COVER PAGE	INDEX

REGISTERED PROFESSIONAL ENGINEER
ARASH MOZAFFARIAN
No. 69771
EXP. 6/30/18
CIVIL
STATE OF CALIFORNIA

TOTAL 13 SHEETS

PROJECT GATEWAY HOTEL 550 GATEWAY BLVD., S.F. CA	***CLIENT*** AKSHAR DEVELOPMENT INC.	BY Vlado DATE 19-Jan-18 CK DATE RV DATE
Tractel Ltd. **Swingstage Division** 1615 Warden Avenue, Toronto, Ontario M1R 2T3		PROJECT NO 8J19 PART A SHEET 1 OF 4

DESIGN NOTE AND MATERIAL SPECIFICATIONS

A) **The design safety factor for window washing equipment is 4 against failure, thus the Φ factor modified to be unity. (Φ = 1)**

B) **Unless otherwise noted, all steel conform to ASTM standard which has the following material strength:**

1)	PLATES AND BARS - DESIGNATION:		A572 GR.42		
			MIN YIELD STRESS	F_y =	42 Ksi
			TENSILE STRESS	F_u =	60 Ksi
2)	STRUCTURAL SHAPES	RECTANGULAR -	A500 GR. C		
			MIN YIELD STRESS	F_y =	50 Ksi
			TENSILE STRESS	F_u =	62 Ksi
		ROUND -	A500 GR. C		
			MIN YIELD STRESS	F_y =	46 Ksi
			TENSILE STRESS	F_u =	62 Ksi
		W, M, S, HP, C, MC, L	A572 GR.42		
			MIN YIELD STRESS	F_y =	42 Ksi
			TENSILE STRESS	F_u =	60 Ksi

C) **Unless otherwise noted, all aluminium conform to ANSI/AWS D1.2-97 /(CAN3-S157-M83) standard, which has the following material strength:**

6061 -T6	NON WELDED	F_y =	35 Ksi
		F_u =	38 Ksi
	WELDED	F_y =	16 Ksi
		F_u =	25 Ksi
6351 -T6	NON WELDED	F_y =	37 Ksi
		F_u =	42 Ksi
	WELDED	F_y =	16 Ksi
		F_u =	25 Ksi

PROJECT

CLIENT

Tractel Ltd.

Swingstage Division

1615 Warden Avenue, Toronto, Ontario M1R 2T3

BY Vlado DATE 2018-Jan-17

CK DATE

RV DATE

PROJECT NO 8J19

PART A SHEET 2 OF 4

Table 2-4
Applicable ASTM Specifications for Various Structural Shapes

Steel Type	ASTM Designation		F_y Min. Yield Stress (ksi)	F_u Tensile Stress[a] (ksi)	Applicable Shape Series: W	M	S	HP	C	MC	L	HSS: Rect.	HSS: Round	Pipe
Carbon	A36		36	58-80[b]										
	A53 Gr. B		35	60										
	A500	Gr. B	42	58										
			46	58										
		Gr. C	46	62										
			50	62										
	A501	Gr. A	36	58										
		Gr. B	50	70										
	A529[c]	Gr. 50	50	65-100										
		Gr. 55	55	70-100										
High-Strength Low-Alloy	A572	Gr. 42	42	60										
		Gr. 50	50	65[d]										
		Gr. 55	55	70										
		Gr. 60[e]	60	75										
		Gr. 65[e]	65	80										
	A618[f]	Gr. I & II	50[g]	70[g]										
		Gr. III	50	65										
	A913	50	50[h]	60[h]										
		60	60	75										
		65	65	80										
		70	70	90										
	A992		50	65[i]										
Corrosion Resistant High-Strength Low-Alloy	A242		42[j]	63[j]										
			46[k]	67[k]										
			50[l]	70[l]										
	A588		50	70										
	A847		50	70										

= Preferred material specification

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

= Material specification does not apply

PROJECT	CLIENT	BY Vlado DATE 2018-Jan-17
		CK DATE
Tractel® Ltd.® Swingstage® Division 1615 Warden Avenue, Scarborough, Ontario M1R 2T3		RV DATE
		PROJECT NO. 8J19
		PART A SHEET 3 OF 4

Table 2.2
Mechanical Properties for Aluminum Alloys
and Products Commonly Used in Buildings (MPa)

	Not welded			Welded	
Alloy and product	Tensile ultimate F_u	Tensile yield F_y	Compressive yield F_y	Tensile ultimate F_{wu}	Tensile yield F_{wy}
Sheet					
3003-H112	115	70	65	100	35
3003-H14	140	115	100	100	35
3003-H16	165	145	125	100	35
Sheet and plate					
5083-H112	275	125	125	260	120
5083-H321	305	215	180	260	120
Extrusions and drawn tube					
6063-T54	230	205	205	120	70
6063-T6	205	170	170	120	120

(Continued)

Table 2.2 (Concluded)

	Not welded			Welded	
Alloy and product	Tensile ultimate F_u	Tensile yield F_y	Compressive yield F_y	Tensile ultimate F_{wu}	Tensile yield F_{wy}
Extrusions, sheet, plate, and drawn tube					
6061-T6	260	240	240	170	110
Extrusions					
6351-T6	290	255	255	170	110

	Ultimate shear stresses for fillet welds (based on throat area)	
Welding wire	Transverse F_{st}	Longitudinal F_{sl}
5356	170	120
4043	140	100
	Rivets	
Rivet wire	Ultimate shear stress	
6053-T61	140	

PROJECT	CLIENT	BY Vlado DATE 2018-Jan-17
		CK ____ DATE ____
Tractel Ltd. Swingstage® Division		RV ____ DATE ____
1615 Warden Avenue, Scarborough, Ontario M1R 2T3		PROJECT NO. 8J19
		PART A SHEET 4 OF 4

1. Input Data

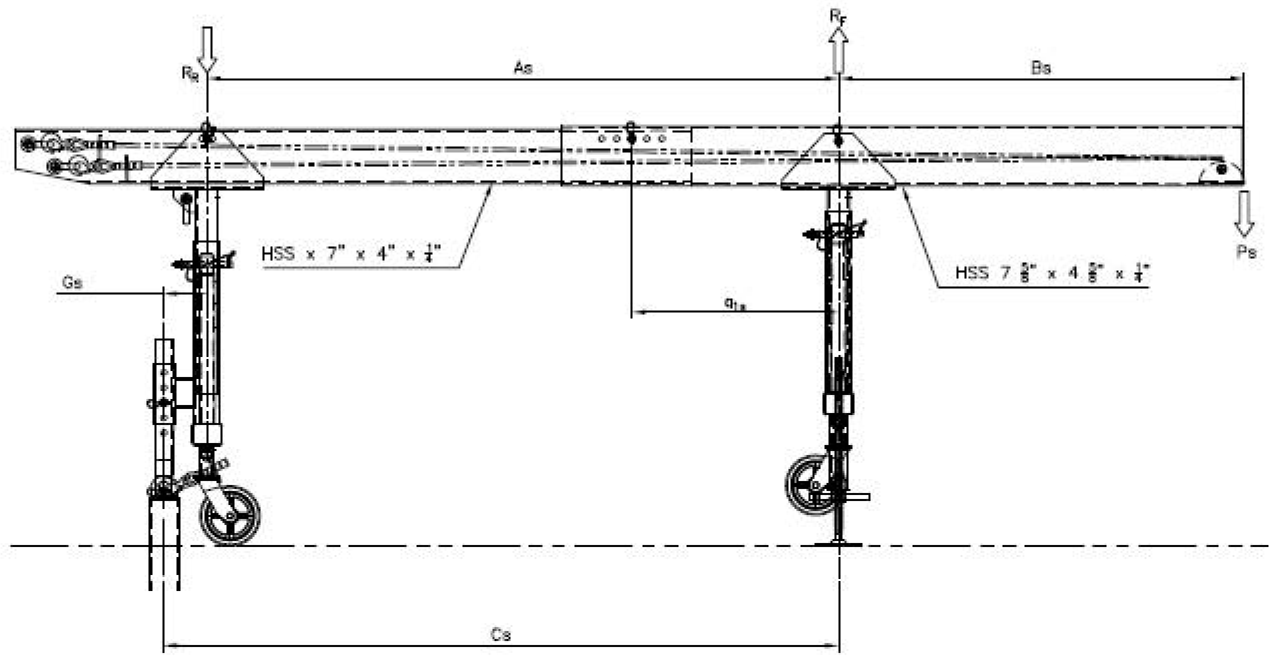


Fig.1

Service Load -> $P_s \equiv 1000\ \text{lbf}$ Load Factor -> $\alpha_f \equiv 4$

Factored Load -> $P_f \equiv \alpha_f \cdot P_s = 4\ \text{kip}$

Distance between wheel supports (minim) -> $A_s \equiv 78\ \text{in}$ $A_s = 6.5\ \text{ft}$

Cantilever - > $B_s \equiv 54\ \text{in}$ $B_s = 4.5\ \text{ft}$

Distance between supports (minim) -> $C_s \equiv 84\ \text{in}$ $C_s = 7\ \text{ft}$

Distance between supports (minim) -> $G_s \equiv C_s - A_s = 0.5\ \text{ft}$ $G_s = 6\ \text{in}$

Distance between supports (minim) -> $a_{1s} \equiv 27\ \text{in}$ $a_{1s} = 2.25\ \text{ft}$

2. Structure Loading

$R_R \equiv \dfrac{P_f \cdot B_s}{C_s} = 2.571 \text{ kip}$ $\quad$ $R_F \equiv \dfrac{P_f \cdot (C_s + B_s)}{C_s} = 6.571 \text{ kip}$

Maximum Bending Momen $\quad$ $M_B \equiv B_s \cdot P_f = 216 \text{ kip} \cdot \text{in}$

Bending moment at a_{1s} $\quad$ $M_{1B} \equiv \dfrac{M_B \cdot (C_s - a_{1s})}{C_s} = 146.571 \text{ kip} \cdot \text{in}$

3. Boom

Boom Material : AL 6061-T6 -> $F_u := 37.7 \text{ ksi}$ $\quad$ $F_y := 35 \text{ ksi}$ $\quad$ $F_{wy} := 16 \text{ ksi}$

$E_{AL} \equiv 10100 \text{ ksi}$ $\quad$ $G_{AL} \equiv 3800 \text{ ksi}$

3.1 HSS 7 5/8" x 4 5/8" x 1/4"

Section Properties

HSS Height -> $h_H := 7.625 \text{ in}$ $\quad$ HSS Width -> $w_H := 4.625 \text{ in}$ $\quad$ Wall thickness -> $t_H := 0.25 \text{ in}$

inside height -> $a_H := h_H - 2 \cdot t_H = 7.125 \text{ in}$ $\quad$ inside width $b_H := w_H - 2 \cdot t_H = 4.125 \text{ in}$

Area -> $A_H := h_H \cdot w_H - a_H \cdot b_H = 5.875 \text{ in}^2$

Moment of inertia -> $I_H := \dfrac{w_H \cdot {h_H}^3 - b_H \cdot {a_H}^3}{12} = 46.528 \text{ in}^4$

Elastic section modulus "x-x" -> $S_H := \dfrac{w_H \cdot {h_H}^3 - b_H \cdot {a_H}^3}{6 \cdot h_H} = 12.204 \text{ in}^3$

radius of gyration -> $r_H := \sqrt{\dfrac{I_H}{A_H}} = 2.814 \text{ in}$

Plastic section modulus "x-x" -> $Z_H := \dfrac{w_H \cdot {h_H}^2 - b_H \cdot {a_H}^2}{4} = 14.873 \text{ in}^3$

$Q_{flg} := w_H \cdot t_H \cdot \left(\dfrac{h_H}{2} - \dfrac{t_H}{2}\right) = 4.264 \text{ in}^3$ $\quad$ $Q_{web} := 2 \cdot \dfrac{a_H}{2} \cdot t_H \cdot \dfrac{a_H}{4} = 3.173 \text{ in}^3$

Static moment -> $Q_H := Q_{flg} + Q_{web} = 7.437 \text{ in}^3$

a) Allowable stress design (weld connection)

$R_F = 6.571\ \text{kip}$ $M_B = 216\ \text{kip} \cdot \text{in}$ $F_y = 35\ \text{ksi}$

$S_H = 12.204\ \text{in}^3$ $I_H = 46.528\ \text{in}^4$ $Q_H = 7.437\ \text{in}^3$ $t_H = 0.25\ \text{in}$

Bending stress - > $\sigma_H := \dfrac{M_B}{S_H} = 17.699\ \text{ksi}$ Shear Stress -> $\tau_H := \dfrac{R_F \cdot Q_H}{I_H \cdot t_H} = 4.201\ \text{ksi}$

equivalent stress -> $\sigma_{equ} := \sqrt{{\sigma_H}^2 + 3 \cdot {\tau_H}^2} = 19.137\ \text{ksi}$

$F_y \geq \sigma_{equ} = 1$ 1=True; 0=False

Load and resistance factor design (LRFD)

$Z_H = 14.873\ \text{in}^3$ $a_H = 7.125\ \text{in}$ $t_H = 0.25\ \text{in}$

Moment capacity -> $M_n := F_y \cdot Z_H = 520.6\ \text{kip} \cdot \text{in}$

shear capacity -> $V_n := 0.6 \cdot F_y \cdot a_H \cdot t_H = 37.406\ \text{kip}$

$chk_1 := \dfrac{M_B}{M_n} + \left(\dfrac{R_F}{V_n}\right)^2 = 0.446$ $chk_1 \leq 1 = 1$ 1=True; 0=False

3.2 HSS 7 " x 4 " x 1/4"

Section Properties

HSS Height -> $h_H := 7.0\ \text{in}$ HSS Width -> $w_H := 4.0\ \text{in}$ Wall thickness -> $t_H := 0.25\ \text{in}$

inside height -> $a_H := h_H - 2 \cdot t_H = 6.5\ \text{in}$ inside width $b_H := w_H - 2 \cdot t_H = 3.5\ \text{in}$

Area -> $A_H := h_H \cdot w_H - a_H \cdot b_H = 5.25\ \text{in}^2$

Moment of inertia -> $I_H := \dfrac{w_H \cdot {h_H}^3 - b_H \cdot {a_H}^3}{12} = 34.234\ \text{in}^4$

Elastic section modulus "x-x" -> $S_H := \dfrac{w_H \cdot {h_H}^3 - b_H \cdot {a_H}^3}{6 \cdot h_H} = 9.781\ \text{in}^3$

radius of gyration -> $r_H := \sqrt{\dfrac{I_H}{A_H}} = 2.554\ \text{in}$

Plastic section modulus "x-x" -> $Z_H := \frac{w_H \cdot {h_H}^2 - b_H \cdot {a_H}^2}{4} = 12.031 \text{ in}^3$

$Q_{flg} := w_H \cdot t_H \cdot \left(\frac{h_H}{2} - \frac{t_H}{2}\right) = 3.375 \text{ in}^3$ $\quad Q_{web} := 2 \cdot \frac{a_H}{2} \cdot t_H \cdot \frac{a_H}{4} = 2.641 \text{ in}^3$

Static moment -> $Q_H := Q_{flg} + Q_{web} = 6.016 \text{ in}^3$

a) Allowable stress design (weld connection)

$R_R = 2.571 \text{ kip}$ $\quad M_{1B} = 146.571 \text{ kip} \cdot \text{in}$ $\quad F_y = 35 \text{ ksi}$

$S_H = 9.781 \text{ in}^3$ $\quad I_H = 34.234 \text{ in}^4$ $\quad Q_H = 6.016 \text{ in}^3$ $\quad t_H = 0.25 \text{ in}$

Bending stress - > $\sigma_H := \frac{M_{1B}}{S_H} = 14.985 \text{ ksi}$ Shear Stress -> $\tau_H := \frac{R_R \cdot Q_H}{I_H \cdot t_H} = 1.807 \text{ ksi}$

equivalent stress -> $\sigma_{equ} := \sqrt{{\sigma_H}^2 + 3 \cdot {\tau_H}^2} = 15.308 \text{ ksi}$

$F_y \geq \sigma_{equ} = 1$ 1=True; 0=False

Load and resistance factor design (LRFD)

$Z_H = 12.031 \text{ in}^3$ $\quad a_H = 6.5 \text{ in}$ $\quad t_H = 0.25 \text{ in}$

Moment capacity -> $M_n := F_y \cdot Z_H = 421.1 \text{ kip} \cdot \text{in}$

shear capacity -> $V_n := 0.6 \cdot F_y \cdot a_H \cdot t_H = 34.125 \text{ kip}$

$chk_1 := \frac{M_B}{M_n} + \left(\frac{R_R}{V_n}\right)^2 = 0.519$ $\quad chk_1 \leq 1 = 1$ 1=True; 0=False

4. Front Frame - Fig.2

$R_F = 6.571 \text{ kip}$

Boom Material :
ASTM500 Gr.C ->

$F_u := 62 \text{ ksi}$

$F_y := 50 \text{ ksi}$

$E_{ST} \equiv 29000 \text{ ksi}$

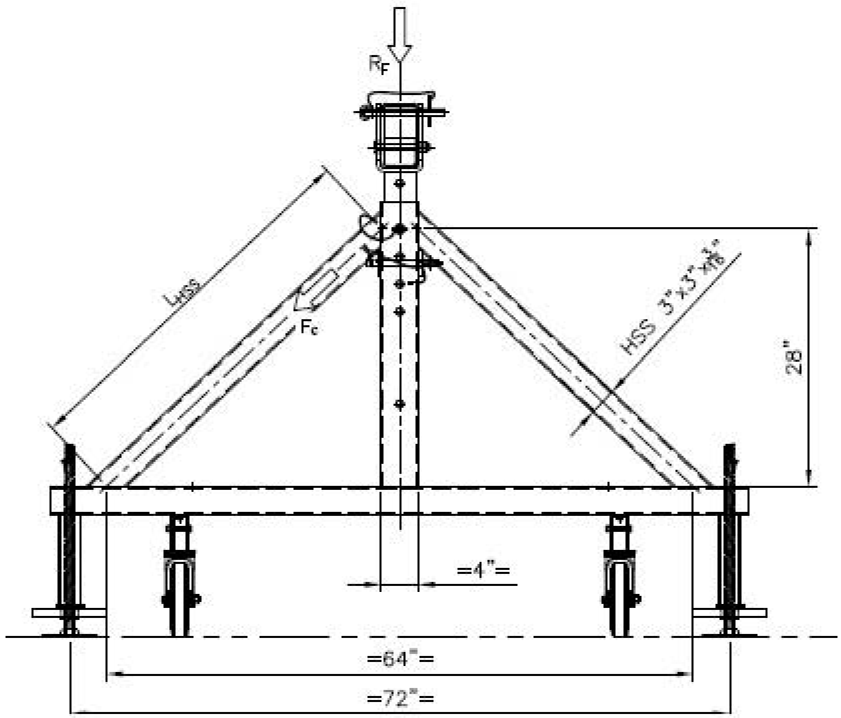


Fig.2

HSS 3" x3"x3/16" Properties

$L_{HSS} := 41 \text{ in}$ $A_{HSS} := 1.89 \text{ in}^2$

$r_{HSS} := 1.14 \text{ in}$ $Z_{HSS} := 1.97 \text{ in}^3$

Lenght Factor $K := 1$

$$F_c := \frac{R_F}{2} \cdot \frac{L_{HSS}}{28 \text{ in}} = 4.811 \text{ kip}$$

$$\lambda_c := \frac{K \cdot L_{HSS}}{\pi \cdot r_{HSS}} \cdot \sqrt{\frac{F_y}{E_{ST}}} = 0.475$$

$$P_n := A_{HSS} \cdot (0.658)^{\lambda_c^{\,2}} \cdot F_y = 86 \text{ kip}$$

$P_n \geq F_c = 1$ 1=True; 0=False

5. Pins- Fig.3

$R_F = 6.571 \text{ kip}$

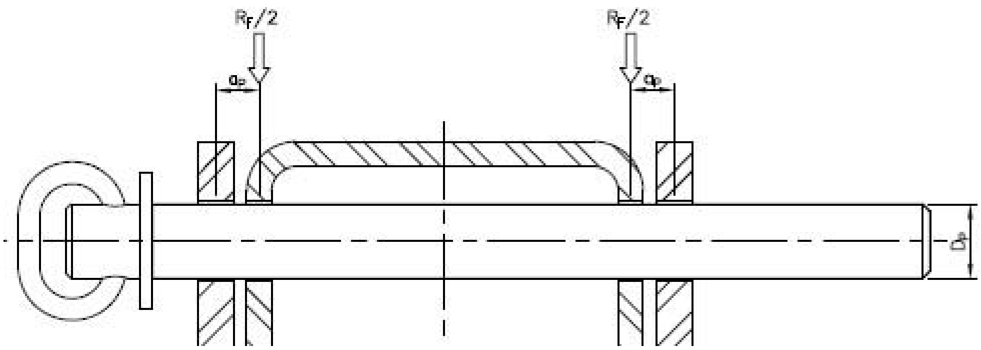


Fig.3

$D_P := \frac{3}{4} \text{ in}$

$a_P := \frac{5}{8} \text{ in}$

$D_P = 0.75 \text{ in}$

$a_P = 0.625 \text{ in}$

Boom Material : SS304 -> $F_y := 35 \text{ ksi}$

$Z_P := \frac{{D_P}^3}{6} = 0.07 \text{ in}^3$ $\qquad A_P := \frac{\pi \cdot {D_P}^2}{4} = 0.442 \text{ in}^2$

$M_n := F_y \cdot Z_P = 2.461 \text{ kip} \cdot \text{in}$ $\qquad V_n := 0.6 \cdot F_y \cdot A_P = 9.278 \text{ kip}$

$M_u := \frac{R_F}{2} \cdot a_P = 2.054 \text{ kip} \cdot \text{in}$ $\qquad V_u := \frac{R_F}{2} = 3.286 \text{ kip}$

$chk_2 := \frac{M_u}{M_n} + \left(\frac{V_u}{V_n}\right)^2 = 0.96$ $\qquad chk_2 \le 1 = 1$ $\qquad$ 1=True; 0=False

6. Pin- Fig.4

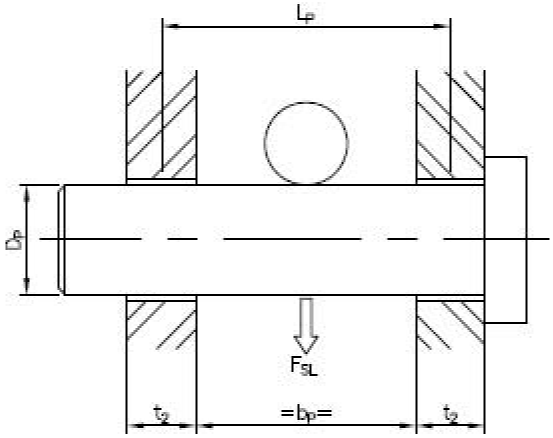


Fig.4

Safety Line Ultimate Force -> $F_{SL} \equiv 5\ \text{kip}$

$b_P := 2\ \text{in}$ $t_2 := \frac{5}{8}\ \text{in}$ $t_2 = 0.625\ \text{in}$

$D_P := 1\ \text{in}$

Boom Material : SS304 -> $F_y := 35\ \text{ksi}$

$L_P := b_P + t_2 = 2.625\ \text{in}$

$Z_P := \frac{{D_P}^3}{6} = 0.167\ \text{in}^3$ $A_P := \frac{\pi \cdot {D_P}^2}{4} = 0.785\ \text{in}^2$

$M_n := F_y \cdot Z_P = 5.833\ \text{kip} \cdot \text{in}$ $V_n := 0.6 \cdot F_y \cdot A_P = 16.493\ \text{kip}$

$M_u := \frac{F_{SL} \cdot L_P}{4} = 3.281\ \text{kip} \cdot \text{in}$ $V_u := \frac{F_{SL}}{2} = 2.5\ \text{kip}$

$chk_3 := \frac{M_u}{M_n} + \left(\frac{V_u}{V_n}\right)^2 = 0.585$ $chk_3 \le 1 = 1$ 1=True; 0=False

Tie Back Anchor			Pedestal Tube
Ultimate Applied Load	5.00	kip	
Height of Tie Back Anchor	24.00	in	

The tie-back anchors are used as anchorage to which personal fall arrest equipment is attached.

Maximum Design load = 5,000 Lbs per OSHA

Actual arresting load with body harness and shock absorber is 900 Lbs

So, $S.F. = \frac{5000}{900} = 5.6$ **for OSHA**

Design anchors for $P_{ult} = 5,000$ **Lbs**

For a safety factor of 5.4 ~ 6.0, the performance factor in design equation shall be ignored.

Loading

$P_f = 5.00$ kip

$h = 26.50$ in

$M_f = P * h$

$= 5.00 * 26.50 = 132.50$ kip-in

Pedestal Tube HSS 4.0" OD x 0.25" wall A500 Gr C

$F_u = 62.00$ ksi $F_y = 46.00$ ksi $Z = 3.31\ in^3$

$r = 1.33$ in $A = 2.76\ in^2$

$M_n = F_y * Z$

$= 46.00 * 3.31 = 152.29$ kip-in

> 132.50 kip-in $= M_f$

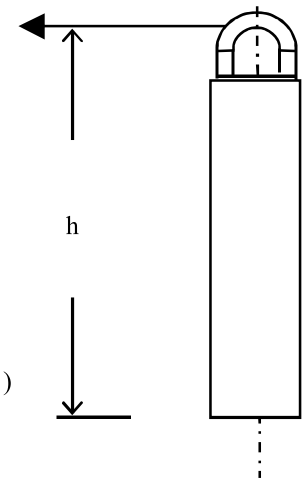
OK

PROJECT	CLIENT				
.	.	BY	Vlado	DATE	19-Jan-18
		CHK	-	DATE	-
Tractel Ltd. Swingstage Division		RV	-	DATE	-
1615 Warden Avenue, Toronto, Ontario M1R 2T3		PROJECT NO	8J19		
		PART C	SHEET 1	OF 2	

Tie Back Anchor			Bottom Plate and Weld Size
Ultimate Applied Load	5.00	kip	
Height of Tie Back Anchor	24.00	in	

Weld Size t_{w1} = 5/16" in E70xx

5,000 Lbs
in any direction



F_{EXX} = 70.00 ksi

$$S_w = \frac{\pi * D^2}{4} = \frac{3.14 * 4^2}{4} = 12.56 \text{ in}^2$$

$$f_{rw} = \frac{M_f}{S_w} = \frac{132.50}{12.56} = 10.55 \text{ kip/in}$$

$$F_w = 0.60 * F_{EXX} * 0.707 * (1 + 0.50 * SIN^{1.5}\theta)$$

$$= 0.60 * 70.00 * 0.707 * 1.50 = 44.54 \text{ kip/in}$$

$$t_{req'd} = \frac{f_{rw}}{F_w} = \frac{10.55}{44.54} = 0.24 \text{ in} < 0.313 \text{ in}$$ **O.K.**

REGISTERED PROFESSIONAL ENGINEER
ARASH MOZAFFARIAN
No. 69771
EXP. 6/30/18
CIVIL
STATE OF CALIFORNIA

PROJECT	CLIENT				
.	.	BY	Vlado	DATE	19-Jan-18
		CHK	-	DATE	-
Tractel Ltd. Swingstage Division		RV	-	DATE	-
1615 Warden Avenue, Toronto, Ontario M1R 2T3		PROJECT NO	8J19		
		PART C	SHEET 2	OF 2	