be used to justify design as

a special reinforced concrete shear wall system.

1.3.2.2 DSA may require a peer review of the test data and documentation in accordance with FEMA P-795 Section 2.9. When required, the peer reviewer shall be acceptable to DSA.

1.3.3 In lieu of either approach in Section 1.3.1 or 1.3.2 above, DSA will permit a prescriptive design of the seismic force resisting system as follows:

1.3.3.1 In consideration of the lack of test data, the seismic design parameters, including the Response Modification Coefficient (R), Overstrength Factor (Ω_0), and Deflection Amplification Factor (C_d), used to determine the seismic force demand and associated seismic acceptance criteria shall be taken from ASCE 7 Table 12.2-1 for "ordinary reinforced concrete shear walls".

1.3.3.2 Because ordinary concrete shear walls are not permitted by ASCE 7 for buildings in SDC D, E, and F, the seismic force resisting system, including ICF walls, shall comply with all requirements for "special reinforced concrete shear walls" given in the CBC, ASCE 7, and ACI CODE-318.

1.4 Development and Lap Splice Lengths

The impact of the frequently spaced crosstie webs on the development and lap splice lengths of horizontal reinforcement bars shall be accounted for. DSA will consider this impact to be accounted for if the development and lap splice lengths are increased by the sum of the thicknesses of the crosstie webs that occur over the code prescribed lap length.

1.5 Construction Documents

The information listed in this section shall be shown on the DSA-approved construction drawings for projects with flat wall ICF systems. Should modification of any of this information be proposed or required during construction, approval of a construction change document (CCD) by DSA is required prior to proceeding with the modification. Refer to *IR A-6: Construction Change Document Submittal and Approval Process*.

1.5.1 Concrete mix design requirements (may by defined in the specifications).

1.5.2 Reinforcement placement requirements. See Section 2.3 below.

1.5.3 Location of vertical rebar splices.

1.5.4 Details specifying the attachment of wall finishes in accordance with Section 3.1 below including the following:

1.5.4.1 Spacing and edge distance of fasteners attached to the vertical crosstie flanges.

1.5.4.2 Requiring the contractor to mark the crosstie flange locations on the surface of the insulation board to ensure proper fastener edge distance is maintained.

1.5.4.3 Fastening details at horizontal joints and the termination of wall finishes when required due to the crosstie flange spacing exceeding fastener spacing requirements. Example locations include but are not limited to horizontal reveals, top of wall, top of door openings, top and bottom of windows, soffits, etc.

1.5.4.4 Alternative fastening details where cutting crossties is necessary to fit congested reinforcement (e.g., lintels, pilasters, wall corners, etc.) or due to other requirements.

1.5.5 Details specifying the attachment of nonstructural components supported by the wall in accordance with Section 3.2 below. When post-installed anchors are specified, details shall indicate any measures required to locate and avoid wall reinforcement and perform quality assurance testing (e.g., removal of insulation board, etc.).

1.5.6 Viewport locations per Section 4.3 below.

1.5.7 Details specifying insulation board repair if required for fire rating or thermal performance.

1.5.8 Mockup panel quantity, dimensions, thickness, and reinforcement configuration per Section 4.4 below. Drawings must indicate if the mockup panel is required to validate installation of exterior wall finishes.

2. INSTALLATION

ICF wall systems shall be installed in accordance with the CBC, DSA-approved construction documents, evaluation report, manufacturer's literature, and this section.

2.1 Erection

ICF systems shall be erected by installers qualified per Section 4.1 below.

2.1.1 Form alignment shall be maintained during erection and concrete placement.

2.1.2 In applications where crosstie flanges are used for the attachment of wall finishes, flanges shall be vertically aligned at all locations over the full height of the wall unless other methods are used and demonstrated (to the satisfaction of DSA) to achieve the positive fastening of finishes at all locations, including blind connections and offsets.

2.2 Concrete Mix

Due to the size and number of crossties in ICF systems, concrete flow is restricted and may cause voids within the concrete, especially in areas of congested reinforcement such as columns, pilasters, jambs, lintels, boundary elements, and wall corners.

2.2.1 The concrete mix shall have a minimum slump of 6 inches. DSA recommends a concrete mix design that yields "flowing concrete", which is defined by ACI Concrete Terminology (ACI CT) as "a cohesive concrete mixture with a slump greater than 7-1/2 inches".

2.2.2 The concrete mix design shall conform to ACI CODE-318 Section 26.4, ACI Specifications for Concrete Construction (ACI SPEC-301) Article 4.2.3, and ACI Guide to Evaluation of Strength Test Results of Concrete (ACI PRC-214).

2.2.3 Water reducing admixtures shall comply with ASTM C494: Standard Specification for Chemical Admixtures for Concrete.

2.2.4 The concrete mix shall demonstrate the ability to be properly placed and consolidated without segregation or rock pockets through the construction of mockup panels per Section 4.4 below. The concrete mix shall be adjusted if segregation or rock pockets are discovered during examination of mockup panels, unless a separate cause is determined and addressed (e.g., consolidation methods).

2.2.5 The maximum aggregate size shall be 3/8-inch unless larger aggregate is expressly permitted by the evaluation report. ←

2.3 Reinforcing Steel Placement

Reinforcing steel placement shall comply with ACI CODE-318 Section 26.6.2.

2.3.1 Vertical and horizontal reinforcing steel shall be secured to prevent movement and dislodgement during concrete placement.

2.3.2 If vertical and horizontal reinforcing steel is not tied together as recommended by the Placing Reinforcing Bars handbook published by the Concrete Reinforcing Steel Institute (CRSI), it shall be demonstrated through the mockup panels that the reinforcement bars have not displaced during concrete placement. Destructive investigation (i.e., cutting, coring, or chipping as required) of the mockup panels shall demonstrate the reinforcement bar positions

are maintained within the tolerances required by ACI 318 Section 26.6.2.

2.3.3 Wet stabbing and wet setting of reinforcing bars is not permitted.

2.3.4 The method of securing bars and splice locations of vertical bars per Section 1.5.3 above shall be coordinated with the type of ICF system and construction joint locations.

2.4 Concrete Placement

Concrete shall be placed in a manner to avoid segregation, and to thoroughly work material around reinforcement, embedded fixtures, and into the corners of forms.

2.4.1 The maximum pour height shall be 4-feet per day. All pours shall be consolidated.

2.4.2 It is the contractor's responsibility to select the appropriate means of consolidation and ensure the cured concrete is free of voids, honeycombs, and other structural deficiencies.

2.4.3 All mechanical vibrators shall be checked before starting work and periodically during construction to verify their proper function and ensure the work is not interrupted due to equipment failure.

2.4.4 Between pours, a horizontal construction joint shall be formed by stopping the pour 1-1/2 inches below the top of ICF forms. Construction joints shall be cleaned and roughened per ACI CODE-318 Section 18.10.10.

2.4.5 Supplemental backing or other means of form bracing shall be provided at all locations where the crossties are cut or damaged and at blow out locations.

2.5 Repair of Defective Work

When defective concrete or wall construction is identified within the ICF system, the design professionals shall prepare a CCD to specify the required repair work and any associated tests and inspections. In accordance with IR A-6, the CCD shall be reviewed and approved by DSA prior to commencing with the repair work.

3. ATTACHMENT OF NONSTRUCTURAL COMPONENTS

The ICF system shall not support any structural loads or be used to seat any fasteners (e.g., screws, bolts, etc.) except as expressly permitted by its evaluation report.

3.1 Wall Finishes

Attachment directly to the EPS insulation panels is not permitted. Many interior (e.g., drywall) and exterior (e.g., metal lath and plaster) wall finish materials may be attached to the vertical crosstie flanges when permitted by the evaluation report and manufacturer's recommendations and installed in accordance with this section.

3.1.1 Adhered masonry veneer applied directly to the EPS insulation panels is not permitted per CBC Section 1403.4.

3.1.2 Anchored masonry veneer fastened to the vertical crosstie flanges is not permitted per CBC Section 1403.4. Anchored veneer must be anchored directly to the concrete wall.

3.1.3 Fasteners supporting approved wall finishes shall be substantiated by structural calculations to resist code prescribed loads. Fastener capacity shall be as listed in the evaluation report. Additionally, fasteners shall comply with the following:

3.1.3.1 Fastener type, size, and load capacity shall be listed in the ICF system evaluation report. Capacities shall be adjusted in accordance with IR A-5 Section 3.2 when applicable.

3.1.3.2 Fastener type and spacing in both the vertical and horizontal directions for lath and plaster systems shall comply with ASTM C1063: Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.

3.1.4 Where cross ties have been cut or damaged, wall finishes shall be fastened directly to the concrete wall. Supplemental details per Section 2.5 above may be required.

3.1.5 It is recognized that plastic can become brittle at extreme low temperatures (i.e., the glass transition temperature), which may compromise the expected fastener performance under code prescribed loads over the life of the structure. The design of fasteners for exterior wall finishes to crosstie flanges shall account for the local historical extreme low temperatures. At sites with a ground snow load greater than zero, the following documentation is required:

3.1.5.1 The design professional shall obtain the historical extreme low temperature from the local authority where the project site is located. In lieu of documentation from the local authority, the design professional may provide a letter confirming the extreme low temperature from a nationally recognized weather service agency (e.g., the National Oceanic and Atmospheric Administration).

3.1.5.2 The design professional shall obtain from the ICF manufacturer the continuous service temperature ranges for which the fastener capacities as published in the evaluation report are applicable and for which the ICF plastic can maintain continuous service.

3.1.5.3 If the local historical extreme low temperature is beyond the limits of the ICF manufacturer's reported continuous service temperatures, the wall finishes shall be secured directly to concrete or a code recognized backing material.

3.1.5.4 A copy of the documents from the ICF manufacturer and those defining the extreme low temperature shall be provided to DSA with the initial project submission.

3.1.6 Where the locations of the vertical crosstie flanges cannot be adequately marked or re-marked thereby hindering verification of proper fastener installation as determined by the mockup panel program described in Section 4.4 below, alternative means for wall finish attachment shall be designed and detailed. If alternative details were not included on the original DSA-approved construction drawings they shall be submitted, reviewed, and approved as a CCD in accordance with IR A-6.

3.2 Building Components

Building components greater than 20 pounds shall be anchored to the concrete wall with cast-in-place anchors, post-installed anchors, or blocking attached directly to the concrete wall.

3.2.1 Calculations of anchor capacity shall account for the eccentricity resulting from the thickness of the insulation panel when applicable.

3.2.2 Concrete protrusions or extensions from the wall surface intended to provide structural support and anchorage for nonstructural components shall be designed and detailed as corbels or other code recognized structural elements.

4. QUALITY ASSURANCE

Special inspections, sampling, and testing of concrete wall construction materials shall be in accordance with ACI CODE-318 Sections 26.12 and 26.13 as modified by CBC Section 1705A.3, Table 1705A.3, Section 1909A.1.16, and Section 1910A. Additionally, the following requirements apply.

4.1 Installer Qualifications

The contractor shall provide personnel qualified in accordance with this section.

4.1.1 ICF system installers shall be trained by the ICF manufacturer when required by the evaluation report or installation manual. Proof of training shall be provided to the school district, design professional in general responsible charge, and project inspector prior to the start of laying forms.

4.1.2 Wall finish installers shall be trained by the ICF manufacturer when required by the evaluation report or installation manual. Trained installers should be able to recognize when a fastener is properly attached to the vertical crosstie flange.

4.2 Inspection

Continuous inspection by the project inspector or a special inspector certified by a state or nationally recognized organization accepted by DSA is required. All aspects of the ICF construction shall be inspected. Special attention must be given to the following actions required of the inspector:

4.2.1 Prior to concrete placement, verify cross tie flanges are aligned vertically for the full height of the wall at all locations. This verification facilitates the installation of wall finish fasteners to the crosstie flanges.

4.2.2 Verify crosstie webs and flanges are not cut unless specifically permitted by the DSA-approved construction drawings.

4.2.3 Verify installation of fasteners for wall finishes to the crosstie flanges including fastener type, size, spacing, and edge distance on the flange. The project inspector, special inspector, or lab technician working under the supervision of the project inspector or special inspector shall independently verify the fasteners of exterior wall finishes as follows:

4.2.3.1 Turn the fastener with a screwdriver and confirm engagement into the crosstie flange by verifying the fastener does not spin freely indicating it has missed the flange.

4.2.3.2 Verification by screwdriver shall be performed on 20 percent of the first 1,600 fasteners, 10 percent of the next 1,900 fasteners, and 5 percent of all fasteners thereafter.

4.2.3.3 If any fastener is found to have missed the crosstie flange, all previously unchecked fasteners installed by the same person shall be verified until 20 consecutive fasteners are found acceptable, after which the verification frequency of Section 4.2.3.2 above can be resumed.

4.2.3.4 All fasteners without proper engagement to the crosstie flange shall be replaced.

4.2.4 Verify ICF wall construction matches the accepted mockup panels including the following characteristics. Refer to Section 4.4 below for mockup panel requirements.

4.2.4.1 Same personnel performing the work.

4.2.4.2 Same materials and concrete mix design.

4.2.4.3 Same concrete placement and consolidation procedures.

4.3 Verification of Concrete Consolidation

Unlike concrete construction with conventional formwork, the insulation panels of ICF construction are not removed after concrete curing thus preventing visual inspection for surface voids. To compensate for the preclusion of this special inspection, the concrete work shall be verified in local regions by removing portions of insulation board to create “viewports” as described in this section.

4.3.1 Concrete consolidation shall be verified through viewports, which are created by cutting and removing sections of the insulation panels between crosstie flanges. Viewports shall be at least 6-inch by 12-inch.

4.3.2 The SEoR shall select the locations for viewports and show them on the construction drawings. Viewports shall be provided at typical walls and special conditions at the frequencies indicated below.

4.3.3 At typical walls, three viewports shall be provided per wall elevation and for each 5,000

square feet (SF) of wall surface area.

4.3.4 At special conditions prone to greater congestion of reinforcement such as wall corners, pilasters, lintels, columns, wall boundary elements, and window/door openings, viewports shall be provided in at least 25 percent of each element type with a minimum of five per type.

4.3.5 Additional viewports will be required when voids or significant cracks are discovered. A CCD shall be prepared by the design team and approved by DSA to define the scope of additional viewports. Defective concrete shall be repaired in accordance with Section 2.5 above.

4.3.6 The following examples illustrate determination of the required number of viewports:

4.3.6.1 A typical wall with a surface area of 400 SF requires three viewports: minimum three viewports per elevation.

4.3.6.2 A typical wall with a surface area of 6,000 SF requires four viewports: 6,000 SF x 3 viewports per 5,000 SF = 3.6, rounded up to four viewports.

4.3.6.3 A building with 60 pilasters (special condition) requires 15 additional viewports for pilasters: 25 percent of 60 pilasters = 15 viewports.

4.3.6.4 A building with 14 pilasters (special condition) requires five additional viewports for pilasters: 25 percent of 14 pilasters = 3.5, rounded up to four, with a minimum of five viewports per special condition type (pilasters).

4.4 Preconstruction Mockup Panels

ICF mockup panels shall be constructed, inspected, and tested prior to construction of permanent ICF walls in accordance with this section. The objectives of the mockup panel program are to ensure proper concrete consolidation, validate the installation procedure, confirm reinforcement bar positions remain within the tolerances required by ACI CODE-318 when Section 2.3.2 above applies, and demonstrate adequate attachment of exterior wall finishes to the vertical crosstie flanges when applicable.

4.4.1 The project inspector and special inspector (when applicable) shall be present during the construction of the mockup panels.

4.4.2 Mockup panels shall have a minimum width of 10-feet and a minimum height of 4-feet. A minimum of two mockup panels shall be prepared for each thickness of concrete wall.

4.4.3 Mockup panels shall be representative of the specified design and include reinforcing configurations representing the most congested conditions (e.g., columns, pilasters, lintel, jamb, wall corners, etc.).

4.4.4 Mockup panels shall be constructed by the same personnel with the same equipment as the permanent ICF wall construction.

4.4.5 Mockup panels shall be constructed with the same mix design to be used in the permanent ICF wall construction. If multiple mix designs are considered or will be used, separate mockup panels shall be constructed for each.

4.4.6 When required by the construction documents (see Section 1.5.7 above), wall finishes shall be installed on the mockup panel to demonstrate adequate marking of crosstie flanges and installation of fasteners. ←

4.4.7 After concrete placement and curing, the insulation shall be removed from the mockup panels in its entirety. Concrete surfaces shall be thoroughly inspected for voids, segregation, and other defects. The inspector shall use a hammer to perform impact sounding and check for internal delamination.

4.4.8 After removal of insulation, the mockup panels shall be cored, sawn, and examined to

determine the adequacy of concrete consolidation and reinforcement bar position.

4.4.9 A minimum of 3 core samples shall be taken from each mockup panel and tested for compressive strength by the laboratory of record.

4.4.10 Results of the examination and tests described above shall be reviewed by the SEoR and submitted to DSA. The SEoR shall notify DSA of acceptance or rejection of the preconstruction mockup panel results. ←

4.4.11 Permanent ICF wall construction may commence upon acceptance of the mockup panel results by the SEoR and DSA concurrence.

4.4.12 Rejection of the mockup panel results by the SEoR will require adjustment to the construction and additional mockup panels for further validation.

5. FIRE AND LIFE SAFETY

When a fire-resistance-rating is required of the wall based on the type of construction or other provisions in the CBC, fire resistive ratings shall be as indicated in the evaluation report in accordance with IR A-5 or another listing by a nationally or State Fire Marshal (SFM) recognized testing laboratory. The manufacturer's supporting test data and associated restrictions on the use of their products in fire-resistance-rated assemblies shall be submitted to DSA.

The plans shall include a manufacturer's construction and installation detail and tested assembly number for fire-resistance-rated assemblies from a nationally or SFM recognized testing laboratory. The components and installation details shall conform in every respect with the listed detail and number, or applicable evaluation report. Details shall clearly depict all components, including insulation materials, framing, and attachment of the design so that the assembly can be constructed and inspected accordingly.

6. ACCESS COMPLIANCE

The total wall thickness may affect door maneuvering clearances at recessed doors and gates; refer to CBC Section 11B-404.2.4.3. Appropriate details shall be provided on the plans to assure compliance with all applicable code requirements.

REFERENCES:

2025 California Code of Regulations (CCR) Title 24
California Building Code (CBC), Sections 11B-404, 1613A.2.5, 1705A.3, 1903A.4, 1903A.5, and 2603.