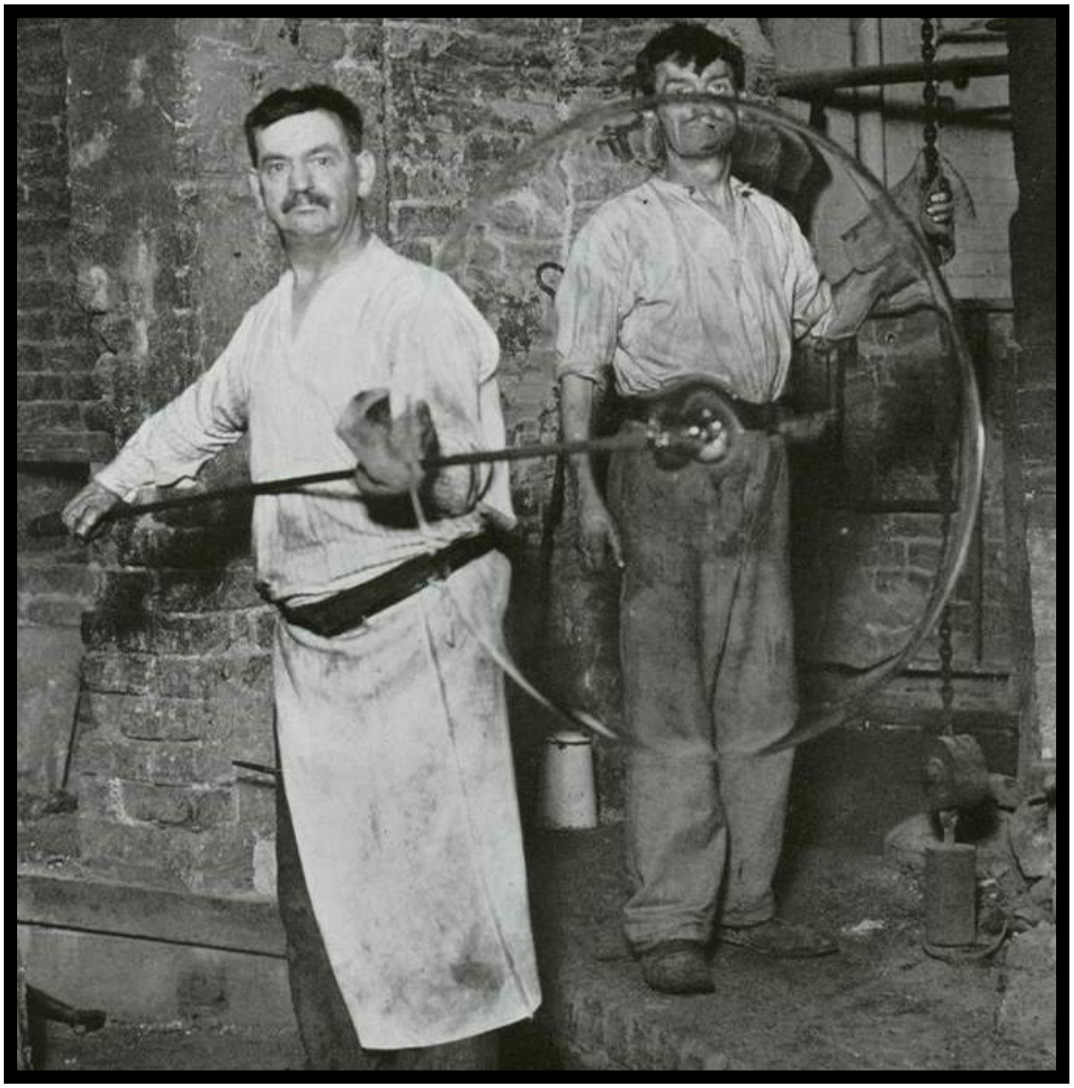
HOW TO BUILD A GLASS HOUSE

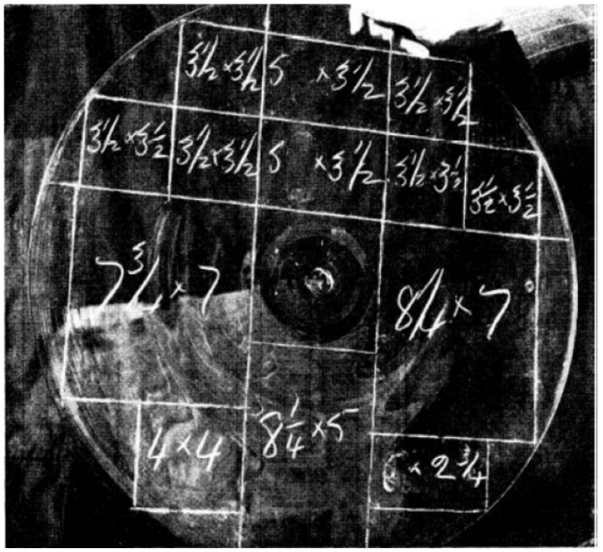
Leonard Pianalto, M.Sc., P.Eng., LEED AP, FEC

Read Jones Christoffersen Ltd.
Creative Thinking Practical Results

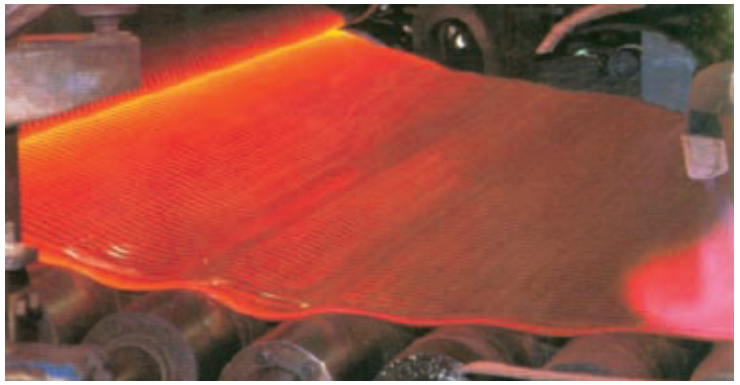
rjc

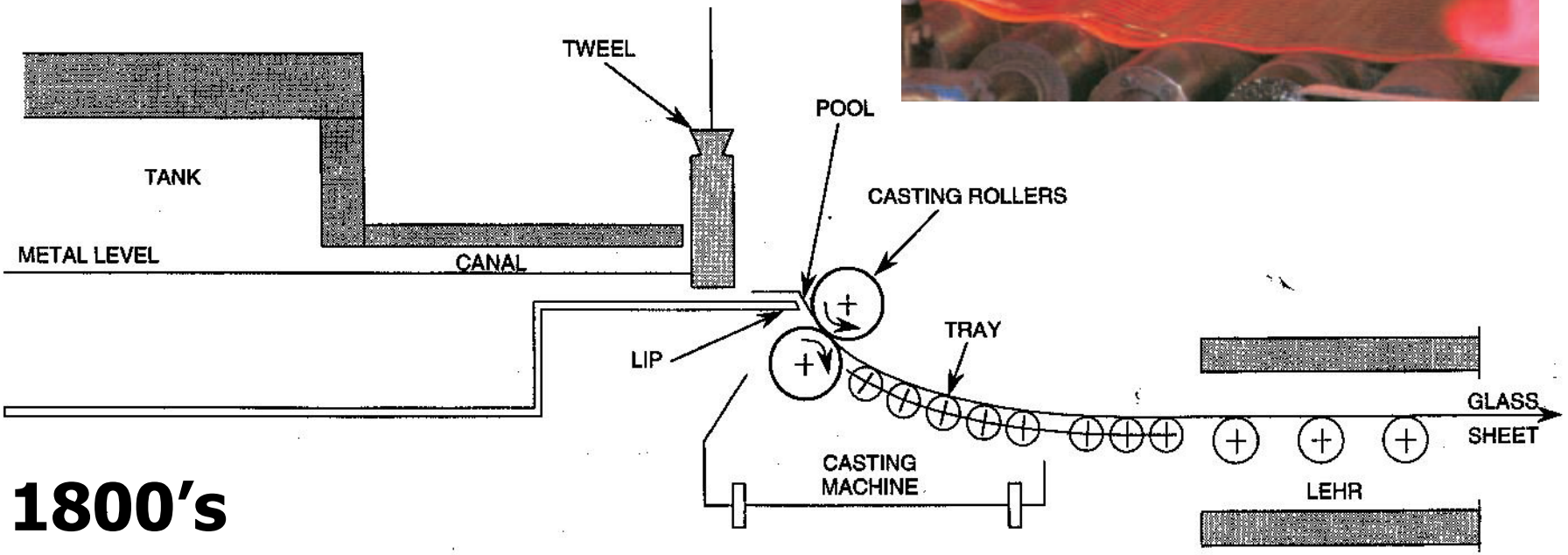
Creative Thinking **Practical Results** rjc




3½×3½
5 ×3½
3½×3½
3½×3½
3½×3½
5 ×3½
3½×3½
3½×5½
7¾×7
8¼×7
4×4
8¼×5
5×2¾

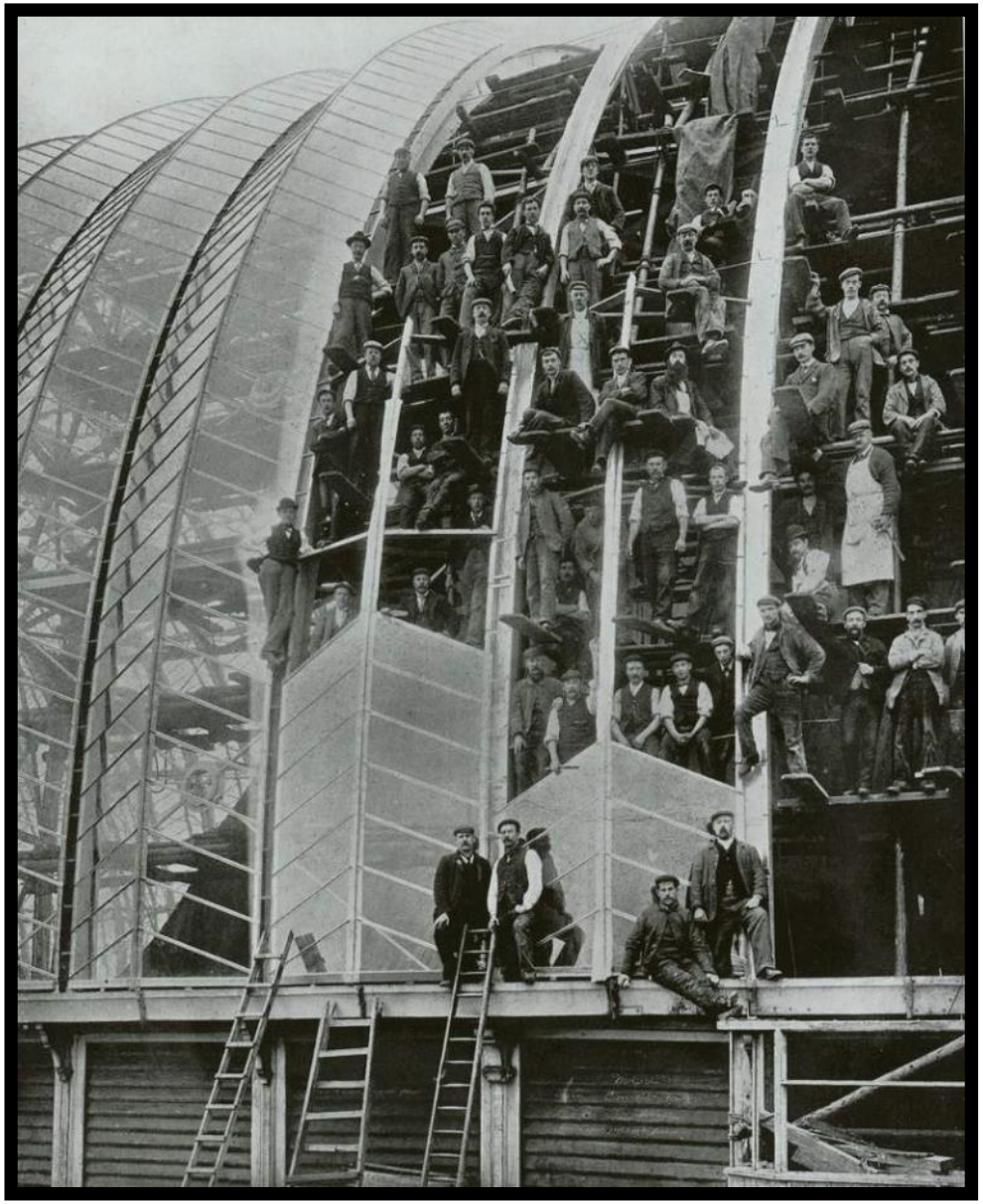
Continuous Casting Process

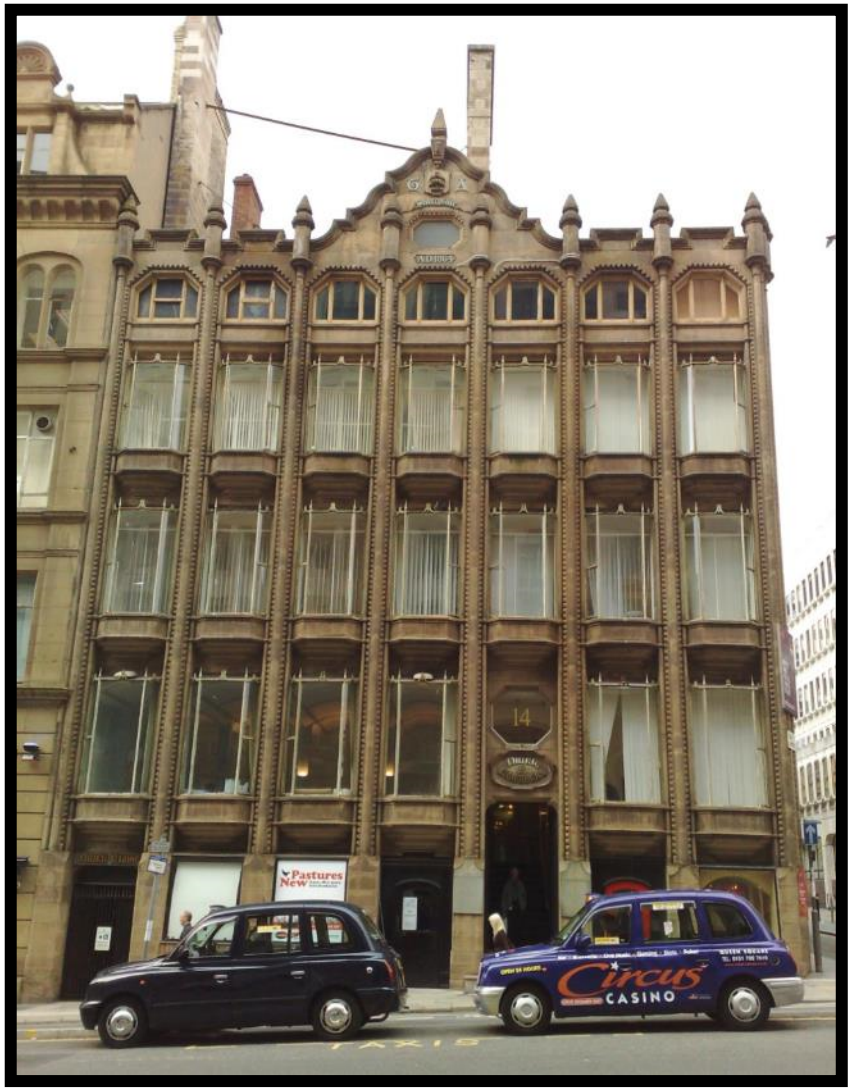




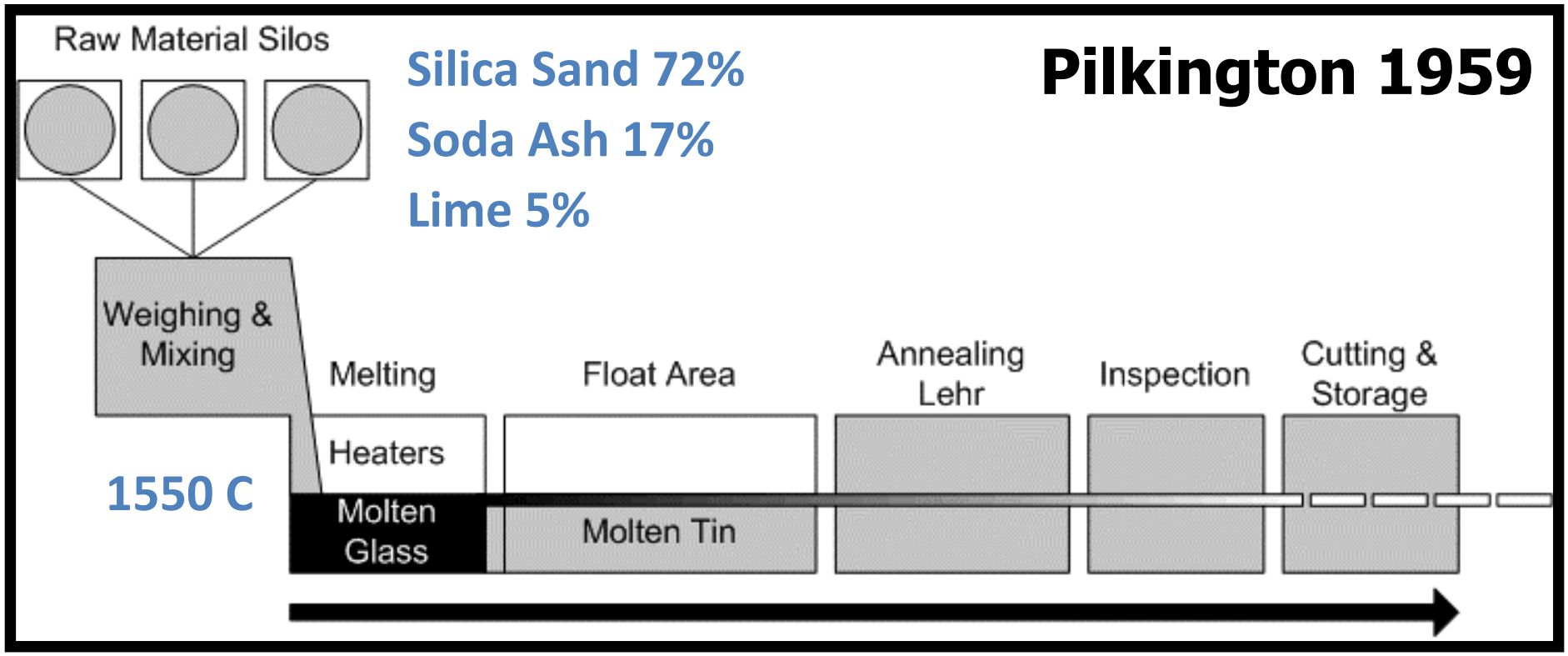
1800's

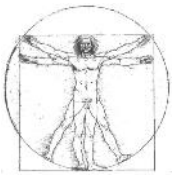
Today - Decorative and Wired Glass




14
Pastures New
Circus
CASINO

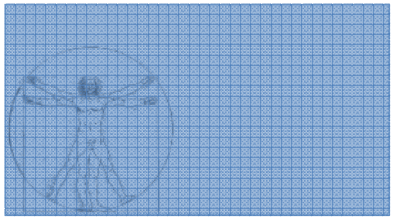
Float Glass Production
Soda Lime Glass



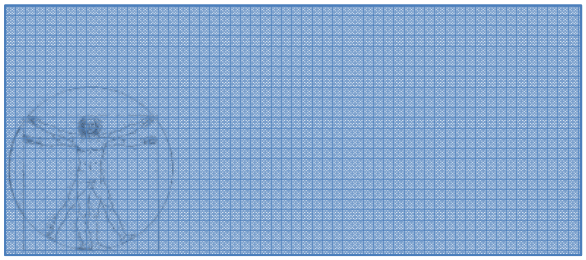


Average Man 1.75m

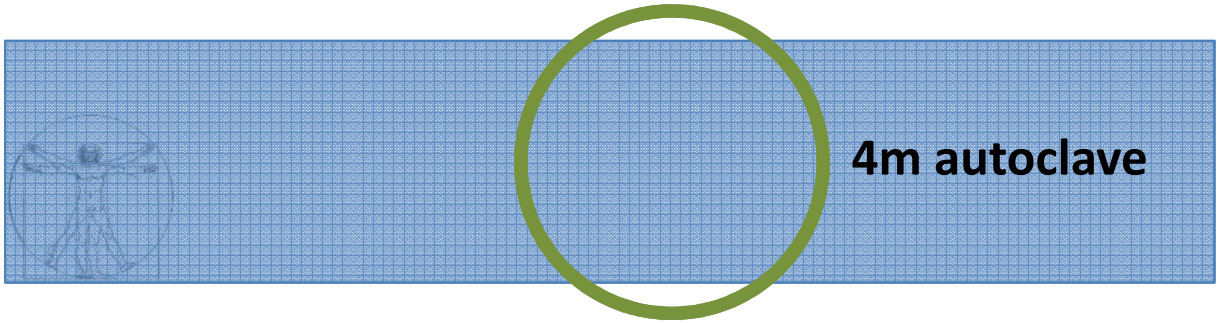
Toyota Corolla 4.65 m x 1.455 m



Vitrum 2.79 m x 5.08 m



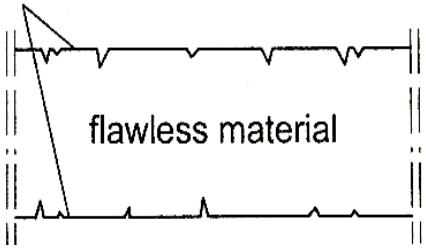
Agnora 3.3 m x 7.62 m



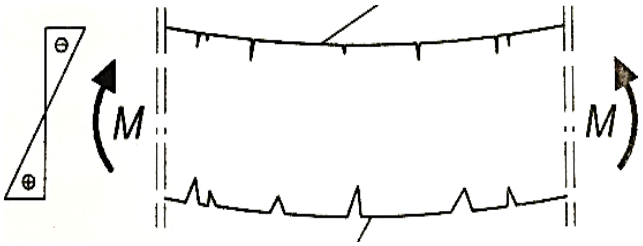
Sedak 3.2 m x 16 m

GLASS STRENGTH → 8 BREAKS / 1000

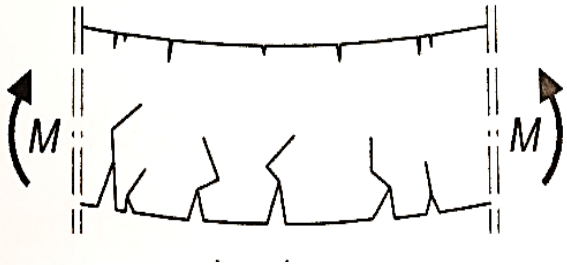
Surface flaws



Flaws close due to compression



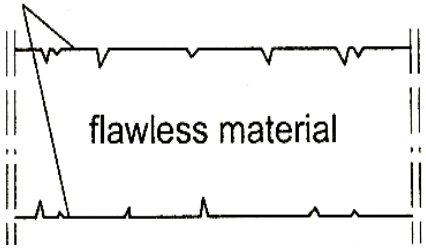
Flaws open due to tension



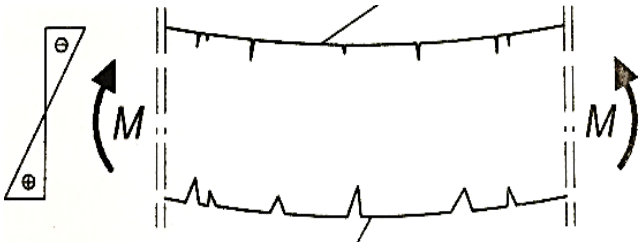
Brittle fracture

GLASS STRENGTH → 8 BREAKS / 1000

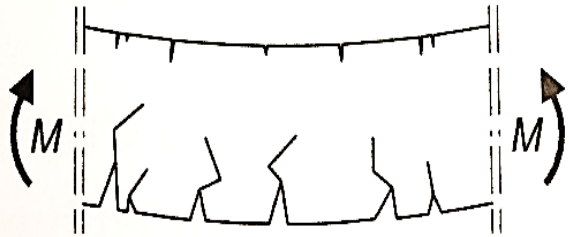
Surface flaws



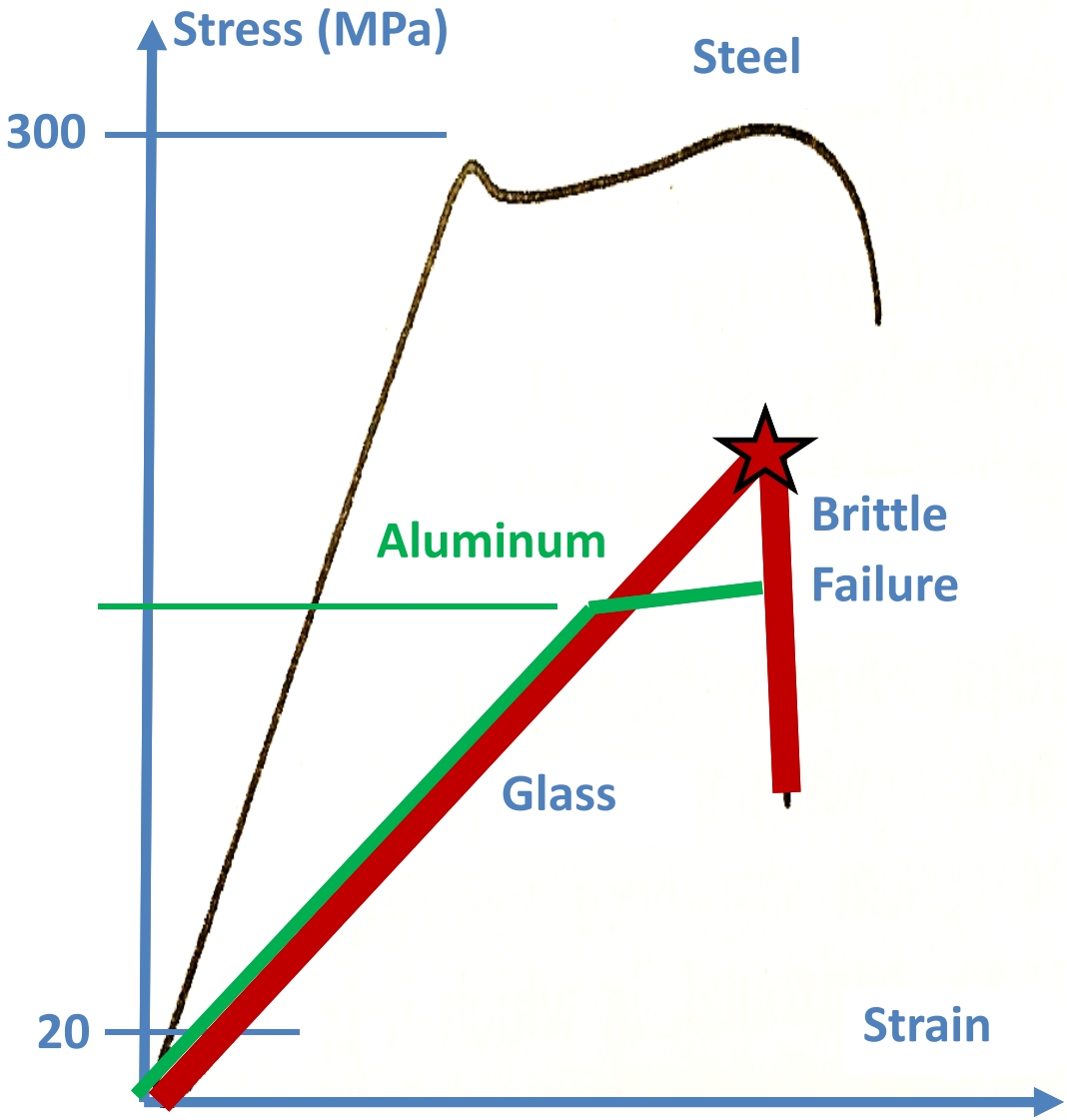
Flaws close due to compression

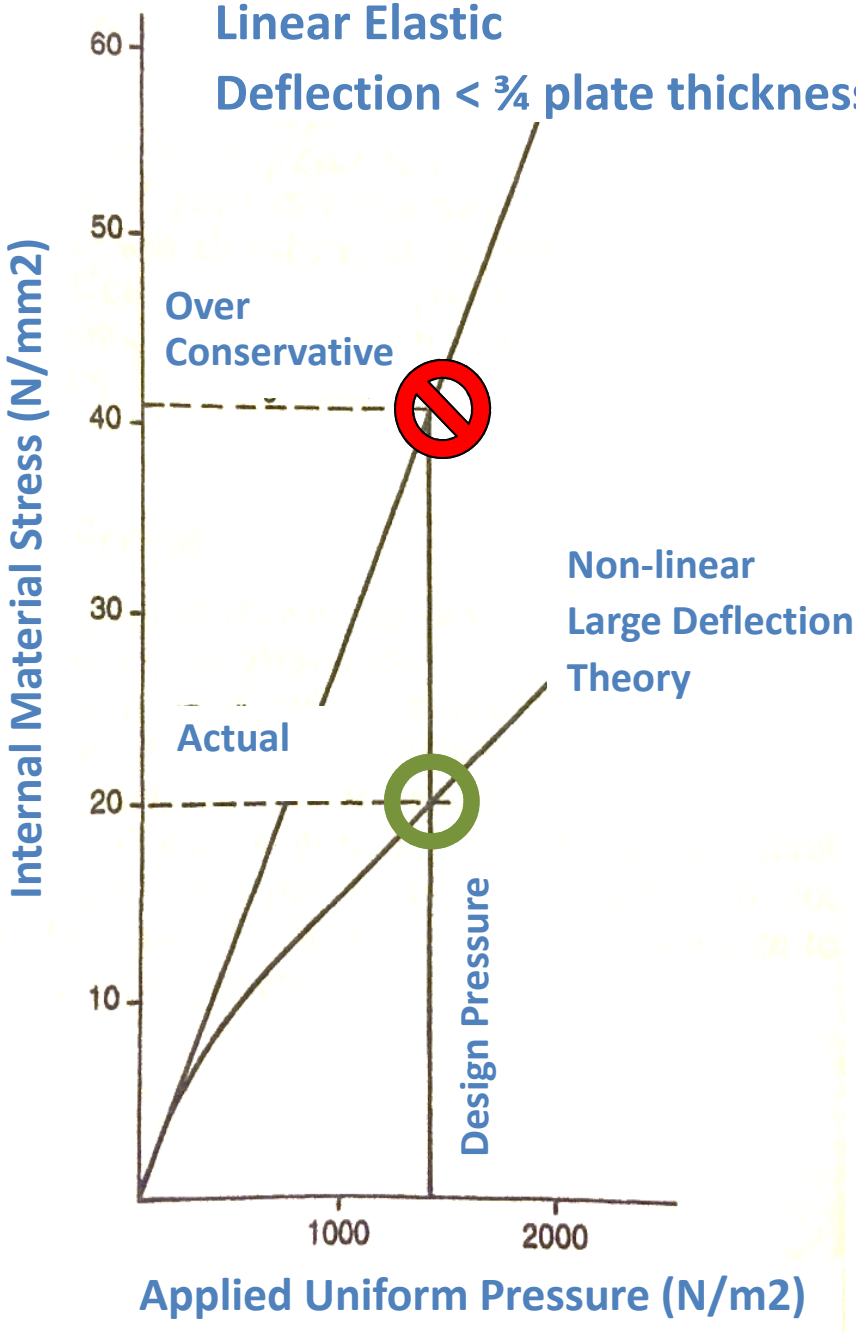


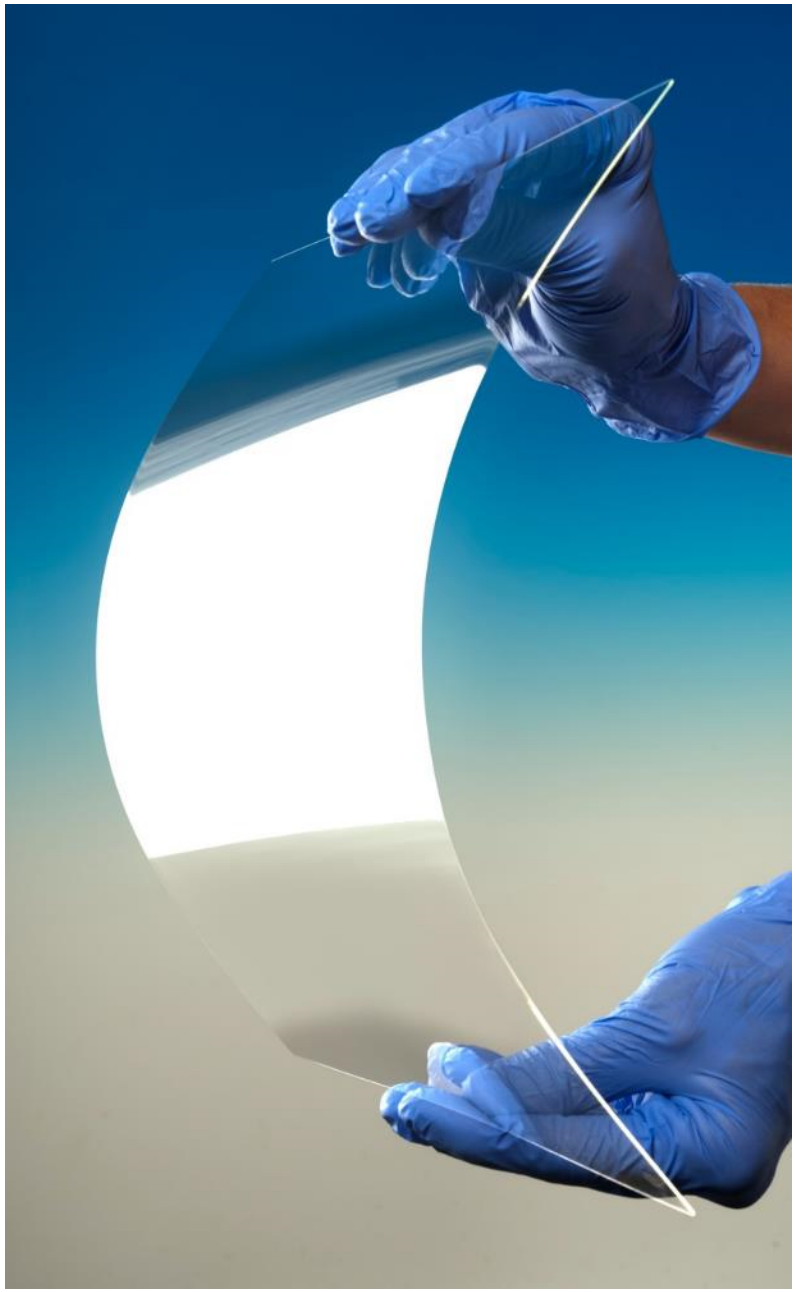
Flaws open due to tension

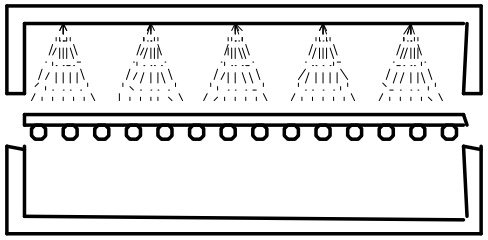


Brittle fracture

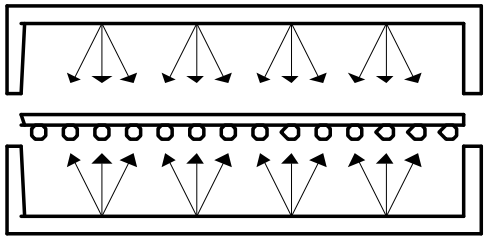



Linear Elastic
Deflection < ¾ plate thickness
Internal Material Stress (N/mm2)
60
50
40
30
20
10
Over
Conservative
Non-linear
Large Deflection
Theory
Actual
Design Pressure
1000
2000
Applied Uniform Pressure (N/m2)

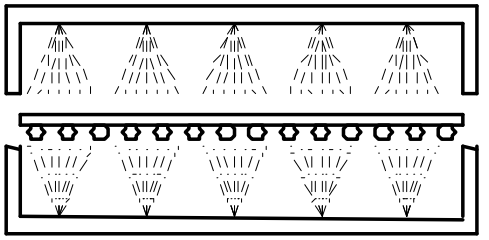




Cleaning



Heating



Quenching

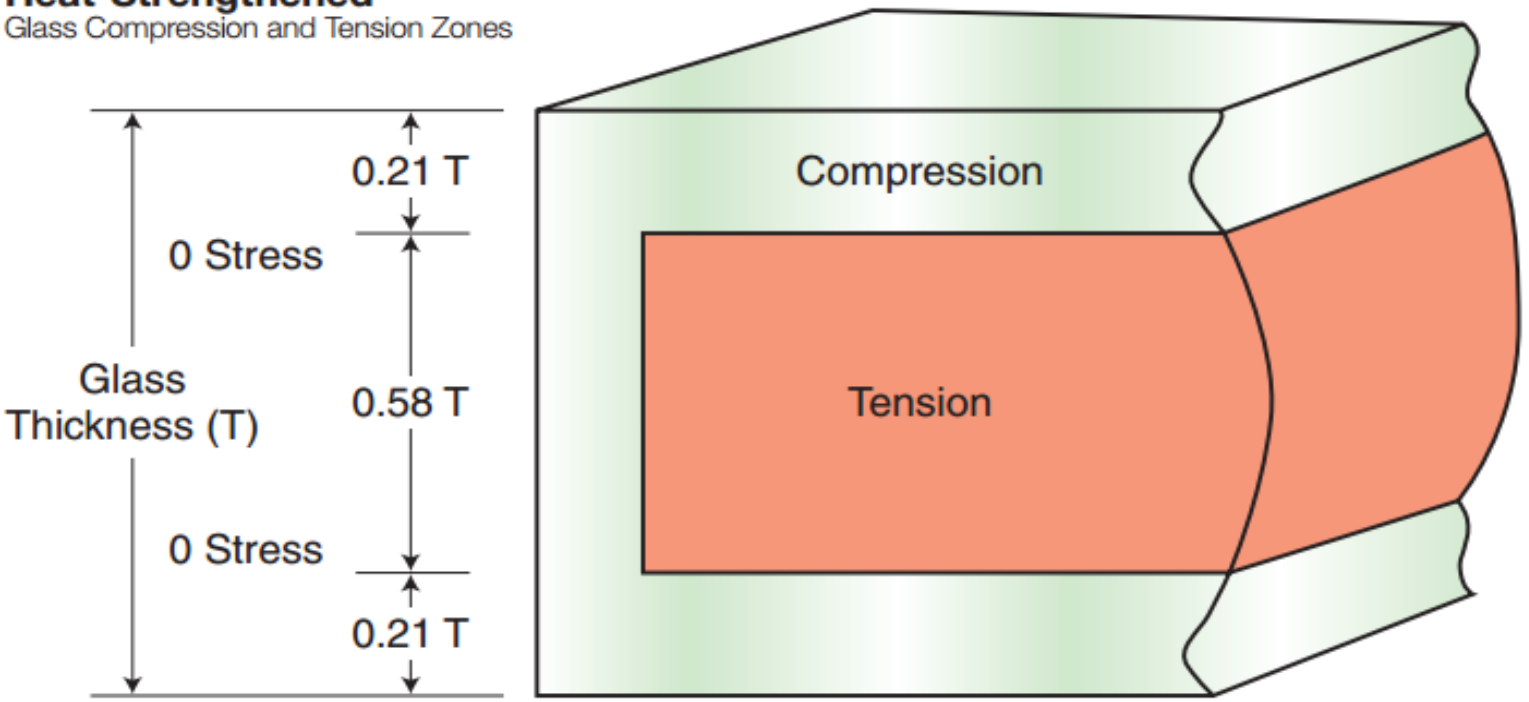
620^{O} Celsius

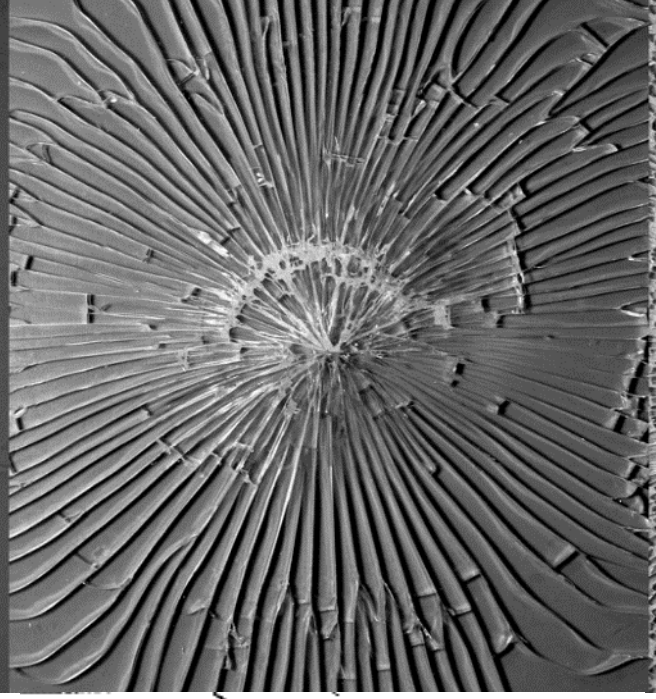
Fully tempered - Rapid

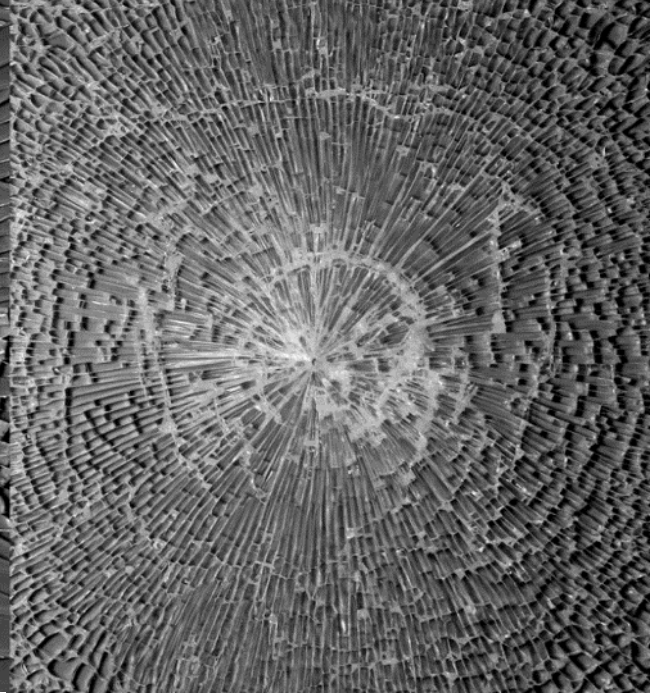
Heat Strength'd - Slower

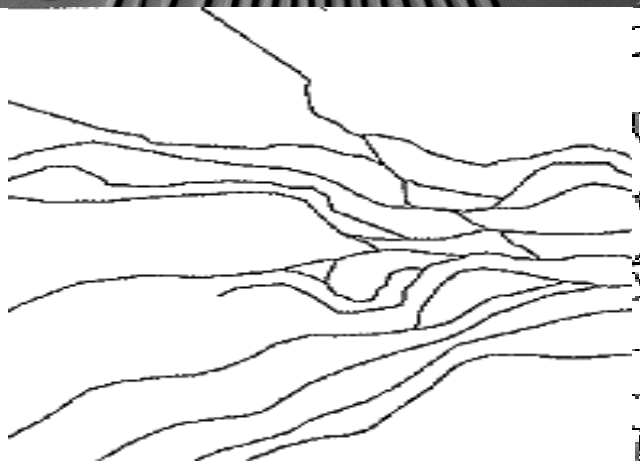
Heat-Strengthened

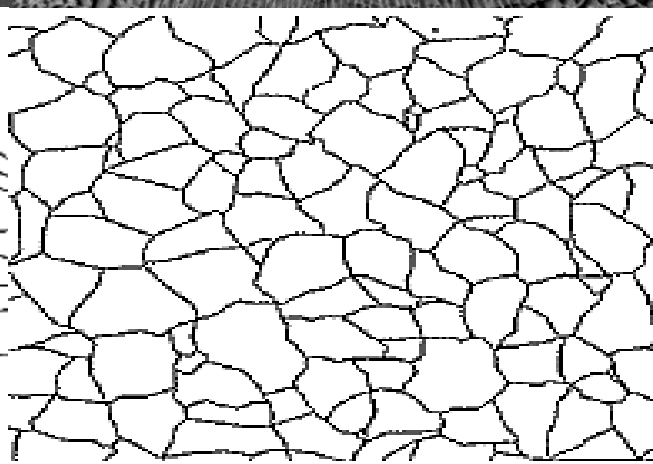
Glass Compression and Tension Zones











Annealed

20 MPa

Heat-Strengthened

40 MPa

Tempered

80 MPa

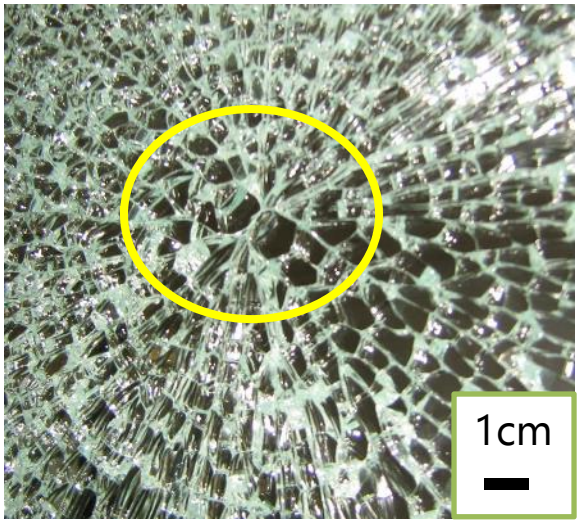
TABLE 4 Minimum Glass Thicknesses

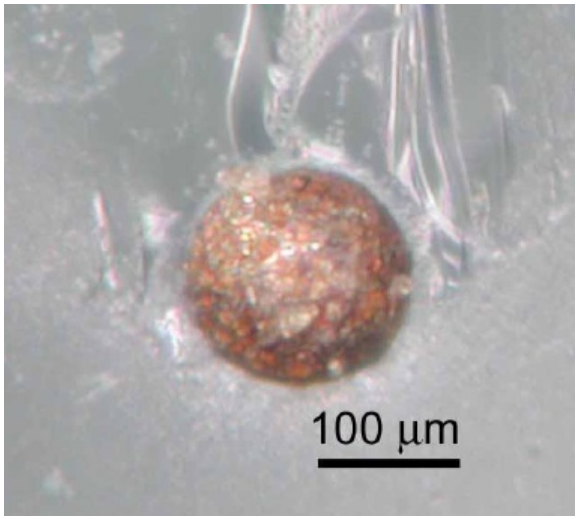
Nominal Thickness or Designation, mm (in.)	Minimum Thickness, mm (in.)
2.5 (3⁄32)	2.16 (0.085)
2.7 (lami)	2.59 (0.102)
3.0 (1⁄8)	2.92 (0.115)
4.0 (5⁄32)	3.78 (0.149)
5.0 (3⁄16)	4.57 (0.180)
6.0 (1⁄4)	5.56 (0.219)
8.0 (5⁄16)	7.42 (0.292)
10.0 (3⁄8)	9.02 (0.355)
12.0 (1⁄2)	11.91 (0.469)
16.0 (5⁄8)	15.09 (0.595)
19.0 (3⁄4)	18.26 (0.719)
22.0 (7⁄8)	21.44 (0.844)

Heat Strengthened Glass

Annealed/Fully Tempered Glass

Spontaneous Failure





Heat Soaking can identify NiS inclusions

Laminated Glass

Post Breakage
Residual Strength

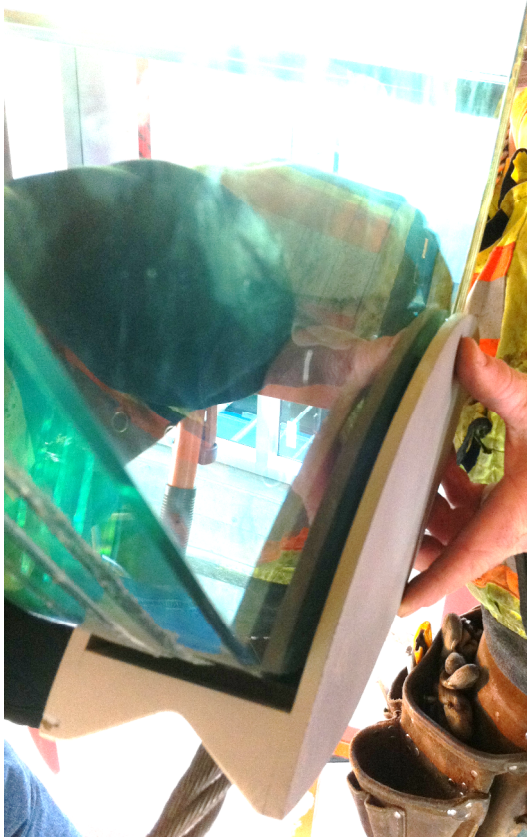
Can have 4 layers or more

Composite Action
Fast Load / Cold
Dupont SentryGlass®

Layers Slide
Slow Load / Warm
Polyvinyl Butryl

HEAT + PRESSURE + interlayer

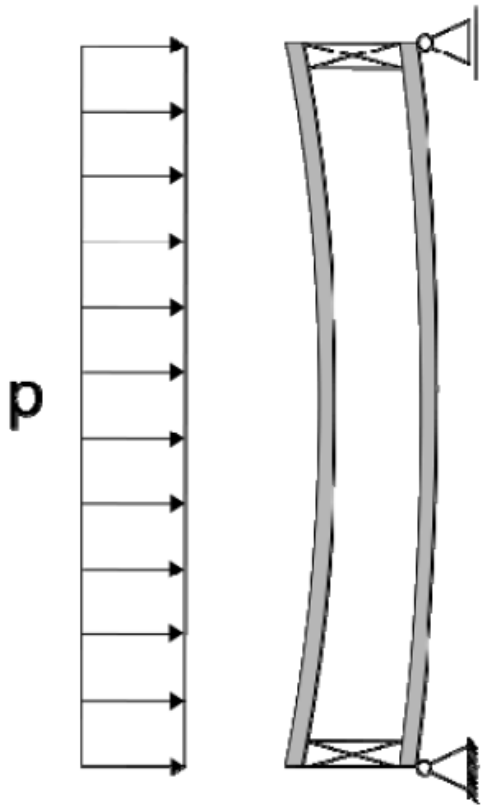
Autoclave



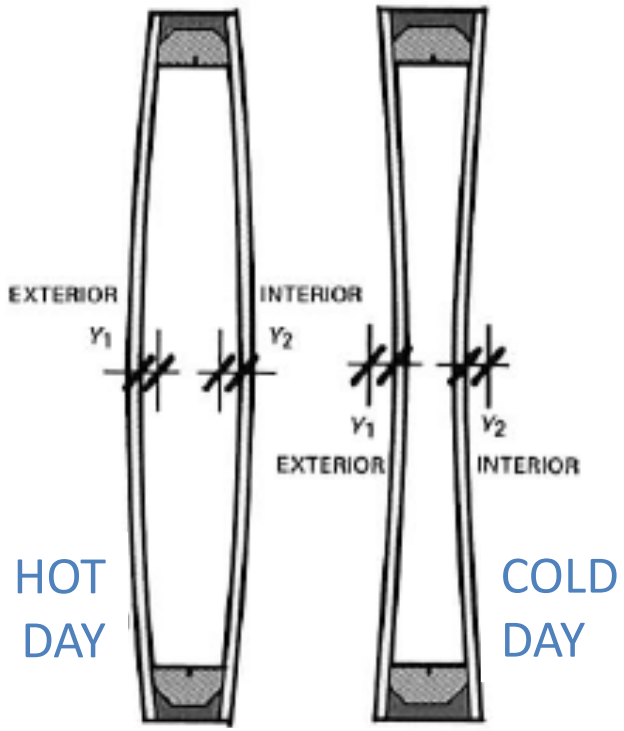
12mmT/10HS/10HS/12T

Roof Truss

Insulated Glazing Units

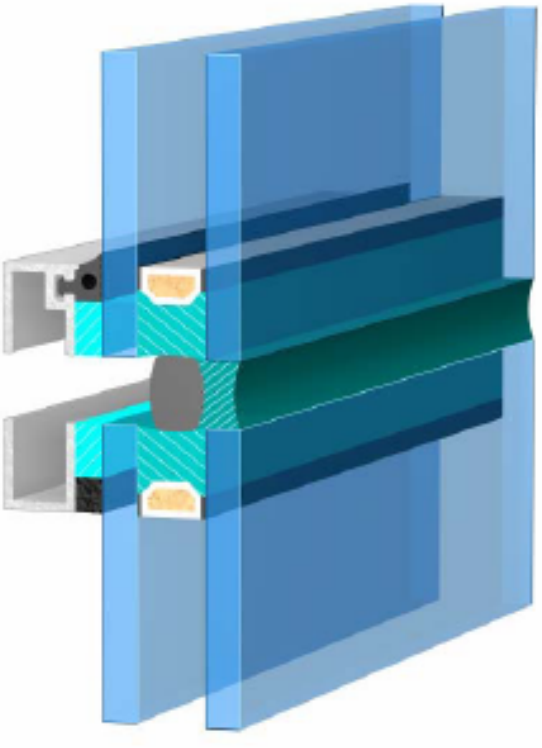


LOAD SHARING

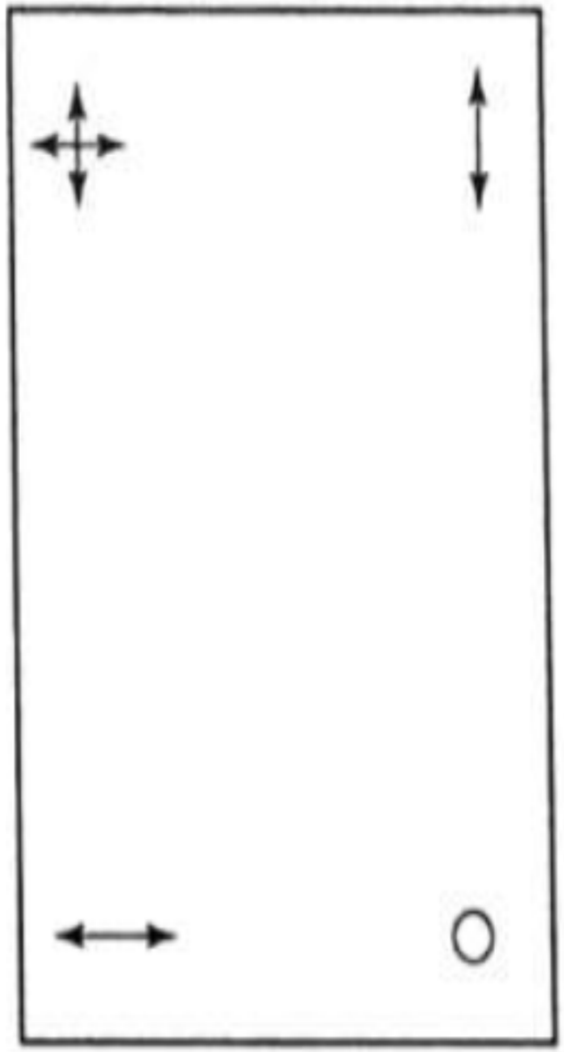


+ 20% INTERNAL PRESSURE

Structural Silicone Glazing



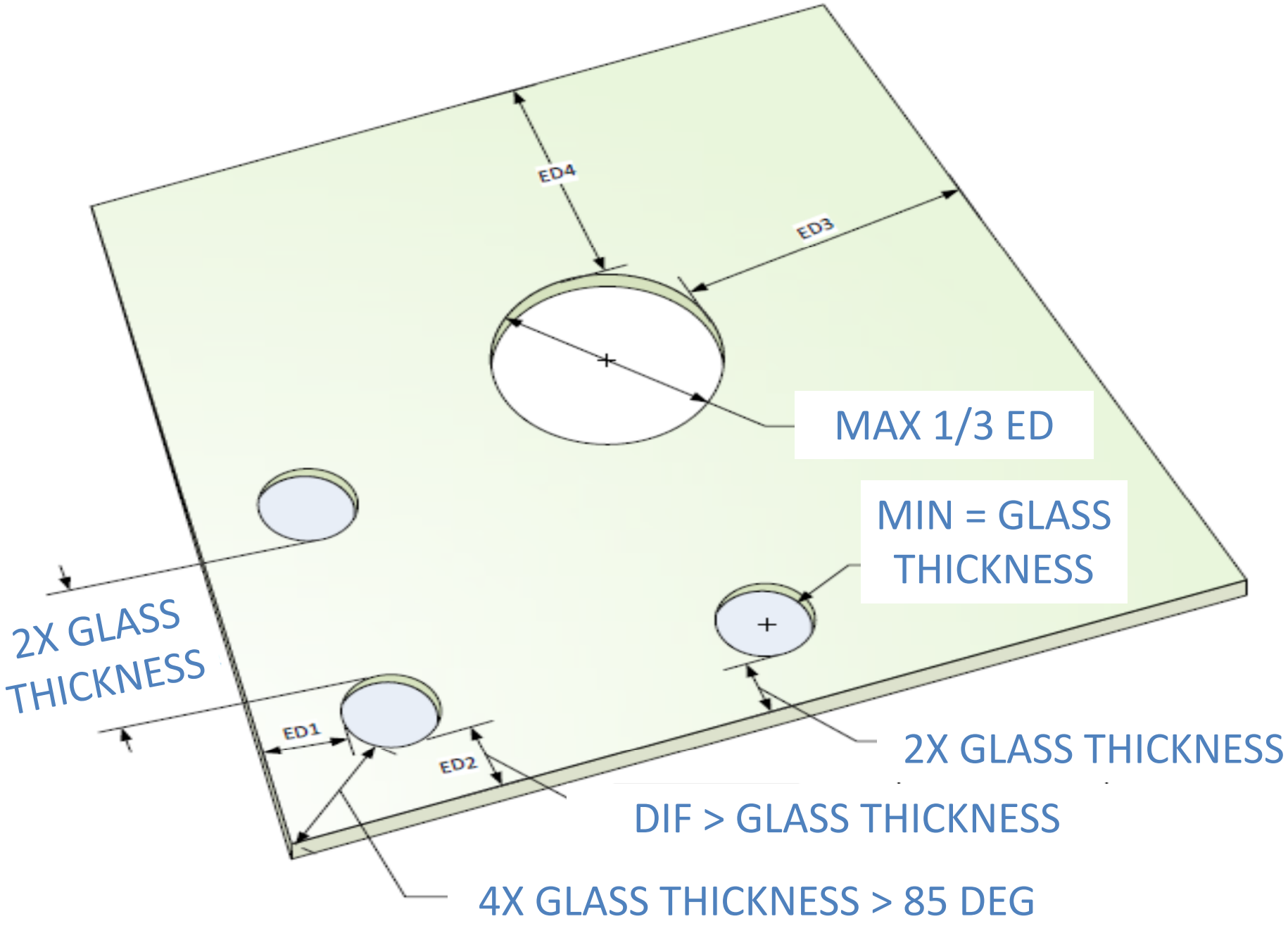
Chicago Art Institute
1973
1st 4 sided SSG
GE Silicone



HORIZONTAL RESTRAINT

VERTICAL RESTRAINT

FREE IN BOTH DIRECTIONS


ED4
ED3
MAX 1/3 ED
MIN = GLASS THICKNESS
2X GLASS THICKNESS
ED1
ED2
2X GLASS THICKNESS
DIF > GLASS THICKNESS
4X GLASS THICKNESS > 85 DEG

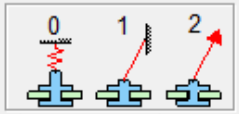
Spring support | Edge support | Glass fixing | Spacer | Edge beam | Elast. edge support | Elast. base | Elast. line support | Bonded edges

Kind of fixing:

New item | Delete item | Show picture...

Manufacturer - product*	Type	r_i	r_a	E_s	E_h	t_s	t_h	h_k	r_k
DiskFixing	2	6	25	60.	500.	3.	2.		
DiskFixing	2	6	25	60.	500.	3.	2.		
ClampFixing circular	3		25	60.	500.	3.	2.		

Position of fixing:



New item | Delete item

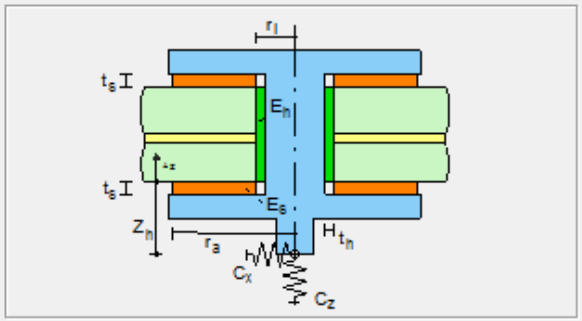
*Reference	X [mm]	Y [mm]	Z_h	C_x	C_y	C_z	C_φ	C_θ	Type
ClampFixing circular	0	100		1.e4	1.e4	1.e4	1.e8	1.e8	0
ClampFixing circular	0	100		1.e4	1.e4	1.e4	1.e8	1.e8	0
ClampFixing circular	0	665		1.e4	1.e4	1.e4	1.e8	1.e8	0
DiskFixing	1208	750				1e6	1e10	1e10	0
DiskFixing	1208	1360				1e6	1e10	1e10	0

Contact approaches (tolerance value):

☑ for the bush 0.001 mm

☑ for the disk layer 0.001 mm

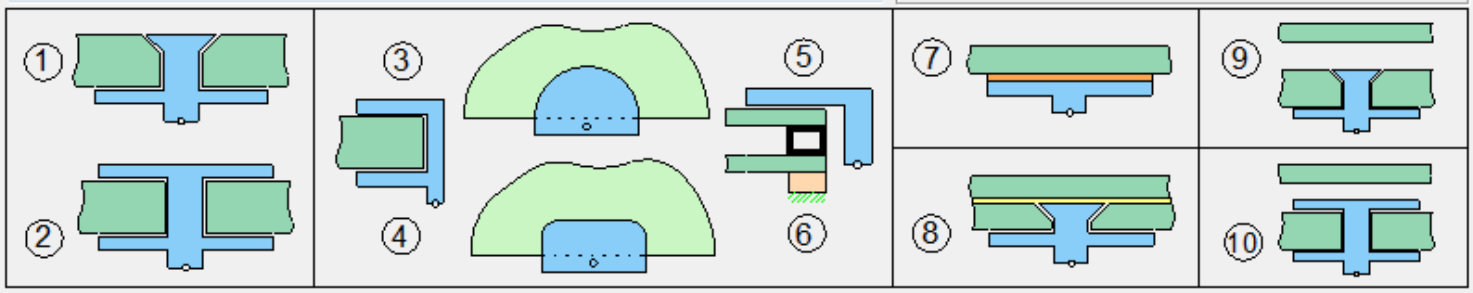
Degree of freedom for rotat

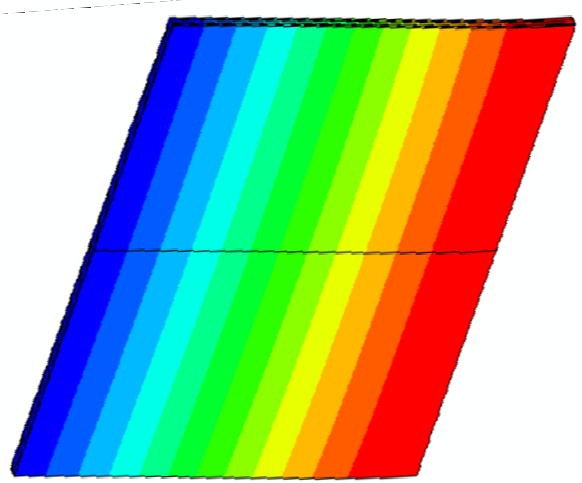


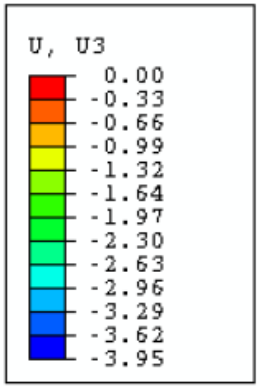
Load transmission at the borehole rim:

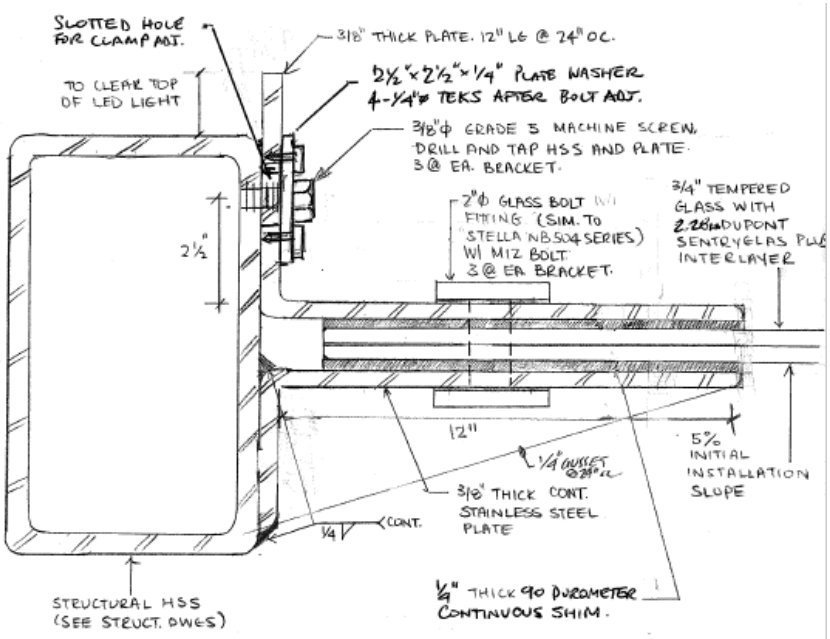
☐ only the countersunk head touches the glass chamfer (type 1, 8, 9)

☐ only glass layer touches the bush (type 2, 10)









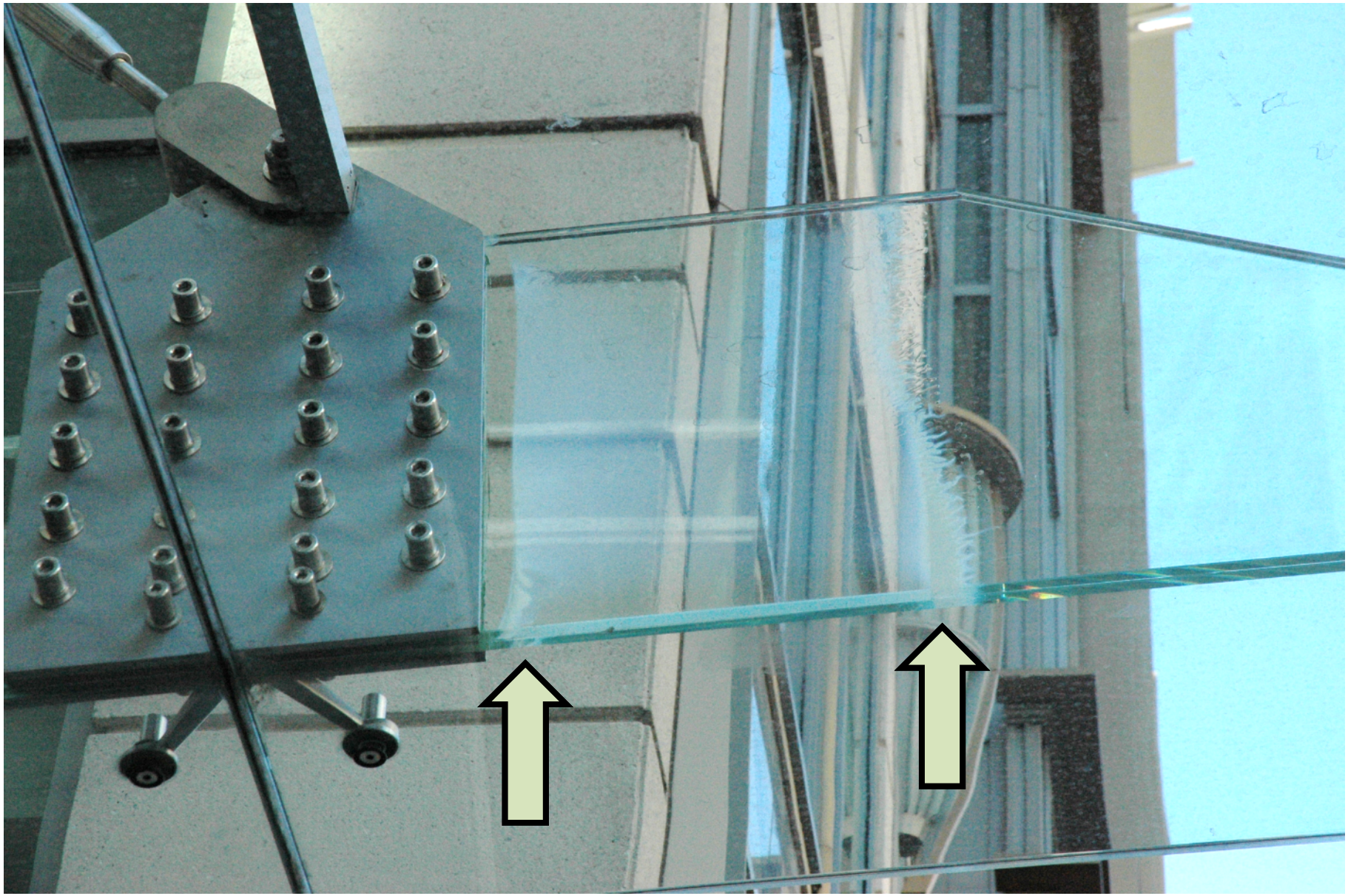
CONSIDER LONG TERM CREEP

HBC Top Shop Canopy

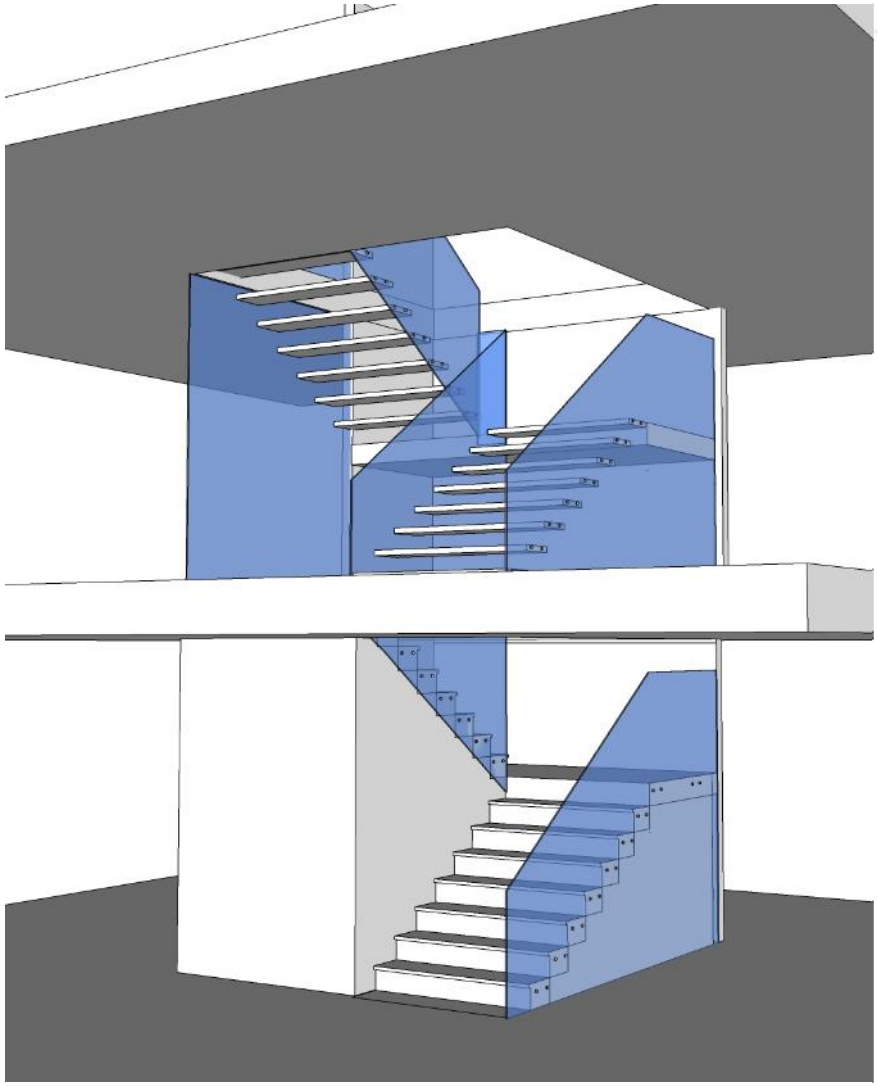
Panel Front Surface

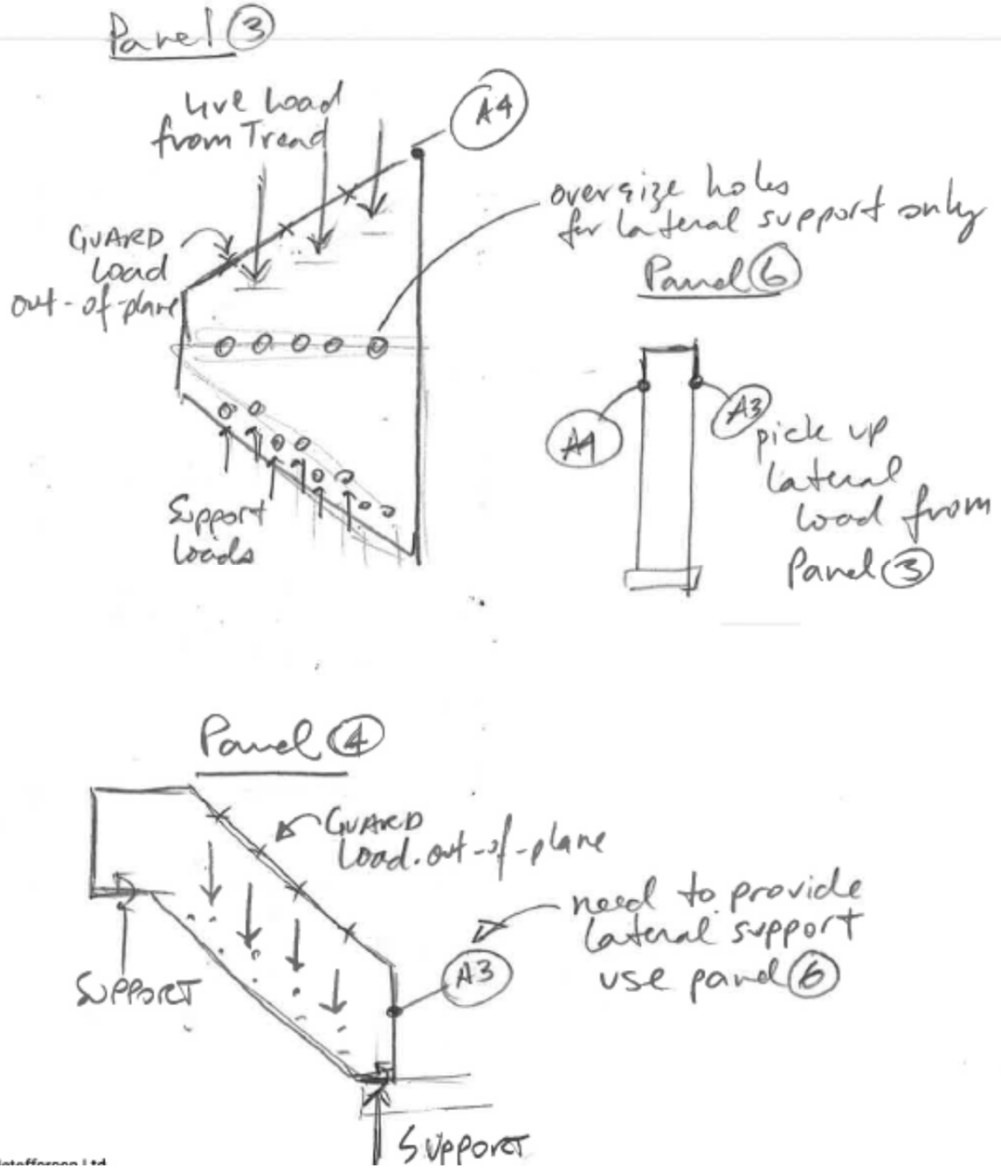
Deflection

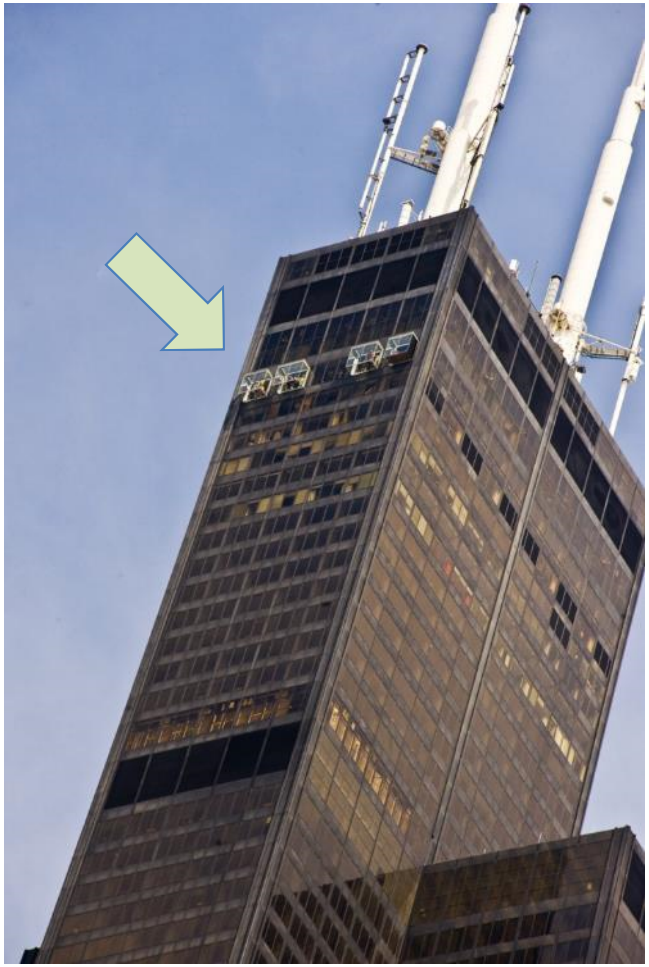
Maximum = 3.95 mm



Creative Thinking **Practical Results** rjc

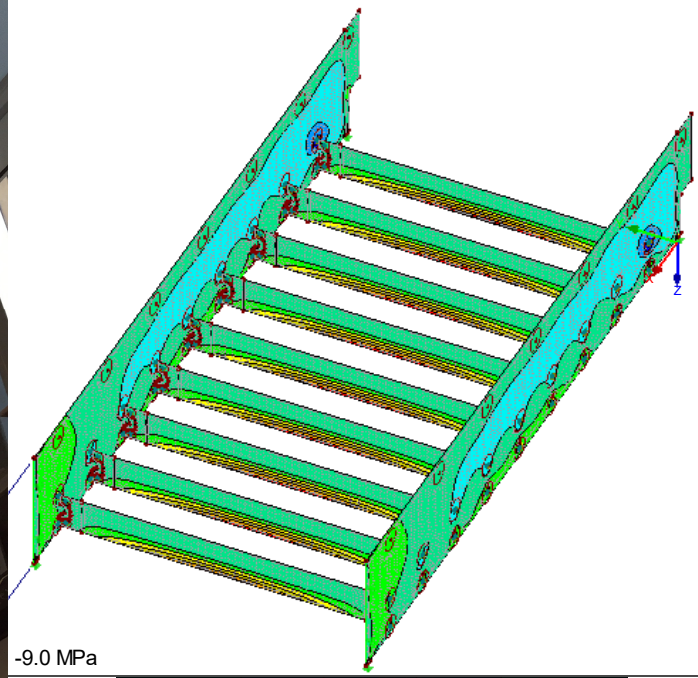


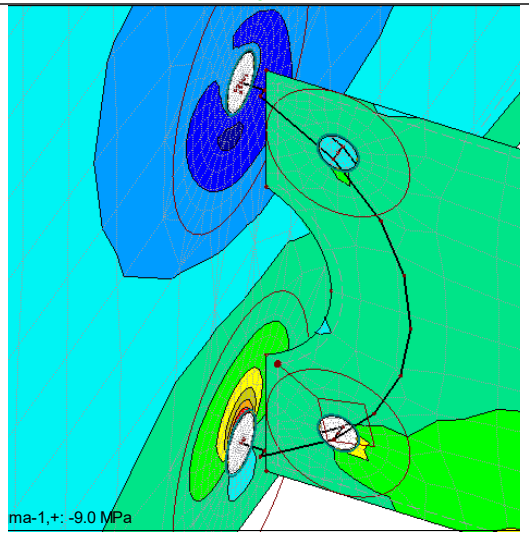

Panel (3)
Live Load from Tread
A4
GUARD Load out-of-plane
oversize holes for lateral support only
Panel (6)
Support loads
A4
A3
pick up lateral load from Panel (3)
Panel (4)
GUARD Load. out-of-plane
need to provide lateral support use panel (6)
A3
SUPPORT
SUPPORT




© Reuters

Creative Thinking **Practical Results**

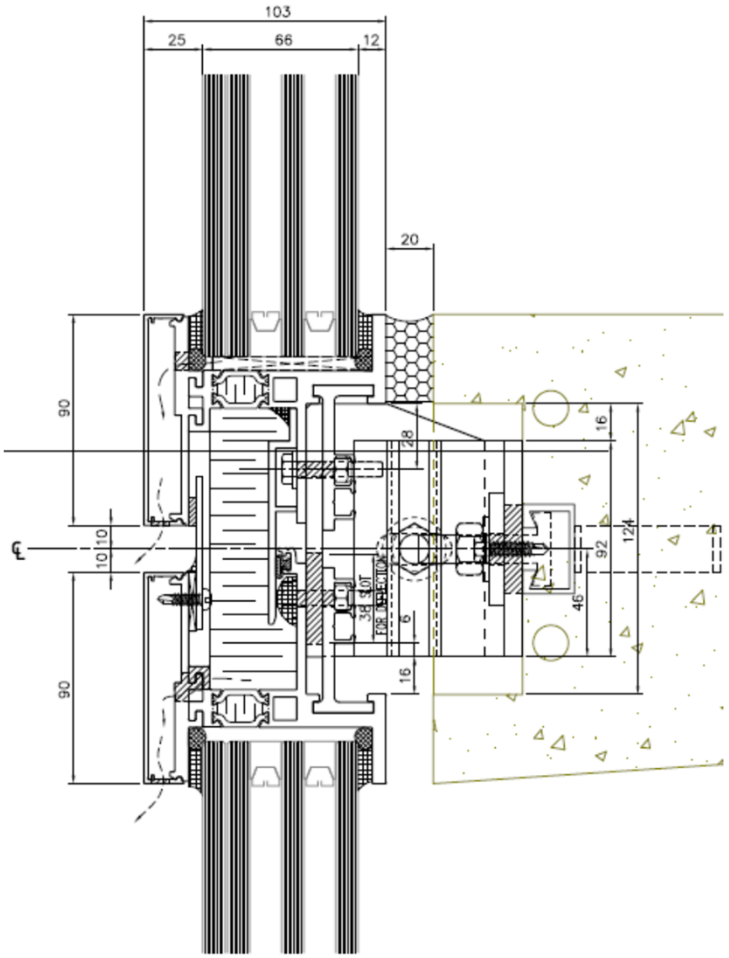

-9.0 MPa

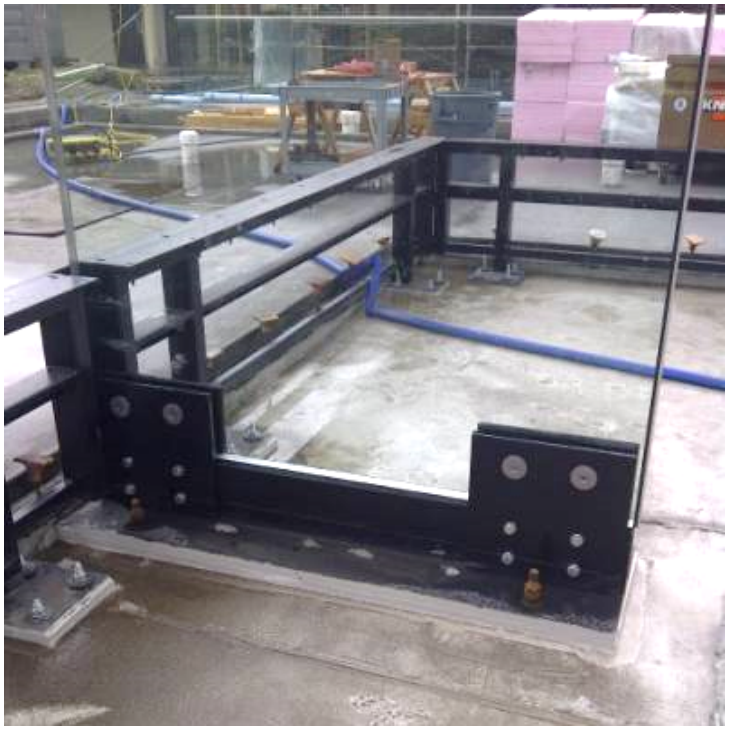

ma-1,+: -9.0 MPa


P4 - +15


Brookfield
defining the skyline

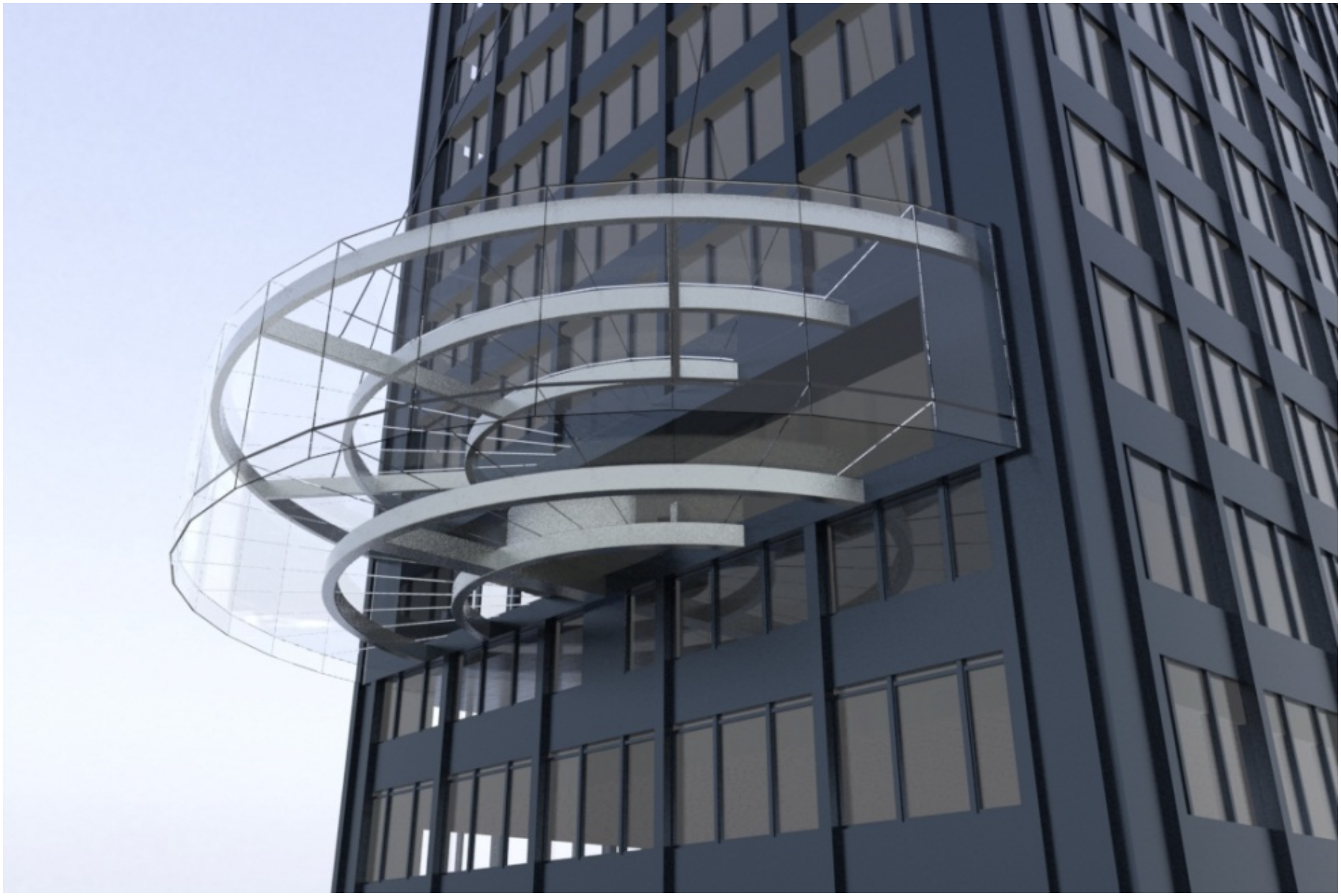

SKYJACK


103
25
66
12
20
90
10
10
28
16
92
124
46
6
16
90



Creative Thinking **Practical Results** rjc

(Completed by J. Kooymans while at previous company)



Creative Thinking **Practical Results** rjc