



# STRUCTURAL CALCULATIONS

Project name:  
**8965 SW 63rd CT**

PACHECO ARCHITECTURE, LLC.  
SHOP DRAWING REVIEW

☒ NO EXCEPTIONS TAKEN  
☐ NOTE COMMENTS

☐ REJECTED  
☐ RE-SUBMIT

CORRECTIONS OR COMMENTS MADE ON SHOP DRAWINGS DURING THIS REVIEW DO NOT RELIEVE CONTRACTOR FROM COMPLYING WITH REQUIREMENTS OF THE PERMITTED DRAWINGS AND SPECIFICATIONS INCLUDING APPLICABLE MANUFACTURER SPECIFICATIONS. THIS CHECK IS ONLY FOR GENERAL CONFORMANCE WITH DESIGN CONCEPT AND GENERAL COMPLIANCE WITH THE INFORMATION IN THE CONTRACT DOCUMENTS. CONTRACTOR IS RESPONSIBLE FOR: CONFIRMING AND CORRELATING ALL QUANTITIES AND DIMENSIONS; SELECTING FABRICATION PROCESSES AND TECHNIQUES OF CONSTRUCTION; COORDINATING HIS WORK WITH THAT OF ALL OTHER TRADES AND PERFORMING HIS WORK IN A SAFE AND SATISFACTORY MANNER.

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DATE: 06-22-26 REVIEWED BY: J. ESTORINO  
ON BEHALF OF PACHECO ARCHITECTURE, LLC.

SHOP DRAWING REVIEW

Project Name  
De La Concepcion Residence

☒ APPROVED  
☐ REJECT & RESUBMIT

☐ REJECTED  
☐ APPROVED AS NOTED

BY Alex Rochell, PE DATE 6/23/2026

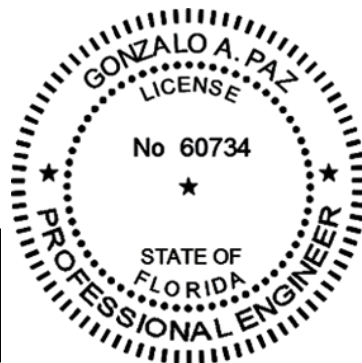
SUBMITTAL# SPEC

THIS REVIEW IS ONLY FOR GENERAL CONFORMANCE OF THE PROJECT AND GENERAL COMPLIANCE. CORRECTIONS OR COMMENTS MADE ON THESE DRAWINGS DURING THIS REVIEW DO NOT RELIEVE CONTRACTOR/SUBCONTRACTOR FROM COMPLIANCE WITH THE REQUIREMENTS OF THE PLANS AND SPECIFICATIONS. CONTRACTOR IS RESPONSIBLE FOR ALL DIMENSIONS AND FABRICATION TO BE CONFIRMED AND CORRELATED AT THE JOB SITE

Job No.:  
**26-0651**

Project address:  
**8965 SW 63rd Ct, Pinecrest,  
FL 33156, USA**

**These calculations are strictly valid for the address above. Use  
in other projects is unauthorized and may constitute fraud.**



Digitally signed by Gonzalo A Paz  
Date: 2026.06.24 13:53:21-04'00'

Prepared by: Gonzalo Paz, PE  
Lic. No. 60734/CAN # 26655

THIS ITEM HAS BEEN DIGITALLY SIGNED AND SEALED BY GONZALO A. PAZ, PE ON THE DATE ADJACENT TO THE SEAL.

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## DESIGN CRITERIA:

Calculations based on:

1. Florida Building Code 8<sup>th</sup> Edition 2023
2. Minimum Design Loads for Buildings and Other Structures ASCE 7-22
3. Building Code Requirements for Structural Concrete ACI 318-19
4. American Institute of Steel Construction AISC 360-16
5. Aluminum Design Manual 2020
6. American Wood Council NDS 2024

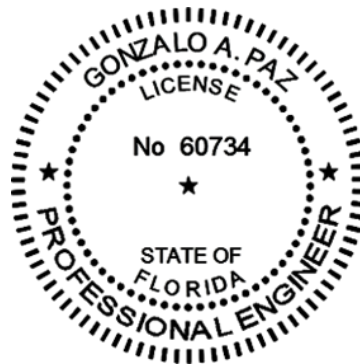
## CALCULATION INDEX:

- |     |                                  |       |
|-----|----------------------------------|-------|
| I.  | Interior Cantilever Stair Design | 3-33  |
| II. | Glass Railing At Stair Design    | 34-54 |

**Total Pages = 54**

## CALCULATION STATEMENT:

To the best of my knowledge, ability, belief and professional judgment, I hereby attest that the manual calculations and computer-generated calculations are in compliance with the existing governing codes.



Digitally signed by Gonzalo A Paz  
Date: 2026.06.24 13:53:10-04'00'

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**Eastern**  
Engineering Group

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[www.easterneg.com](http://www.easterneg.com)



# **INTERIOR CANTILEVER STAIR DESIGN**



## Loads:

DL= 30psf (DLsystem 15 + DLsuperimposed 15psf)

LL= 40psf or 300# conc.

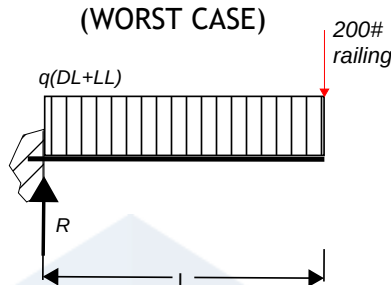
Mrailing= 200#\*3ft= 600#-ft= 0.6k-ft

T.S= 12in

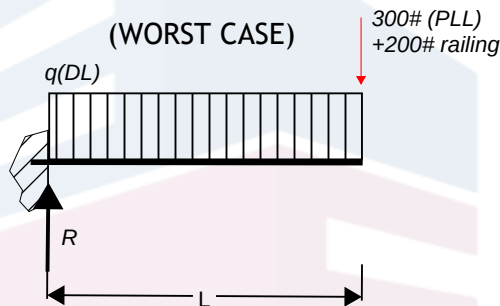
$L = 4'-1" = 4.083\text{ft}$

## Loads Combination

1. DL+LL+Mrailing or 200# Conc.



2. DL+LL(conc.)+Mrailing or 200# Conc.



\*For Tread analysis see spreadsheet printout

\*Deflection Analysis

$\Delta_{\text{actual}} = 0.25\text{ in}$

$\Delta_{\text{Allow}} = L/360 = 4.083\text{ft}/360 * 12 * 2 = 0.27\text{ in}$

$\Delta_{\text{Allow}} = 0.27\text{ in} > \Delta_{\text{actual}} = 0.25\text{ in}$  (OK)

|             |                               |
|-------------|-------------------------------|
| date        | 10.26.2021                    |
| issued      |                               |
| drawn       | M.V/M/R/P                     |
| checked     | A.R                           |
| project no. | 2024                          |
| revisions   |                               |
| 1           | 05-08-25 BLDG. DEPT. COMMENTS |
| 2           | 09-02-25 BLDG. DEPT. COMMENTS |
| 3           | 11-25-25 BLDG. DEPT. COMMENTS |

NEW RESIDENCE FOR:  
**MR & MRS DE LA CONCEPCION**  
8965 SW 63RD COURT  
PINECREST, FLORIDA 33156

B. THE STRUCTURE IS DESIGNED FOR THE FOLLOWING LOADING:

|                 | <u>SUPER IMPOSED</u><br><u>DEAD LOADS</u> | <u>LIVE</u><br><u>LOADS</u> |
|-----------------|-------------------------------------------|-----------------------------|
| ROOF .....      | 25 PSF                                    | 30 PSF                      |
| SECOND FLR..... | 35 PSF                                    | 40 PSF                      |
| GROUND FLR..... | 35 PSF                                    | 40 PSF                      |
| GARAGE .....    | 15 PSF                                    | 50 PSF                      |
| STAIRS .....    | 15 PSF                                    | 40 PSF                      |
| TERRACE .....   | 15 PSF                                    | 60 PSF                      |
| BALCONY .....   | 15 PSF                                    | 60 PSF                      |

TAKEN FROM

Project Title:  
Engineer:  
Project ID:  
Project Descr:

## Steel Beam

Project File: 26-0651.ec6

LIC# : KW-06018068, Build:20.25.07.09

Eastern Engineering Group

(c) ENERCALC, LLC 1982-2026

**DESCRIPTION:** Combination #1 (DL+DLL Dist. + 200 Conc)

### Code References

Governing Code : IBC 2018, CBC 2019

Referenced Design Standard(s) : AISC 360-22\*

Load Combination Set : ASCE 7-22 / IBC 2024

\*User-selected, not referenced by : IBC 2018, CBC 2019

### Material Properties

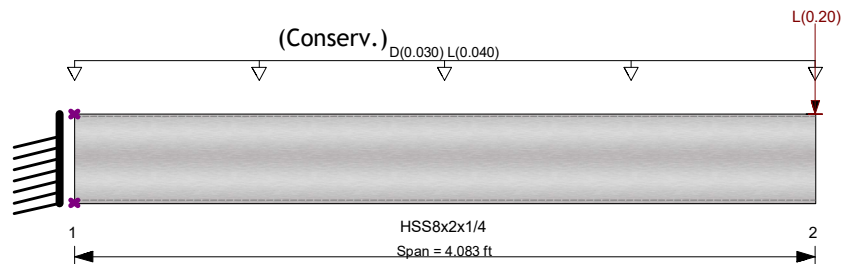
Analysis Method : Allowable Strength Design

Beam Bracing : Completely Unbraced

Bending Axis : Minor Axis Bending

Fy : Steel Yield : 46.0 ksi

E: Modulus : 29,000.0 ksi



### Applied Loads

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

Beam self weight NOT internally calculated and added

Uniform Load : D = 0.030, L = 0.040 ksf, Tributary Width = 1.0 ft

Point Load : L = 0.20 k @ 4.083 ft

### DESIGN SUMMARY

**Design OK**

Maximum Bending Stress Ratio = 0.190 : 1

Maximum Shear Stress Ratio = 0.048 : 1

Section used for this span

Section used for this span

Ma : Applied

Va : Applied

Mn / Omega : Allowable

Vn/Omega : Allowable

Load Combination

Load Combination

+D+L

+D+L

Span # where maximum occurs

Span # 1

Location of maximum on span

0.000 ft

Span # where maximum occurs

Span # 1

#### Maximum Deflection

Max Downward Transient Deflection 0.120 in Ratio = 817 >=360 Span: 1 : L Only

Max Upward Transient Deflection 0 in Ratio = 0 <360 n/a

Max Downward Total Deflection 0.141 in Ratio = 695 >=360 Span: 1 : +D+L

Max Upward Total Deflection 0 in Ratio = 0 <360.0 n/a

### Maximum Forces & Stresses for Load Combinations

| Load Combination  | Segment Length | Span # | Max Stress Ratios |       | Summary of Moment Values |        |        |       |           |      | Summary of Shear Values |        |               |
|-------------------|----------------|--------|-------------------|-------|--------------------------|--------|--------|-------|-----------|------|-------------------------|--------|---------------|
|                   |                |        | M                 | V     | Mmax +                   | Mmax - | Ma Max | Mny   | Mny/Omega | Cb   | Rm                      | Va Max | Vny/Vny/Omega |
| D Only            |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.034             | 0.012 |                          | -0.25  | 0.25   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.12   | 16.73         |
| +D+L              |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.190             | 0.048 |                          | -1.40  | 1.40   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.49   | 16.73         |
| +D+0.750L         |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.151             | 0.039 |                          | -1.11  | 1.11   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.39   | 16.73         |
| +0.60D            |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.020             | 0.007 |                          | -0.15  | 0.15   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.07   | 16.73         |

### Overall Maximum Deflections

| Span | Load Combination | Max. "-" Defl | Location in Span | Load Combination | Max. "+" Defl | Location in Span |
|------|------------------|---------------|------------------|------------------|---------------|------------------|
| 1    | +D+L             | 0.1410        | 4.083            |                  | 0.0000        | 0.000            |

### Maximum Deflections for Load Combinations

| Load Combination | Span | Max. Downward Defl | Location in Span | Span | Max. Upward Defl | Location in Span |
|------------------|------|--------------------|------------------|------|------------------|------------------|
| D Only           | 1    | 0.0211             | 4.083            |      | 0.0000           | 0.000            |
| +D+L             | 1    | 0.1410             | 4.083            |      | 0.0000           | 0.000            |
| +D+0.750L        | 1    | 0.1110             | 4.083            |      | 0.0000           | 0.000            |
| +0.60D           | 1    | 0.0126             | 4.083            |      | 0.0000           | 0.000            |
| L Only           | 1    | 0.1199             | 4.083            |      | 0.0000           | 0.000            |

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

## Steel Beam

Project File: 26-0651.ec6

LIC# : KW-06018068, Build:20.25.07.09

Eastern Engineering Group

(c) ENERCALC, LLC 1982-2026

**DESCRIPTION:** Combination #1 (DL+DLL Dist. + 200 Conc)

### Vertical Reactions

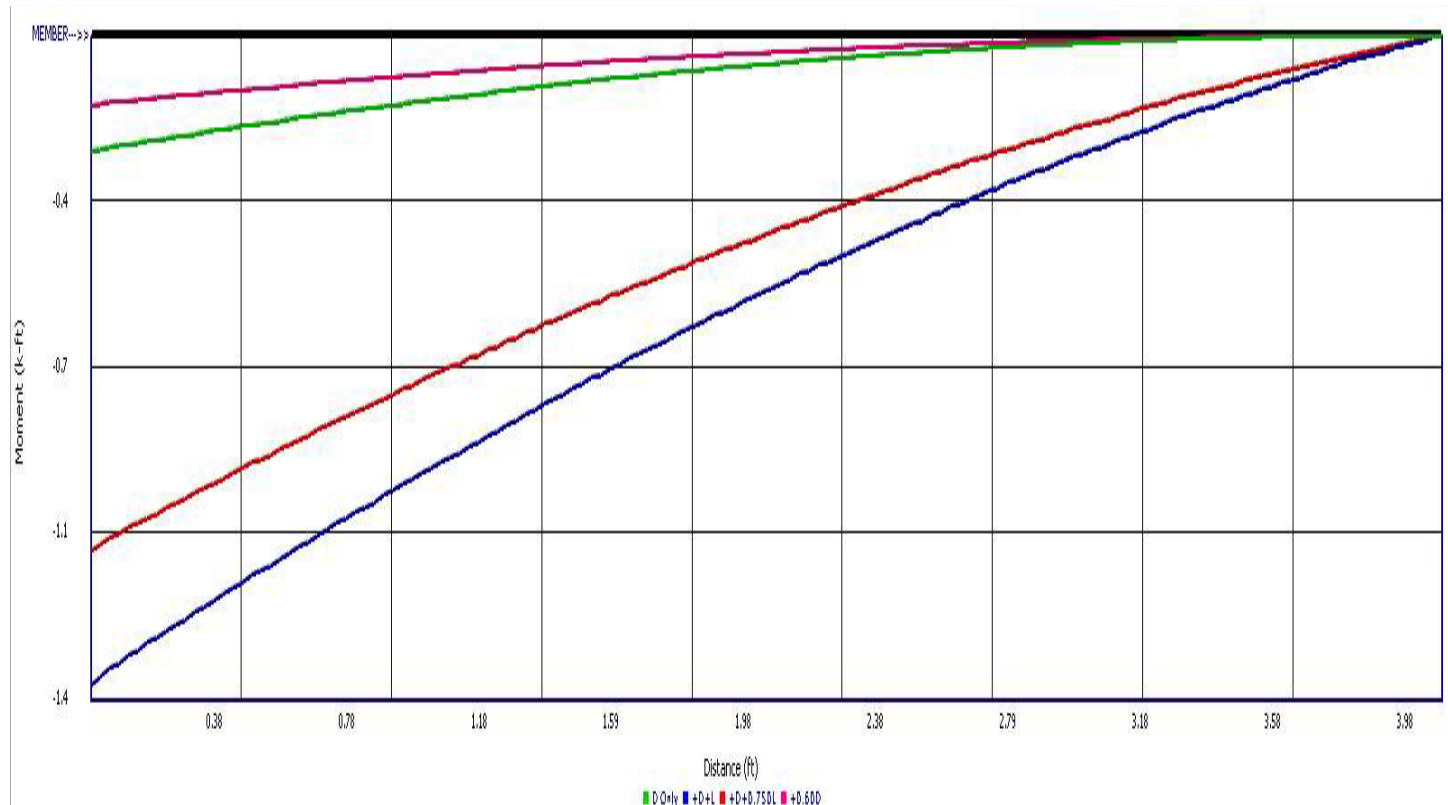
Support notation : Far left is #

Values in KIPS

| Load Combination                    | Support 1 | Support 2 |
|-------------------------------------|-----------|-----------|
| Max Upward from all Load Conditions | 0.486     |           |
| Max Upward from Load Combinations   | 0.486     |           |
| Max Upward from Load Cases          | 0.363     |           |
| D Only                              | 0.122     |           |
| +D+L                                | 0.486     |           |
| +D+0.750L                           | 0.395     |           |
| +0.60D                              | 0.073     |           |
| L Only                              | 0.363     |           |

### Steel Section Properties : HSS8x2x1/4

|            |   |            |      |   |            |    |   |            |
|------------|---|------------|------|---|------------|----|---|------------|
| Depth      | = | 8.000 in   | I xx | = | 28.50 in^4 | J  | = | 9.360 in^4 |
|            |   |            | S xx | = | 7.12 in^3  | Cw | = | 6.35 in^6  |
| Width      | = | 2.000 in   | R xx | = | 2.570 in   |    |   |            |
| Wall Thick | = | 0.233 in   | Zx   | = | 9.680 in^3 |    |   |            |
| Area       | = | 4.300 in^2 | I yy | = | 2.940 in^4 | C  | = | 0.000 in^3 |
| Weight     | = | 15.620 plf | S yy | = | 2.940 in^3 |    |   |            |
|            |   |            | R yy | = | 0.827 in   |    |   |            |
|            |   |            | Zy   | = | 3.430 in^3 |    |   |            |
| Ycg        | = | 4.000 in   |      |   |            |    |   |            |



Steel Beam

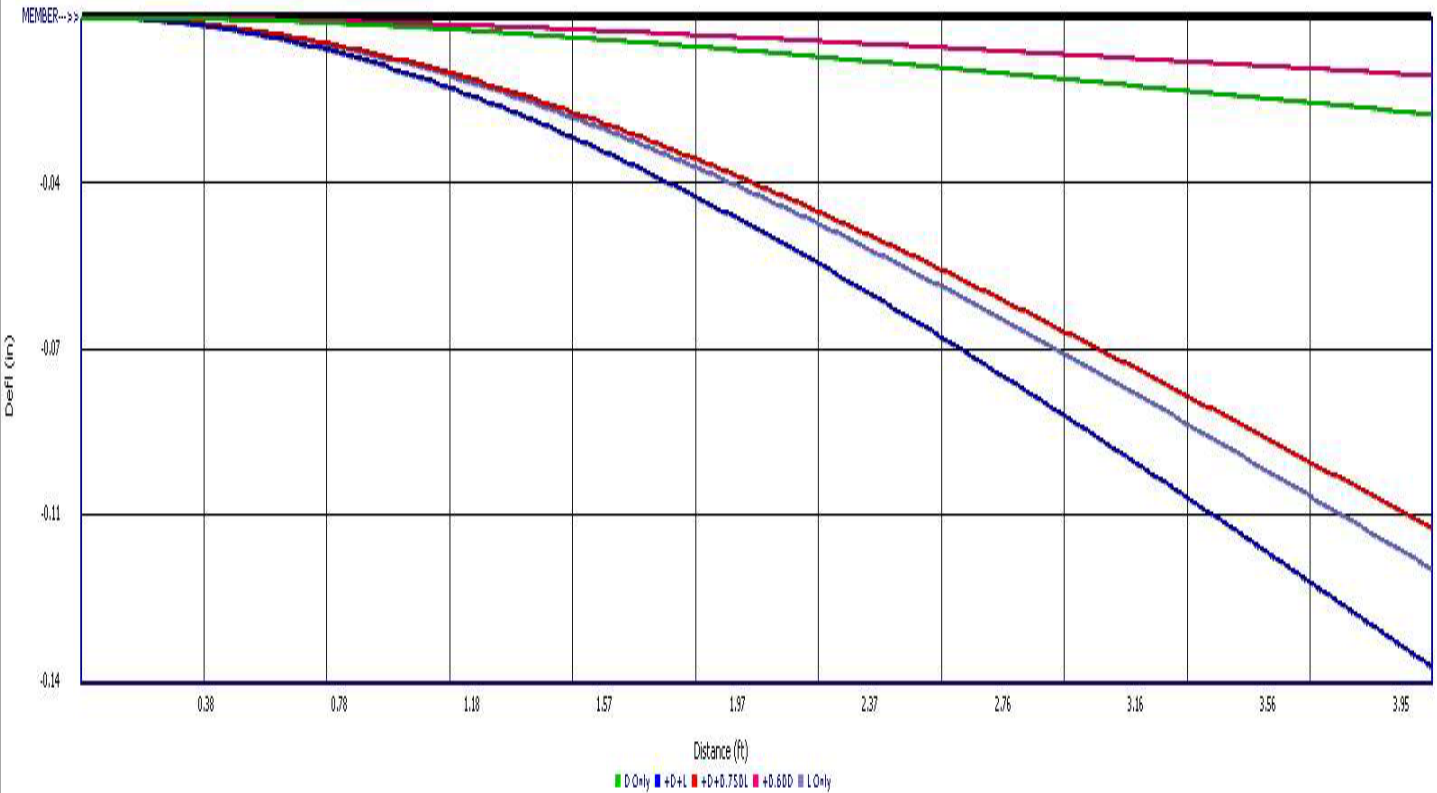
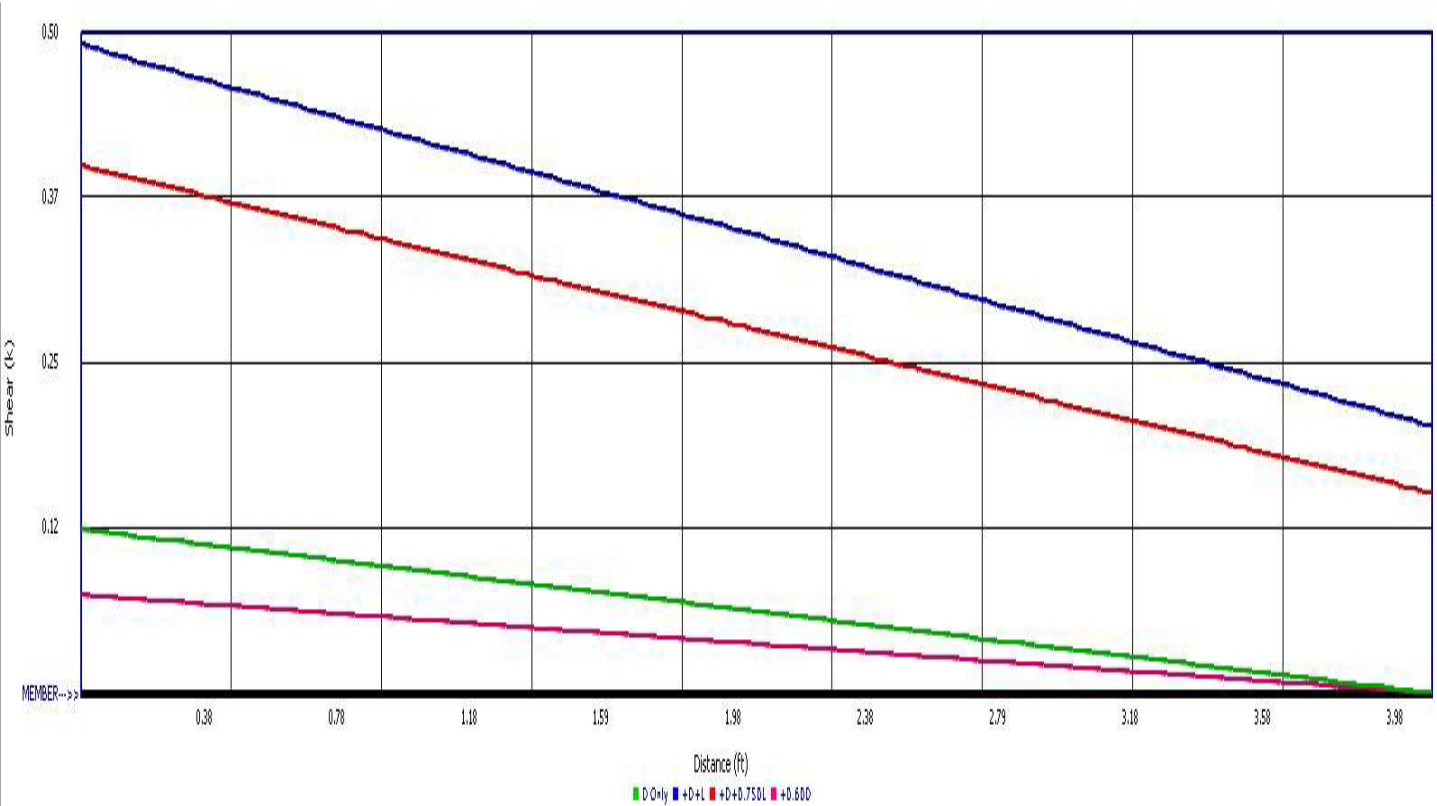
Project File: 26-0651.ec6

LIC# : KW-06018068, Build:20.25.07.09

Eastern Engineering Group

(c) ENERCALC, LLC 1982-2026

DESCRIPTION: Combination #1 (DL+DLL Dist. + 200 Conc)



Beam Span Moments & Shears at Incremental Locations

| Load Type/Combination | Span Location (ft) | Span ID | Shear (k) | Moment (ft-k) |
|-----------------------|--------------------|---------|-----------|---------------|
| D Only                | 0.00               | Span 1  | 0.122     | -0.250        |

Project Title:  
Engineer:  
Project ID:  
Project Descr:

## Steel Beam

Project File: 26-0651.ec6

LIC# : KW-06018068, Build:20.25.07.09

Eastern Engineering Group

(c) ENERCALC, LLC 1982-2026

**DESCRIPTION:** Combination #2 (DL Dist. + 300 Conc. + 200 Conc.)

### Code References

Governing Code : IBC 2018, CBC 2019

Referenced Design Standard(s) : AISC 360-22\*

Load Combination Set : ASCE 7-22 / IBC 2024

\*User-selected, not referenced by : IBC 2018, CBC 2019

### Material Properties

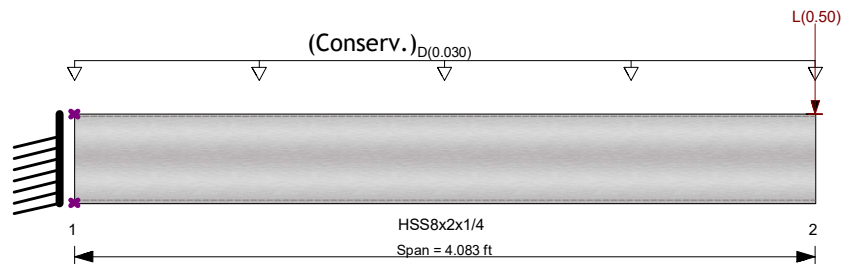
Analysis Method : Allowable Strength Design

Beam Bracing : Completely Unbraced

Bending Axis : Minor Axis Bending

Fy : Steel Yield : 46.0 ksi

E: Modulus : 29,000.0 ksi



### Applied Loads

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

Beam self weight NOT internally calculated and added

Uniform Load : D = 0.030 ksf, Tributary Width = 1.0 ft

Point Load : L = 0.50 k @ 4.083 ft

### DESIGN SUMMARY

**Design OK**

Maximum Bending Stress Ratio = 0.311 : 1

Section used for this span

Ma : Applied

Mn / Omega : Allowable

Load Combination

Span # where maximum occurs

Span # 1

#### Maximum Deflection

Max Downward Transient Deflection 0.229 in Ratio = 427 >= 360

Max Upward Transient Deflection 0 in Ratio = 0 < 360

Max Downward Total Deflection 0.251 in Ratio = 391 >= 360

Max Upward Total Deflection 0 in Ratio = 0 < 360.0

Maximum Shear Stress Ratio = 0.062 : 1

Section used for this span

Va : Applied

Vn / Omega : Allowable

Load Combination

+D+L

Location of maximum on span

Span # where maximum occurs

0.000 ft

Span # 1

+D+L

### Maximum Forces & Stresses for Load Combinations

| Load Combination  | Segment Length | Span # | Max Stress Ratios |       | Summary of Moment Values |        |        |       |           |      | Summary of Shear Values |        |               |
|-------------------|----------------|--------|-------------------|-------|--------------------------|--------|--------|-------|-----------|------|-------------------------|--------|---------------|
|                   |                |        | M                 | V     | Mmax +                   | Mmax - | Ma Max | Mny   | Mny/Omega | Cb   | Rm                      | Va Max | Vny/Vny/Omega |
| D Only            |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.034             | 0.012 |                          | -0.25  | 0.25   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.12   | 16.73         |
| +D+L              |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.311             | 0.062 |                          | -2.29  | 2.29   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.62   | 16.73         |
| +D+0.750L         |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.242             | 0.050 |                          | -1.78  | 1.78   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.50   | 16.73         |
| +0.60D            |                |        |                   |       |                          |        |        |       |           |      |                         |        |               |
| Dsgn. L = 4.08 ft |                | 1      | 0.020             | 0.007 |                          | -0.15  | 0.15   | 12.29 | 7.36      | 1.00 | 1.00                    | 0.07   | 16.73         |

### Overall Maximum Deflections

| Span | Load Combination | Max. "-" Defl | Location in Span | Load Combination | Max. "+" Defl | Location in Span |
|------|------------------|---------------|------------------|------------------|---------------|------------------|
| 1    | +D+L             | 0.2505        | 4.083            |                  | 0.0000        | 0.000            |

### Maximum Deflections for Load Combinations

| Load Combination | Span | Max. Downward Defl | Location in Span | Span | Max. Upward Defl | Location in Span |
|------------------|------|--------------------|------------------|------|------------------|------------------|
| D Only           | 1    | 0.0211             | 4.083            |      | 0.0000           | 0.000            |
| +D+L             | 1    | 0.2505             | 4.083            |      | 0.0000           | 0.000            |
| +D+0.750L        | 1    | 0.1932             | 4.083            |      | 0.0000           | 0.000            |
| +0.60D           | 1    | 0.0126             | 4.083            |      | 0.0000           | 0.000            |
| L Only           | 1    | 0.2294             | 4.083            |      | 0.0000           | 0.000            |

Project Title:  
 Engineer:  
 Project ID:  
 Project Descr:

## Steel Beam

Project File: 26-0651.ec6

LIC# : KW-06018068, Build:20.25.07.09

Eastern Engineering Group

(c) ENERCALC, LLC 1982-2026

**DESCRIPTION:** Combination #2 (DL Dist. + 300 Conc. + 200 Conc.)

### Vertical Reactions

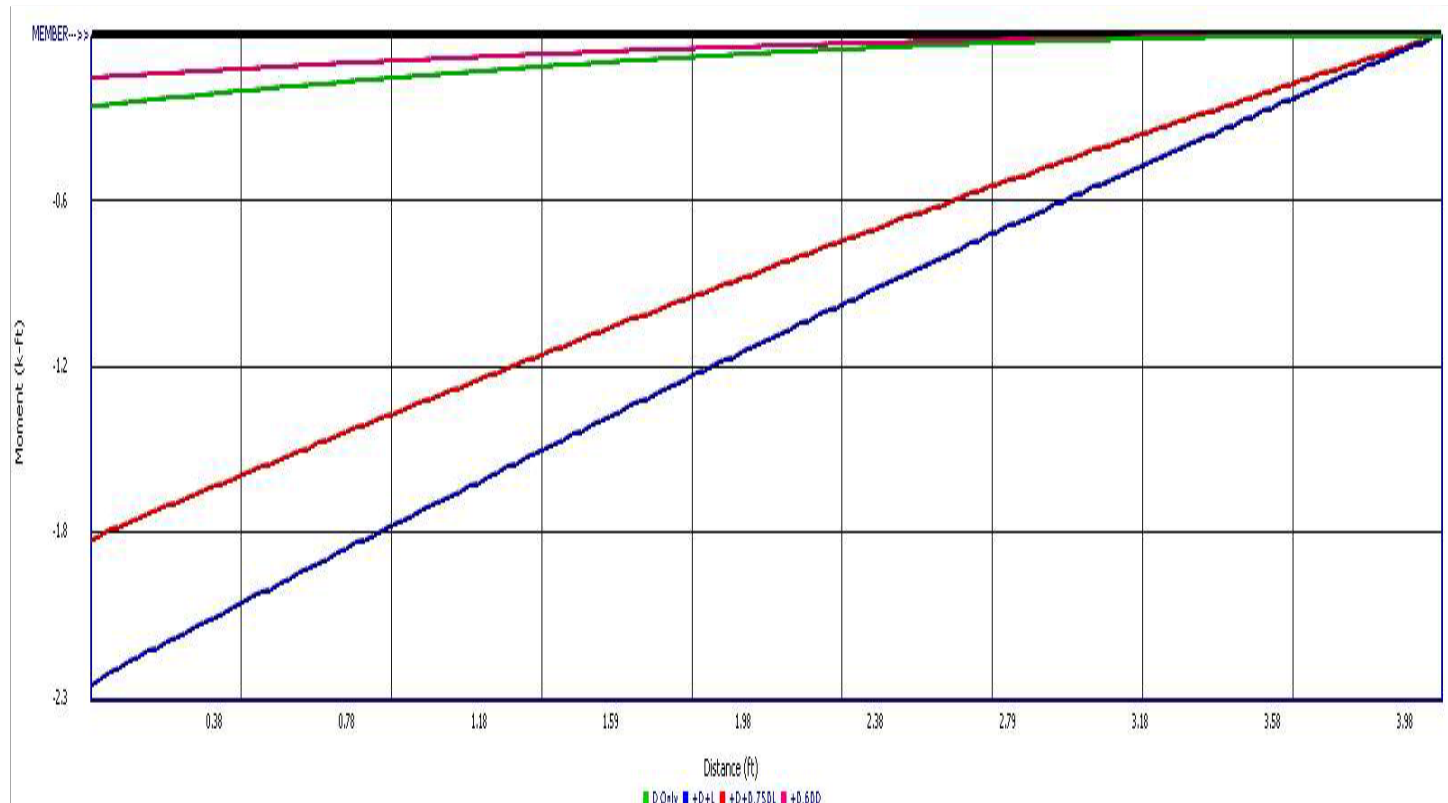
Support notation : Far left is #

Values in KIPS

| Load Combination                    | Support 1 | Support 2 |
|-------------------------------------|-----------|-----------|
| Max Upward from all Load Conditions | 0.622     |           |
| Max Upward from Load Combinations   | 0.622     |           |
| Max Upward from Load Cases          | 0.500     |           |
| D Only                              | 0.122     |           |
| +D+L                                | 0.622     |           |
| +D+0.750L                           | 0.497     |           |
| +0.60D                              | 0.073     |           |
| L Only                              | 0.500     |           |

### Steel Section Properties : HSS8x2x1/4

|            |   |            |      |   |            |    |   |            |
|------------|---|------------|------|---|------------|----|---|------------|
| Depth      | = | 8.000 in   | I xx | = | 28.50 in^4 | J  | = | 9.360 in^4 |
|            |   |            | S xx | = | 7.12 in^3  | Cw | = | 6.35 in^6  |
| Width      | = | 2.000 in   | R xx | = | 2.570 in   |    |   |            |
| Wall Thick | = | 0.233 in   | Zx   | = | 9.680 in^3 |    |   |            |
| Area       | = | 4.300 in^2 | I yy | = | 2.940 in^4 | C  | = | 0.000 in^3 |
| Weight     | = | 15.620 plf | S yy | = | 2.940 in^3 |    |   |            |
|            |   |            | R yy | = | 0.827 in   |    |   |            |
|            |   |            | Zy   | = | 3.430 in^3 |    |   |            |
| Ycg        | = | 4.000 in   |      |   |            |    |   |            |



Steel Beam

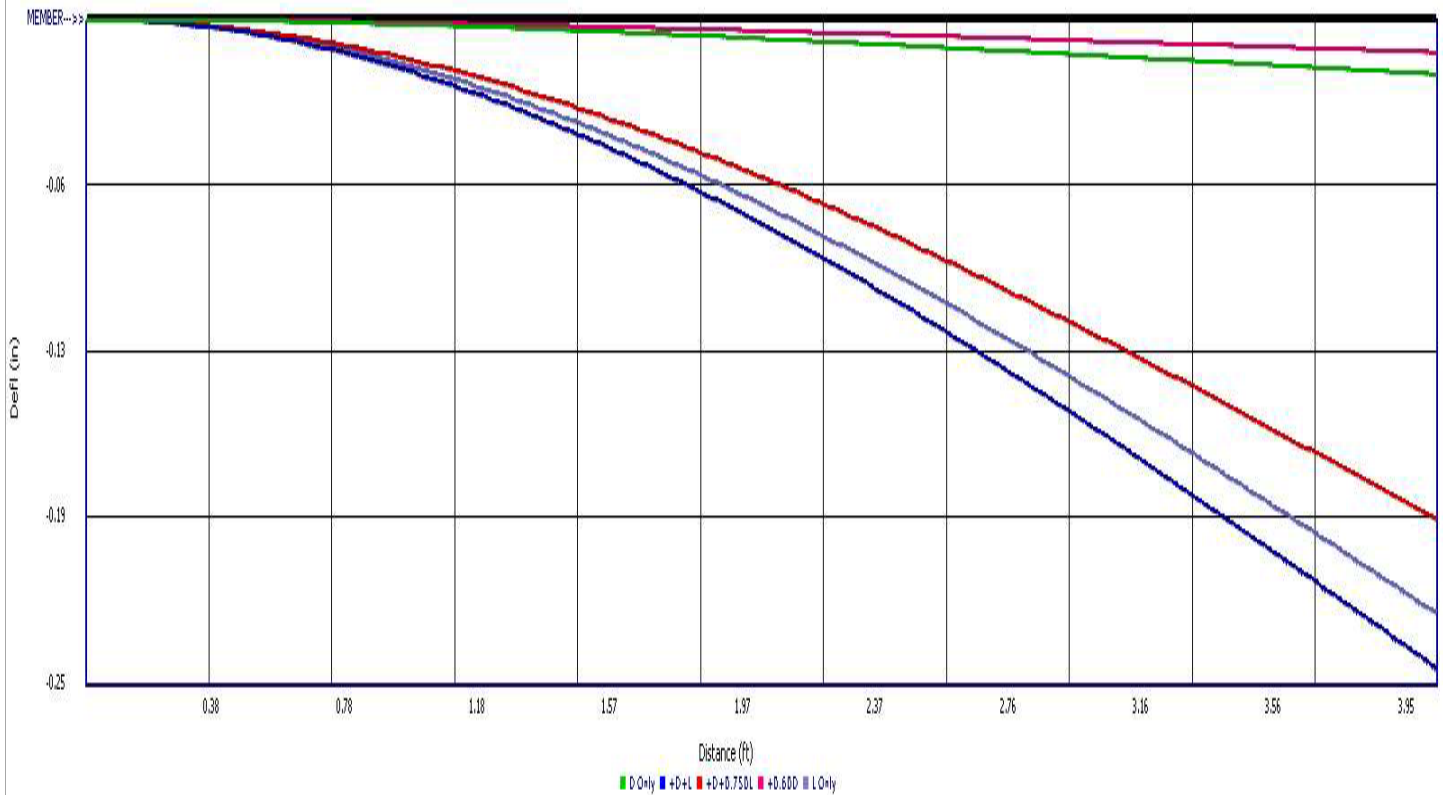
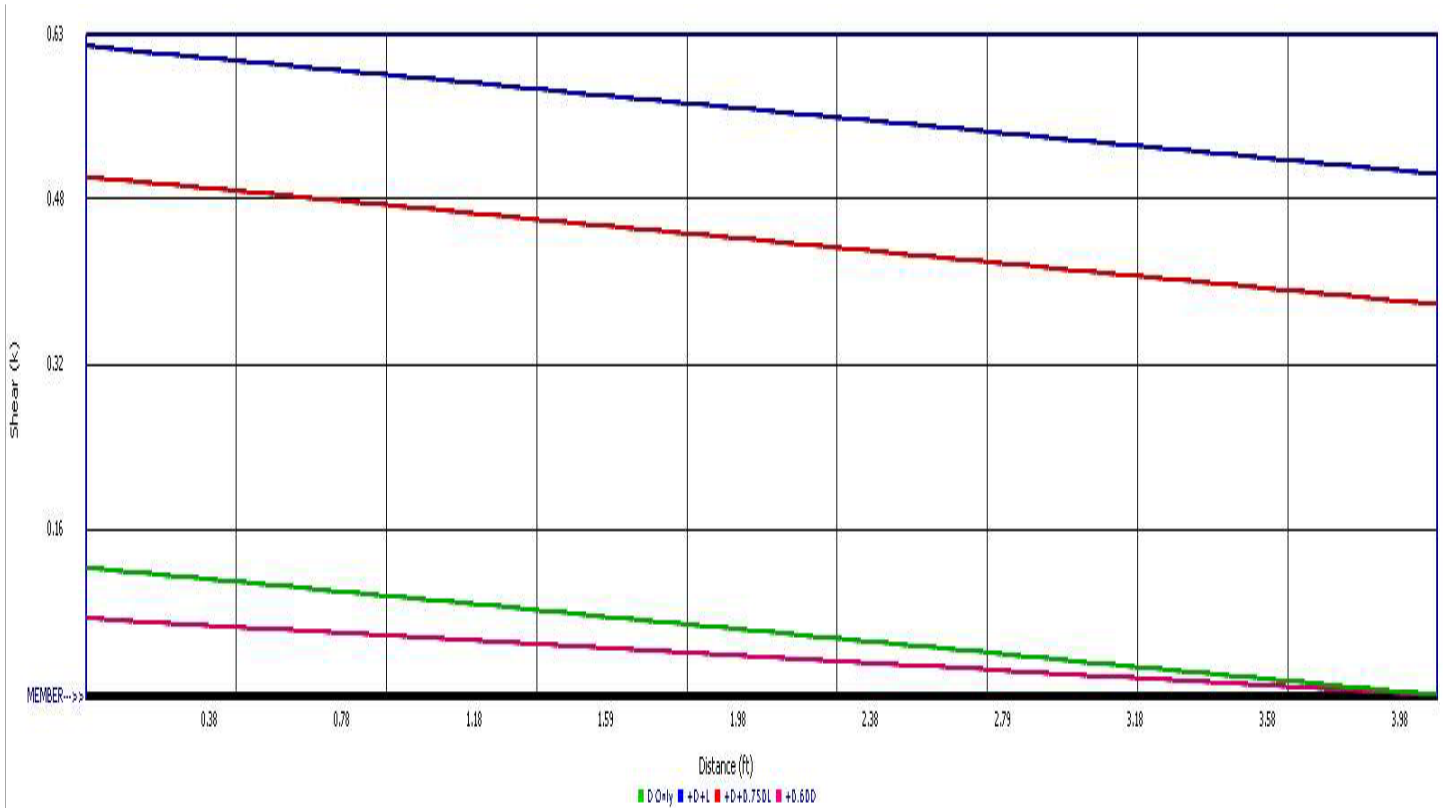
Project File: 26-0651.ec6

LIC# : KW-06018068, Build:20.25.07.09

Eastern Engineering Group

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DESCRIPTION: Combination #2 (DL Dist. + 300 Conc. + 200 Conc.)



Beam Span Moments & Shears at Incremental Locations

| Load Type/Combination | Span Location (ft) | Span ID | Shear (k) | Moment (ft-k) |
|-----------------------|--------------------|---------|-----------|---------------|
| D Only                | 0.00               | Span 1  | 0.122     | -0.250        |



PLATE CONN. AT CONC. WALL

**Loads:**

$$\begin{aligned} V_{\max} &= 0.6225 = 622.5\# \\ M_{\max} &= 2.292 \text{ k-ft} = 27\,504\#-\text{in} \\ \alpha &= 55^\circ \end{aligned}$$

**Loads Processing:**

$$\begin{aligned} M_x &= M_{\max} \cdot \cos 55^\circ \\ M_x &= 27\,504\#-\text{in} \cdot \cos 55^\circ \\ M_x &= 15\,775.64 \#-\text{in} \end{aligned}$$

$$\begin{aligned} M_y &= M_{\max} \cdot \sin 55^\circ \\ M_y &= 27\,504\#-\text{in} \cdot \sin 55^\circ \\ M_y &= 22\,529.95\#-\text{in} \end{aligned}$$

ASD

$$\begin{aligned} F_y &= 622.5\# \cdot \cos 55^\circ \\ F_y &= 357.05\# \end{aligned}$$

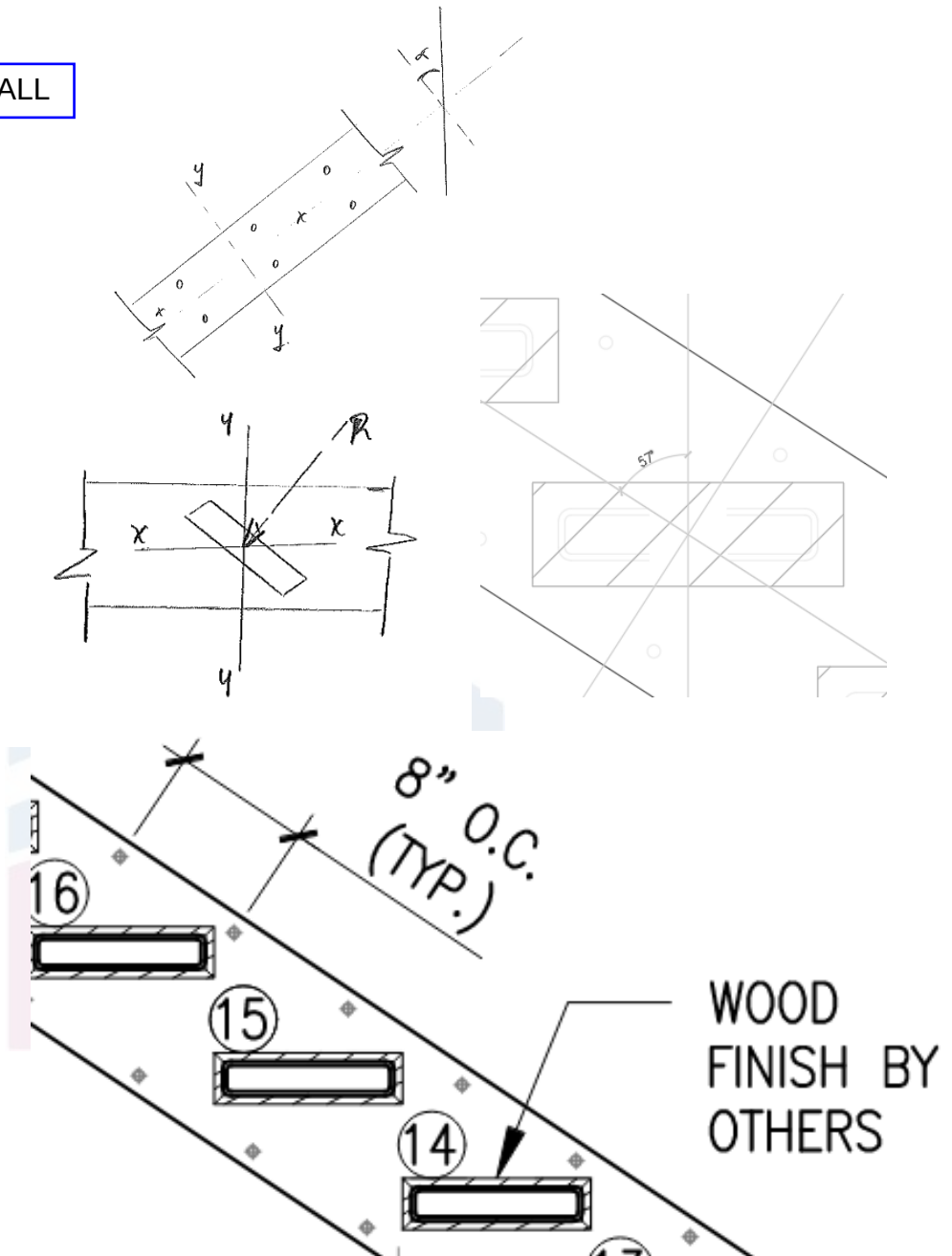
$$\begin{aligned} F_x &= 622.5\# \cdot \sin 55^\circ \\ F_x &= 509.92\# \end{aligned}$$

$$F_z = 200\# \text{ (railing reaction)}$$

LRFD

$$\begin{aligned} F_y &= 572\# \\ F_x &= 816\# \\ F_z &= 320\# \\ M_x &= 25\,242\#-\text{in} \\ M_y &= 36\,048\#-\text{in} \end{aligned}$$

\*See next page spreadsheet printout for connection analysis



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Company:  
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Design: Drafts\_Concrete - Apr 16, 2026 (1)  
Fastening point:

Page: 1  
Specifier:  
E-Mail:  
Date: 6/18/2026

Specifier's comments:

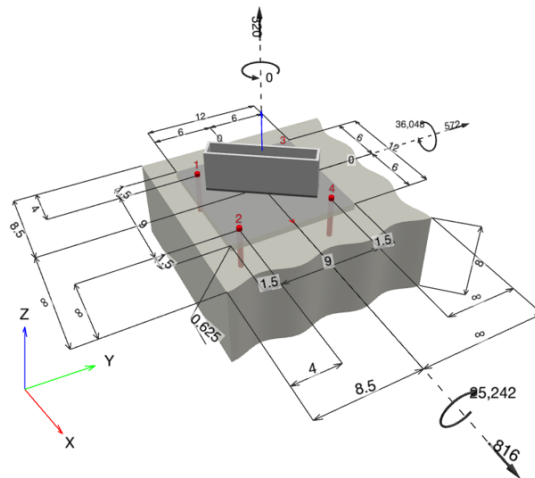
## 1 Anchor Design

### 1.1 Input data

|                                   |                                                                                                                            |
|-----------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| Anchor type and diameter:         | Embed plate D1.1 GR. B 1/2                                                                                                 |
| Item number:                      | not available                                                                                                              |
| Specification text:               | Ø 1/2 IN EMBED PLATE D1.1 GR. B WITH 4 IN NOMINAL EMBEDMENT DEPTH PER TECHNICAL DATA , CAST IN PLACE INSTALLATION PER MPII |
| Effective embedment depth:        | $h_{ef} = 4.000$ in.                                                                                                       |
| Material:                         |                                                                                                                            |
| Evaluation Service Report:        | Hilti Technical Data                                                                                                       |
| Issued   Valid:                   | -   -                                                                                                                      |
| Proof:                            | Design Method ACI 318-19 / CIP                                                                                             |
| Shear edge breakout verification: | Row closest to edge (Case 3 only from ACI 318-19 Fig. R.17.7.2.1b)                                                         |
| Stand-off installation:           | $e_b = 0.000$ in. (no stand-off); $t = 0.625$ in.                                                                          |
| Anchor plate <sup>CBFEM</sup> :   | $l_x \times l_y \times t = 12.000$ in. x $12.000$ in. x $0.625$ in.;                                                       |
| Profile:                          | Rectangular HSS (AISC), HSS10X2X.250; (L x W x T) = $10.000$ in. x $2.000$ in. x $0.250$ in.                               |
| Base material:                    | cracked concrete, 2000, $f'_c = 2,000$ psi; $h = 8.000$ in.                                                                |
| Reinforcement:                    | tension: not present, shear: not present;<br>edge reinforcement: none or < No. 4 bar                                       |

<sup>CBFEM</sup> - The anchor calculation is based on a component-based Finite Element Method (CBFEM)

### Geometry [in.] & Loading [lb, in.lb]



Input data and results must be checked for conformity with the existing conditions and for plausibility!  
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### 1.1.1 Design results

| Case | Description   | Forces [lb] / Moments [in.lb]                                                                                                  | Seismic | Max. Util. Anchor [%] |
|------|---------------|--------------------------------------------------------------------------------------------------------------------------------|---------|-----------------------|
| 1    | Combination 1 | N = 320; V <sub>x</sub> = 816; V <sub>y</sub> = 572;<br>M <sub>x</sub> = -25,242; M <sub>y</sub> = 36,048; M <sub>z</sub> = 0; | no      | 80                    |

### 1.2 Load case/Resulting anchor forces

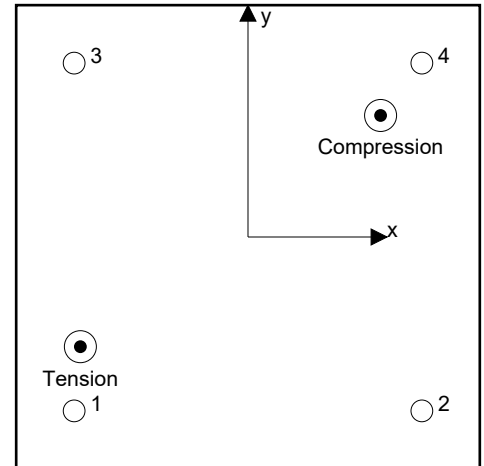
#### Anchor reactions [lb]

Tension force: (+Tension, -Compression)

| Anchor | Tension force | Shear force | Shear force x | Shear force y |
|--------|---------------|-------------|---------------|---------------|
| 1      | 3,709         | 260         | 211           | 152           |
| 2      | 83            | 243         | 200           | 138           |
| 3      | 858           | 243         | 200           | 137           |
| 4      | -1            | 250         | 204           | 144           |

Resulting tension force in (x/y)=(-4.339/-2.839): 4,650 [lb]

Resulting compression force in (x/y)=(3.432/3.145): 4,465 [lb]



Anchor forces are calculated based on a component-based Finite Element Method (CBFEM)

### 1.3 Tension load

|                                          | Load N <sub>ua</sub> [lb] | Capacity $\phi N_n$ [lb] | Utilization $\beta_N = N_{ua}/\phi N_n$ | Status |
|------------------------------------------|---------------------------|--------------------------|-----------------------------------------|--------|
| Steel Strength*                          | 3,709                     | 9,555                    | 39                                      | OK     |
| Pullout Strength*                        | 3,709                     | 6,597                    | 57                                      | OK     |
| Concrete Breakout Failure**              | 4,651                     | 5,838                    | 80                                      | OK     |
| Concrete Side-Face Blowout, direction ** | N/A                       | N/A                      | N/A                                     | N/A    |

\* highest loaded anchor \*\*anchor group (anchors in tension)



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### 1.3.1 Steel Strength

$$N_{sa} = A_{se,N} f_{uta} \quad \text{ACI 318-19 Eq. (17.6.1.2)}$$

$$\phi N_{sa} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

#### Variables

| $A_{se,N} [\text{in.}^2]$ | $f_{uta} [\text{psi}]$ |
|---------------------------|------------------------|
| 0.20                      | 65,000                 |

#### Calculations

| $N_{sa} [\text{lb}]$ |
|----------------------|
| 12,740               |

#### Results

| $N_{sa} [\text{lb}]$ | $\phi_{\text{steel}}$ | $\phi N_{sa} [\text{lb}]$ | $N_{ua} [\text{lb}]$ |
|----------------------|-----------------------|---------------------------|----------------------|
| 12,740               | 0.750                 | 9,555                     | 3,709                |

### 1.3.2 Pullout Strength

$$N_{pN} = \psi_{c,p} N_p \quad \text{ACI 318-19 Eq. (17.6.3.1)}$$

$$N_p = 8 A_{brg} f'_c \quad \text{ACI 318-19 Eq. (17.6.3.2.2a)}$$

$$\phi N_{pN} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

#### Variables

| $\psi_{c,p}$ | $A_{brg} [\text{in.}^2]$ | $\lambda_a$ | $f'_c [\text{psi}]$ |
|--------------|--------------------------|-------------|---------------------|
| 1.000        | 0.59                     | 1.000       | 2,000               |

#### Calculations

| $N_p [\text{lb}]$ |
|-------------------|
| 9,424             |

#### Results

| $N_{pn} [\text{lb}]$ | $\phi_{\text{concrete}}$ | $\phi N_{pn} [\text{lb}]$ | $N_{ua} [\text{lb}]$ |
|----------------------|--------------------------|---------------------------|----------------------|
| 9,424                | 0.700                    | 6,597                     | 3,709                |

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### 1.3.3 Concrete Breakout Failure

$$N_{cbg} = \left( \frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \quad \text{ACI 318-19 Eq. (17.6.2.1b)}$$

$$\phi N_{cbg} \geq N_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left( \frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left( \frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left( \frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

#### Variables

| $h_{ef}$ [in.] | $e_{c1,N}$ [in.] | $e_{c2,N}$ [in.] | $c_{a,min}$ [in.] | $\psi_{c,N}$ |
|----------------|------------------|------------------|-------------------|--------------|
| 4.000          | 2.839            | 1.339            | 4.000             | 1.000        |
| $c_{ac}$ [in.] | $k_c$            | $\lambda_a$      | $f_c$ [psi]       |              |
| -              | 24               | 1.000            | 2,000             |              |

#### Calculations

| $A_{Nc}$ [in. <sup>2</sup> ] | $A_{Nc0}$ [in. <sup>2</sup> ] | $\psi_{ec1,N}$ | $\psi_{ec2,N}$ | $\psi_{ed,N}$ | $\psi_{cp,N}$ | $N_b$ [lb] |
|------------------------------|-------------------------------|----------------|----------------|---------------|---------------|------------|
| 280.00                       | 144.00                        | 0.679          | 0.818          | 0.900         | 1.000         | 8,586      |

#### Results

| $N_{cbg}$ [lb] | $\phi_{concrete}$ | $\phi N_{cbg}$ [lb] | $N_{ua}$ [lb] |
|----------------|-------------------|---------------------|---------------|
| 8,340          | 0.700             | 5,838               | 4,651         |



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### 1.4 Shear load

|                                         | Load $V_{ua}$ [lb] | Capacity $\phi V_n$ [lb] | Utilization $\beta_v = V_{ua} / \phi V_n$ | Status |
|-----------------------------------------|--------------------|--------------------------|-------------------------------------------|--------|
| Steel Strength*                         | 260                | 8,281                    | 4                                         | OK     |
| Steel failure (with lever arm)*         | N/A                | N/A                      | N/A                                       | N/A    |
| Pryout Strength**                       | 996                | 27,123                   | 4                                         | OK     |
| Concrete edge failure in direction y-** | 816                | 5,950                    | 14                                        | OK     |

\* highest loaded anchor \*\*anchor group (relevant anchors)

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

#### 1.4.1 Steel Strength

$$V_{sa} = A_{se,V} f_{uta} \quad \text{ACI 318-19 Eq. (17.7.1.2a)}$$

$$\phi V_{steel} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

#### Variables

| $A_{se,V}$ [in. <sup>2</sup> ] | $f_{uta}$ [psi] |
|--------------------------------|-----------------|
| 0.20                           | 65,000          |

#### Calculations

| $V_{sa}$ [lb] |
|---------------|
| 12,740        |

#### Results

| $V_{sa}$ [lb] | $\phi_{steel}$ | $\phi V_{sa}$ [lb] | $V_{ua}$ [lb] |
|---------------|----------------|--------------------|---------------|
| 12,740        | 0.650          | 8,281              | 260           |

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### 1.4.2 Pryout Strength

$$V_{cp} = k_{cp} \left[ \left( \frac{A_{Nc}}{A_{Nc0}} \right) \psi_{ec,N} \psi_{ed,N} \psi_{c,N} \psi_{cp,N} N_b \right] \quad \text{ACI 318-19 Eq. (17.7.3.1b)}$$

$$\phi V_{cp} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Nc} \text{ see ACI 318-19, Section 17.6.2.1, Fig. R 17.6.2.1(b)}$$

$$A_{Nc0} = 9 h_{ef}^2 \quad \text{ACI 318-19 Eq. (17.6.2.1.4)}$$

$$\psi_{ec,N} = \left( \frac{1}{1 + \frac{2 e_N}{3 h_{ef}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.3.1)}$$

$$\psi_{ed,N} = 0.7 + 0.3 \left( \frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.4.1b)}$$

$$\psi_{cp,N} = \text{MAX} \left( \frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.6.2.6.1b)}$$

$$N_b = k_c \lambda_a \sqrt{f'_c} h_{ef}^{1.5} \quad \text{ACI 318-19 Eq. (17.6.2.2.1)}$$

#### Variables

| $k_{cp}$     | $h_{ef}$ [in.] | $e_{c1,N}$ [in.] | $e_{c2,N}$ [in.] | $c_{a,min}$ [in.] |
|--------------|----------------|------------------|------------------|-------------------|
| 2            | 4.000          | 0.000            | 0.000            | 4.000             |
| $\psi_{c,N}$ | $c_{ac}$ [in.] | $k_c$            | $\lambda_a$      | $f'_c$ [psi]      |
| 1.000        | -              | 24               | 1.000            | 2,000             |

#### Calculations

| $A_{Nc}$ [in. <sup>2</sup> ] | $A_{Nc0}$ [in. <sup>2</sup> ] | $\psi_{ec1,N}$ | $\psi_{ec2,N}$ | $\psi_{ed,N}$ | $\psi_{cp,N}$ | $N_b$ [lb] |
|------------------------------|-------------------------------|----------------|----------------|---------------|---------------|------------|
| 361.00                       | 144.00                        | 1.000          | 1.000          | 0.900         | 1.000         | 8,586      |

#### Results

| $V_{cp}$ [lb] | $\phi_{concrete}$ | $\phi V_{cp}$ [lb] | $V_{ua}$ [lb] |
|---------------|-------------------|--------------------|---------------|
| 38,747        | 0.700             | 27,123             | 996           |

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### 1.4.3 Concrete edge failure in direction y-

$$V_{cbg} = \left( \frac{A_{Vc}}{A_{Vc0}} \right) \psi_{ec,V} \psi_{ed,V} \psi_{c,V} \psi_{h,V} \psi_{parallel,V} V_b \quad \text{ACI 318-19 Eq. (17.7.2.1b)}$$

$$\phi V_{cbg} \geq V_{ua} \quad \text{ACI 318-19 Table 17.5.2}$$

$$A_{Vc} \text{ see ACI 318-19, Section 17.7.2.1, Fig. R 17.7.2.1(b)*}$$

$$A_{Vc0} = 4.5 c_{a1}^2 \quad \text{ACI 318-19 Eq. (17.7.2.1.3)}$$

$$\psi_{ec,V} = \left( \frac{1}{1 + \frac{e_v}{1.5c_{a1}}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.3.1)}$$

$$\psi_{ed,V} = 0.7 + 0.3 \left( \frac{c_{a2}}{1.5c_{a1}} \right) \leq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.4.1b)}$$

$$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0 \quad \text{ACI 318-19 Eq. (17.7.2.6.1)}$$

$$V_b = \left( 7 \left( \frac{l_e}{d_a} \right)^{0.2} \sqrt{d_a} \right) \lambda_a \sqrt{f'_c} c_{a1}^{1.5} \quad \text{ACI 318-19 Eq. (17.7.2.2.1a)}$$

#### Variables

| $c_{a1}$ [in.] | $c_{a2}$ [in.] | $e_{cV}$ [in.] | $\psi_{c,V}$ | $h_a$ [in.]         |
|----------------|----------------|----------------|--------------|---------------------|
| 4.000          | 4.000          | 0.000          | 1.000        | 8.000               |
| $l_e$ [in.]    | $\lambda_a$    | $d_a$ [in.]    | $f'_c$ [psi] | $\psi_{parallel,V}$ |
| 4.000          | 1.000          | 0.500          | 2,000        | 2.000               |

#### Calculations

| $A_{Vc}$ [in. <sup>2</sup> ] | $A_{Vc0}$ [in. <sup>2</sup> ] | $\psi_{ec,V}$ | $\psi_{ed,V}$ | $\psi_{h,V}$ | $V_b$ [lb] |
|------------------------------|-------------------------------|---------------|---------------|--------------|------------|
| 114.00                       | 72.00                         | 1.000         | 1.000         | 1.000        | 2,684      |

#### Results

| $V_{cbg}$ [lb] | $\phi_{concrete}$ | $\phi V_{cbg}$ [lb] | $V_{ua}$ [lb] |
|----------------|-------------------|---------------------|---------------|
| 8,500          | 0.700             | 5,950               | 816           |

\*Anchor row defined by: Anchor 1, 2; Case 3 controls

When the input edge distance is set to "infinity", edge breakout verification is not performed in that direction

### 1.5 Combined tension and shear loads, per ACI 318-19 section 17.8

| $\beta_N$ | $\beta_V$ | $\zeta$ | Utilization $\beta_{N,V}$ [%] | Status |
|-----------|-----------|---------|-------------------------------|--------|
| 0.797     | 0.137     | 5/3     | 73                            | OK     |

$$\beta_{NV} = \beta_N^\zeta + \beta_V^\zeta \leq 1$$



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## 1.6 Warnings

- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (EN1992-4, ACI318, IS1946, AS 5216:2021, ETAG 001/Annex C, EOTA TR029 etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with CBFEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid base plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- The equations presented in this report are based on imperial units. When inputs are displayed in metric units, the user should be aware that the equations remain in their imperial format.
- Condition A applies where the potential concrete failure surfaces are crossed by supplementary reinforcement proportioned to tie the potential concrete failure prism into the structural member. Condition B applies where such supplementary reinforcement is not provided, or where pullout or pryout strength governs.
- For additional information about ACI 318 strength design provisions, please go to <https://viewer.joomag.com/profis-design-guide-us-en-summer-2021/0841849001625154758?short&/>
- Attention! In case of compressive anchor forces a buckling check as well as the proof of the local load transfer into and within the base material (incl. punching) has to be done separately.
- The anchor design methods in PROFIS Engineering require rigid anchor plates per current regulations (EN1992-4, AS5216, etc.). This means load re-distribution on the anchors due to elastic deformations of the anchor plate are not considered - the anchor plate is assumed to be sufficiently stiff, in order not to be deformed when subjected to the design loading. PROFIS Engineering calculates the minimum required anchor plate thickness with FEM to limit the stress of the anchor plate based on the assumptions explained above. The proof if the rigid anchor plate assumption is valid is not carried out by PROFIS Engineering. Input data and results must be checked for agreement with the existing conditions and for plausibility!

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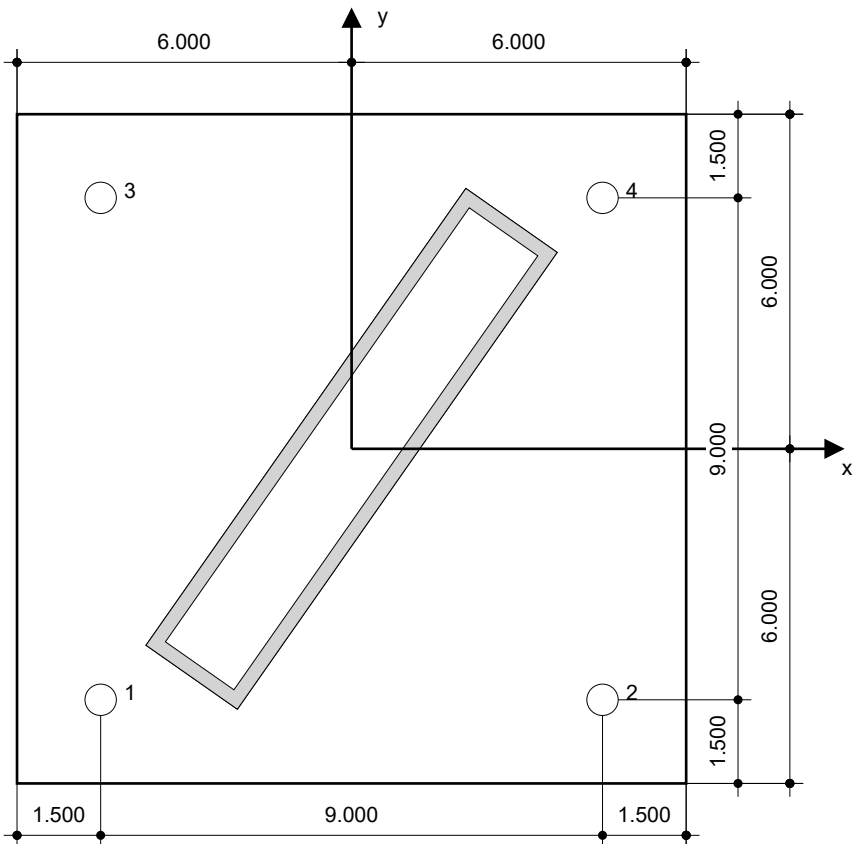
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1.7 Installation data

Profile: Rectangular HSS (AISC), HSS10X2X.250; (L x W x T) = 10.000 in. x 2.000 in. x 0.250 in.  
Hole diameter in the fixture:  $d_f = 0.562$  in.  
Plate thickness (input): 0.625 in.

Anchor type and diameter: Embed plate D1.1 GR. B 1/2  
Item number: not available  
Maximum installation torque: -  
Hole diameter in the base material: - in.  
Hole depth in the base material: 4.000 in.  
Minimum thickness of the base material: 4.813 in.

Ø 1/2 in Embed plate D1.1 GR. B with 4 in nominal embedment depth per Technical data , cast in place installation per MPII



Coordinates Anchor [in.]

| Anchor | x      | y      | c <sub>-x</sub> | c <sub>+x</sub> | c <sub>-y</sub> | c <sub>+y</sub> |
|--------|--------|--------|-----------------|-----------------|-----------------|-----------------|
| 1      | -4.500 | -4.500 | 4.000           | -               | 4.000           | -               |
| 2      | 4.500  | -4.500 | 13.000          | -               | 4.000           | -               |
| 3      | -4.500 | 4.500  | 4.000           | -               | 13.000          | -               |
| 4      | 4.500  | 4.500  | 13.000          | -               | 13.000          | -               |

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## 2 Anchor plate design

### 2.1 Input data

|                                  |                                                                                                                                                                                                                                                                                |
|----------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Anchor plate:                    | Shape: Rectangular<br>$I_x \times I_y \times t = 12.000 \text{ in} \times 12.000 \text{ in} \times 0.625 \text{ in}$<br>Calculation: CBFEM<br>Material: ASTM A36; $F_y = 36,000 \text{ psi}$ ; $\epsilon_{lim} = 5.00\%$                                                       |
| Anchor type and size:            | Embed plate D1.1 GR. B 1/2, $h_{ef} = 4.000 \text{ in}$                                                                                                                                                                                                                        |
| Anchor stiffness:                | The anchor is modeled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results. |
| Design method:                   | AISC and LRFD-based design using component-based FEM                                                                                                                                                                                                                           |
| Stand-off installation:          | $e_b = 0.000 \text{ in}$ (No stand-off); $t = 0.625 \text{ in}$                                                                                                                                                                                                                |
| Profile:                         | HSS10X2X.250; (L x W x T x FT) = 10.000 in x 2.000 in x 0.250 in x -<br>Material: ASTM A500 Gr.B Rect; $F_y = 46,000 \text{ psi}$ ; $\epsilon_{lim} = 5.00\%$<br>Eccentricity x: 0.000 in<br>Eccentricity y: 0.000 in                                                          |
| Base material:                   | Cracked concrete; 2000; $f_{c,cyl} = 2,000 \text{ psi}$ ; $h = 8.000 \text{ in}$                                                                                                                                                                                               |
| Welds (profile to anchor plate): | Type of redistribution: Plastic<br>Material: E70xx                                                                                                                                                                                                                             |
| Mesh size:                       | Number of elements on edge: 8<br>Min. size of element: 0.394 in<br>Max. size of element: 1.969 in                                                                                                                                                                              |



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| Fastening point: |                                    |            |           |

2.2 Summary

| Description |               | Profile             |                        | Anchor plate        |                        | Concrete [%]     |   |
|-------------|---------------|---------------------|------------------------|---------------------|------------------------|------------------|---|
|             |               | $\sigma_{Ed}$ [psi] | $\varepsilon_{Pl}$ [%] | $\sigma_{Ed}$ [psi] | $\varepsilon_{Pl}$ [%] | Hole bearing [%] |   |
| 1           | Combination 1 | 14,439              | 0.00                   | 13,403              | 0.00                   | 1                | 7 |

2.3 Anchor plate classification

Results below are displayed for the decisive load combinations: Combination 1

| Anchor tension forces | Equivalent rigid anchor plate (CBFEM) | Component-based Finite Element Method (CBFEM) anchor plate design |
|-----------------------|---------------------------------------|-------------------------------------------------------------------|
| Anchor 1              | 3,033 lb                              | 3,709 lb                                                          |
| Anchor 2              | 468 lb                                | 83 lb                                                             |
| Anchor 3              | 1,267 lb                              | 858 lb                                                            |
| Anchor 4              | -1 lb                                 | -1 lb                                                             |

User accepted to consider the selected anchor plate as rigid by his/her engineering judgement. This means the anchor design guidelines can be applied.



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2.4 Profile/Stiffeners/Plate

Profile and stiffeners are verified at the level of the steel to concrete connection. The connection design does not replace the steel design for critical cross sections, which should be performed outside of PROFIS Engineering.

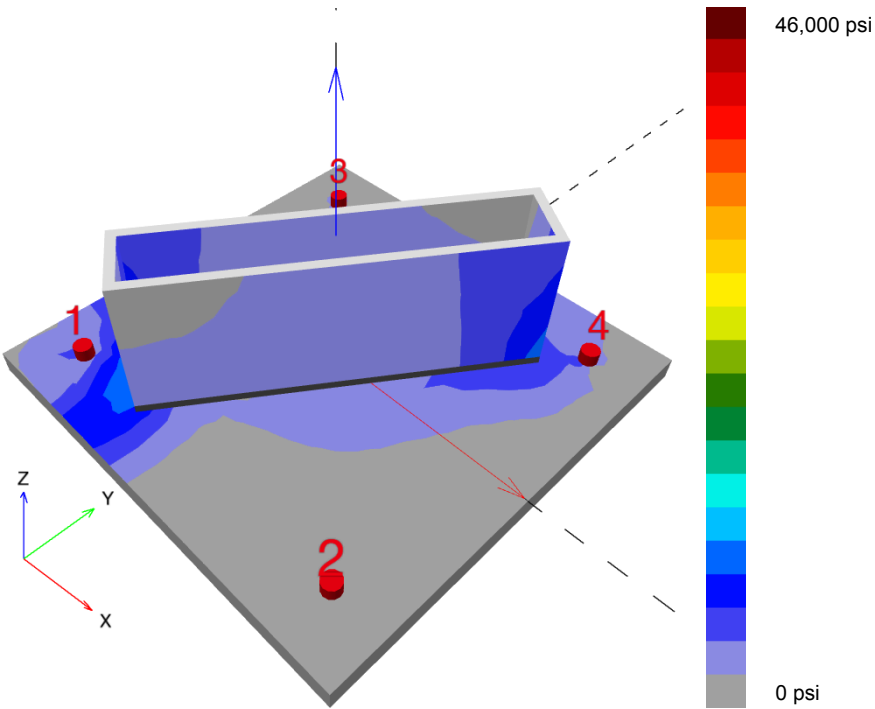
2.4.1 Equivalent stress and plastic strain

| Part    | Load combination | Material            | $f_y$ [psi] | $\epsilon_{lim}$ [%] | $\sigma_{Ed}$ [psi] | $\epsilon_{Pl}$ [%] | Status |
|---------|------------------|---------------------|-------------|----------------------|---------------------|---------------------|--------|
| Plate   | Combination 1    | ASTM A36            | 36,000      | 5.00                 | 13,403              | 0.00                | OK     |
| Profile | Combination 1    | ASTM A500 Gr.B Rect | 46,000      | 5.00                 | 14,439              | 0.00                | OK     |
| Profile | Combination 1    | ASTM A500 Gr.B Rect | 46,000      | 5.00                 | 9,033               | 0.00                | OK     |
| Profile | Combination 1    | ASTM A500 Gr.B Rect | 46,000      | 5.00                 | 8,698               | 0.00                | OK     |
| Profile | Combination 1    | ASTM A500 Gr.B Rect | 46,000      | 5.00                 | 10,681              | 0.00                | OK     |

|                  |                                    |            |           |
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| Fastening point: |                                    |            |           |

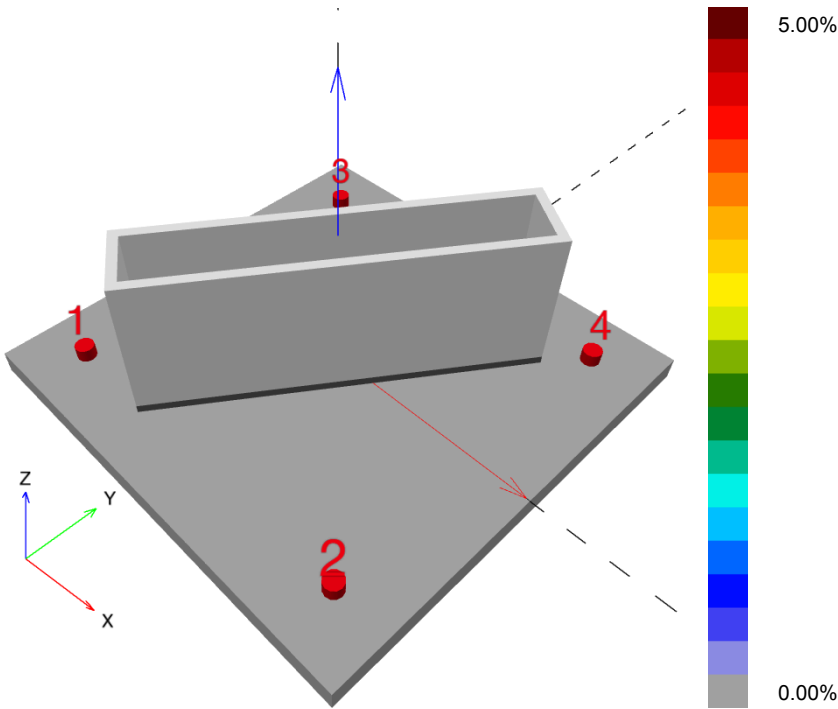
#### 2.4.1.1 Equivalent stress

Results below are displayed for the decisive load combination: 1 - Combination 1



### 2.4.1.2 Plastic strain

Results below are displayed for the decisive load combination: 1 - Combination 1





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| Fastening point: |                                    |            |           |

### 2.4.2 Plate hole bearing resistance, AISC 360-16 Section J3

Decisive load combination: 1 - Combination 1

#### Equations

$$R_n = \min(1.2 l_c t F_u, 2.4 d t F_u) \text{ (AISC 360-16 J3-6a, c)}$$

$$\phi R_n = 0.75 R_n$$

$$V \leq \phi R_n$$

#### Variables

|          | $l_c$ [in] | $t$ [in] | $F_u$ [psi] | $d$ [in] | $R_n$ [lb] |
|----------|------------|----------|-------------|----------|------------|
| Anchor 1 | 1.568      | 0.625    | 58,000      | 0.500    | 43,514     |
| Anchor 2 | 2.359      | 0.625    | 58,000      | 0.500    | 43,514     |
| Anchor 3 | 1.537      | 0.625    | 58,000      | 0.500    | 43,514     |
| Anchor 4 | 12.572     | 0.625    | 58,000      | 0.500    | 43,514     |

#### Results

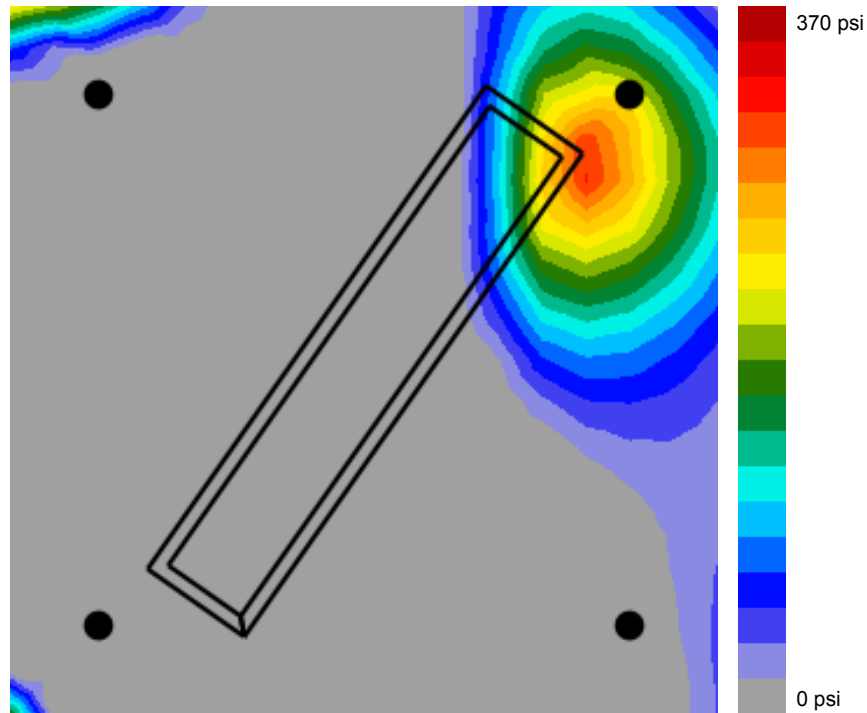
|          | $V$ [lb] | $\phi R_n$ [lb] | Utilization [%] | Status |
|----------|----------|-----------------|-----------------|--------|
| Anchor 1 | 260      | 32,635          | 1               | OK     |
| Anchor 2 | 243      | 32,635          | 1               | OK     |
| Anchor 3 | 243      | 32,635          | 1               | OK     |
| Anchor 4 | 250      | 32,635          | 1               | OK     |

|                  |                                    |            |           |
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| Fastening point: |                                    |            |           |

## 2.5 Concrete

Decisive load combination: 1 - Combination 1

### 2.5.1 Compression in concrete under the anchor plate



### 2.5.2 Concrete block compressive strength resistance check, AISC 360-16 Section J8

#### Equations

$$F_p = \phi f_{p,max}$$

$$f_{p,max} = 0.85 f'_c \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 1.7 f'_c; \sqrt{\left(\frac{A_2}{A_1}\right)} \leq 2$$

$$\sigma = \frac{N}{A_1}$$

$$\text{Utilization} = \frac{\sigma}{F_p}$$



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| Fastening point: |                                    |            |           |

Variables

| N [lb] | $f_c'$ [psi] | $\phi$ | $A_1$ [in <sup>2</sup> ] | $A_2$ [in <sup>2</sup> ] |
|--------|--------------|--------|--------------------------|--------------------------|
| 4,465  | 2,000        | 0.65   | 32.69                    | 126.96                   |

Results

| Load combination | $F_p$ [psi] | $\sigma$ [psi] | Utilization [%] | Status |
|------------------|-------------|----------------|-----------------|--------|
| Combination 1    | 2,178       | 137            | 7               | OK     |

|                  |                                    |            |           |
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| Fastening point: |                                    |            |           |

## 2.6 Symbol explanation

|                     |                                                                                                                                       |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------|
| $A_1$               | Loaded area of concrete                                                                                                               |
| $A_2$               | Supporting area                                                                                                                       |
| $d$                 | Nominal diameter of the bolt                                                                                                          |
| $\varepsilon_{lim}$ | Limit plastic strain                                                                                                                  |
| $\varepsilon_{PI}$  | Plastic strain from CBFEM results                                                                                                     |
| $f_c$               | Concrete compressive strength                                                                                                         |
| $f'_c$              | Concrete compressive strength                                                                                                         |
| $F_u$               | Specified minimum tensile strength of the connected material                                                                          |
| $F_p$               | Concrete block design bearing strength                                                                                                |
| $f_{p,max}$         | Concrete block design bearing strength maximum                                                                                        |
| $f_y$               | Yield strength                                                                                                                        |
| $l_c$               | Clear distance, in the direction of the force, between the edge of the hole and the edge of the adjacent hole or edge of the material |
| $N$                 | Resulting compression force                                                                                                           |
| $\sigma$            | Average stress in concrete                                                                                                            |
| $\sigma_{Ed}$       | Equivalent stress                                                                                                                     |
| $\phi$              | Resistance factor                                                                                                                     |
| $\phi R_n$          | Factored resistance                                                                                                                   |
| $t$                 | Thickness of the anchor plate                                                                                                         |
| $V$                 | Resultant of shear forces $V_y, V_z$ in bolt.                                                                                         |

## 2.7 Warnings

- By using the CBFEM calculation functionality of PROFIS Engineering you may act outside the applicable design codes and your specified anchor plate may not behave rigid. Please, validate the results with a professional designer and/or structural engineer to ensure suitability and adequacy for your specific jurisdiction and project requirements.
- The anchor is modeled considering stiffness values determined from load displacement curves tested in an independent laboratory. Please note that no simple replacement of the anchor is possible as the anchor stiffness has a major impact on the load distribution results.



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### 3 Summary of results

Design of the anchor plate, anchors, welds and other elements are based on CBFEM (component based finite element method) and AISC.

|              | Load combination | Max. utilization | Status |
|--------------|------------------|------------------|--------|
| Anchors      | Combination 1    | 80%              | OK     |
| Anchor plate | Combination 1    | 38%              | OK     |
| Concrete     | Combination 1    | 7%               | OK     |
| Profile      | Combination 1    | 32%              | OK     |

**Fastening meets the design criteria!**



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4 Remarks; Your Cooperation Duties

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## Weld Design For Tube

### MATERIALS:

Electrodes:

E 70 XX ----Fu= 70 Ksi

E 60 XX ----Fu= 60 Ksi

### Weld and Section Data:

$F_u := 70.00$  Ultimate Tensile Strength (ksi)

$b := 8.00$  Width of Tube Steel (in)

$d := 2.00$  Depth of Tube Steel (in)

### Load Data:

$M_{weld} := 2.292$  Moment (Kips-ft)

$V_{weld} := 0.6225$  Shear (Kips)

$P_{weld} := 0.200$  Tension or Compression (Kips)

$T_{weld} := 0.00$  Torsional Moment (kips-ft)

### Check Weld Section :

$F_v := 0.3 \cdot F_u$   $F_v = 21.00$  ksi

$$t_e := \begin{cases} x \leftarrow 0.00001 \\ \text{while } \sqrt{\left[ \frac{P_{weld}}{2(b+d) \cdot x} + \frac{M_{weld} \cdot 12}{\left(b \cdot d + \frac{d^2}{3}\right) \cdot x} \right]^2 + \left[ \frac{1.5V_{weld}}{2(b+d) \cdot x} + \frac{T_{weld} \cdot 12 \cdot \sqrt{\left(\frac{b}{2}\right)^2 + \left(\frac{d}{2}\right)^2}}{\frac{(b+d)^3}{6} \cdot x} \right]^2} \geq F_v \\ x \leftarrow x + 0.01 \end{cases}$$

$t_e = 0.08$  in

$$S_{weld} := \left(b \cdot d + \frac{d^2}{3}\right) \cdot t_e$$

$S_{weld} = 1.39$  in<sup>3</sup>

$$A_{weld} := 2 \cdot (d + b) \cdot t_e$$

$A_{weld} = 1.60$  in<sup>2</sup>

$$J_{weld} := \frac{(b+d)^3}{6} \cdot t_e$$

$J_{weld} = 13.33$  in<sup>3</sup>

### Check Bending Stress :

$$f_b := \frac{M_{\text{weld}} \cdot (12)}{S_{\text{weld}}}$$

$$f_b = 19.83 \quad \text{ksi}$$

### Check Shear Stress :

$$f_v := \frac{1.5V_{\text{weld}}}{A_{\text{weld}}} + \frac{T_{\text{weld}} \cdot 12 \cdot \sqrt{\left(\frac{b}{2}\right)^2 + \left(\frac{d}{2}\right)^2}}{J_{\text{weld}}}$$

$$f_v = 0.58 \quad \text{ksi}$$

### Check Tension Stress :

$$f_a := \frac{P_{\text{weld}}}{A_{\text{weld}}}$$

$$f_a = 0.12 \quad \text{Ksi}$$

### Check Combined Stress :

$$f_{\text{weld}} := \sqrt{(f_b + f_a)^2 + f_v^2}$$

$$f_{\text{weld}} = 19.97 \quad \text{ksi}$$

$$\text{STRESS} := \begin{cases} \text{"N.G."} \\ \text{"OK"} & \text{if } F_v \geq f_{\text{weld}} \end{cases}$$

$$\text{STRESS} = \text{"OK"}$$

$$W_{\text{weld}} := \begin{cases} \text{"3/16"} & \text{if } \frac{t_e}{0.707} \leq 0.1875 \\ \text{"1/4"} & \text{if } 0.1875 < \frac{t_e}{0.707} \leq 0.25 \\ \text{"3/8"} & \text{if } 0.25 < \frac{t_e}{0.707} \leq 0.375 \\ \text{"1/2"} & \text{if } 0.375 < \frac{t_e}{0.707} \leq 0.50 \\ \text{"5/8"} & \text{if } 0.50 < \frac{t_e}{0.707} \leq 0.625 \\ \text{"3/4"} & \text{if } 0.625 < \frac{t_e}{0.707} \leq 0.750 \\ \text{"1"} & \text{if } 0.75 < \frac{t_e}{0.707} \leq 1.00 \end{cases}$$

$$W_{\text{weld}} = \text{"3/16"}$$



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# GLASS RAILING AT STAIR DESIGN

## Glass Effective Laminated Thickness

### Laminate Glass Data:

$$E := 10400 \text{ ksi}$$

Young Modulus of Elasticity of Glass E MPa  
**For Soda Lime Glass:** E=10 400 Ksi (71705.5 MPa)

$$h_v := 0.06 \text{ in}$$

Interlayer Thickness (in)

$$h_1 := 0.219 \text{ in}$$

Glass Ply 1 Minimum Thickness (in) (See ASTM E1300-09a Table 4)

$$h_2 := 0.219 \text{ in}$$

Glass Ply 2 Minimum Thickness (in) (See ASTM E1300-09a Table 4)

$$a := 40 \text{ in}$$

Length Scale (Smallest in-Plane Dimension of the Laminate Plate (in))

$$G := 3830 \text{ psi}$$

Interlayer Storage Shear Modulus G=3830 psi (For Wind 3s/50 Celcius)  
**For Exterior:** SentryGlass 1,640 psi (11.3 MPa) PVB 70 psi (0.48 MPa)  
**For Interior:** SentryGlass 3830 psi (26.4 MPa) PVB 140 psi (0.96 MPa)

### Then

$$h_s := 0.5 \cdot (h_1 + h_2) + h_v$$

$$h_s = 0.279 \text{ in}$$

$$h_{s,1} := \frac{h_s \cdot h_1}{h_1 + h_2}$$

$$h_{s,1} = 0.140 \text{ in}$$

$$h_{s,2} := \frac{h_s \cdot h_2}{h_1 + h_2}$$

$$h_{s,2} = 0.140 \text{ in}$$

$$I_s := h_1 \cdot h_{s,2}^2 + h_2 \cdot h_{s,1}^2$$

$$I_s = 0.009 \text{ in} \cdot \text{in} \cdot \text{in}$$

$$\Gamma := \frac{1}{1 + \frac{9.6 \cdot E \cdot I_s \cdot h_v}{G \cdot h_s^2 \cdot a^2}}$$

$$\Gamma = 0.903$$

### Laminate Effective Thickness For Deflection

$$h_{efw} := \sqrt[3]{h_1^3 + h_2^3 + 12 \cdot \Gamma \cdot I_s}$$

$$h_{efw} = 0.484 \text{ in}$$

### Laminate Effective Thickness For Bending Stress

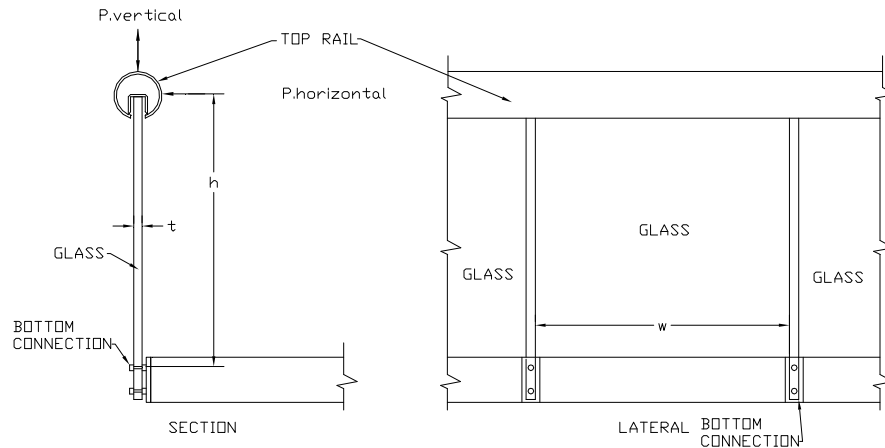
$$h_{l,ef\sigma} := \sqrt{\frac{h_{efw}^3}{\max(h_1, h_2) + 2 \cdot \Gamma \cdot \max(h_{s,1}, h_{s,2})}}$$

$$h_{l,ef\sigma} = 0.491 \text{ in}$$

**TABLE 4 Nominal and Minimum Glass Thicknesses**

| Nominal<br>Thickness or<br>Designation,<br>mm (in.) | Minimum<br>Thickness,<br>mm (in.) |
|-----------------------------------------------------|-----------------------------------|
| 2.5 ( $\frac{3}{32}$ )                              | 2.16 (0.085)                      |
| 2.7 (lami)                                          | 2.59 (0.102)                      |
| 3.0 ( $\frac{1}{8}$ )                               | 2.92 ( 0.115)                     |
| 4.0 ( $\frac{5}{32}$ )                              | 3.78 ( 0.149)                     |
| 5.0 ( $\frac{3}{16}$ )                              | 4.57 (0.180)                      |
| 6.0 ( $\frac{1}{4}$ )                               | 5.56 (0.219)                      |
| 8.0 ( $\frac{5}{16}$ )                              | 7.42 (0.292)                      |
| 10.0 ( $\frac{3}{8}$ )                              | 9.02 (0.355)                      |
| 12.0 ( $\frac{1}{2}$ )                              | 11.91 (0.469)                     |
| 16.0 ( $\frac{5}{8}$ )                              | 15.09 (0.595)                     |
| 19.0 ( $\frac{3}{4}$ )                              | 18.26 (0.719)                     |
| 22.0 ( $\frac{7}{8}$ )                              | 21.44 (0.844)                     |
| 25.0 (1)                                            | 24.61 (0.969)                     |

## Glass Railing Design w/ Standoff Support



### Loads Data:

$P_{200} := 200.00$  Concentrated Load (lbs)

$q_{50} := 50.00$  Uniform Load (plf)

$q_{wind} := 5.00$  Uniform Distributed Load (psf)

### Glass Data:

$E := 10400000.00$  Modulus of Elasticity of Glass (psi)

$Mr_{flexure} := 24000.00$  Modulus of Rupture of Glass in Flexure For Live Loads (psi)

$F_{b.wind} := 9600.00$  Allowable Stress in Flexure For Wind Loads Per ASTM E1300 (psi)

$Mr_{shear} := 12000.00$  Modulus of Rigidity of glass in Shear (psi)

$SF := 4.00$  Safety Factor

### Geometric Glass Railing Data:

$h := 44.0$  Height of Glass Lite Pannel in Cantilever (in)

$t_s := 0.491$  Effective Thickness of Glass Pannel for Stress (in) Per ASTM E1300 Appendix X9

$t_d := 0.484$  Effective Thickness of Glass Pannel for Deflection (in) Per ASTM E1300 Appendix X9

$w_{min} := 40.0$  **Minimum** Width of Glass Pannel (in)

$w_{max} := 60.00$  **Maximum** Width of Glass Pannel (in)

## Then

$$F_{b.live} := \frac{Mr_{flexure}}{SF}$$

$$F_{b.live} = 6000.00 \text{ psi}$$

$$F_v := \frac{Mr_{shear}}{SF}$$

$$F_v = 3000.00 \text{ psi}$$

$$L := \begin{cases} h \\ w_{min} \text{ if } w_{min} < h \end{cases}$$

$$L = 40.00 \text{ in}$$

$$S_x := \frac{L \cdot t_s^2}{6}$$

$$S_x = 1.61 \text{ in}^3$$

$$I_x := \frac{L \cdot t_s^3}{12}$$

$$I_x = 0.39 \text{ in}^4$$

$$A := L \cdot t_s$$

$$A = 19.64 \text{ in}^2$$

## Actual Glass Moment in Length (L):

Concentrated Load = 200 lbs.

$$M_{200} := P_{200} \cdot h$$

$$M_{200} = 8800.00 \text{ lbs} - \text{in}$$

Uniform Load = 50 plf

$$M_{50} := q_{50} \cdot \frac{L}{12} \cdot h$$

$$M_{50} = 7333.33 \text{ lbs} - \text{in}$$

Uniform Distributed Wind Load

$$M_{wind} := \frac{q_{wind}}{144} \cdot L \cdot \frac{h^2}{2}$$

$$M_{wind} = 1344.44 \text{ lbs} - \text{in}$$

$$M_{Glass.live} := \max(M_{200}, M_{50})$$

$$M_{Glass.live} = 8800.00 \text{ lbs} - \text{in}$$

$$M_{Glass.wind} := M_{wind}$$

$$M_{Glass.wind} = 1344.44 \text{ lbs} - \text{in}$$

$$M_{Glass} := \max(M_{Glass.live}, M_{Glass.wind})$$

$$M_{Glass} = 8800.00 \text{ lbs} - \text{in}$$

### Actual Glass Shear in Length (L):

Concentrated Load = 200 lbs.

$$V_{200} := P_{200}$$

$$V_{200} = 200.00 \quad \text{lbs}$$

Uniform Load = 50 plf

$$V_{50} := q_{50} \cdot \frac{L}{12}$$

$$V_{50} = 166.67 \quad \text{lbs}$$

Uniform Distributed Wind Load

$$V_{\text{wind}} := \frac{q_{\text{wind}}}{144} \cdot L \cdot h$$

$$V_{\text{wind}} = 61.11 \quad \text{lbs}$$

$$V_{\text{Glass}} := \max(V_{200}, V_{50}, V_{\text{wind}})$$

$$V_{\text{Glass}} = 200.00 \quad \text{lbs}$$

### Section Required:

Bending Design:

Section Modulus Required

$$S_{x_r} := \max\left(\frac{M_{\text{Glass.live}}}{F_{b.\text{live}}}, \frac{M_{\text{Glass.wind}}}{F_{b.\text{wind}}}\right)$$

$$S_{x_r} = 1.47 \quad \text{in}^3$$

Shear Design:

Area Required

$$A_r := \frac{V_{\text{Glass}}}{F_v}$$

$$A_r = 0.07 \quad \text{in}^2$$

### Section Provided:

$$\text{BENDING}_{\text{glass}} := \text{if}(S_{x_r} \geq \min(S_x), \text{"N.G"}, \text{"OK"})$$

$$\text{BENDING}_{\text{glass}} = \text{"OK"}$$

$$\text{SHEAR}_{\text{glass}} := \text{if}(A_r \geq A, \text{"N.G"}, \text{"OK"})$$

$$\text{SHEAR}_{\text{glass}} = \text{"OK"}$$

## Check Deflection:

$$\Delta_{\text{allow}} := \frac{h}{30}$$

$$\Delta_{\text{allow}} = 1.47$$

in

$$I_d := \frac{L \cdot t_d^3}{12}$$

$$I_d = 0.38$$

in<sup>4</sup>

$$\Delta_{200} := \frac{P_{200} \cdot h^3}{3E \cdot I_d}$$

$$\Delta_{200} = 1.44$$

in

$$\Delta_{\text{wind}} := \frac{\left( \frac{q_{\text{wind}}}{144} \right) L \cdot h^4}{8E \cdot I_d}$$

$$\Delta_{\text{wind}} = 0.17$$

in

$$\text{DEFLECTION}_{\text{glass}} := \begin{cases} \text{"N.G."} \\ \text{"O.K."} & \text{if } \max(\Delta_{200}, \Delta_{\text{wind}}) \leq \Delta_{\text{allow}} \end{cases}$$

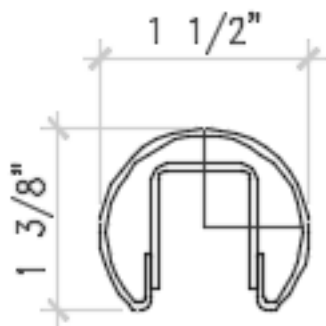
$$\text{DEFLECTION}_{\text{glass}} = \text{"O.K."}$$



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## SECTION PROPERTIES



### TOP RAIL

$$\text{Area} = 0.4003 \text{ in}^2$$

$$I_{xx} = 0.0518 \text{ in}^4$$

$$I_{yy} = 0.0765 \text{ in}^4$$

$$J_z = 0.1283 \text{ in}^4$$

$$P_{xy} = 0.0000 \text{ in}^4$$

$$r_{xx} = 0.3596 \text{ in}$$

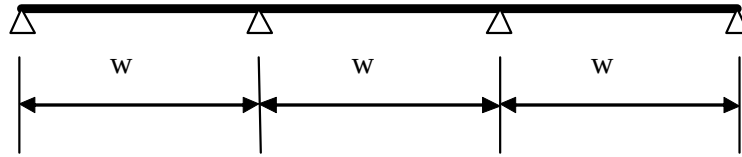
$$r_{yy} = 0.4372 \text{ in}$$

$$S_{xx} \text{ max} = 0.0861 \text{ in}^3$$

$$S_{xx} \text{ min} = 0.0743 \text{ in}^3$$

$$S_{yy} \text{ max} = 0.1020 \text{ in}^3$$

$$S_{yy} \text{ min} = 0.1020 \text{ in}^3$$



Top rail to provide redistribution of load between glass panels & to remain in place in case that one of the glass planes breaks

$F_{b.top} := 34800.00$  Top Railing Allowable Bending Stress (psi)

$F_{v.top} := 23200.00$  Top Railing Allowable Shear Stress (psi)

$S_{x.top} := 0.0743$  Top Railing Inertia Modulus for Vertical Loads (in<sup>3</sup>)

$S_{y.top} := 0.1020$  Top Railing Inertia Modulus for Horizontal Loads (in<sup>3</sup>)

$A_{top} := 0.4003$  Top Railing Area (in<sup>2</sup>)

### Actual Moment:

Concentrated Load = 200 lbs.

$$M_{200.top} := \frac{P_{200} \cdot w_{max}}{5}$$

$M_{200.top} = 2400.00$  lb – in

Uniform Load = 50 plf

$$M_{50.top} := 0.1012 \cdot \frac{q_{50}}{12} \cdot w_{max}^2$$

$M_{50.top} = 1518.00$  lb – in

$$M_{actual.top} := \max(M_{200.top}, M_{50.top})$$

$M_{actual.top} = 2400.00$  lb – in

### Actual Shear:

Concentrated Load = 200 lbs.

$$V_{200.top} := P_{200}$$

$$V_{200.top} = 200.00 \quad \text{lbs}$$

Uniform Load = 50 plf

$$V_{50.top} := 0.6 \cdot \frac{q_{50}}{12} \cdot w_{max}$$

$$V_{50.top} = 150.00 \quad \text{lbs}$$

$$V_{actual.top} := \max(V_{200.top}, V_{50.top})$$

$$V_{actual.top} = 200.00 \quad \text{lbs}$$

### Section Required:

Bending Design:

Section Modulus Required

$$S_{hr} := \frac{M_{actual.top}}{F_{b.top}}$$

$$S_{hr} = 0.07 \quad \text{in}^3$$

Shear Design:

Area Required

$$A_{hr} := \frac{1.5 \cdot V_{actual.top}}{F_{v.top}}$$

$$A_{hr} = 0.01 \quad \text{in}^2$$

### Section Provided:

$$BENDING_{top} := \text{if}(S_{hr} \geq \min(S_{x_{top}}, S_{y_{top}}), "N.G.", "OK")$$

$$BENDING_{top} = "OK"$$

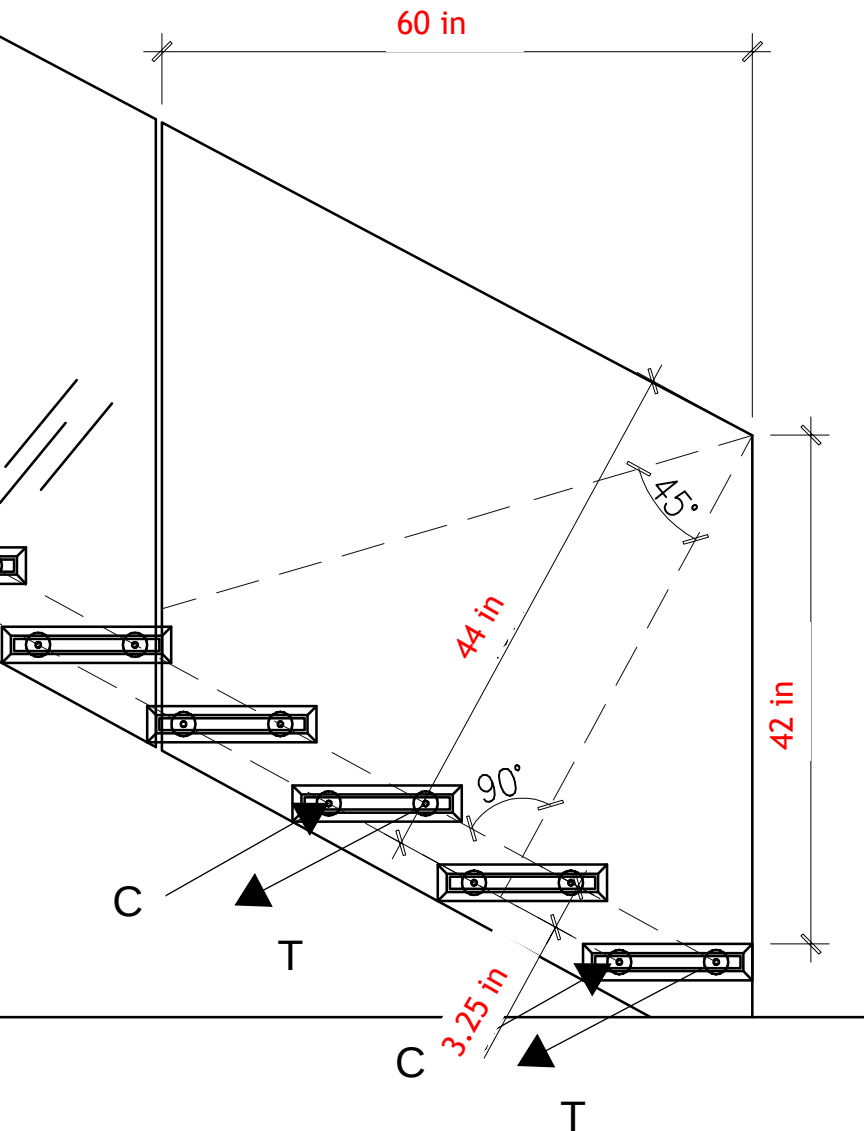
$$SHEAR_{top} := \text{if}(A_{hr} \geq A_{top}, "N.G.", "OK")$$

$$SHEAR_{top} = "OK"$$

## Stair Railing:

## Loads:

- 200# any direction any location. (worst case scenario)
- 50#/ft any direction any location.



Stand-offs two at each treads therefore there will be at least 4 pairs of stand-offs for the 200 pounds (AS A CONSERVATIVE ANALYSIS FOR DESIGN PURPOSES WE WILL ASSUME ONLY 2 PAIR OF STAND-OFF TO TAKE THE 200# ACTION), then the equivalent load per pair of stand-offs for the 50#/ft = 100# (assuming stand-off pairs spaced at 24" o.c.) therefore 200# will be the worst case scenario.

$$T \text{ per stand-off} = 200\# * (44 \text{ in}) / (3.25 \text{ in} * 2 \text{ pairs})$$

$$T \text{ per stand-off} = 1353.84 \#$$

$$\text{Shear per stand-off} = \text{System Weight} = 10 \text{ psf} * 4 \text{ ft} * 5 \text{ ft} / 2 \text{ stand-offs}$$

$$\text{Shear per stand-off} = 120\#$$

## S.S Bolt Threaded Tension & Shear Stress Design 14th

### Data:

|                            |                                                                      |                  |                                                 |
|----------------------------|----------------------------------------------------------------------|------------------|-------------------------------------------------|
| $T_{\text{bolt}} := 1.43$  | Tension in Anchor (kips) (Conservative)                              | $\Omega := 2.25$ | ASD Factor=2.00                                 |
| $V_{\text{bolt}} := 0.120$ | Shear in Anchor (kips) (Conservative)                                |                  |                                                 |
| $F_{\text{nv}} := 33.75$   | Nominal Shear Strength (ksi) Table J3.2 AISC 16.1-120 .....=0.45*Fu  |                  |                                                 |
| $F_{\text{nt}} := 53.25$   | Nominal Tensile Strength (ksi) Table J3.2 AISC 16.1-120.....=0.75*Fu |                  |                                                 |
| $D := 0.375$               | Screw Diameter (in)                                                  | $n := 16.00$     | Threads per in..... (AISC-Table 7-17 page 7-81) |

$$F_v := \frac{F_{\text{nv}}}{\Omega}$$

$$F_v = 15.000 \quad \text{ksi}$$

$$F_t := \frac{F_{\text{nt}}}{\Omega}$$

$$F_t = 23.667 \quad \text{ksi}$$

$$A_{\text{bolt}} := 0.7854 \cdot \left( D - \frac{0.9743}{n} \right)^2$$

$$A_{\text{bolt}} = 0.077 \quad \text{in}^2$$

### Check Shear

$$f_v := \frac{V_{\text{bolt}}}{A_{\text{bolt}}}$$

$$f_v = 1.549 \quad \text{ksi}$$

$$V_{\text{allow}} := F_v \cdot A_{\text{bolt}}$$

$$V_{\text{allow}} = 1.162 \quad \text{kips}$$

$$\text{SHEAR} := \text{if}(f_v \leq F_v, \text{"OK"}, \text{"NG"})$$

$$\text{SHEAR} = \text{"OK"}$$

### Check Tension

$$f_t := \frac{T_{\text{bolt}}}{A_{\text{bolt}}}$$

$$f_t = 18.454 \quad \text{ksi}$$

$$F'_{\text{nt}} := \min \left( F_t, \max \left( 0, 1.3F_{\text{nt}} - \Omega \cdot \frac{F_{\text{nt}}}{F_{\text{nv}}} \cdot f_v \right) \right)$$

$$F'_{\text{nt}} = 23.667 \quad \text{ksi}$$

$$T_{\text{allow}} := F'_{\text{nt}} \cdot A_{\text{bolt}}$$

$$T_{\text{allow}} = 1.834 \quad \text{kips}$$

$$\text{TENSION} := \text{if}(T_{\text{bolt}} \leq T_{\text{allow}}, \text{"OK"}, \text{"NG"})$$

$$\text{TENSION} = \text{"OK"}$$

### Minimum Thread Length

$$TL_{\text{min}} := \frac{2 \cdot T_{\text{bolt}}}{F_v \cdot \pi \cdot \left( D - \frac{0.9743}{n} \right)}$$

$$TL_{\text{min}} = 0.193 \quad \text{in}$$



### Minimum Thread Length Design

.  
\*for 3/8" Diam Bolt A307  $T_{table} = \text{Available Tensile Strength} * \text{Gross Bolt Area} = 2.475 \text{ kips}$

.  
Available Tensile Strength = 22.5 kips (see attached table 7-2)

Gross Bolt Area = 0.11 (see attached table 7-17)

.  
 $F_u = 60 \text{ ksi}$  (table 2-6 see attached)

$L_{table} = 0.25"$  Nut Thread Length for Non High-Strength Bolts (see attached table 7-20)

## Minimum Base Thickness for Bolt Connection Design AISC

### Load Data:

$T_{\text{bolt}} := 1.472$  Tension in Anchor (kips) **conservative**

### Bolt Data:

$D := 0.375$  Bolt Diameter (in)

$n := 16.00$  Threads per in..... (AISC-ASD Table 4-147)

### Base Material Data:

$F_v_{\text{base}} := 18.40$  Base Material Allowable Shear Strength (ksi)

$F_u_{\text{base}} := 58.00$  Base Material Tensile Strength (ksi) by Table 2-3 or 2-4 page 2-39 or 2-40

### AISC Equivalent Bolts Thread Length Data:

$T_{\text{table}} := 2.475$  Maximum Allowable Tension in Anchor by Table 7-2 page 7-23

$F_u_{\text{table}} := 60.00$  Maximum Tensile Strength (ksi) by Table 2-5 page 2-41

$L_{\text{table}} := 0.25$  Nut Thread Length (in) For High-Strength Bolts.....Table 7-15 page 7-80  
For Non High-Strength Bolts.....Table 7-18 page 7-83

### Minimum Thread Length (by Calculations)

$$TL_{\text{calc}} := \frac{2 \cdot T_{\text{bolt}}}{F_v_{\text{base}} \cdot \pi \cdot \left( D - \frac{0.9743}{n} \right)}$$

$TL_{\text{calc}} = 0.162$  in

### Minimum Thread Length (by Equivalent AISC Standard)

$$TL_{\text{equivalent}} := L_{\text{table}} \cdot \frac{T_{\text{bolt}}}{T_{\text{table}}} \cdot \frac{F_u_{\text{table}}}{F_u_{\text{base}}}$$

$TL_{\text{equivalent}} = 0.154$  in

### Minimum Thread Length

$$TL_{\text{min}} := \max(TL_{\text{calc}}, TL_{\text{equivalent}})$$

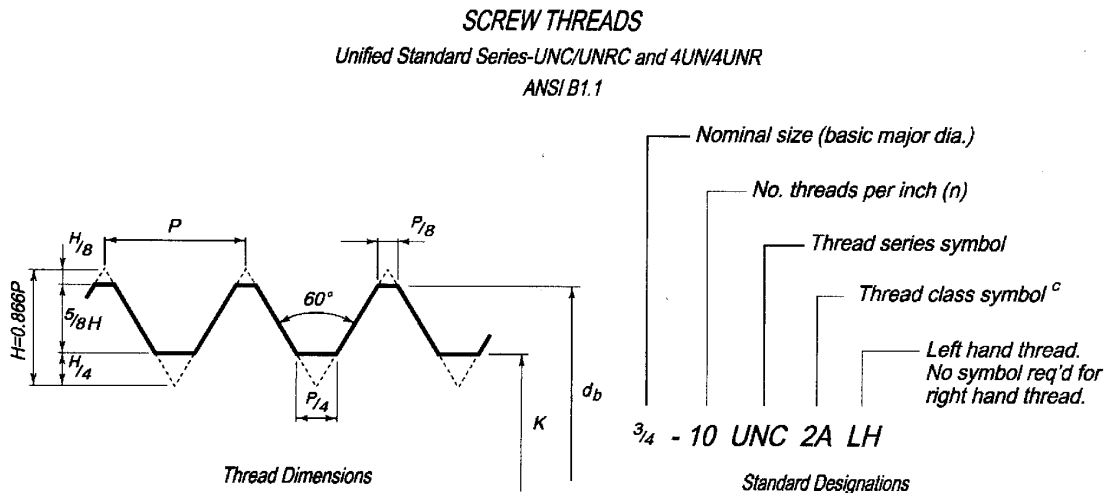
$TL_{\text{min}} = 0.162$  in

**USE MINIMUM 1/4"  
CONSERVATIVE**

**Table 7-2**  
**Available Tensile**  
**Strength of Bolts, kips**

| Nominal Bolt Diameter $d_b$ , in.   |                          |                        | $\frac{5}{8}$  |            | $\frac{3}{4}$  |            | $\frac{7}{8}$  |            | 1              |            |
|-------------------------------------|--------------------------|------------------------|----------------|------------|----------------|------------|----------------|------------|----------------|------------|
| Nominal Bolt Area, in. <sup>2</sup> |                          |                        | 0.307          |            | 0.442          |            | 0.601          |            | 0.785          |            |
| ASTM Desig.                         | $F_{nt}/\Omega$<br>(ksi) | $\phi F_{nt}$<br>(ksi) | $r_n/\Omega$   | $\phi r_n$ | $r_n/\Omega$   | $\phi r_n$ | $r_n/\Omega$   | $\phi r_n$ | $r_n/\Omega$   | $\phi r_n$ |
|                                     | ASD                      | LRFD                   | ASD            | LRFD       | ASD            | LRFD       | ASD            | LRFD       | ASD            | LRFD       |
| A325 & F1852                        | 45.0                     | 67.5                   | 13.8           | 20.7       | 19.9           | 29.8       | 27.1           | 40.6       | 35.3           | 53.0       |
| A490                                | 56.5                     | 84.8                   | 17.3           | 26.0       | 25.0           | 37.4       | 34.0           | 51.0       | 44.4           | 66.6       |
| A307                                | 22.5                     | 33.8                   | 6.90           | 10.4       | 9.94           | 14.9       | 13.5           | 20.3       | 17.7           | 26.5       |
| Nominal Bolt Diameter $d_b$ , in.   |                          |                        | $1\frac{1}{8}$ |            | $1\frac{1}{4}$ |            | $1\frac{3}{8}$ |            | $1\frac{1}{2}$ |            |
| Nominal Bolt Area, in. <sup>2</sup> |                          |                        | 0.994          |            | 1.23           |            | 1.48           |            | 1.77           |            |
| ASTM Desig.                         | $F_{nt}/\Omega$<br>(ksi) | $\phi F_{nt}$<br>(ksi) | $r_n/\Omega$   | $\phi r_n$ | $r_n/\Omega$   | $\phi r_n$ | $r_n/\Omega$   | $\phi r_n$ | $r_n/\Omega$   | $\phi r_n$ |
|                                     | ASD                      | LRFD                   | ASD            | LRFD       | ASD            | LRFD       | ASD            | LRFD       | ASD            | LRFD       |
| A325 & F1852                        | 45.0                     | 67.5                   | 44.7           | 67.1       | 55.2           | 82.8       | 66.8           | 100        | 79.5           | 119        |
| A490                                | 56.5                     | 84.8                   | 56.2           | 84.2       | 69.3           | 104        | 83.9           | 126        | 99.8           | 150        |
| A307                                | 22.5                     | 33.8                   | 22.4           | 33.5       | 27.6           | 41.4       | 33.4           | 50.1       | 39.8           | 59.6       |
| ASD                                 |                          | LRFD                   |                |            |                |            |                |            |                |            |
| $\Omega_v = 2.00$                   |                          | $\phi_v = 0.75$        |                |            |                |            |                |            |                |            |

**Table 7-17**  
**Threading Dimensions for High-Strength**  
**and Non-High-Strength Bolts**



| Diameter                     |                        | Area                                 |                                     |                                                     |                            |
|------------------------------|------------------------|--------------------------------------|-------------------------------------|-----------------------------------------------------|----------------------------|
| Bolt Diameter<br>$d_b$ , in. | Min. Root $K$ ,<br>in. | Gross Bolt<br>Area, in. <sup>2</sup> | Min. Root<br>Area, in. <sup>2</sup> | Net Tensile<br>Area <sup>a</sup> , in. <sup>2</sup> | Threads per<br>inch, $n^b$ |
| $\frac{1}{4}$                | 0.196                  | 0.0490                               | 0.0301                              | 0.0320                                              | 20                         |
| $\frac{3}{8}$                | 0.307                  | 0.110                                | 0.0742                              | 0.0780                                              | 16                         |
| $\frac{1}{2}$                | 0.417                  | 0.196                                | 0.136                               | 0.142                                               | 13                         |
| $\frac{5}{8}$                | 0.527                  | 0.307                                | 0.218                               | 0.226                                               | 11                         |
| $\frac{3}{4}$                | 0.642                  | 0.442                                | 0.323                               | 0.334                                               | 10                         |
| $\frac{7}{8}$                | 0.755                  | 0.601                                | 0.447                               | 0.462                                               | 9                          |
| 1                            | 0.865                  | 0.785                                | 0.587                               | 0.606                                               | 8                          |
| $1\frac{1}{8}$               | 0.970                  | 0.994                                | 0.740                               | 0.763                                               | 7                          |
| $1\frac{1}{4}$               | 1.10                   | 1.23                                 | 0.942                               | 0.969                                               | 7                          |
| $1\frac{3}{8}$               | 1.19                   | 1.49                                 | 1.12                                | 1.16                                                | 6                          |
| $1\frac{1}{2}$               | 1.32                   | 1.77                                 | 1.37                                | 1.41                                                | 6                          |
| $1\frac{3}{4}$               | 1.53                   | 2.41                                 | 1.85                                | 1.90                                                | 5                          |
| 2                            | 1.76                   | 3.14                                 | 2.43                                | 2.50                                                | 4.5                        |
| $2\frac{1}{4}$               | 2.01                   | 3.98                                 | 3.17                                | 3.25                                                | 4.5                        |
| $2\frac{1}{2}$               | 2.23                   | 4.91                                 | 3.90                                | 4.00                                                | 4                          |
| $2\frac{3}{4}$               | 2.48                   | 5.94                                 | 4.83                                | 4.93                                                | 4                          |
| 3                            | 2.73                   | 7.07                                 | 5.85                                | 5.97                                                | 4                          |
| $3\frac{1}{4}$               | 2.98                   | 8.30                                 | 6.97                                | 7.10                                                | 4                          |
| $3\frac{1}{2}$               | 3.23                   | 9.62                                 | 8.19                                | 8.33                                                | 4                          |
| $3\frac{3}{4}$               | 3.48                   | 11.0                                 | 9.51                                | 9.66                                                | 4                          |
| 4                            | 3.73                   | 12.6                                 | 10.9                                | 11.1                                                | 4                          |

<sup>a</sup> Net tensile area =  $0.7854 \times \left( d_b - \frac{0.9743}{n} \right)^2$

<sup>b</sup> For diameters listed, thread series is UNC (coarse). For larger diameters, thread series is 4UN.

<sup>c</sup> 2A denotes Class 2A fit applicable to external threads;  
 2B denotes corresponding Class 2B fit for internal threads.

**Table 2-6**  
**Applicable ASTM Specifications for**  
**Various Types of Structural Fasteners**

| ASTM Designation         | $F_y$<br>Min.<br>Yield<br>Stress<br>(ksi) | $F_u$<br>Tensile<br>Stress <sup>a</sup><br>(ksi) | Diameter Range<br>(in.) | High-Strength Bolts |                                             | Common Bolts | Nuts | Washers | Direct-Tension-Indicator Washers | Threaded Rods | Shear Stud Connectors | Anchor Rods |        |                   |
|--------------------------|-------------------------------------------|--------------------------------------------------|-------------------------|---------------------|---------------------------------------------|--------------|------|---------|----------------------------------|---------------|-----------------------|-------------|--------|-------------------|
|                          |                                           |                                                  |                         | Conventional        | Twist-Off-Type Tension-Control <sup>d</sup> |              |      |         |                                  |               |                       | Hooked      | Headed | Threaded & NUTTED |
| A108                     | —                                         | 65                                               | 0.375 to 0.75, incl.    |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A325 <sup>d</sup>        | —                                         | 105                                              | over 1 to 1.5 incl.     |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | —                                         | 120                                              | 0.5 to 1, incl.         |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A490                     | —                                         | 150                                              | 0.5 to 1.5              |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| F1852                    | —                                         | 105                                              | 1.125                   |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | —                                         | 120                                              | 0.5 to 1, incl.         |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A194 Gr. 2H              | —                                         | —                                                | 0.25 to 4               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A563                     | —                                         | —                                                | 0.25 to 4               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| F436 <sup>b</sup>        | —                                         | —                                                | 0.25 to 4               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| F959                     | —                                         | —                                                | 0.5 to 1.5              |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A36                      | 36                                        | 58-80                                            | to 10                   |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A193 Gr. B7 <sup>e</sup> | —                                         | 100                                              | over 4 to 7             |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | —                                         | 115                                              | over 2.5 to 4           |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | —                                         | 125                                              | 2.5 and under           |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A307                     | Gr. A                                     | 60                                               | 0.25 to 4               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | Gr. C                                     | 58-80                                            | 0.25 to 4               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A354 Gr. BD              | —                                         | 140                                              | 2.5 to 4 incl.          |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | —                                         | 150                                              | 0.25 to 2.5, incl.      |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A449                     | —                                         | 90                                               | 1.75 to 3 incl.         | c                   |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | —                                         | 105                                              | 1.125 to 1.5, incl.     | c                   |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | —                                         | 120                                              | 0.25 to 1, incl.        | c                   |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A572                     | Gr. 42                                    | 42                                               | to 6                    |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | Gr. 50                                    | 50                                               | to 4                    |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | Gr. 55                                    | 55                                               | to 2                    |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | Gr. 60                                    | 60                                               | to 1.25                 |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | Gr. 65                                    | 65                                               | to 1.25                 |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A588                     | 42                                        | 63                                               | Over 5 to 8, incl.      |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | 46                                        | 67                                               | Over 4 to 5, incl.      |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | 50                                        | 70                                               | 4 and under             |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| A687                     | 105                                       | 150 max.                                         | 0.625 to 3              |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
| F1554                    | Gr. 36                                    | 36                                               | 0.25 to 4               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | Gr. 55                                    | 55                                               | 0.25 to 4               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |
|                          | Gr. 105                                   | 105                                              | 0.25 to 3               |                     |                                             |              |      |         |                                  |               |                       |             |        |                   |

■ = Preferred material specification.

▒ = Other applicable material specification, the availability of which should be confirmed prior to specification.

□ = Material specification does not apply.

— Indicates that a value is not specified in the material specification.

<sup>a</sup> Minimum unless a range is shown or maximum (max.) is indicated.

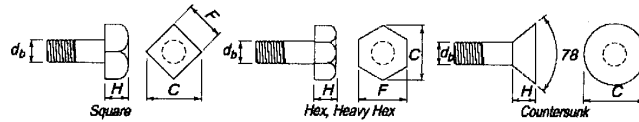
<sup>b</sup> Special washer requirements may apply per RCSC Specification Table 6.1 for some steel-to-steel bolting applications and per Part 14 for anchor-rod applications.

<sup>c</sup> See AISC Specification Section A3.3 for limitations on use of ASTM A449 bolts.

<sup>d</sup> When atmospheric corrosion resistance is desired, Type 3 can be specified.

<sup>e</sup> For anchor rods with temperature and corrosion resistance characteristics.

**Table 7-20**  
**Dimensions of Non-High-Strength Bolts, in.**



| Bolts Dia<br>$d_b$ , in. |                | Square           |                  |                 | Hex              |                  |                  | Heavy Hex        |                  |                  | Countersunk      |                 | Min, Thrd.<br>Length, in. |                |
|--------------------------|----------------|------------------|------------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|------------------|-----------------|---------------------------|----------------|
|                          |                | $F$ , in.        | $C$ , in.        | $H$ , in.       | $F$ , in.        | $C$ , in.        | $H$ , in.        | $F$ , in.        | $C$ , in.        | $H$ , in.        | $C$ , in.        | $H$ , in.       | $L \leq$<br>6 in.         | $L >$<br>6 in. |
| Bolts                    | $\frac{1}{4}$  | $\frac{3}{8}$    | $\frac{1}{2}$    | $\frac{3}{16}$  | $\frac{7}{16}$   | $\frac{1}{2}$    | $\frac{3}{16}$   | —                | —                | —                | $\frac{1}{2}$    | $\frac{1}{8}$   | $\frac{3}{4}$             | 1              |
|                          | $\frac{3}{8}$  | $\frac{9}{16}$   | $\frac{13}{16}$  | $\frac{1}{4}$   | $\frac{9}{16}$   | $\frac{5}{8}$    | $\frac{1}{4}$    | —                | —                | —                | $\frac{11}{16}$  | $\frac{3}{16}$  | 1                         | $1\frac{1}{4}$ |
|                          | $\frac{1}{2}$  | $\frac{3}{4}$    | $1\frac{1}{16}$  | $\frac{5}{16}$  | $\frac{3}{4}$    | $\frac{7}{8}$    | $\frac{3}{8}$    | $\frac{7}{8}$    | 1                | $\frac{3}{8}$    | $\frac{7}{8}$    | $\frac{1}{4}$   | $1\frac{1}{4}$            | $1\frac{1}{2}$ |
|                          | $\frac{5}{8}$  | $\frac{15}{16}$  | $\frac{15}{16}$  | $\frac{7}{16}$  | $\frac{15}{16}$  | $1\frac{1}{16}$  | $\frac{7}{16}$   | $1\frac{1}{16}$  | $1\frac{1}{4}$   | $1\frac{1}{8}$   | $1\frac{1}{8}$   | $\frac{5}{16}$  | $1\frac{1}{2}$            | $1\frac{3}{4}$ |
|                          | $\frac{3}{4}$  | $1\frac{1}{8}$   | $1\frac{9}{16}$  | $\frac{1}{2}$   | $1\frac{1}{8}$   | $1\frac{5}{16}$  | $\frac{1}{2}$    | $1\frac{1}{4}$   | $1\frac{7}{16}$  | $\frac{1}{2}$    | $1\frac{3}{8}$   | $\frac{3}{8}$   | $1\frac{3}{4}$            | 2              |
|                          | $\frac{7}{8}$  | $1\frac{5}{16}$  | $1\frac{7}{8}$   | $\frac{5}{8}$   | $1\frac{5}{16}$  | $1\frac{1}{2}$   | $\frac{9}{16}$   | $1\frac{7}{16}$  | $1\frac{11}{16}$ | $\frac{9}{16}$   | $1\frac{9}{16}$  | $\frac{7}{16}$  | 2                         | $2\frac{1}{4}$ |
|                          | 1              | $1\frac{1}{2}$   | $2\frac{1}{8}$   | $1\frac{1}{16}$ | $1\frac{1}{2}$   | $1\frac{3}{4}$   | $1\frac{1}{16}$  | $1\frac{5}{8}$   | $1\frac{7}{8}$   | $1\frac{1}{16}$  | $1\frac{13}{16}$ | $\frac{1}{2}$   | $2\frac{1}{4}$            | $2\frac{1}{2}$ |
|                          | $1\frac{1}{8}$ | $1\frac{11}{16}$ | $2\frac{3}{8}$   | $\frac{3}{4}$   | $1\frac{11}{16}$ | $1\frac{15}{16}$ | $\frac{3}{4}$    | $1\frac{13}{16}$ | $2\frac{1}{16}$  | $\frac{3}{4}$    | $2\frac{1}{16}$  | $\frac{9}{16}$  | $2\frac{1}{2}$            | $2\frac{3}{4}$ |
|                          | $1\frac{1}{4}$ | $1\frac{7}{8}$   | $2\frac{5}{8}$   | $\frac{7}{8}$   | $1\frac{7}{8}$   | $2\frac{3}{16}$  | $\frac{7}{8}$    | 2                | $2\frac{5}{16}$  | $\frac{7}{8}$    | $2\frac{1}{4}$   | $\frac{5}{8}$   | $2\frac{3}{4}$            | 3              |
|                          | $1\frac{3}{8}$ | $2\frac{1}{16}$  | $2\frac{15}{16}$ | $\frac{15}{16}$ | $2\frac{1}{16}$  | $2\frac{3}{8}$   | $\frac{15}{16}$  | $2\frac{3}{16}$  | $2\frac{1}{2}$   | $\frac{15}{16}$  | $2\frac{1}{2}$   | $\frac{11}{16}$ | 3                         | $3\frac{1}{4}$ |
|                          | $1\frac{1}{2}$ | $2\frac{1}{4}$   | $3\frac{3}{16}$  | 1               | $2\frac{1}{4}$   | $2\frac{5}{8}$   | 1                | $2\frac{3}{8}$   | $2\frac{3}{4}$   | 1                | $2\frac{11}{16}$ | $\frac{3}{4}$   | $3\frac{1}{4}$            | $3\frac{1}{2}$ |
|                          | $1\frac{3}{4}$ | —                | —                | —               | $2\frac{5}{8}$   | 3                | $1\frac{3}{16}$  | $2\frac{3}{4}$   | $3\frac{3}{16}$  | $1\frac{3}{16}$  | —                | —               | $3\frac{3}{4}$            | 4              |
|                          | 2              | —                | —                | —               | 3                | $3\frac{7}{16}$  | $1\frac{3}{8}$   | $3\frac{1}{8}$   | $3\frac{5}{8}$   | $1\frac{3}{8}$   | —                | —               | $4\frac{1}{4}$            | $4\frac{1}{2}$ |
|                          | $2\frac{1}{4}$ | —                | —                | —               | $3\frac{3}{8}$   | $3\frac{7}{8}$   | $1\frac{1}{2}$   | $3\frac{1}{2}$   | $4\frac{1}{16}$  | $1\frac{1}{2}$   | —                | —               | $4\frac{3}{4}$            | 5              |
|                          | $2\frac{1}{2}$ | —                | —                | —               | $3\frac{3}{4}$   | $4\frac{5}{16}$  | $1\frac{11}{16}$ | $3\frac{7}{8}$   | $4\frac{1}{2}$   | $1\frac{11}{16}$ | —                | —               | $5\frac{1}{4}$            | $5\frac{1}{2}$ |
|                          | $2\frac{3}{4}$ | —                | —                | —               | $4\frac{1}{8}$   | $4\frac{3}{4}$   | $1\frac{13}{16}$ | $4\frac{1}{4}$   | $4\frac{15}{16}$ | $1\frac{13}{16}$ | —                | —               | $5\frac{3}{4}$            | 6              |
|                          | 3              | —                | —                | —               | $4\frac{1}{2}$   | $5\frac{3}{16}$  | 2                | $4\frac{5}{8}$   | $5\frac{5}{16}$  | 2                | —                | —               | 6                         | $6\frac{1}{2}$ |
|                          | $3\frac{1}{4}$ | —                | —                | —               | $4\frac{7}{8}$   | $5\frac{5}{8}$   | $2\frac{3}{16}$  | —                | —                | —                | —                | —               | 6                         | 7              |
|                          | $3\frac{1}{2}$ | —                | —                | —               | $5\frac{1}{4}$   | $6\frac{1}{16}$  | $2\frac{5}{16}$  | —                | —                | —                | —                | —               | 6                         | $7\frac{1}{2}$ |
|                          | $3\frac{3}{4}$ | —                | —                | —               | $5\frac{5}{8}$   | $6\frac{1}{2}$   | $2\frac{1}{2}$   | —                | —                | —                | —                | —               | 6                         | 8              |
|                          | 4              | —                | —                | —               | 6                | $6\frac{15}{16}$ | $2\frac{11}{16}$ | —                | —                | —                | —                | —               | 6                         | $8\frac{1}{2}$ |

**Notes:**

For high-strength bolt and nut dimensions, refer to Table 7-15.

Square, hex, and heavy hex bolt dimensions, rounded to nearest  $\frac{1}{16}$  in., are in accordance with ANSI B18.2.1.Countersunk bolt dimensions, rounded to the nearest  $\frac{1}{16}$  in., are in accordance with ANSI 18.5.Minimum thread length =  $2d_b + \frac{1}{4}$ -in. for bolts up to 6 in. long, and  $2d_b + \frac{1}{2}$ -in. for bolts longer than 6 in.



CONNECTION TO CONCRETE SLAB

Load

$$P = 200\#$$

Load processing

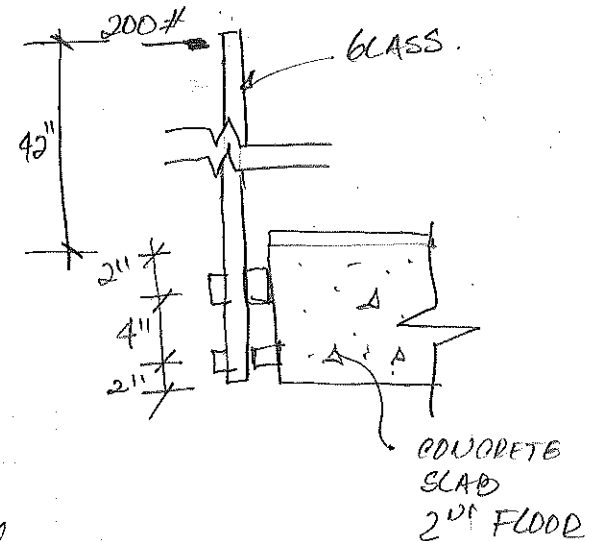
$$T = \frac{P \times L}{d} = \frac{200\# (42" + 2" + 4")}{4}$$

$$T = 2400\#$$

Assuming min (2) pair of stand-off per panel.

$$T_{\text{bolt}} = \frac{2400\#}{2 \text{ bolt}} = 1200\# < 1922.46\# = \text{Tallow (OK)}$$

$$V_{\text{per bolt}} = \frac{200\#}{2} = 100\# < 524.16\# = \text{Vallow (OK)}$$



Use  $\phi 3/8"$  Threaded Rod C6+ Every Epoxy w/ 3- $3/8"$  min embedment, 4" min spacing & 2" min edge dist.

$$T_{\text{bolt}} = 2910\# \times 0.7379 \times 0.8953$$

$$T_{\text{bolt}} = 1922.46\#$$

$$S_{\text{bolt}} = 1300\# \times 0.5166 \times 0.7805$$

$$S_{\text{bolt}} = 524.16\#$$

COMBINED

(Conserv.)

$$1200\# / 1922.46\# + 150\# / 524.16\# < 1.00$$

$$0.91 < 1.00 \quad (\text{OK})$$

## PERFORMANCE TABLE

# C6+

For the Most Demanding Jobs

**Threaded Rod Ultimate Tension and Shear Loads<sup>1,2,3</sup>**  
Installed in Solid Concrete

| THREADED ROD DIA.<br>(in.) | EMBEDMENT IN<br>CONCRETE (in.) | MAX. CLAMPING FORCE<br>AFTER PROPER CURE<br>(ft./lbs.) | ULTIMATE TENSION (lbs.) |                    |                    | ULTIMATE SHEAR (lbs.)          |
|----------------------------|--------------------------------|--------------------------------------------------------|-------------------------|--------------------|--------------------|--------------------------------|
|                            |                                |                                                        | 3,000 PSI CONCRETE      | 5,000 PSI CONCRETE | 7,000 PSI CONCRETE | 3,000 PSI CONCRETE &<br>HIGHER |
| 3/8                        | 1-1/2                          | 9                                                      | 3,160                   | 3,785              | 4,405              | N/A                            |
|                            | 3-3/8                          |                                                        | 11,640                  | 12,315             | 12,985             | 5,200                          |
| 1/2                        | 2                              | 16                                                     | 6,075                   | 7,015              | 7,950              | N/A                            |
|                            | 4-1/2                          |                                                        | 20,005                  | 23,305             | 26,605             | 11,420                         |
| 5/8                        | 2-1/2                          | 47                                                     | 8,570                   | 9,995              | 11,420             | N/A                            |
|                            | 5-5/8                          |                                                        | 24,905                  | 29,015             | 33,125             | 18,300                         |
| 3/4                        | 3                              | 70                                                     | 12,030                  | 13,570             | 15,105             | N/A                            |
|                            | 6-3/4                          |                                                        | 36,645                  | 42,695             | 48,740             | 25,720                         |
| 7/8                        | 3-1/2                          | 90                                                     | 15,005                  | 17,335             | 19,660             | N/A                            |
|                            | 7-7/8                          |                                                        | 55,575                  | 70,338             | 85,100             | 32,120                         |
| 1                          | 4                              | 110                                                    | 17,735                  | 20,390             | 23,045             | N/A                            |
|                            | 9                              |                                                        | 62,250                  | 73,850             | 85,450             | 38,520                         |
| 1-1/4                      | 5                              | 370                                                    | 34,695                  | 36,935             | 39,170             | N/A                            |
|                            | 11-1/4                         |                                                        | 77,815                  | 90,655             | 103,495            | 65,080                         |
| 1-1/2                      | 13                             | 450                                                    | 101,085                 | 117,765            | 134,445            | N/A                            |

1 Allowable working loads for the single installations under static loading should not exceed 25% capacity of the Ultimate Load. To calculate the Allowable Load of the anchor rod, divide the Ultimate Load by 4.

2 Performance values are based on the use of high strength threaded rod (ASTM A193 Gr. B7). The use of lower strength rods will result in lower ultimate tension and shear loads.

3 Linear interpolation may be used for intermediate spacing and edge distances.

## PERFORMANCE TABLE

# C6+

For the Most Demanding Jobs

**Threaded Rod Allowable Tension Loads<sup>1</sup>**  
Installed in Solid Concrete

| THREADED ROD<br>DIA in. | EMBEDMENT IN<br>CONCRETE in. | ALLOWABLE TENSION LOAD BASED ON CONCRETE STRENGTH (lbs.) |                    |                    | ALLOWABLE TENSION LOAD BASED ON STEEL STRENGTH (lbs.) |                       |                          |
|-------------------------|------------------------------|----------------------------------------------------------|--------------------|--------------------|-------------------------------------------------------|-----------------------|--------------------------|
|                         |                              | 3,000 psi concrete                                       | 5,000 psi concrete | 7,000 psi concrete | ASTM A307                                             | ASTM A193 GRADE<br>B7 | ASTM F593 AISI<br>304 SS |
| 3/8                     | 1-1/2                        | 790                                                      | 945                | 1,100              | 2,080                                                 | 4,340                 | 3,995                    |
|                         | 3-3/8                        | 2,910                                                    | 3,080              | 3,245              | 2,080                                                 | 4,340                 | 3,995                    |
| 1/2                     | 2                            | 1,320                                                    | 1,755              | 1,990              | 3,730                                                 | 7,780                 | 7,155                    |
|                         | 4-1/2                        | 5,000                                                    | 5,825              | 6,650              | 3,730                                                 | 7,780                 | 7,155                    |
| 5/8                     | 2-1/2                        | 2,145                                                    | 2,500              | 2,855              | 5,870                                                 | 12,230                | 11,250                   |
|                         | 5-5/8                        | 6,225                                                    | 7,255              | 8,280              | 5,870                                                 | 12,230                | 11,250                   |
| 3/4                     | 3                            | 3,010                                                    | 3,395              | 3,775              | 8,490                                                 | 17,690                | 14,860                   |
|                         | 6-3/4                        | 9,160                                                    | 10,675             | 12,185             | 8,490                                                 | 17,690                | 14,860                   |
| 7/8                     | 3-1/2                        | 3,750                                                    | 4,335              | 4,915              | 11,600                                                | 25,510                | 20,835                   |
|                         | 7-7/8                        | 13,895                                                   | 17,585             | 21,275             | 11,600                                                | 25,510                | 20,835                   |
| 1                       | 4                            | 4,435                                                    | 5,100              | 5,760              | 15,180                                                | 31,620                | 26,560                   |
|                         | 9                            | 15,565                                                   | 18,465             | 21,365             | 15,180                                                | 31,620                | 26,560                   |
| 1-1/4                   | 5                            | 8,675                                                    | 9,235              | 9,795              | 23,800                                                | 49,580                | 34,670                   |
|                         | 11-1/4                       | 19,455                                                   | 22,665             | 25,875             | 23,800                                                | 49,580                | 34,670                   |
| 1-1/2                   | 13                           | 25,270                                                   | 29,440             | 33,610             | 33,720                                                | 70,250                | 47,770                   |

1 Use lower value of either bond or steel strength for allowable tension load.



## PERFORMANCE TABLE

# C6+

For the Most Demanding Jobs

**Threaded Rod Allowable Shear Loads<sup>1</sup>**  
**Installed in Solid Concrete**

| THREADED ROD DIA. (in.) | EMBEDMENT IN CONCRETE (in.) | ALLOWABLE SHEAR LOAD BASED ON CONCRETE STRENGTH (lbs.) |  | ALLOWABLE SHEAR LOAD BASED ON STEEL STRENGTH (lbs.) |                    |                       |
|-------------------------|-----------------------------|--------------------------------------------------------|--|-----------------------------------------------------|--------------------|-----------------------|
|                         |                             | 3,000 psi concrete & higher                            |  | ASTM A307                                           | ASTM A193 GRADE B7 | ASTM F593 AISI 304 SS |
| 3/8                     | 1-1/2                       | N/A                                                    |  | 1,040                                               | 2,170              | 1,995                 |
|                         | 3-3/8                       | 1,300                                                  |  | 1,040                                               | 2,170              | 1,995                 |
| 1/2                     | 2                           | N/A                                                    |  | 1,870                                               | 3,895              | 3,585                 |
|                         | 4-1/2                       | 2,855                                                  |  | 1,870                                               | 3,895              | 3,585                 |
| 5/8                     | 2-1/2                       | N/A                                                    |  | 2,940                                               | 6,125              | 5,635                 |
|                         | 5-5/8                       | 4,575                                                  |  | 2,940                                               | 6,125              | 5,635                 |
| 3/4                     | 3                           | N/A                                                    |  | 4,250                                               | 8,855              | 7,440                 |
|                         | 6-3/4                       | 6,430                                                  |  | 4,250                                               | 8,855              | 7,440                 |
| 7/8                     | 3-1/2                       | N/A                                                    |  | 5,800                                               | 12,760             | 10,730                |
|                         | 7-7/8                       | 8,030                                                  |  | 5,800                                               | 12,760             | 10,730                |
| 1                       | 4                           | N/A                                                    |  | 7,590                                               | 15,810             | 13,285                |
|                         | 9                           | 9,630                                                  |  | 7,590                                               | 15,810             | 13,285                |
| 1-1/4                   | 5                           | N/A                                                    |  | 11,900                                              | 24,790             | 18,840                |
|                         | 11-1/4                      | 16,270                                                 |  | 11,900                                              | 24,790             | 18,840                |

<sup>1</sup> Use lower value of either concrete or steel strength for allowable shear load.

## PERFORMANCE TABLE

# C6+

For the Most Demanding Jobs

**Rebar Ultimate Tension Loads<sup>1,2,3</sup>**  
**Installed in Solid Concrete**

| REINFORCING BAR | EMBEDMENT IN CONCRETE (in.) | ULTIMATE TENSION (lbs.) |                    |                    | ULTIMATE YIELD STRENGTH GRADE 60 REBAR (lbs.) | ULTIMATE TENSILE STRENGTH GRADE 60 REBAR (lbs.) |
|-----------------|-----------------------------|-------------------------|--------------------|--------------------|-----------------------------------------------|-------------------------------------------------|
|                 |                             | 3,000 psi concrete      | 5,000 psi concrete | 7,000 psi concrete |                                               |                                                 |
| #3              | 1-1/2                       | 3,160                   | 3,785              | 4,405              | 6,600                                         | 9,900                                           |
|                 | 3-3/8                       | 11,640                  | 12,315             | 12,985             |                                               |                                                 |
| #4              | 2                           | 6,075                   | 7,015              | 7,950              | 12,000                                        | 18,000                                          |
|                 | 4-1/2                       | 20,005                  | 23,305             | 26,605             |                                               |                                                 |
| #5              | 2-1/2                       | 8,570                   | 9,995              | 11,420             | 18,600                                        | 27,900                                          |
|                 | 5-5/8                       | 24,905                  | 29,015             | 33,125             |                                               |                                                 |
| #6              | 3                           | 12,030                  | 13,570             | 15,105             | 26,400                                        | 39,600                                          |
|                 | 6-3/4                       | 36,645                  | 42,695             | 48,740             |                                               |                                                 |
| #7              | 3-1/2                       | 15,005                  | 17,335             | 19,660             | 36,000                                        | 54,000                                          |
|                 | 7-7/8                       | 55,575                  | 70,338             | 85,100             |                                               |                                                 |
| #8              | 4                           | 17,735                  | 20,390             | 23,045             | 47,400                                        | 71,100                                          |
|                 | 9                           | 62,250                  | 73,850             | 85,450             |                                               |                                                 |
| #10             | 5                           | 34,695                  | 36,935             | 39,170             | 79,200                                        | 114,300                                         |
|                 | 11-1/4                      | 77,815                  | 90,655             | 103,495            |                                               |                                                 |
| #11             | 13                          | 101,085                 | 117,764            | 134,443            | 93,600                                        | 140,400                                         |

<sup>1</sup> Allowable working loads for the single installation under static loading should not exceed 25% capacity of the Ultimate Load. To calculate the Allowable Load of the anchor, divide the ultimate load by 4.

<sup>2</sup> Performance values are based on the use of ASTM A615 Grade 60 reinforcing bar. The use of lower strength rebar will result in lower ultimate tension loads.

<sup>3</sup> SHEAR DATA: Provided the distance from the rebar to the edge of the concrete member exceeds 1.25 times the embedment depth of the rebar, calculate the ultimate shear load for the rebar anchorage as 60% of the ultimate tensile strength of the rebar.

## PERFORMANCE REFERENCE TABLE

# C6+

For the Most Demanding Jobs

**Threaded Rod and Rebar Installation in Solid Concrete**  
**Edge/Spacing Distance Load Factor Summary<sup>1,2</sup>**

| LOAD FACTOR                           |  | DISTANCE FROM EDGE OF CONCRETE |  | LOAD FACTOR                           |  | DISTANCE FROM ANOTHER ANCHOR |  |
|---------------------------------------|--|--------------------------------|--|---------------------------------------|--|------------------------------|--|
| <b>Critical Edge Distance—Tension</b> |  |                                |  | <b>Critical Edge Distance—Tension</b> |  |                              |  |
| 100% Tension Load                     |  | → 1.25 x Anchor Embedment      |  | 100% Tension Load                     |  | → 1.50 x Anchor Embedment (o |  |
| <b>Minimum Edge Distance—Tension</b>  |  |                                |  | <b>Minimum Spacing—Tension</b>        |  | 75% Tension Load             |  |
| 70% Tension Load                      |  | → 0.50 x Anchor Embedment      |  | <b>Critical Edge Distance—Shear</b>   |  | → 0.75 x Anchor Embedment    |  |
| <b>Critical Edge Distance—Shear</b>   |  |                                |  | 100% Shear Load                       |  | → 1.50 x Anchor Embedment    |  |
| 100% Shear Load                       |  | → 1.25 x Anchor Embedment      |  | <b>Minimum Spacing—Shear</b>          |  | 30% Shear Load               |  |
| <b>Minimum Edge Distance—Shear</b>    |  |                                |  |                                       |  | → 0.50 x Anchor Embedment    |  |
| 30% Shear Load                        |  | → 0.30 x Anchor Embedment      |  |                                       |  |                              |  |
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