HW ENGINEERING
STRUCTURAL ENGINEERS & CONSULTANTS

# STRUCTURAL CALCULATIONS

**PROJECT NAME:** KE USA Louver Canopy -- Heavy Duty
**PROJECT ADDRESS:** General USA Area
**PROJECT NO:** 20295B

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

**DATE**: Dec 03, 2020

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12.03.2020

| REV | DATE | BY | DESCRIPTION |
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|---|---|---|
| Job Number: | 20295B | Date: |
| Part: | | Revised: |
| Designer: | YW | Page: |

# KE USA LOUVER CANOPY – HEAVY DUTY

## 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.

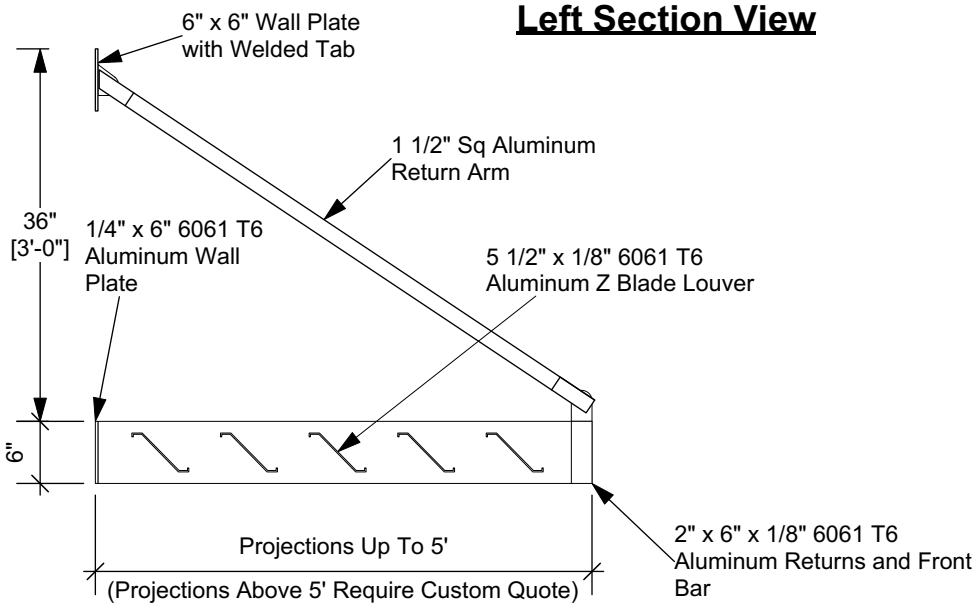
The analysis and design of the awning system included herein were performed with the use of a 3D frame analysis and computer design program – **SAP2000**. It is a structural analysis program developed by Computers and Structures, Inc. Detailed information about the software can be found at the Computers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

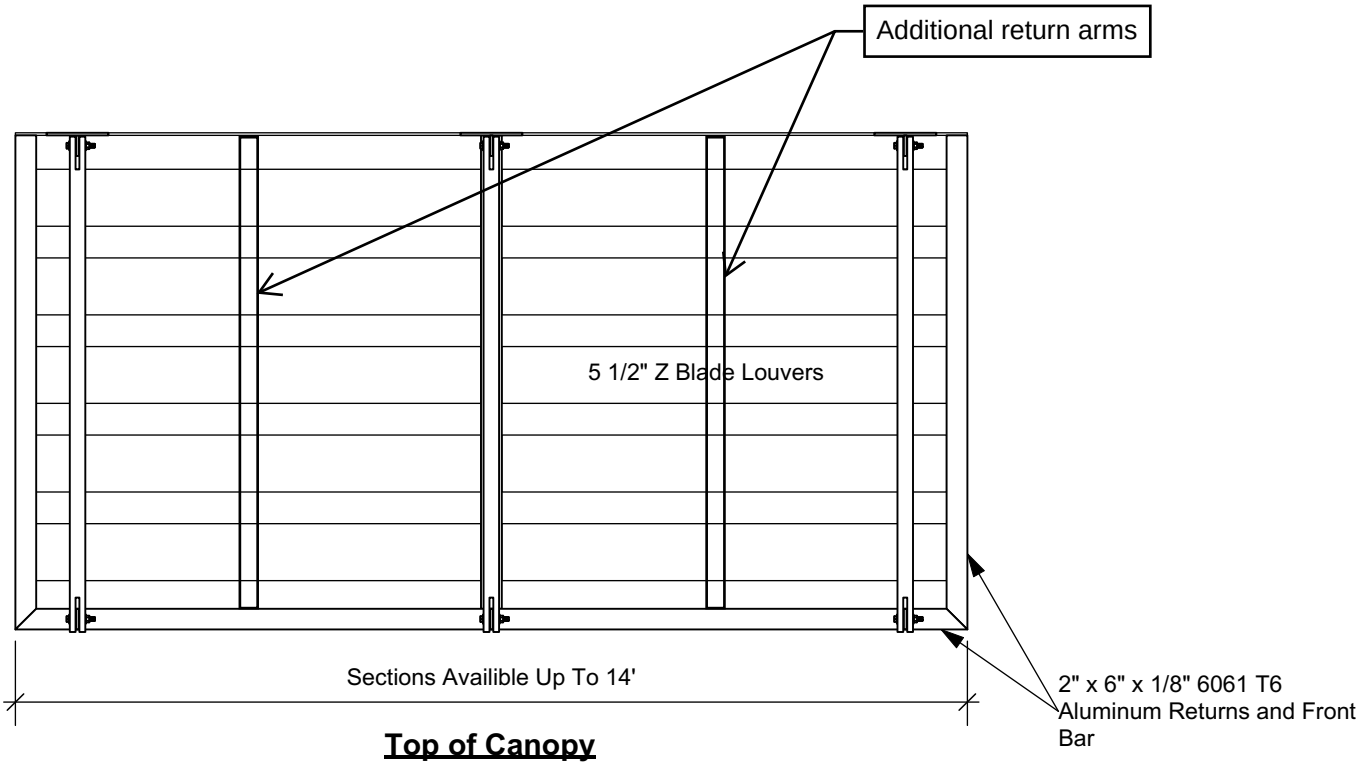
Various load cases and combinations were considered during our structural engineering analysis. Aluminum Design ASD design specifications were used to check the structural capacities of these members based on an applicable minimum yield stress. The demand/capacity ratio of each framing member was calculated 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 3’-6”.
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 160 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




## Top of Canopy

**Product Description:**
**KE Commercial offers several Louver 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.**

KE
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Tel: 802-388-7309
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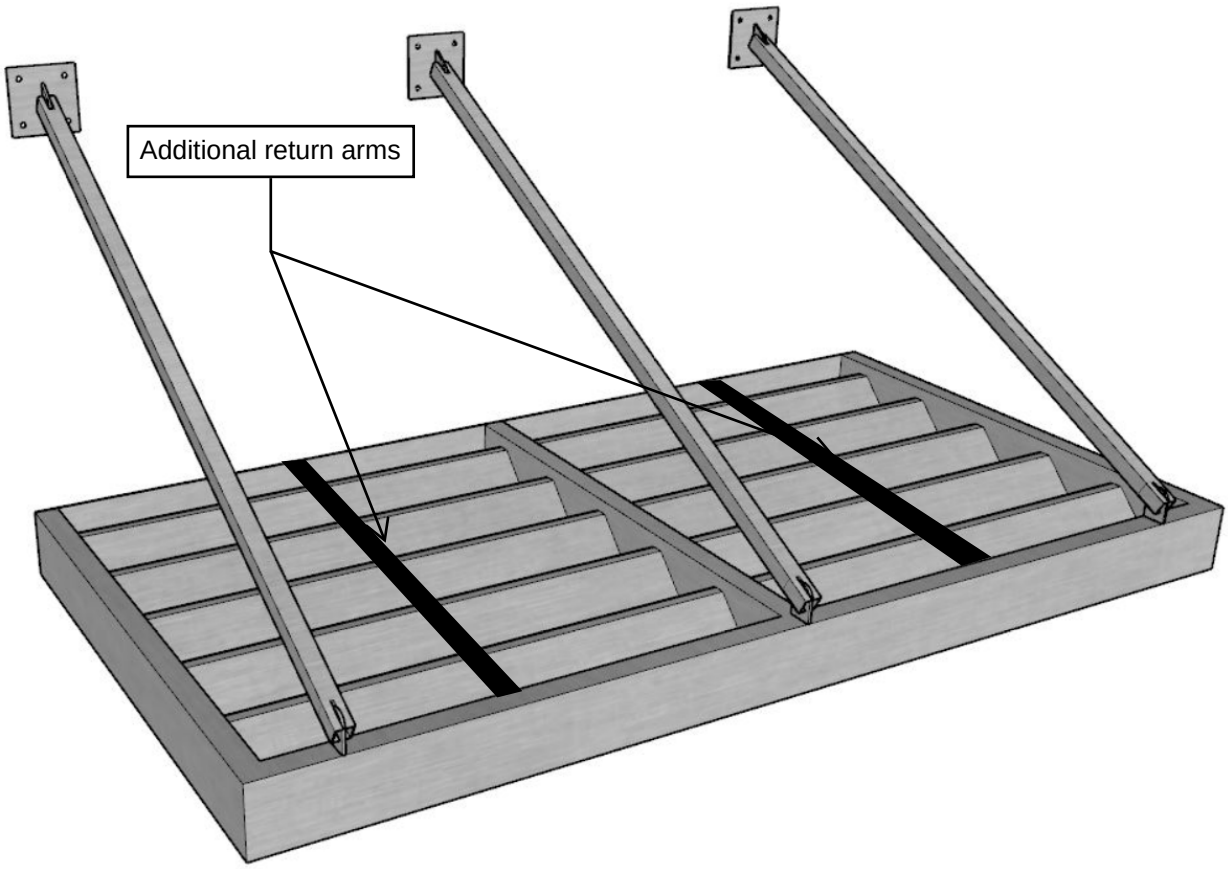
https://www.keoutdoordesign.com

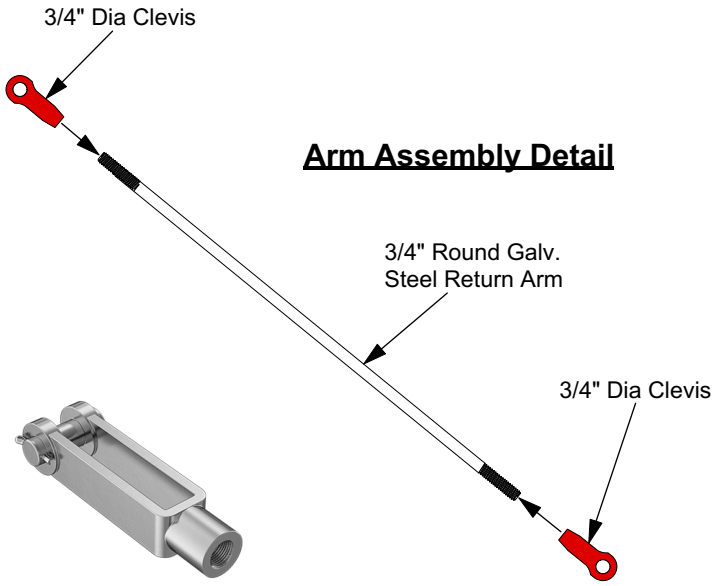
| | | | |
|---|---|---|---|
| Date: | 8/28/20 | Product: | Sheet # |
| Revision #: | R0001 | **Louver Canopy** | **1 of 3** |

# Standard Z Blade Louver Canopy 3D View




## Optional Return Arm Option

(Request Quote if Desired)

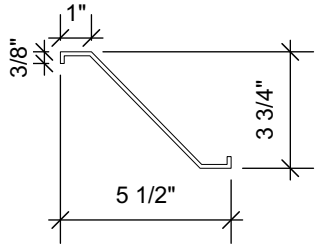



### Arm Assembly Detail

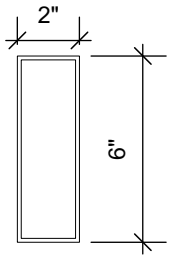


### 3/4" Dia Clevis

### Primary Canopy Profiles




**5 1/2" Z Blade Louver**




**2" x 6" Alumnum Tube**

HW ENGINEERING
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# Basis for Design

**1.1 BUILDING CODE**: 2018 International Building Code

**1.2 GRAVITY DESIGN:**

CANOPY LOADING

| | |
|---|---|
| DEAD LOAD (PSF) | 4psf |
| LIVE LOAD (PSF) | 20psf |
| ROOF SNOW(PSF) | 60psf |

**1.3 LATERAL DESIGN:**

WIND LOADING

| | |
|---|---|
| Basic Wind Speed (3s – Gust) | 160mph |
| Risk Category | II |
| Exposure Category | C |

SEISMIC LOADING

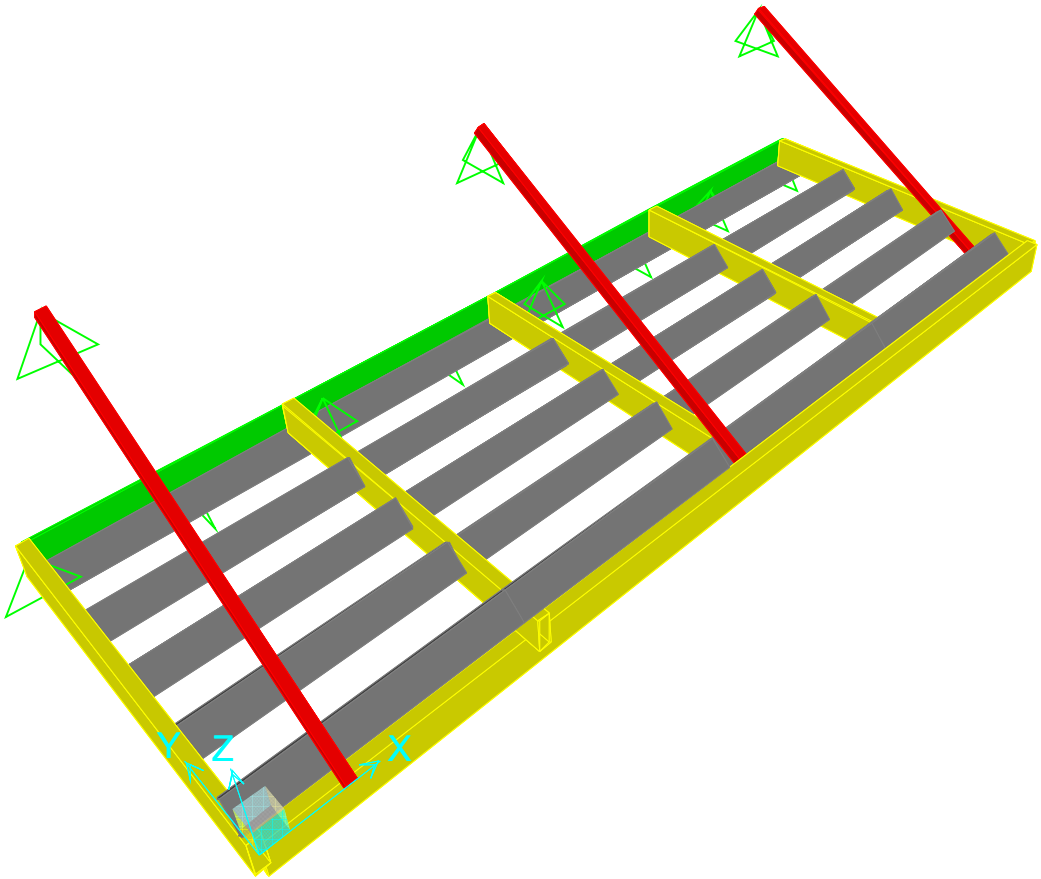
Due to the light weight of framing, seismic loads do not control lateral design.

**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 4psf.

$DL = 4psf$

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

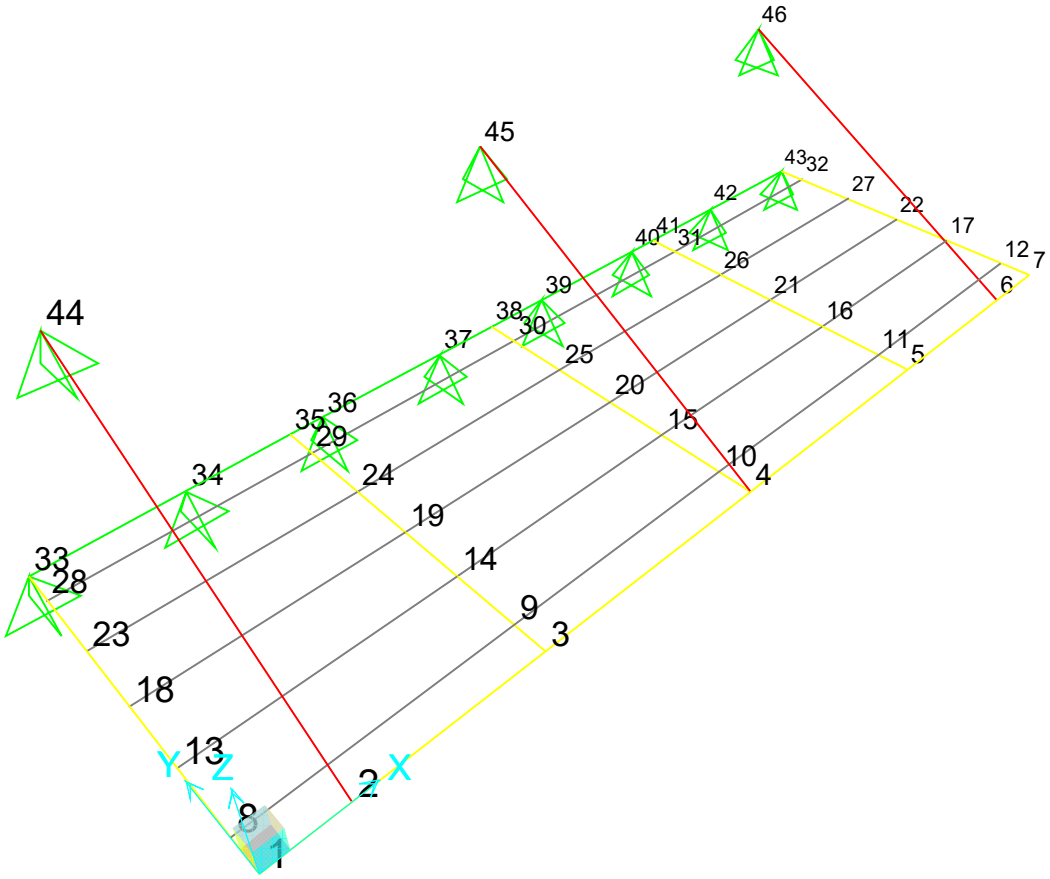
| | |
|---|---|
| $V = 160mph$ | Design wind speed |
| $K_d = 0.85$ | Wind directionality factor, Table 26.6-1 |
| $K_{zt} = 1.0$ | Topographic factor, Section 26.8 |
| $K_e = 1.0$ | Ground elevation factor, Section 26.9 |
| $K_h = 0.85$ | Velocity pressure exposure coefficient, Table 26.10-1, exposure C<br>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 |
| $q_h = 47.35\ psf$ | Velocity Pressure |
| $GC_p = \begin{pmatrix} -1.1 \\ 0.75 \end{pmatrix}$ | Net coefficient, Fig. 30.11-1 |
| $p = q_h\ GC_p = \begin{pmatrix} -52.08 \\ 35.51 \end{pmatrix} psf$ | 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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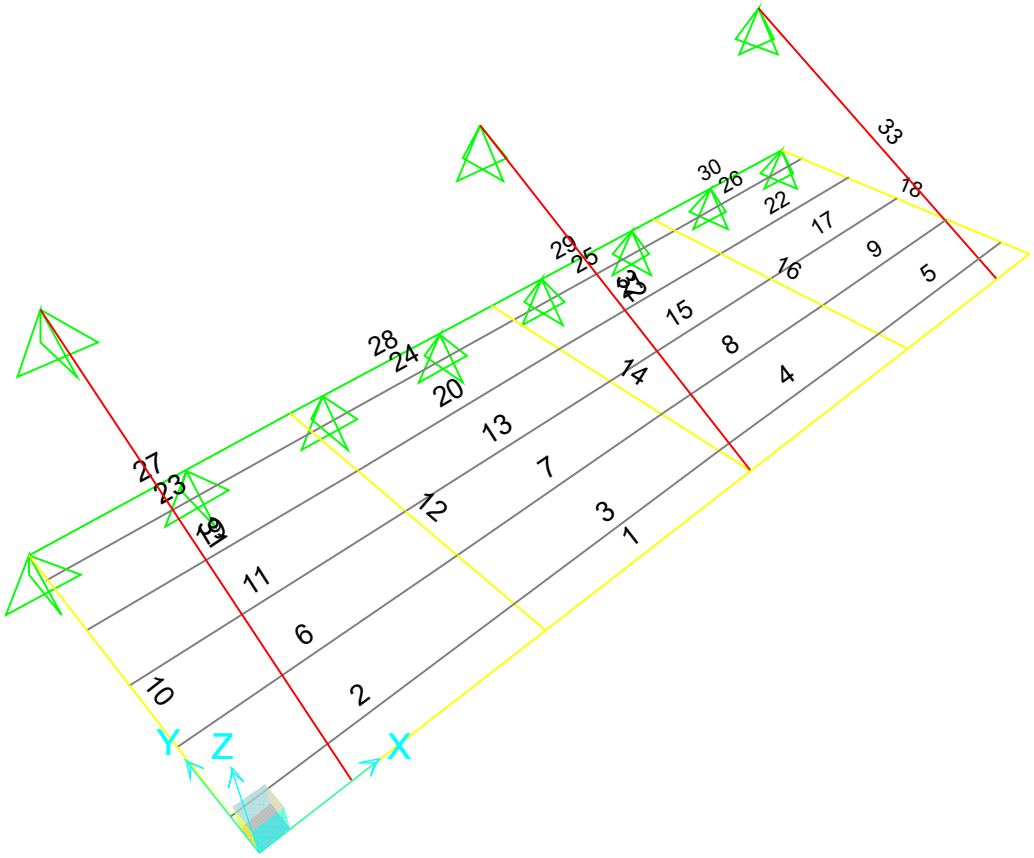
JOINT LABEL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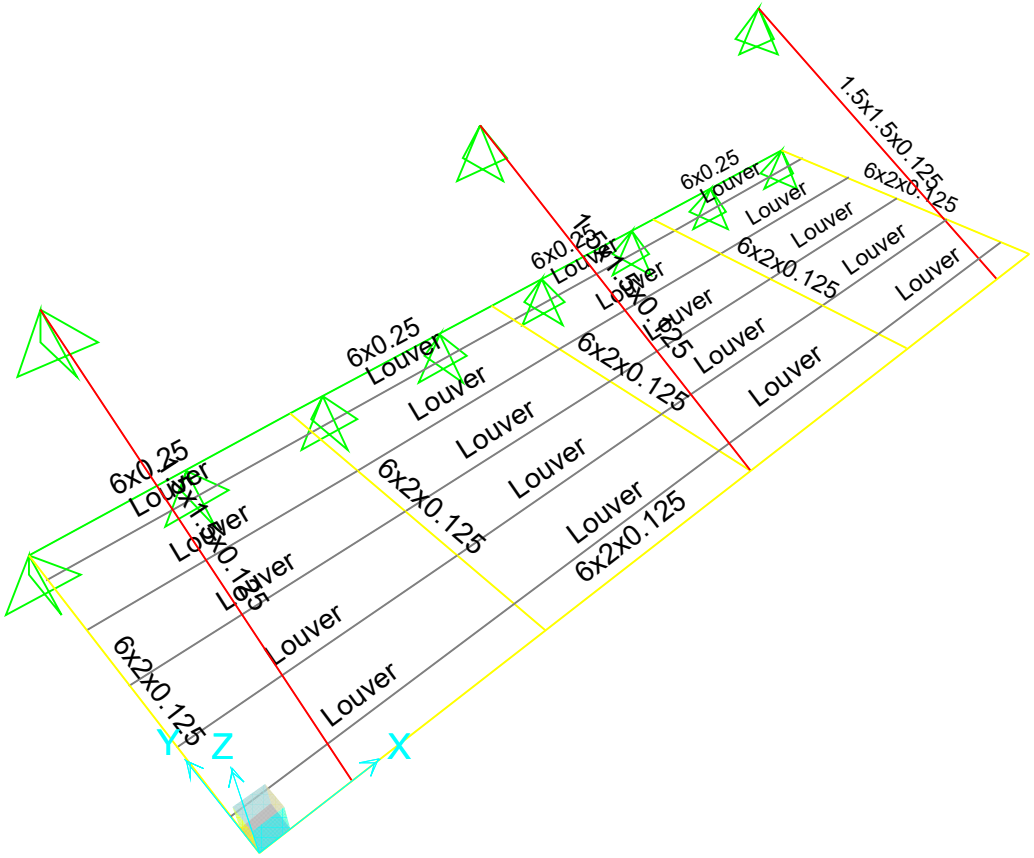
FRAME LABEL




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 |

| 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: 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 |
| 6x0.25 | 6061T6 | Rectangular | 6 | 0.25 | | |
| 6x2x0.125 | 6061T6 | Box/Tube | 6 | 2 | 0.125 | 0.125 |
| Louver | 6061T6 | Channel | 5 | 1 | 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 |
| 6x0.25 | 1.5 | 0.03043 | 4.5 | 0.007813 | 0 | 1.25 | 1.25 |
| 6x2x0.125 | 1.94 | 3.91 | 8.28 | 1.43 | 0 | 1.5 | 0.5 |
| Louver | 0.84 | 0.004241 | 2.6 | 0.05528 | 0 | 0.63 | 0.25 |

| 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 | |
| 6x0.25 | 1.5 | 0.0625 | 2.25 | 0.09375 | 1.7321 | 0.0722 | |
| 6x2x0.125 | 2.76 | 1.43 | 3.54 | 1.6 | 2.0667 | 0.8597 | |
| Louver | 1.04 | 0.06843 | 1.31 | 0.13 | 1.7561 | 0.256 | 0.3794 |

| 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 |
| 6x0.25 | No | No | Green | 0.025 | 6.401E-05 | No | 1 |
| 6x2x0.125 | No | No | Yellow | 0.066 | 0.0001713 | No | 1 |
| Louver | No | No | Gray8Dark | 0.069 | 0.00018 | No | 1 |

| SectionName | A2Mod | A3Mod | JMod | I2Mod | I3Mod | MMod | WMod |
|---|---|---|---|---|---|---|---|
| 1.5x1.5x0.125 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6x0.25 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| 6x2x0.125 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Louver | 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 |
| 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 |

| ComboName | ComboType | AutoDesign | CaseType | CaseName | ScaleFactor | AlumDesign |
|---|---|---|---|---|---|---|
| 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 |
| 1 | W16 | GLOBAL | Force | Y Proj | RelDist | 0 | 1 | 8 | 8 |
| 10 | W16 | GLOBAL | Force | X Proj | RelDist | 0 | 1 | 8 | 8 |
| 12 | W16 | GLOBAL | Force | X Proj | RelDist | 0 | 1 | 8 | 8 |
| 2 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 2 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 2 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 2 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 6 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 6 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 6 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 6 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 11 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 11 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 11 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 11 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 19 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 19 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 19 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 19 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 23 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 23 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 23 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 23 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 3 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 3 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 3 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 3 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 7 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 7 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 7 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 7 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 13 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 13 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 13 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 13 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 20 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 20 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 20 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 20 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 24 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 24 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 24 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 24 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 4 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 4 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |

| Frame | LoadPat | CoordSys | Type | Dir | DistType | RelDistA | RelDistB | FOverLA | FOverLB |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Lb/ft | Lb/ft |
| 4 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 4 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 8 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 8 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 8 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 8 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 15 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 15 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 15 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 15 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 21 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 21 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 21 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 21 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 25 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 25 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 25 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 25 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 5 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 5 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 5 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 5 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 9 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 9 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 9 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 9 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 17 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 17 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 17 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 17 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 22 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 22 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 22 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 22 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |
| 26 | DEAD | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 0.92 | 0.92 |
| 26 | SN | GLOBAL | Force | Gravity | RelDist | 0 | 1 | 27.5 | 27.5 |
| 26 | Wdown | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | -16.28 | -16.28 |
| 26 | Wup | GLOBAL | Force | Z Proj | RelDist | 0 | 1 | 23.87 | 23.87 |

## 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 | |
| 31 | 1.5x1.5x0.125 | Brace | No Messages | 0.6DL+0.6Wup | 34.986 | 1 |
| 32 | 1.5x1.5x0.125 | Brace | No Messages | 0.6DL+0.6Wup | 34.986 | 1 |
| 33 | 1.5x1.5x0.125 | Brace | No Messages | 0.6DL+0.6Wup | 34.986 | 1 |
| 1 | 6x2x0.125 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 168 | 1 |
| 10 | 6x2x0.125 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 14 | 6x2x0.125 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 30 | 1 |
| 18 | 6x2x0.125 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 12 | 6x2x0.125 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 6 | 1 |
| 16 | 6x2x0.125 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 6 | 1 |
| 2 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 27 | 6x0.25 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 28 | 6x0.25 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 29 | 6x0.25 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 30 | 6x0.25 | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 6 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 11 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 19 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 23 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 3 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 7 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 13 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 20 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 24 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 4 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 8 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 15 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 21 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 25 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 0 | 1 |
| 5 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 9 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 17 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 22 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |
| 26 | Louver | Beam | No Messages | DL+0.75(SN+0.6Wdown) | 42 | 1 |

| Frame | CombinedEq | TotalRatio | PRatio | MMajRatio | MMinRatio | VMajRatio | VMinRatio |
|---|---|---|---|---|---|---|---|
| 31 | (H.1-1) | 0.130694 | 0.127488 | 0.003206 | 0 | 0 | 2.392E-20 |
| 32 | (H.1-1) | 0.105104 | 0.101898 | 0.003206 | 0 | 6.327E-20 | 0 |
| 33 | (H.1-1) | 0.130694 | 0.127488 | 0.003206 | 0 | 6.327E-20 | 1.004E-20 |
| 1 | (H.1-1) | 0.258266 | 0.019772 | 0.021717 | 0.216778 | 0.00544 | 0.108985 |
| 10 | (H.1-1) | 0.243783 | 0.020432 | 0.006573 | 0.216778 | 0.00544 | 0.098771 |
| 14 | (H.1-1) | 0.093414 | 0.008168 | 0.085246 | 0 | 0.003683 | 9.54E-16 |
| 18 | (H.1-1) | 0.243783 | 0.020432 | 0.006573 | 0.216778 | 0.00544 | 0.098771 |
| 12 | (H.1-1) | 0.106254 | 0.005817 | 0.026042 | 0.074395 | 0.009098 | 0.033562 |
| 16 | (H.1-1) | 0.106254 | 0.005817 | 0.026042 | 0.074395 | 0.009098 | 0.033562 |
| 2 | (H.1-1) | 0.328782 | 0.017473 | 0.116179 | 0.19513 | 0.000304 | 0.016092 |
| 27 | (H.1-1) | 0.307307 | 0.093099 | 0.167076 | 0.047132 | 0.007661 | 0.000414 |
| 28 | (H.1-1) | 0.373163 | 0.002173 | 0.042123 | 0.328866 | 0.010758 | 0.006692 |

| Frame | CombinedEq | TotalRatio | PRatio | MMajRatio | MMinRatio | VMajRatio | VMinRatio |
|---|---|---|---|---|---|---|---|
| 29 | (H.1-1) | 0.373163 | 0.002173 | 0.042123 | 0.328866 | 0.010758 | 0.006692 |
| 30 | (H.1-1) | 0.307307 | 0.093099 | 0.167076 | 0.047132 | 0.007661 | 0.000414 |
| 6 | (H.1-1) | 0.384024 | 0.010181 | 0.144411 | 0.229432 | 9.2E-05 | 0.017252 |
| 11 | (H.1-1) | 0.342938 | 0.000887 | 0.110432 | 0.23162 | 0.001578 | 0.017324 |
| 19 | (H.1-1) | 0.364628 | 0.017956 | 0.122083 | 0.22459 | 8.928E-06 | 0.017059 |
| 23 | (H.1-1) | 0.482979 | 0.019949 | 0.25702 | 0.20601 | 0.006438 | 0.016366 |
| 3 | (H.1-1) | 0.361489 | 0.016728 | 0.180403 | 0.164358 | 0.001649 | 0.01517 |
| 7 | (H.1-1) | 0.292586 | 0.01649 | 0.087992 | 0.188104 | 0.000584 | 0.015746 |
| 13 | (H.1-1) | 0.226381 | 0.002137 | 0.031146 | 0.193099 | 0.001449 | 0.01582 |
| 20 | (H.1-1) | 0.307509 | 0.044263 | 0.185649 | 0.077597 | 0.009378 | 0.011755 |
| 24 | (H.1-1) | 0.379998 | 0.011198 | 0.280758 | 0.088042 | 0.012693 | 0.01213 |
| 4 | (H.1-1) | 0.361489 | 0.016728 | 0.180403 | 0.164358 | 0.001649 | 0.01517 |
| 8 | (H.1-1) | 0.292586 | 0.01649 | 0.087992 | 0.188104 | 0.000584 | 0.015746 |
| 15 | (H.1-1) | 0.226381 | 0.002137 | 0.031146 | 0.193099 | 0.001449 | 0.01582 |
| 21 | (H.1-1) | 0.307509 | 0.044263 | 0.185649 | 0.077597 | 0.009378 | 0.011755 |
| 25 | (H.1-1) | 0.379998 | 0.011198 | 0.280758 | 0.088042 | 0.012693 | 0.01213 |
| 5 | (H.1-1) | 0.328782 | 0.017473 | 0.116179 | 0.19513 | 0.000304 | 0.016092 |
| 9 | (H.1-1) | 0.384024 | 0.010181 | 0.144411 | 0.229432 | 9.2E-05 | 0.017252 |
| 17 | (H.1-1) | 0.342938 | 0.000887 | 0.110432 | 0.23162 | 0.001578 | 0.017324 |
| 22 | (H.1-1) | 0.364628 | 0.017956 | 0.122083 | 0.22459 | 8.928E-06 | 0.017059 |
| 26 | (H.1-1) | 0.482979 | 0.019949 | 0.25702 | 0.20601 | 0.006438 | 0.016366 |

| Frame | P | MMajor | MMinor | VMajor | VMinor | T | Pnt |
|---|---|---|---|---|---|---|---|
| | Kip | Kip-in | Kip-in | Kip | Kip | Kip-in | Kip |
| 31 | -0.292 | 0.021 | 3.218E-18 | -1.685E-20 | -9.199E-20 | 0 | 13.397 |
| 32 | -0.233 | 0.021 | 0 | 2.434E-19 | 0 | 0 | 13.397 |
| 33 | -0.292 | 0.021 | -1.351E-18 | 2.434E-19 | 3.862E-20 | 0 | 13.397 |
| 1 | -0.532 | -1.448 | -4.727 | -0.094 | 0.587 | 0 | 37.756 |
| 10 | -0.587 | -0.453 | 4.727 | -0.094 | 0.532 | 0 | 37.756 |
| 14 | -0.235 | 5.873 | -3.232E-14 | -0.064 | 5.137E-15 | 0 | 37.756 |
| 18 | -0.587 | -0.453 | -4.727 | -0.094 | -0.532 | 0 | 37.756 |
| 12 | -0.167 | 1.794 | 1.622 | -0.158 | 0.181 | 0 | 37.756 |
| 16 | -0.167 | 1.794 | -1.622 | -0.158 | -0.181 | 0 | 37.756 |
| 2 | 0.287 | 0.755 | -0.383 | -0.00222 | -0.043 | 0 | 16.442 |
| 27 | -0.021 | 1.767 | 0.086 | -0.119 | -0.007638 | 0 | 29.231 |
| 28 | 0.064 | 0.418 | 0.601 | 0.167 | 0.124 | 0 | 29.231 |
| 29 | 0.064 | 0.418 | 0.601 | -0.167 | -0.124 | 0 | 29.231 |
| 30 | -0.021 | 1.767 | 0.086 | 0.119 | 0.007638 | 0 | 29.231 |
| 6 | 0.167 | 0.952 | -0.45 | -0.0006731 | -0.046 | 0 | 16.442 |
| 11 | 0.015 | 0.646 | -0.455 | -0.012 | -0.047 | 0 | 16.442 |
| 19 | -0.029 | 0.805 | -0.441 | -6.524E-05 | -0.046 | 0 | 16.442 |
| 23 | -0.032 | 1.694 | -0.404 | 0.047 | -0.044 | 0 | 16.442 |
| 3 | 0.275 | 1.189 | -0.323 | 0.012 | -0.041 | 0 | 16.442 |
| 7 | 0.271 | 0.58 | -0.369 | -0.004265 | -0.042 | 0 | 16.442 |
| 13 | 0.035 | 0.205 | -0.379 | -0.011 | -0.043 | 0 | 16.442 |
| 20 | -0.071 | -1.224 | -0.152 | 0.069 | 0.032 | 0 | 16.442 |
| 24 | -0.018 | -1.851 | -0.173 | 0.093 | 0.033 | 0 | 16.442 |
| 4 | 0.275 | 1.189 | -0.323 | -0.012 | 0.041 | 0 | 16.442 |
| 8 | 0.271 | 0.58 | -0.369 | 0.004265 | 0.042 | 0 | 16.442 |
| 15 | 0.035 | 0.205 | -0.379 | 0.011 | 0.043 | 0 | 16.442 |
| 21 | -0.071 | -1.224 | -0.152 | -0.069 | -0.032 | 0 | 16.442 |

| Frame | P | MMajor | MMinor | VMajor | VMinor | T | Pnt |
|---|---|---|---|---|---|---|---|
| | Kip | Kip-in | Kip-in | Kip | Kip | Kip-in | Kip |
| 25 | -0.018 | -1.851 | -0.173 | -0.093 | -0.033 | 0 | 16.442 |
| 5 | 0.287 | 0.755 | -0.383 | 0.00222 | 0.043 | 0 | 16.442 |
| 9 | 0.167 | 0.952 | -0.45 | 0.0006731 | 0.046 | 0 | 16.442 |
| 17 | 0.015 | 0.646 | -0.455 | 0.012 | 0.047 | 0 | 16.442 |
| 22 | -0.029 | 0.805 | -0.441 | 6.524E-05 | 0.046 | 0 | 16.442 |
| 26 | -0.032 | 1.694 | -0.404 | -0.047 | 0.044 | 0 | 16.442 |

| Frame | Pnc | MnMajor | MnMinor | VnMajor | VnMinor | ErrMsg |
|---|---|---|---|---|---|---|
| | Kip | Kip-in | Kip-in | Kip | Kip | |
| 31 | 2.291 | 6.616 | 6.927 | 3.846 | 3.846 | No Messages |
| 32 | 2.291 | 6.616 | 6.927 | 3.846 | 3.846 | No Messages |
| 33 | 2.291 | 6.616 | 6.927 | 3.846 | 3.846 | No Messages |
| 1 | 26.9 | 66.686 | 21.808 | 17.369 | 5.385 | No Messages |
| 10 | 28.721 | 68.89 | 21.808 | 17.369 | 5.385 | No Messages |
| 14 | 28.721 | 68.89 | 21.808 | 17.369 | 5.385 | No Messages |
| 18 | 28.721 | 68.89 | 21.808 | 17.369 | 5.385 | No Messages |
| 12 | 28.721 | 68.89 | 21.808 | 17.369 | 5.385 | No Messages |
| 16 | 28.721 | 68.89 | 21.808 | 17.369 | 5.385 | No Messages |
| 2 | 1.609 | 6.502 | 1.963 | 7.308 | 2.692 | No Messages |
| 27 | 0.227 | 10.578 | 1.827 | 15.505 | 18.462 | No Messages |
| 28 | 0.227 | 9.933 | 1.827 | 15.505 | 18.462 | No Messages |
| 29 | 0.227 | 9.933 | 1.827 | 15.505 | 18.462 | No Messages |
| 30 | 0.227 | 10.578 | 1.827 | 15.505 | 18.462 | No Messages |
| 6 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 11 | 1.609 | 5.847 | 1.963 | 7.308 | 2.692 | No Messages |
| 19 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 23 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 3 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 7 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 13 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 20 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 24 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 4 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 8 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 15 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 21 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 25 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 5 | 1.609 | 6.502 | 1.963 | 7.308 | 2.692 | No Messages |
| 9 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 17 | 1.609 | 5.847 | 1.963 | 7.308 | 2.692 | No Messages |
| 22 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |
| 26 | 1.609 | 6.592 | 1.963 | 7.308 | 2.692 | No Messages |

| Frame | WarnMsg |
|---|---|
| 31 | No Messages |
| 32 | No Messages |
| 33 | No Messages |
| 1 | No Messages |
| 10 | No Messages |
| 14 | No Messages |
| 18 | No Messages |

| Frame | WarnMsg |
|---|---|
| 12 | No Messages |
| 16 | No Messages |
| 2 | No Messages |
| 27 | No Messages |
| 28 | No Messages |
| 29 | No Messages |
| 30 | No Messages |
| 6 | No Messages |
| 11 | No Messages |
| 19 | No Messages |
| 23 | No Messages |
| 3 | No Messages |
| 7 | No Messages |
| 13 | No Messages |
| 20 | No Messages |
| 24 | No Messages |
| 4 | No Messages |
| 8 | No Messages |
| 15 | No Messages |
| 21 | No Messages |
| 25 | No Messages |
| 5 | No Messages |
| 9 | No Messages |
| 17 | No Messages |
| 22 | No Messages |
| 26 | No Messages |

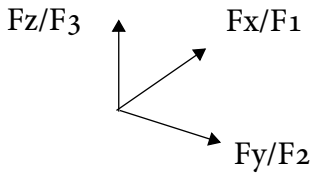
## Table: Joint Reactions

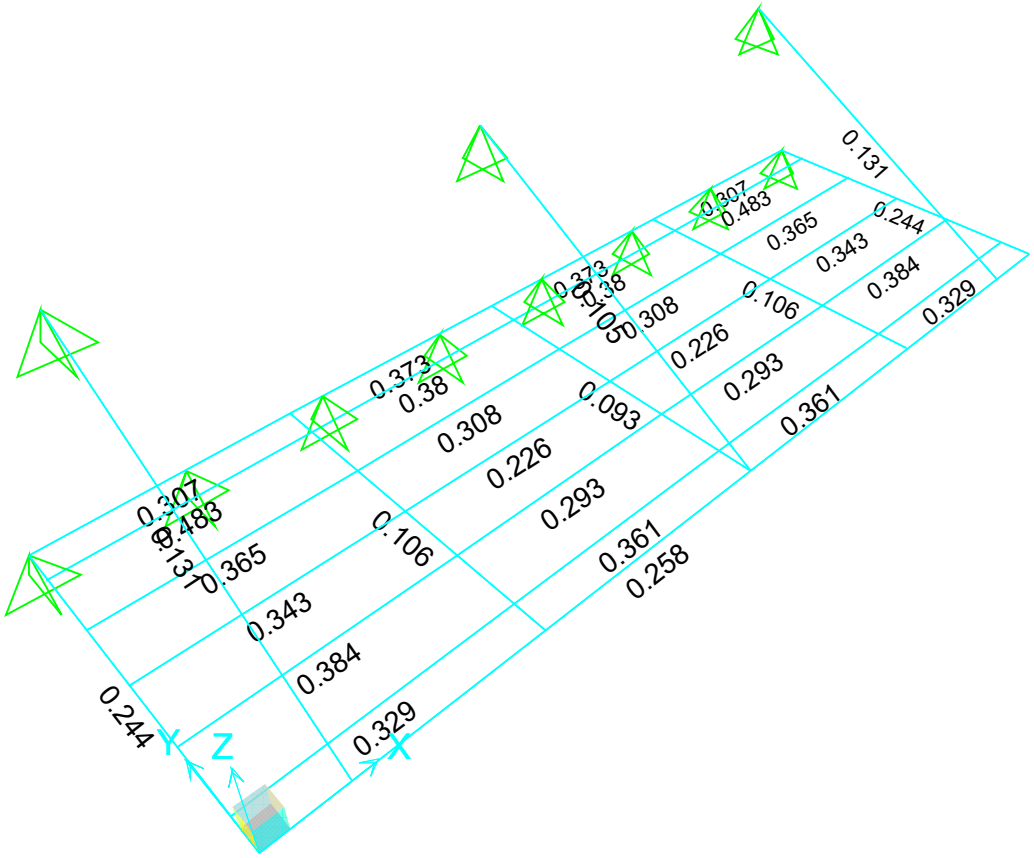
| Joint | OutputCase | CaseType | F1 | F2 | F3 |
|---|---|---|---|---|---|
| | | | Lb | Lb | Lb |
| 33 | DL+SN | Combination | 121.8 | -755.9 | 58.3 |
| 33 | DL+0.6Wup | Combination | -42.3 | 251.8 | -17.6 |
| 33 | DL+0.6Wdown | Combination | 52.2 | -328.6 | 26.1 |
| 33 | 0.6DL+0.6Wup | Combination | -47.9 | 289.1 | -21.0 |
| 33 | 0.6DL+0.6Wdown | Combination | 46.7 | -291.3 | 22.7 |
| 33 | DL+0.75(SN+0.6Wup) | Combination | 52.7 | -331.4 | 26.3 |
| 33 | DL+0.75(SN+0.6Wdown) | Combination | 123.6 | -766.7 | 59.1 |
| 33 | DL+0.6W16 | Combination | 11.2 | -111.1 | 6.5 |
| 33 | 0.6DL+0.6W16 | Combination | 5.6 | -73.8 | 3.2 |
| 33 | DL+0.75(SN+0.6W16) | Combination | 92.8 | -603.6 | 44.4 |
| 34 | DL+SN | Combination | 20.9 | -10.7 | 118.2 |
| 34 | DL+0.6Wup | Combination | -7.2 | 3.7 | -41.3 |
| 34 | DL+0.6Wdown | Combination | 9.0 | -4.6 | 50.6 |
| 34 | 0.6DL+0.6Wup | Combination | -8.2 | 4.2 | -46.6 |
| 34 | 0.6DL+0.6Wdown | Combination | 8.0 | -4.1 | 45.2 |
| 34 | DL+0.75(SN+0.6Wup) | Combination | 9.1 | -4.7 | 51.0 |
| 34 | DL+0.75(SN+0.6Wdown) | Combination | 21.2 | -10.9 | 119.9 |
| 34 | DL+0.6W16 | Combination | -0.2 | -1.7 | 12.6 |
| 34 | 0.6DL+0.6W16 | Combination | -1.2 | -1.2 | 7.2 |
| 34 | DL+0.75(SN+0.6W16) | Combination | 14.3 | -8.7 | 91.4 |
| 36 | DL+SN | Combination | 62.6 | -124.9 | 166.3 |

| Joint | OutputCase | CaseType | F1 | F2 | F3 |
|---|---|---|---|---|---|
| | | | Lb | Lb | Lb |
| 36 | DL+0.6Wup | Combination | -21.6 | 42.5 | -60.9 |
| 36 | DL+0.6Wdown | Combination | 26.9 | -53.9 | 70.0 |
| 36 | 0.6DL+0.6Wup | Combination | -24.5 | 48.4 | -67.7 |
| 36 | 0.6DL+0.6Wdown | Combination | 24.0 | -48.0 | 63.2 |
| 36 | DL+0.75(SN+0.6Wup) | Combination | 27.2 | -54.4 | 70.6 |
| 36 | DL+0.75(SN+0.6Wdown) | Combination | 63.5 | -126.7 | 168.8 |
| 36 | DL+0.6W16 | Combination | -0.6 | -21.6 | 22.2 |
| 36 | 0.6DL+0.6W16 | Combination | -3.5 | -15.6 | 15.4 |
| 36 | DL+0.75(SN+0.6W16) | Combination | 42.9 | -102.4 | 132.9 |
| 37 | DL+SN | Combination | 0.0 | -22.7 | 198.6 |
| 37 | DL+0.6Wup | Combination | 0.0 | 7.8 | -70.8 |
| 37 | DL+0.6Wdown | Combination | 0.0 | -9.7 | 84.4 |
| 37 | 0.6DL+0.6Wup | Combination | 0.0 | 8.9 | -79.4 |
| 37 | 0.6DL+0.6Wdown | Combination | 0.0 | -8.7 | 75.8 |
| 37 | DL+0.75(SN+0.6Wup) | Combination | 0.0 | -9.8 | 85.2 |
| 37 | DL+0.75(SN+0.6Wdown) | Combination | 0.0 | -23.0 | 201.5 |
| 37 | DL+0.6W16 | Combination | -5.5 | -2.9 | 16.5 |
| 37 | 0.6DL+0.6W16 | Combination | -5.5 | -1.9 | 7.9 |
| 37 | DL+0.75(SN+0.6W16) | Combination | -4.1 | -17.9 | 150.6 |
| 39 | DL+SN | Combination | 0.0 | -22.7 | 198.6 |
| 39 | DL+0.6Wup | Combination | 0.0 | 7.8 | -70.8 |
| 39 | DL+0.6Wdown | Combination | 0.0 | -9.7 | 84.4 |
| 39 | 0.6DL+0.6Wup | Combination | 0.0 | 8.9 | -79.4 |
| 39 | 0.6DL+0.6Wdown | Combination | 0.0 | -8.7 | 75.8 |
| 39 | DL+0.75(SN+0.6Wup) | Combination | 0.0 | -9.8 | 85.2 |
| 39 | DL+0.75(SN+0.6Wdown) | Combination | 0.0 | -23.0 | 201.5 |
| 39 | DL+0.6W16 | Combination | -5.5 | -3.5 | 25.2 |
| 39 | 0.6DL+0.6W16 | Combination | -5.5 | -2.5 | 16.6 |
| 39 | DL+0.75(SN+0.6W16) | Combination | -4.1 | -18.3 | 157.1 |
| 40 | DL+SN | Combination | -62.6 | -124.9 | 166.3 |
| 40 | DL+0.6Wup | Combination | 21.6 | 42.5 | -60.9 |
| 40 | DL+0.6Wdown | Combination | -26.9 | -53.9 | 70.0 |
| 40 | 0.6DL+0.6Wup | Combination | 24.5 | 48.4 | -67.7 |
| 40 | 0.6DL+0.6Wdown | Combination | -24.0 | -48.0 | 63.2 |
| 40 | DL+0.75(SN+0.6Wup) | Combination | -27.2 | -54.4 | 70.6 |
| 40 | DL+0.75(SN+0.6Wdown) | Combination | -63.5 | -126.7 | 168.8 |
| 40 | DL+0.6W16 | Combination | -17.0 | -19.7 | 16.5 |
| 40 | 0.6DL+0.6W16 | Combination | -14.1 | -13.7 | 9.8 |
| 40 | DL+0.75(SN+0.6W16) | Combination | -56.1 | -101.0 | 128.7 |
| 42 | DL+SN | Combination | -20.9 | -10.7 | 118.2 |
| 42 | DL+0.6Wup | Combination | 7.2 | 3.7 | -41.3 |
| 42 | DL+0.6Wdown | Combination | -9.0 | -4.6 | 50.6 |
| 42 | 0.6DL+0.6Wup | Combination | 8.2 | 4.2 | -46.6 |
| 42 | 0.6DL+0.6Wdown | Combination | -8.0 | -4.1 | 45.2 |
| 42 | DL+0.75(SN+0.6Wup) | Combination | -9.1 | -4.7 | 51.0 |
| 42 | DL+0.75(SN+0.6Wdown) | Combination | -21.2 | -10.9 | 119.9 |
| 42 | DL+0.6W16 | Combination | -5.7 | -1.8 | 14.0 |
| 42 | 0.6DL+0.6W16 | Combination | -4.7 | -1.3 | 8.7 |
| 42 | DL+0.75(SN+0.6W16) | Combination | -18.7 | -8.7 | 92.5 |
| 43 | DL+SN | Combination | -121.8 | -755.9 | 58.3 |
| 43 | DL+0.6Wup | Combination | 42.3 | 251.8 | -17.6 |
| 43 | DL+0.6Wdown | Combination | -52.2 | -328.6 | 26.1 |

| Joint | OutputCase | CaseType | F1 | F2 | F3 |
|---|---|---|---|---|---|
| | | | Lb | Lb | Lb |
| 43 | 0.6DL+0.6Wup | Combination | 47.9 | 289.1 | -21.0 |
| 43 | 0.6DL+0.6Wdown | Combination | -46.7 | -291.3 | 22.7 |
| 43 | DL+0.75(SN+0.6Wup) | Combination | -52.7 | -331.4 | 26.3 |
| 43 | DL+0.75(SN+0.6Wdown) | Combination | -123.6 | -766.7 | 59.1 |
| 43 | DL+0.6W16 | Combination | -24.8 | -128.9 | 6.7 |
| 43 | 0.6DL+0.6W16 | Combination | -19.3 | -91.6 | 3.3 |
| 43 | DL+0.75(SN+0.6W16) | Combination | -103.0 | -616.9 | 44.5 |
| 44 | DL+SN | Combination | 0.0 | 660.7 | 398.7 |
| 44 | DL+0.6Wup | Combination | 0.0 | -217.0 | -127.9 |
| 44 | DL+0.6Wdown | Combination | 0.0 | 288.5 | 175.5 |
| 44 | 0.6DL+0.6Wup | Combination | 0.0 | -250.5 | -148.9 |
| 44 | 0.6DL+0.6Wdown | Combination | 0.0 | 255.1 | 154.5 |
| 44 | DL+0.75(SN+0.6Wup) | Combination | 0.0 | 290.9 | 176.9 |
| 44 | DL+0.75(SN+0.6Wdown) | Combination | 0.0 | 670.1 | 404.4 |
| 44 | DL+0.6W16 | Combination | 0.0 | 90.5 | 56.6 |
| 44 | 0.6DL+0.6W16 | Combination | 0.0 | 57.0 | 35.6 |
| 44 | DL+0.75(SN+0.6W16) | Combination | 0.0 | 521.6 | 315.3 |
| 45 | DL+SN | Combination | 0.0 | 506.8 | 306.5 |
| 45 | DL+0.6Wup | Combination | 0.0 | -177.4 | -104.1 |
| 45 | DL+0.6Wdown | Combination | 0.0 | 216.7 | 132.4 |
| 45 | 0.6DL+0.6Wup | Combination | 0.0 | -200.2 | -118.7 |
| 45 | 0.6DL+0.6Wdown | Combination | 0.0 | 194.0 | 117.8 |
| 45 | DL+0.75(SN+0.6Wup) | Combination | 0.0 | 218.6 | 133.5 |
| 45 | DL+0.75(SN+0.6Wdown) | Combination | 0.0 | 514.2 | 310.9 |
| 45 | DL+0.6W16 | Combination | 0.0 | 43.1 | 28.2 |
| 45 | 0.6DL+0.6W16 | Combination | 0.0 | 20.3 | 13.6 |
| 45 | DL+0.75(SN+0.6W16) | Combination | 0.0 | 384.0 | 232.7 |
| 46 | DL+SN | Combination | 0.0 | 660.7 | 398.7 |
| 46 | DL+0.6Wup | Combination | 0.0 | -217.0 | -127.9 |
| 46 | DL+0.6Wdown | Combination | 0.0 | 288.5 | 175.5 |
| 46 | 0.6DL+0.6Wup | Combination | 0.0 | -250.5 | -148.9 |
| 46 | 0.6DL+0.6Wdown | Combination | 0.0 | 255.1 | 154.5 |
| 46 | DL+0.75(SN+0.6Wup) | Combination | 0.0 | 290.9 | 176.9 |
| 46 | DL+0.75(SN+0.6Wdown) | Combination | 0.0 | 670.1 | 404.4 |
| 46 | DL+0.6W16 | Combination | 0.0 | 90.5 | 56.6 |
| 46 | 0.6DL+0.6W16 | Combination | 0.0 | 57.0 | 35.6 |
| 46 | DL+0.75(SN+0.6W16) | Combination | 0.0 | 521.6 | 315.3 |

## Reaction Direction






P-M RATIO

0.00 0.50 0.70 0.90 1.00

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# Connection Check

***Typical upper attachment check***

maximum reaction from analysis, worst case considered below

$F_x := 0lbf$ $F_y := 670.11lbf$ $F_z := 404.42lbf$

maximum shear and tension

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

$V_{REC} = 404 \cdot lbf$ $T_{REC} = 670 \cdot lbf$ 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 $S := 34in$

$V_{max} := V_{REC} \cdot \frac{D}{d}$ $T_{max} := T_{REC} \cdot \frac{D}{d} \frac{s}{S}$ $V_{max} = 404 \cdot lbf$ $T_{max} = 710 \cdot lbf$

**Tab plate check**

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

$w := 3 \cdot in$ $t := \frac{3}{8} \cdot in$ $d_{hole} := \frac{7}{16} \cdot in$ $d := \frac{3}{8} \cdot in$ $LC := 1.375 \cdot in$ $a := LC - \frac{d_{hole}}{2}$ $a = 1.156 \cdot in$

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

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

$A_{sf} := 2 \cdot t \cdot \left(a + \frac{d}{2}\right)$ $A_{sf} = 1.008 \cdot in^2$

$V_n := 0.6 \cdot F_u \cdot A_{sf}$ $V_n = 35.072 \cdot kip$ $\Omega_{sf} := 2.0$

$V_a := \frac{V_n}{\Omega_{sf}}$ $V_a = 17.536 \cdot kip$

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

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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 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!"

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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

$P_{max} := \sqrt{T_{max}^2 + V_{max}^2}$ $P_{max} = 817 \cdot lbf$ 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 $C_M := 1.0$ $C_\Delta := 1.0$ $C_t := 1.0$ $C_g := 1.0$ $\theta := \operatorname{atan}\left(\frac{T_{max}}{V_{max}}\right)$

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

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

$Z := \frac{Z1 \cdot Z2}{Z1 \cdot \cos(\theta)^2 + Z2 \cdot \sin(\theta)^2}$ $Z = 315.6 \cdot lbf$

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

$Z_\theta := \frac{n\, W1 \cdot Z}{W1 \cdot \cos(\theta)^2 + Z \cdot \sin(\theta)^2}$ $Z_\theta = 2749 \cdot lbf$

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

check = "Lag screw is Ok"

Use (4) 3/8" dia. x 2-3/4" nominal embed. SS SIMPSON TITEN HD or equivalent screws for wall plate to **masonry wall** (by others)

$S_{crit} := 8in$ $S_{min} := 4in$ $S := 4in$ $fac_{t.min} := 0.81$ $fac_{v.min} := 1$ $n := 4$

$fac_t := \frac{1 - fac_{t.min}}{S_{crit} - S_{min}} \cdot \left(S - S_{min}\right) + fac_{t.min}$ 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

$T_a := \min\left(425lbf \cdot fac_t, 425lbf\right)$ $V_a := \min\left(570lbf \cdot fac_v, 570lbf\right)$ According to ESR-1056

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$$Ratio := \left(\frac{T_{max}}{n \cdot T_a}\right) + \left(\frac{V_{max}}{n \cdot V_a}\right) \qquad Ratio = 0.693$$

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

$check\_anchor = "Anchor is sufficient!"$

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

***Typical lower attachment check***

maximum reaction from analysis, worst case considered below

$F_x := 123.56lbf \qquad F_y := 766.72lbf \qquad F_z := 201.51lbf$

maximum shear and tension

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

$V_{REC} = 236 \cdot lbf \qquad T_{REC} = 767 \cdot lbf$ 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 $S := 34in$

$V_{max} := V_{REC} \cdot \frac{D}{d} \qquad T_{max} := T_{REC} \cdot \frac{D}{d} \frac{s}{S} \qquad V_{max} = 236 \cdot lbf \quad T_{max} = 812 \cdot lbf$

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

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

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

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

Use (1) 3/8" dia. x4" lag screws or equivalent screws to **wood beam or wood blocking** (by others)

$n := 1$

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

$P_{max} := \sqrt{T_{max}^2 + V_{max}^2} \qquad P_{max} = 846 \cdot lbf$ maximum force to screws

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

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

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

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

$$Z := \frac{Z1 \cdot Z2}{Z1 \cdot \cos(\theta)^2 + Z2 \cdot \sin(\theta)^2} \qquad Z = 296.3 \cdot lbf$$

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

$$Z_\theta := \frac{n\,W1 \cdot Z}{W1 \cdot \cos(\theta)^2 + Z \cdot \sin(\theta)^2} \qquad Z_\theta = 916 \cdot lbf$$

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

check = "Lag screw is Ok"

Use (2) 1/2" dia. x 3-1/2" nominal embed. SS SIMPSON TITEN HD or equivalent screws for to **masonry wall** (by others)

$S_{crit} := 8in$ $S_{min} := 4in$ $S := 4in$ $fac_{t.min} := 0.79$ $fac_{v.min} := 0.86$

$$fac_t := \frac{1 - fac_{t.min}}{S_{crit} - S_{min}} \cdot \left(S - S_{min}\right) + fac_{t.min}$$ 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

$T_a := \min\left(665lbf \cdot fac_t, 665lbf\right)$ $V_a := \min\left(990lbf \cdot fac_v, 990lbf\right)$ According to ESR-1056

$n := 2$

$$Ratio := \left(\frac{T_{max}}{n \cdot T_a}\right) + \left(\frac{V_{max}}{n \cdot V_a}\right) \qquad Ratio = 0.911$$

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

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®

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Version 2.8.7094.15

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|---|---|---|---|
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| Engineer: | YW | Page: | 1/5 |
| Project: | KE USA Louver 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

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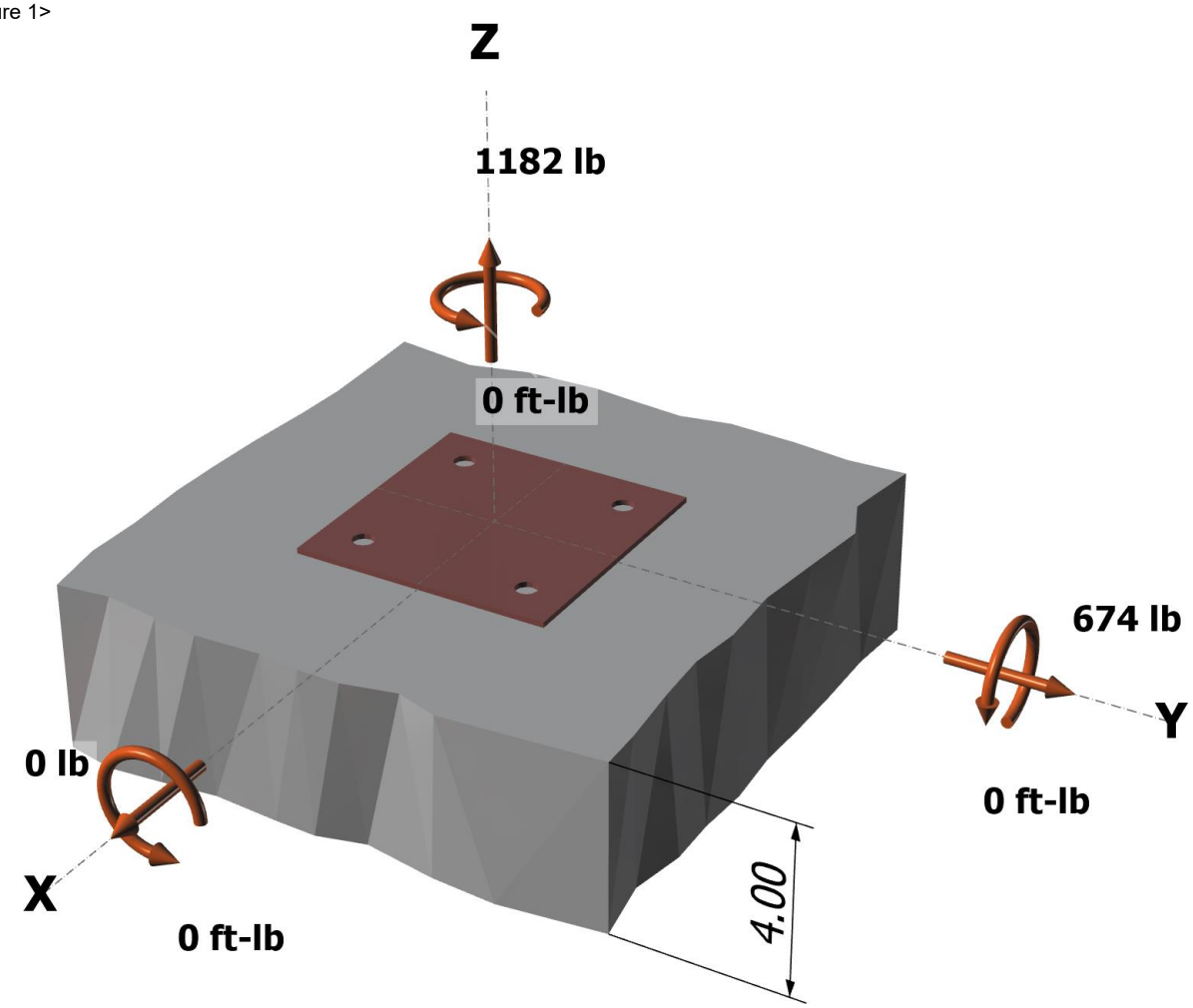
| Phone: | 702-202-0061 | | |
| E-mail: | yijie@hwengineeringusa.com | | |

**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]: 1182
$V_{uax}$ [lb]: 0
$V_{uay}$ [lb]: 674
$M_{ux}$ [ft-lb]: 0
$M_{uy}$ [ft-lb]: 0
$M_{uz}$ [ft-lb]: 0

<Figure 1>



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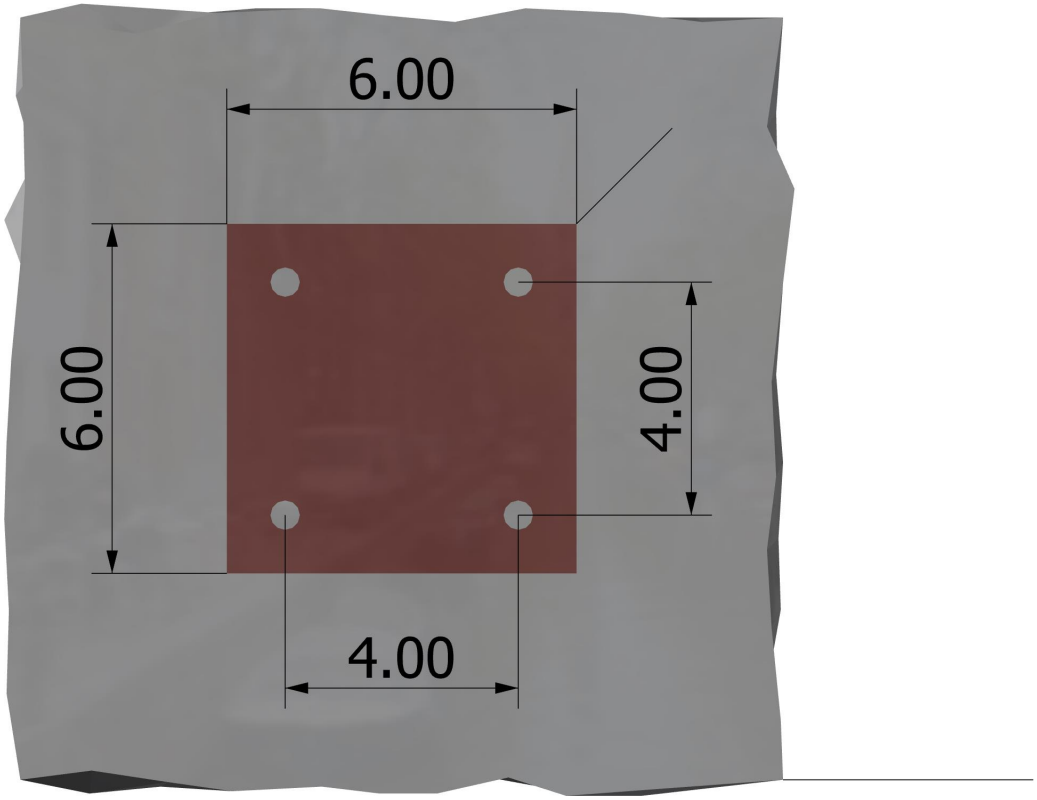
| Phone: | 702-202-0061 | | |
| E-mail: | yijie@hwengineeringusa.com | | |

<Figure 2>



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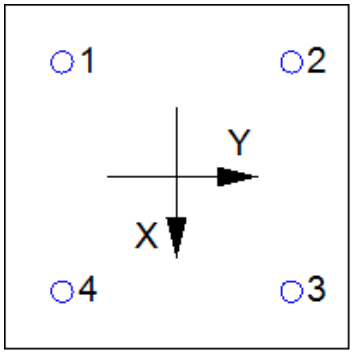
| Phone: | 702-202-0061 | | |
| E-mail: | yijie@hwengineeringusa.com | | |

## 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 | 295.5 | 0.0 | 168.5 | 168.5 |
| 2 | 295.5 | 0.0 | 168.5 | 168.5 |
| 3 | 295.5 | 0.0 | 168.5 | 168.5 |
| 4 | 295.5 | 0.0 | 168.5 | 168.5 |
| Sum | 1182.0 | 0.0 | 674.0 | 674.0 |

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 1182
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) | $\phi$ | $\phi N_{sa}$ (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)

| $k_c$ | $\lambda_a$ | $f'_c$ (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)

| $A_{Nc}$ (in²) | $A_{Nco}$ (in²) | $c_{a,min}$ (in) | $\Psi_{ec,N}$ | $\Psi_{ed,N}$ | $\Psi_{c,N}$ | $\Psi_{cp,N}$ | $N_b$ (lb) | $\phi$ | $\phi N_{cbg}$ (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) | $\phi_{grout}$ | $\phi$ | $\phi_{grout}\phi V_{sa}$ (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)

| $k_{cp}$ | $A_{Nc}$ (in²) | $A_{Nco}$ (in²) | $\Psi_{ec,N}$ | $\Psi_{ed,N}$ | $\Psi_{c,N}$ | $\Psi_{cp,N}$ | $N_b$ (lb) | $\phi$ | $\phi V_{cpg}$ (lb) |
|---|---|---|---|---|---|---|---|---|---|
| 1.0 | 67.24 | 17.64 | 1.000 | 1.000 | 1.000 | 1.000 | 2236 | 0.70 | 5967 |

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| Project: | KE USA Louver Canopy | | |
| 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, ø$N_n$ (lb) | Ratio | Status |
|---|---|---|---|---|
| Steel | 296 | 9133 | 0.03 | Pass |
| **Concrete breakout** | **1182** | **5541** | **0.21** | **Pass (Governs)** |

| Shear | Factored Load, $V_{ua}$ (lb) | Design Strength, ø$V_n$ (lb) | Ratio | Status |
|---|---|---|---|---|
| Steel | 169 | 2464 | 0.07 | Pass |
| **Pryout** | **674** | **5967** | **0.11** | **Pass (Governs)** |

| Interaction check | $N_{ua}/\phi N_n$ | $V_{ua}/\phi V_n$ | Combined Ratio | Permissible | Status |
|---|---|---|---|---|---|
| Sec. 17.6..1 | 0.21 | 0.00 | 21.3% | 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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| 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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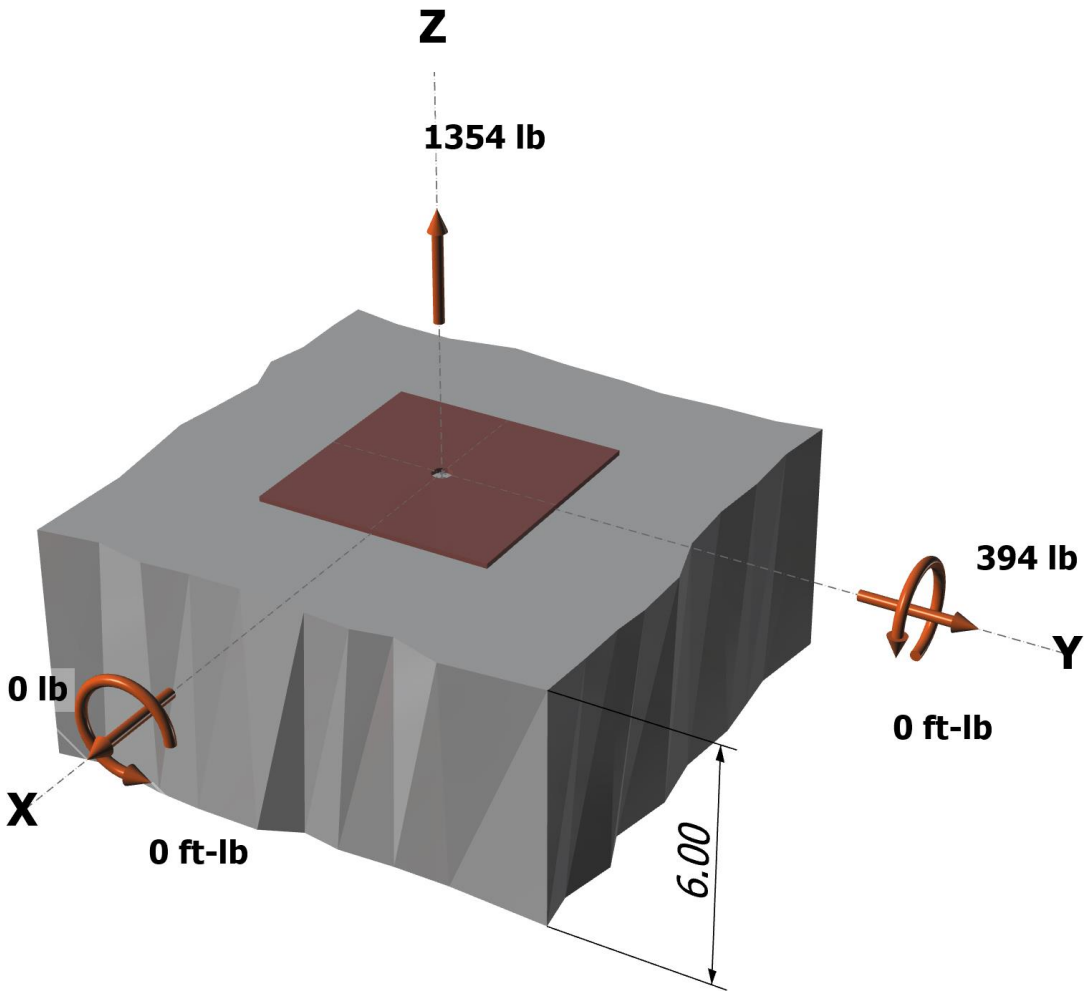
**Load and Geometry**
Load factor source: ACI 318 Section 5.3
Load combination: not set
Seismic design: No
Anchors subjected to sustained tension: Not applicable
Apply entire shear load at front row: No
Anchors only resisting wind and/or seismic loads: No

Strength level loads:

$N_{ua}$ [lb]: 1354
$V_{uax}$ [lb]: 0
$V_{uay}$ [lb]: 394
$M_{ux}$ [ft-lb]: 0
$M_{uy}$ [ft-lb]: 0

<Figure 1>



| | | | |
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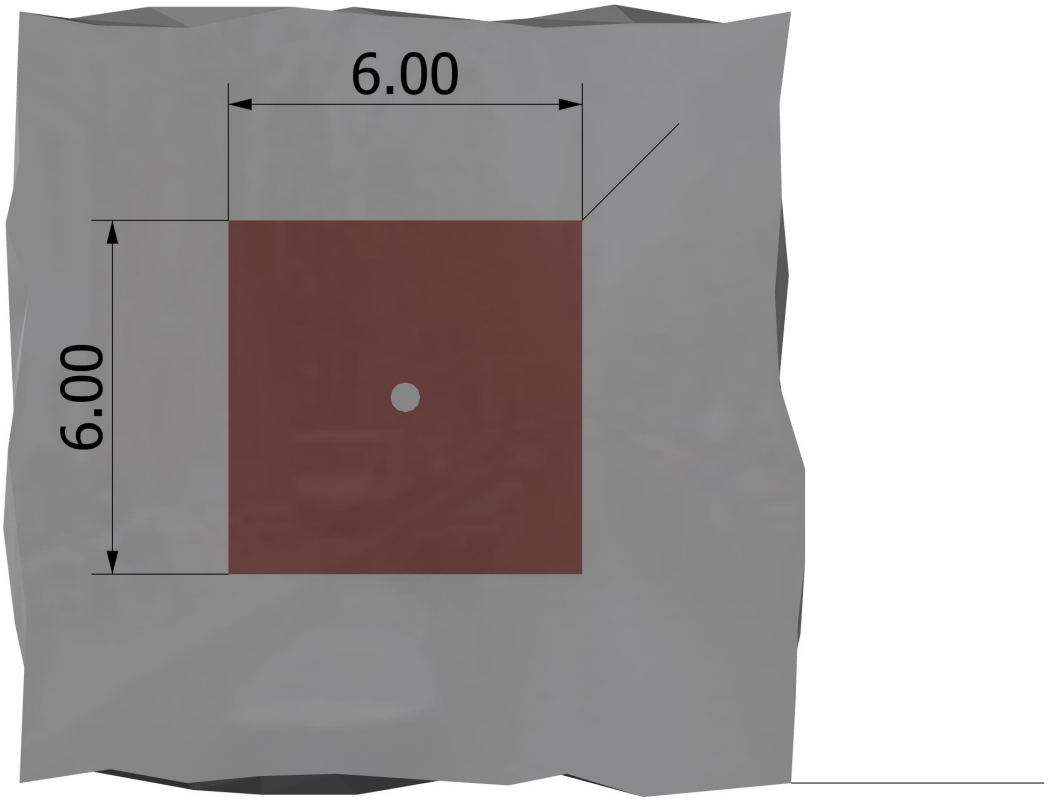
| E-mail: | yijie@hwengineeringusa.com | | |

<Figure 2>



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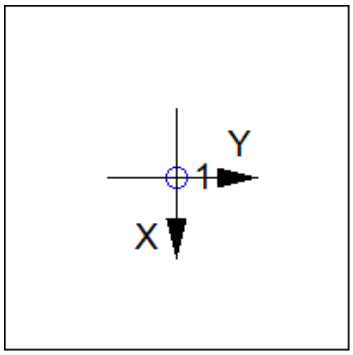
| E-mail: | yijie@hwengineeringusa.com | | |

## 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 | 1354.0 | 0.0 | 394.0 | 394.0 |
| Sum | 1354.0 | 0.0 | 394.0 | 394.0 |

Maximum concrete compression strain (‰): 0.00
Maximum concrete compression stress (psi): 0
Resultant tension force (lb): 1354
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) | $\phi$ | $\phi N_{sa}$ (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)

| $k_c$ | $\lambda_a$ | $f'_c$ (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) | $\phi$ | $\phi N_{cb}$ (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) | $\phi_{grout}$ | $\phi$ | $\phi_{grout}\phi V_{sa}$ (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) | $\phi$ | $\phi V_{cp}$ (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. 17.6.)

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

| Tension | Factored Load, $N_{ua}$ (lb) | Design Strength, ø$N_n$ (lb) | Ratio | Status |
|---|---|---|---|---|
| Steel | 1354 | 9133 | 0.15 | Pass |
| **Concrete breakout** | **1354** | **1915** | **0.71** | **Pass (Governs)** |

| Shear | Factored Load, $V_{ua}$ (lb) | Design Strength, ø$V_n$ (lb) | Ratio | Status |
|---|---|---|---|---|
| Steel | 394 | 2893 | 0.14 | Pass |
| **Pryout** | **394** | **2062** | **0.19** | **Pass (Governs)** |

| Interaction check | $N_{ua}/\phi N_n$ | $V_{ua}/\phi V_n$ | Combined Ratio | Permissible | Status |
|---|---|---|---|---|---|
| Sec. 17.6..1 | 0.71 | 0.00 | 70.7% | 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 | 671 | 405 |
| Wall or Backing | Connection | | |
| Metal | (4) 3/8" Dia A307 Thru Bolt | | |
| Wood | (4) 3/8" Dia x 4" Lag Screws | | |
| Masonry | (4) 3/8" Dia x 2-3/4" 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) | 124 | 767 | 202 |
| Wall or Backing | Connection | | |
| Metal | (1) 3/8" Dia A307 Thru Bolt at 24"O.C. | | |
| Wood | (1) 3/8" Dia x 4" Lag Screws at 24" O.C. | | |
| Masonry | (2) 1/2" Dia x 3-1/2" 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