DSA IR PC-2

PRE-CHECK (PC) DESIGN CRITERIA FOR MODULAR BUILDINGS: 2022 CBC

Disciplines: All

History: Revised 12/05/22 under 2022 CBC
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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 relating to pre-check (PC) submittals to promote uniform statewide criteria for code compliance in design and in plan review of modular buildings for projects under DSA jurisdiction. The PC Design Criteria documents were created by DSA as a means for the responsible engineer to demonstrate code compliance when developing and submitting construction documents for DSA review.

The provisions of this IR are intended to be a tool to identify and highlight the common and unique, critical and/or overlooked code requirements that must be considered and incorporated into the design, as applicable, to provide a complete and consistent set of construction documents accepted at all DSA regional offices. Other methods proposed by design professionals to solve a particular issue may be considered by DSA and reviewed for code and regulation compliance, subject to concurrence of DSA Codes and Standards Unit. For methods not specifically prescribed in the code, see California Building Code (CBC) Section 104.11.

Appendix A below is provided as a guide to assist design professionals and DSA plan reviewers when preparing and reviewing site-specific project applications that incorporate PC modular buildings designed in accordance with this IR.

SCOPE

The provisions of this IR apply to 2022 PC plans for new modular buildings submitted to DSA under the 2022 CBC. A modular building is defined as any building primarily constructed with modules that may be assembled onsite or in-plant, has a permanent foundation, may have an integral floor structure, and shall not be moved after initial installation without DSA review and approval. This document does not address relocatable buildings, cargo container conversions, and modular elevator towers.

As noted in Bulletin (*BU) 18-01: Applicability of Pre-Check (PC) Design Criteria for Non-PC Projects*, these provisions shall also be considered and incorporated in site-specific submittals for structures of the same project type, even if the submittal is not part of a PC application.

BACKGROUND

The PC approval process is intended to streamline DSA plan review by providing a procedure for approving the design of commonly used structures prior to the submittal of plans to DSA for construction projects. The PC approval process allows designers to incorporate designs for structures that have already been “pre-checked” by DSA into their plans for actual site-specific construction projects. The design criteria provided in this document are neither regulations nor law and are not appropriate for verbatim inclusion in project specifications. The design professional in charge is responsible for specifying and detailing requirements for each project.

Additional information regarding the design and site application of PC structures and modular buildings can be found in the following documents:

- *IR 16-1: Design and Construction Requirements for Relocatable Buildings and Modular Elevator Towers.*
- Policy *(PL) 07-02: Over-the-Counter Review of Projects Using Pre-Check Approved Designs.*
- Procedure *(PR) 07-01: Pre-Check Approval.*

1. GENERAL

1.1 Pre-Check Approval Requirements

See PR 07-01 for a more detailed list of items that are required for all PC submittals. The documents required to be submitted for PC approval are listed on form *DSA 3: Project Submittal Checklist*. Site-specific information is not necessary as that information will be provided when a specific construction project is submitted for DSA review. ←

1.2 Cover Sheet and General Notes

1.2.1 In accordance with PR 07-01 Section 2.4 the first sheet(s) of the PC drawings shall include a design information section that defines the basis of the PC design. Refer to PR 07-01 Appendices B and C and the remainder of this IR for required content of the design information section.

1.2.2 The PC construction documents shall include complete and comprehensive general notes and/or specifications as required for construction and inspection. It is common for PC construction documents to consist of drawings only without a book specification or project manual. Refer to PR 07-02 Appendix B, Footnote 6. In this case, the PC drawings shall include information that might otherwise be communicated in a project manual or book specification. For each primary material or group of the materials, the following information shall be specified in the construction documents when applicable:

1.2.2.1 Required material properties, including compliance with American Society for Testing and Materials (ASTM) specifications when applicable.

1.2.2.2 Proprietary products name, manufacturer, and evaluation report number. Refer to Section 1.13 below.

1.2.2.3 Quality control performed by the supplier.

1.2.2.4 Standards for the execution of the work, including associated tolerances. References to recognized standards are acceptable.

1.2.2.5 Required qualifications of personnel performing the work for each applicable trade.

1.2.2.6 Product and material finishes where required for weather protection or safety.

1.2.2.7 Quality assurance tests and frequency requirements, including citation of ASTM standards when applicable, not covered by Section 1.3 below.

1.3 Structural Tests and Special Inspections

Provide example form(s) *DSA 103: List of Required Structural Tests and Special Inspections* on the drawings. See PR 07-01 Section 2.5 for additional information.

1.3.1 Example form DSA 103 will be used as a guide to develop a site-specific form DSA 103 for the site-specific project. Example form(s) on the PC drawings will be crossed out when the site-specific form DSA 103 is provided during plan review.

1.3.2 The example form DSA 103 will include both in-plant and on-site testing and inspection requirements. Manufacturers shall be involved in the coordination of in-plant testing and inspection with the project inspector and Laboratory of Record (LOR) of the site-specific project application using the PC design prior to commencing fabrication.

1.3.3 Only the site-specific form DSA 103 can identify exemptions from the required structural tests and special inspections; therefore, the Appendix of the example form(s) DSA 103 shall not be included on the PC drawings. Applicability of exemptions may be considered during plan review for site-specific applications, shall be justified by the project design professional, and is subject to DSA review and approval. Refer to Appendix A below for additional information

1.3.4 See Section 2.11 below for specific structural tests and special inspection requirements that often occur in Modular Buildings.

1.4 Options and Variations

Provide checkboxes of options and variations if there is more than one configuration or design loading criteria. For a PC that includes any restrooms, the plans, elevations and details shall be presented separately on stand-alone sheets for each age-related use group (e.g., age 3-4, age 5-8, etc.). See PR 07-01 Section 3 for more details, including the maximum number of options permitted in a single PC.

1.5 Design Parameters

The PC drawings shall provide on the coversheet (and subsequent sheets as necessary) Design Information as defined in PR 07-01 Section 2.4 and Appendix B. In accordance with Section 8 of this IR, Photovoltaic (PV) requirements shall also be included in the Design Information section. If the PC includes design variations for multiple tiers or levels of the same design parameter(s), all or part of the Design Information should be presented in a checklist format and provide general direction to future users (design professionals and plan reviewers) for the application of the PC to site-specific projects. The checklist shall include any cut sheets of boards, boxes and equipment to be mounted on the structure, including weights and dimensions. Additionally, refer to and coordinate with PL 07-02 Section 3, which summarizes common site-specific parameters to be verified at Over-the-Counter (OTC) plan reviews.

1.6 Required Photovoltaic (PV) Systems

When a PV system is required by the California Energy Code for a PC building configuration, the PV system design shall be in accordance with *IR 16-8: Solar Photovoltaic and Thermal Systems Review and Approval Requirements*. The PC design shall show that the structure can support the required system loads when the building is supporting the PV system. The PV system design may be included in the PC or may be submitted with the PC at the time of the siting application.

1.7 Risk Category and Occupant Load

PC drawings shall indicate the maximum Risk Category (RC) the structure is designed for in the Design Information section of the coversheet. In addition, a Code Analysis shall be shown on the coversheet to indicate the intended Use and Occupancy. The DSA reviewer of the site application shall verify the RC of the PC structure as it applies to the site in accordance with CBC Section 1604A.5. The Code Analysis shall include line items to indicate selection of Use and Occupancy classification per CBC Chapter 3, Occupant Load Factor (OLF) per CBC Table 1004.5, and determination of RC per CBC Table 1604A.5, to be completed by the Design Professional at time of OTC or project submittal. Refer to Appendix A for additional information.

1.8 Flood Zone

The PC design shall comply with CBC Section 1612A and *PR 14-01: Flood Design and Project Submittal Requirements*.

1.8.1 The design information section shall include a note requiring the building pad be raised above the design flood elevation. See PL 07-02 Section 4.9 for additional information.

1.8.2 The design information section shall include a note stating that when a site-specific project is located in a flood zone other than Zone X, a letter from a geotechnical engineer (bearing his/her stamp and signature) is required to validate the applicability of the allowable soil values listed on the PC drawings.

This note may include an exemption for the validation letter for projects located in Zone D (undefined) if a geotechnical report written for improvements on the same campus and in accordance with the current CBC is provided that either (1) confirms the site is not in a flood hazard zone or (2) acknowledges the flood hazard but confirms it does not result in a reduction of soil capacity values.

1.8.3 The location of electrical elements shall conform to American Society of Civil Engineers Standard 24: Flood Resistant Design and Construction (ASCE 24) Section 7.2.

1.9 Geohazard Reports

The Design Information section shall indicate whether a geohazard report is required for the project. A geohazard report is required to be provided and approved by California Geological Survey (CGS) for all projects unless it meets the exemption as outlined below, *and* the design does not rely on parameters which must be identified in a geohazard report such as site class and exposure categories.

1.9.1 Existing Sites Outside of a Mapped Geologic Hazard Zone

A geohazard report may be exempt for single-story modular buildings provided they do not exceed 4,000 Square Feet (Sq. Ft.) in plan area and are not located within state or local geologic hazard zones in accordance with *IR A-4: Geohazard Report Requirements*, Section 3.2.1. The structures may be split into multiple seismically separated structures to stay below the 4,000 Sq. Ft. trigger. Refer to Appendix A below for additional information.

1.10 Weather Protection

The PC design shall comply with the requirements of IR 16-1 Section 2.1. Cold-formed steel and structural steel members shall be protected by rust inhibitive coating where exposed to weather or moisture. Refer to CBC Section 2203A.1 and American Iron and Steel Institute (AISI) S240 Table A4-1.

1.11 Sheet Index

The PC drawings shall include a sheet index. When a PC includes multiple major options such that not all sheets are applicable to a given site-specific project application based on the option being used, the sheet index shall include check boxes. When the PC drawings are incorporated into a site-specific application, the submitted sheets will be identified by marking the check boxes (i.e., it is not necessary to strike out sheets that are not applicable). See PR 07-01 Appendix E for additional information.

1.12 Stamps

The PC drawings shall include the following:

1.12.1 2022 CBC PC Stamp per PR 07-01 Section 6.1.

1.12.2 Two blank areas on each PC sheet title block as indicated in *PR 18-04: Electronic Plan Review for Design Professionals of Record*, Section 1: one for the PC Identification Stamp and one for the future site-specific Identification Stamp.

1.13 Structural Products Acceptance

All structural products shall meet the requirements set forth in *IR A-5: Acceptance of Products, Materials, and Evaluation Reports*. Code-based engineering calculations to support a manufactured product will be considered.

2. MODULAR BUILDING PROVISIONS

2.1 Building Configuration & Structural System

Refer to CBC Sections 2211A, 2212A, or Chapter 23, as applicable.

2.1.1 When the lateral system is light modular steel moment frames, the design, fabrication and erection shall comply with CBC Section 2212A.1.2, as well as the American Institute of Steel Construction (AISC) 360 for structural steel or the American Iron and Steel Institute (AISI) S100 for cold-formed steel (CFS). Light modular steel moment frames designed per CBC Section 2212A.1.2 do not require compliance with AISC 341; however, special inspection and nondestructive testing shall conform to AISC 341 Chapter J per CBC Section 1705A.2.1.

2.1.2 When the lateral system is light-framed shear walls, comply with CBC Chapter 23 or Section 2211A, as applicable.

2.1.3 For CFS wall systems using flat strap bracing, comply with AISI S400 Section E3.

2.1.4 For sheet steel sheathing systems, comply with AISI S240 Section B5.2.2.3.2 and AISI S400 Section E2.

2.1.5 Concrete Masonry Unit (CMU) toilet buildings are not addressed in this document.

2.2 Protection Against Deterioration

2.2.1 Refer to IR 16-1 Section 2.1 for measures to protect the building from deterioration due to decay, termite damage and rust.

2.2.2 Drainage shall be provided to prevent water from ponding beneath and immediately adjacent to buildings. Sloped drainage shall be provided away from the building in accordance with CBC Section 1804A.4. Refer to Appendix A for additional information.

2.2.3 Regardless of construction material type or building size, the net free cross-ventilation area shall comply with CBC Section 1202.4 at under-floor spaces and CBC Section 1202.2 for enclosed spaces above ceilings.

2.2.4 Exterior balcony and elevated walking surfaces exposed to water shall comply with the requirements of CBC Sections 107.2.5 and 110.3.7.

2.2.5 Wood structural members supporting moisture-permeable floors or roofs that are exposed to the weather shall be protected in accordance with CBC Section 2304.12.2.4.

2.2.6 Ventilation of enclosed spaces beneath exterior balcony and elevated walking surfaces exposed to water shall comply with CBC Section 2304.12.2.5.

2.2.7 CFS and structural steel members shall be protected by rust inhibitive coating (refer to CBC Section 2203A, AISI S220 Section A5 and AISI S240 Section A4).

2.2.8 Grade Clearance Requirements

Framing protection/treatment and clearance requirements shall be provided in accordance with CBC Section 2304.12 and IR 16-1 Section 2.

2.2.8.1 Under-floor clearance and the treatment of wood members in close proximity to exposed ground shall comply with IR 16-1 Section 2.2.1.

2.2.8.2 Clearance from exterior grade to untreated wood construction shall comply with IR 16-1 Section 2.2.2.1.

2.2.8.3 Exterior Grade Higher than the Bottom of Floor Framing

Refer to IR 16-1 Section 2.2.2.2. Where the adjacent exterior grade is higher than the bottom of the floor framing on any side of the building, then all wood in the substructure and floor framing (including floor sheathing) shall be naturally durable or preservative-treated, all exposed steel and welds shall have a rust inhibitive coating, and the exterior wall envelope shall be weather-resistant with a continuous water-resistive barrier extending down to top of foundation wall. In addition, walls that retain earth and enclose interior spaces and floors below grade shall be waterproofed and dampproofed per CBC Section 1805A.1. Refer to Appendix A below for additional information.

2.2.8.3.1 Details providing an equivalent means of protection against decay, termite and deterioration may be considered by DSA in lieu of providing naturally durable or preservative-treated wood per CBC Section 2304.12.1.2 and rust inhibitive coating over exposed steel and welds. This exception requires a form *DSA 1-AMM: Request for Alternate Design, Materials and Methods of Construction* to be submitted for DSA review and approval in accordance with IR 16-1 Section 2.2.2.2.

2.3 Concrete Curbs in Wood Framed Buildings

CBC Section 2304.12.1.4.1 requires wood framed walls at shower or toilet rooms with more than two plumbing fixtures as well as walls at exterior locations to be constructed on concrete curbs at least 6 inches tall.

2.3.1 Shower and Toilet Rooms

In lieu of six-inch high concrete curbs, *IR 23-3: Concrete Curbs in Wood Framed Buildings* provides alternative means that will be accepted for stud wall and partition protection.

Note: If concrete curbs are omitted, the alternative means for protection shall be specified and detailed on the submittal for approval. Refer to Appendix A for additional information.

2.3.2 Exterior Walls

Per IR 23-3, the concrete curb may be omitted if the exterior ground surface is paved for 18 inches and sloped away from the building, and the roof overhang length is equal to, or greater than, the height of the exterior wall.

For additional requirements and exceptions, such as mow strip and flashing details, refer to IR 16-1.

2.4 Access Required for Under-Floor Utilities

Refer to IR 16-1 for opening size requirement to all under-floor utilities such as electrical, mechanical and plumbing.

2.5 Floor Live Load and Roof Snow Load Postings

Refer to IR 16-1 for signage requirements. Signs for load postings shall be posted in public view, whereas, Building Module Identification Labels do not necessarily have to be in public view.

2.6 Utility and Service Lines

Per ASCE 7 Section 13.6.9, all cables or flexible conduit across separation joints shall be designed to accommodate, without rupture or distress, differential movements from design displacements between cable connection points. PC drawings must indicate the maximum drift demand for each building option in the Design Information section of the coversheet. The DSA reviewer shall verify there is adequate flexibility provided in the utility and service lines, if applicable, at time of OTC or project submittal. Refer to Appendix A below for additional information.

2.7 Plan Offsets

If plan offsets are allowed between typical modules (i.e., 12'x40' module), the drawings need to provide specific plan views showing allowed building configurations depicting maximum and minimum offsets. Special details are needed at the foundation and roof. General configuration shall be as noted in CBC Section 2212A.1.1 with maximum module dimensions identified. The design calculations and detailing needs to account for any reentrant corners and local diaphragm chord/drag loads. Reentrant corner cases shall meet requirements of ASCE 7 Section 12.3.2.1 and Table 12.3-1. It is acceptable to provide small scale "cartoon" drawings showing overall layout geometry.

2.8 Canopies

If attached canopies are part of the PC, the load path to the building needs to be coordinated. The allowed locations of canopies need to be indicated. Partial plans must show any added roof framing or bracing required where canopies frame to the "long" side of a module. Wall panel design shall account for all loads imposed by the canopy.

2.9 Column Schedules or Tables

Where schedules or tables are used to define column size based on column height, clearly define in the structural drawings the basis for column height (i.e., column height measured from base plate to top of beam versus underside of beam). Tables need to consider different heights associated with sloped roofs (i.e., column size may need to change for differing heights due to sloped roofs).

2.10 Ramps and Landings

2.10.1 Ramp/Landing Connection to Building

A nominal connection between the ramp structure and modular building is permitted as required for non-structural purposes, but a standalone lateral system shall be provided for the ramp structure unless the following items are provided:

- Provide calculations that demonstrate the connection between the ramp structure to building interface is capable of transferring the full seismic force from the ramp based on ASCE 7 Chapter 13 for "Egress Stairways not part of the building structure", including any increase in force resulting from load eccentricities or irregular configurations. It shall also be demonstrated that the load path is complete, including collectors and chords as required to transfer forces to the building.
- Provide verification that the adjacent modular building has been designed to include any lateral forces imposed by the ramp system. Refer to Appendix A below for additional information.

2.10.2 Ramp/Landing Foundation

Refer to IR 16-1 for non-permanent foundations. The foundation shall be designed to prevent sliding on the supporting surface by attaching the wood foundation plates for the ramp to the

ground with restraining devices, unless it can be demonstrated that the ramp can be supported by the adjacent building.

2.10.3 Ramp/Landing Lateral System

Refer to ASCE 7 Chapter 12 for lateral systems or Chapter 15 for “All other self-supporting structures…” utilizing R=1.25. Common systems include ordinary moment frames or ordinary concentrically braced frames. It is permitted to attach ramps to adjacent building for non-structural purposes, but a standalone lateral system for the ramp is still required unless it can be demonstrated that the ramp can be supported by the adjacent building per Section 2.10.1 above.

2.10.4 Ramp/Landing Loading

Design ramp for the more severe of 100 psf Live Load (unreducible) or applicable Snow Load where occurs.

2.10.5 Ramp/Landing Floor Deck

A positive connection between the decking and structure shall be provided for continuous load path.

2.10.6 Ramp/Landing Posts

For telescoping systems, a positive connection is required (e.g., bolts extending through both posts, sheet metal screw penetrating inner post, etc.) that is capable of transferring moment demands. Friction system (e.g., screw passing through outer post only) is prohibited for items supporting sustained gravity loads.

2.10.7 Ramp/Landing Handrails

Per CBC Section 1015, guards are required along the edge of ramp or landing if located more than 30" measured vertically to the grade below. If a guardrail is required, the rail shall be designed to resist the greater of a 200-pound service load or 50 pounds per foot service load in accordance with CBC Section 1607A.8 and applied at 42 inches height per CBC Section 1015.3.

2.10.8 Ramp/Landing Welding

Per the Appendix of the DSA 103, welding inspection may be exempted by the design professional for relocatable ramps less than 30 inches above adjacent grade, except for base connections of cantilevered rail posts which do require welding inspection. If special inspection for structural welding for the ramp is exempted by the design professional on the DSA 103, the following note shall be added to the PC drawings:

“The design professional has exempted this ramp from special inspection requirements for material identification and structural welding. Ramp shall not be modified nor have shims added causing the distance between the highest ramp walking surface and the adjacent grade to be more than 30 inches. If this condition is not met, structural testing and/or inspection will be required to verify materials and structural welding. This applies to scopes of work including new construction, alteration, or relocation of the ramp.”

2.11 Structural Tests and Special Inspection Requirements

The tests mentioned are not inclusive of all inspections required for the project, but outline some of the unique or overlooked inspections that must be provided for a PC when applicable. Items apply to both in-plant and site inspections.

2.11.1 Nondestructive Testing (NDT)

NDT of complete joint penetration welds at moment-resisting connections shall comply with AISC 341 Chapter J per CBC Section 1705A.2.1. The example DSA 103 on the PC drawings shall have the boxes checked for both Ultrasonic and Magnetic Particle Testing. In addition, the following note shall be provided on the PC drawings in the design parameters section to clarify the scope and frequency of testing – "The Nondestructive Testing Inspection is TBD by Architect of Record (AOR)/DSA per project specific requirements. Ultrasonic Testing (UT) shall be performed on 100 percent of the complete joint penetration (CJP) groove welds when the columns per Schedule on Sheets XX (xx to be filled out by PC applicant) have a thickness of 5/16" or greater. Magnetic particle testing shall be performed on 25 percent of all beam-to-column CJP groove welds." Refer to Appendix A below for additional information.

NDT of complete joint penetration welds at gravity connections shall comply with AISC 360 Chapter N per CBC Section 1705A.2.1.

2.11.2 Concrete Testing

The example DSA 103 on the PC drawings shall clearly identify each item that requires concrete material verification and testing such as concrete foundations and/or steel deck diaphragms with structural concrete fill where beams are designed as composite members or concrete fill is designed to transfer lateral loads.

2.11.3 Post-Installed Anchors in Concrete

Post-installed anchors in concrete shall be installed in accordance with CBC Section 1910A.5. Loads for testing shall be specified on the design documents.

3. GRAVITY LOAD DESIGN

3.1 Roof Loads

3.1.1 Roof Dead Loads

Per CBC Section 1606A.6, the design dead load shall provide for the weight of at least one additional roof covering in addition to other applicable loadings, if the new roof is permitted to be applied over the original roofing without its removal.

3.1.2 Partial Roof Live Loading

Include the effects of partial live loading in the structural design as required per CBC Section 1607A.14.1 if it produces a more unfavorable load effect than the same intensity applied over the full member. In particular, this should be considered at balcony floor framing where it occurs on two-story structures.

3.1.3 Snow Load

3.1.3.1 The design information section shall state the snow and ice loads accounted for in the PC design. The PC drawings shall indicate 0 (zero) pounds per square foot (psf) if the design does not account for snow or ice loads.

3.1.3.2 If the structure is designed for snow load, the design information section of the PC drawings shall include a note the same as or similar to the following: "Site application design professional and DSA plan reviewer shall verify the structure to be located at least xx feet from any adjacent higher structure" where the distance "xx" is calculated and stated by the PC applicant. Refer to ASCE 7 Section 7.7. If the horizontal separation from a higher structure is less than 20 feet and six times the vertical dimension separating the roofs, snow drift analysis shall be provided by the PC applicant, and the project is not eligible for OTC submittal.

3.1.3.3 Refer to IR 16-1 Section 4.2 for roof snow load posting signage requirements. Signs shall be posted in public view.

3.1.3.4 Effective seismic weight shall include snow load per ASCE 7 Section 12.7.2.

3.1.4 Ponding Loads

Roof configurations that allow for ponding are to be properly drained with primary and secondary drain systems, and roof framing design to account for any ponding buildup in event of primary blockage. Refer to ASCE 7 Chapter 8, and CBC Sections 1503 and 1611A.

3.1.5 Areas of Roof Designated as Future Solar Zone

Refer to PR 18-02, Energy Code Section 110.10, and CBC Sections 1603A.1.8.1 and 1607A.14.4.

For areas of the roof designated as a solar zone, the structural design loads for roof dead load and roof live load shall be clearly indicated on the construction documents, including any superimposed load for future solar components, etc. Include information to define the effective seismic weight considered in the structural design. Per Energy Code Section 110.10(b)4, the selection of the superimposed design loads for future solar components are solely at the discretion of the design professional and DSA will not mandate any additional prescribed minimum load.

Provide note on plans that future solar installation will require separate DSA application.

3.1.6 Gypsum Board Soffits

Gypsum board is acceptable for bracing of soffits, but not permitted for lateral resistance in shear walls per CBC 1617A.1.4. Ceiling detailing with gypsum board must be in accordance with *IR 25-3: Gypsum Board Ceiling Suspension Conventional Construction—One Layer*.

3.1.7 Interior and Exterior Wall Framing

Drawings shall show interior and exterior wall framing, clearly defining maximum openings and associated details. Details shall show connections that can resist concentrated reactions from jambs. Refer to Appendix A below for additional information.

3.1.8 Equipment Locations and Weights

The roof plans shall show the allowed locations and weights of mechanical equipment, coordinated with the mechanical plans.

3.1.9 Diagonal Bracing to Roof or Floor Framing

When diagonal bracing (for ceilings, piping, etc.) normal to the purlin span direction is attached to the bottom flange or web of the framing member, justify framing and load path for transfer of loads to the diaphragm for the horizontal load, or provide blocking section between the two purlins. Design shall account for any horizontal loads imposed on purlin.

3.2 Floor Loading

3.2.1 Partial Floor Live Loading

Include effects of partial live loading in design of structure as required per CBC Section 1607A.13 if it produces a more unfavorable load effect than the same intensity applied over the full member. In particular, this should be considered at balcony floor framing where occurs on two-story structures.

3.2.2 Wall Partition Parallel to Joists

Check condition where partition wall extends parallel to floor joists. Provide additional joist under wall, add support blocking between joists, or provide calculations to check floor sheathing/deck for line load where wall above occurs.

3.2.3 Decks Supporting Concrete Fill

Include additional dead load due to calculated deck deflection between support members. In lieu of calculation or other substantiation (e.g., shoring during manufacturing to limit framing deflection during the pour), DSA will accept application of an additional 3 psf dead load for lightweight concrete fill or an additional 4 psf dead load for normal weight concrete fill. This additional dead load shall also be included in the effective seismic weight.

3.2.4 Unbraced Ceiling Joists

When horizontal loads are imposed on ceiling joists by ceiling bracing wires, mechanical, electrical, or plumbing components, fire sprinkler piping, etc., justify load path for transfer of loads to the floor or roof diaphragm. Provide solid blocking between the joists as needed to stabilize joists. Ceiling joists shall also be checked for vertical loading from compression struts unless the struts are detailed to extend vertically with positive attachment to floor or roof structure.

3.2.5 Composite Action Between Upper and Lower Modules

For multistory assemblies, the connection between the floor beam (upper level) and ceiling beam (lower level) shall be evaluated to consider composite action if these connections are detailed such that composite action could occur. Detailing to release composite action by providing slotted connections has been accepted by DSA as long as the connections can still transfer the uplift and shear forces from the upper to lower modules. Refer to Section 4.1.19 below for more information regarding upper to lower module connections.

4. LATERAL LOAD DESIGN

4.1 Seismic (Requirements Applicable to All Systems)

4.1.1 Seismic Load Criteria

The seismic design criteria upon which the PC design is based shall be stated in the design information section of the PC drawings in accordance with PR 07-01 and CBC Section 1603A.1.5.

4.1.1.1 Maximum Seismic Force

If the design is based upon the maximum S_S value for the state of California (ASCE 7-16 data), the PC can be used at any site in the state of California. Other S_S values are permitted but will limit the applicable site locations for the PC.

4.1.1.2 Ground Motion Hazard Analysis

The 2022 CBC adopts ASCE 7 with Supplement 3, which modifies Section 11.4.8. Due to the site-specific ground motion hazard analysis requirements of ASCE 7 Section 11.4.8, the seismic load criteria selected for the PC design per Section 4.1 above on Site Class D and E shall consider the Exceptions of ASCE Section 11.4.8, Items 1 and 2.

4.1.1.3 The PC option for Site Class D shall include following note in the design information section: “Unless a site-specific ground motion hazard analysis is performed, the S_{M1} value increased by 50% shall be less than the design criteria stated herein.”

4.1.1.4 The PC option for Site Class E shall state in the design information section whether or not the PC design complies with the conditions of Exception 1 of ASCE 7 Section 11.4.8, Item 2.

4.1.2 Maximum S_{DS} Value in Determination of C_s and E_v

The base shear is permitted to be calculated using a cap on the maximum design spectral response acceleration parameter value of S_{DS} in accordance with ASCE 7 Section 12.8.1.3, provided that *all* of the noted criteria are met. The DSA reviewer shall verify any maximum limits applied to the base shear at time of OTC or project submittal. Refer to Appendix A for additional information.

4.1.2.1 The PC drawings shall demonstrate compliance with the required criteria (e.g., no irregularities, period less than 0.5 sec, rho equals 1.0, not Site Class E or F, RC I or II, etc.) in the Design Information section of the coversheet. For purposes of checking compliance with these criteria, the period shall be determined based on the actual properties of the structure, and not use the approximate period in ASCE 7 Section 12.8.2.1. ←

4.1.2.2 The design information section of the PC drawings shall also contain a note stating the site-specific limitations of the design based on the S_{DS} cap and requiring these be verified by the site-specific project applicant: e.g., Site Class E not allowed, RC I or II, etc.

4.1.2.3 Per PR 07-01 Appendix C, if a capped value of S_{DS} is used to determine C_S, the Design Information section of the coversheet shall list the S_{DS} (cap) used to determine C_S as well as the S_{DS} (no cap) used for verification of site-specific application and to determine other parameters such as non-structural component anchorage.

4.1.3 Effective Seismic Weight

4.1.3.1 Snow Load

If the site has a ground snow load greater than zero, effective seismic weight shall include snow load per ASCE 7 Section 12.7.2.

4.1.3.2 Areas of Roof Designated as Solar Zone

Where portions of the roof are designated as solar zones, the building design loads due to future solar components shall be included in the effective seismic weight. For additional information, refer to Section 3.1.5 above.

4.1.3.3 Partition Load

If the PC drawings include an option for interior partition walls, the actual partition weight or a minimum weight of 10 psf of floor area shall be included in the effective seismic weight per ASCE 7 Section 12.7.2.

4.1.4 Story Drift

4.1.4.1 Allowable Story Drift

The allowable story drift limit shall be based on the limits for “All other structures” per ASCE 7 Table 12.12-1.

Exception: The less stringent drift limit listed in the first row of ASCE 7 Table 12.12-1 for “Structures, other than masonry shear wall structures, four stories or less above the base…” may be used if all interior walls, partitions, ceilings, and exterior wall systems have been designed and detailed to accommodate the story drifts unless specifically noted otherwise in this document.

4.1.4.2 Story Drift Determination

The design story drift shall be determined in accordance with ASCE 7 Section 12.8.6. For two-story buildings, the story drift shall be evaluated separately and shall not exceed the allowable story drift for each story height under consideration.

4.1.5 Vertical Structural Irregularities

For multistory assemblies, the soft story and weak story irregularities per ASCE 7 Section 12.3.2.2 need not be applied for modules in the stacked condition.

4.1.6 Deformation Compatibility

Buildings shall be designed and detailed for deformation compatibility as required per this section.

4.1.7 Interior Non-bearing Non-shear Walls

4.1.7.1 In-plane Story Drift

Interior non-bearing non-shear walls shall be designed and detailed to accommodate the building story drifts in accordance with ASCE 7 Equation 12.8-15. Special detailing is not required at wall intersections of conventional interior partitions to accommodate drift.

Exception: Design and detailing for story drift is permitted to be exempt for interior non-bearing non-shear walls in buildings satisfying drift limit for “All other structures” per ASCE 7 Table 12-12.1.

4.1.7.2 Vertical Deflections

Interior non-bearing non-shear walls shall be designed and detailed to accommodate vertical deflection in all cases.

4.1.8 Exterior Non-bearing Non-shear Walls

4.1.8.1 In-plane Story Drift

Exterior non-bearing non-shear walls shall be designed and detailed to accommodate story drift per ASCE 7 Section 13.5.3 for all cases except as noted below. Special detailing is not required at wall intersections or end conditions to accommodate drift.

Exception: Design and detailing for story drift is permitted to be exempt for exterior non-bearing non-shear walls in buildings satisfying drift limit for “All other structures” per ASCE 7 Table 12-12.1 for relatively light-weight exterior wall finishes that are attached to wall studs or substrate in a manner to accommodate cracking or spalling without becoming a falling hazard, including, but not limited to the following wall finishes:

- Wood siding (or like material such as Hardie-board) or metal siding.
- Stucco: one or three-coat with lath properly fastened and embedded in the plaster coat in compliance with CBC Section 2512.1.
- Adhered veneer installed in accordance with CBC Chapter 14.
- Exterior insulation and finish system (EIFS) or other insulation board systems mechanically fastened to the studs or substrate and finished with similar light-weight finish materials.

4.1.8.2 Vertical Deflections

Exterior non-bearing non-shear walls shall be designed and detailed to accommodate vertical deflection.

Exception: For buildings satisfying drift limit for “All other structures” per ASCE 7 Table 12-12.1, exterior non-bearing non-shear walls are permitted to be exempt from accommodating vertical deflection, provided they are designed for their tributary dead, live and wind loads.

4.1.9 Structural Separation

All portions of the structure shall be designed and constructed to act as an integral unit in resisting seismic forces with interconnected modules, unless each module is separated structurally by a distance sufficient to avoid damaging contact in accordance with ASCE 7 Section 12.12.3. PC drawings must indicate the maximum drift demand for each building option in the Design Information section of the coversheet. The DSA reviewer shall verify there is adequate structural separation, if applicable, at time of OTC or project submittal. Refer to Appendix A below for additional information.

4.1.10 Interconnected Modules – Diaphragms, Chords, and Collectors

4.1.10.1 Buildings with interconnected modules and balconies shall comply with all applicable building code requirements, including, but not limited to the following items:

- Continuous load path and interconnection per ASCE 7 Section 12.1.3.
- Analysis of diaphragm flexibility per ASCE 7 Section 12.3.1, including torsional effects as applicable per ASCE 7 Section 12.8.4.
- Diaphragm design per ASCE 7 Section 12.10, including chord continuity and force transfer along and across the modlines and balconies.

4.1.10.2 Buildings with interconnected modules shall specify and detail on the construction documents the maximum gap permitted between adjacent modules to ensure diaphragm and chord continuity in both directions. A positive connection such as through-bolts shall be designed and detailed to transfer tension forces between adjacent columns and beams on each side of the modline. Where the gap exceeds 1/8 inch, filler or shim plates shall also be added as required to effectively transfer compressive chord forces. In order to accommodate vertical movements between adjacent modules, the shim plates shall be detailed with a vertical slot or other mechanism to prevent vertical loads from being transferred across the joint.

4.1.10.3 Buildings with interconnected modules and balconies shall be analyzed as an integral unit per ASCE 7 Section 12.12.3, by complying with the following provisions (i.e., “full building analysis” is required):

- Diaphragms shall be designed in accordance with ASCE 7 Section 12.10. Compliance may be deemed satisfied by demonstrating continuity of load path for transfer of chord and collector forces without necessarily requiring a single continuous tie element.
- Diaphragms composed of structural concrete over metal deck shall be analyzed as rigid diaphragms. For levels with rigid diaphragms, the stiffness of the exterior wall framing supporting that level shall be included in the diaphragm flexibility and torsional analysis.
- Diaphragms composed of bare metal deck or wood sheathing shall meet the conditions noted in ASCE 7 Section 12.3.1 to confirm flexible diaphragm classification. This includes metal deck diaphragms topped with wood sheathing and/or non-structural concrete floor underlayment/insulating fill. The stiffness of the exterior wall framing supporting a flexible diaphragm level is permitted to be excluded from the diaphragm flexibility and torsional analysis.

Exception: For single-story buildings, interconnected modules may be exempt from analysis as an integral unit when *all* of the following conditions are met:

- Each module has a Seismic Force-Resisting element (e.g., moment frame, shear wall, braced frame) on all four sides.
- All Seismic Force-Resisting elements in a direction are identical.
- The roof elevation is the same for all modules.

- The frames are not staggered (i.e., plan offset of modules is not allowed).

If any one of these conditions is not met, a “full building analysis” shall be provided in accordance with this section.

4.1.11 Collector Design

For exemption from load combinations with overstrength factor per ASCE 7 Section 12.10.2.1, Exception 1, the entire structure shall be light-frame construction, including the diaphragms, in addition to the requirements therein.

4.1.12 Cold-Formed Steel Light Frame Flat-Strap Braced Roof Systems

4.1.12.1 General

Where a diagonal flat-strap roof system is used as a means of lateral resistance, the shear resistance shall be determined based on the principles of mechanics. Sloping roofs shall consider and resolve any vertical load components. The requirements for strap-braced shearwalls in AISI S400 Section E3 shall be applied to the roof structure as appropriate and as stated in this section.

4.1.12.2 Connections shall be designed for the expected yield strength of the diagonal strap bracing member but need not exceed the amplified seismic load per AISI S400 Section E3.4.2 for light gauge steel (up to 3/16”) and AISC 341 Section F1.6 for heavier steel straps.

4.1.12.3 Connections shall be welded unless the criteria in AISI S400 Section E3.4.1 are satisfied for light gauge straps.

4.1.12.4 Per AISI S400 Section E3.4.2, collectors, connections of strap bracing, chords, boundary elements, and all other components and connections of the strap braced roof shall have required strength to resist loads from the expected strength of the strap braced wall but need not exceed the amplified seismic load with overstrength factor.

4.1.12.5 Aspect Ratio

Maximum total aspect ratio (length: width) for strapped diaphragm roof system shall be 4:1.

4.1.12.6 Strap Configuration

Per AISI S400 Section E3.4.1(c), provisions shall be made for pretensioning or other methods for installing tension-only strap bracing to guard against loose strap bracing. Since the strap bracing are expected to be installed taut, the slenderness ratio of the diagonal strap member may exceed 200.

4.1.12.7 Per AISI S400 Section E3.4.2, the effect of eccentricity shall be considered in the design for connections, chord members, and collector elements.

4.1.13 Attachment of Horizontal Plywood Diaphragms to CFS Framing Using Power Actuated Fasteners

Refer to *BU 17-02: Power-driven Fasteners Attaching Wood Structural Panel Sheathing Diaphragms to Cold-formed Steel Framing*.

Note: DSA will accept the listed values in ET&F Fastening Systems, Inc. (ET&F’s) International Association of Plumbing and Mechanical Officials (IAPMO) Report ER-335, subject to the requirements of IR A-5 (i.e., 0.8 multiplier for seismic loads) and 24 inches max CFS joist/rafter spacing as stated in bulletin *BU 20-02: Maximum Spacing of Cold-Formed Steel Joists for Diaphragms with Wood Structural Panels*.

4.1.14 Maximum Spacing of CFS Joists for Diaphragms with Wood Structural Panels

Per AISI S240 Section B5.4.1(k) and AISI S400 Section F2.4.1.1(k), the maximum spacing for CFS joists shall be 24 inches on center when the diaphragm is sheathed with wood structural panels.

Note: In prior code editions, it has been common practice for modular buildings to have CFS joists spaced up to 48 inches on center for diaphragms sheathed with wood structural panels. As stated in this section, the reference standards adopted by the 2022 CBC explicitly require a maximum CFS joist/rafter spacing of 24 inches on center which will be enforced for 2022 CBC PC designs.

4.1.15 Redundancy Factor

A redundancy factor of 1.0 is permitted to be used for single-story or two-story buildings containing multiple modules designed as an integral unit that have a moment frame on all four sides of each module. For buildings with a single bay module (e.g., Toilet Building) or any other lateral system, a redundancy factor of 1.3 shall be used unless the conditions in ASCE 7 Section 12.3.4.2 are met.

4.1.16 Overstrength Factor Reduction

ASCE 7 Table 12.2-1 Footnote ‘b’ reduction to Omega for structures with flexible diaphragms is not applicable for light modular steel moment frame structures designed per CBC Section 2212A.2.

For all other structures, use of ASCE 7 Table 12.2-1 Footnote ‘b’ reduction to Omega is allowed only if flexible diaphragms are present at every level.

4.1.17 Base Connection to Foundation

The design shall explicitly state whether the base connection to the foundation is considered as pinned or fixed. The design and detailing shall match the fixity assumption.

4.1.18 Design Load Combinations

Verify basic seismic load combinations per CBC 1605A, where E is defined in ASCE 7 Section 12.4.2, incorporating vertical seismic load effects. Where seismic load effects including overstrength factor are required, the combinations of ASCE 7 Section 2.3.6 shall be applicable.

4.1.19 Upper to Lower Module Connections

The connection between upper and lower levels in two-story modules shall be designed to resist the maximum seismic load effect, E_m, per ASCE 7 Section 12.4.3. Provide calculations that demonstrate the connection is capable of transferring the seismic load between levels, including any increase in force resulting from load eccentricities (e.g., beam offsets, asymmetrical welds, irregular or offset anchor layout, etc.) in the connection.

4.1.20 Cantilever and Offset Diaphragms, Including Clerestories

4.1.20.1 Design and detailing of cantilevered and/or vertically offset diaphragms shall satisfy the requirements of American Wood Council (AWC) Special Design Provisions for Wind & Seismic (SDPWS) Section 4.2. Provide calculations and details showing the values of loads to be transferred, as well as the load path, for offset diaphragms that are dependent on bending of vertical members to transfer loads back to main diaphragms.

4.1.20.2 Vertical elements which span from high to low roof must satisfy continuous load path requirements of ASCE 7 Section 12.1.3 to keep the roofs moving in unison under lateral loads and satisfy deformation compatibility requirements per ASCE 7 Section 12.12.5. Deflection calculations shall consider out-of-phase vibration (i.e., check square root of the sum of the

squares of roofs moving in opposite directions; other modal combination methods may also be used).

4.1.20.3 If vertical members are utilized as collectors to transfer loads between diaphragms within the same story, then these vertical members and their connections must be designed using overstrength factor in accordance with ASCE 7 Section 12.10.2.1.

4.2 Seismic (Light Modular Steel Moment Frame)

4.2.1 Maximum Design Dead Loads

Refer to CBC Section 2212A.1.2 for 25 psf roof, 50 psf elevated floor, and 45 psf exterior wall for maximum dead loads and the following clarifications:

4.2.1.1 Interior partitions need not be counted towards the dead load limits since partitions are classified as live load per ASCE 7 Section 4.3.2. However, partition load shall be included in effective seismic weight utilized for lateral analysis per ASCE 7 Section 12.7.2.

4.2.1.2 Parapet weight need not be counted towards the roof dead load limit, but it shall be counted towards the exterior wall dead load limit and shall be included in effective seismic weight utilized for lateral analysis.

4.2.1.3 When checking the dead load limit for elevated floors in two-story modules, the weight of both the "floor" of the upper module and the "ceiling" of the lower module shall be included. The “floor” and “ceiling” elements may be modeled separately in the engineering analysis for the building design, but for purposes of demonstrating compliance with CBC Section 2212A.1.2, the weights of those elements must be combined when checking the 50 psf limit.

4.2.1.4 For areas of the roof designated as a solar zone on a solar ready building, any superimposed load for future solar components, etc., shall be included in the effective seismic weight. This weight shall also be counted towards the roof dead load limit for purposes of demonstrating compliance with CBC Section 2212A.1.2. Refer to Section 3.1.5 above for additional information.

4.2.2 Beam-to-Column Strength Ratio

Beam-to-column strength ratios shall be greater than or equal to 1.4 (i.e., weak-column strong-beam) in accordance with CBC Section 2212A.2.2.

Exception: Beam-to-column strength ratios less than 1.4 are allowed if proven to be acceptable by analysis or testing, which shall be submitted to DSA using the Alternate Means and Methods procedure defined in California Administrative Code (CAC) Section 4-304 and CBC Section 104.11.

4.2.3 Beam-to-Column Connection Design

Refer to CBC Section 2212A.2.4 and the following clarifications:

4.2.3.1 Beam-to-Corner Columns

All connections shall be designed as moment-resisting connections.

4.2.3.2 Moment Frame Connections

4.2.3.2.1 For frames with beam-to-column strength ratio greater than or equal to 1.4, connections shall have the design strength to resist the maximum seismic load effect, E_m, per ASCE 7 Section 12.4.3. Connections do not need to be designed for the expected yield strength of the connecting members.

4.2.3.2.2 For frames using exceptions permitted in CBC Section 2212A.2.2 with beam-to-column strength ratio less than 1.4, connections shall be designed for a required flexural

strength that is equal to the expected beam flexural strength using the expected yield stress per AISC 341 Section E1.6b.

4.2.4 Connection Between Levels

The connection between upper and lower levels in two-story modules shall be designed to resist the maximum seismic load effect, E_m, per ASCE 7 Section 12.4.3.

4.2.5 HSS Connections

For Hollow Structural Sections (HSS) beam to HSS column connections at the roof or floor level, the connection design is permitted to be based on AISC 360, Chapter K.

4.2.6 Welding

Refer to CBC Section 2212A.2.3.

4.2.7 Moment Frame Beams with Web Openings

4.2.7.1 Web openings shall not be permitted in moment frame beams over a length equal to the beam depth away from the face of column. All openings shall be clearly located on plan (preferably near midspan of beam where shear demand is typically lowest) with opening size and height relative to top flange shown.

4.2.7.2 The design shear force used to evaluate the beam opening shall be based on the maximum probable moment (M_{pr}) that can be developed (i.e., $2M_{pr}/L$) or load combinations with overstrength factor, whichever is less. The steel reinforcement around the opening shall be sized to develop the full yielding of the effective section to achieve the required bending or shear strength.

For additional requirements, refer to the design references noted below:

4.2.7.3 Structural Steel

Refer to AISC Design Guide 2 - Design of Steel and Composite Beams with Web Openings for design of openings.

4.2.7.4 Cold-Formed Steel

Per the AISI S240 Section C2.1, holes in webs of CFS framing members shall be in conformance with an approved design based on AISI S100 such as Cold-Formed Steel Engineers Institute (CFSEI) Tech Note G900-15. Webs with holes not conforming to AISI S100 shall be reinforced or patched in accordance with a consensus design standard.

4.3 Seismic (Flat Strap Braced Shearwalls)

4.3.1 General

4.3.1.1 Where diagonal strap bracing is provided for lateral resistance, the connections shall be designed for the expected yield strength of the diagonal strap bracing member but need not exceed the amplified seismic load per AISI S400 Section E3.4.2 for light gauge steel (up to 3/16”) and AISC 341 Section F1.6 for heavier steel straps.

4.3.1.2 Connections shall be welded unless the criteria in AISI S400 Section E3.4.1 are satisfied for light gauge straps.

4.3.1.3 Per AISI S400 Section E3.4.2, collectors, connections of strap bracing, chord studs, vertical boundary elements and anchorage connected thereto, and all other components and connections of the strap braced wall shall have required strength to resist loads from the expected strength of the strap braced wall but need not exceed the amplified seismic load with overstrength factor.

4.3.2 Vertical Boundary Members and Anchorage

Per AISI S400 Section E3.4.1(d), anchorage of vertical boundary members shall be provided such that the bottom track does not resist uplift by bending of the track web.

4.3.3 Aspect Ratio

Per AISI S400 Section E3.4.1(b), light gauge flat strap braced wall shall have an aspect ratio less than 1.9:1 unless a lateral frame analysis is performed based on the assumption of full joint fixity.

4.3.4 Strap Configuration

4.3.4.1 Per AISI S400 Section E3.4.1(c), provisions shall be made for pretensioning or other methods for installing tension-only strap bracing to guard against loose strap bracing. Since the strap bracing are expected to be installed taut, the slenderness ratio of the diagonal strap member may exceed 200.

4.3.4.2 Per AISI S400 Section E3.4.2, the effect of eccentricity shall be considered in the design for connections, chord studs, holdowns and anchorage.

4.4 Seismic (Light Framed Wood Wall with Wood Structural Panels Rated for Shear Resistance)

4.4.1 General

4.4.1.1 Per the AWC SDPWS Section 4.3.4, maximum aspect ratio for blocked shear walls is 3.5 to 1, with strength reductions from National Design Specification (NDS), Section 4.3 applied. Full design values can be used for aspect ratios up to 2 to 1.

4.4.1.2 Unblocked shear walls are not permitted per CBC Section 2301.1.4.

4.4.2 Holdowns

4.4.2.1 Holdown Load Capacities

In accordance with IR A-5, design capacity values shall be 80 percent of the listed seismic load capacity for manufactured wood construction connectors unless the values listed in the evaluation report were established on the basis of cyclic test results.

4.4.2.2 Holdown Body and Anchor Bolt Area

Per CBC Section 1617A.1.16 Exception 1, the wood-framed shear wall holdown body and anchor bolt area are exempt from amplified seismic load with overstrength factor.

4.4.2.3 Holdown Anchor Bolt Embedment

Per *IR 23-1: Prefabricated Wood Construction Connectors*, cast-in-place anchors and post-installed anchors for holdowns shall comply with ACI 318 Chapter 17, except items excluded in ACI 318 Section 17.1.2. In addition, the holdown anchor bolt diameter shall not be less than that stated in the evaluation report for the holdown specified.

4.4.3 In-Plane Shear Anchorage for Shear Walls

Foundation anchor bolts or screws with a valid evaluation report for this application shall have plate washers meeting the requirements of the AWC SDPWS Section 4.3.6.4.3.

Note: The exception in AWC SDPWS Section 4.3.6.4.3 allowing cut washers is not permitted per CBC Section 2301.1.4 Item 3.

4.4.4 Shear Wall Construction

Structural sheathing shall be applied directly to the framing per CBC Section 2301.1.4 Item 6. For other system requirements, refer to AWC SDPWS Section 4.3.7.1.

4.5 Wind Design

4.5.1 Metal Roof Panel Systems

Metal roof panel systems shall comply with CBC Sections 1504.4 and 1507.4. A manufacturer, product, and basis of approval for the metal roof panel system and fastener parts/layout shall be specified. The interpretations noted below do not preclude the project from meeting the other requirements of CBC Chapter 15 (e.g., fire classification, insulation, etc.).

4.5.2 The PC drawings shall fully detail the panel clip spacing and fasteners, metal material specification, panel profile, thickness, etc.

4.5.3 The underlayment, flashing and other waterproofing shall be fully detailed on the PC drawings and shall comply with CBC Chapter 15.

4.5.4 The wind load uplift resistance provided by the panels and their connections shall be based on test data in accordance with ASTM E1592, Underwriters Laboratory (UL) 580, UL 1897, or Factory Mutual (FM) 4474 as appropriate by an independent accredited laboratory. Qualification of the metal roof panel system shall be provided in accordance with the one of the following methods:

4.5.4.1 If the system has a UL or FM certification or has an evaluation report issued by an accepted agency per IR A-5, this basis of approval shall be denoted on the PC drawings. A copy of the UL or FM product report, if applicable, shall be submitted to substantiate the design capacity of the products.

4.5.4.2 If the system does not have a qualified certification per Section 4.5.4.1 above, a wind uplift test report by an independent accredited testing laboratory shall be submitted with the PC project. The test results shall be interpreted for applicability and adjusted for factor of safety in accordance with AISI S100 Section I6.3.1 by a California registered Structural Engineer. The testing laboratory shall be accredited by International Organization for Standardization (ISO) 17025 in accordance with International Code Council Evaluation Service (ICC-ES) AC85. Other accreditations (e.g., ISO 17020) may be acceptable with DSA approval.

4.5.5 Wind Loads on Trusses, Girders, Beams and Purlins

For conditions where trusses, girders, beams or purlins are subject to compression or wind uplift, the bottom chord/flange shall be braced or justified by calculation as not requiring bracing where reverse curvature occurs or where top of exterior stud wall imparts a horizontal reaction to bottom chord/flange. In addition, member end connections shall be checked for wind uplift where occurs.

4.5.6 Parapet Vertical Support Post Layout

Parapet vertical support post locations shall be shown on a typical layout plan. Indicate where posts occur on the “long” and “short” sides of a module with details showing how base moments from the parapet supports are transferred into the supporting structure.

4.5.7 Exterior Wall Insets

Exterior non-bearing non-shear walls are permitted to be “inset” if details are provided that clearly define acceptable wall locations and demonstrate how out-of-plane wind loads are transferred to the roof or floor structure. A slip track is required at the top of wall to allow for both in-plane and vertical movement. The floor system shall be checked per Section 3.2.2 above if the inset wall extends parallel to floor joists.

5. FOUNDATION

5.1 General

Refer to CBC Section 1808A.1.

5.2 Allowable Soil Pressure and Bearing

Maximum soil pressure and bearing values shall be in accordance with Class 5 soil as specified in CBC Table 1806A.2 unless justified by a site-specific geotechnical report. Alternative values may be included as an option if the PC drawings clearly indicate in the Design Parameter Information section on the PC drawings that a site-specific geotechnical report is required at the time of site application. Refer to Appendix A for additional information.

5.2.1 An allowable stress increase is not permitted for Basic Allowable Load Combinations, including footings, per ASCE 7 Section 2.4. An allowable stress increase is permitted for Alternative Basic Load Combinations per CBC Section 1605A.2.

5.2.2 Reduction of foundation overturning per ASCE 7 Section 12.13.4 is permitted with Basic Allowable Load Combinations but not permitted for Alternative Basic Load Combinations per CBC Section 1605A.2.

5.3 Liquefiable Soil or Site Class F

A PC's option shall not include liquefiable soil nor site Class F. If the structure is located in an area with liquefiable soil or Site Class F, OTC review is not allowed, and site-specific project submittal is required. If the site is not in a mapped liquefaction hazard zone, it may be presumed that no liquefaction hazard exists on that site unless a site-specific geotechnical report identifies such hazard.

5.4 Foundations on or Adjacent to Slopes

PC drawing shall specify minimum setback limits (values are required) of the structure per CBC Section 1808A.7 for building clearance, foundation setback, etc. for protection from slope drainage, erosion and shallow failures. If setback limits are smaller than CBC requires, site-specific geotechnical report is required. Refer to Appendix A below for additional information.

5.5 Concrete Mix

In addition to those requirements dictated by the PC design, the concrete mix used in the foundation elements shall comply with the durability requirements of American Concrete Institute (ACI) 318 Section 19.3. The PC drawings shall account for the dependency of these durability requirements on site-specific characteristics.

5.5.1 When the PC drawings do not require a site-specific geotechnical report that quantifies sulfate content in the soil, the PC drawings shall require a concrete mix shall complying with one of the following per ACI 318 Table 19.3.2.1.

5.5.1.1 Maximum water/cement ratio of 0.45; minimum compressive strength of 4,500 pounds per square inch (psi); Type V cement plus pozzolan or slag cement complying with Footnote 7; and prohibition of admixtures containing calcium chloride.

5.5.1.2 Maximum water/cement ratio of 0.40; minimum compressive strength of 5,000 psi; Type V cement complying with Footnote 8; and prohibition of admixtures containing calcium chloride.

5.5.2 When the PC drawings require a site-specific geotechnical report that quantifies sulfate content in the soil, the PC drawings shall clearly state the exposure class for each category (i.e., F, S, W and C) or combination thereof the PC design is approved for. The maximum

water/cement ratio, minimum compressive strength, cementitious material requirements, and admixture limitations shall be stated on the PC drawings for each approved case.

5.5.3 Both approaches given in Sections 5.5.1 and 5.5.2 above can be included on the PC drawings as alternate options in accordance with Section 1.4 above.

5.5.4 Concrete exposed to thaw and freeze cycles shall be air entrained per ACI 318 Section 19.3.3.1.

5.6 Foundation Design Load

The design of the foundation and connections shall include overstrength factor in accordance with CBC Section 1617A.1.15.

5.7 Lateral Force Distribution to Concrete Piers

Lateral forces shall be distributed to each modline foundation element on a tributary area basis. Along interior modlines, the lateral force shall be distributed to each foundation element (i.e., interior piers, partial strip footing) based on relative rigidity, or the tributary load may be dragged to the end strip footings on that modline.

5.8 Foundations Supporting Raised Floors

5.8.1 Concrete piers supporting raised floor framing shall be evaluated for overturning stability.

5.8.2 Per ASCE 7 Section 12.1.4, positive attachment of raised floor framing to interior pier supports is required.

5.9 Anchorage and Shear Connections to Concrete

5.9.1 The connection of the superstructure to foundation shall be designed for forces per CBC Section 1617A.1.15 and ACI 318 Chapter 17. “Can-outs” (i.e., temporary blockout in concrete to allow anchor bolt installation after concrete placement) are not permitted.

5.9.2 Determination of shear strength of sill bolts for walls in light-frame structures may be eligible for exemption from portions of ACI 318 Chapter 17 requirements in accordance with CBC Section 1905A.1.8.

5.9.3 Post-installed anchor placement must comply with ACI 318 Chapter 17 and product evaluation report per IR A-5. Post-installed anchors in concrete must be tested in accordance with CBC Section 1905 and the test loads must be specified on the plans.

5.9.4 Connections to the foundation are required on all four sides of each module. These connections may be achieved through a combination of primary shear connections along with nominal anchorages. Nominal anchorages to the supporting foundation shall be spaced as needed to ensure structural integrity of all portions of the structure. Floor beams shall be designed to span vertically between points of anchorage.

Exception: If it can be shown by engineering analysis that a load path meeting the requirements of Section 5.9.5 below is provided without anchoring all four sides of a module and that the structural integrity of all parts of the structure is maintained, then the requirements in Section 5.9.4 above need not be met. The analysis shall demonstrate the integrity of any unanchored foundation walls with seismic and soil loads and shall show that the horizontal deflection of floor elements, diaphragms, and foundation elements will not cause the floor beams to lose vertical support at any point along the beams.

5.9.5 All elements of the connection to the foundation, including the anchor bolts and the entire load path to the connection shall be analyzed for the effects of load eccentricities, prying action, stiffness compatibility, load reversals and appropriate boundary conditions to ensure all code requirements are satisfied.

5.9.6 The connection shall also be designed for uplift where occurs based on the maximum seismic load effect, E_m, per ASCE 7 Section 12.4.3. Provide calculations that demonstrate the connection is capable of transferring the seismic load into the foundation, including any increase in force resulting from load eccentricities (e.g., member offsets, asymmetrical welds, irregular or offset anchor layout, etc.) in the connection. In order to minimize the amount of load eccentricity in the connection between perimeter floor framing and foundation anchor plates, it is recommended to provide welds connecting both sides of the framing to the embed plate and aligning the beam centroid over the anchor to the greatest extent possible.

5.9.7 Per CBC Section 1617A.1.20, power actuated fasteners (PAF) shall not be allowed for anchorage into concrete for exterior wall applications. PAF are permitted for anchorage to steel on exterior wall applications in accordance with an approved evaluation report.

5.9.8 Wood Sill Plates

Wood sill plates with anchorage to concrete under exterior walls, bearing walls and shear walls shall be bolted to concrete and properly spaced with clearance to end of sill plate in accordance with CBC Section 2304.3.4 Item 2.

6. ACCESSIBILITY

6.1 PC Submittals

Refer to PR 07-01 Section 4.3.

Accessibility requirements shall comply with CBC Chapter 11B. Appropriate details shall be provided on plans to assure compliance with all applicable code requirements. ←

7. FIRE AND LIFE SAFETY REQUIREMENTS

7.1 PC Submittals

Refer to PR 07-01 Section 4.2.

7.2 Type of Construction

Specify type of construction per CBC Chapter 6.

7.3 Hazardous Fire Area

Buildings intended for construction or installation in a designated hazardous fire area shall also comply with the construction and material requirements of CBC Chapter 7A. Plans shall reflect a notation indicating that the building has been designed for compliance with CBC Chapter 7A. Additionally, the plans shall indicate the specific construction compliance method for the building features as outlined in Sections 707A.3 through 707A.10, 708A, and 709A, as applicable.

7.4 Total and Allowable Areas of Structure

Specify total area of structure and provide calculations indicating that total area is less than permitted allowable area as determined per CBC Section 506.2 based on type of construction and proposed occupancy classification(s), and any applied frontage increases per CBC Section 506.3.

7.5 Use and Occupancy Classification(s)

Specify proposed use and occupancy classification(s) per CBC Chapter 3.

7.6 Occupant Load

Specify calculated occupant load based on function per CBC Table 1004.5. The following may be required where occupant load exceeds 49:

7.6.1 Two or more exits per CBC Table 1006.2.1 and Table 1006.3.3. Exit and exit access doorway configuration shall comply with CBC Section 1007.

7.6.2 Panic hardware per CBC Section 1010.2.9.

7.6.3 Emergency power for egress illumination (including exterior landings) per CBC Section 1008.3.

7.6.4 Exit signs with backup power per CBC Section 1013.

7.6.5 Occupant load sign per CBC Section 1004.9.

7.7 Roof Fire Hazard Classification

Specify roof fire hazard classification per CBC Section 1505. For modular buildings located in a designated hazardous fire area, roof assemblies shall also comply with CBC Chapter 7A.

7.8 Fire Extinguishers

Provide fire extinguisher locations and specify type per California Fire Code (CFC) Section 906.

7.9 Interior Finishes

Interior wall, ceiling, floor, and decorative finishes shall comply with CBC Chapter 8, and CCR Title 19.

7.10 Group E Door Hardware

Group E doors shall be lockable from the inside in accordance with CBC Section 1010.2.8.2.

7.11 Stairways

Stairways shall comply with CBC Section 1011.

7.12 Ramps

Ramps shall comply with CBC Section 1012.

7.13 Handrails

Handrails shall comply with CBC Section 1014.

7.14 Guards

Guards shall comply with CBC Section 1015.

7.15 Safety Glazing

Safety glazing is required in hazardous locations (in doors, adjacent to doors, in windows, etc.) per CBC Section 2406.4.

7.16 For Multistory Modular Buildings

Elevator design and construction shall comply with the following:

7.16.1 CBC Chapter 30.

7.16.2 CFC Section 606.

7.16.3 California Code of Regulations, Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders.

8. SUSTAINABILITY REQUIREMENTS

PC designs for permanent modular buildings must comply with the mandatory measures of the California Green Building Standards Code (CALGreen) and the California Energy Code (Energy Code).

8.1 Plans must show the primary exterior entries are protected from water intrusion by adding a recessed door, awning, or roof overhang at least 4 feet in depth in addition to using nonabsorbent floor and wall finishes within 2 feet around and perpendicular to such openings in accordance with CALGreen Section 5.407.2.2.

8.2 For a more detailed list of CALGreen/Energy items that are required for all PC submittals, refer to IR 16-1, PR 07-01, *PR 18-02: Pre-Check (PC) Permanent Modular or Relocatable Building Designs CALGreen/Energy Code Compliance Review*, and form *DSA 403-PC: CALGreen and Energy Code-Compliance Checklist for Pre-Checked (PC) Permanent and Modular Relocatable Building Designs.*

8.3 Required Photovoltaic (PV) Systems Energy Review

When a PV System is required per the California Energy Code for a PC configuration, the system power requirements shall be clearly delineated on the PC plans in the Design Information section for the PC. See Section 1.6 above for design and submittal requirements of the PV system.

REFERENCES:

2022 California Code of Regulations (CCR) Title 8, Division 1, Chapter 4, Subchapter 6, Elevator Safety Orders
2022 CCR Title 24
- Part 1: California Administrative Code (CAC), Section 4-304.
- Part 2: California Building Code (CBC), Chapters 3, 6, 7A, 8, 10, 11B, 14, 15, 16A, 30, and Sections 104.11, 107.2.5, 110.3.6, 202, 506, 1202, 1705A.2.1, 1804A.4, 1806A.2, 1808A, 1910A.5, 2203A, 2211A, 2212A, 2301.1.4, 2304.3.4, 2304.12, 2406.4, 2512.1.
- Part 9: California Fire Code (CFC), Sections 606, 906.
- Part 11: California Green Building Standards Code (CALGreen), Section 5.407.2.2.

APPENDIX A: SITE-SPECIFIC APPLICATION GUIDE

The following notes are provided as a guide to assist design professionals and DSA plan reviewers when preparing and reviewing site-specific project applications that incorporate PC modular buildings designed in accordance with this IR. This Appendix is not intended to be an all-inclusive list of design and submittal requirements but rather is an aid to identify aspects of the design criteria described in this IR of particular interest to its site application.

- ☐ Verify site-specific suitability of the PC Modular Building including all parameters in PL 07-02 Section 3.
- ☐ Verify site-specific requirements of PL 07-02 Section 4 are met.
- ☐ Verify the RC and occupancy classification of the site-specific design is compliant with the Design Information section of the approved PC. RC is determined by the requirements of CBC Section 1604A.5. As described in CBC Table 1604A.5, this determination is based on the nature of the Occupancy and Occupant Load. Refer to Sections 1.6 and 7 above for additional information.
  - ☐ Where structures have two or more portions that are structurally separated and each have separate means of egress, the RC of each portion shall be separately determined in accordance with CBC Section 1604A.5.1.
  - ☐ Because Occupant Load is a fire and life safety issue, buildings or structures that are structurally separate but share the same code-required means of egress shall be considered together for Occupant Load and, therefore, RC determination.
  - ☐ Where a structurally separate portion is in the path of egress for other structurally separate portions, the Occupant Load used to determine the RC of the first portion shall be as defined in CBC Section 202 and shall be computed in accordance with CBC Section 1004.
  - ☐ The Occupant Load for any structurally separate portion shall be the sum of the Occupant Load originating in that portion plus the number of occupants egressing through it from other structurally separate portions.
  - ☐ The number of occupants egressing through a structurally separate portion shall be based on an exiting analysis that satisfies the requirements of CBC Chapter 10 for Means of Egress as defined in CBC Section 202, including consideration of the requirements of CBC Section 1029 for Assembly Occupancies where applicable.
- ☐ Review the appendix of the site-specific DSA 103 for any exemptions from the required structural tests and special inspections. Applicability and consideration of exemptions may be discussed during plan review for site-specific applications and shall be justified by the applicable project design professional for DSA review and approval. Refer to Section 1.3 and 2.11 above for additional information.
- ☐ In addition to the requirements of PL 07-02 Section 4.9, if the site is located in a flood zone other than Zone X, verify a validation letter from a geotechnical engineer is provided. Refer to Section 1.8 above for additional information.
- ☐ If the site-specific building design exceeds 4,000 Sq. Ft. in plan area or is located within state or local geologic hazard zones, verify submittal and approval of a geohazard report by CGS in accordance with IR A-4. The structures may be split into multiple seismically separated structures to stay below the 4,000 Sq. Ft. trigger. Refer to Section 1.9.1 above for additional information.

- ☐ Verify there is adequate drainage at the site to prevent water from ponding beneath and immediately adjacent to buildings, including sloped drainage away from the building in accordance with CBC Section 1804A.4. Refer to Section 2.2.2 above for additional information.
- ☐ Verify spot elevations are provided on the site plan to ensure the following criteria are met:
  - ☐ Proper clearance shall be maintained from grade to untreated wood construction per IR 16-1 Section 2. Refer to Section 2.2.8 above for additional information.
  - ☐ Verify the foundation height does not exceed the PC design limits. Refer to Section 5.8 above for additional information.
- ☐ Verify under-floor ventilation is provided in accordance with CBC Section 1202.4 for buildings with under-floor spaces. Where the adjacent exterior grade is higher than the bottom of the floor framing on any side of the building, verify the following criteria are met. Refer to Sections 2.2.3 and 2.2.8 above for additional information.
  - ☐ Verify all wood in the substructure and floor framing (including floor sheathing) is naturally durable or preservative-treated, all exposed steel and welds have a rust inhibitive coating, and the exterior wall envelope is weather-resistant with a continuous water-resistive barrier extending down to top of foundation wall in accordance with IR 16-1 Section 2.2.2.2.
  - ☐ Verify details of vent wells are shown on the site plan as required to provide cross ventilation of the under-floor space.
- ☐ If the site-specific building design includes shower or toilet rooms with more than two plumbing fixtures, verify curbs or an alternate means of protection is provided in accordance with CBC Section 2304.12.1.4.1 and IR 23-3. If the PC drawings do not provide details for this condition, they shall be provided on the site-specific drawings. Refer to Section 2.3.1 above for additional information.
- ☐ If the site has a ground snow load greater than zero, verify the modular building is positioned with sufficient distance from any adjacent structure as defined on the PC drawings. If the horizontal separation is less than 20 feet, snow drift analysis shall be provided by the PC applicant, and the project is not eligible for OTC review. Refer to Section 3.1.3 above for additional information.
- ☐ Verify utility and services lines crossing building separation joints are designed to accommodate, without rupture or distress, differential building movements as defined on the PC drawings. Refer to Section 2.6 above for additional information.
- ☐ If the site-specific building design includes plan offsets of modules, verify the design complies with plan offset limitations defined in the PC drawings. Refer to Section 2.7 above for additional information.
- ☐ Verify the site-specific building design of window and/or door openings falls within the dimensional limits and wall framing conditions covered on the PC drawings. Refer to Section 3.1.7 above for additional information.
- ☐ If soil pressure and bearing values exceed Class 5 soil as specified in CBC Table 1806A.2, a site-specific geotechnical report shall be provided at the time of site application to justify values used. Refer to Section 5.2 above for additional information.
- ☐ If the building is placed adjacent to a slope, verify the building location complies with the setback requirements defined on the PC drawings. Refer to Section 5.4 above for additional information.

- ☐ If the site-specific building is designed for Site Class D or E, verify if a site-specific ground motion hazard analysis is required. Refer to Section 4.1.1.2 above for additional information.
- ☐ If a ground motion cap is applied to the value of S_{DS} in determination of the seismic base shear, verify the required criteria per ASCE 7 Section 12.8.1.3 are met at time of OTC or project submittal. In addition, verify the value of S_{DS} for the site-specific application does not exceed the value of S_{DS} (no cap) listed on the PC drawings. Refer to Section 4.1.2 above for additional information.
- ☐ Verify the building location on the site complies with the dimensional requirements for separation from existing buildings or other new buildings as defined on the PC drawings. Unless a detailed analysis is provided, the movement of an adjacent existing building shall be assumed to be that corresponding to the maximum drift allowed by the governing code at the time of the existing building's design or construction. Refer to Section 4.1.9 above for additional information.
- ☐ Verify the scope of nondestructive testing of complete joint penetration welds listed on the site-specific DSA 103 is in accordance with the example DSA 103 on the PC drawings and the design option(s) utilized in the site-specific modular building design. Refer to Section 2.11.1 above for additional information.
- ☐ If the building has a ramp, verify the ramp structure and configuration matches the ramp included in the approved PC documents or has a separate PC approval that is appropriate for the site-specific project. Otherwise, the project is not eligible for OTC review, and additional items must be provided for review in accordance with Section 2.10.1.