

Structural Analysis & Design

DRBirt Solutions

1300 28th St. Rd
Greeley, CO 80631

MWS tanks

Certified & Stamped
Drawings

40,000 bbl
153ft Dia.

Water Tank Fence

Colorado – Various Locations

October 19, 2011

Prepared By:
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Behrent Engineering Job # 11178

Reviewed By: Pete Sopher, P.E. 10/19/11



Overview

Objective:

Perform a structural analysis and design to determine the member sizes required for the 20' water tank fence sections (20 sections per unit). The tank will be designed assuming it is completely full of water. Because the tank is open and water is free to flow over the top, no additional lateral load has been applied to the structure due to sloshing from seismic activity or otherwise. We expect expansion of water due to freeze not to impact the structure. Expansion and contraction due to temperature will be mitigated at the pin connections with up to 1/2" of space per section.

References:

1. AISC 13th Edition
2. ASCE 7 – 05

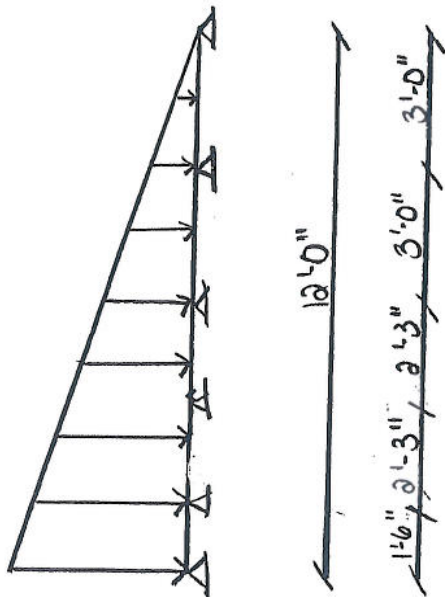
BEHRENT ENGINEERING COMPANY • CALCULATION SHEET

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 Subject Structural
 By KG

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Check Plate

Water = 62.4 psf/ft



$$w(0) = 0 \text{ psf}$$

$$w(3) = 187 \text{ psf}$$

$$w(6) = 375 \text{ psf}$$

$$w(8.25) = 515 \text{ psf}$$

$$w(10.5) = 655 \text{ psf}$$

$$w(12) = 750 \text{ psf}$$

see Pg 3
 $M_{max} = 0.124 \text{ k-ft} = 2.88 \text{ k-in}$

try 1/4" steel plate ($F_y = 36 \text{ ksi}$)

$$S = (12" \times 0.25 \text{ in}^2) / 6 = 0.125 \text{ in}^3$$

$$f_b = m/s = 23.04 \text{ ksi}$$

$$F_b = 0.75 F_y = 27.0 \text{ ksi}$$

$$f_b / F_b = 0.85 < 1.0 \rightarrow \underline{\underline{1/4" \text{ plate ok!}}}$$

Title :
Dsgnr:
Description :

Job #
Date: 3:51PM, 12 MAY 11

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Scope :

Rev: 560100
User: KW-0602014, Ver 5.6.1, 25-Oct-2002
(c)1993-2002 ENERCALC Engineering Software

Multi-Span Steel Beam

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p:\2011-beco\11111 - drbird solutions - water

Description Plate

General Information

Calculations are designed to AISC 9th Edition ASD and 1997 UBC Requirements

Fy - Yield Stress 36.00 ksi Load Duration Factor 1.00

Spans Considered Continuous Over Supports

Span Information

Description						
Span	ft	1.50	2.25	2.25	3.00	3.00
Steel Section						
End Fixity		Pin-Pin	Pin-Pin	Pin-Pin	Pin-Pin	Pin-Pin
Unbraced Length	ft	1.50	2.25	2.25	3.00	3.00

Loads

Live Load Used This Span ?		Yes	Yes	Yes	Yes	Yes
DL @ Left	k/ft					
DL @ Right	k/ft					
LL @ Left	k/ft	0.750	0.655	0.515	0.375	0.187
LL @ Right	k/ft	0.655	0.515	0.375	0.187	0.187
Start	ft					
End	ft					

Results

Mmax @ Cntr	k-ft	0.10	0.14	0.07	0.13	0.03
@ X =	ft	0.52	1.12	1.09	1.48	1.86
Max @ Left End	k-ft	0.00	-0.24	-0.21	-0.21	-0.16
Max @ Right End	k-ft	-0.24	-0.21	-0.21	-0.16	0.00
fb : Actual	psi	0.0	0.0	0.0	0.0	0.0
Fb : Allowable	psi	0.0	0.0	0.0	0.0	0.0
fv : Actual	psi	0.0	0.0	0.0	0.0	0.0
Fv : Allowable	psi	0.0	0.0	0.0	0.0	0.0
		Shear OK	Shear OK	Shear OK	Shear OK	Shear OK

Reactions & Deflections

Shear @ Left	k	0.38	0.70	0.53	0.49	0.24
Shear @ Right	k	0.67	0.62	0.47	0.36	0.04
Reactions...						
DL @ Left	k	0.00	0.00	0.00	0.00	0.00
LL @ Left	k	0.38	1.37	1.15	0.96	0.60
Total @ Left	k	0.38	1.37	1.15	0.96	0.60
DL @ Right	k	0.00	0.00	0.00	0.00	0.00
LL @ Right	k	1.37	1.15	0.96	0.60	0.04
Total @ Right	k	1.37	1.15	0.96	0.60	0.04
Max. Deflection	in	0.000	0.000	0.000	0.000	0.000
@ X =	ft	0.00	0.00	0.00	0.00	0.00
Span/Deflection Ratio		0.0	0.0	0.0	0.0	0.0

Query Values

Location	ft	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Shear	k	0.38	0.70	0.53	0.49	0.24	0.00	0.00
Moment	k-ft	0.00	-0.24	-0.21	-0.21	-0.16	0.00	0.00
Max. Deflection	in	538.75	684.37	526.87	468.50	187.00	0.00	0.00

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Check Horizontal Members

hoop stress:

- @ 11.63 ft - $725 \text{ psf} (0.75' \times 120') / 2 = 32.6 \text{ k}$ 1/2
 @ 10.5 ft - $1055 \text{ psf} (1.875' \times 120') / 2 = 73.7 \text{ k}$ ← worst case
 @ 8.25 ft - $515 \text{ psf} (0.25' \times 120') / 2 = 69.5 \text{ k}$ " "
 @ 6 ft - $375 \text{ psf} (0.25' \times 120') / 2 = 59.0 \text{ k}$ 3/4
 @ 3 ft - $187 \text{ psf} (3' \times 120') / 2 = 33.7 \text{ k}$ 1/2 "
 @ 0 ft - $47 \text{ psf} (1.5' \times 120') / 2 = 4.23 \text{ k}$ 1/2

try HSS 4x4x5/16

$$A = 4.10$$

$$\text{Capacity} = 4.10 \text{ in}^2 (0.6) (46 \text{ ksi}) = 113.2 \text{ k} > 73.7 \text{ k}$$

HSS 4x4x5/16 OK!

Try HSS 4x4x

$$\text{Capacity} (1/4") = 93.0 \text{ k} < 73.7 \text{ k}$$

HSS 4x4x1/4 OK!

* add 5" width of 1/4" plate

$$A = 3.37 \text{ in}^2 + 0.25" (5") = 4.62 \text{ in}^2$$

$$\text{Capacity} = 4.62 \text{ in}^2 (0.6) (46 \text{ ksi}) = 127.5 \text{ k} > 73.7 \text{ k} \therefore \text{OK}$$

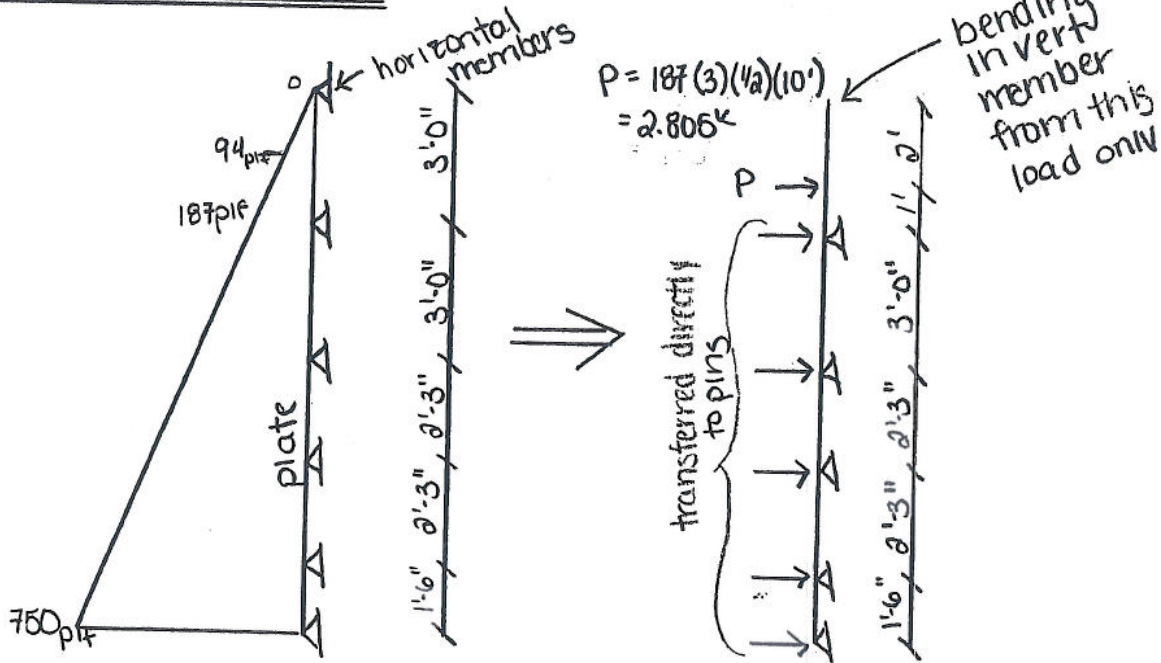
Use: HSS 4x4x1/4

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Check Vertical member



$$M_{max} = 2.805 k (1') = 2.805 k-ft = 33.66 k-in$$

$$F_b = 0.6 F_y = 27.6 \text{ ksi}$$

$$f_b = m/s = 33.66 k-in / 3.9 in^3 = 8.63 k/in^2$$

$$f_b / F_b = 0.31 < 1.0$$

HSS4x4x1/4 (Vert) OK

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Check Welds:

Worst case -

$$V = 105k$$

$$\text{load/plate} = 105k / 5 \text{ plates} = 21.0k/\text{plate}$$

$$\text{weld} = 1/4" \times 14"$$

$$\text{capacity} = (4)(0.928)(14) = 51.97k$$

$$51.97k > 21.0k$$

∴ welds okCheck Pins by Hoop stress

$$V(10.5')_1 = 665 \text{ psf} (2.625') (120') / 2 = 104.7k$$

$$V(8.25')_2 = 515 \text{ psf} (2.25') (120') / 2 = 69.5k$$

$$V(6.0')_3 = 363 \text{ psf} (2.625') (120') / 2 = 57.2k$$

$$V(3.0') = 140 \text{ psf} (4.5') (120') / 2 = 37.8k$$

$$F_v = 0.4(60 \text{ ksi})(2) = 48 \text{ ksi}$$

↑
double shear

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Check Pins: Cont'd

$$A_{req} @ 10.5' = 105 \text{ k} / 48 \text{ ksi} = 2.19 \text{ in}^2 \leftarrow \text{worst case}$$

$$A_{req} @ 8.25' = 69.5 \text{ k} / 48 \text{ ksi} = 1.45 \text{ in}^2$$

$$A_{req} @ 6.00' = 57.2 \text{ k} / 48 \text{ ksi} = 1.19 \text{ in}^2$$

$$A_{req} @ 3.00' = 37.8 \text{ k} / 48 \text{ ksi} = 0.79 \text{ in}^2$$

Use: 2" ϕ PIN (A=3.14 in²)

Check Shear Plates

$$V_{max} @ 10.5' = 105 \text{ k} / 2 \text{ plates} = 52.5 \text{ k}$$

