HW ENGINEERING
STRUCTURAL ENGINEERS & CONSULTANTS

STRUCTURAL CALCULATIONS

PROJECT NAME: KE USA Hanger Rod Canopy -- High Snow
PROJECT ADDRESS: General USA Area
PROJECT NO: 20294B

CLIENT: Curtis LaRose
COMPANY: KE USA Inc.
38 Pond Lane Suite B
Middlebury, VT 05753

DATE: Dec 03, 2020

12.03.2020

REV	DATE	BY	DESCRIPTION
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HW ENGINEERING
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Project:	KE USA Hanger Rod Canopy – High Snow	
Job Number:	20294B	Date:
Part:		Revised:
Designer:	YW	Page:

KE USA HANGER ROD CANOPY – High Snow

ALUMINUM STRUCTURE EVALUATION

ASCE 7-16 & IBC 2018

EVALUATION SUMMARY AND RECOMMENDATIONS

This calculation package addresses the Structural Evaluation of hanger rod canopies manufactured by KE USA, Inc. Evaluation is solely based on the ASCE 7-16 Components and Cladding provisions for attached canopies on low-rise buildings as referenced in the current International Building Code 2018 (IBC2018).

The intent of this report is to provide calculation to justify the structural efficiency under ultimate wind speed at exposure C based on the current ASCE 7-16 and IBC2018 requirements.

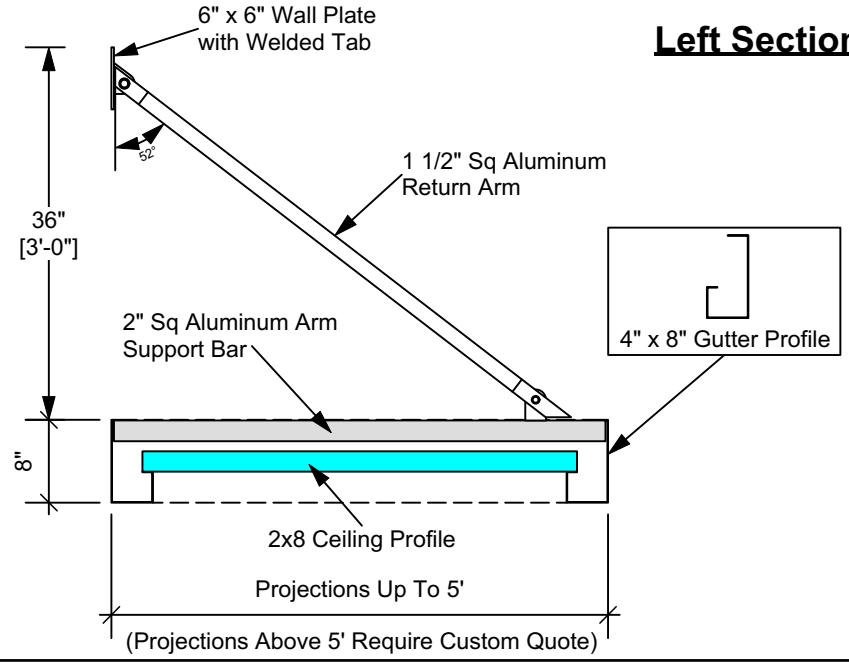
The analysis and design of the awning system included herein were performed with the use of a 3D frame analysis and computer design program – **SAP2000**. It is a structural analysis program developed by Computers and Structures, Inc. Detailed information about the software can be found at the Computers and Structures, Inc. website.

Various load cases and combinations were considered during our structural engineering analysis. Aluminum Design ASD design specifications were used to check the structural capacities of these members based on an applicable minimum yield stress. The demand/capacity ratio of each framing member was calculated and found to be less than 1.0 for all members.

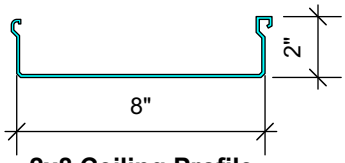
Through our investigation, HW ENGINEERING arrived at the following conclusions and recommendations:

1. Maximum spacing between return arms was taken to be 7 feet.
2. Critical member to member connections were checked and calculated. Reaction outputs were provided to assist site specific anchorage solution.
3. The frames should be anchored securely to the walls of existing building to prevent uplift and lateral shear forces per support reactions listed in this document.
4. Unit is assumed to be attached canopy on buildings, canopy mean roof height no more than 15 feet.
5. Unit is analyzed with an ultimate design wind speed of 115 mph and a canopy roof snow load of 60 psf.
6. All aluminum material grade should be 6061-T6 unless noted otherwise.

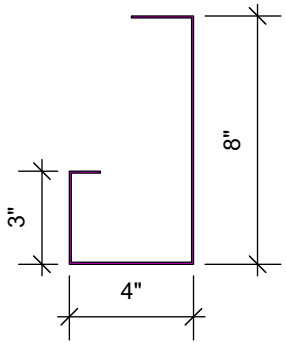
Left Section View



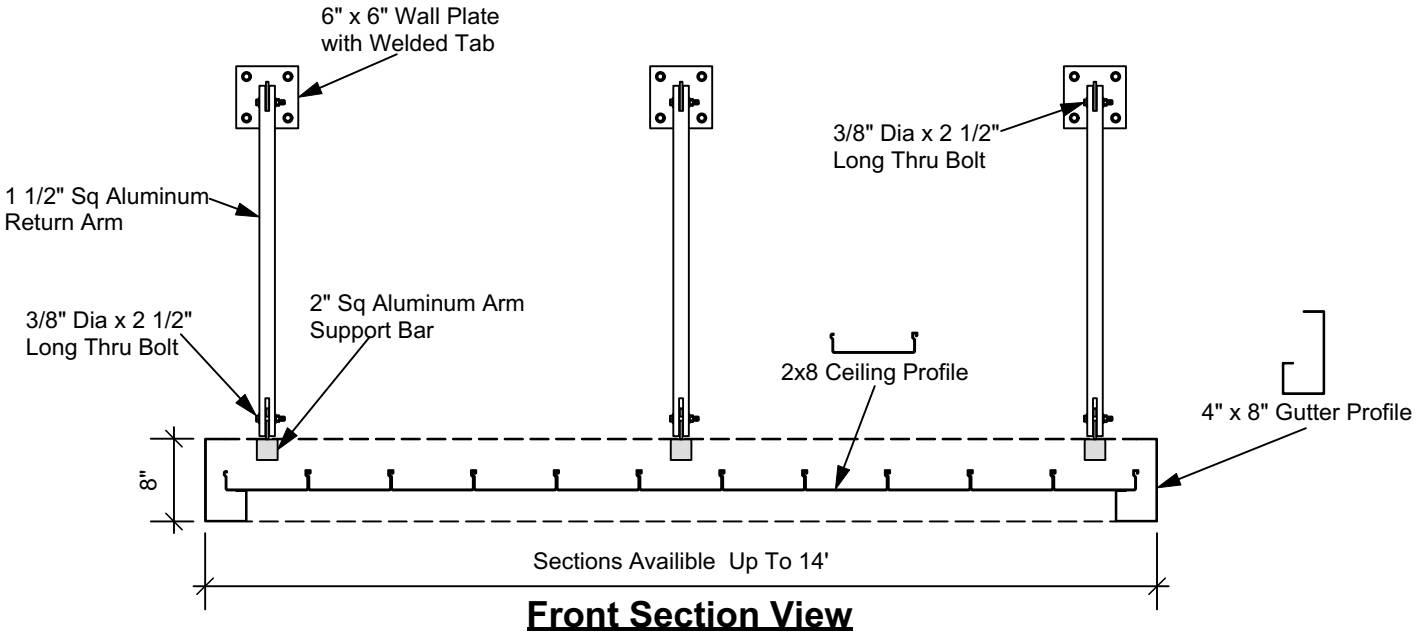
Primary Canopy Profiles



2x8 Ceiling Profile



4" x 8" Gutter Profile



Front Section View

Product Description:
KE Commercial offers several Hanger Rod Canopy models to accomodate your architectural needs.

Product Specifications:
- All framing material to be 6061 T6 Aluminum.
- All Product is Powder Coated In House with your choice of RAL colors, See our Coating Specifications.
- All frame to frame connections to be welded and ground smooth as required.
- Scupper Drains @ Each End of Canopy To Divert Water.
- Integrated 2" x 8" Ceiling Panel System.
- Continious 8" x 4" Gutter Profile Around Perimeter To Maximize Water Diversion.

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38 Pond Lane Suite B
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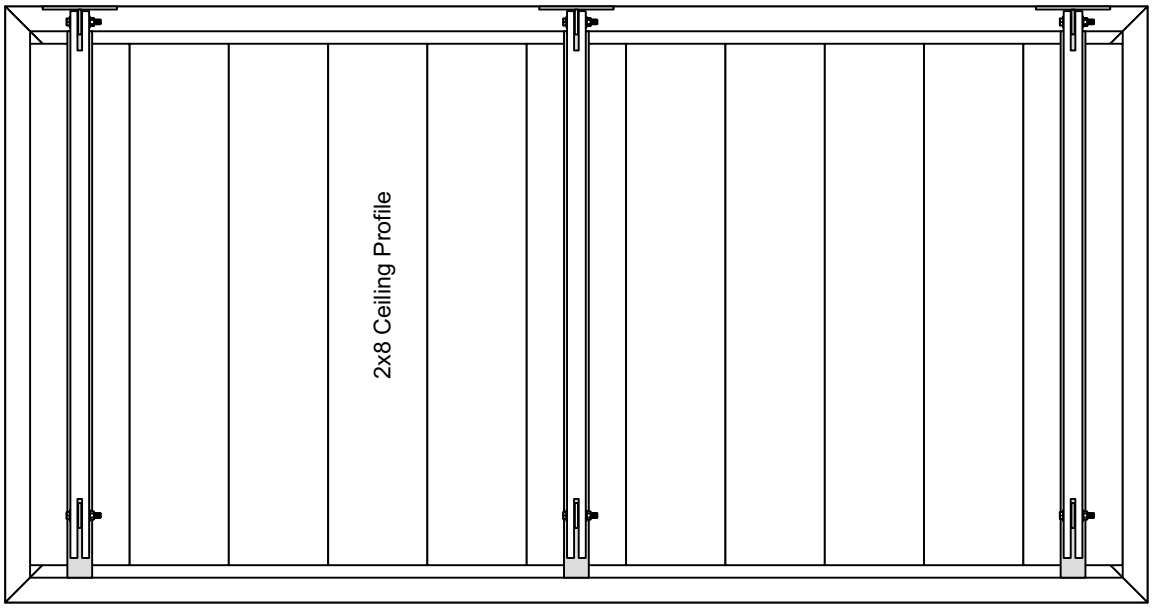
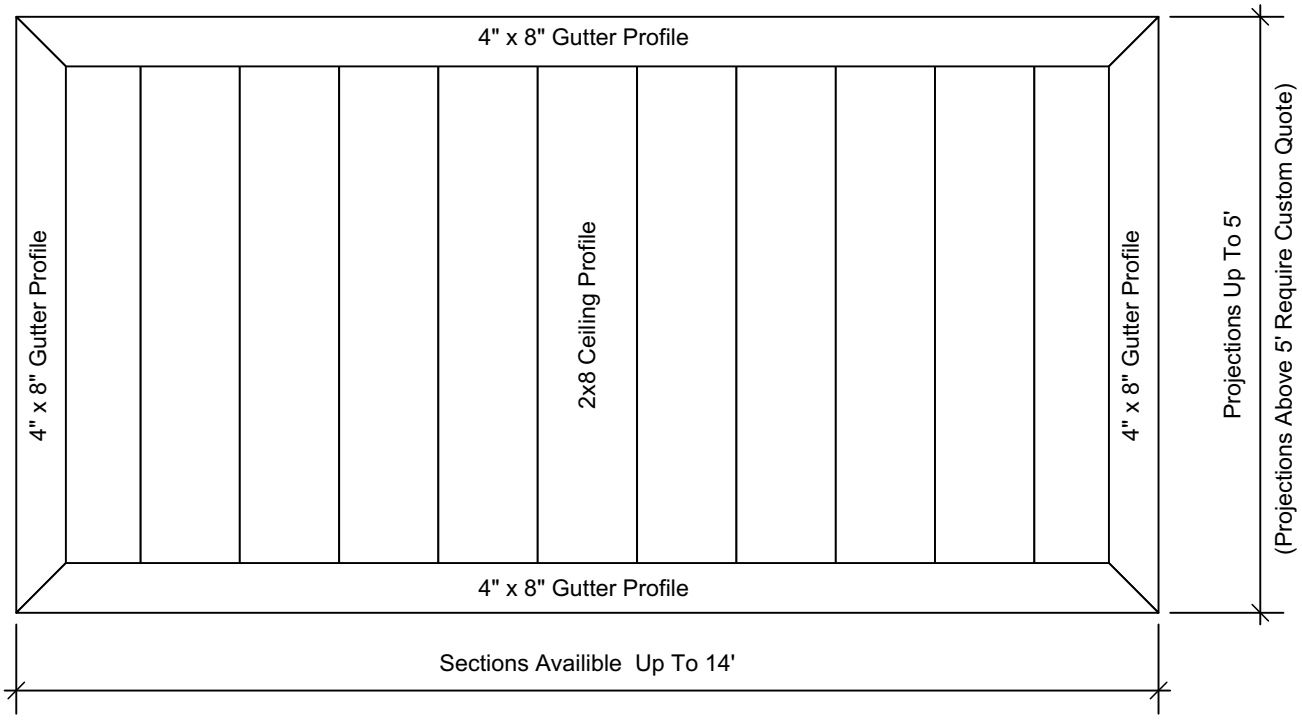
Tel: 802-388-7309
Fax: 802-388-9625
https://www.keoutdoordesign.com

Date:	8/26/20	Product:	Sheet #
Revision #:	R0001	**Hanger Rod Canopy**	**1 of 5**



Top of Canopy



Bottom of Canopy

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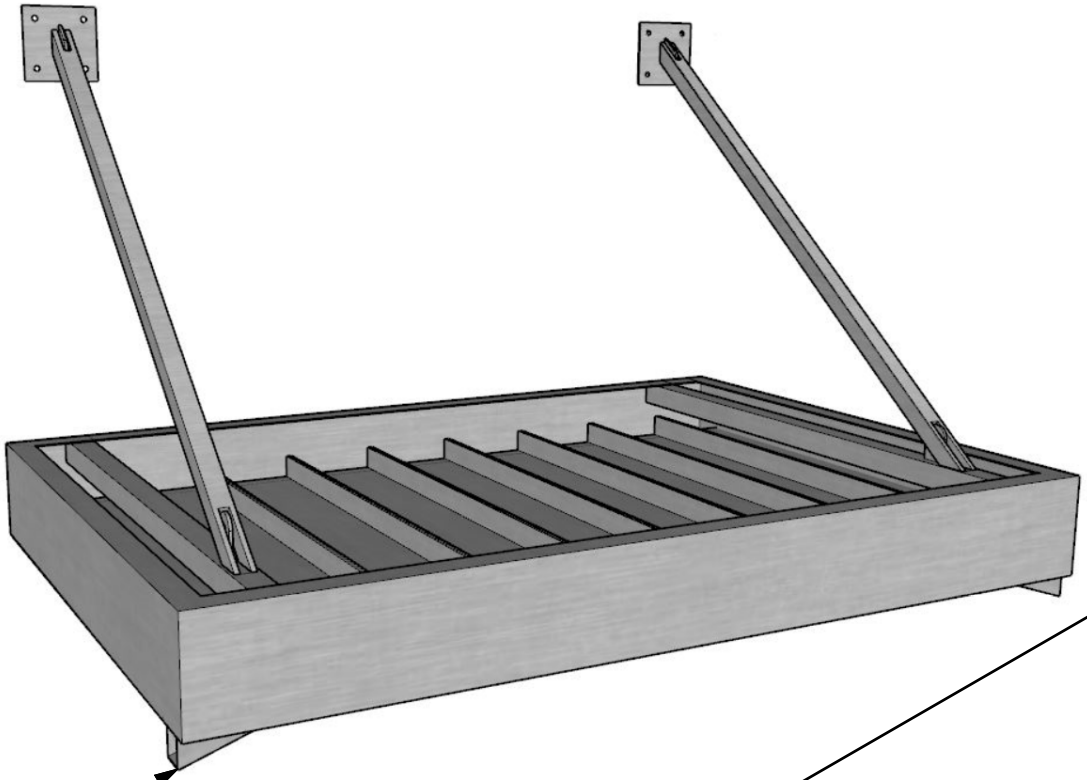
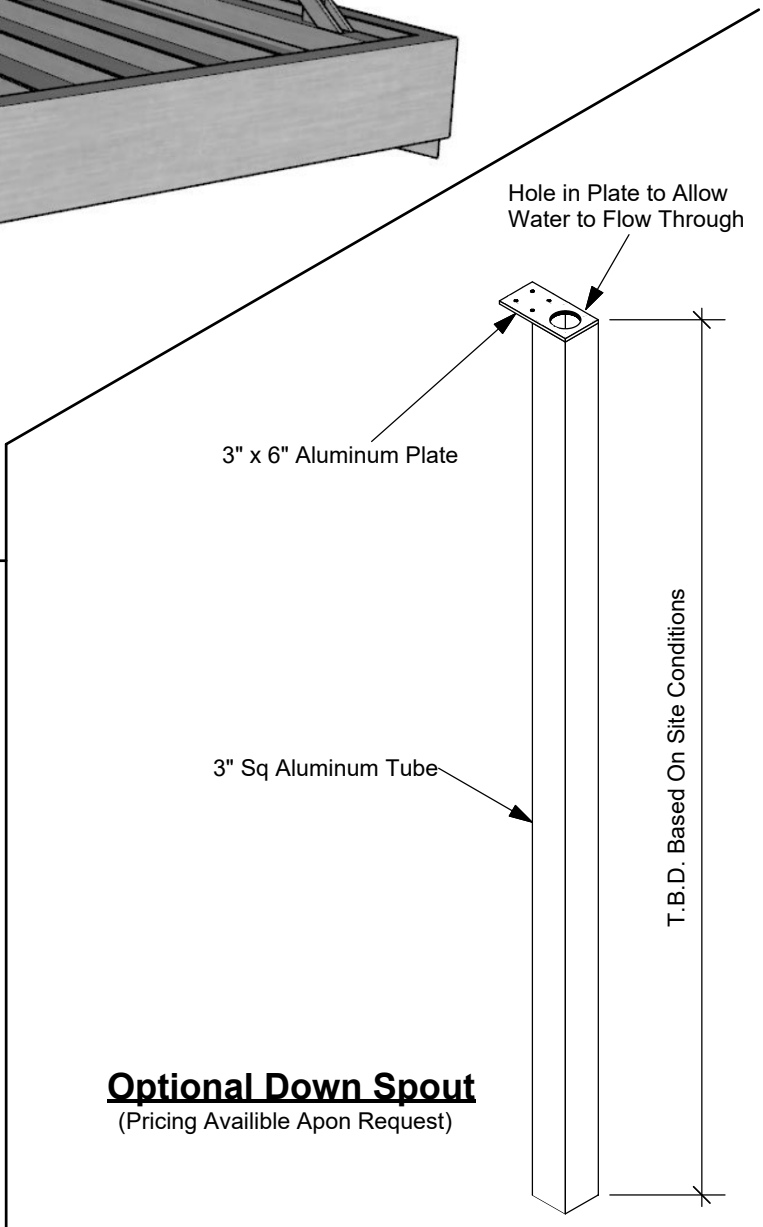
Date:	8/26/20	Product:	Sheet #
Revision #:	R0001	**Hanger Rod Canopy**	**2 of 5**

Standard Hanger Rod Canopy 3D View

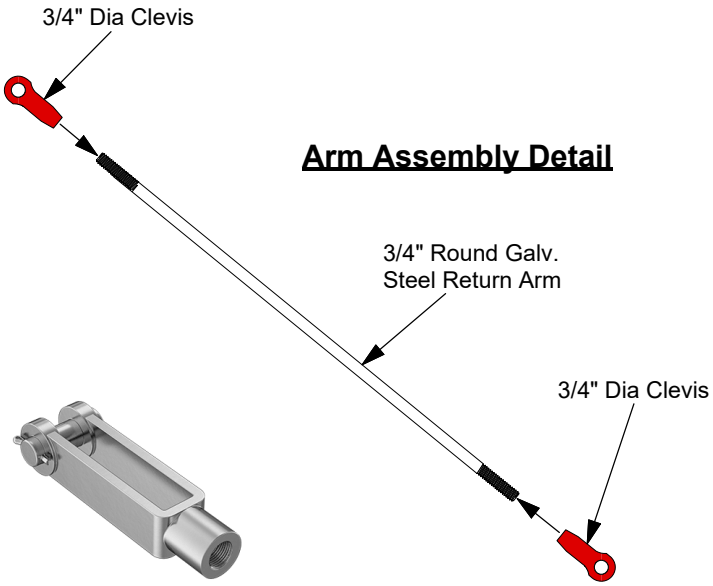


Scupper Detail



Optional Return Arm Option

(Request Quote if Desired)



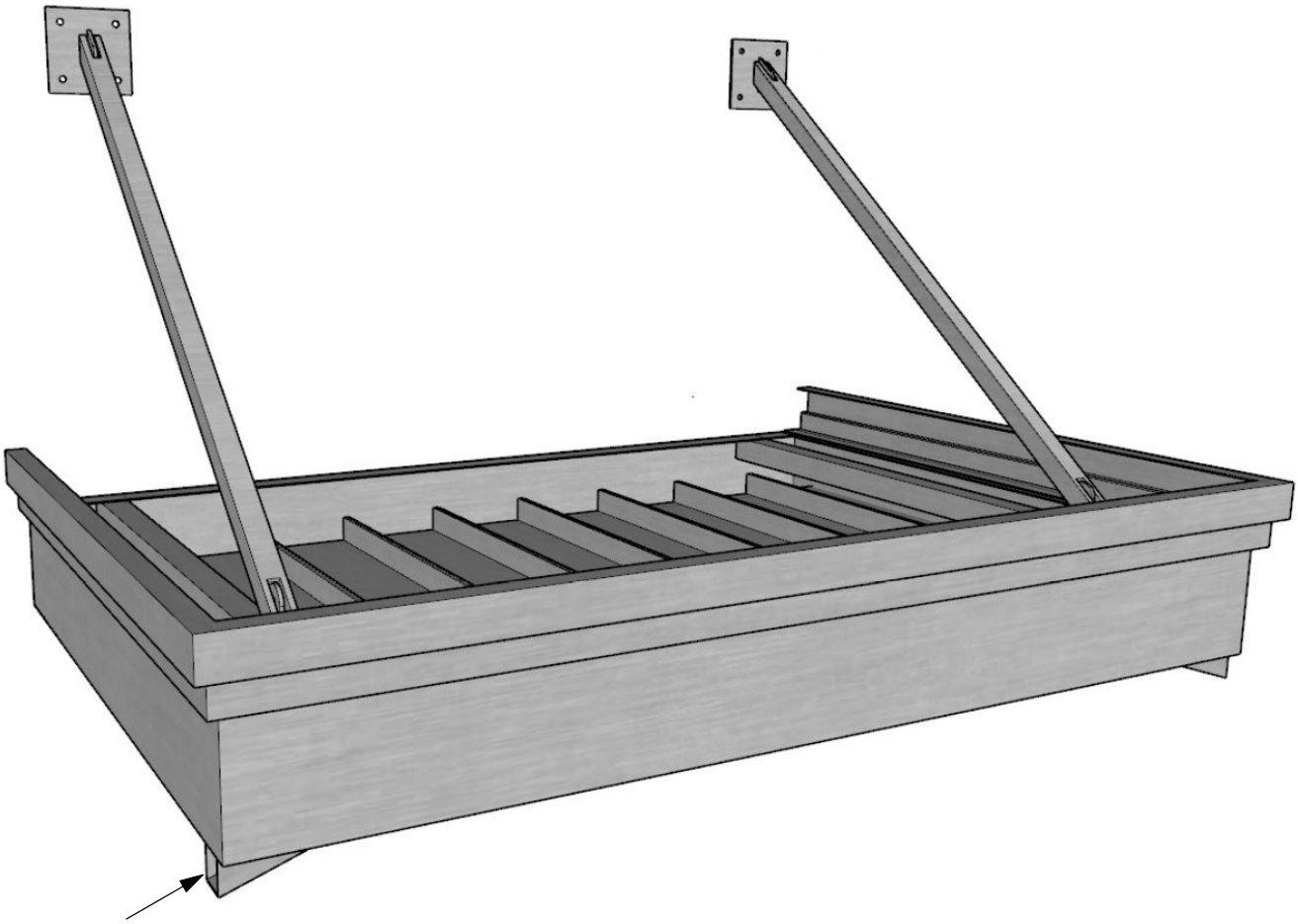
Arm Assembly Detail

3/4" Dia Clevis

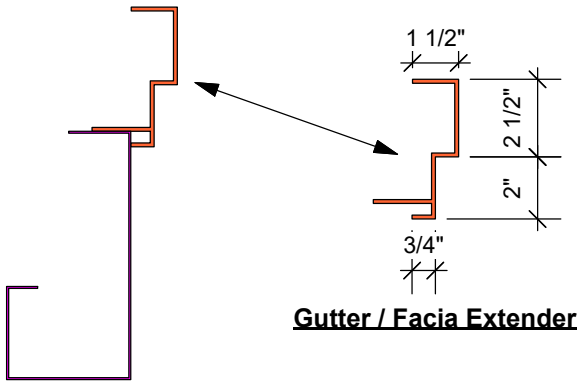
Optional Down Spout

(Pricing Availible Apon Request)

Hanger Rod Canopy 3D View
Facia Extender Applied



Pricing Availible Apon Request



Gutter / Facia Extender

Gutter / Facia Extender Applied

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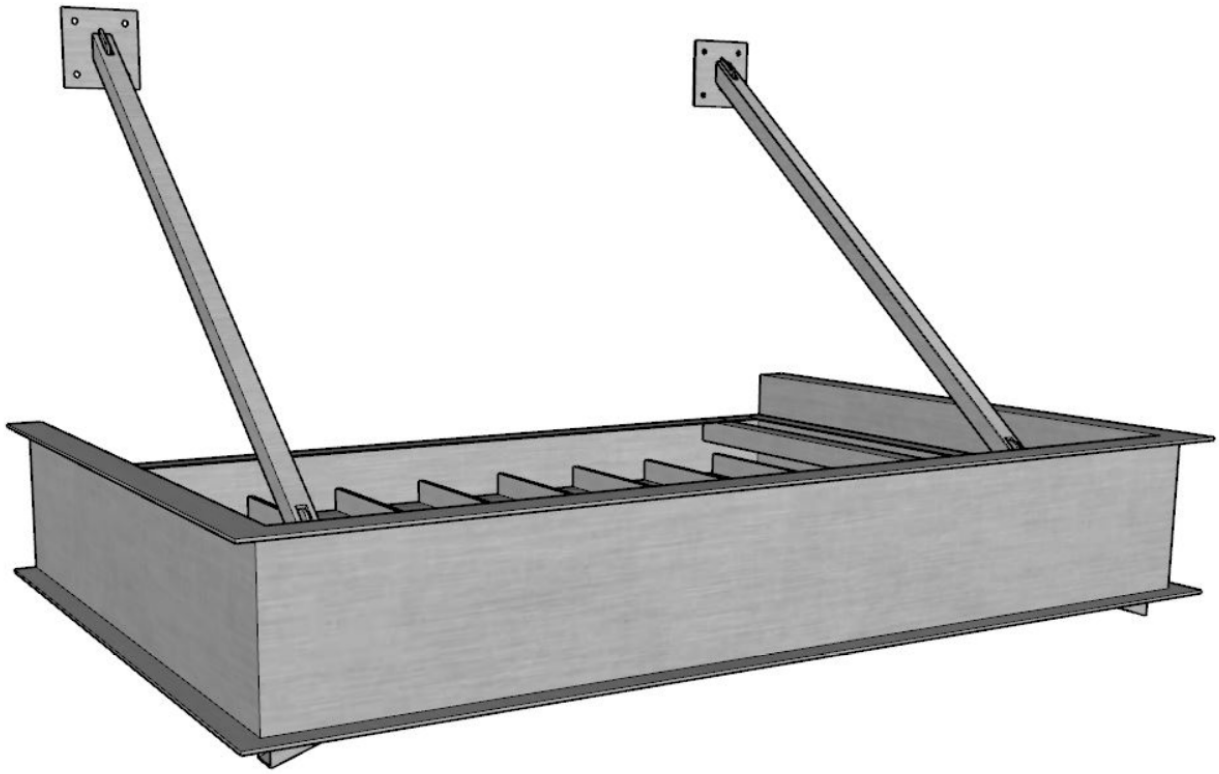
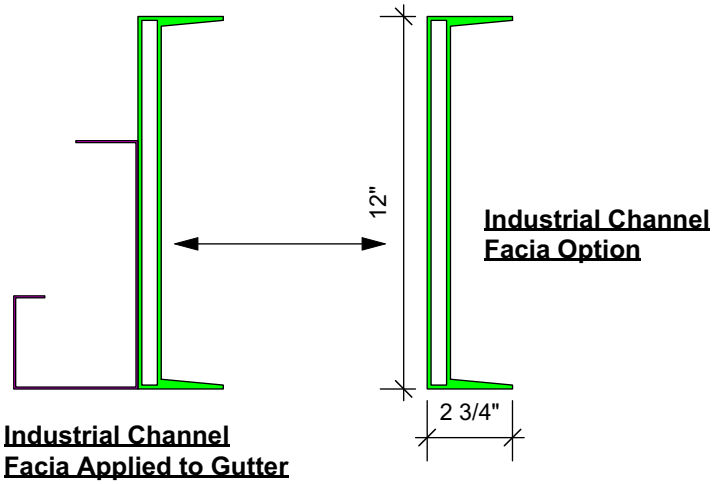
Hanger Rod Canopy 3D View
Industrial C Channel Facia Applied



Pricing Availible Apon Request



Industrial Channel Facia Option

Industrial Channel Facia Applied to Gutter

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Basis for Design

1.1 BUILDING CODE: 2018 International Building Code

1.2 GRAVITY DESIGN:

CANOPY LOADING

DEAD LOAD (PSF)	5psf
LIVE LOAD (PSF)	20psf
ROOF SNOW(PSF)	60psf

1.3 LATERAL DESIGN:

WIND LOADING

Basic Wind Speed (3s – Gust)	115mph
Risk Category	II
Exposure Category	C

SEISMIC LOADING

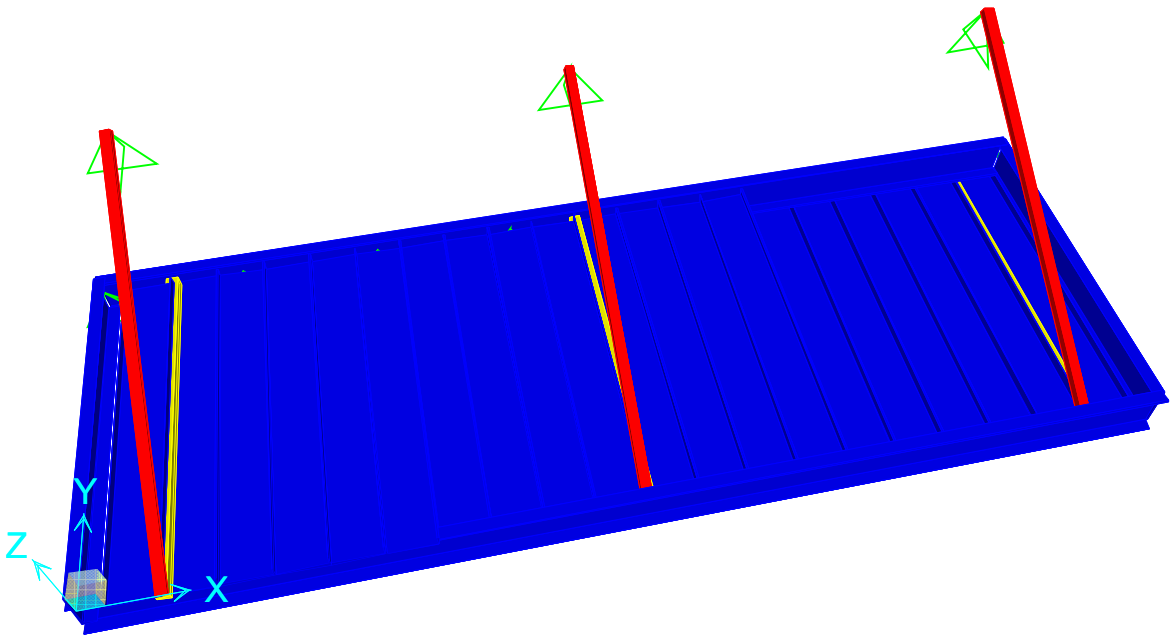
Due to the light weight of framing, seismic loads do not control lateral design

2.1 ALUMINUM DESIGN:

Extruded 6061-T6 with minimum yield stress equal to 35 ksi.
ER4043 electrodes/rods shall be used for all aluminum to aluminum welds.

3.1 INSPECTION, SPECIAL INSPECTION, AND STRUCTURAL OBSERVATION:

AS REQUIRED BY THE GOVERNING MUNICIPALITY.



3D VIEW

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Design Loads

Design Dead Loads

Canopy frame self weight. Framing weight will be included in to computer model automatically. Add 2psf for miscellaneous dead load. Total dead load no more than 5psf

$DL = 5psf$

Design Live Loads $LL = 20psf$ (Non_reducible per ASCE 7-16 Table 4.3-1)

Design Snow Loads $SN = 60psf$

Design Wind Loads

Wind parameters: 115 mph wind speed, exposure C. Wind loads are based on IBC2018/ASCE 7-16 Component and Cladding for attahced canopies.

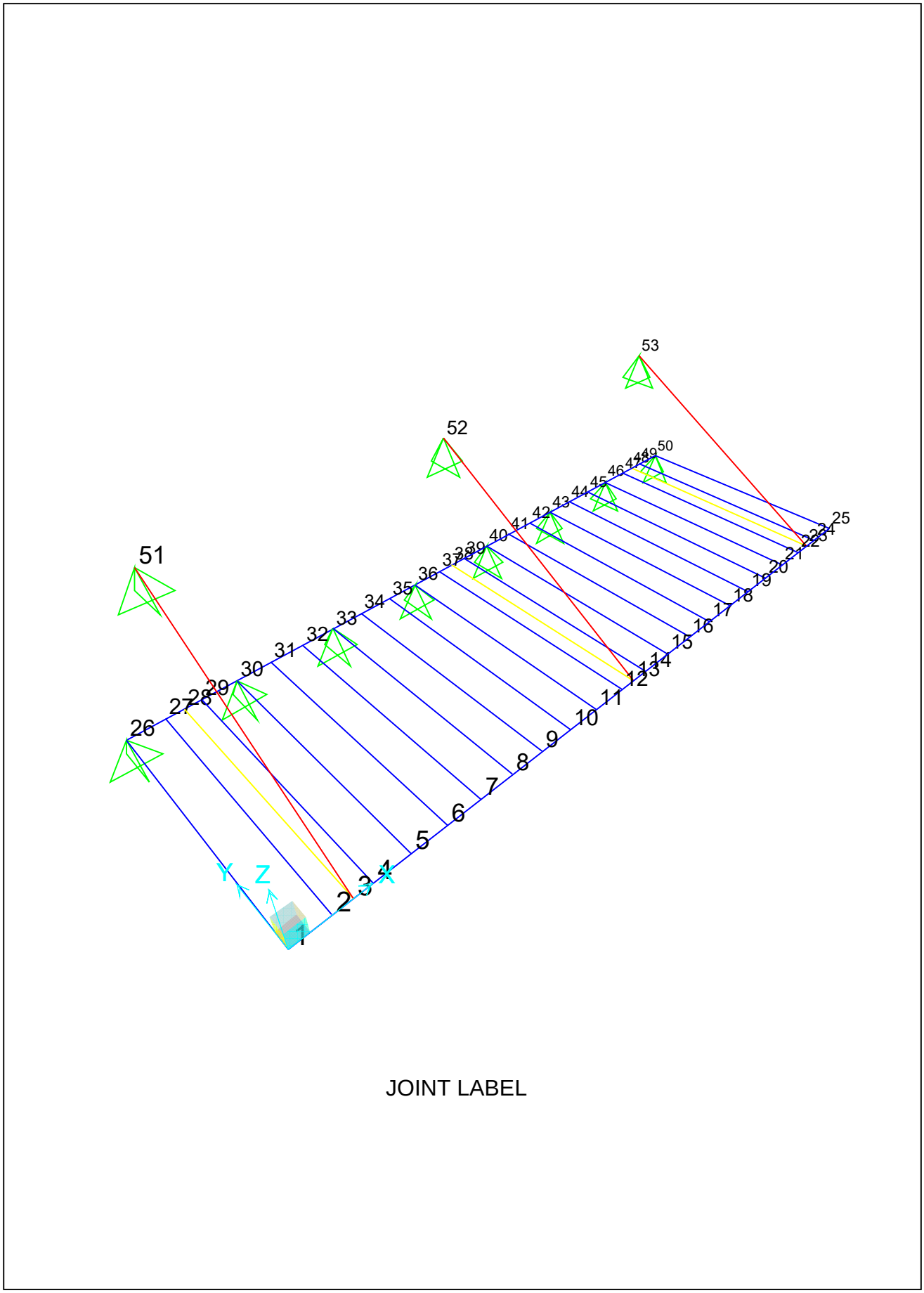
$V = 115mph$	Design wind speed
$K_d = 0.85$	Wind directionality factor, Table 26.6-1
$K_{zt} = 1.0$	Topographic factor, Section 26.8
$K_e = 1.0$	Ground elevation factor, Section 26.9
$K_h = 0.85$	Velocity pressure exposure coefficient, Table 26.10-1, exposure C Canopy mean roof height no more than 15'-0"
$c = 0.00256 \frac{hr^2\ lbf}{mi^2\ ft^2}$	Constant for Eq. 26.10-1
$q_h = c\ K_d\ K_{zt}\ K_e\ K_h\ V^2$	Eq. 26.10-1
$q_h = 24.46\ psf$	Velocity Pressure
$GC_p = \begin{pmatrix} -1.1 \\ 0.75 \end{pmatrix}$	Net coefficient, Fig. 30.11-1
$p = q_h\ GC_p = \begin{pmatrix} -26.91 \\ 18.35 \end{pmatrix} psf$	Design wind pressure

Design wind force shall be not less than 16psf according as section 30.2.2 of ASCE 7-16

$P_{min} = 16\ psf$

Design Seismic Loads

Due to the light weight of framing, seismic loads do not control lateral design.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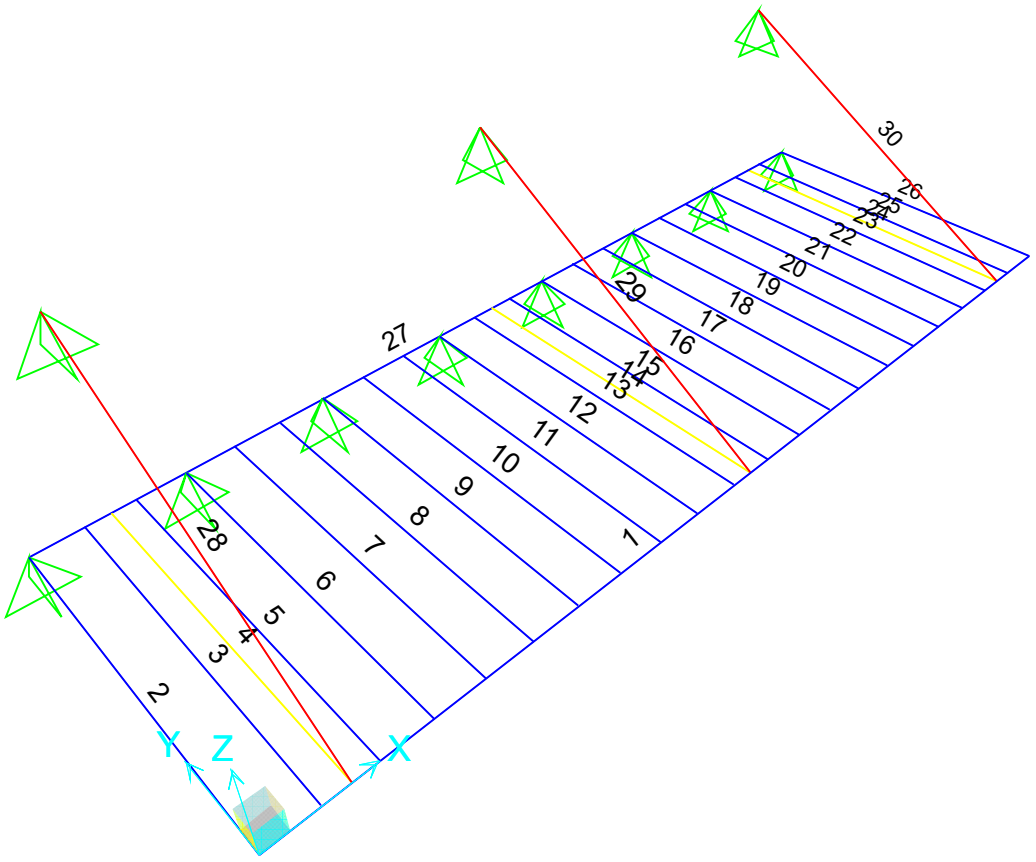
JOINT LABEL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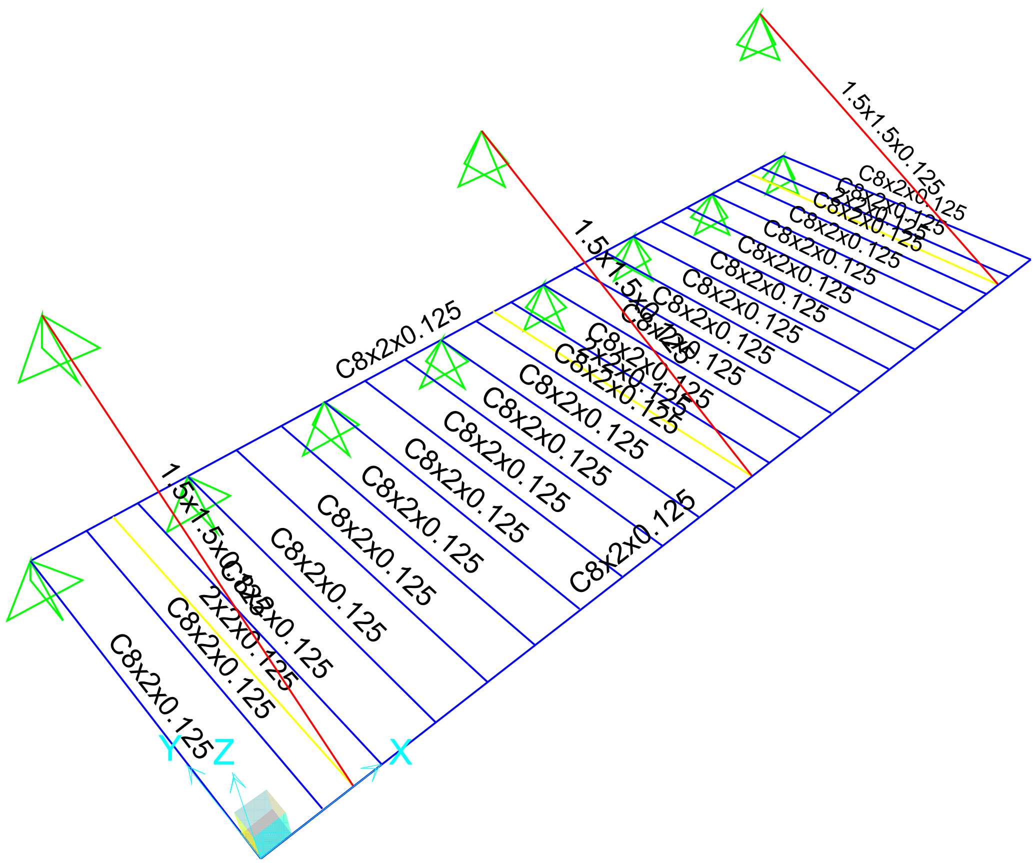
FRAME LABEL



FRAME SECTION

Table: Material Properties 03c - Aluminum Data

Material	AlumType	Alloy	Fcy	Fty	Ftu	Fsu	SSHysType	CoupModType
			Kip/in2	Kip/in2	Kip/in2	Kip/in2		
6061T6	Wrought	6061-T6	35	35	38	24	Kinematic	Von Mises

Table: Frame Section Properties 01 - General

SectionName	Material	Shape	t3	t2	tf	tw
			in	in	in	in
1.5x1.5x0.125	6061T6	Box/Tube	1.5	1.5	0.125	0.125
2x2x0.125	6061T6	Box/Tube	2	2	0.125	0.125
C8x2x0.125	6061T6	Channel	8	2	0.125	0.125

SectionName	Area	TorsConst	I33	I22	I23	AS2	AS3
	in2	in4	in4	in4	in4	in2	in2
1.5x1.5x0.125	0.69	0.32	0.22	0.22	0	0.38	0.38
2x2x0.125	0.94	0.82	0.55	0.55	0	0.5	0.5
C8x2x0.125	1.47	0.007496	12.6	0.46	0	1	0.5

SectionName	S33	S22	Z33	Z22	R33	R22	EccV2
	in3	in3	in3	in3	in	in	in
1.5x1.5x0.125	0.29	0.29	0.36	0.36	0.5637	0.5637	
2x2x0.125	0.55	0.55	0.66	0.66	0.7672	0.7672	
C8x2x0.125	3.15	0.28	3.85	0.49	2.9291	0.5583	0.8959

SectionName	ConcCol	ConcBeam	Color	TotalWt	TotalMass	FromFile	AMod
				Kip	Kip-s2/in		
1.5x1.5x0.125	No	No	Red	0.014	3.666E-05	No	1
2x2x0.125	No	No	Yellow	0.017	4.286E-05	No	1
C8x2x0.125	No	No	Blue	0.238	0.0006178	No	1

SectionName	A2Mod	A3Mod	JMod	I2Mod	I3Mod	MMod	WMod
1.5x1.5x0.125	1	1	1	1	1	1	1
2x2x0.125	1	1	1	1	1	1	1
C8x2x0.125	1	1	1	1	1	1	1

Table: Load Pattern Definitions

LoadPat	DesignType	SelfWtMult	AutoLoad	GUID	Notes
DEAD	Dead	1			
SN	Snow	0			
Wup	Wind	0	None		
Wdown	Wind	0	None		
W16	Wind	0	None		

Table: Load Case Definitions

Case	Type	InitialCond	ModalCase	BaseCase	MassSource	DesTypeOpt	DesignType
DEAD	LinStatic	Zero				Prog Det	Dead
SN	LinStatic	Zero				Prog Det	Snow
Wup	LinStatic	Zero				Prog Det	Wind

Case	Type	InitialCond	ModalCase	BaseCase	MassSource	DesTypeOpt	DesignType
Wdown	LinStatic	Zero				Prog Det	Wind
W16	LinStatic	Zero				Prog Det	Wind

Case	DesActOpt	DesignAct	AutoType	RunCase	CaseStatus	GUID
DEAD	Prog Det	Non-Composite	None	Yes	Finished	
SN	Prog Det	Short-Term Composite	None	Yes	Finished	
Wup	Prog Det	Short-Term Composite	None	Yes	Finished	
Wdown	Prog Det	Short-Term Composite	None	Yes	Finished	
W16	Prog Det	Short-Term Composite	None	Yes	Finished	

Table: Combination Definitions

ComboName	ComboType	AutoDesign	CaseType	CaseName	ScaleFactor	AlumDesign
DL+SN	Linear Add	No	Linear Static	DEAD	1	Strength
DL+SN			Linear Static	SN	1	
DL+0.6Wup	Linear Add	No	Linear Static	DEAD	1	Strength
DL+0.6Wup			Linear Static	Wup	0.6	
DL+0.6Wdown	Linear Add	No	Linear Static	DEAD	1	Strength
DL+0.6Wdown			Linear Static	Wdown	0.6	
0.6DL+0.6Wup	Linear Add	No	Linear Static	DEAD	0.6	Strength
0.6DL+0.6Wup			Linear Static	Wup	0.6	
0.6DL+0.6Wdown	Linear Add	No	Linear Static	DEAD	0.6	Strength
0.6DL+0.6Wdown			Linear Static	Wdown	0.6	
DL+0.75(SN+0.6Wup)	Linear Add	No	Linear Static	DEAD	1	Strength
DL+0.75(SN+0.6Wup)			Linear Static	SN	0.75	
DL+0.75(SN+0.6Wup)			Linear Static	Wup	0.45	
DL+0.75(SN+0.6Wdown)	Linear Add	No	Linear Static	DEAD	1	Strength
DL+0.75(SN+0.6Wdown)			Linear Static	SN	0.75	
DL+0.75(SN+0.6Wdown)			Linear Static	Wdown	0.45	
DL+0.6W16	Linear Add	No	Linear Static	DEAD	1	Strength
DL+0.6W16			Linear Static	W16	0.6	
0.6DL+0.6W16	Linear Add	No	Linear Static	DEAD	0.6	Strength
0.6DL+0.6W16			Linear Static	W16	0.6	
DL+0.75(SN+0.6W16)	Linear Add	No	Linear Static	DEAD	1	Strength
DL+0.75(SN+0.6W16)			Linear Static	SN	0.75	
DL+0.75(SN+0.6W16)			Linear Static	W16	0.45	

Table: Frame Loads - Distributed

Frame	LoadPat	CoordSys	Type	Dir	DistType	RelDistA	RelDistB	FOverLA	FOverLB
								Lb/ft	Lb/ft
2	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	0.67	0.67
2	W16	GLOBAL	Force	X	RelDist	0	1	-8.97	-8.97
2	Wup	Local	Force	2	RelDist	0	1	6.2	6.2
2	Wdown	Local	Force	2	RelDist	0	1	10.67	10.67
2	SN	GLOBAL	Force	Gravity	RelDist	0	1	20	20
1	W16	GLOBAL	Force	Y Proj	RelDist	0	1	10.67	10.67
26	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	0.67	0.67
26	Wup	Local	Force	2	RelDist	0	1	8.97	8.97
26	Wdown	Local	Force	2	RelDist	0	1	-6.2	-6.2
26	SN	GLOBAL	Force	Gravity	RelDist	0	1	20	20

Frame	LoadPat	CoordSys	Type	Dir	DistType	RelDistA	RelDistB	FOverLA	FOverLB
								Lb/ft	Lb/ft
3	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
3	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
3	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
3	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
5	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
5	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
5	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
5	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
6	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
6	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
6	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
6	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
7	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
7	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
7	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
7	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
8	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
8	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
8	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
8	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
9	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
9	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
9	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
9	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
10	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
10	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
10	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
10	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
11	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
11	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
11	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
11	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
12	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
12	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
12	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
12	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
13	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
13	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
13	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
13	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
16	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
16	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
16	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
16	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
17	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
17	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
17	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
17	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
18	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
18	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
18	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
18	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40

Frame	LoadPat	CoordSys	Type	Dir	DistType	RelDistA	RelDistB	FOverLA	FOverLB
								Lb/ft	Lb/ft
19	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
19	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
19	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
19	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
20	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
20	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
20	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
20	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
21	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
21	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
21	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
21	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
22	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
22	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
22	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
22	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
23	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
23	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
23	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
23	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
25	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
25	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
25	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23
25	SN	GLOBAL	Force	Gravity	RelDist	0	1	40	40
15	DEAD	GLOBAL	Force	Gravity	RelDist	0	1	1.33	1.33
15	SN	GLOBAL	Force	Gravity	RelDist	0	1	10	10
15	Wup	Local	Force	3	RelDist	0	1	-17.94	-17.94
15	Wdown	Local	Force	3	RelDist	0	1	12.23	12.23

Table: Preferences - Aluminum Design

THDesign	SRatioLimit	Provision	LatFact	UseLatFact	Bridge	OmegaTy	OmegaTr	OmegaC
Envelopes	1	ASD	1.23	No	No	1.65	1.95	1.65

OmegaBo	OmegaBr	OmegaVo	OmegaVr
1.65	1.95	1.65	1.95

Table: Aluminum Design 1 - Summary Data

Frame	DesignSect	DesignType	Status	Combo	Location	SRLimit
					in	
28	1.5x1.5x0.125	Brace	No Messages	0.6DL+0.6Wup	69.971	1
29	1.5x1.5x0.125	Brace	No Messages	0.6DL+0.6Wup	69.971	1
30	1.5x1.5x0.125	Brace	No Messages	0.6DL+0.6Wup	69.971	1
4	2x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	0	1
14	2x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	0	1
24	2x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	0	1
2	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	0	1
1	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	84	1
26	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	0	1

Frame	DesignSect	DesignType	Status	Combo	Location in	SRLimit
27	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	80	1
3	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
5	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
6	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1
7	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
8	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
9	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1
10	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
11	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
12	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1
13	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1
16	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1
17	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
18	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
19	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1
20	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
21	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
22	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1
23	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
25	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	40	1
15	C8x2x0.125	Beam	No Messages	DL+0.75(SN+0.6Wdown)	20	1

Frame	CombinedEq	TotalRatio	PRatio	MMajRatio	MMinRatio	VMajRatio	VMinRatio
28	(H.1-1)	0.224622	0.209312	0.011146	0.004164	0.000598	0.000107
29	(H.1-1)	0.404013	0.387009	0.01694	6.5E-05	0.000743	1.676E-06
30	(H.1-1)	0.223333	0.208126	0.011102	0.004106	0.000597	0.000106
4	(H.1-1)	0.047789	0.020553	0.02467	0.002566	0.000277	0.000213
14	(H.1-1)	0.078713	0.037546	0.041166	1.229E-06	0.000975	3.071E-08
24	(H.1-1)	0.047601	0.020463	0.024579	0.00256	0.000274	0.000212
2	(H.1-1)	0.063812	0.018956	0.001044	0.043812	0.003888	0.00143
1	(H.1-1)	0.284053	0.004475	0.078783	0.200794	0.038567	0.079102
26	(H.1-1)	0.063506	0.018863	0.001044	0.0436	0.003888	0.001423
27	(H.1-1)	0.238069	0.001468	0.004019	0.232582	0.006694	0.056512
3	(H.1-1)	0.188905	0.01373	0.007293	0.167881	0.003071	0.003782
5	(H.1-1)	0.196678	0.015831	0.010795	0.170051	0.003818	0.003787
6	(H.1-1)	0.188051	0.026054	0.009783	0.152213	0.002612	0.003739
7	(H.1-1)	0.179676	0.00287	0.002489	0.174317	4.6E-05	0.003776
8	(H.1-1)	0.174909	3.6E-05	0.000338	0.174535	7E-05	0.003773
9	(H.1-1)	0.158386	8.3E-05	0.000151	0.158153	4.5E-05	0.004049
10	(H.1-1)	0.174635	5E-05	4.5E-05	0.17454	2.3E-05	0.003773
11	(H.1-1)	0.181121	0.004202	0.002415	0.174504	0.000195	0.003773
12	(H.1-1)	0.210616	0.038526	0.01502	0.15707	0.003971	0.003997
13	(H.1-1)	0.215499	0.027308	0.024692	0.163499	0.005486	0.0045
16	(H.1-1)	0.210037	0.038532	0.015021	0.156484	0.003972	0.004027
17	(H.1-1)	0.181122	0.004203	0.002419	0.1745	0.000194	0.003773
18	(H.1-1)	0.174635	5E-05	4.6E-05	0.174539	2.2E-05	0.003773
19	(H.1-1)	0.158356	8.1E-05	0.000145	0.15813	4.4E-05	0.004048
20	(H.1-1)	0.174899	3.6E-05	0.000329	0.174534	6.8E-05	0.003773
21	(H.1-1)	0.179624	0.002857	0.00245	0.174317	4.8E-05	0.003775
22	(H.1-1)	0.187897	0.025937	0.009747	0.152213	0.002602	0.003739
23	(H.1-1)	0.196562	0.01576	0.010754	0.170048	0.003803	0.003787
25	(H.1-1)	0.188801	0.013671	0.007252	0.167878	0.003055	0.003782
15	(H.1-1)	0.145502	0.027303	0.024699	0.0935	0.005488	0.002509

Frame	P	MMajor	MMinor	VMajor	VMinor	T	Pnt
	Kip	Kip-in	Kip-in	Kip	Kip	Kip-in	Kip
28	-0.48	-0.076	-0.029	0.002301	0.0004123	0	13.397
29	-0.887	-0.115	0.0004512	0.002857	-6.448E-06	0	13.397
30	-0.477	-0.076	0.028	0.002297	-0.0004065	0	13.397
4	-0.162	0.312	-0.033	0.001493	-0.001145	0	18.269
14	-0.296	0.524	-1.581E-05	0.00525	-1.653E-07	0	18.269
24	-0.161	0.311	0.033	0.001474	0.001142	0	18.269
2	-0.124	0.02	-0.245	0.038	-0.008249	0	28.622
1	-0.069	4.308	-1.121	-0.38	0.456	0	28.622
26	-0.123	-0.02	-0.244	-0.038	-0.008209	0	28.622
27	-0.018	-0.22	-1.299	0.066	0.326	0	28.622
3	-0.09	-0.205	-0.938	0.03	-0.022	0	28.622
5	-0.103	0.304	-0.95	-0.038	-0.022	0	28.622
6	-0.17	-0.275	-0.85	-0.026	0.022	0	28.622
7	-0.019	-0.05	-0.974	-0.0004575	-0.022	0	28.622
8	0.001039	-0.009524	-0.975	0.0006908	-0.022	0	28.622
9	0.00237	0.004247	-0.883	0.0004447	0.023	0	28.622
10	0.001442	0.001254	-0.975	0.0002222	-0.022	0	28.622
11	-0.027	0.061	-0.975	0.001919	-0.022	0	28.622
12	-0.252	0.423	-0.877	0.039	0.023	0	28.622
13	-0.178	0.695	-0.913	0.054	0.026	0	28.622
16	-0.252	-0.423	-0.874	-0.039	0.023	0	28.622
17	-0.027	-0.061	-0.975	-0.001914	-0.022	0	28.622
18	0.001435	-0.00129	-0.975	-0.0002167	-0.022	0	28.622
19	0.002308	-0.004095	-0.883	-0.0004297	0.023	0	28.622
20	0.001028	0.009253	-0.975	-0.0006666	-0.022	0	28.622
21	-0.019	0.05	-0.974	0.0004769	-0.022	0	28.622
22	-0.169	0.274	-0.85	0.026	0.022	0	28.622
23	-0.103	-0.303	-0.95	0.038	-0.022	0	28.622
25	-0.089	0.204	-0.938	-0.03	-0.022	0	28.622
15	-0.178	-0.695	-0.522	-0.054	0.014	0	28.622

Frame	Pnc	MnMajor	MnMinor	VnMajor	VnMinor	ErrMsg
	Kip	Kip-in	Kip-in	Kip	Kip	
28	2.291	6.834	6.927	3.846	3.846	No Messages
29	2.291	6.793	6.927	3.846	3.846	No Messages
30	2.291	6.834	6.927	3.846	3.846	No Messages
4	7.87	12.667	12.865	5.385	5.385	No Messages
14	7.87	12.733	12.865	5.385	5.385	No Messages
24	7.87	12.666	12.865	5.385	5.385	No Messages
2	6.53	19.217	5.585	9.865	5.769	No Messages
1	15.517	54.681	5.585	9.865	5.769	No Messages
26	6.53	19.217	5.585	9.865	5.769	No Messages
27	12.288	54.681	5.585	9.865	5.769	No Messages
3	6.53	28.152	5.585	9.865	5.769	No Messages
5	6.53	28.152	5.585	9.865	5.769	No Messages
6	6.53	28.152	5.585	9.865	5.769	No Messages
7	6.53	20.086	5.585	9.865	5.769	No Messages
8	6.53	28.152	5.585	9.865	5.769	No Messages
9	6.53	28.152	5.585	9.865	5.769	No Messages
10	6.53	28.152	5.585	9.865	5.769	No Messages
11	6.53	25.313	5.585	9.865	5.769	No Messages
12	6.53	28.152	5.585	9.865	5.769	No Messages
13	6.53	28.152	5.585	9.865	5.769	No Messages
16	6.53	28.152	5.585	9.865	5.769	No Messages

Frame	Pnc	MnMajor	MnMinor	VnMajor	VnMinor	ErrMsg
	Kip	Kip-in	Kip-in	Kip	Kip	
17	6.53	25.293	5.585	9.865	5.769	No Messages
18	6.53	28.152	5.585	9.865	5.769	No Messages
19	6.53	28.152	5.585	9.865	5.769	No Messages
20	6.53	28.152	5.585	9.865	5.769	No Messages
21	6.53	20.231	5.585	9.865	5.769	No Messages
22	6.53	28.152	5.585	9.865	5.769	No Messages
23	6.53	28.152	5.585	9.865	5.769	No Messages
25	6.53	28.152	5.585	9.865	5.769	No Messages
15	6.53	28.152	5.585	9.865	5.769	No Messages

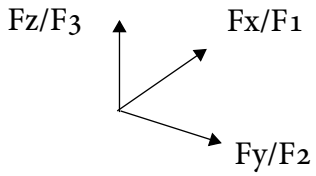
Table: Joint Reactions

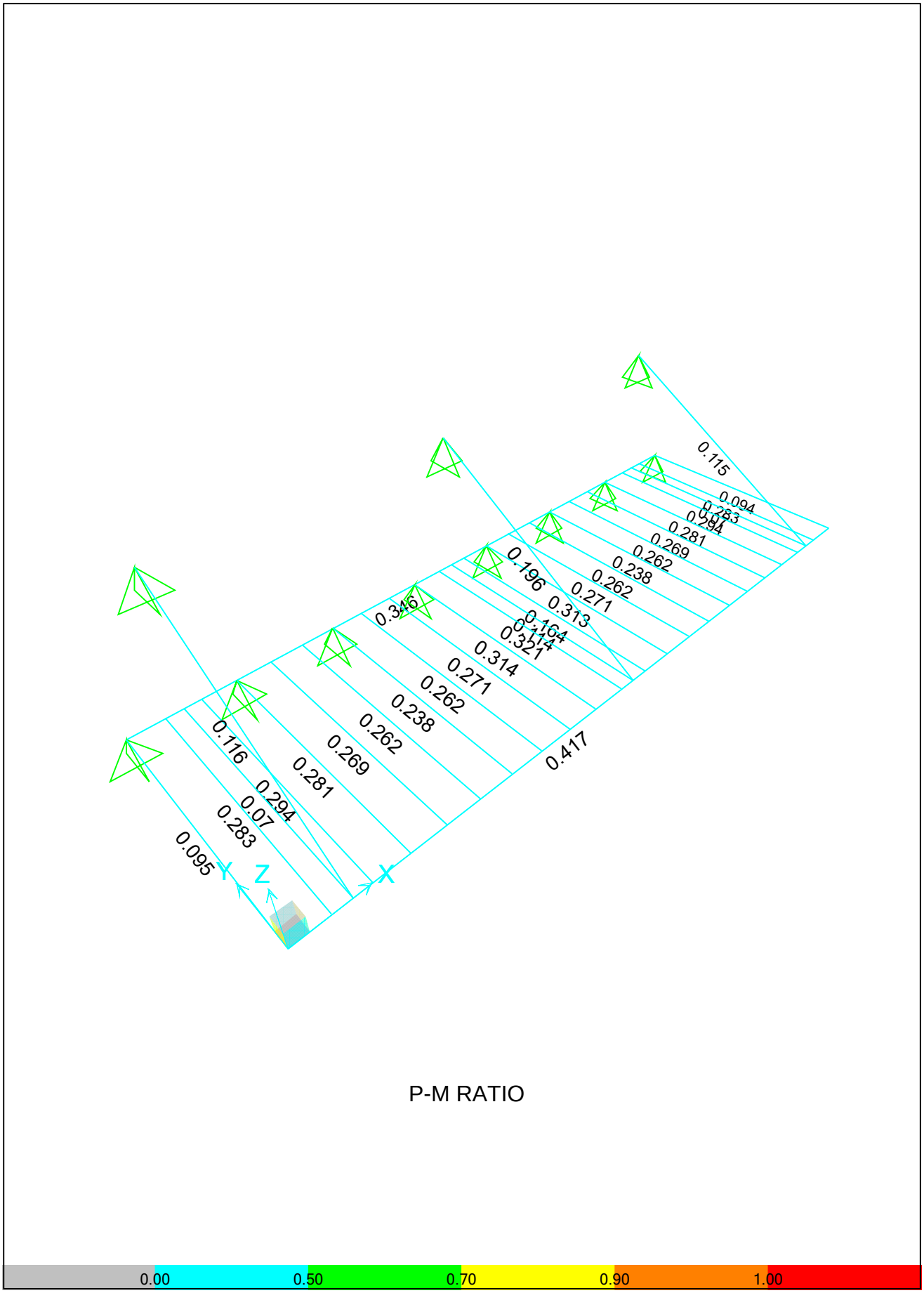
Joint	OutputCase	CaseType	F1	F2	F3
			Lb	Lb	Lb
26	DL+SN	Combination	22.7	-386.2	86.1
26	DL+0.6Wup	Combination	-3.5	59.0	-9.4
26	DL+0.6Wdown	Combination	5.9	-100.4	24.8
26	0.6DL+0.6Wup	Combination	-4.3	73.3	-13.7
26	0.6DL+0.6Wdown	Combination	5.1	-86.1	20.5
26	DL+0.75(SN+0.6Wup)	Combination	13.3	-227.5	52.1
26	DL+0.75(SN+0.6Wdown)	Combination	20.4	-347.1	77.8
26	DL+0.6W16	Combination	-15.0	-34.7	11.0
26	0.6DL+0.6W16	Combination	-15.8	-20.4	6.6
26	DL+0.75(SN+0.6W16)	Combination	4.8	-297.8	67.4
30	DL+SN	Combination	-61.4	-604.7	458.9
30	DL+0.6Wup	Combination	9.2	92.0	-76.0
30	DL+0.6Wdown	Combination	-16.0	-157.4	114.5
30	0.6DL+0.6Wup	Combination	11.5	114.5	-90.9
30	0.6DL+0.6Wdown	Combination	-13.7	-134.9	99.6
30	DL+0.75(SN+0.6Wup)	Combination	-36.2	-356.4	268.5
30	DL+0.75(SN+0.6Wdown)	Combination	-55.1	-543.5	411.4
30	DL+0.6W16	Combination	-8.5	-70.1	37.3
30	0.6DL+0.6W16	Combination	-6.2	-47.6	22.4
30	DL+0.75(SN+0.6W16)	Combination	-49.5	-477.9	353.5
33	DL+SN	Combination	2.2	6.8	277.8
33	DL+0.6Wup	Combination	-0.4	-1.2	-45.3
33	DL+0.6Wdown	Combination	0.6	1.7	69.3
33	0.6DL+0.6Wup	Combination	-0.5	-1.4	-54.5
33	0.6DL+0.6Wdown	Combination	0.5	1.5	60.2
33	DL+0.75(SN+0.6Wup)	Combination	1.2	4.0	162.9
33	DL+0.75(SN+0.6Wdown)	Combination	2.0	6.1	248.9
33	DL+0.6W16	Combination	-2.3	-12.6	22.8
33	0.6DL+0.6W16	Combination	-2.3	-12.8	13.7
33	DL+0.75(SN+0.6W16)	Combination	-0.1	-4.6	214.0
36	DL+SN	Combination	85.1	-877.2	297.9
36	DL+0.6Wup	Combination	-14.7	150.9	-52.1
36	DL+0.6Wdown	Combination	22.9	-235.4	82.0
36	0.6DL+0.6Wup	Combination	-17.7	182.4	-63.1
36	0.6DL+0.6Wdown	Combination	19.8	-203.9	71.0
36	DL+0.75(SN+0.6Wup)	Combination	49.0	-505.3	170.6
36	DL+0.75(SN+0.6Wdown)	Combination	77.2	-795.0	271.1

Joint	OutputCase	CaseType	F1	F2	F3
			Lb	Lb	Lb
36	DL+0.6W16	Combination	5.3	-91.6	27.7
36	0.6DL+0.6W16	Combination	2.2	-60.1	16.6
36	DL+0.75(SN+0.6W16)	Combination	64.0	-687.2	230.4
40	DL+SN	Combination	-85.2	-877.4	269.4
40	DL+0.6Wup	Combination	14.7	150.9	-52.1
40	DL+0.6Wdown	Combination	-22.9	-235.4	82.0
40	0.6DL+0.6Wup	Combination	17.7	182.4	-63.1
40	0.6DL+0.6Wdown	Combination	-19.8	-203.9	71.0
40	DL+0.75(SN+0.6Wup)	Combination	-49.1	-505.5	149.2
40	DL+0.75(SN+0.6Wdown)	Combination	-77.2	-795.2	249.7
40	DL+0.6W16	Combination	-10.0	-92.1	27.7
40	0.6DL+0.6W16	Combination	-6.9	-60.6	16.6
40	DL+0.75(SN+0.6W16)	Combination	-67.6	-687.8	209.0
43	DL+SN	Combination	-2.1	6.5	278.9
43	DL+0.6Wup	Combination	0.4	-1.2	-45.3
43	DL+0.6Wdown	Combination	-0.6	1.7	69.3
43	0.6DL+0.6Wup	Combination	0.5	-1.4	-54.5
43	0.6DL+0.6Wdown	Combination	-0.5	1.5	60.2
43	DL+0.75(SN+0.6Wup)	Combination	-1.2	3.7	163.8
43	DL+0.75(SN+0.6Wdown)	Combination	-1.9	5.9	249.7
43	DL+0.6W16	Combination	-2.4	-12.4	22.8
43	0.6DL+0.6W16	Combination	-2.3	-12.6	13.7
43	DL+0.75(SN+0.6W16)	Combination	-3.3	-4.7	214.9
46	DL+SN	Combination	61.1	-600.4	458.9
46	DL+0.6Wup	Combination	-9.2	92.0	-76.0
46	DL+0.6Wdown	Combination	16.0	-157.4	114.5
46	0.6DL+0.6Wup	Combination	-11.5	114.5	-90.9
46	0.6DL+0.6Wdown	Combination	13.7	-134.9	99.6
46	DL+0.75(SN+0.6Wup)	Combination	36.0	-353.2	268.6
46	DL+0.75(SN+0.6Wdown)	Combination	54.9	-540.2	411.4
46	DL+0.6W16	Combination	3.9	-71.3	37.3
46	0.6DL+0.6W16	Combination	1.6	-48.8	22.4
46	DL+0.75(SN+0.6W16)	Combination	45.9	-475.7	353.5
50	DL+SN	Combination	-22.5	-383.1	86.2
50	DL+0.6Wup	Combination	3.5	59.0	-9.4
50	DL+0.6Wdown	Combination	-5.9	-100.4	24.8
50	0.6DL+0.6Wup	Combination	4.3	73.3	-13.7
50	0.6DL+0.6Wdown	Combination	-5.1	-86.1	20.5
50	DL+0.75(SN+0.6Wup)	Combination	-13.2	-225.2	52.2
50	DL+0.75(SN+0.6Wdown)	Combination	-20.2	-344.8	77.8
50	DL+0.6W16	Combination	-3.1	-45.5	10.8
50	0.6DL+0.6W16	Combination	-2.2	-31.2	6.5
50	DL+0.75(SN+0.6W16)	Combination	-18.1	-303.6	67.3
51	DL+SN	Combination	-0.9	982.6	594.2
51	DL+0.6Wup	Combination	0.2	-149.4	-88.0
51	DL+0.6Wdown	Combination	-0.2	255.6	156.1
51	0.6DL+0.6Wup	Combination	0.2	-185.9	-110.8
51	0.6DL+0.6Wdown	Combination	-0.2	219.1	133.3
51	DL+0.75(SN+0.6Wup)	Combination	-0.5	579.2	351.1
51	DL+0.75(SN+0.6Wdown)	Combination	-0.9	883.0	534.2
51	DL+0.6W16	Combination	-0.1	91.1	56.9
51	0.6DL+0.6W16	Combination	0.0	54.6	34.1

Joint	OutputCase	CaseType	F1	F2	F3
			Lb	Lb	Lb
51	DL+0.75(SN+0.6W16)	Combination	-0.7	759.6	459.8
52	DL+SN	Combination	0.0	1757.4	1060.5
52	DL+0.6Wup	Combination	0.0	-302.4	-180.1
52	DL+0.6Wdown	Combination	0.0	471.9	286.3
52	0.6DL+0.6Wup	Combination	0.0	-365.6	-219.0
52	0.6DL+0.6Wdown	Combination	0.0	408.6	247.4
52	DL+0.75(SN+0.6Wup)	Combination	0.0	1012.3	611.7
52	DL+0.75(SN+0.6Wdown)	Combination	0.0	1592.9	961.5
52	DL+0.6W16	Combination	0.0	158.2	97.3
52	0.6DL+0.6W16	Combination	0.0	94.9	58.4
52	DL+0.75(SN+0.6W16)	Combination	0.0	1357.7	819.7
53	DL+SN	Combination	0.9	975.6	590.0
53	DL+0.6Wup	Combination	-0.2	-149.4	-88.0
53	DL+0.6Wdown	Combination	0.2	255.6	156.1
53	0.6DL+0.6Wup	Combination	-0.2	-185.9	-110.8
53	0.6DL+0.6Wdown	Combination	0.2	219.1	133.3
53	DL+0.75(SN+0.6Wup)	Combination	0.5	574.0	348.0
53	DL+0.75(SN+0.6Wdown)	Combination	0.8	877.8	531.1
53	DL+0.6W16	Combination	0.1	91.4	57.1
53	0.6DL+0.6W16	Combination	0.0	54.9	34.3
53	DL+0.75(SN+0.6W16)	Combination	0.7	754.6	456.8

Reaction Direction




0.115
0.094
0.283
0.294
0.281
0.269
0.262
0.238
0.262
0.271
0.313
0.196
0.164
0.114
0.321
0.314
0.271
0.262
0.238
0.262
0.269
0.281
0.294
0.07
0.283
0.095
0.116
0.417
0.346
Y
Z
X
0.00
0.50
0.70
0.90
1.00

P-M RATIO

HW ENGINEERING
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Connection Check

Typical upper attachment check

maximum reaction from analysis, worst case considered below

$F_x := 0lbf$ $F_y := 1757.42lbf$ $F_z := 1060.49lbf$

maximum shear and tension

$V_{REC} := \sqrt{F_x^2 + F_z^2}$ $T_{REC} := F_y$

$V_{REC} = 1060 \cdot lbf$ $T_{REC} = 1757 \cdot lbf$ worst case

attachment horizontal spacing in model $d := 72 \cdot in$

attachment horizontal trib. width $D := 72 \cdot in$

attachment vertical spacing in model $s := 36 \cdot in$

attachment vertical trib. width $S := 37in$

$V_{max} := V_{REC} \cdot \frac{D}{d}$ $T_{max} := T_{REC} \cdot \frac{D}{d} \frac{s}{S}$ $V_{max} = 1060 \cdot lbf$ $T_{max} = 1710 \cdot lbf$

Tab plate check

plate information $F_y := 36 \cdot ksi$ $F_u := 58 \cdot ksi$ A36 plate

$w := 3 \cdot in$ $t := \frac{3}{8} \cdot in$ $d_{hole} := \frac{7}{16} \cdot in$ $d := \frac{3}{8} \cdot in$ $LC := 1 \cdot in$ $a := LC - \frac{d_{hole}}{2}$ $a = 0.781 \cdot in$

$b := \frac{w}{2} - \frac{d_{hole}}{2}$ $b = 1.281 \cdot in$ $b_{eff} := \min(2 \cdot t + 0.63 \cdot in, b)$ $b_{eff} = 1.281 \cdot in$

check tensile rupture on the net effective area

$P_n := 2 \cdot t \cdot b_{eff} \cdot F_u$ $P_n = 55.734 \cdot kip$ $\Omega_t := 2.0$

$T_a := \frac{P_n}{\Omega_t}$ $T_a = 27.867 \cdot kip$

$check\_T := if(T_a \geq T_{max}, "Tension is Ok", "NG")$ check_T = "Tension is Ok"

check shear rupture

$A_{sf} := 2 \cdot t \cdot \left(a + \frac{d}{2}\right)$ $A_{sf} = 0.727 \cdot in^2$

$V_n := 0.6 \cdot F_u \cdot A_{sf}$ $V_n = 25.284 \cdot kip$ $\Omega_{sf} := 2.0$

$V_a := \frac{V_n}{\Omega_{sf}}$ $V_a = 12.642 \cdot kip$

$check\_V := if(V_a \geq T_{max}, "Shear rupture is Ok", "NG")$ check_V = "Shear rupture is Ok"

HW ENGINEERING
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check bearing

$A_{pb} := t \cdot d$ $A_{pb} = 0.141 \cdot in^2$

$R_n := 1.8 \cdot F_y \cdot A_{pb}$ $R_n = 9.112 \cdot kip$ $\Omega_t := 2.0$

$P_a := \frac{R_n}{\Omega_t}$ $P_a = 4.6 \cdot kip$

$check\_bearing := if\left(P_a \geq T_{max}, "Bearing\ is\ Ok" , "NG"\right)$ $check\_bearing = "Bearing\ is\ Ok"$

check tensile yielding

$A_g := w \cdot t$ $A_g = 1.125 \cdot in^2$

$P_n := F_y \cdot A_g$ $P_n = 40.5 \cdot kip$ $\Omega_y := 1.67$

$T_y := \frac{P_n}{\Omega_y}$ $T_y = 24.251 \cdot kip$

$check\_yielding := if\left(T_y \geq T_{max}, "Tensile\ yielding\ is\ Ok" , "NG"\right)$

$check\_yielding = "Tensile\ yielding\ is\ Ok"$

3/16" welding for tab plate to back wall plate

welding information $t_w := \frac{3}{16} \cdot in$ $D := \frac{t_w}{\frac{1}{16} \cdot in}$ $D = 3$ $L_w := 3 \cdot in$

3" welding used for conservative design

allowable welding strength

$F_{weld} := 0.928 \cdot \frac{kip}{in} \cdot D \cdot L_w$ $F_{weld} = 8.352 \cdot kip$

$check\_welding := if\left(F_{weld} \geq T_{max}, "Welding\ is\ OK" , "NG"\right)$

$check\_welding = "Welding\ is\ OK"$

Wall plate connection check

Use (4) 3/8" dia. A307 thru bolt or equivalent bolt wall plate to **stud or metal backing** (by others)

$V_a := 1.48kip$ $T_a := 2.48kip$

$check\_bolt := if\left(V_a > V_{max} \wedge T_a > T_{max}, "Bolt\ is\ sufficient!" , "NG!!!"\right)$

$check\_bolt = "Bolt\ is\ sufficient!"$

Use (4) 3/8" dia. x4" lag screws or equivalent screws for wall plate to **wood beam or wood blocking** (by others)

$n := 4$ Number of screws

$T\_E := \left(2 + \frac{9}{32}\right) in$ Penetration into wood for a conservative design

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$P_{max} := \sqrt{T_{max}^2 + V_{max}^2}$ $P_{max} = 2012 \cdot lbf$ maximum force to screws

$Z_{penp} := 180 \cdot lbf$ $Z_{par} := 280 \cdot lbf$ $W := 305 \cdot \frac{lbf}{in}$

$C_D := 1.6$ for wind $C_M := 1.0$ $C_\Delta := 1.0$ $C_t := 1.0$ $C_g := 1.0$ $\theta := \operatorname{atan}\left(\frac{T_{max}}{V_{max}}\right)$

$Z1 := Z_{penp} \cdot C_D \cdot C_M \cdot C_\Delta \cdot C_t \cdot C_g$ $Z1 = 288 \cdot lbf$

$Z2 := Z_{par} \cdot C_D \cdot C_M \cdot C_\Delta \cdot C_t \cdot C_g$ $Z2 = 448 \cdot lbf$

$$Z := \frac{Z1 \cdot Z2}{Z1 \cdot \cos(\theta)^2 + Z2 \cdot \sin(\theta)^2} \qquad Z = 319.7 \cdot lbf$$

$W1 := W \cdot T\_E \cdot C_D \cdot C_M \cdot C_t$ $W1 = 1.113 \cdot kip$

$$Z_\theta := \frac{n\,W1 \cdot Z}{W1 \cdot \cos(\theta)^2 + Z \cdot \sin(\theta)^2} \qquad Z_\theta = 2636 \cdot lbf$$

$check := \text{if}\left(P_{max} < Z_\theta, \text{"Lag screw is Ok"}, \text{"NG"}\right)$

check = "Lag screw is Ok"

Use (4) 5/8" dia. x 4-1/2" nominal embed. SS SIMPSON TITEN HD or equivalent screws for wall plate to **masonry wall** (by others)

$S_{crit} := 8in$ $S_{min} := 4in$ $S := 4in$ $fac_{t.min} := 0.87$ $fac_{v.min} := 0.9$ $n := 4$

$$fac_t := \frac{1 - fac_{t.min}}{S_{crit} - S_{min}} \cdot \left(S - S_{min}\right) + fac_{t.min}$$ tension reduction factor due to anchor spacing

$$fac_v := \frac{1 - fac_{v.min}}{S_{crit} - S_{min}} \cdot \left(S - S_{min}\right) + fac_{v.min}$$ shear reduction factor due to anchor spacing

$T_a := \min\left(770lbf \cdot fac_t, 770lbf\right)$ $V_a := \min\left(985lbf \cdot fac_v, 985lbf\right)$ According to ESR-1056

$$Ratio := \left(\frac{T_{max}}{n \cdot T_a}\right) + \left(\frac{V_{max}}{n \cdot V_a}\right) \qquad Ratio = 0.937$$

$check\_anchor := \text{if}\left(Ratio \le 1, \text{"Anchor is sufficient!"}, \text{"NG"}\right)$

check_anchor = "Anchor is sufficient!"

Use (4) 3/8" dia. x2-1/2" nominal embed. SS SIMPSON TITEN HD or equivalent screws for wall plate to concrete **wall** (by others). See attached report.

HW ENGINEERING
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Typical lower attachment check

maximum reaction from analysis, worst case considered below

$F_x := 85.18lbf$ $F_y := 887.43lbf$ $F_z := 458.88lbf$

maximum shear and tension

$V_{REC} := \sqrt{F_x^2 + F_z^2}$ $T_{REC} := F_y$

$V_{REC} = 467 \cdot lbf$ $T_{REC} = 887 \cdot lbf$ worst case

attachment horizontal spacing in model $d := 24 \cdot in$

attachment horizontal trib. width $D := 24 \cdot in$

attachment vertical spacing in model $s := 36 \cdot in$

attachment vertical trib. width $S := 37in$

$V_{max} := V_{REC} \cdot \frac{D}{d}$ $T_{max} := T_{REC} \cdot \frac{D}{d} \frac{s}{S}$ $V_{max} = 467 \cdot lbf$ $T_{max} = 863 \cdot lbf$

Use (1) 3/8" dia. A307 thru bolt or equivalent bolt to **stud or metal backing** (by others)

$V_a := 1.48kip$ $T_a := 2.48kip$

$check\_bolt := if\left(V_a > V_{max} \wedge T_a > T_{max}, "Bolt\ is\ sufficient!", "NG!!!"\right)$

check_bolt = "Bolt is sufficient!"

Use (2) 3/8" dia. x4" lag screws or equivalent screws to **wood beam or wood blocking** (by others)

$n := 2$

$T\_E := \left(2 + \frac{9}{32}\right)in$ Penetration into wood for a conservative design

$P_{max} := \sqrt{T_{max}^2 + V_{max}^2}$ $P_{max} = 982 \cdot lbf$ maximum force to screws

$Z_{penp} := 180 \cdot lbf$ $Z_{par} := 280 \cdot lbf$ $W := 305 \cdot \frac{lbf}{in}$

$C_D := 1.6$ for wind $C_M := 1.0$ $C_\Delta := 1.0$ $C_t := 1.0$ $C_g := 1.0$ $\theta := atan\left(\frac{T_{max}}{V_{max}}\right)$

$Z1 := Z_{penp} \cdot C_D \cdot C_M \cdot C_\Delta \cdot C_t \cdot C_g$ $Z1 = 288 \cdot lbf$

$Z2 := Z_{par} \cdot C_D \cdot C_M \cdot C_\Delta \cdot C_t \cdot C_g$ $Z2 = 448 \cdot lbf$

$Z := \frac{Z1 \cdot Z2}{Z1 \cdot \cos(\theta)^2 + Z2 \cdot \sin(\theta)^2}$ $Z = 313.3 \cdot lbf$

HW ENGINEERING
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$W1 := W \cdot T\_E \cdot C_D \cdot C_M \cdot C_t$ $W1 = 1.113 \cdot kip$

$$Z_\theta := \frac{n\,W1 \cdot Z}{W1 \cdot \cos(\theta)^2 + Z \cdot \sin(\theta)^2} \qquad Z_\theta = 1412 \cdot lbf$$

$check := if\left(P_{max} < Z_\theta, "Lag\ screw\ is\ Ok" , "NG"\right)$

check = "Lag screw is Ok"

Use (2) 5/8" dia. x4-1/2" nominal embed. SS SIMPSON TITEN HD or equivalent screws for to **masonry wall** (by others)

$S_{crit} := 8in$ $S_{min} := 4in$ $S := 4in$ $fac_{t.min} := 0.87$ $fac_{v.min} := 0.9$

$$fac_t := \frac{1 - fac_{t.min}}{S_{crit} - S_{min}} \cdot \left(S - S_{min}\right) + fac_{t.min}$$ tension reduction factor due to anchor spacing

$$fac_v := \frac{1 - fac_{v.min}}{S_{crit} - S_{min}} \cdot \left(S - S_{min}\right) + fac_{v.min}$$ shear reduction factor due to anchor spacing

$T_a := \min\left(770lbf \cdot fac_t, 770lbf\right)$ $V_a := \min\left(985lbf \cdot fac_v, 985lbf\right)$ According to ESR-1056

$n := 2$

$$Ratio := \left(\frac{T_{max}}{n \cdot T_a}\right) + \left(\frac{V_{max}}{n \cdot V_a}\right) \qquad Ratio = 0.908$$

$check\_anchor := if(Ratio \le 1, "Anchor\ is\ sufficient!" , "NG")$

check_anchor = "Anchor is sufficient!"

Use (1) 3/8" dia. x 3" nominal embed. SS SIMPSON TITEN HD or equivalent screws for wall plate to concrete **wall** (by others). See attached report.

Frame to frame

Use typical 1/8" all around fillet welding for frame to frame, well sufficient.

SIMPSON Strong-Tie®

Anchor Designer™ Software
Version 2.8.7094.15

Company:	HW Engineering	Date:	11/30/2020
Engineer:	YW	Page:	1/5
Project:	KE USA Hanger Rod Canopy		
Address:	8887 W Flamingo Rd		
Phone:	702-202-0061		
E-mail:	yijie@hwengineeringusa.com		

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description: Top attachment to concrete wall design
Location:
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

Anchor Information:
Anchor type: Concrete screw
Material: Stainless Steel
Diameter (inch): 0.375
Nominal Embedment depth (inch): 2.500
Effective Embedment depth, h_{ef} (inch): 1.400
Code report: IAPMO UES ER-493
Anchor category: 1
Anchor ductility: Yes
h_{min} (inch): 4.00
c_{ac} (inch): 4.50
C_{min} (inch): 1.75
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 4.00
State: Uncracked
Compressive strength, f'_c (psi): 2500
$\Psi_{c,V}$: 1.4
Reinforcement condition: B tension, B shear
Supplemental reinforcement: No
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 6.00 x 6.00 x 0.13

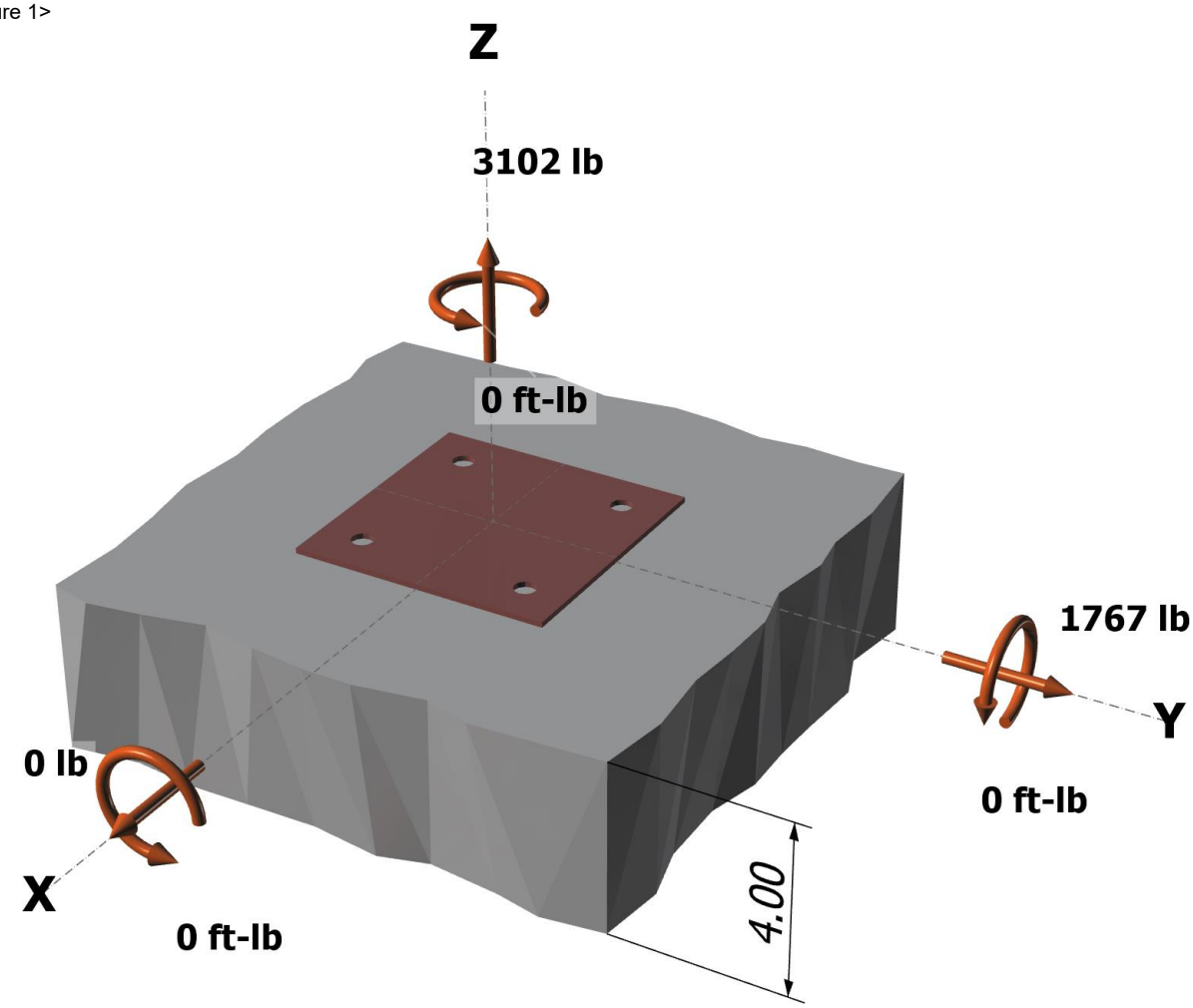
Recommended Anchor
Anchor Name: Titen HD® Stainless Steel - 3/8"Ø SS Titen HD, hnom:2.5" (64mm)
Code Report: IAPMO UES ER-493

Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: 3102
V_{uax} [lb]: 0
V_{uay} [lb]: 1767
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: 0
M_{uz} [ft-lb]: 0

<Figure 1>



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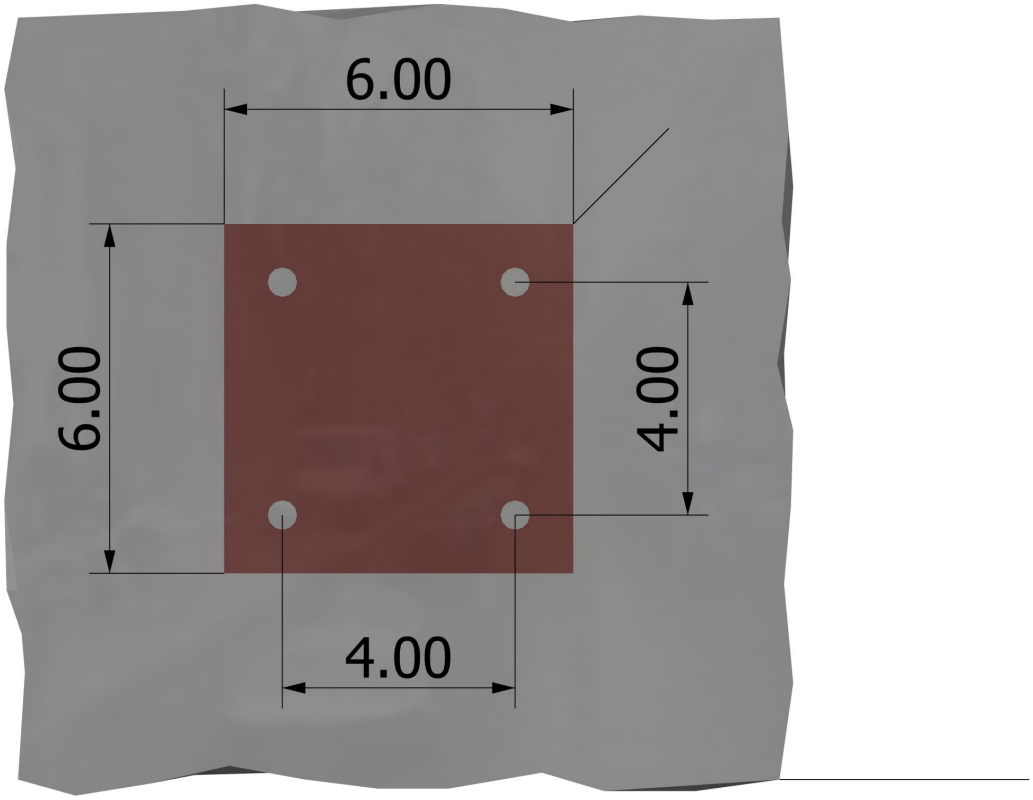
Phone:	702-202-0061		
E-mail:	yijie@hwengineeringusa.com		

<Figure 2>



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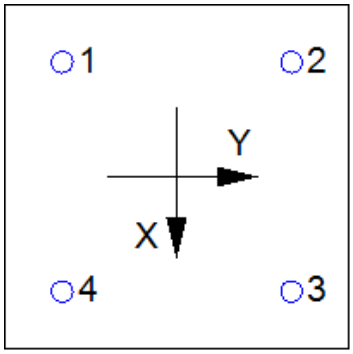
Phone:	702-202-0061		
E-mail:	yijie@hwengineeringusa.com		

3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	775.5	0.0	441.8	441.8
2	775.5	0.0	441.8	441.8
3	775.5	0.0	441.8	441.8
4	775.5	0.0	441.8	441.8
Sum	3102.0	0.0	1767.0	1767.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 3102
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
12177	0.75	9133

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. 17.4.2.2a)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
27.0	1.00	2500	1.400	2236

$\phi N_{cbg} = \phi (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1b)

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cbg} (lb)
67.24	17.64	-	1.000	1.000	1.00	1.000	2236	0.65	5541

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
3790	1.0	0.65	2464

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$\phi V_{cpg} = \phi k_{cp} N_{cbg} = \phi k_{cp} (A_{Nc} / A_{Nco}) \Psi_{ec,N} \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.5.3.1b)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ec,N}$	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cpg} (lb)
1.0	67.24	17.64	1.000	1.000	1.000	1.000	2236	0.70	5967

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Address:	8887 W Flamingo Rd		
Phone:	702-202-0061		
E-mail:	yijie@hwengineeringusa.com		

11. Results

Interaction of Tensile and Shear Forces (Sec. 17.6.)

Tension	Factored Load, N_{ua} (lb)	Design Strength, øN_n (lb)	Ratio	Status
Steel	776	9133	0.08	Pass
Concrete breakout	**3102**	**5541**	**0.56**	**Pass (Governs)**

Shear	Factored Load, V_{ua} (lb)	Design Strength, øV_n (lb)	Ratio	Status
Steel	442	2464	0.18	Pass
Pryout	**1767**	**5967**	**0.30**	**Pass (Governs)**

Interaction check	$N_{ua}/\phi N_n$	$V_{ua}/\phi V_n$	Combined Ratio	Permissible	Status
Sec. 17.6..1	0.56	0.00	56.0%	1.0	Pass

3/8"Ø SS Titen HD, hnom:2.5" (64mm) meets the selected design criteria.

12. Warnings

- Minimum spacing and edge distance requirement of 6da per ACI 318 Sections 17.7.1 and 17.7.2 for torqued cast-in-place anchor is waived per designer option.

- Designer must exercise own judgement to determine if this design is suitable.

- Refer to manufacturer's product literature for hole cleaning and installation instructions.

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Anchor Designer™ Software
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Company:	HW Engineering	Date:	11/30/2020
Engineer:	YW	Page:	1/5
Project:	KE USA Hanger Rod Canopy		
Address:	8887 W Flamingo Rd		
Phone:	702-202-0061		
E-mail:	yijie@hwengineeringusa.com		

1.Project information

Customer company:
Customer contact name:
Customer e-mail:
Comment:

Project description: Lower attachment to concrete wall design
Location:
Fastening description:

2. Input Data & Anchor Parameters

General
Design method:ACI 318-14
Units: Imperial units

Anchor Information:
Anchor type: Concrete screw
Material: Stainless Steel
Diameter (inch): 0.375
Nominal Embedment depth (inch): 3.000
Effective Embedment depth, h_{ef} (inch): 1.820
Code report: IAPMO UES ER-493
Anchor category: 1
Anchor ductility: Yes
h_{min} (inch): 4.67
c_{ac} (inch): 5.17
C_{min} (inch): 1.75
S_{min} (inch): 3.00

Base Material
Concrete: Normal-weight
Concrete thickness, h (inch): 6.00
State: Uncracked
Compressive strength, f'_c (psi): 2500
$\Psi_{c,V}$: 1.4
Reinforcement condition: B tension, B shear
Supplemental reinforcement: No
Reinforcement provided at corners: No
Ignore concrete breakout in tension: No
Ignore concrete breakout in shear: No
Ignore 6do requirement: Not applicable
Build-up grout pad: No

Base Plate
Length x Width x Thickness (inch): 6.00 x 6.00 x 0.13

Recommended Anchor
Anchor Name: Titen HD® Stainless Steel - 3/8"Ø SS Titen HD, hnom:3.0" (76mm)
Code Report: IAPMO UES ER-493

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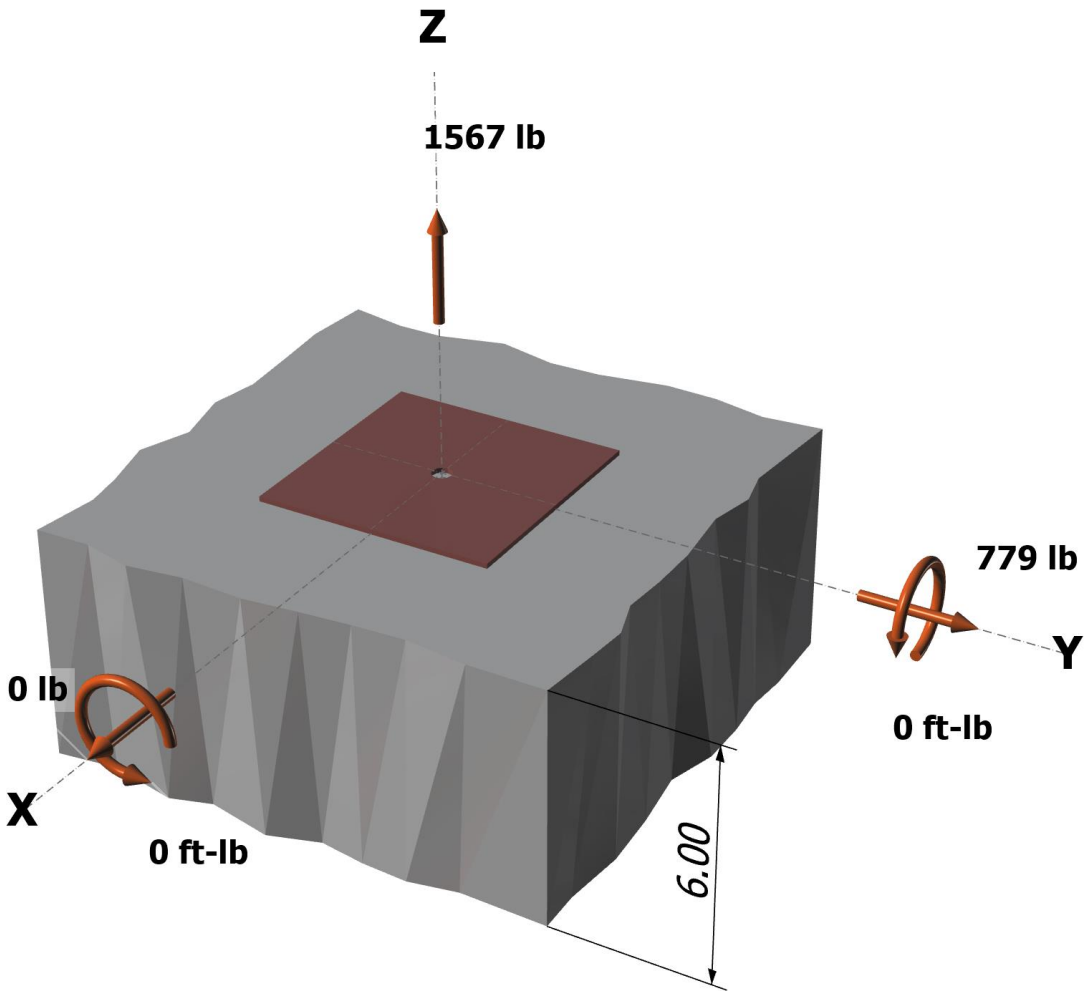
Load and Geometry
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Strength level loads:

N_{ua} [lb]: 1567
V_{uax} [lb]: 0
V_{uay} [lb]: 779
M_{ux} [ft-lb]: 0
M_{uy} [ft-lb]: 0

<Figure 1>



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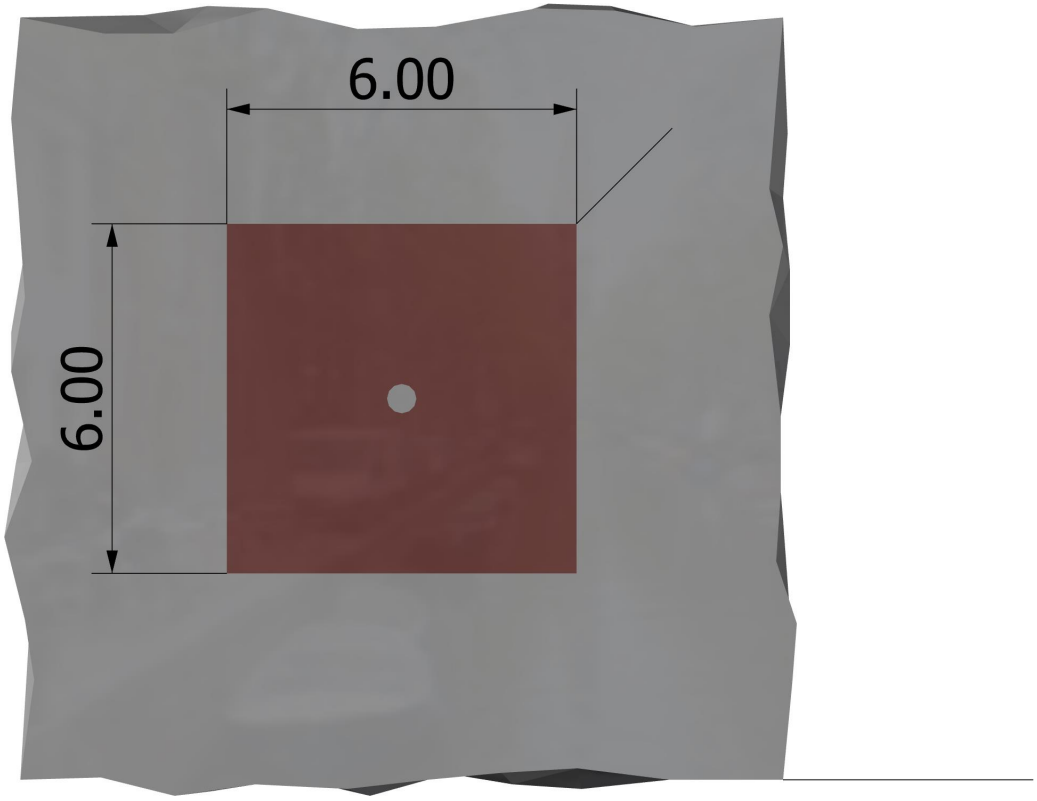
<Figure 2>



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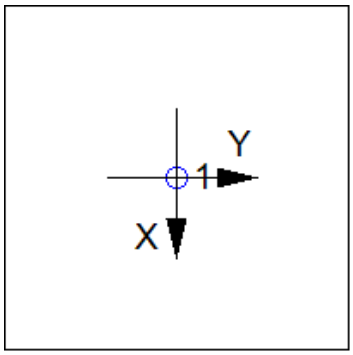
3. Resulting Anchor Forces

Anchor	Tension load, N_{ua} (lb)	Shear load x, V_{uax} (lb)	Shear load y, V_{uay} (lb)	Shear load combined, $\sqrt{(V_{uax})^2+(V_{uay})^2}$ (lb)
1	1567.0	0.0	779.0	779.0
Sum	1567.0	0.0	779.0	779.0

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 1567
Resultant compression force (lb): 0
Eccentricity of resultant tension forces in x-axis, e'_{Nx} (inch): 0.00
Eccentricity of resultant tension forces in y-axis, e'_{Ny} (inch): 0.00
Eccentricity of resultant shear forces in x-axis, e'_{Vx} (inch): 0.00
Eccentricity of resultant shear forces in y-axis, e'_{Vy} (inch): 0.00

<Figure 3>



4. Steel Strength of Anchor in Tension (Sec. 17.4.1)

N_{sa} (lb)	ϕ	ϕN_{sa} (lb)
12177	0.75	9133

5. Concrete Breakout Strength of Anchor in Tension (Sec. 17.4.2)

$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5}$ (Eq. 17.4.2.2a)

k_c	λ_a	f'_c (psi)	h_{ef} (in)	N_b (lb)
24.0	1.00	2500	1.820	2946

$\phi N_{cb} = \phi (A_{Nc} / A_{Nco}) \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.4.2.1a)

A_{Nc} (in^2)	A_{Nco} (in^2)	$c_{a,min}$ (in)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕN_{cb} (lb)
29.81	29.81	-	1.000	1.00	1.000	2946	0.65	1915

8. Steel Strength of Anchor in Shear (Sec. 17.5.1)

V_{sa} (lb)	ϕ_{grout}	ϕ	$\phi_{grout}\phi V_{sa}$ (lb)
4450	1.0	0.65	2893

10. Concrete Pryout Strength of Anchor in Shear (Sec. 17.5.3)

$\phi V_{cp} = \phi k_{cp} N_{cb} = \phi k_{cp} (A_{Nc} / A_{Nco}) \Psi_{ed,N} \Psi_{c,N} \Psi_{cp,N} N_b$ (Sec. 17.3.1 & Eq. 17.5.3.1a)

k_{cp}	A_{Nc} (in^2)	A_{Nco} (in^2)	$\Psi_{ed,N}$	$\Psi_{c,N}$	$\Psi_{cp,N}$	N_b (lb)	ϕ	ϕV_{cp} (lb)
1.0	29.81	29.81	1.000	1.000	1.000	2946	0.70	2062

11. Results

Interaction of Tensile and Shear Forces (Sec. R17.6)

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Tension	Factored Load, N_{ua} (lb)	Design Strength, øN_n (lb)	Ratio	Status
Steel	1567	9133	0.17	Pass
Concrete breakout	**1567**	**1915**	**0.82**	**Pass (Governs)**

Shear	Factored Load, V_{ua} (lb)	Design Strength, øV_n (lb)	Ratio	Status
Steel	779	2893	0.27	Pass
Pryout	**779**	**2062**	**0.38**	**Pass (Governs)**

Interaction check	$(N_{ua}/\phi N_{ua})^{5/3}$	$(V_{ua}/\phi V_{ua})^{5/3}$	Combined Ratio	Permissible	Status
Sec. R17.6	0.72	0.20	91.3%	1.0	Pass

3/8"Ø SS Titen HD, hnom:3.0" (76mm) meets the selected design criteria.

12. Warnings

- Minimum spacing and edge distance requirement of 6da per ACI 318 Sections 17.7.1 and 17.7.2 for torqued cast-in-place anchor is waived per designer option.

- Designer must exercise own judgement to determine if this design is suitable.

- Refer to manufacturer's product literature for hole cleaning and installation instructions.

Typical Tie Back Attachment			
	Fx	Fy	Fz
Reaction(lbs)	0	1756	1061
Wall or Backing	Connection		
Metal	(4) 3/8" Dia A307 Thru Bolt		
Wood	(4) 3/8" Dia x 4" Lag Screws		
Masonry	(4) 5/8" Dia x 4-1/2" Nominal Embed.SS SIMPSON TITEN HD		
Concrete	(4) 3/8" Dia x 2-1/2" Nominal Embed. SS SIMPSON TITEN HD		
Typical Lower Attachment			
	Fx	Fy	Fz
Reaction(lbs)	59	604	308
Wall or Backing	Connection		
Metal	(1) 3/8" Dia A307 Thru Bolt at 24"O.C.		
Wood	(2) 3/8" Dia x 4" Lag Screws at 24" O.C.		
Masonry	(2) 5/8" Dia x 4-1/2" Nominal Embed.SS SIMPSON TITEN HD at 24" O.C.		
Concrete	(1) 3/8" Dia x 3" Nominal Embed. SS SIMPSON TITEN HD at 24" O.C.		

Reaction Direction