ICC-ES Evaluation Report

ESR-4814

Reissued September 2024

Subject to renewal September 2025

This report also contains:

LABC Supplement

CBC Supplement

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DIVISION: 05 00 00—METALS **Section: 05 52 00–Metal Railings** **Section: 05 73 13-Glazed Decorative Metal Railings** **DIVISION: 08 00 00—OPENINGS** **Section: 08 81 00-Glass Glazing** **Section: 08 88 00-Special Function Glazing** **DIVISION: 32 00 00—EXTERIOR IMPROVEMENTS** **Section: 32 35 00-Screening Devices**	**REPORT HOLDER:** **FRAMELESS HARDWARE COMPANY LLC**	**EVALUATION SUBJECT:** **ACHIEVE FRAMELESS GLASS RAILING SYSTEM**	

1.0 EVALUATION SCOPE

Compliance with the following codes:

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

For evaluation for compliance with codes adopted by *Los Angeles Department of Building and Safety (LADBS)*, see ESR-4814 LABC and LARC Supplement.

Properties evaluated:

- Structural
- Durability

2.0 USES

The Achieve Frameless Glass Railing (Achieve) System used to construct structural glass balustrades evaluated in this report are intended for interior and exterior weather exposed applications and is suitable for use in most natural environments. The Achieve system may be used for residential, commercial and industrial applications for fall protection along balconies, porches, mezzanines, stairs and similar locations except where vehicle impact resistance is required.

The system is compatible with all construction types. Use in Wind-borne Debris Regions is outside the scope of this report. The Achieve system is intended for use with short term temperatures under 140˚F (60˚C) and long-term temperatures under 130˚F (54.4˚C).

3.0 DESCRIPTION

3.1 General:

The Achieve Frameless Glass Railing System utilizes an extruded aluminum 6063-T5 Alloy shoe to anchor and support fully tempered structural glass balustrades (monolithic glass $^{1}/_{2}$-inch [12mm]—$^{5}/_{8}$-inch [16mm] or $^{3}/_{4}$-inch [19mm]) (laminated glass $^{9}/_{16}$-inch [14mm] $^{11}/_{16}$-inch [17.5mm], $^{13}/_{16}$-inch [21.5mm], or $1^{1}/_{16}$-inch [25mm] depending on use) which support the selected top rail and/or grab rail. A complete system installation specification requires identification of the top rail (cap rail), profile and material, glass thickness and type with the maximum and minimum lite widths, glazing system either wet or specific dry glazing method, base shoe and anchorage to the supporting structure. When a handrail is used, the handrail profile, mounting bracket, and mounting bracket spacing must be specified. A complete installation requires either a top rail or handrail or the laminated glass must be as specified in this report for installation without a top rail. The base shoe may be installed with non-structural cladding of any compatible material bonded to it with adhesive. Figure 1 shows the typical guard elevation with the components. The complete installation specifications must be noted on plans submitted to the code official for approval.

3.2 Material:

The profiles and section properties and strengths of the various base shoes are designated as T5LM, T5L, A1M, A2M, A3M, A4M, A5M AND A6M with dimensions detailed in Section 4.2.3 and Figure 2.

The glass must be Kind FT fully tempered glass conforming to the requirements of ANSI Z97.1-14, ASTM C1048, ASTM C1172 and CPSC 16 CFR 1201. The fully tempered glass must have an average Modulus of Rupture Fr ≥ 24,000 psi (165.5 MPa). Laminated glass must use an interlayer with a shear modulus of 1,640 psi (11.3 MPa) or greater at 122˚F (50˚ C). Glass type, condition, class, form, quality and finish may be any meeting these standards and modulus of rupture. Stricter tolerances than those specified in ASTM C1172 Standard Specification for Laminated Architectural Flat Glass must be specified if desired for a specific installation. When installed without a top rail the glass must be specified to have the top edge polished, fully laminated to edge and glass plies flush. Post-laminating edge polishing is allowed for all edges.

3.3 Durability:

The materials incorporated in the system described in this report are inherently corrosion resistant. The material type specified shall be appropriate for the environment of the installation. Information verifying the durability must be submitted to the code official, when requested.

4.0 DESIGN AND INSTALLATION

4.1 Design:

Installation of the Achieve Frameless Glass Railing System must comply with the manufacturer's published instructions, this report and 2021 or 2018 IBC Sections 1015 and 1607.8.1 or 2021 or 2018 IRC Section R312, whichever is applicable. Handrails/grab rails must comply with 2021 or 2018 IBC Sections 1011.11 and 1014, or 2021 or 2018 IRC Section R311.7.8 and R311.8.3, whichever is applicable. The manufacturer's published instructions called FHC Achieve Frameless Glass Railing System Installation Instructions must be available at the jobsite at all times during installation. In the event of a conflict between this report and the manufacturer's instructions, this report governs.

4.1.1 Loading: The applicable project specific loads shall be identified. Typical loads are:

- 50 plf (0.73 kN/m) on the top rail in any direction or
- 200 lbs (0.89 kN) on top rail any direction or
- 50 lbs (0.22 kN) on one square foot at any location perpendicular to the glass balustrade or
- Wind load on full area of glass in psf.

Wind load shall be determined by a qualified individual based on the project specific conditions, taking into account the balustrade location on the structure. For installations in compliance with the IRC Section R312 the 50 plf (0.73 kN/m) top rail load is not applicable.

4.1.2 Glass: The glass thickness shall be at least, the thickness necessary to safely support the live loads and wind loads. The allowable glass loads are based on allowable glass edge stresses. Tables 1A through 1E of this report provide allowable wind load in psf for given glass thickness, interlayer and minimum height or width dimension, assuming the allowable stress noted in this section of the report. Glass sand-blasted etched or fused ceramic on monolithic glass either surface or laminated glass on surfaces 1 or 4 is outside the scope of this report. Treatments to laminated glass surfaces 2 or 3 compatible with the interlayer are permitted without modifications of the allowable loads shown in this report. Allowable loads are based on the minimum glass thickness for the nominal glass thickness based on ASTM C1172. All glass thicknesses in fractions are nominal. Glass thickness designations are nominal unless specified otherwise.

Minimum spacing between glass lites is 1/4-inch (6.4 mm) for 1/2-inch (12 mm), 9/16-inch (14 mm), 5/8-inch (15 mm) and 11/16-inch (16.5 mm) thick glass lites and 1/2-inch (12 mm) for 3/4-inch (19 mm), 13/16-inch (21.5 mm) and 1 1/16-inch (25 mm) thick glass lites.

Glass lites serve as balusters to support the top rail or grab rail and form the guard infill. Allowable glass bending stress is the average modulus of rupture used for the designs noted in this report divided by a safety factor of 4 [24,000/4 = 6,000 psi (41.3 MPa)]. – Tension bending stress is based on the minimum glass thickness, except for wind loads. A wind load stress in accordance with ASTM E1300-12a was used in development of this report.

4.1.2.1 Holes and Notches: Holes and notches are permitted for mounting handrails and similar appurtenances. Holes and notches must conform to ASTM C1048 and must not exceed 2 inches wide. Notches or holes must not exceed 1/12th of the glass width. Holes or notches located within the first third of the balustrade height from the base shoe or exceeding 2 inches wide are outside the scope of this report.

4.1.3 Base Shoes: The appropriate base shoe must be selected based on glass thickness, installation method and loading. Figure 2 shows the base shoe options. Table 2 provides the allowable wind loads for the base shoes and anchorages. The base shoe must be installed in accordance with the manufacturer's published instructions and this report. The end anchor must be installed within 12 inches (305 mm) of the end of the base shoe and no less than 1 1/2 inches (38 mm) to the centerline of the anchor.

A minimum of two anchors are required for any base shoe section required to support cantilevered glass.

4.1.3.1 Steel Substrate: Base shoe is attached to a structural steel member with a minimum thickness of 1/4-inch (6.4 mm) using 1/2-by 3/4-inch (12.7 mm by 19.1 mm) ASTM F-837 Alloy Group 1 (any condition), stainless steel socket head cap screws into tapped holes. When installed in a through-bolt condition the cap screw length shall be increased to a length sufficient to permit proper installation with full engagement in the nut. When installed with through weld blocks, or solid shims greater than 2 inches (50.8 mm) long by the full base shoe width at each anchor, no reduction in allowable wind loads is required. Minimum thread engagement into tapped holes is 5/16-inch (8 mm) (for steel with Fu ≤ 58 ksi (400 MPa).

4.1.3.1.1 Surface Mounted to Steel: The allowable wind loads must not exceed those shown in Table 2. An appropriate top rail or grab rail must be used when required.

4.1.3.1.2 Fascia Mounted to Steel: The allowable wind loads must not exceed those shown in Table 2.

4.1.3.2 Concrete Substrate: Base shoe is attached to a concrete member with minimum compression strength of 3,000 psi (20.6 MPa) in an uncracked condition or 4,000 psi (27.6 MPa) in a cracked condition, using screw-in Hilti HUS-EZ (KH-EZ) anchor in accordance with ESR-3027. For base shoes for 1/2-inch (12 mm), 9/16-inch (14 mm), 5/8-inch (15 mm) and 3/4-inch (19 mm) glass, anchor shall be HUS-EZ 3/8-inch by 4-inches (9.5 mm by 102 mm). For all other base shoes anchor size to be HUS-EZ 1/2-inch by 4 inches (12 mm by 102 mm). Minimum spacing between anchors is 6-inches (152 mm) for HUS-EZ anchors. For 12 inches (305 mm) on center anchor spacing, anchor locations may be moved to avoid reinforcement provided the same number of anchors are provided and no two anchors are closer than 6 inches (152 mm) center to center.

For cracked concrete with strength f'c under 4,000 psi (27.6 MPa) multiply the allowable loads in Table 2 by 0.71. Alternative anchorage must be demonstrated as adequate for the project specific conditions by calculation or testing per ACI 318. Anchor lengths assume base shoe is in direct contact with structural concrete, anchor length must be increased for any material between the base shoe and concrete surface.

4.1.3.2.1 Concrete Strength Uncracked: The allowable wind load for concrete strengths, f'c, between 3000 psi (20.6 MPa) to 9,000 psi (34.4 MPa) may be adjusted by applying the adjustment factor determined by the following equation:

cw = √(f'c/3000)

W' = cw*W

where W is allowable wind load from Table 2

f'c = specified concrete compressive strength, in psi

Allowable wind load must not exceed the value based on the glass strength.

4.1.3.2.2 Sand-Lightweight Concrete: When installed into sand lightweight concrete the allowable wind loads from the tables in this report must be reduced by multiplying by a factor of 0.6.

4.1.3.2.3 Surface Mounted: When edge distance is equal to or greater than 3.5 inches (89 mm) (concrete edge parallel to the anchor to centerline of anchor) the allowable wind loads must be as provided in Table 2 for the guard height (Hg) from the bottom of the base shoe. For edge distances less than 3.5 inches (89 mm) required for the full anchor strength, the allowable wind load must be reduced for edge distances 3.5 inches > e >1.75 inches (89 mm > e > 44.5 mm) by multiplying allowable moment strength and allowable wind load by √(e/3.5). Minimum slab or wall thickness is 6 inches (152 mm) for $^3/_8$-inch HUS anchors. Minimum slab thickness is 6.75 inches (171.5 mm) for the for $^1/_2$-inch HUS anchors. Anchor end distance to be $^1/_2$ of specified anchor spacing. Minimum wall thickness is 6.95 inches (176.5 mm) for anchors into top of concrete wall.

4.1.3.2.3.1 Surface-mounted over Drainage Blocks: When installed through drainage blocks or solid shims, 2 inches (50.8 mm) long by the full base shoe width at each anchor, the allowable wind loads must be multiplied by 0.94.

4.1.3.2.4 Fascia-mounted: When fascia-mounted to a slab edge, beam, wall or similar condition, the minimum concrete thickness must be 6 inches (152 mm). The top and bottom of the base shoe must not extend past the concrete edge. The allowable wind load shall be as determined using Table 2, where guard height is total height above the top of the base shoe. Applicable adjustment factors from Sections 4.1.3.2.1 and 4.1.3.2.2 must be applied. Allowable wind loads must be verified in accordance with Section 4.1.3.2.3.

4.1.3.2.4.1 Fascia-mounted over Drainage Blocks: When installed with metal drainage blocks 2 inches (51 mm) wide by 4 inches (102 mm) deep at each anchor the allowable wind load must be reduced by multiplying by 0.8 as shown in the following equation:

W' = 0.8W

4.1.3.3 Wood Substrate: Wood must have a moisture content under 19 percent at the time of fabrication and be a species and grade with specific gravity G ≥ 0.49. For exterior locations all base shoe fasteners must be stainless steel (304 or 316). Fasteners must be tightened so that the base shoe is in tight contact to the supporting wood. If installed with drain blocks anchor spacing must be 6 in. (152mm) o.c. and allowable wind load reduced by 0.75 as shown in the following equation:

W '= 0.75W

4.1.3.3.1 Surface Mounted:

4.1.3.3.1.1 Exterior: Direct surface mounting to wood in locations subject to moisture contents exceeding 19% when in use is prohibited. When surface mounted in these locations the base shoe must be attached to steel or aluminum brackets attached to the wood structure.

Refer to Figure 3 for the aluminum bracket. Refer to Figure 4 for the steel bracket. Allowable wind load for these options are:

Allowable Moment: Ma = 2,773 in-lbs/ft (1.03 m-kN/m)

36-inch Guard height- W = 46.7 psf (2.24 kN/m^2)

42-inch Guard height - W = 34.3 psf (1.64 kN/m^2)

When attached using a continuous angle with #14-by-3-inch (76 mm) wood screws at 3 inches (76 mm) on center:

Allowable Moment: Ma = 5,562 in-lbs/ft (2.06 m-kN/m)

42-inch Guard height - W = 68.8 psf (3.29 kN/m^2)

4.1.3.3.1.2 Protected Locations: Base shoes surface mounted directly to wood with a specific gravity G ≥ 0.49 and compressive strength perpendicular to the grain ≥ 625 psi (4.1 MPa) are limited to locations where the supporting wood has an in service moisture content less than or equal to 19 percent and will not be subject to wetting. The base shoe must be anchored with $^3/_8$-inch (9.5 mm)-by-5-inch (127 mm) lag screws.

4.1.3.3.1.2.1 One- and Two-family Dwellings and IRC Applications [(200 pounds (0.89 kN) Top Rail Live Load only)]: When installed in these locations the anchors must be installed at 24 inches (635 mm) on center or less. Per balustrade segment—for 36-inch (914 mm) guard height the minimum number of anchors is four (4); and for a 42-inch (1067 mm) guard height, the minimum number of anchors is five (5).

4.1.3.3.1.2.2 Locations Subject to 50 plf [0.73 kN/m] Top Rail Live Load: When installed in applications where the 50 plf (0.73 kN/m) live load is applicable the anchors must be installed at 6 inches (152mm) on center or less. The minimum number of anchors in any guard segment is five (5).

4.1.3.3.1.2.3 Other Locations excepted from the 50 plf [0.73 kN/m] Top Rail Live Load: Locations allowed in IBC 1607.8.1 Exception 2 are subject to a 20 plf (0.29 kN/m) load and 200 lbs (0.89 kN) Top Rail Live Load non-concurrently. When installed in these locations the anchors must be installed at 24 inches (635 mm) on center or less. Per balustrade segment for 36-inch (914 mm) guard height, the minimum number of anchors is four (4); and for a 42-inch (1067 mm) guard height, the minimum number of anchors is five (5).

4.1.3.3.2 Fascia Mounted: The base shoes must be attached with $^1/_2$-inch (12 mm)-by-4-inch (102 mm) lag screws installed directly to the structural wood member. The top of the base shoe must be flush with or below the top of the beam corner radius and the beam must extend below the bottom of the base shoe. The allowable wind load must be as determined in Table 2. Linear interpolation for other heights or anchor spacing is permitted.

4.1.4 Top Rails: A top rail may be required for a code compliant installation. The term cap rail is the same as top rail. Glass lite sizes must not exceed the lengths given in Table 3 unless the installation complies with the requirements for installation without a top rail. When installed without a top rail or handrail the laminated glass must comply with IBC 2407.1.2 Exception and Section 4.2.4.2 of this report.

4.1.4.1 Support: The top rail must be installed so as to remain in place in the event of the failure of any one glass lite. This requires the use of a minimum of three glass lites or a combination of other top rail supports and glass lites totaling three, minimum. Figure 5 illustrates the top rail support conditions. The top rail end condition must be checked to verify that the rail will remain in place in the event of failure of the end glass lite. End support must be designed when required for a code-compliant installation. The stabilizing end cap shown in Figure 11 is an acceptable method of end support.

4.1.4.2 Installation Without a Top Rail or Handrail: When installed without a top rail or attached handrail the minimum glass lite lengths must be as shown in Table 4 except as allowed below. The differential deflection at the top of the glass lites must be checked using the following equation:

$$\Delta = \frac{200\text{lbs} * h_e^3 \ [1+b/(h_e/12)]^{1/2}}{3 * 10.4\text{x}10^6\text{psi} * b * t_\partial^3}$$

Δ = Deflection from 200 lb load at top corner of lite

where:

h = effective glass cantilever height = height above base shoe + $^1/_2$ inch

b = glass width

t_∂ = effective glass thickness for deflection based on glass makeup and lite size from Table 1

When deflection exceeds the overall glass thickness or any glass lite is less than the minimum shown in Table 4 (glass is taller than indicated for the lite width), the adjacent lites must be connected together with an H-clamp or a mall-front clamp installed no lower than 4 inches from the top edge of the glass or a U-channel or short cap rail segment with three-quarter inch bite and extending 2 inches minimum onto each lite and bonded to the glass with structural silicone or other adhesive approved for metal to glass. Corner lites must be similarly connected together. If end lite length is less than shown in Table 4 it must be similarly attached to a wall, post or similar structural member capable of supporting a 200 lb load. The connection between lites is not required when designed for wind load only and a 3-inch (75mm) minimum gap between lites is maintained.

4.1.4.3 Top Rail Profiles: The top rail profiles are shown in Figure 7. The allowable glass lite widths for the top rail profiles are given in Table 3 based on the live loads of 50 plf (0.73 kN/m) uniform load or 200 lb (0.89 kN) concentrated load whichever is critical. Glass lite widths must be less than or equal to the maximum widths shown in Table 3. If the end lite width exceeds the value shown in Table 3 the top rail must be attached to a wall or post or the end lite must meet the requirements for installation without a top rail. This section does not apply to installations where the glass has adequate strength to allow for installation without a top rail or attached handrail.

4.1.5 Dry Glazed System: A dry glazing system where the glass is clamped inside the base shoe by the Setting Plate (L shaped piece on the back side) and the shims (front side) as illustrated in Figure 8. The glass is locked in place by the compressive forces created when shims are spread apart by the installation tool. The dry glazing system is compatible with all "A" Series base shoes in this report and the corresponding glass thickness.

4.1.6 Wet Glazing: Glass may be wet-glazed into any of the base shoes using a pourable grout or mortar that is compatible with aluminum and selected laminated glass. Any of the glass thicknesses in this report may be wet-glazed into any of the base shoes in this report. The allowable load must be the lesser of the allowable load on the glass or the base shoe for the anchorage method used. (Figure 6).

4.1.6.1 Installation: The grout or mortar must be approved by the manufacturer for contact with laminated glass when applicable. Minimum grout compressive strength must exceed 1,500 psi (10.3 MPa) at 24 hours and 4,000 psi (27.6 MPa) at 28 days. The grout must be mixed, placed and cured in accordance with the grout manufacturer's instructions. Wet glazing grout must be continuous in the bases shoe filling all voids and extend to the roll-in rubber glazing channel in the base shoe.

4.1.7 Handrails and Grab Rails

4.1.7.1 Use: Handrails and grab rails are required along ramps and stairs in accordance with 2021 and 2018 IBC Sections 1011.11 and 1012.8 and 2021 and 2018 IRC Sections R311.7.8 and R311.8.3. Also, the handrail must comply with the requirements with the applicable code sections noted in Section 4.1 of this report.

4.1.7.2 Brackets: The handrails may use any of the brackets or combinations of the brackets demonstrated as acceptable for mounting handrails to glass, as shown on Figure 10.

4.1.7.3 Handrail and Grab rails: The handrails may use any of the rails noted below:

$1^{1}/_{4}$-inch Schedule 40 pipe - steel, stainless steel or aluminum

$1^{1}/_{2}$-inch Schedule 40 pipe - steel, stainless steel or aluminum

$1^{1}/_{2}$-inch OD by $^{1}/_{8}$-inch tube - stainless steel or aluminum

$1^{1}/_{2}$-inch OD by 0.05-inch tube - stainless steel

2-inch OD by 0.05-inch tube - stainless steel

$1^{1}/_{2}$-inch square by .05-inch tube-stainless steel

2-inch by 1 inch rectangular by $^{1}/_{8}$-inch tube-stainless steel

Other handrail and grab rail providing equivalent strength and grasp ability.

4.1.7.4 Installation: Handrails may be installed to glass balustrade guards using approved through-glass mounting brackets. The brackets must be installed in accordance with the manufacturer's instructions. The glass holes must comply with Section 4.1.2.1 of this report.\

4.1.7.5 Support: The handrail must be installed so as to remain in place in the event of the failure of any one glass lite. This requires the use of a minimum of three glass lites or a combination of other handrail supports and glass lites totaling three, minimum, similar to the top rail support illustrated in Figure 5. The handrail end condition must be checked to verify that the rail will remain in place in the event of failure of the end glass lite. End support must be designed when required for a code-compliant-installation.

4.1.7.6 Spacing: The bracket spacing must be within the limits shown in Table 5 with dimensions as defined in Figure 9.

5.0 CONDITIONS OF USE:

The Achieve Frameless Glass Railing System described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 The product is limited to installation where it is not subject to vehicle impacts.

5.2 Installation must comply with this report, the manufacturer's published installation instructions, and Sections 1012, 1013 and 2407 of the IBC or Sections R311 and R312 of the IRC, whichever is applicable. The system is intended for use with short term temperatures under 140˚F (60˚C) and long term temperatures under 130˚F (54.4˚C). For use in higher temperatures the glass strength must be evaluated for the project conditions. When the manufacturer's instructions conflict with this report, this report governs.

5.3 The supporting structure must be designed and constructed to support the loads imposed by the guards in accordance with the applicable code. Anchorage to the substrate must be as specified in this report or designed to provide the required strength for the specified balustrade height and imposed loads. Drawings and design details for the Achieve Frameless Glass Railing System, using the information noted in this report, must be included on construction plans submitted to the code official for approval. The drawings and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.4 When use is in exterior locations, the wind loads on the guards must be determined by a qualified design professional and must not exceed the values noted in this report. For glass heights other than those noted in this report, the allowable wind loads must not exceed the value calculated by the following equation:

$w_{all} = M_{all}*12/(0.55*h^2)$

Where:

w_{all} = allowable wind load for the desired glass height

M_{all} = Lesser of allowable glass moment from Table 1 or base shoe allowable moment for the anchorage method from Table 2

h = glass height in feet if glass strength controls or total height from bottom of base shoe if anchorage controls.

5.5 When installed where the base shoe anchors are exposed to moisture, the base shoe anchors must be of a material intended for the use and identified by the manufacturer as acceptable for exterior applications. When installed in a corrosive environment, such as exposure to saltwater or pool water, the anchors must be 316 stainless steel or equivalent corrosion resistance and strength.

5.6 All metals in contact with aluminum must be either an alloy approved for direct aluminum contact, or isolated from the aluminum by an approved coating.

5.7 The systems described in this report may be used in Wind-Borne Debris Regions when installed with laminated glass.

5.8 A proper top rail or handrail must be installed in accordance with the manufacturer's instructions and this report when guards are required by Section 1013 of the IBC or Section R312 of the IRC, as applicable except where it meets all requirements for installation without a top rail.

5.9 All glass must be fully tempered, fabricated, and inspected in accordance with ASTM C1048, and the glass fabricator must provide certification of compliance with ASTM C1048 for fully tempered glass. Glass must be procured directly from a qualified glass fabricator.

5.10 The Achieve Frameless Glass Railing System components (except for the glass) are supplied by Frameless Hardware Company, LLC of South Gate, California.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Glass Railing and Balustrade Systems (AC439) dated April 2019 (editorially revised August 2020) and FHC published installation instructions.

7.0 IDENTIFICATION

7.1 Product labeling shall include the name of the report holder or listee, and the ICC-ES mark of conformity. The listing or evaluation report number (ICC-ES ESR-4814) may be used in lieu of the mark of conformity.]

7.2 The report holder's contact information is the following:

FRAMELESS HARDWARE COMPANY LLC

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TABLE 1A—NOMINAL 9/16 in (13.52 mm) LAMINATED GLASS PANEL STRENGTH[1]

GLASS PANEL WIDTH (in)	EFFECTIVE GLASS PANEL THICKNESS (in.)[2]		$M_{all\ wind}$ (lb.-in./ft.)[3]	ALLOWABLE WIND PRESSURE ($w_{all\ wind}$)[4], psf For glass panel height (H_c)[5], in.					Live Load 50 lbs/ft	
	t_∂ for deflection	t_e for stress		36	42	48	60	72	Maximum Height (H_c) inches based on:	
9/16 in with Ionoplast interlayer Shear Modulus (G) ≥ 1,460 psi for T ≤ 122˚F									Stress[6]	1-in Defl.[7]
12	0.3121	0.3525	2386	40.2	29.5	22.6	14.5	10.0	29.3	26.2
24	0.3695	0.4105	3235	54.5	40.0	30.6	19.6	13.6	40.0	31.1
36	0.4116	0.4451	3804	64.0	47.0	36.0	23.1	16.0	47.1	34.7
41	0.4242	0.4543	3963	*	49.0	37.5	24.0	16.7	49.1	35.8
48	0.4383	0.4638	4130	*	*	39.1	25.0	17.4	51.1	37.0
60	0.4551	0.4744	4321	*	*	*	26.2	18.2	53.5	38.4
72	0.4660	0.4808	4438	*	*	*	*	18.7	55.0	39.3

GLASS PANEL WIDTH (in)	EFFECTIVE GLASS PANEL THICKNESS (in.)[2]		$M_{all\ wind}$ (lb.-in./ft.)[3]	Interior Climate Controlled Use Only					Live Load 50 lbs/ft	
	t_∂ for deflection	t_e for stress		36	42	48	60	72	Maximum Height (H_c) inches based on:	
9/16" with Stiff PVB interlayer Shear Modulus (G) ≥ 400 psi for T= 95˚F, 1 min									Stress[6]	1-in Defl.[7]
12	0.3082	0.3481	2327	n/a	n/a	n/a	n/a	n/a	28.6	25.9
24	0.3624	0.4041	3135	n/a	n/a	n/a	n/a	n/a	38.7	30.5
36	0.4044	0.4397	3712	n/a	n/a	n/a	n/a	n/a	45.9	34.1
41	0.4175	0.4495	3879	n/a	n/a	n/a	n/a	n/a	48.0	35.2
48	0.4322	0.4598	4059	n/a	n/a	n/a	n/a	n/a	50.3	36.5
60	0.4503	0.4714	4267	n/a	n/a	n/a	n/a	n/a	52.8	38.0
72	0.4622	0.4786	4398	n/a	n/a	n/a	n/a	n/a	54.5	39.0

For **SI:** 1 inch = 25.4 mm; 1 foot = 305 mm

Footnotes to Tables 1A—1E

* Allowable load is same as last value in column

1. Least dimension of glass panel height or width
2. Effective glass thickness for laminated glass is less than actual thickness. Nominal glass thickness and minimum thickness: 0.498-in for 9/16-in; 0.644-in for 11/16-in and 0.77-in for 13/16-in.
3. Based on maximum edge stress of 10,600 psi, 8:1,000 probability of failure.
4. Calculated from: $w_{all} = M_{all}*12/(0.55*h_g^2)$
5. Glass height above top of base shoe H_c.
6. Height for live load based on stress: h = (6000*12"*t_e^2/6)/50 - 0.48-in (Distance from top of base shoe to glass fixity based on FEA modeling) = 240t_e^2 - 0.48-in. Deflection at top of glass will exceed 1-in and may be estimated as H_s/H_Δ
7. Height in which 50 plf or 200lb concentrated top load (assuming 4-ft minimum length) causes 1-in of deflection at top of glass.

TABLE 1B—NOMINAL 11/16-in LAMINATED GLASS STRENGTH[1]

GLASS PANEL WIDTH (in)	EFFECTIVE GLASS PANEL THICKNESS (in.)[2]		$M_{all\ wind}$ (lb.-in./ft.)[3]	ALLOWABLE WIND PRESSURE ($w_{all\ wind}$)[4], psf For glass panel height (H_c)[5], in.					Live Load 50 lbs/ft	
	t_∂ for deflection	t_e for stress		36	42	48	60	72	Maximum Height (H_c) inches based on:	
Ionoplast interlayer Shear Modulus (G) must be ≥ 1,460 psi for T ≤ 122˚F									Stress[6]	1-in Defl.[7]
12	0.4578	0.5114	5021	84.5	62.1	47.6	30.4	21.1	62.2	38.6
24	0.5457	0.5850	6571	110.6	81.3	62.2	39.8	27.7	81.6	46.1
36	0.5883	0.6132	7219	121.5	89.3	68.4	43.8	30.4	89.7	49.7
41	0.5987	0.6194	7366	*	91.1	69.8	44.6	31.0	91.5	50.6
48	0.6092	0.6255	7512	*	*	71.1	45.5	31.6	93.4	51.5
60	0.6205	0.6317	7662	*	*	*	46.4	32.2	95.2	52.5
72	0.6271	0.6352	7747	*	*	*	*	32.6	96.3	53.0

GLASS PANEL WIDTH (in)	EFFECTIVE GLASS PANEL THICKNESS (in.)[2]		$M_{all\ wind}$ (lb.-in./ft.)[3]	Interior Climate Controlled Use Only					Live Load 50 lbs/ft	
	t_∂ for deflection	t_e for stress		36	42	48	60	72	Maximum Height (H_c) inches based on:	
11/16-in with Stiff PVB interlayer Shear Modulus (G) ≥ 400 psi for T= 95˚F, 1 min									Stress[6]	1-in Defl.[7]
12	0.3983	0.4488	3867	n/a	n/a	n/a	n/a	n/a	47.8	33.5
24	0.4564	0.5100	4994	n/a	n/a	n/a	n/a	n/a	61.9	38.5
36	0.5073	0.5556	5927	n/a	n/a	n/a	n/a	n/a	73.5	42.8
41	0.5243	0.5691	6218	n/a	n/a	n/a	n/a	n/a	77.2	44.3
48	0.5442	0.5840	6548	n/a	n/a	n/a	n/a	n/a	81.3	46.0
60	0.5696	0.6015	6947	n/a	n/a	n/a	n/a	n/a	86.3	48.1
72	0.5872	0.6126	7205	n/a	n/a	n/a	n/a	n/a	89.5	49.6

See footnotes under Table 1A

TABLE 1C—NOMINAL 13/16-in LAMINATED GLASS STRENGTH[1]

GLASS PANEL WIDTH (in)	EFFECTIVE GLASS PANEL THICKNESS (in.)[2]		$M_{all\ wind}$ (lb.-in./ft.)[3]	ALLOWABLE WIND PRESSURE ($w_{all\ wind}$)[4], psf For glass panel height (H_c)[5], in.					Live Load 50 lbs/ft	
	t_∂ for deflection .	t_e for stress		36	42	48	60	72	Maximum Height (H_c) inches based on:	
Ionoplast interlayer Shear Modulus (G) must be ≥ 1,460 psi for T ≤ 122˚F									Stress[6]	1-in Defl.[7]
12	0.5384	0.6023	6965	117.3	86.1	66.0	42.2	29.3	86.4	45.3
24	0.6399	0.6901	9144	153.9	113.1	86.6	55.4	38.5	113.6	54.0
36	0.6938	0.7272	10153	170.9	125.6	96.1	61.5	42.7	126.2	58.6
41	0.7075	0.7356	10389	*	128.5	98.4	63.0	43.7	129.2	59.7
48	0.7216	0.7440	10628	*	*	100.6	64.4	44.7	132.1	61.0
60	0.7370	0.7527	10878	*	*	*	65.9	45.8	135.3	62.3
72	0.7462	0.7577	11023	*	*	*	*	46.4	137.1	63.1
13/16-in with Stiff PVB interlayer Shear Modulus (G) ≥ 86 psi for T= 122˚F, 1 min										
12	0.4542	0.5103	5000	84.2	61.8	47.3	30.3	21.0	61.8	38.1
24	0.4730	0.5323	5440	91.6	67.3	51.5	33.0	22.9	67.3	39.7
36	0.4990	0.5614	6051	101.9	74.8	57.3	36.7	25.5	74.9	41.9
41	0.5109	0.5741	6328	*	78.3	59.9	38.4	26.6	78.4	42.9
48	0.5279	0.5917	6722	*	*	63.7	40.7	28.3	83.3	44.4
60	0.5563	0.6196	7371	*	*	*	44.7	31.0	91.4	46.8
72	0.5827	0.6436	7953	*	*	*	*	33.5	98.7	49.1

See footnotes under Table 1A

TABLE 1D—NOMINAL 1 1/16-in LAMINATED GLASS STRENGTH[1]

GLASS PANEL WIDTH (in)	EFFECTIVE GLASS PANEL THICKNESS (in.)[2]		$M_{all\ wind}$ (lb.-in./ft.)[3]	ALLOWABLE WIND PRESSURE ($w_{all\ wind}$)[4], psf For glass panel height (H_c)[5], in.					Live Load 50 lbs/ft	
	t_d for deflection	t_e for stress		36	42	48	60	72	Maximum Height (H_c) inches based on:	
1 1/16-in with Ionoplast interlayer Shear Modulus (G) must be ≥ 1,460 psi for T ≤ 122˚F									Stress[6]	1-in Defl.[7]
12	0.6837	0.7657	11257	189.5	139.2	106.6	68.2	47.4	140.0	57.7
24	0.8056	0.8758	14727	247.9	182.2	139.5	89.3	62.0	183.4	68.1
36	0.8795	0.9295	16588	279.3	205.2	157.1	100.5	69.8	206.6	74.4
41	0.8995	0.9425	17055	*	211.0	161.5	103.4	71.8	212.5	76.2
48	0.9206	0.9555	17529	*	*	166.0	106.2	73.8	218.4	78.0
60	0.9444	0.9695	18047	*	*	*	109.4	76.0	224.9	80.0
72	0.9590	0.9776	18349	*	*	*	*	77.2	228.7	81.2
1 1/16-in with Stiff PVB interlayer Shear Modulus (G) ≥ 86 psi for T= 122˚F, 1 min										
12	0.5974	0.6709	8642	145.5	106.9	81.8	52.4	36.4	107.3	50.3
24	0.6155	0.6919	9192	154.7	113.7	87.0	55.7	38.7	114.2	51.9
36	0.6417	0.7213	9989	168.2	123.6	94.6	60.5	42.0	124.2	54.1
41	0.6541	0.7347	10364	*	128.2	98.1	62.8	43.6	128.8	55.2
48	0.6722	0.7538	10910	*	*	103.3	66.1	45.9	135.7	56.7
60	0.7037	0.7857	11853	*	*	*	71.8	49.9	147.4	59.4
72	0.7344	0.8149	12750	*	*	*	*	53.7	158.7	62.0

See footnotes under Table 1A

TABLE 1E—MONOLITHIC GLASS STRENGTH[1]

PANEL THICKNESS (in)		$M_{all,}$ (lb.-in./ft.)[3]	ALLOWABLE WIND PRESSURE ($w_{all\ wind}$)[4], psf For glass panel height (H_c)[5], in.					Live Load 50 lbs/ft	
t_{nom}	t_{min}		36	42	48	60	72	Maximum Height (H_c) inches based on:	
								Stress[6]	1-in Defl.[7]
1/2	0.469	4223	71.1	52.2	40.0	25.6	17.8	52.3	39.6
5/8	0.595	6797	114.4	84.1	64.4	41.2	28.6	84.3	50.3
3/4	0.719	9926	167.1	122.8	94.0	60.2	41.8	123.4	60.9

See footnotes under Table 1A

TABLE 2—BASE SHOE ANCHORAGE METHODS AND STRENGTH

Substrate - Anchor Spacing	Allowable. Moment in-lbs/ft	Allowable wind load in psf[1]							Live Load
		Overall Guard height from bottom of base shoe top of top rail (H_g), in.							Max. guard ht (H_g) in.
		36	39	42	45	48	54	60	
BASE SHOE: A1M Surface Mounted									
Steel 12” o.c.	4766	80.2	68.4	58.9	51.4	45.1	35.7	28.9	99.94
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2590	43.6	37.2	32.0	27.9	24.5	19.4	15.7	54.32
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	3976	66.9	57.0	49.2	42.8	37.7	29.7	24.1	83.38
Wood Bracket	4290	72.2	61.5	53.1	46.2	40.6	32.1	26.0	85.8
BASE SHOE: A1M Fascia Mounted									
Steel 12” o.c	4450	74.9	63.8	55.0	47.9	42.1	33.3	27.0	123
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2060	34.7	29.5	25.5	22.2	19.5	15.4	12.5	41.2
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	3400	57.2	48.8	42.1	36.6	32.2	25.4	20.6	68
Wood Bracket	4766	80.2	68.4	58.9	51.4	45.1	35.7	28.9	99.94

For **SI**: 1 inch = 25.4 mm; 1 psf = 0.0479 MPa

1. Linear interpolation between guard heights, anchor spacing and edge distances is permitted.
2. Adjustment for uncracked concrete strength greater than f'_c = 3,000 psi. See Section 4.1.3.2.1
3. Adjustment for cracked concrete see Section 4.1.3.2
4. Adjustment for sand light-weight concrete: W ’= 0.6*W

TABLE 2—BASE SHOE ANCHORAGE METHODS AND STRENGTH (Continued)

Substrate - Anchor Spacing	Allowable Moment in-lbs/ft	Allowable wind load in psf[1]							Live Load
		Overall Guard height from bottom of base shoe top of top rail (H_g), in.							Max. guard ht (H_g) in.
		36	39	42	45	48	54	60	
BASE SHOE: A2M Surface Mounted									
Steel 12” o.c	4766	80.2	68.4	58.9	51.4	45.1	35.7	28.9	99.94
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2590	43.6	37.2	32.0	27.9	24.5	19.4	15.7	54.32
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	3976	66.9	57.0	49.2	42.8	37.7	29.7	24.1	83.38
Wood Bracket	4290	72.2	61.5	53.1	46.2	40.6	32.1	26.0	85.8
BASE SHOE: A2M Fascia Mounted									
Steel 12” o.c	4450	74.9	63.8	55.0	47.9	42.1	33.3	27.0	123
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2060	34.7	29.5	25.5	22.2	19.5	15.4	12.5	41.2
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	3400	57.2	48.8	42.1	36.6	32.2	25.4	20.6	68
Angle to Wood	4997	80.2	68.4	58.9	51.4	45.1	35.7	28.9	99.94
BASE SHOE: A3M Surface Mounted									
Steel 12” o.c	5126	86.3	73.5	63.4	55.2	48.5	38.4	31.1	102.52
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2786	46.9	40.0	34.5	30.0	26.4	20.8	16.9	55.72
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	4277	72.0	61.4	52.9	46.1	40.5	32.0	25.9	85.54
Wood Bracket	4290	72.2	61.5	53.1	46.2	40.6	32.1	26.0	85.8
BASE SHOE: A3M Fascia Mounted									
Steel 12” o.c	6150	103.5	88.2	76.1	66.3	58.2	46.0	37.3	123
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2060	34.7	29.5	25.5	22.2	19.5	15.4	12.5	41.2
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	3400	57.2	48.8	42.1	36.6	32.2	25.4	20.6	68
Angle to Wood	5100	85.9	73.2	63.1	54.9	48.3	38.2	30.9	102

TABLE 2—BASE SHOE ANCHORAGE METHODS AND STRENGTH (Continued)

Substrate - Anchor Spacing	Allowable Moment in-lbs/ft	Allowable wind load in psf[1]							Live Load
		Overall Guard height from bottom of base shoe top of top rail (H_g), in.							Max. guard ht (H_g) in.
		36	39	42	45	48	54	60	
BASE SHOE: A4M Surface Mounted									
Steel 12” o.c	7327	123.4	105.1	90.6	78.9	69.4	54.8	44.4	146.54
Concrete[2,3,4] 1/2” HUS-EZ 12” o.c.	3167	53.3	45.4	39.2	34.1	30.0	23.7	19.2	63.34
Concrete[2,3,4] 1/2” HUS-EZ 6” o.c.	3820	64.3	54.8	47.2	41.2	36.2	28.6	23.2	76.4
Wood Bracket	4290.0	72.2	61.5	53.1	46.2	40.6	32.1	26.0	85.8
BASE SHOE: A4M Fascia Mounted									
Steel 12” o.c	6150	103.5	88.2	76.1	66.3	58.2	46.0	37.3	123
Concrete[2,3,4] 1/2” HUS-EZ 12” o.c.	2020	34.0	29.0	25.0	21.8	19.1	15.1	12.2	40.4
Concrete[2,3,4] 1/2” HUS-EZ 6” o.c.	2670	44.9	38.3	33.0	28.8	25.3	20.0	16.2	53.4
Angle to Wood	5100	85.9	73.2	63.1	54.9	48.3	38.2	30.9	102
BASE SHOE: A5M Surface Mounted									
Steel 12” o.c	7456	125.5	107.0	92.2	80.3	70.6	55.8	45.2	149.12
Concrete[2,3,4] 1/2” HUS-EZ 12” o.c.	3222	54.2	46.2	39.9	34.7	30.5	24.1	19.5	64.44
Concrete[2,3,4] 1/2” HUS-EZ 6” o.c.	3887	65.4	55.8	48.1	41.9	36.8	29.1	23.6	77.74
Wood Bracket	4290	72.2	61.5	53.1	46.2	40.6	32.1	26.0	85.8
BASE SHOE: A5M Fascia Mounted									
Steel 12” o.c	6150	103.5	88.2	76.1	66.3	58.2	46.0	37.3	123
Concrete[2,3,4] 1/2” HUS-EZ 12” o.c.	2020	34.0	29.0	25.0	21.8	19.1	15.1	12.2	40.4
Concrete[2,3,4] 1/2” HUS-EZ 6” o.c.	2670	44.9	38.3	33.0	28.8	25.3	20.0	16.2	53.4
Angle to Wood	5100	85.9	73.2	63.1	54.9	48.3	38.2	30.9	102

TABLE 2—BASE SHOE ANCHORAGE METHODS AND STRENGTH (Continued)

Substrate - Anchor Spacing	Allowable Moment in-lbs/ft	Allowable wind load in psf[1]							Live Load
		Overall Guard height from bottom of base shoe top of top rail (H_g), in.							Max. guard ht (H_g) in.
		36	39	42	45	48	54	60	
BASE SHOE: A6M Surface Mounted									
Steel 12” o.c	8081	136.0	115.9	100.0	87.1	76.5	60.5	49.0	161.62
Concrete[2,3,4] 1/2” HUS-EZ 12” o.c.	3492	58.8	50.1	43.2	37.6	33.1	26.1	21.2	69.8
Concrete[2,3,4] 1/2” HUS-EZ 6” o.c.	4213	70.9	60.4	52.1	45.4	39.9	31.5	25.5	84.3
Wood Bracket	4290	72.2	61.5	53.1	46.2	40.6	32.1	26.0	85.8
BASE SHOE: A6M Fascia Mounted									
Steel 12” o.c	6150	103.5	88.2	76.1	66.3	58.2	46.0	37.3	123
Concrete[2,3,4] 1/2” HUS-EZ 12” o.c.	2020	34.0	29.0	25.0	21.8	19.1	15.1	12.2	40.4
Concrete[2,3,4] 1/2” HUS-EZ 6” o.c.	2670	44.9	38.3	33.0	28.8	25.3	20.0	16.2	53.4
Angle to Wood	5100	85.9	73.2	63.1	54.9	48.3	38.2	30.9	102
BASE SHOE: T5M Surface Mounted									
Steel 12” o.c	4282	72.1	61.4	53.0	46.1	40.5	32.0	26.0	85.64
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2327	39.2	33.4	28.8	25.1	22.0	17.4	14.1	46.54
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	3572	60.1	51.2	44.2	38.5	33.8	26.7	21.6	71.44
Wood Bracket	4280	72.1	61.4	52.9	46.1	40.5	32.0	25.9	85.6
BASE SHOE: T5M Fascia Mounted									
Steel 12” o.c	4450	74.9	63.8	55.0	47.9	42.1	33.3	27.0	89
Concrete[2,3,4] 3/8” HUS-EZ 12” o.c.	2060	34.7	29.5	25.5	22.2	19.5	15.4	12.5	41.2
Concrete[2,3,4] 3/8” HUS-EZ 6” o.c.	3400	57.2	48.8	42.1	36.6	32.2	25.4	20.6	68
Angle to Wood	4282	72.1	61.4	53.0	46.1	40.5	32.0	26.0	85.64

TABLE 3—ALLOWABLE GLASS LITE WIDTHS FOR TOP RAIL

Top Rail Profile	Material	For Use With Glass Thickness (Inch)	Max supported panel width (inches)	Max unsupported monolithic end lite width (inches)[2]
REC2	Stainless	1/2 through 3/4	72	28
SC15	Stainless	1/2 through 3/4	72	38.5
SC20	Stainless	1/2 through 13/16	72	72
RC15	Stainless	1/2 through 3/4	72	22.5
RC20	Stainless	1/” through 13/16	72	45
CRVG1	Stainless	1/2 through 5/8	72	42.5
CRVG7	Stainless	11/16 and 3/4	72	45.5
CRVG8	Stainless	13/16	72	46.5
CREC5	Stainless	1/2 through 5/8	72	18.5
CREC7	Stainless	11/16 and 3/4	72	23
CR19	Aluminum	1/2 through 13/16	72	43.5
CRU1	Aluminum	1/2 through 5/8	72	20
CRU7	Aluminum	11/16 and 3/4	72	22
CRU8	Aluminum	13/16	72	22

For **SI**: 1 inch = 25.4 mm

1. Based on the capacity of the top rail considering the worst case between a 50 plf uniform load and a 200 lb. concentrated load.
2. Maximum end lite width applies if glass cantilever height H_c exceeds the limits in Table 4.

TABLE 4—MAXIMUM LITE HEIGHT FOR LITE WIDTH FOR INSTALLATION WITHOUT TOP RAIL

Lite width inches	Max. height 9/16 inches	Max. height 11/16 inches	Max. height 13/16 inches
12	5.60	11.80	16.30
24	15.20	30.80	42.50
36	26.70	43.30	51.30
41	31.70	45.60	54.20
48	36.30	46.90	57.80
60	38.80	47.90	63.00
72	38.80	48.40	64.80

For **SI**: 1 inch = 25.4 mm

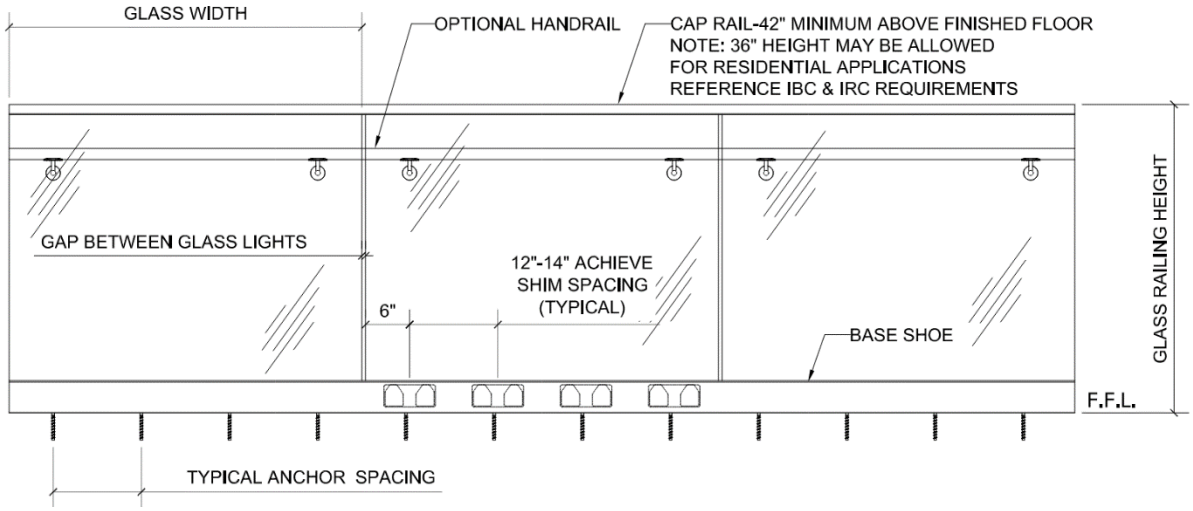
1. Linear interpolation for other panel widths is permitted.
2. Based on the worse case between a 50 plf uniform load and a 200 lb. concentrated load applied at max panel height.

TABLE 5—HANDRAIL BRACKET SPACING[2]

Handrail	Material[1]	L2-inches	Le-inches
1-1/4-inch Sched 40	St or SS	96	24
1-1/4-inch Sched 40	6063-T6 Al	84	21
1-1/2-inch Sched 40	St or SS	115	34
1-1/2-inch Sched 40	6063-T6 Al	96	29
1-1/2-inch x 1/8-inch Tube	SS	102	27
1-1/2-inch x 1/8-inch Tube	6063-T6 Al	62	15
1-1/2-inch x 0.05-inch Tube	SS	50	12
2-inches x 0.05-inch Tube	SS	92	22
1-1/2-inch x 0.05 inch SQ Tube	SS	84	21
2 x 1-inch x 1/8 inch Rec. Tube	SS	113	31

For **SI**: 1 inch = 25.4 mm

1. St = A53 Steel, SS = 304 or 316 stainless steel
2. See Figure 9



FHC ACHIEVE FRAMELESS
GLASS RAILING SYSTEM TYPICAL ELEVATION

FIGURE 1—TYPICAL GUARDRAIL ELEVATION

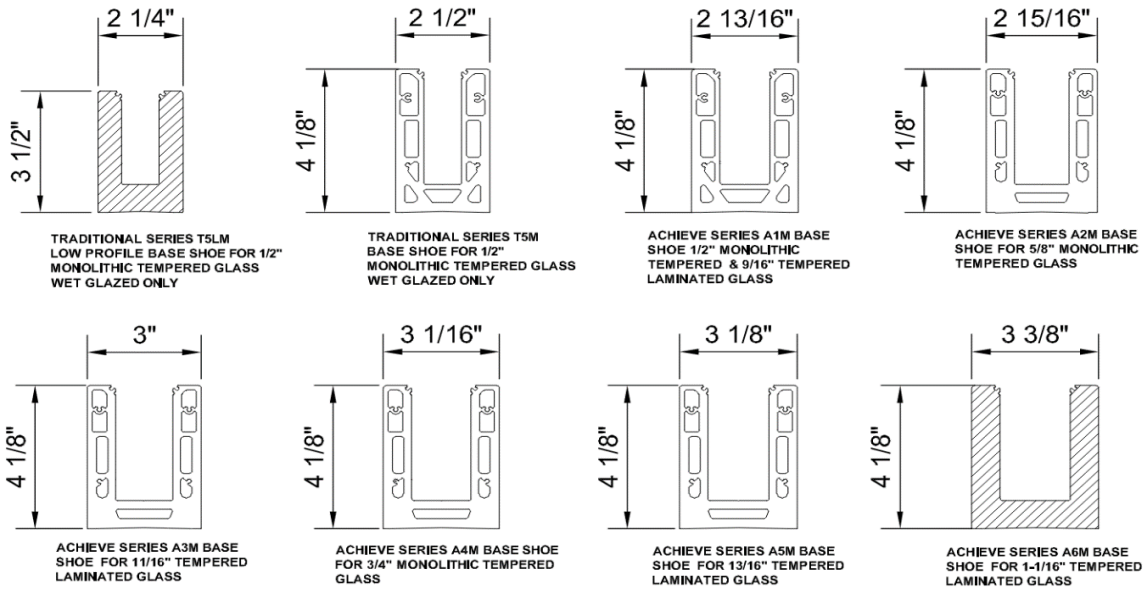


FIGURE 2—BASE SHOES

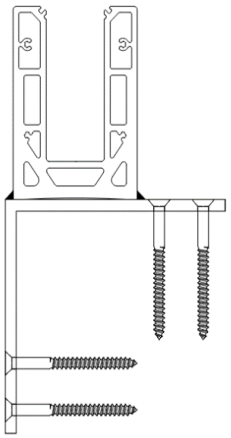


FIGURE 3—ALUMINUM BRACKET TO WOOD SUBSTRATE SURFACE MOUNT DETAIL

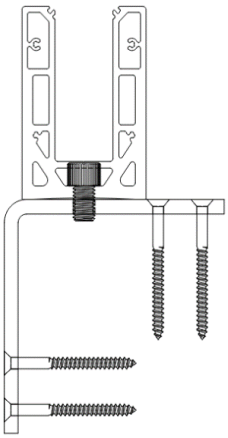
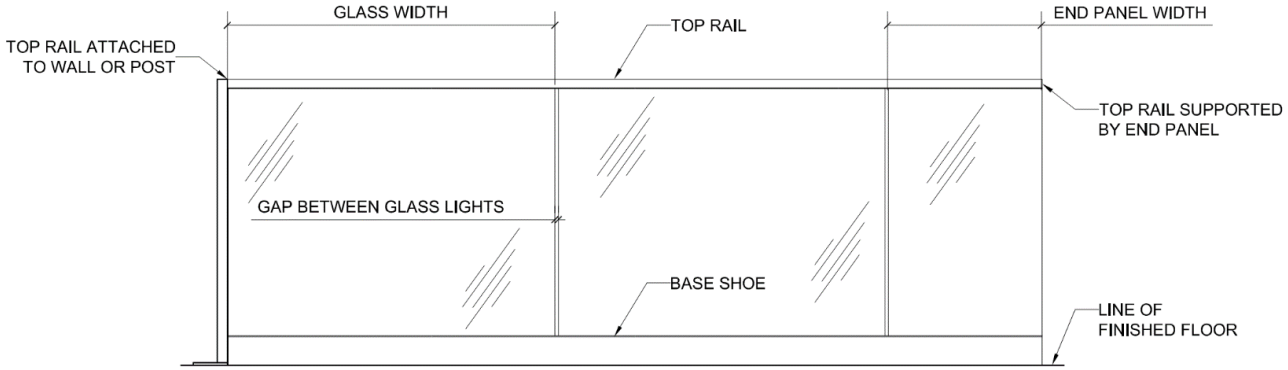


FIGURE 4—STEEL BRACKET TO WOOD SUBSTRATE SURFACE MOUNT DETAIL

Notes for Figures 3
1/4”x6” 6063 T5 aluminum bars or bent plate
Fillet weld corner slot 3” @ 12” o.c.
Base shoe weld 3/16” fillet 3”@12”o.c.
Screws to deck to be designed based on conditions.

Notes for Figure 4
L5x5x5/16x4” at 12 in o.c.
Bolt base shoe per steel attachment.
Screws to deck to be designed based on conditions.

Alternative plates or angles may be designed based on imposed loads and wood framing.



FHC ACHIEVE FRAMELESS
GLASS RAILING SYSTEM TYPICAL ELEVATION

FIGURE 5—TOP RAIL SUPPORT OPTIONS

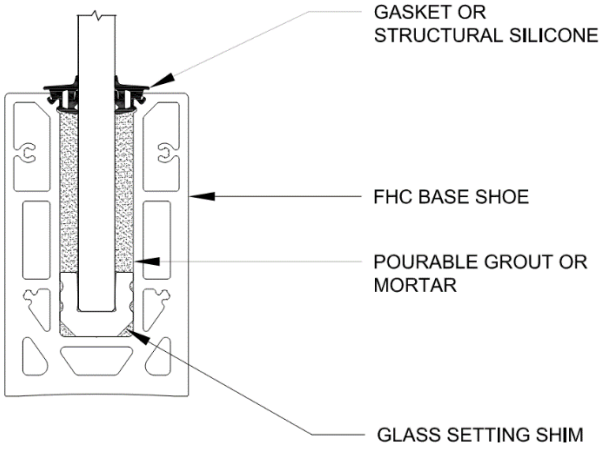
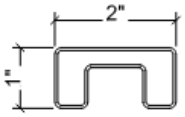
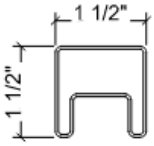


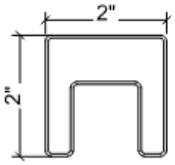
FIGURE 6—WET GLAZING



REC2 2"X1" STAINLESS CAP RAIL FOR 1/2", 9/16" 5/8",11/16 & 3/4" GLASS



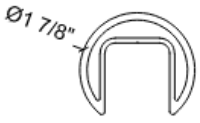
SC15 1.5" STAINLESS CAP RAIL FOR 1/2", 9/16" 5/8",11/16 & 3/4" GLASS



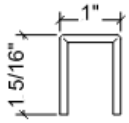
SC20 2" STAINLESS CAP RAIL FOR 1/2", 9/16" 5/8",11/16, 3/4"& 13/16" GLASS

RC15 1.5" STAINLESS CAP RAIL FOR 1/2", 9/16" 5/8",11/16 & 3/4" GLASS

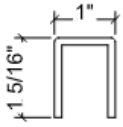
RC20 2" STAINLESS CAP RAIL FOR 1/2", 9/16" 5/8", 11/16, 3/4"& 13/16" GLASS



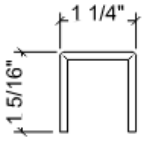
CR19 1.9" ALUMINUM CAP RAIL FOR 1/2", 9/16" 5/8",11/16, 3/4"& 13/16" GLASS



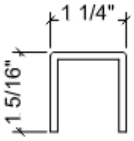
CRVG1 V-CUT STAINLESS CAP RAIL FOR 1/2", 9/16" & 5/8" GLASS



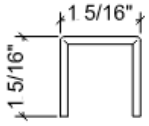
CRU1 ALUMINUM CAP RAIL FOR 1/2", 9/16" & 5/8" GLASS



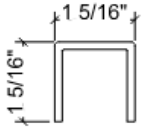
CRVG7 V-CUT STAINLESS CAP RAIL FOR 11/16" & 3/4" GLASS



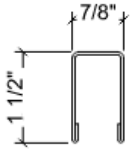
CRU7 ALUMINUM CAP RAIL FOR 11/16" & 3/4" GLASS



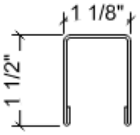
CRVG8 V-CUT STAINLESS CAP RAIL FOR 13/16" GLASS



CRU8 ALUMINUM CAP RAIL FOR 13/16" GLASS



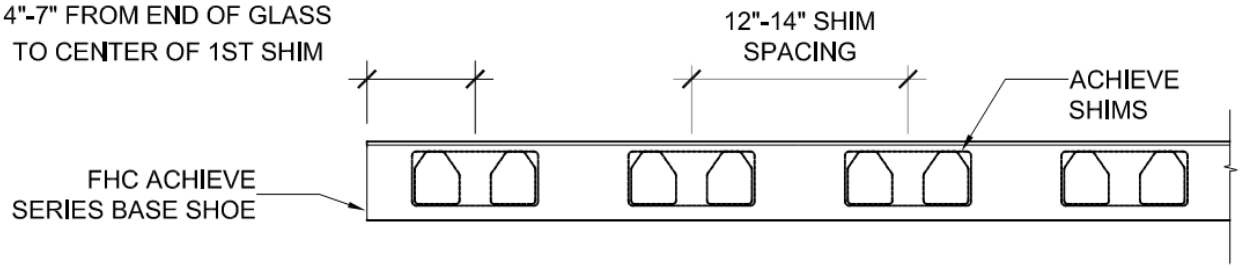
CREC5- STAINLESS STEEL GLASS EDGE PROTECTOR FOR 1/2", 9/16" AND 5/8" GLASS



CREC7- STAINLESS STEEL GLASS EDGE PROTECTOR FOR 11/16" AND 3/4" GLASS

Install Base Shoe, Exterior Gasket & Setting Block

Install Glass & Set Shims Using ACH1K Install Tool Kit



FHC ACHIEVE SHIM SPACING

Minimum # of shim sets	Glass lite width
1 shim set	≤ 14 inches
2 shim sets	14-in < L ≤ 28-in
3 shim sets	28-in < L ≤ 42-in
4 shim sets	42-in < L ≤ 56-in
5 shim sets	56-in < L ≤ 70-in
6 shim sets	70-in < L ≤ 84-in
7 shim sets	84-in < L ≤ 96-in

FIGURE 8—ACHIEVE SHIMS

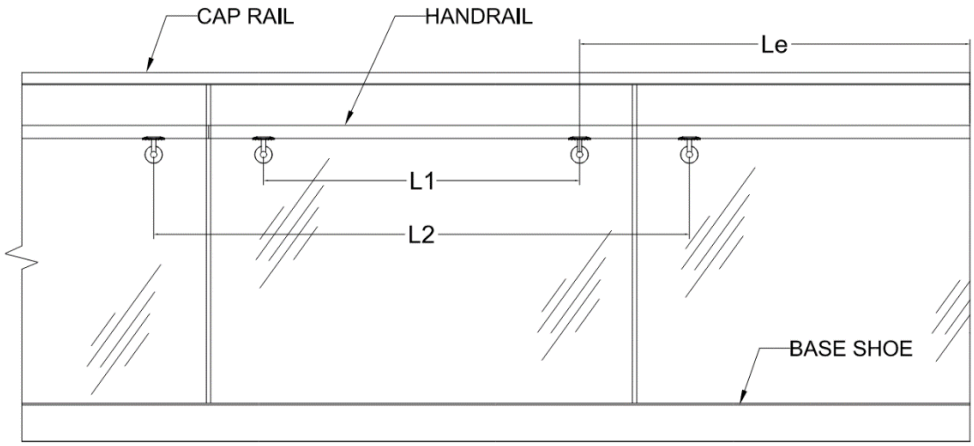
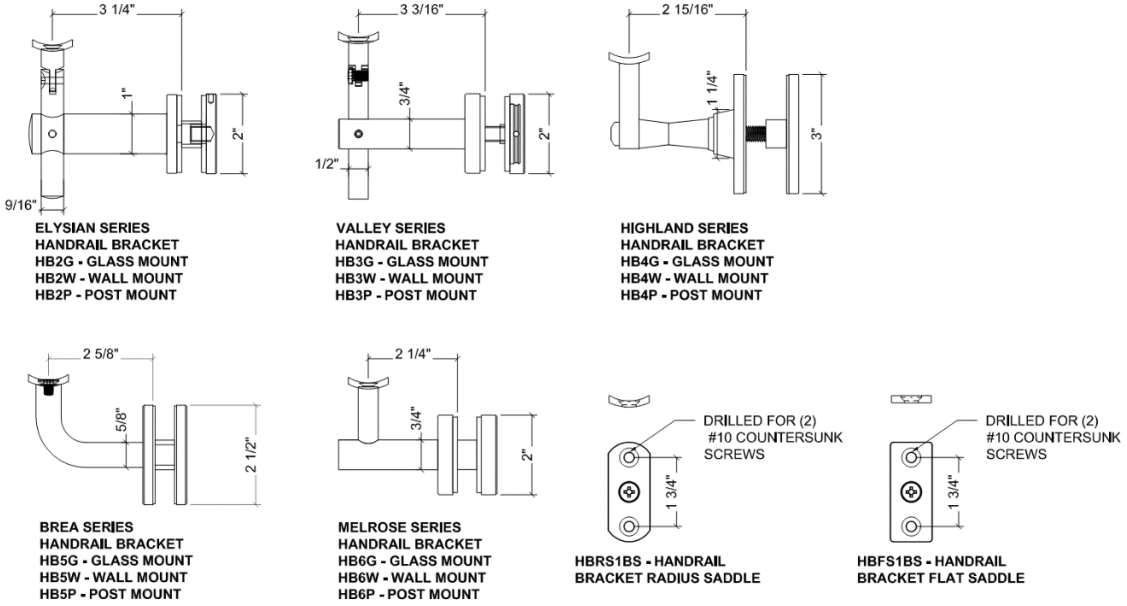


FIGURE 9—TOP RAIL AND HANDRAIL SUPPORT OPTIONS



Bracket Series	Allowable Load	Maximum Spacing
Elysian	250 lbs	5 ft o.c.
Valley	250 lbs	5 ft o.c.
Highland Series	276 lbs	5 ft 6 in o.c
Brea	392 lbs	7 ft 10 in o.c
Melrose	250 lbs	5 ft o.c.

FIGURE 10—HANDRAIL BRACKETS

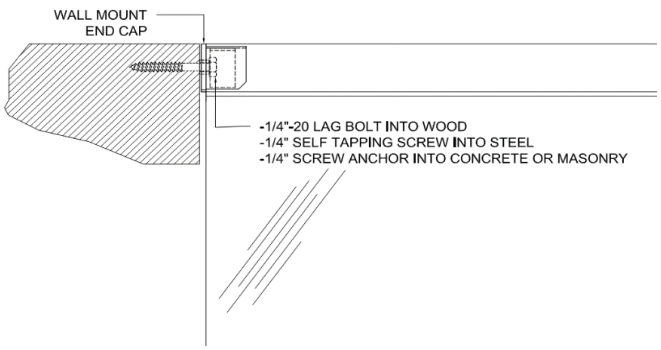


FIGURE 11—STABILIZING END CAP

DIVISION: 05 00 00—METALS
Section: 05 52 00—Metal Railings
Section: 05 73 13—Glazed Decorative Metal Railings

DIVISION: 08 00 00—OPENINGS
Section: 08 81 00—Glass Glazing
Section: 08 88 00—Special Function Glazing

DIVISION: 32 00 00—EXTERIOR IMPROVEMENTS
Section: 32 35 00—Screening Devices

REPORT HOLDER:

FRAMELESS HARDWARE COMPANY LLC

EVALUATION SUBJECT:

ACHIEVE FRAMELESS GLASS RAILING SYSTEM

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Achieve Frameless Glass Railing System, described in ICC-ES evaluation report ESR-4814, has also been evaluated for compliance with the codes noted below as adopted by the Los Angeles Department of Building and Safety (LADBS).

Applicable code editions:

- 2020 *City of Los Angeles Building Code* (LABC)
- 2020 *City of Los Angeles Residential Code* (LARC)

2.0 CONCLUSIONS

The Achieve Frameless Glass Railing System described in Sections 2.0 through 7.0 of the evaluation report ESR-4814, complies with the LABC Chapters 10 and 24, and the LARC, and are subject to the conditions of use described in this supplement.

3.0 CONDITIONS OF USE

The Achieve Frameless Glass Railing System described in this evaluation report supplement must comply with all of the following conditions:

- All applicable sections in the evaluation report ESR-4814.
- The design, installation, conditions of use and identification of the Achieve Frameless Glass Railing System are in accordance with the 2018 *International Building Code®* (IBC) provisions noted in the evaluation report ESR-4814.
- The design, installation and inspection are in accordance with additional requirements of LABC Chapters 16 and 17, as applicable.

This supplement expires concurrently with the evaluation report, reissued September 2024.

DIVISION: 05 00 00—METALS
Section: 05 52 00—Metal Railings
Section: 05 73 13—Glazed Decorative Metal Railings

DIVISION: 08 00 00—OPENINGS
Section: 08 81 00—Glass Glazing
Section: 08 88 00—Special Function Glazing

DIVISION: 32 00 00—EXTERIOR IMPROVEMENTS
Section: 32 35 00—Screening Devices

REPORT HOLDER:

FRAMELESS HARDWARE COMPANY LLC

EVALUATION SUBJECT:

ACHIEVE FRAMELESS GLASS RAILING SYSTEM

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that The Achieve Frameless Glass Railing System, described in ICC-ES evaluation report ESR-4814, has also been evaluated for compliance with the codes noted below.

Applicable code editions:

- 2019 *California Building Code*® (CBC)

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

- 2019 *California Residential Code*® (CRC)

2.0 CONCLUSIONS

2.1 CBC:

The Achieve Frameless Glass Railing System, described in Sections 2.0 through 7.0 of the evaluation report ESR-4814, complies with CBC Chapters 10 and 24, provided the design and installation are in accordance with the 2018 *International Building Code*® (IBC) provisions noted in the evaluation report and the additional requirements of CBC Chapters 10, 16 and 24, as applicable.

2.1.1 OSHPD:

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

2.1.2 DSA:

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

2.2 CRC:

The Achieve Frameless Glass Railing System, described in Sections 2.0 through 7.0 of the evaluation report ESR-4814, complies with CRC Chapters 3, provided the design and installation are in accordance with the 2018 *International Residential Code*® (IRC) provisions noted in the evaluation report.

This supplement expires concurrently with the evaluation report, reissued September 2024.