

PRE-CHECK (PC) DESIGN CRITERIA FOR OPEN FABRIC SHADE STRUCTURES: 2019 CBC

Disciplines: All

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

PURPOSE: This Interpretation of Regulations (IR) clarifies requirements relating to pre-check (PC) submittals to promote uniform statewide criteria for code compliance in design and plan review of open fabric shade structures 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 is provided as a guide to assist design professionals and DSA plan reviewers when preparing and reviewing site-specific project applications that incorporate PC fabric shade structures designed in accordance with this IR.

SCOPE: The provisions of this IR apply to 2019 PC plans for new open fabric shade structures submitted to DSA under the 2019 CBC after January 1, 2020. Open fabric shade structures are defined as exterior free-standing structures with open sides and a fabric canopy covering the top surface. They are used for various occupancies. Structural framing shall provide support for the canopy for all vertical and lateral loads.

As noted in *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 “prechecked” 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 responsible charge is responsible for specifying and detailing requirements for each project. Additional information regarding the design and site application of PC structures can be found in the following documents:

- Procedure *PR 07-01: Pre-Check Approval*
- Policy *PL 07-02: Over-the-Counter Review of Projects Using Pre-Check Approved Designs*

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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 (e.g., design information on coversheet, example form *DSA 103: List of Required Structural Tests and Special Inspections* on the drawings, PC sheet index, etc.). 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. Design Information on the Coversheet: See PR 07-01 Section 2.4 and Appendices B & C. Indicate snow and ice loads allowed. Note 0 pounds per square foot (psf) if not used in design.

The following information, as minimum, must be included in the design drawings or specifications. This is not intended to be an all-inclusive list, and additional items may be required:

1.2.1. Applied design loads.

1.2.2. Base reactions for each load case at points of support.

1.2.3. Type of fabric, specified strength of fabric and seams for each part of structure.

1.2.4. The maximum cable allowable strength (S_a) per ASCE 19 Section 3.3.1 for each cable size in the PC.

1.2.5. The direction of the warp and fill.

1.2.6. Type and location of any mechanical connections.

1.3. Structural Tests and Special Inspections: Provide example form(s) DSA-103 on the drawings. 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. See PR 07-01 Section 2.5.

1.3.1 A qualified representative of Laboratory of Record (LOR) or approved Special Inspector shall verify all steel identification per CBC Section 2202A.1 and *IR 17-3: Structural Welding Inspection*, Section 3.2.3.

1.3.2 Only the site-specific form DSA-103 can incorporate exemptions from the required structural tests and special inspections in accordance with the Appendix of form DSA-103. 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 Appendix A for additional information.

1.4. Options and Variations: Provide checkboxes of options and variations if there is more than one configuration or design load criteria. See PR 07-01 Section 3 for more details, including the maximum number of options permitted in a single PC.

1.5. Design Parameters: Provide on the coversheet (and subsequent sheets as necessary) Design Information as defined in PR 07-01 Section 2.4 and Appendix B. 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. Additionally, refer to and coordinate with PL 07-02 Section

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3, which summarizes common site specific parameters to be verified at Over-the-Counter (OTC) plan reviews.

- 1.6. Risk Category and Occupant Load:** PC drawings must indicate the maximum Risk Category (RC) the structure is designed for in the Design Information section of the coversheet.

In addition, the Design Information section shall include a note requiring the intended Use and Occupancy be specified on the site-specific application drawings, so the DSA reviewer can verify the RC of the PC structure as it applies to the site in accordance with CBC Section 1604A.5. For this purpose, the PC drawings shall include a Code Analysis table with columns for the definition of Use and Occupancy classification per CBC Chapter 3, Occupant Load Factor (OLF) per CBC Table 1004.5 and total occupant load, to be completed by the design professional at time of the site specific application. The site-specific RC will be correspondingly be determined from the site-specific occupant load in accordance with CBC Table 1604A.5. Refer to Appendix A for additional information.

- 1.7. Flood Zone:** Design shall comply with CBC Section 1612A and procedure *PR 14-01: Flood Design and Project Submittal Requirements*.

- 1.7.1** Provide a note in the Design Information section indicating that when a site-specific project is located in a flood zone other than Zone X a letter stamped and signed from a geotechnical engineer is needed to validate the allowable soil values specified in the PC are still applicable.

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

- 1.7.2.** Location of electrical elements shall conform to the American Society of Civil Engineers (ASCE) 24 Section 7.2 as required per procedure *PR 14-01: Flood Design and Project Submittal Requirements*, Section 1.2.1.

- 1.8. Geohazard Reports:** Provide a note in the Design Information section indicating that geohazard reports are not required for open fabric shade structures 1,600 Square Feet (Sq. Ft.) or less complying with the requirements of *IR A-4: Geohazard Report Requirements*, Section 3.1.1. Open fabric shade structures greater than 1,600 Sq. Ft. up to a maximum of 4,000 Sq. Ft. and complying with the requirements noted in *IR A-4* Section 3.1.1 do not require a geohazard report provided a geotechnical report indicates that no liquefaction potential exists.

- 1.9. Weather Protection:** PC drawings shall specify the type of weather protection selected for all weather-exposed steel members (structural steel and cold-formed steel) in accordance with CBC Section 2203A.1.

- 1.9.1.** Structural steel shall be one of the following:

- Hot-dip galvanized, minimum American Society for Testing Materials (ASTM) A123 or A153 Class D, as applicable.
- Painted with zinc-rich primer, undercoat and finish coat; or equivalent paint system.

- 1.9.2.** Cold-formed steel members shall be 55 percent aluminum-zinc alloy coated per ASTM A792/A792M standard in accordance to the American Iron and Steel Institute (AISI) S240 Table A4-1, CP 90 coating designation.

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- 1.9.3.** Cables shall be stainless steel or galvanized per ASCE 19 Sections 6.0 and 6.1.
- 1.9.4.** All exposed steel fasteners, including cast-in-place anchor bolts/rods, shall be stainless steel (Type 304 minimum), hot-dip galvanized (ASTM A153 Class D minimum or ASTM F2329), or protected with corrosion-preventive coating that demonstrated no more than 2 percent of red rust in minimum 1,000 hours of exposure in salt spray test per ASTM B117. Zinc-plated fasteners do not comply with this requirement. Examples of proprietary coatings that do comply with the 1000-hour requirement include, but are not necessarily limited to, the following: Quik Guard by Simpson, Kwik-Cote by Hilti, Stalgard by Elco, vistaCorr by SFS intec, etc.
- 1.9.5.** Post-installed anchors used for exterior exposure shall comply with the requirements of the evaluation report.
- 1.10. PC Sheet Index:** Provide a PC sheet index. See PR 07-01, Appendix E.
- 1.11. DSA ID Stamp and PC Stamp:** Provide 2019 CBC PC Stamp per PR 07-01 Section 6.1. Provide two blank areas on each PC sheet title block as indicated in procedure *PR 18-04.BB18: Electronic Plan Review for Design Professionals of Record Using Bluebeam 2018*, Section 1.2.2.2: one for the PC ID stamp and one for the future site-specific DSA Identification Stamp. See policy *PL 18-02: Record Sets of DSA-Approved Construction Documents*.
- 1.12. 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.
- 1.13. CALGreen/Energy Code Requirements:** Design shall comply with the mandatory measures of the California Green Code (CALGreen) and the California Energy Code (Energy Code). Refer to PR 07-01 for mandatory requirements.
- 1.14. Software:** Design Professional shall provide to DSA sufficient documentation to verify and substantiate input and output of all software used for design, including but not limited to:
- Electronic file upon request.
 - Input and output data in PDF file format.
 - Description of input and output – schematic framing plans, member and joint labeling, member loads, checks of elements, cables, connections, etc.
 - Derivation of loads.
 - Hand calculations to approximate and validate analysis results for cable forces and reactions.
 - Narrative summary of key results.
 - Validation by hand calculation or other software upon request.
 - Explanation, read-me file, or user guide for unusual modeling upon request.
- 2. LOAD CRITERIA:**
- 2.1. Dead Load:** See ASCE 55 Section 4.2.2.
- 2.2. Superimposed Load:** See ASCE 55 Section 4.2.3.
- 2.3. Live Load:** Live load shall be per CBC Table 1607A.1.

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- 2.4. Snow load:** Snow load shall be per ASCE 7 (per ASCE 55 Section 4.2.4). Design shall consider deflection of the membrane under accumulated snow and other loads. The shape of PC fabric shade structure must be covered by ASCE 7 for the snow load calculation. Shapes not covered by ASCE 7 may be used, provided research and testing is used as basis for design. See ASCE 55 Section C4.2.
- 2.5. Wind Load:** Wind load shall be per ASCE 7 (per ASCE 55 Section 4.2.5).
- 2.5.1** For open fabric shade structures utilizing “sail” shapes: if the fabric does not have a relative slope change greater than 7.5 degrees along any catenary curve, the shape is permitted to be considered “flat” rather than hyperbolic paraboloid and may utilize the monoslope provisions per ASCE 7 Figure 27.3-4. When the fabric relative slope change exceeds 7.5 degrees in one or more directions but has at least one catenary curve between 2 points of support along which the relative slope change does not exceed 7.5 degrees, the shape is permitted to be considered a “pitched” or “troughed” roof (where the “flat” curve between the 2 points of support forms the trough or ridge) and may utilize the provisions of ASCE 7 Figures 27.3-5 or 27.3-6, respectively.
- 2.5.2** Open fabric shade structures with roof shapes meeting the prescriptive requirements of ASCE 7 (i.e., hip, gable, monoslope, etc.) shall use a gust factor G per ASCE 7 Section 26.11. The structures will not be considered as dynamically sensitive if the structural calculations contain a statement from the structural engineer of record that the structure is not dynamically sensitive for purposes of determining the gust factor.
- 2.5.3** Open fabric shade structures with roof shape not covered by ASCE 7 or where the Main Wind Force Resisting System is cables guyed to the ground: the structure may need to be considered as dynamically sensitive for calculation of gust factor, G . The flexibility of all surfaces resisting wind loads shall be included as resisting elements in determining whether the structure is dynamically sensitive.
- 2.5.4** Shapes not covered by ASCE 7 may be used, provided wind tunnel testing is used as basis for design. See ASCE 55 Section C4.2.
- 2.6. Ponding:** If shape or configuration of the structure does not maintain positive drainage from all areas of the roof, then design must consider ponding in accordance with ASCE 55 Section 4.3.4.
- 2.7. Seismic Force Resisting System:** Open fabric shade structures shall comply with ASCE 7, Chapter 12. These structures shall be considered as “steel cantilevered column systems” ($R = 1.25$ ordinary; $R = 2.5$ special) or other systems allowed per ASCE 7, Chapter 12.
- 2.8. Seismic Load Criteria:**
- 2.8.1. 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. Other S_s values are permitted but will limit the applicable site locations for the PC.
- 2.8.2. Ground Motion Hazard Analysis:** Due to the site-specific ground motion analysis requirements of ASCE 7 Section 11.4.8, PC designs shall be based on the short period seismic response parameter S_{DS} and ASCE 7 Equations 12.8-2 and 12.8-5. Where a PC design is provided for Site Class E, the short-period site coefficient as required by ASCE 7 Section 11.4.8 Exception 1 shall be used. Alternatively, if the PC design is not based on the short period seismic response parameter S_{DS} , the PC design shall comply with the requirements of ASCE 7 Section 11.4.8, and the Design Information section shall state the fundamental period of the structure(s) and include

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notes alerting the site-specific user of the PC to the conditions requiring a site-specific ground motion hazard analysis.

- 2.8.3. 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 criteria therein are met.
- 2.8.3.1.** The PC design shall demonstrate compliance with the required criteria specific to the open fabric shade structure: e.g., no irregularities, period not exceeding 0.5 seconds, redundancy factor equal to 1.0, etc. The PC drawings shall list these properties in the Design Information section. For the purpose of checking compliance with these criteria, the period shall be determined based on the actual properties of the structure, including foundation flexibility, and not use the approximate period in ASCE 7 Section 12.8.2.1.
- 2.8.3.2.** 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 or F not allowed, RC I or II, etc.
- 2.8.3.3.** 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.
- 2.9. Drift:** For open structures, there is no drift limit for Risk Category I or II structures; however, there are drift limits for Risk Category III structures per ASCE 7 Section 12.12.1 and CBC Section 1609A.1.2.
- 3. FABRIC STRUCTURE ANALYSIS:**
- 3.1. Fabric Does Not Provide Lateral Resistance:** Fabric materials shall not be considered as contributing to the primary lateral resistance of the structure. Design must account for forces acting upon fabric as transferring directly to the supporting structure.
- 3.2. Membrane Breaking Strength:** Breaking strength in both warp and fill directions of the membrane shall be determined via testing. Provide published values for the specified fabric in accordance with ASCE 55 Section 2.4.2. Evaluation report per IR A-5 is not required. Test reports or published values are not required to be stamped by a California registered Professional Engineer (PE) or Structural Engineer (SE).
- 3.3. Membrane Design:** Design of membrane components shall utilize load combinations and strength reduction factors per ASCE 55 Table 4-2. Allowable stress increase is not permitted. The membrane resistance shall be checked per ASCE 55 Section 4.6.1.
- 3.4. Cables and Cable Connections:** Design cables and cable connections in accordance with ASCE 19. Cables to be specified per ASTM A1023/A1023M. S_a shall be greater than the required strength (S_r).
- 3.5. Catenary Action and Forces Transmitted to Support Elements:** Catenary action of fabric and cables (where occur) shall be considered in the design of open fabric shade structures. Catenary action must be accounted for in the design of the catenary elements themselves and when considering their reactions on supporting elements. Specifically, design shall include large-deflections analysis that accounts for fabric properties and behavior when considering the forces transmitted to supporting cables, beams and columns. Such analysis is usually accomplished using software to perform Nonlinear Finite

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Element Analysis. The design must include the tensile reaction forces from the fabric and/or cables to the supporting structure (i.e., columns, beams). See Section 1.14 above for software verification requirements.

In a tensile membrane structure, the catenary is the curved shape developed at the boundary of the fabric or by any cable support member in tension between points of restraint.

- 3.6. Full-scale Testing in Lieu of Analysis:** As an alternate method to stress analysis, the fabric may be subjected to full-scale load testing which support the load combinations of ASCE 55 Table 4-2 increased by a safety factor.

The safety factor in the testing = $1/(\beta \cdot L_t)$, where:

- β is the strength reduction factor per ASCE 55 Table 4-2.
- L_t is Life-cycle factor per ASCE 55 Section 4.4.2.
- Testing protocol must be approved by DSA.

4. FOUNDATION:

- 4.1. Allowable Soil Pressure and Bearing:** Maximum soil pressure and bearing values shall be in accordance with Class 5 soil in CBC Table 1806A.2 unless justified by a site-specific geotechnical report. In order to use load-bearing values above the stated maximums for Class 5 soil, a statement requiring a site-specific geotechnical report at the time of site application must be included in the Design Information section on the PC drawings.

An allowable stress increase is not permitted for Basic Allowable Load Combinations including footings per CBC Section 1605A.3.1. An allowable stress increase is permitted for Alternative Basic Load Combinations per CBC Section 1605A.3.2.

- 4.2. Lateral Bearing Pressure Increase:** Allowed per CBC Section 1806A.3.4.

If two times the tabular value is used, under Design Information section, list the tabulated soils lateral bearing pressure value used in the design and indicate if this value has been increased per CBC Section 1806A.3.4 for pole footing design.

- 4.3. Foundation Design Load:** The design of the foundation elements (both pier footings and shallow spread footings) and connections shall include the overstrength factor for cantilever column systems per ASCE 7 Section 12.2.5.2 and CBC Section 1617A.1.16.

4.4. Pier Footing

- 4.4.1.** Comply with CBC Section 1810A.3.9 if the column anchors at the top of the pier or is partially embedded. See Sections 4.7, 4.12 and 4.13 below. See also bulletin *BU 09-06: Minimum Reinforcement of Concrete Piers and Caissons Embedded with Steel Poles*, which can be followed if the steel columns are embedded to within six inches of the bottom of the pier.
- 4.4.2.** See Section 4.8 below for pier footings used in combination with shallow spread footings.
- 4.4.3.** In accordance with CBC Section 1810A.2.4, the depth of pier footing is permitted to be designed per CBC Section 1807A.3.2 if the pier footing is assumed to be rigid. The pier footing may be assumed to be rigid if the ratio of the specified depth (not the minimum depth required by CBC Section 1807A.3.2) to diameter is equal to or less than eight (8). Otherwise, pier footing design including its reinforcing shall consider the nonlinear interaction of the pier and soil (e.g. L-pile analysis including group effects as required by CBC Section 1810A.2.5).

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4.4.4. Maximum pier embedment depth for the purpose of computing lateral pressure (S_1) is 12 feet per CBC Section 1807A.3.2.1.

4.4.5. Provide a note in the Design Information section specifying the minimum clearance required between drilled piers when placing multiple canopies. Design must consider group effects if applicable per CBC Section 1810A.2.5.

4.5. Allowable Pier Frictional Resistance and Uplift Capacity: The allowable frictional resistance and uplift capacity used in the design shall be included in the Design Information section.

When a site-specific geotechnical report is not available, CBC Section 1810A.3.3.1.4 can be used to obtain allowable frictional resistance value. Presume Class 5 soils as noted in Section 4.1 above. For uplift capacity per CBC Section 1810A.3.3.1.5, a Factor of Safety of 3 shall be applied to the frictional resistance value obtained in CBC Section 1810A.3.3.1.4; where uplift is due to wind or seismic loading, a Factor of Safety of 2 can be used.

4.6. Unconstrained vs. Constrained Ground Surface Condition: When CBC Section 1807A.3.2 is utilized, asphalt pavement does not constitute a "constrained" condition and does not justify the use of CBC Equation 18A-2 to determine the required pier depth. Where the constrained condition is used with concrete pavement, the reaction shall be adequately resisted and justified by calculations. The construction necessary to resist this reaction shall be clearly detailed on the PC drawings.

4.7. Pier Reinforcing: For piers with partial column embedment or a base plate with anchor bolts, tie reinforcing shall comply with CBC Section 1810A.3.9.4.2, except the tie spacing need not be less than the following where $P_u < 0.10f_c A_g$ (see Figures A through D below). These exceptions are only applicable to open fabric shade structures. This type of structure is lightly loaded and has a low ductility demand. These exceptions may not be extended to any other types of structure.

4.7.1. Site Class A - D: For the top 3d of the pier (where "d" is the pier diameter) provide the smallest of d/4, $6d_b$ (where " d_b " is the diameter of the longitudinal bars), and 6". For remainder of section provide smallest of d/2, $12d_b$, and 12". Refer to Figures A and C.

4.7.2. Site Class E: For the top 7d of the pier (where "d" is the pier diameter) and 7d above and below the interface of each soil stratum, provide the smallest of d/4, $6d_b$ (where " d_b " is the diameter of the longitudinal bars), and 6". For remainder of section provide smallest of d/2, $12d_b$, and 12". Refer to Figures B and D.

4.7.3. For partially embedded columns, the ties shall be designed for the transfer force based on a rational method and accepted principles of engineering mechanics.

4.8. Shallow Spread Footing: Shallow spread footings shall be designed per CBC Chapter 18A and for stability in accordance with CBC Section 1605A.1.1.

If the cantilevered column structure is supported by the combination of a pier footing(s) and a shallow spread footing(s), all steel columns within the structure shall have the same column heights/lengths unless the column stiffness is accounted for in design.

4.9. Adjacent Slope: PC drawing shall specify minimum setback limits (values are required) of the structure per CBC Section 1808A.7.

Alternatively, the depth of required pier embedment can start from an elevation that corresponds with a horizontal clear distance of seven times (7x) the pier diameter that intersects with the slope (daylighting). If setback limits are smaller than CBC requires, a site-specific geotechnical report is required. If the pier is lowered per the above

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requirements, then the design height of the column for the purpose of calculating pier depth and moment must be increased to the theoretical top of the required pier embedment depth.

- 4.10. Liquefiable Soil or Site Class F:** PC options shall not include liquefiable soil (Exception: open fabric shade structures 1,600 Sq. Ft. or less complying with requirements of IR A-4 Section 3.1.1). If the structure is to be located in an area with liquefiable soil or Site Class F, OTC submittal is not allowed and regular 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.

4.11. Concrete Mix:

- 4.11.1.** Unless concrete exposure is classified per the American Concrete Institute (ACI) 318 Section 19.3.1.1 whereby the concrete mix design can comply with ACI 318 Section 19.3.2.1, concrete mix shall consist of Type V cement with a minimum compressive strength of 4,500 psi and maximum water/cement ratio of 0.45.
- 4.11.2.** If ACI 318 Section 19.3.2.1 is used for concrete mix design, the PC shall clearly indicate the exposure levels applicable in the Design Information section. This may be tabulated for multiple categories or limited to specific exposure categories with conservative values.
- 4.11.3.** Concrete exposed to thaw and freeze cycles shall be air entrained per ACI 318 Section 19.3.3.1.

- 4.12. Partially Embedded Columns:** When cantilevered columns are partially embedded into concrete foundation piers, *BU 09-06: Minimum Reinforcement of Concrete Piers and Caissons Embedded with Steel Poles* is not applicable:

- 4.12.1.** The load transfer mechanism of partially embedded columns shall include the design of both the column and concrete pier ties. Minimum column embedment depth into concrete pier shall be the greater of the following:
- Seven times the least dimension of column section.
 - Minimum development length of the longitudinal pier reinforcing.
- 4.12.2** All embedded columns into pier footings shall have mechanical connection to resist uplift. AISC 360 Section I6 provides an acceptable criteria for demonstrating the adequacy of the load transfer from the partially embedded column to the drilled pier.
- Exception: For steel columns with minimum 48" embedment into concrete, an allowable bonding stress of 25 psi between steel columns and concrete is permitted to be utilized. The first 12" of embedment must be disregarded and no increase in this allowable bonding stress value is permitted for wind or seismic loads.

4.13. Column Base Connection:

- 4.13.1.** Embedment depth of the anchor rods shall be sufficient to lap with the longitudinal pier reinforcement. The lap length shall be based on developing the longitudinal pier reinforcement beyond the projected failure plane of the anchor bolt heads. Refer to Figures A through D below and ACI 318 Figure R17.4.2.9. The lap length is not permitted to be reduced based on applied loads.
- 4.13.2.** Anchor rods shall be designed for combined shear and tension. If the maximum grout thickness between the top of footing and bottom of base plate exceeds two times the anchor rod diameter, the anchor rods shall be designed for bending in combination with tension and shear. Refer to American National Standards

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Institute/Telecommunication Industry Association (ANSI/TIA) 222-H Section 4.9.9 and *Design Guide 1: Base Plate and Anchor Rod Design* published by AISC. When oversized holes are used in the base plate the design shall comply with CBC Section 2204A.4.

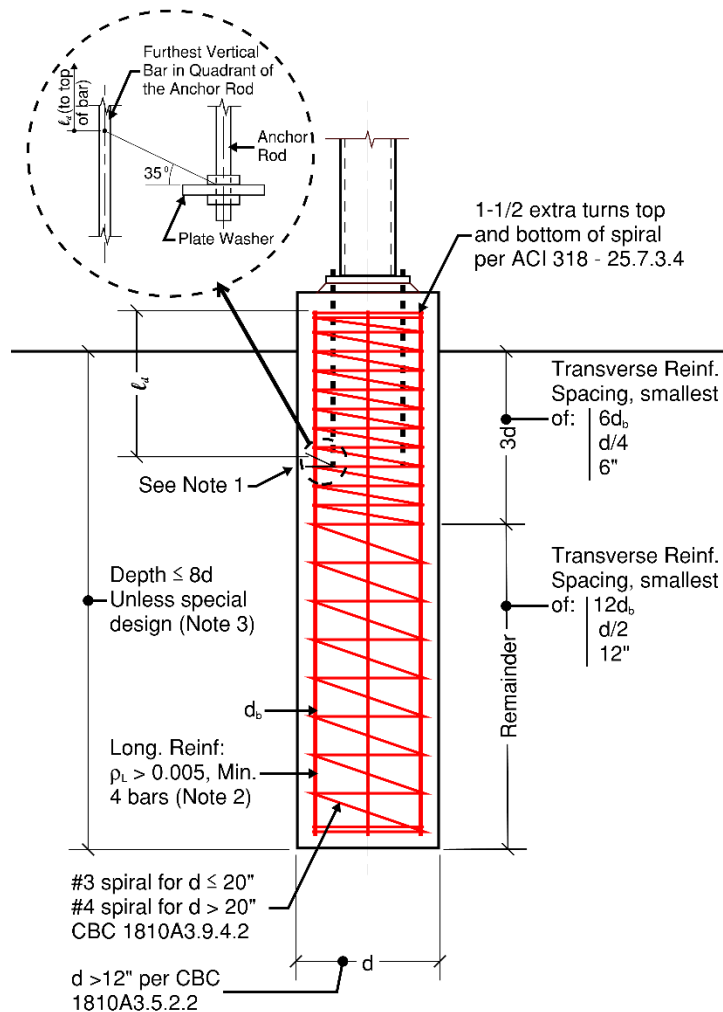
5. ACCESS COMPLIANCE REQUIREMENTS:

- 5.1. Protruding Objects in Circulation Areas:** Protruding objects such as column-mounted equipment shall comply with CBC Section 11B-307.
- 5.2. Vertical Clearance in Circulation Areas:** Vertical clearance to supporting structures shall comply with CBC Section 11B-307.4.

6. FIRE AND LIFE SAFETY REQUIREMENTS:

- 6.1. Type of Construction:** Specify type of construction per CBC Chapter 6 in the Design Information section on the coversheet.
- 6.2. Total Area of Structure:** Specify total area of structure in the Design Information section on the coversheet and demonstrate that the total area is compliant with the allowable area criteria as determined per CBC Section 506.2 based on type of construction and proposed occupancy classification(s).
- 6.3. Use and Occupancy Classification(s):** Specify proposed use and occupancy classification(s) per CBC Chapter 3 in the Design Information section on the coversheet.
- 6.4. Special Construction Requirements:** Fabric shade structures shall comply with the applicable provisions of CBC Section 3102.
- 6.5. Membrane Fabric:** Fabric material shall comply with CBC Section 3102.3.1 (see also CCR, Title 19, Division 1, Chapter 8).

Figure A



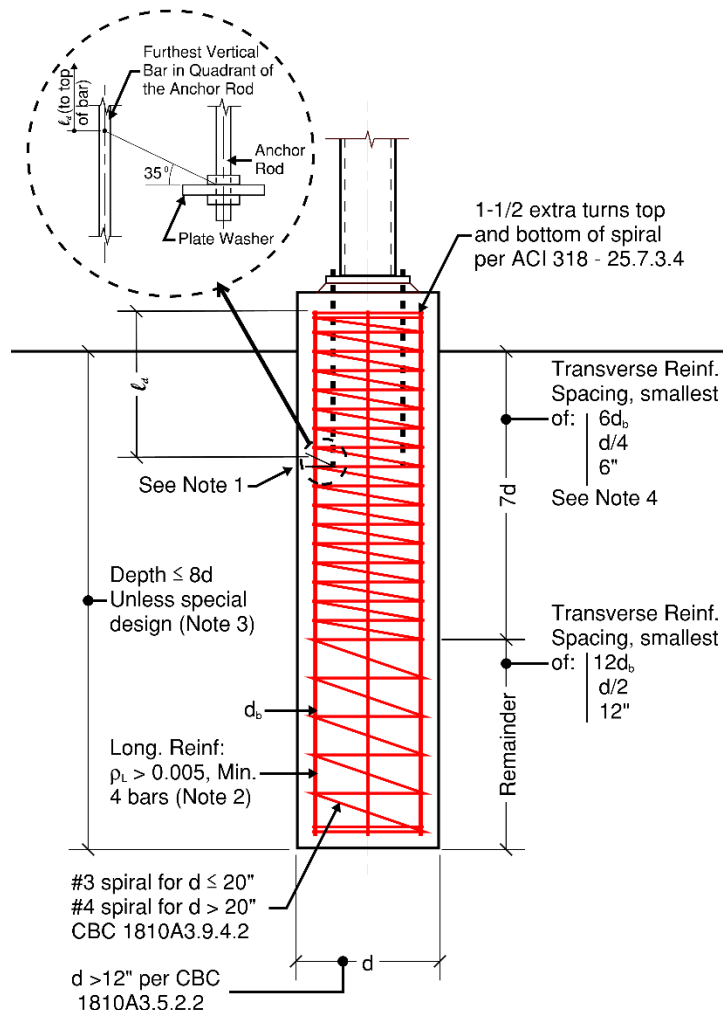
Note 1: Development length of vertical reinforcing steel that engages the anchor rod, ℓ_d , must meet ACI 318 Section 25.4. It is measured from the top of vertical bar to the point shown in the enlarged detail. Alternatively, the embedment depth of the anchor rod may be determined as the development length of the vertical bar plus one quarter of the pier diameter ($\ell_d + d/4$).

Note 2: The total longitudinal reinforcing steel area (A_s) shall be enough to transfer the loads from the total required anchor rod area ($A_{rod-req}$) taking into account relative yield stress, as follows: $A_s \geq A_{rod-req} \times (f_{y-rod} / f_{ys})$. However, if the spacing between vertical bars is 6" or less, the steel area (A_s) need not exceed 33% more than that required to resist the column design moment in the pier section.

Note 3: The prescriptive longitudinal and transverse reinforcing requirements shown may be used when the embedded pier depth to diameter ratio ≤ 8. If this ratio is exceeded, the pier must be analyzed and designed as required per CBC Section 1810A.2.4.

Spiral Reinforcing in Site Classes A-D

Figure B



Note 1: Development length of vertical reinforcing steel that engages the anchor rod, l_d , must meet ACI 318 Section 25.4. It is measured from the top of vertical bar to the point shown in the enlarged detail. Alternatively, the embedment depth of the anchor rod may be determined as the development length of the vertical bar plus one quarter of the pier diameter ($l_d + d/4$).

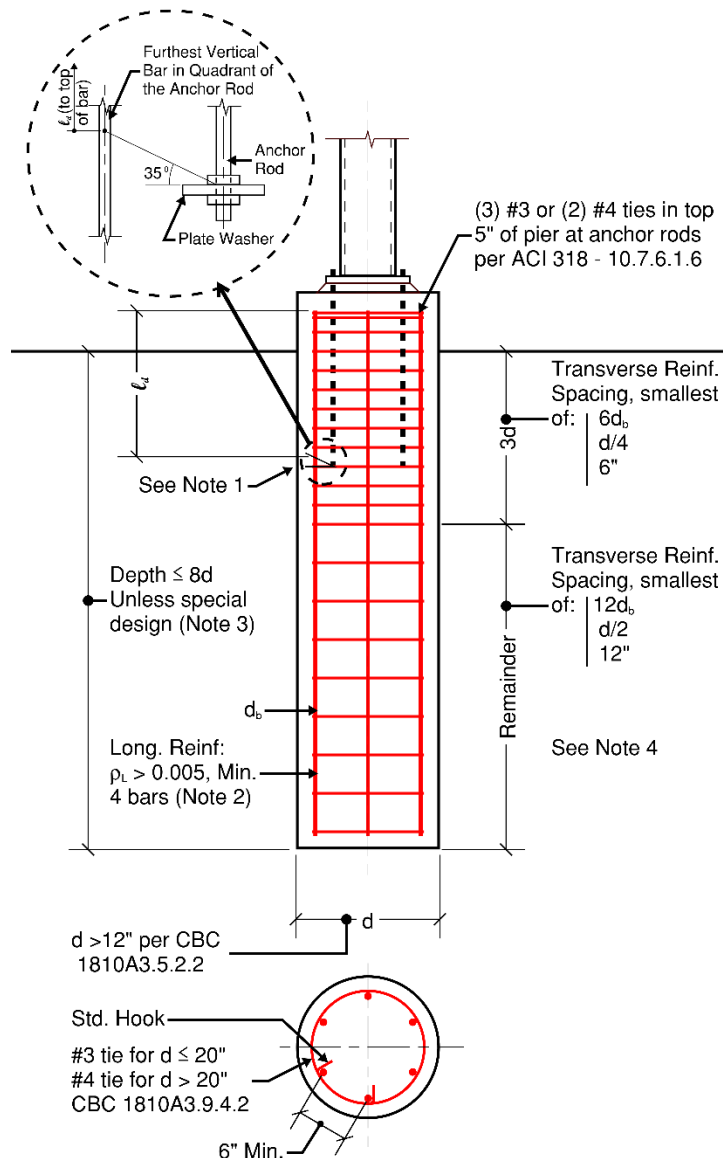
Note 2: The total longitudinal reinforcing steel area (A_s) shall be enough to transfer the loads from the total required anchor rod area ($A_{rod-req}$) taking into account relative yield stress, as follows: $A_s \geq A_{rod-req} \times (f_{y-rod} / f_{ys})$. However, if the spacing between vertical bars is 6" or less, the steel area (A_s) need not exceed 33% more than that required to resist the column design moment in the pier section.

Note 3: The prescriptive longitudinal and transverse reinforcing requirements shown may be used when the embedded pier depth to diameter ratio ≤ 8 . If this ratio is exceeded, the pier must be analyzed and designed as required per CBC Section 1810A.2.4.

Note 4: The 7d distance is also required above and below soil strata identified as liquefiable or hard or stiff as required per CBC Section 1810A.3.9.4.2.2.

Spiral Reinforcing in Site Class E

Figure C



Note 1: Development length of vertical reinforcing steel that engages the anchor rod, l_d , must meet ACI 318 Section 25.4. It is measured from the top of vertical bar to the point shown in the enlarged detail. Alternatively, the embedment depth of the anchor rod may be determined as the development length of the vertical bar plus one quarter of the pier diameter ($l_d + d/4$).

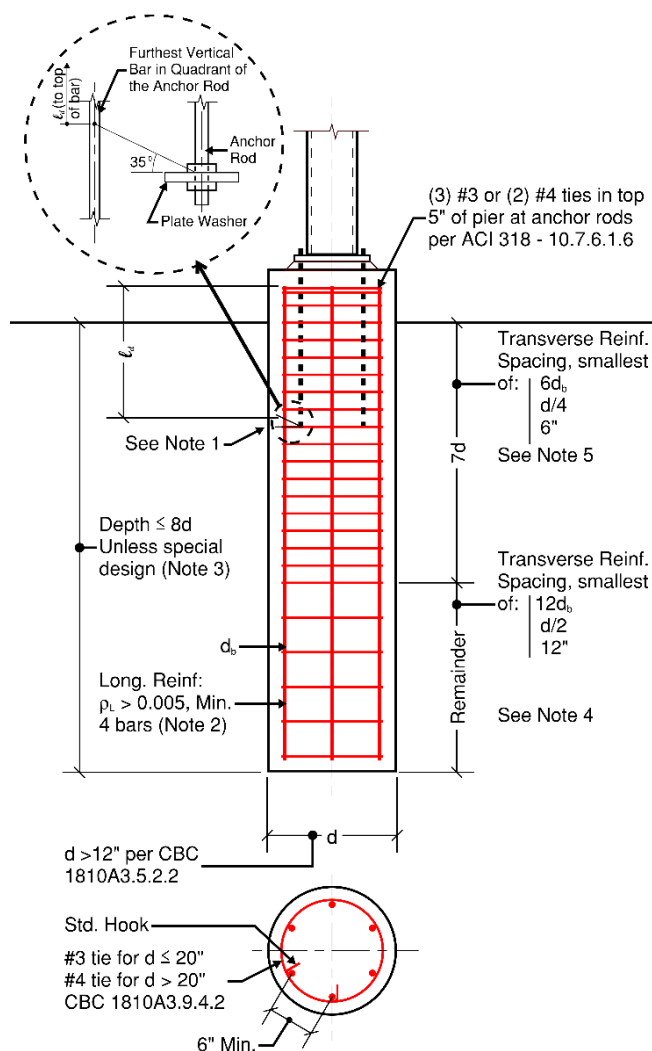
Note 2: The total longitudinal reinforcing steel area (A_s) shall be enough to transfer the loads from the total required anchor rod area ($A_{rod-req}$) taking into account relative yield stress, as follows: $A_s \geq A_{rod-req} \times (f_{y-rod} / f_{ys})$. However, if the spacing between vertical bars is 6" or less, the steel area (A_s) need not exceed 33% more than that required to resist the column design moment in the pier section.

Note 3: The prescriptive longitudinal and transverse reinforcing requirements shown may be used when the embedded pier depth to diameter ratio ≤ 8 . If this ratio is exceeded, the pier must be analyzed and designed as required per CBC Section 1810A.2.4.

Note 4: Ties shall comply with ACI 318 Section 25.7.2.4.1 including: (a) ends overlap by at least 6", (b) ends terminate with a standard hook engaging a longitudinal bar, and (c) overlaps of adjacent ties are staggered around the perimeter.

Tie Reinforcing in Site Classes A-D

Figure D



Note 1: Development length of vertical reinforcing steel that engages the anchor rod, ℓ_d , must meet ACI 318 Section 25.4. It is measured from the top of vertical bar to the point shown in the enlarged detail. Alternatively, the embedment depth of the anchor rod may be determined as the development length of the vertical bar plus one quarter of the pier diameter ($\ell_d + d/4$).

Note 2: The total longitudinal reinforcing steel area (A_s) shall be enough to transfer the loads from the total required anchor rod area ($A_{rod-req}$) taking into account relative yield stress, as follows: $A_s \geq A_{rod-req} \times (f_{y-rod} / f_{ys})$. However, if the spacing between vertical bars is 6" or less, the steel area (A_s) need not exceed 33% more than that required to resist the column design moment in the pier section.

Note 3: The prescriptive longitudinal and transverse reinforcing requirements shown may be used when the embedded pier depth to diameter ratio ≤ 8 . If this ratio is exceeded, the pier must be analyzed and designed as required per CBC Section 1810A.2.4.

Note 4: Ties shall comply with ACI 318 Section 25.7.2.4.1 including: (a) ends overlap by at least 6", (b) ends terminate with a standard hook engaging a longitudinal bar, and (c) overlaps of adjacent ties are staggered around the perimeter.

Note 5: The $7d$ distance is also required above and below soil strata identified as liquefiable or hard or stiff as required per CBC Section 1810A.3.9.4.2.2.

Tie Reinforcing in Site Class E

PRE-CHECK (PC) DESIGN CRITERIA FOR OPEN FABRIC SHADE STRUCTURES

REFERENCES:

2019 California Code of Regulations (CCR) Title 24

Part 1: California Administrative Code (CAC), Section 4-333(b)8

Part 2: California Building Code (CBC), Chapters 3 and 6; Sections 104.11, 1004.6, 11B-307, 11B-307.4, 1604A.5, 1605A.1.1, 1605A.3.1, 1605A.3.2, 1609A.1.2, 1617A.1.16, 1806A.3, 1807A.3.2, 1808A.7, 1810A.2.4, 1810A.2.5, 1810A.3.3.1, 1810A.3.9, 2202A.1, 2203A.1; Tables 1004.5, 1604A.5, 1607A.1, 1806A.2

This IR is intended for use by DSA staff and by design professionals to promote statewide consistency for review and approval of plans and specifications as well as construction oversight of projects within the jurisdiction of DSA, which includes State of California public schools (K–12), community colleges and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

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PRE-CHECK (PC) DESIGN CRITERIA FOR OPEN FABRIC SHADE STRUCTURES

APPENDIX A | SITE-SPECIFIC APPLICATION OF PC FABRIC SHADE STRUCTURES

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 fabric shade structures 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.

Refer also to *PL 07-02: Over-the-Counter Review of Projects Using Pre-Check Approved Designs*

1. Verify site-specific suitability of the PC including all parameters in PL 07-02 Section 3.
2. Verify site-specific requirements of PL 07-02 Section 4 are met.
3. 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 above for additional information.
4. Verify Risk Category (RC) of the site-specific design is compliant with the Design Information section of the approved PC. RC determination is based on the Occupant Load (OL) of the site-specific code analysis and Occupant Load Factors (OLF) per CBC Table 1004.5. Refer to Section 1.6 above for additional information. The following are some examples of common Use and Occupancy classifications with associated OLF and sizing limits for RC II:
 - Lunch Shelter | Assembly Use 'A-2': OLF = 15 Sq. Ft. /person or if a combination of table-bench seating is provided, 18 inches/person measured along linear bench length. Group 'A' structures with OLF of 15 must not exceed $(300 \times 15 =)$ 4,500 Sq. Ft. for RC II.
 - Shade Structure | Concentrated Assembly, Group 'A': OLF = 7 Sq. Ft./person or if fixed seating is provided, calculate per CBC Section 1004.6. Group 'A' structures with OLF of 7 must not exceed $(300 \times 7 =)$ 2,100 Sq.Ft. for RC II.
 - Shade Structure | Outdoor Instructional Use, Group 'E': OLF = 20 Sq. Ft./person. Group 'E' structures with OLF of 20 must not exceed $(250 \times 20 =)$ 5,000 Sq. Ft. for RC II.
 - Shade Structure over Playground Equipment, Group 'E' (classified same as the campus): OLF = 20 Sq. Ft./person shall be utilized for purposes of assigning a risk category. Group 'E' structures with OLF of 20 must not exceed $(250 \times 20 =)$ 5,000 Sq. Ft. for RC II.
 - Shade Structure over Parking: Group 'S-2' or 'U' (determined by design professional): OLF = 200 Sq. Ft./person. Structures assigned this Use are unlikely to exceed RC II unless utilized for emergency vehicles.

Regardless of size, if a structure that would otherwise qualify as RC II provides shelter for emergency vehicles or equipment; or provides required access to, required egress from or shares life safety components with an RC III or IV building, the more restrictive RC must be applied. See CBC Section 1604A.5.1, including the exception for storm shelters constructed in accordance with ICC 500.

5. 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 1.7 above for additional information.
6. If the site is classified as Site Class D or E and the seismic design of the PC is not based on the short period seismic response parameter S_{DS} as indicated in the Design Information section of

PRE-CHECK (PC) DESIGN CRITERIA FOR OPEN FABRIC SHADE STRUCTURES

the PC drawings, verify if a site-specific ground motion hazard analysis is required. Refer to Section 2.8.2 above for additional information.

7. In addition to the requirements of PL 07-02 Section 3.1.3, if the PC design is based on a capped S_{DS} value per ASCE 7 Section 12.8.1.3 verify the site specific criteria are met. Refer to Section 2.8.3 above for additional information.
8. If drilled pier foundations are used and multiple structures are placed at a site, verify the site-specific drawings comply with the clearance requirements listed on the PC drawings. Refer to Section 4.4 above for additional information.
9. If drilled pier foundations are used and the constrained ground surface condition option is applied, verify the site-specific drawings comply with the ground surface requirements defined on the PC drawings. Note: Asphalt concrete is not acceptable. Refer to Section 4.6 above for additional information.
10. If the foundation of shade structure contains both drilled piers and shallow spread footings, verify all columns are the same height unless differing column heights are specifically allowed by the PC drawings. Refer to Section 4.8 above for additional information.
11. If structures are placed adjacent to a slope, verify the site-specific drawings comply with the setback and/or pier embedment requirements defined on the PC drawings. Refer to Section 4.9 above for additional information.