

CHAPTER 24

GLASS AND GLAZING

SECTION 2401 GENERAL

2401.1 Scope. The provisions of this chapter shall govern the materials, design, construction and quality of glass, light-transmitting ceramic and light-transmitting plastic panels for exterior and interior use in both vertical and sloped applications in buildings and structures.

2401.2 Glazing replacement. The installation of replacement glass shall be as required for new installations.

SECTION 2402 DEFINITIONS

2402.1 Definitions. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

DALLE GLASS. A decorative composite glazing material made of individual pieces of glass that are embedded in a cast matrix of concrete or epoxy.

DECORATIVE GLASS. A carved, leaded or Dalle glass or glazing material whose purpose is decorative or artistic, not functional; whose coloring, texture or other design qualities or components cannot be removed without destroying the glazing material and whose surface, or assembly into which it is incorporated, is divided into segments.

SECTION 2403 GENERAL REQUIREMENTS FOR GLASS

2403.1 Identification. Each pane shall bear the manufacturer's label designating the type and thickness of the glass or glazing material. The identification shall not be omitted unless approved and an affidavit is furnished by the glazing contractor certifying that each light is glazed in accordance with approved construction documents that comply with the provisions of this chapter. Safety glazing shall be identified in accordance with Section 2406.2.

Each pane of tempered glass, except tempered spandrel glass, shall be permanently identified by the manufacturer. The identification label shall be acid etched, sand blasted, ceramic fired, embossed or shall be of a type that once applied cannot be removed without being destroyed.

Tempered spandrel glass shall be provided with a removable paper marking by the manufacturer.

2403.2 Glass supports. Where one or more sides of any pane of glass are not firmly supported, or are subjected to unusual load conditions, detailed construction documents, detailed shop drawings and analysis or test data assuring safe performance for the specific installation shall be prepared by a registered design professional.

2403.3 Framing. To be considered firmly supported, the framing members for each individual pane of glass shall be designed

so the deflection of the edge of the glass perpendicular to the glass pane shall not exceed $1/175$ of the glass edge length or $3/4$ inch (19.1 mm), whichever is less, when subjected to the larger of the positive or negative load where loads are combined as specified in Section 1605.

2403.4 Interior glazed areas. Where interior glazing is installed adjacent to a walking surface, the differential deflection of two adjacent unsupported edges shall not be greater than the thickness of the panels when a force of 50 pounds per linear foot (plf) (730 N/m) is applied horizontally to one panel at any point up to 42 inches (1067 mm) above the walking surface.

2403.5 Louvered windows or jalousies. Float, wired and patterned glass in louvered windows and jalousies shall be no thinner than nominal $3/16$ inch (4.8 mm) and no longer than 48 inches (1219 mm). Exposed glass edges shall be smooth.

Wired glass with wire exposed on longitudinal edges shall not be used in louvered windows or jalousies.

Where other glass types are used, the design shall be submitted to the building official for approval.

SECTION 2404 WIND, SNOW, SEISMIC AND DEAD LOADS ON GLASS

2404.1 Vertical glass. Glass sloped 15 degrees (0.26 rad) or less from vertical in windows, curtain and window walls, doors and other exterior applications shall be designed to resist the wind loads in Section 1609 for components and cladding. Glass in glazed curtain walls, glazed storefronts and glazed partitions shall meet the seismic requirements of ASCE 7, Section 9.6.2.10. Glazing firmly supported on all four edges is permitted to be designed by the following provisions. Where the glass is not firmly supported on all four edges, analysis or test data ensuring safe performance for the specific installation shall be prepared by a registered design professional.

The design of vertical glazing shall be based on the following equation:

$$F_{gw} \leq F_{ga} \quad \text{(Equation 24-1)}$$

where:

F_{gw} is the wind load on the glass computed in accordance with Section 1609 and F_{ga} is the maximum allowable load on the glass computed by the following formula:

$$F_{ga} = c_1 F_{ge} \quad \text{(Equation 24-2)}$$

where:

F_{ge} = Maximum allowable equivalent load, pounds per square foot (psf) (kN/m²) determined from Figures 2404(1) through 2404(12) for the applicable glass dimensions and thickness.

c_1 = Factor determined from Table 2404.1 based on glass type.

TABLE 2404.1
c₁ FACTORS FOR VERTICAL AND SLOPED GLASS^a
[For use with Figures 2404(1) through 2404(12)]

GLASS TYPE	FACTOR
Single Glass	
Regular (annealed)	1.0
Heat strengthened	2.0
Fully tempered	4.0
Wired	0.50
Patterned ^c	1.0
Sandblasted ^d	0.50
Laminated—regular plies ^e	0.7/0.90 ^f
Laminated—heat-strengthened plies ^e	1.5/1.8 ^f
Laminated—fully tempered plies ^e	3.0/3.6 ^f
Insulating Glass^b	
Regular (annealed)	1.8
Heat strengthened	3.6
Fully tempered	7.2
Laminated—regular plies ^e	1.4/1.6 ^f
Laminated—heat-strengthened plies ^e	2.7/3.2 ^f
Laminated—fully tempered plies ^e	5.4/6.5 ^f

- a. Either Table 2404.1 or 2404.2 shall be appropriate for sloped glass depending on whether the snow or wind load is dominant (see Section 2404.2). For glass types (vertical or sloped) not included in the tables, refer to ASTM E 1300 for guidance.
- b. Values apply for insulating glass with identical panes.
- c. The value for patterned glass is based on the thinnest part of the pattern; interpolation between graphs is permitted.
- d. The value for sandblasted glass is for moderate levels of sandblasting.
- e. Values for laminated glass are based on the total thickness of the glass and apply for glass with two equal glass ply thicknesses.
- f. The lower value applies if, for any laminated glass pane, either the ratio of the long to short dimension is greater than 2.0 or the lesser dimension divided by the thickness of the pane is 150 or less; the higher value applies in all other cases.

2404.2 Sloped glass. Glass sloped more than 15 degrees (0.26 rad) from vertical in skylights, sunrooms, sloped roofs and other exterior applications shall be designed to resist the most critical of the following combinations of loads.

$$F_g = W_o - D \quad \text{(Equation 24-3)}$$

$$F_g = W_i + D + 0.5 S \quad \text{(Equation 24-4)}$$

$$F_g = 0.5 W_i + D + S \quad \text{(Equation 24-5)}$$

where:

D = Glass dead load (psf)
For glass sloped 30 degrees (0.52 rad) or less from horizontal,

$$D = 13 t_g \quad \text{(For SI: } 0.0245 t_g \text{)}$$

For glass sloped more than 30 degrees (0.52 rad) from horizontal,

$$D = 13 t_g \cos \theta \quad \text{(For SI: } 0.0245 t_g \cos \theta \text{)}$$

F_g = Total load, psf (kN/m²) on glass.

S = Snow load, psf (kN/m²) as determined in Section 1608.

t_g = Total glass thickness, inches (mm) of glass panes and plies.

W_i = Inward wind force, psf (kN/m²) as calculated in Section 1609.

W_o = Outward wind force, psf (kN/m²) as calculated in Section 1609.

θ = Angle of slope from horizontal.

Exception: Unit skylights shall be designed in accordance with Section 2405.5.

The design of sloped glazing shall be based on the following equation:

$$F_g \leq F_{ga} \quad \text{(Equation 24-6)}$$

where F_g is the maximum load on the glass determined from Equations 24-3 through 24-5, and F_{ga} is the maximum allowable load on the glass.

If F_g is determined by Equation 24-3 or 24-4 above, F_{ga} shall be computed as for vertical glazing in Section 2404.1. If F_g is determined by Equation 24-5 above, F_{ga} shall be computed by the following equation:

$$F_{ga} = c_2 F_{ge} \quad \text{(Equation 24-7)}$$

where:

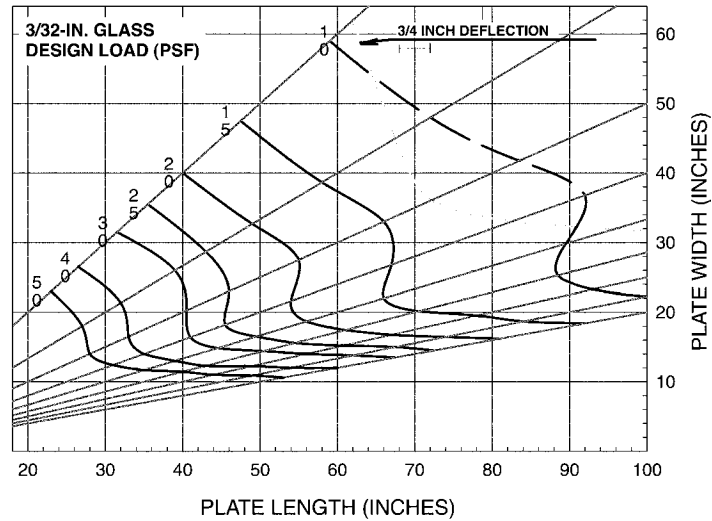
F_{ge} = Maximum allowable equivalent load (psf) determined from Figures 2404(1) through 2404(12) for the applicable glass dimensions and thickness.

c_2 = Factor determined from Table 2404.2 based on glass type.

TABLE 2404.2
c₂ FACTORS FOR SLOPED GLASS^a
[For use with Figures 2404(1) through 2404(12)]

GLASS TYPE	FACTOR
Single Glass	
Regular (annealed)	0.6
Heat strengthened	1.6
Fully tempered	3.6
Wired	0.3
Patterned ^c	0.6
Laminated — regular plies ^d	0.3/0.45 ^e
Laminated — heat-strengthened plies ^d	0.8/1.2 ^e
Laminated — fully tempered plies ^d	1.8/2.7 ^e
Insulating Glass^b	
Regular (annealed)	1.1
Heat strengthened	2.9
Fully tempered	6.5
Laminated — regular plies ^d	0.54/0.81 ^e
Laminated — heat-strengthened plies ^d	1.4/2.2 ^e
Laminated — fully tempered plies ^d	3.3/4.9 ^e

- a. Either Table 2404.1 or 2404.2 shall be appropriate for sloped glass depending on whether the snow or wind load is dominant (see Section 2404.2). For glass types (vertical or sloped) not included in the tables, refer to ASTM E 1300 for guidance.
- b. Values apply for insulating glass with identical panes.
- c. The value for patterned glass is based on the thinnest part of the pattern; interpolation between graphs is permitted.
- d. Values for laminated glass are based on the total thickness of the glass and apply for glass with two equal glass ply thicknesses.
- e. The lower value applies where, for any laminated glass pane, either the ratio of the long to short dimension is greater than 2.0 or the lesser dimension divided by the thickness of the pane is 150 or less. The higher value applies in all other cases.

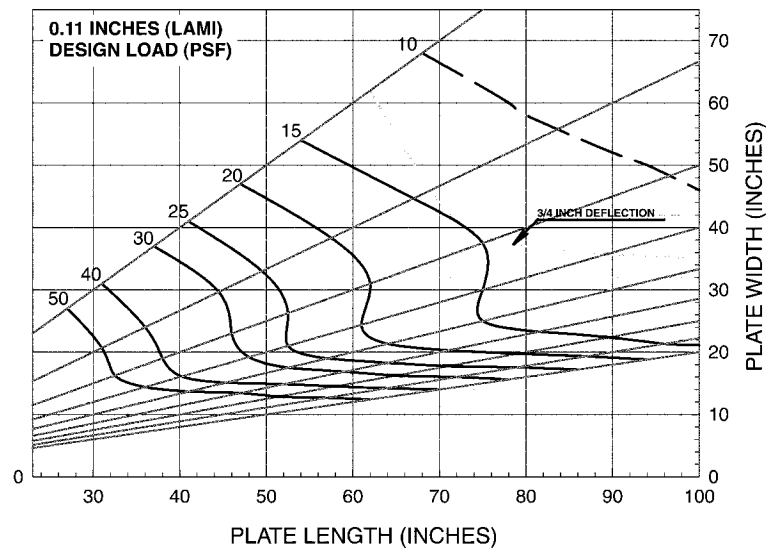


For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

FIGURE 2404(1)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of $3/4$ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

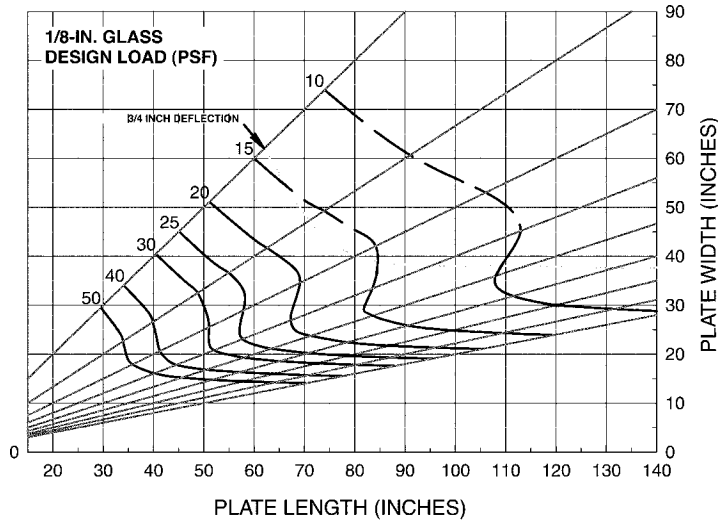


For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

FIGURE 2404(2)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of $3/4$ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

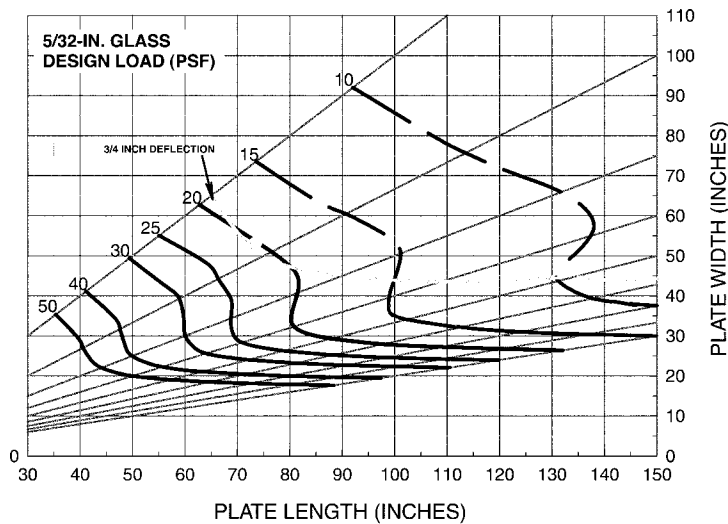


For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

**FIGURE 2404(3)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES**

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of $\frac{3}{4}$ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

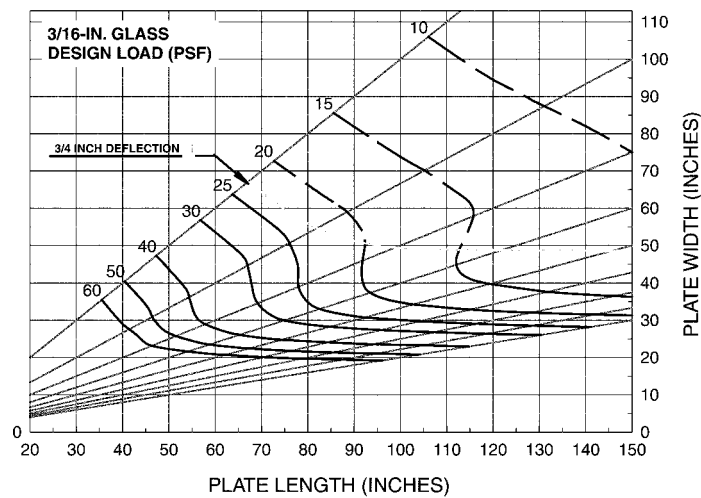


For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

**FIGURE 2404(4)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES**

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of $\frac{3}{4}$ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

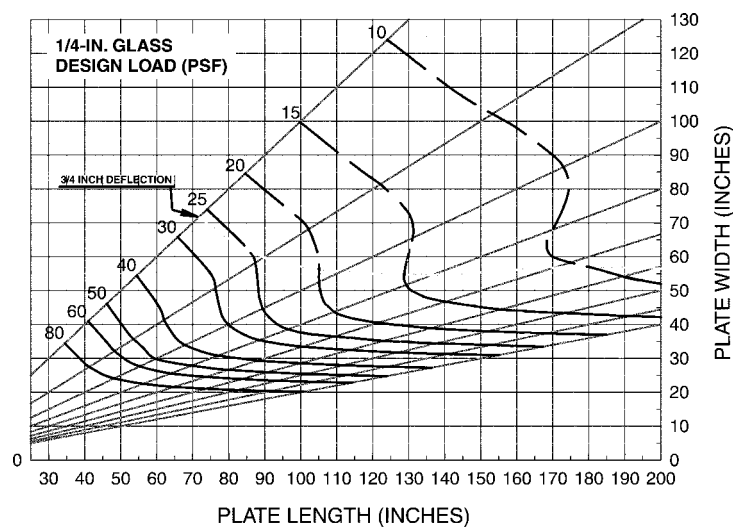


For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

FIGURE 2404(5)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of ³/₄ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

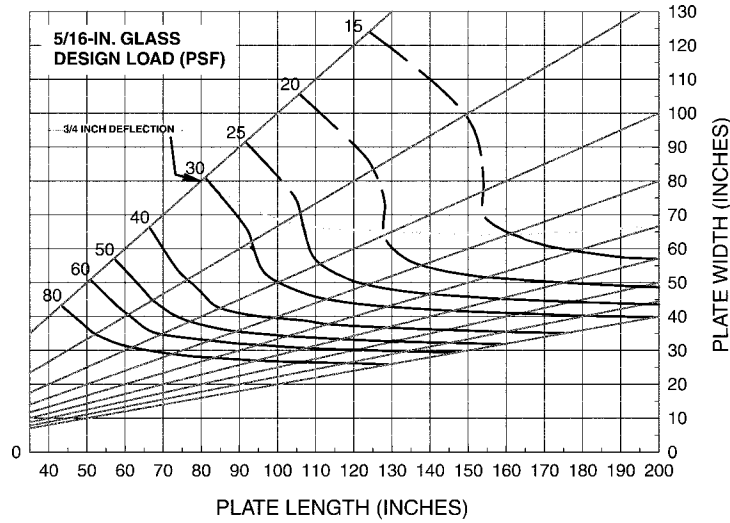


For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

FIGURE 2404(6)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of ³/₄ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.

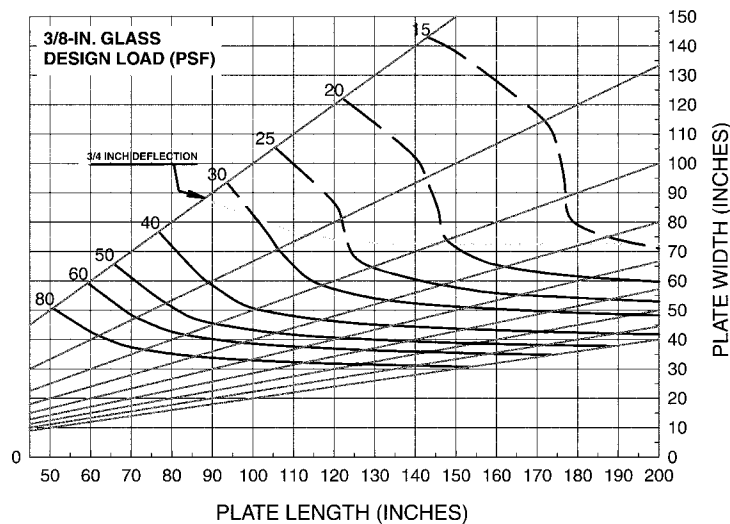


For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

FIGURE 2404(7)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of $\frac{3}{4}$ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.



For SI: 1 inch = 25.4 mm, 1 pound per square foot = 0.0479 kPa.

FIGURE 2404(8)^{a, b, c, d, e, f}
MAXIMUM ALLOWABLE LOAD FOR VERTICAL AND SLOPED
RECTANGULAR GLASS SUPPORTED ON ALL EDGES

NOTES:

- a. In each graph, the vertical axis is the lesser dimension; the horizontal axis is the greater dimension.
- b. The diagonal number on each graph shows the equivalent design load in psf.
- c. The dashed lines indicate glass that has deflection in excess of $\frac{3}{4}$ inch.
- d. Interpolation between lines is permitted. Extrapolation is not allowed.
- e. For laminated glass, the applicable glass thickness is the total glass thickness.
- f. For insulating glass panes, the applicable glass thickness is the thickness of one pane.