STRUCTURAL CALCULATIONS FOR

W12 GATES

AT

DANA POINT MARINA

Building&Safety: Roshanak Amirazizi 3/14/2023

Revision: 7
Permits: BNR21-0604.R7

County of Orange - OC Public Works
OC Development Services
APPROVED

This set of plans and specifications must be kept on the job at all times. It is unlawful to make any changes or alterations to these plans without written permission from OC Public Works, OC Development Services of Orange County. The stamping of these plan specifications SHALL NOT be held to permit or be an approval of the violation of any provisions of any County Ordinance or State law.

Hadi Tabatabaee
BUILDING OFFICIAL

7

REGISTERED PROFESSIONAL ENGINEER
FREDERICK WILLIAM GRANTHAM
No. 82413
CIVIL
STATE OF CALIFORNIA

February 08, 2023

BELLINGHAM MARINE INDUSTRIES, INC.

[X] NO EXCEPTIONS TAKEN

[ ] REVISE AND RESUBMIT (RAR)

[ ] OTHER: _____

REVIEW IS ONLY FOR GENERAL CONFORMANCE WITH THE DESIGN CONCEPT OF THE PROJECT AND GENERAL COMPLIANCE WITH THE INFORMATION GIVEN IN THE CONTRACT DOCUMENTS, ANY ACTION SHOWN IS SUBJECT TO THE REQUIREMENTS OF THE PLANS AND SPECIFICATIONS. CONTRACTOR IS RESPONSIBLE FOR DIMENSIONS WHICH SHALL BE CONFIRMED AND CORRELATED AT THE JOB SITE; ENGINEERING; FABRICATION PROCESSES AND TECHNIQUES OF CONSTRUCTION; COORDINATION OF THEIR WORK WITH THAT OF ALL OTHER TRADES AND THE SATISFACTORY PERFORMANCE OF THEIR WORK.

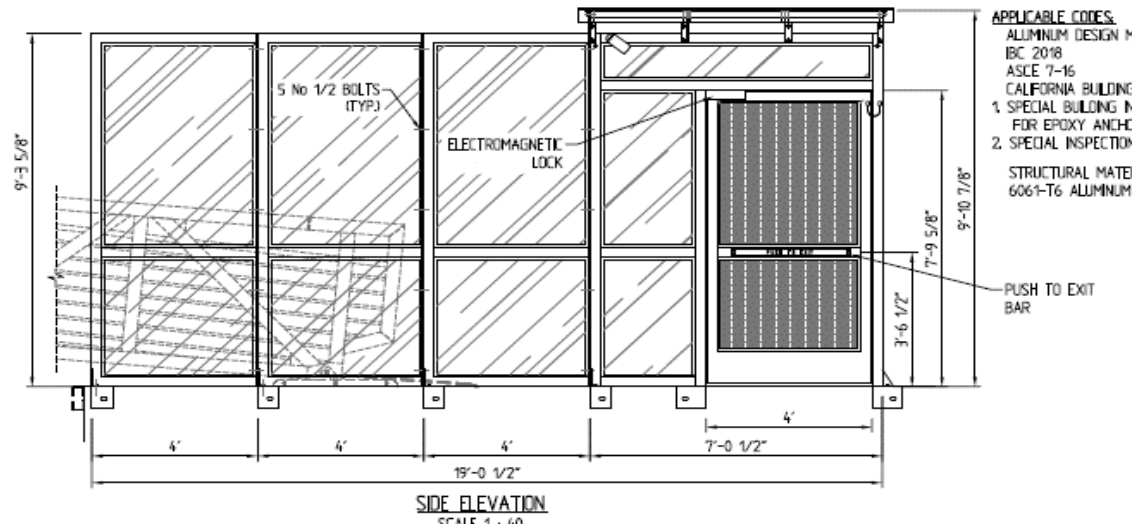
Craig Funston P.E., S.E.

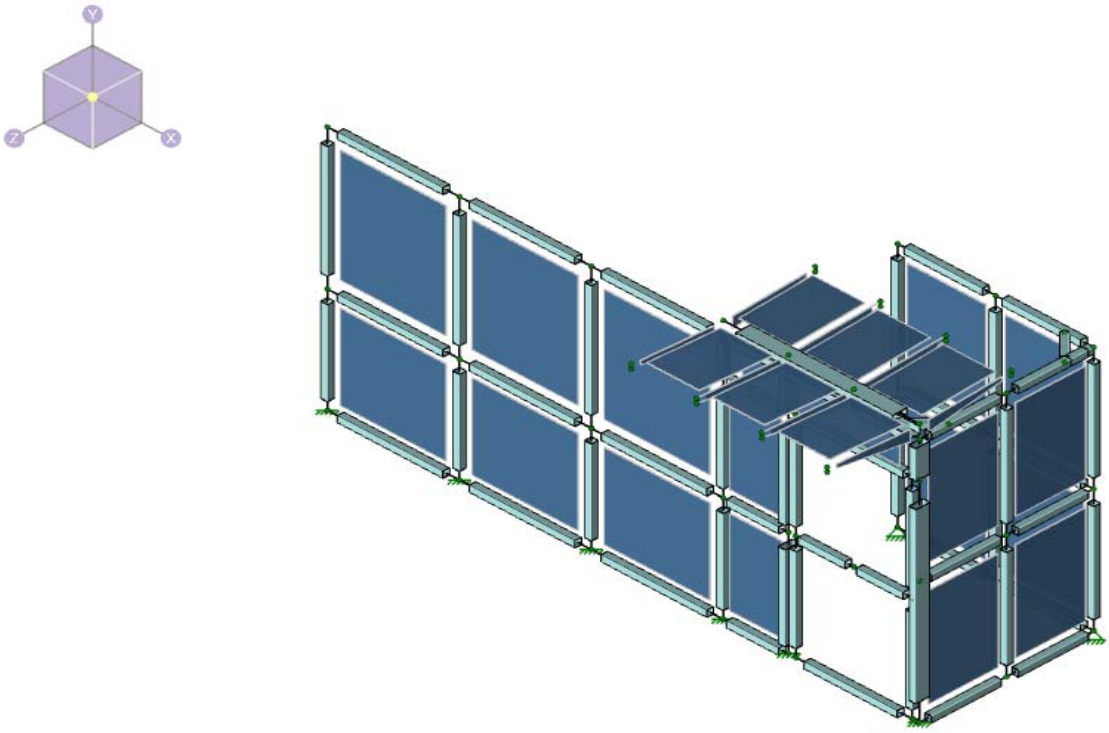
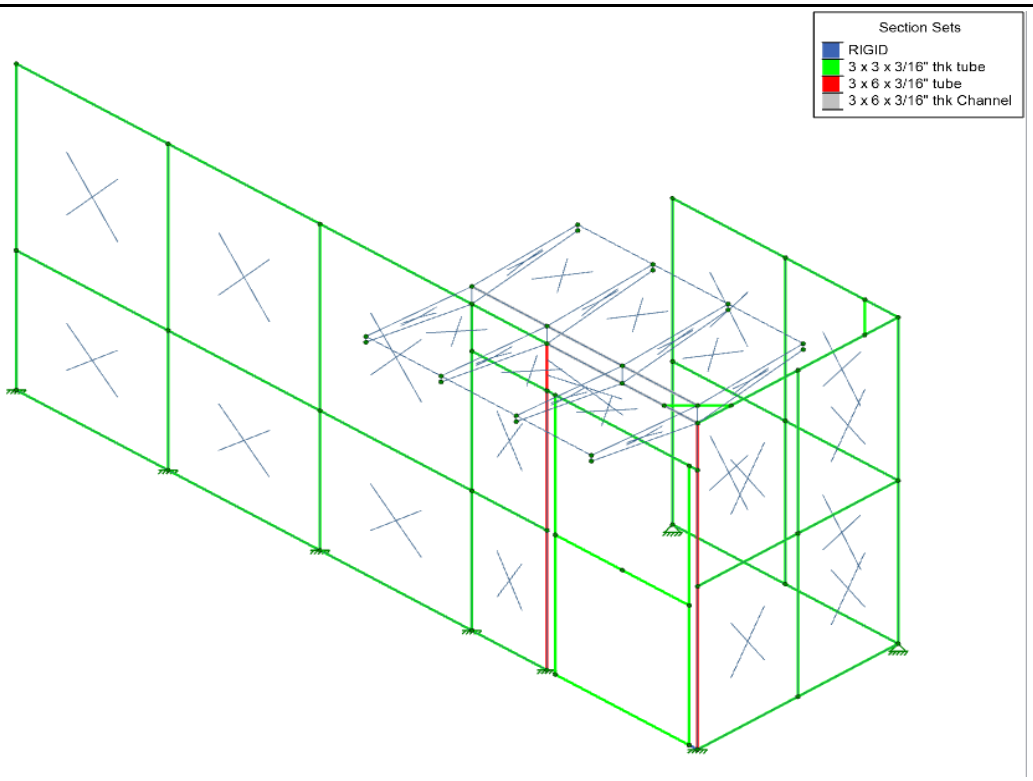
02/08/2023

Prepared By:

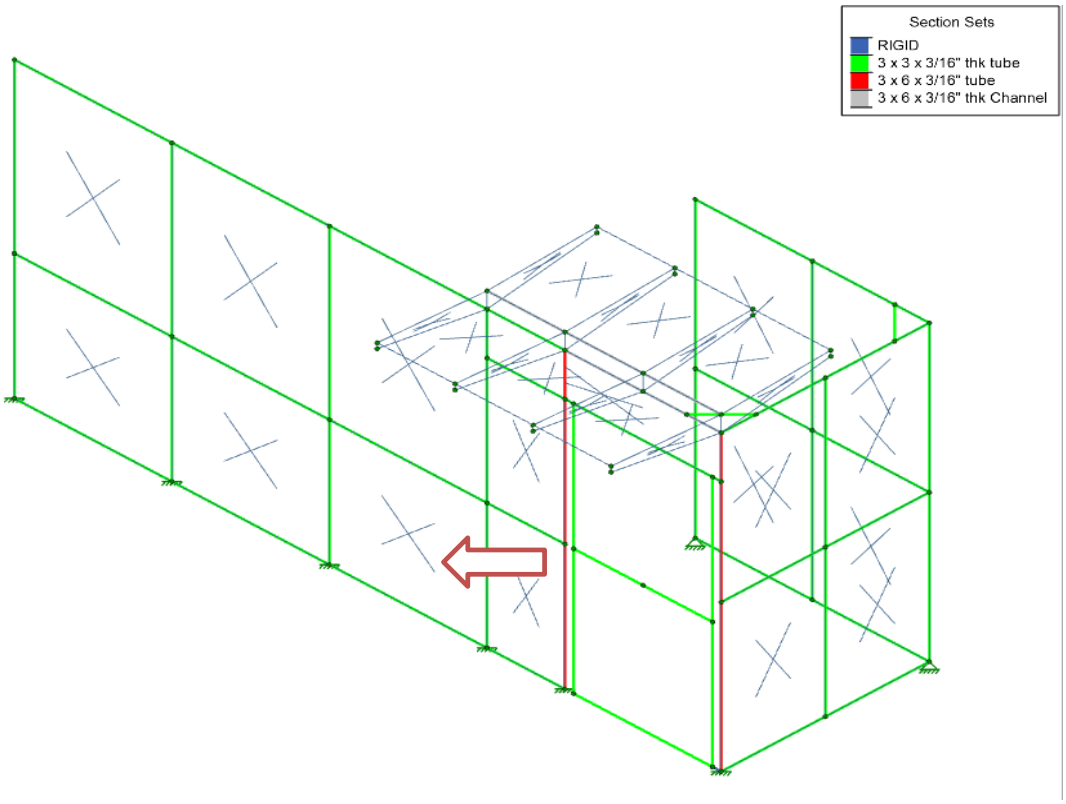
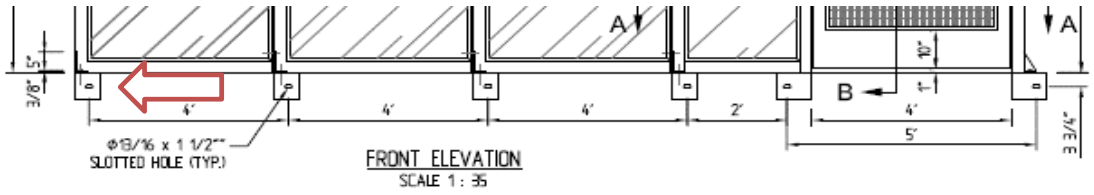
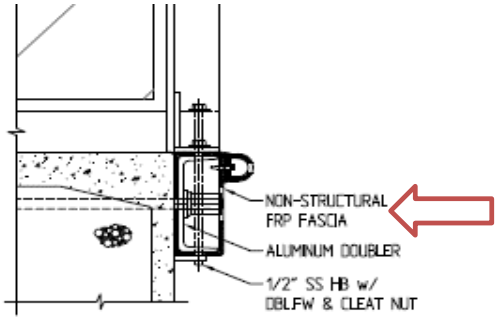
Grantham Engineering, Inc.
7807 Hillandale Drive
San Diego, CA 92120
(619) 994-0748

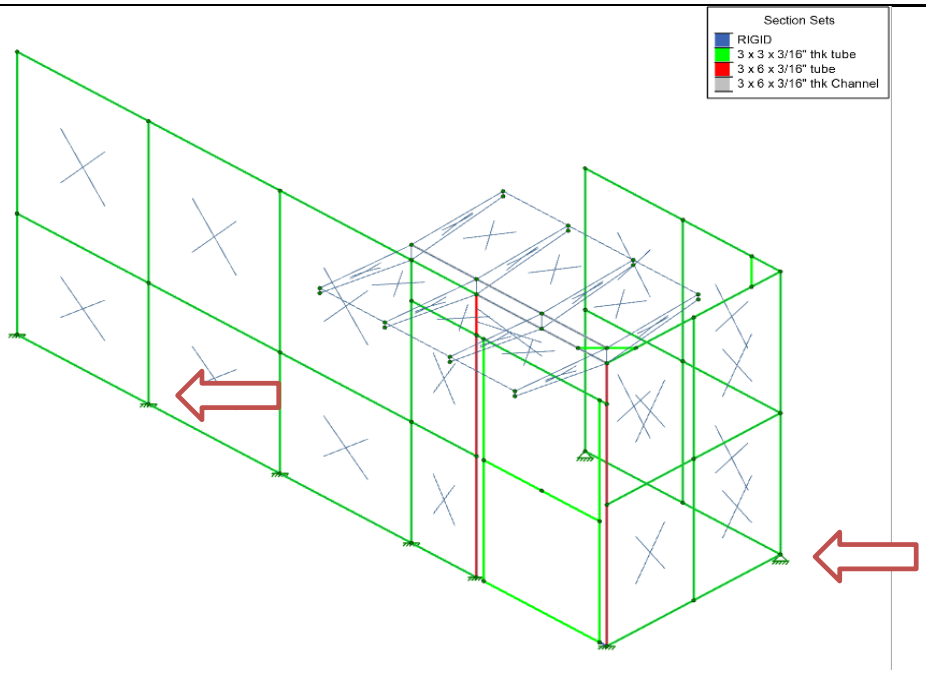
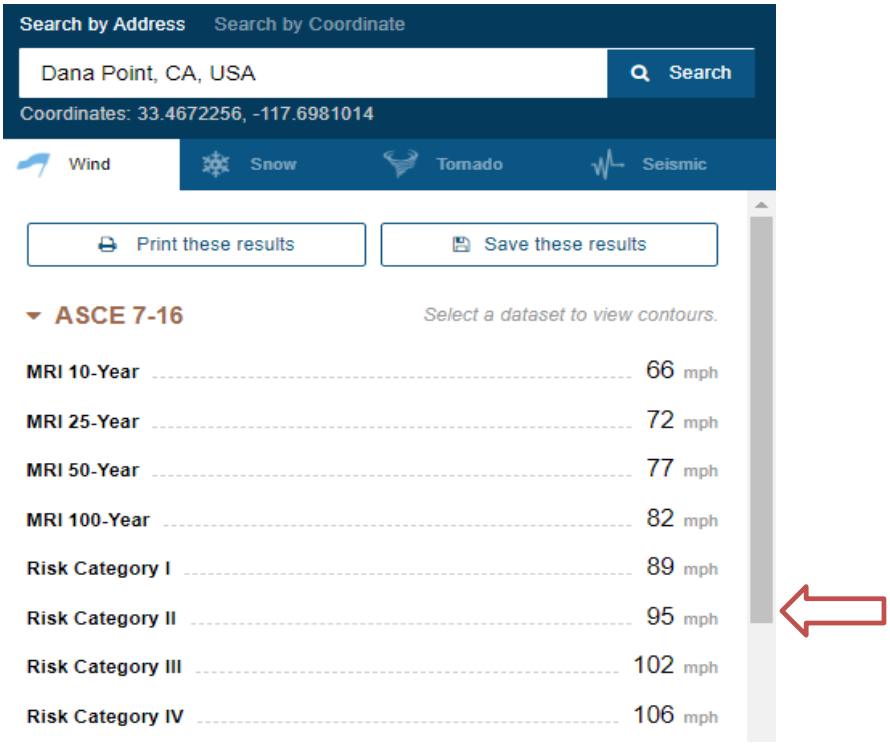
GRANTHAM ENGINEERING
Civil • Mechanical • Marine

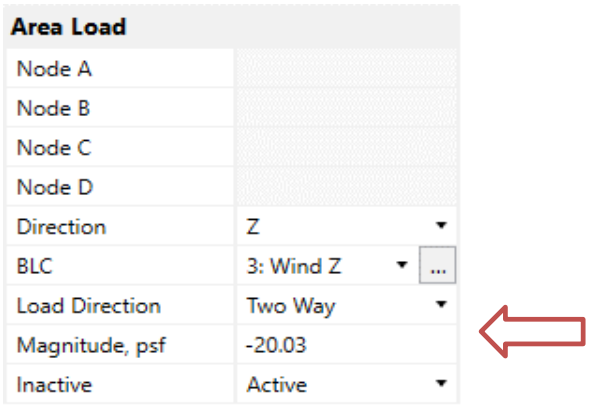
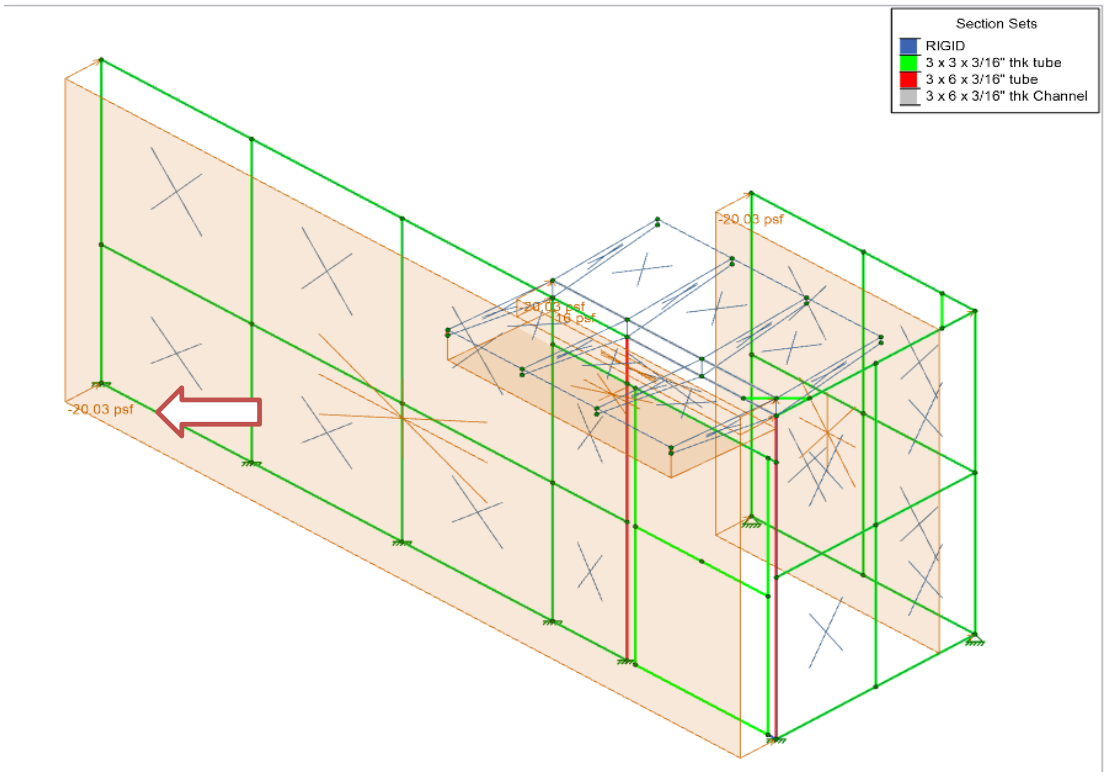
1	**Structural Calculations for Dana Point Gangway W12 ADA Gate**		
2	**Version 2**		
3	**Applicable Codes**		
4	ASCE 7-16 Minimum Design Loads for Building and other Structures		
5	California Layout and Design Marina Berthing Facilities 2005		
6	Aluminum Design Manual 2015 and 2020		
7	California Building Code 2019		
8	**Analytical Software**		
9	RISA 3D Version 20 (Structural)		
10	MECAWind PRO V2342 (Wind Loading)		
11	**Side View of Gate**		
12			
13	**Item**	**Value**	**Comments**
14	**Gate RISA Model**		

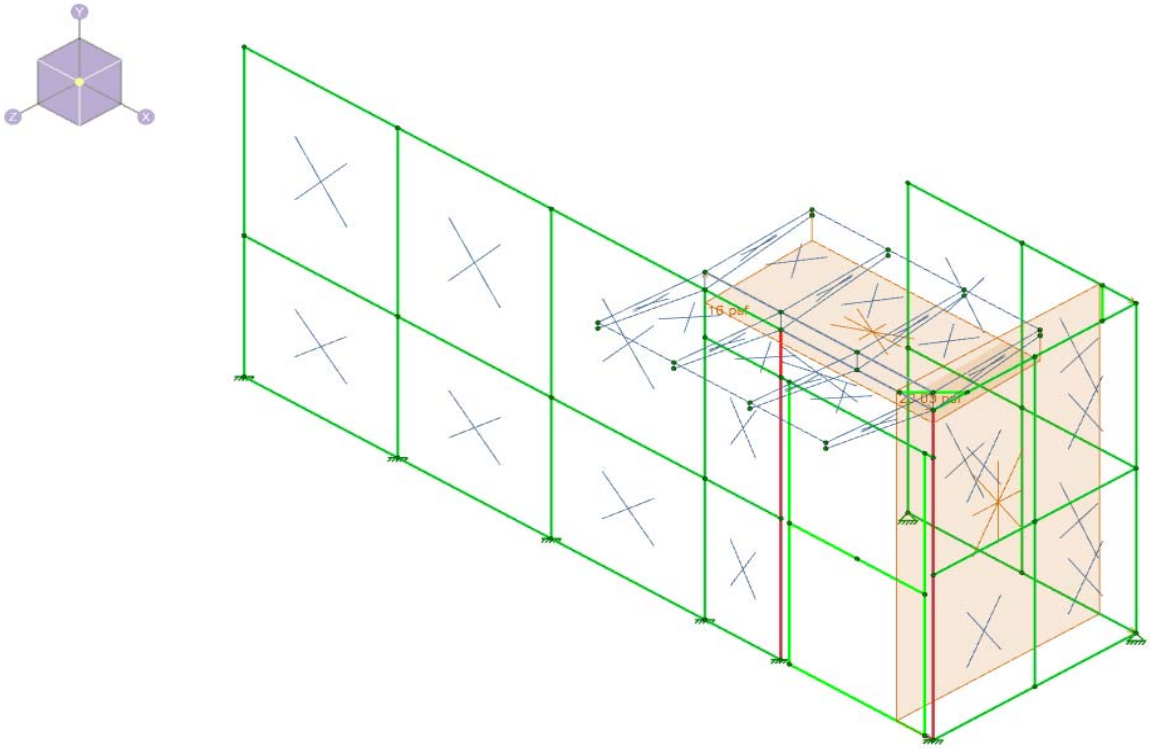
15	
16	 Section Sets RIGID 3 x 3 x 3/16" thk tube 3 x 6 x 3/16" tube 3 x 6 x 3/16" thk Channel

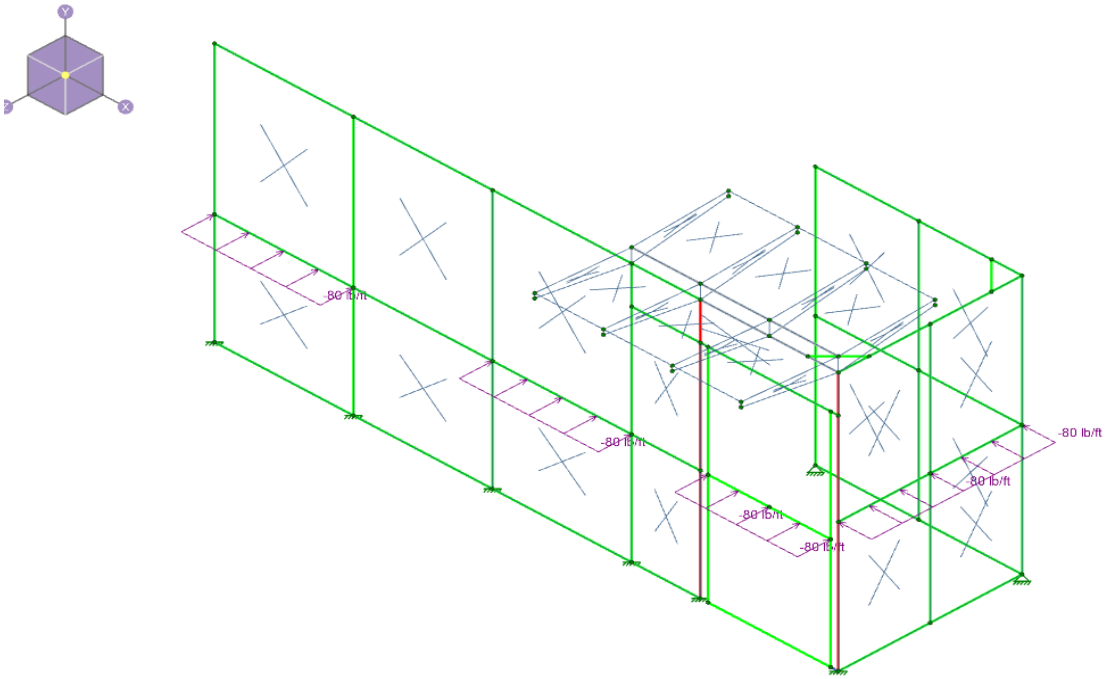
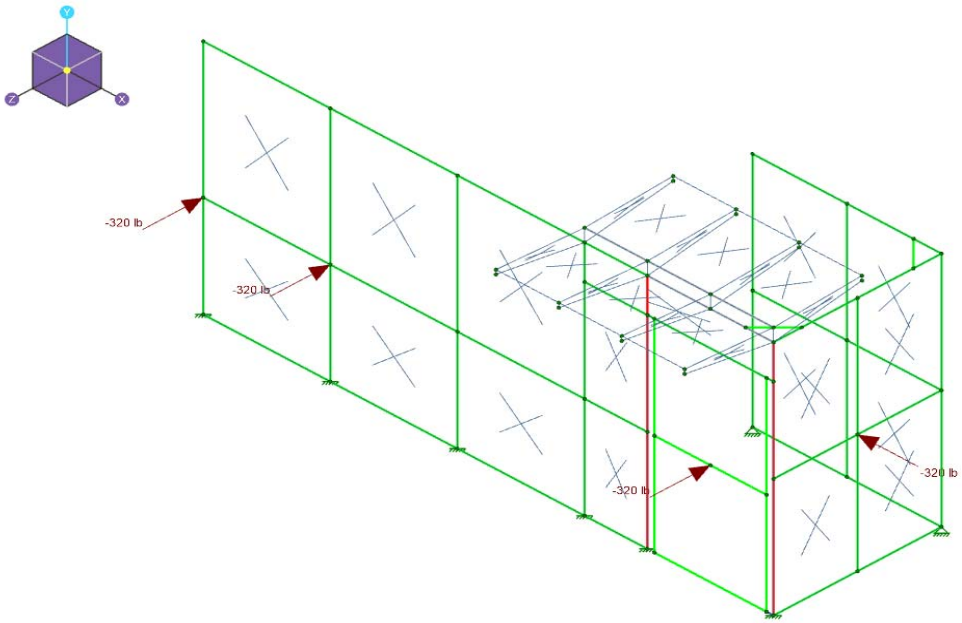
17	Aluminum Section Sets Hot Rolled | Cold Formed | Wood | Concrete | Aluminum | Stainless | General 1 — 3 x 3 x 3/16" thk tube — RT3X3X0.188 — None — None — 6061-T6 2 — 3 x 6 x 3/16" tube — RT3X6X0.188 — None — None — 6061-T6 3 — 3 x 6 x 3/16" thk Channel — 3X6X3/16"THK — None — None — 6061-T6 4 — Door Frame — RT2X2X0.125 — None — None — 6061-T6
18	The Section Sets define the major structural components of the Model match the parts list defined on the drawing
19	The glass panels are model as plates
20	General Materials Properties Hot Rolled | Cold Formed | Wood | Concrete | Masonry | Aluminum | Stainless | General 1 — gen_Conc3NW — 3155 — 1372 — 0.15 — 0.6 — 0.145 — Isotropic 2 — gen_Conc4NW — 3644 — 1584 — 0.15 — 0.6 — 0.145 — Isotropic 3 — gen_Conc3LW — 2085 — 906 — 0.15 — 0.6 — 0.11 — Isotropic 4 — gen_Conc4LW — 2408 — 1047 — 0.15 — 0.6 — 0.11 — Isotropic 5 — gen_Alum — 10600 — 4077 — 0.3 — 1.29 — 0.173 — Isotropic 6 — gen_Steel — 29000 — 11154 — 0.3 — 0.65 — 0.49 — Isotropic 7 — RIGID — 1e+6 — — 0.3 — 0 — 0 — Isotropic 8 — Glass — 1e+6 — — 0.3 — 0 — 0.175 — Isotropic
21	Set Plate Properties Draw Plates | Modify Plates | AutoMesh | Quad Submesh | Tri Submes Material Set: Glass — Plate Label Prefix: P Thickness: .375 in — Joint Label Prefix: N A Release Code: Fully Fixed / Pinned B Release Code: Fully Fixed / Pinned C Release Code: Fully Fixed / Pinned D Release Code: Fully Fixed / Pinned

22	
23	Add reaction points. The wall connection to the dock will be analyised in using solidworks simulation
24	 FRONT ELEVATION SCALE 1 : 35  DETAIL 1 SCALE 1 : 10

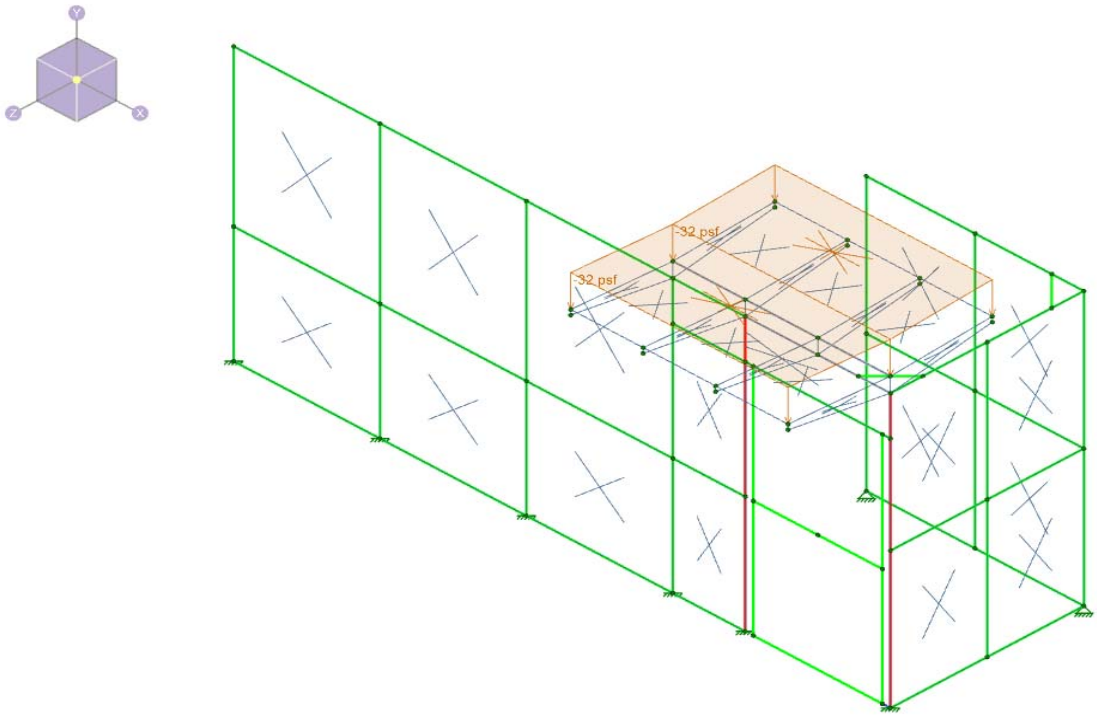
25			
26	**Loading the RISA Model**		
27	Wind Pressure, Qz (lbs/ft^2)	20.03	0.00256 x kz x kzt x Kd x Ws^2, Kz = .85, Kzt = 1.2, Kd =.75 Use in RISA analysis
28	Basic Wind Speed, V (mph)	95.00	See below
29			

30	Wind Directionality factor, Kd	0.85	Section 26.6-1
31	Exposure Category	C	Section 26.7.3, If not Exposure B or D, use Exposure C.
32			
33	Wind Load in the Z-direction		
34			
35	Wind Load in the X-direction		

36	
37	**Wind Uplift Load**
38	Wind Uplift Load, Wu (psf) 16 See Below
39	**Wind Pressures for C&C on a Canopy per Ch 30 Part 7 and Sec 30.11** **Wind Pressures for C&C on Canopy per Ch 30 Part 7 & Fig 30.11-1A/B** **All wind pressures include a load factor of 1.0** Description Zone Width Span Area GCp Pos GCp Neg P Min psf P Max psf ft ft ft ft Zone Lower Surface Lower Surface 9.000 26.000 234.000 0.600 -0.650 -16.00 16.00 Zone Upper Surface Upper Surface 10.000 26.000 260.000 0.600 -0.700 -16.00 16.00
40	**See above in both the X and Z directions**
41	**Equivalent Lateral Force Procedure for Seismic Loading**
42	**Seismic Analysis (none) The Gate is not effected by base shear loads.**
43	Uniform Handrail Load - 50 plf

44	
45	Concentrated Handrail Load - 200 lbs
46	
47	Roof Live Load: 20 psf

48



49 Define Basic Load Cases

50

Basic Load Cases

	BLC Description	Category	X Gravity	Y Gravity	Z Gravity	Nodal	Point	Distributed	Area(Member)
1	Self Weight	DL		-1					
2	Wind X	WLX							3
3	Wind Z	WLZ							4
4	Seismic X	ELX							
5	Roof Live Load	RLL							2
6	Seismic Z	ELZ							
7	Uniform handrail load	OL1						6	
8	Concentrated Load	OL2				4			

51 **Define Load Combinations**

52

Load Combinations

Combinations | Design

LC Generator | RSA Scaling Factor

	Description	Solve	P-Delta	SRSS	BLC	Factor	BLC	Factor
1	Dead Load	☑	Y		DL	1		
2	Roof Load	☑	Y		DL	1.2	RLL	1.6
3	Concentrated handrail l...	☑	Y		DL	1.2	OL2	1.6
4	handrail uniform load	☑	Y		DL	1.2	OL1	1.6
5	Wind Down X	☑	Y		DL	1.2	WLX	1
6	Wind Up X	☑	Y		DL	0.9	WLX	1
7	Wind Down Z	☑	Y		DL	1.2	WLZ	1
8	Wind Down -Z	☑	Y		DL	0.9	WLZ	-1
9	Wind Up Z	☑	Y		DL	0.9	WLZ	1
10	Wind Up -Z	☑	Y		DL	0.9	WLZ	-1

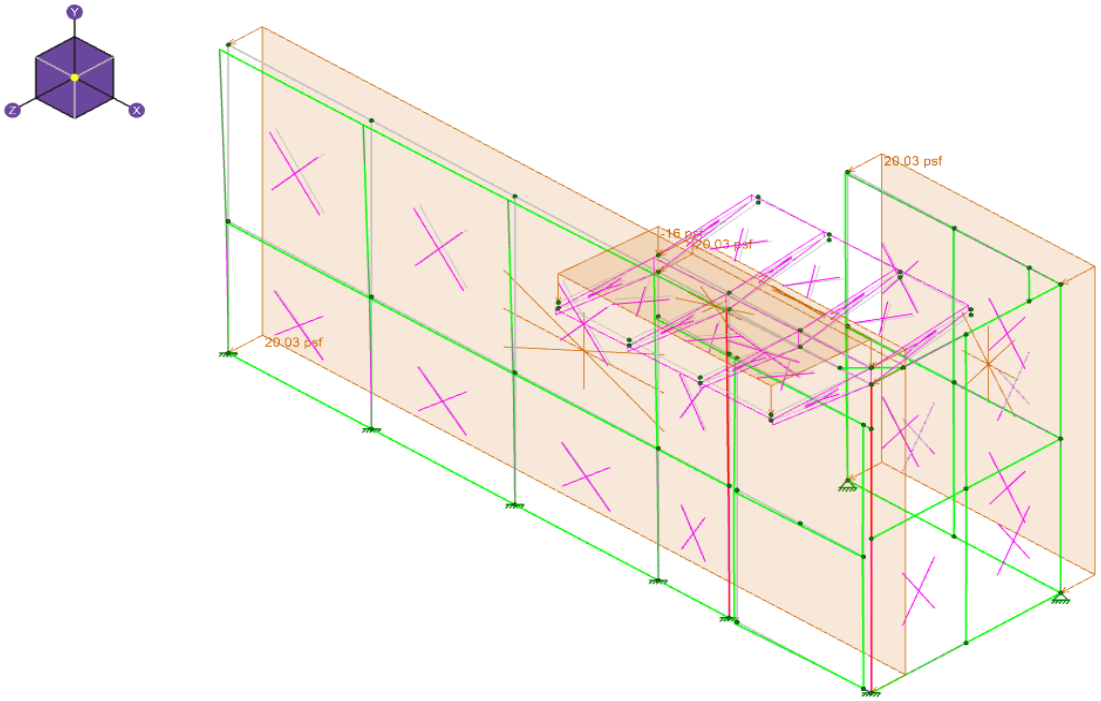
53 **Deflection Analysis**

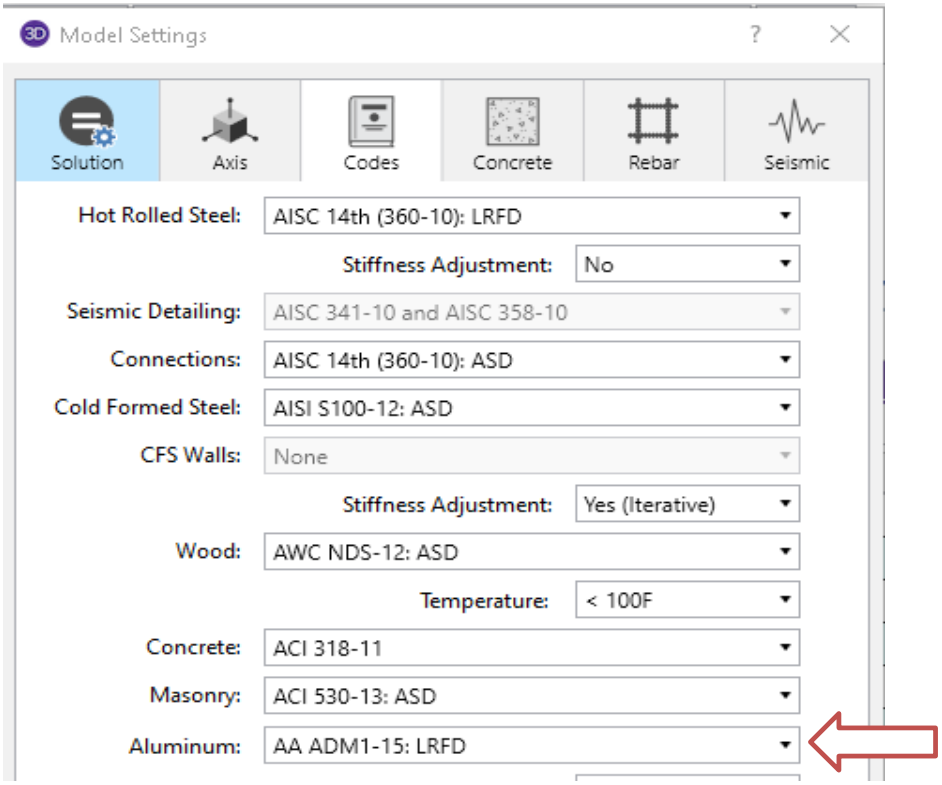
54 Run all the Load Combinations to determine the largest deflection

55

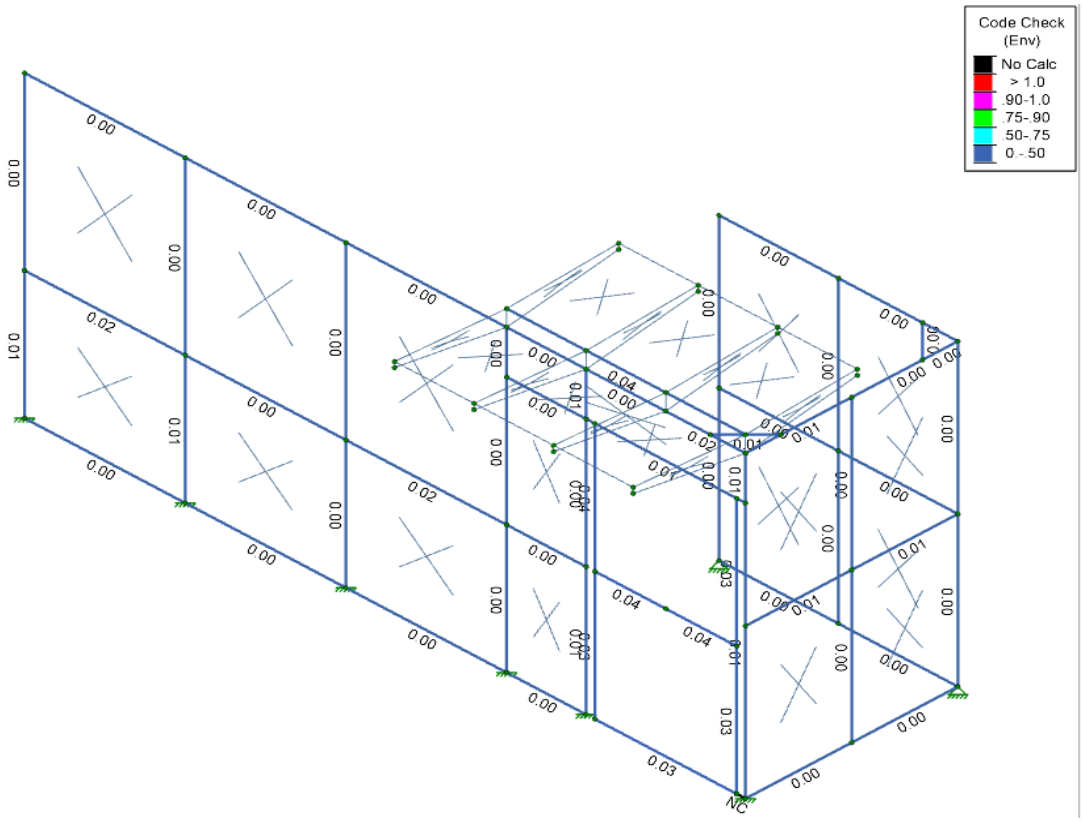
Envelope Node Displacements

	Node Label		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation [rad]	LC
1	N97	max	0	10	0	10	0.412	10	-3	10
2		min	0	9	0	7	-0.412	7	-5.626e-3	7
3	N93	max	0	10	0	10	0.396	10	5.02e-3	10
4		min	0	9	0	7	-0.396	7	-5.021e-3	7

56			
57	Max Allowable Deflection, Dam (in)	1.333	10 ft height x 12 /180 for Cantilever Systems.
58	Max Deflection, Dm (in)	0.412	See above
59	**Safety Factor**	**3.24**	**Dam/Dm >1 OK**
60	**Verify Code Compliance**		

61	
62	**Strength Analysis**
63	Run the all Load Combinations

64



65

Envelope AA ADM1-15: LRFD - Building Aluminum Code Checks

Hot Rolled Steel | Cold Formed Steel | Wood | Concrete Beams | Concrete Columns | Aluminum | Stainless

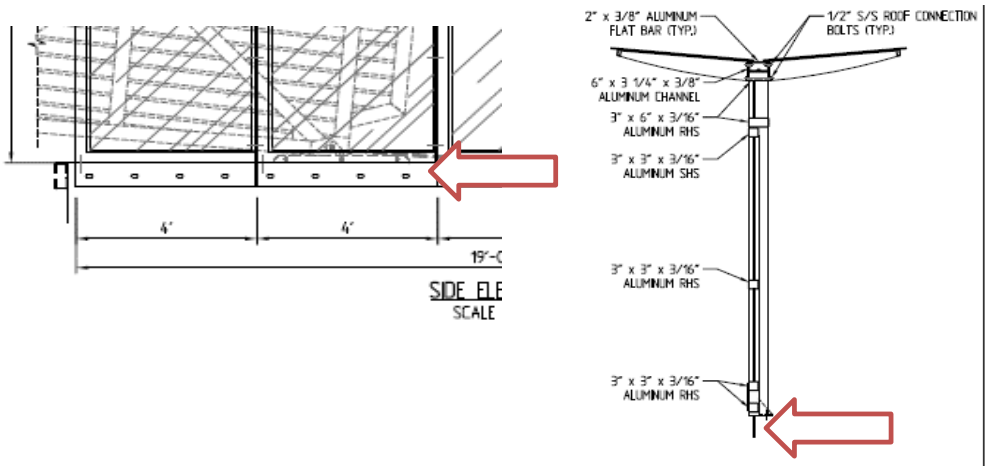
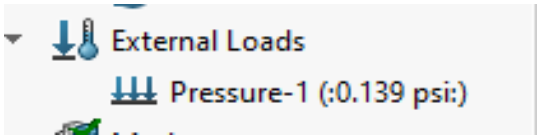
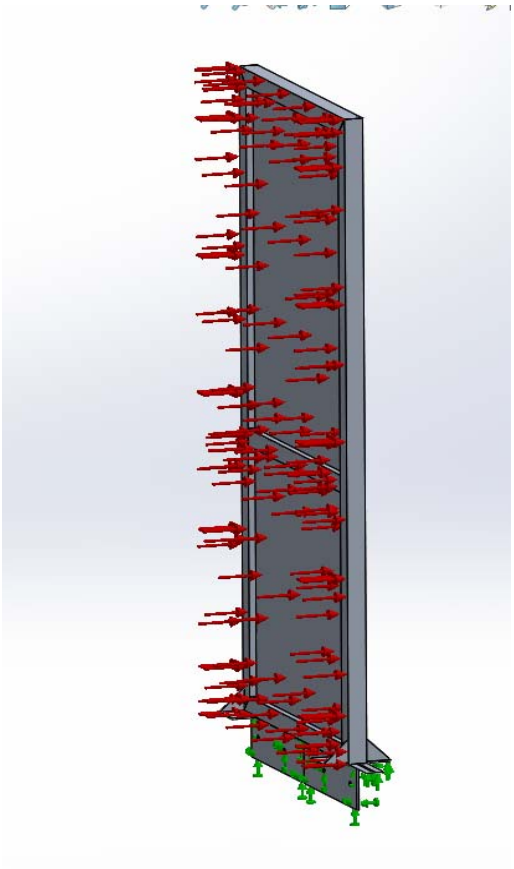
	Member	Shape	Code Che...	Loc[in]	LC	Shear Check	Loc[in]	Dir	LC
1	M78	RT3X3X0.188	0.044			0.014	24.02	z	4
2	M19	RT3X3X0.188	0.044	24.02	3	0.015	0	z	4
3	M32	3X6X3/16"THK	0.038	27.003	2	0.011	27.003	z	2
4	M14	RT3X3X0.188	0.036	0	4	0.008	47.5	y	3
5	M18	RT3X3X0.188	0.033	47.5	3	0.017	47.5	y	3

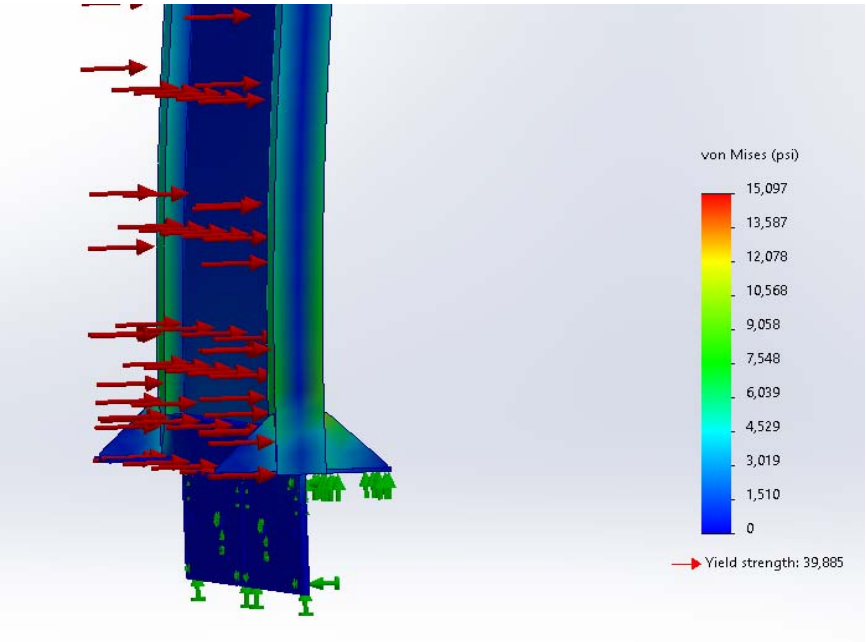
66

The code check values are the UC Max and Shear UC shown on the bridge. The colors represent a factored ratio of actual to allowable load for LFRD based on the provisions of the Aluminum Design Manual 2015. Ratios greater than 1 are shown in RED; therefore, any member in RED is not acceptable.

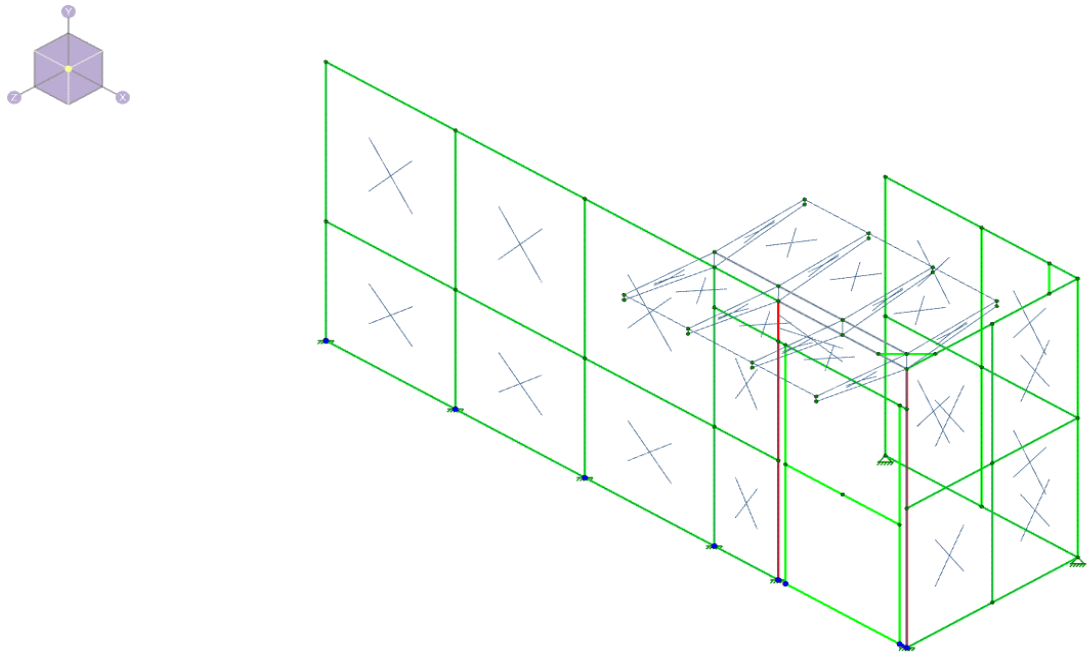
67

Check Wall to Dock Connections

68			
69	**Wind Load, WL (psf)**	**20.03**	**See above**
70	**Wind Load, WL (psi)**	**0.139**	**WL/144**
71	 		

72			
73	Max Stress of Member, Fm (psi)	6,000	See above. This area is in the weld effected zone.
74	Yield Stress of Material, Fy (psi)	11,250.00	See below. 15,000 (Welded affected Zone Area) x 0.75 (strength reduction factor).
75	**Design of Aluminum Structure** **Design of member in Tension** **Strength reduction factor and safety factor** **LRFD design:** Strength reduction factors-building type structures $\phi = 0.75$ for tensile rupture $\phi = 0.75$ for tensile yielding		
76	**Safety Factor**	**1.88**	**Fy/Fm > 1 OK**
77	**Check Nylon Rod Shear Capacity**		

78



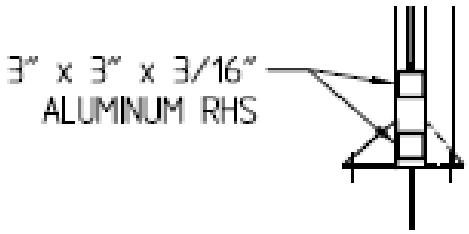
79

Envelope Node Reactions

	Node Label		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-ft]	LC	MY [lb-ft]
1	N91	max	183.912	7	512.353	7	954.078	7	3539.608	7	113
2		min	-183.859	8	59.514	8	-953.984	8	-3539.006	8	-45.278
3	N87	max	150.27	7	667.251	2	783.867	7	2949.145	7	95.673
4		min	-116.511	8	243.581	6	-783.718	8	-2948.301	8	-95.676

80	**Moment Load on Wall, ML (ft-lbs)**	**3,539.00**	**See above**

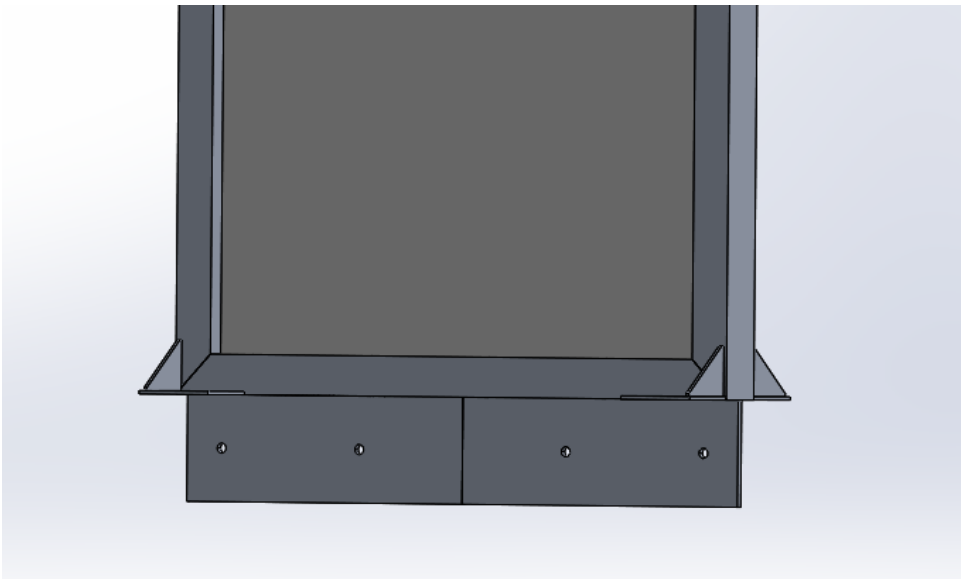
81

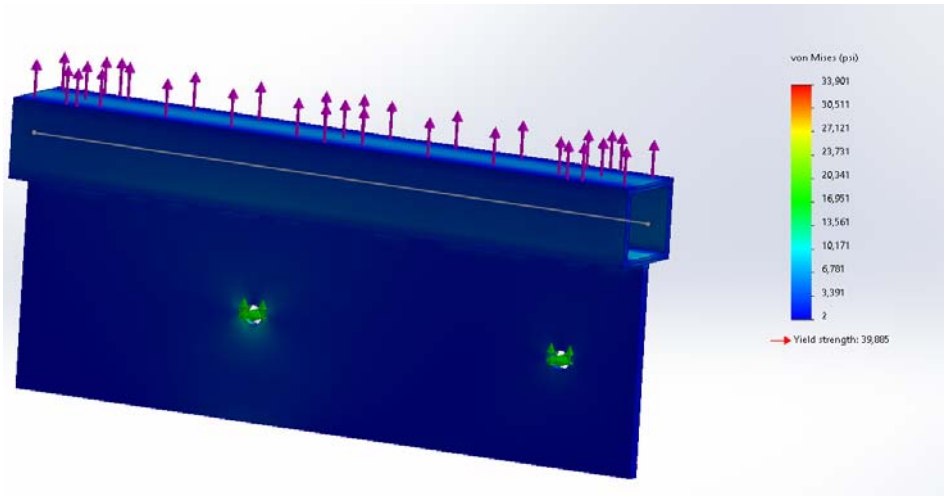
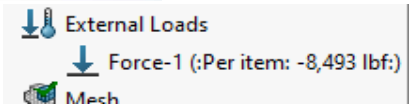


82	**Distance from Gusset Edge to center of Panel, D (in)**	**5.00**	**10in / 2**
83	**Shear Load on Nylon Rods, T (lbs)**	**8,493.60**	**ML / (D/12)**
84	**Diamer of Rods, Dr (in)**	**0.75**	

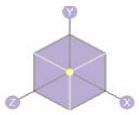
85	**Cross Sectional Area of Rods, Ar (in^2)**	**0.44**	**.25 X 3.141 X Dr^2**
86	**Number of Rods, N**	**2.00**	
87	**Shear Stress per Rod, Vr (lbs)**	**4,807.30**	**T / Ar / N/ 2 faces (double shear)**
88	**Shear Capacity of Nylon, Vc (psi)**	**7,200.00**	**9600 psi x 0.75 (resistance factor)**
89	**Nylon 6/6 Mechanical Properties (73o F / 23o C)**		

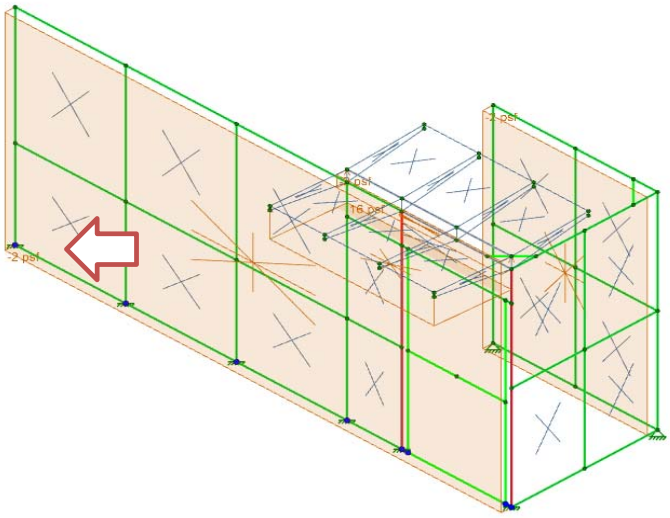
TENSILE STRENGTH	D638	12,000 PSI.	82.7 MPA
ELONGATION	D638	60%	60%
SHEAR STRENGTH	D732	9,600 PSI.	66.2 MPA
FLEXUARAL MODULUS	D790	410,000 PSI.	2.,287 MPA
IMPACT STRENGTH	D256	1.0 FT/LB/IN	5.5 KG/CM2
HARDNESS	D785	R121	M79
SPECIFIC GRAVITY	D792	1.13	1.13
MELTING POINT	D789	500 F	2600 C
DIELECTRIC STRENGTH	D149	600 V/MIL	10 OHM-CM
UNDERWRITERS LABORATORY RATING	BUL. 94	94V2	94V2

90	**Safety Factor**	**1.50**	**See above**
91	**Check Wall Stress between Blade and Tubing**		
92			

93	 		
94	Max Stress of Member, Fm (psi)	6,500	See above. This area is in the weld effected zone.
95	Yield Stress of Material, Fy (psi)	11,250.00	See below. 15,000 (Welded affected Zone Area) x 0.75 (strength reduction factor).
96	**Design of Aluminum Structure** **Design of member in Tension** **Strength reduction factor and safety factor** **LRFD design:** Strength reduction factors-building type structures $\phi = 0.75$ for tensile rupture $\phi = 0.75$ for tensile yielding		
97	**Safety Factor**	**1.73**	**Fy/Fm > 1 OK**
98	**Shear Load, V (lbs)**	**954.00**	**See above**
99	**Determine Fatigue Stress on Connection**		
100	**Wind Load at 25 mph (psf)**	**2.00**	

101





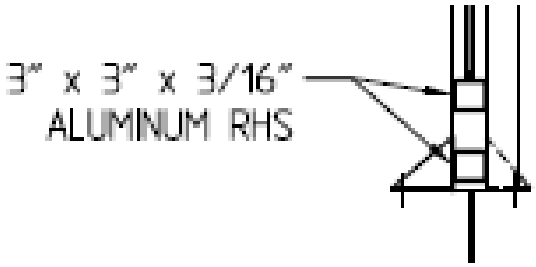
102

Node Reactions (By Combination)

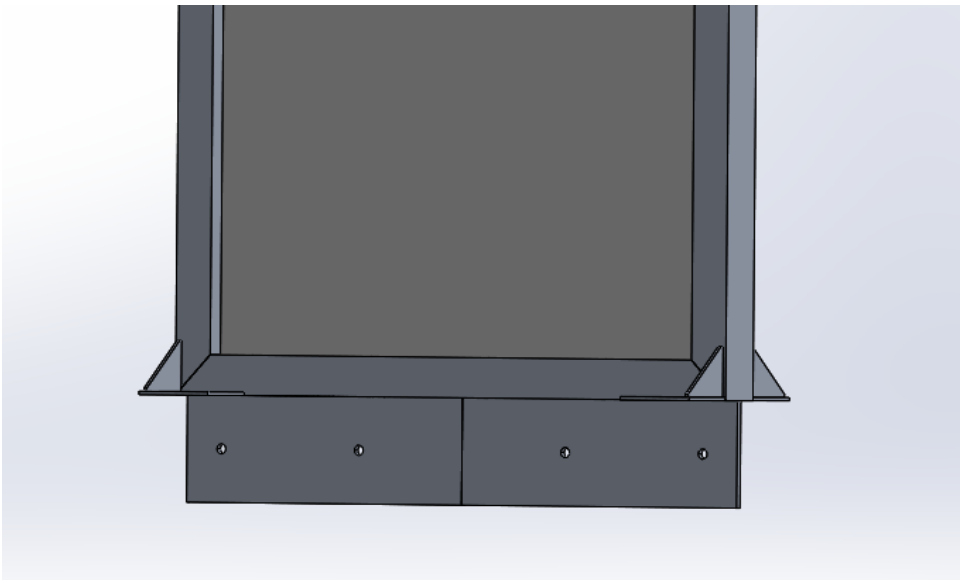
	LC	Node Label	X [lb]	Y [lb]	Z [lb]	MX [lb-ft]	MY [lb-ft]	MZ [lb-ft]
1	7	N91	25.086	354.913	95.249	353.368	4.521	0.073
2	7	N87	19.363	368.642	78.288	294.45	9.543	-0.059
3	7	N27	2.987	295.461	59.16	189.072	12.912	-3.556

103	**Moment Load on Wall, ML (ft-lbs)**	**353.00**	**See above**

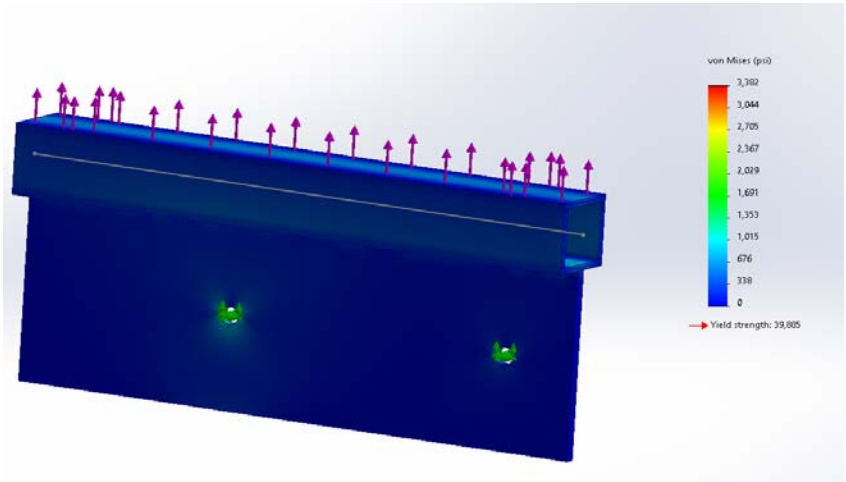
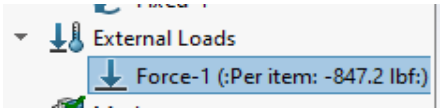
104



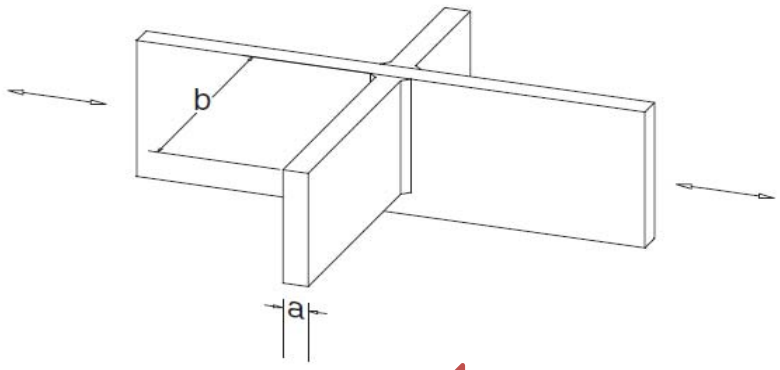
105	**Distance from Gusset Edge to center of Panel, D (in)**	**5.00**	**10in / 2**
106	**Shear Load on Nylon Rods, T (lbs)**	**847.20**	**ML / (D/12)**
107	**Diamer of Rods, Dr (in)**	**0.75**	
108	**Cross Sectional Area of Rods, Ar (in^2)**	**0.44**	**.25 X 3.141 X Dr^2**

109	**Number of Rods, N**	**2.00**	
110	**Shear Stress per Rod, Vr (lbs)**	**479.51**	**T / Ar / N/ 2 faces (double shear)**
111	**Shear Capacity of Nylon, Vc (psi)**	**7,200.00**	**9600 psi x 0.75 (resistance factor)**
112	Nylon 6/6 Mechanical Properties (73o F / 23o C)		
113	**Safety Factor**	**15.02**	**See above**
114	**Check Wall Stress between Blade and Tubing**		
115			

TENSILE STRENGTH	D638	12,000 PSI.	82.7 MPA
ELONGATION	D638	60%	60%
SHEAR STRENGTH	D732	9,600 PSI.	2 MPA
FLEXUARAL MODULUS	D790	410,000 PSI.	2.,287 MPA
IMPACT STRENGTH	D256	1.0 FT/LB/IN	5.5 KG/CM2
HARDNESS	D785	R121	M79
SPECIFIC GRAVITY	D792	1.13	1.13
MELTING POINT	D789	500 F	260O C
DIELECTRIC STRENGTH	D149	600 V/MIL	10 OHM-CM
UNDERWRITERS LABORATORY RATING	BUL. 94	94V2	94V2

116	 		
117	Max Stress of Member, Fm (psi)	1,000	See above.
118	**B.3.5 Design for Fatigue** Structures and their components subjected to repeated loading shall meet the requirements of Appendix 3. Fatigue need not be considered for seismic loads.		
119	**Figure 3.1** **FATIGUE DESIGN DETAILS**		

120



19

121

Table 3.1
STRESS CATEGORY

GENERAL CONDITION	DETAIL	Detail Category	Fatigue Design Details ①

122

Attachments	Base metal detail of any length attached by groove welds subject to transverse and/or longitudinal loading, with a transition radius $R \geq 2$ in. (50 mm) and with the weld termination ground smooth:		
	$R \geq 24$ in. (610 mm)	B	13
	24 in. > $R \geq 6$ in. (150 mm)	C	13
	6 in. > $R \geq 2$ in. (50 mm)	D	13
	Base metal at a detail attached by groove welds or fillet welds with a detail dimension parallel to the direction of stress $a < 2$ in. (50 mm)	C	19
	Base metal at a detail attached by groove welds or fillet welds subject to longitudinal loading, with a transition radius, if any, < 2 in. (50 mm): 2 in. (50 mm) $\leq a \leq 12b$ or 4 in. (100 mm) $a > 12b$ or 4 in. (100 mm)		
	Base metal at a detail of any length attached by fillet welds or partial-penetration groove welds in the direction parallel to the stress, with a transition radius $R \geq 2$ in. (50 mm), and the weld termination is ground smooth:	D E	14 14, 19, 20
	$R \geq 24$ in. (610 mm)	B	16
	24 in. > $R \geq 6$ in. (150 mm)	C	16
	6 in. > $R \geq 2$ in. (50 mm)	D	16

123

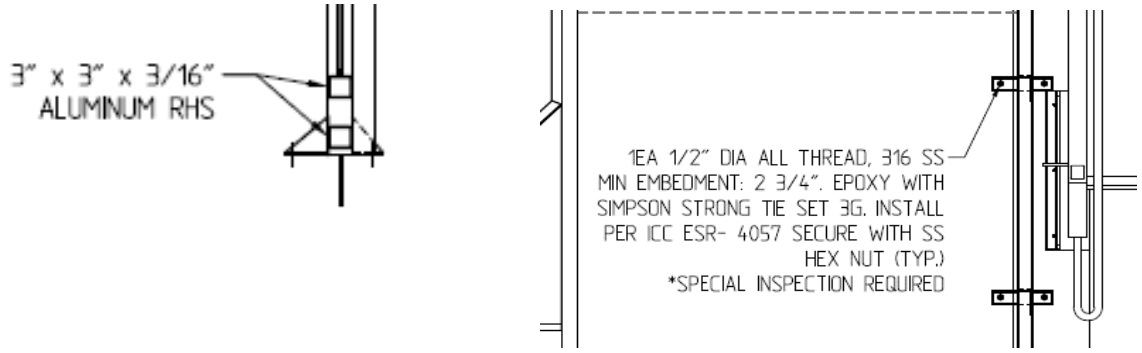
Table 3.2
CONSTANTS FOR S-N CURVES

Detail Category	C_f		m	Constant Amplitude Fatigue Limit	
	ksi	MPa		ksi	MPa
A	96.5	665	6.85	10.2	70
B	130	900	4.84	5.4	37
C	278	1920	3.64	4.0	28
D	157	1080	3.73	2.5	17
E	160	1100	3.45	1.8	13
F	174	1200	3.42	1.9	13
F1	29.0	200	7.31	3.2	22

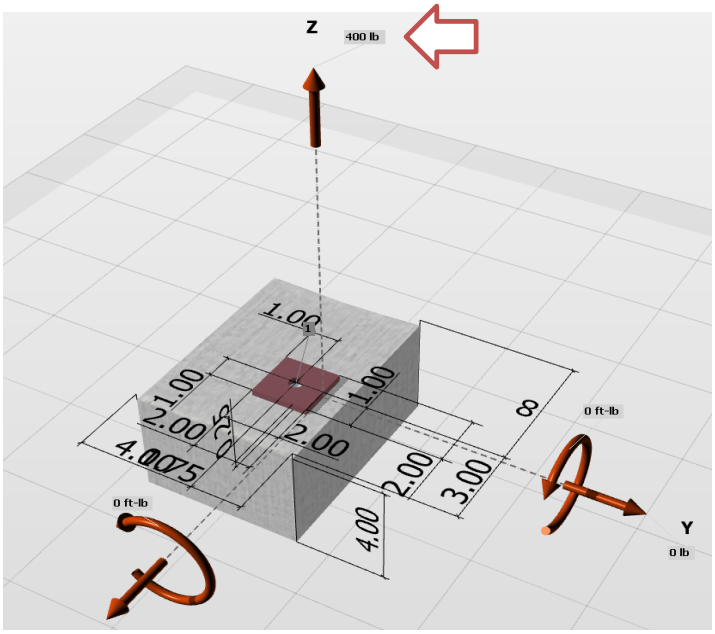
Constant amplitude fatigue limit is based on $N = 5 \times 10^6$ except for detail category F1 where $N = 10 \times 10^6$.

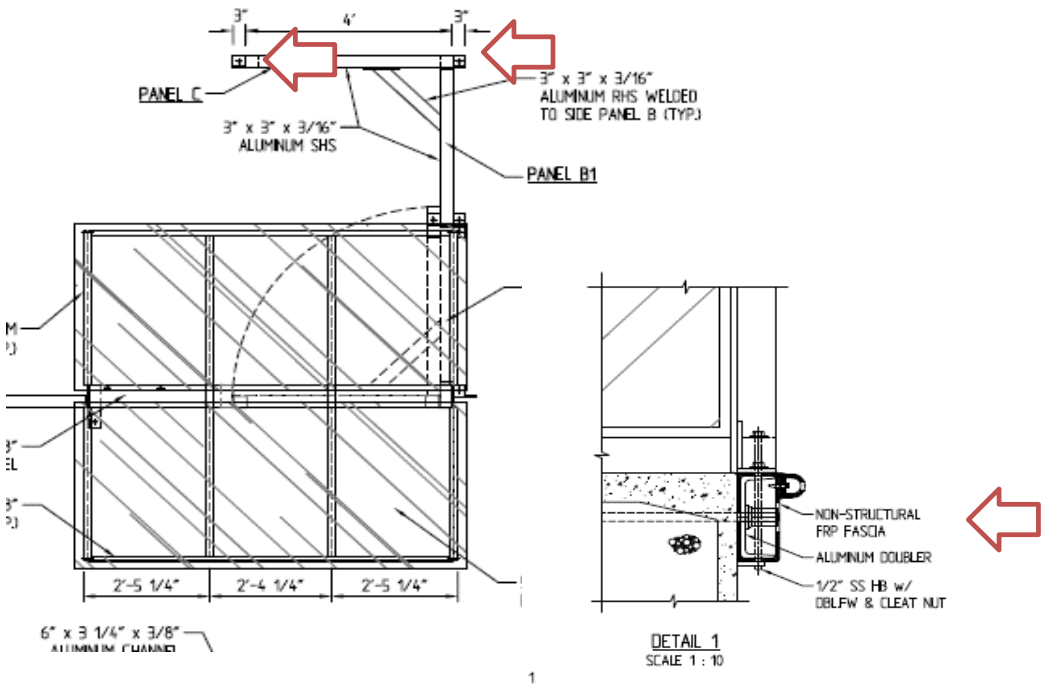
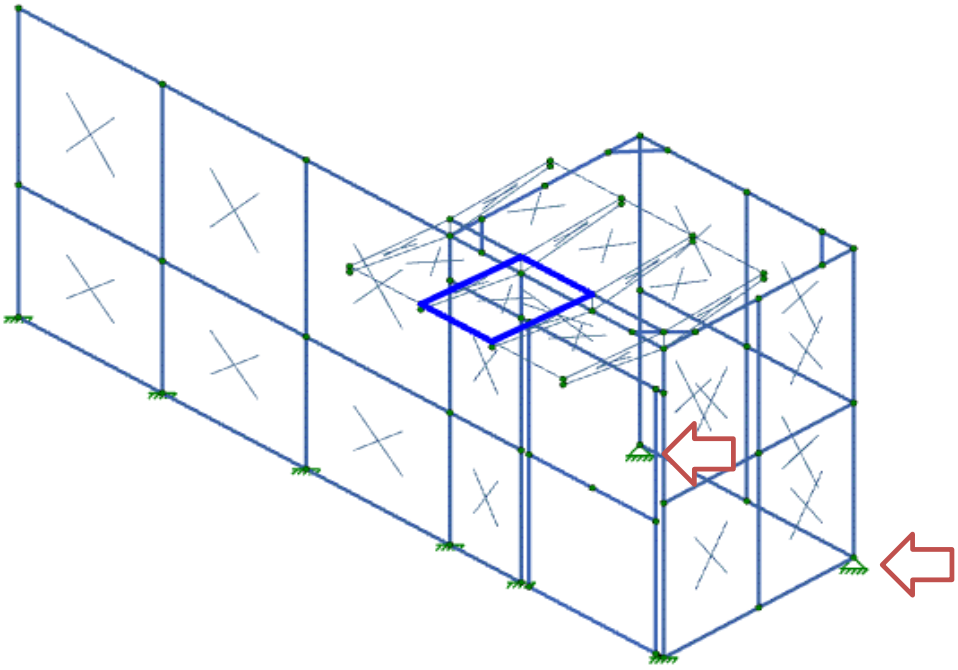
124	Max Stress of Member, Fm (psi)	1,000	See above. This area is in the weld effected zone.
125	Fatigue Stress Limit, Ff (psi)	4,000	See above
126	**Safety Factor**	**4.00**	**Ff / fm > 1 ok**
127	**Check Concrete Anchors**		

128



129	**Tensile Capacity of Anchor, T (lbs)**	**400.00**	**See below**

130	 **Input Data** Design method: ACI 318-14 Anchor: SET-3G w/ 1/2"Ø A193 Gr. B8/B8M (304/316SS) Effective Embedment depth: 2.750 inch Concrete: Normal-weight State: Cracked Compressive strength: 3000 psi Seismic design: No  **Resulting Anchor Forces** \# Tension [lb] Shear [lb] 1 882 0 **Governing tension ratio: 97.5% (Pass)** Ratio N_{ua} [lb] ΦN_n [lb] Steel strength 14.5% 882 6071 Concrete breakout 64.0% 882 1378 Adhesive 97.5% 882 905 **SET-3G w/ 1/2"Ø A193 Gr. B8/B8M (304/316SS) with hef = 2.750 inch meets the selected design criteria.**		
131	**Distance from bolt to opposite anchor plate, D (in)**	**9.00**	**See above**
132	**Moment Capacity, M (ft-lbs)**	**300.00**	**T x D / 12**
133	**Moment Load on Wall, ML (ft-lbs)**	**353.00**	**See above during a 25 mph constant wind load**
134	**Proportional Support, P (%)**	**84.99**	**M / ML x 100**
135	**These anchors help resist the 25 mph wind loads but not much else.**		
136	**Other Waler Anchors**		

137	
138	
139	**Run all load combinations**

140

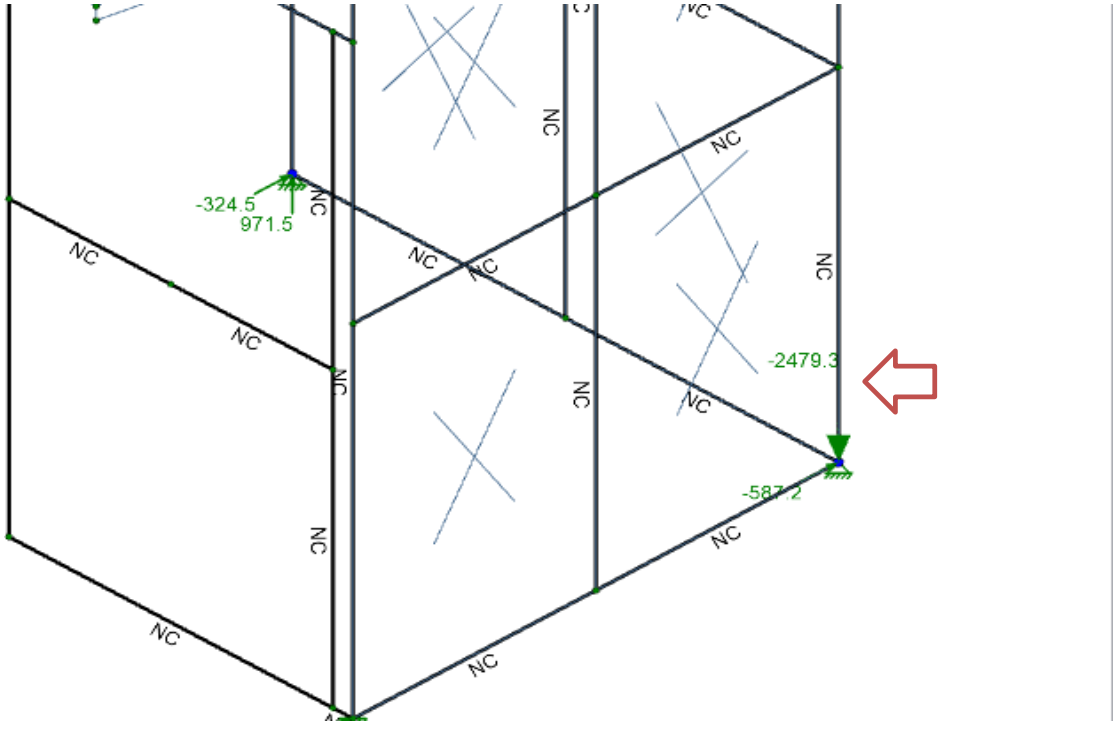
Envelope Node Reactions

	Node Label		X [lb]	LC	Y [lb]	LC	Z [lb]	LC
1	N63	max	350.652	10	3367.419	7	809.997	7
2		min	-506.268	7	-2479.263	8	-587.246	8
3	N70	max	341.199	10	971.479	10	324.405	9
4		min	-207.941	9	-554.325	9	-324.451	8

Node Reactions (By Combination)

	LC	Node Label	X [lb]	Y [lb]	Z [lb]
1	8	N63	350.652	-2479.263	-587.246
2	8	N70	341.199	971.479	-324.451
3	8	COG (in):	X: 10.081	Y: 68.588	Z: -17.254

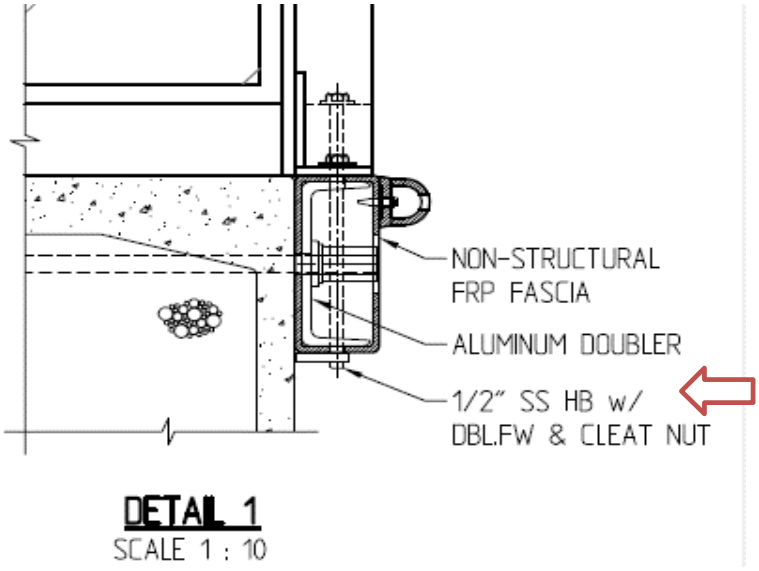
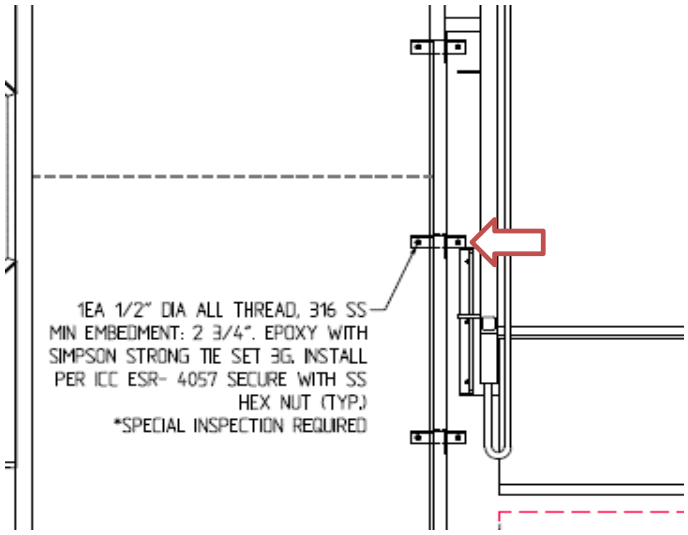
141

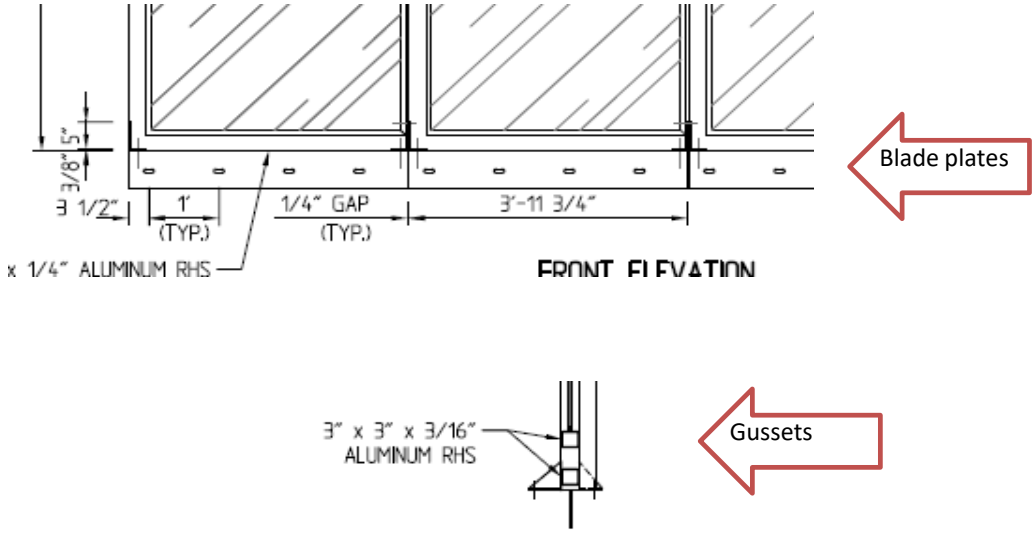
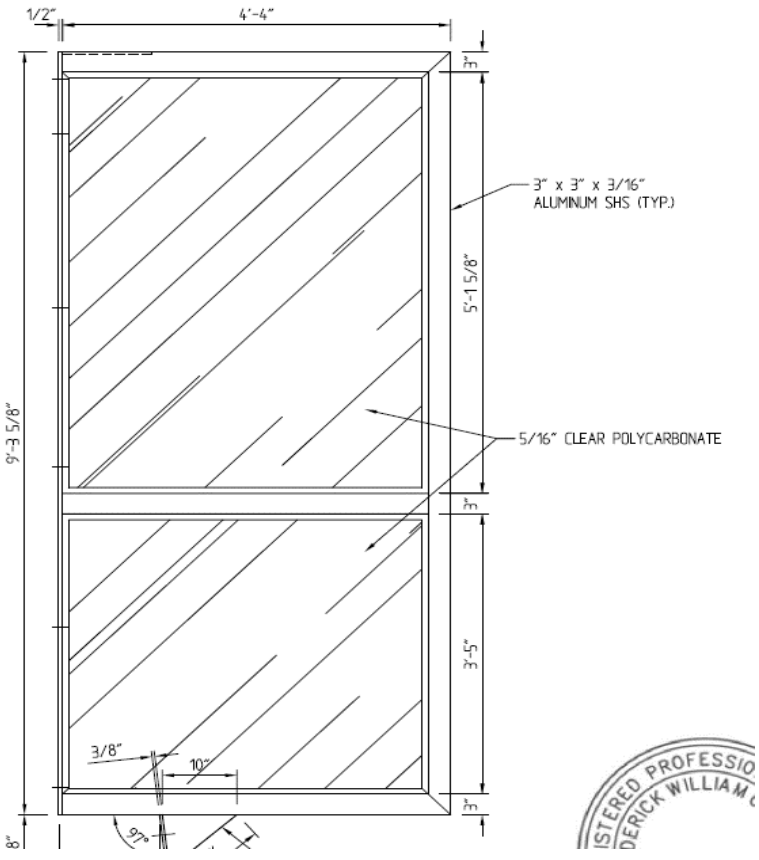


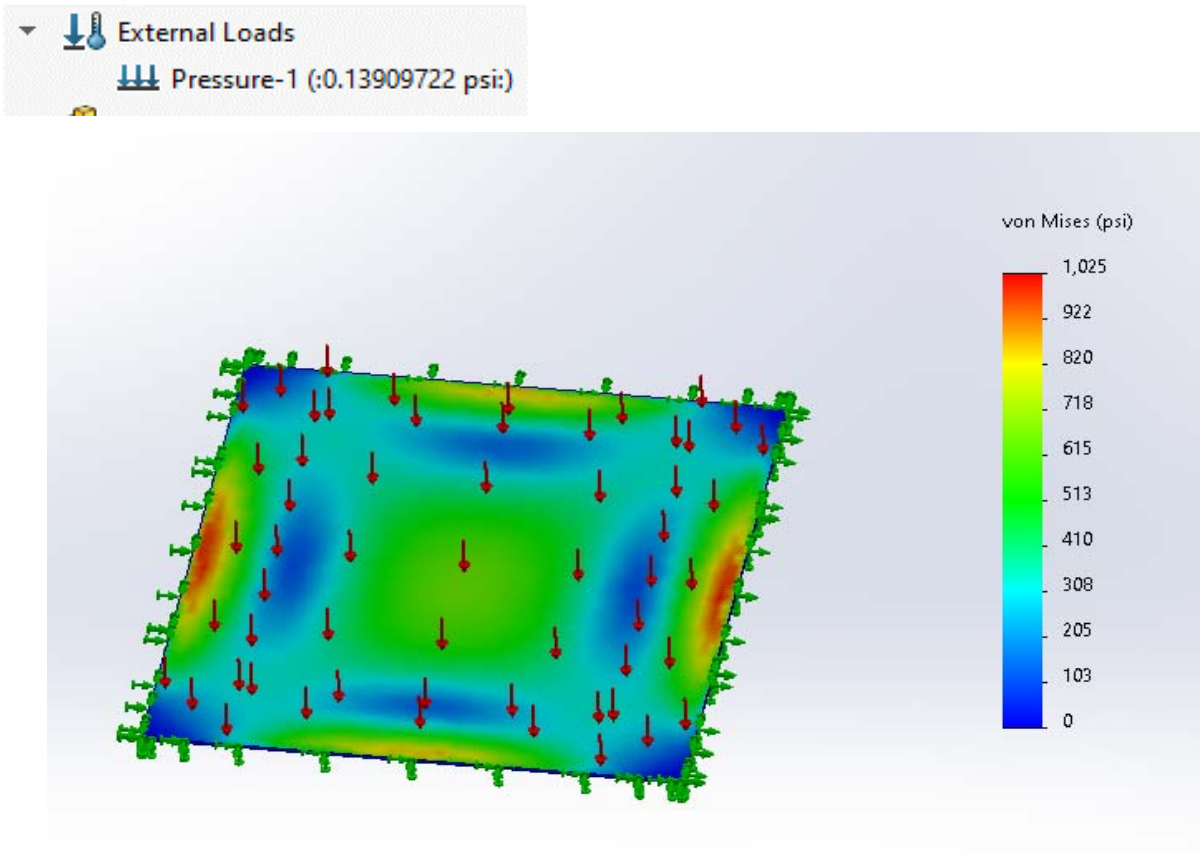
142

Bolt Capacity Check

143			
144	Nominal Tensile Strength of Fastener, Fnt (ksi)	31.20	See above
145	Nominal Shear Strength of Fastener, Fnv (ksi)	18.00	.577 x Fnt
146	Bolt Diameter, Db (in)	0.5	1/2"
147	Cross Sectional Area of Bolt, Ab (in^2)	0.20	.25 x 3.141 x Db^2
148	Tensile Strength of Bolt, Rnt (lbs)	4,593.71	Fnt x Ab x .75 (Resistance Factor) x 1000 (matches values in Table 7-2)
149	Shear Strength of Bolt, Rnv (lbs)	2,650.57	Fnv x Ab x .75 (Resistance Factor) x 1000 (matches values in Table 7-1)
150	Tensile Load on the single bolt, Tsb (lbs)	2,479.0	See above
151	Shear Load on a single bolt, Vsb (lbs)	683.4	(350^2 + 587^2)^1/2
152	**Combined Tension and Shear in Bearing-Type Connections** Tests have shown that the strength of bearing fasteners subject to combined shear and tension resulting from externally applied forces can be closely defined by an ellipse (Kulak and others, 1987). The relationship is expressed as $\left(\frac{f_t}{\phi F_{nt}}\right)^2 + \left(\frac{f_v}{\phi F_{nv}}\right)^2 = 1$ (LRFD) (C-J3-5a)		
153	Value needs to be less than 1	0.3577	See above formula <1 OK

154	
155	**Wall Panel Anchor**
156	**The wall panel anchors are meant to keep the panels flat against the concrete dock. However under all loads, the blade plates resist all the moment loads along with the gussets. See line 67**
157	

158	
159	**Verify Polycarbonate Plate will meet the loads.**
160	Check Wing Walls (straight wind loads)
161	

162	Use solidworks simulation to determine the max stress on the material.		
163	Roof Uplift Load, RLL (psf)	16	See above
164	Wing Wall Wind Load, Wm (psf)	20.03	See above
165	Max wind load, Wm (psi)	0.14	Wm is controlling both in magnitude and has a larger span between supports. Wm / 144
166			
167	Max stress of polycarbonate, Fm (psi)	1,095.00	See above
168	Yield Stress of Material, Fy (psi)	6,705.00	See below. 8940 x 0.75.

169	TUFFAK® GP sheets with thicknesses ranging between 0.030 to 0.060-inch-thick (0.76 to 1.5 mm) for wall and ceiling applications comply with the interior finish requirements of IBC Section 803.1. Select TUFFAK® GP, **MECHANICAL** Tensile Strength, Ultimate — ASTM D 638 — psi — 9,500 Tensile Strength, Yield — ASTM D 638 — psi — 9,000 Tensile Modulus — ASTM D 638 — psi — 340,000		
170	Safety Factor	6.12	Fy / Fm > 1 OK
171	End of Analysis		