

  
**N·E·X·U·S**  
GREENHOUSE CORPORATION  
10983 LEROY DRIVE  
NORTHGLENN, CO 80233  
303-457-9199

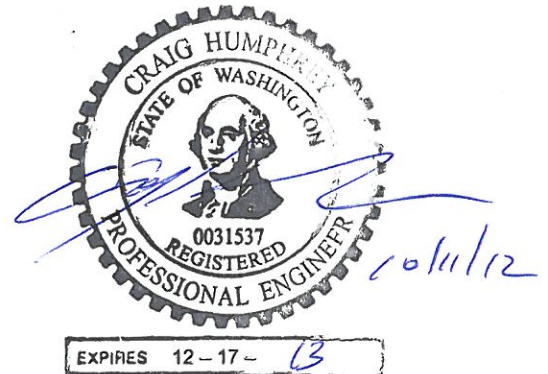
# STRUCTURAL CALCULATIONS

**Yakima Firing Range**  
**970 Firing Center Rd**  
**Yakima, WA 98901**

Project No.           N26357            
Prepared By           N. Bokelman            
Date           10/9/12          

(1) 41'-6" X 110'-0" 'Vail' Peak Greenhouse

10'- 0" Bay Spacing  
10'- 0" Column Height  
11 Roof Purlins



## DESIGN LOADS

DESIGN CODE - 2009 International Building Code/ASCE 7-05  
AISI S-100 & AISI S-213 (2007 Editions)

OCCUPANCY CATEGORY - II

DEAD LOAD - 1.5 psf (Purlin Design)  
1.5 psf (Truss Design)  
3.0 psf (Column / Reaction Design)

ROOF LIVE LOAD - 30 psf

SNOW LOAD - Min. Roof Snow Load,  $P_{fmin}$  35 psf

WIND LOAD - Basic Wind Speed,  $V$  85 mph  
Importance Factor,  $I$  1  
Wind Exposure  $C$   
Interior Pressure Coefficient,  $GC_{pi}$   $\pm 0.18$

SEISMIC LOAD - Importance Factor,  $I$  1  
Spectral Response Acceleration  
 $S_s$  0.514  
 $S_1$  0.174  
Site Class  $D$

LOAD COMBINATIONS - (per ASCE 2.4.1)

D+L  
D+W  
D+0.7E  
D+0.75L+0.75W  
D+0.75L+0.75(0.7E)  
0.6D+W  
0.6D+0.7E

## WIND LOADS

(Per ASCE 7-05)

### DESIGN CRITERIA -

V = 85 mph, Exposure 'C'		GC <sub>pf</sub> = (Fig. 6-10) (MWFRS)
K <sub>Z</sub> = 0.91	l = 1.00	GC <sub>p</sub> = (Fig. 6-11) (COMP / CLAD)
K <sub>ZT</sub> = 1.0	K <sub>d</sub> = 0.85	GC <sub>pi</sub> = ± 0.18

$$q = 0.00256 * K_Z * K_{ZT} * K_d * V^2 * I = 0.00256(0.91)(1)(0.85)(85)^2(1) = 14.3 \text{ psf}$$

### MFWRs -

$$P = q [(GC_{pf}) - (GC_{pi})]$$

#### Case A: Lateral Wind

Case 1:	GC <sub>pi</sub> = -0.18	
	P = 14.3 [(0.55) - (-0.18)] =	10.4 psf (WW)
	P = 14.3 [(-0.11) - (-0.18)] =	1.0 psf (WR)
	P = 14.3 [(-0.45) - (-0.18)] =	-3.9 psf (LR)
	P = 14.3 [(-0.39) - (-0.18)] =	-3.0 psf (LW)
	P = 14.3 [(-0.45) - (-0.18)] =	-3.9 psf (SW)
Case 2:	GC <sub>pi</sub> = 0.18	
	P = 14.3 [(0.55) - (0.18)] =	5.3 psf (WW)
	P = 14.3 [(-0.11) - (0.18)] =	-4.1 psf (WR)
	P = 14.3 [(-0.45) - (0.18)] =	-9.0 psf (LR)
	P = 14.3 [(-0.39) - (0.18)] =	-8.2 psf (LW)
	P = 14.3 [(-0.45) - (0.18)] =	-9.0 psf (SW)

#### Case B: Longitudinal Wind

Case 1:	GC <sub>pi</sub> = -0.18	
	P = 14.3 [(0.4) - (-0.18)] =	8.3 psf (WW)
	P = 14.3 [(-0.69) - (-0.18)] =	-7.3 psf (WR)
	P = 14.3 [(-0.37) - (-0.18)] =	-2.7 psf (LR)
	P = 14.3 [(-0.29) - (-0.18)] =	-1.6 psf (LW)
	P = 14.3 [(-0.45) - (-0.18)] =	-3.9 psf (SW)
Case 2:	GC <sub>pi</sub> = 0.18	
	P = 14.3 [(0.4) - (0.18)] =	3.1 psf (WW)
	P = 14.3 [(-0.69) - (0.18)] =	-12.4 psf (WR)
	P = 14.3 [(-0.37) - (0.18)] =	-7.9 psf (LR)
	P = 14.3 [(-0.29) - (0.18)] =	-6.7 psf (LW)
	P = 14.3 [(-0.45) - (0.18)] =	-9.0 psf (SW)

## SEISMIC LOADS

### DESIGN CRITERIA -

Site Class = D

Importance Factor, I = 1.00

$$S_S = 0.514 \quad F_a = 1.389 \quad S_{MS} = F_a \times S_s = 0.714$$

$$S_1 = 0.174 \quad F_v = 2.104 \quad S_{M1} = F_v \times S_1 = 0.366$$

$$S_{DS} = 2/3 S_{ms} = 0.476$$

$$S_{D1} = 2/3 S_{1s} = 0.244$$

Design Category = D

### SEISMIC BASE SHEAR - Based on ASCE7-05 12.8 Equivalent Lateral Force Procedure

$$V = C_s W \quad (\text{Equation 12.8-1})$$

$$C_s = S_{DS} / (R/I) \quad (\text{Equation 12.8-2})$$

#### Lateral Shear

$$R_{LAT} = 3.5 \quad [\text{Table 12.2-1 C4. Ordinary Steel Moment Frames}]$$

$$W = 41.5\text{ft}(\text{width}) * 10\text{ft}(\text{bay}) * 3\text{psf}$$

$$W = 1.245 \text{ Kips per bay}$$

$$C_s = 0.14$$

$$V = 0.169 \text{ Kips (Seismic Base Shear per Bay)}$$

#### Longitudinal Shear

$$R_{LONG} = 3.25 \quad [\text{Table 12.2-1 B4. Ordinary Steel Concentrically Braced Frames}]$$

$$W = 41.5\text{ft}(\text{width}) * 110\text{ft}(\text{length}) * 10\text{psf} / 2 \text{ Column Rows}$$

$$W = 22.83 \text{ Kips per column line}$$

$$C_s = 0.15$$

$$V = 3.343 \text{ Kips (Seismic Base Shear per Column line)}$$

## PURLIN CHECK

### Purlins

2-1/4" 14ga Galvanized Structural Tube

$$A = 0.719 \text{ in}^2 \quad r = 0.885 \text{ in}$$
$$S = 0.501 \text{ in}^3 \quad F_y = 50000 \text{ psi}$$

$$M_c = M_n / \Omega = F_y \times S / \Omega = 50000 \times 0.501 / 1.67 = 15000 \text{ lb-in} = \underline{\underline{1250 \text{ lb-ft}}}$$

$$\text{Clear Span of Purlin} = 9.83 \text{ ft}$$

$$\text{Purlin Spacing} = 3.5 \text{ ft}$$

Maximum Load = Roof Live Load + Purlin Dead Load

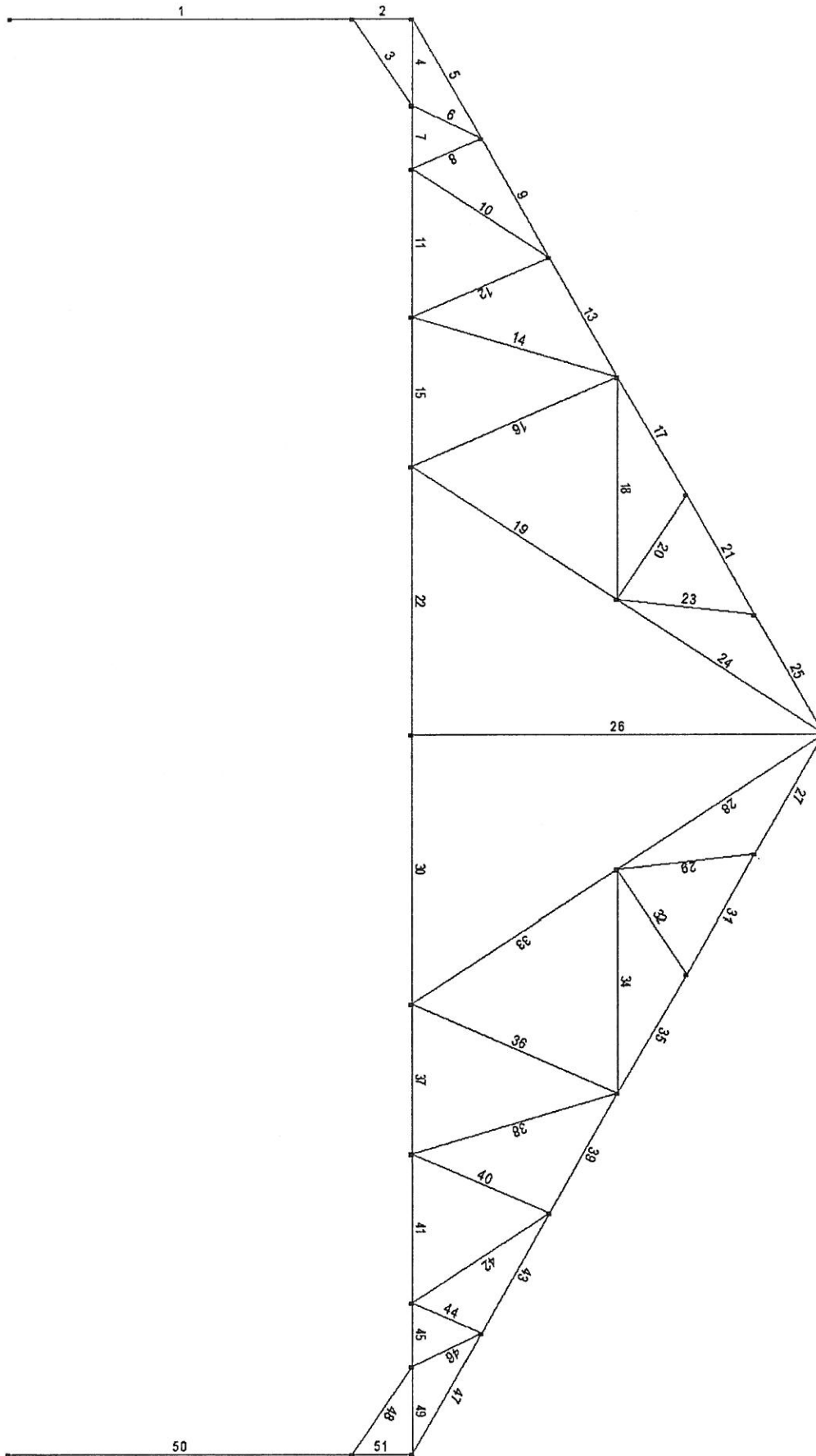
$$35 \text{ psf} + 1.5 \text{ psf} = 36.5 \text{ psf}$$

Maximum Wind Pressure From a 90 mph Wind Load

$$0.6D+W(\text{Case B.2}) = 0.9 \text{ psf} + -12.4 \text{ psf} = -11.5 \text{ psf}$$

$$M_r = w L^2 / 12 = (36.5 \text{ psf} * 3.5 \text{ ft})(9.83 \text{ ft})^2 / 12 = \underline{\underline{1029 \text{ lb-ft}}} \quad \text{OK}$$

# TRUSS MEMBER LABELS



## TRUSS MEMBER CHECK

(Data and Formulas Used for Calculation on the Following Page)

### 1-1/2" 18ga Galvanized Structural Tube

$$A = 0.284 \text{ in}^2 \quad r = 0.593 \text{ in}$$
$$S = 0.133 \text{ in}^3 \quad F_y = 45000 \text{ psi}$$

### 2" 15ga Galvanized Structural Tube

$$A = 0.58 \text{ in}^2 \quad r = 0.785 \text{ in}$$
$$S = 0.358 \text{ in}^3 \quad F_y = 50000 \text{ psi}$$

### 2-1/4" 14ga Galvanized Structural Tube

$$A = 0.719 \text{ in}^2 \quad r = 0.885 \text{ in}$$
$$S = 0.501 \text{ in}^3 \quad F_y = 50000 \text{ psi}$$

### COMPRESSION CHECK:

$$\lambda_c = (F_y / (\pi^2 * 290000 / (Kl/r)^2))^{1/2}$$

$$\text{If } \lambda_c \leq 1.5 \quad F_n = 0.658 \lambda_c^2 * F_y$$

$$\text{If } \lambda_c > 1.5 \quad F_n = 0.877 / \lambda_c^2 * F_y$$

$$\text{Allowable Load in Compression, } P_c = P_n / \Omega = A_e F_n / \Omega$$

$$\Omega = 1.8$$

### TENSION CHECK:

$$\text{Allowable Load in Tension, } T_t = T_n / \Omega = F_y A_g / \Omega$$

$$\Omega = 1.67$$

## TRUSS MEMBER CHECK

Span	Tube Size	L (in)	KI / r	$\lambda_c$	$F_n$ (kips)	Comp. $P_n/\Omega$	Comp. $P_r$	Tens. $P_n/\Omega$	Tens. $P_r$	Result
Top Chord										
5	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	15.5	21.5	0.0	OK
9	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	15.0	21.5	0.0	OK
13	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	13.3	21.5	0.9	OK
17	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	13.8	21.5	1.6	OK
21	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	12.5	21.5	1.5	OK
25	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	12.7	21.5	1.6	OK
27	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	12.7	21.5	3.1	OK
31	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	12.5	21.5	2.8	OK
35	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	13.9	21.5	3.0	OK
39	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	14.0	21.5	3.1	OK
43	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	16.2	21.5	4.8	OK
47	2-1/4" 14ga	46	52.4	0.69	40.9	16.3	15.8	21.5	6.7	OK
Bottom Chord										
4	2" 15ga	30	38.2	0.51	44.9	14.5	1.1	17.4	13.9	OK
7	2" 15ga	22	27.9	0.37	47.2	15.2	0.0	17.4	13.9	OK
11	2" 15ga	52	66.1	0.87	36.3	11.7	0.0	17.4	12.6	OK
15	2" 15ga	52	66.1	0.87	36.3	11.7	0.4	17.4	11.4	OK
22	2" 15ga	93	118.9	1.57	17.7	5.7	0.6	17.4	7.6	OK
30	2" 15ga	93	118.9	1.57	17.7	5.7	0.6	17.4	7.6	OK
37	2" 15ga	52	66.1	0.87	36.3	11.7	2.2	17.4	11.4	OK
41	2" 15ga	52	66.1	0.87	36.3	11.7	3.0	17.4	13.2	OK
45	2" 15ga	22	27.9	0.37	47.2	15.2	4.9	17.4	14.6	OK
49	2" 15ga	30	38.2	0.51	44.9	14.5	2.6	17.4	16.3	OK
Web Members										
6	1-1/2" 18ga	24	40.0	0.50	40.5	6.4	1.8	7.7	3.0	OK
8	1-1/2" 18ga	23	39.1	0.49	40.7	6.4	1.6	7.7	0.0	OK
10	1-1/2" 18ga	52	87.5	1.10	27.2	4.3	0.0	7.7	1.8	OK
12	1-1/2" 18ga	46	78.3	0.98	30.1	4.7	1.7	7.7	0.0	OK
14	1-1/2" 18ga	66	110.7	1.39	20.1	3.2	0.0	7.7	1.6	OK
16	2" 15ga	70	88.7	1.17	28.1	9.1	3.4	17.4	0.0	OK
18	1-1/2" 18ga	78	131.2	1.65	14.6	2.3	0.3	7.7	2.5	OK
19	2" 15ga	78	99.1	1.31	24.4	7.9	0.0	17.4	3.8	OK
20	1-1/2" 18ga	42	70.5	0.88	32.4	5.1	1.4	7.7	0.2	OK
23	1-1/2" 18ga	42	70.5	0.88	32.4	5.1	1.4	7.7	0.2	OK
24	2" 15ga	78	99.1	1.31	24.4	7.9	0.1	17.4	6.3	OK
26	1-1/2" 18ga	125	209.9	2.63	5.7	0.9	0.0	7.7	0.0	OK
28	2" 15ga	78	99.1	1.31	24.4	7.9	2.3	17.4	7.4	OK
29	1-1/2" 18ga	42	70.5	0.88	32.4	5.1	1.4	7.7	0.4	OK
32	1-1/2" 18ga	42	70.5	0.88	32.4	5.1	1.5	7.7	0.4	OK
33	2" 15ga	78	99.1	1.31	24.4	7.9	1.6	17.4	5.0	OK
34	1-1/2" 18ga	78	131.2	1.65	14.6	2.3	0.7	7.7	2.6	OK
36	2" 15ga	70	88.7	1.17	28.1	9.1	4.4	17.4	1.4	OK
38	1-1/2" 18ga	66	110.7	1.39	20.1	3.2	1.1	7.7	2.4	OK
40	1-1/2" 18ga	46	78.3	0.98	30.1	4.7	2.5	7.7	1.1	OK
42	1-1/2" 18ga	52	87.5	1.10	27.2	4.3	2.0	7.7	1.4	OK
44	1-1/2" 18ga	23	39.1	0.49	40.7	6.4	1.2	7.7	1.8	OK
46	1-1/2" 18ga	24	40.0	0.50	40.5	6.4	3.4	7.7	0.0	OK

## COLUMN CHECK

4" 11 ga Galvanized Structural Tube

$$A = 1.862 \text{ in}^2 \quad r = 1.585 \text{ in}$$
$$S = 2.34 \text{ in}^3 \quad F_y = 55000 \text{ psi}$$

### COMPRESSION CHECK:

Unbraced Length,  $\ell = 120 \text{ in}$

$$K \ell / r = 120 / 1.585 = 76$$

$$\lambda_c = 1.05 < 1.5$$

$$F_n = 0.658^{\lambda_c^2} * F_y = 22.85 \text{ kips}$$

Allowable load in Compression,  $P_c = P_n / \Omega = A_e F_n / \Omega$

$$P_n / \Omega_c = (1.862)(22.8) / (1.80) = \underline{\underline{23.6 \text{ kips}}}$$

$$\text{Maximum Load in Compression, } P_r = \underline{\underline{10.0 \text{ kips}}} \quad \text{OK}$$

### BENDING CHECK:

$$M_n / \Omega_b = S_a \times F_y / \Omega = (2.34)(55000) / 1.67 = \underline{\underline{6422 \text{ lb-ft}}}$$

$$\text{Maximum Moment, } M_r = \underline{\underline{5980 \text{ lb-ft}}} \quad \text{OK}$$

(Including Moment Bracing at Truss Due to Lateral loading)

## LONGITUDINAL BRACING CHECK

**WIND:** Maximum Wind Pressures = 8.3 lb/ft<sup>2</sup> Windward  
 -1.6 lb/ft<sup>2</sup> Leeward

$$P = (211\text{ft}^2) \times (8.3\text{lb/ft}^2 + 1.6\text{lb/ft}^2) = \underline{\underline{2.09 \text{ kips}}}$$

**SEISMIC:** P = 3.34 kips x 0.91 = 3.04 kips (Controls)

### RODS

$$\text{Two sets of rods} = P/2T = \underline{\underline{1.52 \text{ kips}}}$$

$$\text{Maximum Load in Tension} = P_r = P(13'-2''/9'-8'') = \underline{\underline{2.08 \text{ k}}}$$

$$3/8'' \text{ diameter all-thread rod, } T_{\text{allow}} = 0.6(36\text{ksi})(0.11\text{in}^2) = \underline{\underline{2.38 \text{ k}}} \quad \text{OK}$$

### CONNECTIONS

Bolts (1/2" Hex Head)

$$\text{Max. Tension} = 2.08(9'-8''/13'-2'') = \underline{\underline{1.52 \text{ k}}} \quad r_n/\Omega = \underline{\underline{4.4 \text{ k}}} \quad \text{OK}$$

$$\text{Max. Shear} = 2.08(9'-0''/13'-2'') = \underline{\underline{1.50 \text{ k}}} \quad r_n/\Omega = \underline{\underline{2.4 \text{ k}}} \quad \text{OK}$$

$$\text{Combined} = \sqrt{(0.35)^2 + (0.64)^2} = \leq 1.0$$

$$0.53 \leq 1.0 \quad \text{OK}$$

## ENDWALL AND SIDEWALL ANALYSIS

Wind Load= 85 mph, Exp. "C"  
Side Wall Wind Load= 10.4 lbs / ft<sup>2</sup>  
Gable Wall Wind Load= 9.0 lbs / ft<sup>2</sup>  
Max. Gable Post Spacing = 8.3 ft  
Gable Post Length = 16 ft  
Number of Wall Members = 2

### GABLE POST CHECK:

2" x 4" 14ga. (Strong Axis) Galvanized Steel Tubing

A = 0.968 in<sup>2</sup>      r = 0.48 in  
S = 1.027 in<sup>3</sup>      Fy = 50000 psi

$$M_n / \Omega_b = S_a \times F_y / \Omega = (1.027)(50000) / 1.67 = \underline{\underline{2562 \text{ lb-ft}}}$$
$$M_r = w l^2 / 8 = (9\text{psf} \times 8.3\text{ft}) \times (16\text{ft})^2 / 8 = \underline{\underline{2390 \text{ lb-ft}}} \quad \text{OK}$$

### HORIZONTAL WALL GIRT CHECK:

2" 15ga Galvanized Steel Tubing

A = 0.58 in<sup>2</sup>      r = 0.785 in  
S = 0.358 in<sup>3</sup>      Fy = 50000 psi

$$M_n / \Omega_b = S_a \times F_y / \Omega = (0.358)(50000) / 1.67 = \underline{\underline{893 \text{ lb-ft}}}$$
$$M_r = w L^2 / 12 = (10.4\text{psf}) \times (5\text{ft}) \times (10\text{ft})^2 / 12 = \underline{\underline{433.3 \text{ lb-ft}}} \quad \text{OK}$$

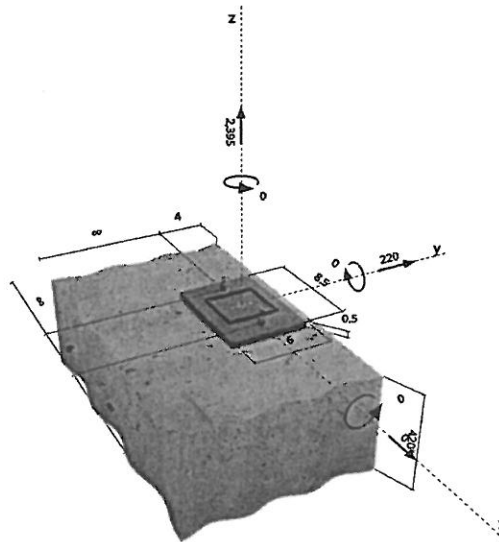
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 Company:  
 Specifier:  
 Address:  
 Phone | Fax: - | -  
 E-Mail:

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 Project: Yakima Firing Range  
 Sub-Project | Pos. No.: N26357  
 Date: 10/10/2012

**Specifier's comments:**
**Input data**

**Anchor type and diameter:** Kwik Bolt 3 - CS, 1/2  
**Effective embedment depth:**  $h_{ef} = 2.250$  in.  
**Material:** Carbon Steel  
**Proof:** design method Hilti ASD from Hilti Product Technical Guide  
**Stand-off installation:**  $e_o = 0.000$  in. (no stand-off);  $t = 0.500$  in.  
**Anchor plate:**  $l_x \times l_y \times t = 8.500 \times 6.000 \times 0.500$  in. (Recommended plate thickness: not calculated)  
**Profile:** Square HSS (AISC); (L x W x T) = 4.000 in. x 4.000 in. x 0.125 in.  
**Base material:** uncracked concrete, 2500,  $f'_c = 2500$  psi;  $h = 420.000$  in.  
**Reinforcement:** -

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

**Proof I Utilization (Governing Cases)**
**Highest loaded anchor: 2**

Proof	Load	Design values [lb]		Utilization [%]		Status
		Capacity		$\beta_N / \beta_V$		
Tension load	1198	1332		90 / -		OK
Shear load without lever arm	110	1021		- / 11		OK

**Combined tension and shear loads**

$\beta_N$	$\beta_V$	$\alpha$	Utilization $\beta_{NV}$ [%]	Status
0.899	0.108	1.667	86	OK

$$\beta_N^{\alpha} + \beta_V^{\alpha} \leq 1$$

**Warnings**

- Please consider all details and hints/warnings given in the detailed report!

**Fastening meets the design criteria!**

Input data and results must be checked for agreement with the existing conditions and for plausibility!

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

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