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STRUCTURAL ENGINEERING

STRUCTURAL CALCULATIONS
FOR

HELIODYNE SOLAR COLLECTOR RACK STRUCTURES

Gobi 410
FOR HELIODYNE, INC.

March 13, 2026

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SCOPE OF WORK

This report is for the Heliodyne Rack Stucture with Gobi 410 Collector. The purpose of the analysis was to determine appropriate loadings for the Heliodyne rack structure with Gobi 410 collectors following the current most design codes with an emphasis on California. The analysis looked at dead loads from collectors and racking, wind loads scenarios, as well as light snow loads. The analysis considered 110mph wind speed at exposure C. The governing design was a 35 degree tilt array. Their respective acceptable design criteria are outlined in this report. In the course of this analysis, the client agreed to increase the width of the T-flange from 1/4 inch to 3/8 inch. The analysis is based on this updated design.

CONCLUSION

After analysis, and with the new T-flange design, the rack has been determined to be adequate to support imposed loads in conditions outlined below. With the exception of special wind region and high snow areas, most low altitude California areas are covered by the tabulated conditions. All racking and collector parts shall be designed and installed per manufacturer's approved installation specifications.

Table 1: Design Criteria for Obstructed Wind Flow

Codes: 2025 California Building Code, ASCE 7-22

Risk Category: II

Design Criteria:

Basic wind speed V, mph:	110
Exposure Category:	C
Dead Load, psf:	3.3
Ground Snow Load, psf:	30
Seismic, S_{MS}:	2.54
Seismic, S_{M1}:	1.9

REFERENCES

ASCE Minimum Design Loads for Buildings and Other Structures (ASCE 7-22)

2018 National Design Specification for Wood Construction (NDS)

2015 Aluminum Design Manual (ADM)

NOTES AND LIMITS OF SCOPE OF WORK

1. Racks are installed on both long sides of the collectors with a maximum spacing of 4ft
2. The strength of the collectors is not part of the scope of this report
3. Engineer of Record for each specific site shall be responsible for verifying design criteria are within these limits, verifying connections to existing, strength of existing structures, and analysis of any structures not included in this report
4. This report can be used for reference only for sites meeting conditions in Table 1
5. Maximum building height considered is 40 feet for 110 mph
6. Atmospheric ice loading and flood loading are beyond the scope of this report
7. The rack structure in this report is defined in a drawing package prepared by Heliodyne, Inc. Titled Heliodyne Rack Installation Guide, dated 12/15/2010 (Available upon request)

BACKGROUND

Finite Element Analysis was performed to verify the structural adequacy of the Heliodyne mounting clip and rail to resist design loads including module weight, snow loads, and wind uplift.

With the exception of special wind region, all Category II structures in California have basic wind speeds of 100 mph or less. Our analysis used 110 mph with exposure C in order to consider special regions in California.

Velocity Pressure was calculated as follow:

$qh = 0.00256K_zK_{zt}K_eV^2$ eq. 26.10-1 ASCE 7-22

Site specific variables are:

Basic wind speed: V

Velocity pressure exposure coefficient, evaluated at height z: K_z

Topographic factor: K_{zt}

Ground elevation Factor Ke (Conservatively used 1)

Non Site specific variables are:

Wind directionality factor: $K_d = 0.85$

Gust effect factor: $G = 0.85$

The Net design pressure was calculated as follow:

$p=q_hK_dGC_N$ eq. 27.3-2 ASCE 7-22

C_N= Net pressure Coefficient determined from fig 27.3-4 of ASCE 7-22

Wind Pressure

Analysis performed per ASCE 7-22

Site Information:

Basic wind speed V, mph:	110
Risk Category:	II
Exposure Category:	C
Elevation, ft:	0

Geometry:

Tributary width, ft:	4.00
Tributary length, ft:	5.06
Tilt Angle, deg:	35
Sin of angle	0.57
Cos of angle	0.82
Mean Roof Height, ft:	40.00

Pressure Calculation:

Ground elevation factor K_e:	1.00	per Table 26.9-1
Wind directionality factor K_d:	0.85	per Table 26.6-1
Topographic factor K_{zt}:	1.00	per Figure 26.8-1
Velocity pressure coefficient K_z:	1.04	per Table 26.10-1
Velocity Pressure q_h, psf:	32.22	per Equation 26.10-1
Gust effect factor G:	0.85	per C26.11.1, structure assumed rigid
Wind Flow:	Clear	

Net Pressure Coefficients :
(per Figure 27.3-4)

#	Dir., deg	Load Case	C_{NW}	C_{NL}
1	0	A	-1.8	-1.8
2	0	B	-2.4	-0.6
3	180	A	2.1	2.2
4	180	B	2.7	1.1

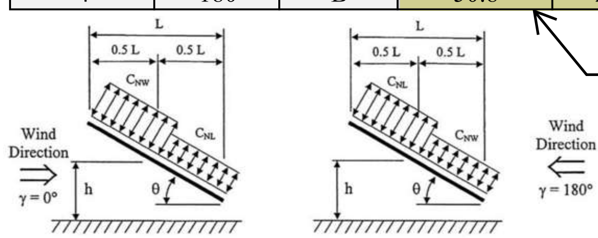
Design Wind Forces - x-dir (psf):
(per Equation 27.3-2)

#	Dir., deg	Load Case	q_hGC_{NW}	q_hGC_{NL}
1	0	A	-24.0	-24.0
2	0	B	-32.5	-7.6
3	180	A	28.0	28.9
4	180	B	35.6	14.2

Design Wind Forces - y-dir (psf):
(per Equation 27.3-2)

#	Dir., deg	Load Case	q_hGC_{NW}	q_hGC_{NL}
1	0	A	-34.3	-34.3
2	0	B	-46.4	-10.8
3	180	A	40.0	41.3
4	180	B	50.8	20.3

Governs when averaged
(see next page)



Wind Pressures

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Wind Load Calculation

The wind loads are modeled as two uniformly distributed loads acting over different portions of the span. Each distributed load is replaced with an equivalent resultant force acting at the centroid of its loaded length. Taking moments about the left support gives the right support reaction as:

Wind Load, $W = 0.75W_1 + 0.25W_2$	**43.2**	psf

Snow Load Calculation

Ground Snow Load, P_g	30	psf
Exposure Factor, C_e	0.9	
Thermal Factor, C_t	1.2	
Importance Factor, I_s	0.8	
Flat Roof Snow Load	18.144	Eqn. 7.3-1 or jurisdiction min.
Slope	35.00	degrees
Unobstructed Slippery Surface?	Yes	
Slope Factor, C_s	0.64	
Sloped Roof Snow Load	**11.5**	psf

Dead Load Calculation

Solar Collector GOBI 410	**3.3**	psf

LOAD COMBINATIONS

Stength Level Combination (LRFD) per ASCE 7-22 Sections 2.3.1

LC1: 1.2D + W	47.18	psf
LC2: 0.9D + W	46.19	psf
LC3: 1.2D + W + 0.5S	52.95	psf
LC4: 1.2D + 0.5W + 1.6S	44.03	psf

Among the four load combinations evaluated, LC3 produces the maximum critical demand and is therefore considered for the analysis

Solar Collector Tributary length	2.53	ft
LC3: 1.2D + W + 0.5S	**134.0**	plf

Finite Element Analysis (Loading)

A distributed line load of 134 lb/ft representing the load combination 1.2D + W + 0.5S is applied along the length of the Heliodyne rail. The load simulates a continuous uniform load acting along the member to evaluate structural response under combined dead, wind, and reduced snow loading.

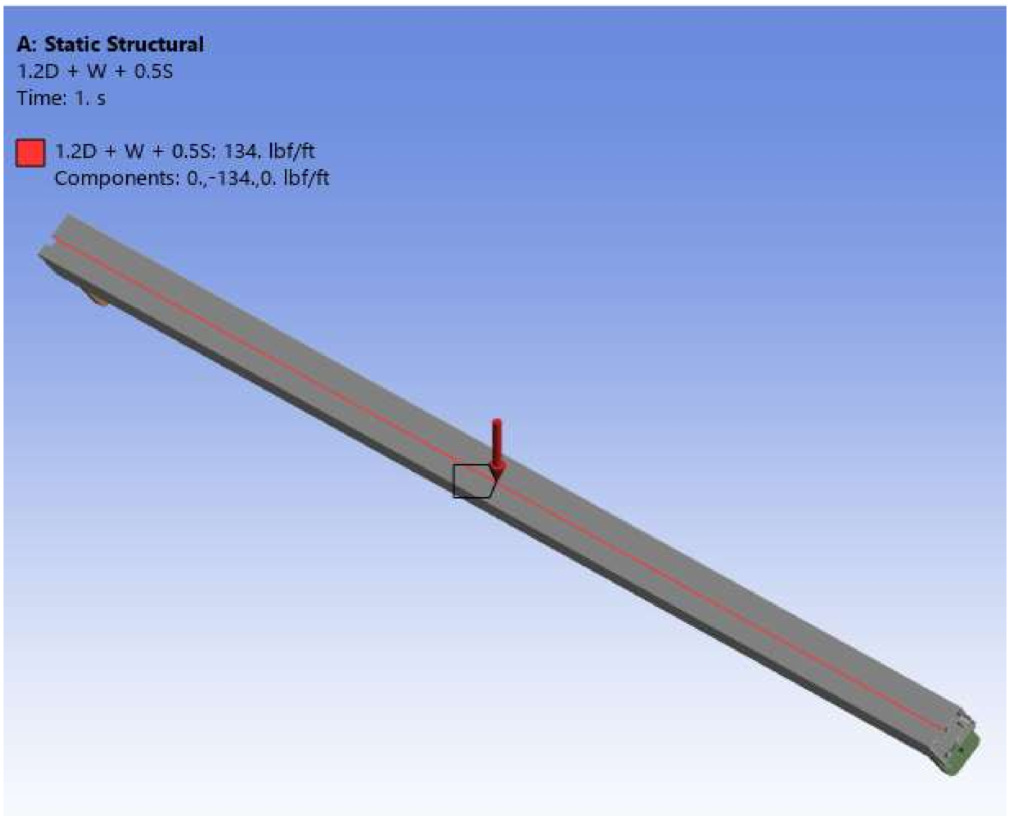

Figure 1. Distributed line load applied to Heliodyne rail

<u>Finite Element Analysis (Rail and Clip Component)</u>

The allowable stress for a strength design, per the Aluminum Design manual is the lesser of $\varphi_{t,y} \times F_{y,t}$ and $\varphi_{t,ult} \times F_{ult,t}$. The governing value was for yielding, which is 0.9 x 40 ksi ($F_{y,t}$ for Aluminum grade 6061 - T6) = 36 ksi. The computed maximum equivalent (von Mises) stress is 31.7 ksi, which is below the allowable stress of 36 ksi, corresponding to a stress ratio of 0.88. Therefore, the structure satisfies the stress acceptance criteria.

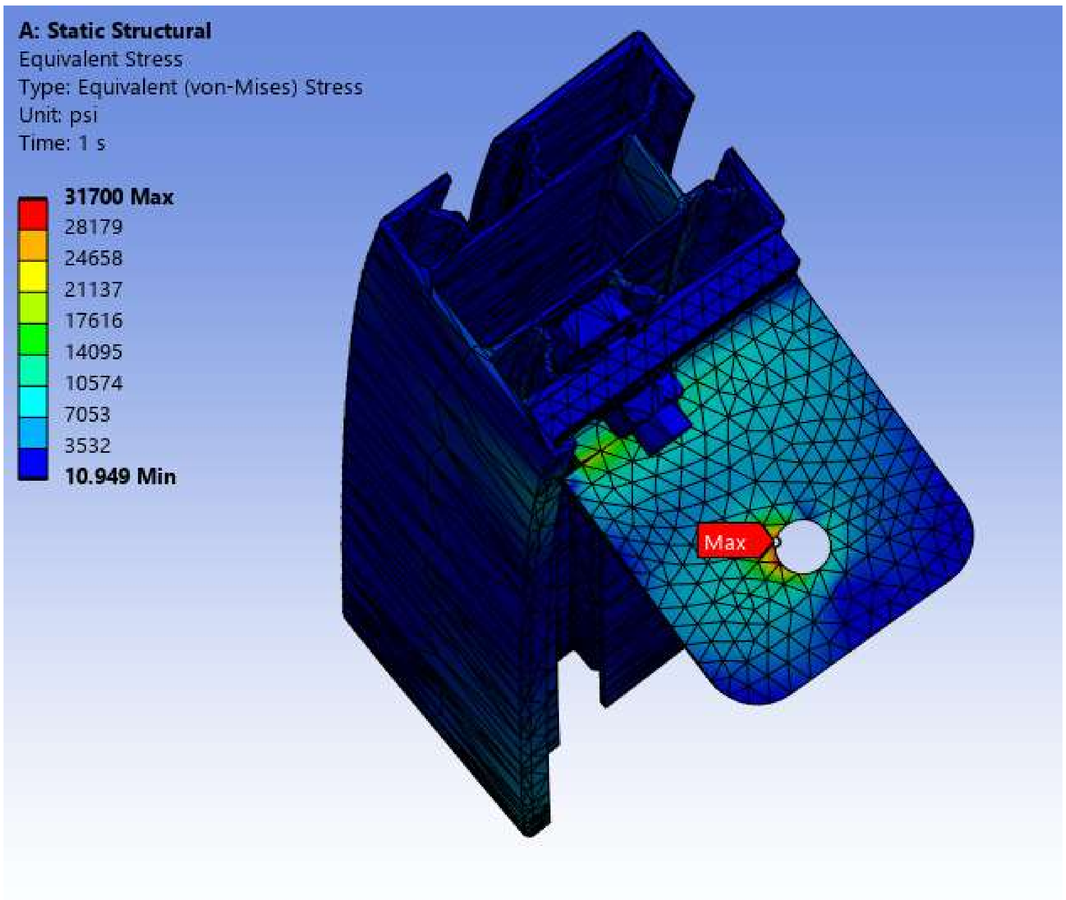

Figure 2. Equivalent (von Mises) stress contour for the Heliodyne rail and clip component

Finite Element Analysis (Rail Mounting Foot Connectiona and Leg Component)

The finite element analysis indicates a maximum equivalent (von Mises) stress of 22.11 ksi. This stress was compared against the material yield stress and fracture stress to assess both yielding and ultimate failure potential. For the stainless steel bolt material considered:

Fracture stress, F_u =85 ksi;   Yield stress, F_y=30 ksi

which is less than both the material yield stress and fracture stress. The corresponding factors of safety are 1.35 against yielding and 3.84 against fracture. Based on these results, the component is not expected to yield or fracture under the analyzed loading condition

In addition, the Pipe leg (Aluminum 6061-T6) calculated stress remains below the yield stress, the material would remain within the elastic range of behavior under the analyzed loading condition. The stress level is substantially below the ultimate strength of the alloy, indicating that rupture or fracture of the pipe leg would not occur.

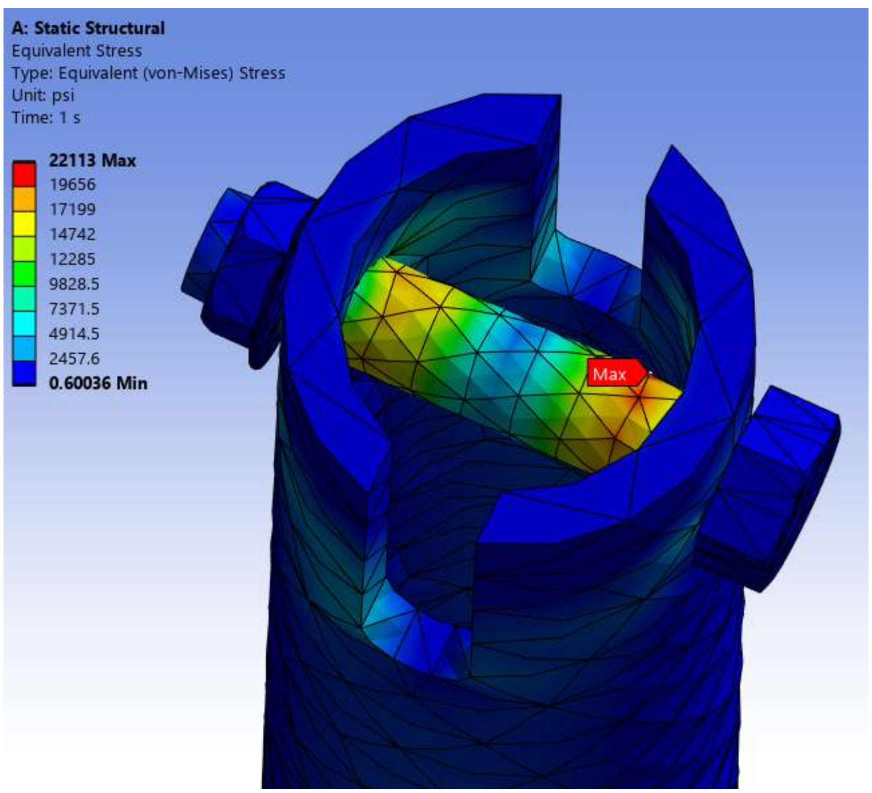

Figure 3. Equivalent (von Mises) stress contour for the Heliodyne Rail Mounting Foot Connection and Leg Component

Finite Element Analysis (Pedestal Foot Capacity Analysis)

Previously submitted engineering calculations from Matrix Consulting Engineers (dated 1/28/2011 - available upon request) show a maximum pedestal foot stress demand of 24.3 ksi. As it was not expected to govern, it has not been modelled.

The increase in demand on the connections between our loading analysis and that of Matrix was approximately 30.45%. A linear scaling of those results by 30.45% results in 31.7 ksi maximum stress, a result which remains below the maximum allowable stress of 36 ksi. Therefore, this analysis was not rerun.

Table 3. Foot Analysis Input

Case 1		Case 2		Case 3			Case 4	Case 5
T(k)	V (k)	C (k)	V (k)	C (k)	V (k)		T (k)	C (k)
0.08	-0.84	0.31	0.75	0.49	0.59		1.58	1.96
Max Stress (ksi)	24.3	Max Stress	23.4	Max Stress (ksi)	16.6	Max Stress (ksi)	8.8	18.9

Figure 4. Analysis reference from Matrix Consulting Engineers report