ZCS ENGINEERING ARCHITECTURE

Structural Calculations

Humbolt ES HVAC

329 N Humbolt St
Canyon City, Oregon 97820

Prepared for:
Grant County School District
401 N. Canyon City Blvd.
Canyon City, OR 97820

ZCS	**PROJECT:** Humbolt ES HVAC		**PROJECT #:** P-2870-23
	CLIENT: Grant County School District		
	DATE: 10/2/2023	**VERSION:** 3.05	**DESIGNED BY:** BLD

PROJECT INFORMATION

Project	Project Number	P-2870-23
	Project Name	Humbolt ES HVAC
Address	Legal Description of Property	
	Street Address	329 N Humbolt St
	City, State Zip-Code	Canyon City, Oregon 97820
Client	Client	Grant County School District
	Address	401 N. Canyon City Blvd.
		Canyon City, OR 97820
Contact	Contact	Mark Witty
	Phone	541-575-1799
	Fax	
	Email	markwitty@grantesd.org
Billing	Bill to	Grant County School District
	Billing Address	401 N. Canyon City Blvd.
		Canyon City, OR 97820

PROJECT DESIGN CRITERIA

Governing Body & Building Type	Building Department	Grant County
	Governing Codes	Building: 2022 OSSC ASCE: ASCE 7-16
	Occupancy & Risk Category	Educational III
Snow Loading	Ground Snow Load	8.00 *psf*
	Minimum Roof Snow Load?	Yes 20.00 *psf*
	Exposure of Roof	Fully Exposed
	Duration Factor for Wood?	Yes
Wind Loading	Design Wind Speed	108 mph LRFD
	Enclosure Classification	Enclosed Buildings
	Exposure Classification	C
	Roof Angle	2.5/12 11.77°
	Mean Height	12.00 ft
	Minimum Building Length	40.00 ft
	Site Elevation	3,160 ft
	Topographic Factor (K_{zt})	1.000
	Wind Elevation Factor (K_e)	0.892
Seismic Loading	Site Soil Classification	Site Class D – Stiff Soil
	Seismic Design Category	C
	Acceleration Parameters:	**ASCE 7**
	Short-Period	S_S = 0.310 g S_{DS} = 0.321
	One Second	S_1 = 0.123 g S_{D1} = 0.193
	Seismic Design Values	I_e = 1.25 R_X = 6 1/2 C_{sX} = 0.043
		R_Y = 6 1/2 C_{sY} = 0.043
Soil Loading	Geotech Report	No
	Soil Bearing Pressure	1,500
	Frost Depth	24.00 in

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ASCE 7-16 DESIGN WIND SPEED

ASCE AMERICAN SOCIETY OF CIVIL ENGINEERS

ASCE 7 Hazards Report

Address:
329 N Humbolt St
Canyon City, Oregon
97820

Standard: ASCE/SEI 7-16
Risk Category: III
Soil Class: D - Default (see Section 11.4.3)

Latitude: 44.399275
Longitude: -118.948895
Elevation: 0 ft (NAVD 88)

Wind

Results:

Wind Speed	107 Vmph ← USE 108 MPH PER OSSC.
10-year MRI	69 Vmph
25-year MRI	76 Vmph
50-year MRI	80 Vmph
100-year MRI	86 Vmph

Data Source: ASCE/SEI 7-16, Fig. 26.5-1C and Figs. CC.2-1–CC.2-4, and Section 26.5.2
Date Accessed: Mon Sep 25 2023

Value provided is 3-second gust wind speeds at 33 ft above ground for Exposure C Category, based on linear interpolation between contours. Wind speeds are interpolated in accordance with the 7-16 Standard. Wind speeds correspond to approximately a 3% probability of exceedance in 50 years (annual exceedance probability = 0.000588, MRI = 1,700 years).

Site is not in a hurricane-prone region as defined in ASCE/SEI 7-16 Section 26.2.

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ASCE 7-16 SEISMIC DESIGN CRITERIA

OSHPD

329 N Humbolt St, Canyon City, OR 97820, USA

Latitude, Longitude: 44.4007646, -118.9488919

Date	9/25/2023, 4:52:10 PM
Design Code Reference Document	ASCE7-16
Risk Category	III
Site Class	D - Default (See Section 11.4.3)

Type	Value	Description
S_S	0.31	MCE_R ground motion. (for 0.2 second period)
S_1	0.123	MCE_R ground motion. (for 1.0s period)
S_{MS}	0.481	Site-modified spectral acceleration value
S_{M1}	0.289	Site-modified spectral acceleration value
S_{DS}	0.32	Numeric seismic design value at 0.2 second SA
S_{D1}	0.193	Numeric seismic design value at 1.0 second SA

Type	Value	Description
SDC	C	Seismic design category
F_a	1.552	Site amplification factor at 0.2 second
F_v	2.354	Site amplification factor at 1.0 second
PGA	0.139	MCE_G peak ground acceleration
F_{PGA}	1.522	Site amplification factor at PGA
PGA_M	0.211	Site modified peak ground acceleration
T_L	16	Long-period transition period in seconds
SsRT	0.31	Probabilistic risk-targeted ground motion. (0.2 second)
SsUH	0.34	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration
SsD	1.5	Factored deterministic acceleration value. (0.2 second)
S1RT	0.123	Probabilistic risk-targeted ground motion. (1.0 second)
S1UH	0.136	Factored uniform-hazard (2% probability of exceedance in 50 years) spectral acceleration.
S1D	0.6	Factored deterministic acceleration value. (1.0 second)
PGAd	0.5	Factored deterministic acceleration value. (Peak Ground Acceleration)

SNOW LOADS

Site & Building Design Criteria

Ground Snow Load, p_g =	8.00 *psf*	Exposure of Roof =	Fully Exposed
Snow Density, γ =	15.04 *pcf*	Exposure Category =	C
Importance Factor, I_s =	1.10	Exposure Factor, C_e =	0.90

Flat & Sloped Roof Snow Loads

Roof	Roof Slope X:12	Roof Slope θ°	Obstructed	Rain on Snow?	Thermal Factor C_t	Slope Factor C_s	**Flat Roof SL p_f (psf)**	**Sloped Roof SL p_s (psf)**
1	2.5	11.77	Yes	No	1.1	1.00	**22.00**	**22.00**

L

SEAO GROUND SNOW LOAD

Oregon Snow Loading

The design ground snow of any location in the state of Oregon may be determined by entering the latitude and longitude of your site into the boxes below. The tool provides the design ground snow load (pg in ASCE7*) for your site. The design ground snow load values can also be viewed on the online map. Users are strongly recommended to review the Map Usage Notes.

Ground snow loads are very sensitive to geographic location, and particularly sensitive to elevation. It is recommended that the latitude and longitude values be entered with a precision of 0.001 (about 105 yards).

* ASCE Standard (ASCE/SEI 7-10) *Minimum Design Loads for Buildings and Other Structures* published by the American Society of Civil Engineers.

Latitude - Longitude Lookup

Results

Latitude:	44.40076460
Longitude:	-118.94889190
Snow Load:	8.0 psf
Modeled Elevation:	3307 ft

Site Elevation versus Modeled Grid Elevation

Site elevation refers to the elevation (above sea level, in feet) of the location for which the snow load is required. The modeled grid elevation is the average elevation of the 4 km (about 2-1/2 miles) grid cell that was used in the snow load modeling. In relatively flat terrain, the two elevations will likely be the same or very similar. In sloped or mountainous terrain, the two elevations may be quite different.

The design ground snow load may be underreported for some locations where the site elevation is higher than the modeled grid elevation. Consult the Map Usage Notes if your site elevation is more than 100 ft. above the modeled grid elevation shown, or if your site is at or near the top of a hill.

Oregon Design Ground Snow Load Look Up Results

It is important that the user of this tool understand the principals and limitations of the modeling used to create it. Ground snow loads can vary dramatically over short distances due to changes in precipitation and elevation. It is critical to use good engineering judgment when interpreting and using the results reported by this tool. The user is recommended to review the online map, to gain a better understanding of the variations and range of magnitudes of the ground snow loads in the vicinity of the site location.

In remote regions at high elevation, reliable snow data was not available during the creation of the map. A site-specific case study is required to determine the design ground snow load in these areas. The ground snow load values on the map are based on extrapolation, and are not recommended for design. See the Map Usage Notes for the regions that require a site-specific case study.

It is recommended that the local building official having jurisdiction at the site be consulted for minimum design ground snow or roof snow loads.

The reported design ground snow loads must be adjusted as required by Chapter 7 of ASCE7* for site exposure, roof slope, roof configuration, etc. Only the properly adjusted loads can be used to design roof structural elements.

Oregon requires a minimum roof snow load of 20 psf (pm in ASCE7*) for all roofs, plus a 5 psf rain-on-snow surcharge for many roof types, resulting in a 25 psf minimum roof design load for most roofs. See the Map Usage Notes or *Snow Load Analysis for Oregon, Part II* for further information.

* ASCE Standard (ASCE/SEI 7-10) Minimum Design Loads for Buildings and Other Structures published by the American Society of Civil Engineers.

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GRAVITY LOADS

Roof Dead Load			Load (psf)
Roofing Type:	Standing Seam Metal		2.0
Sheathing:	1/2" Plywood Sheathing		1.4
Sheathing:	1x6 T&G Decking		2.2
Roof Framing:	2x10	@ 24 OC	1.7
Insulation:	12" Batt Insulation		0.5
Ceiling:	1/2" Gyp		2.2
Misc:	Misc.		2.5
		Total:	12.4 psf
		Use Sloped:	**12.5 psf**
		Use Flat:	**13.0 psf**

Slope Correction	
3/12	0.98

Roof Live Load		Load (psf)
Snow	**Use:**	**22.0 psf**
Live	**Use:**	**20.0 psf**

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SEISMIC DEMANDS ON NONSTRUCTURAL COMPONENTS

GROUND UNITS

Seismic Design Criteria

Building Occupancy Risk Category		Risk Category =	III	Table 1.5-1
Seismic Importance Factor (I_p)		I_p =	1.00	Table 1.5-2
Site Soil Classification		Site Class =	D	11.4.2
Structure Height (h_n)		h_n =	12.00 ft	12.8.2.1
Attachment Height (z)		z =	0.00 ft	
Short-Period Acceleration Parameter (S_S)		S_S =	0.310 g	11.4.1
One Second Acceleration Parameter (S_1)		S_1 =	0.123 g	
Seismic Design Category (SDC)		SDC =	C	11.6
Long-Period Transition Period (T_L)		T_L =	16 sec	12.8.1.1
Regular Structure Less than 5 Stories, w/ Redundancy Factor =1.0 ?			Yes	12.8.1.3
Site Adjusted Short-Period Acceleration (S_{MS})	$S_{MS} = F_a S_S$	S_{MS} =	0.481 g	11.4.3
Site Adjusted One Second Acceleration (S_{M1})	$S_{M1} = F_v S_1$	S_{M1} =	0.290 g	
Design Short-Period Acceleration (S_{DS})	$S_{DS} = \left(\frac{2}{3}\right) S_{MS}$	S_{DS} =	0.321 g	11.4.4
Design One Second Acceleration (S_{D1})	$S_{D1} = \left(\frac{2}{3}\right) S_{M1}$	S_{D1} =	0.193 g	
Approximate Fundamental Period, conservative (T_a)	$T_a = 0.02 * h_n^{0.75}$	T_a =	0.129 sec	12.8.2.1
(For All Other Structural Systems)				

Seismic Response Coefficient: Nonstructural Component

Include Overstrength Factor? Yes — 13.3.1

Architectural Component	a_P [a]	R_P	Ω_0 [c]	Table 13.5-1
Air-side HVACR, fans, air handlers, air conditioning units, cabinet heaters, air distribution boxes, and other mechanical components constructed of sheet metal framing	2 1/2	6	2	

Horizontal Seismic Coefficient Minimum ($C_{c\,min}$)		$C_{c\,min}$ =	0.096	13.3-3
Horizontal Seismic Coefficient Maximum ($C_{c\,max}$)		$C_{c\,max}$ =	0.513	13.3-2
Horizontal Seismic Coefficient (C_c) (ASD)		**C_c =**	**0.096**	13.3-1
Vertical Seismic Coefficient (C_{cv}) (ASD)	$C_{cv} = 0.2 * S_{DS}$	**C_{cv} =**	**0.064**	13.3.1

$$C_{c\,min} = 0.3 S_{DS} I_p \qquad C_{c\,max} = 1.6 S_{DS} I_p \qquad C_c = \frac{0.4 a_p S_{DS}}{\left(\frac{R_p}{I_p}\right)} \left(1 + 2\frac{Z}{h}\right)$$

Equipment Weight (W)	W =	278.00 lbs
Horizontal Seismic Forece (F_h)	**$\Omega^* F_h$ =**	**53.50 lbs**
Vertical Seismic Force (F_v)	**$\Omega^* F_v$ =**	**35.67 lbs**

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SEISMIC LOADS ON GROUND EQUIPMENT

Ground Equipment

Length of Equipment (*L*)	*L* =	7.39	ft
Depth of Equipment (*D*)	*D* =	4.44	ft
Height of Equipment (*H*)	*H* =	3.91	ft
Weight of Equipment (*W*)	*W* =	1239	lbs

Seismic Forces on Equipment

Horizontal Seismic Coefficient (Cc)	Cc =	0.096	
Vertical Seismic Coefficient (Ccv)	Ccv =	0.064	
Horizontal Seismic Force (F_H)	F_H =	119	lbs
Vertical Seismic Force (F_V)	F_V =	79	lbs

Overturning Moment

Center of Force	H_C =	1.96	ft
Overturning Moment	M_O =	233	ft-lbs

Resistive Moment

Center of Force	D_C =	2.22	ft
Resistive Moment	M_R =	2751	ft-lbs

$M_R > M_O$ No Net Overtruning

Net Tension per Anchor

Dead Load Per Anchor	DL =	310	lbs
Seimic Vertical Forec Per Anchor	F_V =	40	lbs
	T =	0	lbs

Net Shear per Anchor

	V =	30	lbs

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SEISMIC DEMANDS ON NONSTRUCTURAL COMPONENTS

ROOFTOP UNITS

Seismic Design Criteria

Building Occupancy Risk Category		Risk Category =	III	Table 1.5-1
Seismic Importance Factor (I_p)		I_p =	1.00	Table 1.5-2
Site Soil Classification		Site Class =	D	11.4.2
Structure Height (h_n)		h_n =	12.00 ft	12.8.2.1
Attachment Height (z)		z =	12.00 ft	
Short-Period Acceleration Parameter (S_S)		S_S =	0.310 g	11.4.1
One Second Acceleration Parameter (S_1)		S_1 =	0.123 g	
Seismic Design Category (SDC)		SDC =	C	11.6
Long-Period Transition Period (T_L)		T_L =	16 sec	12.8.1.1
Regular Structure Less than 5 Stories, w/ Redundancy Factor =1.0 ?			Yes	12.8.1.3
Site Adjusted Short-Period Acceleration (S_{MS})	$S_{MS} = F_a S_S$	S_{MS} =	0.481 g	11.4.3
Site Adjusted One Second Acceleration (S_{M1})	$S_{M1} = F_v S_1$	S_{M1} =	0.290 g	
Design Short-Period Acceleration (S_{DS})	$S_{DS} = \left(\frac{2}{3}\right) S_{MS}$	S_{DS} =	0.321 g	11.4.4
Design One Second Acceleration (S_{D1})	$S_{D1} = \left(\frac{2}{3}\right) S_{M1}$	S_{D1} =	0.193 g	
Approximate Fundamental Period, conservative (T_a)	$T_a = 0.02 * h_n^{0.75}$	T_a =	0.129 sec	12.8.2.1
(For All Other Structural Systems)				

Seismic Response Coefficient: Nonstructural Component

Include Overstrength Factor? No — 13.3.1

Architectural Component	a_p [a]	R_P	Ω_0 [c]	Table 13.5-1
Roof-mounted stacks, cooling and electrical towers laterally braced below their center of mass	2 1/2	3	2	

Horizontal Seismic Coefficient Minimum ($C_{c\,min}$)		$C_{c\,min}$ =	0.096	13.3-3
Horizontal Seismic Coefficient Maximum ($C_{c\,max}$)		$C_{c\,max}$ =	0.513	13.3-2
Horizontal Seismic Coefficient (C_c)		**C_c =**	**0.321**	13.3-1
Vertical Seismic Coefficient (C_{cv})	$C_{cv} = 0.2 * S_{DS}$	**C_{cv} =**	**0.064**	13.3.1

$$C_{c\,min} = 0.3 S_{DS} I_p \qquad C_{c\,max} = 1.6 S_{DS} I_p \qquad C_c = \frac{0.4 a_p S_{DS}}{\left(\frac{R_p}{I_p}\right)} \left(1 + 2\frac{Z}{h}\right)$$

Equipment Weight (W)	W =	278.00 lbs
Horizontal Seismic Forece (F_h)	**F_h =**	**89.17 lbs**
Vertical Seismic Force (F_v)	**F_v =**	**17.83 lbs**

WIND CONTROLS

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WIND LOADS ON ROOFTOP EQUIPMENT

TRANSVERS LOADING

Building Data

Structure Type:	Rooftop Equipment		Table 26.6-1
Exposure Category:	C		
Mean Roof Height:	12.00	ft	
Elevation	3,160	ft	

Velocity Pressure

Velocity Pressure Exposure Coefficient (K_z)	K_z =	0.85		Table 26.10-1
Topographic Factor (K_{zt})	K_{zt} =	1.00		Figure 26.8-1
Wind Directionality Factor (K_d)	K_d =	0.85		Table 26.6-1
Ground Elevation Factor (K_e)	K_e =	0.89		Table 26.9-1
Basic Wind Speed (V)	V =	108	mph	26.5.1
Velocity Pressure (q_z)	q_z =	19.24	psf	26.10-1

Rooftop Equipment

Length of Equipment (B)	B =	3.50	ft
Height of Equipment (L)	L =	4.42	ft
Height from Groung to Top of Equipment (h)	h =	19.00	ft
Vertical Projected Area (A_f)	A_f =	15.46	ft^2
Horizontal Projected Area (A_r)	A_r =	3.79	ft^2

Horizontal Force on Equipment			Vertical Force on Equipment			29.4.1
		$(GC_r)_h$			$(GC_r)_v$	
*0.1*B*h* =	6.65	1.90	*0.1*B*L* =	1.55	1.50	
*B*h* =	66.50	1.00	*B*L* =	15.46	1.00	
A_f =	15.46	**1.77**	A_r =	3.79	**1.42**	

Horizontal Wind Pressure (p_h)		p_h =	34.01	psf
Vertical Wind Pressure (p_v)		p_v =	27.31	psf
Horizontal Wind Force (F_h)	$F_h = q_h(GC_r)_h A_f$	F_h =	**526**	**lbs**
Vertical Wind Force (F_v)	$F_v = q_h(GC_r)_v A_v$	F_v =	**104**	**lbs**

29.4-2

29.4-3

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WIND LOADS ON ROOFTOP EQUIPMENT

LONGITUDINAL LOADING

Building Data

Structure Type:	Rooftop Equipment		Table 26.6-1
Exposure Category:	C		
Mean Roof Height:	12.00	ft	
Elevation	3,160	ft	

Velocity Pressure

Velocity Pressure Exposure Coefficient (K_z)	K_z =	0.85		Table 26.10-1
Topographic Factor (K_{zt})	K_{zt} =	1.00		Figure 26.8-1
Wind Directionality Factor (K_d)	K_d =	0.85		Table 26.6-1
Ground Elevation Factor (K_e)	K_e =	0.89		Table 26.9-1
Basic Wind Speed (V)	V =	108	mph	26.5.1
Velocity Pressure (q_z)	q_z =	19.24	psf	26.10-1

Rooftop Equipment

Length of Equipment (B)	B =	1.00	ft
Height of Equipment (L)	L =	4.42	ft
Height from Groung to Top of Equipment (h)	h =	19.00	ft
Vertical Projected Area (A_f)	A_f =	4.42	ft^2
Horizontal Projected Area (A_r)	A_r =	1.08	ft^2

Horizontal Force on Equipment			Vertical Force on Equipment			
		$(GC_r)_h$			$(GC_r)_v$	29.4.1
0.1*B*h =	1.90	1.90	0.1*B*L =	0.44	1.50	
B*h =	19.00	1.00	B*L =	4.42	1.00	
A_f =	4.42	**1.77**	A_r =	1.08	**1.42**	

Horizontal Wind Pressure (p_h)	p_h =	34.01	psf	
Vertical Wind Pressure (p_v)	p_v =	27.31	psf	

Horizontal Wind Force (F_h)	$F_h = q_h(GC_r)_h A_f$	F_h =	**150 lbs**	29.4-2
Vertical Wind Force (F_v)	$F_v = q_h(GC_r)_v A_v$	F_v =	**30 lbs**	29.4-3

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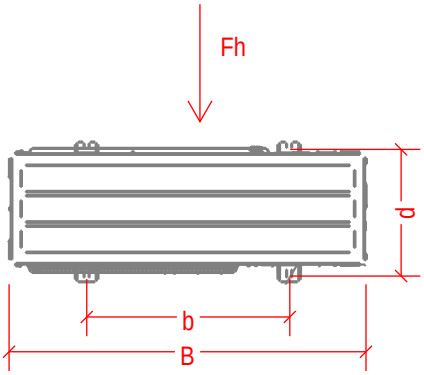
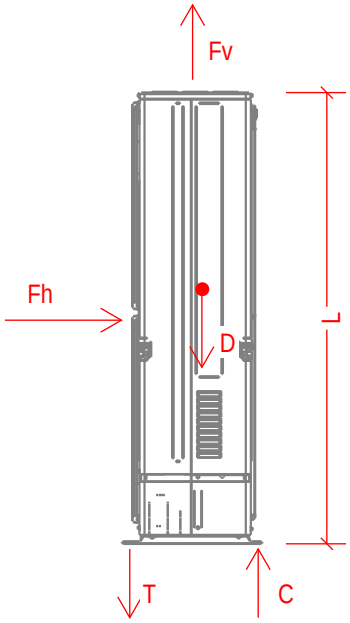
RTU ROOFTOP RACK DESIGN



PLAN VIEW



ELEVATION VIEW

DIMENSIONS
B = 42"
L = 53"
d = 14.5"
b = 23.5"

LOADS
D = 278 LBS
Fh = 526 LBS
Fv = 104 LBS

WIND LOAD REACTIONS
Twind = (L/2*Fh + d/2*Fv) / d
Twind = ((42"/2)*(526 LBS) + (14.5"/2)*(104 LBS)) / (14.5")
Twind = 813.79 LBS
Twind = 406.89 LBS PER ANCHOR

Cwind = Twind - Fv
Cwind = (813.79 LBS) - (104 LBS)
Cwind = 709.79 LBS
Cwind = 354.89 LBS PER ANCHOR

DEAD LOAD REACTIONS
Tdead = -((d/2)*D) / d
Tdead = -((14.5"/2)*(278 LBS)) / (14.5")
Tdead = -139 LBS
Tdead = -69.5 LBS PER ANCHOR

Cdead = Tdead + D
Cdead = (-139 LBS) + (278 LBS)
Cdead = 139 LBS
Cdead = 69.5 LBS PER ANCHOR

ASD FACTORED VERTICAL REACTIONS
0.6D+0.6W:
T = 0.6*Tdead + 0.6*Twind
T = 0.6*(-139 LBS) + 0.6*(813.79 LBS)
T = 404.87 LBS
T = 202.43 LBS PER ANCHOR

1.0D+0.6W:
C = 1.0*Cdead + 0.6*Cwind
C = 1.0*(139 LBS) + 0.6*(709.79 LBS)
C = 564.87 LBS
C = 282.43 LBS PER ANCHOR

ASD FACTORED SHEAR REACTIONS
1.0D+0.6W:
V = 0.6*Fh
V = 0.6*(560 LBS)
V = 336 LBS
V = 84 LBS PER ANCHOR

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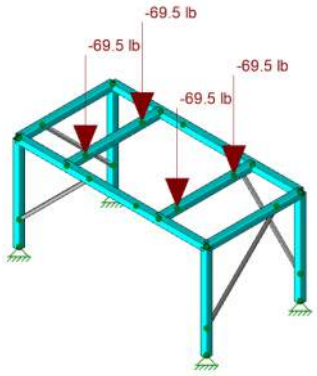
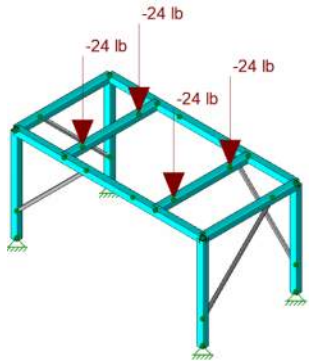
RISA ROOFTOP RACK DESIGN

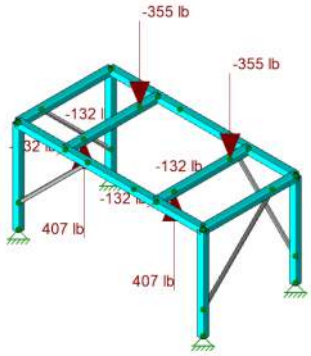
LOADING



DEAD LOAD

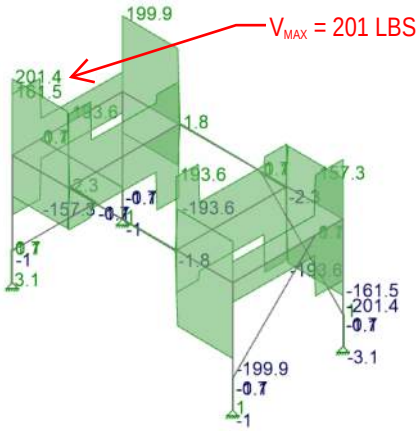


SNOW LOAD

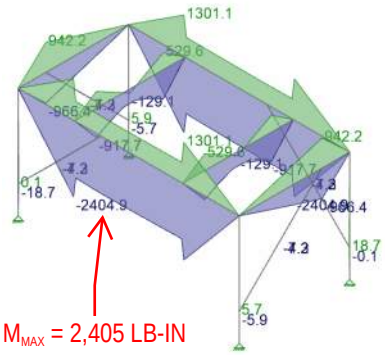


WIND LOAD

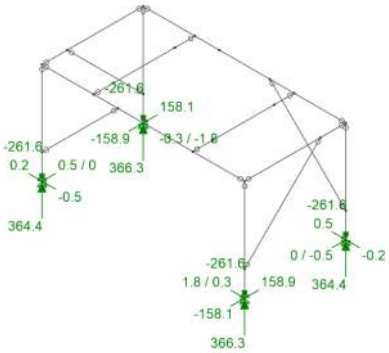
FORCES AND REACTIONS



ENVELOPE DESIGN SHEARS (LBS)



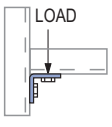
ENVELOPE DESIGN MOMENTS (LB-IN)



ENVELOPE DESIGN REACTIONS (LBS)

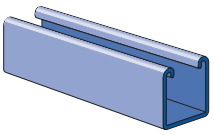
DESIGN CHECKS

Load – P1026		Channel Thickness 12 ga.	14 ga.	16 ga.
	Lbs	1,500	1,000	750
	kN	*6.67*	*4.45*	*3.34*



V_A = 1,500 LBS

UNISTRUT FITTING P1026



M_A = 5,070 LB-IN

Wt/100 Ft:189 Lbs (281 kg/100 m)
Allowable Moment 5,070 In-Lbs (570 N•m)
12 Gauge Nominal Thickness .105" (2.7mm)

UNISTRUT P1000

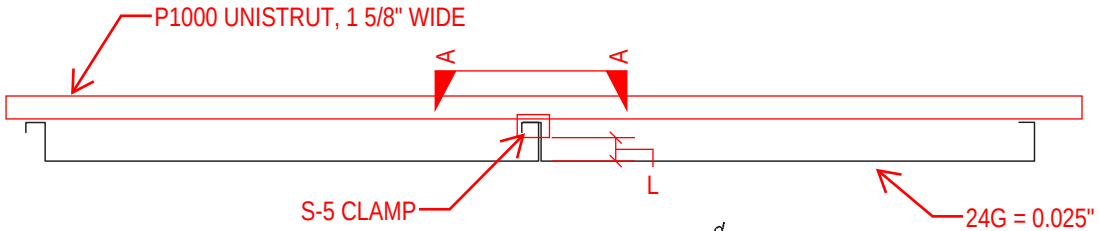
V_{MAX} / V_A = (201 LBS) / (1,500 LBS)
= 0.13 < 1.00 --> OK

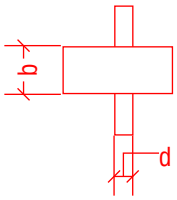
M_{MAX} / M_A = (2,405 LB-IN) / (5,070 LB-IN)
= 0.47 < 1.00 --> OK

ZCS	**PROJECT:** Humbolt ES HVAC	**PROJECT #:** P-2870-23
	CLIENT: Grant County School District	
	DATE: 09/29/2023	**DESIGNED BY:** BLD

S-5 BEARING DESIGN

CHECK METAL ROOF SEAM BUCKING CAPACITY





SECTION A-A

d = 2*0.025" = 0.050"
b = 1.625"
L = 1.25"
Ag = 0.08125IN2
K = 2

Fy =47KSI
E = 29,000KSI

$r = \frac{d}{\sqrt{12}}$ = 0.0144IN

$\frac{KL}{r}$ = 173.61

$4.71\sqrt{\frac{E}{F_y}}$ = 117

$F_e = \frac{\pi^2 E}{\left(\frac{KL}{r}\right)^2}$ = 9.496KSI (E3-4)

When $\frac{KL}{r} > 4.71\sqrt{\frac{E}{F_y}}$ $F_{cr} = 0.877F_e$ = 8.328KSI (E3-3)

$P_n = F_{cr} A_g$ = 0.676K (E3-1)

Ω = 1.67 $P_a = P_n/\Omega$ =0.405K

USE Pa = 400 LBS PER CLAMP

WALKWAY LOADING

CLAMP SPACING:
PARALLEL TO SEAM = 21"
PERPENDICULAR TO SEAM = 32"
TRIBUTARY AREA, A = 4.67 SQ. FT

LOADING:
D = 13PSF
Lr = 20PSF
S = 22PSF

POINT LOAD:
A*D = 60.6 => 61 LBS
A*Lr = 93.3 => 94 LBS
A*S = 102.6 => 103 LBS

P = 61 LBS+103 LBS

P = 164 LBS < Pa

ROOFTOP RACK TRANSVERSE LOADING

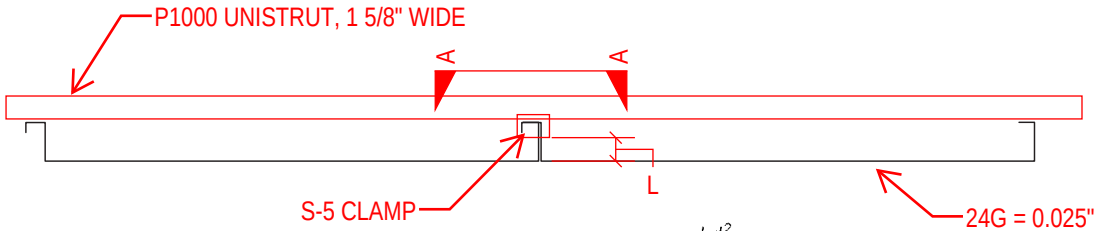
RISA ROOFTOP RACK VERTICAL REACTIONS:
DL = 84.6 LBS
SL = 24.0 LBS
WL+Z = 469.4 LBS
WL-Z =-522.3 LBS

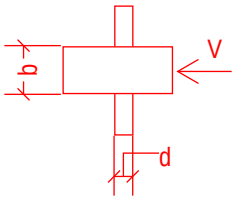
RACK REACTION AT EACH LEG:
P = DL+0.6WL
P = 84.6 LBS+0.6*469.4 LBS

P = 366 LBS < Pa

S-5 BEARING DESIGN CONT.

CHECK METAL ROOF SEAM BENDING CAPACITY





SECTION A-A

d = 2*0.025" = 0.050"
b = 1.625"
L = 1.25"

Fy =47KSI

$Z = \frac{bd^2}{4}$ = 0.0010156IN^3

$M_n = M_p = F_y Z$ = 0.0477K-IN (F11-1)

$\Omega_b = 1.67$ $M_a = M_n/\Omega_b$ = 28.58LB-IN

Va = Ma / L = 22.87 LBS

USE Va = 20LBS PER CLAMP

ROOFTOP RACK LONGITUDINAL LOADING

ROOFTOP RACK SHEAR REACTIONS:
W = 150 LBS
W = 37.5 LBS PER LEG

RACK REACTION AT EACH LEG:
# OF CLAMPS = 1.5
V = 0.6*W / (# OF CLAMPS)
V = 15 LBS

V = 15 LBS < Va

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 29 SEP 2023, 2:42PM

Wood Beam

Project File: p-2870-23 - humbolt es hvac.ec6

DESCRIPTION: (E) 2x4 SLEEPER w/ S-5 CLAMP POINT LOAD

CODE REFERENCES

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : ASCE 7-16

Wood Species : Douglas Fir-Larch
Wood Grade : No.1

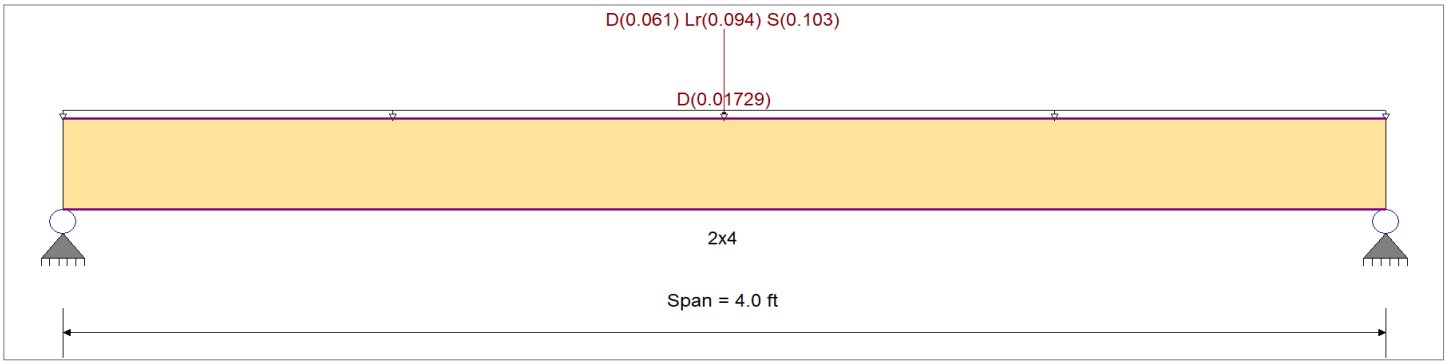
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling

Fb +	1000 psi
Fb -	1000 psi
Fc - Prll	1500 psi
Fc - Perp	625 psi
Fv	180 psi
Ft	675 psi

E : Modulus of Elasticity

Ebend- xx	1700 ksi
Eminbend - xx	620 ksi
Density	31.21 pcf

Repetitive Member Stress Increase



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added
Loads on all spans...
Uniform Load on ALL spans : D = 0.0130 ksf, Tributary Width = 1.330 ft
Point Load : D = 0.0610, Lr = 0.0940, S = 0.1030 k @ 2.0 ft, (S-5 CLAMP)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.832 : 1	Maximum Shear Stress Ratio	=	0.154 : 1
Section used for this span		2x4	Section used for this span		2x4
fb: Actual	=	1,815.59 psi	fv: Actual	=	31.94 psi
F'b	=	2,182.13 psi	F'v	=	207.00 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	2.000 ft	Location of maximum on span	=	3.723 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.143 in	Ratio =	336 >=180	Span: 1 : S Only
Max Upward Transient Deflection	0 in	Ratio =	0 <180	n/a
Max Downward Total Deflection	0.287 in	Ratio =	167 >=120	Span: 1 : +D+S
Max Upward Total Deflection	0 in	Ratio =	0 <120	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	CD	CM	C_t	CLx	C_F	Cfu	C_i	C_r	Moment Values M	fb	F'b	Shear Values V	fv	F'v
D Only														0.0	0.00	0.0	0.0
Length = 4.0 ft	1	0.512	0.106	0.90	1.00	1.00	1.00	1.500	1.10	1.00	1.15	0.10	873.9	1,707.8	0.06	17.2	162.0
+D+Lr					1.00	1.00	1.00	1.500	1.10	1.00	1.15			0.0	0.00	0.0	0.0
Length = 4.0 ft	1	0.731	0.136	1.25	1.00	1.00	1.00	1.500	1.10	1.00	1.15	0.19	1,733.3	2,371.9	0.11	30.7	225.0
+D+S					1.00	1.00	1.00	1.500	1.10	1.00	1.15			0.0	0.00	0.0	0.0
Length = 4.0 ft	1	0.832	0.154	1.15	1.00	1.00	1.00	1.500	1.10	1.00	1.15	0.20	1,815.6	2,182.1	0.11	31.9	207.0
+D+0.750Lr					1.00	1.00	1.00	1.500	1.10	1.00	1.15			0.0	0.00	0.0	0.0
Length = 4.0 ft	1	0.640	0.121	1.25	1.00	1.00	1.00	1.500	1.10	1.00	1.15	0.17	1,518.4	2,371.9	0.10	27.3	225.0
+D+0.750S					1.00	1.00	1.00	1.500	1.10	1.00	1.15			0.0	0.00	0.0	0.0

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 29 SEP 2023, 2:42PM

Wood Beam

Project File: p-2870-23 - humbolt es hvac.ec6

DESCRIPTION: (E) 2x4 SLEEPER w/ S-5 CLAMP POINT LOAD

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	CD	CM	C_t	CLx	C_F	Cfu	C_i	C_r	Moment Values M	fb	F'b	Shear Values V	fv	F'v
Length = 4.0 ft	**1**	0.724	0.137	1.15	1.00	1.00	1.00	1.500	1.10	1.00	1.15	0.17	1,580.2	2,182.1	0.10	28.3	207.0
+0.60D					1.00	1.00	1.00	1.500	1.10	1.00	1.15			0.0	0.00	0.0	0.0
Length = 4.0 ft	**1**	0.173	0.036	1.60	1.00	1.00	1.00	1.500	1.10	1.00	1.15	0.06	524.3	3,036.0	0.04	10.3	288.0

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S	1	0.2869	2.015		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.117	0.117
Max Upward from Load Combinations	0.117	0.117
Max Upward from Load Cases	0.065	0.065
D Only	0.065	0.065
+D+Lr	0.112	0.112
+D+S	0.117	0.117
+D+0.750Lr	0.100	0.100
+D+0.750S	0.104	0.104
+0.60D	0.039	0.039
Lr Only	0.047	0.047
S Only	0.052	0.052

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 26 SEP 2023, 11:11AM

Wood Beam

Project File: p-2870-23 - humbolt es hvac.ec6

LIC# : KW-06014690, Build:20.23.08.30 ZCS, INC. (c) ENERCALC INC 1983-2023

DESCRIPTION: (E) 2x10 RAFTER SS w/ RTU WL+Z

CODE REFERENCES

Calculations per NDS 2018, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : ASCE 7-16

Wood Species : Douglas Fir - Larch
Wood Grade : No.2

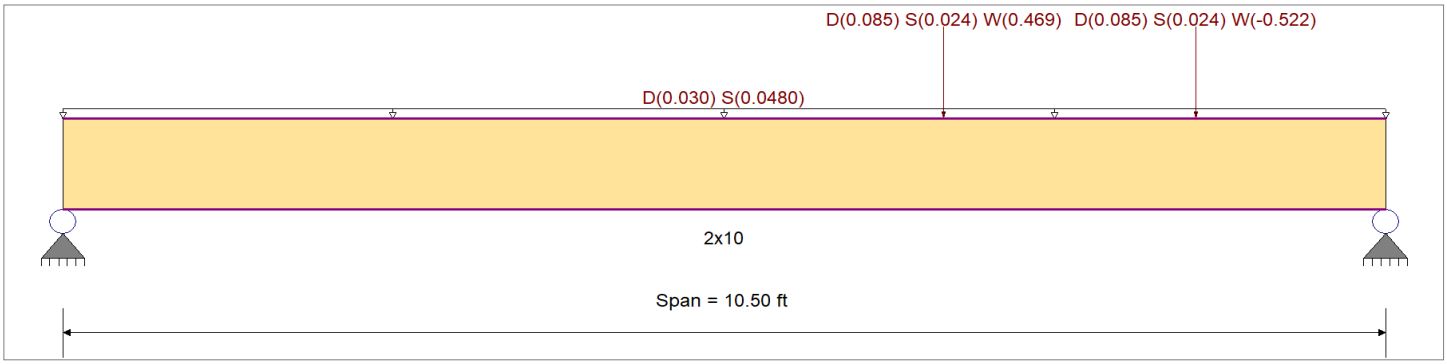
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling

Fb +	900.0 psi
Fb -	900.0 psi
Fc - Prll	1,350.0 psi
Fc - Perp	625.0 psi
Fv	180.0 psi
Ft	575.0 psi

E : Modulus of Elasticity

Ebend- xx	1,600.0 ksi
Eminbend - xx	580.0 ksi
Density	31.210 pcf

Repetitive Member Stress Increase



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight NOT internally calculated and added
Loads on all spans...
Uniform Load on ALL spans : D = 0.0150, S = 0.0240 ksf, Tributary Width = 2.0 ft
Point Load : D = 0.0850, S = 0.0240, W = 0.4690 k @ 7.0 ft, (RTU WL+Z)
Point Load : D = 0.0850, S = 0.0240, W = -0.5220 k @ 9.0 ft, (RTU WL+Z)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.585 : 1	Maximum Shear Stress Ratio	=	0.269 : 1
Section used for this span		2x10	Section used for this span		2x10
fb: Actual	=	765.59 psi	fv: Actual	=	55.76 psi
F'b	=	1,309.28 psi	F'v	=	207.00 psi
Load Combination		+D+S	Load Combination		+D+S
Location of maximum on span	=	5.901 ft	Location of maximum on span	=	9.734 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward Transient Deflection	0.091 in	Ratio =	1377 >=180	Span: 1 : S Only
Max Upward Transient Deflection	0 in	Ratio =	0 <180	n/a
Max Downward Total Deflection	0.172 in	Ratio =	731 >=120	Span: 1 : +D+S
Max Upward Total Deflection	0 in	Ratio =	0 <120	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	CD	CM	C_t	CLx	C_F	Cfu	C_i	C_r	Moment Values M	fb	F'b	Shear Values V	fv	F'v
D Only														0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.358	0.176	0.90	1.00	1.00	1.00	1.100	1.00	1.00	1.15	0.65	366.5	1,024.7	0.26	28.5	162.0
+D+S					1.00	1.00	1.00	1.100	1.00	1.00	1.15			0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.585	0.269	1.15	1.00	1.00	1.00	1.100	1.00	1.00	1.15	1.36	765.6	1,309.3	0.52	55.8	207.0
+D+0.750S					1.00	1.00	1.00	1.100	1.00	1.00	1.15			0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.508	0.237	1.15	1.00	1.00	1.00	1.100	1.00	1.00	1.15	1.19	664.9	1,309.3	0.45	49.0	207.0
+D+0.60W					1.00	1.00	1.00	1.100	1.00	1.00	1.15			0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.306	0.146	1.60	1.00	1.00	1.00	1.100	1.00	1.00	1.15	0.99	557.2	1,821.6	0.39	42.0	288.0

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 26 SEP 2023, 11:11AM

Wood Beam

Project File: p-2870-23 - humbolt es hvac.ec6

DESCRIPTION: (E) 2x10 RAFTER SS w/ RTU WL+Z

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	CD	CM	C_t	CLx	C_F	Cfu	C_i	C_r	Moment Values M	fb	F'b	Shear Values V	fv	F'v
+D+0.450W					1.00	1.00	1.00	1.100	1.00	1.00	1.15			0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.280	0.124	1.60	1.00	1.00	1.00	1.100	1.00	1.00	1.15	0.91	509.2	1,821.6	0.33	35.7	288.0
+D+0.750S+0.450W					1.00	1.00	1.00	1.100	1.00	1.00	1.15			0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.436	0.178	1.60	1.00	1.00	1.00	1.100	1.00	1.00	1.15	1.42	794.4	1,821.6	0.47	51.2	288.0
+0.60D+0.60W					1.00	1.00	1.00	1.100	1.00	1.00	1.15			0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.226	0.122	1.60	1.00	1.00	1.00	1.100	1.00	1.00	1.15	0.73	411.1	1,821.6	0.33	35.2	288.0
+0.60D					1.00	1.00	1.00	1.100	1.00	1.00	1.15			0.0	0.00	0.0	0.0
Length = 10.50 ft	1	0.121	0.059	1.60	1.00	1.00	1.00	1.100	1.00	1.00	1.15	0.39	219.9	1,821.6	0.16	17.1	288.0

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S	1	0.1722	5.403		0.0000	0.000

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.461	0.576
Max Upward from Load Combinations	0.461	0.576
Max Upward from Load Cases	0.263	0.289
Max Downward from all Load Conditio		-0.135
Max Downward from Load Cases (Resis		-0.135
D Only	0.198	0.287
+D+S	0.461	0.576
+D+0.750S	0.396	0.503
+D+0.60W	0.247	0.206
+D+0.450W	0.235	0.226
+D+0.750S+0.450W	0.432	0.443
+0.60D+0.60W	0.168	0.091
+0.60D	0.119	0.172
S Only	0.263	0.289
W Only	0.082	-0.135

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 21 AUG 2023, 9:45AM

General Beam Analysis

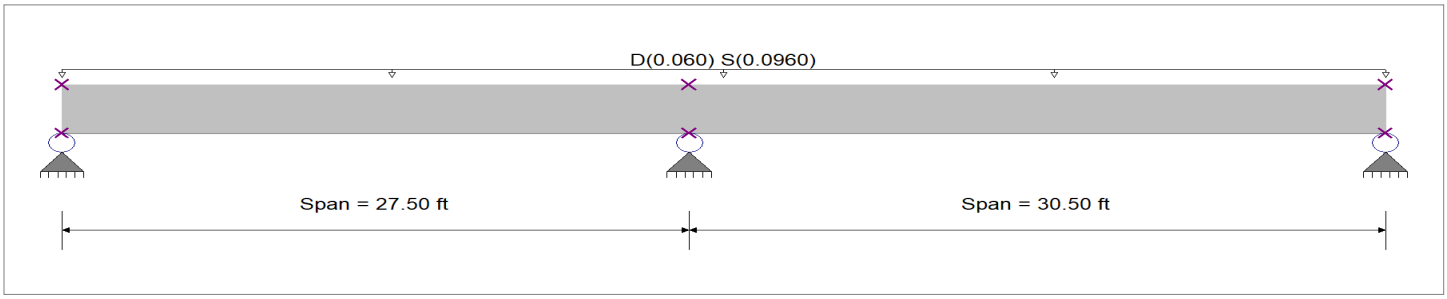
Project File: P-2870-23 - Humbolt ES HVAC.ec6

DESCRIPTION: (E) TRUSS

General Beam Properties

Elastic Modulus 1,800.0 ksi

Span #1	Span Length =	27.50 ft	Area =	10.0 in^2	Moment of Inertia =	100.0	in^4
Span #2	Span Length =	30.50 ft	Area =	10.0 in^2	Moment of Inertia =	100.0	in^4



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Loads on all spans...
Uniform Load on ALL spans : D = 0.0150, S = 0.0240 k/ft, Tributary Width = 4.0 ft

DESIGN SUMMARY

MAXIMUM EXISTING MOMENT, M_E

Maximum Bending =	16.531 k-ft	Maximum Shear =	2.921 k
Load Combination	+D+S	Load Combination	+D+S
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	27.500 ft	Location of maximum on span	27.500 ft

Maximum Deflection

Max Downward Transient Deflection	4.846 in	75
Max Upward Transient Deflection	0.023 in	16145
Max Downward Total Deflection	7.875 in	46
Max Upward Total Deflection	-0.020 in	16456

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	Summary of Moment Values (k-ft) Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Shear Values (k) Va Max	Vnx/Vnx/Omega
Overall MAXimum Envelope												
Dsgn. L = 27.50 ft	1			7.64	-16.53	16.53					2.92	
Dsgn. L = 30.50 ft	2			10.82	-16.53	16.53					2.92	
D Only												
Dsgn. L = 27.50 ft	1			2.94	-6.36	6.36					1.12	
Dsgn. L = 30.50 ft	2			4.16	-6.36	6.36					1.12	
+D+S												
Dsgn. L = 27.50 ft	1			7.64	-16.53	16.53					2.92	
Dsgn. L = 30.50 ft	2			10.82	-16.53	16.53					2.92	
+D+0.750S												
Dsgn. L = 27.50 ft	1			6.46	-13.99	13.99					2.47	
Dsgn. L = 30.50 ft	2			9.15	-13.99	13.99					2.47	
+0.60D												
Dsgn. L = 27.50 ft	1			1.76	-3.81	3.81					0.67	
Dsgn. L = 30.50 ft	2			2.50	-3.81	3.81					0.67	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S	1	3.9607	11.212	+D+S	-0.0201	26.442
+D+S	2	7.8745	17.362		0.0000	26.442

Vertical Reactions

Support notation : Far left is #: Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Overall MAXimum	1.544	5.667	1.837
Overall MINimum			
D Only	0.594	2.180	0.707
+D+S	1.544	5.667	1.837
+D+0.750S	1.306	4.795	1.554
+0.60D	0.356	1.308	0.424
S Only	0.950	3.487	1.130

Project Title:
Engineer:
Project ID:
Project Descr:

Printed: 26 SEP 2023, 11:14AM

General Beam Analysis

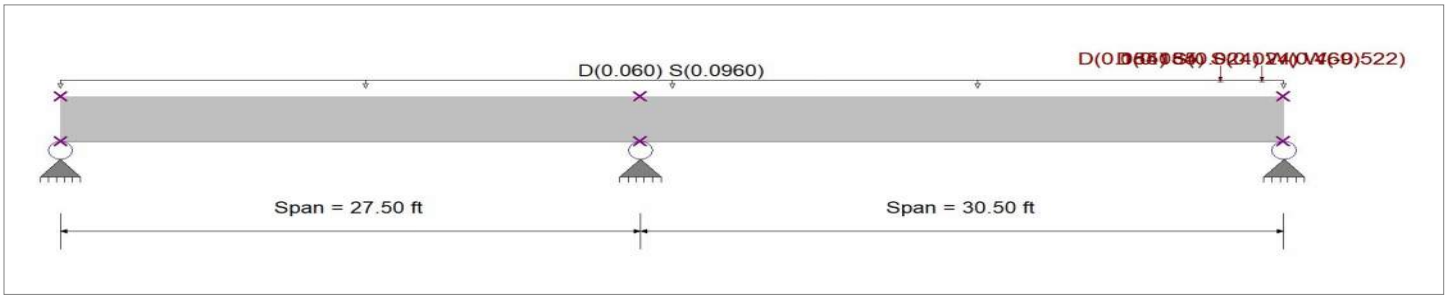
Project File: p-2870-23 - humbolt es hvac.ec6

DESCRIPTION: (E) TRUSS w/ RTU WL+Z

General Beam Properties

Elastic Modulus 1,800.0 ksi

Span #1	Span Length =	27.50 ft	Area =	10.0 in^2	Moment of Inertia =	100.0 in^4
Span #2	Span Length =	30.50 ft	Area =	10.0 in^2	Moment of Inertia =	100.0 in^4



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Loads on all spans...
Uniform Load on ALL spans : D = 0.0150, S = 0.0240 k/ft, Tributary Width = 4.0 ft

Load(s) for Span Number 2
Point Load : D = 0.0850, S = 0.0240, W = 0.4690 k @ 27.50 ft, (RTU WL+Z)

Point Load : D = 0.1540, S = 0.0240, W = 0.4690 k @ 27.50 ft, (RTU WL+Z)

Point Load : D = 0.0850, S = 0.0240, W = -0.5220 k @ 29.50 ft, (RTU WL+Z)

Point Load : D = 0.1540, S = 0.0240, W = -0.5220 k @ 29.50 ft, (RTU WL+Z)

M_E = 16.5 K-FT
M_N = 16.8 K-FT
M_N / M_E = 1.02 < 1.05 --> OK

DESIGN SUMMARY

MAXIMUM NEW MOMENT, M_N

Maximum Bending =	16.831 k-ft	Maximum Shear =	2.968 k
Load Combination	+D+S	Load Combination	+D+S
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Location of maximum on span	27.500 ft	Location of maximum on span	27.500 ft

Maximum Deflection

Max Downward Transient Deflection	4.929 in	74
Max Upward Transient Deflection	-0.216 in	1530
Max Downward Total Deflection	8.370 in	43
Max Upward Total Deflection	-0.103 in	3201

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	Summary of Moment Values (k-ft) Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Shear Values (k) Va Max	Vnx	Vnx/Omega
Overall MAXimum Envelope													
Dsgn. L = 27.50 ft	1			7.53	-16.83	16.83					2.97		
Dsgn. L = 30.50 ft	2			11.41	-16.83	16.83					2.97		
D Only													
Dsgn. L = 27.50 ft	1			2.85	-6.61	6.61					1.16		
Dsgn. L = 30.50 ft	2			4.66	-6.61	6.61					1.16		
+D+S													
Dsgn. L = 27.50 ft	1			7.53	-16.83	16.83					2.97		
Dsgn. L = 30.50 ft	2			11.41	-16.83	16.83					2.97		
+D+0.750S													
Dsgn. L = 27.50 ft	1			6.36	-14.27	14.27					2.52		
Dsgn. L = 30.50 ft	2			9.72	-14.27	14.27					2.52		
+D+W													
Dsgn. L = 27.50 ft	1			2.69	-7.07	7.07					1.24		
Dsgn. L = 30.50 ft	2			5.67	-7.07	7.07					1.70		
+D+0.750W													
Dsgn. L = 27.50 ft	1			2.73	-6.95	6.95					1.22		
Dsgn. L = 30.50 ft	2			5.41	-6.95	6.95					1.48		

Project Title:
Engineer:
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Printed: 26 SEP 2023, 11:14AM

General Beam Analysis

Project File: p-2870-23 - humbolt es hvac.ec6

DESCRIPTION: (E) TRUSS w/ RTU WL+Z

Load Combination / Segment Length	Span #	Max Stress Ratios M	V	Summary of Moment Values (k-ft) Mmax +	Mmax -	Ma - Max	Mnx	Mnx/Omega	Cb	Rm	Shear Values (k) Va Max	VnxVnx/Omega
+D+0.750S+0.750W												
Dsgn. L = 27.50 ft	1			6.24	-14.62	14.62					2.57	
Dsgn. L = 30.50 ft	2			10.44	-14.62	14.62					2.57	
+0.60D+W												
Dsgn. L = 27.50 ft	1			1.55	-4.42	4.42					0.77	
Dsgn. L = 30.50 ft	2			3.83	-4.42	4.42					1.37	
+0.60D												
Dsgn. L = 27.50 ft	1			1.71	-3.96	3.96					0.70	
Dsgn. L = 30.50 ft	2			2.80	-3.96	3.96					0.70	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+S	1	3.8370	11.000	+D+W	-0.1031	25.385
+D+S	2	8.3704	17.596		0.0000	25.385

Vertical Reactions

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2	Support 3
Overall MAXimum	1.533	5.725	2.364
Overall MINimum	-0.017		-0.179
D Only	0.585	2.228	1.145
+D+S	1.533	5.725	2.364
+D+0.750S	1.296	4.851	2.059
+D+W	0.568	2.318	0.966
+D+0.750W	0.572	2.296	1.011
+D+0.750S+0.750W	1.283	4.918	1.925
+0.60D+W	0.334	1.427	0.508
+0.60D	0.351	1.337	0.687
S Only	0.948	3.497	1.219
W Only	-0.017	0.090	-0.179