SOLAR PV GROUND MOUNT
STRUCTURAL CALCULATIONS

APA SOLAR RACKING

20-345 County Road X, PO Box 326
Ridgeville Corners, OH 43555

Office: 419.267.5280
Fax: 419.267.5214

LOCATION
CONNECTICUT

PRINT PACKAGE NUMBER:
210261

ON:
06/24/2021

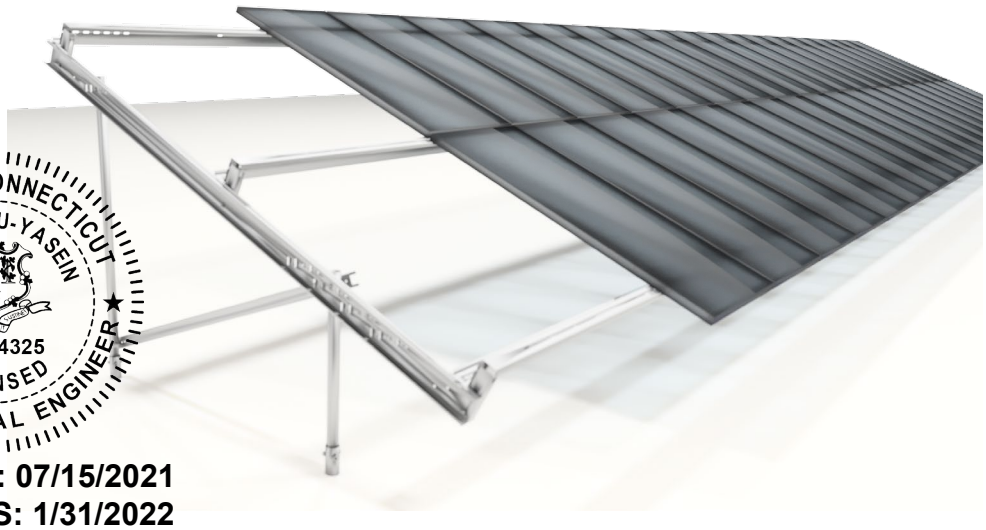
DESIGN CRITERIA:
TITAN
20° TILT
30 PSF SNOW
116 MPH WIND, RISK CAT 1, EX. C.

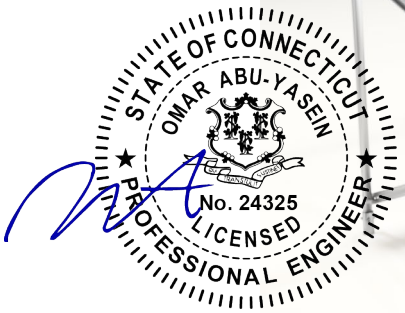
the jdi group
architects & engineers

360 W. Dussel Drive
Maumee, OH 43537

Office: 419.725.7161
Fax: 419.725.7160

ASCE 7-10
Load & Resistance Factor Design (LRFD) - Code Check
Allowable Stress Design (ASD) - Foundation Reactions





DATE SIGNED: 07/15/2021
DATE EXPIRES: 1/31/2022

REPORT: APA SOLAR
REVIEW: THE JDI GROUP

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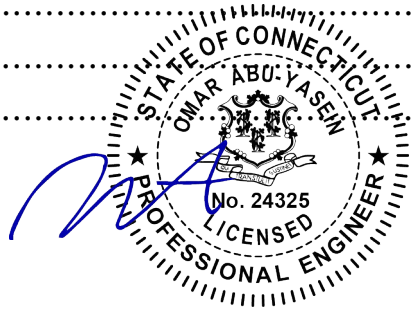

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LOAD CALCULATIONS

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General Calculations

Interface Title

General Dimensions

Racking Type	R_T = **1**
Quantity of PV Modules, Vertically (Cartridge)	PV_Q = **1**
PV Module Tilt	PV_T = **20.000** °
PV Module Length	PV_L = **82.50** in
PV Module Width	PV_W = **40.90** in
PV Module Area	$PV_A = PV_L \times PV_W$ = **23.43** ft^2
PV Module Weight	PV_{LB} = **60.000** lbs
Force Resisting Members Quantity	M_Q = **2.0**
Vertical Section Flat Length (chord)	PV_{FL} = if(R_T==1,$PV_L \times PV_Q$, $PV_W \times PV_Q$) = **6.88** ft
Vertical Section Profile Length (at tilt)	$PV_{PL} = PV_{FL} \times \cos(PV_T)$ = **6.46** ft
Horizontal Width (at tilt)	PV_{PW} = if(R_T==1,PV_W, PV_L) = **3.41** ft
Profile Height (at tilt)	$PV_{PH} = PV_{FL} \times \sin(PV_T)$ = **2.35** ft
Area Projected Vertically	$PV_{AV} = PV_{PL} \times PV_{PW}$ = **22.02** ft^2
Area Projected Horizontally	$PV_{AH} = PV_{PH} \times PV_{PW}$ = **8.01** ft^2

Dead Loading

Force Resisting Member Weight	M_W = **2.750** lbs/ft
Cartridge Weight per Member	$PV_{LBT} = PV_{LB} / PV_Q / M_Q$ = **30.000** lbs
Misc. Hardware Weight per Vertical Section	W_{MH} = **5.000** lbs
Dead Load per Vertical Section	$DL_T = -(PV_{LB} \times PV_Q + M_W \times PV_W \times M_Q \times PV_Q + W_{MH})$ = **-83.75** lbs
TD: Distributed Dead Load on Outer Member	$DL_o = DL_T / PV_Q / M_Q / PV_W \times 1.27879$ = **-15.71** lbs/ft
TD: Distributed Dead Load on Inner Member	$DL_i = DL_T / PV_Q / M_Q / PV_W \times 2 \times 0.7212$ = **-17.72** lbs/ft

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SNOW

SNOW LOADING (ASCE7-10)

Tedds calculation version 1.0.09

Building details

Roof type	Monopitch
Width of roof	b = **6.46** ft
Slope of roof 1	α = **20.00** deg

Ground snow load

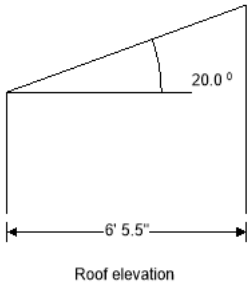
Ground snow load	p_g = **30.00** lb/ft^2
Density of snow	γ = min(0.13 × p_g / 1ft + 14lb/ft^3, 30lb/ft^3) = **17.90** lb/ft^3
Terrain type	C
Exposure condition (Table 7-2)	Fully exposed
Exposure factor (Table 7-2)	C_e = **0.90**
Thermal condition (Table 7-3)	Unheated structures
Thermal factor (Table 7-3)	C_t = **1.20**
Risk category (Table 1-1)	I
Risk factor (Table 7-4)	I_s = **0.80**
Flat roof snow load (Sect 7.3)	p_f = 0.7 × C_e × C_t × I_s × p_g = **18.14** lb/ft^2

Cold roof slope factor (C_t > 1.0)

Roof surface type	Slippery
Ventilation	Ventilated
Thermal resistance (R-value)	R = **30.00**°F h ft^2 / Btu
Roof slope factor Fig 7-2c (dashed line)	C_s = **0.91**

Monoslope

Sloped roof snow load (Cl.7.4)	p_s = C_s × p_f = **16.49** lb/ft^2



Roof elevation

Distributed Snow Loading

Snow Load per Vertical Section	SL_T = -(p_s × PV_{AV}) = **363.20** lb
TD: Distributed Snow Load on Outer Member	SL = SL_T / PV_Q / M_Q / PV_W × 1.27879 = **-68.135** lbs/ft
TD: Distributed Snow Load on Inner Member	SL = SL_T / PV_Q / M_Q / PV_W × 2 × 0.7212= **-76.85** lbs/ft

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SEISMIC

SEISMIC FORCES (ASCE 7-10)

Tedds calculation version 3.1.01

Site parameters

Site class	**D**
Mapped acceleration parameters (Section 11.4.1)	
at short period	S_S = **0.260**
at 1 sec period	S_1 = **0.070**
Site coefficientat short period (Table 11.4-1)	F_a = **1.592**
at 1 sec period (Table 11.4-2)	F_v = **2.4**

Spectral response acceleration parameters

at short period (Eq. 11.4-1)	$S_{MS} = F_a \times S_S$ = **0.414**
at 1 sec period (Eq. 11.4-2)	$S_{M1} = F_v \times S_1$ = **0.168**

Design spectral acceleration parameters (Sect 11.4.4)

at short period (Eq. 11.4-3)	$S_{DS} = 2 / 3 \times S_{MS}$ = **0.276**
at 1 sec period (Eq. 11.4-4)	$S_{D1} = 2 / 3 \times S_{M1}$ = **0.112**

Seismic design category

Risk category (Table 1.5-1)	**I**
Seismic design category	**B**

Approximate fundamental period

Height above base to highest level of building	h_n = **7.34 ft**
From Table 12.8-2:	
Structure type	All other systems
Building period parameter C_t	C_t = **0.02**
Building period parameter x	x = **0.75**
Approximate fundamental period (Eq 12.8-7)	$T_a = C_t \times (h_n)^x \times 1sec / (1ft)^x$= **0.089** sec
Building fundamental period (Sect 12.8.2)	$T = T_a$ = **0.089** sec
Long-period transition period	T_L = 6 sec

Seismic response coefficient

Seismic force-resisting system (Table 12.2-1)	G. CANTILEVERED COLUMN SYSTEMS DETAILED TO CONFORM TO THE REQUIRE
	2. Steel ordinary cantilever column systems
Response modification factor (Table 12.2-1)	R = **1.25**
Seismic importance factor (Table 1.5-2)	I_e = **1.000**
Seismic response coefficient (Sect 12.8.1.1)	
Maximum ((Eq 12.8-3))	$C_{s\_max} = S_{D1} / (T \times (R / I_e))$ = **1.0046**
Minimum:	
Eq 12.8-5	$C_{s\_min1} = \max(0.044 \times S_{DS} \times I_e, 0.01)$ = **0.0121**
Seismic response coefficient	C_s = **0.2208**
Calculated (Eq 12.8-3)	$C_{s\_calc} = S_{DS} / (R / I_e)$ = **0.2208**

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Seismic base shear (Sect 12.8.1)

Effective seismic weight of the structure	W = **8.4 kips**
Seismic base shear (Eq 12.8-1)	$V = C_s \times W$ = **1.8 kips**

Distributed Seismic Loading

Analyzed Rack Length	AR_L = **2124** in
Analyzed Rack Weight	$AR_{LB} = AR_L / (PV_{PW} \times 0.75) \times 2 \times DL_T$ = **-8375** lbs
Analyzed Rack Anchor Qty	AR_A = **22.000**
Load per node (anchor top)	EL = V / AR_A = **84.03** lbs

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WIND

WIND LOADING (ASCE7-10)

In accordance with ASCE7-10 incorporating Errata No. 1 and Errata No. 2

Using the directional design method

Tedds calculation version 2.1.07

Wall/sign data

Length of wall/sign;	B = **3.41** ft
Height of wall/sign;	s = **2.35** ft
Height to top of sign;	h = **4.85** ft

General wind load requirements

Basic wind speed;	V = **116.0** mph
Risk category;	I
Velocity pressure exponent coeff (Table 26.6-1);	K_d = **0.85**
Exposure category (cl.26.7.3);	C
Gust effect factor;	G_f = **0.85**

Topography

Topography factor not significant;	K_{zt} = 1.0

Velocity pressure

Velocity pressure coefficient (T.29.3-1);	K_z = **0.85**
Velocity pressure;	$q_h = 0.00256 \times K_z \times K_{zt} \times K_d \times V^2 \times 1\text{psf/mph}^2$ = **24.9** psf

Pressures and forces

Net pressure;	$p = q_h \times GC_N$
Net force;	$F_w = p \times A_{ref}$
Area (per zone);	$A_{ref} = PV_A$

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CPP Wind Loading Table

Titan

	Load Case	Load Case Desc.	Load Dir.	Panel Load Loc.	CPP pressure coeff. GCN	Net pressure p (psf)	Net force Fw (lbs)	Rails	Net force per Rail Fw (lbs/ft.)
GREEN ZONE	1	CPP E-W Rail	Up	1	-1.36	-33.77	-252.94	3	148
				2	-0.67	-16.76	-141.60		83
				3	-0.37	-9.21	-68.98		40
	2	CPP Half Chord		1	-1.40	-34.84	-204.12		142
				2	-0.95	-23.64	-138.51		93
				3	-0.56	-14.02	-82.13		42
				4	-0.34	-8.38	-49.08		
	3	CPP Post Pair		1	-1.34	-33.43	-195.85		137
				2	-0.93	-23.23	-136.08		98
				3	-0.66	-16.34	-95.74		50
				4	-0.40	-9.87	-57.83		
	4	CPP Post Pair	Down	1	0.27	6.64	38.88		-32
				2	0.38	9.37	54.92		-48
				3	0.41	10.12	59.29		-58
				4	0.57	14.19	83.10		
	5	CPP Half Chord		1	0.20	4.98	29.16		-24
				2	0.30	7.47	43.74		-44
				3	0.42	10.45	61.23		-62
				4	0.61	15.26	89.42		
	6	CPP E-W Rail		1	0.21	5.14	38.53		-23
				2	0.33	8.13	68.70		-40
				3	0.60	14.85	111.24		-65

	Load Case	Load Case Desc.	Load Dir.	Panel Load Loc.	CPP pressure coeff. GCN	Net pressure p (psf)	Net force Fw (lbs)	Rails	Net force per Rail Fw (lbs/ft.)
YELLOW ZONE	1	CPP E-W Rail	Up	1	-1.80	-44.72	-334.98	3	197
				2	-0.90	-22.40	-189.27		111
				3	-0.47	-11.78	-88.25		52
	2	CPP Half Chord		1	-1.76	-43.72	-256.12		179
				2	-1.22	-30.45	-178.36		120
				3	-0.72	-17.84	-104.49		53
				4	-0.42	-10.54	-61.72		
	3	CPP Post Pair		1	-1.35	-33.60	-196.83		146
				2	-1.26	-31.44	-184.19		149
				3	-1.15	-28.54	-167.18		88
				4	-0.70	-17.50	-102.54		
	4	CPP Post Pair	Down	1	0.38	9.46	55.40		-48
				2	0.66	16.34	95.74		-96
				3	0.90	22.40	131.22		-121
				4	1.16	28.87	169.12		
	5	CPP Half Chord		1	0.33	8.30	48.60		-42
				2	0.58	14.44	84.56		-92
				3	0.91	22.57	132.19		-125
				4	1.21	30.11	176.41		
	6	CPP E-W Rail		1	0.38	9.46	70.85		-42
				2	0.71	17.75	150.01		-88
				3	1.19	29.62	221.87		-130

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	Load Case	Load Case Desc.	Load Dir.	Panel Load Loc.	CPP pressure coeff. GCN	Net pressure p (psf)	Net force Fw (lbs)	Rails	Net force per Rail Fw (lbs/ft.)
ORANGE ZONE	1	CPP E-W Rail	Up	1	-2.23	-55.62	-416.66	3	244
				2	-0.71	-17.63	-153.32		90
				3	-0.37	-9.17	-68.69		40
	2	CPP Half Chord		1	-2.18	-54.32	-318.23		221
				2	-1.42	-35.40	-207.38		150
				3	-1.00	-24.99	-146.42		81
				4	-0.67	-16.66	-97.61		
	3	CPP Post Pair		1	-2.13	-53.03	-310.63		216
				2	-1.42	-35.40	-207.38		152
				3	-1.05	-26.01	-152.39		89
				4	-0.75	-18.62	-109.08		
	4	CPP Post Pair	Down	1	0.68	16.83	98.58		-84
				2	1.10	27.33	160.09		-171
				3	1.68	41.78	244.74		-203
				4	1.90	47.39	277.60		
	5	CPP Half Chord		1	0.63	15.72	92.10		-79
				2	1.03	25.66	150.35		-168
				3	1.70	42.25	247.50		-206
				4	1.93	48.13	281.95		
	6	CPP E-W Rail		1	0.42	10.54	78.93		-46
				2	0.79	19.54	165.13		-97
				3	1.52	37.76	282.85		-166

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Load data - with ASD Combos (for reactions)

GLOSSARY

Comb : Indicates if load condition is a load combination

Load conditions

Condition	Description	Comb.	Category
DL	Dead Load	No	DL
SL	Snow Load	No	SNOW
WL1	Wind - APA_CPP - EW Rail / Up - 0° (S-N)	No	WIND
WL2	Wind - APA_CPP - Half Chord/ Up - 0° (S-N)	No	WIND
WL3	Wind - APA_CPP - Post Pair / Up - 0° (S-N)	No	WIND
WL4	Wind - APA_CPP - Post Pair / Down - 180° (N-S)	No	WIND
WL5	Wind - APA_CPP - Half Chord / Down - 180° (N-S)	No	WIND
WL6	Wind - APA_CPP - EW Rail / Down - 180° (N-S)	No	WIND
EL1	Seismic Left	No	EQ
EL2	Seismic Right	No	EQ
EL3	Seismic North	No	EQ
EL4	Seismic South	No	EQ
D1	DL	Yes	
D2	DL+SL	Yes	
D3	DL+0.75SL	Yes	
D4	DL+0.6WL1	Yes	
D5	DL+0.6WL2	Yes	
D6	DL+0.7EL1	Yes	
D7	DL+0.7EL2	Yes	
D8	DL+0.7EL3	Yes	
D9	DL+0.7EL4	Yes	
D10	DL+0.75SL+0.45WL1	Yes	
D11	DL+0.75SL+0.45WL2	Yes	
D12	DL+0.75SL+0.525EL1	Yes	
D13	DL+0.75SL+0.525EL2	Yes	
D14	DL+0.75SL+0.525EL3	Yes	
D15	DL+0.75SL+0.525EL4	Yes	
D16	0.6DL+0.6WL1	Yes	
D17	0.6DL+0.6WL2	Yes	
D18	0.6DL+0.7EL1	Yes	
D19	0.6DL+0.7EL2	Yes	
D20	0.6DL+0.7EL3	Yes	
D21	0.6DL+0.7EL4	Yes	
D22	DL+0.6WL3	Yes	
D23	DL+0.6WL4	Yes	
D24	DL+0.6WL5	Yes	
D25	DL+0.6WL6	Yes	
D26	DL+0.75SL+0.45WL3	Yes	
D27	DL+0.75SL+0.45WL4	Yes	
D28	DL+0.75SL+0.45WL5	Yes	
D29	DL+0.75SL+0.45WL6	Yes	
D30	0.6DL+0.6WL3	Yes	
D31	0.6DL+0.6WL4	Yes	
D32	0.6DL+0.6WL5	Yes	
D33	0.6DL+0.6WL6	Yes	

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Load data - with LRFD Combos (for code check)

GLOSSARY

Comb : Indicates if load condition is a load combination

Load conditions

Condition	Description	Comb.	Category
DL	Dead Load	No	DL
SL	Snow Load	No	SNOW
WL1	Wind - APA_CPP - EW Rail / Up - 0° (S-N)	No	WIND
WL2	Wind - APA_CPP - Half Chord/ Up - 0° (S-N)	No	WIND
WL3	Wind - APA_CPP - Post Pair / Up - 0° (S-N)	No	WIND
WL4	Wind - APA_CPP - Post Pair / Down - 180° (N-S)	No	WIND
WL5	Wind - APA_CPP - Half Chord / Down - 180° (N-S)	No	WIND
WL6	Wind - APA_CPP - EW Rail / Down - 180° (N-S)	No	WIND
EL1	Seismic Left	No	EQ
EL2	Seismic Right	No	EQ
EL3	Seismic North	No	EQ
EL4	Seismic South	No	EQ
D1	1.4DL	Yes	
D2	1.2DL+0.5SL	Yes	
D3	1.2DL+1.6SL	Yes	
D4	1.2DL+0.5WL1	Yes	
D5	1.2DL+0.5WL2	Yes	
D6	1.2DL+0.5WL3	Yes	
D7	1.2DL+0.5WL4	Yes	
D8	1.2DL+0.5WL5	Yes	
D9	1.2DL+0.5WL6	Yes	
D10	1.2DL+1.6SL+0.5WL1	Yes	
D11	1.2DL+1.6SL+0.5WL2	Yes	
D12	1.2DL+1.6SL+0.5WL3	Yes	
D13	1.2DL+1.6SL+0.5WL4	Yes	
D14	1.2DL+1.6SL+0.5WL5	Yes	
D15	1.2DL+1.6SL+0.5WL6	Yes	
D16	1.2DL+WL1	Yes	
D17	1.2DL+WL2	Yes	
D18	1.2DL+WL3	Yes	
D19	1.2DL+WL4	Yes	
D20	1.2DL+WL5	Yes	
D21	1.2DL+WL6	Yes	
D22	1.2DL+0.5SL+WL1	Yes	
D23	1.2DL+0.5SL+WL2	Yes	
D24	1.2DL+0.5SL+WL3	Yes	
D25	1.2DL+0.5SL+WL4	Yes	
D26	1.2DL+0.5SL+WL5	Yes	
D27	1.2DL+0.5SL+WL6	Yes	
D28	1.2DL+0.2SL	Yes	
D29	1.2DL+EL1	Yes	
D30	1.2DL+EL2	Yes	
D31	1.2DL+EL3	Yes	
D32	1.2DL+EL4	Yes	
D33	1.2DL+0.2SL+EL1	Yes	
D34	1.2DL+0.2SL+EL2	Yes	
D35	1.2DL+0.2SL+EL3	Yes	
D36	1.2DL+0.2SL+EL4	Yes	
D37	0.9DL+WL1	Yes	
D38	0.9DL+WL2	Yes	
D39	0.9DL+WL3	Yes	
D40	0.9DL+WL4	Yes	
D41	0.9DL+WL5	Yes	
D42	0.9DL+WL6	Yes	
D43	0.9DL+EL1	Yes	
D44	0.9DL+EL2	Yes	
D45	0.9DL+EL3	Yes	
D46	0.9DL+EL4	Yes	

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DEF1	DL+SL	Yes
DEF2	DL+0.7WL1	Yes
DEF3	DL+0.7WL2	Yes
DEF4	DL+0.7WL3	Yes
DEF5	DL+0.7WL4	Yes
DEF6	DL+0.7WL5	Yes
DEF7	DL+0.7WL6	Yes

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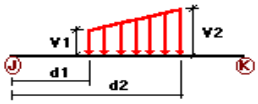
Load on nodes

Condition	Node	FX [Lb]	FY [Lb]	FZ [Lb]	MX [Lb*ft]	MY [Lb*ft]	MZ [Lb*ft]
EL1	153	100.00	0.00	0.00	0.00	0.00	0.00
EL2	153	-100.00	0.00	0.00	0.00	0.00	0.00
EL3	153	0.00	0.00	100.00	0.00	0.00	0.00
EL4	153	0.00	0.00	-100.00	0.00	0.00	0.00

Distributed Forces on Members



Condition	Member	Dir1	Val1 [Lb/ft]	Val2 [Lb/ft]	Dist1 [in]	%	Dist2 [in]	%
DL	351(Outer Rail)	Y	-15.71	-15.71	0.00	Yes	100.00	Yes
SL	351(Outer Rail)	Y	-68.135	-68.135	0.00	Yes	100.00	Yes
DL	350(Inner Rail)	Y	-17.72	-17.72	0.00	Yes	100.00	Yes
SL	350(Inner Rail)	Y	-76.85	-76.85	0.00	Yes	100.00	Yes
WL1	See Pages 9-10							
WL2	See Pages 9-10							
WL3	See Pages 9-10							
WL4	See Pages 9-10							
WL5	See Pages 9-10							
WL6	See Pages 9-10							

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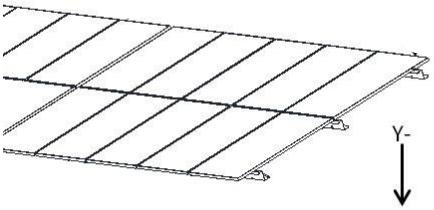
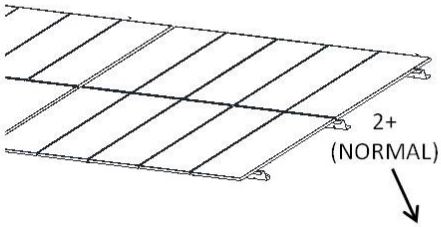


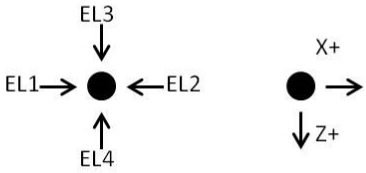
DEAD, SNOW

Figure 1: Load Direction Y



WIND

Figure 2: Load Direction 2



SEISMIC LOADS – PLAN VIEW

Figure 3: Load Direction X & Z

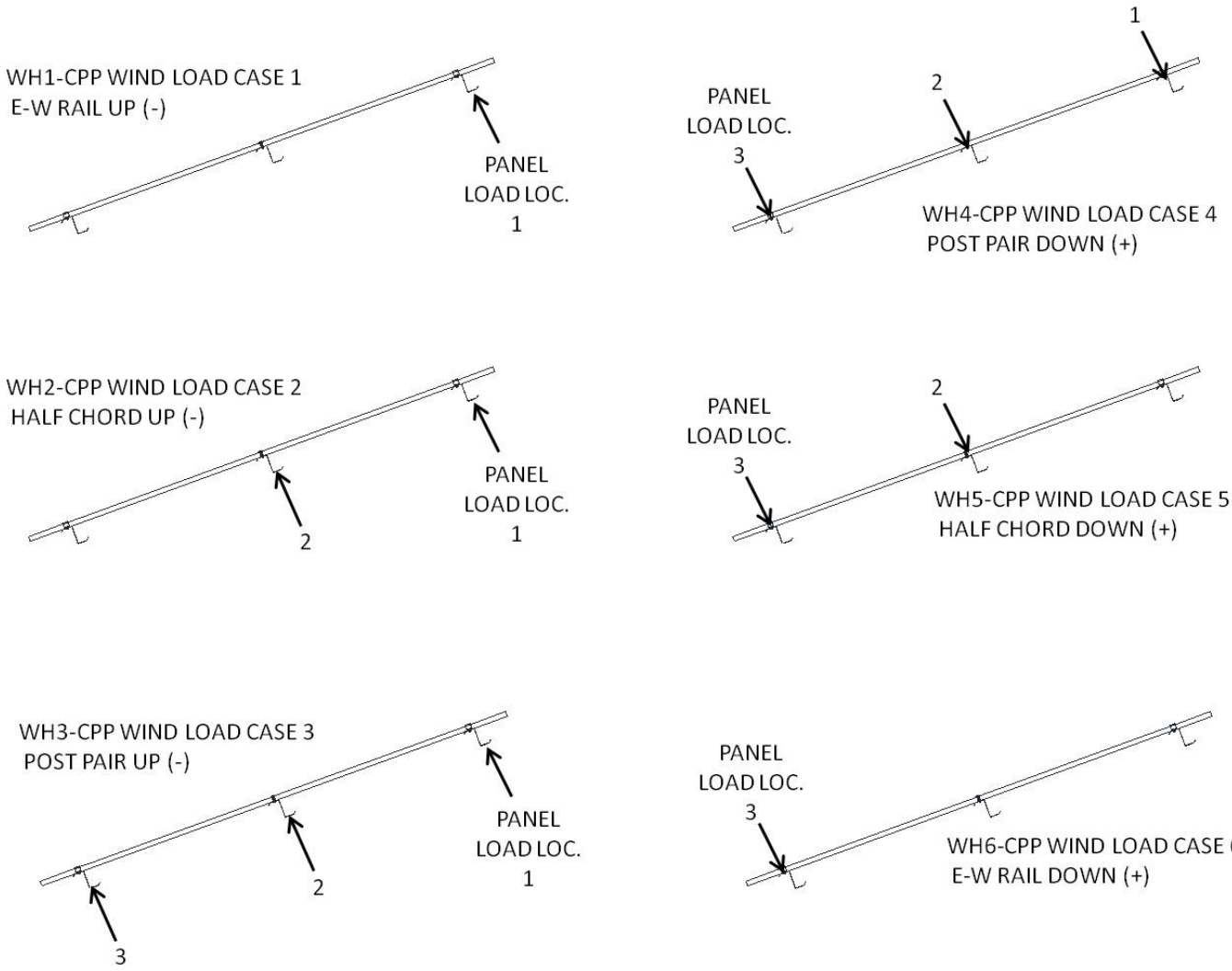


Figure 4: Load CPP Wind Loads

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WIND TUNNEL DATA

CERMAK PETERKA PETERSEN

CPP Project **11825** -
Wind Tunnel Tests and Wind Load Analysis for **AP ALTERNATIVES FIXED-TILT GROUND MOUNT**

Executive Summary

CPP, Inc. has evaluated wind loads on a generic array of fixed-tilt ground mounted photovoltaic (PV) solar modules produced by AP Alternatives. The wind tunnel data used in the analysis is from the CPP proprietary ground mount wind loads database. This database consists of simultaneous surface pressure measurements at a large number of locations on the solar modules. The database contains data for a large number of configurations with varying combinations of tilt, ground clearance, and row spacing. The geometric parameters of the AP Alternatives system studied are summarized below:

Parameter	*Range of applicability*
Chord length:	140 in to 170 in, allowable application range, with no adjustment
Tilt:	10°, 15°, 22.5° and 30°, allowable with interpolation appropriate between presented results. Extrapolation up to 35° is also acceptable.
Height (low edge of modules):	18 in to 42 in, allowable application range, with no adjustment
Row spacing (clear gap):	2.75*L*Sin(tilt) and 4*L*Sin(tilt) with interpolation appropriate between presented results, *L* being the chord length
Post spacing (along row):	≥72in (results presented for 72in, 100in and 200in) with interpolation appropriate between presented results. Direct use of 200in results at greater spacing is also acceptable with some conservatism.

The wind loads determined by CPP are based upon measurements obtained in an atmospheric boundary layer wind tunnel study conducted in accordance with the test procedures described in ASCE 7. The primary goal of this study was to determine peak forces on an array of panels for the purpose of calculating design wind loads. The results are presented as load cases, defined in this document. These loads vary with position within the array and, as expected, the worst case- loads were found at the array perimeter. Interior portions of the array were generally found to have substantially lower wind loads than perimeter locations due to sheltering

Wind Tunnel Load Cases

The load cases are listed below. In some cases the load effect is the peak load on a fraction of the chord (e.g. the high rail or half the chord).

$GC_{N\text{-}Post\ pair}$ – Peak net pressure on a post-pair tributary area; uplift and downforces; for designs of posts, N-S strut/beam and braces. The tributary area considered includes the full chord and spans halfway to the next post pair; the nominal tributary area for a pair of posts in a dual-post system.

$GC_{N\text{-}Post\ half\text{-}chord}$ – Peak net pressure on a single post tributary area; uplift on upper post and downforce on lower post cases; for design of posts, N-S strut, and braces. The tributary area considered includes half of the chord and spans halfway to the next post pair; the nominal tributary area for a single post in a dual-post system.

$GC_{N\ Rail}$– Peak net pressure on E-W rails spanning between posts, supporting modules; uplift and downforce cases. The tributary area considered includes one quarter of the chord and spans from one post pair to the next post pair; the nominal tributary area for a rail.

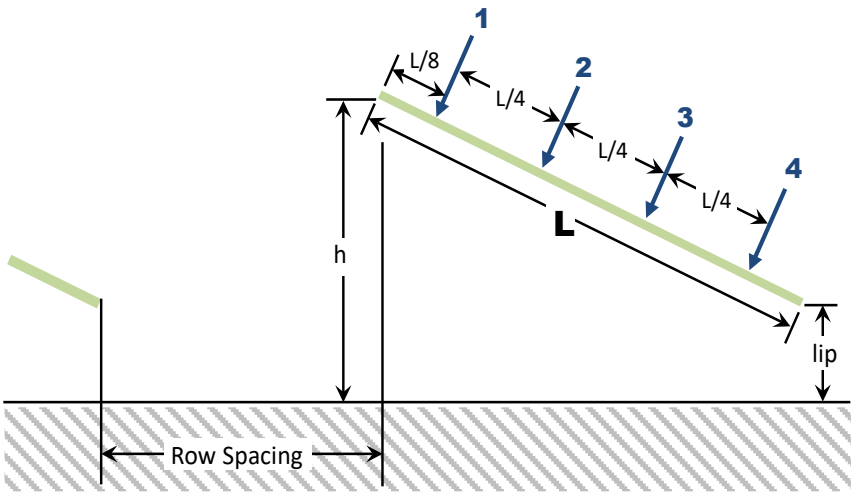

Figure 5: Wind Tunnel Load Distribution Schematic

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Wind Tunnel Zone Map

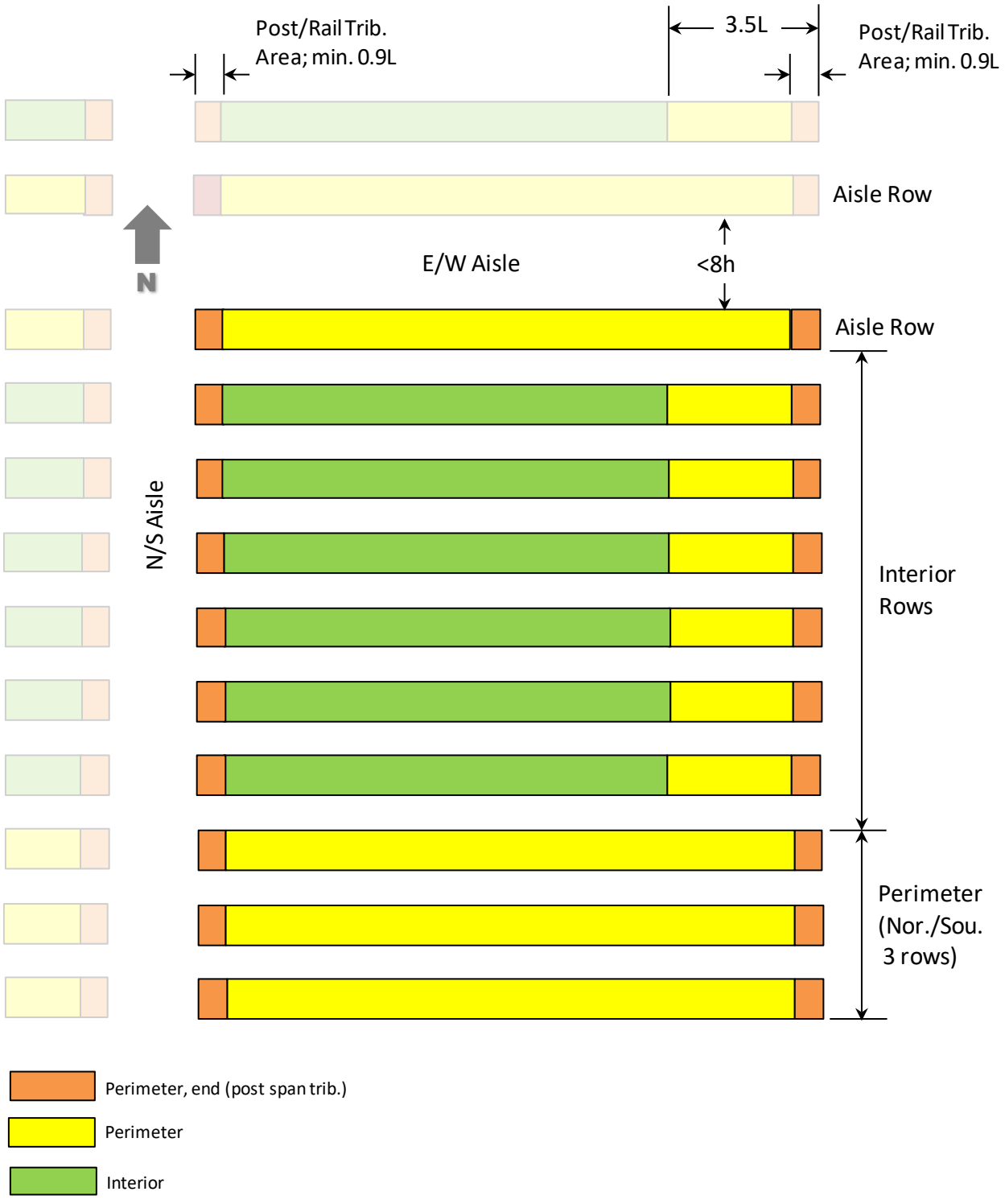

Figure 6: Wind Tunnel Zone Map

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SETUP & ANALYSIS

(ASD)

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Parts list

Note.- Only the graphically selected elements are listed below

Profile	Length [in]	N° of pieces
CABLE BRACE - 1/8	181.23	4
CABLE BRACE - 1/8	220.25	4
STD BIG ZEE - 6 X 3 X .055	152.00	6
STD BIG ZEE - 6 X 3 X .055	177.50	24
STD BIG ZEE - 6 X 3 X .055	56.00	6
STD BIG ZEE - 6 X 3 X .11...	16.00	54
STD. TITAN DUO POST - 2...	36.04	11
STD. TITAN DUO POST - 2...	66.98	11
TITAN KNEE BRACE - 3X2...	91.20	11
TITAN NS CHORD - 6X2...	119.75	11
Total N° of pieces		142

List of materials

Note.- Only the graphically selected members and shells are listed

Members:

Profile	Material	Uweight [Lb/ft]	Length [in]	Weight [Lb]
CABLE BRACE - 1/8	APA - A36 - CABLES	1.67E-01	1605.944	22.369
STD BIG ZEE - 6 X 3 X .055	A653 SS 80-1	2.51E+00	5508.000	1153.820
STD BIG ZEE - 6 X 3 X .11 - SPLICE	A653 SS 80-1	4.97E+00	864.000	358.076
STD. TITAN DUO POST - 2.375 X 0.095	APA - A570 GR50	2.34E+00	1133.220	220.997
TITAN KNEE BRACE - 3X2X078	A653 SS 80-1	1.99E+00	1003.152	166.729
TITAN NS CHORD - 6X2X108	A653 SS 80-1	3.72E+00	1317.280	408.526
Total weight [Lb]				2330.517

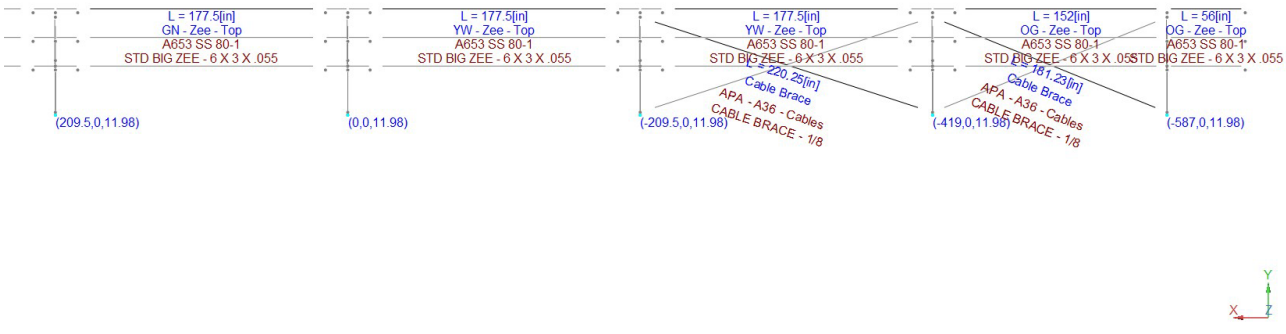

Figure 7: - Member Length, Name, Material, And Section - ORANGE,YELLOW, & GREEN ZONE

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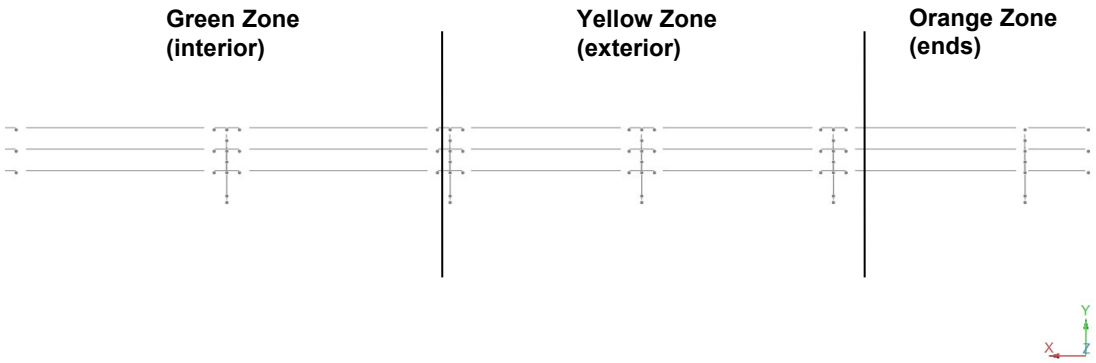

Figure 8: - Racking Zones

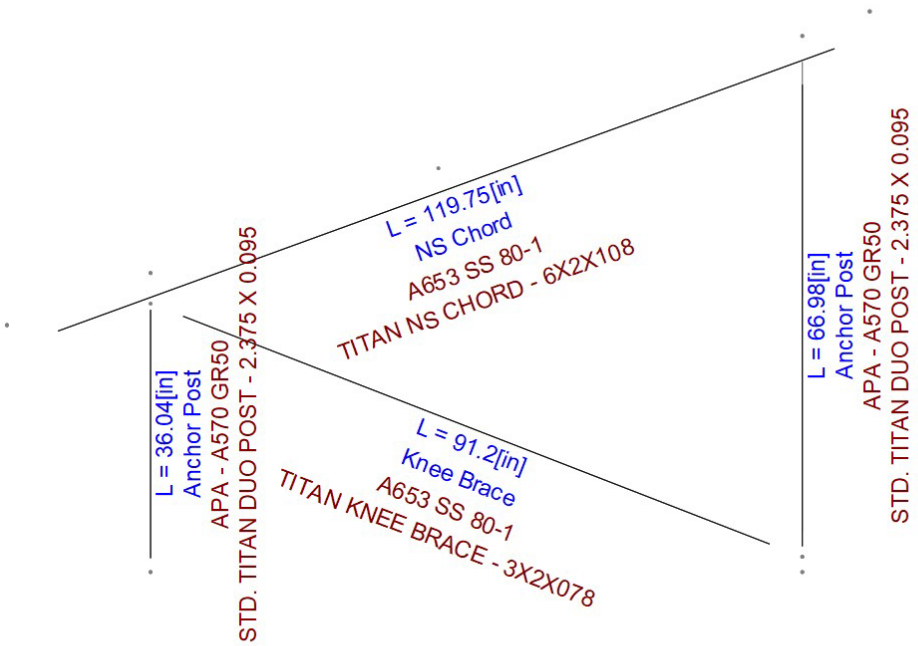

Figure 9: - Member Length, Name, Material, and Section

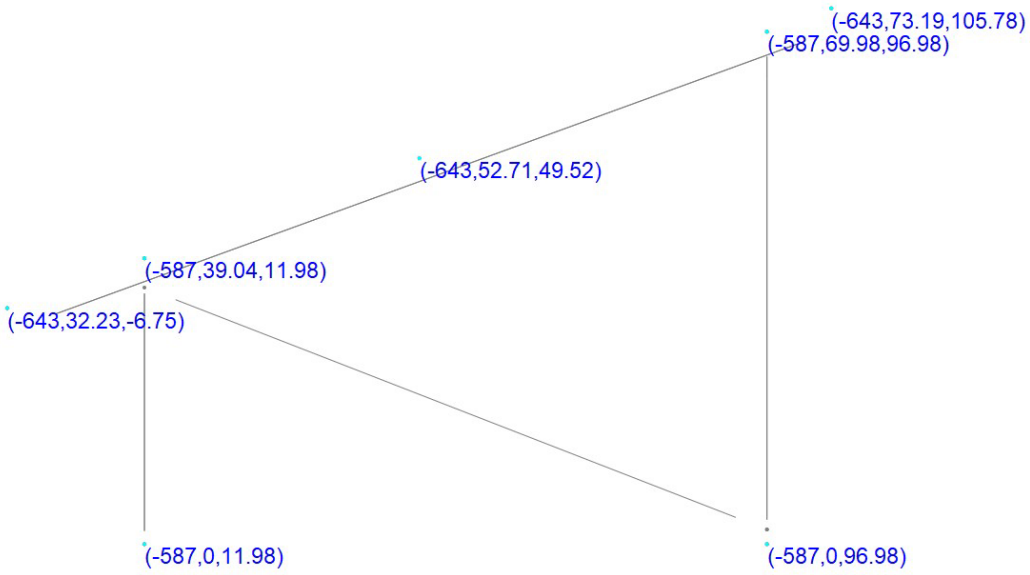

Figure 10: - Node X,Y,Z Coordinate

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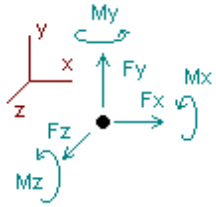
Analysis - Reaction Envelope - ASD

Reactions



Direction of positive forces and moments

Max Uplift:	-3306 lbs	(D16)
Max Down Load:	3303 lbs	(D28)
Max Lateral:	1455 lbs	(D30)

Node		Forces						Moments					
		Fx [Lb]	lc	Fy [Lb]	lc	Fz [Lb]	lc	Mx [Lb*ft]	lc	My [Lb*ft]	lc	Mz [Lb*ft]	lc
145	Max	376.457	D19	2504.909	D27	1444.875	D30	0.00000	D1	150.16243	D27	0.00000	D1
	Min	-0.021	D27	-3305.706	D16	-1001.608	D25	0.00000	D1	-196.98617	D16	0.00000	D1
151	Max	-0.001	D20	2021.332	D27	1082.306	D30	0.00000	D1	217.93091	D13	0.00000	D1
	Min	-393.658	D18	-2392.494	D17	-1108.585	D23	0.00000	D1	-144.80538	D16	0.00000	D1
173	Max	-0.015	D19	2489.421	D27	1442.322	D30	0.00000	D1	231.31490	D13	0.00000	D1
	Min	-378.748	D6	-3292.145	D16	-998.024	D25	0.00000	D1	-184.42552	D16	0.00000	D1
174	Max	392.084	D19	1950.445	D27	1032.949	D22	0.00000	D1	115.80246	D27	0.00000	D1
	Min	-0.017	D27	-2345.016	D17	-1051.188	D31	0.00000	D1	-161.36782	D16	0.00000	D1
185	Max	395.162	D7	2598.889	D27	1430.080	D30	0.00000	D1	225.51038	D13	0.00000	D1
	Min	-386.846	D6	-3223.082	D16	-1211.265	D23	0.00000	D1	-189.58753	D16	0.00000	D1
195	Max	379.754	D19	2652.142	D27	1455.177	D30	0.00000	D1	223.73246	D13	0.00000	D1
	Min	-384.153	D18	-3264.953	D16	-1241.631	D23	0.00000	D1	-189.26863	D16	0.00000	D1
205	Max	0.012	D18	2286.166	D27	1231.971	D22	0.00000	D1	147.85468	D27	0.00000	D1
	Min	-0.023	D13	-2781.843	D16	-750.405	D31	0.00000	D1	-167.45486	D16	0.00000	D1
212	Max	0.012	D18	2283.553	D27	1230.833	D22	0.00000	D1	146.77321	D27	0.00000	D1
	Min	-0.023	D13	-2777.962	D16	-748.682	D31	0.00000	D1	-162.67740	D16	0.00000	D1
213	Max	0.012	D18	2075.277	D27	1024.329	D30	0.00000	D1	144.32128	D12	0.00000	D1
	Min	-0.023	D13	-2290.084	D16	-472.501	D23	0.00000	D1	-135.61240	D16	0.00000	D1
214	Max	0.012	D18	2117.818	D27	1065.107	D22	0.00000	D1	144.11455	D12	0.00000	D1
	Min	-0.023	D13	-2390.560	D16	-527.836	D31	0.00000	D1	-141.16061	D16	0.00000	D1
215	Max	0.012	D18	2075.019	D27	1024.123	D30	0.00000	D1	144.29137	D12	0.00000	D1
	Min	-0.023	D13	-2290.118	D16	-472.089	D23	0.00000	D1	-134.43964	D16	0.00000	D1
294	Max	0.039	D13	3277.586	D29	28.647	D25	0.00000	D1	341.10120	D29	0.00000	D1
	Min	-0.023	D18	-595.636	D30	-41.325	D30	0.00000	D1	-152.06068	D30	0.00000	D1
296	Max	0.039	D13	2423.649	D28	31.707	D23	0.00000	D1	271.79640	D28	0.00000	D1
	Min	-0.018	D18	-130.036	D30	-30.955	D30	0.00000	D1	-85.66115	D30	0.00000	D1
298	Max	0.042	D13	3280.848	D29	28.544	D25	0.00000	D1	340.95031	D29	0.00000	D1
	Min	-0.021	D30	-597.042	D30	-41.252	D30	0.00000	D1	-151.55022	D30	0.00000	D1
300	Max	0.034	D13	2476.339	D28	30.065	D31	0.00000	D1	265.42618	D28	0.00000	D1
	Min	-0.024	D18	-166.547	D30	-29.543	D22	0.00000	D1	-84.01360	D30	0.00000	D1
302	Max	0.038	D27	3302.540	D28	34.643	D23	0.00000	D1	352.52589	D28	0.00000	D1
	Min	-0.020	D30	-383.913	D30	-40.902	D30	0.00000	D1	-132.45384	D30	0.00000	D1
304	Max	0.039	D27	3278.004	D28	35.512	D23	0.00000	D1	353.50535	D28	0.00000	D1

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	Min	-0.019	D30	-365.717	D30	-41.619	D30	0.00000	D1	-131.26850	D30	0.00000	D1
306	Max	0.042	D13	2911.620	D29	21.462	D31	0.00000	D1	294.05716	D29	0.00000	D1
	Min	-0.023	D18	-259.676	D30	-35.236	D22	0.00000	D1	-108.51519	D30	0.00000	D1
308	Max	0.042	D13	2910.281	D29	21.413	D31	0.00000	D1	291.22108	D29	0.00000	D1
	Min	-0.023	D18	-257.797	D30	-35.203	D22	0.00000	D1	-105.20500	D30	0.00000	D1
310	Max	0.042	D13	2614.337	D2	13.514	D23	0.00000	D1	249.57249	D29	0.00000	D1
	Min	-0.023	D18	42.967	D30	-29.297	D30	0.00000	D1	-65.92941	D30	0.00000	D1
312	Max	0.042	D13	2651.182	D29	15.097	D31	0.00000	D1	257.91780	D29	0.00000	D1
	Min	-0.022	D18	-19.247	D30	-30.463	D22	0.00000	D1	-73.91550	D30	0.00000	D1
314	Max	0.042	D13	2614.535	D2	13.502	D23	0.00000	D1	248.91156	D29	0.00000	D1
	Min	-0.023	D18	43.109	D30	-29.291	D30	0.00000	D1	-65.11046	D30	0.00000	D1

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CODE CHECK

(ASCE 7-10, LRFD)

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Steel Code Check - SUMMARY

Report: Summary - Group by description

Description	Section	Member	Ctrl Eq.	Ratio	Status	Reference
Anchor Post	*STD. TITAN DUO POST - 2...*	418	D26 at 100.00%	0.48	OK	Eq. H3-6
Cable Brace	*CABLE BRACE - 1/8*	426	D34 at 50.00%	0.40	OK	Eq. H1-1a
Knee Brace	*TITAN KNEE BRACE - 3X2...*	339	D25 at 0.00%	0.44	OK	C5.2.2-1
NS Chord	*TITAN NS CHORD - 6X2X108*	338	D14 at 15.63%	0.71	OK	C5.2.2-2
Splice	*STD BIG ZEE - 6 X 3 X .11 -...*	451	D13 at 0.00%	0.58	OK	C5.2.2-3
ZEE PURLIN	*STD BIG ZEE - 6 X 3 X .055*	314	D13 at 0.00%	**0.77**	**OK**	C5.2.2-3

Steel Code Check - NS CHORD

Report: Concise

Members: Cold-formed
Design code: AISI 2001 Sup. 2004 LRFD

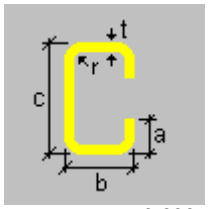
Member : 338 (NS Chord)
Design status : OK

PROPERTIES

Section information

Section name: TITAN NS CHORD - 6X2X108 **(US)**

Dimensions



a	=	0.600	[in]	Lip
b	=	2.000	[in]	Flange width
c	=	6.000	[in]	Depth
r	=	0.219	[in]	Inside bend radius
t	=	0.108	[in]	Thickness

Properties

Section properties	Unit	Major axis	Minor axis
Gross area of the section. (Ag)	[in2]	1.108	
Moment of Inertia (principal axes) (I')	[in4]	5.733	0.525
Bending constant for moments (principal axis) (J')	[in]	0.000	3.324
Radius of gyration (principal axes) (r')	[in]	2.275	0.688
Saint-Venant torsion constant. (J)	[in4]	0.005	
Section warping constant. (Cw)	[in6]	4.248	
Distance from centroid to shear center (principal axis) (xo,yo)	[in]	-1.466	0.000
Top elastic section modulus of the section (principal axis) (S'sup)	[in3]	1.911	0.364
Bottom elastic section modulus of the section (principal axis) (S'inf)	[in3]	1.911	0.942
Polar radius of gyration. (ro)	[in]	2.793	

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Material : A653 SS 80-1

Description	Unit	Value
Yield stress (Fy):	[Lb/in2]	80000.00
Tensile strength (Fu):	[Lb/in2]	82000.00
Elasticity Modulus (E):	[Lb/in2]	2.95E07
Shear modulus for steel (G):	[Lb/in2]	1.134615E07

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Unbraced compression length (Lx, Ly)	[in]	53.50	85.00
Length for torsion and lateral-torsional buckling	[in]	47.00	
Lateral bracing	--	No	No
Additional hypotheses			
Bearing length	[in]	3.25	
Positive flange fastened		No	
Negative flange fastened		No	
Continuous lateral torsional restraint		No	

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Maximum geometric slenderness (L/r)	--	122.83		(Com. C4F)
Geometric slenderness (KL/r)	--	122.83		
Deflection in compression and/or bending	[in]	-0.12	DEF7 at 0.00%	

DESIGN CHECKS

DESIGN FOR FLEXURE

✔

Bending about major axis, M33

Ratio : 0.53
Capacity : 10422.38 [Lb*ft]
Demand : -5512.61 [Lb*ft]
Reference : (Sec. C3)
Ctrl Eq. : D14 at 15.63%

Intermediate results	Unit	Value	Reference
Nominal flexural strength (Mnx)	[Lb*ft]	11580.42	(Sec. C3)

Bending about minor axis, M22

Ratio : 0.23
Capacity : 2220.74 [Lb*ft]
Demand : -509.69 [Lb*ft]
Reference : (Sec. C3)
Ctrl Eq. : D34 at 92.19%

Intermediate results	Unit	Value	Reference
Nominal flexural strength (Mny)	[Lb*ft]	2467.49	(Sec. C3)

DESIGN FOR SHEAR

✔

Shear parallel to minor axis, V2

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Ratio : 0.15
Capacity : 23602.01 [Lb]
Demand : -3481.22 [Lb]
Reference : (Sec. C3.2)
Ctrl Eq. : D26 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Lb]	24844.22	(Sec. C3.2)

Shear parallel to major axis, V3

Ratio : 0.03
Capacity : 13257.56 [Lb]
Demand : -336.74 [Lb]
Reference : (Sec. C3.2)
Ctrl Eq. : D44 at 92.19%

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Lb]	13955.33	(Sec. C3.2)

DESIGN FOR TENSION ✔

Tension

Ratio : 0.01
Capacity : 80164.14 [Lb]
Demand : 767.36 [Lb]
Reference : (Eq. C2-1)
Ctrl Eq. : D25 at 51.56%

Intermediate results	Unit	Value	Reference
Nominal tension strength (Tn)	[Lb]	89071.27	(Sec. C2)

DESIGN FOR COMPRESSION ✔

Compression

Ratio : 0.12
Capacity :-16015.91 [Lb]
Demand : -1978.77 [Lb]
Reference : (Sec. C4)
Ctrl Eq. : D22 at 17.19%

Intermediate results	Unit	Value	Reference
Nominal compression strength (Pn)	[Lb]	-18842.24	(Eq. C4.1)

DESIGN FOR TORSION ✔

Torsion

Ratio : 0.23
Capacity : 159.09 [Lb*ft]
Demand : -37.26 [Lb*ft]
Reference : (AISC, Sec. H)
Ctrl Eq. : D37 at 92.19%

Intermediate results	Unit	Value	Reference
Nominal torsion strength	[Lb*ft]	167.46	

DESIGN FOR CRIPPLING ✔

Web crippling strength

Ratio : 0.47

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Capacity	: 12067.02 [Lb]	Reference	: (Sec. C3.4)
Demand	: 5707.78 [Lb]	Ctrl Eq.	: D26 at 17.19%

Intermediate results	Unit	Value	Reference
Nominal crippling strength (Pn)	[Lb]	13407.80	(Eq. C3.4.1-1)
Crippling strength factor (Ωw)	--	0.90	(Tables C3.4.1)

INTERACTION ✔

Combined bending and web crippling ratio

Ratio	: 0.67	Ctrl Eq.	:	D26 at 17.19%
		Reference	:	C3.5.2-1

***The equation has been modified for a maximum ratio equal to 1.0**

Combined bending and shear ratio (x-x)

Ratio	: 0.49	Ctrl Eq.	:	D26 at 15.63%
		Reference	:	C3.3.2-1

Combined bending and shear ratio (y-y)

Ratio	: 0.23	Ctrl Eq.	:	D34 at 92.19%
		Reference	:	C3.3.2-1

Combined flexure and tension ratio

Ratio	: 0.70	Ctrl Eq.	:	D14 at 15.63%
		Reference	:	C5.1.2-2

Combined flexure and compression ratio

Ratio	: 0.71	Ctrl Eq.	:	D14 at 15.63%
		Reference	:	C5.2.2-2

CRITICAL STRENGTH RATIO ✔

Ratio	: 0.71			
Ctrl Eq.	: D14 at 15.63%	Reference	:	C5.2.2-2

SOLAR RACKING

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Steel Code Check - ANCHOR POST

Report: Concise

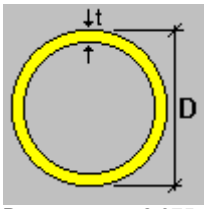
Members: Hot-rolled
Design code: AISC 360-2010 LRFD

Member	**:**	**418 (Anchor Post)**
Design status	**:**	**OK**

Section information

Section name: STD. TITAN DUO POST - 2.375 X 0.095 **(US)**

Dimensions



D	=	2.375	[in]	Diameter
T	=	0.095	[in]	Thickness

Properties

Section properties	Unit	Major axis	Minor axis
Gross area of the section. (Ag)	[in2]	0.687	
Moment of Inertia (local axes) (I)	[in4]	0.444	0.444
Moment of Inertia (principal axes) (I')	[in4]	0.444	0.444
Bending constant for moments (principal axis) (J')	[in]	0.000	0.000
Radius of gyration (local axes) (r)	[in]	0.804	0.804
Radius of gyration (principal axes) (r')	[in]	0.804	0.804
Saint-Venant torsion constant. (J)	[in4]	0.868	
Section warping constant. (Cw)	[in6]	6.25E-05	
Distance from centroid to shear center (principal axis) (xo,yo)	[in]	0.000	0.000
Top elastic section modulus of the section (local axis) (Ssup)	[in3]	0.367	0.367
Bottom elastic section modulus of the section (local axis) (Sinf)	[in3]	0.367	0.367
Top elastic section modulus of the section (principal axis) (S'sup)	[in3]	0.367	0.367
Bottom elastic section modulus of the section (principal axis) (S'inf)	[in3]	0.367	0.367
Plastic section modulus (local axis) (Z)	[in3]	0.497	0.497
Plastic section modulus (principal axis) (Z')	[in3]	0.497	0.497
Polar radius of gyration. (ro)	[in]	1.138	
Area for shear (Aw)	[in2]	0.442	0.442
Torsional constant. (C)	[in3]	0.772	

Material : APA - A570 GR50

Properties	Unit	Value
Yield stress (Fy):	[Lb/in2]	50000.00
Tensile strength (Fu):	[Lb/in2]	65300.00
Elasticity Modulus (E):	[Lb/in2]	2.9E07
Shear modulus for steel (G):	[Lb/in2]	1.150794E07

DESIGN CRITERIA

Description	Unit	Value
Length for tension slenderness ratio (L)	[in]	36.04

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Distance between member lateral bracing points

Length (Lb) [in]	
Top	Bottom
36.04	36.04

Laterally unbraced length

Length [in]			Effective length factor		
Major axis(L33)	Minor axis(L22)	Torsional axis(Lt)	Major axis(K33)	Minor axis(K22)	Torsional axis(Kt)
36.04	36.04	36.04	1.0	1.0	1.0

Additional assumptions

Continuous lateral torsional restraint	No
Tension field action	No
Continuous flexural torsional restraint	No
Effective length factor value type	None
Major axis frame type	Non sway
Minor axis frame type	Non sway

DESIGN CHECKS

AXIAL TENSION DESIGN ✔

Axial tension

Ratio : 0.05
Capacity : 30900.55 [Lb]
Demand : 1627.19 [Lb]
Reference : Eq. Sec. D2
Ctrl Eq. : D39 at 100.00%

Intermediate results	Unit	Value	Reference
Factored axial tension capacity(ϕP_n)	[Lb]	30900.55	Eq. Sec. D2

AXIAL COMPRESSION DESIGN ✔

Compression in the major axis 33

Ratio : 0.21
Capacity : 26682.72 [Lb]
Demand : 5628.17 [Lb]
Reference : Sec. E1
Ctrl Eq. : D14 at 100.00%

Intermediate results	Unit	Value	Reference
Section classification			
Factored flexural buckling strength(ϕP_{n33})	[Lb]	26682.72	Sec. E1

Compression in the minor axis 22

Ratio : 0.21
Capacity : 26682.72 [Lb]
Demand : 5628.17 [Lb]
Reference : Sec. E1
Ctrl Eq. : D14 at 100.00%

Intermediate results	Unit	Value	Reference
Section classification			
Factored flexural buckling strength(ϕP_{n22})	[Lb]	26682.72	Sec. E1

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FLEXURAL DESIGN

Bending about major axis, M33

Ratio	:	0.00		
Capacity	:	1863.80 [Lb*ft]	Reference	: Sec. F1
Demand	:	-0.18 [Lb*ft]	Ctrl Eq.	: D13 at 96.88%

Intermediate results	Unit	Value	Reference
Section classification			
Factored yielding strength(ϕM_n)	[Lb*ft]	1863.80	Sec. F1

Bending about minor axis, M22

Ratio	:	0.11		
Capacity	:	1863.80 [Lb*ft]	Reference	: Sec. F1
Demand	:	201.87 [Lb*ft]	Ctrl Eq.	: D39 at 96.88%

Intermediate results	Unit	Value	Reference
Section classification			
Factored yielding strength(ϕM_n)	[Lb*ft]	1863.80	Sec. F1

DESIGN FOR SHEAR

Shear in major axis 33

Ratio	:	0.26		
Capacity	:	9270.17 [Lb]		
Demand	:	2431.22 [Lb]	Ctrl Eq.	: D39 at 100.00%

Intermediate results	Unit	Value	Reference
Factored shear capacity(ϕV_n)	[Lb]	9270.17	

Shear in minor axis 22

Ratio	:	0.00		
Capacity	:	9270.17 [Lb]		
Demand	:	-0.06 [Lb]	Ctrl Eq.	: D13 at 100.00%

Intermediate results	Unit	Value	Reference
Factored shear capacity(ϕV_n)	[Lb]	9270.17	

TORSION DESIGN

Torsion

Ratio	:	0.31		
Capacity	:	1736.61 [Lb*ft]		
Demand	:	-539.95 [Lb*ft]	Ctrl Eq.	: D26 at 100.00%

Intermediate results	Unit	Value	Reference
Factored torsion capacity(ϕT_n)	[Lb*ft]	1736.61	

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COMBINED ACTIONS DESIGN ✔

Combined flexure and axial compression

Ratio	:	0.21			
Ctrl Eq.	:	D14 at 100.00%	Reference	:	Eq. H1-1a

Intermediate results	Unit	Value	Reference
Interaction of flexure and axial force	--	0.21	Eq. H1-1a

Combined flexure and axial tension

Ratio	:	0.12			
Ctrl Eq.	:	D39 at 96.88%	Reference	:	Eq. H1-1b

Intermediate results	Unit	Value	Reference

Combined flexure and axial compression about local axis

Ratio	:	N/A			
Ctrl Eq.	:	--	Reference	:	

Combined flexure and axial tension about local axis

Ratio	:	N/A			
Ctrl Eq.	:	--	Reference	:	

Combined torsion, flexure, shear and axial compression

Ratio	:	0.48			
Ctrl Eq.	:	D26 at 100.00%	Reference	:	Eq. H3-6

Intermediate results	Unit	Value	Reference

Combined torsion, flexure, shear and axial tension

Ratio	:	0.28			
Ctrl Eq.	:	D25 at 100.00%	Reference	:	Eq. H3-6

Intermediate results	Unit	Value	Reference

SOLAR RACKING

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Steel Code Check - CABLE BRACE

Report: Concise

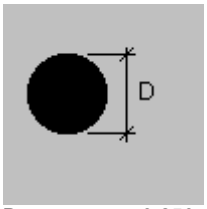
Members: Hot-rolled
Design code: AISC 360-2010 LRFD

Member	:	**426 (Cable Brace)**
Design status	:	**OK**

Section information

Section name: CABLE BRACE - 1/8 **(US)**

Dimensions



D = 0.250 [in] Diameter

Properties

Section properties	Unit	Major axis	Minor axis
Gross area of the section. (Ag)	[in2]	0.049	
Moment of Inertia (local axes) (I)	[in4]	1.91E-04	1.91E-04
Moment of Inertia (principal axes) (I')	[in4]	1.91E-04	1.91E-04
Bending constant for moments (principal axis) (J')	[in]	0.000	0.000
Radius of gyration (local axes) (r)	[in]	0.062	0.062
Radius of gyration (principal axes) (r')	[in]	0.062	0.062
Saint-Venant torsion constant. (J)	[in4]	3.97E-04	
Section warping constant. (Cw)	[in6]	0.000	
Distance from centroid to shear center (principal axis) (xo,yo)	[in]	0.000	0.000
Top elastic section modulus of the section (local axis) (Ssup)	[in3]	0.001	0.001
Bottom elastic section modulus of the section (local axis) (Sinf)	[in3]	0.001	0.001
Top elastic section modulus of the section (principal axis) (S'sup)	[in3]	0.001	0.001
Bottom elastic section modulus of the section (principal axis) (S'inf)	[in3]	0.001	0.001
Plastic section modulus (local axis) (Z)	[in3]	0.003	0.003
Plastic section modulus (principal axis) (Z')	[in3]	0.003	0.003
Polar radius of gyration. (ro)	[in]	0.088	
Area for shear (Aw)	[in2]	0.049	0.049
Torsional constant. (C)	[in3]	0.004	

Material : APA - A36 - Cables

Properties	Unit	Value
Yield stress (Fy):	[Lb/in2]	36000.00
Tensile strength (Fu):	[Lb/in2]	58000.00
Elasticity Modulus (E):	[Lb/in2]	2.9E07
Shear modulus for steel (G):	[Lb/in2]	1.150794E07

DESIGN CRITERIA

Description	Unit	Value
Length for tension slenderness ratio (L)	[in]	181.23

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Distance between member lateral bracing points

Length (Lb) [in]	
Top	Bottom
181.23	181.23

Laterally unbraced length

Length [in]			Effective length factor		
Major axis(L33)	Minor axis(L22)	Torsional axis(Lt)	Major axis(K33)	Minor axis(K22)	Torsional axis(Kt)
181.23	181.23	181.23	1.0	1.0	1.0

Additional assumptions

Continuous lateral torsional restraint	No
Tension field action	No
Continuous flexural torsional restraint	No
Effective length factor value type	None
Major axis frame type	Sway
Minor axis frame type	Sway

DESIGN CHECKS

AXIAL TENSION DESIGN ✔

Axial tension

Ratio	:	0.40			
Capacity	:	1589.05 [Lb]	Reference	:	Eq. Sec. D2
Demand	:	634.23 [Lb]	Ctrl Eq.	:	D34 at 50.00%

Intermediate results	Unit	Value	Reference
Factored axial tension capacity(ϕP_n)	[Lb]	1589.05	Eq. Sec. D2

AXIAL COMPRESSION DESIGN ✔

Compression in the major axis 33

Ratio	:	0.00			
Capacity	:	1.32 [Lb]	Reference	:	Sec. E1
Demand	:	0.00 [Lb]	Ctrl Eq.	:	D29 at 0.00%

Intermediate results	Unit	Value	Reference
Section classification			
Factored flexural buckling strength(ϕP_{n33})	[Lb]	1.32	Sec. E1

Compression in the minor axis 22

Ratio	:	0.00			
Capacity	:	1.32 [Lb]	Reference	:	Sec. E1
Demand	:	0.00 [Lb]	Ctrl Eq.	:	D29 at 0.00%

Intermediate results	Unit	Value	Reference
Section classification			
Factored flexural buckling strength(ϕP_{n22})	[Lb]	1.32	Sec. E1

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FLEXURAL DESIGN ✔

Bending about major axis, M33

Ratio	:	0.00			
Capacity	:	6.47 [Lb*ft]	Reference	:	Sec. F1
Demand	:	0.01 [Lb*ft]	Ctrl Eq.	:	D29 at 46.88%

Intermediate results	Unit	Value	Reference
Section classification			
Factored yielding strength(ϕM_n)	[Lb*ft]	6.47	Sec. F1

Bending about minor axis, M22

Ratio	:	0.00			
Capacity	:	6.47 [Lb*ft]	Reference	:	Sec. F1
Demand	:	-0.01 [Lb*ft]	Ctrl Eq.	:	D29 at 50.00%

Intermediate results	Unit	Value	Reference
Section classification			
Factored yielding strength(ϕM_n)	[Lb*ft]	6.47	Sec. F1

DESIGN FOR SHEAR ✔

Shear in major axis 33

Ratio	:	0.00			
Capacity	:	953.43 [Lb]			
Demand	:	0.00 [Lb]	Ctrl Eq.	:	D29 at 50.00%

Intermediate results	Unit	Value	Reference
Factored shear capacity(ϕV_n)	[Lb]	953.43	

Shear in minor axis 22

Ratio	:	0.00			
Capacity	:	953.43 [Lb]			
Demand	:	0.00 [Lb]	Ctrl Eq.	:	D29 at 0.00%

Intermediate results	Unit	Value	Reference
Factored shear capacity(ϕV_n)	[Lb]	953.43	

TORSION DESIGN ✔

Torsion

Ratio	:	0.01			
Capacity	:	5.14 [Lb*ft]			
Demand	:	-0.04 [Lb*ft]	Ctrl Eq.	:	D34 at 0.00%

Intermediate results	Unit	Value	Reference
Factored torsion capacity(ϕT_n)	[Lb*ft]	5.14	

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COMBINED ACTIONS DESIGN

Combined flexure and axial compression

Ratio	:	0.00			
Ctrl Eq.	:	D29 at 46.88%	Reference	:	Eq. H1-2

Intermediate results	Unit	Value	Reference
Interaction for doubly symmetric members for in-plane bending	--	0.00	Eq. H1-1b
Interaction for doubly symmetric members for out-of-plane bending	--	0.00	Eq. H1-2

Combined flexure and axial tension

Ratio	:	0.40			
Ctrl Eq.	:	D34 at 50.00%	Reference	:	Eq. H1-1a

Intermediate results	Unit	Value	Reference

Combined flexure and axial compression about local axis

Ratio	:	N/A			
Ctrl Eq.	:	--	Reference	:	

Combined flexure and axial tension about local axis

Ratio	:	N/A			
Ctrl Eq.	:	--	Reference	:	

Combined torsion, flexure, shear and axial compression

Ratio	:	N/A			
Ctrl Eq.	:	--	Reference	:	

Combined torsion, flexure, shear and axial tension

Ratio	:	N/A			
Ctrl Eq.	:	--	Reference	:	

SOLAR RACKING

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Steel Code Check – KNEE BRACE

Report: Concise

Members: Cold-formed
Design code: AISI 2001 Sup. 2004 LRFD

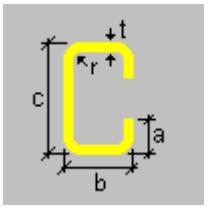
Member	:	**339 (Knee Brace)**
Design status	:	**OK**

PROPERTIES

Section information

Section name: TITAN KNEE BRACE - 3X2X078 **(US)**

Dimensions



a	=	0.630	[in]	Lip
b	=	2.000	[in]	Flange width
c	=	3.000	[in]	Depth
r	=	0.141	[in]	Inside bend radius
t	=	0.078	[in]	Thickness

Properties

Section properties	Unit	Major axis	Minor axis
Gross area of the section. (Ag)	[in2]	0.594	
Moment of Inertia (principal axes) (I')	[in4]	0.871	0.333
Bending constant for moments (principal axis) (J')	[in]	0.000	2.304
Radius of gyration (principal axes) (r')	[in]	1.211	0.749
Saint-Venant torsion constant. (J)	[in4]	0.001	
Section warping constant. (Cw)	[in6]	0.845	
Distance from centroid to shear center (principal axis) (xo,yo)	[in]	-1.909	0.000
Top elastic section modulus of the section (principal axis) (S'sup)	[in3]	0.581	0.273
Bottom elastic section modulus of the section (principal axis) (S'inf)	[in3]	0.581	0.427
Polar radius of gyration. (ro)	[in]	2.381	

Material : A653 SS 80-1

Description	Unit	Value
Yield stress (Fy):	[Lb/in2]	80000.00
Tensile strength (Fu):	[Lb/in2]	82000.00
Elasticity Modulus (E):	[Lb/in2]	2.95E07
Shear modulus for steel (G):	[Lb/in2]	1.134615E07

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Unbraced compression length (Lx, Ly)	[in]	91.20	91.20
Length for torsion and lateral-torsional buckling	[in]	91.20	
Lateral bracing	--	No	No

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Additional hypotheses		
Bearing length	[in]	0.00
Positive flange fastened		No
Negative flange fastened		No
Continuous lateral torsional restraint		No

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Maximum geometric slenderness (L/r)	--	121.42		(Com. C4F)
Geometric slenderness (KL/r)	--	121.42		
Deflection in compression and/or bending	[in]	0.01	DEF2 at 0.00%	

DESIGN CHECKS

DESIGN FOR FLEXURE

Bending about major axis, M33

Ratio : 0.00
Capacity : 1684.60 [Lb*ft] Reference : (Sec. C3)
Demand : 0.00 [Lb*ft] Ctrl Eq. : D1 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal flexural strength (Mnx)	[Lb*ft]	1871.78	(Sec. C3)

Bending about minor axis, M22

Ratio : 0.00
Capacity : 689.54 [Lb*ft] Reference : (Sec. C3)
Demand : 0.00 [Lb*ft] Ctrl Eq. : D14 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal flexural strength (Mny)	[Lb*ft]	766.16	(Sec. C3)

DESIGN FOR SHEAR

Shear parallel to minor axis, V2

Ratio : 0.00
Capacity : 9112.52 [Lb] Reference : (Sec. C3.2)
Demand : 0.00 [Lb] Ctrl Eq. : D1 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Lb]	9592.13	(Sec. C3.2)

Shear parallel to major axis, V3

Ratio : 0.00
Capacity : 11111.44 [Lb] Reference : (Sec. C3.2)
Demand : 0.00 [Lb] Ctrl Eq. : D14 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Lb]	11696.26	(Sec. C3.2)

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DESIGN FOR TENSION ✔

Tension

Ratio	: 0.06		
Capacity	: 42937.00 [Lb]	Reference	: (Eq. C2-1)
Demand	: 2682.87 [Lb]	Ctrl Eq.	: D39 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal tension strength (Tn)	[Lb]	47707.78	(Sec. C2)

DESIGN FOR COMPRESSION ✔

Compression

Ratio	: 0.44		
Capacity	: -5186.37 [Lb]	Reference	: (Sec. C4)
Demand	: -2300.51 [Lb]	Ctrl Eq.	: D25 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal compression strength (Pn)	[Lb]	-6101.62	(Eq. C4.1)

DESIGN FOR TORSION ✔

Torsion

Ratio	: 0.00		
Capacity	: 61.25 [Lb*ft]	Reference	: (AISC, Sec. H)
Demand	: -0.20 [Lb*ft]	Ctrl Eq.	: D13 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal torsion strength	[Lb*ft]	64.47	

DESIGN FOR CRIPPLING ✔

Web crippling strength

Ratio	: 0.00		
Capacity	: 2334.31 [Lb]	Reference	: (Sec. C3.4)
Demand	: 0.00 [Lb]	Ctrl Eq.	: D1 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal crippling strength (Pn)	[Lb]	2917.89	(Eq. C3.4.1-1)
Crippling strength factor (Ωw)	--	0.80	(Tables C3.4.1)

INTERACTION ✔

Combined bending and web crippling ratio

Ratio	: 0.00		
		Ctrl Eq.	: D1 at 0.00%
		Reference	: C3.5.2-1

***The equation has been modified for a maximum ratio equal to 1.0**

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Combined bending and shear ratio (x-x)

Ratio : 0.00

Ctrl Eq. : D1 at 0.00%
Reference : C3.3.2-1

Combined bending and shear ratio (y-y)

Ratio : 0.00

Ctrl Eq. : D14 at 0.00%
Reference : C3.3.2-1

Combined flexure and tension ratio

Ratio : 0.06

Ctrl Eq. : D39 at 93.75%
Reference : C5.1.2-1

Combined flexure and compression ratio

Ratio : 0.44

Ctrl Eq. : D25 at 0.00%
Reference : C5.2.2-1

CRITICAL STRENGTH RATIO ✔

Ratio : 0.44
Ctrl Eq. : D25 at 0.00% Reference : C5.2.2-1

APA SOLAR RACKING

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Steel Code Check - ZEE PURLIN

Report: Concise

Members: Cold-formed
Design code: AISI 2001 Sup. 2004 LRFD

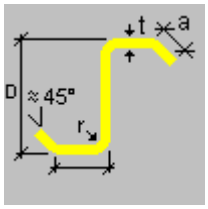
Member	:	**314 (ZEE PURLIN)**
Design status	:	**OK**

PROPERTIES

Section information

Section name: STD BIG ZEE - 6 X 3 X .055 **(US)**

Dimensions



a	=	1.000	[in]	Lip
b	=	3.000	[in]	Flange width
D	=	6.000	[in]	Depth
r	=	0.187	[in]	Inside bend radius
t	=	0.055	[in]	Thickness

Properties

Section properties	Unit	Major axis	Minor axis
Gross area of the section. (Ag)	[in2]	0.748	
Moment of Inertia (principal axes) (I')	[in4]	4.452	2.135
Bending constant for moments (principal axis) (J')	[in]	0.000	0.000
Radius of gyration (principal axes) (r')	[in]	2.439	1.689
Saint-Venant torsion constant. (J)	[in4]	7.70E-04	
Section warping constant. (Cw)	[in6]	12.653	
Distance from centroid to shear center (principal axis) (xo,yo)	[in]	0.000	0.000
Top elastic section modulus of the section (principal axis) (S'sup)	[in3]	1.484	0.577
Bottom elastic section modulus of the section (principal axis) (S'inf)	[in3]	1.484	0.577
Polar radius of gyration. (ro)	[in]	2.967	

Material : A653 SS 80-1

Description	Unit	Value
Yield stress (Fy):	[Lb/in2]	80000.00
Tensile strength (Fu):	[Lb/in2]	82000.00
Elasticity Modulus (E):	[Lb/in2]	2.95E07
Shear modulus for steel (G):	[Lb/in2]	1.134615E07

DESIGN CRITERIA

Description	Unit	Major axis	Minor axis
Effective length factor (K)	--	1.00	1.00
Effective length factor for torsion	--	1.00	
Unbraced compression length (Lx, Ly)	[in]	40.90	177.50
Length for torsion and lateral-torsional buckling	[in]	40.90	
Lateral bracing	--	Yes	Yes

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Additional hypotheses		
Bearing length	[in]	3.00
Positive flange fastened		No
Negative flange fastened		No
Continuous lateral torsional restraint		No

SERVICE CONDITIONS

Verification	Unit	Value	Ctrl EQ	Reference
Maximum geometric slenderness (L/r)	--	104.43		(Com. C4F)
Geometric slenderness (KL/r)	--	104.43		
Deflection in compression and/or bending	[in]	0.31	DEF4 at 52.50%	

DESIGN CHECKS

DESIGN FOR FLEXURE

Bending about major axis, M33

Ratio : 0.45
Capacity : 6719.91 [Lb*ft]
Demand : -3048.12 [Lb*ft]
Reference : (Sec. C3)
Ctrl Eq. : D13 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal flexural strength (Mnx)	[Lb*ft]	7073.59	(Sec. C3)

Bending about minor axis, M22

Ratio : 0.32
Capacity : 2810.23 [Lb*ft]
Demand : -899.12 [Lb*ft]
Reference : (Sec. C3)
Ctrl Eq. : D13 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal flexural strength (Mny)	[Lb*ft]	3122.48	(Sec. C3)

DESIGN FOR SHEAR

Shear parallel to minor axis, V2

Ratio : 0.34
Capacity : 4079.70 [Lb]
Demand : 1369.36 [Lb]
Reference : (Sec. C3.2)
Ctrl Eq. : D13 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Lb]	4294.42	(Sec. C3.2)

Shear parallel to major axis, V3

Ratio : 0.03
Capacity : 12242.13 [Lb]
Demand : -380.38 [Lb]
Reference : (Sec. C3.2)
Ctrl Eq. : D14 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal shear strength (Vn)	[Lb]	12886.45	(Sec. C3.2)

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DESIGN FOR TENSION ✔

Tension

Ratio	: 0.00		
Capacity	: 54218.21 [Lb]	Reference	: (Eq. C2-1)
Demand	: 9.57 [Lb]	Ctrl Eq.	: D11 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal tension strength (Tn)	[Lb]	60242.46	(Sec. C2)

DESIGN FOR COMPRESSION ✔

Compression

Ratio	: 0.00		
Capacity	:-11798.01 [Lb]	Reference	: (Sec. C4)
Demand	: -33.00 [Lb]	Ctrl Eq.	: D40 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal compression strength (Pn)	[Lb]	-13880.02	(Eq. C4.1)

DESIGN FOR TORSION ✔

Torsion

Ratio	: 0.00		
Capacity	: 53.22 [Lb*ft]	Reference	: (AISC, Sec. H)
Demand	: 0.00 [Lb*ft]	Ctrl Eq.	: D44 at 0.00%

Intermediate results	Unit	Value	Reference
Nominal torsion strength	[Lb*ft]	56.02	

DESIGN FOR CRIPPLING ✔

Web crippling strength

Ratio	: 0.00		
Capacity	: 2984.46 [Lb]	Reference	: (Sec. C3.4)
Demand	: 0.00 [Lb]	Ctrl Eq.	: D15 at 12.50%

Intermediate results	Unit	Value	Reference
Nominal crippling strength (Pn)	[Lb]	3316.07	(Eq. C3.4.1-1)
Crippling strength factor (Ωw)	--	0.90	(Tables C3.4.1)

INTERACTION ✔

Combined bending and web crippling ratio

Ratio	: 0.32		
		Ctrl Eq.	: D13 at 0.00%
		Reference	: C3.5.2-1

***The equation has been modified for a maximum ratio equal to 1.0**

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Combined bending and shear ratio (x-x)

Ratio : 0.56

Ctrl Eq. : D13 at 0.00%
Reference : C3.3.2-1

Combined bending and shear ratio (y-y)

Ratio : 0.32

Ctrl Eq. : D13 at 0.00%
Reference : C3.3.2-1

Combined flexure and tension ratio

Ratio : 0.77

Ctrl Eq. : D13 at 0.00%
Reference : C5.1.2-2

Combined flexure and compression ratio

Ratio : 0.77

Ctrl Eq. : D13 at 0.00%
Reference : C5.2.2-3

CRITICAL STRENGTH RATIO ✔

Ratio : 0.77
Ctrl Eq. : D13 at 0.00% Reference : C5.2.2-3