DSA IR 24-2

WINDOW WALL SYSTEMS: 2016 CBC

Disciplines: All **History:** Issued 09/22/17

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

PURPOSE: This Interpretation of Regulations (IR) establishes the criteria required to determine if window wall system construction documents must be submitted for DSA approval and clarifies the criteria and process under which those documents will be evaluated and approved for use on projects under DSA jurisdiction. For the purposes of this IR, window wall systems include curtain wall systems, storefront systems, window systems and other glass wall systems.

GENERAL: All interior and exterior window wall systems shall be designed to meet the provisions of the following:

- California Building Code (CBC) as adopted by DSA and the State Fire Marshal.
- California Fire Code (CFC) as adopted by the State Fire Marshal.

In addition, all interior and exterior window wall systems shall be engineered to meet the provisions of Section 2 of this IR.

DEFINITIONS: Curtain Wall: A curtain wall is a non-load-bearing wall system in which the vertical framing members of the system run past intermediate floors. The system is typically located at the exterior of the building and is anchored to the building through the curtain wall vertical framing members.

Storefront: A storefront is a system of doors and windows in which vertical framing members typically run between the top of the floor and structure above. The system is typically anchored to the building at the perimeter.

Window: A window is an operable or non-operable assembly that is installed in a framed opening.

Span: The clear distance between supports parallel to the direction of the window wall framing members. The window wall framing members are typically, but not necessarily, oriented to span in the vertical direction.

1. DSA REQUIREMENTS FOR SUBMITTAL OF WINDOW WALL SYSTEMS: The requirements for submitting window wall system construction documents to DSA for structural review are given in this section.

1.1 Structures with window wall systems having no element with a span greater than 10 feet: DSA structural safety review and approval of window wall plans is not required when all elements of all window wall systems in a structure have a span less than or equal to 10 feet and the system and its components comply with all of the following:

- The window wall system in the building is comprised of conventionally framed (vertical systems consisting entirely of straight elements) curtain walls, storefront systems, windows and door panels without attached structures such as fins, sun shades, etc.
- All spans between support attachments are simple spans. No multi-span or cantilevered members.
- Total length of the mullion shall not exceed 10 feet including mullion slip joints.
- The window wall system is not continuous into the adjacent story past a floor or roof level (e.g.

multistory curtain walls are not exempt).

- The window wall system is not required to have in-plane panel distortion in order to comply with the seismic relative displacement requirements of American Society of Civil Engineers (ASCE) 7 Section 13.5.9 (e.g. slip tracks at the head of the window wall system).

The 10 foot span limit does not apply to the framed wall sill, jamb and header members (e.g. light gauge built-up jambs, structural steel, etc.) supporting the window wall.

Note: Exclusion of a window wall system from DSA approval does not relieve the project design team from the duty to properly design the window wall system to meet the provisions of the CBC as adopted by DSA and the State Fire Marshal; and the design requirements of Section 2 of this IR.

1.2 Structures with a window wall system having at least one element with a span greater than 10 feet: DSA structural safety review is required if any one element of the window wall system has a span greater than 10 feet or the system otherwise fails to comply with Section 1.1. In this case the construction documents for all window wall systems, regardless of span, shall be submitted for DSA review and approval as follows:

- Documents may be included with the building submittal construction documents or may be a deferred submittal.
- If the submittal will be deferred, DSA plan review will not require details of construction for connections of storefront on the building submittal construction documents. However, if the approved construction documents show connection details and the same connections are detailed on a deferred submittal, the details provided in the deferred submittal shall take precedence.

2. STRUCTURAL DESIGN OF WINDOW WALL SYSTEMS: In compliance with Section 1, all window wall systems shall be designed in accordance with the CBC and ASCE 7-10.

2.1 Wind Loads: Wind loads shall be in accordance with CBC Section 1609A and ASCE 7-10.

2.1.1 Wind Speed: Wind speed shall be determined per CBC Section 1609A.3. If the project is located in a special wind region, the wind speed shall be determined by the local jurisdiction in accordance with CBC Section 1609A.3.

2.1.2 Exposure Category: The exposure category shall be determined in accordance with CBC 1609A.4. When the exposure categories cannot be clearly differentiated for a site, then the methods outlined in ASCE 7-10 commentary Section C26.7 shall be used to make the final determination. Per ASCE 7-10 Section 26.7.4.4, the design wind pressures for components and cladding shall be based on the exposure category resulting in the highest wind loads for any direction at the site.

2.2 Deflection: The deflection of window wall framing and glazing shall not exceed the limits specified in this section.

2.2.1 Window wall framing: The out-of-plane deflection limit for window wall framing supporting individual panes of glass shall be in accordance with CBC Section 2403.3 (L/175, ¾" maximum).

For the out-of-plane deflection limit for window wall framing supporting multiple panes of glass, DSA will accept the recommendations in American Architectural Manufacturers Association (AAMA) Technical Information Report (TIR) A11, "Maximum Allowable Deflection of Framing Systems for Building Cladding Components at Design Wind Loads" which prescribes design deflection limits of L/175 for a clear span "L" up to 13 feet 6 inches and L/240 + ¼ inch for spans greater than 13 feet 6 inches, but equal to or less than 40 feet. For spans greater than 40 feet, acceptance of the deflection limit will be addressed on a case-by-case basis.

If testing will be performed on exterior window wall systems to show compliance with specified deflection limits, the testing shall comply with CBC 1709A.5.

2.2.2 **Glazing:** The out-of-plane deflection limit for glazing shall not exceed L/60 where "L" is the shortest span of the glazing.

2.2.3 **Unsupported Glass Edges:** To avoid creating a pinching hazard, the out-of-plane deflection limit for interior glazing adjacent to a walking surface, with two adjacent unsupported glass edges, shall comply with CBC 2403.4.

Clips or other means/devices may be installed between the adjacent glazing panel edges as an alternate means of complying with CBC 2403.4 provided load testing demonstrates the clips or other means/devices will limit the out-of-plane differential deflection to the thickness of the panels.

The load test shall be performed by the application of 50 pounds per linear foot applied horizontally to one panel at any point up to 42 inches above the walking surface, whichever height produces the maximum deflection.

2.3 **Story Drift:** The inelastic seismic story drift of the building shall be accommodated in the exterior wall systems of buildings in accordance with ASCE 7 Chapter 13. If this drift, or a portion thereof, is required to be accommodated within the window wall system by in-plane panel distortion, then the glazing systems shall be designed to accommodate the seismic relative displacement requirements of ASCE 7 Section 13.5.9.

If slip track or other sliding means outside the body of window wall system is used to accommodate the seismic relative displacement requirements, then the inelastic seismic drift need not be accommodated in the glazing. In any case, the means by which the seismic relative displacement requirements are accommodated by the exterior wall system shall be compatible with the adjacent/abutting window wall system that may deform in a different manner.

For example, if a metal stud exterior wall system is designed to accommodate the seismic relative displacement with horizontal slip tracks and the adjacent/abutting window wall system is designed to distort to accommodate the displacement, then the interface between the two systems shall be detailed so the mechanism for each of the two separate systems is not impeded.

2.4 **Fasteners:** The design values for window wall fasteners shall be based on acceptable reference standards, product approvals in compliance with *IR A-5: Acceptance of Products, Materials and Evaluation Reports* or testing done by a third party testing laboratory in accordance with the appropriate ASTM standards. Acceptable reference standards include the Aluminum Design Manual and AAMA TIR A9.

2.5 **Steel Reinforced Aluminum Mullions:** When aluminum mullions are reinforced with internal steel reinforcement (channels, plates, etc.), the design shall comply with the following design requirements:

- Wind load is resisted between the two nested members as a combined section which shares load based on relative stiffness (EI) over the length of the combined section. Alternatively, the wind load may be resisted by a composite section if mechanical fasteners are designed to be capable of transferring the entire shear flow (e.g. VQ/I) between the two members.
- The aluminum member and the steel reinforcement shall be designed to comply with AA ADM1, AISC 360, AISI S100, as applicable. Unless substantiated by rational analysis or full scale testing, the design shall assume the aluminum mullion alone does not provide lateral torsional bracing to the steel reinforcement except at each location where transverse mullions brace the reinforced mullion. Local buckling of the steel reinforcement shall not be assumed to be restrained by the aluminum section alone.

- Do not allow dissimilar metals from coming in contact with each other in order to prevent galvanic corrosion. Application of zinc rich primer is one acceptable means of separating dissimilar metals.
- A two-staged deflection analysis is required unless one of the following two conditions are met:
    - o The reinforcement is placed inside the aluminum mullion with a tight fit. A tight fit can be accomplished in either of the two following ways:
        - The steel reinforcement is sized so the gap between the reinforcement and the aluminum mullion complies with the requirements shown in Attachment 1.
        - Shims are provided at regular intervals between the aluminum mullion and the steel reinforcement to limit the design gap per item 1.
    - o Mechanical connections are provided at regular intervals to share the load between the aluminum mullion and the steel reinforcement.
- The following additional requirements apply to partial length steel reinforced aluminum mullions where the steel reinforcement terminates more than approximately a distance equal to the mullion depth from the ends of the aluminum mullion supports:
    - o There shall be at least one mechanical fastener to hold the steel reinforcing steel in position vertically for gravity support of the steel reinforcement.
    - o Analysis shall be provided demonstrating that the reinforced and unreinforced mullion sections have adequate strength for the loads imposed and that the deflection calculations consider the change in stiffness over the length of the member. Alternatively, testing may be performed in accordance with AAMA 450 Voluntary Performance Rating Method for Mulled Fenestration Assemblies. The testing need not be project specific, but needs to be relevant to that detailing for the project, subject to DSA approval.

2.6 Thermal Breaks in Aluminum Extrusions: When thermal barriers separate two individual aluminum extrusions which are intended to act compositely, they shall meet the requirements listed below. Alternatively, DSA will accept AAMA TIR A8, “Structural Performance of Composite Thermal Barrier Framing Systems” as a standard for acceptance of window wall systems with thermal barriers.

- The thermal material shall be a high-strength polyurethane with minimum:
    - o Ultimate tensile strength of 4500 psi,
    - o Modulus of Elasticity of 240,000 psi
- For both poured and debridged systems and thermal strut systems, the design will be accepted based upon one of the following:
    - o Window mullion design based upon 85% of the gross moment of inertia (I_{gross}) of the assumed full aluminum section or
    - o Window mullion design in accordance with TIR A8, Section 7.5 “Structural Design Method for Composite Aluminum/Elastomer Beams”
- For both poured and debridged systems and thermal strut systems, the design of the head, sill and/or jamb sections will be accepted based upon both of the following:
    - o The mullion reaction may be resisted by a 12 inch length of section centered upon the mullion and
    - o The maximum tension and flexural tension stress on the thermal material shall not exceed 900 psi.

2.7 Structural Sealant Glazing (SSG): SSG systems shall comply with CBC 2410.

2.8 Handrails and Guards: Glass used as a handrail assembly or guard section shall be designed in accordance with CBC 2407 and *IR 24-1: Glass Panel Railings*.

Full height glass walls designed to comply with the safety glazing requirements of CBC 2406 do not need to also comply with the guard requirements.

2.9 Other Glass Systems: Systems that utilize glass as structural members other than glass panes such as glass fins, glass channel, point-supported glass and other members, shall be submitted as an alternate materials and methods of construction per CBC 104.11 and CAC 4-304. The alternate design criteria shall include, but is not limited to, the analysis and design approach, material design values, design standards (i.e. Australian Code AS1288, ASTM E1300, etc.) and testing and inspection requirements.

3. CONSTRUCTION DOCUMENT SUBMITTAL: Window wall system construction documents can be either included in the project submittal or submitted as a deferred submittal and shall include the following:

- Schematic layout of all window wall systems.
- Schematic layouts of all attachment locations. For multi-story window wall systems, clearly indicate the difference between connection points intended as gravity support only, lateral support only, both gravity and lateral support or other applicable connection types.
- Complete details of construction for all connections of the mullion to sill/jamb and connections to the structure.
- The deflection limits that the window wall system supporting members were designed to accommodate.
- Specify the maximum inelastic story drifts that the window wall is required to accommodate.
- For window wall system in-plane displacement, show how seismic relative displacement (inter-story drift) is accommodated between the wall or floor/roof system and the window wall system (e.g. sliding joints, panel distortion, rocking, etc.).

3.1 Project Submittal: Window wall construction documents submitted with the project submittal shall be stamped and signed by the design professional in responsible charge.

- For window wall systems that meet the requirements of Section 1.1, all perimeter intermittent attachments of the window wall system at the sill, head and jambs to the structural members (e.g. metal stud framing, slab, structural steel, etc.) shall be shown on the DSA approved construction documents.

3.2 Deferred Submittal: Window wall construction documents submitted as a deferred submittal shall be stamped and signed in accordance with *IR A-19: Design Professional's Signature and Seal (Stamp) on Construction Documents*.

- When a project contains both window wall systems that require DSA structural review and window wall systems that are exempt from DSA structural review, all window wall systems must be submitted for DSA structural review.
- DSA will stamp and approve all deferred submittal construction documents.

4. DSA STRUCTURAL REVIEW: DSA structural review of the project submittal will include the following:

- Review of the mullion design, connections of the mullion to sill/jamb and connections to the structure. When the gap between two connected parts of the window wall system or between parts of the window wall and the structure, is less than or equal to ½", the fasteners/anchors need only be

checked for shear. When the gap exceeds ½", the fasteners/anchors must be checked for both shear and bending.

- In-plane drift, thermal expansion and live load deflections shall be evaluated for all spans.

5. FIRE AND LIFE SAFETY REVIEW AND APPROVAL OF CONSTRUCTION DOCUMENTS: Window Wall Systems shall comply with all applicable Fire and Life Safety portions of the codes and standards adopted by the State of California. The project construction documents shall include, but not be limited to, the information listed below, regardless if the window wall system(s) will be submitted as a deferred submittal.

- Exiting requirements.
  - Corridor continuity.
  - Protection of openings.
  - Egress illumination.
  - Panic hardware.
- Location of safety glazing shall comply with CBC Section 2406.
  - Verify safety glazing is specified where required (i.e. in doors, adjacent to doors, next to walking surfaces, in guards and railings, etc.).
  - Verify correct impact resistance classification is specified.
  - Verify glazing has been impact tested to the correct standard, Consumer Protection Safety Commission (CPSC) or American National Standards Institute (ANSI).
  - Wire glass not meeting CPSC safety glazing requirements is prohibited.
- Fire rated glazing requirements.
  - Verify fire rated glazing is specified where required.
  - Verify glazing is of the proper type (fire-protection-rated glazing, or fire-resistance-rated glazing) for the application.
  - Verify glazing has proper fire rating.
  - Verify glazing has hose stream test certification.
- Fire assemblies.
  - The gap between the floor and the curtain wall shall be fully filled with a fire resistive material/assembly to form both a heat and smoke barrier. The fire resistive material/assembly shall have a fire resistive rating that meets or exceeds the rating of the adjacent floor assembly. In addition, the gap shall be protected with a cover capable of supporting the normal occupant live load or shall be protected with guards and railing, etc., to deter/prevent occupants from imposing loads on the gap.
  - Rated safety glazing shall meet or exceed adopted CBC and CFC requirements and standards.
  - Doors in rated glazing assemblies shall meet or exceed adopted CBC and CFC requirements and standards.

6. ACCESS COMPLIANCE REVIEW AND APPROVAL OF CONSTRUCTION DOCUMENTS: Window Wall Systems shall comply with all applicable Access Compliance portions of the codes and standards adopted by the State of California. The project construction documents shall address all Access Compliance provisions

triggered by the scope of work regardless of whether the window wall system(s) will be submitted as a deferred submittal.

REFERENCES:

California Code of Regulations, Title 24
2016 California Building Code, Chapter 24

ASCE 7-10, Section 13.5.9

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.

This IR is subject to revision at any time. Please check DSA's website for currently effective IRs. Only IRs listed on the webpage at www.dgs.ca.gov/dsa/publications at the time of project application submittal to DSA are considered applicable.

WINDOW WALL SYSTEMS

ATTACHMENT 1

Maximum gap between steel reinforcement and the inside of the aluminum mullion to be considered a tight fit.