RICE ENGINEERING
105 School Creek Trail | Luxemburg, WI 54217
(P) 920.617.1042 | (F) 920.617.1100

Panel Grip 2 - Fascia Mount Guardrail Testing to Conform ASTM E985

Project Location:
Milwaukee, Wisconsin
REI Project # R16-02-285

Prepared for:
R&B Wagner, Inc. - Milwaukee, WI
5/17/2016

Project Scope:

Rice Engineering was contacted by R&B Wagner, Inc. to witness testing of their Panel Grip 2 fascia shoe guardrail system, specifically the amount of deflection that would occur in:

3/4" thick monolithic tempered glass

3/4" thick tempered SGP laminated glass

3/4" thick tempered PVB laminated glass

5/8" thick tempered SGP laminated glass (Thick Out), 5/8" thick tempered SGP laminated glass (Thin Out)

5/8" thick tempered PVB laminated glass (Thick Out), 5/8" thick tempered PVB laminated glass (Thin Out)

21.5 mm thick tempered SGP laminated glass

21.5 mm thick tempered PVB laminated glass

When pulled to design loads as described in ASTM E985.

On March 29, 2016 Taurino Garcia, P.E. of Rice Engineering witnessed testing for the nine different configurations. The testing was performed on-site at the R&B Wagner facility and was conducted by Kelly Bauserman and Justin Wesser.

This report is only intended to analyze the deflection of the various glass types. The structural integrity of the base shoe, anchors and anchor substrate is outside the scope of this report. It should be noted that upon observation, no visual damage to the shoe, anchors or concrete barrier was observed after all testing was completed.

Conclusions:

See sheets: A3 -3/4" thick monolithic tempered glass, A5 - 3/4" thick tempered SGP laminated glass, A7 - 3/4" thick tempered PVB laminated glass, A9 – 5/8" thick tempered SGP laminated glass (Thick Out), A11 - 5/8" thick tempered SGP laminated glass (Thin Out), A13 - 5/8" thick tempered PVB laminated glass (Thick Out), A15 - 5/8" thick tempered PVB laminated glass (Thin Out),A17 -21.5 mm thick tempered SGP laminated glass and A19 -21.5 mm thick tempered PVB laminated glass.

Disclaimer:

This Certification is limited to the structural design of structural components of this handrail or divider system. It does NOT include responsibility for:

- Structural design of misc. hardware (latches, hinges, etc.).
- Structural design of concrete slabs and other masonry units
- Structural design of wood blocking or wood framing
- Structural design of all other anchorage substrates
- Glass breakage due to airborne debris or foreign objects
- The manufacture, assembly, or installation of the system.
- Quantities of materials or dimensional accuracy of drawings

Engineer Prepared And Witnessed Approval Stamp:

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- Structural design of all other anchorage substrates
- Glass breakage due to airborne debris or foreign objects
- The manufacture, assembly, or installation of the system.
- Quantities of materials or dimensional accuracy of drawings

Engineer Prepared And Witnessed Approval Stamp:

R & B WAGNER, INC.
PO BOX 423 | BUTLER, WI | 53007
10600 W BROWN DEER ROAD | MILWAUKEE, WI | 53224
PH 414.214.0444 FAX 414.214.8326

MASTER TABLE

ZERO POINT FOR CALCULATIONS	
Height of Rail (h) (in.)	42
Length of Rail (l) (in.)	48
Max Mid Deflection [(h/24)+(l/96)] (in.)	2.25
Max Residual Deflection (20% of Max Mid) (in.)	0.45

3/4 Inch

All inputs should be unadjusted read outs from test	Actual lbsf	MONO	Actual lbsf	SGP	Actual lbsf	PVB
Deflection Reading @ 0 lbsf	0		0	4.890	0	4.627
Deflection Reading @ Pre-Load (180 lbsf)	179	3.169	180	6.089	180	6.475
Deflection Reading @ Released Test Load (1/2 Pre-load)	90	2.477	91	5.543	91	5.658
Deflection Reading @ 150 lbsf	150	2.945	150	5.879	150	6.210
Deflection Reading @ 200 lbsf	199	3.371	202	6.251	199	6.746
Deflection Reading @ 250 lbsf	248	3.792	251	6.589	250	7.306
Deflection Reading @ 300 lbsf	300	4.237	299	6.915	300	7.870
Deflection Reading @ Ultimate Test Load (365 lbsf)	364	4.726	364	7.371	364	8.586
Deflection Reading @ Released Test Load (1/2 Pre-load)	90	2.709	90	5.640	90	5.975

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MASTER TABLE

ZERO POINT FOR CALCULATIONS	
Height of Rail (h) (in.)	41.75
Length of Rail (l) (in.)	48
Max Mid Deflection [(h/24)+(l/96)] (in.)	2.240
Max Residual Deflection (20% of Max Mid) (in.)	0.448

5/8 Inch

All inputs should be unadjusted read outs from test	Actual lbsf	SGP - Thick Out	Actual lbsf	SGP - Thin Out	Actual lbsf	PVB - Thick Out	Actual lbsf	PVB - Thin Out
Deflection Reading @ 0 lbsf	0	4.471	0	5.353	0	5.319	0	1.296
Deflection Reading @ Pre-Load (180 lbsf)	180	6.099	180	6.991	180	7.987	180	4.026
Deflection Reading @ Released Test Load (1/2 Pre-load)	91	5.443	90	6.372	90	6.986	90	3.047
Deflection Reading @ 150 lbsf	152	5.873	150	6.765	150	7.655	149	3.688
Deflection Reading @ 200 lbsf	201	6.258	200	7.149	200	8.341	199	4.353
Deflection Reading @ 250 lbsf	250	6.683	249	7.548	249	9.056	251	5.15
Deflection Reading @ 300 lbsf	300	7.143	300	7.964	301	9.772	298	5.876
Deflection Reading @ Ultimate Test Load (365 lbsf)	367	7.687	364	8.495	MAXED OUT		367	6.789
Deflection Reading @ Released Test Load (1/2 Pre-load)	90	5.667	89	6.533	92	7.278	91	3.442

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MASTER TABLE

ZERO POINT FOR CALCULATIONS	
Height of Rail (h) (in.)	48
Length of Rail (l) (in.)	48
Max Mid Deflection [(h/24)+(l/96)] (in.)	2.5
Max Residual Deflection (20% of Max Mid) (in.)	0.5

21.5 mm

All inputs should be unadjusted read outs from test	Actual lbsf	SGP	Actual lbsf	PVB
Deflection Reading @ 0 lbsf	0	2.838	0	2.159
Deflection Reading @ Pre-Load (180 lbsf)	180	3.933	181	4.219
Deflection Reading @ Released Test Load (1/2 Pre-load)	90	3.407	90	3.457
Deflection Reading @ 150 lbsf	152	3.748	150	3.986
Deflection Reading @ 200 lbsf	199	4.052	199	4.484
Deflection Reading @ 250 lbsf	249	4.401	251	5.164
Deflection Reading @ 300 lbsf	303	4.822	300	5.762
Deflection Reading @ Ultimate Test Load (365 lbsf)	366	5.287	366	6.502
Deflection Reading @ Released Test Load (1/2 Pre-load)	93	3.562	91	3.901

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Railing System Load/Deflection Testing

Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	3/4" monolithic glass, 42" x 48", PGISO75, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	180 (lbsf)	Preload	-0.692			
Released Test Load	90 (lbsf)	RTL	0			
		150	-0.468			
Ultimate Test Load	365 (lbsf)	200	-0.894			
		250	-1.315			
Deflection Specifications Per ASTM E985		300	-1.76			
Max Mid Deflection	2.25	UTL	-2.249			
		RD	-0.232			
Residual Deflection (At RTL)	0.45					

Notes

Potentiometer cannot be zeroed, so calculations are done manually

Shoe mounted to steel plate

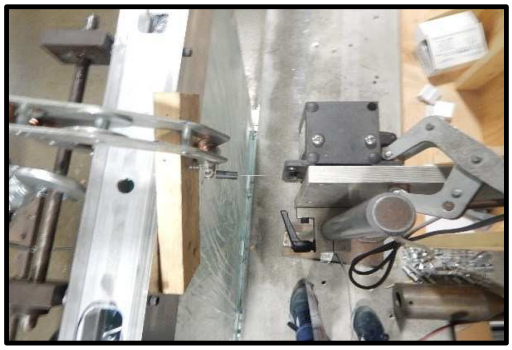
Conclusions

Rail meets ASTM Standard for Max. Allowed Deflection for Mid

Rail meets ASTM Standard for Residual Deflection

TEST PHOTOS

Initial Setup: Mid



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Railing System Load/Deflection Testing

Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	3/4" SGP glass, 48" x 48", PGISO75, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	**180 (lbsf)**	Preload	-0.546			
Released Test Load	**90 (lbsf)**	RTL	0			
		150	-0.336			
Ultimate Test Load	**365 (lbsf)**	200	-0.708			
		250	-1.046			
Deflection Specifications Per ASTM E985		300	-1.372			
Max Mid Deflection	**2.25**	UTL	-1.828			
		RD	-0.097			
Residual Deflection (At RTL)	**0.45**					

Notes

Potentiometer cannot be zeroed, so calculations are done manually

Shoe mounted to steel plate

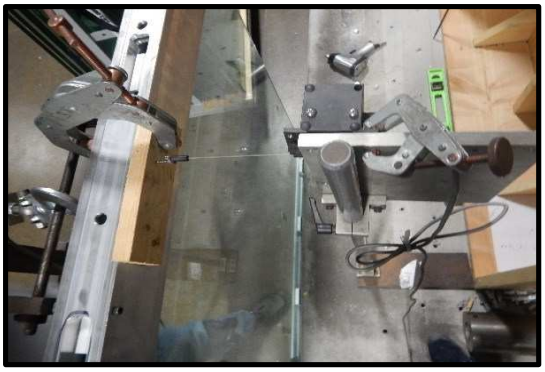
Conclusions

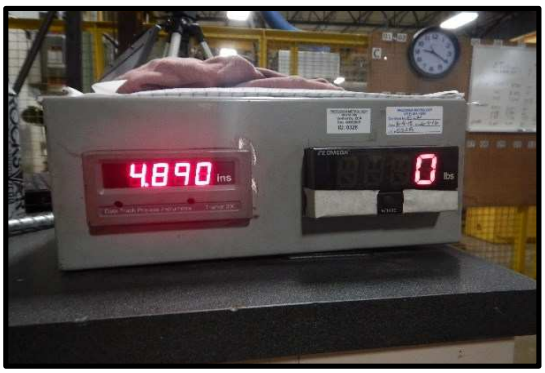
Rail meets ASTM Standard for Max. Allowed Deflection for Mid

Rail meets ASTM Standard for Residual Deflection

TEST PHOTOS

Initial Setup: Mid





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Railing System Load/Deflection Testing

Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	3/4" PVB glass, 48" x 48", PGISO75, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	180 (lbsf)	Preload	-0.817			
Released Test Load	90 (lbsf)	RTL	0			
		150	-0.552			
Ultimate Test Load	365 (lbsf)	200	-1.088			
		250	-1.648			
Deflection Specifications Per ASTM E985		300	-2.212			
Max Mid Deflection	2.25	UTL	-2.928			
		RD	-0.317			
Residual Deflection (At RTL)	0.45					

Notes

Potentiometer cannot be zeroed, so calculations are done manually

Shoe mounted to steel plate

Conclusions

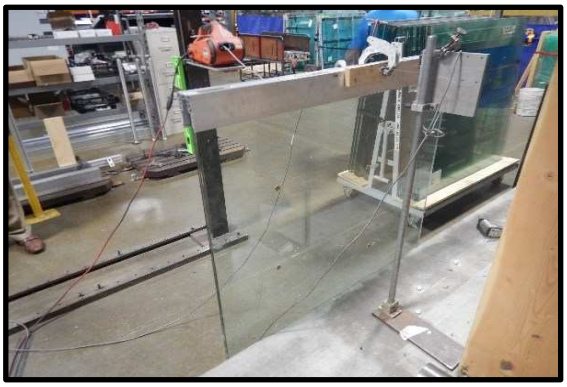
Rail does not meet ASTM Standard for Max. Allowed Deflection for Mid

Rail meets ASTM Standard for Residual Deflection

Rail fails.

TEST PHOTOS

Initial Setup: Mid



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Railing System Load/Deflection Testing

Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	5/8" SGP glass, 48" x 48", PGISO17, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	180 (lbsf)	Preload	-0.656			
Released Test Load	90 (lbsf)	RTL	0			
		150	-0.43			
Ultimate Test Load	365 (lbsf)	200	-0.815			
		250	-1.24			
Deflection Specifications Per ASTM E985		300	-1.7			
Max Mid Deflection	2.25	UTL	-2.244			
		RD	-0.224			
Residual Deflection (At RTL)	0.45					

Notes

Potentiometer cannot be zeroed, so calculations are done manually
Shoe mounted to steel plate
Thick side of glass facing out

Conclusions

Rail meets ASTM Standard for Max. Allowed Deflection for Mid
Rail meets ASTM Standard for Residual Deflection

TEST PHOTOS

Initial Setup: Mid

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Railing System Load/Deflection Testing

Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	5/8" SGP glass, 48" x 48", PGISO17, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	180 (lbsf)	Preload	-0.619			
Released Test Load	90 (lbsf)	RTL	0			
		150	-0.393			
Ultimate Test Load	365 (lbsf)	200	-0.777			
		250	-1.176			
Deflection Specifications Per ASTM E985		300	-1.592			
Max Mid Deflection	2.25	UTL	-2.123			
		RD	-0.161			
Residual Deflection (At RTL)	0.45					

Notes

Potentiometer cannot be zeroed, so calculations are done manually

Shoe mounted to steel plate

Thin side of glass facing out

Conclusions

Rail meets ASTM Standard for Max. Allowed Deflection for Mid

Rail meets ASTM Standard for Residual Deflection

TEST PHOTOS

Initial Setup: Mid

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Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	5/8" PVB glass, 48" x 48", PGISO17, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	**180 (lbsf)**	Preload	-1.001			
Released Test Load	**90 (lbsf)**	RTL	0			
		150	-0.669			
Ultimate Test Load	**365 (lbsf)**	200	-1.355			
		250	-2.07			
Deflection Specifications Per ASTM E985		300	-2.786			
Max Mid Deflection	**2.25**	UTL				
		RD	-0.292			
Residual Deflection (At RTL)	**0.45**					

Notes

Potentiometer cannot be zeroed, so calculations are done manually
Shoe mounted to steel plate
Thick side of glass facing out
Pot. Maxed out during ultimate load - no reading taken

Conclusions

Rail does not meet ASTM Standard for Max. Allowed Deflection for Mid
Rail meets ASTM Standard for Residual Deflection
Rail fails.

TEST PHOTOS

Initial Setup: Mid

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Test Focus (Part #s):	5/8" PVB glass, 48" x 48", PGISO17, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	**180 (lbsf)**	Preload	-0.979			
Released Test Load	**90 (lbsf)**	RTL	0			
		150	-0.641			
Ultimate Test Load	**365 (lbsf)**	200	-1.306			
		250	-2.103			
Deflection Specifications Per ASTM E985		300	-2.829			
Max Mid Deflection	**2.25**	UTL	-3.742			
		RD	-0.395			
Residual Deflection (At RTL)	**0.45**					

Notes

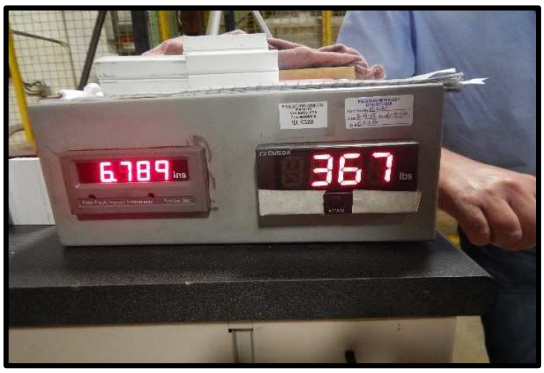
Potentiometer cannot be zeroed, so calculations are done manually
Shoe mounted to steel plate
Thin side of glass facing out

Conclusions

Rail does not meet ASTM Standard for Max. Allowed Deflection for Mid
Rail meets ASTM Standard for Residual Deflection
Rail fails.

TEST PHOTOS

Initial Setup: Mid



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Railing System Load/Deflection Testing

Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	21.5 mm SGP glass, 48" x 48", PGISO21, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	180 (lbsf)	Preload	-0.526			
Released Test Load	90 (lbsf)	RTL	0			
		150	-0.341			
Ultimate Test Load	365 (lbsf)	200	-0.645			
		250	-0.994			
Deflection Specifications Per ASTM E985		300	-1.415			
Max Mid Deflection	2.25	UTL	-1.88			
		RD	-0.155			
Residual Deflection (At RTL)	0.45					

Notes

Potentiometer cannot be zeroed, so calculations are done manually

Shoe mounted to steel plate

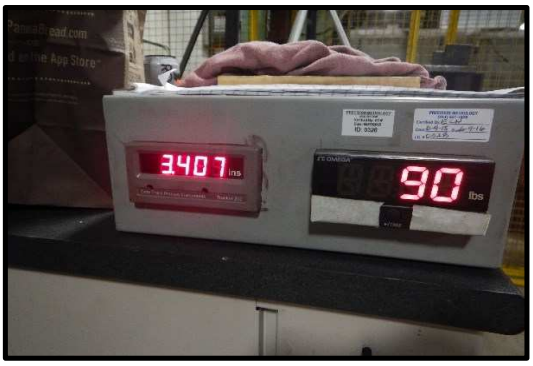
Conclusions

Rail meets ASTM Standard for Max. Allowed Deflection for Mid

Rail meets ASTM Standard for Residual Deflection

TEST PHOTOS

Initial Setup: Mid



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Railing System Load/Deflection Testing

Test Type:	Horizontal Load to 365 lbsf per ASTM E985 per section 7.1.5	Submitted By:	KGB	Submitted On:	04/21/16
Test Focus (Part #s):	21.5 mm PVB glass, 48" x 48", PGISO21, PG2475				
Railing Type:	Shoe molding, 4 panel grips, glass, unsupported sides				
Railing Specifications:	42" TOR, no caprail, 12" C-C mounting holes				
Test Method:	365 lbsf load per ASTM standards				

Test Specifications per ASTM E985		Results				
	System Calculations	Load (lbsf)	Displacement (in.)			Test Avg.
			Midrail	N/A	N/A	
Pre Load	**180 (lbsf)**	Preload	-0.762			
Released Test Load	**90 (lbsf)**	RTL	0			
		150	-0.529			
Ultimate Test Load	**365 (lbsf)**	200	-1.027			
		250	-1.707			
Deflection Specifications Per ASTM E985		300	-2.305			
Max Mid Deflection	**2.25**	UTL	-3.045			
		RD	-0.444			
Residual Deflection (At RTL)	**0.45**					

Notes

Potentiometer cannot be zeroed, so calculations are done manually

Shoe mounted to steel plate

Conclusions

Rail does not meet ASTM Standard for Max. Allowed Deflection for Mid

Rail meets ASTM Standard for Residual Deflection

Rail fails.

TEST PHOTOS

Initial Setup: Mid