



January 30, 2025

**To:** Whom it may concern,  
**From:** Building Drops, Inc.  
**On behalf of:** Glass Warehouse LLC / Future Glass  
1319 Rocky Point Drive, Suite 200  
Oceanside, CA 92056  
**Report:** PER 9164  
**Subject:** RAN-CHRES Base Shoe System

**Scope:**

The purpose of this report is to evaluate the performance of the RAN-CHRES Base Shoe System manufactured by Glass Warehouse LLC / Future Glass. The conditions in this report meet all the applicable requirements of the current International Building Code. Glass thicknesses and properties were extracted from ASTM E1300. Steel members and connections were designed according to AISC Design Guides. ICC Acceptance Criteria AC439 and ASTM E2358 were used for determining applicable design criteria for railing systems. A summary of standards can be found on the following pages.

Only rectangular glass is covered within this report, different glass shapes do not apply to this analysis. Gaskets may be modified according to different glass thicknesses as long as thickness is specified in this analysis.

The glass balustrade system uses a stainless steel base shoe to support the glass lights specified herein. The glass base shoe system has been designed for the following loading conditions:

- 200 lb concentrated load at the top of glass or at the top rail
- 50 lbs linear load applied at the top of glass or at the top rail
- Allowable wind load as shown on the tables within this report

This report provides glass thicknesses the base shoe has been designed to support. Other glass thicknesses may be used but are outside of the scope of this report.

**Instructions for Use**

1. Determine jobsite wind load using table 1.
2. Select desired glass composition from tables 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12.
3. Determine max. glass size based on wind load requirements using table 1 for reference.
4. Using table 15, choose desired anchor type and verify allowable wind load is greater than the glass allowable wind load.

**RAN-CHRES Base Shoe System**

|  |                        |  |                      |
|--|------------------------|--|----------------------|
| Project Description:<br>Glass Warehouse LLC / Future Glass RAN-CHRES Base Shoe<br>Engineering Analysis | Date: January 30, 2025 | Customer: Glass Warehouse LLC / Future Glass |                      |
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**Standards/Referenced Publications**

|                      |                    |  |
|----------------------|--------------------|--|
| ASTM E1300           | IBC 1607.8.1       | ICC AC439                                      |
| ASTM E2358           | AISC Design Guides | ASTM C1048-97b                                 |
| CPSC 16 CFR 1201     | ANSI Z97.1         | AAMA CW-12-84, Structural Properties for glass |
| AISC Design Guide 27 | IBC 2407.1.1       | NDS 2018                                       |
| ASTM E6.2.1.1        | SEI/ASCE 8-02      |  |

**Limits of Use:**

|  |                        |  |                      |
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1. This product has been evaluated and is in compliance with the 2015, 2018, and 2021 editions of the International Building Code.
2. Product installation shall be as listed herein. Site conditions that deviate from those specified shall require further engineering analysis by a licensed engineer or registered architect.
3. When used in areas requiring wind borne debris protection this product complies with chapter 16 of the 2015, 2018, and 2021 editions of the International Building Code and does require an impact resistant covering in areas requiring impact resistance.

**Conclusion:**

In my professional opinion, the RAN-CHRES Base Shoe System manufactured by Glass Warehouse LLC / Future Glass is adequate for use under the limitations provided within this report.

I trust that this will satisfy your needs, however, feel free to call if you have any questions.



**Certification of Independence:** Please note that I do not have nor will I acquire a financial interest in any company manufacturing or distributing the product(s) for which this report is being issued. Also, I do not have nor will I acquire a financial interest in any other entity involved in the approval process of the listed product(s).

|   |                        |  |                      |
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**Analysis and Findings**

Under the appropriate load conditions for the system, the main load cases are summarized below:

Loading:

Horizontal Load to Base Shoe:  $25 \text{ psf} * H$  or  $W_L * H$

Balustrade Moments:  $M_i = 25 \text{ psf} * H^2/2$  or  $W_L * H^2/2$

For Top Rails:  
 $M_C = 200 \text{ lbs} * H$   
 $M_U = 50 \text{ plf} * H$



**Wind Loads on Fences or Guards**

The wind load table below has been calculated in accordance with ASCE 7-22 section 29.4, Design Wind Loads on Solid Freestanding Wall and Solid Signs. This section is applicable for free standing building guard rails, wind walls, and balcony railings that return to building walls.

Table 1: Wind Loads on Fences or Guards

| Wind Loads (PSF) |                           |                        |                        |                           |                        |                        |
|------------------|---------------------------|------------------------|------------------------|---------------------------|------------------------|------------------------|
| Wind Speed (mph) | $W_{ASD}$ for $C_f = 1.3$ |                        |                        | $W_{ASD}$ for $C_f = 2.6$ |                        |                        |
|                  | Exp. B<br>$K_z = 0.7$     | Exp. C<br>$K_z = 0.85$ | Exp. D<br>$K_z = 1.03$ | Exp. B<br>$K_z = 0.7$     | Exp. C<br>$K_z = 0.85$ | Exp. D<br>$K_z = 1.03$ |
| 100              | 9.50                      | 11.53                  | 13.98                  | 19.00                     | 23.07                  | 27.95                  |
| 110              | 11.49                     | 13.95                  | 16.91                  | 22.98                     | 27.91                  | 33.82                  |
| 120              | 13.68                     | 16.61                  | 20.12                  | 27.35                     | 33.21                  | 40.25                  |
| 130              | 16.05                     | 19.49                  | 23.62                  | 32.10                     | 38.98                  | 47.24                  |
| 140              | 18.62                     | 22.60                  | 27.39                  | 37.23                     | 45.21                  | 54.78                  |
| 150              | 21.37                     | 25.95                  | 31.44                  | 42.74                     | 51.90                  | 62.89                  |
| 160              | 24.31                     | 29.52                  | 35.78                  | 48.63                     | 59.05                  | 71.55                  |
| 170              | 27.45                     | 33.33                  | 40.39                  | 54.90                     | 66.66                  | 80.78                  |
| 180              | 30.77                     | 37.37                  | 45.28                  | 61.54                     | 74.73                  | 90.56                  |

Refer to the appendix of this report for detailed wind load calculations.

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**Glass Strength**

**Table 2: Glass properties extracted from ASTM E1300**

| Glass properties  |                         |                          |                              |                                       |
|-------------------|-------------------------|--------------------------|------------------------------|---------------------------------------|
| Glass types       | Modulus of rupture, psi | All. Bending Stress, psi | All. Compressive Stress, psi | All. Glass Stress per ASTM E1300, psi |
| Tempered          | 24000                   | 6000                     | 6000                         | 10600                                 |
| Heat Strengthened | 12000                   | 3000                     | 3000                         | 5300                                  |
| Annealed          | 6000                    | 1500                     | 1500                         | 2900                                  |

**Allowable Wind Load Table for Monolithic Glass**

**Table 3: 1/2" Monolithic Tempered Glass**

| Allowable Wind Pressure (PSF) |                    |       |       |       |       |       |
|-------------------------------|--------------------|-------|-------|-------|-------|-------|
| Glass Width (in.)             | Glass Height (in.) |       |       |       |       |       |
|                               | 36                 | 39.75 | 42    | 48    | 60    | 72    |
| 12                            | 59.67              | 48.52 | 42.92 | 31.76 | 19.77 | 11.15 |
| 24                            | 48.25              | 39.14 | 34.71 | 25.78 | 16.09 | 9.05  |
| 36                            | 39.64              | 32.38 | 28.70 | 21.36 | 13.36 | 7.61  |
| 42                            | *                  | *     | 25.24 | 18.85 | 11.80 | 6.72  |
| 48                            | *                  | *     | *     | 16.56 | 10.41 | 5.88  |
| 60                            | *                  | *     | *     | *     | 8.51  | 4.86  |
| 72                            | *                  | *     | *     | *     | *     | 4.09  |

\*Note: Allowable wind load is the same as last value in the column.

**Allowable Wind Load Tables for Laminated Glass**

**Table 4: 7/16" O.A. Laminated Glass: 3/16" Tempered Glass – 0.060" PVB – 3/16" Tempered Glass**

| Allowable Wind Pressure (PSF) |                     |        |                             |                    |       |       |       |       |       |
|-------------------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
| Glass Width (in.)             | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|                               | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
| 12                            | 0.234               | 0.264  | 1472                        | 24.78              | 20.33 | 18.21 | 13.94 | 8.92  | 6.20  |
| 24                            | 0.252               | 0.285  | 1724                        | 29.02              | 23.80 | 21.32 | 16.32 | 10.45 | 7.25  |
| 36                            | 0.274               | 0.310  | 2038                        | 34.31              | 28.14 | 25.20 | 19.30 | 12.35 | 8.58  |
| 42                            | 0.285               | 0.322  | 2194                        | *                  | *     | 27.14 | 20.78 | 13.30 | 9.23  |
| 48                            | 0.296               | 0.332  | 2342                        | *                  | *     | *     | 22.18 | 14.19 | 9.86  |
| 60                            | 0.316               | 0.350  | 2602                        | *                  | *     | *     | *     | 15.77 | 10.95 |
| 72                            | 0.332               | 0.364  | 2813                        | *                  | *     | *     | *     | *     | 11.84 |

\*Note: Allowable wind load is the same as last value in the column.

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**Table 5: 7/16" O.A. Laminated Glass: 3/16" Tempered Glass – 0.060" PVB Stiff – 3/16" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
|                   |                     |        |                             |                    |       |       |       |       |       |
| 12                | 0.249               | 0.282  | 1687                        | 28.41              | 23.30 | 20.87 | 15.98 | 10.23 | 7.10  |
| 24                | 0.291               | 0.327  | 2270                        | 38.22              | 31.35 | 28.08 | 21.50 | 13.76 | 9.55  |
| 36                | 0.327               | 0.360  | 2740                        | 46.14              | 37.84 | 33.90 | 25.95 | 16.61 | 11.53 |
| 42                | 0.340               | 0.371  | 2912                        | *                  | *     | 36.01 | 27.57 | 17.65 | 12.25 |
| 48                | 0.352               | 0.379  | 3048                        | *                  | *     | *     | 28.86 | 18.47 | 12.83 |
| 60                | 0.369               | 0.391  | 3242                        | *                  | *     | *     | *     | 19.65 | 13.65 |
| 72                | 0.381               | 0.399  | 3368                        | *                  | *     | *     | *     | *     | 14.18 |

\*Note: Allowable wind load is the same as last value in the column.

**Table 6: 7/16" O.A. Laminated Glass: 3/16" Tempered Glass – 0.060" SentryGlas – 3/16" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
|                   |                     |        |                             |                    |       |       |       |       |       |
| 12                | 0.313               | 0.348  | 2564                        | 43.16              | 35.40 | 31.71 | 24.28 | 15.54 | 10.79 |
| 24                | 0.371               | 0.392  | 3266                        | 54.98              | 45.09 | 40.39 | 30.93 | 19.79 | 13.74 |
| 36                | 0.394               | 0.406  | 3498                        | 58.88              | 48.30 | 43.26 | 33.12 | 21.20 | 14.72 |
| 42                | 0.400               | 0.409  | 3554                        | *                  | *     | 43.96 | 33.66 | 21.54 | 14.96 |
| 48                | 0.404               | 0.412  | 3593                        | *                  | *     | *     | 34.02 | 21.78 | 15.12 |
| 60                | 0.409               | 0.414  | 3640                        | *                  | *     | *     | *     | 22.06 | 15.32 |
| 72                | 0.412               | 0.416  | 3666                        | *                  | *     | *     | *     | *     | 15.43 |

\*Note: Allowable wind load is the same as last value in the column.

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**Table 7: 9/16" O.A. Laminated Glass: 1/4" Tempered Glass – 0.090" PVB – 1/4" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
|                   |                     |        |                             |                    |       |       |       |       |       |
| 12                | 0.283               | 0.318  | 2142                        | 36.06              | 29.58 | 26.49 | 20.29 | 12.98 | 9.02  |
| 24                | 0.300               | 0.338  | 2428                        | 40.87              | 33.52 | 30.03 | 22.99 | 14.71 | 10.22 |
| 36                | 0.322               | 0.364  | 2803                        | 47.18              | 38.70 | 34.67 | 26.54 | 16.99 | 11.80 |
| 42                | 0.334               | 0.376  | 2997                        | *                  | *     | 37.07 | 28.38 | 18.17 | 12.61 |
| 48                | 0.345               | 0.388  | 3186                        | *                  | *     | *     | 30.17 | 19.31 | 13.41 |
| 60                | 0.367               | 0.408  | 3533                        | *                  | *     | *     | *     | 21.41 | 14.87 |
| 72                | 0.386               | 0.425  | 3825                        | *                  | *     | *     | *     | *     | 16.10 |

\*Note: Allowable wind load is the same as last value in the column.

**Table 8: 9/16" O.A. Laminated Glass: 1/4" Tempered Glass – 0.090" PVB Stiff – 1/4" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
|                   |                     |        |                             |                    |       |       |       |       |       |
| 12                | 0.297               | 0.335  | 2386                        | 40.17              | 32.95 | 29.51 | 22.59 | 14.46 | 10.04 |
| 24                | 0.340               | 0.382  | 3094                        | 52.09              | 42.73 | 38.27 | 29.30 | 18.75 | 13.02 |
| 36                | 0.379               | 0.419  | 3723                        | 62.68              | 51.41 | 46.05 | 35.26 | 22.56 | 15.67 |
| 42                | 0.395               | 0.433  | 3966                        | *                  | *     | 49.06 | 37.56 | 24.04 | 16.69 |
| 48                | 0.409               | 0.443  | 4166                        | *                  | *     | *     | 39.45 | 25.25 | 17.53 |
| 60                | 0.431               | 0.459  | 4460                        | *                  | *     | *     | *     | 27.03 | 18.77 |
| 72                | 0.446               | 0.469  | 4657                        | *                  | *     | *     | *     | *     | 19.60 |

\*Note: Allowable wind load is the same as last value in the column.

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**Table 9: 9/16" O.A. Laminated Glass: 1/4" Tempered Glass – 0.090" SentryGlas – 1/4" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
|                   |                     |        |                             |                    |       |       |       |       |       |
| 12                | 0.364               | 0.405  | 3480                        | 58.59              | 48.06 | 43.05 | 32.96 | 21.09 | 14.65 |
| 24                | 0.433               | 0.461  | 4496                        | 75.69              | 62.08 | 55.61 | 42.58 | 27.25 | 18.92 |
| 36                | 0.463               | 0.479  | 4864                        | 81.89              | 67.17 | 60.16 | 46.06 | 29.48 | 20.47 |
| 42                | 0.471               | 0.484  | 4957                        | *                  | *     | 61.31 | 46.94 | 30.04 | 20.86 |
| 48                | 0.476               | 0.487  | 5020                        | *                  | *     | *     | 47.54 | 30.43 | 21.13 |
| 60                | 0.484               | 0.490  | 5099                        | *                  | *     | *     | *     | 30.90 | 21.46 |
| 72                | 0.488               | 0.493  | 5143                        | *                  | *     | *     | *     | *     | 21.65 |

\*Note: Allowable wind load is the same as last value in the column.

**Table 10: 11/16" O.A. Laminated Glass: 5/16" Tempered Glass – 0.090" PVB – 5/16" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
|                   |                     |        |                             |                    |       |       |       |       |       |
| 12                | 0.374               | 0.420  | 3743                        | 63.02              | 51.69 | 46.30 | 35.45 | 22.69 | 15.75 |
| 24                | 0.390               | 0.439  | 4092                        | 68.89              | 56.51 | 50.62 | 38.75 | 24.80 | 17.22 |
| 36                | 0.413               | 0.465  | 4578                        | 77.07              | 63.21 | 56.62 | 43.35 | 27.74 | 19.27 |
| 42                | 0.425               | 0.478  | 4843                        | *                  | *     | 59.90 | 45.86 | 29.35 | 20.38 |
| 48                | 0.437               | 0.491  | 5110                        | *                  | *     | *     | 48.39 | 30.97 | 21.51 |
| 60                | 0.462               | 0.515  | 5624                        | *                  | *     | *     | *     | 34.09 | 23.67 |
| 72                | 0.484               | 0.536  | 6086                        | *                  | *     | *     | *     | *     | 25.61 |

\*Note: Allowable wind load is the same as last value in the column.

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**Table 11: 11/16" O.A. Laminated Glass: 5/16" Tempered Glass – 0.090" PVB ES – 5/16" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |       |       |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|-------|-------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75 | 42    | 48    | 60    | 72    |
|                   |                     |        |                             |                    |       |       |       |       |       |
| 12                | 0.388               | 0.437  | 4040                        | 68.01              | 55.79 | 49.97 | 38.26 | 24.49 | 17.00 |
| 24                | 0.431               | 0.485  | 4979                        | 83.81              | 68.75 | 61.58 | 47.14 | 30.17 | 20.95 |
| 36                | 0.476               | 0.529  | 5922                        | 99.70              | 81.78 | 73.25 | 56.08 | 35.89 | 24.93 |
| 42                | 0.496               | 0.546  | 6320                        | *                  | *     | 78.16 | 59.84 | 38.30 | 26.60 |
| 48                | 0.513               | 0.560  | 6660                        | *                  | *     | *     | 63.07 | 40.36 | 28.03 |
| 60                | 0.542               | 0.582  | 7189                        | *                  | *     | *     | *     | 43.57 | 30.26 |
| 72                | 0.563               | 0.597  | 7561                        | *                  | *     | *     | *     | *     | 31.82 |

\*Note: Allowable wind load is the same as last value in the column.

**Table 12: 11/16" O.A. Laminated Glass: 5/16" Tempered Glass – 0.090" SentryGlas – 5/16" Tempered Glass**

| Glass Width (in.) | Effective Thickness |        | Allowable Moment (lb-in/ft) | Glass Height (in.) |        |        |       |       |       |
|-------------------|---------------------|--------|-----------------------------|--------------------|--------|--------|-------|-------|-------|
|                   | Deflection          | Stress |                             | 36                 | 39.75  | 42     | 48    | 60    | 72    |
|                   |                     |        |                             |                    |        |        |       |       |       |
| 12                | 0.458               | 0.511  | 5544                        | 93.34              | 76.56  | 68.57  | 52.50 | 33.60 | 23.33 |
| 24                | 0.546               | 0.585  | 7256                        | 122.15             | 100.19 | 89.75  | 68.71 | 43.98 | 30.54 |
| 36                | 0.588               | 0.613  | 7972                        | 134.21             | 110.08 | 98.60  | 75.49 | 48.31 | 33.55 |
| 42                | 0.600               | 0.620  | 8162                        | *                  | *      | 100.95 | 77.29 | 49.46 | 34.35 |
| 48                | 0.609               | 0.625  | 8294                        | *                  | *      | *      | 78.54 | 50.27 | 34.91 |
| 60                | 0.620               | 0.632  | 8460                        | *                  | *      | *      | *     | 51.27 | 35.60 |
| 72                | 0.627               | 0.635  | 8555                        | *                  | *      | *      | *     | *     | 36.00 |

\*Note: Allowable wind load is the same as last value in the column.

Refer to the appendix of this report for detailed glass capacity calculations.

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**Glass Height based on 1” Deflection Limitation**

**Table 13: 7/16” O.A. Laminated Glass**

| Light Width (in) | Max. Glass Height (in.) |              |           |           |              |           |
|------------------|-------------------------|--------------|-----------|-----------|--------------|-----------|
|                  | 50plf PVB               | 50plf PVB ES | 50plf SGP | 200lb PVB | 200lb PVB ES | 200lb SGP |
| 12               | 22.52                   | 24.11        | 29.72     | 12.09     | 12.87        | 15.58     |
| 24               | 24.37                   | 27.96        | 33.54     | 17.00     | 19.41        | 23.08     |
| 36               | 26.49                   | 30.72        | 34.71     | 21.36     | 24.67        | 27.77     |
| 42               | 27.49                   | 31.67        | 34.99     | 23.39     | 26.86        | 29.60     |
| 48               | 28.40                   | 32.40        | 35.18     | 25.32     | 28.81        | 31.22     |
| 60               | 29.94                   | 33.42        | 35.41     | 28.84     | 32.13        | 34.01     |
| 72               | 31.13                   | 34.06        | 35.54     | 31.93     | 34.90        | 36.38     |

**Table 14: 9/16” O.A. Laminated Glass**

| Light Width (in) | Max. Glass Height (in.) |              |           |           |              |           |
|------------------|-------------------------|--------------|-----------|-----------|--------------|-----------|
|                  | 50plf PVB               | 50plf PVB ES | 50plf SGP | 200lb PVB | 200lb PVB ES | 200lb SGP |
| 12               | 27.16                   | 28.67        | 34.62     | 14.36     | 15.08        | 17.84     |
| 24               | 28.92                   | 32.65        | 39.35     | 20.04     | 22.50        | 26.85     |
| 36               | 31.07                   | 35.81        | 40.93     | 24.94     | 28.62        | 32.55     |
| 42               | 32.13                   | 36.96        | 41.32     | 27.24     | 31.22        | 34.77     |
| 48               | 33.13                   | 37.88        | 41.58     | 29.44     | 33.55        | 36.73     |
| 60               | 34.88                   | 39.19        | 41.91     | 33.51     | 37.56        | 40.10     |
| 72               | 36.30                   | 40.05        | 42.09     | 37.15     | 40.92        | 42.96     |

|   |                        |  |                       |
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**RAN-CHRES Base Shoe Installation**

**Anchor Schedule**

| Anchor Schedule           |   |   |                          |                         |                          |
|---------------------------|---|---|--------------------------|-------------------------|--------------------------|
| Substrate                 | Anchor Type                                   | Min. Embedment (in.)                            | Min. Edge Distance (in.) | On Center Spacing (in.) | Allowable Moment (in-lb) |
| Wood<br>SG = 0.55 min.    | 1/2" ASTM F593 Bolt                           | 3.00  | 0.75                     | 9.84                    | 5810.03                  |
|                           | 3/8" Lag Screw                                | 3.00  | 0.75                     | 9.84                    | 1295.53                  |
|                           | 1/2" Lag Screw                                | 3.00  | 0.75                     | 9.84                    | 1609.13                  |
| Concrete<br>4000 PSI min. | 3/8" Dewalt Screw-Bolt+                       | 4.50  | 2.50                     | 9.84                    | 2658.31                  |
|                           | 1/2" Dewalt Screw-Bolt+                       | 4.50  | 2.50                     | 9.84                    | 3307.69                  |
|                           | 3/8" ITW RedHead Dynabolt                     | 1.50  | 2.50                     | 9.84                    | 841.78                   |
|                           | 1/2" ITW RedHead Dynabolt                     | 1.875   | 2.50                     | 9.84                    | 1194.59                  |
|                           | 3/8" Hilti HIT-Z Rod with HIT-HY 200 Adhesive | 4.50  | 2.375                    | 9.84                    | 1403.51                  |
|                           | 1/2" Hilti HIT-Z Rod with HIT-HY 200 Adhesive | 4.50  | 2.625                    | 9.84                    | 1810.37                  |
| Steel<br>1/4" Thk. Min.   | 3/8" HWH Self-Tapping Screw                   | Min. 3 threads penetration past steel structure | 0.50                     | 9.84                    | 1672.71                  |
|                           | 1/2" HWH Self-Tapping Screw                   | Min. 3 threads penetration past steel structure | 0.50                     | 9.84                    | 2229.55                  |

|   |                        |  |                       |
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**Table 15: Installation Design Pressure Table**

| Anchors Allowable Wind Load Capacity (PSF) |   |                    |       |       |       |       |       |
|--|---|--------------------|-------|-------|-------|-------|-------|
| Substrate                                  | Anchor Type                                   | Guard Height (in.) |       |       |       |       |       |
|  |   | 36                 | 39.75 | 42    | 48    | 60    | 72    |
| Wood<br>SG = 0.55 min.                     | 1/2" ASTM F593 Bolt                           | 97.81              | 80.23 | 71.86 | 55.02 | 35.21 | 24.45 |
|  | 3/8" Lag Screw                                | 21.81              | 17.89 | 16.02 | 12.27 | 7.85  | 5.45  |
|  | 1/2" Lag Screw                                | 27.09              | 22.22 | 19.90 | 15.24 | 9.75  | 6.77  |
| Concrete<br>4000 PSI min.                  | 3/8" Dewalt Screw-Bolt+                       | 44.75              | 36.71 | 32.88 | 25.17 | 16.11 | 11.19 |
|  | 1/2" Dewalt Screw-Bolt+                       | 55.69              | 45.67 | 40.91 | 31.32 | 20.05 | 13.92 |
|  | 3/8" ITW RedHead Dynabolt                     | 14.17              | 11.62 | 10.41 | 7.97  | 5.10  | 3.54  |
|  | 1/2" ITW RedHead Dynabolt                     | 20.11              | 16.50 | 14.78 | 11.31 | 7.24  | 5.03  |
|  | 3/8" Hilti HIT-Z Rod with HIT-HY 200 Adhesive | 23.63              | 19.38 | 17.36 | 13.29 | 8.51  | 5.91  |
|  | 1/2" Hilti HIT-Z Rod with HIT-HY 200 Adhesive | 30.48              | 25.00 | 22.39 | 17.14 | 10.97 | 7.62  |
| Steel<br>1/4" Thk. Min.                    | 3/8" HWH Self-Tapping Screw                   | 28.16              | 23.10 | 20.69 | 15.84 | 10.14 | 7.04  |
|  | 1/2" HWH Self-Tapping Screw                   | 37.53              | 30.79 | 27.58 | 21.11 | 13.51 | 9.38  |

\*Note: Common wood species with SG ≥ 0.42 include the following: Spruce Pine Fir, Southern Pine, Mixed Maple, Douglas Fir Larch.

|  |                        |  |                       |
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**Handrail Allowable Span Calculations**

Guard applications require a top rail or handrail. The rail shall have adequate strength to support the live load of 200 lb concentrated or 50 plf distributed load assuming the failure of one glass light at the location of the loading. No US building codes or adopted standards define the limit state of the guard hand rail for this condition. IBC 2407.1.2 states “shall be otherwise supported to remain in place should one baluster fail.” There is no additional explanation in the IBC as to how this is to be determined. ICC Acceptance Criteria 439 was adopted to provide a methodology for determining if a glass balustrade guard meets the requirements of IBC 2407. ICC AC 439 requires the rail to be capable of supporting a 334# load (SF = 1.67 for 200# load) with no more than 12” deflection, yielding or other damage is permitted since the loss of a glass light will necessitate guard repairs. For light failure only the horizontal load case applies for laminated glass.



|  |                        |  |                       |
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**COR-AHS Handrail Allowable Span**



Cap Rail = AH4036  
 Area = 0.7269 in<sup>2</sup>  
 Perim. = 14.3614 in  
 Ixx = 0.1389 in<sup>4</sup>  
 Iyy = 0.2377 in<sup>4</sup>  
 rxx = 0.4371 in  
 ryy = 0.5719 in  
 Cxx = 0.7875 in  
 Cyy = 0.8968 in  
 Sxx = 0.1549 in<sup>3</sup>  
 Syy = 0.3018 in<sup>3</sup>  
 t = 0.071 in  
 w = 0.9449 in

Material = 2205 Stainless Steel  
 Fy = 65 ksi  
 Fu = 90 ksi

$$F_{cr} = \frac{\pi^2 k \eta E_o}{12(1-\mu^2)(w/t)^2}$$

η (Plasticity Reduction Factor) = 0.5 (Table A6a)  
 K (plate buckling coef.) = 3.51 (Section 2)  
 E<sub>o</sub> = 27000 ksi  
 μ (Poisson's Ratio) = 0.3 (Elastic Range)

$$\eta = \sqrt{\frac{E_t}{E_o}}$$

F<sub>cr</sub> = 241.67 ksi

|  |                        |  |                       |
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$$M_n = 1.25S_eF_y$$

$$M_n \text{ Vertical Load} = 12.5843 \text{ k-in}$$

$$M_n \text{ Horizontal Load} = 24.5246 \text{ k-in}$$

$$M_{nult} = S_eF_{cr}$$

$$M_{ULT} \text{ Vertical Load} = 13.9396 \text{ k-in}$$

$$M_{ULT} \text{ Horizontal Load} = 27.1657 \text{ k-in}$$

**Simply Supported Rail**

$$M_w = wL^2/10$$

$$L_{\text{uniform Vert.}} = 137.39 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 191.80 \text{ in}$$

$$M_c = PL/5$$

$$L_{\text{concentrated vert.}} = 188.39 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 367.13 \text{ in}$$

$$\text{Allowable Rail Span} = 137 \text{ in} = 11.42 \text{ ft}$$

**Cantilever Supported Rail**

$$M_{wc} = wL^2/2$$

$$L_{\text{uniform Vert.}} = 61.44 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 85.78 \text{ in}$$

$$M_{cc} = PL$$

$$L_{\text{concentrated vert.}} = 37.68 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 73.43 \text{ in}$$

$$\text{Allowable Rail Span} = 37 \text{ in} = 3.08 \text{ ft}$$

|  |                        |  |                       |
|--|------------------------|--|-----------------------|
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**DRA-AHR42 Handrail Allowable Span**



Cap Rail = AHR42  
 Area = 0.6745 in<sup>2</sup>  
 Perim. = 11.8379 in  
 Ixx = 0.1130 in<sup>4</sup>  
 Iyy = 0.1996 in<sup>4</sup>  
 rxx = 0.4092 in  
 ryy = 0.5439 in  
 Cxx = 0.8347 in  
 Cyy = 0.8254 in  
 Sxx = 0.1369 in<sup>3</sup>  
 Syy = 0.2391 in<sup>3</sup>  
 t = 0.0866 in  
 w = 0.9442 in

Material = 2205 Stainless Steel

Fy = 65 ksi  
 Fu = 90 ksi

$$F_{cr} = \frac{\pi^2 k \eta E_0}{12(1-\mu^2)(w/t)^2}$$

η (Plasticity Reduction Factor) = 0.5 (Table A6a)  
 K (plate buckling coef.) = 4 (Section 2)  
 E<sub>0</sub> = 27000 ksi  
 μ (Poisson's Ratio) = 0.3 (Elastic Range)

$$\eta = \sqrt{\frac{E_t}{E_0}}$$

F<sub>cr</sub> = 410.56 ksi

|  |                        |  |                       |
|--|------------------------|--|-----------------------|
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$$M_n = 1.25S_eF_y$$

$$M_{n \text{ Vertical Load}} = 11.1234 \text{ k-in}$$

$$M_{n \text{ Horizontal Load}} = 19.4291 \text{ k-in}$$

$$M_{nult} = S_eF_{cr}$$

$$M_{ULT \text{ Vertical Load}} = 12.3213 \text{ k-in}$$

$$M_{ULT \text{ Horizontal Load}} = 21.5215 \text{ k-in}$$

**Simply Supported Rail**

$$M_w = wL^2/10$$

$$L_{\text{uniform Vert.}} = 129.17 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 170.72 \text{ in}$$

$$M_c = PL/5$$

$$L_{\text{concentrated vert.}} = 166.52 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 290.86 \text{ in}$$

Allowable Rail Span = 129 in = 10.75 ft

**Cantilever Supported Rail**

$$M_{wc} = wL^2/2$$

$$L_{\text{uniform Vert.}} = 57.77 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 76.35 \text{ in}$$

$$M_{cc} = PL$$

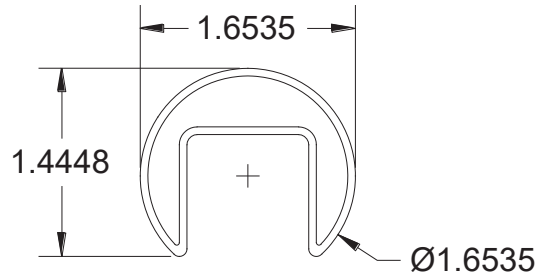
$$L_{\text{concentrated vert.}} = 33.30 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 58.17 \text{ in}$$

Allowable Rail Span = 33 in = 2.75 ft

|  |                        |  |                       |
|--|------------------------|--|-----------------------|
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AGE-SHR42 Handrail Allowable Span



Cap Rail = HR42  
 Area = 0.3905 in<sup>2</sup>  
 Perim. = 13.2204 in  
 Ixx = 0.0668 in<sup>4</sup>  
 Iyy = 0.1178 in<sup>4</sup>  
 rxx = 0.4135 in  
 ryy = 0.5492 in  
 Cxx = 0.8268 in  
 Cyy = 0.7533 in  
 Sxx = 0.0887 in<sup>3</sup>  
 Syy = 0.1425 in<sup>3</sup>  
 t = 0.059055 in  
 w = 0.7224 in

Material = 2205 Stainless Steel

Fy = 65 ksi  
 Fu = 90 ksi

$$F_{cr} = \frac{\pi^2 k \eta E_o}{12(1-\mu^2)(w/t)^2}$$

η (Plasticity Reduction Factor) = 0.62 (Table A6a)  
 K (plate buckling coef.) = 4 (Section 2)  
 E<sub>o</sub> = 29000 ksi  
 μ (Poisson's Ratio) = 0.3 (Elastic Range)

$$\eta = \sqrt{\frac{E_t}{E_o}}$$

F<sub>cr</sub> = 434.40 ksi

|  |                        |  |                       |
|--|------------------------|--|-----------------------|
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$$M_n = 1.25 S_e F_y$$

$$M_n \text{ Vertical Load} = 7.2050 \text{ k-in}$$

$$M_n \text{ Horizontal Load} = 11.5763 \text{ k-in}$$

$$M_{mult} = S_e F_{cr}$$

$$M_{ULT} \text{ Vertical Load} = 38.5208 \text{ k-in}$$

$$M_{ULT} \text{ Horizontal Load} = 61.8915 \text{ k-in}$$

### Simply Supported Rail

$$M_w = wL^2/10$$

$$L_{\text{uniform Vert.}} = 131.50 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 166.68 \text{ in}$$

$$M_c = PL/5$$

$$L_{\text{concentrated vert.}} = 180.12 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 289.41 \text{ in}$$

$$\text{Allowable Rail Span} = 131 \text{ in} = 10.92 \text{ ft}$$

### Cantilever Supported Rail

$$M_{wc} = wL^2/2$$

$$L_{\text{uniform Vert.}} = 58.81 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 74.54 \text{ in}$$

$$M_{cc} = PL$$

$$L_{\text{concentrated vert.}} = 36.02 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 57.88 \text{ in}$$

$$\text{Allowable Rail Span} = 36 \text{ in} = 3.00 \text{ ft}$$

|  |                        |  |                       |
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**MAT-SHS Handrail Allowable Span**



Cap Rail = MH4030S-XS

- Area = 0.4022 in<sup>2</sup>
- Perim. = 13.621 in
- Ixx = 0.0588 in<sup>4</sup>
- Iyy = 0.1302 in<sup>4</sup>
- rxx = 0.3824 in
- ryy = 0.569 in
- Cxx = 0.7874 in
- Cyy = 0.7041 in
- Sxx = 0.0835 in<sup>3</sup>
- Syy = 0.1654 in<sup>3</sup>
- t = 0.0591 in
- w = 0.59055 in

Material = 2205 Stainless Steel

- Fy = 65 ksi
- Fu = 90 ksi

$$F_{cr} = \frac{\pi^2 k \eta E_o}{12(1-\mu^2)(w/t)^2}$$

- η (Plasticity Reduction Factor) = 0.62 (Table A6a)
- K (plate buckling coef.) = 4 (Section 2)
- E<sub>o</sub> = 29000 ksi
- μ (Poisson's Ratio) = 0.3 (Elastic Range)

$$\eta = \sqrt{\frac{E_t}{E_o}}$$

F<sub>cr</sub> = 651.01 ksi

|  |                        |  |                       |
|--|------------------------|--|-----------------------|
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$$M_n = 1.25 S_e F_y$$

$$M_n \text{ Vertical Load} = 6.7853 \text{ k-in}$$

$$M_n \text{ Horizontal Load} = 13.4350 \text{ k-in}$$

$$M_{nult} = S_e F_{cr}$$

$$M_{ULT} \text{ Vertical Load} = 54.3665 \text{ k-in}$$

$$M_{ULT} \text{ Horizontal Load} = 107.6475 \text{ k-in}$$

### Simply Supported Rail

$$M_w = wL^2/10$$

$$L_{\text{uniform Vert.}} = 127.61 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 179.57 \text{ in}$$

$$M_c = PL/5$$

$$L_{\text{concentrated vert.}} = 169.63 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 335.88 \text{ in}$$

|                       |     |      |       |    |
|-----------------------|-----|------|-------|----|
| Allowable Rail Span = | 127 | in = | 10.58 | ft |
|-----------------------|-----|------|-------|----|

### Cantilever Supported Rail

$$M_{wc} = wL^2/2$$

$$L_{\text{uniform Vert.}} = 57.07 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 80.30 \text{ in}$$

$$M_{cc} = PL$$

$$L_{\text{concentrated vert.}} = 33.93 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 67.18 \text{ in}$$

|                       |    |      |      |    |
|-----------------------|----|------|------|----|
| Allowable Rail Span = | 33 | in = | 2.75 | ft |
|-----------------------|----|------|------|----|

|  |                        |  |  |
|--|------------------------|--|--|
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HG25S XS Handrail Allowable Span



Cap Rail = HG25S

- Area = 0.2071 in<sup>2</sup>
- Perim. = 8.7687 in
- Ixx = 0.0143 in<sup>4</sup>
- Iyy = 0.0261 in<sup>4</sup>
- rxx = 0.2629 in
- ryy = 0.3548 in
- Cxx = 0.4921 in
- Cyy = 0.4685 in
- Sxx = 0.0305 in<sup>3</sup>
- Syy = 0.0530 in<sup>3</sup>
- t = 0.0472 in
- w = 0.5906 in

Material = 2205 Stainless Steel

- Fy = 65 ksi
- Fu = 90 ksi

$$F_{cr} = \frac{\pi^2 k \eta E_o}{12(1-\mu^2)(w/t)^2}$$

- η (Plasticity Reduction Factor) = 0.5 (Table A6a)
- K (plate buckling coef.) = 4 (Section 2)
- E<sub>o</sub> = 27000 ksi
- μ (Poisson's Ratio) = 0.3 (Elastic Range)

$$\eta = \sqrt{\frac{E_t}{E_o}}$$

F<sub>cr</sub> = 311.72 ksi

|  |                        |  |                       |
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$$M_n = 1.25S_eF_y$$

$$M_{n \text{ Vertical Load}} = 2.4800 \text{ k-in}$$

$$M_{n \text{ Horizontal Load}} = 4.3093 \text{ k-in}$$

$$M_{mult} = S_eF_{cr}$$

$$M_{ULT \text{ Vertical Load}} = 2.7471 \text{ k-in}$$

$$M_{ULT \text{ Horizontal Load}} = 4.7734 \text{ k-in}$$

**Simply Supported Rail**

$$M_w = wL^2/10$$

$$L_{\text{uniform Vert.}} = 60.99 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 80.40 \text{ in}$$

$$M_c = PL/5$$

$$L_{\text{concentrated vert.}} = 37.13 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 64.51 \text{ in}$$

Allowable Rail Span = 37 in = 3.08 ft

**Cantilever Supported Rail**

$$M_{wc} = wL^2/2$$

$$L_{\text{uniform Vert.}} = 27.28 \text{ in}$$

$$L_{\text{uniform Horiz.}} = 35.96 \text{ in}$$

$$M_{cc} = PL$$

$$L_{\text{concentrated vert.}} = 7.43 \text{ in}$$

$$L_{\text{concentrated horiz.}} = 12.90 \text{ in}$$

Allowable Rail Span = 7 in = 0.58 ft

|  |                        |  |                       |
|--|------------------------|--|-----------------------|
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# APPENDIX

|  |                        |  |                       |
|--|------------------------|--|-----------------------|
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Wind Loads on Fences or Guards

$p = q_h(GC_p) = q_zGC_f$  (ASCE 7-10 eq. 7-16)  
 $G = 0.85$  from (section 26.9.4.)  
 $C_f = 2.5 * 0.8 * 0.6 = 1.2$  (Figure 29.4-1) with reduction for solid and end returns, will vary.  
 $q_h = 0.00256K_zK_{zt}K_dV^2$  Where:  
 $K_z$  from (Table 29.3-1) at the height  $z$  of the railing centroid and exposure.  
 $K_d = 0.85$  from (Table 26-6).  
 $K_{zt}$  From (Figure 26.8-1) for the site topography, typically 1.0.  
 $V =$  Wind speed (mph) 3 second gust, (Figure 26.5-1A) or per local authority.  
 Simplifying - Assuming  $1.3 \leq C_f \leq 2.6$  (Typical limits for fence or guard with returns.)  
 Adjustment for full height solid:  $f = 1.8 - 1 = 0.8$   
 Adjustment to Allowable Stress Design:  $w_{asd} = 0.6w_{strength}$   
 For  $C_f = 1.3$ :  $F = q_h * 0.85 * 1.3 * 0.8 * 0.6 = 0.53 q_h$   
 For  $C_f = 2.6$ :  $F = q_h * 0.85 * 2.6 * 0.8 * 0.6 = 1.06 q_h$

|          |      |      |      |
|----------|------|------|------|
| Exposure | B    | C    | D    |
| $K_z =$  | 0.70 | 0.85 | 1.03 |

Centroid of wind load acts at 0.55h on the fence.  
 $w_{asd} = 0.53 * 0.00256 * K_z * V^2$  or  $w_{asd} = 1.06 * 0.00256 * K_z * V^2$

| Wind Loads (PSF) |                           |                     |                     |                           |                     |                     |
|------------------|---------------------------|---------------------|---------------------|---------------------------|---------------------|---------------------|
| Wind Speed (mph) | $W_{ASD}$ for $C_f = 1.3$ |                     |                     | $W_{ASD}$ for $C_f = 2.6$ |                     |                     |
|                  | Exp. B $K_z = 0.7$        | Exp. C $K_z = 0.85$ | Exp. D $K_z = 1.03$ | Exp. B $K_z = 0.7$        | Exp. C $K_z = 0.85$ | Exp. D $K_z = 1.03$ |
| 100              | 9.50                      | 11.53               | 13.98               | 19.00                     | 23.07               | 27.95               |
| 110              | 11.49                     | 13.95               | 16.91               | 22.98                     | 27.91               | 33.82               |
| 120              | 13.68                     | 16.61               | 20.12               | 27.35                     | 33.21               | 40.25               |
| 130              | 16.05                     | 19.49               | 23.62               | 32.10                     | 38.98               | 47.24               |
| 140              | 18.62                     | 22.60               | 27.39               | 37.23                     | 45.21               | 54.78               |
| 150              | 21.37                     | 25.95               | 31.44               | 42.74                     | 51.90               | 62.89               |
| 160              | 24.31                     | 29.52               | 35.78               | 48.63                     | 59.05               | 71.55               |
| 170              | 27.45                     | 33.33               | 40.39               | 54.90                     | 66.66               | 80.78               |
| 180              | 30.77                     | 37.37               | 45.28               | 61.54                     | 74.73               | 90.56               |

|   |                        |  |                       |
|---|------------------------|--|-----------------------|
| Project Description:<br>Glass Warehouse LLC / Future Glass RAN-CHRES Base Shoe Engineering Analysis | Date: January 30, 2025 | Customer: Glass Warehouse LLC / Future Glass |                       |
|   | Engineer: SH           | Project #: EEV-24-0207                       |                       |
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**7/16" Laminated Glass Capacity**

$$\begin{aligned}
 h_1 &= 0.180 \text{ in} \\
 h_2 &= 0.180 \text{ in} \\
 h_v &= 0.060 \text{ in} \\
 h_s &= 0.5(h_1+h_2)+h_v \\
 h_s &= 0.240 \text{ in} \\
 h_{s,1} &= h_{s,2} = (h_s h_1)/(h_1+h_2) \\
 h_{s,1} &= 0.120 \text{ in} \\
 h_{s,2} &= 0.120 \text{ in} \\
 I_s &= h_1 h_{s,2}^2 + h_2 h_{s,1}^2 \\
 I_s &= 0.0052
 \end{aligned}$$

| Shortest Dimension (a) (in) | $\Gamma$ PVB | $\Gamma$ PVB ES | $\Gamma$ SGP | $h_{ef,w}$ PVB | $h_{ef,w}$ PVB ES | $h_{ef,w}$ SGP | $h_{1,ef,o}$ PVB | $h_{1,ef,o}$ PVB ES | $h_{1,ef,o}$ SGP |
|-----------------------------|--------------|-----------------|--------------|----------------|-------------------|----------------|------------------|---------------------|------------------|
| 12                          | 0.018        | 0.062           | 0.304        | 0.234          | 0.249             | 0.313          | 0.264            | 0.282               | 0.348            |
| 24                          | 0.070        | 0.208           | 0.636        | 0.252          | 0.291             | 0.371          | 0.285            | 0.327               | 0.392            |
| 36                          | 0.144        | 0.372           | 0.798        | 0.274          | 0.327             | 0.394          | 0.310            | 0.360               | 0.406            |
| 39.75                       | 0.170        | 0.419           | 0.828        | 0.281          | 0.335             | 0.398          | 0.317            | 0.367               | 0.408            |
| 42                          | 0.186        | 0.447           | 0.843        | 0.285          | 0.340             | 0.400          | 0.322            | 0.371               | 0.409            |
| 48                          | 0.230        | 0.513           | 0.875        | 0.296          | 0.352             | 0.404          | 0.332            | 0.379               | 0.412            |
| 60                          | 0.319        | 0.622           | 0.916        | 0.316          | 0.369             | 0.409          | 0.350            | 0.391               | 0.414            |
| 72                          | 0.402        | 0.703           | 0.940        | 0.332          | 0.381             | 0.412          | 0.364            | 0.399               | 0.416            |

$$\begin{aligned}
 \Gamma &= 1/[1+9.6(EI_s h_v)/(Gh^2 a^2)] \\
 \text{effective thickness for deflection:} \\
 h_{ef,w} &= (h_1^3 + h_2^3 + 12\Gamma I_s)^{1/3} \\
 \text{effective thickness for glass stress:} \\
 h_{1,ef,o} &= [h_{ef,w}^3/(h+2\Gamma h_{s,1})]^{1/2}
 \end{aligned}$$

| Shortest Dimension (a) (in) | All. Wind Moment (lb-ft) PVB | All. Wind Moment (lb-ft) PVB ES | All. Wind Moment (lb-ft) SGP | All. LL Moment (lb-in/ft) PVB | All. LL Moment (lb-in/ft) PVB ES | All. LL Moment (lb-in/ft) SGP |
|-----------------------------|------------------------------|---------------------------------|------------------------------|-------------------------------|----------------------------------|-------------------------------|
| 12                          | 123                          | 141                             | 214                          | 833                           | 955                              | 1451                          |
| 24                          | 144                          | 189                             | 272                          | 976                           | 1285                             | 1849                          |
| 36                          | 170                          | 228                             | 291                          | 1153                          | 1551                             | 1980                          |
| 39.75                       | 178                          | 238                             | 295                          | 1209                          | 1614                             | 2001                          |
| 42                          | 183                          | 243                             | 296                          | 1242                          | 1648                             | 2012                          |
| 48                          | 195                          | 254                             | 299                          | 1326                          | 1725                             | 2034                          |
| 60                          | 217                          | 270                             | 303                          | 1473                          | 1835                             | 2060                          |
| 72                          | 234                          | 281                             | 306                          | 1592                          | 1907                             | 2075                          |

$$\begin{aligned}
 M_{GL} &= 6,000\text{psi} \cdot 2 \cdot h_{1,ef,o}^2 = 12,000 h_{1,ef,o}^2 \text{ ''/ft} = 1,000 h_{1,ef,o}^2 \text{ ''/ft} \text{ For Live Loads} \\
 M_{LW} &= 9,600\text{psi} \cdot 2 \cdot h_{1,ef,o}^2 \text{ For Wind Loads}
 \end{aligned}$$

**Glass Panel Loads**  
 From IBC 1607.7.1

| Light Width (in) | Max. Panel Height Live Loads (in.) |               |            |            |               |            |
|------------------|------------------------------------|---------------|------------|------------|---------------|------------|
|                  | 50 plf PVB                         | 50 plf PVB ES | 50 plf SGP | 200 lb PVB | 200 lb PVB ES | 200 lb SGP |
| 12               | 16.67                              | 19.10         | 29.02      | 33.33      | 38.21         | 58.05      |
| 24               | 19.51                              | 25.70         | 36.97      | 78.05      | 102.80        | 147.88     |
| 36               | 23.07                              | 31.02         | 39.60      | 138.41     | 186.15        | 237.58     |
| 39.75            | 24.18                              | 32.29         | 40.03      | 160.21     | 213.90        | 265.19     |
| 42               | 24.84                              | 32.96         | 40.24      | 173.86     | 230.74        | 281.68     |
| 48               | 26.51                              | 34.50         | 40.68      | 212.09     | 276.03        | 325.40     |
| 60               | 29.46                              | 36.71         | 41.21      | 294.60     | 367.06        | 412.08     |
| 72               | 31.84                              | 38.13         | 41.51      | 382.09     | 457.57        | 498.08     |

For 50 plf distributed load:  
 $h = (M_L/h) = M_L/50\text{plf}$

For 200# load, not top rail:  
 $h = M_L \cdot S/200\#$  where S = light length in feet when installed with cap rail  
 For installation without a cap rail and load at corner of glass:  
 $h = M_L \cdot (2/3 \cdot S)/200\#$  where S ≤ h

|   |                        |  |  |
|---|------------------------|--|--|
| Project Description:<br>Glass Warehouse LLC / Future Glass RAN-CHRES Base Shoe Engineering Analysis | Date: January 30, 2025 | Customer: Glass Warehouse LLC / Future Glass |  |
|   | Engineer: SH           | Project #: EEV-24-0207                       |  |
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**9/16" Laminated Glass Capacity**

$$\begin{aligned}
 h_1 &= 0.219 \text{ in} \\
 h_2 &= 0.219 \text{ in} \\
 h_v &= 0.060 \text{ in} \\
 h_s &= 0.5(h_1+h_2)+h_v \\
 h_s &= 0.279 \text{ in} \\
 h_{s,1} &= h_{s,2} = (h_s h_1)/(h_1+h_2) \\
 h_{s,1} &= 0.140 \text{ in} \\
 h_{s,2} &= 0.140 \text{ in} \\
 I_s &= h_1 h_{s,2}^2 + h_2 h_{s,1}^2 \\
 I_s &= 0.0085
 \end{aligned}$$

| Shortest Dimension (a) (in) | $\Gamma$ PVB | $\Gamma$ PVB ES | $\Gamma$ SGP | $h_{eTW}$ PVB | $h_{eTW}$ PVB ES | $h_{eTW}$ SGP | $h_{1,2\sigma}$ PVB | $h_{1,2\sigma}$ PVB ES | $h_{1,2\sigma}$ SGP |
|-----------------------------|--------------|-----------------|--------------|---------------|------------------|---------------|---------------------|------------------------|---------------------|
| 12                          | 0.015        | 0.051           | 0.265        | 0.283         | 0.297            | 0.364         | 0.318               | 0.335                  | 0.405               |
| 24                          | 0.058        | 0.178           | 0.590        | 0.300         | 0.340            | 0.433         | 0.338               | 0.382                  | 0.461               |
| 36                          | 0.121        | 0.328           | 0.764        | 0.322         | 0.379            | 0.463         | 0.364               | 0.419                  | 0.479               |
| 39.75                       | 0.144        | 0.373           | 0.798        | 0.329         | 0.390            | 0.468         | 0.371               | 0.428                  | 0.482               |
| 42                          | 0.158        | 0.399           | 0.815        | 0.334         | 0.395            | 0.471         | 0.376               | 0.433                  | 0.484               |
| 48                          | 0.197        | 0.464           | 0.852        | 0.345         | 0.409            | 0.476         | 0.388               | 0.443                  | 0.487               |
| 60                          | 0.278        | 0.575           | 0.900        | 0.367         | 0.431            | 0.484         | 0.408               | 0.459                  | 0.490               |
| 72                          | 0.356        | 0.661           | 0.928        | 0.386         | 0.446            | 0.488         | 0.425               | 0.469                  | 0.493               |

$\Gamma = 1/[1+9.6(EL_h)/(Gh^2a^2)]$   
 effective thickness for deflection:  
 $h_{eTW} = (h_1^3 + h_2^3 + 12\Gamma I_s)^{1/3}$   
 effective thickness for glass stress:  
 $h_{1,2\sigma} = [h_{eTW}^3/(h+2\Gamma h_{s,1})]^{1/2}$

| Shortest Dimension (a) (in) | All. Wind Moment (lb-ft) PVB | All. Wind Moment (lb-ft) PVB ES | All. Wind Moment (lb-ft) SGP | All. LL Moment (lb-in/ft) PVB | All. LL Moment (lb-in/ft) PVB ES | All. LL Moment (lb-in/ft) SGP |
|-----------------------------|------------------------------|---------------------------------|------------------------------|-------------------------------|----------------------------------|-------------------------------|
| 12                          | 179                          | 199                             | 290                          | 1213                          | 1351                             | 1970                          |
| 24                          | 202                          | 258                             | 375                          | 1374                          | 1751                             | 2545                          |
| 36                          | 234                          | 310                             | 405                          | 1586                          | 2107                             | 2753                          |
| 39.75                       | 244                          | 323                             | 411                          | 1655                          | 2197                             | 2788                          |
| 42                          | 250                          | 331                             | 413                          | 1697                          | 2245                             | 2806                          |
| 48                          | 266                          | 347                             | 418                          | 1804                          | 2358                             | 2842                          |
| 60                          | 294                          | 372                             | 425                          | 2000                          | 2525                             | 2886                          |
| 72                          | 319                          | 388                             | 429                          | 2165                          | 2636                             | 2911                          |

$M_d = 6,000\text{psi} \cdot 2 \cdot h_{1,2\sigma}^2 = 12,000 h_{1,2\sigma}^2$  #/ft =  $1,000 h_{1,2\sigma}^2$  #/ft For Live Loads  
 $M_{dW} = 9,600\text{psi} \cdot 2 \cdot h_{1,2\sigma}^2$  For Wind Loads

**Glass Panel Loads**  
 From IBC 1607.7.1

| Light Width (in) | Max. Panel Height Live Loads (in.) |               |            |            |               |            |
|------------------|------------------------------------|---------------|------------|------------|---------------|------------|
|                  | 50 plf PVB                         | 50 plf PVB ES | 50 plf SGP | 200 lb PVB | 200 lb PVB ES | 200 lb SGP |
| 12               | 24.25                              | 27.01         | 39.40      | 48.50      | 54.02         | 78.80      |
| 24               | 27.48                              | 35.03         | 50.90      | 109.94     | 140.11        | 203.59     |
| 36               | 31.73                              | 42.15         | 55.07      | 190.37     | 252.90        | 330.39     |
| 39.75            | 33.11                              | 43.93         | 55.77      | 219.34     | 291.06        | 369.47     |
| 42               | 33.93                              | 44.90         | 56.11      | 237.52     | 314.33        | 392.80     |
| 48               | 36.07                              | 47.16         | 56.83      | 288.58     | 377.28        | 454.67     |
| 60               | 39.99                              | 50.49         | 57.72      | 399.91     | 504.90        | 577.20     |
| 72               | 43.30                              | 52.72         | 58.22      | 519.58     | 632.59        | 698.66     |

For 50 plf distributed load:  
 $h = (M_d/u) = M_d/50\text{plf}$

For 200# load, not top rail:  
 $h = M_d \cdot S/200\#$  where S = light length in feet when installed with cap rail  
 For installation without a cap rail and load at corner of glass:  
 $h = M_d \cdot (2/3 \cdot S)/200\#$  where S ≤ h

|   |                        |  |  |
|---|------------------------|--|--|
| Project Description:<br>Glass Warehouse LLC / Future Glass RAN-CHRES Base Shoe Engineering Analysis | Date: January 30, 2025 | Customer: Glass Warehouse LLC / Future Glass |  |
|   | Engineer: SH           | Project #: EEV-24-0207                       |  |
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**1 1/16" Laminated Glass Capacity**

$$\begin{aligned}
 h_1 &= 0.292 \text{ in} \\
 h_2 &= 0.292 \text{ in} \\
 h_v &= 0.060 \text{ in} \\
 h_s &= 0.5(h_1+h_2)+h_v \\
 h_s &= 0.352 \text{ in} \\
 h_{s,1} = h_{s,2} &= (h_s h_1)/(h_1+h_2) \\
 h_{s,1} &= 0.176 \text{ in} \\
 h_{s,2} &= 0.176 \text{ in} \\
 I_s &= h_1 h_{s,2}^2 + h_2 h_{s,1}^2 \\
 I_s &= 0.0181
 \end{aligned}$$

| Shortest Dimension (a) (in) | $\Gamma$ PVB | $\Gamma$ PVB ES | $\Gamma$ SGP | $h_{def,W}$ PVB | $h_{def,W}$ PVB ES | $h_{def,W}$ SGP | $h_{1,def,\sigma}$ PVB | $h_{1,def,\sigma}$ PVB ES | $h_{1,def,\sigma}$ SGP |
|-----------------------------|--------------|-----------------|--------------|-----------------|--------------------|-----------------|------------------------|---------------------------|------------------------|
| 12                          | 0.011        | 0.039           | 0.212        | 0.374           | 0.388              | 0.458           | 0.420                  | 0.437                     | 0.511                  |
| 24                          | 0.044        | 0.140           | 0.519        | 0.390           | 0.431              | 0.546           | 0.439                  | 0.485                     | 0.585                  |
| 36                          | 0.094        | 0.268           | 0.708        | 0.413           | 0.476              | 0.588           | 0.465                  | 0.529                     | 0.613                  |
| 39.75                       | 0.112        | 0.308           | 0.748        | 0.420           | 0.489              | 0.596           | 0.473                  | 0.540                     | 0.618                  |
| 42                          | 0.124        | 0.332           | 0.768        | 0.425           | 0.496              | 0.600           | 0.478                  | 0.546                     | 0.620                  |
| 48                          | 0.156        | 0.394           | 0.812        | 0.437           | 0.513              | 0.609           | 0.491                  | 0.560                     | 0.625                  |
| 60                          | 0.224        | 0.504           | 0.871        | 0.462           | 0.542              | 0.620           | 0.515                  | 0.582                     | 0.632                  |
| 72                          | 0.293        | 0.594           | 0.907        | 0.484           | 0.563              | 0.627           | 0.536                  | 0.597                     | 0.635                  |

$\Gamma = 1/[1+9.6(EI_h h_v)/(Gh^3 a^2)]$   
effective thickness for deflection:  
 $h_{def,W} = (h_1^3 + h_2^3 + 12\Gamma I_s)^{1/3}$   
effective thickness for glass stress:  
 $h_{1,def,\sigma} = [h_{def,W}^3/(h+2\Gamma h_{s,1})]^{1/2}$

| Shortest Dimension (a) (in) | All. Wind Moment (lb-ft) PVB | All. Wind Moment (lb-ft) PVB ES | All. Wind Moment (lb-ft) SGP | All. LL Moment (lb-in/ft) PVB | All. LL Moment (lb-in/ft) PVB ES | All. LL Moment (lb-in/ft) SGP |
|-----------------------------|------------------------------|---------------------------------|------------------------------|-------------------------------|----------------------------------|-------------------------------|
| 12                          | 312                          | 337                             | 462                          | 2119                          | 2287                             | 3138                          |
| 24                          | 341                          | 415                             | 605                          | 2316                          | 2818                             | 4107                          |
| 36                          | 381                          | 494                             | 664                          | 2591                          | 3352                             | 4512                          |
| 39.75                       | 395                          | 515                             | 675                          | 2685                          | 3497                             | 4584                          |
| 42                          | 404                          | 527                             | 680                          | 2741                          | 3577                             | 4620                          |
| 48                          | 426                          | 555                             | 691                          | 2892                          | 3770                             | 4695                          |
| 60                          | 469                          | 599                             | 705                          | 3183                          | 4069                             | 4788                          |
| 72                          | 507                          | 630                             | 713                          | 3445                          | 4280                             | 4842                          |

$M_{dL} = 6,000\text{psi} \cdot 2 \cdot h_{1,def,\sigma}^2 = 12,000 h_{1,def,\sigma}^2 \text{ } \#/\text{ft} = 1,000 h_{1,def,\sigma}^2 \text{ } \#/\text{ft}$  For Live Loads  
 $M_{dW} = 9,600\text{psi} \cdot 2 \cdot h_{1,def,\sigma}^2$  For Wind Loads

**Glass Panel Loads**  
From IBC 1607.7.1

| Light Width (in) | Max. Panel Height Live Loads (in.) |               |            |            |               |            |
|------------------|------------------------------------|---------------|------------|------------|---------------|------------|
|                  | 50 plf PVB                         | 50 plf PVB ES | 50 plf SGP | 200 lb PVB | 200 lb PVB ES | 200 lb SGP |
| 12               | 42.38                              | 45.74         | 62.76      | 84.76      | 91.47         | 125.53     |
| 24               | 46.33                              | 56.36         | 82.14      | 185.31     | 225.44        | 328.57     |
| 36               | 51.82                              | 67.04         | 90.25      | 310.94     | 402.26        | 541.49     |
| 39.75            | 53.69                              | 69.93         | 91.68      | 355.70     | 463.30        | 607.40     |
| 42               | 54.82                              | 71.54         | 92.40      | 383.77     | 500.79        | 646.77     |
| 48               | 57.85                              | 75.39         | 93.89      | 462.79     | 603.16        | 751.15     |
| 60               | 63.67                              | 81.38         | 95.77      | 636.69     | 813.82        | 957.70     |
| 72               | 68.89                              | 85.60         | 96.85      | 826.72     | 1027.16       | 1162.15    |

For 50 plf distributed load:  
 $h = (M_{dL}/w) = M_{dL}/50\text{plf}$

For 200# load, not top rail:  
 $h = M_{dL} \cdot S / 200\#$  where S = light length in feet when installed with cap rail  
For installation without a cap rail and load at corner of glass:  
 $h = M_{dL} \cdot (2/3 \cdot S) / 200\#$  where S ≤ h

|   |                        |  |  |
|---|------------------------|--|--|
| Project Description:<br>Glass Warehouse LLC / Future Glass RAN-CHRES Base Shoe Engineering Analysis | Date: January 30, 2025 | Customer: Glass Warehouse LLC / Future Glass |  |
|   | Engineer: SH           | Project #: EEV-24-0207                       |  |
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