RICE ENGINEERING
105 School Creek Trail | Luxemburg, WI 54217
(P) 920.617.1042 | (F) 920.617.1100

Morse Industries Calculations
Railing Calculations

Project Location:
Kent, Washington
REI Project # R18-05-167

Prepared for:
Morse Industries - Kent, WA
1/18/2019

Design Criteria:

The structural calculations contained within this report are not intended to be submitted as project specific structural calculations. Rice Engineering assumes no liability for use of calculations. If project specific calculations are required, please contact Rice Engineering, 920-617-1042. The analysis within this report provides an acceptable engineered design for Morse Industries to resist the specified loading, as well as the requirements outlined in IBC 2015.

1. Railing live loads per **IBC 2015**:
   - Guardrails
     - 50 plf uniform load in any direction on handrails and top rails of guards
     - 200 pound concentrated load in any direction on handrails and top rails of guards
     - 50 lb concentrated load over 1 ft^2 of infill area
     - Concentrated load and uniform loads need not be assumed to act concurrently
2. Railing deflections per ASTM E985 or IBC (Most Stringent)
3. Aluminum members designed per AA, “Aluminum Design Manual”
4. Stainless steel members designed per AISC Structural Steel Design Guide 27.
5. Railing design wind loads per IBC (ASCE-7 Components & Cladding): **10 PSF Interior Load**
6. Member sizes, grade, alloy and strengths shall be as recommended in the calculation package
7. Stainless steel fasteners to be minimum **Condition “CW”, 300 Series, Fy= 65 ksi**
8. All other fasteners shall be the size and strength as is recommended in the calculation package
9. Steel & stainless steel welds to be **70 ksi minimum tensile strength**
10. Aluminum welds to be **5356 filler alloy unless otherwise noted**
11. Concrete strength is assumed to be **F’c= 4,000 psi, normal weight cracked concrete**
12. Concrete anchors shall be as recommended in the calculation package. Installer is responsible for maintaining the fastener spacing, edge distance, end distance, embedment depth and minimum substrate thickness that is recommended in the calculation package
13. Concrete anchors shall be installed per manufacturer’s recommended installation procedures, including recommended ambient temperatures for chemical/adhesive anchors
14. **Concrete slabs, concrete curbs, structural steel, masonry units and all other anchorage substrates designed by others**

Disclaimer:

This Certification is limited to the structural design of structural components of this handrail or divider system. It does NOT include responsibility for:

- Structural design of misc. hardware (latches, hinges, etc.).
- Structural design of concrete slabs and other masonry units
- Structural design of wood blocking or wood framing
- Structural design of all other anchorage substrates
- Glass breakage due to airborne debris or foreign objects
- The manufacture, assembly, or installation of the system.
- Quantities of materials or dimensional accuracy of drawings

Engineers Design Approval Stamp:

PRELIMINARY DESIGN
NOT FOR CONSTRUCTION

RICE ENGINEERING
105 School Creek Trail | Luxemburg, WI 54217
(P) 920.617.1042 | (F) 920.617.1100

Morse Industries Calculations
Railing Calculations

Project Location:
Kent, Washington
REI Project # R18-05-167

Prepared for:
Morse Industries - Kent, WA
1/18/2019

Design Criteria:

15. All glass is to be fully tempered laminated glass with 3/8" thick lites and 0.06" thick Dupont SentryGlas Plus Interlayer or noted in calculations.
16. Per IBC, glass has been designed using a safety factor of 4 in determining the allowable flexural stress (24,000/4= 6,000 psi)
17. Per IBC, glass panels need to be manufactured from an approved safety glazing material conforming to CPSC 16 CFR 1201 (II). The glass manufacturer is responsible to provide acceptable safety glass conforming to the IBC & CPSC provisions.
18. Whenever glass guards are used in overhanging applications, Rice Engineering recommends using fully tempered and laminated glass lites along with standard cap channels to protect the glass edges. Fully tempered glass is susceptible to breakage due to impact on the glass edge by airborne debris, as well as the possibility of spontaneous breakage due to nickel sulfide contamination. In the case of accidental breakage, laminated glass minimizes the risk of falling glass.
19. Shim dis-similar metals. Maximum recommended shim height for guardrails is 1/2", full bearing shims
20. Wood substrates are assumed to be **Spruce Pine Fir or Equal, SG=0.42 minimum unless otherwise noted**

Page:	Description:	Date:	Revision:
A1-A1A	Standoff Mounted 13/16" Lami. Glass	7/11/18	
A1B	Lag Screw Analysis	7/11/18	
	Hilti PROFIS	11/19/18	
	Glass Model Analysis		
B1-B1A	Standoff Mounted 11/16" Lami. Glass	7/11/18	
B1B	Lag Screw Analysis	7/11/18	
	Hilti PROFIS	12/5/18	
	Glass Model Analysis		

Disclaimer:

This Certification is limited to the structural design of structural components of this handrail or divider system.
It does NOT include responsibility for:

- Structural design of misc. hardware (latches, hinges, etc.).
- Structural design of concrete slabs and other masonry units
- Structural design of wood blocking or wood framing
- Structural design of all other anchorage substrates
- Glass breakage due to airborne debris or foreign objects
- The manufacture, assembly, or installation of the system.
- Quantities of materials or dimensional accuracy of drawings

Engineers Design Approval Stamp:

PRELIMINARY DESIGN
NOT FOR CONSTRUCTION

Inputs:

Standoff Mounted Glass	Detail Ref.	Sheet No: A1

$WL := 10$ psf (wind load)

$P := 200$ lb (point load)

$W_h := 4.17$ pli (horizontal uniform load)

$h := 46$ in (height of rail above upper standoff)

$w := 60$ in (glass width)

$t := 0.719$ in (glass thickness)

Calculations: *(Reactions from RISA 3D FEA Model)*

Use 13/16" Glass, Fully Tempered & Laminated
with polished edges (3/8" / 0.060" SGP / 3/8")
*Minimum Glass Lite Width: 3'-0" **
Maximum Glass Lite Width: 5'-0"

Point Load:

$\sigma_p := 4750$ psi $\sigma_{all} := 6000$ psi

$\Delta_p := 0.542$ in $\Delta_{all} := \frac{h}{24} + \frac{w}{96} = 2.54$ in

Uniform Load:

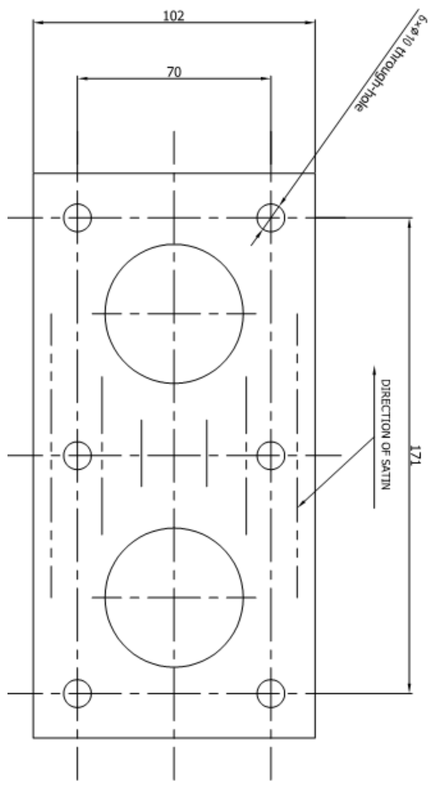
$\sigma_u := 5050$ psi $\sigma_{all} := 6000$ psi

$\Delta_u := 0.644$ in $\Delta_{all} := \frac{h}{24} + \frac{w}{96} = 2.54$ in

Wind Load:

$\sigma_w := 2080$ psi $\sigma_{all} := 6000$ psi

$\Delta_w := 0.212$ in $\Delta_{all} := \frac{h}{24} + \frac{w}{96} = 2.54$ in



Reactions from Point Load:

$V_p := 108$ lb

$T_p := 1484$ lb

Reactions from Uniform Load:

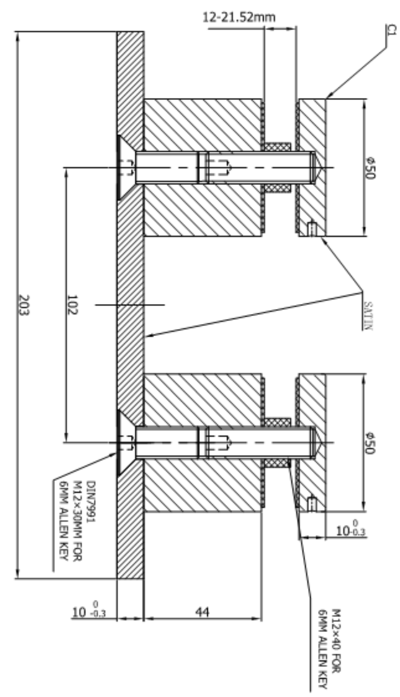
$V_u := 108$ lb

$T_u := 1564$ lb

Reactions from Wind Load:

$V_w := 108$ lb

$T_w := 647$ lb



NOTE: *Under full design load, the rail will deflect about 11/16", this is acceptable per ASTM E2358 deflection limits. Customer please verify the deflection is acceptable.*

$$GLASS := \begin{cases} \text{"OK"} & \text{if } \frac{\max(\sigma_p, \sigma_u, \sigma_w)}{\sigma_{all}} \le 1 \\ \text{"FAILS"} & \text{otherwise} \end{cases}$$

GLASS = "OK"

RICE ENGINEERING
105 School Creek Trail
Luxemburg, WI 54217
Phone: (920) 617-1042
Fax: (920) 617-1100
www.rice-inc.com

Template: REI-MC-5735	Project Description: **Morse Industries Calculations**	Job No: R18-05-167	
		Engineer: JJW	Sheet No: A1
		Date: 7/11/18	Rev:
		Chk By:	Date:

Inputs:

Standoff Mounted Glass	Detail Ref.	Sheet No: A1 A

$e := 2.0625$ in (Eccentricity)

$D := 2$ in (Diameter of Standoff)

Calculations:

$R_y := \max(V_p, V_u, V_w) = 108$ lb

$R_z := \max(T_p, T_u, T_w) = 1564$ lb

(Worst Case Loads)

Chk Bolt into Standoffs:

$V := R_y = 108$ lb

$T := \frac{R_y \cdot e}{0.5 \cdot D} + R_z = 1787$ lb

$V_{all} := 1614$ lb

$T_{all} := 3100 \cdot \frac{0.25}{0.375} = 2067$ lb

$I := \left(\frac{V}{V_{all}}\right)^2 + \left(\frac{T}{T_{all}}\right)^2 = 0.75 \quad < \quad 1.0$

Use 3/8" Dia. S.S. Flat Headed Threaded Rods
(300 Series S.S., Cond. CW, Fy = 65 ksi)
as shown 1/4" Thread Engagement

Chk Anchors into Concrete:

$V_2 := R_y \cdot 1.6 = 173$ lb

$T_2 := \left(\frac{R_y \cdot e}{0.5 \cdot D \cdot 0.85} + R_z\right) \cdot 1.6 = 2922$ lb

SEE HILTI PROFIS OR POWERS PDA DATA

Use 3/8" Dia. SS HIT-Z-R Rod w/ Hilti HIT-HY 200 or Equal
300 Series Stainless Steel

Embedment: 2-3/8" Min.
Edge Distance: 2-1/4"
2nd Edge Distance: 4"
Spacing: 2-3/4" and 3-3/8"
Min. Slab Thickness: 8"
Concrete Strength: f'c= 4,000 psi, Normal Wt. Cracked

Install per Manufacturer's instructions

Chk Bearing on Face of Glass:

$A_f := \left(\frac{D}{2}\right)^2 \cdot \pi - \left(\frac{0.75}{2}\right)^2 \cdot \pi = 2.7$ in^2

$P_f := \frac{R_y \cdot e}{D \cdot (0.67)} + R_z \qquad P_f = 1730$ lb

$f_{pf} := \frac{P_f}{A_f} \qquad f_{pf} = 641$ psi

$F_{pf} := 3000$ psi

Bearing on Glass Face "OK"

Glass Standoffs are Proprietary Design
Glass Standoffs Designed By Others
Use Standard Gaskets and Bushing
to Protect Glass Edge

Chk Alum. Back Plate:

$L1 := 4$ in $\qquad D1 := 0.625$ in

$L2 := 4.625$ in $\qquad D2 := 0.625$ in

assume load is in the direction of L2

$L := L2 - (2 \cdot D2) \qquad L = 3.38$ in

$A := \frac{L - d}{2} \qquad A = 0.688$ in

$B := L - A \qquad B = 2.688$ in

$P := T \qquad P = 1787$ lb

$M_{pl} := \frac{P \cdot L}{8} \qquad M_{pl} = 754$ in·lb

$t_{req} := \sqrt{\frac{M_{pl} \cdot 6}{28000 \cdot L1}} \qquad t_{req} = 0.201$ in

Use 3/8" x 4" x 8" Plate
6061-T6 alloy

Chk Anchors into Wood:

$V_1 := \frac{R_y}{6} = 18$ lb

$T_1 := \left(\frac{R_y \cdot e}{0.5 \cdot D \cdot 0.85} + \frac{R_z}{6}\right) = 523$ lb

SEE SHEET A1B

Use 3/8" Dia. SS Lag Bolts
300 Series Stainless Steel
3" Min. Thread Penetration
Edge Distance: 1-1/2"
Spacing: 2-3/4" and 3-3/8"
Spruce-Pine-Fir (SG = 0.42)

Chk Anchors into Steel:

$V_3 := R_y = 108$ lb

$T_3 := \frac{R_y \cdot e}{0.5 \cdot D} + R_z = 1787$ lb

$V_{all3} := 1614$ lb

$T_{all3} := 3100$ lb

$I_3 := \left(\frac{V_3}{V_{all3}}\right)^2 + \left(\frac{T_3}{T_{all3}}\right)^2 = 0.34 \quad < \quad 1.0$

Use 3/8"-16 Dia. S.S. Threaded Rods
(300 Series S.S., Cond. CW, Fy = 65 ksi)
3/8" min. Thread Engagement
Separate Dissimilar Metals
as shown

Dowel Type Fastener Capacity (NDS 2012)

Lag Bolts	Detail Ref.	Sheet No: A1B

$V_{pos} := 18 \cdot lbf$ $V_{neg} := 18 \cdot lbf$

$T_{pos} := 523 \cdot lbf$ $T_{neg} := 523 \cdot lbf$

3/8 in Lag Screw SS

$l_m := 3$ thickness of main member, in.

$l_s := 0.375$ thickness of side member, in

6061-T6 Hole

$F_{yb} = 65000$ bending yield strength, psi.

$D = 0.375$ unthreaded shank diameter of screw, in.

$D_r = 0.27$ root diameter of screw

$F_{es} = 43000$ bearing strength, psi

$G = 0.42$ Material = "Spruce Pine-Fir"

Spruce Pine-Fir $G = 0.42$

$p := 3$ penetration, in

$t_{shim} := 0.5$ maximum thickness of shim, in

$C_D := 1.6$ load duration factor, 10.3.2

$C_M := 1.0$ wet service factor, 10.3.3

$C_t := 1.0$ temperature factor, 10.3.4

$C_g := 1.0$ group action factor, 10.3.6

$C_\Delta := 1.0$ geometry factor, 11.5.1

$C_{eg} := 1.0$ end grain factor, 11.5.2

$C_{di} := 1.0$ diaphragm factor, 11.5.3

$\theta := 90$ angle of Shear load to grain, degree

Calculations

$K_\theta := 1 + 0.25 \cdot \frac{\theta}{90} = 1.25$ $R_e := \frac{F_{em}}{F_{es}} = 0.07$ $R_t := \frac{l_m}{l_s} = 8$

$$K_D := \begin{cases} 2.2 & \text{if } D_r \le 0.17 \\ \text{otherwise} & \begin{cases} 10 \cdot D_r + 0.5 & \text{if } 0.17 < D_r \le 0.25 \\ 0 & \text{otherwise} \end{cases} \end{cases} = 0$$

$$k_1 := \frac{\sqrt{R_e + 2 \cdot R_e^2 \cdot (1 + R_t + R_t^2) + R_t^2 \cdot R_e^3} - R_e \cdot (1 + R_t)}{1 + R_e} = 0.24$$

$$R_{d1} := \begin{cases} K_D & \text{if } D_r \le 0.25 \\ 4.0 \cdot K_\theta & \text{if } 0.25 < D_r \le 1 \text{ otherwise} \end{cases} = 5$$

$$k_2 := -1 + \sqrt{2 \cdot (1 + R_e) + \frac{2 \cdot F_{yb} \cdot (1 + 2 \cdot R_e) \cdot D_r^2}{3 \cdot F_{em} \cdot l_m^2}} = 0.51$$

$$R_{d2} := \begin{cases} K_D & \text{if } D_r \le 0.25 \\ 3.6 \cdot K_\theta & \text{if } 0.25 < D_r \le 1 \text{ otherwise} \end{cases} = 4.5$$

$$k_3 := -1 + \sqrt{\frac{2 \cdot (1 + R_e)}{R_e} + \frac{2 \cdot F_{yb} \cdot (2 + R_e) \cdot D_r^2}{3 \cdot F_{em} \cdot l_s^2}}$$

$$R_{d3} := \begin{cases} K_D & \text{if } D_r \le 0.25 \\ 3.2 \cdot K_\theta & \text{if } 0.25 < D_r \le 1 \text{ otherwise} \end{cases} = 4$$

$Z_{Im} := \frac{D_r \cdot l_m \cdot F_{em}}{R_{d1}} = 450.22$ $Z_{Is} := \frac{D_r \cdot l_s \cdot F_{es}}{R_{d1}} = 854.63$ $Z_{II} := \frac{k_1 \cdot D_r \cdot l_s \cdot F_{es}}{R_{d2}} = 226.5$ $Z_{IIIm} := \frac{k_2 \cdot D_r \cdot l_m \cdot F_{em}}{(1 + 2R_e) \cdot R_{d3}} = 251.43$

$Z_{IIIs} := \frac{k_3 \cdot D_r \cdot l_s \cdot F_{em}}{(2 + R_e) \cdot R_{d3}} = 202.26$ $Z_{IV} := \frac{D_r^2}{R_{d3}} \cdot \sqrt{\frac{2 \cdot F_{em} \cdot F_{yb}}{3 \cdot (1 + R_e)}} = 188.37$

$Z_1 := \min(Z_{Im}, Z_{Is}, Z_{II}, Z_{IIIm}, Z_{IIIs}, Z_{IV}) = 188.37$

$W_1 = 234.78$

$R_{pos} := \sqrt{T_{pos}^2 + V_{pos}^2} = 523.31 \text{ lbf}$ $R_{neg} := \sqrt{T_{neg}^2 + V_{neg}^2} = 523.31 \text{ lbf}$

$\alpha_{pos} := \operatorname{atan}(T_{pos} \cdot V_{pos}^{-1}) = 88.03 \cdot deg$ $\alpha_{neg} := \operatorname{atan}(T_{neg} \cdot V_{neg}^{-1}) = 88.03 \cdot de$

Results

$Z' := Z_1 \cdot C_D \cdot C_M \cdot C_t \cdot C_g \cdot C_\Delta \cdot C_{eg} \cdot C_{di} \cdot lbf = 301.39 \text{ lbf}$ **Allowable Shear**

$W' := W_1 \cdot C_D \cdot C_M \cdot C_t \cdot C_{eg} \cdot p_{ten} \cdot lbf = 915.66 \text{ lbf}$ **Allowable Tension**

$$Z_{\alpha pos} := \frac{W' \cdot Z'}{W' \cdot (\cos(\alpha_{pos}))^2 + Z' \cdot (\sin(\alpha_{pos}))^2} = 913.46 \text{ lbf}$$ $$Int_{pos} := \frac{R_{pos}}{Z_{\alpha pos}} = 0.57$$

$$Z_{\alpha neg} := \frac{W' \cdot Z'}{W' \cdot (\cos(\alpha_{neg}))^2 + Z' \cdot (\sin(\alpha_{neg}))^2} = 913.46 \text{ lbf}$$ $$Int_{neg} := \frac{R_{neg}}{Z_{\alpha neg}} = 0.57$$

Fastener = "3/8 in Lag Screw SS"
Predrill = "Predrill Holes at 40% - 70% D"
Penetration = "Verify Blocking Thickness"
Material = "Spruce Pine-Fir"

Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	11/19/2018
E-Mail:			

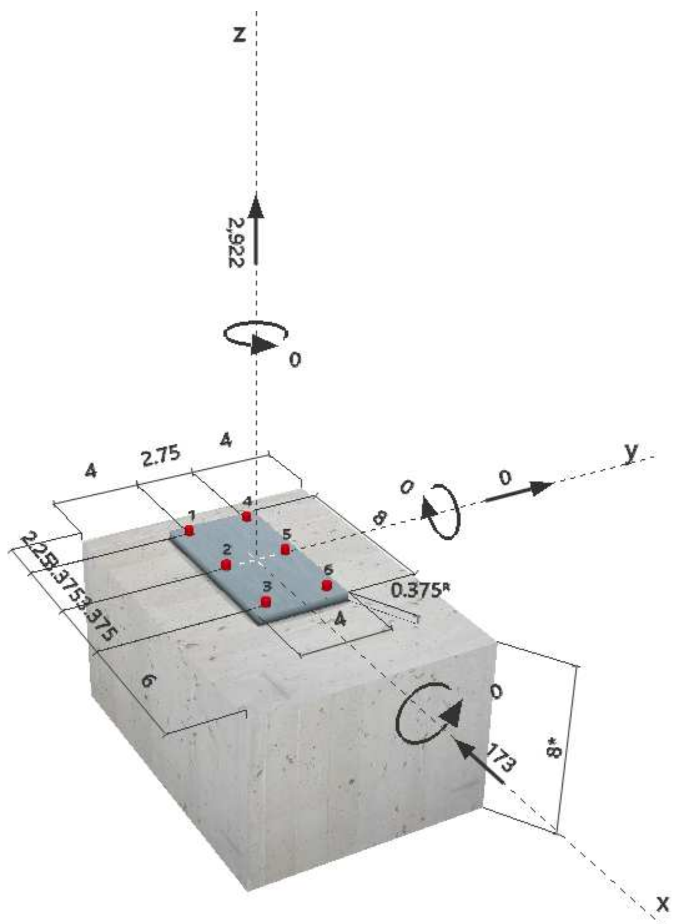
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 + HIT-Z-R 3/8**
Effective embedment depth:	$h_{ef,opti}$ = 2.375 in. ($h_{ef,limit}$ = 4.500 in.)
Material:	A4
Evaluation Service Report:	ESR-3187
Issued I Valid:	3/1/2018 | 3/1/2020
Proof:	Design method ACI 318-14 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.375 in.
Anchor plate:	l_x x l_y x t = 8.000 in. x 4.000 in. x 0.375 in.; (Recommended plate thickness: not calculated
Profile:	no profile
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 8.000 in., Temp. short/long: 130/110 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

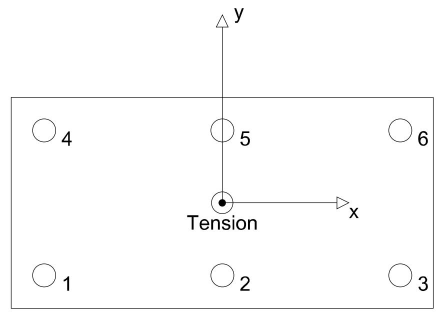
R - user is responsible to ensure a rigid base plate for the entered thickness with appropriate solutions (stiffeners,...)

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



2 Load case/Resulting anchor forces

Load case: Design loads



Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	487	29	-29	0
2	487	29	-29	0
3	487	29	-29	0
4	487	29	-29	0
5	487	29	-29	0
6	487	29	-29	0

max. concrete compressive strain:	- [‰]
max. concrete compressive stress:	- [psi]
resulting tension force in (x/y)=(0.000/0.000):	2,922 [lb]
resulting compression force in (x/y)=(0.000/0.000):	0 [lb]

Anchor forces based on a rigid base plate assumption!

3 Tension load

	Load N_{ua} [lb]	Capacity ϕ N_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	487	4,749	11	OK
Pullout Strength*	487	5,169	10	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	2,922	5,560	53	OK

* anchor having the highest loading **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-3187
$\phi N_{sa} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.08	94,200

Calculations

N_{sa} [lb]
7,306

Results

N_{sa} [lb]	ϕ_{steel}	ϕ N_{sa} [lb]	N_{ua} [lb]
7,306	0.650	4,749	487

3.2 Pullout Strength

$N_{pn} = N_p \lambda_a$ refer to ICC-ES ESR-3187
$\phi N_{pn} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

λ_a	N_p [lb]
1.000	7,952

Calculations

-
-

Results

N_{pn} [lb]	$\phi_{concrete}$	ϕ N_{pn} [lb]	N_{ua} [lb]
7,952	0.650	5,169	487

3.3 Concrete Breakout Strength

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$	ACI 318-14 Eq. (17.4.2.1b)
$\phi\ N_{cbg} \geq N_{ua}$	ACI 318-14 Table 17.3.1.1
A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)	
$A_{Nc0} = 9\ h_{ef}^2$	ACI 318-14 Eq. (17.4.2.1c)
$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}}\right) \leq 1.0$	ACI 318-14 Eq. (17.4.2.4)
$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$	ACI 318-14 Eq. (17.4.2.5b)
$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$	ACI 318-14 Eq. (17.4.2.7b)
$N_b = k_c\ \lambda_a\ \sqrt{f'_c}\ h_{ef}^{1.5}$	ACI 318-14 Eq. (17.4.2.2a)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2.375	0.000	0.000	2.250	1.000

c_{ac} [in.]	k_c	λ_a	f'_c [psi]
3.563	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
124.05	50.77	1.000	1.000	0.889	1.000	3,935

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
8,554	0.650	5,560	2,922

4 Shear load

	Load V_{ua} [lb]	Capacity ϕ V_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	29	2,630	2	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	173	5,988	3	OK
Concrete edge failure in direction x-**	173	1,304	14	OK

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength

$V_{sa} = (0.6\ A_{se,V}\ f_{uta})$ refer to ICC-ES ESR-3187

$\phi\ V_{steel} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]	$(0.6\ A_{se,V}\ f_{uta})$ [lb]
0.08	94,200	4,384

Calculations

V_{sa} [lb]
4,384

Results

V_{sa} [lb]	ϕ_{steel}	$\phi\ V_{sa}$ [lb]	V_{ua} [lb]
4,384	0.600	2,630	29

4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b\right]$ ACI 318-14 Eq. (17.5.3.1b)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e_N'}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c\ \lambda_a \sqrt{f_c'}\ h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
1	2.375	0.000	0.000	2.250

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f_c' [psi]
1.000	3.563	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
124.05	50.77	1.000	1.000	0.889	1.000	3,935

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi\ V_{cpg}$ [lb]	V_{ua} [lb]
8,554	0.700	5,988	173

4.3 Concrete edge failure in direction x-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\, \psi_{ed,V}\, \psi_{c,V}\, \psi_{h,V}\, \psi_{parallel,V}\, V_b$ ACI 318-14 Eq. (17.5.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Vc} see ACI 318-14, Section 17.5.2.1, Fig. R 17.5.2.1(b)

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-14 Eq. (17.5.2.1c)

$\psi_{ec,V} = \left(\frac{1}{1+\frac{2e'_V}{3c_{a1}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.5.2.5)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-14 Eq. (17.5.2.6b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-14 Eq. (17.5.2.8)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2}\sqrt{d_a}\right)\lambda_a \sqrt{f'_c}\, c_{a1}^{1.5}$ ACI 318-14 Eq. (17.5.2.2a)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
2.250	4.000	0.000	1.000	8.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
2.375	1.000	0.375	4,000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
32.06	22.78	1.000	1.000	1.000	1,324

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
1,863	0.700	1,304	173

5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.526	0.133	5/3	38	OK

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

6 Warnings

- The anchor design methods in PROFIS Anchor require rigid anchor plates per current regulations (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 Anchor 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 base plate assumption is valid is not carried out by PROFIS Anchor. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-14, Section 17.8.1.

Fastening meets the design criteria!

7 Installation data

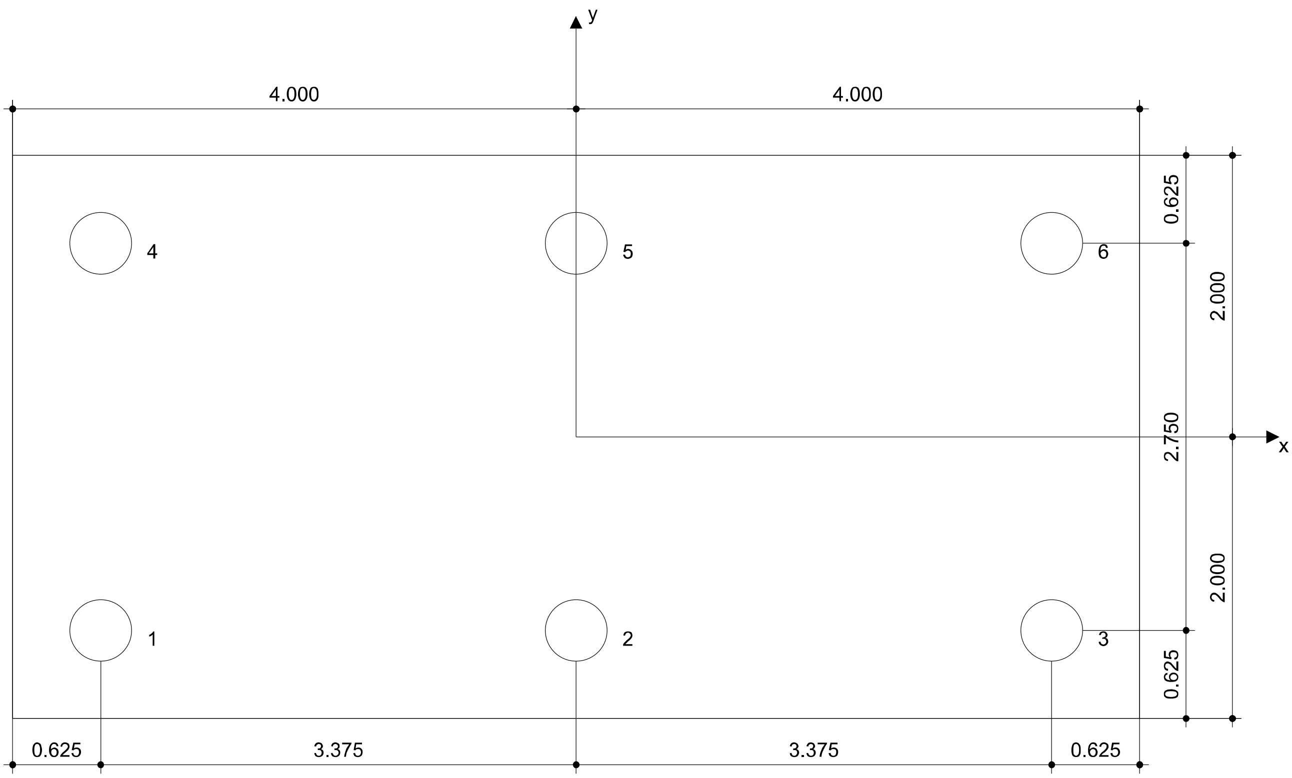
Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture (pre-setting) : d_f = 0.438 in.
Hole diameter in the fixture (through fastening) : d_f = 0.500 in.
Plate thickness (input): 0.375 in.
Recommended plate thickness: not calculated
Drilling method: Hammer drilled
Cleaning: No cleaning of the drilled hole is required

Anchor type and diameter: HIT-HY 200 + HIT-Z-R 3/8
Installation torque: 177.015 in.lb
Hole diameter in the base material: 0.438 in.
Hole depth in the base material: 3.375 in.
Minimum thickness of the base material: 4.625 in.

R - user is responsible to ensure a rigid base plate for the entered thickness with appropriate solutions (stiffeners,...)

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer	• No accessory required	• Dispenser including cassette and mixer
• Properly sized drill bit		• Torque wrench



Coordinates Anchor in.

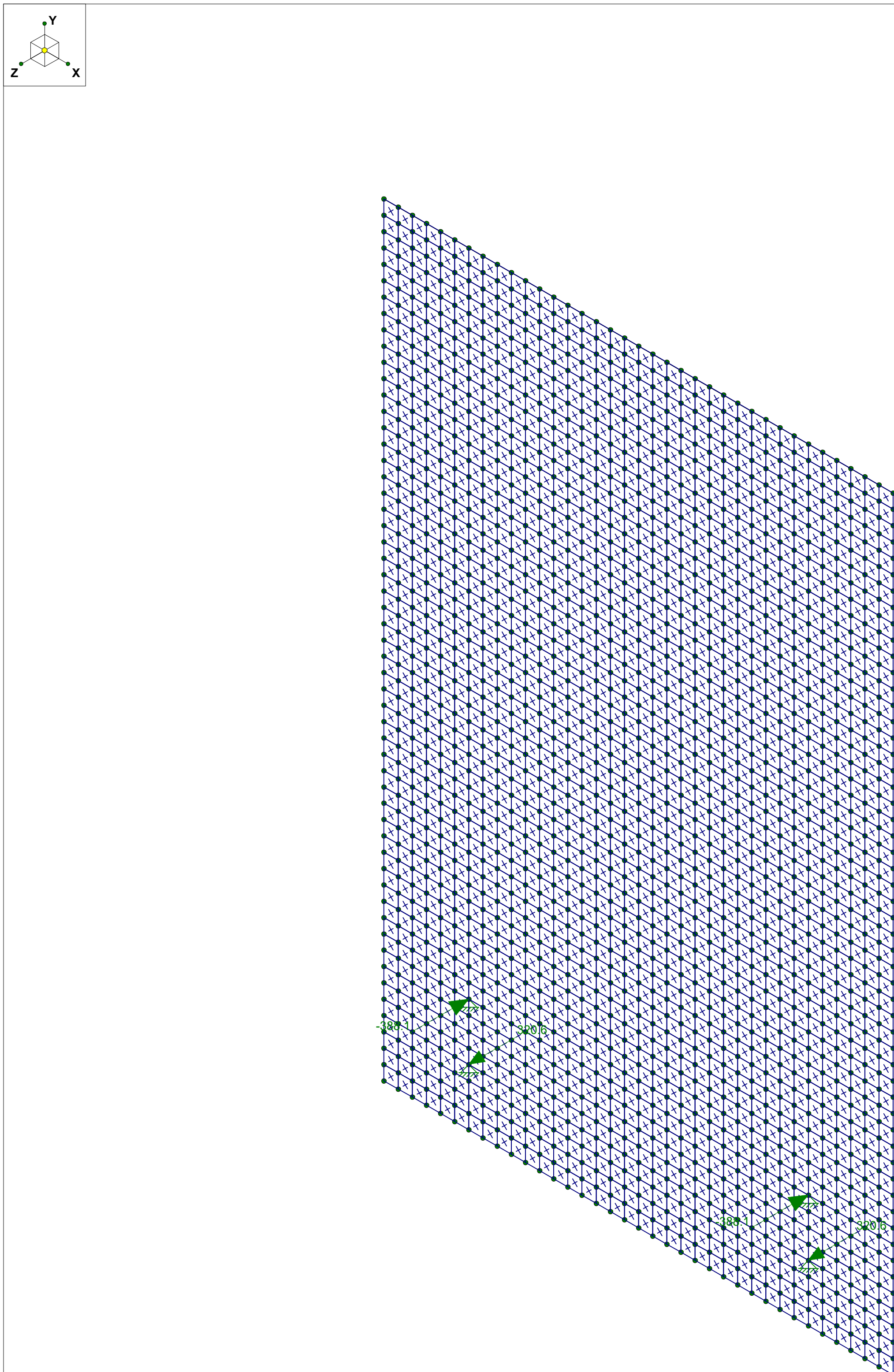
Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-3.375	-1.375	2.250	12.750	4.000	6.750
2	0.000	-1.375	5.625	9.375	4.000	6.750
3	3.375	-1.375	9.000	6.000	4.000	6.750

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
4	-3.375	1.375	2.250	12.750	6.750	4.000
5	0.000	1.375	5.625	9.375	6.750	4.000
6	3.375	1.375	9.000	6.000	6.750	4.000

Company:		Page:	7
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	11/19/2018
E-Mail:			

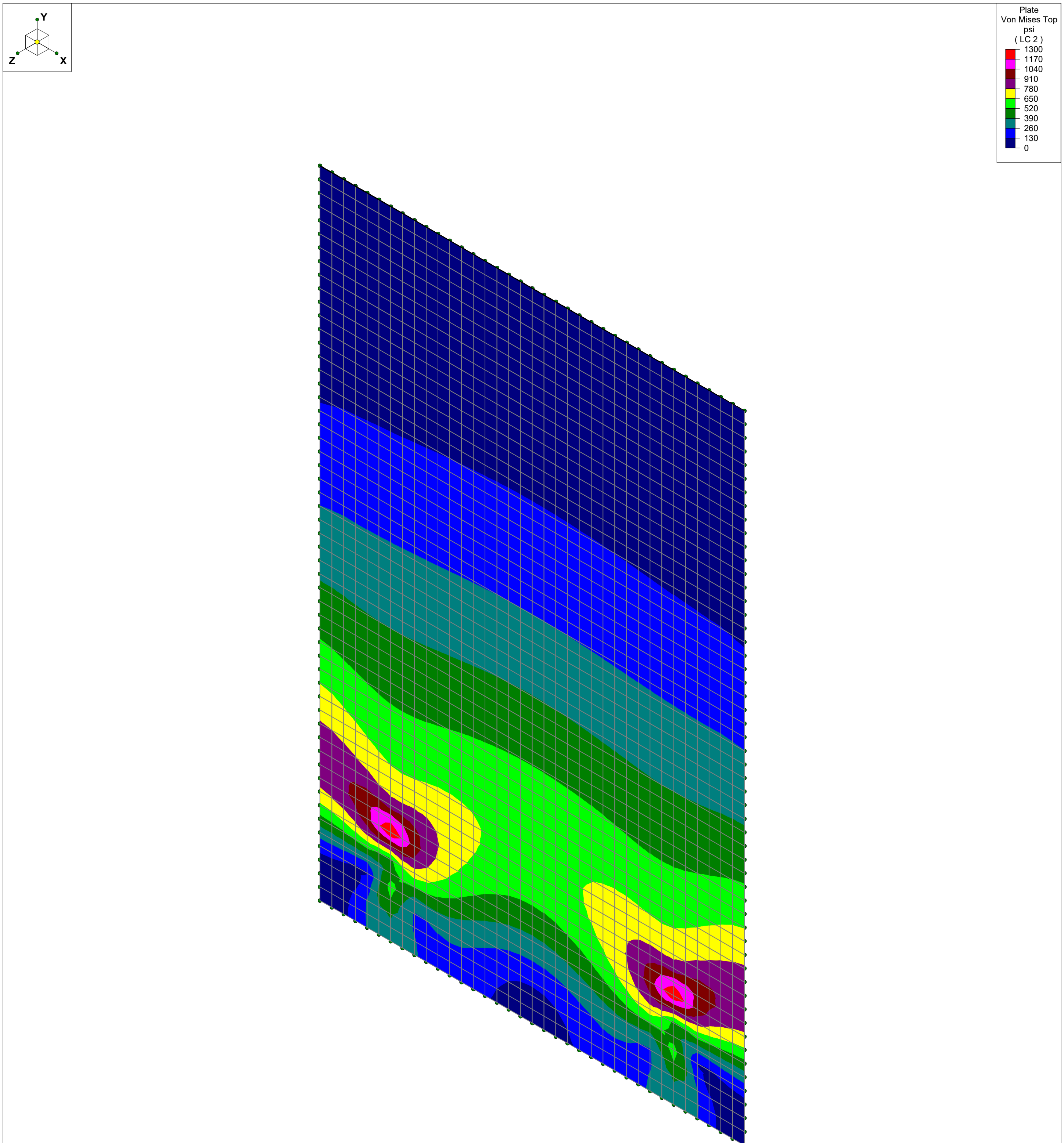
8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.



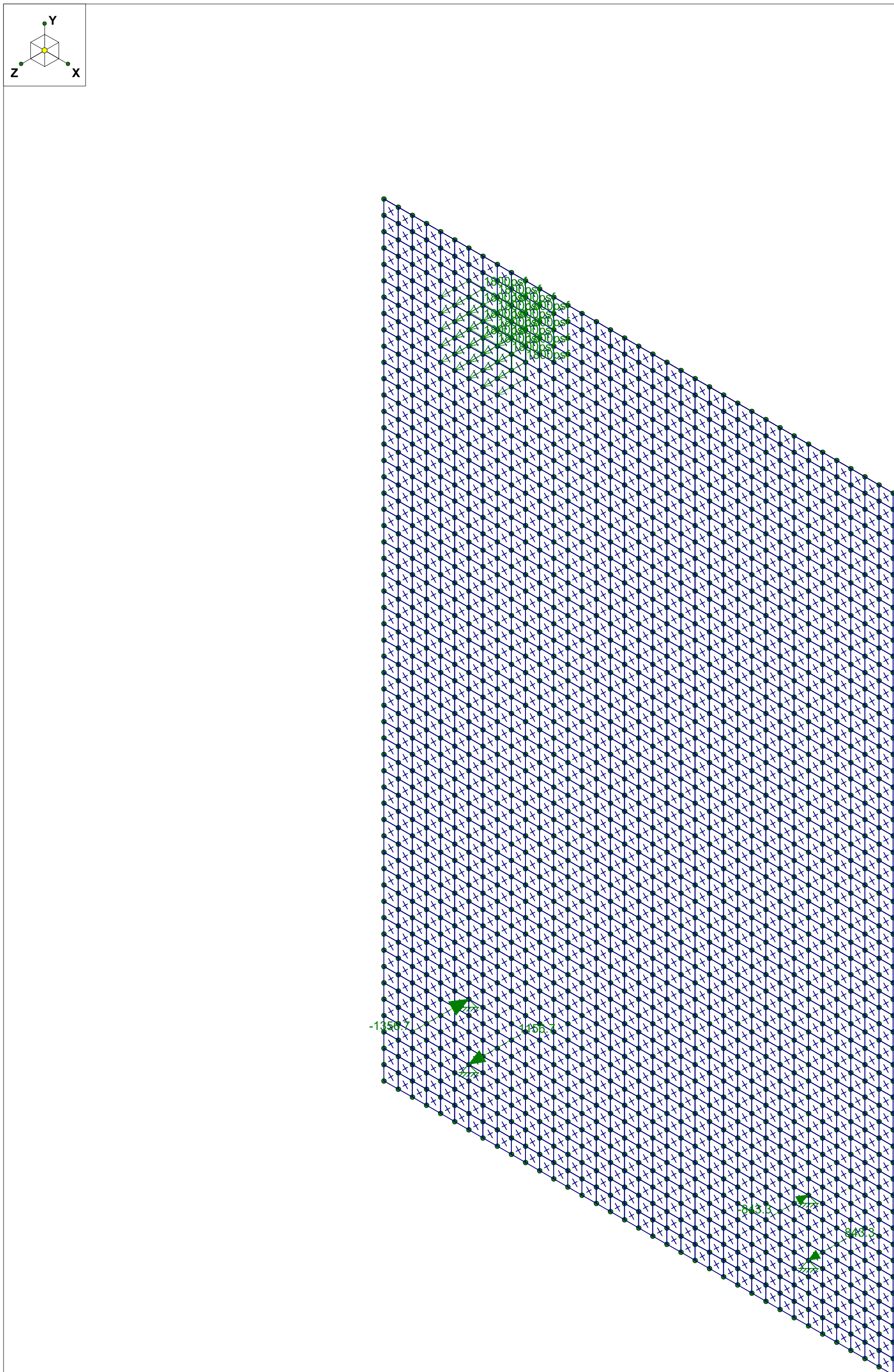
Results for LC 2, Interior Load
Z-direction Reaction Units are lb and lb-in

Rice Engineering	Morse Industires Standoff Mounts	
JJW		Nov 19, 2018 at 5:12 PM
		0.75 Inch Thick 3 ft wide.r3d



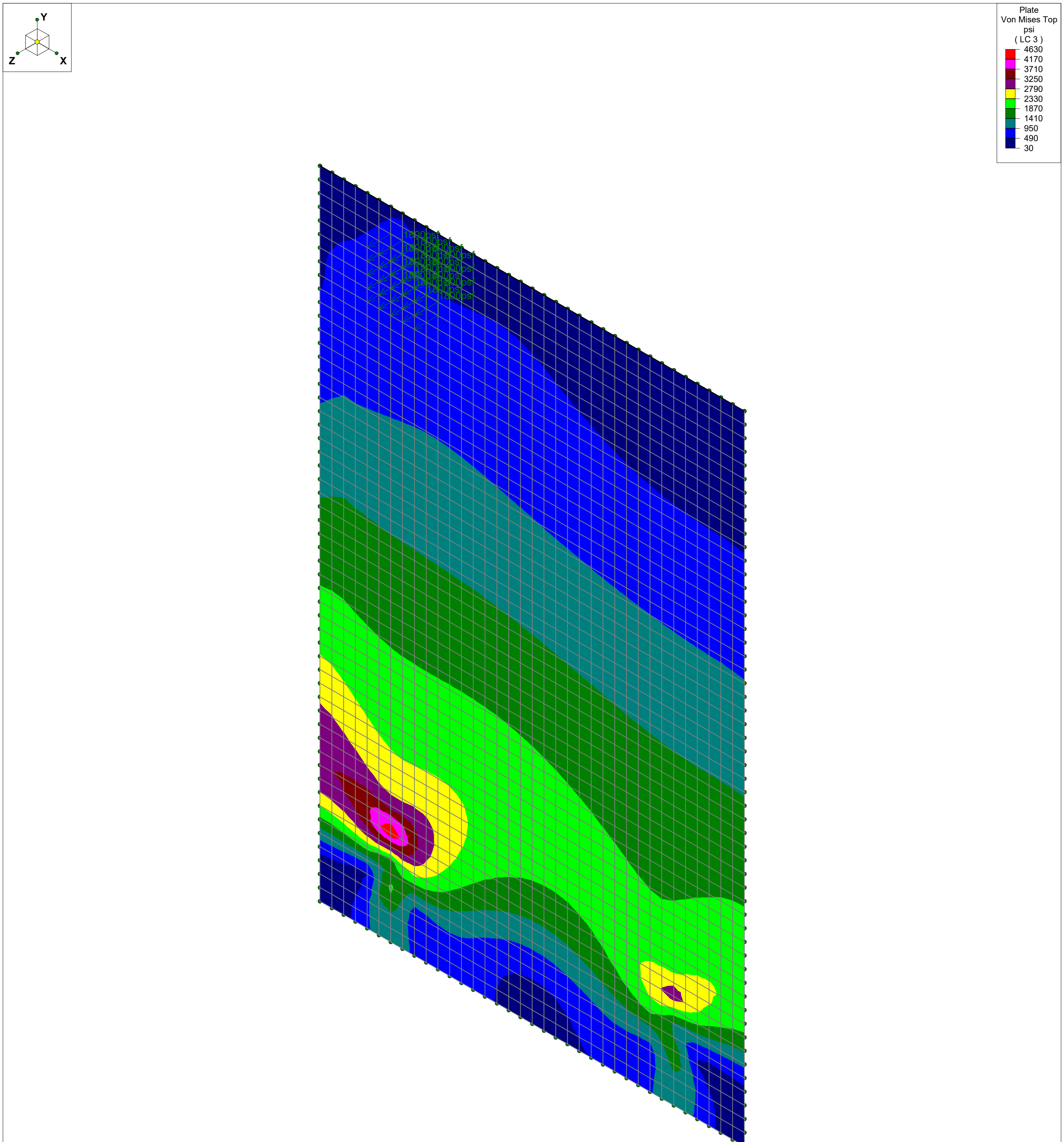
Results for LC 2, Interior Load

Rice Engineering	Morse Industires Standoff Mounts	
JJW		Nov 19, 2018 at 5:11 PM
		0.75 Inch Thick 3 ft wide.r3d



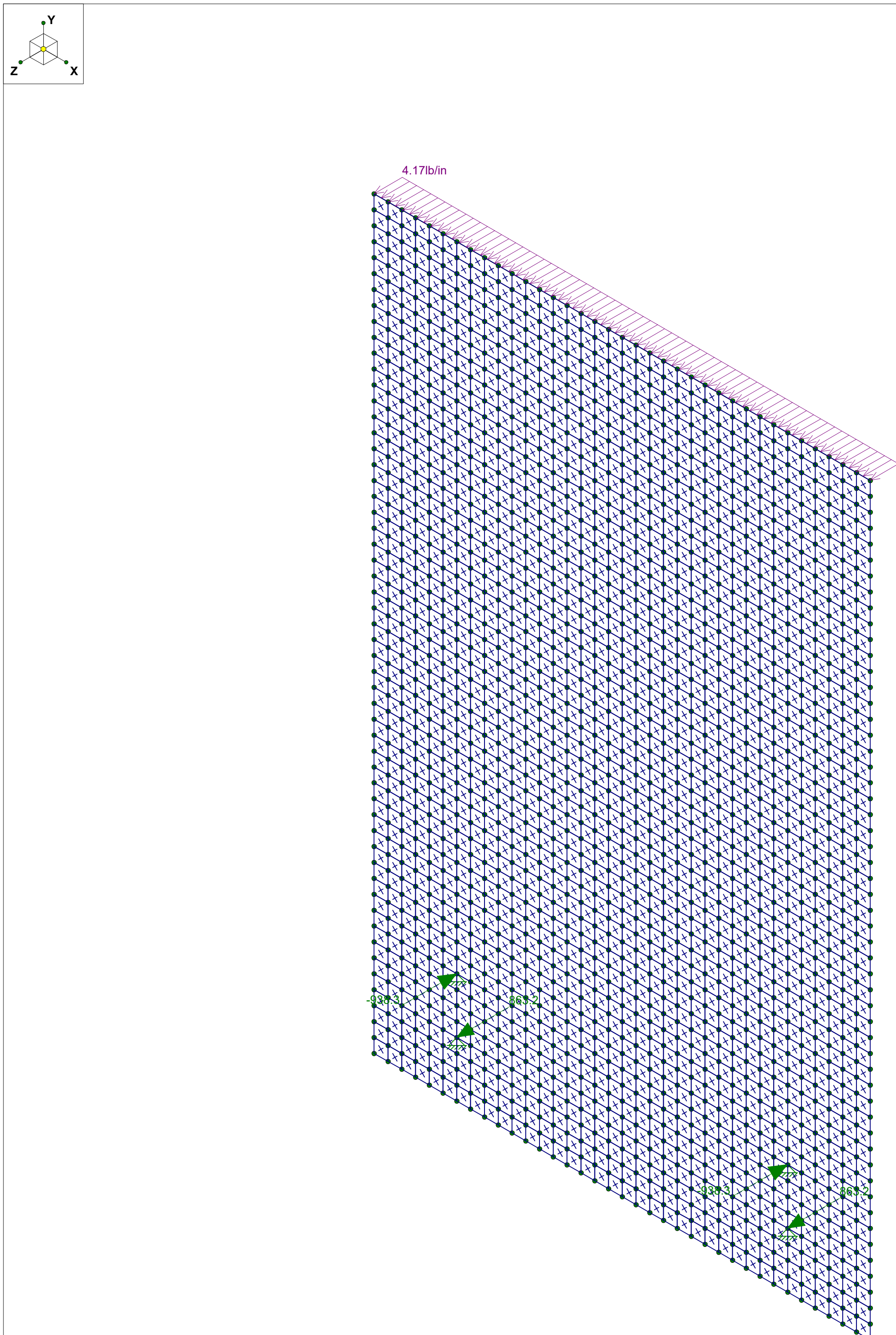
Loads: BLC 4, 200
Results for LC 3, 200
Z-direction Reaction Units are lb and lb-in

Rice Engineering		
JJW	Morse Industires Standoff Mounts	Nov 19, 2018 at 5:12 PM
		0.75 Inch Thick 3 ft wide.r3d



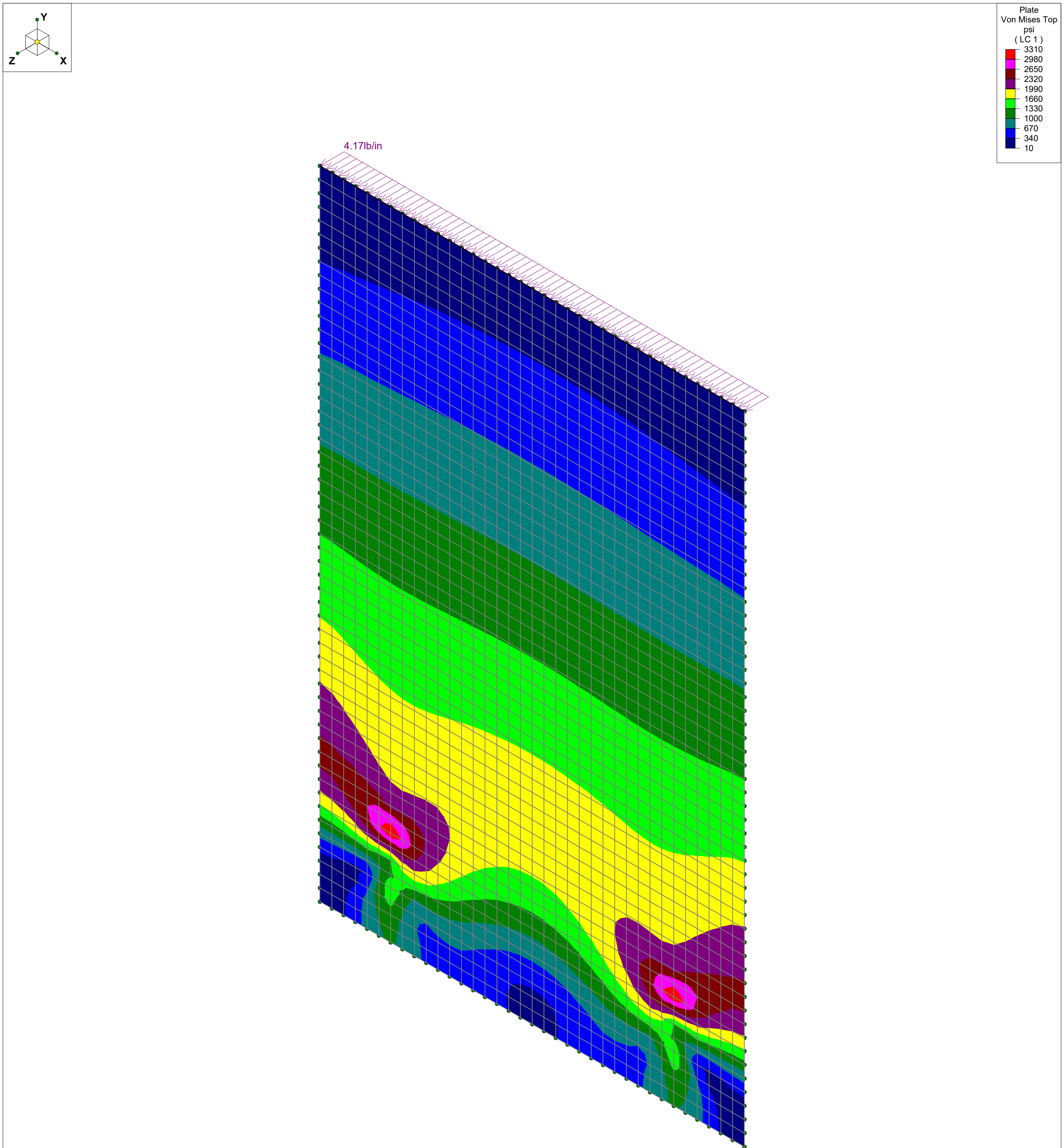
Loads: BLC 4, 200
Results for LC 3, 200

Rice Engineering	Morse Industires Standoff Mounts	
JJW		Nov 19, 2018 at 5:13 PM
		0.75 Inch Thick 3 ft wide.r3d



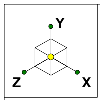
Loads: BLC 1, 50 psf
Results for LC 1, 50 psf
Z-direction Reaction Units are lb and lb-in

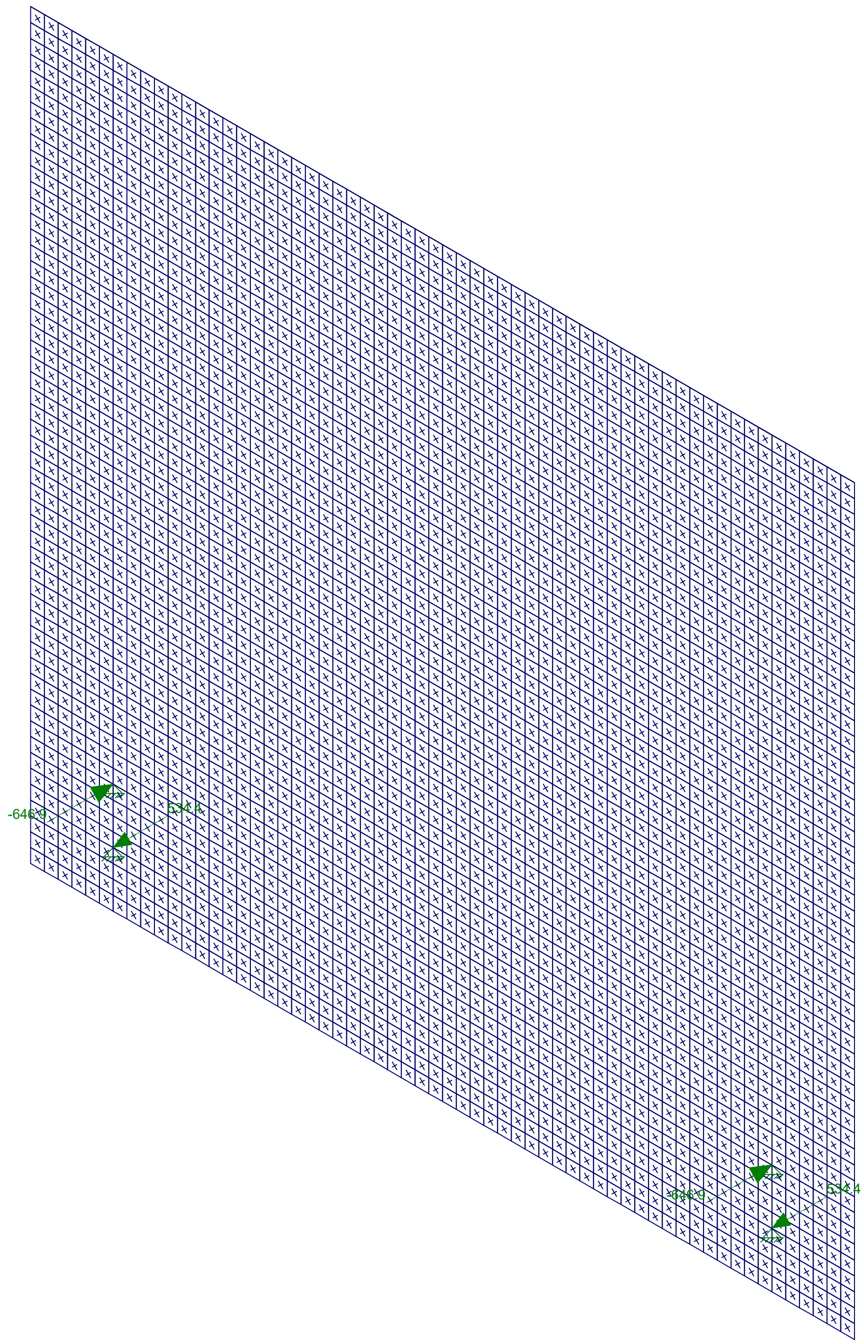
Rice Engineering	Morse Industires Standoff Mounts	SK - 1
JJW		Nov 19, 2018 at 5:10 PM
		0.75 Inch Thick 3 ft wide.r3d



Loads: BLC 1, 50 psf
Results for LC 1, 50 psf

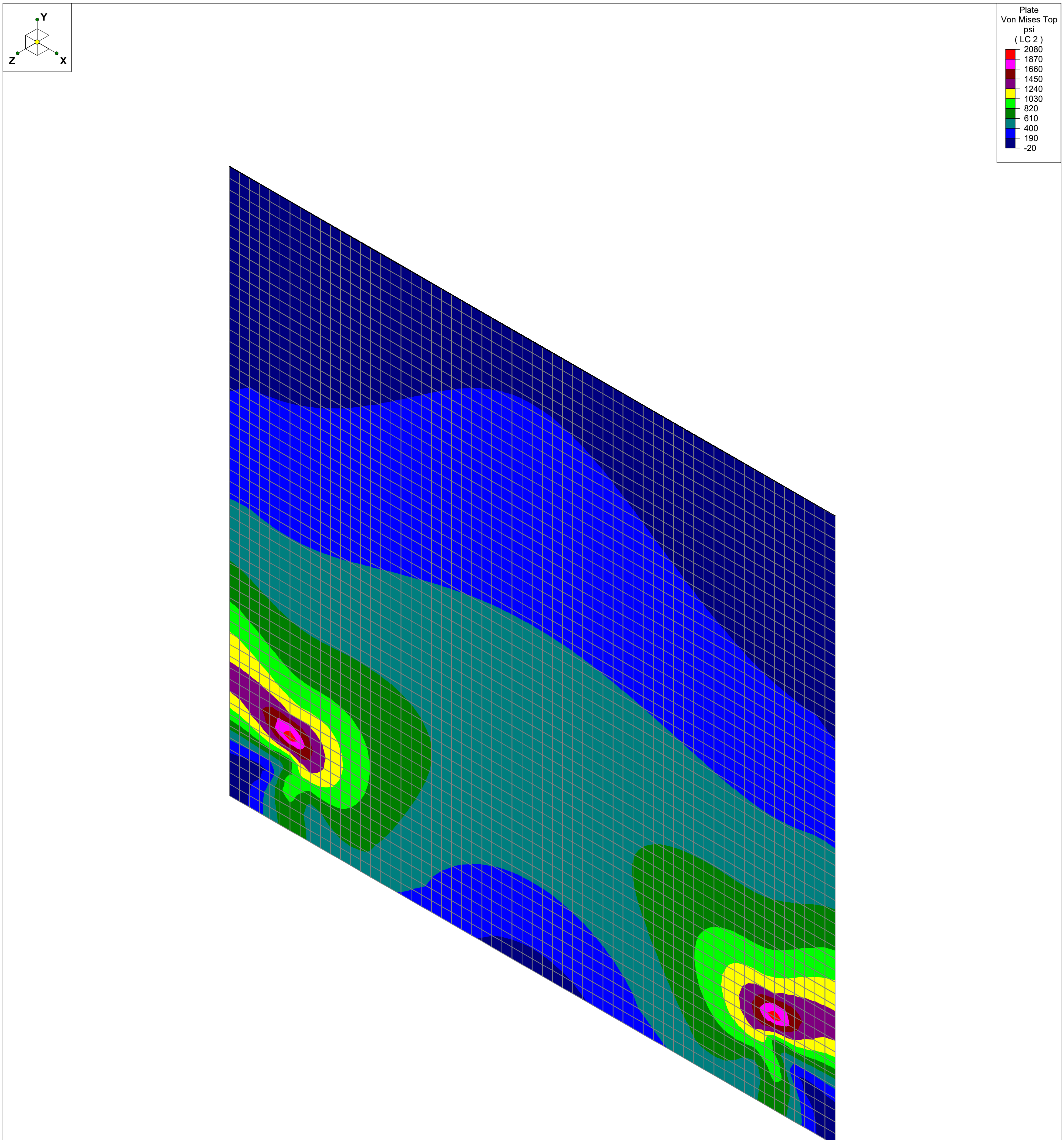
Rice Engineering	Morse Industires Standoff Mounts	
JJW		Nov 19, 2018 at 5:11 PM
		0.75 Inch Thick 3 ft wide.r3d





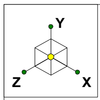
Results for LC 2, Interior Load
Z-direction Reaction Units are lb and lb-in

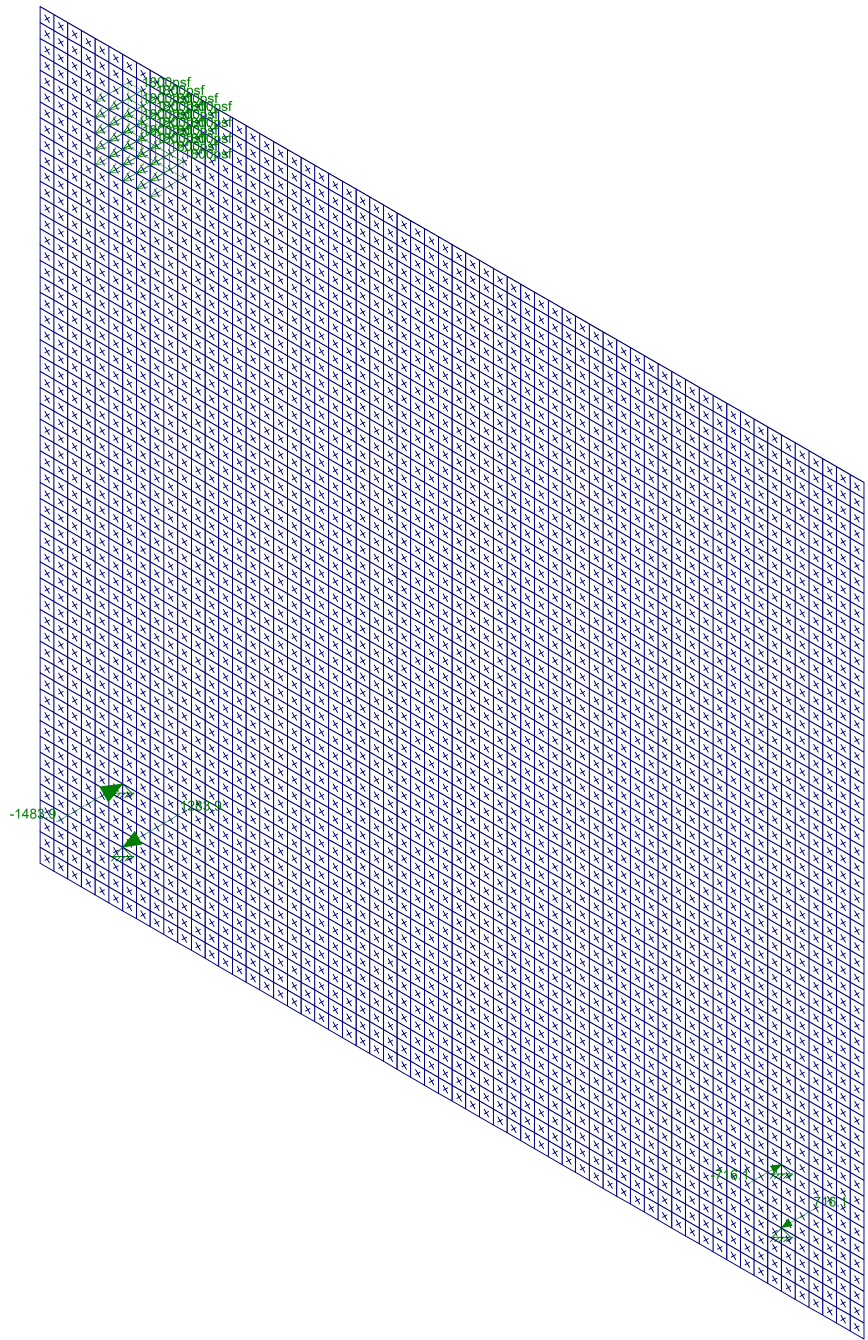
Rice Engineering	Morse Industies Standoff Mounts	
JJW		Nov 19, 2018 at 5:08 PM
		0.75 Inch Thick 5 ft wide.r3d



Results for LC 2, Interior Load

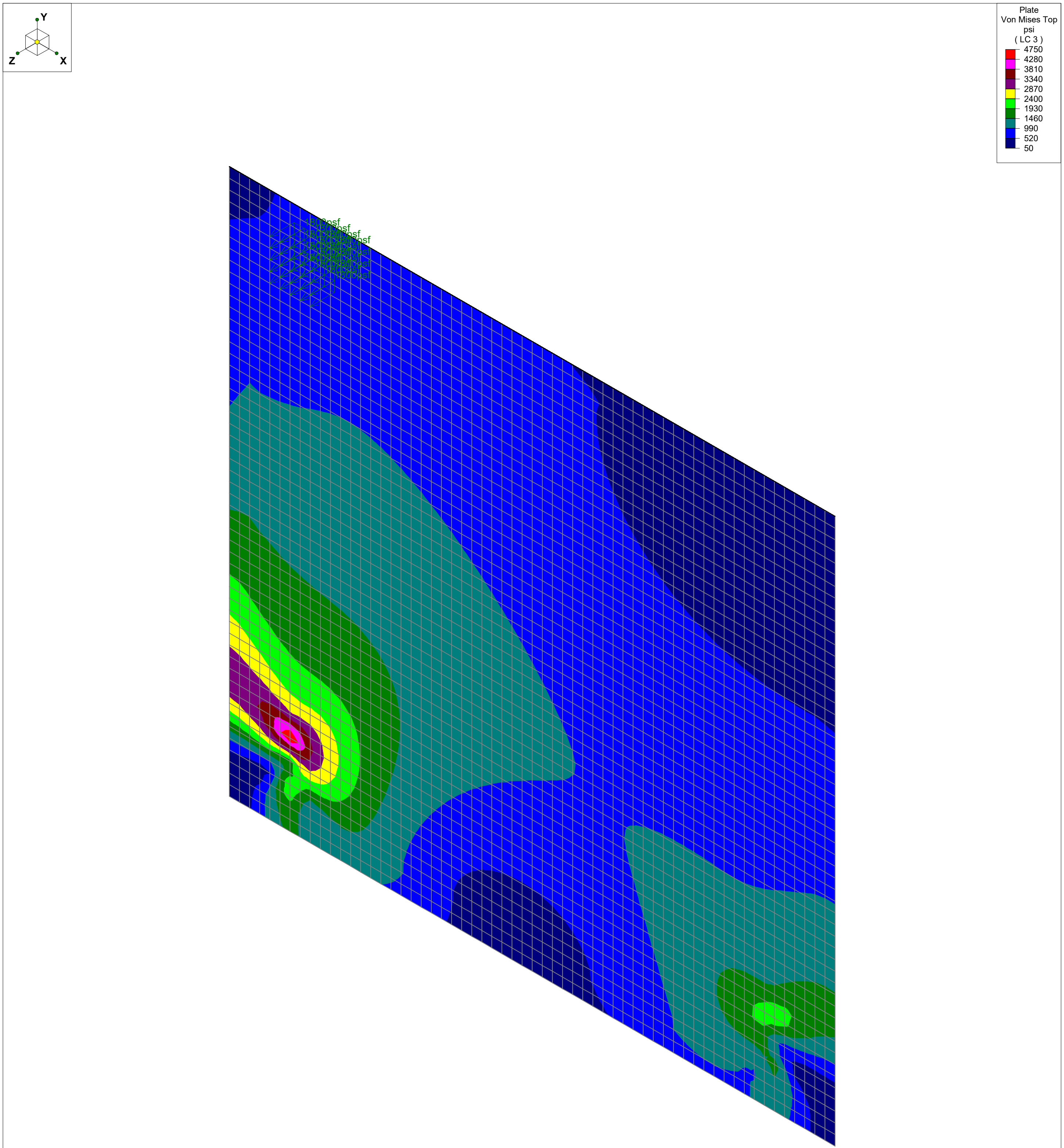
Rice Engineering	Morse Industies Standoff Mounts	
JJW		Nov 19, 2018 at 5:07 PM
		0.75 Inch Thick 5 ft wide.r3d





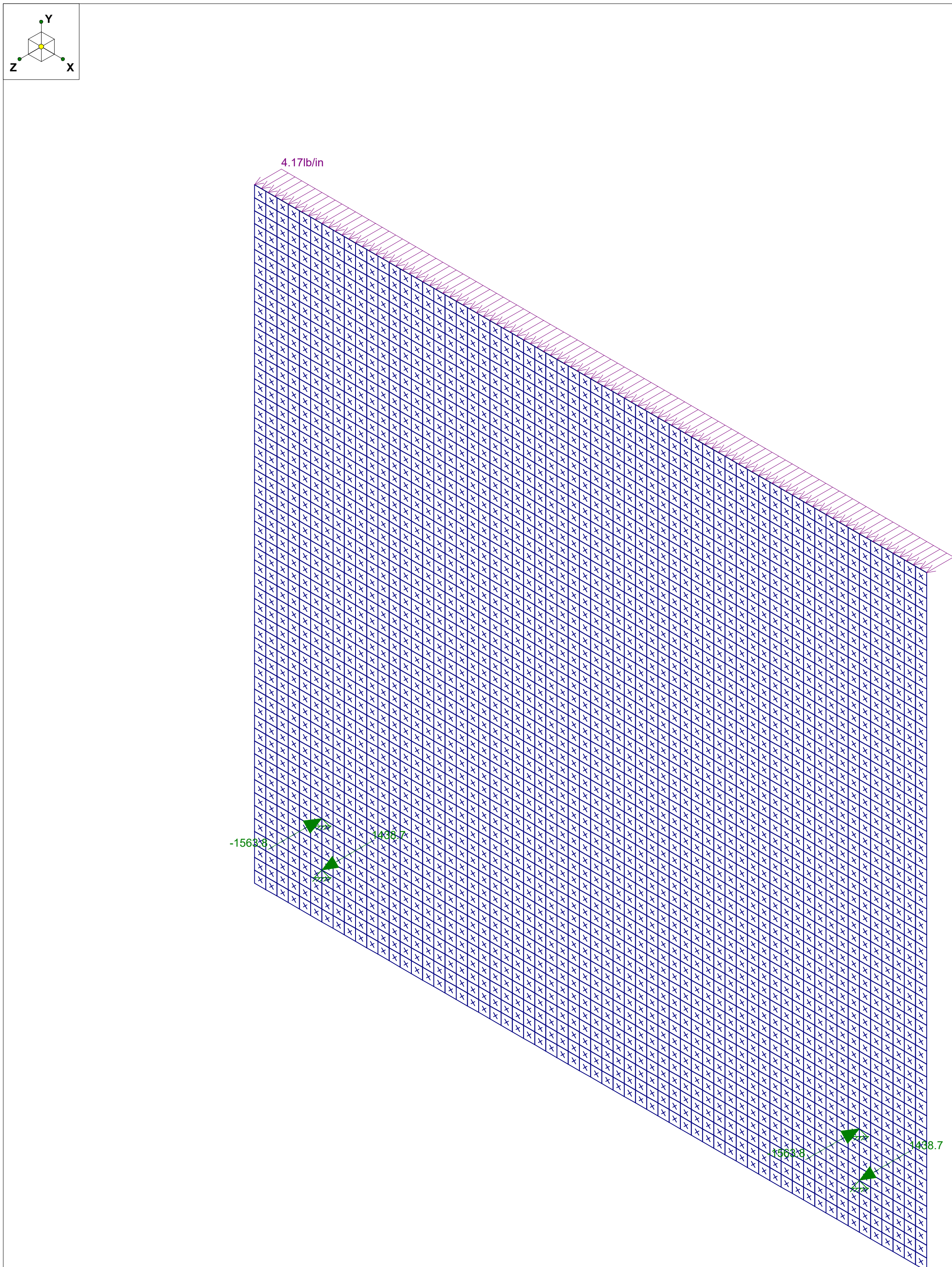
Loads: BLC 4, 200
Results for LC 3, 200
Z-direction Reaction Units are lb and lb-in

Rice Engineering	Morse Industies Standoff Mounts	
JJW		Nov 19, 2018 at 5:04 PM
		0.75 Inch Thick 5 ft wide.r3d



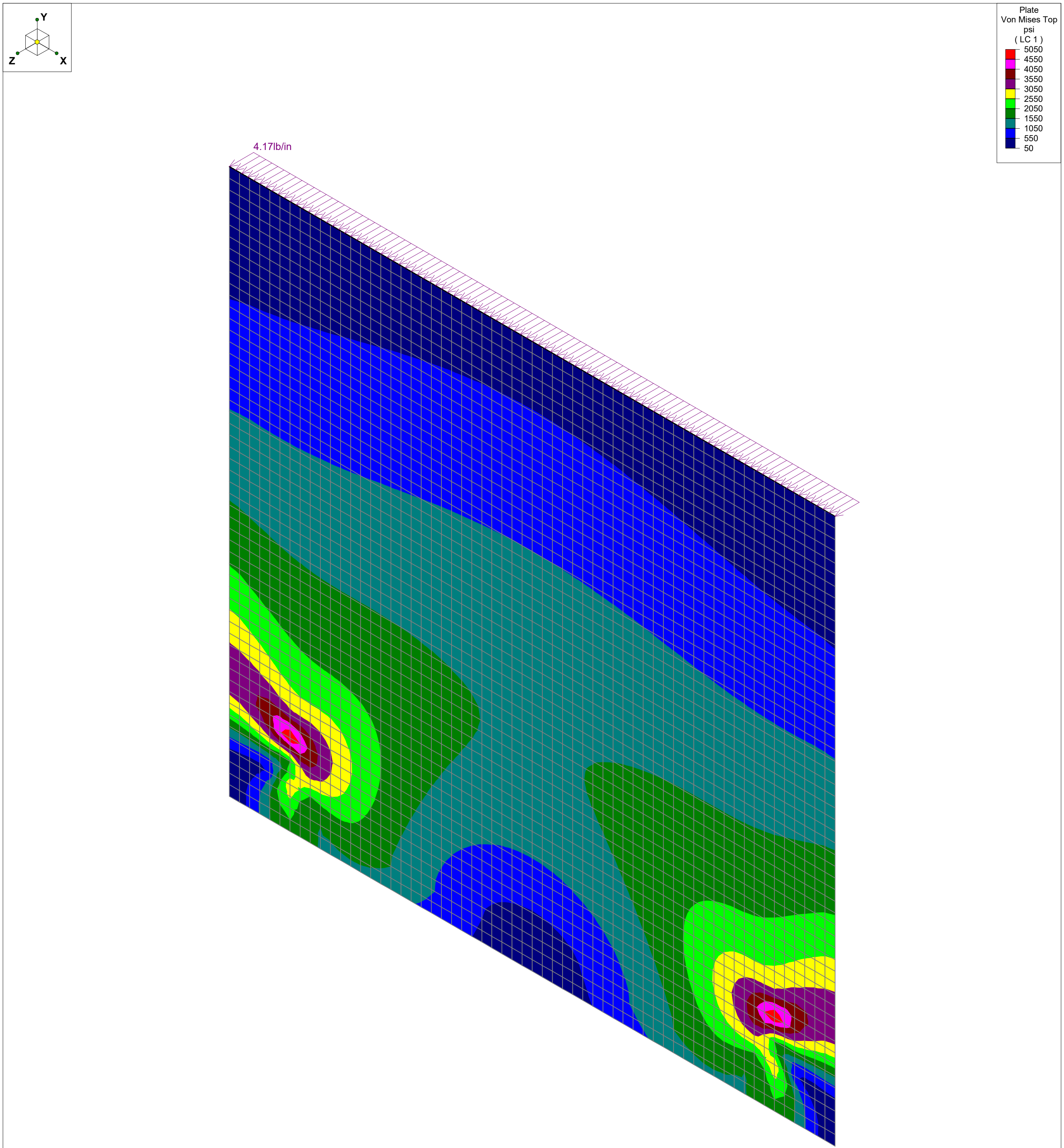
Loads: BLC 4, 200
Results for LC 3, 200

Rice Engineering	Morse Industies Standoff Mounts	
JJW		Nov 19, 2018 at 5:04 PM
		0.75 Inch Thick 5 ft wide.r3d



Loads: BLC 1, 50 psf
Results for LC 1, 50 psf
Z-direction Reaction Units are lb and lb-in

Rice Engineering	Morse Industies Standoff Mounts	
JJW		Nov 19, 2018 at 5:03 PM
		0.75 Inch Thick 5 ft wide.r3d



Loads: BLC 1, 50 psf
Results for LC 1, 50 psf

Rice Engineering	Morse Industies Standoff Mounts	
JJW		Nov 19, 2018 at 5:02 PM
		0.75 Inch Thick 5 ft wide.r3d

Standoff Mounted Glass	Detail Ref.	Sheet No: B1

Inputs:

$WL := 10$	psf	(wind load)
$P := 200$	lb	(point load)
$W_h := 4.17$	pli	(horizontal uniform load)
$h := 46$	in	(height of rail above upper standoff)
$w := 46$	in	(glass width)
$t := 0.63$	in	(glass thickness)

Calculations: *(Reactions from RISA 3D FEA Model)*

<u>Use 11/16" Glass, Fully Tempered & Laminated</u>
with polished edges (5/16" / 0.060" SGP / 5/16")
Minimum Glass Lite Width: 3'-0"
Maximum Glass Lite Width: 3'-10"

Point Load:

$\sigma_p := 5990$ psi $\quad \sigma_{all} := 6000$ psi

$\Delta_p := 0.979$ in $\quad \Delta_{all} := \frac{h}{24} + \frac{w}{96} = 2.4$ in

Uniform Load:

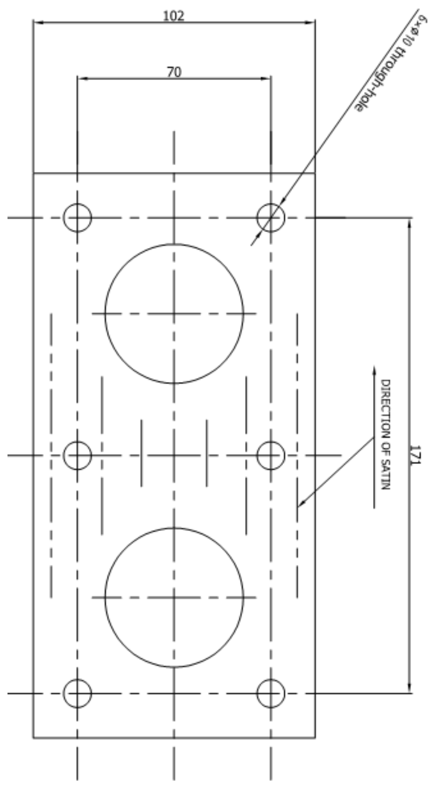
$\sigma_u := 5170$ psi $\quad \sigma_{all} := 6000$ psi

$\Delta_u := 0.867$ in $\quad \Delta_{all} := \frac{h}{24} + \frac{w}{96} = 2.4$ in

Wind Load:

$\sigma_w := 2090$ psi $\quad \sigma_{all} := 6000$ psi

$\Delta_w := 0.27$ in $\quad \Delta_{all} := \frac{h}{24} + \frac{w}{96} = 2.4$ in



Reactions from Point Load:

$V_p := 72$ lb

$T_p := 1415$ lb

Reactions from Uniform Load:

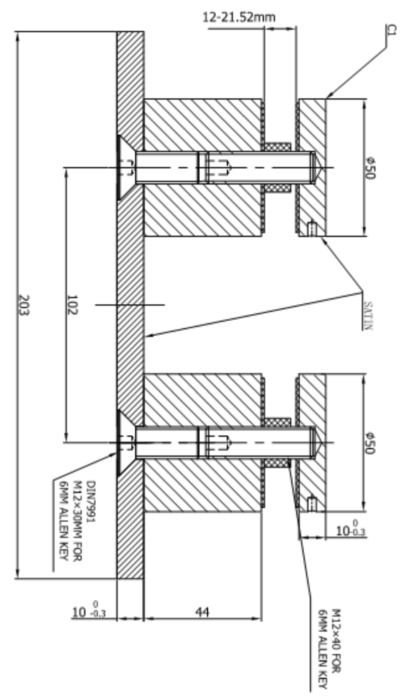
$V_u := 72$ lb

$T_u := 1199$ lb

Reactions from Wind Load:

$V_w := 72$ lb

$T_w := 496$ lb



<u>NOTE:</u> *Under full design load, the rail will deflect about 1", this is acceptable per ASTM E2358 deflection limits. Customer please verify the deflection is acceptable.*

$$GLASS := \begin{cases} \text{"OK"} & \text{if } \frac{\max(\sigma_p, \sigma_u, \sigma_w)}{\sigma_{all}} \le 1 \\ \text{"FAILS"} & \text{otherwise} \end{cases}$$

GLASS = "OK"

Standoff Mounted Glass	Detail Ref.	Sheet No: B1 A

Inputs:

$e := 2.0625$ in (Eccentricity)

$D := 2$ in (Diameter of Standoff)

Calculations:

$R_y := \max(V_p, V_u, V_w) = 72$ lb

$R_z := \max(T_p, T_u, T_w) = 1415$ lb

(Worst Case Loads)

Chk Bolt into Standoffs:

$V := R_y = 72$ lb

$T := \frac{R_y \cdot e}{0.5 \cdot D} + R_z = 1564$ lb

$V_{all} := 1614$ lb

$T_{all} := 3100 \cdot \frac{0.25}{0.375} = 2067$ lb

$I := \left(\frac{V}{V_{all}}\right)^2 + \left(\frac{T}{T_{all}}\right)^2 = 0.57 < 1.0$

Use 3/8" Dia. S.S. Flat Headed Threaded Rods
(300 Series S.S., Cond. CW, Fy = 65 ksi)
as shown 1/4" Thread Engagement

Chk Anchors into Concrete:

$V_2 := R_y \cdot 1.6 = 115$ lb

$T_2 := \left(\frac{R_y \cdot e}{0.5 \cdot D \cdot 0.85} + R_z\right) \cdot 1.6 = 2544$ lb

*****SEE HILTI PROFIS OR POWERS PDA DATA*****

Use 3/8" Dia. SS HIT-Z-R Rod w/ Hilti HIT-HY 200 or Equal
300 Series Stainless Steel

Embedment: 2-3/8" Min.
Edge Distance: 2-1/4"
2nd Edge Distance: 4"
Spacing: 2-3/4" and 3-3/8"
Min. Slab Thickness: 8"
Concrete Strength: f'c= 4,000 psi, Normal Wt. Cracked

*****Install per Manufacturer's instructions*****

Chk Bearing on Face of Glass:

$A_f := \left(\frac{D}{2}\right)^2 \cdot \pi - \left(\frac{0.75}{2}\right)^2 \cdot \pi = 2.7$ in^2

$P_f := \frac{R_y \cdot e}{D \cdot (0.67)} + R_z$ $P_f = 1526$ lb

$f_{pf} := \frac{P_f}{A_f}$ $f_{pf} = 565$ psi

$F_{pf} := 3000$ psi

Bearing on Glass Face "OK"

Glass Standoffs are Proprietary Design
Glass Standoffs Designed By Others
Use Standard Gaskets and Bushing
to Protect Glass Edge

Chk Alum. Back Plate:

$L1 := 4$ in $D1 := 0.625$ in

$L2 := 4.625$ in $D2 := 0.625$ in

assume load is in the direction of L2

$L := L2 - (2 \cdot D2)$ $L = 3.38$ in

$A := \frac{L - d}{2}$ $A = 0.688$ in

$B := L - A$ $B = 2.688$ in

$P := T$ $P = 1564$ lb

$M_{pl} := \frac{P \cdot L}{8}$ $M_{pl} = 660$ in·lb

$t_{req} := \sqrt{\frac{M_{pl} \cdot 6}{28000 \cdot L1}}$ $t_{req} = 0.188$ in

Use 3/8" x 4" x 8" Plate
6061-T6 alloy

Chk Anchors into Wood:

$V_1 := \frac{R_y}{6} = 12$ lb

$T_1 := \left(\frac{R_y \cdot e}{0.5 \cdot D \cdot 0.85} + \frac{R_z}{6}\right) = 411$ lb

*****SEE SHEET A1B*****

Use 3/8" Dia. SS Lag Bolts
300 Series Stainless Steel
3" Min. Thread Penetration
Edge Distance: 1-1/2"
Spacing: 2-3/4" and 3-3/8"
Spruce-Pine-Fir (SG = 0.42)

Chk Anchors into Steel:

$V_3 := R_y = 72$ lb

$T_3 := \frac{R_y \cdot e}{0.5 \cdot D} + R_z = 1564$ lb

$V_{all3} := 1614$ lb

$T_{all3} := 3100$ lb

$I_3 := \left(\frac{V_3}{V_{all3}}\right)^2 + \left(\frac{T_3}{T_{all3}}\right)^2 = 0.26 < 1.0$

Use 3/8"-16 Dia. S.S. Threaded Rods
(300 Series S.S., Cond. CW, Fy = 65 ksi)
3/8" min. Thread Engagement
Separate Dissimilar Metals
as shown

Dowel Type Fastener Capacity (NDS 2012)

Lag Bolts	Detail Ref.	Sheet No: B1B

$V_{pos} := 12 \cdot lbf$ $V_{neg} := 12 \cdot lbf$

$T_{pos} := 411 \cdot lbf$ $T_{neg} := 411 \cdot lbf$

3/8 in Lag Screw SS

$l_m := 3$ thickness of main member, in.

$l_s := 0.375$ thickness of side member, in

6061-T6 Hole

$F_{yb} = 65000$ bending yield strength, psi.

$D = 0.375$ unthreaded shank diameter of screw, in.

$D_r = 0.27$ root diameter of screw

$F_{es} = 43000$ bearing strength, psi

$G = 0.42$ Material = "Spruce Pine-Fir"

Spruce Pine-Fir $G = 0.42$

$p := 3$ penetration, in

$t_{shim} := 0.5$ maximum thickness of shim, in

$C_D := 1.6$ load duration factor, 10.3.2

$C_M := 1.0$ wet service factor, 10.3.3

$C_t := 1.0$ temperature factor, 10.3.4

$C_g := 1.0$ group action factor, 10.3.6

$C_\Delta := 1.0$ geometry factor, 11.5.1

$C_{eg} := 1.0$ end grain factor, 11.5.2

$C_{di} := 1.0$ diaphragm factor, 11.5.3

$\theta := 90$ angle of Shear load to grain, degree

Calculations

$K_\theta := 1 + 0.25 \cdot \frac{\theta}{90} = 1.25$ $R_e := \frac{F_{em}}{F_{es}} = 0.07$ $R_t := \frac{l_m}{l_s} = 8$

$K_D := \begin{cases} 2.2 & \text{if } D_r \le 0.17 \\ \text{otherwise} & \begin{cases} 10 \cdot D_r + 0.5 & \text{if } 0.17 < D_r \le 0.25 \\ 0 & \text{otherwise} \end{cases} \end{cases} = 0$

$$k_1 := \frac{\sqrt{R_e + 2 \cdot R_e^2 \cdot \left(1 + R_t + R_t^2\right) + R_t^2 \cdot R_e^3} - R_e \cdot (1 + R_t)}{1 + R_e} = 0.24$$

$R_{d1} := \begin{cases} K_D & \text{if } D_r \le 0.25 \\ 4.0 \cdot K_\theta & \text{if } 0.25 < D_r \le 1 \text{ otherwise} \end{cases} = 5$

$$k_2 := -1 + \sqrt{2 \cdot (1 + R_e) + \frac{2 \cdot F_{yb} \cdot (1 + 2 \cdot R_e) \cdot D_r^2}{3 \cdot F_{em} \cdot l_m^2}} = 0.51$$

$R_{d2} := \begin{cases} K_D & \text{if } D_r \le 0.25 \\ 3.6 \cdot K_\theta & \text{if } 0.25 < D_r \le 1 \text{ otherwise} \end{cases} = 4.5$

$$k_3 := -1 + \sqrt{\frac{2 \cdot (1 + R_e)}{R_e} + \frac{2 \cdot F_{yb} \cdot (2 + R_e) \cdot D_r^2}{3 \cdot F_{em} \cdot l_s^2}}$$

$R_{d3} := \begin{cases} K_D & \text{if } D_r \le 0.25 \\ 3.2 \cdot K_\theta & \text{if } 0.25 < D_r \le 1 \text{ otherwise} \end{cases} = 4$

$Z_{Im} := \frac{D_r \cdot l_m \cdot F_{em}}{R_{d1}} = 450.22$ $Z_{Is} := \frac{D_r \cdot l_s \cdot F_{es}}{R_{d1}} = 854.63$ $Z_{II} := \frac{k_1 \cdot D_r \cdot l_s \cdot F_{es}}{R_{d2}} = 226.5$ $Z_{IIIm} := \frac{k_2 \cdot D_r \cdot l_m \cdot F_{em}}{(1 + 2R_e) \cdot R_{d3}} = 251.43$

$Z_{IIIs} := \frac{k_3 \cdot D_r \cdot l_s \cdot F_{em}}{(2 + R_e) \cdot R_{d3}} = 202.26$ $Z_{IV} := \frac{D_r^2}{R_{d3}} \cdot \sqrt{\frac{2 \cdot F_{em} \cdot F_{yb}}{3 \cdot (1 + R_e)}} = 188.37$

$Z_1 := \min(Z_{Im}, Z_{Is}, Z_{II}, Z_{IIIm}, Z_{IIIs}, Z_{IV}) = 188.37$

$W_1 = 234.78$

$R_{pos} := \sqrt{T_{pos}^2 + V_{pos}^2} = 411.18 \text{ lbf}$ $R_{neg} := \sqrt{T_{neg}^2 + V_{neg}^2} = 411.18 \text{ lbf}$

$\alpha_{pos} := \text{atan}\left(T_{pos} \cdot V_{pos}^{-1}\right) = 88.33 \cdot \text{deg}$ $\alpha_{neg} := \text{atan}\left(T_{neg} \cdot V_{neg}^{-1}\right) = 88.33 \cdot \text{de}$

Results

$Z' := Z_1 \cdot C_D \cdot C_M \cdot C_t \cdot C_g \cdot C_\Delta \cdot C_{eg} \cdot C_{di} \cdot lbf = 301.39 \text{ lbf}$ **Allowable Shear**

$W' := W_1 \cdot C_D \cdot C_M \cdot C_t \cdot C_{eg} \cdot p_{ten} \cdot lbf = 915.66 \text{ lbf}$ **Allowable Tension**

$$Z_{\alpha pos} := \frac{W' \cdot Z'}{W' \cdot \left(\cos(\alpha_{pos})\right)^2 + Z' \cdot \left(\sin(\alpha_{pos})\right)^2} = 914.07 \text{ lbf}$$ $Int_{pos} := \frac{R_{pos}}{Z_{\alpha pos}} = 0.45$

$$Z_{\alpha neg} := \frac{W' \cdot Z'}{W' \cdot \left(\cos(\alpha_{neg})\right)^2 + Z' \cdot \left(\sin(\alpha_{neg})\right)^2} = 914.07 \text{ lbf}$$ $Int_{neg} := \frac{R_{neg}}{Z_{\alpha neg}} = 0.45$

Fastener = "3/8 in Lag Screw SS"
Predrill = "Predrill Holes at 40% - 70% D"
Penetration = "Verify Blocking Thickness"
Material = "Spruce Pine-Fir"

Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	12/5/2018
E-Mail:			

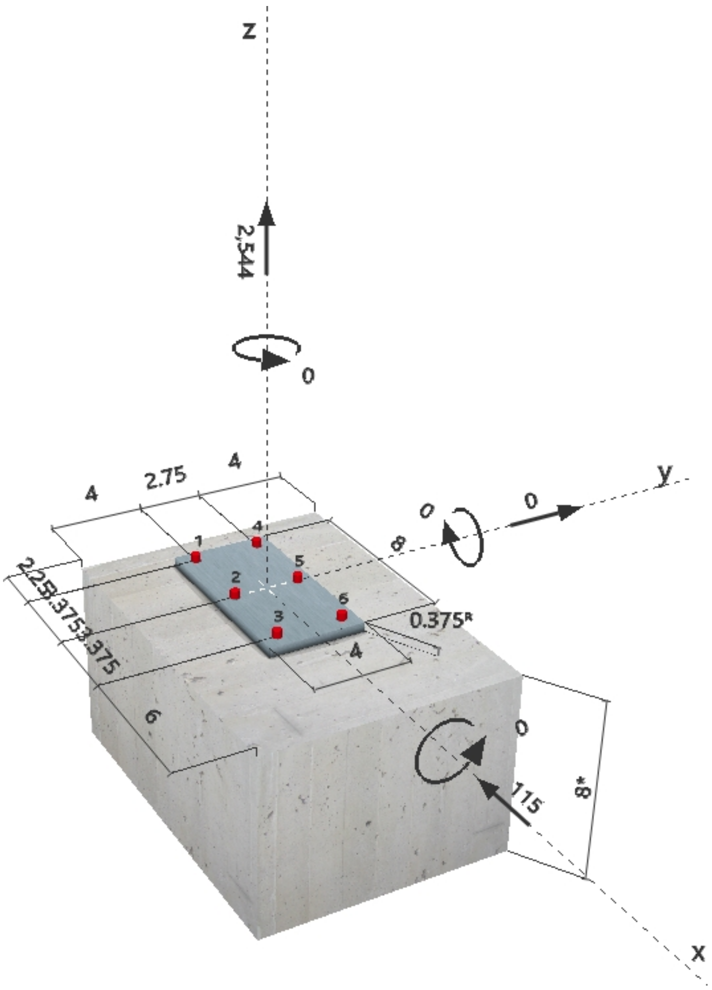
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 + HIT-Z-R 3/8**
Effective embedment depth:	$h_{ef,opti}$ = 2.375 in. ($h_{ef,limit}$ = 4.500 in.)
Material:	A4
Evaluation Service Report:	ESR-3187
Issued I Valid:	3/1/2018 | 3/1/2020
Proof:	Design method ACI 318-14 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.375 in.
Anchor plate:	l_x x l_y x t = 8.000 in. x 4.000 in. x 0.375 in.; (Recommended plate thickness: not calculated
Profile:	no profile
Base material:	cracked concrete, 4000, f_c' = 4,000 psi; h = 8.000 in., Temp. short/long: 130/110 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar

R - user is responsible to ensure a rigid base plate for the entered thickness with appropriate solutions (stiffeners,...)

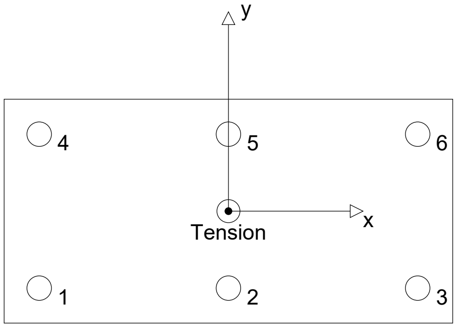
Geometry [in.] & Loading [lb, in.lb]



Company:		Page:	2
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	12/5/2018
E-Mail:			

2 Load case/Resulting anchor forces

Load case: Design loads



Anchor reactions [lb]
Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	424	19	-19	0
2	424	19	-19	0
3	424	19	-19	0
4	424	19	-19	0
5	424	19	-19	0
6	424	19	-19	0

max. concrete compressive strain:	- [‰]
max. concrete compressive stress:	- [psi]
resulting tension force in (x/y)=(0.000/0.000):	2,544 [lb]
resulting compression force in (x/y)=(0.000/0.000):	0 [lb]

Anchor forces based on a rigid base plate assumption!

3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	424	4,749	9	OK
Pullout Strength*	424	5,169	9	OK
Sustained Tension Load Bond Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	2,544	5,560	46	OK

* anchor having the highest loading **anchor group (anchors in tension)

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR-3187
$\phi N_{sa} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
0.08	94,200

Calculations

N_{sa} [lb]
7,306

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
7,306	0.650	4,749	424

3.2 Pullout Strength

$N_{pn} = N_p \lambda_a$ refer to ICC-ES ESR-3187
$\phi N_{pn} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

λ_a	N_p [lb]
1.000	7,952

Calculations

-
-

Results

N_{pn} [lb]	$\phi_{concrete}$	ϕN_{pn} [lb]	N_{ua} [lb]
7,952	0.650	5,169	424

3.3 Concrete Breakout Strength

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b$ ACI 318-14 Eq. (17.4.2.1b)

$\phi\ N_{cbg} \geq N_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e_N'}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c\ \lambda_a \sqrt{f_c'}\ h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
2.375	0.000	0.000	2.250	1.000

c_{ac} [in.]	k_c	λ_a	f_c' [psi]
3.563	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
124.05	50.77	1.000	1.000	0.889	1.000	3,935

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\ N_{cbg}$ [lb]	N_{ua} [lb]
8,554	0.650	5,560	2,544

Company:
Specifier:
Address:
Phone I Fax: |
E-Mail:

4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	19	2,630	1	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	115	5,988	2	OK
Concrete edge failure in direction x-**	115	1,304	9	OK

* anchor having the highest loading **anchor group (relevant anchors)

4.1 Steel Strength

$V_{sa} = (0.6\ A_{se,V}\ f_{uta})$ refer to ICC-ES ESR-3187

$\phi\ V_{steel} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

Variables

$A_{se,V}$ [in.^{2}]	f_{uta} [psi]	$(0.6\ A_{se,V}\ f_{uta})$ [lb]
0.08	94,200	4,384

Calculations

V_{sa} [lb]
4,384

Results

V_{sa} [lb]	ϕ_{steel}	$\phi\ V_{sa}$ [lb]	V_{ua} [lb]
4,384	0.600	2,630	19

4.2 Pryout Strength (Concrete Breakout Strength controls)

$V_{cpg} = k_{cp} \left[\left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\ \psi_{ed,N}\ \psi_{c,N}\ \psi_{cp,N}\ N_b\right]$ ACI 318-14 Eq. (17.5.3.1b)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Nc} see ACI 318-14, Section 17.4.2.1, Fig. R 17.4.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-14 Eq. (17.4.2.1c)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e_N'}{3\ h_{ef}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.4)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.5b)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-14 Eq. (17.4.2.7b)

$N_b = k_c\ \lambda_a \sqrt{f_c'}\ h_{ef}^{1.5}$ ACI 318-14 Eq. (17.4.2.2a)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
1	2.375	0.000	0.000	2.250

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ_a	f_c' [psi]
1.000	3.563	17	1.000	4,000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
124.05	50.77	1.000	1.000	0.889	1.000	3,935

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi\ V_{cpg}$ [lb]	V_{ua} [lb]
8,554	0.700	5,988	115

Company:		Page:	5
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	12/5/2018
E-Mail:			

4.3 Concrete edge failure in direction x-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\ \psi_{ed,V}\ \psi_{c,V}\ \psi_{h,V}\ \psi_{parallel,V}\ V_b$ ACI 318-14 Eq. (17.5.2.1b)

$\phi\ V_{cbg} \geq V_{ua}$ ACI 318-14 Table 17.3.1.1

A_{Vc} see ACI 318-14, Section 17.5.2.1, Fig. R 17.5.2.1(b)

$A_{Vc0} = 4.5\ c_{a1}^2$ ACI 318-14 Eq. (17.5.2.1c)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e'_V}{3c_{a1}}}\right) \leq 1.0$ ACI 318-14 Eq. (17.5.2.5)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-14 Eq. (17.5.2.6b)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-14 Eq. (17.5.2.8)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda_a \sqrt{f'_c}\ c_{a1}^{1.5}$ ACI 318-14 Eq. (17.5.2.2a)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
2.250	4.000	0.000	1.000	8.000

l_e [in.]	λ_a	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
2.375	1.000	0.375	4,000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
32.06	22.78	1.000	1.000	1.000	1,324

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi\ V_{cbg}$ [lb]	V_{ua} [lb]
1,863	0.700	1,304	115

5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.458	0.088	5/3	29	OK

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

6 Warnings

- The anchor design methods in PROFIS Anchor require rigid anchor plates per current regulations (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 Anchor 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 base plate assumption is valid is not carried out by PROFIS Anchor. Input data and results must be checked for agreement with the existing conditions and for plausibility!
- Condition A applies when supplementary reinforcement is used. The Φ factor is increased for non-steel Design Strengths except Pullout Strength and Pryout strength. Condition B applies when supplementary reinforcement is not used and for Pullout Strength and Pryout Strength. Refer to your local standard.
- Design Strengths of adhesive anchor systems are influenced by the cleaning method. Refer to the INSTRUCTIONS FOR USE given in the Evaluation Service Report for cleaning and installation instructions
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI 318 or the relevant standard!
- Installation of Hilti adhesive anchor systems shall be performed by personnel trained to install Hilti adhesive anchors. Reference ACI 318-14, Section 17.8.1.

Fastening meets the design criteria!

Company:		Page:	6
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	12/5/2018
E-Mail:			

7 Installation data

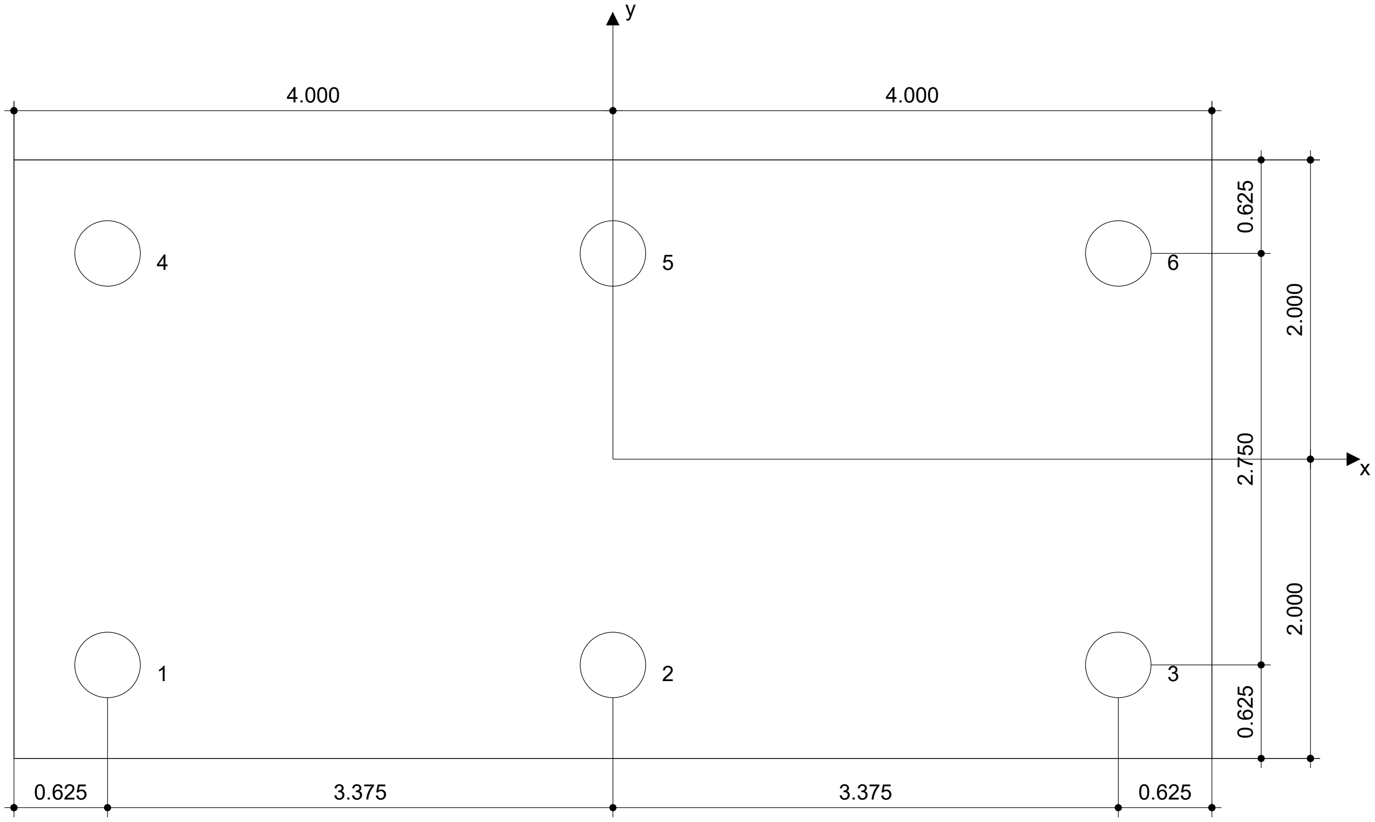
Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture (pre-setting) : d_f = 0.438 in.
Hole diameter in the fixture (through fastening) : d_f = 0.500 in.
Plate thickness (input): 0.375 in.
Recommended plate thickness: not calculated
Drilling method: Hammer drilled
Cleaning: No cleaning of the drilled hole is required

Anchor type and diameter: HIT-HY 200 + HIT-Z-R 3/8
Installation torque: 177.015 in.lb
Hole diameter in the base material: 0.438 in.
Hole depth in the base material: 3.375 in.
Minimum thickness of the base material: 4.625 in.

R - user is responsible to ensure a rigid base plate for the entered thickness with appropriate solutions (stiffeners,...)

7.1 Recommended accessories

Drilling	Cleaning	Setting
• Suitable Rotary Hammer	• No accessory required	• Dispenser including cassette and mixer
• Properly sized drill bit		• Torque wrench



Coordinates Anchor in.

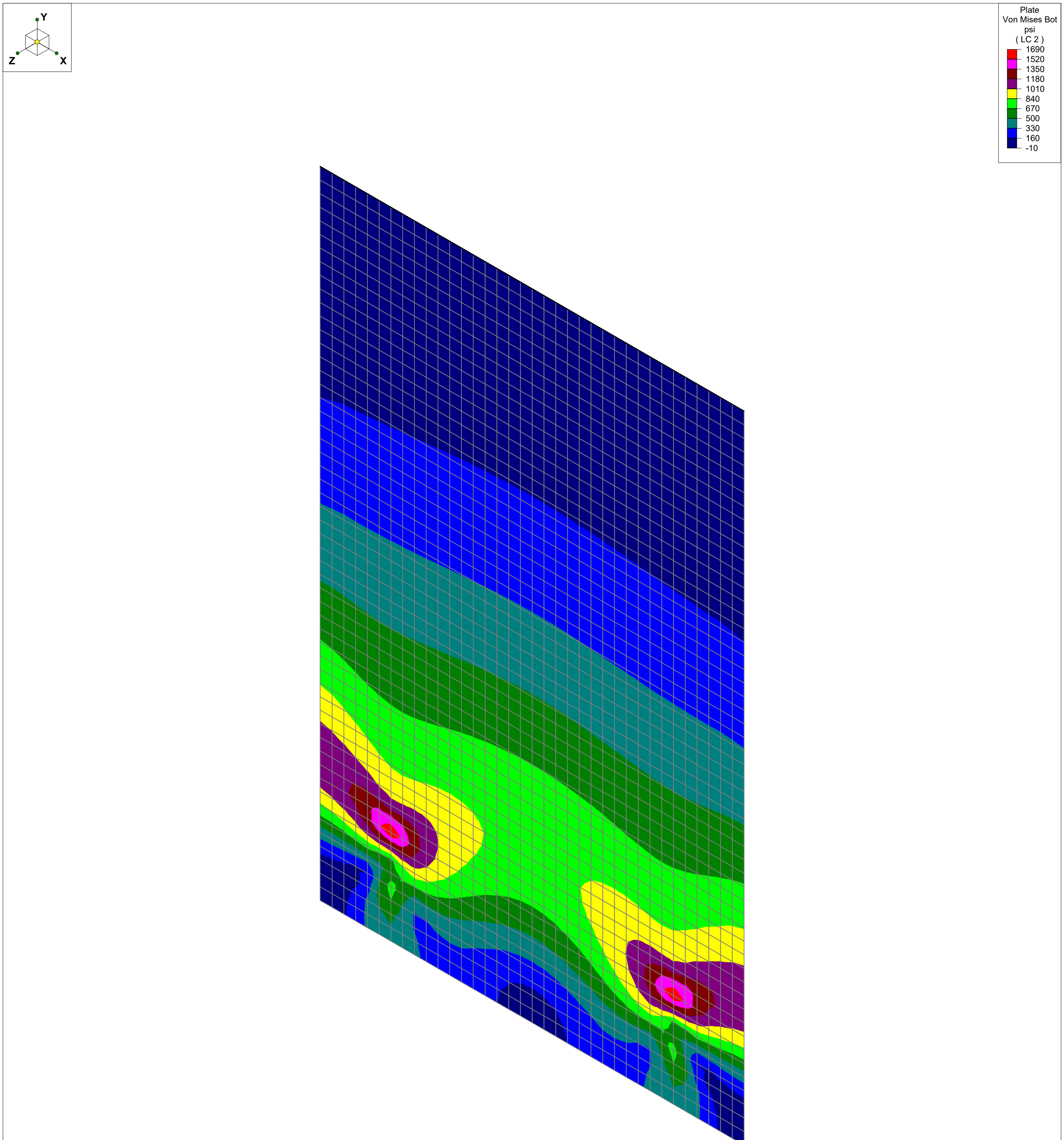
Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-3.375	-1.375	2.250	12.750	4.000	6.750
2	0.000	-1.375	5.625	9.375	4.000	6.750
3	3.375	-1.375	9.000	6.000	4.000	6.750

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
4	-3.375	1.375	2.250	12.750	6.750	4.000
5	0.000	1.375	5.625	9.375	6.750	4.000
6	3.375	1.375	9.000	6.000	6.750	4.000

Company:		Page:	7
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	12/5/2018
E-Mail:			

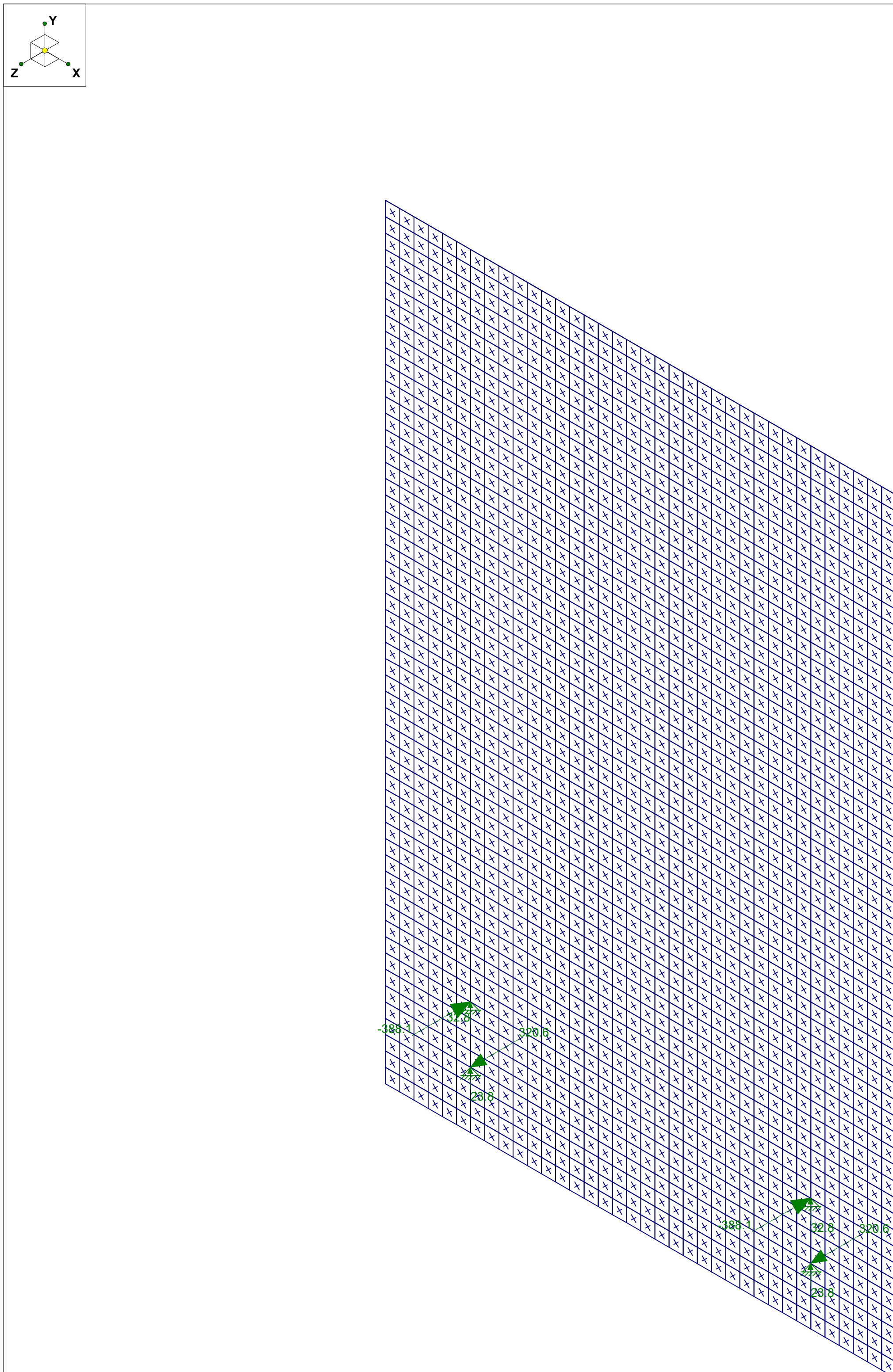
8 Remarks; Your Cooperation Duties

- Any and all information and data contained in the Software concern solely the use of Hilti products and are based on the principles, formulas and security regulations in accordance with Hilti's technical directions and operating, mounting and assembly instructions, etc., that must be strictly complied with by the user. All figures contained therein are average figures, and therefore use-specific tests are to be conducted prior to using the relevant Hilti product. The results of the calculations carried out by means of the Software are based essentially on the data you put in. Therefore, you bear the sole responsibility for the absence of errors, the completeness and the relevance of the data to be put in by you. Moreover, you bear sole responsibility for having the results of the calculation checked and cleared by an expert, particularly with regard to compliance with applicable norms and permits, prior to using them for your specific facility. The Software serves only as an aid to interpret norms and permits without any guarantee as to the absence of errors, the correctness and the relevance of the results or suitability for a specific application.
- You must take all necessary and reasonable steps to prevent or limit damage caused by the Software. In particular, you must arrange for the regular backup of programs and data and, if applicable, carry out the updates of the Software offered by Hilti on a regular basis. If you do not use the AutoUpdate function of the Software, you must ensure that you are using the current and thus up-to-date version of the Software in each case by carrying out manual updates via the Hilti Website. Hilti will not be liable for consequences, such as the recovery of lost or damaged data or programs, arising from a culpable breach of duty by you.



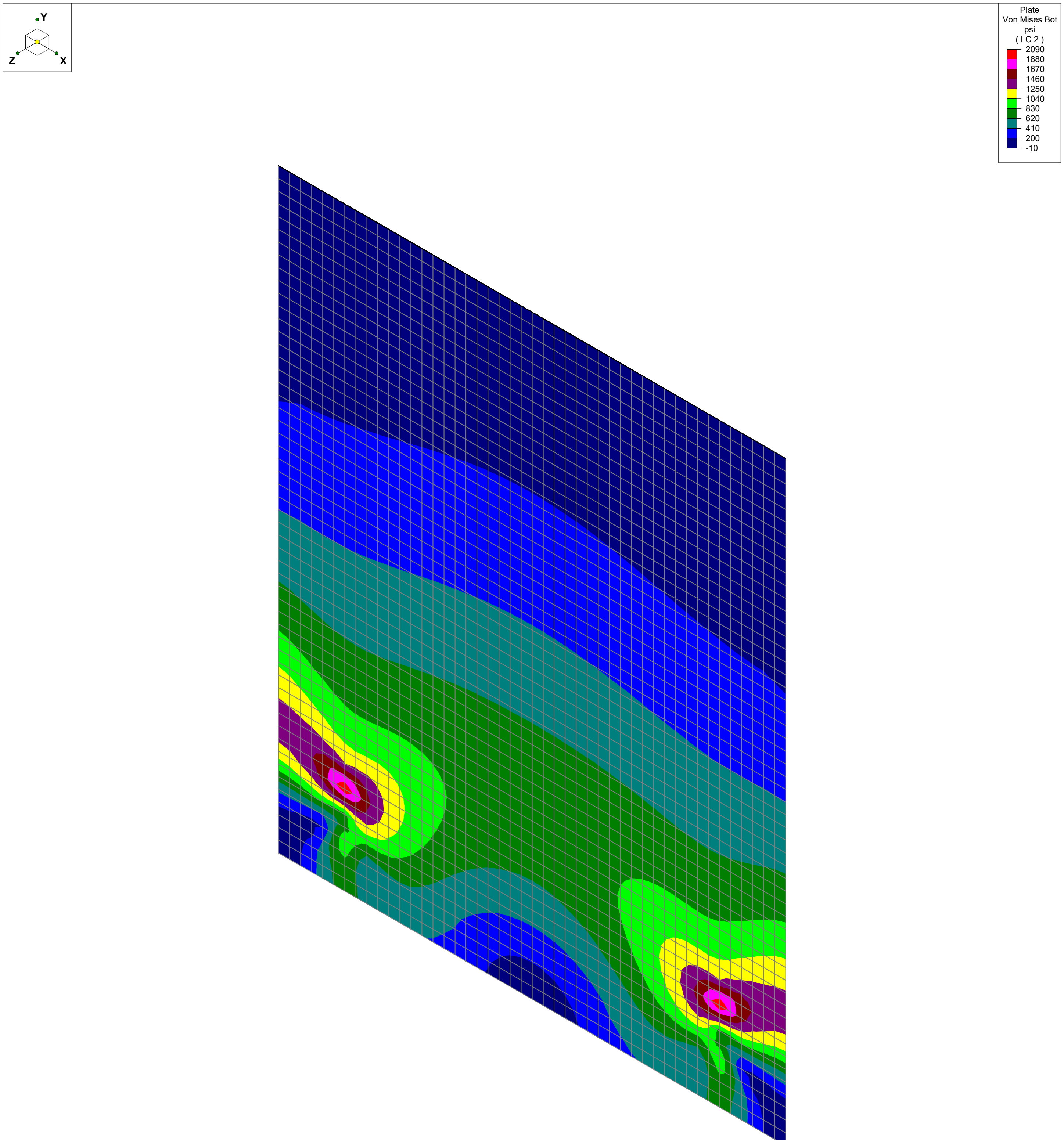
Results for LC 2, Interior Load

Rice Engineering		
JJW		Dec 5, 2018 at 12:54 PM
		0.625 Inch Thick 3 ft wide.r3d



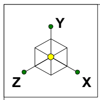
Results for LC 2, Interior Load
Reaction and Moment Units are lb and lb-in

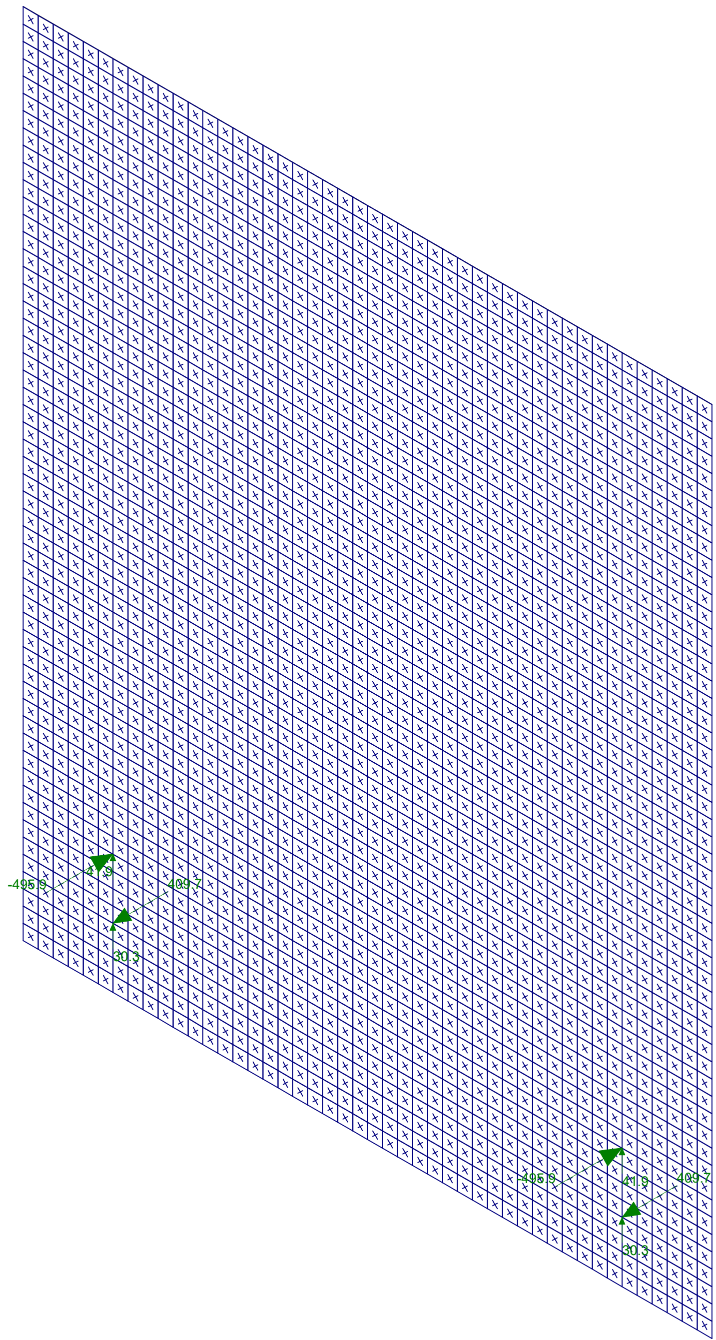
Rice Engineering		
JJW		Dec 5, 2018 at 12:55 PM
		0.625 Inch Thick 3 ft wide.r3d



Results for LC 2, Interior Load

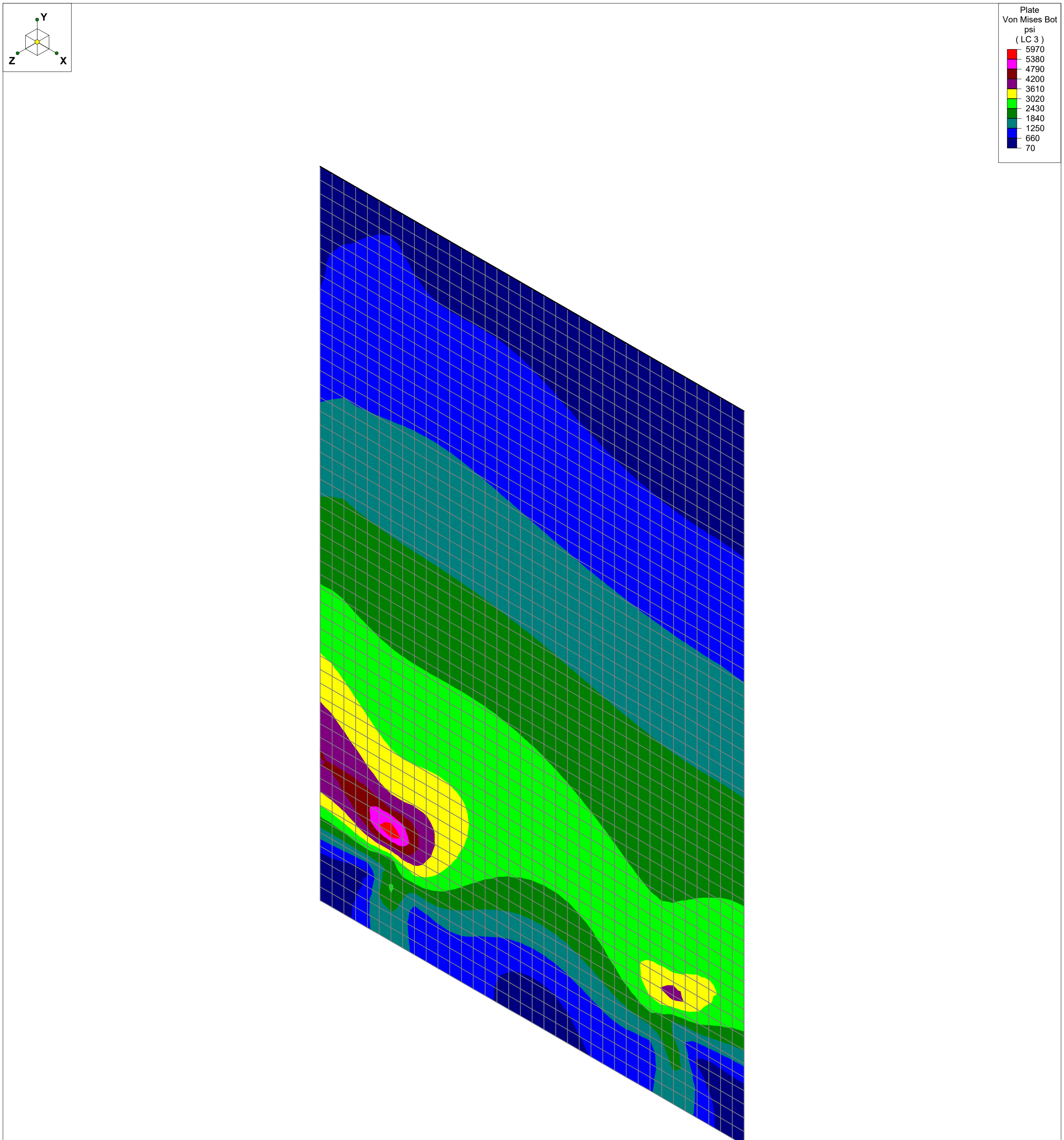
Rice Engineering		
JJW		Dec 5, 2018 at 1:54 PM
		0.625 Inch Thick 46 Inch wide.r3d





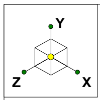
Results for LC 2, Interior Load
Reaction and Moment Units are lb and lb-in

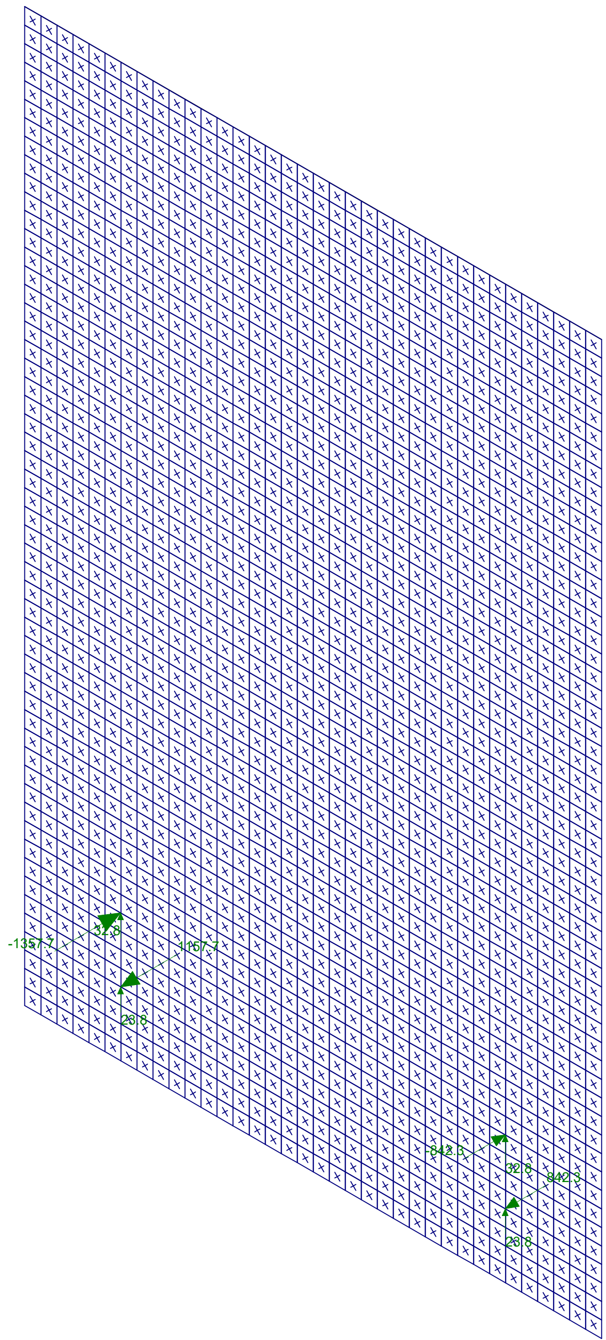
Rice Engineering		
JJW		Dec 5, 2018 at 1:55 PM
		0.625 Inch Thick 46 Inch wide.r3d



Results for LC 3, 200

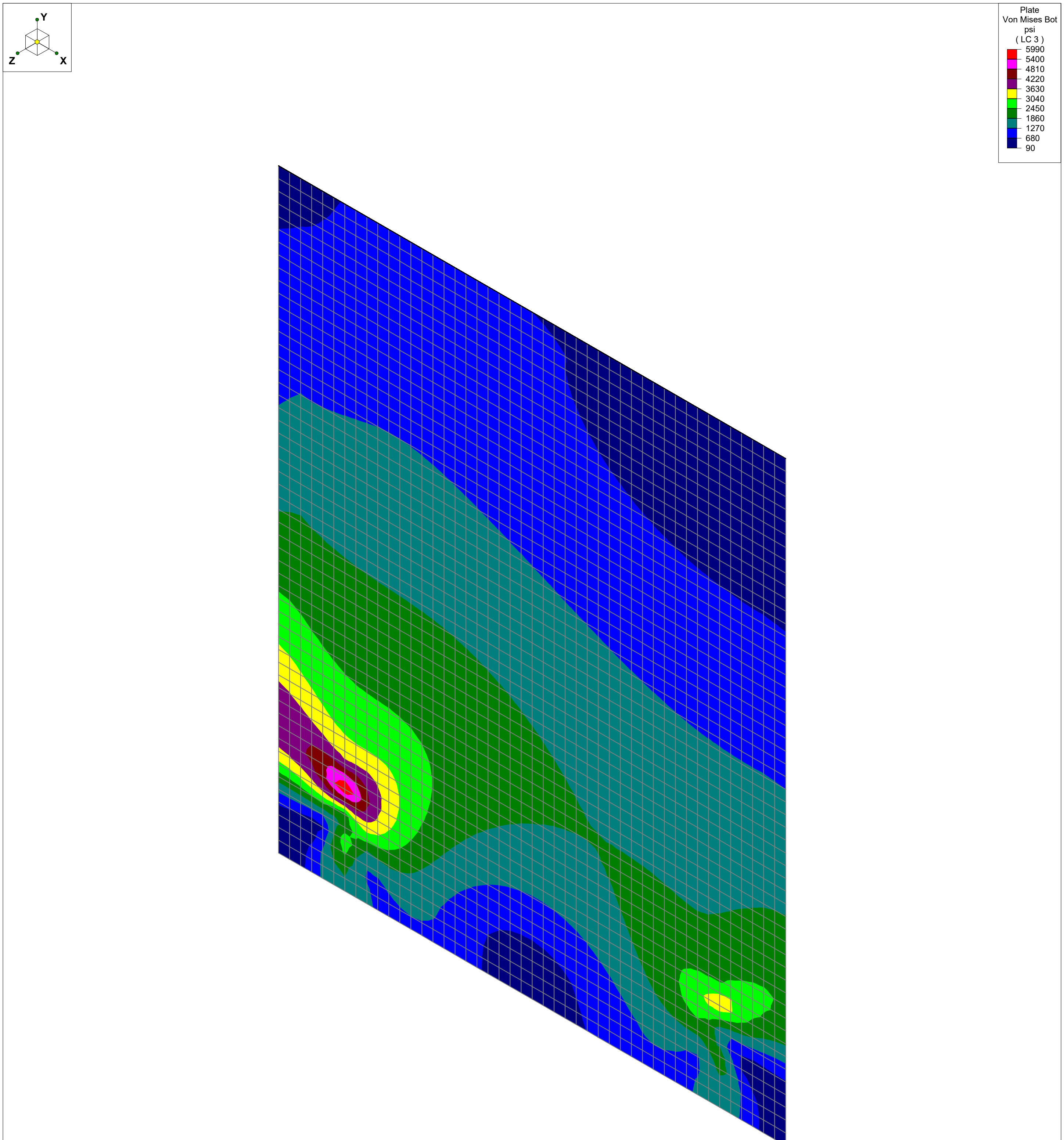
Rice Engineering		
JJW		Dec 5, 2018 at 12:53 PM
		0.625 Inch Thick 3 ft wide.r3d





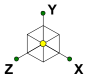
Results for LC 3, 200
Reaction and Moment Units are lb and lb-in

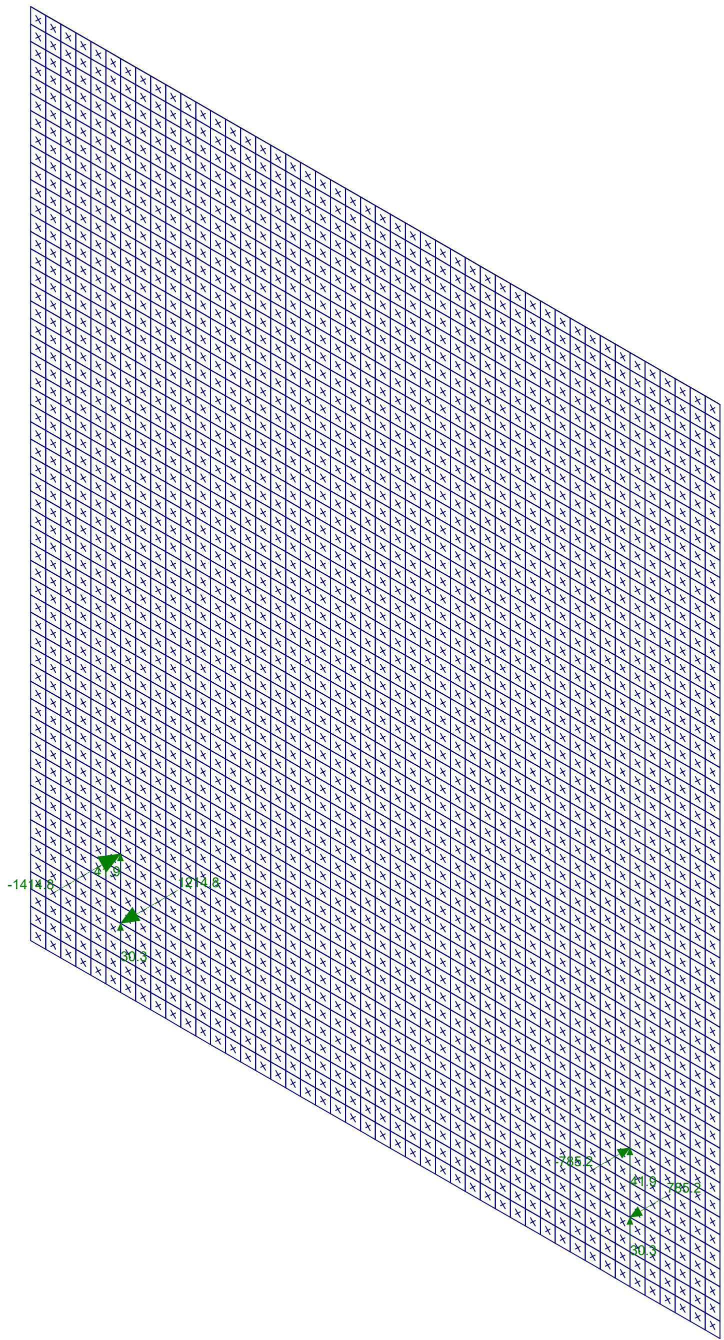
Rice Engineering		
JJW		Dec 5, 2018 at 12:56 PM
		0.625 Inch Thick 3 ft wide.r3d



Results for LC 3, 200

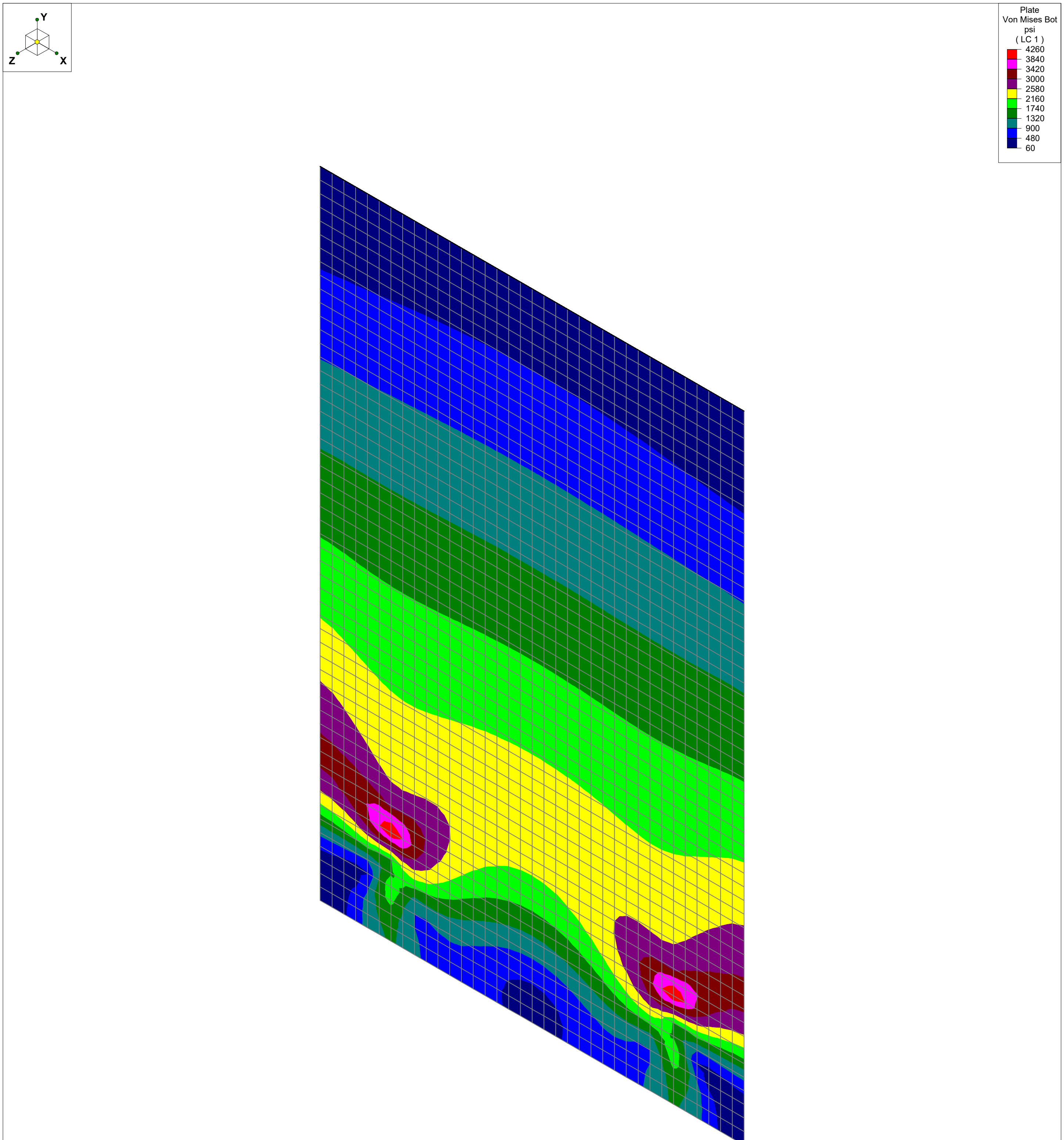
Rice Engineering		
JJW		Dec 5, 2018 at 1:53 PM
		0.625 Inch Thick 46 Inch wide.r3d





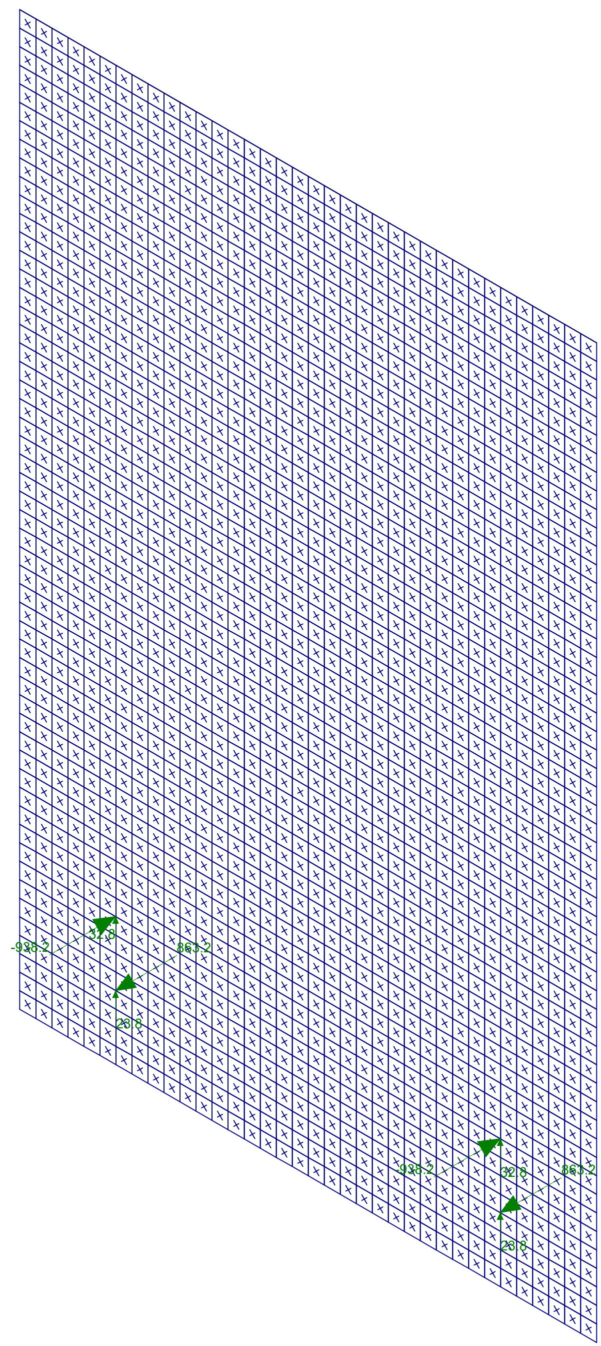
Results for LC 3, 200
Reaction and Moment Units are lb and lb-in

Rice Engineering		
JJW		Dec 5, 2018 at 1:56 PM
		0.625 Inch Thick 46 Inch wide.r3d



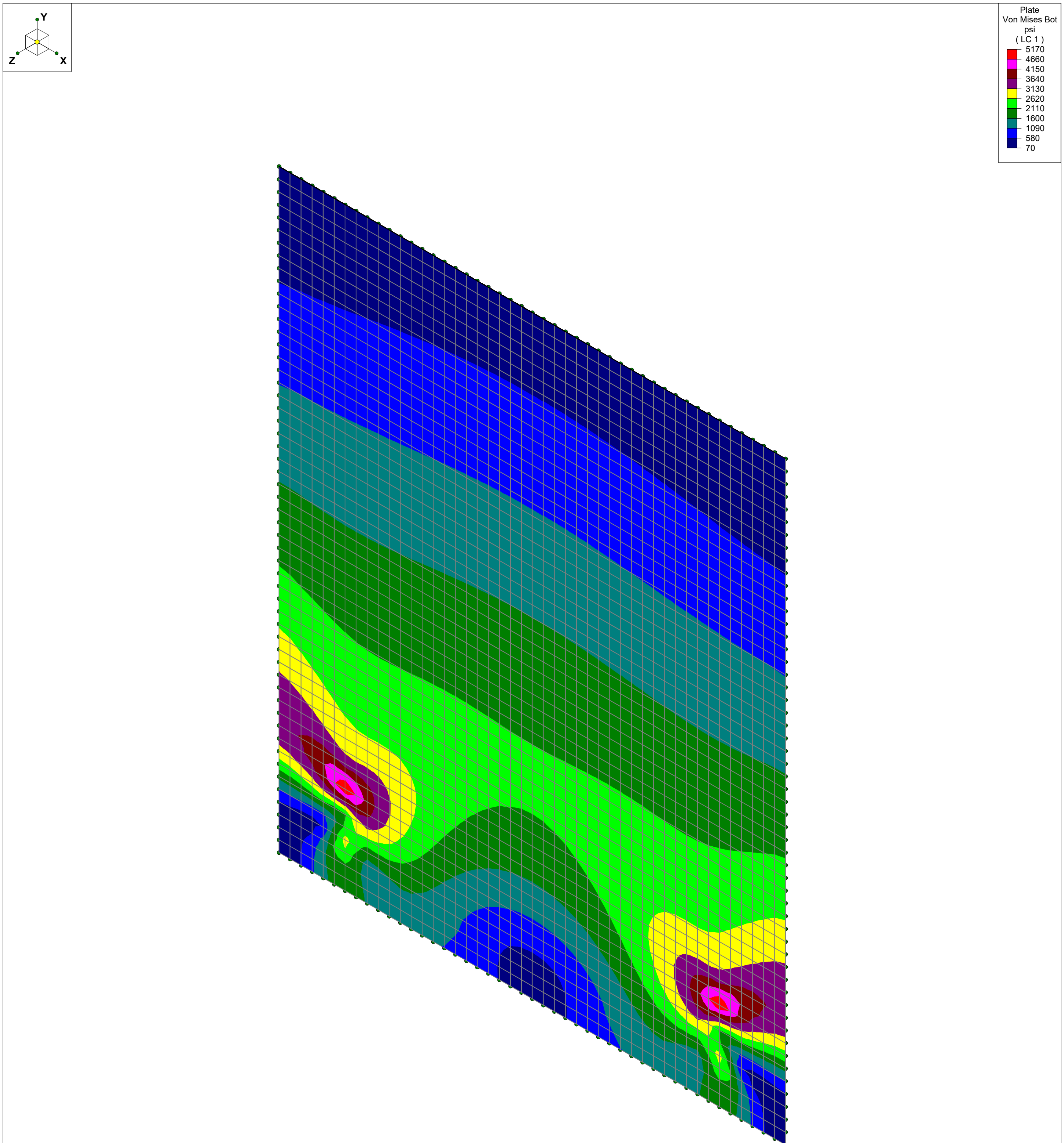
Results for LC 1, 50 psf

Rice Engineering		
JJW		Dec 5, 2018 at 12:54 PM
		0.625 Inch Thick 3 ft wide.r3d



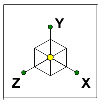
Results for LC 1, 50 psf
Reaction and Moment Units are lb and lb-in

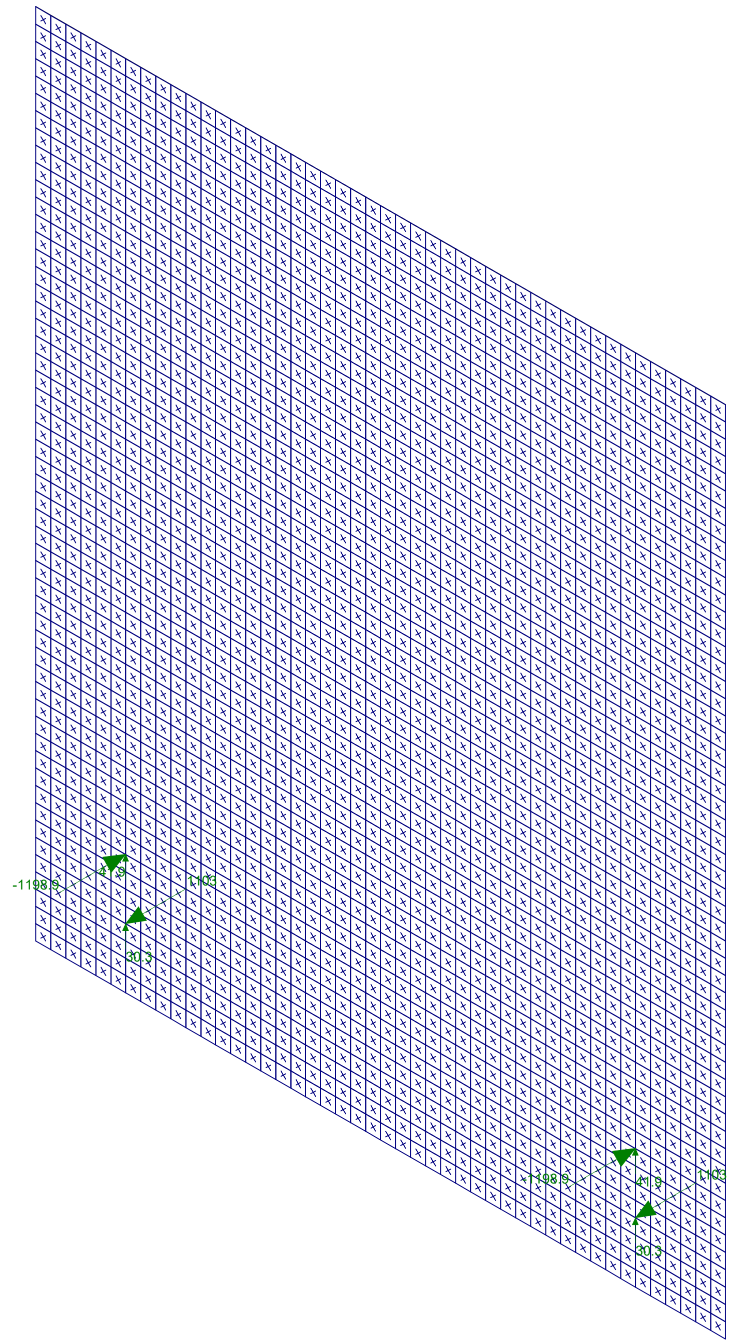
Rice Engineering		
JJW		Dec 5, 2018 at 12:56 PM
		0.625 Inch Thick 3 ft wide.r3d



Results for LC 1, 50 psf

Rice Engineering		
JJW		Dec 5, 2018 at 1:30 PM
		0.625 Inch Thick 46 Inch wide.r3d





Results for LC 1, 50 psf
Reaction and Moment Units are lb and lb-in

Rice Engineering		
JJW		Dec 5, 2018 at 1:56 PM
		0.625 Inch Thick 46 Inch wide.r3d