



# ICC-ES Evaluation Report ESR-4725

Issued May 2023

This report is subject to renewal May 2024.

**DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES**

**Section: 06 12 00—Structural Panels**

**REPORT HOLDER:**

**BOXABL**

**EVALUATION SUBJECT:**

**BOXABL STRUCTURAL INSULATED PANELS (SIPs)**

## 1.0 EVALUATION SCOPE

**Compliance with the following codes:**

- 2021 and 2018 *International Building Code*® (IBC)
- 2021 and 2018 *International Residential Code*® (IRC)

For evaluation for compliance with codes adopted by the Los Angeles Department of Building and Safety (LADBS) see [ESR-4725 LABC and LARC Supplement](#).

**Properties evaluated:**

- Structural
- Thermal Barrier
- Weather Resistive Barrier
- Seismic Performance

## 2.0 USES

### 2.1 General.

Boxabl Structural Insulated Panels (SIPs) are used as load-bearing wall, floor, and roof panels capable of resisting transverse, axial and in-plane shear loads. Boxabl SIPs are only used in Boxabl Casitas, factory-built structures using the proprietary Boxabl connection system.

### 2.2 Construction Types

The Structural Insulated Panels shall be considered combustible building elements when determining the construction type in accordance with IBC Chapter 6.

### 2.3 Fire Resistive Assemblies

Structural Insulated Panels have not been evaluated in fire-resistance-rated construction.

## 3.0 DESCRIPTION

### 3.1 General:

Boxabl Structural Insulated Panels are factory-laminated sandwich panels consisting of one steel facing and one magnesium oxide panel facing with an expanded polystyrene (EPS) foam core. The Structural Insulated Panels are available in 6 inch (152.4 mm) thick wall panels and 7.5 inch (190.5 mm) thick roof and floor panels.

### 3.2 Material:

**3.2.1 Expanded Polystyrene:** The EPS foam plastic core complies with ASTM C578, Type I. The EPS foam plastic has a flame-spread index not exceeding 25 and a smoke-developed index not exceeding 450 when tested in accordance with ASTM E84.

**3.2.2 Exterior Facing:** The exterior facing material has a minimum yield strength of 50 ksi (345 MPa) 24 ga. (0.0289 inch or 0.73 mm) Steel with a G60 galvanization coating and a primer paint. The steel facing is 57 inches (1447.8 mm) wide and the full height of the structural insulated panel. The edges of the facings are hemmed and bent with a design to allow interlocking between each panel as shown in Figure 1. The ends of the facings are hemmed and bent to allow the metal to insert into a slot in the end caps of the wall and roof panels as shown in Figure 2.

**3.2.3 Interior Facing:** The interior facing material is 0.236-inch (6 mm) thick magnesium oxide (MgO) board complying with ICC-ES Acceptance Criteria for Fiber-Reinforced Magnesium-Oxide-Based Sheets (AC386). The boards are 48 inches (1219.2 mm) wide and the full height of the structural insulated panel.

**3.2.4 Adhesive:** The adhesives comply with Type II, Class 2, performance requirements set forth in the ICC-ES Acceptance Criteria for Sandwich Panel Adhesives (AC05).

**3.2.5 Panel Seams:** Boxabl SIP walls, floors and roofs have seams in the facings, and core material. Seams between EPS core, steel facing and MgO facings are staggered such that there are no continuous joints from outside facing to inside facing (see Figure 3). Metal facings are hemmed together with folded edges which fit inside each other as shown in Figure 1. MgO seams have an additional MgO backer connecting the two panels.

**3.2.6 Panel Joints:** Wall to wall, wall to roof, wall to floor connections are made through PVC connector plates

designed to interlock and seal with each other. The joints are detailed in Figure 6.

**3.2.6.1 Edge and End Plates:** Boxabl SIP wall and roof ends and edges use PVC profiles attached to 2.0E LVL members embedded in the panels to connect and seal between panels. Additional PVC profiles are used for connections at wall-to-wall corners and wall-to-roof or floor corners (Figure 4).

**3.2.6.2 Hinges:** Boxabl Casita's use hinged connections at wall-to-wall panel connection and roof-to-roof panel connections to accommodate the Casita folding design.

**3.2.6.3 EPDM Seals:** Boxabl uses EPDM seals between the PVC profiles as part of the system of sealing the joint between walls, roofs and floors. (See Figure 5)

## 4.0 DESIGN AND INSTALLATION

### 4.1 Design:

Boxabl Structural Insulated Panels are manufactured specifically for use in Boxabl Casita factory-built structures. Panels are interconnected using proprietary hinged connections and interlocking PVC profiles and seals. Boxabl wall, roof, and floor SIPs are limited to the allowable loads and loading conditions indicated in Tables 1 through 4 of this report.

The seismic-force-resisting system of structures consisting of the panels as shear walls, in whole or in part, must be designed and detailed in accordance with the IBC.

Where loading conditions result in the panels resisting combined stresses, the sum of the ratios of actual load over allowable load must be less than 1.0.

Use of roof and floor panels to resist lateral forces as diaphragms is outside scope of this report.

**4.2 Installation:** Boxabl SIPs must be installed in accordance with the manufacturer's published installation instructions, this evaluation report and the plans and specifications approved by the code official. A copy of the instructions must be available at all times on the jobsite during installation.

**4.3 Panel Connections:** Boxabl panel to panel connections are accomplished through mating PVC connectors described in Section 3.2.6.1 and shown in Figures 4 through 6. Panel to panel connections are secured using 10-inch-long (254 mm) SIPLD-1000 Fasteners spaced a minimum of 10 inches (254 mm) on center fastened into end and edge cap plates. Capacity of the panel to panel connections must be designed by a registered design professional.

**4.4 Cutting and Notching:** No field cutting or routing of the panels shall be permitted except as shown on approved construction documents.

**4.5 Heat-Producing Fixtures:** Heat producing fixtures shall not be installed in the panels unless protected by a method approved by the code official or documented in test reports.

**4.6 Plumbing Installation Restrictions:** Plumbing and waste lines may extend at right angles through the wall panels but are not permitted vertically within the core. Lines shall not interrupt splines or panel plates unless approved by a registered design professional.

**4.7 Voids and Holes:** Voids may be provided in the panel core during fabrication at predetermined locations only. Voids parallel to the panel span shall be limited to a single 1-1/2 inch (38.1 mm) maximum diameter hole. Such voids shall be spaced a minimum of 4 feet (1219 mm) on-center

measured perpendicular to the panel span. Voids perpendicular to the panel span shall be limited to a single 1-1/2 inch (38.1 mm) maximum diameter hole placed not closer than 15-1/4 inches (387.4 mm) from the support.

**4.8 In-Plane Shear Design:** Shear walls utilizing Boxabl SIPs shall be sized to resist all code required wind and seismic loads without exceeding the allowable loads provided in Table 3 or Table 4, as applicable. Shear walls are constructed in one piece with top and bottom cap plates. Shear wall chords, hold-downs and connections to transfer shear forces between the wall and surrounding structure shall be designed in accordance with accepted engineering practice.

**4.8.1 Special Inspections:** SIP shear walls installed in buildings in IBC Seismic Design Categories C, D, E and F; Seismic Design Categories C, D<sub>0</sub>, D<sub>1</sub>, D<sub>2</sub> and E for townhouses under the IRC; or Seismic Design Categories D<sub>0</sub>, D<sub>1</sub>, D<sub>2</sub> and E for detached one-and two-family dwellings under the IRC, periodic inspections of the fastening and anchoring of the shear wall assembly within the seismic-force-resisting system must be provided. Inspection must include connections of the assemblies to drag struts and hold-downs, in accordance with 2021 IBC Section 1705.13 and 2018 IBC Section 1705.12

**4.8.2 Seismic Design Categories A, B, and C:** Use of the shear wall configurations in Table 3 is limited to structures in Seismic Design Categories A, B, and C, where SIPs are used to resist seismic forces the following factors shall be used for design: Response Modification Coefficient  $R = 2.0$ ; System Overstrength Factor,  $\Omega_0 = 2.5$ ; Deflection Amplification Factor,  $C_d = 2.0$ . The maximum panel height-to-width ratio shall be 1:1. Building height is limited by IBC Section 503 and 504.

**4.8.3 Seismic Design Categories D, E, and F:** Shear wall configurations in Table 4 may be used in Seismic Design Categories A through F. The following factors shall be used for design to resist seismic forces: Response Modification Coefficient  $R = 6-1/2$ ; System Overstrength Factor,  $\Omega_0 = 3$ ; Deflection Amplification Factor,  $C_d = 4$ . The maximum panel height-to-width ratio shall be 1:1. In Seismic Design Categories D through F, building height shall be the lesser of 65 ft and IBC Sections 503 and 504. The axial capacity of shearwalls used in Seismic Design Categories D, E, and F is limited to 11 percent of the value in Table 2.

**4.9 Roof Exterior:** Boxabl SIP roofs shall be protected by an approved roof covering.

**4.10 Wall Exterior:** Boxabl SIPs installed and sealed in accordance with this report and the manufacturer's installation instructions meet the requirements of IBC Section 1402.2 Exception 2 and do not require additional weather protection.

**4.10.1 Sealing Panel Joints:** EPDM seals (Figure 6) are used in all PVC profiles connecting panels at corners and at wall-to-wall, roof-to-roof, and floor-to-floor.

**4.10.2 Sealant:** A 3/8-inch (9.5 mm) bead of DAP Dynaflex 230 sealant is applied outboard of each EPDM seal. A 3/8-inch (9.5 mm) bead of DAP Dynaflex 230 sealant is applied between door and window flanges and the exterior SIP facing.

**4.11 Interior Finish:** Boxabl SIPs wall and roof panels have a Class A interior finish when tested in accordance with ASTM E84 and have been tested in accordance with IBC 2603.9 and meet the requirements of 2603.4.1.14 and do not require the additional thermal barrier as specified in IBC 2603.4.

**5.0 CONDITIONS OF USE**

The Boxabl Structural Insulated Panels described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 Boxabl SIPs are fabricated, identified, and erected in accordance with this report and the manufacturer’s published installation instructions. If there is a conflict between this report and the manufacturer’s instructions, the more restrictive governs.
- 5.2 Design loads to be resisted by the SIP must be determined in accordance with the IBC or IRC, as applicable, and must not exceed the allowable loads noted in this report.
- 5.3 This report applies only to the panel thicknesses and lengths specifically listed herein.
- 5.4 The SIPs are limited to use in buildings of Type V construction.
- 5.5 Wood-based materials must be protected from decay and termite damage in accordance with IBC Section 2304.12 and IRC Section R317.
- 5.6 Shear walls constructed of SIPs, used in buildings in Seismic Design Categories C through F, must be subject to special inspection in accordance with Section 4.8.1.
- 5.7 Shear walls used in seismic design categories D through F collectors and their connections, bearing and anchorage of the Lateral Force Resisting Vertical Assemblies (LFRVA) and the lateral load path to the LFRVA are designed in accordance with the special

load combinations of Section 12.4.3 of ASCE/SEI 7, using  $E_m$ , where  $E_m$  is computed using the maximum observed overstrength of the LFRVA test specimens of the specific LFRVA configuration.

- 5.8 The Boxabl SIPs are manufactured under a quality control program with inspections by ICC-ES.

**6.0 EVIDENCE SUBMITTED**

- 6.1 Data in accordance with the ICC-ES Acceptance Criteria for Sandwich Panels (AC04), dated June 2019 (editorially revised December 2020).
- 6.2 Reports of fire testing in accordance with NFPA 286.
- 6.3 Report on resistance to water penetration in accordance with ASTM E331 and IBC Section 1402.2 Exception 2.
- 6.4 Reports of cyclic racking shear load testing in accordance with ASTM E2126.

**7.0 IDENTIFICATION**

- 7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-4725) along with the name, registered trademark, or registered logo of the report holder must be included in the product label.
- 7.2 In addition, each Boxabl SIP is marked with the project or batch number, and the manufacturing location.
- 7.3 The report holder’s contact information is the following:

**BOXABL**  
**5345 EAST NORTH BELT ROAD,**  
**NORTH LAS VEGAS, NEVADA 89115**

**Table 1: Transverse Load Capacity (psf)**

Panel Configuration	L/180	L/240	L/360
Floor and Roof Panel, Positive Wind Load <sup>1,3</sup> (113.875-inch long)	31.3	31.3	31.3
Floor and Roof Panel, Negative Wind Load <sup>2,3</sup> (113.875-inch long)	86.7	86.7	63.5
Wall Panel, Positive Wind Load <sup>1,4</sup> (113.875-inch long)	38.3	38.3	38.3
Wall Panel, Negative Wind Load <sup>2,4</sup> (113.875-inch long)	36.6	36.6	36.6

For SI: 1 inch=25.4 mm, 1 psf= 47.88 Pa.

<sup>1</sup>Positive wind load direction indicates force applied to the metal facing of the panel (outside surface) towards the MgO facing of the panel (inside surface).

<sup>2</sup>Negative wind load direction indicates force applied to the MgO facing of the panel (inside surface) towards the metal facing of the panel (outside surface).

<sup>3</sup>Roof and floor panels are supported with 3 inches of bearing on one end and 6 inches bearing on the other end.

<sup>4</sup>Wall panel allowable loads are based on panels supported through the end caps.

**Table 2: Axial Load Capacity<sup>1,2</sup>**

Panel Configuration	Allowable Load (plf)
<b>113.875-inch Wall Height</b>	<b>2200</b>

For SI: 1 inch=25.4 mm, 1 plf = 14.59 N/m.

<sup>1</sup>Tabulated axial load is the maximum uniform load (pounds per linear foot) applied concentrically to the full thickness of the SIP, including facings, to the top. Eccentric axial loading to one face of the SIP is outside the scope of this report.

<sup>2</sup>For combined loading, the requirements of Section 4.1 must be applied.

**Table 3: Seismic Design Categories A, B, and C Shearwall Racking Load Capacity<sup>1</sup>**

Panel Configuration	Allowable Load (plf)
<b>113.875-inch Wall Height</b>	<b>349</b>

For SI: 1 inch=25.4 mm, 1 plf = 14.59 N/m.

<sup>1</sup>Shearwall capacity limited to walls with a 1:1 (h:w) aspect ratio.

<sup>2</sup>This shearwall design is limited to use in Seismic Design Categories A, B, and C.

**Table 4: Seismic Design Categories A through F Shearwall Racking Load Capacity<sup>1</sup>**

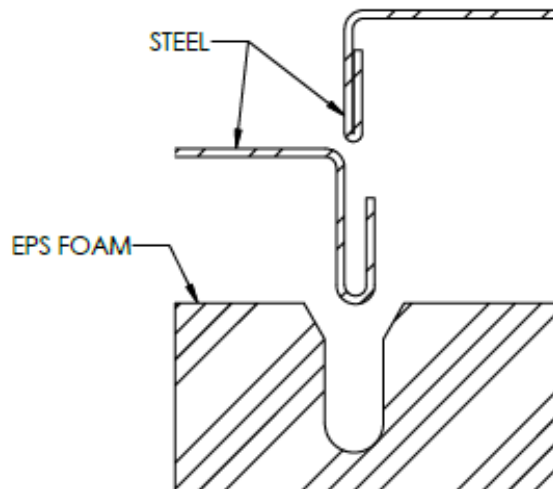
Panel Configuration	Allowable Load (plf)
<b>113.875-inch Wall Height</b>	<b>127</b>

For SI: 1 inch=25.4 mm, 1 plf = 14.59 N/m.

<sup>1</sup>Shearwall capacity limited to walls with a 1:1 (h:w) aspect ratio.

<sup>2</sup>Axial capacity of shearwalls used in Seismic Design Categories D, E, and F is limited to 11% of the value in Table 2.

<sup>3</sup>The deflection at allowable shear load is 0.25 inches (6 mm).



**Figure 1: Steel Facing Hem Insert into EPS Core**

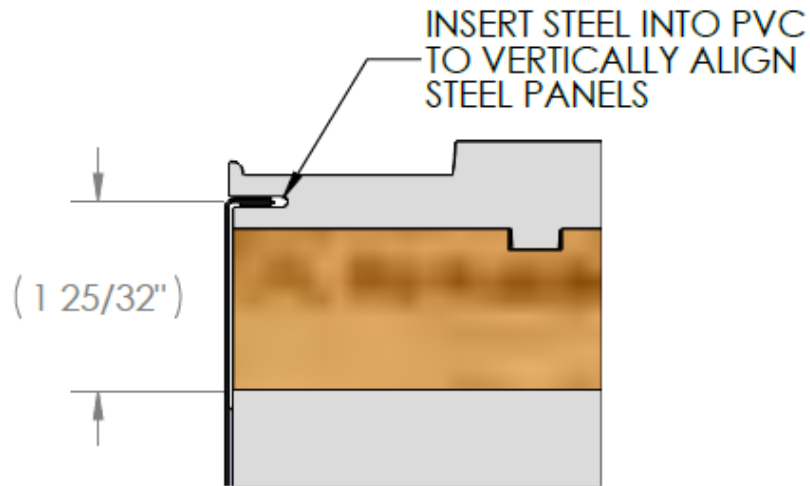


Figure 2: Steel Facing Hem Insert into PVC Endcap

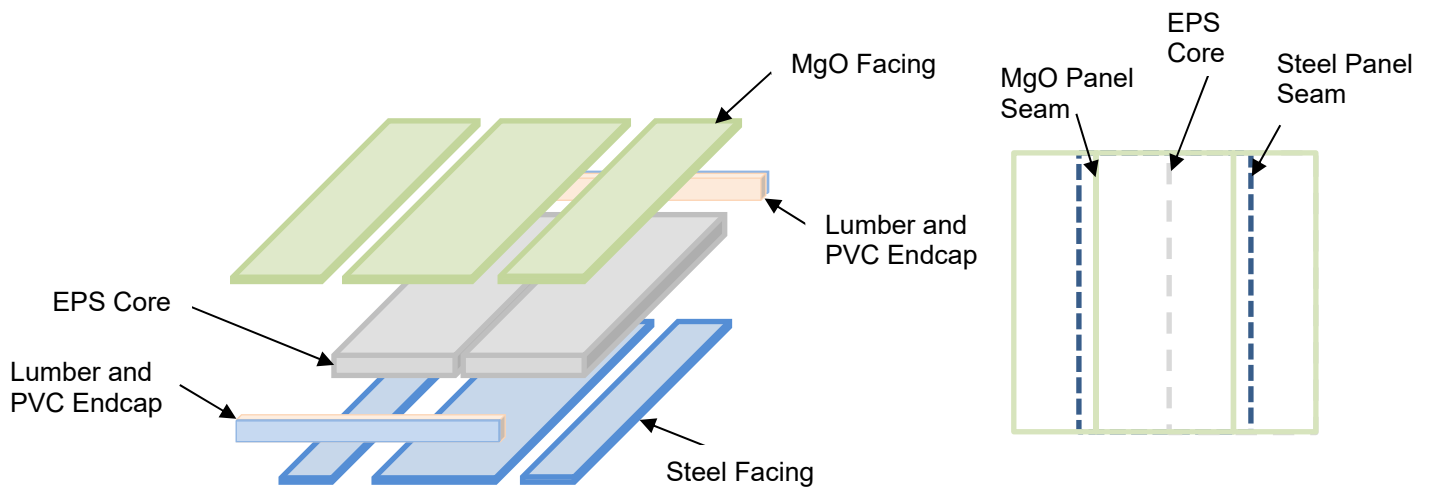


Figure 3: Panel Construction and Staggered Seams

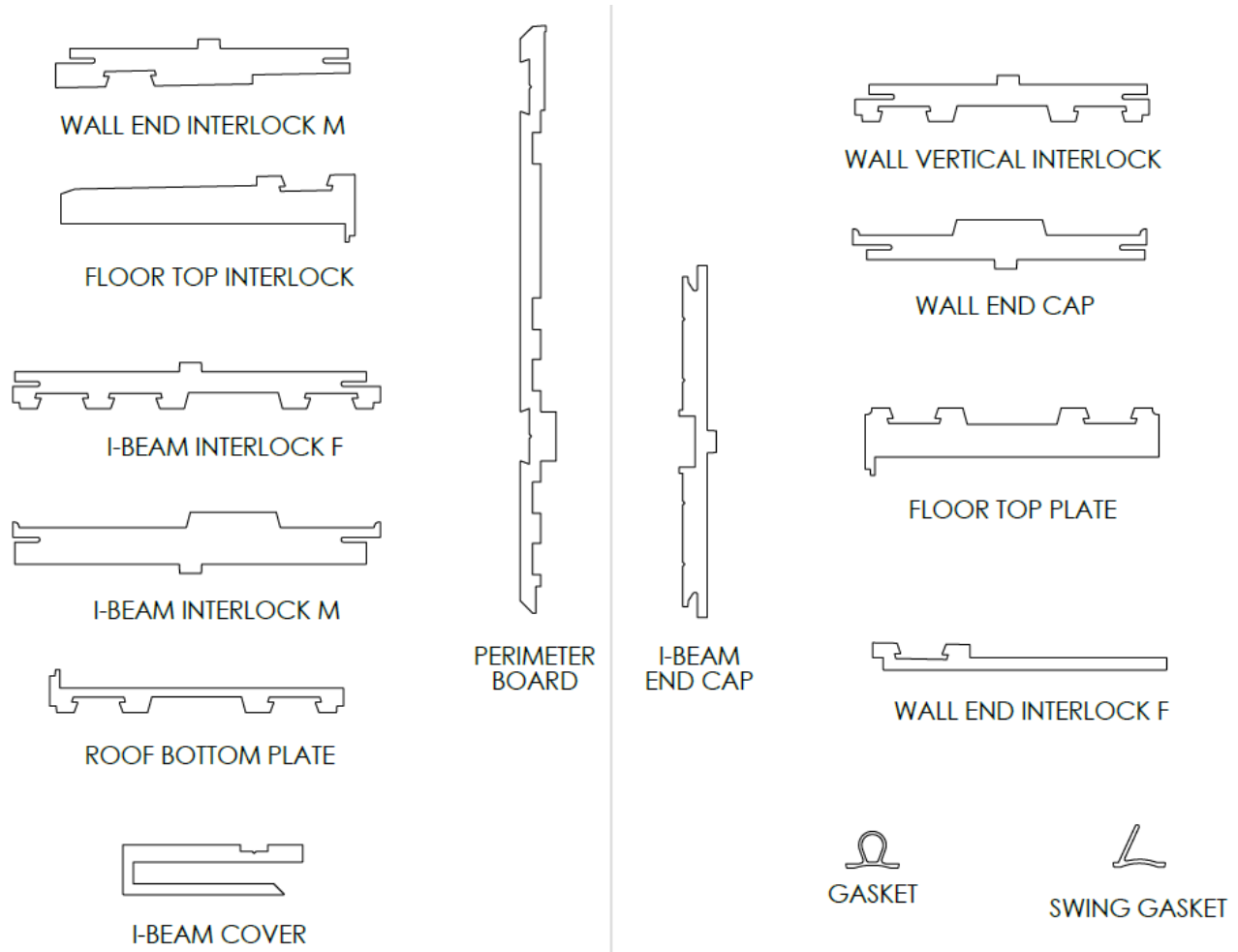


Figure 4: PVC Panel Connectors



Figure 5: EPDM Seals

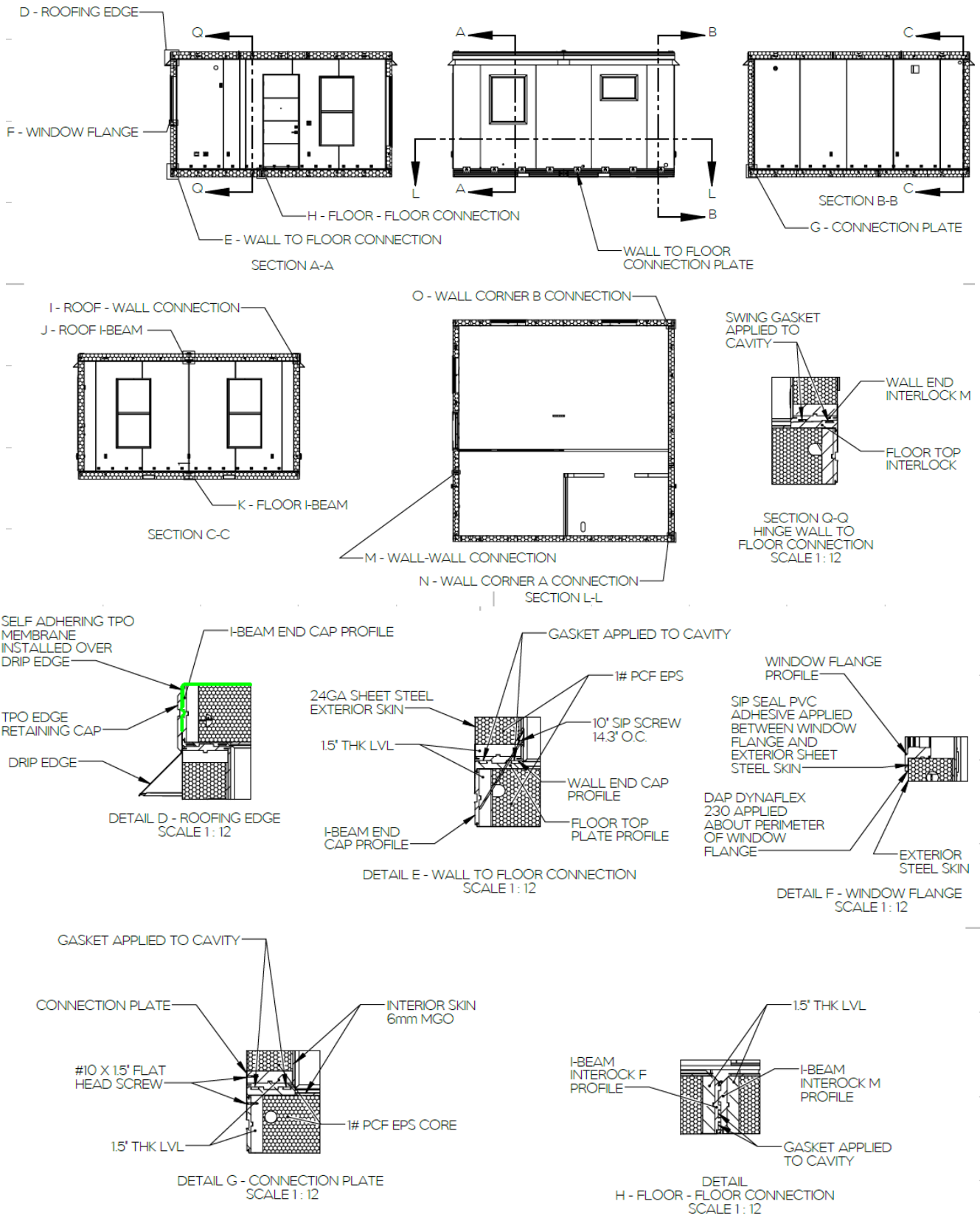


Figure 6: Panel Connections

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Section: 06 12 00—Structural Panels

**REPORT HOLDER:**

Boxabl

**EVALUATION SUBJECT:****BOXABL STRUCTURAL INSULATED PANELS (SIPs)****1.0 REPORT PURPOSE AND SCOPE****Purpose:**

The purpose of this evaluation report supplement is to indicate that Boxabl Structural Insulated Panels, described in ICC-ES evaluation report [ESR-4725](#), have also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

**Applicable code editions:**

- 2023 *City of Los Angeles Building Code* (LABC)
- 2023 *City of Los Angeles Residential Code* (LARC)

**2.0 CONCLUSIONS**

The Boxabl Structural Insulated Panels, described in Sections 2.0 through 7.0 of the evaluation report [ESR-4725](#), comply with the LABC Chapter 14, 15, 16 and 26, and the LARC, and are subject to the conditions of use described in this supplement.

**3.0 CONDITIONS OF USE**

The Boxabl Structural Insulated Panels described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report [ESR-4725](#).
- The design, installation, conditions of use and identification of the *Structural Insulated Panels* are in accordance with the 2021 *International Building Code*® (IBC) provisions noted in the evaluation report [ESR-4725](#).
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.
- Under the LARC, an engineered design in accordance with LARC Section R301.1.3 must be submitted.

This supplement expires concurrently with the evaluation report, issued May 2023.



**DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES**  
**Section: 06 12 00—Structural Panels**

**REPORT HOLDER:**

Boxabl

**EVALUATION SUBJECT:****BOXABL STRUCTURAL INSULATED PANELS (SIPs)****1.0 REPORT PURPOSE AND SCOPE****Purpose:**

The purpose of this evaluation report supplement is to indicate that Boxabl SIPs, described in ICC-ES evaluation report ESR-4725, have also been evaluated for compliance with the code(s) noted below.

**Applicable code edition(s):**

- 2022 California Building Code (CBC)

For evaluation of applicable Chapters adopted by the California Office of Statewide Health Planning and Development (OSHPD) AKA: California Department of Health Care Access and Information (HCAI) and the Division of State Architect (DSA), see Sections 2.1.1 and 2.1.2 below.

- 2022 California Residential Code (CRC)

**2.0 CONCLUSIONS****2.1 CBC:**

The Boxabl Structural Insulated Panels, described in Sections 2.0 through 7.0 of the evaluation report ESR-4725, comply with CBC Chapters 14, 15, 16, and 26, provided the design and installation are in accordance with the 2021 *International Building Code*® (IBC) provisions noted in the evaluation report and the additional requirements of CBC of Chapters 16, 17 and 26, as applicable.

**2.1.1 OSHPD:** The applicable OSHPD Sections and Chapters of the CBC are beyond the scope of this supplement.

**2.1.2 DSA:** The applicable DSA Sections and Chapters of the CBC are beyond the scope of this supplement.

**2.2 CRC:**

The Boxabl Structural Insulated Panels, described in Sections 2.0 through 7.0 of the evaluation report ESR-4725, complies with CRC Chapter 3, 5, 6, and 8 provided the design and installation are in accordance with the 2021 *International Residential Code*® (IRC) provisions noted in the evaluation report and the additional requirements of the CRC as applicable.

This supplement expires concurrently with the evaluation report, issued May 2023.