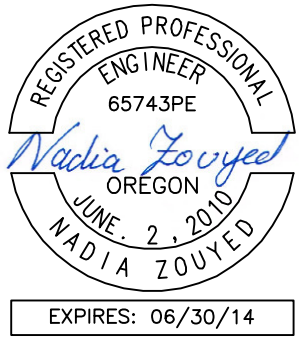
Appendix 5.05
Seismic Calculations

PORTLAND STATE UNIVERSITY
WEST HEATING PLANT BOILER REPLACEMENT

Structural Calculations
Project No. 12-020
November 02, 2012

Submitted to:

Portland State University
Facilities and Planning-FAP
617 SW Montgomery Street
Portland, OR 97201



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STRUCTURAL CALCULATIONS

Project: **Portland State University**

Re: **West Heating Plant Boiler Replacement**

Client: **Quinn Soifer**
Facilities and Planning-FAP
617 SW Montgomery Street
Portland, OR 97201

Job No.: **12-020**

Date: **November 02, 2012**

Attached please find calculations pages 1 trough 160 which verify the structural adequacy of the West Heating Plant Boiler Replacement at the Portland State University as shown on drawings S-0 through S-9. Design is based on the requirement of the 2010 Oregon Structural Specialty Code.

TABLE OF CONTENTS

NBZ
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Project: WHP BOILER REPLACEMENT		Sheet # 1
Location: PSU, PORTLAND OR		
Client: PSU		Job # 12-020
Date: 11/02/12	By:	

TUNNEL PIPING SUPPORT

A] Gravity frames "A, B, C*, D, E"

Pipes assumed filled w/ water per specs & 10% add'l

Pipe weights:

a) 16"Φ LPS w/ 3½" insulation = 169 PLF

b) 4"Φ PCR w/ 3½" insulation = 24 PLF

c) 2"Φ CR = 8 PLF

Max tributary length = 10'-6"

a) $P_1 = 169 \times 10'6" = 1774$ Lbs

$F_{V_1} = 1774 \times .11 = 195$ Lbs

b) $P_2 = 24 \times 10.5 = 252^{\#}$

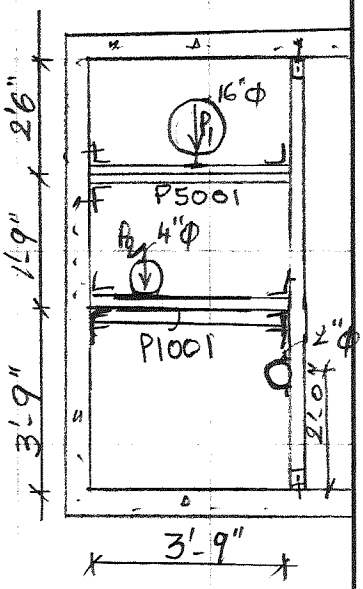
$F_{V_2} = 252 \times .11 = 28$ Lbs

c) $P_3 = 8 \times 10.5 = 84$ Lbs

$F_{V_3} = 84 \times .11 = 9.3$ Lbs

$F_{t_3} = F_L = 84$ Lbs (seismic force = 1.0 G per specs)

P5001 & P1001 OK w/ deflection < L/600



P1001, TYP + P5001

RISA "TunnelFrame ABCDEGravity"

B] Guide Frames "A, B, C, D, E"

Transverse seismic force = 1.0G

Tributary length = 40'-0"

16"Φ $F_{L_1} = 169 \times 40 = 6740^{\#}$

$M_1 = 6.74 \times \frac{(16/2 + 8 + 3/2)}{12} = 9.83$ k'

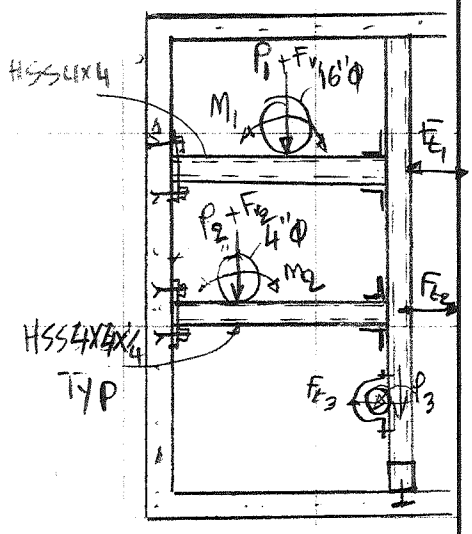
$F_{V_1} = 195$ Lbs

4"Φ $F_{t_2} = 24 \times 40 = 960$ Lbs

$M_2 = .96 \times \frac{1/2 + 8 + 3/2}{12} = .92$ k'

$F_{V_2} = 28$ Lbs

$F_{t_3} = 84$ Lbs ; $F_{V_3} = 9.3^{\#}$



HSS 4 x 4 x ¼ OK See Risa output "TunnelFrameABCDEGuide"

$P_1 = 1774^{\#}$

$P_2 = 252^{\#}$

$P_3 = 84^{\#}$

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Project:		Sheet # 2
Location:		
Client:		Job #
Date:	By:	

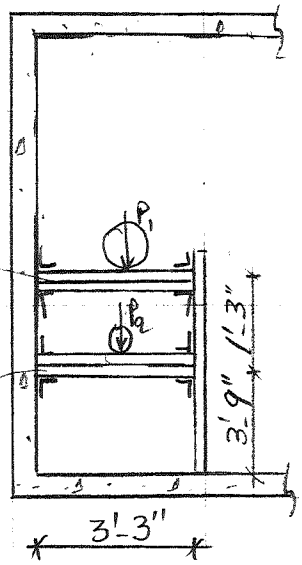
C] Frame G "Gravity"

$P_1 = 1774$ Lbs $F_{V_1} = 195$ #

$P_2 = 252$ Lbs $F_{V_2} = 28$ #

P1001, TYP OK

P1000 & P1001 OK See Risa "TunnelFrameGgravity"



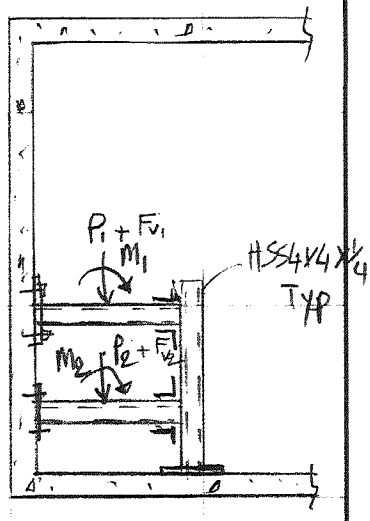
D] Frame G "Guide"

$F_{t_1} = 6740$ Lbs ; $M_1 = 9.83$ k'

$F_{t_2} = 960$ Lbs ; $M_2 = .92$ k'

$F_{V_1} = 195$ # ; $F_{V_2} = 28$ #

See Risa output "TunnelFrameGguide"



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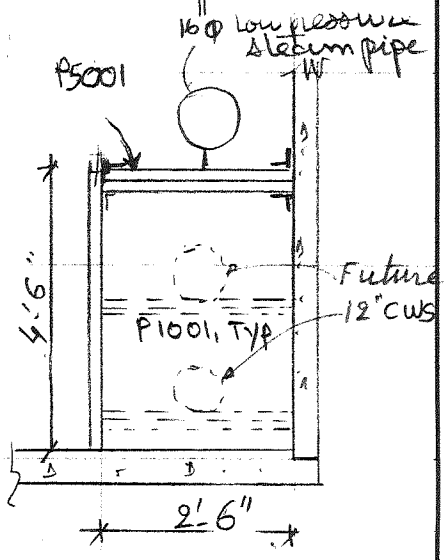
Project:		Sheet # 3
Location:		
Client:		Job #
Date:	By:	

E) H & J Racks "Gravity"

Gravity & transverse seismic force @ guides transferred to frame.
No longitudinal force ⇒ 16"Φ Pipe is on sliding plates

Max Trib Length = $\frac{11'9\frac{1}{2} + 10'-9\frac{1}{2}}{2} = 11'-3\frac{1}{2}"$

16"Φ pipe weight = 169 PLF
3½" insul + water + 10%



see Risa output "Tunnel Frame HJ gravity"

12"Φ → 1" insul. D_L = 122 PLF

$D_{L1} = D_{L2} = 169 \times 11.29 = 1908$ Lbs

$D_{L3} = 122 \times 11.29 = 1377$ Lbs

$F_V = .2 S_{DS} W_t / 1.4 = .11 W_t$

$F_{V1} = F_{V2} = 1377 \times .11 = 152$ Lbs

$F_{V3} = 1908 \times .11 = 210$ Lbs

P5001 & P1001 @ gravity supports, Deflection < $\frac{L}{600}$

F) AT Guides / Trans. & long. bracing:

Trib = $\frac{52'}{2}$ $F_{t1} = F_{t2} = 122 \times \frac{52}{2} = 3172$ Lbs

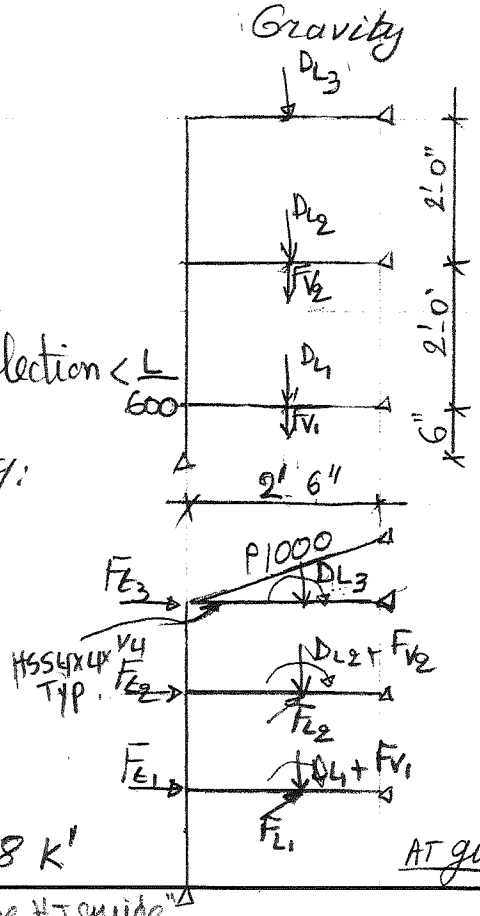
$F_{L1} = F_{L2} = 3172$ Lbs

$M_{t1} = M_{t2} = 3172 \times \frac{(12+3)}{2 \times 12} = 1.983$ k'

Trib = $\frac{42'}{2}$ $F_{V3} = 169 \times 42/2 \times .11 = 390$ Lbs

$F_{t3} = 169 \times 42/2 = 3549$ #

$M_{t3} = 3.549 \times \left(\frac{16\frac{1}{2} + 8 + 3/2}{12}\right) = 5.18$ k'



"Tunnel Frame HJ guide"

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Project:		Sheet # 4
Location:		
Client:		Job #
Date:	By:	

5) Trapeze next to frame F

16" LPS $P_1 = 169 \times 8.5 = 1437$ Lbs

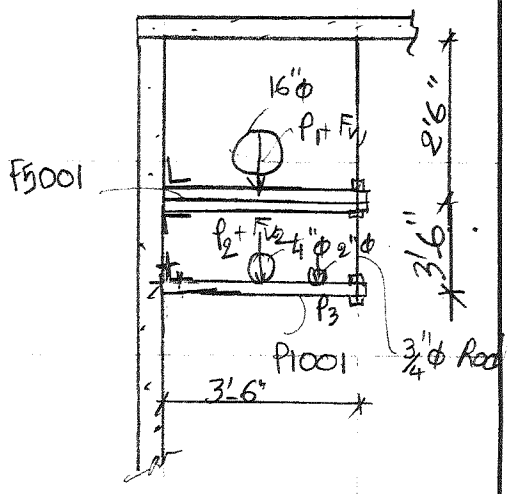
4"ϕ PCR $P_2 = 24 \times 8.5 = 204$ Lbs

2"ϕ CR $P_3 = 8 \times 8.5 = 68$ Lbs

$F_{V_1} = .11 \times 1437 = 158$ Lbs

$F_{V_2} = .11 \times 204 = 23$ Lbs

$F_{V_3} = .11 \times 68 = 8$ Lbs



Risa "Tunnel Trapeze F"

Maximum rod reaction:

$R_{max} = \frac{2}{3}(1437 + 204 + 68 + 158 + 23 + 8) = 1266$ Lbs

5/8"ϕ rod capacity = 2160 Lbs OK

use 5/8"ϕ Hilti ss KB-TZ w/ 3¼" embed (see Profis)

$T = 1266 \times 1.4 \times 1.3 = 2304$ Lbs

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Project:		Sheet # 5
Location:		
Client:		Job #
Date:	By:	

Check connections:

A] At gravity supports "Unistrut framing"

Max vertical reaction = 984# based on pipe @ center span

Assume pipe location varies $R_y = (984 \times 2) \times \frac{2}{3} = 1312\#$

Bracket P1346 $P_{ALL} = 2000\#$

* Connection to concrete wall:

$R_y = 1312 \times 1.3 = 1706$ Lbs

Use ½" Φ Hilti KB-TZ w/ 3¼" embed (per bracket)

See Profis

B] At guide / seismic bracing "HSS 4x4 Frames"

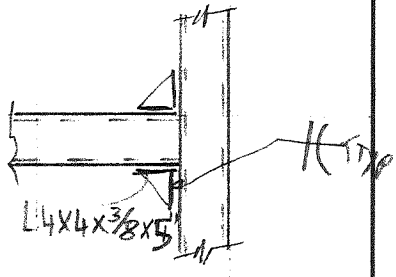
a) HSS to HSS connection

(assume pipe @ ⅓ pt)

$R_y = (4.009\,k \times 2) \frac{2}{3} = 5.35\,k$

$M = (5.35/2) \times 4/2 = 5.35\ k''$

$t_{req} = \sqrt{\frac{5.35 \times 6}{5 \times .75 \times 36}} = .487''$ Use 3/8" w/ stiff. PL



Check weld: $R_y = 5.35\,k$ (conserv.) , $R_x = 6.643\,k$

$f_{w_1} = \frac{6.653/2}{3 \times 4} = .277\ k/in$ →

$f_{w_2} = \frac{(5.35/2)}{3 \times 4} = .22\ k/in$ ↓

$f_{w_3} = \frac{(5.35/2)\,4/2}{4^2/3} = 1\ k/in$ →

$f_w = \sqrt{(.277+1)^2 + (.22)^2} = 1.3\ k/in$

$F_w = 14.8 \times (5/8 \times 1/4) = 2.3\ k/in$

b) HSS to concrete wall

$R_y = 5.35\,k$; $R_x = 6.643\,k$

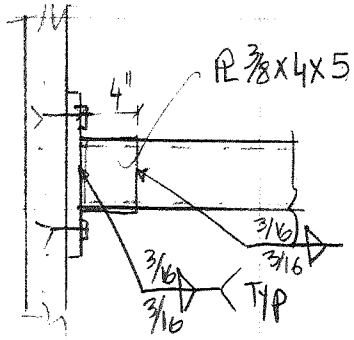
* PL 3/8 x 4 x 5 to PL ½ x 8 x 8

$f_{w_1} = \frac{5.35/2}{2 \times 5} = .27\ k/in$ ↓

$f_{w_2} = \frac{6.643/2}{2 \times 5} = .33\ k/in$ →

$f_{w_3} = \frac{(5.35/2)\,4/2}{5^2/3} = .64\ k/in$ →

$f_w = 1\ k/in$ ok



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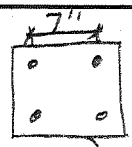
Project:		Sheet # 6
Location:		
Client:		Job #
Date:	By:	

c) Check PL thickness:

$M = 6.643 \times 8\frac{1}{4} = 13.3\ k''$

$t_{req} = \sqrt{\frac{13.3 \times 6}{10 \times .75 \times 36}} = .543''$ use $\frac{5}{8}''$



PL 5/8 x 10 x 10

d) Check anchorage to concrete wall.

$V = 5.35 \times 1.3 = 6.955k$

$T = 6.643 \times 1.3 = 8.636k$

Use PL 5/8 x 10 x 10 w/ (4) 3/4" ϕ SS Hilti KB-TZ w/ 4" embed
see Profis output

e) Check base plate PL 1/2 x 8 x 8 w/ (2) SS 1/2" ϕ Hilti KB-TZ w/ 2 3/4" embed

$P_{max} = 6336\#$ $R_x = 335\#$

$f_p = \frac{6.336}{5 \times 10} = .126\ ksi$

$t_{req} = 2 \times 2.875 \sqrt{\frac{.126}{36}} = .34''$

PL 1/2 x 5 x 10

f) Check brace connection P1000

$P_{axial} = 1346\#$ $L_{unb} = \sqrt{2 \times 2.5^2} = 3.5'$

$P_{ALL} = 2770\ Lbs$

Shear $= 952 \times 1.3 = 1238\ Lbs$

Tension $= 952 \times 1.3 \times \frac{3}{1.5} = 2475\ Lbs$

Use 2 5/8 ϕ Hilti KB-TZ w/ 4" embed

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Project:		Sheet # 7
Location:		
Client:		Job #
Date:	By:	

PIPE ANCHORS DESIGN

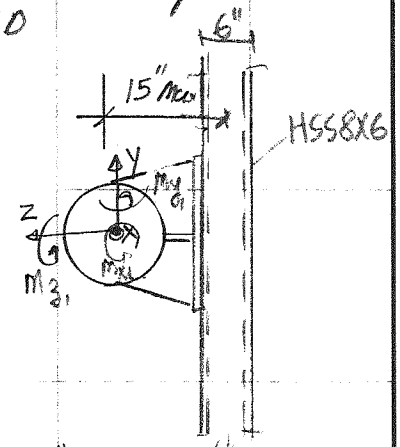
A] 16"Φ LPS

1) Anchor A11 (To steel frame) Thermal loads provided by GHD

$F_x = 32422$ Lbs $\quad M_{x_1} = 32024$ Lb"

$F_y = -509$ Lbs $\quad M_{y_1} = 233786$ Lb"

$F_z = 700$ Lbs $\quad M_{z_1} = 4661$ Lb"



$M_x = 32024 + F_y \times 15$

$= 32024 + 509 \times 15$

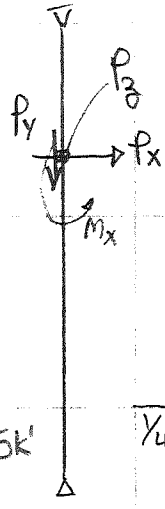
$= 39659$ Lb"

$M_y = 233786 + F_x \times 15$

$= 233786 + 32422 \times 15$

$= 720116$ Lb"

$M_z = 4661$ Lb"



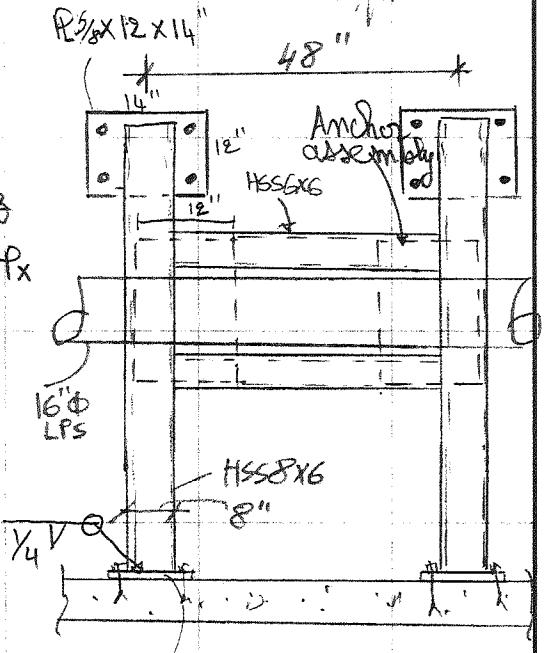
HSS 8X6X3/8 forces:

$P_x = \frac{32422}{2} = 16211$ Lbs

$P_y = \frac{509}{2} + \frac{4661}{48} = 352$ Lbs

$P_z = \frac{700}{2} + \frac{720116}{48} = 15353$ Lbs

$M_x = 39659/2 = 19830$ Lb" $= 1.65$k'



See Risa output:
Deflection limited to L/600 ok

* Bot. reaction: $R_x = 4.053$k

$R_y = .352$k

$R_z = 3.632$k

Check weld:

$$f_w = \sqrt{\left(\frac{4.053}{(6+8)\times 2}\right)^2 + \left(\frac{3.632}{(6+8)\times 2}\right)^2} = .2 \text{ k/in} < F_w = 14.8 \times 1/4 = 3.7 \text{ k/in}$$

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Project:		Sheet # 8
Location:		
Client:		Job #
Date:	By:	

Check anchorage:

$R_x = 4.053 \times 1.2 = 4.864\ K$

$R_z = 3.632 \times 1.2 = 4.359\ K$

Use plate ½ x 7 x 1'-2" w/ (2) ¾"Φ SS Hilti KB-TZ w/ 4" embed

See Profis output

* Top reaction:

$R_x = 12.158\ k$

$R_z = 11.721\ K$

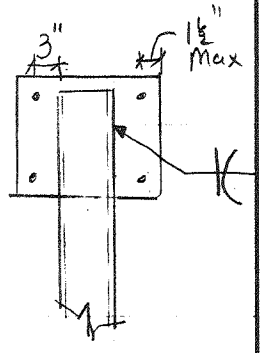
Check weld:

$$f_w = \sqrt{\left(\frac{12.158}{2\times10}\right)^2 + \left(\frac{11.721}{2\times10}\right)^2} = .85\ K/in < F_w = 14.8 \times \left(\frac{5}{8}\times\frac{3}{8}\right) = 3.46\ K/in$$ OK

Check plate thickness:

$M = (11.72 \tfrac{1}{2}) \times 3 = 17.58\ K"$

$$t_{req} = \sqrt{\frac{17.58 \times 6}{12 \times .75 \times 36}} = .57"$$ use ⅝" PL



Check anchorage:

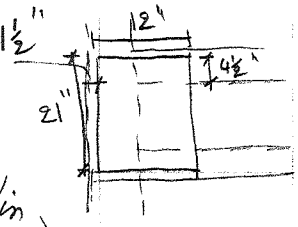
$V = 12.158 \times 1.2 = 14.59\ K$

$T = 11.721 \times 1.2 = 14.07\ K$

$M = 14.59 \times 3 = 43.77\ K"$

Use (4) ¾"Φ SS Hilti KB-TZ w/ 4" emb (see Profis output)

Check HSS wall thickness:



$P_z = 15353\ Lbs$

$M_x = 19830\ Lb"$

$$w_1 = \frac{15353}{2\times12 + 21 + (2\times4.5)} = 284\ Lb/in$$

$$w_2 = \frac{19830}{21 \times 12} = 78.7\ Lb/in$$

$w = 284 + 78.7 = 363\ Lbs/in$

Connection PL welded 1½" from edge of HSS

$M = 363 \times 1.5 = 545\ Lb"$

$$f_b = \frac{.545}{\frac{1 \times (3/8)^2}{6}} = 23.23\ ksi$$

$F_b = .75 \times 46 = 34.5\ ksi$

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Project:		Sheet # 9
Location:		
Client:		Job #
Date:	By:	

2) Anchor A10 (to wall or ceiling) Thermal loads provided by GHD

$F_x = 2395 \times 1.2 = 2874$ Lbs

$F_y = -1025 \times 1.2 = 1230$ Lbs

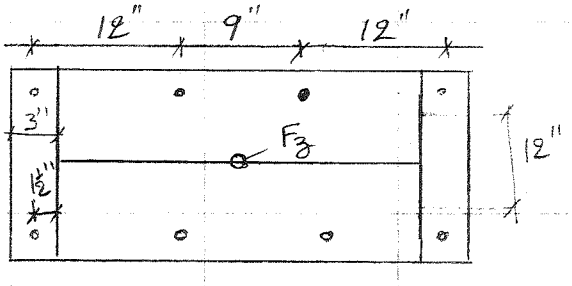
$F_z = 887 \times 1.2 = 1065$ Lbs

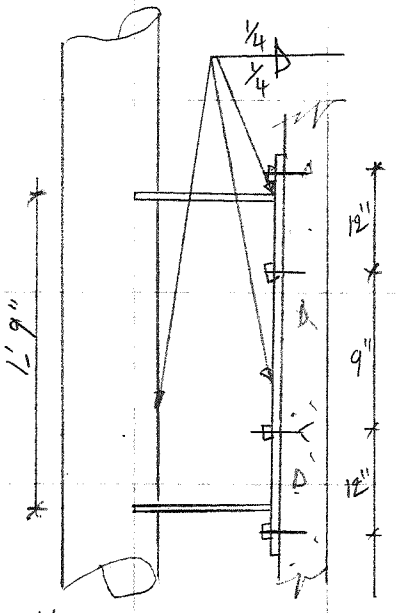
$M_x = (8901 + 1025 \times 15) \times 1.2 = 29131$ Lb"

$M_y = (409545 + 2395 \times 15) \times 1.2 = 534564$ Lb"

$M_z = 83935 \times 1.2 = 100722$ Lb"

Anchorage: See Profis output
PL 3/4 x 24 x 3'-0" w/ (8) 3/4" ø SS Hilti KB-TZ w/ 4" embed.



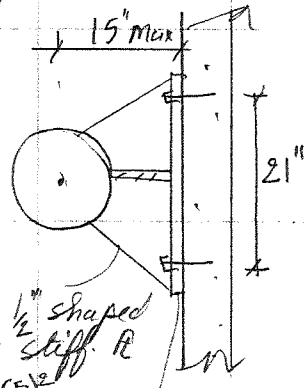


$$w = \frac{F_z = 1065\#}{30 + 2\times24} + \frac{M_x = 29131\,Lb"}{12 \times (2 \times 12)} + \frac{M_y = 534564\,Lb"}{30 \times 24} = 1565\ Lb/in$$

Check plate bending between anchors:

$$M = \frac{1.565 \times 1.5 \times 10.5}{12} = 2.055\ K"/1.2 = 1.713\ K"$$

$$t_{req} = \sqrt{\frac{1.713 \times 6}{1 \times .75 \times 36}} = .62" \quad \text{use } 3/4"$$



Check weld:

$$f_w = \sqrt{\left(\frac{2,395}{2\times24 + 2\times30}\right)^2 + \left(\frac{1.230}{2\times24+2\times30} + \frac{83935}{30\times2\times24}\right)^2 + \left(\frac{1.565}{1.2}\right)^2}$$

$$f_w = \sqrt{.023^2 + .07^2 + 1.304^2} = 1.306\ K/in$$

$F_w = 14.8 \times \frac{1}{4} = 3.7\ K/in$

PL 3/4 x 24 x 3'-0" w/ (8) 3/4ø SS Hilti KB-TZ w/ 4" embed

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Project:		Sheet # 10
Location:		
Client:		Job #
Date:	By:	

3) Anchor A13 (To steel frame) Frame similar to A11 w/ Top connection to tunnel slab (ceiling)

$F_x = -2587$ Lbs

$F_y = 57847$ Lbs

$F_z = 8$ Lbs

$M_x = (-445 - 57847 \times 15) = 868150$ Lbs"

$M_y = (-1006 - 2587 \times 15) = 39811$ Lbs"

$M_z = -1879701$ Lbs"

HSS 8x6x3/8 forces:

$P_x = 2587/2 = 1294$ Lbs

$P_y = \frac{57847}{2} + \frac{1879701}{48} = 68084$ Lbs

$P_z = \frac{8}{2} + \frac{39811}{48} = 833$ Lbs

$M_x = 868150/2 = 434075$ Lb" $= 36.17$ k'

See "Risa output"

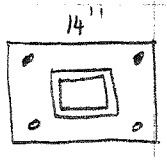
* Bottom reactions: $R_x = .324$K . $R_y = 68.1$K . $R_z = 4.314$K
welds & anchorage OK, see previous calcs

Check plate thickness:

$P_{max} = 68.1$K

$f_p = 68.1/12 \times 14 = .405$ksi

$t_{req} = 2 \times 3.375\sqrt{\frac{.405}{36}} = .71"$



Use PL 3/4" x 12 x 1'-2"
w/ (4) 3/4"ϕ SS KB-TZ
w/ 4" embed.

Check slab punching shear:

$P_{ult} = 68.1 \times 1.2 = 81.7$K

$\phi V_c = .75 \times 4\sqrt{f'_c}\, b_w d = .75 \times 4\sqrt{4000} \times (20+18) \times 2 \times 6 = 86.5$K

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fx: 503.848.8748

Project:		Sheet # 11
Location:		
Client:		Job #
Date:	By:	

4) Anchor A14

$F_x = -36971$ Lbs

$F_y = -206$ Lbs

$F_z = 682$ Lbs

$M_x = 14102 + 206 \times 15 = 17192$ Lb"

$M_y = 106781 + 36971 \times 15 = 661346$ Lb"

$M_z = 1075$ Lbs"

HSS 8X6X 3/8 forces:

$P_x = \frac{36971}{2} = 18486$ Lbs

Members OK, see Risa output

$P_y = \frac{206}{2} + \frac{1075}{48} = 126$ Lbs

$P_z = \frac{682}{2} + \frac{661346}{48} = 14119$ Lbs

$M_x = 17192/2 = 8596$ Lbs" $= .716$ K'

* Bottom reaction:

$R_x = 4622$ Lbs ; $R_y = 126$ Lbs ; $R_z = 3440$ Lbs OK

* Top reactions:

$R_x = 13864$ Lbs ; $R_z = 10679$ Lbs

Check thru bolt:

Shear/bolt $= \frac{13864}{2} = 6.932$ K $< V_{ALL} = 15$ K (Double Shear)

Tension/bolt $= 10679/2 = 5.338$ K $< T_{ALL} = 19.4$ K

Check connection plates in bending:

$M = 5.388 \times (1 + 1.5 + 1) = 18.86$ K" (Loads conserv)

$t_{req} = \sqrt{\frac{18.86 \times 6}{10 \times .75 \times 36}} = .647$" Use 5/8"

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Project:		Sheet # 12
Location:		
Client:		Job #
Date:	By:	

Check welds:

$\rightarrow f_{w_1} = \frac{13.864/2}{2 \times 10} = .347\ k/in$

$\circledcirc\ f_{w_2} = \frac{10.679/2}{2 \times 10} = .267\ k/in$

$\downarrow f_{w_3} = \frac{(13.864/2)\,3.5}{2 \times 10^2/3} + \frac{(10.679/2)\,3.5}{6 \times (2 \times 10)} = .52\ k/in$

$f_w = \sqrt{.347^2 + .267^2 + .52^2}$
$= .68\ k/in$
$F_w = 2.7\ k/in$

Check anchor plate thickness:

$M = 13.864 \times 3.5 = 48.53\ k''$

$t_{req} = \sqrt{\frac{48.53/2 \times 6}{12 \times .75 \times 36}} = .67''$ use $3/4''$

Check anchorage:

$R_x = 13.864\ K \times 1.2 = 16.64\ K$
$R_z = 10.679\ K \times 1.2 = 12.82\ K$

Use (4) $3/4''$ Ø SS KB-TZ w/ $4''$ embed OK see profis output

NBZ
Consulting Engineers
ph: 971.222.4378
fx: 503.848.8748

Project:		Sheet # 13
Location:		
Client:		Job #
Date:	By:	

B] 4" Φ PCR

$F_x = 425 \times 1.2 = 510$ Lbs

$F_y = 343 \times 1.2 = 412$ Lbs

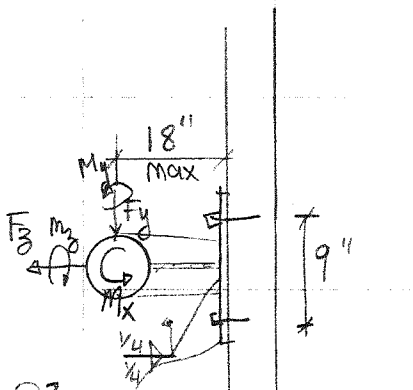
$F_z = 66 \times 1.2 = 79$ Lbs

$M_x = (843 + 343 \times 18)1.2 = 8420$ Lb"

$M_y = (8101 + 425 \times 18)1.2 = 18901$ Lb"

$M_z = 14869 \times 1.2 = 17843$ Lb"

see Profis output



PL 3/4 x 12 x 12
w/ (4) 5/8" Φ SS
Hilti KB.TZ w/ 4" embed

Check base plate: 3/4" x 12 x 14

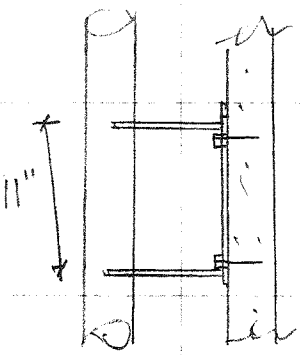
$M_x = 843 + 343 \times 18 + \frac{79 \times 9}{4} = 7195$ Lb"

$f_{bx} = \frac{7.195 \times 6}{12 \times .75^2} = 6.4$ ksi

$M_y = 8101 + 425 \times 18 = 15751$ Lb"

$f_{by} = \frac{15.751 \times 6}{12 \times .75^2} = 14$ ksi

$\frac{6.4 + 14}{.75 \times 36} = .94 < 1$ OK



Check welds to base plate:

$\rightarrow f_{w1} = \frac{.079}{2 \times 12} = .003$ k/in

$\downarrow f_{w2} = \frac{.412}{2 \times 12} = .017$ k/in

$\odot f_{w3} = \frac{.51}{2 \times 12} = .021$ k/in

$\rightarrow f_{w4} = (8.420/1.2)/(12^2/3) = .146$ k/in

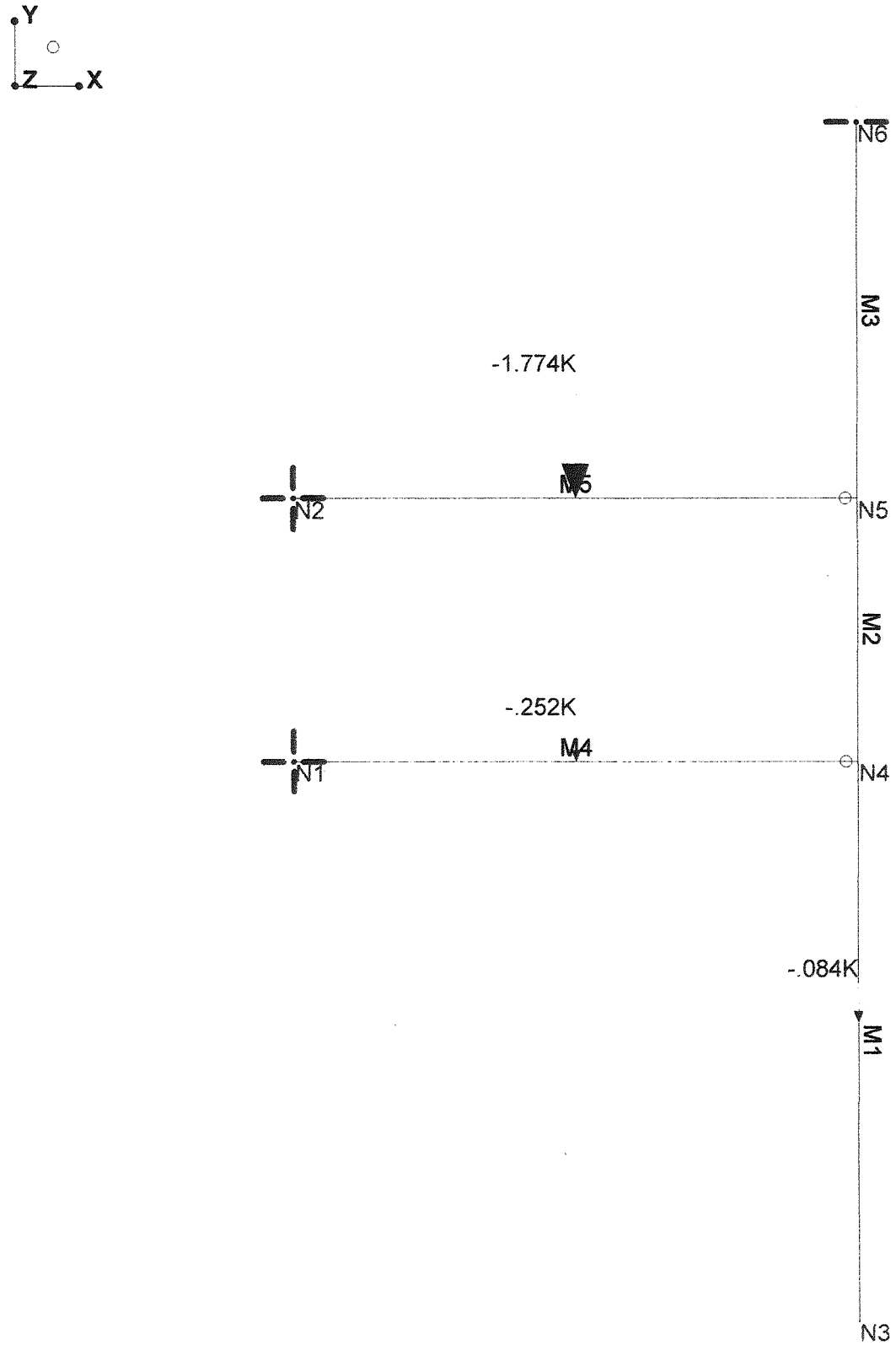
$\rightarrow f_{w5} = (18.901/1.2)/12^2/6 = .656$ k/in

Resisted by stiff. PL $f_{w6} = [(17.843/1.2)/11]/2 \times 12 = .056$ k/in OK

$f_w = \sqrt{(.003 + .146 + .656)^2 + .017^2 + .021^2}$

$= .805$ k/in

$F_w = 14.8 \times 1/4 = 3.7$ k/in



Loads: BLC 1, DL

NBZ Consulting Engineers	Tunnel Frame A,B,C,D & E Gravity	October 28, 2012
NZ		TunnelframeABCDEGravity.r3d

Company : **NBZ Consulting Engineers** October 28, 2012
Designer : **NZ**
Job Number : **Tunnel Frame A,B,C,D & E Gravity** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	33

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	1-5/8"STRUTEQU...	STL	.555	1.2	1.2	.185	.236	.002	
SEC2	15/8"DOUBLEST...	STL	1.111	1.2	1.2	.928	.471	1	
SEC3	P5001	STL	1.793	1.2	1.2	6.227	.866	.004	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	3.75	0	0
N2	0	5.5	0	0
N3	3.75	0	0	0
N4	3.75	3.75	0	0
N5	3.75	5.5	0	0
N6	3.75	8	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction	Reaction		
N2	Reaction	Reaction	Reaction	Reaction		
N6	Reaction		Reaction		Reaction	
N3	Reaction	Reaction	Reaction			

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N3	N4		90	SEC2						3.75
M2	N4	N5		90	SEC2						1.75
M3	N5	N6		90	SEC2						2.5
M4	N1	N4		90	SEC2		AllPIN				3.75
M5	N2	N5		90	SEC3		AllPIN				3.75

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	DL	DL	Dead Load		3		
2	VERTICAL SEISMIC	EL	Earthquake Load	1	3		
3	TRANSVERSE SEISMIC	EL	Earthquake Load		1		
4	LONG. SEISMIC	EL	Earthquake Load		1		

Member Point Loads, Category : DL, BLC 1 : DL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M5	N2	N5	Y	-1.774	1.875
M1	N3	N4	Y	-.084	2
M4	N1	N4	Y	-.252	1.875

Member Point Loads, Category : EL, BLC 2 : VERTICAL SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N3	N4	Y	-.009	2
M4	N1	N4	Y	-.028	1.875
M5	N2	N5	Y	-.195	1.875

Member Point Loads, Category : EL, BLC 3 : TRANSVERSE SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N3	N4	X	.084	2

Member Point Loads, Category : EL, BLC 4 : LONG. SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N3	N4	Z	.084	2

Joint Loads/Enforced Displacements, Category : EL, BLC 2 : VERTICAL SEISMIC

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N1	L	Y	0

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL	y				1	1	1						
2	DL+Fv+Ft	y				1	1	1	2	1	3	1		
3	DL+Fv+Fl	y				1	1	1	2	1	4	1		
4	.9DL-Fv+Ft	y				1	1	.9	2	-1	3	1		
5	.9DL-Fv+Fl	y				1	1	.9	2	-1	4	1		
6	DL+Fv-Ft	y				1	1	1	2	1	3	-1		

Envelope Reactions

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N1	max	0.083	6	0.14	2	0.000	3	0.000	1	0.000	1	0.000	1
	min	-0.083	2	0.099	4	0.000	1	0.000	1	0.000	1	0.000	1
N2	max	0.03	2	0.984	2	0.000	3	0.000	1	0.000	1	0.000	1
	min	-0.03	6	0.701	4	0.000	1	0.000	1	0.000	1	0.000	1
N6	max	0.003	6	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.003	2	0.000	1	-0.021	3	0.000	1	0.000	1	0.000	1
N3	max	0.028	6	1.218	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.028	2	0.867	4	-0.063	3	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	0.084	6	2.342	2	0.000	1						
	min	-0.084	2	1.667	4	-0.084	3						

Envelope Member Section Forces

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
M1	1	max	1.218	2	0	1	0.028	6	0	1	0	1	0	1
		min	0.867	4	-0.063	3	-0.028	2	0	1	0	1	0	1
	2	max	1.218	2	0	1	0.028	6	0	1	0.027	6	0.059	3
		min	0.867	4	-0.063	3	-0.028	2	0	1	-0.027	2	0	1
	3	max	1.218	2	0	1	0.028	6	0	1	0.053	6	0.118	3
		min	0.867	4	-0.063	3	-0.028	2	0	1	-0.053	2	0	1
	4	max	1.125	2	0.021	3	0.056	2	0	1	0.012	6	0.109	3
		min	0.8	4	0	1	-0.056	6	0	1	-0.012	2	0	1
	5	max	1.125	2	0.021	3	0.056	2	0	1	0.041	2	0.089	3
		min	0.8	4	0	1	-0.056	6	0	1	-0.041	6	0	1
M2	1	max	0.985	2	0.021	3	0.027	6	0	1	0.041	2	0.089	3
		min	0.701	4	0	1	-0.027	2	0	1	-0.041	6	0	1
	2	max	0.985	2	0.021	3	0.027	6	0	1	0.029	2	0.08	3
		min	0.701	4	0	1	-0.027	2	0	1	-0.029	6	0	1
	3	max	0.985	2	0.021	3	0.027	6	0	1	0.017	2	0.071	3
		min	0.701	4	0	1	-0.027	2	0	1	-0.017	6	0	1
	4	max	0.985	2	0.021	3	0.027	6	0	1	0.005	2	0.062	3
		min	0.701	4	0	1	-0.027	2	0	1	-0.005	6	0	1
	5	max	0.985	2	0.021	3	0.027	6	0	1	0.007	6	0.052	3
		min	0.701	4	0	1	-0.027	2	0	1	-0.007	2	0	1
M3	1	max	0	1	0.021	3	0.003	2	0	1	0.007	6	0.052	3
		min	0	1	0	1	-0.003	6	0	1	-0.007	2	0	1
	2	max	0	1	0.021	3	0.003	2	0	1	0.005	6	0.039	3
		min	0	1	0	1	-0.003	6	0	1	-0.005	2	0	1
	3	max	0	1	0.021	3	0.003	2	0	1	0.003	6	0.026	3
		min	0	1	0	1	-0.003	6	0	1	-0.003	2	0	1
	4	max	0	1	0.021	3	0.003	2	0	1	0.002	6	0.013	3
		min	0	1	0	1	-0.003	6	0	1	-0.002	2	0	1
	5	max	0	1	0.021	3	0.003	2	0	1	0	1	0	1
		min	0	1	0	1	-0.003	6	0	1	0	1	0	1
M4	1	max	0.083	6	0	1	-0.099	4	0	1	0	1	0	1
		min	-0.083	2	0	1	-0.14	2	0	1	0	1	0	1
	2	max	0.083	6	0	1	-0.099	4	0	1	-0.093	4	0	1
		min	-0.083	2	0	1	-0.14	2	0	1	-0.131	2	0	1
	3	max	0.083	6	0	1	0.14	2	0	1	-0.186	4	0	1
		min	-0.083	2	0	1	0.099	4	0	1	-0.262	2	0	1
	4	max	0.083	6	0	1	0.14	2	0	1	-0.093	4	0	1
		min	-0.083	2	0	1	0.099	4	0	1	-0.131	2	0	1
	5	max	0.083	6	0	1	0.14	2	0	1	0	1	0	1
		min	-0.083	2	0	1	0.099	4	0	1	0	1	0	1
M5	1	max	0.03	2	0	1	-0.701	4	0	1	0	1	0	1
		min	-0.03	6	0	1	-0.984	2	0	1	0	1	0	1
	2	max	0.03	2	0	1	-0.701	4	0	1	-0.657	4	0	1
		min	-0.03	6	0	1	-0.984	2	0	1	-0.923	2	0	1
	3	max	0.03	2	0	1	0.985	2	0	1	-1.314	4	0	1
		min	-0.03	6	0	1	0.701	4	0	1	-1.846	2	0	1
	4	max	0.03	2	0	1	0.985	2	0	1	-0.657	4	0	1
		min	-0.03	6	0	1	0.701	4	0	1	-0.923	2	0	1
	5	max	0.03	2	0	1	0.985	2	0	1	0	1	0	1
		min	-0.03	6	0	1	0.701	4	0	1	0	1	0	1

Envelope Member Section Stresses

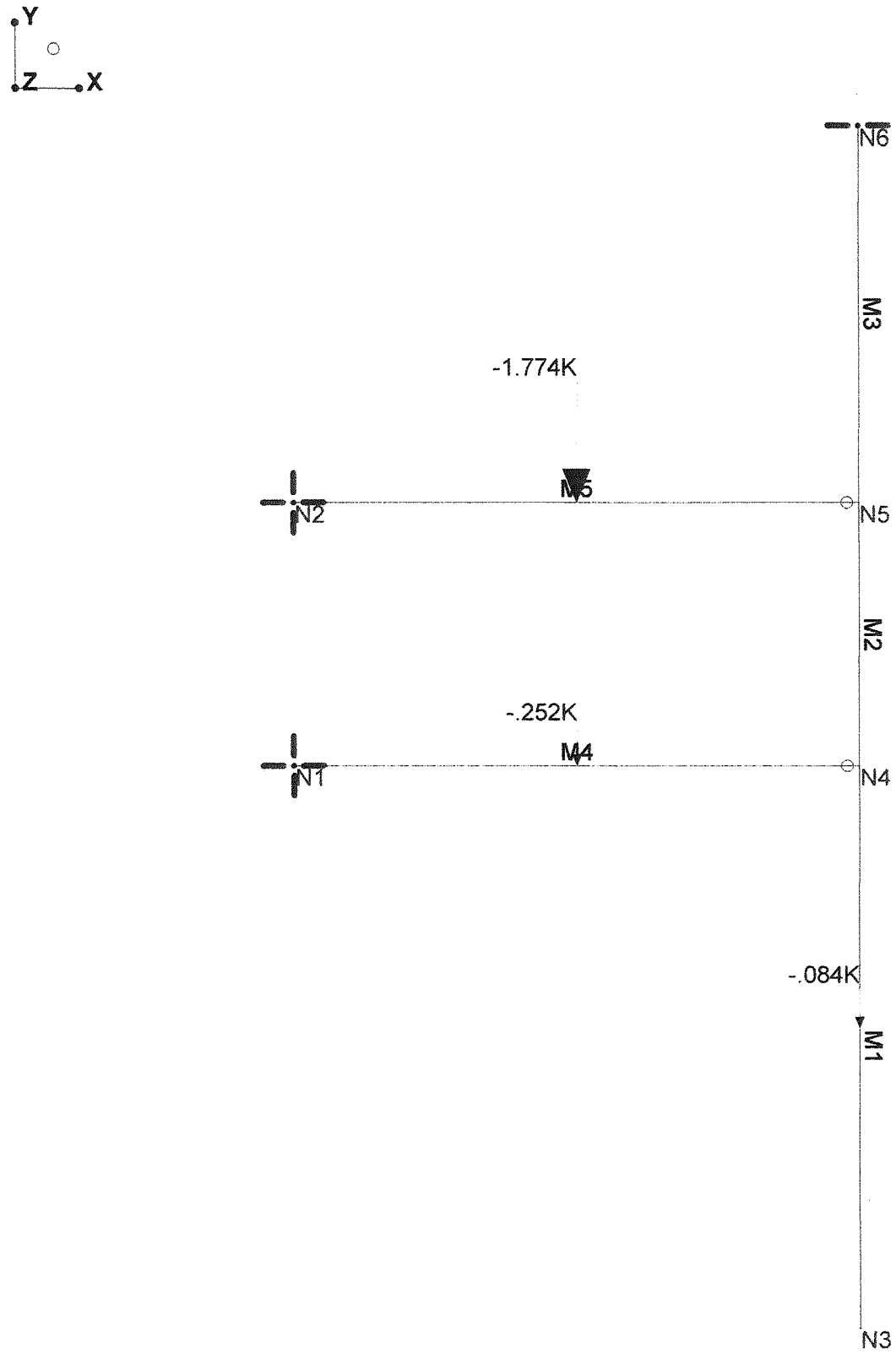
Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
M1	1	max	1.096	2	0	1	0.05	6	0	1	0	1	0	1	0	1
		min	0.78	4	-0.443	3	-0.05	2	0	1	0	1	0	1	0	1
	2	max	1.096	2	0	1	0.05	6	0	1	1.223	3	0.559	6	0.559	2
		min	0.78	4	-0.443	3	-0.05	2	-1.223	3	0	1	-0.559	2	-0.559	6
	3	max	1.096	2	0	1	0.05	6	0	1	2.445	3	1.119	6	1.119	2
		min	0.78	4	-0.443	3	-0.05	2	-2.445	3	0	1	-1.119	2	-1.119	6
	4	max	1.012	2	0.148	3	0.098	2	0	1	2.255	3	0.244	6	0.244	2
		min	0.72	4	0	1	-0.098	6	-2.255	3	0	1	-0.244	2	-0.244	6
	5	max	1.012	2	0.148	3	0.098	2	0	1	1.848	3	0.851	2	0.851	6
		min	0.72	4	0	1	-0.098	6	-1.848	3	0	1	-0.851	6	-0.851	2
M2	1	max	0.886	2	0.148	3	0.047	6	0	1	1.848	3	0.851	2	0.851	6
		min	0.631	4	0	1	-0.047	2	-1.848	3	0	1	-0.851	6	-0.851	2
	2	max	0.886	2	0.148	3	0.047	6	0	1	1.657	3	0.603	2	0.603	6
		min	0.631	4	0	1	-0.047	2	-1.657	3	0	1	-0.603	6	-0.603	2
	3	max	0.886	2	0.148	3	0.047	6	0	1	1.467	3	0.355	2	0.355	6
		min	0.631	4	0	1	-0.047	2	-1.467	3	0	1	-0.355	6	-0.355	2
	4	max	0.886	2	0.148	3	0.047	6	0	1	1.277	3	0.107	2	0.107	6
		min	0.631	4	0	1	-0.047	2	-1.277	3	0	1	-0.107	6	-0.107	2
	5	max	0.886	2	0.148	3	0.047	6	0	1	1.087	3	0.141	6	0.141	2
		min	0.631	4	0	1	-0.047	2	-1.087	3	0	1	-0.141	2	-0.141	6
M3	1	max	0	1	0.148	3	0.005	2	0	1	1.087	3	0.141	6	0.141	2
		min	0	1	0	1	-0.005	6	-1.087	3	0	1	-0.141	2	-0.141	6
	2	max	0	1	0.148	3	0.005	2	0	1	0.815	3	0.106	6	0.106	2
		min	0	1	0	1	-0.005	6	-0.815	3	0	1	-0.106	2	-0.106	6
	3	max	0	1	0.148	3	0.005	2	0	1	0.543	3	0.071	6	0.071	2
		min	0	1	0	1	-0.005	6	-0.543	3	0	1	-0.071	2	-0.071	6
	4	max	0	1	0.148	3	0.005	2	0	1	0.272	3	0.035	6	0.035	2
		min	0	1	0	1	-0.005	6	-0.272	3	0	1	-0.035	2	-0.035	6
	5	max	0	1	0.148	3	0.005	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	-0.005	6	0	1	0	1	0	1	0	1
M4	1	max	0.074	6	0	1	-0.175	4	0	1	0	1	0	1	0	1
		min	-0.074	2	0	1	-0.246	2	0	1	0	1	0	1	0	1
	2	max	0.074	6	0	1	-0.175	4	0	1	0	1	-1.958	4	2.758	2
		min	-0.074	2	0	1	-0.246	2	0	1	0	1	-2.758	2	1.958	4
	3	max	0.074	6	0	1	0.246	2	0	1	0	1	-3.916	4	5.516	2
		min	-0.074	2	0	1	0.175	4	0	1	0	1	-5.516	2	3.916	4
	4	max	0.074	6	0	1	0.246	2	0	1	0	1	-1.958	4	2.758	2
		min	-0.074	2	0	1	0.175	4	0	1	0	1	-2.758	2	1.958	4
	5	max	0.074	6	0	1	0.246	2	0	1	0	1	0	1	0	1
		min	-0.074	2	0	1	0.175	4	0	1	0	1	0	1	0	1
M5	1	max	0.017	2	0	1	-0.616	4	0	1	0	1	0	1	0	1
		min	-0.017	6	0	1	-0.865	2	0	1	0	1	0	1	0	1
	2	max	0.017	2	0	1	-0.616	4	0	1	0	1	-4.115	4	5.781	2
		min	-0.017	6	0	1	-0.865	2	0	1	0	1	-5.781	2	4.115	4
	3	max	0.017	2	0	1	0.865	2	0	1	0	1	-8.23	4	11.561	2
		min	-0.017	6	0	1	0.616	4	0	1	0	1	-11.561	2	8.23	4
	4	max	0.017	2	0	1	0.865	2	0	1	0	1	-4.115	4	5.781	2
		min	-0.017	6	0	1	0.616	4	0	1	0	1	-5.781	2	4.115	4
	5	max	0.017	2	0	1	0.865	2	0	1	0	1	0	1	0	1
		min	-0.017	6	0	1	0.616	4	0	1	0	1	0	1	0	1

Member Deflection

Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	4	0.034	3	0.003	2	0	1	3204.008	3	NC	
		min	0	2	0	1	-0.003	6	0	1	NC		NC	
	3	max	-0.001	4	0.061	3	0.004	2	0	1	2090.822	3	NC	
		min	-0.001	2	0	1	-0.004	6	0	1	NC		NC	
	4	max	-0.001	4	0.077	3	0.002	2	0	1	2676.024	3	NC	
		min	-0.001	2	0	1	-0.002	6	0	1	NC		NC	
	5	max	-0.001	4	0.08	3	0	2	0	1	NC		NC	
		min	-0.002	2	0	1	0	6	0	1	NC		NC	
M2	1	max	-0.001	4	0.08	3	0	2	0	1	NC		NC	
		min	-0.002	2	0	1	0	6	0	1	NC		NC	
	2	max	-0.001	4	0.077	3	0	6	0	1	7819.56	3	NC	
		min	-0.002	2	0	1	0	2	0	1	NC		NC	
	3	max	-0.001	4	0.073	3	0	6	0	1	6118.082	3	NC	
		min	-0.002	2	0	1	0	2	0	1	NC		NC	
	4	max	-0.002	4	0.067	3	0	6	0	1	8525.843	3	NC	
		min	-0.002	2	0	1	0	2	0	1	NC		NC	
	5	max	-0.002	4	0.06	3	0	6	0	1	NC		NC	
		min	-0.002	2	0	1	0	2	0	1	NC		NC	
M3	1	max	-0.002	4	0.06	3	0	6	0	1	NC		NC	
		min	-0.002	2	0	1	0	2	0	1	NC		NC	
	2	max	-0.002	4	0.047	3	0	2	0	1	NC		NC	
		min	-0.002	2	0	1	0	6	0	1	NC		NC	
	3	max	-0.002	4	0.033	3	0	2	0	1	NC		NC	
		min	-0.002	2	0	1	0	6	0	1	NC		NC	
	4	max	-0.002	4	0.017	3	0	2	0	1	NC		NC	
		min	-0.002	2	0	1	0	6	0	1	NC		NC	
	5	max	-0.002	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
M4	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	2	0.02	3	0.014	2	0	1	2260.857	3	3313.839	2
		min	0	6	0	1	0.01	4	0	3	NC		4667.379	4
	3	max	0	2	0.04	3	0.021	2	0	1	1130.429	3	2278.265	2
		min	0	6	0	1	0.015	4	0	3	NC		3208.823	4
	4	max	0	2	0.06	3	0.015	2	0	1	753.619	3	3313.839	2
		min	0	6	0	1	0.011	4	0	3	NC		4667.379	4
	5	max	0	2	0.08	3	0.002	2	0	1	565.214	3	NC	
		min	0	6	0	1	0.001	4	0	3	NC		NC	
M5	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	6	0.015	3	0.015	2	0	1	3004.566	3	3162.093	2
		min	0	2	0	1	0.011	4	0	3	NC		4442.181	4
	3	max	0	6	0.03	3	0.022	2	0	1	1502.283	3	2173.939	2
		min	0	2	0	1	0.016	4	-0.001	3	NC		3054	4
	4	max	0	6	0.045	3	0.016	2	0	1	1001.522	3	3162.093	2
		min	0	2	0	1	0.011	4	-0.001	3	NC		4442.181	4
	5	max	0	6	0.06	3	0.002	2	0	1	751.141	3	NC	
		min	0	2	0	1	0.002	4	-0.002	3	NC		NC	

Envelope Member AISC ASD 9th Code Checks

Member Label	Code Chk	Loc (Ft)	Lc	Shear Chk	Loc (Ft)	Dir	Lc	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.186	1.979	3	0.034	0	y	3	15.42	20.806	19.8	H1-1
M2	0.136	0	3	0.011	0	y	3	18.222	20.806	20.202	H1-2
M3	0.054	0	3	0.011	0	y	3	17.283	20.806	20.202	H1-2
M4	0.27	1.875	6	0.019	1.875	z	2	15.42	20.806	19.8	H1-3
M5	0.787	1.875	2	0.066	1.875	z	2	12.297	14.723	14.723	H1-3



Loads: BLC 1, DL
Solution: Envelope

NBZ Consulting Engineers	Tunnel Frame A,B,C,D & E Guide	October 29, 2012
NZ		TunnelframeABCDEguide.r3d

Company : **NBZ Consulting Engineers** October 29, 2012
Designer : **NZ**
Job Number : **Tunnel Frame A,B,C,D & E Guide** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	46

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	1-5/8"STRUTEQU...	STL	.555	1.2	1.2	.185	.236	.002	
SEC2	15/8"DOUBLEST...	STL	1.111	1.2	1.2	.928	.471	1	
SEC3	TU4X4X4	STL	3.59	1.2	1.2	8.22	8.22	13.5	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	3.75	0	0
N2	0	5.5	0	0
N3	3.75	0	0	0
N4	3.75	3.75	0	0
N5	3.75	5.5	0	0
N6	3.75	8	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction	Reaction		
N2	Reaction	Reaction	Reaction	Reaction		
N6	Reaction		Reaction		Reaction	
N3	Reaction	Reaction	Reaction			

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N3	N4			SEC3						3.75
M2	N4	N5			SEC3						1.75
M3	N5	N6			SEC3						2.5
M4	N1	N4			SEC3		AllPIN				3.75
M5	N2	N5			SEC3		AllPIN				3.75

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	DL	DL	Dead Load		3		
2	VERTICAL SEISMIC	EL	Earthquake Load	1	3		
3	TRANSVERSE SEISMIC	EL	Earthquake Load	2	3		
4	LONG. SEISMIC	EL	Earthquake Load		1		

Joint Loads/Enforced Displacements, Category : EL, BLC 2 : VERTICAL SEISMIC

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N1	L	Y	0

Joint Loads/Enforced Displacements, Category : EL, BLC 3 : TRANSVERSE SEISMIC

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N4	L	X	.96
N5	L	X	6.74

Member Point Loads, Category : DL, BLC 1 : DL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M5	N2	N5	Y	-1.774	1.875
M1	N3	N4	Y	-.084	2
M4	N1	N4	Y	-.252	1.875

Member Point Loads, Category : EL, BLC 2 : VERTICAL SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N3	N4	Y	-.009	2
M4	N1	N4	Y	-.028	1.875
M5	N2	N5	Y	-.195	1.875

Member Point Loads, Category : EL, BLC 3 : TRANSVERSE SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N3	N4	X	.084	2
M4	N1	N4	Mz	-.92	1.825
M5	N2	N5	Mz	-9.83	2

Member Point Loads, Category : EL, BLC 4 : LONG. SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N3	N4	Z	.088	2

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL	y				1	1	1						
2	DL+Fv+Ft	y				1	1	1	2	1	3	1		
3	DL+Fv+Fl	y				1	1	1	2	1	4	1		
4	.9DL-Fv+Ft	y				1	1	.9	2	-1	3	1		
5	.9DL-Fv+Fl	y				1	1	.9	2	-1	4	1		
6	DL+Fv-Ft	y				1	1	1	2	1	3	-1		

Envelope Reactions

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N1	max	1.27	6	0.385	6	0.000	1	0.000	1	0.000	1	0.000	1
	min	-1.27	2	-0.146	4	0.000	3	0.000	1	0.000	1	0.000	1

Envelope Reactions, (continued)

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N2	max	6.418	6	3.606	6	0.000	1	0.000	1	0.000	1	0.000	1
	min	-6.418	2	-1.921	4	0.000	3	0.000	1	0.000	1	0.000	1
N6	max	0.097	6	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.097	2	0.000	1	-0.022	3	0.000	1	0.000	1	0.000	1
N3	max	0.001	2	4.084	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.001	6	-1.649	6	-0.066	3	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	7.784	6	2.342	6	0.000	1						
	min	-7.784	2	1.667	4	-0.088	3						

Envelope Member Section Forces

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
M1	1	max	4.084	2	0.001	6	0	1	0	1	0	1	0	1
		min	-1.649	6	-0.001	2	-0.066	3	0	1	0	1	0	1
	2	max	4.084	2	0.001	6	0	1	0	1	0	1	0.001	2
		min	-1.649	6	-0.001	2	-0.066	3	0	1	-0.062	3	-0.001	6
	3	max	4.084	2	0.001	6	0	1	0	1	0	1	0.002	2
		min	-1.649	6	-0.001	2	-0.066	3	0	1	-0.124	3	-0.002	6
	4	max	3.991	2	0.085	6	0.022	3	0	1	0	1	0.072	2
		min	-1.742	6	-0.085	2	0	1	0	1	-0.114	3	-0.072	6
	5	max	3.991	2	0.085	6	0.022	3	0	1	0	1	0.151	2
		min	-1.742	6	-0.085	2	0	1	0	1	-0.093	3	-0.151	6
M2	1	max	3.606	2	0.225	2	0.022	3	0	1	0	1	0.151	2
		min	-1.637	6	-0.225	6	0	1	0	1	-0.093	3	-0.151	6
	2	max	3.606	2	0.225	2	0.022	3	0	1	0	1	0.053	2
		min	-1.637	6	-0.225	6	0	1	0	1	-0.084	3	-0.053	6
	3	max	3.606	2	0.225	2	0.022	3	0	1	0	1	0.046	6
		min	-1.637	6	-0.225	6	0	1	0	1	-0.074	3	-0.046	2
	4	max	3.606	2	0.225	2	0.022	3	0	1	0	1	0.144	6
		min	-1.637	6	-0.225	6	0	1	0	1	-0.065	3	-0.144	2
	5	max	3.606	2	0.225	2	0.022	3	0	1	0	1	0.243	6
		min	-1.637	6	-0.225	6	0	1	0	1	-0.055	3	-0.243	2
M3	1	max	0	1	0.097	6	0.022	3	0	1	0	1	0.243	6
		min	0	1	-0.097	2	0	1	0	1	-0.055	3	-0.243	2
	2	max	0	1	0.097	6	0.022	3	0	1	0	1	0.182	6
		min	0	1	-0.097	2	0	1	0	1	-0.041	3	-0.182	2
	3	max	0	1	0.097	6	0.022	3	0	1	0	1	0.121	6
		min	0	1	-0.097	2	0	1	0	1	-0.028	3	-0.121	2
	4	max	0	1	0.097	6	0.022	3	0	1	0	1	0.061	6
		min	0	1	-0.097	2	0	1	0	1	-0.014	3	-0.061	2
	5	max	0	1	0.097	6	0.022	3	0	1	0	1	0	1
		min	0	1	-0.097	2	0	1	0	1	0	1	0	1
M4	1	max	1.27	6	0.385	6	0	1	0	1	0	1	0	1
		min	-1.27	2	-0.146	4	0	1	0	1	0	1	0	1
	2	max	1.27	6	0.385	6	0	1	0	1	0	1	0.137	4
		min	-1.27	2	-0.146	4	0	1	0	1	0	1	-0.361	6
	3	max	1.27	6	0.105	6	0	1	0	1	0	1	0.198	6
		min	-1.27	2	-0.385	2	0	1	0	1	0	1	-0.722	2
	4	max	1.27	6	0.105	6	0	1	0	1	0	1	0.099	6
		min	-1.27	2	-0.385	2	0	1	0	1	0	1	-0.361	2
	5	max	1.27	6	0.105	6	0	1	0	1	0	1	0	1
		min	-1.27	2	-0.385	2	0	1	0	1	0	1	0	1
M5	1	max	6.418	6	3.606	6	0	1	0	1	0	1	0	1

Envelope Member Section Forces, (continued)

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
		min	-6.418	2	-1.921	4	0	1	0	1	0	1	0	1
	2	max	6.418	6	3.606	6	0	1	0	1	0	1	1.8	4
		min	-6.418	2	-1.921	4	0	1	0	1	0	1	-3.38	6
	3	max	6.418	6	1.637	6	0	1	0	1	0	1	3.601	4
		min	-6.418	2	-3.606	2	0	1	0	1	0	1	-6.761	6
	4	max	6.418	6	1.637	6	0	1	0	1	0	1	1.535	6
		min	-6.418	2	-3.606	2	0	1	0	1	0	1	-3.38	2
	5	max	6.418	6	1.637	6	0	1	0	1	0	1	0	1
		min	-6.418	2	-3.606	2	0	1	0	1	0	1	0	1

Envelope Member Section Stresses

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
M1	1	max	1.138	2	0.001	6	0	1	0	1	0	1	0	1	0	1
		min	-0.459	6	-0.001	2	-0.04	3	0	1	0	1	0	1	0	1
	2	max	1.138	2	0.001	6	0	1	0.003	6	0.003	2	0	1	0.181	3
		min	-0.459	6	-0.001	2	-0.04	3	-0.003	2	-0.003	6	-0.181	3	0	1
	3	max	1.138	2	0.001	6	0	1	0.006	6	0.006	2	0	1	0.361	3
		min	-0.459	6	-0.001	2	-0.04	3	-0.006	2	-0.006	6	-0.361	3	0	1
	4	max	1.112	2	0.051	6	0.013	3	0.209	6	0.209	2	0	1	0.333	3
		min	-0.485	6	-0.051	2	0	1	-0.209	2	-0.209	6	-0.333	3	0	1
	5	max	1.112	2	0.051	6	0.013	3	0.442	6	0.442	2	0	1	0.273	3
		min	-0.485	6	-0.051	2	0	1	-0.442	2	-0.442	6	-0.273	3	0	1
M2	1	max	1.004	2	0.135	2	0.013	3	0.442	6	0.442	2	0	1	0.273	3
		min	-0.456	6	-0.135	6	0	1	-0.442	2	-0.442	6	-0.273	3	0	1
	2	max	1.004	2	0.135	2	0.013	3	0.154	6	0.154	2	0	1	0.245	3
		min	-0.456	6	-0.135	6	0	1	-0.154	2	-0.154	6	-0.245	3	0	1
	3	max	1.004	2	0.135	2	0.013	3	0.133	2	0.133	6	0	1	0.217	3
		min	-0.456	6	-0.135	6	0	1	-0.133	6	-0.133	2	-0.217	3	0	1
	4	max	1.004	2	0.135	2	0.013	3	0.421	2	0.421	6	0	1	0.189	3
		min	-0.456	6	-0.135	6	0	1	-0.421	6	-0.421	2	-0.189	3	0	1
	5	max	1.004	2	0.135	2	0.013	3	0.709	2	0.709	6	0	1	0.161	3
		min	-0.456	6	-0.135	6	0	1	-0.709	6	-0.709	2	-0.161	3	0	1
M3	1	max	0	1	0.058	6	0.013	3	0.709	2	0.709	6	0	1	0.161	3
		min	0	1	-0.058	2	0	1	-0.709	6	-0.709	2	-0.161	3	0	1
	2	max	0	1	0.058	6	0.013	3	0.532	2	0.532	6	0	1	0.12	3
		min	0	1	-0.058	2	0	1	-0.532	6	-0.532	2	-0.12	3	0	1
	3	max	0	1	0.058	6	0.013	3	0.354	2	0.354	6	0	1	0.08	3
		min	0	1	-0.058	2	0	1	-0.354	6	-0.354	2	-0.08	3	0	1
	4	max	0	1	0.058	6	0.013	3	0.177	2	0.177	6	0	1	0.04	3
		min	0	1	-0.058	2	0	1	-0.177	6	-0.177	2	-0.04	3	0	1
	5	max	0	1	0.058	6	0.013	3	0	1	0	1	0	1	0	1
		min	0	1	-0.058	2	0	1	0	1	0	1	0	1	0	1
M4	1	max	0.354	6	0.231	6	0	1	0	1	0	1	0	1	0	1
		min	-0.354	2	-0.088	4	0	1	0	1	0	1	0	1	0	1
	2	max	0.354	6	0.231	6	0	1	1.055	6	0.399	4	0	1	0	1
		min	-0.354	2	-0.088	4	0	1	-0.399	4	-1.055	6	0	1	0	1
	3	max	0.354	6	0.063	6	0	1	2.109	2	0.577	6	0	1	0	1
		min	-0.354	2	-0.231	2	0	1	-0.577	6	-2.109	2	0	1	0	1
	4	max	0.354	6	0.063	6	0	1	1.055	2	0.288	6	0	1	0	1
		min	-0.354	2	-0.231	2	0	1	-0.288	6	-1.055	2	0	1	0	1
	5	max	0.354	6	0.063	6	0	1	0	1	0	1	0	1	0	1
		min	-0.354	2	-0.231	2	0	1	0	1	0	1	0	1	0	1
M5	1	max	1.788	6	2.163	6	0	1	0	1	0	1	0	1	0	1

Member Stresses, (continued)

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
		min	-1.788	2	-1.152	4	0	1	0	1	0	1	0	1	0	1
	2	max	1.788	6	2.163	6	0	1	9.87	6	5.257	4	0	1	0	1
		min	-1.788	2	-1.152	4	0	1	-5.257	4	-9.87	6	0	1	0	1
	3	max	1.788	6	0.982	6	0	1	19.74	6	10.514	4	0	1	0	1
		min	-1.788	2	-2.163	2	0	1	-10.514	4	-19.74	6	0	1	0	1
	4	max	1.788	6	0.982	6	0	1	9.87	2	4.48	6	0	1	0	1
		min	-1.788	2	-2.163	2	0	1	-4.48	6	-9.87	2	0	1	0	1
	5	max	1.788	6	0.982	6	0	1	0	1	0	1	0	1	0	1
		min	-1.788	2	-2.163	2	0	1	0	1	0	1	0	1	0	1

Member Deflection

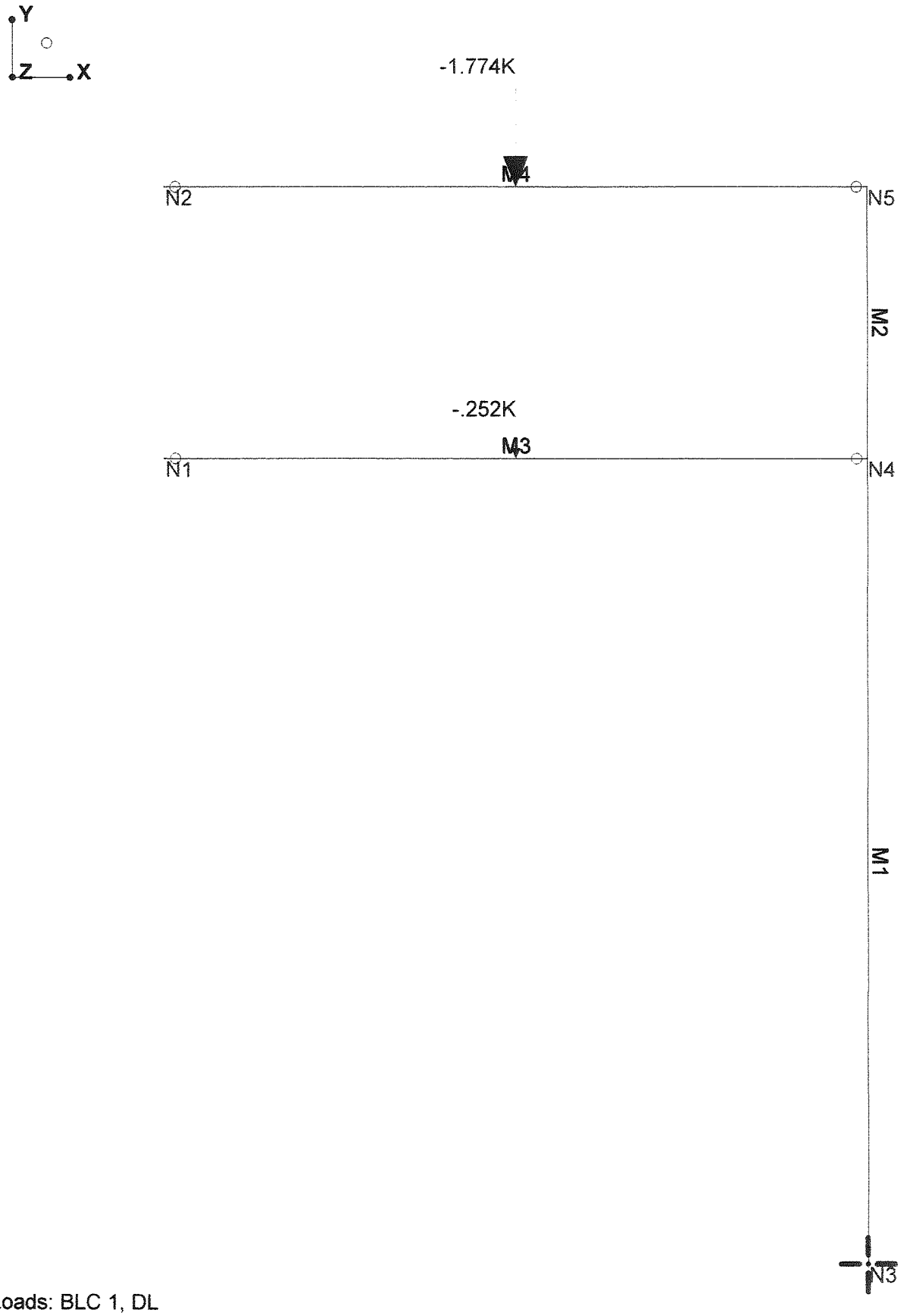
Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	6	0	2	0.002	3	0	1	NC		NC	
		min	0	2	0	6	0	1	0	1	NC		NC	
	3	max	0	6	0	2	0.004	3	0	1	NC		NC	
		min	-0.001	2	0	6	0	1	0	1	NC		NC	
	4	max	0.001	6	0	6	0.005	3	0	1	NC		NC	
		min	-0.001	2	0	2	0	1	0	1	NC		NC	
	5	max	0.001	6	0.001	6	0.005	3	0	1	NC		NC	
		min	-0.002	2	-0.001	2	0	1	0	1	NC		NC	
M2	1	max	0.001	6	0.001	6	0.005	3	0	1	NC		NC	
		min	-0.002	2	-0.001	2	0	1	0	1	NC		NC	
	2	max	0.001	6	0.001	6	0.005	3	0	1	NC		NC	
		min	-0.002	2	-0.001	2	0	1	0	1	NC		NC	
	3	max	0.001	6	0.002	6	0.004	3	0	1	NC		NC	
		min	-0.002	2	-0.002	2	0	1	0	1	NC		NC	
	4	max	0.001	6	0.002	6	0.004	3	0	1	NC		NC	
		min	-0.002	2	-0.002	2	0	1	0	1	NC		NC	
	5	max	0.001	6	0.003	6	0.004	3	0	1	NC		NC	
		min	-0.002	2	-0.003	2	0	1	0	1	NC		NC	
M3	1	max	0.001	6	0.003	6	0.004	3	0	1	NC		NC	
		min	-0.002	2	-0.003	2	0	1	0	1	NC		NC	
	2	max	0.001	6	0.003	6	0.003	3	0	1	NC		NC	
		min	-0.002	2	-0.003	2	0	1	0	1	NC		NC	
	3	max	0.001	6	0.002	6	0.002	3	0	1	NC		NC	
		min	-0.002	2	-0.002	2	0	1	0	1	NC		NC	
	4	max	0.001	6	0.001	6	0.001	3	0	1	NC		NC	
		min	-0.002	2	-0.001	2	0	1	0	1	NC		NC	
	5	max	0.001	6	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
M4	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	2	-0.001	4	0.001	3	0	1	NC		NC	
		min	0	6	-0.002	6	0	1	0	3	NC		NC	
	3	max	0	2	-0.002	6	0.002	3	0	1	NC		NC	
		min	0	6	-0.003	2	0	1	0	3	NC		NC	
	4	max	0	2	0	6	0.004	3	0	1	NC		NC	
		min	0	6	-0.004	2	0	1	0	3	NC		NC	
	5	max	0.001	2	0.001	6	0.005	3	0	1	NC		NC	
		min	-0.001	6	-0.002	2	0	1	0	3	NC		NC	
M5	1	max	0	1	0	1	0	1	0	1	NC		NC	

Member Deflections, (continued)

Member Label	Section		x-Translate (In)	Lc	x-Translate (In)	Lc	x-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0.001	2	0.004	4	0.001	3	0	1	NC		NC	
		min	-0.001	6	-0.022	6	0	1	0	3	1987.175	6	NC	
	3	max	0.001	2	-0.004	4	0.002	3	0	1	NC		NC	
		min	-0.001	6	-0.023	6	0	1	0	3	1894.496	6	NC	
	4	max	0.002	2	-0.006	6	0.003	3	0	1	6192.794	6	NC	
		min	-0.002	6	-0.016	2	0	1	0	3	3148.001	2	NC	
	5	max	0.003	2	0.001	6	0.004	3	0	1	NC		NC	
		min	-0.003	6	-0.002	2	0	1	0	3	NC		NC	

Envelope Member AISC ASD 9th Code Checks

Member Label	Code Chk	Loc (Ft)	Lc	Shear Chk	Loc (Ft)	Dir	Lc	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.057	3.75	2	0.003	2.083	y	2	25.147	30.36	30.36	H1-1
M2	0.06	1.75	2	0.007	0	y	2	26.644	30.36	30.36	H1-2
M3	0.023	0	2	0.003	0	y	2	26.13	30.36	30.36	H1-2
M4	0.082	1.875	2	0.013	1.875	y	2	25.147	30.36	30.36	H2-1
M5	0.738	1.979	6	0.118	1.875	y	2	25.147	30.36	30.36	H1-3



Loads: BLC 1, DL

	Tunnel Frame G Gravity	October 28, 2012
NZ		TunnelframeGGravity.r3d

Tunnel Frame G Gravity

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	33

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	1-5/8"STRUTEQU...	STL	.555	1.2	1.2	.185	.236	.002	
SEC2	15/8"DOUBLEST...	STL	1.111	1.2	1.2	.928	.471	1	
SEC3	P5001	STL	1.793	1.2	1.2	6.227	.866	.004	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	3.75	0	0
N2	0	5	0	0
N3	3.25	0	0	0
N4	3.25	3.75	0	0
N5	3.25	5	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N3	Reaction	Reaction	Reaction		Reaction	
N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N2	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N5				Reaction		

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N3	N4		90	SEC2						3.75
M3	N1	N4		90	SEC2	AllPIN	BenPIN				3.25
M4	N2	N5		90	SEC3	AllPIN	BenPIN				3.25
M2	N4	N5		90	SEC2						1.25

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Nodal	Load Type Totals Point	Distributed	Surface
1	DL	DL	Dead Load		2		
2	VERTICAL SEISMIC	EL	Earthquake Load	1	2		

Joint Loads/Enforced Displacements, Category : EL, BLC 2 : VERTICAL SEISMIC

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N1	L	Y	0

Member Point Loads, Category : DL, BLC 1 : DL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Y	-1.774	1.625
M3	N1	N4	Y	-.252	1.625

Member Point Loads, Category : EL, BLC 2 : VERTICAL SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M3	N1	N4	Y	-.028	1.625
M4	N2	N5	Y	-.195	1.625

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL	y				1	1	1						
2	DL+Fv+Ft	y				1	1	1	2	1	3	1		
3	DL+Fv+Fl	y				1	1	1	2	1	4	1		
4	.9DL-Fv+Ft	y				1	1	.9	2	-1	3	1		
5	.9DL-Fv+Fl	y				1	1	.9	2	-1	4	1		
6	DL+Fv-Ft	y				1	1	1	2	1	3	-1		

Envelope Reactions

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N3	max	0.000	1	1.124	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.8	4	0.000	1	0.000	1	0.000	1	0.000	1
N1	max	0.000	1	0.14	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.099	4	0.000	1	0.000	1	0.000	1	0.000	1
N2	max	0.000	1	0.984	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.701	4	0.000	1	0.000	1	0.000	1	0.000	1
N5	max	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	0.000	1	2.249	2	0.000	1						
	min	0.000	1	1.6	4	0.000	1						

Envelope Member Section Forces

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
M1	1	max	1.124	2	0	1	0	1	0	1	0	1	0	1
		min	0.8	4	0	1	0	1	0	1	0	1	0	1
	2	max	1.124	2	0	1	0	1	0	1	0	1	0	1
		min	0.8	4	0	1	0	1	0	1	0	1	0	1
	3	max	1.124	2	0	1	0	1	0	1	0	1	0	1
		min	0.8	4	0	1	0	1	0	1	0	1	0	1
	4	max	1.124	2	0	1	0	1	0	1	0	1	0	1
		min	0.8	4	0	1	0	1	0	1	0	1	0	1
	5	max	1.124	2	0	1	0	1	0	1	0	1	0	1
		min	0.8	4	0	1	0	1	0	1	0	1	0	1
M3	1	max	0	1	0	1	-0.099	4	0	1	0	1	0	1
		min	0	1	0	1	-0.14	2	0	1	0	1	0	1
	2	max	0	1	0	1	-0.099	4	0	1	-0.081	4	0	1
		min	0	1	0	1	-0.14	2	0	1	-0.114	2	0	1
	3	max	0	1	0	1	0.14	2	0	1	-0.162	4	0	1
		min	0	1	0	1	0.099	4	0	1	-0.228	2	0	1

Company :
Designer : NZ
Job Number :

October 28, 2012

Tunnel Frame G Gravity

Checked By:_____

Envelope Member Section Forces, (continued)

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
	4	max	0	1	0	1	0.14	2	0	1	-0.081	4	0	1
		min	0	1	0	1	0.099	4	0	1	-0.114	2	0	1
	5	max	0	1	0	1	0.14	2	0	1	0	1	0	1
		min	0	1	0	1	0.099	4	0	1	0	1	0	1
M4	1	max	0	1	0	1	-0.701	4	0	1	0	1	0	1
		min	0	1	0	1	-0.985	2	0	1	0	1	0	1
	2	max	0	1	0	1	-0.701	4	0	1	-0.569	4	0	1
		min	0	1	0	1	-0.985	2	0	1	-0.8	2	0	1
	3	max	0	1	0	1	0.984	2	0	1	-1.139	4	0	1
		min	0	1	0	1	0.701	4	0	1	-1.6	2	0	1
	4	max	0	1	0	1	0.984	2	0	1	-0.569	4	0	1
		min	0	1	0	1	0.701	4	0	1	-0.8	2	0	1
	5	max	0	1	0	1	0.984	2	0	1	0	1	0	1
		min	0	1	0	1	0.701	4	0	1	0	1	0	1
M2	1	max	0.985	2	0	1	0	1	0	1	0	1	0	1
		min	0.701	4	0	1	0	1	0	1	0	1	0	1
	2	max	0.985	2	0	1	0	1	0	1	0	1	0	1
		min	0.701	4	0	1	0	1	0	1	0	1	0	1
	3	max	0.985	2	0	1	0	1	0	1	0	1	0	1
		min	0.701	4	0	1	0	1	0	1	0	1	0	1
	4	max	0.985	2	0	1	0	1	0	1	0	1	0	1
		min	0.701	4	0	1	0	1	0	1	0	1	0	1
	5	max	0.985	2	0	1	0	1	0	1	0	1	0	1
		min	0.701	4	0	1	0	1	0	1	0	1	0	1

Envelope Member Section Stresses

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
M1	1	max	1.012	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.72	4	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	1.012	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.72	4	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	1.012	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.72	4	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	1.012	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.72	4	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	1.012	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.72	4	0	1	0	1	0	1	0	1	0	1	0	1
M3	1	max	0	1	0	1	-0.175	4	0	1	0	1	0	1	0	1
		min	0	1	0	1	-0.246	2	0	1	0	1	0	1	0	1
	2	max	0	1	0	1	-0.175	4	0	1	0	1	-1.697	4	2.39	2
		min	0	1	0	1	-0.246	2	0	1	0	1	-2.39	2	1.697	4
	3	max	0	1	0	1	0.246	2	0	1	0	1	-3.394	4	4.78	2
		min	0	1	0	1	0.175	4	0	1	0	1	-4.78	2	3.394	4
	4	max	0	1	0	1	0.246	2	0	1	0	1	-1.697	4	2.39	2
		min	0	1	0	1	0.175	4	0	1	0	1	-2.39	2	1.697	4
	5	max	0	1	0	1	0.246	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	0.175	4	0	1	0	1	0	1	0	1
M4	1	max	0	1	0	1	-0.616	4	0	1	0	1	0	1	0	1
		min	0	1	0	1	-0.865	2	0	1	0	1	0	1	0	1
	2	max	0	1	0	1	-0.616	4	0	1	0	1	-3.566	4	5.01	2
		min	0	1	0	1	-0.865	2	0	1	0	1	-5.01	2	3.566	4
	3	max	0	1	0	1	0.865	2	0	1	0	1	-7.132	4	10.02	2
		min	0	1	0	1	0.616	4	0	1	0	1	-10.02	2	7.132	4

Member Stresses, (continued)

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
	4	max	0	1	0	1	0.865	2	0	1	0	1	-3.566	4	5.01	2
		min	0	1	0	1	0.616	4	0	1	0	1	-5.01	2	3.566	4
	5	max	0	1	0	1	0.865	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	0.616	4	0	1	0	1	0	1	0	1
M2	1	max	0.886	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.631	4	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	0.886	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.631	4	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	0.886	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.631	4	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	0.886	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.631	4	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	0.886	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.631	4	0	1	0	1	0	1	0	1	0	1	0	1

Member Deflection

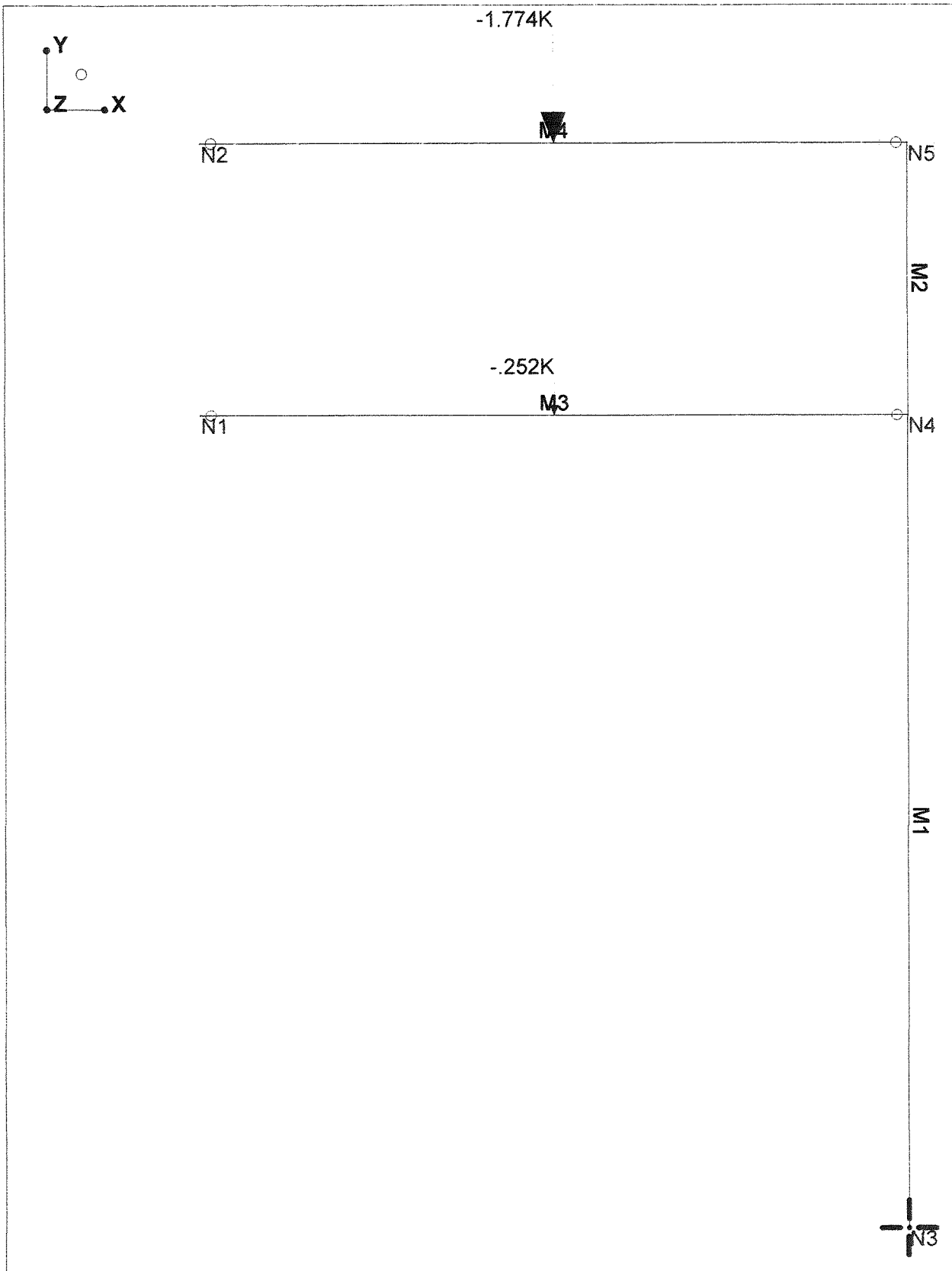
Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	4	0	1	0	1	0	1	NC		NC	
		min	0	2	0	1	0	1	0	1	NC		NC	
	3	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.001	2	0	1	0	1	0	1	NC		NC	
	4	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.001	2	0	1	0	1	0	1	NC		NC	
	5	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
M3	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	1	0	1	0.009	2	0	1	NC		4411.916	2
		min	0	1	0	1	0.007	4	0	1	NC		6213.967	4
	3	max	0	1	0	1	0.014	2	0	1	NC		3033.192	2
		min	0	1	0	1	0.01	4	0	1	NC		4272.102	4
	4	max	0	1	0	1	0.01	2	0	1	NC		4411.916	2
		min	0	1	0	1	0.007	4	0	1	NC		6213.967	4
	5	max	0	1	0	1	0.002	2	0	1	NC		NC	
		min	0	1	0	1	0.001	4	0	1	NC		NC	
M4	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	1	0	1	0.01	2	0	1	NC		4209.887	2
		min	0	1	0	1	0.007	4	0	1	NC		5914.147	4
	3	max	0	1	0	1	0.014	2	0	1	NC		2894.298	2
		min	0	1	0	1	0.01	4	0	1	NC		4065.976	4
	4	max	0	1	0	1	0.011	2	0	1	NC		4209.887	2
		min	0	1	0	1	0.008	4	0	1	NC		5914.147	4
	5	max	0	1	0	1	0.002	2	0	1	NC		NC	
		min	0	1	0	1	0.001	4	0	1	NC		NC	
M2	1	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	2	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	3	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	

Member Deflections, (continued)

Member Label	Section		x-Translate (In)	Lc	x-Translate (In)	Lc	x-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
4	max		-0.001	4	0	1	0	1	0	1	NC		NC	
	min		-0.002	2	0	1	0	1	0	1	NC		NC	
5	max		-0.001	4	0	1	0	1	0	1	NC		NC	
	min		-0.002	2	0	1	0	1	0	1	NC		NC	

Envelope Member AISC ASD 9th Code Checks

Member Label	Code Chk	Loc (Ft)	Lc	Shear Chk	Loc (Ft)	Dir	Lc	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.066	0	2	0	0	y	1	15.42	20.806	19.8	H1-1
M3	0.23	1.625	2	0.019	0	z	2	16.208	20.806	20.202	H1-1
M4	0.681	1.625	2	0.066	0	z	2	12.724	14.723	14.723	H1-1
M2	0.047	0	2	0	0	y	1	18.766	20.806	20.202	H1-1



Loads: BLC 1, DL

NBZ Consulting Engineers	Tunnel Frame G Guide	October 29, 2012
NZ		TunnelframeGguide.r3d

Company : **NBZ Consulting Engineers** October 29, 2012
Designer : **NZ**
Job Number : **Tunnel Frame G Guide** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	46

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	1-5/8"STRUTEQU...	STL	.555	1.2	1.2	.185	.236	.002	
SEC2	15/8"DOUBLEST...	STL	1.111	1.2	1.2	.928	.471	1	
SEC3	TU4X4X4	STL	3.59	1.2	1.2	8.22	8.22	13.5	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	3.75	0	0
N2	0	5	0	0
N3	3.25	0	0	0
N4	3.25	3.75	0	0
N5	3.25	5	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N3	Reaction	Reaction	Reaction		Reaction	
N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N2	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N5				Reaction		

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N3	N4			SEC3						3.75
M3	N1	N4			SEC3	AllPIN	BenPIN				3.25
M4	N2	N5			SEC3	AllPIN	BenPIN				3.25
M2	N4	N5			SEC3						1.25

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	DL	DL	Dead Load		2		
2	VERTICAL SEISMIC	EL	Earthquake Load	1	2		
3	TRANSVERSE SEISMIC	EL	Earthquake Load	2	2		

Joint Loads/Enforced Displacements, Category : EL, BLC 2 : VERTICAL SEISMIC

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N1	L	Y	0

Joint Loads/Enforced Displacements, Category : EL, BLC 3 : TRANSVERSE SEISMIC

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N4	L	X	.96
N5	L	X	6.74

Member Point Loads, Category : DL, BLC 1 : DL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Y	-1.774	1.625
M3	N1	N4	Y	-.252	1.625

Member Point Loads, Category : EL, BLC 2 : VERTICAL SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M3	N1	N4	Y	-.028	1.625
M4	N2	N5	Y	-.195	1.625

Member Point Loads, Category : EL, BLC 3 : TRANSVERSE SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Mz	-9.83	1.875
M3	N1	N4	Mz	-.92	1.875

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL	y				1	1	1						
2	DL+Fv+Ft	y				1	1	1	2	1	3	1		
3	DL+Fv+Fl	y				1	1	1	2	1	4	1		
4	.9DL-Fv+Ft	y				1	1	.9	2	-1	3	1		
5	.9DL-Fv+Fl	y				1	1	.9	2	-1	4	1		
6	DL+Fv-Ft	y				1	1	1	2	1	3	-1		

Envelope Reactions

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N3	max	0.032	2	4.432	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.032	6	-2.183	6	0.000	1	0.000	1	0.000	1	0.000	1
N1	max	1.09	6	0.423	6	0.000	1	0.000	1	0.000	1	0.000	1
	min	-1.09	2	-0.184	4	0.000	1	0.000	1	0.000	1	0.000	1
N2	max	6.643	6	4.009	6	0.000	1	0.000	1	0.000	1	0.000	1
	min	-6.643	2	-2.324	4	0.000	1	0.000	1	0.000	1	0.000	1
N5	max	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	7.7	6	2.249	6	0.000	1						
	min	-7.7	2	1.6	4	0.000	1						

Company : **NBZ Consulting Engineers** October 29, 2012
Designer : **NZ**
Job Number : **Tunnel Frame G Guide** Checked By:_____

Envelope Member Section Forces

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
M1	1	max	4.432	2	0.032	6	0	1	0	1	0	1	0	1
		min	-2.183	6	-0.032	2	0	1	0	1	0	1	0	1
	2	max	4.432	2	0.032	6	0	1	0	1	0	1	0.03	2
		min	-2.183	6	-0.032	2	0	1	0	1	0	1	-0.03	6
	3	max	4.432	2	0.032	6	0	1	0	1	0	1	0.061	2
		min	-2.183	6	-0.032	2	0	1	0	1	0	1	-0.061	6
	4	max	4.432	2	0.032	6	0	1	0	1	0	1	0.091	2
		min	-2.183	6	-0.032	2	0	1	0	1	0	1	-0.091	6
	5	max	4.432	2	0.032	6	0	1	0	1	0	1	0.122	2
		min	-2.183	6	-0.032	2	0	1	0	1	0	1	-0.122	6
M3	1	max	1.09	6	0.423	6	0	1	0	1	0	1	0	1
		min	-1.09	2	-0.184	4	0	1	0	1	0	1	0	1
	2	max	1.09	6	0.423	6	0	1	0	1	0	1	0.149	4
		min	-1.09	2	-0.184	4	0	1	0	1	0	1	-0.344	6
	3	max	1.09	6	0.143	6	0	1	0	1	0	1	0.298	4
		min	-1.09	2	-0.423	2	0	1	0	1	0	1	-0.688	6
	4	max	1.09	6	0.143	6	0	1	0	1	0	1	0.116	6
		min	-1.09	2	-0.423	2	0	1	0	1	0	1	-0.344	2
	5	max	1.09	6	0.143	6	0	1	0	1	0	1	0	1
		min	-1.09	2	-0.423	2	0	1	0	1	0	1	0	1
M4	1	max	6.643	6	4.009	6	0	1	0	1	0	1	0	1
		min	-6.643	2	-2.324	4	0	1	0	1	0	1	0	1
	2	max	6.643	6	4.009	6	0	1	0	1	0	1	1.888	4
		min	-6.643	2	-2.324	4	0	1	0	1	0	1	-3.257	6
	3	max	6.643	6	2.04	6	0	1	0	1	0	1	3.776	4
		min	-6.643	2	-4.009	2	0	1	0	1	0	1	-6.515	6
	4	max	6.643	6	2.04	6	0	1	0	1	0	1	1.658	6
		min	-6.643	2	-4.009	2	0	1	0	1	0	1	-3.257	2
	5	max	6.643	6	2.04	6	0	1	0	1	0	1	0	1
		min	-6.643	2	-4.009	2	0	1	0	1	0	1	0	1
M2	1	max	4.009	2	0.097	2	0	1	0	1	0	1	0.122	2
		min	-2.04	6	-0.097	6	0	1	0	1	0	1	-0.122	6
	2	max	4.009	2	0.097	2	0	1	0	1	0	1	0.091	2
		min	-2.04	6	-0.097	6	0	1	0	1	0	1	-0.091	6
	3	max	4.009	2	0.097	2	0	1	0	1	0	1	0.061	2
		min	-2.04	6	-0.097	6	0	1	0	1	0	1	-0.061	6
	4	max	4.009	2	0.097	2	0	1	0	1	0	1	0.03	2
		min	-2.04	6	-0.097	6	0	1	0	1	0	1	-0.03	6
	5	max	4.009	2	0.097	2	0	1	0	1	0	1	0	1
		min	-2.04	6	-0.097	6	0	1	0	1	0	1	0	1

Envelope Member Section Stresses

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
M1	1	max	1.235	2	0.019	6	0	1	0	1	0	1	0	1	0	1
		min	-0.608	6	-0.019	2	0	1	0	1	0	1	0	1	0	1
	2	max	1.235	2	0.019	6	0	1	0.089	6	0.089	2	0	1	0	1
		min	-0.608	6	-0.019	2	0	1	-0.089	2	-0.089	6	0	1	0	1
	3	max	1.235	2	0.019	6	0	1	0.178	6	0.178	2	0	1	0	1
		min	-0.608	6	-0.019	2	0	1	-0.178	2	-0.178	6	0	1	0	1
	4	max	1.235	2	0.019	6	0	1	0.267	6	0.267	2	0	1	0	1
		min	-0.608	6	-0.019	2	0	1	-0.267	2	-0.267	6	0	1	0	1
	5	max	1.235	2	0.019	6	0	1	0.356	6	0.356	2	0	1	0	1

Company : **NBZ Consulting Engineers** October 29, 2012
Designer : **NZ**
Job Number : **Tunnel Frame G Guide** Checked By:_____

Member Stresses, (continued)

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
		min	-0.608	6	-0.019	2	0	1	-0.356	2	-0.356	6	0	1	0	1
M3	1	max	0.304	6	0.254	6	0	1	0	1	0	1	0	1	0	1
		min	-0.304	2	-0.11	4	0	1	0	1	0	1	0	1	0	1
	2	max	0.304	6	0.254	6	0	1	1.004	6	0.436	4	0	1	0	1
		min	-0.304	2	-0.11	4	0	1	-0.436	4	-1.004	6	0	1	0	1
	3	max	0.304	6	0.086	6	0	1	2.007	6	0.871	4	0	1	0	1
		min	-0.304	2	-0.254	2	0	1	-0.871	4	-2.007	6	0	1	0	1
	4	max	0.304	6	0.086	6	0	1	1.004	2	0.339	6	0	1	0	1
		min	-0.304	2	-0.254	2	0	1	-0.339	6	-1.004	2	0	1	0	1
	5	max	0.304	6	0.086	6	0	1	0	1	0	1	0	1	0	1
		min	-0.304	2	-0.254	2	0	1	0	1	0	1	0	1	0	1
M4	1	max	1.85	6	2.405	6	0	1	0	1	0	1	0	1	0	1
		min	-1.85	2	-1.394	4	0	1	0	1	0	1	0	1	0	1
	2	max	1.85	6	2.405	6	0	1	9.511	6	5.513	4	0	1	0	1
		min	-1.85	2	-1.394	4	0	1	-5.513	4	-9.511	6	0	1	0	1
	3	max	1.85	6	1.224	6	0	1	19.021	6	11.025	4	0	1	0	1
		min	-1.85	2	-2.405	2	0	1	-11.025	4	-19.021	6	0	1	0	1
	4	max	1.85	6	1.224	6	0	1	9.511	2	4.84	6	0	1	0	1
		min	-1.85	2	-2.405	2	0	1	-4.84	6	-9.511	2	0	1	0	1
	5	max	1.85	6	1.224	6	0	1	0	1	0	1	0	1	0	1
		min	-1.85	2	-2.405	2	0	1	0	1	0	1	0	1	0	1
M2	1	max	1.117	2	0.058	2	0	1	0.356	6	0.356	2	0	1	0	1
		min	-0.568	6	-0.058	6	0	1	-0.356	2	-0.356	6	0	1	0	1
	2	max	1.117	2	0.058	2	0	1	0.267	6	0.267	2	0	1	0	1
		min	-0.568	6	-0.058	6	0	1	-0.267	2	-0.267	6	0	1	0	1
	3	max	1.117	2	0.058	2	0	1	0.178	6	0.178	2	0	1	0	1
		min	-0.568	6	-0.058	6	0	1	-0.178	2	-0.178	6	0	1	0	1
	4	max	1.117	2	0.058	2	0	1	0.089	6	0.089	2	0	1	0	1
		min	-0.568	6	-0.058	6	0	1	-0.089	2	-0.089	6	0	1	0	1
	5	max	1.117	2	0.058	2	0	1	0	1	0	1	0	1	0	1
		min	-0.568	6	-0.058	6	0	1	0	1	0	1	0	1	0	1

Member Deflection

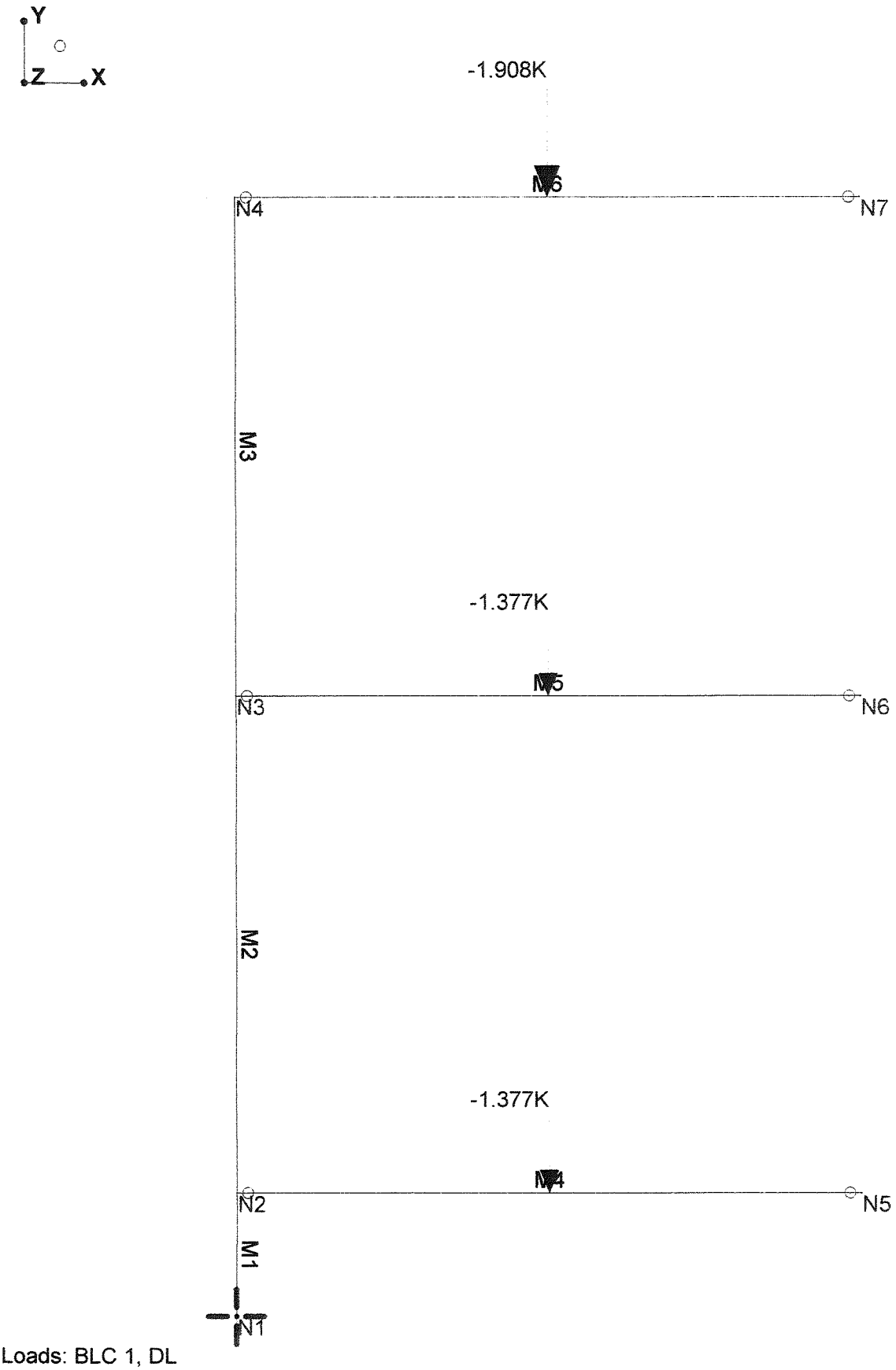
Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	6	0	2	0	1	0	1	NC		NC	
		min	0	2	0	6	0	1	0	1	NC		NC	
	3	max	0	6	0.001	2	0	1	0	1	NC		NC	
		min	-0.001	2	-0.001	6	0	1	0	1	NC		NC	
	4	max	0.001	6	0	2	0	1	0	1	NC		NC	
		min	-0.001	2	0	6	0	1	0	1	NC		NC	
	5	max	0.001	6	0	6	0	1	0	1	NC		NC	
		min	-0.002	2	0	2	0	1	0	1	NC		NC	
M3	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	2	0	4	0	1	0	1	NC		NC	
		min	0	6	-0.002	6	0	1	0	1	NC		NC	
	3	max	0	2	-0.001	4	0	1	0	1	NC		NC	
		min	0	6	-0.002	6	0	1	0	1	NC		NC	
	4	max	0	2	0	6	0	1	0	1	NC		NC	
		min	0	6	-0.002	2	0	1	0	1	NC		NC	
	5	max	0	2	0.001	6	0	1	0	1	NC		NC	

Member Deflections, (continued)

Member Label	Section		x-Translate (In)	Lc	x-Translate (In)	Lc	x-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
		min	0	6	-0.002	2	0	1	0	1	NC		NC	
M4	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0.001	2	0.007	4	0	1	0	1	5155.369	4	NC	
		min	-0.001	6	-0.019	6	0	1	0	1	1992.008	6	NC	
	3	max	0.001	2	0.005	4	0	1	0	1	6399.22	4	NC	
		min	-0.001	6	-0.023	6	0	1	0	1	1654.758	6	NC	
	4	max	0.002	2	-0.005	4	0	1	0	1	NC		NC	
		min	-0.002	6	-0.008	6	0	1	0	1	4366.596	6	NC	
	5	max	0.002	2	0.001	6	0	1	0	1	NC		NC	
		min	-0.002	6	-0.002	2	0	1	0	1	NC		NC	
M2	1	max	0.001	6	0	6	0	1	0	1	NC		NC	
		min	-0.002	2	0	2	0	1	0	1	NC		NC	
	2	max	0.001	6	0.001	6	0	1	0	1	NC		NC	
		min	-0.002	2	-0.001	2	0	1	0	1	NC		NC	
	3	max	0.001	6	0.001	6	0	1	0	1	NC		NC	
		min	-0.002	2	-0.001	2	0	1	0	1	NC		NC	
	4	max	0.001	6	0.002	6	0	1	0	1	9959.113	6	NC	
		min	-0.002	2	-0.002	2	0	1	0	1	9959.113	2	NC	
	5	max	0.001	6	0.002	6	0	1	0	1	7211.356	6	NC	
		min	-0.002	2	-0.002	2	0	1	0	1	7211.356	2	NC	

Envelope Member AISC ASD 9th Code Checks

Member Label	Code Chk	Loc (Ft)	Lc	Shear Chk	Loc (Ft)	Dir	Lc	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.056	3.75	2	0.001	0	y	2	25.147	30.36	30.36	H1-2
M3	0.08	1.806	6	0.014	1.625	y	2	25.558	30.36	30.36	H1-3
M4	0.734	1.806	6	0.131	1.625	y	2	25.558	30.36	30.36	H1-3
M2	0.052	0	2	0.003	0	y	2	26.954	30.36	30.36	H1-2



Loads: BLC 1, DL

NBZ Consulting Engineers	Tunnel Frame H & J Gravity	October 28, 2012
NZ		TunnelframeJHgravity.r3d

Company : **NBZ Consulting Engineers** October 28, 2012
Designer : **NZ**
Job Number : **Tunnel Frame H & J Gravity** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	33

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	1-5/8"STRUTEQU...	STL	.555	1.2	1.2	.185	.236	.002	
SEC2	15/8"DOUBLEST...	STL	1.111	1.2	1.2	.928	.471	1	
SEC3	P5001	STL	1.793	1.2	1.2	6.227	.866	.004	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	0	.5	0	0
N3	0	2.5	0	0
N4	0	4.5	0	0
N5	2.5	.5	0	0
N6	2.5	2.5	0	0
N7	2.5	4.5	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction		Reaction	
N5	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N6	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N7	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N4				Reaction		

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N1	N2		90	SEC2						.5
M2	N2	N3		90	SEC2						2
M3	N3	N4		90	SEC2						2
M4	N2	N5		90	SEC2	AllPIN	BenPIN				2.5
M5	N3	N6		90	SEC2	AllPIN	BenPIN				2.5
M6	N4	N7		90	SEC3	AllPIN	BenPIN				2.5

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Nodal	Load Type Totals Point	Distributed	Surface
1	DL	DL	Dead Load		3		
2	VERTICAL SEISMIC	EL	Earthquake Load		3		

Member Point Loads, Category : DL, BLC 1 : DL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Y	-1.377	1.25
M5	N3	N6	Y	-1.377	1.25
M6	N4	N7	Y	-1.908	1.25

Member Point Loads, Category : EL, BLC 2 : VERTICAL SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Y	-.152	1.25
M5	N3	N6	Y	-.152	1.25
M6	N4	N7	Y	-.21	1.25

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL	y				1	1	1						
2	DL+Fv+Ft	y				1	1	1	2	1	3	1		
3	DL+Fv+Fl	y				1	1	1	2	1	4	1		
4	.9DL-Fv+Ft	y				1	1	.9	2	-1	3	1		
5	.9DL-Fv+Fl	y				1	1	.9	2	-1	4	1		
6	DL+Fv-Ft	y				1	1	1	2	1	3	-1		

Envelope Reactions

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N1	max	0.000	1	2.588	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	1.841	4	0.000	1	0.000	1	0.000	1	0.000	1
N5	max	0.000	1	0.764	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.544	4	0.000	1	0.000	1	0.000	1	0.000	1
N6	max	0.000	1	0.764	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.544	4	0.000	1	0.000	1	0.000	1	0.000	1
N7	max	0.000	1	1.059	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.754	4	0.000	1	0.000	1	0.000	1	0.000	1
N4	max	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	0.000	1	5.176	2	0.000	1						
	min	0.000	1	3.682	4	0.000	1						

Envelope Member Section Forces

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
M1	1	max	2.588	2	0	1	0	1	0	1	0	1	0	1
		min	1.841	4	0	1	0	1	0	1	0	1	0	1
	2	max	2.588	2	0	1	0	1	0	1	0	1	0	1
		min	1.841	4	0	1	0	1	0	1	0	1	0	1
	3	max	2.588	2	0	1	0	1	0	1	0	1	0	1
		min	1.841	4	0	1	0	1	0	1	0	1	0	1

Envelope Member Section Forces, (continued)

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
	4	max	2.588	2	0	1	0	1	0	1	0	1	0	1
		min	1.841	4	0	1	0	1	0	1	0	1	0	1
	5	max	2.588	2	0	1	0	1	0	1	0	1	0	1
		min	1.841	4	0	1	0	1	0	1	0	1	0	1
M2	1	max	1.824	2	0	1	0	1	0	1	0	1	0	1
		min	1.297	4	0	1	0	1	0	1	0	1	0	1
	2	max	1.824	2	0	1	0	1	0	1	0	1	0	1
		min	1.297	4	0	1	0	1	0	1	0	1	0	1
	3	max	1.824	2	0	1	0	1	0	1	0	1	0	1
		min	1.297	4	0	1	0	1	0	1	0	1	0	1
	4	max	1.824	2	0	1	0	1	0	1	0	1	0	1
		min	1.297	4	0	1	0	1	0	1	0	1	0	1
	5	max	1.824	2	0	1	0	1	0	1	0	1	0	1
		min	1.297	4	0	1	0	1	0	1	0	1	0	1
M3	1	max	1.059	2	0	1	0	1	0	1	0	1	0	1
		min	0.754	4	0	1	0	1	0	1	0	1	0	1
	2	max	1.059	2	0	1	0	1	0	1	0	1	0	1
		min	0.754	4	0	1	0	1	0	1	0	1	0	1
	3	max	1.059	2	0	1	0	1	0	1	0	1	0	1
		min	0.754	4	0	1	0	1	0	1	0	1	0	1
	4	max	1.059	2	0	1	0	1	0	1	0	1	0	1
		min	0.754	4	0	1	0	1	0	1	0	1	0	1
	5	max	1.059	2	0	1	0	1	0	1	0	1	0	1
		min	0.754	4	0	1	0	1	0	1	0	1	0	1
M4	1	max	0	1	0	1	-0.544	4	0	1	0	1	0	1
		min	0	1	0	1	-0.764	2	0	1	0	1	0	1
	2	max	0	1	0	1	-0.544	4	0	1	-0.34	4	0	1
		min	0	1	0	1	-0.764	2	0	1	-0.478	2	0	1
	3	max	0	1	0	1	0.764	2	0	1	-0.68	4	0	1
		min	0	1	0	1	0.544	4	0	1	-0.956	2	0	1
	4	max	0	1	0	1	0.764	2	0	1	-0.34	4	0	1
		min	0	1	0	1	0.544	4	0	1	-0.478	2	0	1
	5	max	0	1	0	1	0.764	2	0	1	0	1	0	1
		min	0	1	0	1	0.544	4	0	1	0	1	0	1
M5	1	max	0	1	0	1	-0.544	4	0	1	0	1	0	1
		min	0	1	0	1	-0.764	2	0	1	0	1	0	1
	2	max	0	1	0	1	-0.544	4	0	1	-0.34	4	0	1
		min	0	1	0	1	-0.764	2	0	1	-0.478	2	0	1
	3	max	0	1	0	1	0.764	2	0	1	-0.68	4	0	1
		min	0	1	0	1	0.544	4	0	1	-0.956	2	0	1
	4	max	0	1	0	1	0.764	2	0	1	-0.34	4	0	1
		min	0	1	0	1	0.544	4	0	1	-0.478	2	0	1
	5	max	0	1	0	1	0.764	2	0	1	0	1	0	1
		min	0	1	0	1	0.544	4	0	1	0	1	0	1
M6	1	max	0	1	0	1	-0.754	4	0	1	0	1	0	1
		min	0	1	0	1	-1.059	2	0	1	0	1	0	1
	2	max	0	1	0	1	-0.754	4	0	1	-0.471	4	0	1
		min	0	1	0	1	-1.059	2	0	1	-0.662	2	0	1
	3	max	0	1	0	1	1.059	2	0	1	-0.942	4	0	1
		min	0	1	0	1	0.754	4	0	1	-1.324	2	0	1
	4	max	0	1	0	1	1.059	2	0	1	-0.471	4	0	1
		min	0	1	0	1	0.754	4	0	1	-0.662	2	0	1
	5	max	0	1	0	1	1.059	2	0	1	0	1	0	1
		min	0	1	0	1	0.754	4	0	1	0	1	0	1

Company : **NBZ Consulting Engineers** October 28, 2012
Designer : **NZ**
Job Number : **Tunnel Frame H & J Gravity** Checked By:_____

Envelope Member Section Stresses

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
M1	1	max	2.329	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.657	4	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	2.329	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.657	4	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	2.329	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.657	4	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	2.329	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.657	4	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	2.329	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.657	4	0	1	0	1	0	1	0	1	0	1	0	1
M2	1	max	1.641	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.168	4	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	1.641	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.168	4	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	1.641	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.168	4	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	1.641	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.168	4	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	1.641	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	1.168	4	0	1	0	1	0	1	0	1	0	1	0	1
M3	1	max	0.953	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.678	4	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	0.953	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.678	4	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	0.953	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.678	4	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	0.953	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.678	4	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	0.953	2	0	1	0	1	0	1	0	1	0	1	0	1
		min	0.678	4	0	1	0	1	0	1	0	1	0	1	0	1
M4	1	max	0	1	0	1	-0.956	4	0	1	0	1	0	1	0	1
		min	0	1	0	1	-1.344	2	0	1	0	1	0	1	0	1
	2	max	0	1	0	1	-0.956	4	0	1	0	1	-7.14	4	10.04	2
		min	0	1	0	1	-1.344	2	0	1	0	1	-10.04	2	7.14	4
	3	max	0	1	0	1	1.344	2	0	1	0	1	-14.28	4	20.08	2
		min	0	1	0	1	0.956	4	0	1	0	1	-20.08	2	14.28	4
	4	max	0	1	0	1	1.344	2	0	1	0	1	-7.14	4	10.04	2
		min	0	1	0	1	0.956	4	0	1	0	1	-10.04	2	7.14	4
	5	max	0	1	0	1	1.344	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	0.956	4	0	1	0	1	0	1	0	1
M5	1	max	0	1	0	1	-0.956	4	0	1	0	1	0	1	0	1
		min	0	1	0	1	-1.344	2	0	1	0	1	0	1	0	1
	2	max	0	1	0	1	-0.956	4	0	1	0	1	-7.14	4	10.04	2
		min	0	1	0	1	-1.344	2	0	1	0	1	-10.04	2	7.14	4
	3	max	0	1	0	1	1.344	2	0	1	0	1	-14.28	4	20.08	2
		min	0	1	0	1	0.956	4	0	1	0	1	-20.08	2	14.28	4
	4	max	0	1	0	1	1.344	2	0	1	0	1	-7.14	4	10.04	2
		min	0	1	0	1	0.956	4	0	1	0	1	-10.04	2	7.14	4
	5	max	0	1	0	1	1.344	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	0.956	4	0	1	0	1	0	1	0	1
M6	1	max	0	1	0	1	-0.663	4	0	1	0	1	0	1	0	1
		min	0	1	0	1	-0.931	2	0	1	0	1	0	1	0	1
	2	max	0	1	0	1	-0.663	4	0	1	0	1	-2.95	4	4.145	2
		min	0	1	0	1	-0.931	2	0	1	0	1	-4.145	2	2.95	4

Member Stresses, (continued)

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
	3	max	0	1	0	1	0.931	2	0	1	0	1	-5.9	4	8.291	2
		min	0	1	0	1	0.663	4	0	1	0	1	-8.291	2	5.9	4
	4	max	0	1	0	1	0.931	2	0	1	0	1	-2.95	4	4.145	2
		min	0	1	0	1	0.663	4	0	1	0	1	-4.145	2	2.95	4
	5	max	0	1	0	1	0.931	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	0.663	4	0	1	0	1	0	1	0	1

Member Deflection

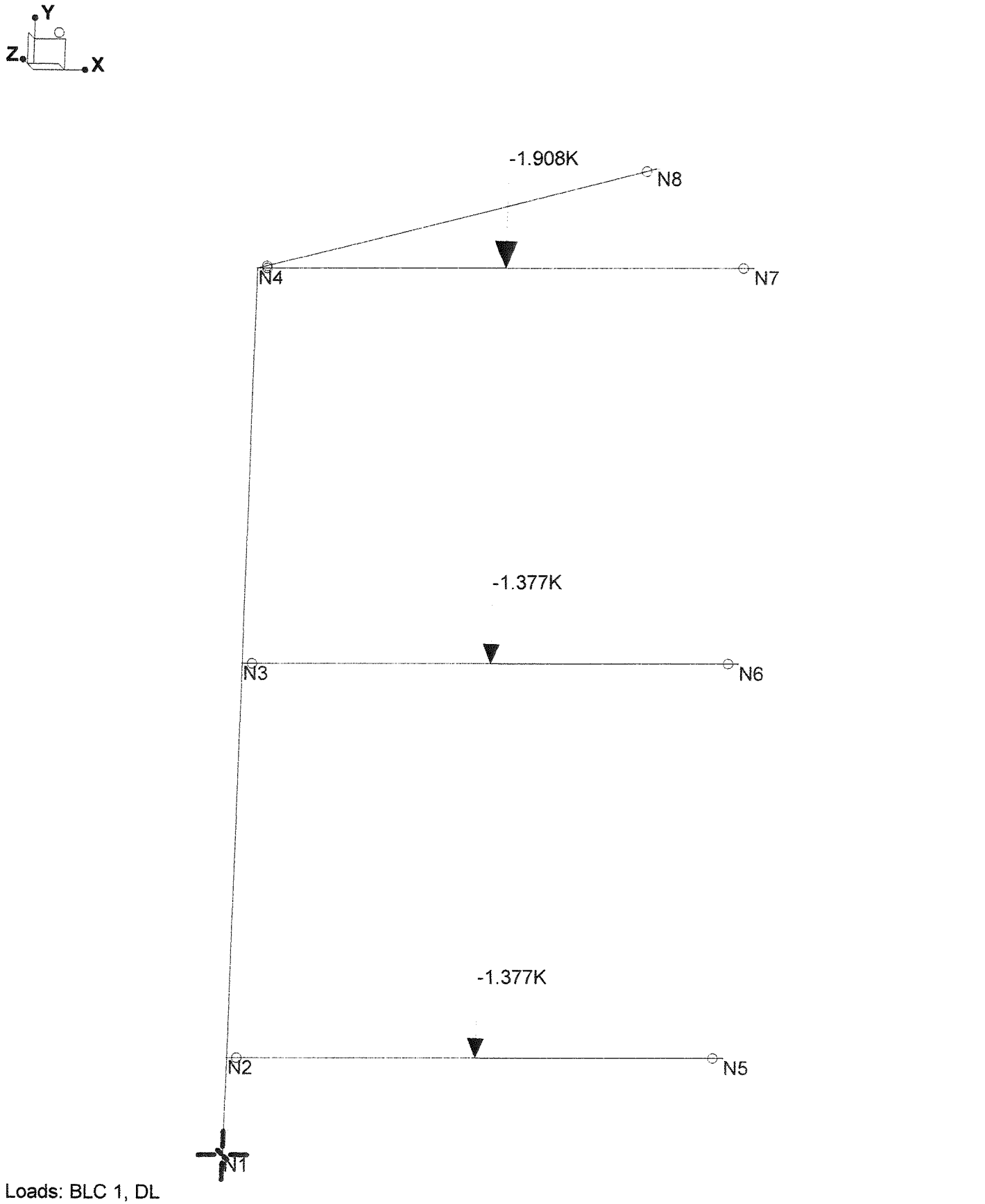
Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	4	0	1	0	1	0	1	NC		NC	
		min	0	2	0	1	0	1	0	1	NC		NC	
	3	max	0	4	0	1	0	1	0	1	NC		NC	
		min	0	2	0	1	0	1	0	1	NC		NC	
	4	max	0	4	0	1	0	1	0	1	NC		NC	
		min	0	2	0	1	0	1	0	1	NC		NC	
	5	max	0	4	0	1	0	1	0	1	NC		NC	
		min	0	2	0	1	0	1	0	1	NC		NC	
M2	1	max	0	4	0	1	0	1	0	1	NC		NC	
		min	0	2	0	1	0	1	0	1	NC		NC	
	2	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.001	2	0	1	0	1	0	1	NC		NC	
	3	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.001	2	0	1	0	1	0	1	NC		NC	
	4	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	5	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
M3	1	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	2	max	-0.001	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	3	max	-0.002	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	4	max	-0.002	4	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	5	max	-0.002	4	0	1	0	1	0	1	NC		NC	
		min	-0.003	2	0	1	0	1	0	1	NC		NC	
M4	1	max	0	1	0	1	0	2	0	1	NC		NC	
		min	0	1	0	1	0	4	0	1	NC		NC	
	2	max	0	1	0	1	0.022	2	0	1	NC		1365.415	2
		min	0	1	0	1	0.016	4	0	1	NC		1920.095	4
	3	max	0	1	0	1	0.032	2	0	1	NC		938.722	2
		min	0	1	0	1	0.023	4	0	1	NC		1320.065	4
	4	max	0	1	0	1	0.022	2	0	1	NC		1365.415	2
		min	0	1	0	1	0.016	4	0	1	NC		1920.095	4
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
M5	1	max	0	1	0	1	0.002	2	0	1	NC		NC	
		min	0	1	0	1	0.001	4	0	1	NC		NC	
	2	max	0	1	0	1	0.023	2	0	1	NC		1365.415	2
		min	0	1	0	1	0.017	4	0	1	NC		1920.095	4

Member Deflections, (continued)

Member Label	Section		x-Translate (In)	Lc	x-Translate (In)	Lc	x-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
	3	max	0	1	0	1	0.033	2	0	1	NC		938.722	2
		min	0	1	0	1	0.023	4	0	1	NC		1320.065	4
	4	max	0	1	0	1	0.022	2	0	1	NC		1365.415	2
		min	0	1	0	1	0.016	4	0	1	NC		1920.095	4
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
M6	1	max	0	1	0	1	0.003	2	0	1	NC		NC	
		min	0	1	0	1	0.002	4	0	1	NC		NC	
	2	max	0	1	0	1	0.007	2	0	1	NC		6614.194	2
		min	0	1	0	1	0.005	4	0	1	NC		9294.628	4
	3	max	0	1	0	1	0.008	2	0	1	NC		4547.258	2
		min	0	1	0	1	0.006	4	0	1	NC		6390.057	4
	4	max	0	1	0	1	0.005	2	0	1	NC		6614.194	2
		min	0	1	0	1	0.004	4	0	1	NC		9294.628	4
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	

Envelope Member AISC ASD 9th Code Checks

Member Label	Code Chk	Loc (Ft)	Lc	Shear Chk	Loc (Ft)	Dir	Lc	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.12	0	2	0	0	y	1	19.446	20.806	20.202	H1-1
M2	0.092	0	2	0	0	y	1	17.925	20.806	20.202	H1-1
M3	0.053	0	2	0	0	y	1	17.925	20.806	20.202	H1-1
M4	0.965	1.25	2	0.102	0	z	2	17.283	20.806	20.202	H1-1
M5	0.965	1.25	2	0.102	0	z	2	17.283	20.806	20.202	H1-1
M6	0.563	1.25	2	0.071	0	z	2	13.311	14.723	14.723	H1-1



Loads: BLC 1, DL

NBZ Consulting Engineers	Tunnel Frame H & J Guide	October 29, 2012
NZ		TunnelframeJHguide.r3d

Company : **NBZ Consulting Engineers** October 29, 2012
Designer : **NZ**
Job Number : **Tunnel Frame H & J Guide** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	46

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	1-5/8"STRUTEQU...	STL	.555	1.2	1.2	.185	.236	.002	
SEC2	15/8"DOUBLEST...	STL	1.111	1.2	1.2	.928	.471	1	
SEC3	TU4X4X4	STL	3.59	1.2	1.2	8.22	8.22	13.5	
SEC4	L3X3X6	STL	2.11	1.2	1.2	1.76	1.76	.103	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	0	.5	0	0
N3	0	2.5	0	0
N4	0	4.5	0	0
N5	2.5	.5	0	0
N6	2.5	2.5	0	0
N7	2.5	4.5	0	0
N8	2.5	4.5	2.5	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction		Reaction	
N5	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N6	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N7	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N8	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N1	N2		90	SEC3						.5
M2	N2	N3		90	SEC3						2
M3	N3	N4		90	SEC3						2
M4	N2	N5		90	SEC3	AllPIN	BenPIN				2.5
M5	N3	N6		90	SEC3	AllPIN	BenPIN				2.5
M6	N4	N7		90	SEC3	AllPIN	BenPIN				2.5
M7	N4	N8		90	SEC4	AllPIN	BenPIN				3.536

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	DL	DL	Dead Load		3		
2	VERTICAL SEISMIC	EL	Earthquake Load		3		
3	TRANSVERSE SEISMIC	EL	Earthquake Load	3	3		
4	LONG. SEISMIC	EL	Earthquake Load		2		

Joint Loads/Enforced Displacements, Category : EL, BLC 3 : TRANSVERSE SEISMIC

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N2	L	X	-3.172
N3	L	X	-3.172
N4	L	X	-3.549

Member Point Loads, Category : DL, BLC 1 : DL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Y	-1.377	1.25
M5	N3	N6	Y	-1.377	1.25
M6	N4	N7	Y	-1.908	1.25

Member Point Loads, Category : EL, BLC 2 : VERTICAL SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Y	-.152	1.25
M5	N3	N6	Y	-.152	1.25
M6	N4	N7	Y	-.39	1.25

Member Point Loads, Category : EL, BLC 3 : TRANSVERSE SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	My	1.983	1.375
M5	N3	N6	My	1.983	1.375
M6	N4	N7	My	5.18	1.375

Member Point Loads, Category : EL, BLC 4 : LONG. SEISMIC

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M4	N2	N5	Z	3.172	1.375
M5	N3	N6	Z	3.172	1.375

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL	y				1	1	1						
2	DL+Fv+Ft	y				1	1	1	2	1	3	1		
3	DL+Fv+Fl	y				1	1	1	2	1	4	1		
4	.9DL-Fv+Ft	y				1	1	.9	2	-1	3	1		
5	.9DL-Fv+Fl	y				1	1	.9	2	-1	4	1		
6	DL+Fv-Ft	y				1	1	1	2	1	3	-1		

Envelope Reactions

Joint Label	X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc

Envelope Reactions, (continued)

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N1	max	0.395	2	6.336	2	0.000	6	0.000	1	0.000	6	0.000	1
	min	-0.395	6	-0.98	6	-1.903	3	0.000	1	0.000	2	0.000	1
N5	max	2.661	2	1.558	6	0.000	2	0.000	1	0.000	3	0.000	2
	min	-2.661	6	-0.25	4	-1.745	3	0.000	1	0.000	6	0.000	6
N6	max	3.305	2	1.558	6	0.000	2	0.000	1	0.000	3	0.000	2
	min	-3.305	6	-0.25	4	-1.745	3	0.000	1	0.000	6	0.000	6
N7	max	3.532	2	3.221	6	0.000	3	0.000	1	0.000	3	0.000	2
	min	-3.532	6	-1.408	4	0.000	6	0.000	1	0.000	6	0.000	6
N8	max	0.000	6	0.000	6	0.000	6	0.000	1	0.000	1	0.000	1
	min	-0.952	3	0.000	2	-0.952	3	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	9.893	2	5.356	2	0.000	6						
	min	-9.893	6	3.502	4	-6.344	3						

Envelope Member Section Forces

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
M1	1	max	6.336	2	0	1	0.395	2	0	1	0	1	0	1
		min	-0.98	6	-1.903	3	-0.395	6	0	1	0	1	0	1
	2	max	6.336	2	0	1	0.395	2	0	1	0.049	2	0.238	3
		min	-0.98	6	-1.903	3	-0.395	6	0	1	-0.049	6	0	1
	3	max	6.336	2	0	1	0.395	2	0	1	0.099	2	0.476	3
		min	-0.98	6	-1.903	3	-0.395	6	0	1	-0.099	6	0	1
	4	max	6.336	2	0	1	0.395	2	0	1	0.148	2	0.714	3
		min	-0.98	6	-1.903	3	-0.395	6	0	1	-0.148	6	0	1
	5	max	6.336	2	0	1	0.395	2	0	1	0.198	2	0.952	3
		min	-0.98	6	-1.903	3	-0.395	6	0	1	-0.198	6	0	1
M2	1	max	4.779	2	0	1	0.116	6	0	1	0.198	2	0.952	3
		min	-0.952	6	-0.476	3	-0.116	2	0	1	-0.198	6	0	1
	2	max	4.779	2	0	1	0.116	6	0	1	0.14	2	1.19	3
		min	-0.952	6	-0.476	3	-0.116	2	0	1	-0.14	6	0	1
	3	max	4.779	2	0	1	0.116	6	0	1	0.082	2	1.427	3
		min	-0.952	6	-0.476	3	-0.116	2	0	1	-0.082	6	0	1
	4	max	4.779	2	0	1	0.116	6	0	1	0.024	2	1.665	3
		min	-0.952	6	-0.476	3	-0.116	2	0	1	-0.024	6	0	1
	5	max	4.779	2	0	1	0.116	6	0	1	0.034	6	1.903	3
		min	-0.952	6	-0.476	3	-0.116	2	0	1	-0.034	2	0	1
M3	1	max	3.221	2	0.952	3	0.017	2	0	1	0.034	6	1.903	3
		min	-0.923	6	0	1	-0.017	6	0	1	-0.034	2	0	1
	2	max	3.221	2	0.952	3	0.017	2	0	1	0.026	6	1.427	3
		min	-0.923	6	0	1	-0.017	6	0	1	-0.026	2	0	1
	3	max	3.221	2	0.952	3	0.017	2	0	1	0.017	6	0.952	3
		min	-0.923	6	0	1	-0.017	6	0	1	-0.017	2	0	1
	4	max	3.221	2	0.952	3	0.017	2	0	1	0.009	6	0.476	3
		min	-0.923	6	0	1	-0.017	6	0	1	-0.009	2	0	1
	5	max	3.221	2	0.952	3	0.017	2	0	1	0	1	0	1
		min	-0.923	6	0	1	-0.017	6	0	1	0	1	0	1
M4	1	max	2.661	6	0	1	0.029	6	0	1	0	1	0	1
		min	-2.661	2	-1.427	3	-1.558	2	0	1	0	1	0	1
	2	max	2.661	6	0	1	0.029	6	0	1	0.018	6	0.892	3
		min	-2.661	2	-1.427	3	-1.558	2	0	1	-0.974	2	0	1
	3	max	2.661	6	0	1	1.558	6	0	1	0.036	6	1.784	3
		min	-2.661	2	-1.427	3	-0.25	4	0	1	-1.947	2	0	1
	4	max	2.661	6	1.745	3	1.558	6	0	1	0.156	4	1.09	3

Envelope Member Section Forces, (continued)

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
		min	-2.661	2	0	1	-0.25	4	0	1	-0.974	6	0	1
	5	max	2.661	6	1.745	3	1.558	6	0	1	0	1	0	1
		min	-2.661	2	0	1	-0.25	4	0	1	0	1	0	1
M5	1	max	3.305	6	0	1	0.029	6	0	1	0	1	0	1
		min	-3.305	2	-1.427	3	-1.558	2	0	1	0	1	0	1
	2	max	3.305	6	0	1	0.029	6	0	1	0.018	6	0.892	3
		min	-3.305	2	-1.427	3	-1.558	2	0	1	-0.974	2	0	1
	3	max	3.305	6	0	1	1.558	6	0	1	0.036	6	1.784	3
		min	-3.305	2	-1.427	3	-0.25	4	0	1	-1.947	2	0	1
	4	max	3.305	6	1.745	3	1.558	6	0	1	0.156	4	1.09	3
		min	-3.305	2	0	1	-0.25	4	0	1	-0.974	6	0	1
	5	max	3.305	6	1.745	3	1.558	6	0	1	0	1	0	1
		min	-3.305	2	0	1	-0.25	4	0	1	0	1	0	1
M6	1	max	3.532	6	0	1	0.923	6	0	1	0	1	0	1
		min	-3.532	2	0	1	-3.221	2	0	1	0	1	0	1
	2	max	3.532	6	0	1	0.923	6	0	1	0.577	6	0	1
		min	-3.532	2	0	1	-3.221	2	0	1	-2.013	2	0	1
	3	max	3.532	6	0	1	3.221	6	0	1	1.154	6	0	1
		min	-3.532	2	0	1	-1.408	4	0	1	-4.026	2	0	1
	4	max	3.532	6	0	1	3.221	6	0	1	0.88	4	0	1
		min	-3.532	2	0	1	-1.408	4	0	1	-2.013	6	0	1
	5	max	3.532	6	0	1	3.221	6	0	1	0	1	0	1
		min	-3.532	2	0	1	-1.408	4	0	1	0	1	0	1
M7	1	max	1.346	3	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	1.346	3	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	1.346	3	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	1.346	3	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	1.346	3	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1

Envelope Member Section Stresses

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
M1	1	max	1.765	2	0	1	0.237	2	0	1	0	1	0	1	0	1
		min	-0.273	6	-1.142	3	-0.237	6	0	1	0	1	0	1	0	1
	2	max	1.765	2	0	1	0.237	2	0	1	0.695	3	0.144	2	0.144	6
		min	-0.273	6	-1.142	3	-0.237	6	-0.695	3	0	1	-0.144	6	-0.144	2
	3	max	1.765	2	0	1	0.237	2	0	1	1.389	3	0.288	2	0.288	6
		min	-0.273	6	-1.142	3	-0.237	6	-1.389	3	0	1	-0.288	6	-0.288	2
	4	max	1.765	2	0	1	0.237	2	0	1	2.084	3	0.433	2	0.433	6
		min	-0.273	6	-1.142	3	-0.237	6	-2.084	3	0	1	-0.433	6	-0.433	2
	5	max	1.765	2	0	1	0.237	2	0	1	2.778	3	0.577	2	0.577	6
		min	-0.273	6	-1.142	3	-0.237	6	-2.778	3	0	1	-0.577	6	-0.577	2
M2	1	max	1.331	2	0	1	0.07	6	0	1	2.778	3	0.577	2	0.577	6
		min	-0.265	6	-0.285	3	-0.07	2	-2.778	3	0	1	-0.577	6	-0.577	2
	2	max	1.331	2	0	1	0.07	6	0	1	3.473	3	0.408	2	0.408	6
		min	-0.265	6	-0.285	3	-0.07	2	-3.473	3	0	1	-0.408	6	-0.408	2
	3	max	1.331	2	0	1	0.07	6	0	1	4.168	3	0.238	2	0.238	6
		min	-0.265	6	-0.285	3	-0.07	2	-4.168	3	0	1	-0.238	6	-0.238	2
	4	max	1.331	2	0	1	0.07	6	0	1	4.862	3	0.069	2	0.069	6

Member Stresses, (continued)

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
		min	-0.265	6	-0.285	3	-0.07	2	-4.862	3	0	1	-0.069	6	-0.069	2
	5	max	1.331	2	0	1	0.07	6	0	1	5.557	3	0.1	6	0.1	2
		min	-0.265	6	-0.285	3	-0.07	2	-5.557	3	0	1	-0.1	2	-0.1	6
M3	1	max	0.897	2	0.571	3	0.01	2	0	1	5.557	3	0.1	6	0.1	2
		min	-0.257	6	0	1	-0.01	6	-5.557	3	0	1	-0.1	2	-0.1	6
	2	max	0.897	2	0.571	3	0.01	2	0	1	4.168	3	0.075	6	0.075	2
		min	-0.257	6	0	1	-0.01	6	-4.168	3	0	1	-0.075	2	-0.075	6
	3	max	0.897	2	0.571	3	0.01	2	0	1	2.778	3	0.05	6	0.05	2
		min	-0.257	6	0	1	-0.01	6	-2.778	3	0	1	-0.05	2	-0.05	6
	4	max	0.897	2	0.571	3	0.01	2	0	1	1.389	3	0.025	6	0.025	2
		min	-0.257	6	0	1	-0.01	6	-1.389	3	0	1	-0.025	2	-0.025	6
	5	max	0.897	2	0.571	3	0.01	2	0	1	0	1	0	1	0	1
		min	-0.257	6	0	1	-0.01	6	0	1	0	1	0	1	0	1
M4	1	max	0.741	6	0	1	0.017	6	0	1	0	1	0	1	0	1
		min	-0.741	2	-0.856	3	-0.935	2	0	1	0	1	0	1	0	1
	2	max	0.741	6	0	1	0.017	6	0	1	2.605	3	0.052	6	2.843	2
		min	-0.741	2	-0.856	3	-0.935	2	-2.605	3	0	1	-2.843	2	-0.052	6
	3	max	0.741	6	0	1	0.935	6	0	1	5.209	3	0.105	6	5.685	2
		min	-0.741	2	-0.856	3	-0.15	4	-5.209	3	0	1	-5.685	2	-0.105	6
	4	max	0.741	6	1.047	3	0.935	6	0	1	3.184	3	0.455	4	2.843	6
		min	-0.741	2	0	1	-0.15	4	-3.184	3	0	1	-2.843	6	-0.455	4
	5	max	0.741	6	1.047	3	0.935	6	0	1	0	1	0	1	0	1
		min	-0.741	2	0	1	-0.15	4	0	1	0	1	0	1	0	1
M5	1	max	0.921	6	0	1	0.017	6	0	1	0	1	0	1	0	1
		min	-0.921	2	-0.856	3	-0.935	2	0	1	0	1	0	1	0	1
	2	max	0.921	6	0	1	0.017	6	0	1	2.605	3	0.052	6	2.843	2
		min	-0.921	2	-0.856	3	-0.935	2	-2.605	3	0	1	-2.843	2	-0.052	6
	3	max	0.921	6	0	1	0.935	6	0	1	5.209	3	0.105	6	5.685	2
		min	-0.921	2	-0.856	3	-0.15	4	-5.209	3	0	1	-5.685	2	-0.105	6
	4	max	0.921	6	1.047	3	0.935	6	0	1	3.184	3	0.455	4	2.843	6
		min	-0.921	2	0	1	-0.15	4	-3.184	3	0	1	-2.843	6	-0.455	4
	5	max	0.921	6	1.047	3	0.935	6	0	1	0	1	0	1	0	1
		min	-0.921	2	0	1	-0.15	4	0	1	0	1	0	1	0	1
M6	1	max	0.984	6	0	1	0.554	6	0	1	0	1	0	1	0	1
		min	-0.984	2	0	1	-1.933	2	0	1	0	1	0	1	0	1
	2	max	0.984	6	0	1	0.554	6	0	1	0	1	1.684	6	5.878	2
		min	-0.984	2	0	1	-1.933	2	0	1	0	1	-5.878	2	-1.684	6
	3	max	0.984	6	0	1	1.933	6	0	1	0	1	3.369	6	11.755	2
		min	-0.984	2	0	1	-0.845	4	0	1	0	1	-11.755	2	-3.369	6
	4	max	0.984	6	0	1	1.933	6	0	1	0	1	2.57	4	5.878	6
		min	-0.984	2	0	1	-0.845	4	0	1	0	1	-5.878	6	-2.57	4
	5	max	0.984	6	0	1	1.933	6	0	1	0	1	0	1	0	1
		min	-0.984	2	0	1	-0.845	4	0	1	0	1	0	1	0	1
M7	1	max	0.638	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	0.638	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	0.638	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	0.638	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	0.638	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	0	1	0	1	0	1	0	1	0	1	0	1	0	1

Member Deflection

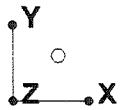
Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	6	0.003	3	0	6	0	1	NC		NC	
		min	0	2	0	6	0	2	0	1	NC		NC	
	3	max	0	6	0.005	3	0	6	0	1	NC		NC	
		min	0	2	0	6	0	2	0	1	NC		NC	
	4	max	0	6	0.008	3	0.001	6	0	1	NC		NC	
		min	0	2	0	6	-0.001	2	0	1	NC		NC	
	5	max	0	6	0.01	3	0.001	6	0	1	NC		NC	
		min	0	2	0	6	-0.001	2	0	1	NC		NC	
M2	1	max	0	6	0.01	3	0.001	6	0	1	NC		NC	
		min	0	2	0	6	-0.001	2	0	1	NC		NC	
	2	max	0	6	0.018	3	0.001	6	0	1	6549.135	3	NC	
		min	-0.001	2	0	6	-0.001	2	0	1	NC		NC	
	3	max	0	6	0.024	3	0.001	6	0	1	4638.971	3	NC	
		min	-0.001	2	0	6	-0.001	2	0	1	NC		NC	
	4	max	0	6	0.027	3	0.001	6	0	1	5859.752	3	NC	
		min	-0.001	2	0	6	-0.001	2	0	1	NC		NC	
	5	max	0	6	0.027	3	0.001	6	0	1	NC		NC	
		min	-0.001	2	-0.001	6	-0.001	2	0	1	NC		NC	
M3	1	max	0	6	0.027	3	0.001	6	0	1	NC		NC	
		min	-0.001	2	-0.001	6	-0.001	2	0	1	NC		NC	
	2	max	0	6	0.024	3	0.001	6	0	1	7952.521	3	NC	
		min	-0.002	2	-0.001	6	-0.001	2	0	1	NC		NC	
	3	max	0	6	0.018	3	0.001	6	0	1	6958.456	3	NC	
		min	-0.002	2	-0.001	6	-0.001	2	0	1	NC		NC	
	4	max	0	6	0.01	3	0.001	6	0	1	NC		NC	
		min	-0.002	2	-0.001	6	-0.001	2	0	1	NC		NC	
	5	max	0	6	0.002	3	0.001	6	0	1	NC		NC	
		min	-0.002	2	-0.001	6	-0.001	2	0	1	NC		NC	
M4	1	max	0.001	6	0.01	3	0	2	0	1	NC		NC	
		min	-0.001	2	0	6	0	6	0	1	NC		NC	
	2	max	0.001	6	0.012	3	0.004	2	0	1	6059.064	3	8073.667	2
		min	-0.001	2	0	6	0.001	6	0	1	NC		NC	
	3	max	0	6	0.012	3	0.005	2	0	1	4067.043	3	6417.367	2
		min	0	2	0	6	0.003	6	0	1	NC		NC	
	4	max	0	6	0.008	3	0.003	6	0	1	5738.111	3	NC	
		min	0	2	0	6	0.002	4	0	1	NC		NC	
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
M5	1	max	0.001	6	0.027	3	0.001	2	0	1	NC		NC	
		min	-0.001	2	-0.001	6	0	6	0	1	NC		NC	
	2	max	0.001	6	0.026	3	0.005	2	0	1	6059.064	3	8073.667	2
		min	-0.001	2	0	6	0.001	6	0	1	NC		NC	
	3	max	0	6	0.021	3	0.005	2	0	1	4067.043	3	6417.367	2
		min	0	2	0	6	0.002	6	0	1	NC		NC	
	4	max	0	6	0.012	3	0.003	2	0	1	5738.111	3	NC	
		min	0	2	0	6	0.002	5	0	1	NC		NC	
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
M6	1	max	0.001	6	0.002	3	0.002	2	0	1	NC		NC	
		min	-0.001	2	-0.001	6	0	6	0	1	NC		NC	
	2	max	0.001	6	0.001	3	0.009	2	0	1	NC		4313.504	2
		min	-0.001	2	-0.001	6	0	6	0	1	NC		NC	

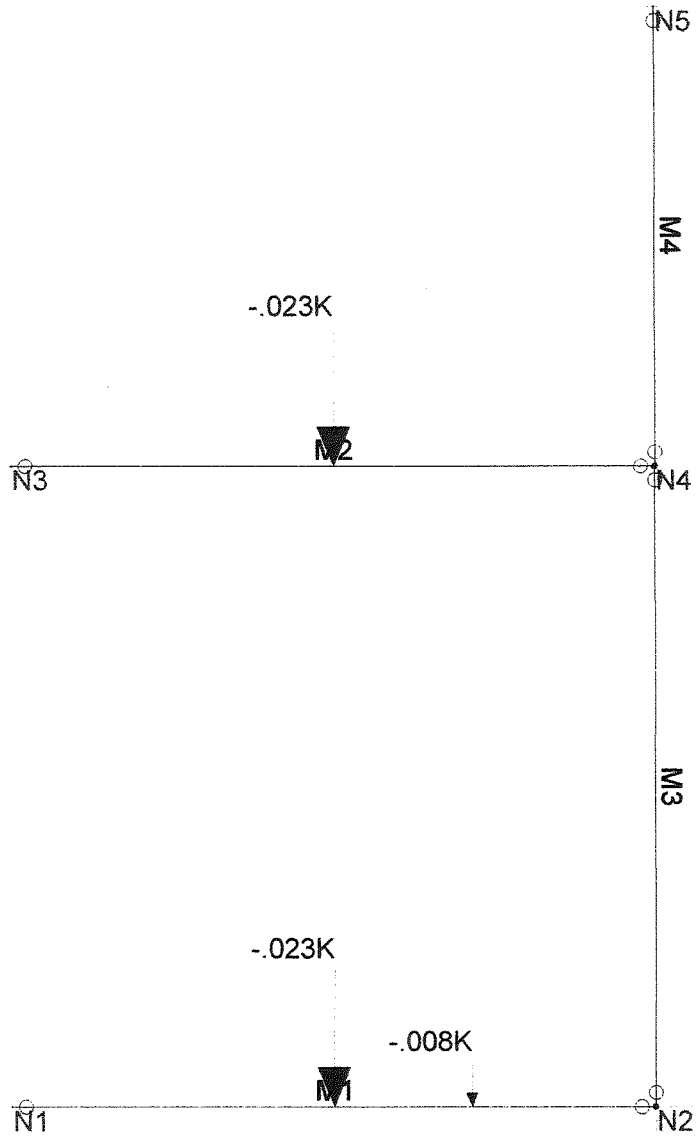
Member Deflections, (continued)

Member Label	Section		x-Translate (In)	Lc	x-Translate (In)	Lc	x-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
	3	max	0.001	6	0.001	3	0.009	2	0	1	NC		3654.341	2
		min	-0.001	2	-0.001	6	0.002	6	0	1	NC		NC	
	4	max	0	6	0	3	0.004	2	0	1	NC		8734.538	2
		min	0	2	0	6	0.002	5	0	1	NC		NC	
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
M7	1	max	0.001	3	0.001	2	0.002	2	0	1	NC		NC	
		min	0	1	-0.001	6	0	6	0	1	NC		NC	
	2	max	0.001	3	0.001	2	0.002	2	0	1	NC		NC	
		min	0	1	-0.001	6	0	6	0	1	NC		NC	
	3	max	0	3	0.001	2	0.001	2	0	1	NC		NC	
		min	0	1	-0.001	6	0	6	0	1	NC		NC	
	4	max	0	3	0	2	0.001	2	0	1	NC		NC	
		min	0	1	0	6	0	6	0	1	NC		NC	
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	

Envelope Member AISC ASD 9th Code Checks

Member Label	Code Chk	Loc (Ft)	Lc	Shear Chk	Loc (Ft)	Dir	Lc	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.119	0.5	3	0.062	0	y	3	27.364	30.36	30.36	H1-2
M2	0.204	2	3	0.016	0	y	3	26.48	30.36	30.36	H1-2
M3	0.196	0	3	0.031	0	y	3	26.48	30.36	30.36	H1-2
M4	0.268	1.389	3	0.057	1.389	y	3	26.13	30.36	30.36	H1-3
M5	0.268	1.389	3	0.057	1.389	y	3	26.13	30.36	30.36	H2-1
M6	0.429	1.319	2	0.105	0	z	2	26.13	30.36	30.36	H2-1
M7	0.033	0	3	0	0	y	1	19.37 Code check based on z-z Axial ONLY -			





Loads: BLC 2, Fv

NBZ Consulting Engineers	Tunnel Trapeze F	October 28, 2012
NZ		TunneltrapezeF.r3d

Company : **NBZ Consulting Engineers** October 28, 2012
Designer : **NZ**
Job Number : **Tunnel Trapeze F** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	33

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	15/8"DOUBLEST...	STL	1.111	1.2	1.2	.928	.471	1	
SEC2	P5001	STL	1.793	1.2	1.2	6.227	.866	.004	
SEC3	3/4"ROD	STL	.442	1.2	1.2	.016	.016	.031	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	3.5	0	0	0
N3	0	3.5	0	0
N4	3.5	3.5	0	0
N5	3.5	6	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N3	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N5	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N2			Reaction	Reaction	Reaction	Reaction
N4			Reaction	Reaction	Reaction	Reaction

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N1	N2		90	SEC1	AllPIN	BenPIN				3.5
M2	N3	N4		90	SEC2	AllPIN	BenPIN				3.5
M3	N2	N4			SEC3	AllPIN	BenPIN				3.5
M4	N4	N5			SEC3	AllPIN	BenPIN				2.5

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Nodal	Load Type Totals Point	Distributed	Surface
1	DL	DL	Dead Load		3		
2	Fv	EL	Earthquake Load		3		

Member Point Loads, Category : DL, BLC 1 : DL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M2	N3	N4	Y	-1.437	1.75
M1	N1	N2	Y	-.204	1.75
M1	N1	N2	Y	-.068	2.5

Company : **NBZ Consulting Engineers** October 28, 2012
Designer : **NZ**
Job Number : **Tunnel Trapeze F** Checked By:_____

Member Point Loads, Category : EL, BLC 2 : Fv

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N1	N2	Y	-.008	2.5
M1	N1	N2	Y	-.023	1.75
M2	N3	N4	Y	-.023	1.75

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL	y				1	1	1						
2	DL+Fv	y				1	1	1	2	1				
3	.9DL-Fv	y				1	1	.9	2	-1				

Envelope Reactions

Joint Label		X Force (K)	Lc	Y Force (K)	Lc	Z Force (K)	Lc	X Moment (K-ft)	Lc	Y Moment (K-ft)	Lc	Z Moment (K-ft)	Lc
N1	max	0.000	1	0.135	2	0.000	1	0.000	1	0.000	1	0.000	3
	min	0.000	1	0.096	3	0.000	1	0.000	1	0.000	1	0.000	2
N3	max	0.000	1	0.73	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.635	3	0.000	1	0.000	1	0.000	1	0.000	1
N5	max	0.000	1	0.898	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.753	3	0.000	1	0.000	1	0.000	1	0.000	1
N2	max	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
N4	max	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	0.000	1	1.763	2	0.000	1						
	min	0.000	1	1.484	3	0.000	1						

Envelope Member Section Forces

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
M1	1	max	0	1	0	1	-0.096	3	0	1	0	1	0	1
		min	0	1	0	1	-0.135	2	0	1	0	1	0	1
	2	max	0	1	0	1	-0.096	3	0	1	-0.084	3	0	1
		min	0	1	0	1	-0.135	2	0	1	-0.118	2	0	1
	3	max	0	1	0	1	0.092	2	0	1	-0.167	3	0	1
		min	0	1	0	1	0.065	3	0	1	-0.237	2	0	1
	4	max	0	1	0	1	0.168	2	0	1	-0.104	3	0	1
		min	0	1	0	1	0.118	3	0	1	-0.147	2	0	1
	5	max	0	1	0	1	0.168	2	0	1	0	1	0	1
		min	0	1	0	1	0.118	3	0	1	0	1	0	1
M2	1	max	0	1	0	1	-0.635	3	0	1	0	1	0	1
		min	0	1	0	1	-0.73	2	0	1	0	1	0	1
	2	max	0	1	0	1	-0.635	3	0	1	-0.556	3	0	1
		min	0	1	0	1	-0.73	2	0	1	-0.639	2	0	1
	3	max	0	1	0	1	0.73	2	0	1	-1.112	3	0	1
		min	0	1	0	1	0.635	3	0	1	-1.277	2	0	1
	4	max	0	1	0	1	0.73	2	0	1	-0.556	3	0	1
		min	0	1	0	1	0.635	3	0	1	-0.639	2	0	1
	5	max	0	1	0	1	0.73	2	0	1	0	1	0	1

Envelope Member Section Forces, (continued)

Member Label	Section		Axial (K)	Lc	Shear y-y (K)	Lc	Shear z-z (K)	Lc	Torque (K-ft)	Lc	Moment y-y (K-ft)	Lc	Moment z-z (K-ft)	Lc
		min	0	1	0	1	0.635	3	0	1	0	1	0	1
M3	1	max	-0.118	3	0	1	0	1	0	1	0	1	0	1
		min	-0.168	2	0	1	0	1	0	1	0	1	0	1
	2	max	-0.118	3	0	1	0	1	0	1	0	1	0	1
		min	-0.168	2	0	1	0	1	0	1	0	1	0	1
	3	max	-0.118	3	0	1	0	1	0	1	0	1	0	1
		min	-0.168	2	0	1	0	1	0	1	0	1	0	1
	4	max	-0.118	3	0	1	0	1	0	1	0	1	0	1
		min	-0.168	2	0	1	0	1	0	1	0	1	0	1
	5	max	-0.118	3	0	1	0	1	0	1	0	1	0	1
		min	-0.168	2	0	1	0	1	0	1	0	1	0	1
M4	1	max	-0.753	3	0	1	0	1	0	1	0	1	0	1
		min	-0.898	2	0	1	0	1	0	1	0	1	0	1
	2	max	-0.753	3	0	1	0	1	0	1	0	1	0	1
		min	-0.898	2	0	1	0	1	0	1	0	1	0	1
	3	max	-0.753	3	0	1	0	1	0	1	0	1	0	1
		min	-0.898	2	0	1	0	1	0	1	0	1	0	1
	4	max	-0.753	3	0	1	0	1	0	1	0	1	0	1
		min	-0.898	2	0	1	0	1	0	1	0	1	0	1
	5	max	-0.753	3	0	1	0	1	0	1	0	1	0	1
		min	-0.898	2	0	1	0	1	0	1	0	1	0	1

Envelope Member Section Stresses

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
M1	1	max	0	1	0	1	-0.168	3	0	1	0	1	0	1	0	1
		min	0	1	0	1	-0.238	2	0	1	0	1	0	1	0	1
	2	max	0	1	0	1	-0.168	3	0	1	0	1	-1.756	3	2.486	2
		min	0	1	0	1	-0.238	2	0	1	0	1	-2.486	2	1.756	3
	3	max	0	1	0	1	0.161	2	0	1	0	1	-3.512	3	4.972	2
		min	0	1	0	1	0.114	3	0	1	0	1	-4.972	2	3.512	3
	4	max	0	1	0	1	0.295	2	0	1	0	1	-2.175	3	3.085	2
		min	0	1	0	1	0.208	3	0	1	0	1	-3.085	2	2.175	3
	5	max	0	1	0	1	0.295	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	0.208	3	0	1	0	1	0	1	0	1
M2	1	max	0	1	0	1	-0.558	3	0	1	0	1	0	1	0	1
		min	0	1	0	1	-0.642	2	0	1	0	1	0	1	0	1
	2	max	0	1	0	1	-0.558	3	0	1	0	1	-3.481	3	4.001	2
		min	0	1	0	1	-0.642	2	0	1	0	1	-4.001	2	3.481	3
	3	max	0	1	0	1	0.642	2	0	1	0	1	-6.961	3	8.001	2
		min	0	1	0	1	0.558	3	0	1	0	1	-8.001	2	6.961	3
	4	max	0	1	0	1	0.642	2	0	1	0	1	-3.481	3	4.001	2
		min	0	1	0	1	0.558	3	0	1	0	1	-4.001	2	3.481	3
	5	max	0	1	0	1	0.642	2	0	1	0	1	0	1	0	1
		min	0	1	0	1	0.558	3	0	1	0	1	0	1	0	1
M3	1	max	-0.268	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-0.38	2	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	-0.268	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-0.38	2	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	-0.268	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-0.38	2	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	-0.268	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-0.38	2	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	-0.268	3	0	1	0	1	0	1	0	1	0	1	0	1

Company : **NBZ Consulting Engineers** October 28, 2012
Designer : **NZ**
Job Number : **Tunnel Trapeze F** Checked By:_____

Member Stresses, (continued)

Member Label	Section		Axial (Ksi)	Lc	Shear y-y (Ksi)	Lc	Shear z-z (Ksi)	Lc	Bending y-top (Ksi)	Lc	Bending y-bot (Ksi)	Lc	Bending z-top (Ksi)	Lc	Bending z-bot (Ksi)	Lc
		min	-0.38	2	0	1	0	1	0	1	0	1	0	1	0	1
M4	1	max	-1.705	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-2.032	2	0	1	0	1	0	1	0	1	0	1	0	1
	2	max	-1.705	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-2.032	2	0	1	0	1	0	1	0	1	0	1	0	1
	3	max	-1.705	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-2.032	2	0	1	0	1	0	1	0	1	0	1	0	1
	4	max	-1.705	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-2.032	2	0	1	0	1	0	1	0	1	0	1	0	1
	5	max	-1.705	3	0	1	0	1	0	1	0	1	0	1	0	1
		min	-2.032	2	0	1	0	1	0	1	0	1	0	1	0	1

Member Deflection

Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	1	0	1	0.012	2	0	1	NC		3789.749	2
		min	0	1	0	1	0.008	3	0	1	NC		5367.549	3
	3	max	0	1	0	1	0.018	2	0	1	NC		2568.998	2
		min	0	1	0	1	0.013	3	0	1	NC		3638.994	3
	4	max	0	1	0	1	0.014	2	0	1	NC		3617.103	2
		min	0	1	0	1	0.01	3	0	1	NC		5125.024	3
	5	max	0	1	0	1	0.003	2	0	1	NC		NC	
		min	0	1	0	1	0.002	3	0	1	NC		NC	
M2	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	1	0	1	0.009	2	0	1	NC		4895.465	2
		min	0	1	0	1	0.008	3	0	1	NC		5626.528	3
	3	max	0	1	0	1	0.014	2	0	1	NC		3365.632	2
		min	0	1	0	1	0.012	3	0	1	NC		3868.238	3
	4	max	0	1	0	1	0.01	2	0	1	NC		4895.465	2
		min	0	1	0	1	0.009	3	0	1	NC		5626.528	3
	5	max	0	1	0	1	0.002	2	0	1	NC		NC	
		min	0	1	0	1	0.002	3	0	1	NC		NC	
M3	1	max	-0.002	3	0	1	0	1	0	1	NC		NC	
		min	-0.003	2	0	1	0	1	0	1	NC		NC	
	2	max	-0.002	3	0	1	0	1	0	1	NC		NC	
		min	-0.003	2	0	1	0	1	0	1	NC		NC	
	3	max	-0.002	3	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	4	max	-0.002	3	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	5	max	-0.002	3	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
M4	1	max	-0.002	3	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	2	max	-0.001	3	0	1	0	1	0	1	NC		NC	
		min	-0.002	2	0	1	0	1	0	1	NC		NC	
	3	max	-0.001	3	0	1	0	1	0	1	NC		NC	
		min	-0.001	2	0	1	0	1	0	1	NC		NC	
	4	max	0	3	0	1	0	1	0	1	NC		NC	
		min	-0.001	2	0	1	0	1	0	1	NC		NC	
	5	max	0	1	0	1	0	1	0	1	NC		NC	

Member Deflections, (continued)

Member Label	Section		x-Translate (In)	Lc	x-Translate (In)	Lc	x-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
		min	0	1	0	1	0	1	0	1	NC		NC	

Envelope Member AISC ASD 9th Code Checks

Member Label	Code Chk	Loc (Ft)	Lc	Shear Chk	Loc (Ft)	Dir	Lc	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.239	1.75	2	0.022	2.528	z	2	15.821	20.806	20.202	H1-1
M2	0.543	1.75	2	0.049	0	z	2	12.514	14.723	14.723	H1-1
M3	0.019	0	2	0	0	0	1	2.976	24.75	24.75	H2-1
M4	0.103	0	2	0	0	0	1	5.833	24.75	24.75	H2-1

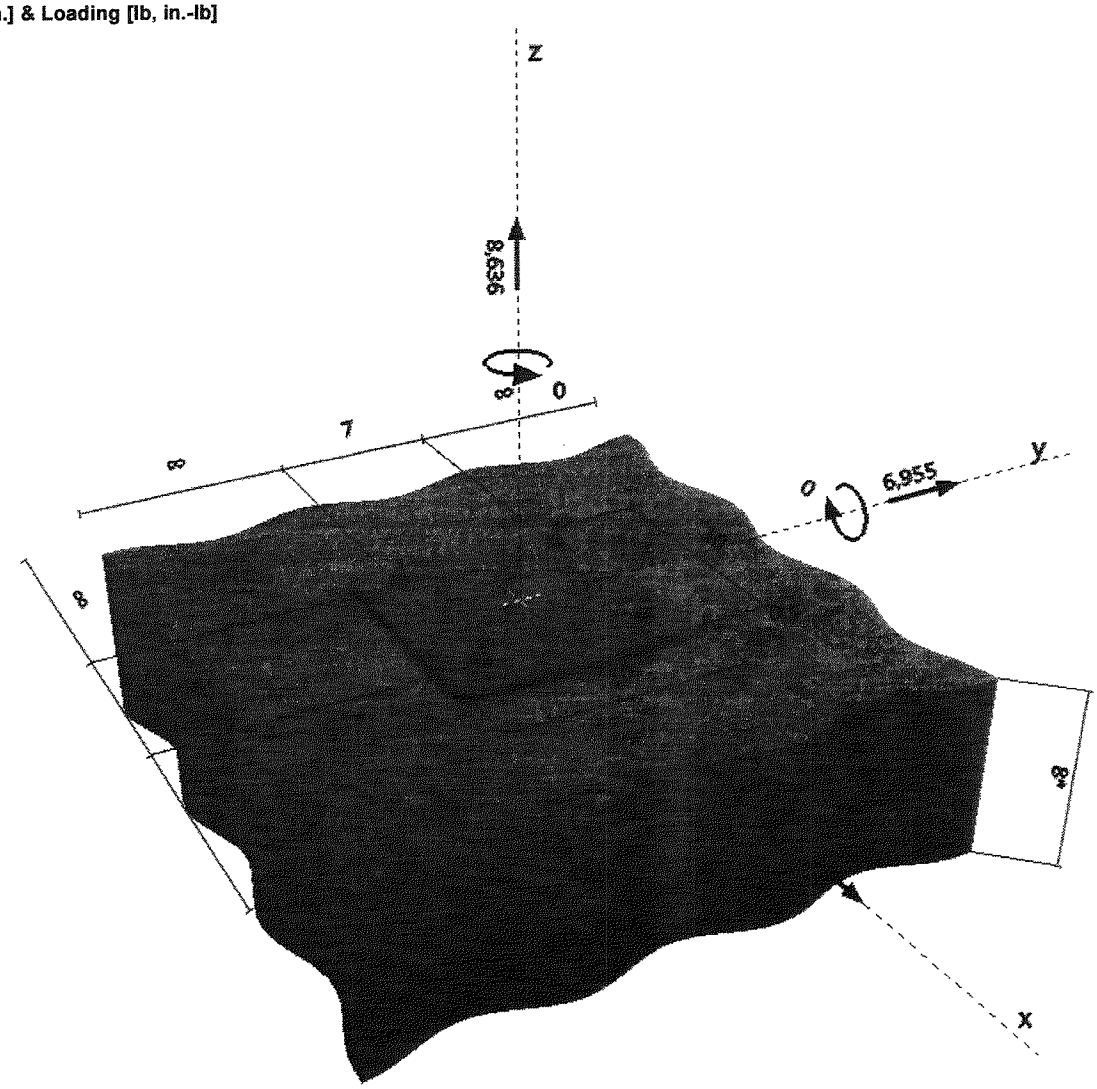
Company:	NBZ Consulting Engineers	Page:	1
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	HSS to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

Specifier's comments:

1. Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 3/4 (3 3/4)**
Effective embedment depth:	h_{ef} = 3.750 in., h_{nom} = 4.625 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 10.000 x 10.000 x 0.500 in. (Recommended plate thickness: not calculated)
Profile	no profile
Base material:	cracked concrete , 3000, f_c' = 3000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	yes (D.3.3.6)

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



Company:	NBZ Consulting Engineers	Page:	2
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	HSS to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

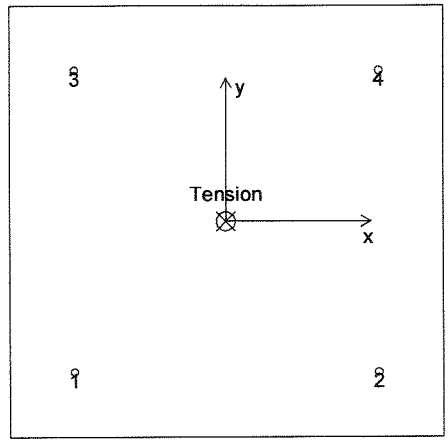
2. Load case/Resulting anchor forces

Load case (governing):

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	2159	1739	0	1739
2	2159	1739	0	1739
3	2159	1739	0	1739
4	2159	1739	0	1739



max. concrete compressive strain [‰]: 0.00
max. concrete compressive stress [psi]: 0
resulting tension force in (x/y)=(0.000/0.000) [lb]: 8635
resulting compression force in (x/y)=(0/0) [lb]: 0

3. Tension load

Proof	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization β_N [%] = $N_{ua}/\phi N_n$	Status
Steel Strength*	2159	18041	12	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	8636	12246	71	OK

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

Steel Strength

Equations

N_{sa} = ESR value — refer to ICC-ES ESR 1917

$\phi N_{steel} \geq N_{ua}$ — ACI 318-08 Eq. (D-1)

Variables

n	$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
1	0.24	101500

Calculations

N_{sa} [lb]
24055

Results

N_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	ϕN_{sa} [lb]	N_{ua} [lb]
24055	0.750	1.000	18041	2159

Company:	NBZ Consulting Engineers	Page:	3
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	HSS to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

Concrete Breakout Strength

Equations

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\, \psi_{ed,N}\, \psi_{c,N}\, \psi_{cp,N}\, N_b$ ACI 318-08 Eq. (D-5)

$\phi\, N_{cbg} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\, h_{ef}^2$ ACI 318-08 Eq. (D-6)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\, e'_N}{3\, h_{ef}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-9)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-08 Eq. (D-11)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-08 Eq. (D-13)

$N_b = k_c\, \lambda\, \sqrt{f'_c}\, h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c	λ
3.750	0.000	0.000	3936.969	1.000	7.000	24	1

f'_c [psi]
3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
333.06	126.56	1.000	1.000	1.000	1.000	9546

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\, N_{cbg}$ [lb]	N_{ua} [lb]
25121	0.650	0.750	1.000	12246	8636

Company:	NBZ Consulting Engineers	Page:	4
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	HSS to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

4. Shear load

Proof	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization β_V [%] = $V_{ua}/\phi V_n$	Status
Steel Strength*	1739	8378	21	OK
*Steel failure (with lever arm)**	N/A	N/A	N/A	N/A
Pryout Strength**	6955	26377	26	OK
Concrete edge failure in direction**	N/A	N/A	N/A	N/A

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

Steel Strength

Equations

V_{seis} = ESR value — refer to ICC-ES ESR 1917

$\phi V_{steel} \geq V_{ua}$ — ACI 318-08 Eq. (D-1)

Variables

n	$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
1	0.24	101500

Calculations

V_{sa} [lb]
12890

Results

V_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	ϕV_{sa} [lb]	V_{ua} [lb]
12890	0.650	1.000	8378	1739

Company:	NBZ Consulting Engineers	Page:	5
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	HSS to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

Pryout Strength (Concrete Breakout Strength controls)

Equations

$V_{cpg} = k_{cp}\left[\left(\frac{A_{Nc}}{A_{Nc0}}\right)\psi_{ec,N}\,\psi_{ed,N}\,\psi_{c,N}\,\psi_{cp,N}\,N_b\right]$ ACI 318-08 Eq. (D-31)

$\phi\,V_{cpg} \geq V_{ua}$ ACI 318-08 Eq. (D-1)

A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\,h_{ef}^2$ ACI 318-08 Eq. (D-6)

$\psi_{ec,N} = \left(\frac{1}{1+\frac{2\,e_N}{3\,h_{ef}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-9)

$\psi_{ed,N} = 0.7 + 0.3\left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-08 Eq. (D-11)

$\psi_{cp,N} = \mathrm{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-08 Eq. (D-13)

$N_b = k_c\,\lambda\,\sqrt{f'_c}\,h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c
2	3.750	0.000	0.000	-	1.000	-	24

λ	f'_c [psi]
1	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
333.06	126.56	1.000	1.000	1.000	1.000	9546

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\,V_{cpg}$ [lb]	V_{ua} [lb]
50242	0.700	0.750	1.000	26377	6955

5. Combined tension and shear loads

$\beta_N = N_u/\phi N_n$	$\beta_V = V_u/\phi V_n$	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.705	0.264	5/3	67	OK

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

Company:	NBZ Consulting Engineers	Page:	6
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	HSS to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

6. Warnings

- 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 ACI 318, Part D.4.4(c).
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- The anchor plate is assumed to be sufficiently stiff in order to be not deformed when subjected to the actions!
- An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-08 Appendix D, Part D.3.3.4 that requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, Part D.3.3.5 requires that the attachment that the anchor is connecting to the structure shall be designed so that the attachment will undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. In lieu of D.3.3.4 and D.3.3.5, the minimum design strength of the anchors shall be multiplied by a reduction factor per D.3.3.6.
  An alternative anchor design approach to ACI 318-08, Part D.3.3 is given in IBC 2009, Section 1908.1.9. This approach contains "Exceptions" that may be applied in lieu of D.3.3 for applications involving "non-structural components" as defined in ASCE 7, Section 13.4.2.
  An alternative anchor design approach to ACI 318-08, Part D.3.3 is given in IBC 2009, Section 1908.1.9. This approach contains "Exceptions" that may be applied in lieu of D.3.3 for applications involving "wall out-of-plane forces" as defined in ASCE 7, Equation 12.11-1 or Equation 12.14-10.
- It is the responsibility of the user when inputing values for brittle reduction factors ($\phi_{nonductile}$) different than those noted in ACI 318-08, Part D.3.3.6 to determine if they are consistent with the design provisions of ACI 318-08, ASCE 7 and the governing building code.
  Selection of $\phi_{nonductile}$ = 1.0 as a means of satisfying ACI 318-08, Part D.3.3.5 assumes the user has designed the attachment that the anchor is connecting to undergo ductile yielding at a force level <= the design strengths calculated per ACI 318-08, Part D.3.3.3.

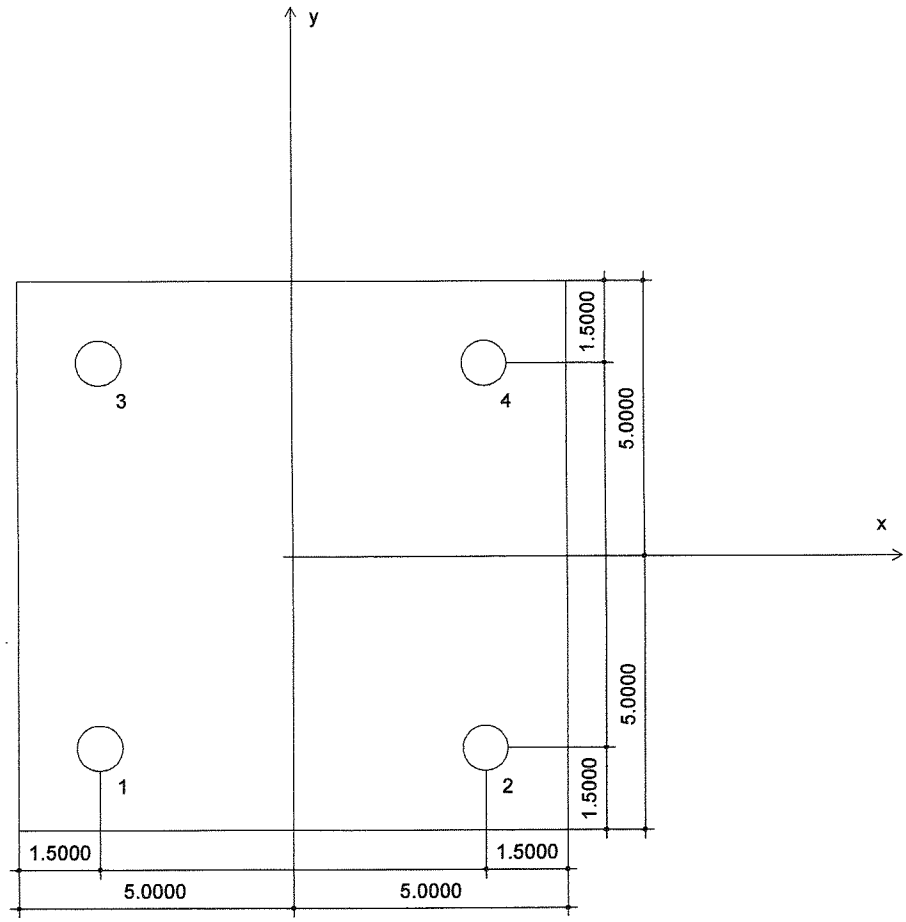
Fastening meets the design criteria!

Company:	NBZ Consulting Engineers	Page:	7
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	HSS to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

7. Installation data

Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.500 in.
Recommended plate thickness: not calculated

Anchor type and diameter: Kwik Bolt TZ - SS 304, 3/4 (3 3/4)
Installation torque: 1320.002 in.-lb
Hole diameter in the base material: 0.750 in.
Hole depth in the base material: 4.625 in.
Minimum thickness of the base material: 8.000 in.



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-3.500	-3.500	-	-	-	-
2	3.500	-3.500	-	-	-	-
3	-3.500	3.500	-	-	-	-
4	3.500	3.500	-	-	-	-

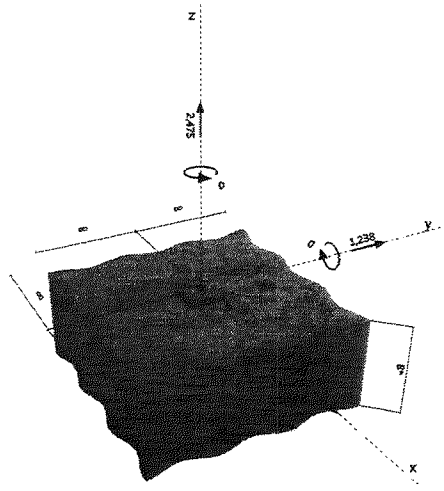
Company:	NBZ Consulting Engineers	Page:	1
Specifier:		Project:	PSU Tunnel Frames
Address:		Sub-Project I Pos. No.:	Brace to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

Specifier's comments:

Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 5/8 (4)**
Effective embedment depth:	h_{ef} = 4.000 in., h_{nom} = 4.750 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 3.000 x 3.000 x 0.500 in. (Recommended plate thickness: not calculated)
Profile	no profile
Base material:	cracked concrete , 3000, f_c' = 3000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	yes (D.3.3.6)

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



Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization [%]	
Loading	Proof	Load	Capacity	β_N/β_V	Status
Tension	Concrete Breakout Strength	2475	3631	68 / -	OK
Shear	Steel Strength (without lever arm)	1238	6077	- / 20	OK

Loading	β_N	β_V	ζ	Utilization $\beta_{N,V}$[%]	Status
Combined tension and shear loads	0.682	0.204	5/3	60	OK

Warnings

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

Fastening meets the design criteria!

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PROFIS Anchor 2.2.3

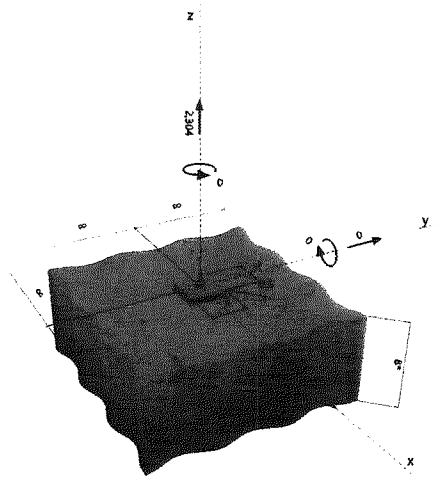
Company:	NBZ Consulting Engineers	Page:	0
Specifier:		Project:	Trapeze rod anchorage
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	- |	Date:	11/2/2012
E-Mail:			

Specifier's comments:

Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 5/8 (3 1/8)**
Effective embedment depth:	h_{ef} = 3.125 in., h_{nom} = 3.875 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 3.000 x 3.000 x 0.500 in. (Recommended plate thickness: not calculated)
Profile	no profile
Base material:	cracked concrete , 3000, f_c' = 3000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	no

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



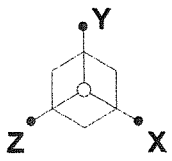
Proof I Utilization (Governing Cases)

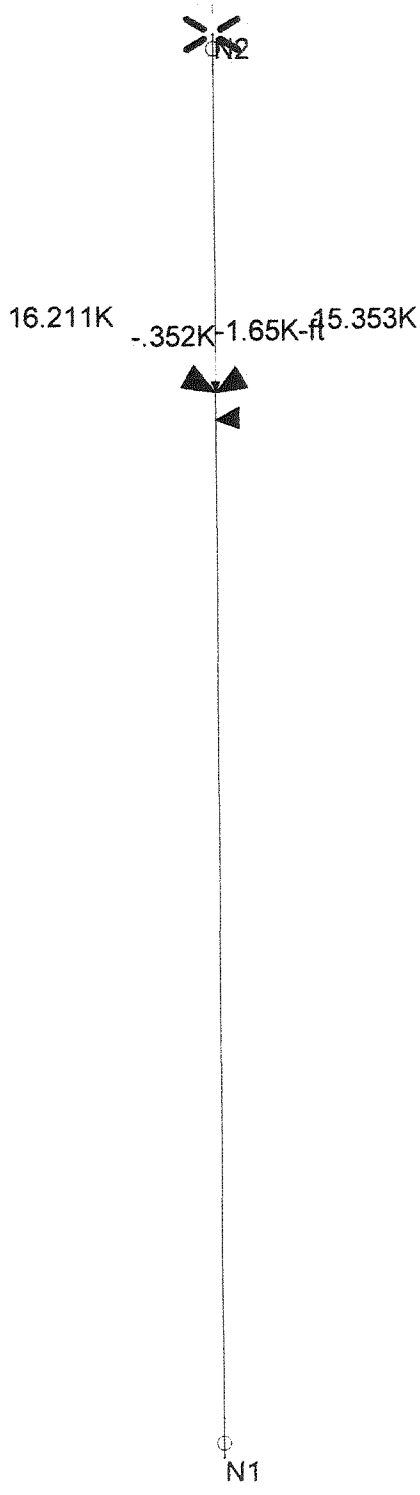
		Design values [lb]		Utilization [%]	
Loading	Proof	Load	Capacity	β_N/β_V	Status
Tension	Concrete Breakout Strength	2304	3343	69 / -	OK
Shear	-	-	-	-/-	-

Warnings

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

Fastening meets the design criteria!





Loads: BLC 1, DL+THERMAL
Solution: LC 1, lc1

NBZ Consulting Engineers	Frame at anchor A11	November 1, 2012
NZ		PSUANCHORA11.r3d

Company : **NBZ Consulting Engineers** November 1, 2012
Designer : **NZ**
Job Number : **Frame at anchor A11** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	46

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	TU8X6X6	STL	9.58	1.2	1.2	53.5	83.7	107	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	0	8	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N2	Reaction		Reaction	Reaction	Reaction	Reaction

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N1	N2			SEC1	BenPIN	AllPIN				8

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Nodal	Load Type Totals Point	Distributed	Surface
1	DL+THERMAL	None			4		

Member Point Loads, Category : None, BLC 1 : DL+THERMAL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N1	N2	Y	-.352	6
M1	N1	N2	Z	15.353	6
M1	N1	N2	X	16.211	6
M1	N1	N2	My	-1.65	6

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	lc1					1	1	1						

Reactions, LC 1 : lc1

Joint Label	X Force (K)	Y Force (K)	Z Force (K)	X Moment (K-ft)	Y Moment (K-ft)	Z Moment (K-ft)
N1	-4.053	0.352	-3.632	0.000	0.000	0.000

Reactions, LC 1 : lc1, (continued)

Joint Label	X Force (K)	Y Force (K)	Z Force (K)	X Moment (K-ft)	Y Moment (K-ft)	Z Moment (K-ft)
N2	-12.158	0.000	-11.721	0.000	0.000	0.000
Reaction Totals :	-16.211	0.352	-15.353			
Center of Gravity Coords (X,Y,Z) (Ft) :				0.000	6	0.000

Member Section Forces, LC 1 : lc1

Member Label	Section	Axial (K)	Shear y-y (K)	Shear z-z (K)	Torque (K-ft)	Moment y-y (K-ft)	Moment z-z (K-ft)
M1	1	0.352	4.053	-3.632	0	0	0
	2	0.352	4.053	-3.632	0	-7.264	-8.105
	3	0.352	4.053	-3.632	0	-14.528	-16.211
	4	0.352	4.053	-3.632	0	-21.792	-24.316
	5	0	-12.158	11.721	0	0	0

Member Stresses, LC 1 : lc1

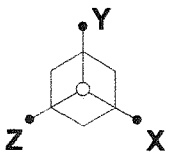
Member Label	Section	Axial (Ksi)	Shear y-y (Ksi)	Shear z-z (Ksi)	Bending y-top (Ksi)	Bending y-bot (Ksi)	Bending z-top (Ksi)	Bending z-bot (Ksi)
M1	1	0.037	0.811	-0.969	0	0	0	0
	2	0.037	0.811	-0.969	4.648	-4.648	-4.888	4.888
	3	0.037	0.811	-0.969	9.297	-9.297	-9.776	9.776
	4	0.037	0.811	-0.969	13.945	-13.945	-14.664	14.664
	5	0	-2.432	3.126	0	0	0	0

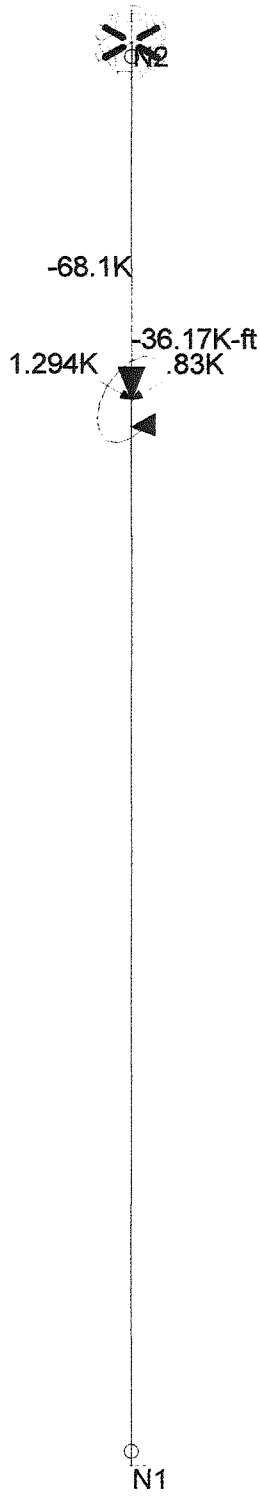
Member Deflections, LC 1 : lc1

Member Label	Section	x-Translation (In)	y-Translation (In)	z-Translation (In)	x-Rotation (radians)	(n) L/y Ratio	(n) L/z Ratio
M1	1	0	0	0	0	NC	NC
	2	0	-0.054	0.076	0	1782.52	1261.124
	3	0	-0.085	0.12	0	1134.331	800.776
	4	0	-0.069	0.099	0	1386.404	970.461
	5	0	0	0	0	NC	NC

Member AISC ASD 9th Code Checks, LC 1 : lc1

Member Label	Code Chk	Loc (Ft)	Shear Chk	Loc (Ft)	Dir	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.944	6	0.17	6.222	z	23.898	30.36	30.36	H1-3





Loads: BLC 1, DL+THERMAL

NBZ Consulting Engineers	Frame at anchor A13	November 1, 2012
NZ		PSUANCHORA13b.r3d

Company : **NBZ Consulting Engineers** November 1, 2012
Designer : **NZ**
Job Number : **Frame at anchor A13** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	46

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	TU8X6X6	STL	9.58	1.2	1.2	53.5	83.7	107	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	0	8	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N2	Reaction		Reaction	Reaction	Reaction	Reaction

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N1	N2			SEC1	BenPIN	AllPIN				8

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	DL+THERMAL	None			4		

Member Point Loads, Category : None, BLC 1 : DL+THERMAL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N1	N2	Y	-68.1	6
M1	N1	N2	Z	.83	6
M1	N1	N2	X	1.294	6
M1	N1	N2	My	-36.17	6

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	lc1					1	1	1						

Reactions, LC 1 : lc1

Joint Label	X Force (K)	Y Force (K)	Z Force (K)	X Moment (K-ft)	Y Moment (K-ft)	Z Moment (K-ft)
N1	-0.324	68.1	4.314	0.000	0.000	0.000

Reactions, LC 1 : lc1, (continued)

Joint Label	X Force (K)	Y Force (K)	Z Force (K)	X Moment (K-ft)	Y Moment (K-ft)	Z Moment (K-ft)
N2	-0.97	0.000	-5.144	0.000	0.000	0.000
Reaction Totals :	-1.294	68.1	-0.83			
Center of Gravity Coords (X,Y,Z) (Ft) :				0.000	6	0.000

Member Section Forces, LC 1 : lc1

Member Label	Section	Axial (K)	Shear y-y (K)	Shear z-z (K)	Torque (K-ft)	Moment y-y (K-ft)	Moment z-z (K-ft)
M1	1	68.1	0.324	4.314	0	0	0
	2	68.1	0.324	4.314	0	8.628	-0.647
	3	68.1	0.324	4.314	0	17.255	-1.294
	4	68.1	0.324	4.314	0	25.882	-1.941
	5	0	-0.97	5.144	0	0	0

Member Stresses, LC 1 : lc1

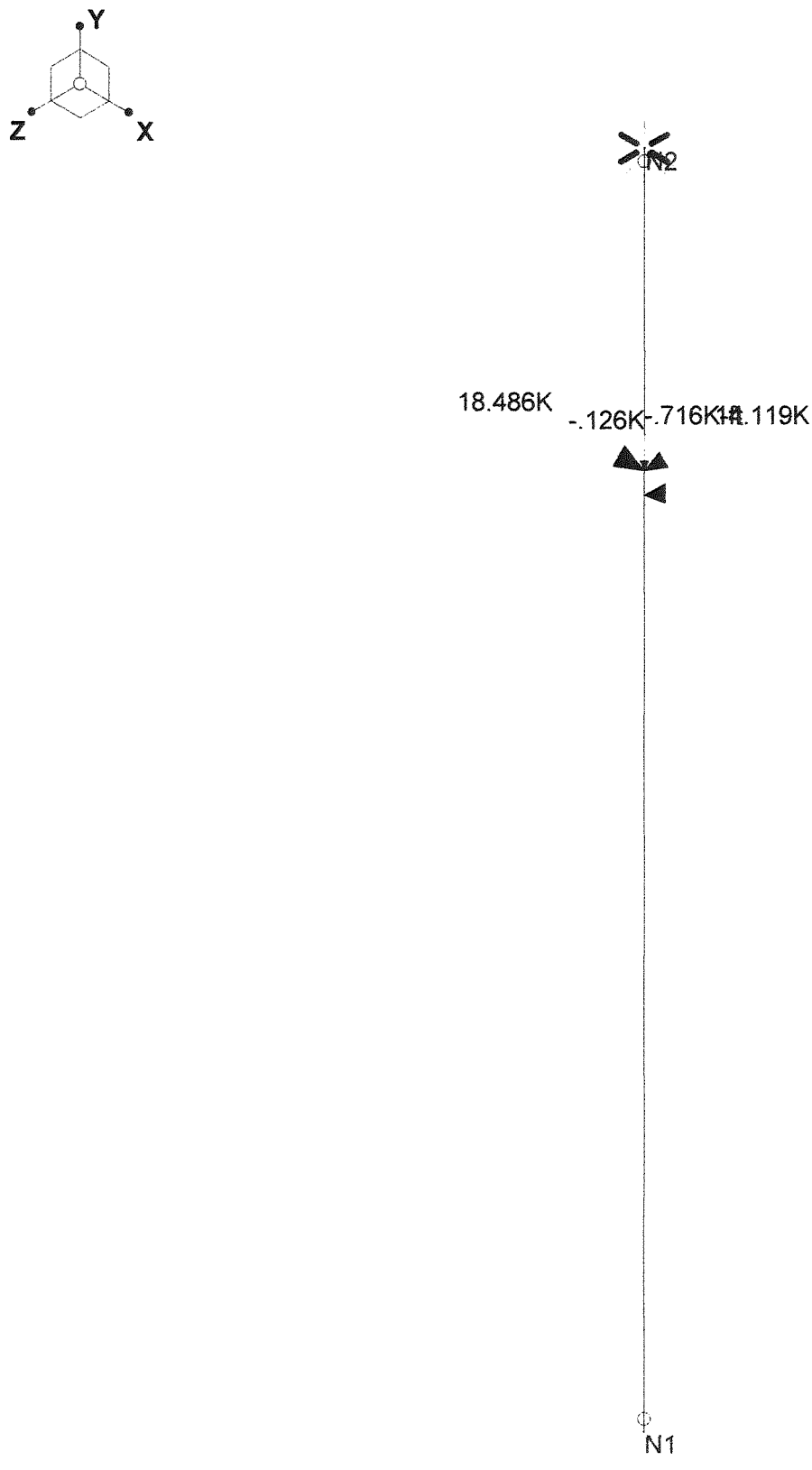
Member Label	Section	Axial (Ksi)	Shear y-y (Ksi)	Shear z-z (Ksi)	Bending y-top (Ksi)	Bending y-bot (Ksi)	Bending z-top (Ksi)	Bending z-bot (Ksi)
M1	1	7.109	0.065	1.15	0	0	0	0
	2	7.109	0.065	1.15	0.371	-0.371	5.805	-5.805
	3	7.109	0.065	1.15	0.742	-0.742	11.611	-11.611
	4	7.109	0.065	1.15	1.113	-1.113	17.416	-17.416
	5	0	-0.194	1.372	0	0	0	0

Member Deflections, LC 1 : lc1

Member Label	Section	x-Translation (In)	y-Translation (In)	z-Translation (In)	x-Rotation (radians)	(n) L/y Ratio	(n) L/z Ratio
M1	1	0	0	0	0	NC	NC
	2	-0.004	-0.004	-0.076	0	NC	1258.926
	3	-0.009	-0.007	-0.114	0	NC	841.551
	4	-0.013	-0.006	-0.075	0	NC	1279.609
	5	-0.018	0	0	0	NC	NC

Member AISC ASD 9th Code Checks, LC 1 : lc1

Member Label	Code Chk	Loc (Ft)	Shear Chk	Loc (Ft)	Dir	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.959	6	0.075	6.222	z	23.898	30.36	30.36	H1-1



Loads: BLC 1, DL+THERMAL

NBZ Consulting Engineers	Frame at anchor A14	November 1, 2012
NZ		PSUANCHORA14.r3d

Company : **NBZ Consulting Engineers** November 1, 2012
Designer : **NZ**
Job Number : **Frame at anchor A14** Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	46

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	TU8X6X6	STL	9.58	1.2	1.2	53.5	83.7	107	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	0	8	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
N2	Reaction		Reaction	Reaction	Reaction	Reaction

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N1	N2			SEC1	BenPIN	AllPIN				8

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	DL+THERMAL	None			4		

Member Point Loads, Category : None, BLC 1 : DL+THERMAL

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N1	N2	Y	-.126	6
M1	N1	N2	Z	14.119	6
M1	N1	N2	X	18.486	6
M1	N1	N2	My	-.716	6

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	lc1					1	1	1						

Reactions, LC 1 : lc1

Joint Label	X Force (K)	Y Force (K)	Z Force (K)	X Moment (K-ft)	Y Moment (K-ft)	Z Moment (K-ft)
N1	-4.622	0.126	-3.44	0.000	0.000	0.000

Reactions, LC 1 : lc1, (continued)

Joint Label	X Force (K)	Y Force (K)	Z Force (K)	X Moment (K-ft)	Y Moment (K-ft)	Z Moment (K-ft)
N2	-13.864	0.000	-10.679	0.000	0.000	0.000
Reaction Totals :	-18.486	0.126	-14.119			
Center of Gravity Coords (X,Y,Z) (Ft) :				0.000	6	0.000

Member Section Forces, LC 1 : lc1

Member Label	Section	Axial (K)	Shear y-y (K)	Shear z-z (K)	Torque (K-ft)	Moment y-y (K-ft)	Moment z-z (K-ft)
M1	1	0.126	4.622	-3.44	0	0	0
	2	0.126	4.622	-3.44	0	-6.881	-9.243
	3	0.126	4.622	-3.44	0	-13.761	-18.486
	4	0.126	4.622	-3.44	0	-20.641	-27.729
	5	0	-13.864	10.679	0	0	0

Member Stresses, LC 1 : lc1

Member Label	Section	Axial (Ksi)	Shear y-y (Ksi)	Shear z-z (Ksi)	Bending y-top (Ksi)	Bending y-bot (Ksi)	Bending z-top (Ksi)	Bending z-bot (Ksi)
M1	1	0.013	0.924	-0.917	0	0	0	0
	2	0.013	0.924	-0.917	5.301	-5.301	-4.63	4.63
	3	0.013	0.924	-0.917	10.601	-10.601	-9.26	9.26
	4	0.013	0.924	-0.917	15.902	-15.902	-13.89	13.89
	5	0	-2.773	2.848	0	0	0	0

Member Deflections, LC 1 : lc1

Member Label	Section	x-Translation (In)	y-Translation (In)	z-Translation (In)	x-Rotation (radians)	(n) L/y Ratio	(n) L/z Ratio
M1	1	0	0	0	0	NC	NC
	2	0	-0.061	0.072	0	1563.152	1337.246
	3	0	-0.097	0.113	0	994.733	850.116
	4	0	-0.079	0.093	0	1215.785	1034.971
	5	0	0	0	0	NC	NC

Member AISC ASD 9th Code Checks, LC 1 : lc1

Member Label	Code Chk	Loc (Ft)	Shear Chk	Loc (Ft)	Dir	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.982	6	0.155	6.222	z	23.898	30.36	30.36	H1-3

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PROFIS Anchor 2.2.1

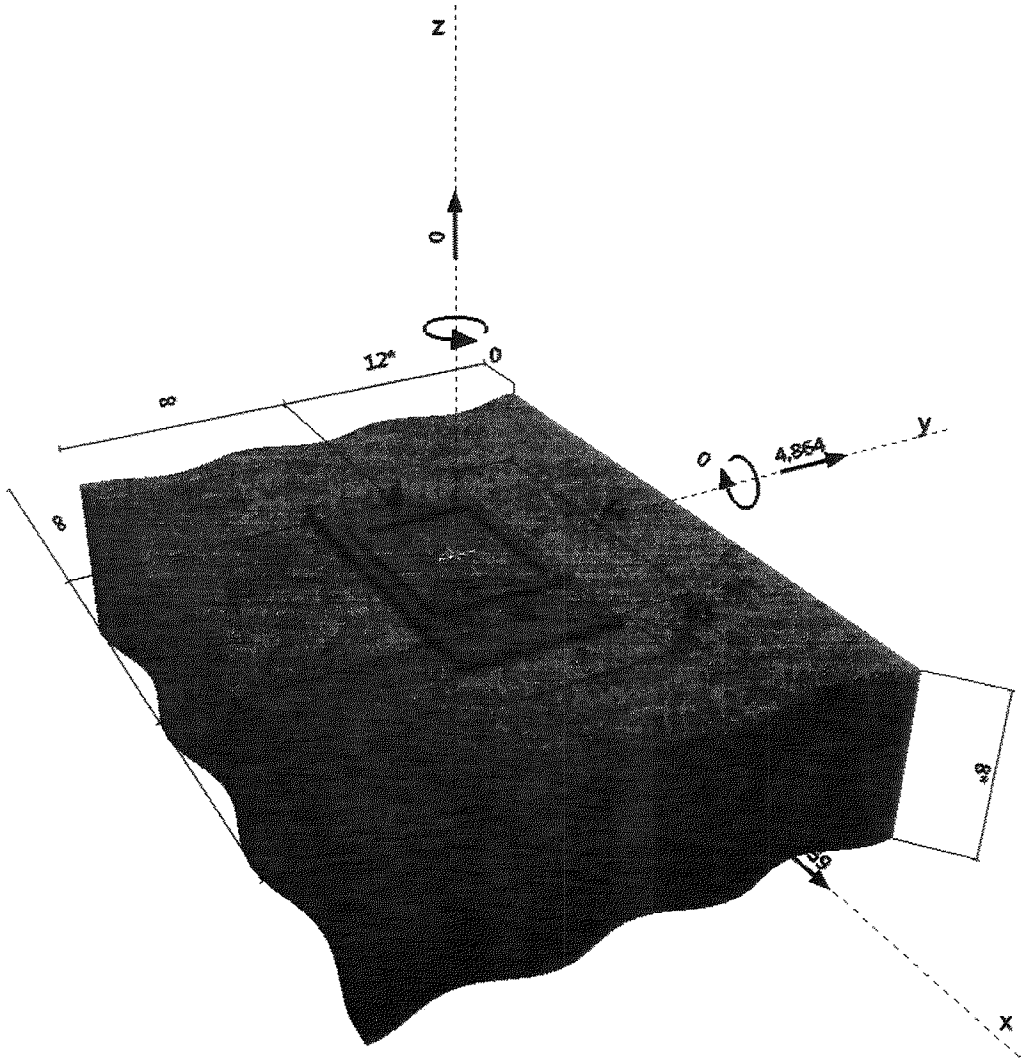
Company:	NBZ Consulting Engineers	Page:	1
Specifier:		Project:	WHPTunnel Anchor A11
Address:		Sub-Project I Pos. No.:	Bottom Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

Specifier's comments:

1. Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 3/4 (3 3/4)**
Effective embedment depth:	h_{ef} = 3.750 in., h_{nom} = 4.625 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 14.000 x 7.000 x 0.500 in. (Recommended plate thickness: not calculated)
Profile	Rectangular HSS (AISC); (L x W x T) = 8.000 in. x 6.000 in. x 0.625 in.
Base material:	cracked concrete , 4000, f_c' = 4000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	no

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



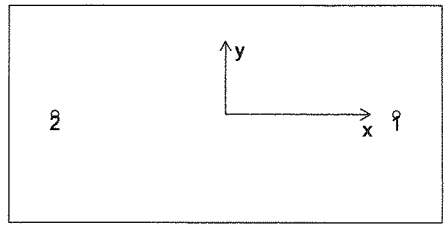
Company:	NBZ Consulting Engineers	Page:	2
Specifier:		Project:	WHPTunnel Anchor A11
Address:		Sub-Project I Pos. No.:	Bottom Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

2. Load case/Resulting anchor forces

Load case (governing):

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

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0	3266	2180	2432
2	0	3266	2180	2432



max. concrete compressive strain [‰]: 0.00
max. concrete compressive stress [psi]: 0
resulting tension force in (x/y)=(0.000/0.000) [lb]: 0
resulting compression force in (x/y)=(0/0) [lb]: 0

3. Tension load

Proof	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization β_N [%] = $N_{ua}/\phi N_n$	Status
Steel Strength*	N/A	N/A	N/A	N/A
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	N/A	N/A	N/A	N/A

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

4. Shear load

Proof	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization β_V [%] = $V_{ua}/\phi V_n$	Status
Steel Strength*	3266	10212	32	OK
*Steel failure (with lever arm)**	N/A	N/A	N/A	N/A
Pryout Strength**	6531	30521	21	OK
Concrete edge failure in direction y+**	6531	13397	49	OK

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

Steel Strength

V_{sa} [lb]	ϕ	ϕV_{sa} [lb]	V_{ua} [lb]
15711	0.650	10212	3266

Company:	NBZ Consulting Engineers	Page:	3
Specifier:		Project:	WHPTunnel Anchor A11
Address:		Sub-Project I Pos. No.:	Bottom Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

Pryout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c [in.]	k_{cp}
250.31	126.56	12.000	2.000

$e_{c1,V}$ [in.]	$\psi_{ec1,N}$	$e_{c2,V}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
0.000	1.000	0.000	1.000	1.000	1.000	24.000

N_b [lb]	ϕ	ϕV_{cpg} [lb]	V_{ua} [lb]
11023	0.700	30521	6531

Concrete edge failure in direction y+

l_e [in.]	d_o [in.]	c_1 [in.]	A_{Vc} [in²]	A_{Vco} [in²]
3.750	0.750	12.000	376.00	648.00

$\psi_{ed,V}$	$\psi_{\alpha,V}$	$e_{c,V}$ [in.]	$\psi_{ec,V}$	$\psi_{c,V}$	$\psi_{h,V}$
1.000	1.000	0.000	1.000	1.000	1.500

V_b [lb]	ϕ	ϕV_{cbg} [lb]	V_{ua} [lb]
21990	0.700	13397	6531

5. Warnings

- 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 ACI 318, Part D.4.4(c).
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- The anchor plate is assumed to be sufficiently stiff in order to be not deformed when subjected to the actions!

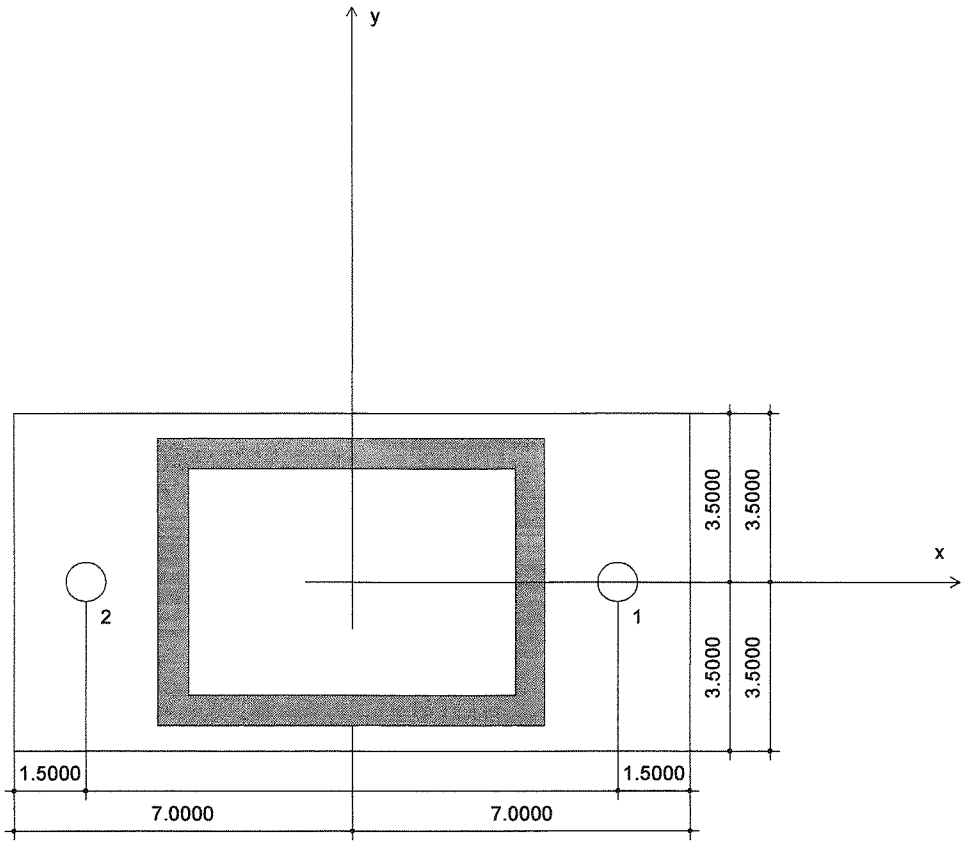
Fastening meets the design criteria!

Company:	NBZ Consulting Engineers	Page:	4
Specifier:		Project:	WHPTunnel Anchor A11
Address:		Sub-Project I Pos. No.:	Bottom Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

6. Installation data

Anchor plate, steel: -
Profile: Rectangular HSS (AISC), 8.000 in. x 6.000 in. x 0.625 in.
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.500 in.
Recommended plate thickness: not calculated

Anchor type and diameter: Kwik Bolt TZ - SS 304, 3/4 (3 3/4)
Installation torque: 1320.002 in.-lb
Hole diameter in the base material: 0.750 in.
Hole depth in the base material: 4.625 in.
Minimum thickness of the base material: 8.000 in.



Coordinates Anchor [in.]

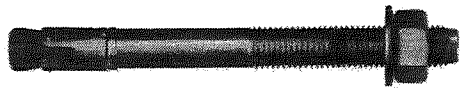
Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	5.500	0.000	-	-	-	12.000
2	-5.500	0.000	-	-	-	12.000

Company:		Page:	1
Specifier:		Project:	WHP Anchor A11
Address:		Sub-Project I Pos. No.:	Top Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

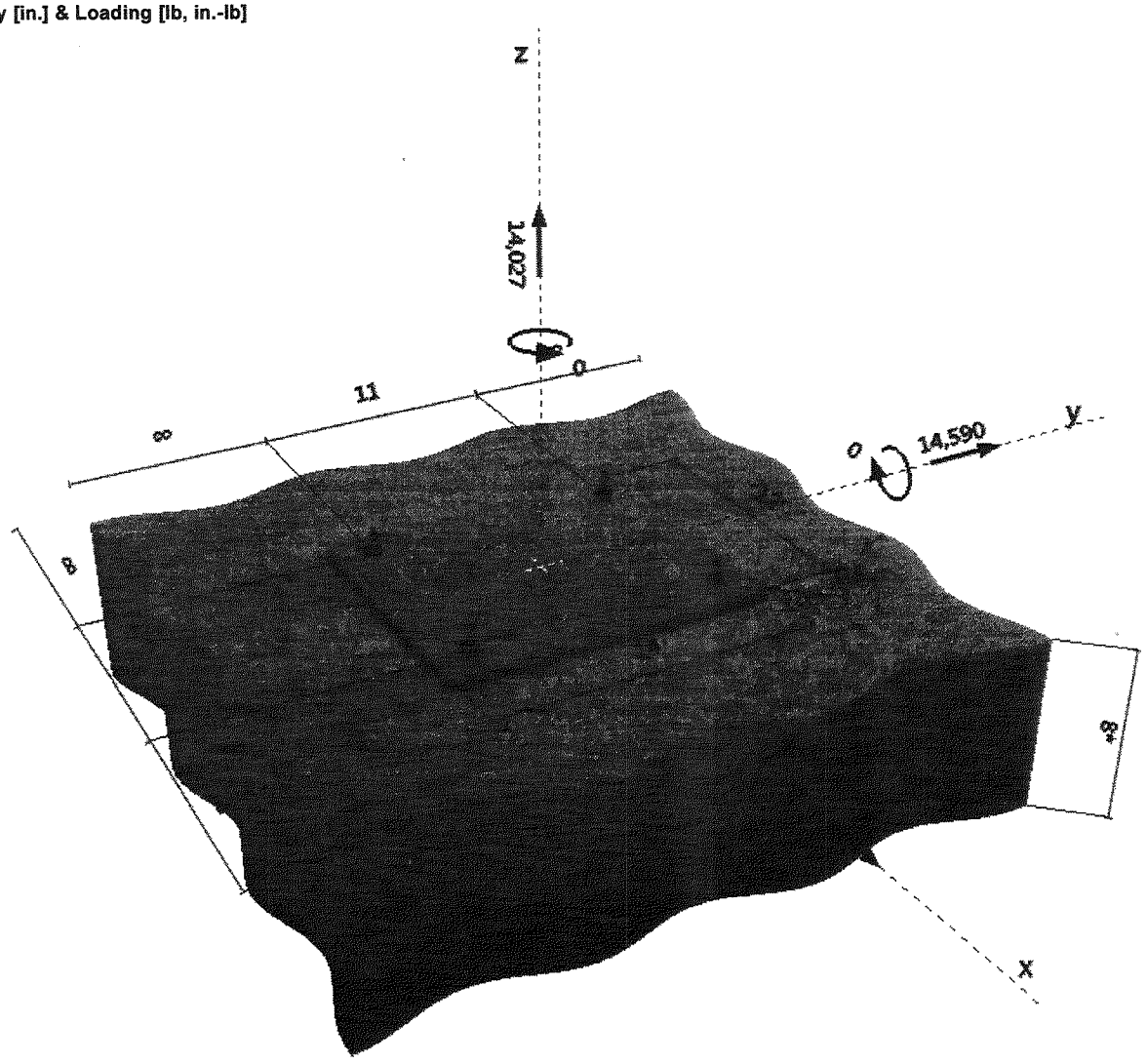
Specifier's comments:

1. Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 3/4 (3 3/4)**
Effective embedment depth:	h_{ef} = 3.750 in., h_{nom} = 4.625 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 12.000 x 14.000 x 0.500 in. (Recommended plate thickness: not calculated)
Profile	no profile
Base material:	cracked concrete , 4000, f_c' = 4000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	no



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



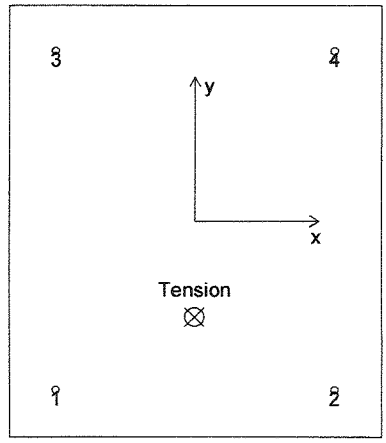
Company:
Specifier:
Address:
Phone I Fax: - | -
E-Mail:

2. Load case/Resulting anchor forces

Load case (governing):

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

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	5499	3648	0	3648
2	5499	3648	0	3648
3	1515	3648	0	3648
4	1515	3648	0	3648



max. concrete compressive strain [‰]: 0.00
max. concrete compressive stress [psi]: 0
resulting tension force in (x/y)=(0.000/-3.110) [lb]: 14028
resulting compression force in (x/y)=(0/0) [lb]: 0

3. Tension load

Proof	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization β_N [%] = $N_{ua}/\phi N_n$	Status
Steel Strength*	5498	18041	30	OK
Pullout Strength*	5498	6668	82	OK
Concrete Breakout Strength**	14027	16400	86	OK

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

Steel Strength

N_{sa} [lb]	ϕ	ϕN_{sa} [lb]	N_{ua} [lb]
24055	0.750	18041	5498

Pullout Strength

N_p [lb]	$(f_c'/2500)^{0.5}$	ϕ	$\phi N_{pn,fc}$ [lb]	N_{ua} [lb]
8110	1.265	0.650	6668	5498

Concrete Breakout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c [in.]	c_{ac} [in.]
450.56	126.56	3936.969	7.000

$e_{c1,N}$ [in.]	$\psi_{ec1,N}$	$e_{c2,N}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
0.000	1.000	3.123	0.643	1.000	1.000	24.000

N_b [lb]	ϕ	ϕN_{cbg} [lb]	N_{ua} [lb]
11023	0.650	16400	14027

Company:		Page:	3
Specifier:		Project:	WHP Anchor A11
Address:		Sub-Project I Pos. No.:	Top Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

4. Shear load

Proof	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization β_V [%] = $V_{ua}/\phi V_n$	Status
Steel Strength*	3648	10212	36	OK
*Steel failure (with lever arm)**	N/A	N/A	N/A	N/A
Pryout Strength**	14590	54937	27	OK
Concrete edge failure in direction**	N/A	N/A	N/A	N/A

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

Steel Strength

V_{sa} [lb]	ϕ	ϕV_{sa} [lb]	V_{ua} [lb]
15711	0.650	10212	3648

Pryout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c	k_{cp}
450.56	126.56	-	2.000

$e_{c1,V}$ [in.]	$\psi_{ec1,N}$	$e_{c2,V}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
0.000	1.000	0.000	1.000	1.000	1.000	24.000

N_b [lb]	ϕ	ϕV_{cpg} [lb]	V_{ua} [lb]
11023	0.700	54937	14590

5. Combined tension and shear loads

$\beta_N = N_u/\phi N_n$	$\beta_V = V_u/\phi V_n$	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.855	0.357	5/3	95	OK

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

6. Warnings

- 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 ACI 318, Part D.4.4(c).
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- The anchor plate is assumed to be sufficiently stiff in order to be not deformed when subjected to the actions!

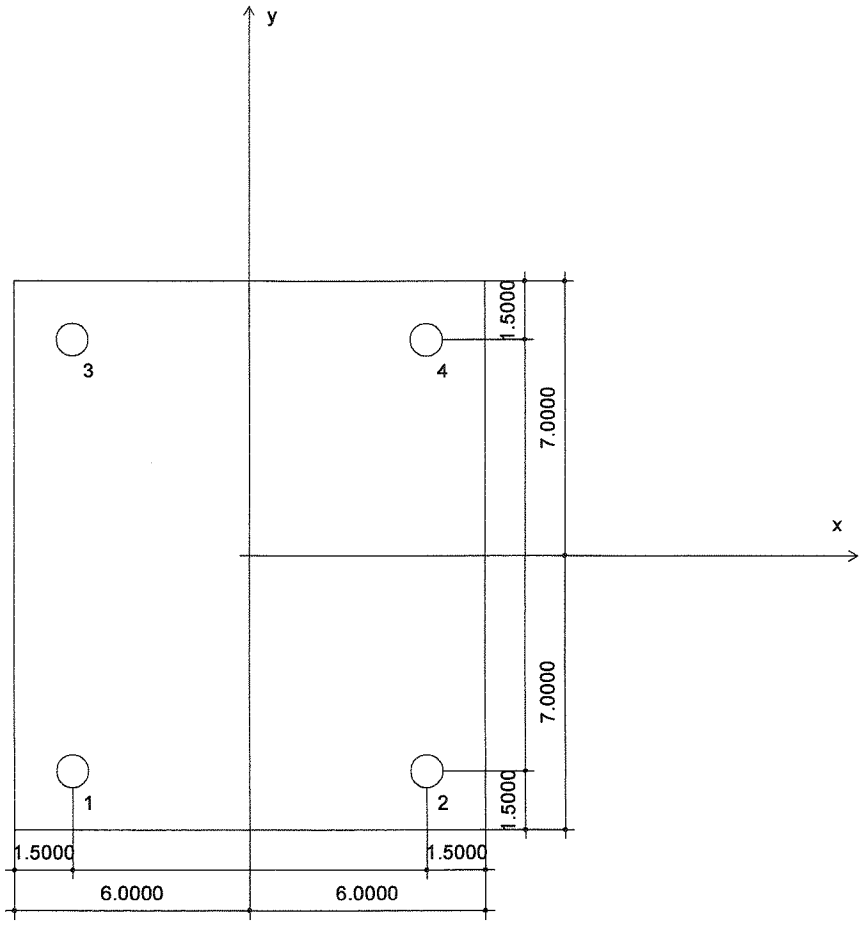
Fastening meets the design criteria!

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

7. Installation data

Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.500 in.
Recommended plate thickness: not calculated

Anchor type and diameter: Kwik Bolt TZ - SS 304, 3/4 (3 3/4)
Installation torque: 1320.002 in.-lb
Hole diameter in the base material: 0.750 in.
Hole depth in the base material: 4.625 in.
Minimum thickness of the base material: 8.000 in.



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-4.500	-5.500	-	-	-	-
2	4.500	-5.500	-	-	-	-
3	-4.500	5.500	-	-	-	-
4	4.500	5.500	-	-	-	-

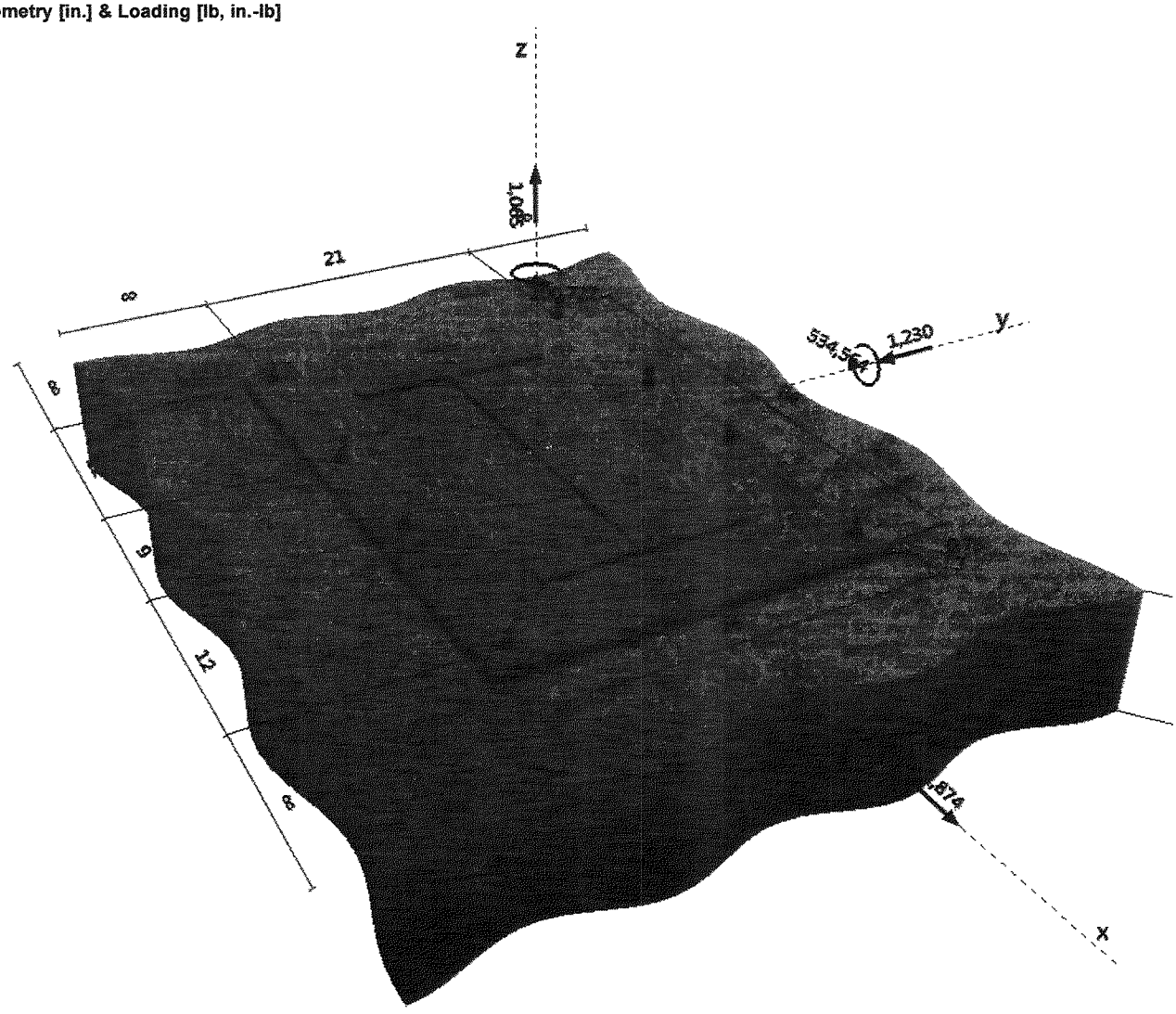
Company:		Page:	1
Specifier:		Project:	WHP
Address:		Sub-Project I Pos. No.:	Anchor A10
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

Specifier's comments:

1. Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 3/4 (4 3/4)**
Effective embedment depth:	h_{ef} = 4.750 in., h_{nom} = 5.750 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 36.000 x 24.000 x 0.750 in. (Recommended plate thickness: not calculated)
Profile	W shape (AISC); (L x W x T x FT) = 25.200 in. x 12.900 in. x 0.750 in. x 1.340 in.
Base material:	cracked concrete , 4000, f_c' = 4000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	no

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



Company:		Page:	2
Specifier:		Project:	WHP
Address:		Sub-Project I Pos. No.:	Anchor A10
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

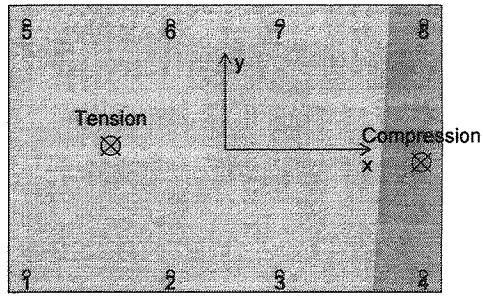
2. Load case/Resulting anchor forces

Load case (governing):

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	5575	1303	876	-965
2	3255	953	876	-375
3	1515	878	876	67
4	0	1095	876	658
5	5807	978	-157	-965
6	3487	407	-157	-375
7	1747	171	-157	67
8	0	676	-157	658



max. concrete compressive strain [‰]: 0.09
max. concrete compressive stress [psi]: 377
resulting tension force in (x/y)=(-9.528/0.354) [lb]: 21388
resulting compression force in (x/y)=(16.292/-1.074) [lb]: 20323

3. Tension load

Proof	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization β_N [%] = $N_{ua}/\phi N_n$	Status
Steel Strength*	5807	18041	32	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	21388	21850	98	OK

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

Steel Strength

N_{sa} [lb]	ϕ	ϕN_{sa} [lb]	N_{ua} [lb]
24055	0.750	18041	5807

Concrete Breakout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c [in.]	c_{ac} [in.]
1004.63	203.06	3936.969	9.000

$e_{c1,N}$ [in.]	$\psi_{ec1,N}$	$e_{c2,N}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
4.014	0.640	0.341	0.954	1.000	1.000	17.000

N_b [lb]	ϕ	ϕN_{cbg} [lb]	N_{ua} [lb]
11131	0.650	21850	21388

Company:		Page:	3
Specifier:		Project:	WHP
Address:		Sub-Project I Pos. No.:	Anchor A10
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

4. Shear load

Proof	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization β_V [%] = $V_{ua}/\phi V_n$	Status
Steel Strength*	1303	10212	13	OK
*Steel failure (with lever arm)**	N/A	N/A	N/A	N/A
Pryout Strength*	1303	14352	9	OK
Concrete edge failure in direction**	N/A	N/A	N/A	N/A

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

Steel Strength

V_{sa} [lb]	ϕ	ϕV_{sa} [lb]	V_{ua} [lb]
15711	0.650	10212	1303

Pryout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c	k_{cp}
187.03	203.06	-	2.000

$e_{c1,V}$ [in.]	$\psi_{ec1,N}$	$e_{c2,V}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
0.000	1.000	0.000	1.000	1.000	1.000	17.000

N_b [lb]	ϕ	ϕV_{cp} [lb]	V_{ua} [lb]
11131	0.700	14352	1303

5. Combined tension and shear loads

$\beta_N = N_u/\phi N_n$	$\beta_V = V_u/\phi V_n$	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.979	0.128	-	92	OK

$\beta_{NV} = (\beta_N + \beta_V) / 1.2 <= 1$

6. Warnings

- 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 ACI 318, Part D.4.4(c).
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- The anchor plate is assumed to be sufficiently stiff in order to be not deformed when subjected to the actions!

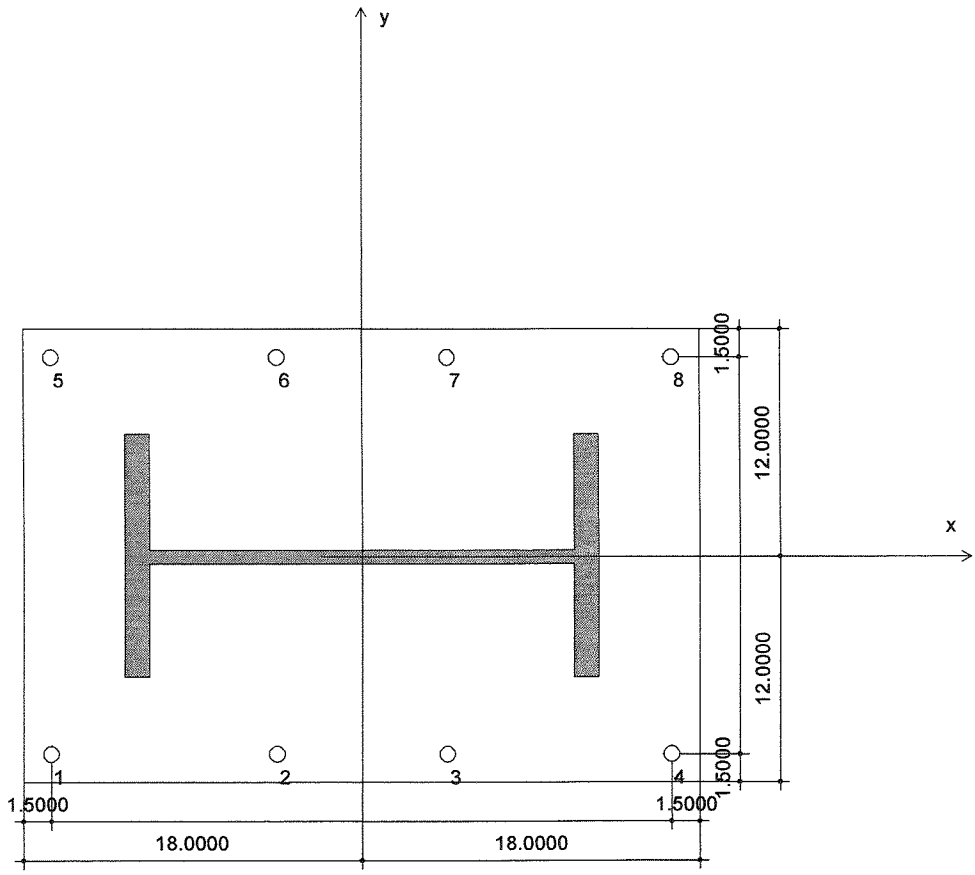
Fastening meets the design criteria!

Company:		Page:	4
Specifier:		Project:	WHP
Address:		Sub-Project I Pos. No.:	Anchor A10
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

7. Installation data

Anchor plate, steel: -
Profile: W shape (AISC), 25.200 in. x 12.900 in. x 0.750 in. x 1.340 in.
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.750 in.
Recommended plate thickness: not calculated

Anchor type and diameter: Kwik Bolt TZ - SS 304, 3/4 (4 3/4)
Installation torque: 1320.002 in.-lb
Hole diameter in the base material: 0.750 in.
Hole depth in the base material: 5.750 in.
Minimum thickness of the base material: 8.000 in.



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-16.500	-10.500	-	-	-	-
2	-4.500	-10.500	-	-	-	-
3	4.500	-10.500	-	-	-	-
4	16.500	-10.500	-	-	-	-

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
5	-16.500	10.500	-	-	-	-
6	-4.500	10.500	-	-	-	-
7	4.500	10.500	-	-	-	-
8	16.500	10.500	-	-	-	-

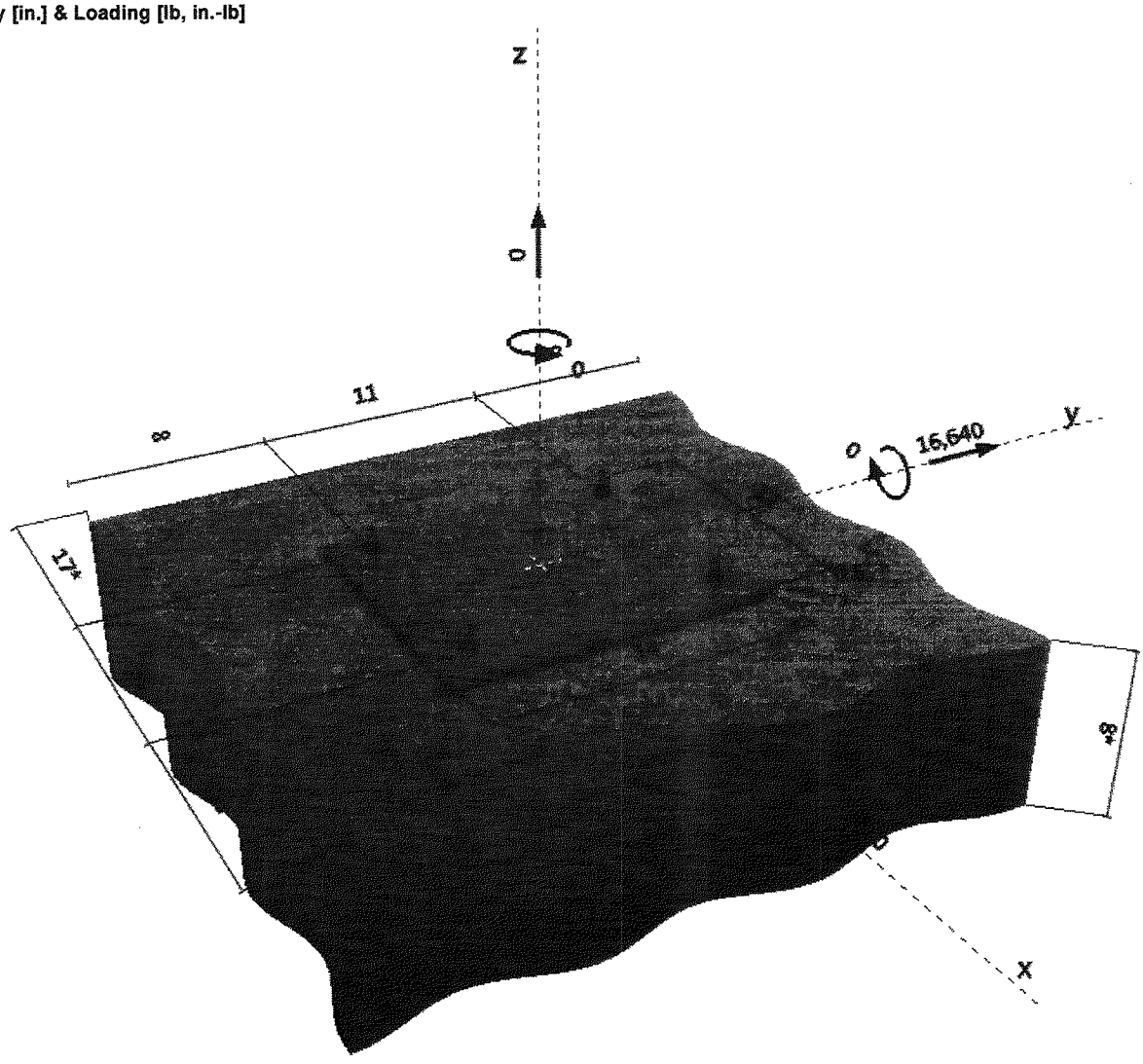
Company:		Page:	1
Specifier:		Project:	WHP Anchor A14
Address:		Sub-Project I Pos. No.:	Top Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

Specifier's comments:

1. Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 3/4 (4 3/4)**
Effective embedment depth:	h_{ef} = 4.750 in., h_{nom} = 5.750 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 12.000 x 14.000 x 0.500 in. (Recommended plate thickness: not calculated)
Profile	no profile
Base material:	cracked concrete , 4000, f_c' = 4000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: > No. 4 bar
Seismic loads (cat. C, D, E, or F):	no

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



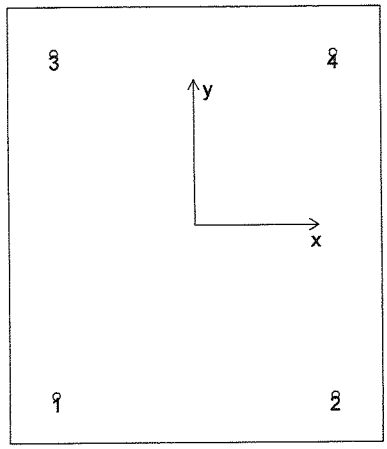
Company:
Specifier:
Address:
Phone I Fax: - | -
E-Mail:

2. Load case/Resulting anchor forces

Load case (governing):

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

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	0	5252	-3205	4160
2	0	5252	-3205	4160
3	0	5252	-3205	4160
4	0	5252	-3205	4160



max. concrete compressive strain [‰]: 0.00
max. concrete compressive stress [psi]: 0
resulting tension force in (x/y)=(0.000/0.000) [lb]: 0
resulting compression force in (x/y)=(0/0) [lb]: 0

3. Tension load

Proof	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization β_N [%] = $N_{ua}/\phi N_n$	Status
Steel Strength*	N/A	N/A	N/A	N/A
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	N/A	N/A	N/A	N/A

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

4. Shear load

Proof	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization β_V [%] = $V_{ua}/\phi V_n$	Status
Steel Strength*	5252	10212	51	OK
*Steel failure (with lever arm)**	N/A	N/A	N/A	N/A
Pryout Strength**	21006	45051	47	OK
Concrete edge failure in direction x-**	21006	22235	94	OK

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

Steel Strength

V_{sa} [lb]	ϕ	ϕV_{sa} [lb]	V_{ua} [lb]
15711	0.650	10212	5252

Company:		Page:	3
Specifier:		Project:	WHP Anchor A14
Address:		Sub-Project I Pos. No.:	Top Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

Pryout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c [in.]	k_{cp}
587.06	203.06	17.000	2.000

$e_{c1,V}$ [in.]	$\psi_{ec1,N}$	$e_{c2,V}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
0.000	1.000	0.000	1.000	1.000	1.000	17.000

N_b [lb]	ϕ	ϕV_{cpg} [lb]	V_{ua} [lb]
11131	0.700	45051	21006

Concrete edge failure in direction x-

l_e [in.]	d_o [in.]	c_1 [in.]	A_{Vc} [in²]	A_{Vco} [in²]
4.750	0.750	17.000	496.00	1300.50

$\psi_{ed,V}$	$\psi_{\alpha,V}$	$e_{c,V}$ [in.]	$\psi_{ec,V}$	$\psi_{c,V}$	$\psi_{h,V}$
1.000	1.000	0.000	1.000	1.200	1.785

V_b [lb]	ϕ	ϕV_{cbg} [lb]	V_{ua} [lb]
38874	0.700	22235	21006

5. Warnings

- 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 ACI 318, Part D.4.4(c).
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- The anchor plate is assumed to be sufficiently stiff in order to be not deformed when subjected to the actions!

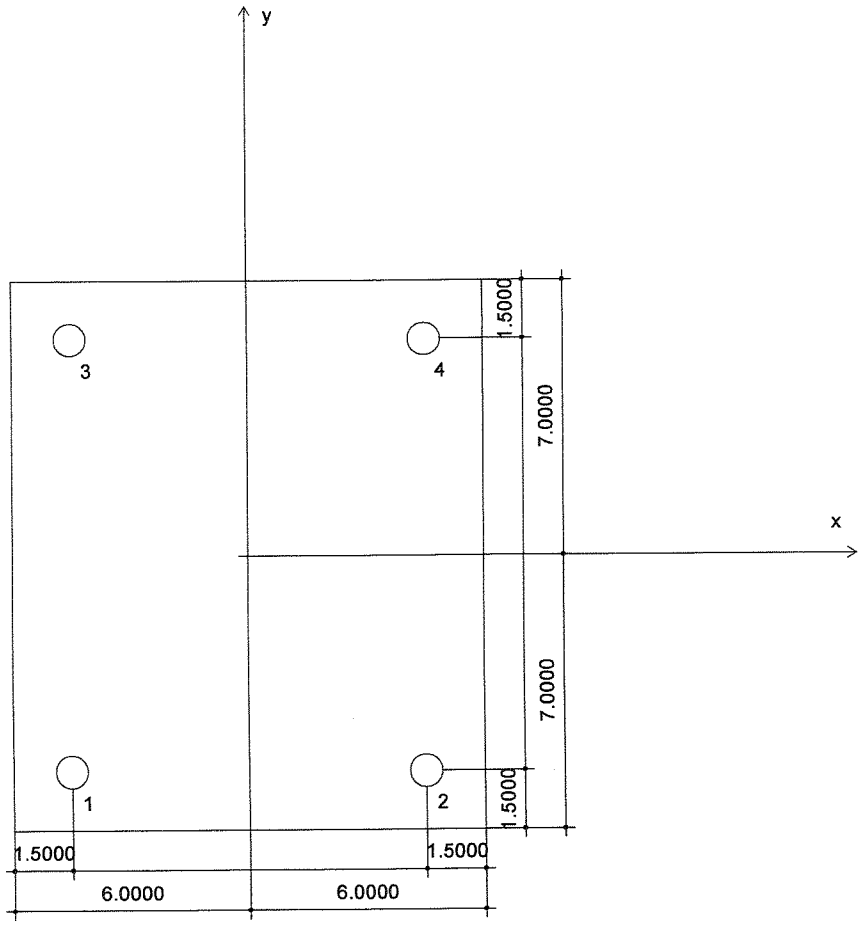
Fastening meets the design criteria!

Company:		Page:	4
Specifier:		Project:	WHP Anchor A14
Address:		Sub-Project I Pos. No.:	Top Connection
Phone I Fax:	- | -	Date:	11/1/2012
E-Mail:			

6. Installation data

Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.500 in.
Recommended plate thickness: not calculated

Anchor type and diameter: Kwik Bolt TZ - SS 304, 3/4 (4 3/4)
Installation torque: 1320.002 in.-lb
Hole diameter in the base material: 0.750 in.
Hole depth in the base material: 5.750 in.
Minimum thickness of the base material: 8.000 in.



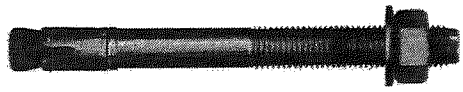
Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-4.500	-5.500	17.000	-	-	-
2	4.500	-5.500	26.000	-	-	-
3	-4.500	5.500	17.000	-	-	-
4	4.500	5.500	26.000	-	-	-

Company:	NBZ Consulting Engineers	Page:	1
Specifier:	NZ	Project:	PSU 4" pipe anchor
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

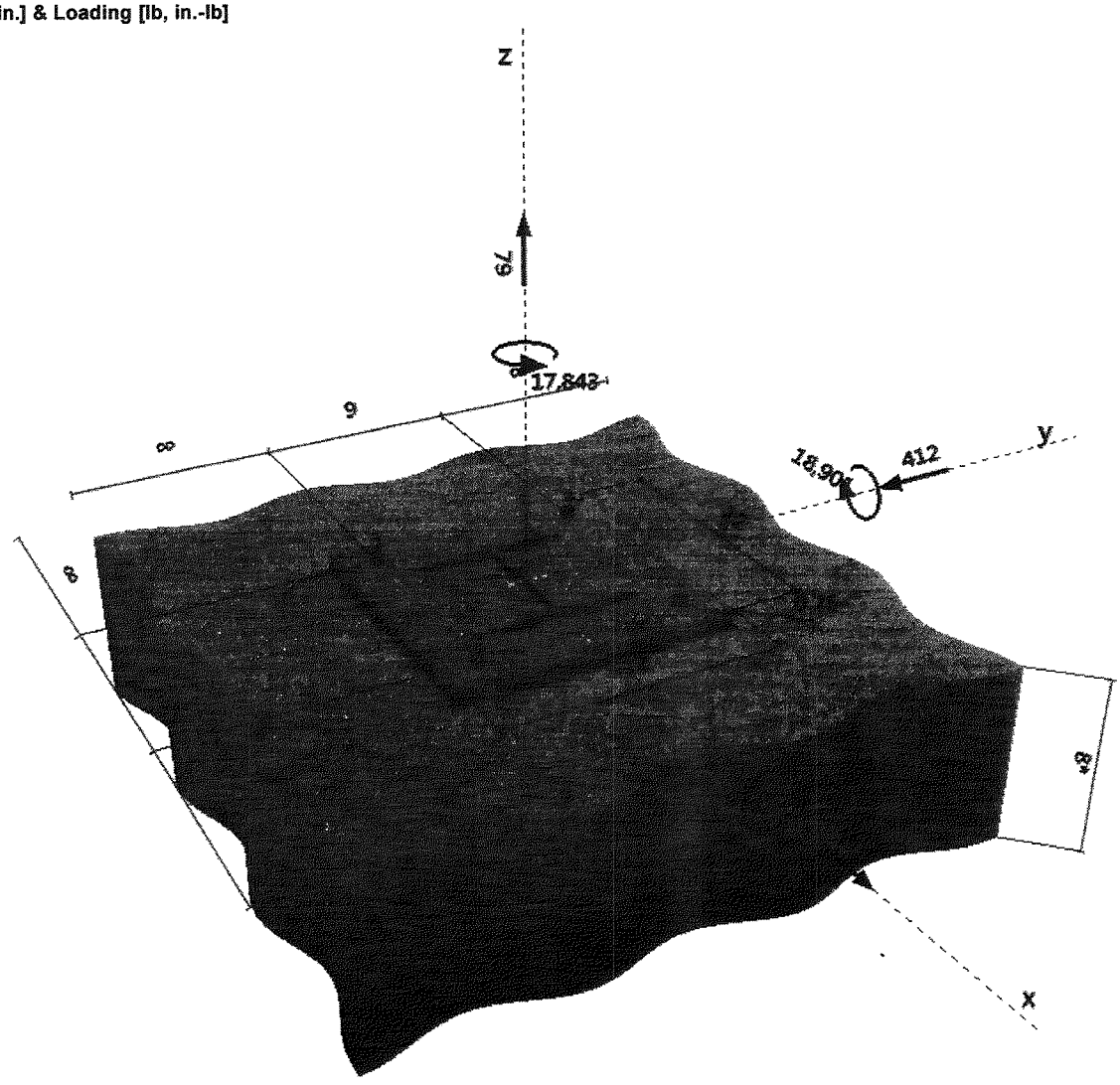
Specifier's comments:

1. Input data



Anchor type and diameter:	**Kwik Bolt TZ - SS 304, 5/8 (4)**
Effective embedment depth:	h_{ef} = 4.000 in., h_{nom} = 4.750 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 12.000 x 12.000 x 0.750 in. (Recommended plate thickness: not calculated)
Profile	W shape (AISC); (L x W x T x FT) = 6.380 in. x 6.080 in. x 0.320 in. x 0.455 in.
Base material:	cracked concrete , 4000, f_c' = 4000 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	no

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



Company:	NBZ Consulting Engineers	Page:	2
Specifier:	NZ	Project:	PSU 4" pipe anchor
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

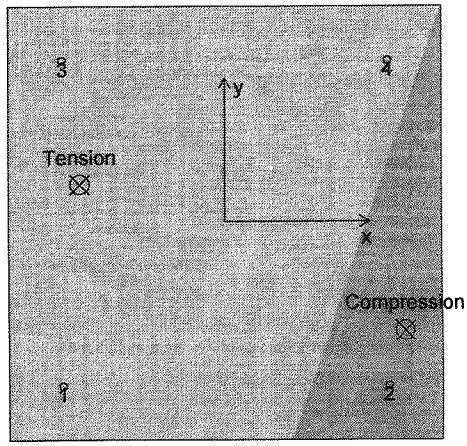
2. Load case/Resulting anchor forces

Load case (governing):

Anchor reactions [lb]

Tension force: (+Tension, -Compression)

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	830	865	624	-600
2	0	738	624	394
3	1208	704	-369	-600
4	116	540	-369	394



max. concrete compressive strain [‰]: 0.06
max. concrete compressive stress [psi]: 247
resulting tension force in (x/y)=(-4.016/1.024) [lb]: 2155
resulting compression force in (x/y)=(4.957/-2.984) [lb]: 2076

3. Tension load

Proof	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization β_N [%] = $N_{ua}/\phi N_n$	Status
Steel Strength*	1208	13973	9	OK
Pullout Strength*	1208	4802	25	OK
Concrete Breakout Strength**	2155	9136	24	OK

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

Steel Strength

N_{sa} [lb]	ϕ	ϕN_{sa} [lb]	N_{ua} [lb]
18630	0.750	13973	1208

Pullout Strength

N_p [lb]	$(f_c'/2500)^{0.5}$	ϕ	$\phi N_{pn,fc}$ [lb]	N_{ua} [lb]
5840	1.265	0.650	4802	1208

Concrete Breakout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c [in.]	c_{ac} [in.]
360.00	144.00	3936.969	6.000

$e_{c1,N}$ [in.]	$\psi_{ec1,N}$	$e_{c2,N}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
2.514	0.705	0.469	0.928	1.000	1.000	17.000

N_b [lb]	ϕ	ϕN_{cbg} [lb]	N_{ua} [lb]
8601	0.650	9136	2155

Company:	NBZ Consulting Engineers	Page:	3
Specifier:	NZ	Project:	PSU 4" pipe anchor
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

4. Shear load

Proof	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization β_V [%] = $V_{ua}/\phi V_n$	Status
Steel Strength*	866	6417	13	OK
*Steel failure (with lever arm)**	N/A	N/A	N/A	N/A
Pryout Strength*	866	9220	9	OK
Concrete edge failure in direction**	N/A	N/A	N/A	N/A

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

Steel Strength

V_{sa} [lb]	ϕ	ϕV_{sa} [lb]	V_{ua} [lb]
9872	0.650	6417	866

Pryout Strength

A_{Nc} [in²]	A_{Nco} [in²]	c	k_{cp}
110.25	144.00	-	2.000

$e_{c1,V}$ [in.]	$\psi_{ec1,N}$	$e_{c2,V}$ [in.]	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	k_{cr}
0.000	1.000	0.000	1.000	1.000	1.000	17.000

N_b [lb]	ϕ	ϕV_{cp} [lb]	V_{ua} [lb]
8601	0.700	9220	866

5. Combined tension and shear loads

$\beta_N = N_u/\phi N_n$	$\beta_V = V_u/\phi V_n$	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.252	0.135	5/3	14	OK

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

6. Warnings

- 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 ACI 318, Part D.4.4(c).
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- The anchor plate is assumed to be sufficiently stiff in order to be not deformed when subjected to the actions!

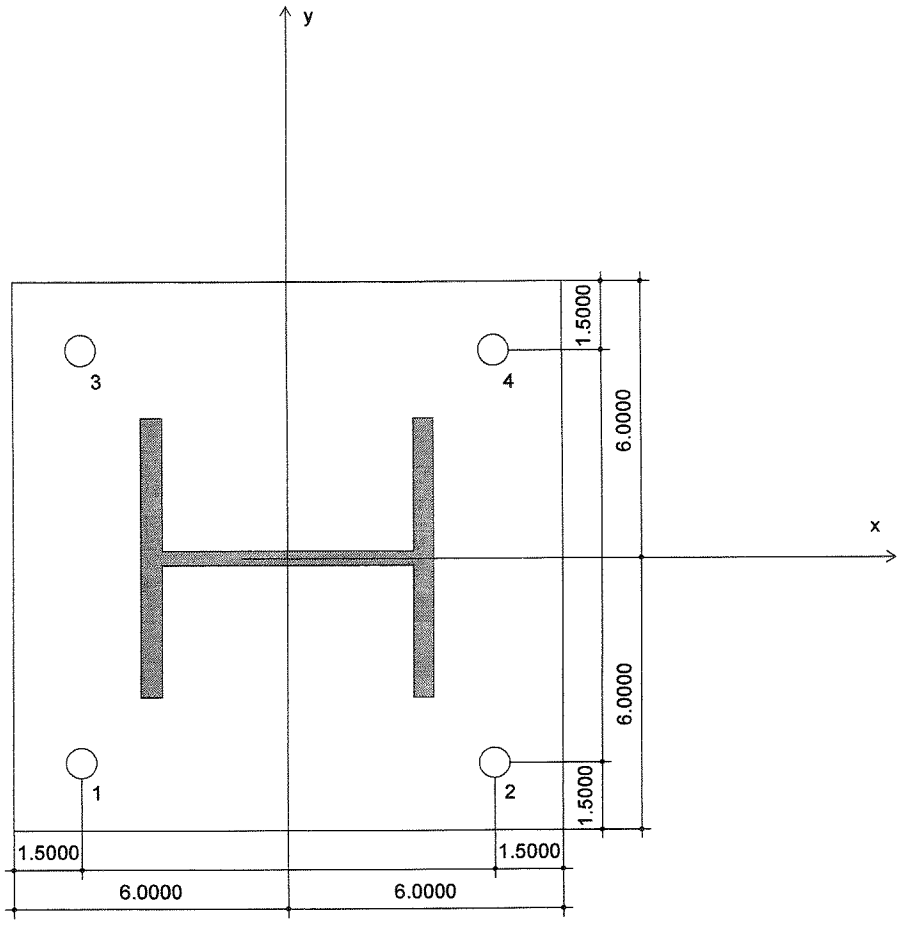
Fastening meets the design criteria!

Company:	NBZ Consulting Engineers	Page:	4
Specifier:	NZ	Project:	PSU 4" pipe anchor
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	- | -	Date:	10/29/2012
E-Mail:			

7. Installation data

Anchor plate, steel: -
Profile: W shape (AISC), 6.380 in. x 6.080 in. x 0.320 in. x 0.455 in.
Hole diameter in the fixture: d_f = 0.688 in.
Plate thickness (input): 0.750 in.
Recommended plate thickness: not calculated

Anchor type and diameter: Kwik Bolt TZ - SS 304, 5/8 (4)
Installation torque: 720.001 in.-lb
Hole diameter in the base material: 0.625 in.
Hole depth in the base material: 4.750 in.
Minimum thickness of the base material: 8.000 in.



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-4.500	-4.500	-	-	-	-
2	4.500	-4.500	-	-	-	-
3	-4.500	4.500	-	-	-	-
4	4.500	4.500	-	-	-	-

NBZ
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ph: 971.222.4378
fx: 503.848.8748

Project:		Sheet # 99
Location:		
Client:		Job #
Date:	By:	

UPPER PIPING SUPPORT & BRACING

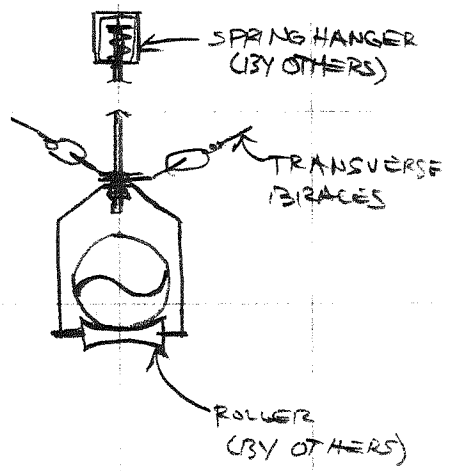
MAX 16" SCH 40 PIPE, WT/FT = 160 #/FT × 1.1 = 176 #/FT

MAX SUPPORT SPACING = 10'

$W_p = 176\ \#/FT \times 10' = 1760\ \#$

$F_{PV} = 0.11 \times W_p = 194\ \#$

$W_p + F_{PV} = 1954\ \#$



TYP. VERTICAL SUPPORTS

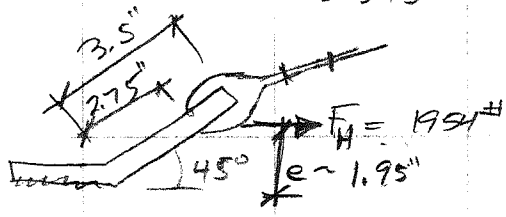
USE MIN. 3/4" ROD,

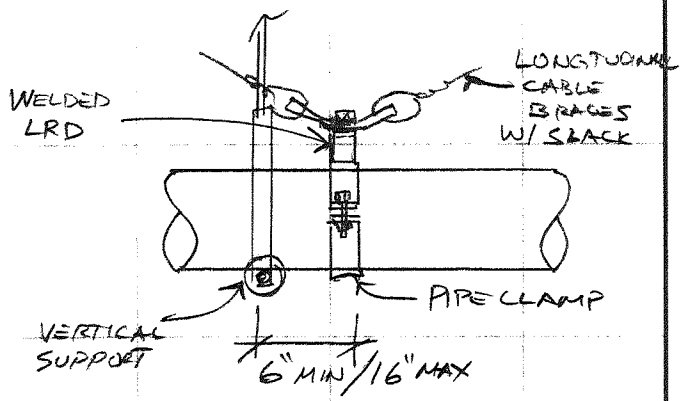
$P_{ALLOW} = 3230\ \# > W_p + F_{PV}$

BRACING:

@ 10' SPACING

$F_{BR} = \frac{1954\ \#}{\cos 45^\circ} = 2763\ \#$





TYPICAL BRACE DETAIL

$M_{MAX} = 1.95^k \times 1.95'' = 3.803\ ^{"k}$

$S_{REQ'D} = \frac{3.803\ ^{"k}}{0.75(36\ ksi)} = 0.141\ in^3$

4" × 1/2" BENT PL

$S = \frac{4 \times 0.5^2}{6} = 0.167\ in^3 > S_{REQ'D}$ OK.

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Project:		Sheet # 100
Location:		
Client:		Job #
Date:	By:	

6" PIPES - SINGLE HUNG

GRAVITY: $W_p = 43\ plf \times 12' \times 1.1 = 567^{\#}$

$W_p + F_{pu} = 1.11 \times W_p = 630^{\#} = P_{ROD}$

½" ROD OK

$P_{ALLOW} = 1350^{\#} > P_{ROD}$ OK.

SEISMIC: USE TYP. BRACE FOR 16" MAX PIPE, SEE PREV. CALC

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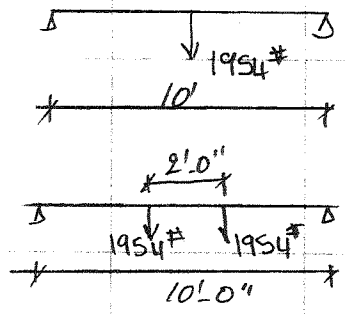
Project:		Sheet # 101
Location:		
Client:		Job #
Date:	By:	

a) Back to back ⊥L 6x4x3/8 "up to 16"ϕ"

$M_1 = \frac{2.281}{4 \text{ @ SHI only}} \times 10/4 = 5.7\ k'$

$M_2 = 1.954 \times 4 = 7.816\ k'$ controls

$f_b = \frac{7.816 \times 12}{6.64} = 14.2\ ksi$ OK



$\Delta_{max} = \frac{Pa}{24EI}(3\ell^2 - 4a^2)$

$= \frac{1.954 \times 48}{24 \times 29000 \times 26.7}(3 \times 120^2 - 4 \times 48^2) = .17 < \frac{L}{600} = .2"$

b) Pipes up to 6"ϕ ⊥L 4x4x5/16

$P_{max} = 630\ lbs$

$M_1 = .630 \times 10/4 = 1.58\ k'$

$M_2 = .630 \times 4 = 2.52\ k'$

$f_b = \frac{2.52 \times 12}{2.58} = 11.73\ ksi$

$\Delta_{max} = \frac{.630 \times 48}{24 \times 29000 \times 7.43}(3 \times 120^2 - 4 \times 48^2) = 0.199" < \frac{L}{600} = .2"$

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Project:		Sheet # 102
Location:		
Client:		Job #
Date:	By:	

2-4" PIPE SUPPORT & BRACING - SINGLE HUNG

$W_p = 24\ plf \times 40\ FT = 960^{\#} \times 1.1 = 1056^{\#}$

USE 40' MAX SPACING FOR BOTH TRANSVERSE & LONGITUDINAL

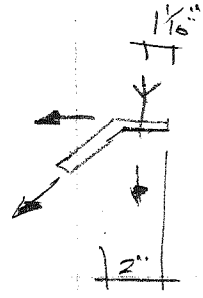
SEISMIC

$F_{BR} = \frac{1056}{\cos 45^\circ} = 1494^{\#} < P_{ALLOW} = 1500^{\#}$

3/16" CABLES w/ P1546

CK ANCHORS

$V_{ULT} = T_{ULT.} = 1.3 \times 1494^{\#} \times \cos 45^\circ = 1372^{\#}$



=> SEE PROFIS OUTPUT

GRAVITY:

$P_{ROD} = 24\ plf \times 12' \times 1.1 \times 1.11$
$= 352^{\#}$

$T_{ANCHOR} = 352^{\#} \times 1.3 = 458^{\#}$ => SEE PROFIS 1/2" KB-TZ w/ 2" EMB.

MIN. 1/2" ROD, $P_{ALLOW} = 1350^{\#} > P_{ROD}$ OK.

2" PIPE REDUCED ROD & ANCHOR SIZE:

$P_{ROD} = 8\ plf \times 10' \times 1.1 \times 1.11 = 98^{\#}$

$T_{ANCHOR} = 98 \times 1.3 = 127^{\#}$ => SEE PROFIS 3/8" KB-TZ w/ 2" EMB.

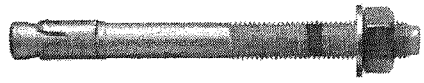
www.hilti.us

Profis Anchor 2.3.0

Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	I	Date:	11/4/2012
E-Mail:			

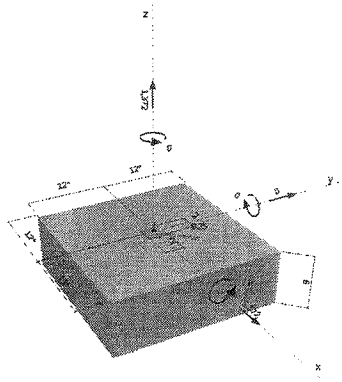
Specifier's comments: 4"PIPE BRACE ANCHORAGE (2" SIMILAR)

1 Input data



Anchor type and diameter:	**Kwik Bolt TZ - CS 1/2 (3 1/4)**
Effective embedment depth:	h_{ef} = 3.250 in., h_{nom} = 3.625 in.
Material:	Carbon Steel
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | 5/1/2013
Proof:	design method ACI 318 / AC193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate:	l_x x l_y x t = 2.000 in. x 2.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 6.000 in.
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Pullout Strength	1372	2625	53 / -	OK
Shear	Steel Strength	1372	3572	- / 39	OK

Loading	β_N	β_V	ζ	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.523	0.387	5/3	55	OK

3 Warnings

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

Fastening meets the design criteria!

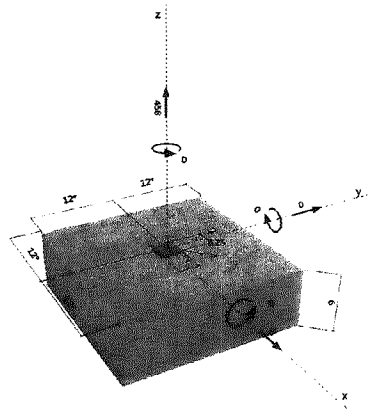
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	11/4/2012
E-Mail:			

Specifier's comments: 4"PIPE VERTICAL SUPPORT ANCHORAGE

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304 1/2 (2)**
Effective embedment depth:	h_{ef} = 2.000 in., h_{nom} = 2.375 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	4/1/2012 | 5/1/2013
Proof:	design method ACI 318 / AC193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate:	l_x x l_y x t = 2.000 in. x 2.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 6.000 in.
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Pullout Strength	458	1236	38 / -	OK
Shear	-	-	-	- / -	-

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	-

3 Warnings

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

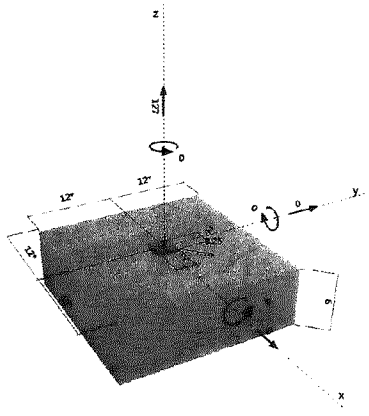
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	11/4/2012
E-Mail:			

Specifier's comments: 2"PIPE VERTICAL SUPPORT ANCHORAGE

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ - SS 304 3/8 (2)**
Effective embedment depth:	h_{ef} = 2.000 in., h_{nom} = 2.313 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	4/1/2012 | 5/1/2013
Proof:	design method ACI 318 / AC193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate:	l_x x l_y x t = 2.000 in. x 2.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 6.000 in.
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Strength	127	1481	9 / -	OK
Shear	-	-	-	- / -	-

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	-

3 Warnings

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

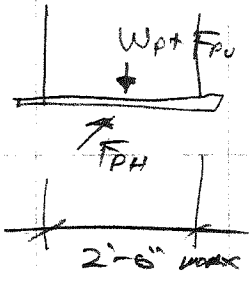
NBZ
Consulting Engineers
ph: 971.222.4378
fx: 503.848.8748

Project:		Sheet #
Location:		
Client:		Job #
Date:	By:	

PIPE SUPPORT TRAPEZE FOR (1) 2" + (1) 4"

GRAVITY: $W_{PD} = (24\ plf + 8\ plf) \times 10'\ MAX \times 1.1 = 352^{\#}$

$W_P + F_{PV} = 1.1 \times W_P = 391^{\#}$



SEISMIC: $W_{P(SEIS.)} = (244\#) \times 30' \times 1.1 = 1056^{\#}$

$F_{PH} = 1056^{\#}$

$F_{PR} = 1056 / \cos 45° = 1494^{\#}$ ⇒ USE SAME BRACE AS SINGLE HUNG 2-4" PER PREV. CALC

CK TRAPEZE:

STRUT → $M_{MAX\ xx} = \frac{391^{\#} \times 30"}{4} = 2933\ "\#$

P1000, $M_{ALLOW} = 25^{KSI} \times 0.202\ in^3 = 5050\ "\# > M_{MAX\ xx}$ OK.

W/SEIS. $M_{MAX\ yy} = \frac{1056^{\#} \times 30"}{4} = 7920\ "\#$

USE P1001 @ SEIS. RACKS

$M_{ALLOW\ xx} = 25^{KSI} \times 0.571\ in^3 = 14{,}275\ "\#$

$M_{ALLOW\ yy} = 25 \times 0.58 = 14{,}500\ "\#$

$\frac{2933}{14275} + \frac{7920}{14{,}500} = 0.75 < 1.0$ OK.

½" ROD → $P_{ROD} = 391^{\#} \times \frac{2}{3} = 261^{\#} \times 1.1 \times 1.11 = 318^{\#}$

$P_{ANCHOR} = 1.3\ P_{ROD} = 414^{\#}$ ⇒ SEE PROFIS

USE ½" HB-TZ W/ 2" EMB.

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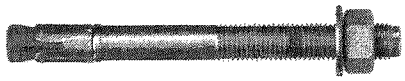
Profis Anchor 2.3.0

Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	11/4/2012
E-Mail:			

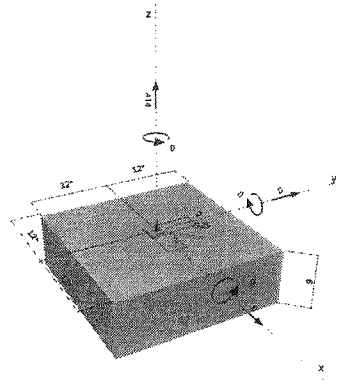
Specifier's comments: 4" + 2" PIPE TRAPEZE VERTICAL SUPPORT ANCHORS

1 Input data



Anchor type and diameter:	**Kwik Bolt TZ - SS 304 1/2 (2)**
Effective embedment depth:	h_{ef} = 2.000 in., h_{nom} = 2.375 in.
Material:	AISI 304
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | 5/1/2013
Proof:	design method ACI 318 / AC193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate:	l_x x l_y x t = 2.000 in. x 2.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 6.000 in.
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Pullout Strength	414	1236	34 / -	OK
Shear	-	-	-	- / -	-

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	-

3 Warnings

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

Fastening meets the design criteria!

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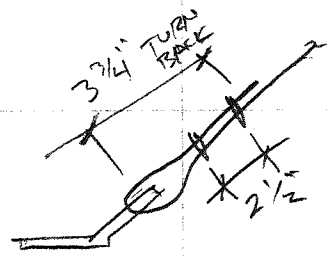
Project:		Sheet # 108
Location:		
Client:		Job #
Date:	By:	

DETERMINE CAPACITY OF CABLE BRACE ASSEMBLY

FOR 2→6" PIPES: USE 3/16" 7x19 GALVANIZED CABLE

$P_{ULT.} = 4200^{\#} \Rightarrow P_{ALLOW} = \frac{4200}{1.67} = 2515^{\#}$

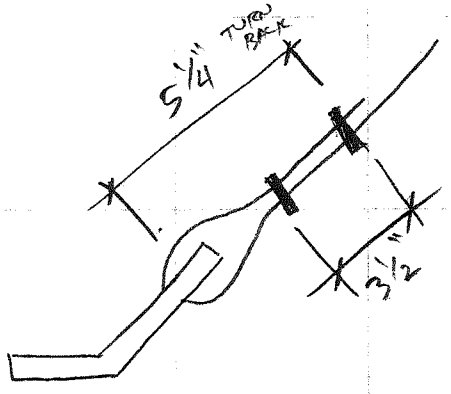


⇒ LOADING LIMITED BY P1546 BRACKET

$P_{ALLOW} = 1500^{\#}$

FOR 12→16" PIPES: USE 5/16" 7x19 GALVANIZED CABLE

$P_{ULT} = 9800^{\#} \Rightarrow P_{ALLOW} = \frac{9800^{\#}}{1.67} = 5868^{\#}$



⇒ USE CUSTOM BRACKETS TO DEVELOP REQUIRED LOAD RATING

$P_{MAX} = 2763^{\#}$

⇒ SEE PREV. CALC

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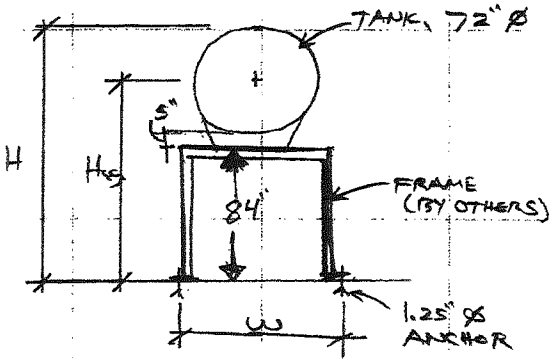
Project: PSU WHP		Sheet # 109
Location:		
Client:		Job #
Date:	By:	

EQUIPMENT DATA – FLOOR MOUNTED

1) DEAERATOR TANK

W_p = 20,000# (FILLED)

L = 123" @ TANK / 91" @ FRAME
W = 75.5" (BTWN. HOLES)
H = 181"



END VIEW

DETERMINE $H_{C.G.}$

TOTAL DRY WT. = 8100#
TANK DRY WT. = -3200#
4900# FRAME WT. ($h = \frac{84"}{2} = 42"$)

TANK WT. FILLED = 3200# + (1400 GAL × 8.34 #/GAL) = 14,876# ($h = 84" + 5" + \frac{72}{2} = 125"$)

EFFECTIVE $H_{C.G.} = \frac{4900\# \times 42" + 14,876\# \times 125"}{4900 + 14876} = 104.4"$

⇒ LET $H_{C.G.} = 105"$

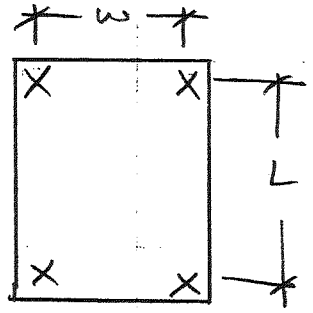
ADD 10% TO W_p PER SPEC.

$W_{p(MAX)} = 1.1 \times 20,000\# = 22,000\#$

5) STACKED TANKS

$W_p = 5985\# \times 1.1 = 6584\#$

L = 54"
W = 30"
h = 120"
} DISTANCE BETWEEN ANCHOR POINTS



PLAN

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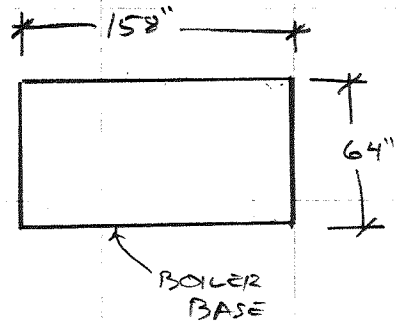
Project:		Sheet # 110
Location:		
Client:		Job #
Date:	By:	

2) 300 HP BOILER:

$$W_p = [27{,}200^{\#}_{(\text{ship wt.})} + 13{,}000^{\#}_{(H_2O)}] \times 1.1 = 44{,}220^{\#}$$

(10% INCREASE)

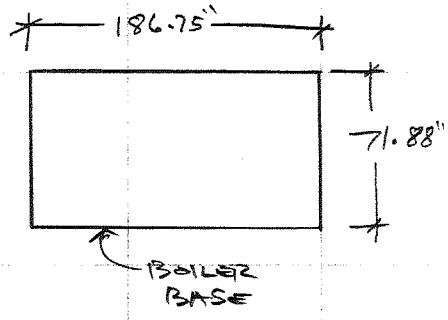
$L = 220"$ (OVERALL) / $158"$ (BASE FRAME)
$w = 106.5"$ (OVERALL) / $64"$ (BASE O.D.)
$h = 115"$
$H_{c.g.} \simeq \frac{115"}{2} = 57.5" \sim 58"$



3) 600 HP BOILER:

$$W_p = [49{,}400^{\#} + 19270^{\#}] \times 1.1 = 75{,}537^{\#}$$

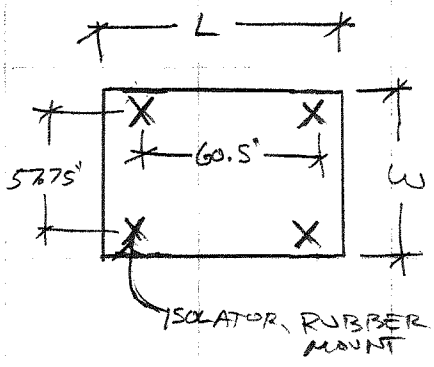
$L = 259.75"$ (OVERALL) / $186.75"$ (BASE FRAME)
$w = 124"$ (OVERALL) / $71.88"$ (BASE O.D.)
$h = 134"$
$H_{c.g.} \simeq \frac{134"}{2} = 67"$



4) IF-2 FAN:

$$W_p = (1500^{\#} + 116^{\#} + 88^{\#}) \times 1.1 = 1875^{\#}$$

$L = 68.5"$
$w = 60.75"$
$h = 83"$
$H_{c.g.} \simeq \frac{83}{2} = 41.5" \sim 42"$



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JOB: PSU WHP
SHEET NO.: ____ OF ____
CALCULATED BY: DS DATE 10/21/12
CHECKED BY: ____ DATE ____
PROJECT NO.: ____

DESIGN OF CONNECTIONS FOR EQUIPMENT ANCHORAGE (DIRECTION 1)

EQUIPMENT INFORMATION: **Deaerator Tank**

Equipment weight, Wp =	**22000**	lbs
Length, L =	**91**	in
Width, w =	**75.5**	in
Height, h =	**181**	in
Height to C.G., Hc.g. =	**105**	in

SEISMIC FORCE:

Fph =	**1.0**	x	Wp x 1.3 =	28600	lbs
Fpv =	**0.11**	x	Wp x 1.3 =	3146	lbs

ANALYSIS:

M(overturning) = Fph x Hc.g. =	3003000	in-lbs
M(resisting) = (0.9Wp - Fpv) x (w/2) =	628689	in-lbs
Tension per side, Ts = (Mo - Mr)/w =	31448	lbs (if negative Ts = 0)
Shear per side, Vs = Fph/2 =	14300	lbs
Number of Connections per side, n =	**2**	

Tension per connection, T = Ts/n =	**15724 lbs**
Shear per connection, V = Vs/n =	**7150 lbs**

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JOB: PSU WHP
SHEET NO.: _____ OF _____
CALCULATED BY: DS DATE 10/26/12
CHECKED BY: _____ DATE _____
PROJECT NO.: _____

DESIGN OF CONNECTIONS FOR EQUIPMENT ANCHORAGE (Load Direction 2)

EQUIPMENT INFORMATION: **Deaerator Tank**

Equipment weight, Wp =	**22000**	lbs
Length, L =	**80**	in
Width, w =	**86**	in
Height, h =	**181**	in
Height to C.G., Hc.g. =	**105**	in

SEISMIC FORCE:

Fph =	**1.0**	x Wp x 1.3 =	28600	lbs
Fpv =	**0.11**	x Wp x 1.3 =	3146	lbs

ANALYSIS:

M(overturning) = Fph x Hc.g. =	3003000	in-lbs
M(resisting) = (0.9Wp - Fpv) x (w/2) =	716122	in-lbs
Tension per side, Ts = (Mo - Mr)/w =	26592	lbs (if negative Ts = 0)
Shear per side, Vs = Fph/2 =	14300	lbs
Number of Connections per side, n =	**2**	

Tension per connection, T = Ts/n =	**13296**	**lbs**
Shear per connection, V = Vs/n =	**7150**	**lbs**

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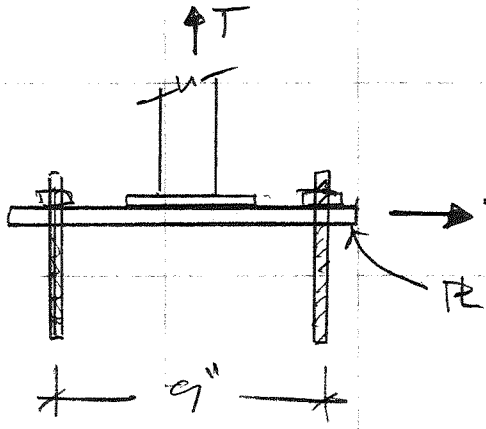
Project:		Sheet # 113
Location:		
Client:		Job #
Date:	By:	

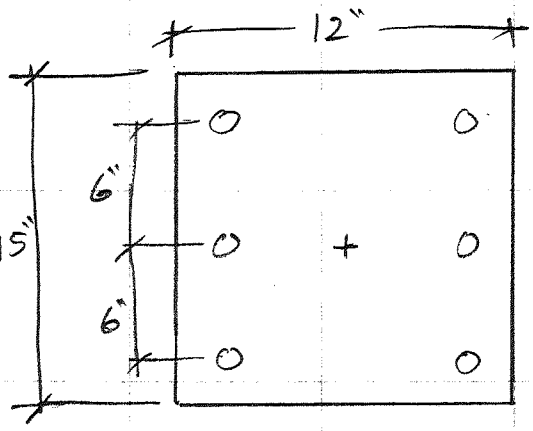
CONNECTION DESIGN - DEAERATOR TANK



$T = 15{,}724^{\#} / 1.3 = 12.1^{k}$

$V = 7150^{\#} / 1.3 = 5.5^{k}$

$M_{max} = \frac{12.1^{k} \times 9"}{4} = 27.23"^{k}$



$t = 3/4" \rightarrow S = \frac{15" \times t^2}{6} = 1.41 in^3$

$f_b = \frac{M_{max}}{S} = 19.4^{ksi}$

$F_b = .75(36^{ksi}) = 27^{ksi} > f_b$ OK.

⇒ SEE PROFIS OUTPUT FOR ANCHOR DESIGN

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Profis Anchor 2.3.2

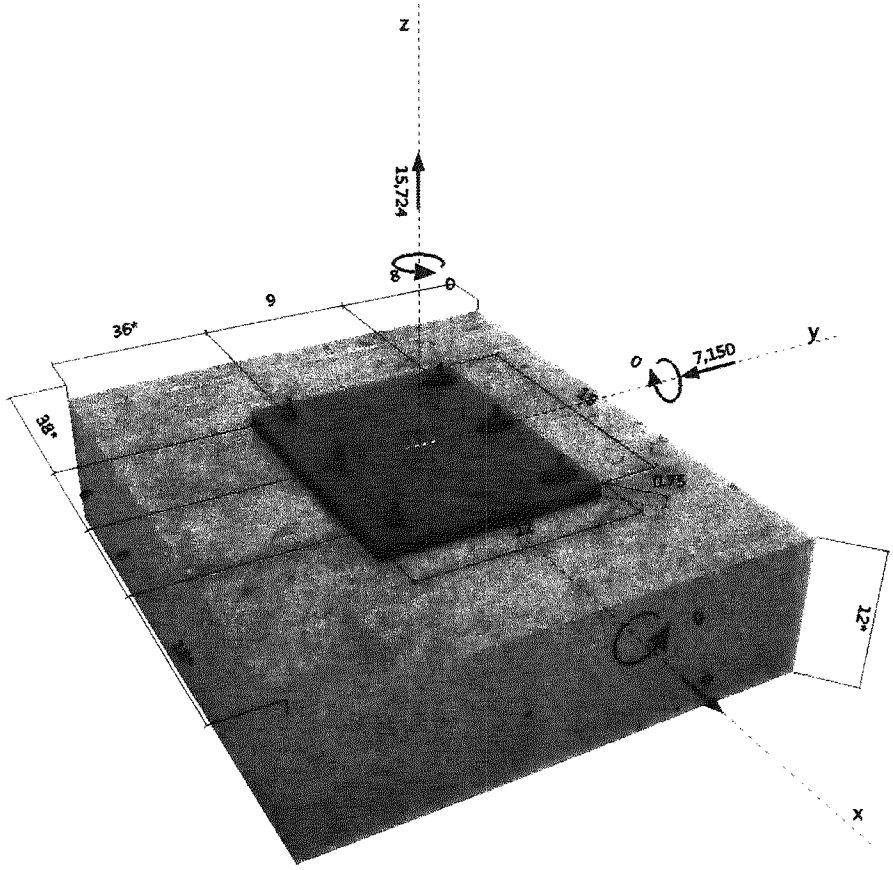
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: DEAERATOR TANK ANCHORAGE (direction 1 tension and shear)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 10.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 15.000 in. x 12.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 12.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: > No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



Company:
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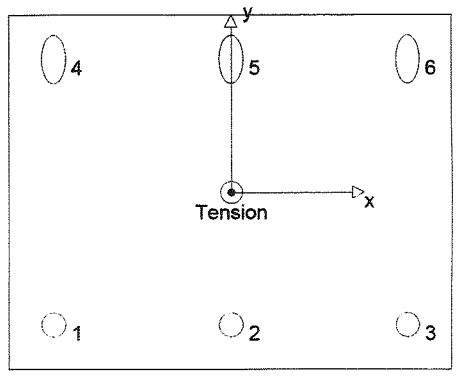
Page: 2
Project:
Sub-Project I Pos. No.:
Date: 10/26/2012

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	2621	2383	0	-2383
2	2621	2383	0	-2383
3	2621	2383	0	-2383
4	2621	0	0	0
5	2621	0	0	0
6	2621	0	0	0

max. concrete compressive strain: - [‰]
max. concrete compressive stress: - [psi]
resulting tension force in (x/y)=(0.000/0.000): 15724 [lb]
resulting compression force in (x/y)=(0.000/0.000): 0 [lb]

3 Tension load

	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization $\beta_N = N_{ua}/\phi N_n$	Status
Steel Strength*	2621	18479	15	OK
Bond Strength**	15724	20047	79	OK
Concrete Breakout Strength**	15724	21271	74	OK

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

3.1 Steel Strength

N_{sa} = ESR value refer to ICC-ES ESR 2322
$\phi N_{steel} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

Variables

n	$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
1	0.33	85000

Calculations

N_{sa} [lb]
28430

Results

N_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	ϕN_{sa} [lb]	N_{ua} [lb]
28430	0.650	1.000	18479	2621

Company:
Specifier:
Address:
Phone I Fax: |
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3.2 Bond Strength

$N_{ag} = \left(\frac{A_{Na}}{A_{Na0}}\right) \psi_{ed,Na}\, \psi_{g,Na}\, \psi_{ec,Na}\, \psi_{p,Na}\, N_{a0}$ ICC-ES AC308 Eq. (D-16b)

$\phi\, N_{ag} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

A_{Na} = see ICC-ES AC308, Part D.5.3.7

$A_{Na0} = s_{cr,Na}^2$ ICC-ES AC308 Eq. (D-16c)

$s_{cr,Na} = 20d \sqrt{\frac{\tau_{k,uncr}}{1450}} \leq 3\, h_{ef}$ ICC-ES AC308 Eq. (D-16d)

$c_{cr,Na} = \frac{s_{cr,Na}}{2}$ ICC-ES AC308 Eq. (D-16e)

$\psi_{ed,Na} = 0.7 + 0.3 \left(\frac{c_{a,min}}{c_{cr,Na}}\right) \leq 1.0$ ICC-ES AC308 Eq. (D-16m)

$\psi_{g,Na} = \psi_{g,Na0} + \left[\left(\frac{s_{avg}}{s_{cr,Na}}\right)^{0.5} \cdot (1 - \psi_{g,Na0})\right] \geq 1.0$ ICC-ES AC308 Eq. (D-16g)

$\psi_{g,Na0} = \sqrt{n} - \left[(\sqrt{n} - 1) \cdot \left(\frac{\tau_{k,c}}{\tau_{k,max,c}}\right)^{1.5}\right] \geq 1.0$ ICC-ES AC308 Eq. (D-16h)

$\tau_{k,max,c} = \frac{k_c}{\pi \cdot d} \sqrt{h_{ef} \cdot f_c'}$ ICC-ES AC308 Eq. (D-16i)

$\psi_{ec,Na} = \left(\frac{1}{1 + \frac{2e_N''}{s_{cr,Na}}}\right) \leq 1.0$ ICC-ES AC308 Eq. (D-16j)

$\psi_{p,Na} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{c_{cr,Na}}{c_{ac}}\right) \leq 1.0$ ICC-ES AC308 Eq. (D-16p)

$N_{a0} = \tau_{k,c} \cdot \kappa_{bond} \cdot \pi \cdot d \cdot h_{ef}$ ICC-ES AC308 Eq. (D-16f)

Variables

$\tau_{k,c,uncr}$ [psi]	d_{anchor} [in.]	h_{ef} [in.]	$c_{a,min}$ [in.]	s_{avg} [in.]	n	$\tau_{k,c}$ [psi]
2065	0.750	10.000	8.000	7.500	6	1000

k_c	f_c' [psi]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	c_{ac} [in.]	κ_{bond}
17	3000	0.000	0.000	25.000	1.00

Calculations

$s_{cr,Na}$ [in.]	$c_{cr,Na}$ [in.]	A_{Na} [in.^{2}]	A_{Na0} [in.^{2}]	$\psi_{ed,Na}$	$\tau_{k,max}$ [psi]
17.901	8.950	775.93	320.43	0.968	1250

$\psi_{g,Na0}$	$\psi_{g,Na}$	$\psi_{ec1,Na}$	$\psi_{ec2,Na}$	$\psi_{p,Na}$	N_{a0} [lb]
1.412	1.145	1.000	1.000	1.000	23562

Results

N_{ag} [lb]	ϕ_{bond}	$\phi_{seismic}$	$\phi_{nonductile}$	$\alpha_{N,seis}$	$\phi\, \alpha_{N,seis}\, N_{ag}$ [lb]	N_{ua} [lb]
63264	0.650	0.750	1.000	0.650	20047	15724

Company:
Specifier:
Address:
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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 318-08 Eq. (D-5)

$\phi\, N_{cbg} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\, h_{ef}^2$ ACI 318-08 Eq. (D-6)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\, e'_N}{3\, h_{ef}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-9)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-08 Eq. (D-11)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-08 Eq. (D-13)

$N_b = k_c\, \lambda\, \sqrt{f'_c}\, h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$
10.000	0.000	0.000	8.000	1.000

c_{ac} [in.]	k_c	λ	f'_c [psi]
25.000	17	1	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
1344.00	900.00	1.000	1.000	0.860	1.000	29445

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\, N_{cbg}$ [lb]	N_{ua} [lb]
37815	0.750	0.750	1.000	21271	15724

Company:		Page:	5
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

4 Shear load

	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization $\beta_V = V_{ua}/\phi V_n$	Status
Steel Strength*	2383	7165	34	OK
Steel failure (with lever arm)*	N/A	N/A	N/A	N/A
Pryout Strength (Concrete Breakout Strength controls)**	7150	43284	17	OK
Concrete edge failure in direction y-**	7150	18340	39	OK

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

4.1 Steel Strength

$V_{sa} = \alpha_{V,seis} (n\ 0.6\ A_{se,V}\ f_{uta})$ refer to ICC-ES ESR 2322

$\phi\ V_{steel} \geq V_{ua}$ ACI 318-08 Eq. (D-2)

Variables

n	$A_{se,V}$ [in.^{2}]	f_{uta} [psi]	$\alpha_{V,seis}$	$(n\ 0.6\ A_{se,V}\ f_{uta})$ [lb]
1	0.33	85000	0.700	17059

Calculations

V_{sa} [lb]
11941

Results

V_{sa} [lb]	ϕ_{steel}	$\phi_{nonductile}$	$\phi\ V_{sa}$ [lb]	V_{ua} [lb]
11941	0.600	1.000	7165	2383

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 318-08 Eq. (D-31)

$\phi\ V_{cpg} \geq V_{ua}$ ACI 318-08 Eq. (D-2)

A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\ h_{ef}^2$ ACI 318-08 Eq. (D-6)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\ e'_N}{3\ h_{ef}}} \right) \leq 1.0$ ACI 318-08 Eq. (D-9)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}} \right) \leq 1.0$ ACI 318-08 Eq. (D-11)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}} \right) \leq 1.0$ ACI 318-08 Eq. (D-13)

$N_b = k_c\ \lambda\ \sqrt{f'_c}\ h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]
2	10.000	0.000	0.000	17.000

$\psi_{c,N}$	c_{ac} [in.]	k_c	λ	f'_c [psi]
1.000	25.000	17	1	3000

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
1260.00	900.00	1.000	1.000	1.000	1.000	29445

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\ V_{cpg}$ [lb]	V_{ua} [lb]
82446	0.700	0.750	1.000	43284	7150

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

4.3 Concrete edge failure in direction y-

$V_{cbg} = \left(\frac{A_{Vc}}{A_{Vc0}}\right) \psi_{ec,V}\, \psi_{ed,V}\, \psi_{c,V}\, \psi_{h,V}\, \psi_{parallel,V}\, V_b$ ACI 318-08 Eq. (D-22)

$\phi\, V_{cbg} \geq V_{ua}$ ACI 318-08 Eq. (D-2)

A_{Vc} see ACI 318-08, Part D.6.2.1, Fig. RD.6.2.1(b)

$A_{Vc0} = 4.5\, c_{a1}^2$ ACI 318-08 Eq. (D-23)

$\psi_{ec,V} = \left(\frac{1}{1 + \frac{2e'_v}{3c_{a1}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-26)

$\psi_{ed,V} = 0.7 + 0.3\left(\frac{c_{a2}}{1.5c_{a1}}\right) \leq 1.0$ ACI 318-08 Eq. (D-28)

$\psi_{h,V} = \sqrt{\frac{1.5c_{a1}}{h_a}} \geq 1.0$ ACI 318-08 Eq. (D-29)

$V_b = \left(7\left(\frac{l_e}{d_a}\right)^{0.2} \sqrt{d_a}\right) \lambda \sqrt{f'_c}\, c_{a1}^{1.5}$ ACI 318-08 Eq. (D-24)

Variables

c_{a1} [in.]	c_{a2} [in.]	e_{cV} [in.]	$\psi_{c,V}$	h_a [in.]
25.333	18.000	0.000	1.200	12.000

l_e [in.]	λ	d_a [in.]	f'_c [psi]	$\psi_{parallel,V}$
6.000	1	0.750	3000	1.000

Calculations

A_{Vc} [in.^{2}]	A_{Vc0} [in.^{2}]	$\psi_{ec,V}$	$\psi_{ed,V}$	$\psi_{h,V}$	V_b [lb]
816.00	2888.00	1.000	0.842	1.780	64172

Results

V_{cbg} [lb]	$\phi_{concrete}$	$\phi_{seismic}$	$\phi_{nonductile}$	$\phi\, V_{cbg}$ [lb]	V_{ua} [lb]
32605	0.750	0.750	1.000	18340	7150

5 Combined tension and shear loads

β_N	β_V	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.784	0.390	5/3	88	OK

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

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

6 Warnings

- To avoid failure of the anchor plate the required thickness can be calculated in PROFIS Anchor. Load re-distributions 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 loading!
- 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 ACI 318, Part D.4.4(c).
- 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
- The present version of the software does not account for adhesive anchor special design provisions corresponding to overhead applications. Refer to the ICC-ES Evaluation Service Report (e.g. section 4.1.1 of the ICC-ESR 2322) for details.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- An anchor design approach for structures assigned to Seismic Design Category C, D, E or F is given in ACI 318-08 Appendix D, Part D.3.3.4 this requires the governing design strength of an anchor or group of anchors be limited by ductile steel failure. If this is NOT the case, Part D.3.3.5 requires that the attachment that the anchor is connecting to the structure shall be designed so that the attachment will undergo ductile yielding at a load level corresponding to anchor forces no greater than the controlling design strength. In lieu of D.3.3.4 and D.3.3.5, the minimum design strength of the anchors shall be multiplied by a reduction factor per D.3.3.6.
  An alternative anchor design approach to ACI 318-08, Part D.3.3 is given in IBC 2009, Section 1908.1.9. This approach contains "Exceptions" that may be applied in lieu of D.3.3 for applications involving "non-structural components" as defined in ASCE 7, Section 13.4.2.
  An alternative anchor design approach to ACI 318-08, Part D.3.3 is given in IBC 2009, Section 1908.1.9. This approach contains "Exceptions" that may be applied in lieu of D.3.3 for applications involving "wall out-of-plane forces" as defined in ASCE 7, Equation 12.11-1 or Equation 12.14-10.
- It is the responsibility of the user when inputting values for brittle reduction factors ($\phi_{nonductile}$) different than those noted in ACI 318-08, Part D.3.3.6 to determine if they are consistent with the design provisions of ACI 318-08, ASCE 7 and the governing building code.
  Selection of $\phi_{nonductile}$ = 1.0 as a means of satisfying ACI 318-08, Part D.3.3.5 assumes the user has designed the attachment that the anchor is connecting to undergo ductile yielding at a force level <= the design strengths calculated per ACI 318-08, Part D.3.3.3.

Fastening meets the design criteria!

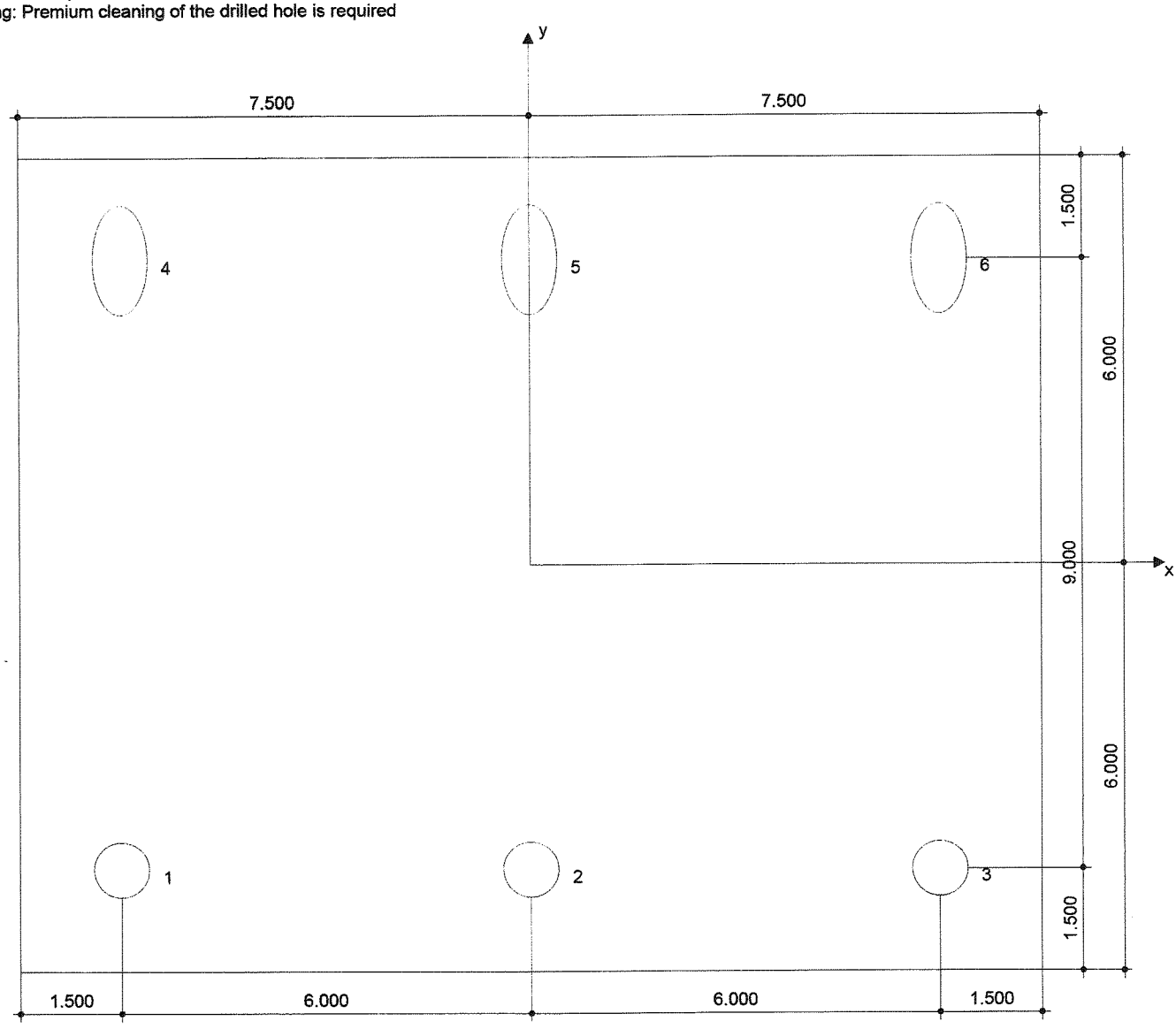
Company:
Specifier:
Address:
Phone I Fax:
E-Mail:

Page: 8
Project:
Sub-Project I Pos. No.:
Date: 10/26/2012

7 Installation data

Anchor plate, steel: -
Profile: no profile; 0.000 x 0.000 x 0.000 in.
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.750 in.
Recommended plate thickness: not calculated
Cleaning: Premium cleaning of the drilled hole is required

Anchor type and diameter: HIT-RE 500-SD + HAS-R 304/316, 3/4
Installation torque: 1200.000 in.lb
Hole diameter in the base material: 0.875 in.
Hole depth in the base material: 10.000 in.
Minimum thickness of the base material: 11.750 in.



Coordinates Anchor in.

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	-6.000	-4.500	38.000	30.000	36.000	17.000
2	0.000	-4.500	44.000	24.000	36.000	17.000
3	6.000	-4.500	50.000	18.000	36.000	17.000

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
4	-6.000	4.500	38.000	30.000	45.000	8.000
5	0.000	4.500	44.000	24.000	45.000	8.000
6	6.000	4.500	50.000	18.000	45.000	8.000

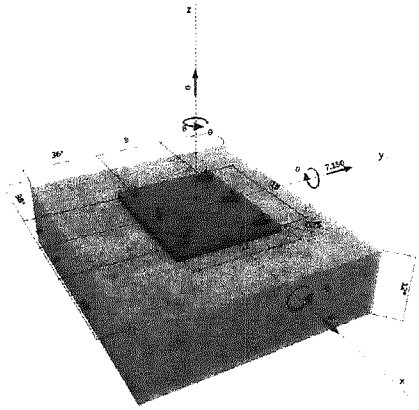
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: DEAERATOR TANK ANCHORAGE (direction 1 shear only)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 10.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 15.000 in. x 12.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 12.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: > No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	-	-	-	- / -	-
Shear	Concrete edge failure in direction y+	7150	15220	- / 47	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	-

3 Warnings

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

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Profis Anchor 2.3.2

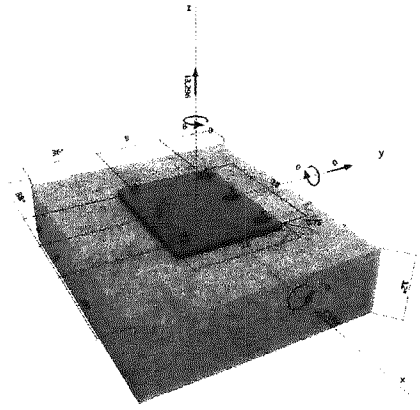
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: DEAERATOR TANK ANCHORAGE (direction 2 tension and shear)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 10.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 15.000 in. x 12.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 12.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: > No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Bond Strength	13296	20047	67 / -	OK
Shear	Concrete edge failure in direction x-	7150	13014	- / 55	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.663	0.549	5/3	88	OK

3 Warnings

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

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Profis Anchor 2.3.2

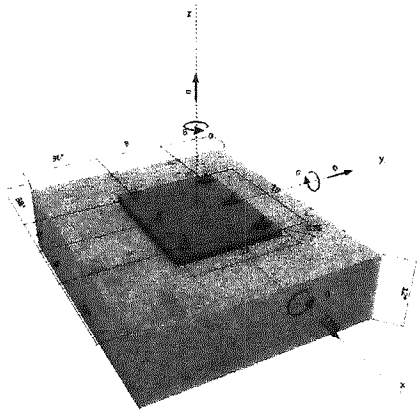
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: DEAERATOR TANK ANCHORAGE (direction 2 shear only)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 10.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 15.000 in. x 12.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 12.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: > No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	-	-	-	- / -	-
Shear	Concrete edge failure in direction x+	7150	10505	- / 69	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	-

3 Warnings

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

NBZ
Consulting Engineers
ph: 971.222.4378
fx: 503.848.8748

JOB: **PSU WHP**
SHEET NO.: _____ OF _____
CALCULATED BY: **DS** DATE ***10/21/12***
CHECKED BY: _____ DATE _____
PROJECT NO.: _____

DESIGN OF CONNECTIONS FOR EQUIPMENT ANCHORAGE

EQUIPMENT INFORMATION: **300 HP Boiler**

Equipment weight, Wp =	**44220**	lbs
Length, L =	**158**	in
Width, w =	**64**	in
Height, h =	**115**	in
Height to C.G., Hc.g. =	**58**	in

SEISMIC FORCE:

Fph =	**1.0**	x Wp x 1.3 =	57486	lbs
Fpv =	**0.11**	x Wp x 1.3 =	6323	lbs

ANALYSIS:

M(overturning) = Fph x Hc.g. =	3334188	in-lbs
M(resisting) = (0.9Wp - Fpv) x (w/2) =	1071185	in-lbs
Tension per side, Ts = (Mo - Mr)/w =	35359	lbs (if negative Ts = 0)
Shear per side, Vs = Fph/2 =	28743	lbs

Tension per foot, T = Ts/L =	**2686 lb/ft**
Shear per foot, V = Vs/L =	**2183 lb/ft**

ANCHOR SPACING = 18"

CK GROUP OF (3) ANCHORS.

$T = 1.5' \times 3 \times 2686\ plf = 12{,}087\ \#$

$V = 1.5' \times 3 \times 2183\ plf = 9{,}824\ \#$

⇒ SEE PROFIS OUTPUT

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Profis Anchor 2.3.2

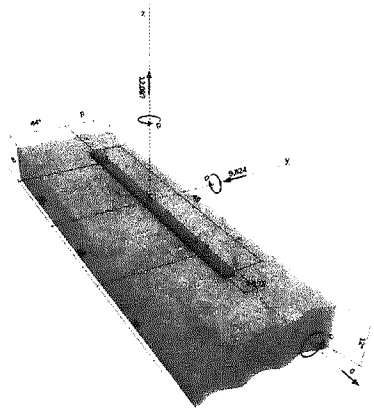
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: 300 HP BOILER ANCHORAGE (tension and shear)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 7.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 48.000 in. x 2.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 12.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Bond Strength	12087	15679	78 / -	OK
Shear	Steel Strength	3275	7165	- / 46	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.771	0.457	5/3	92	OK

3 Warnings

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

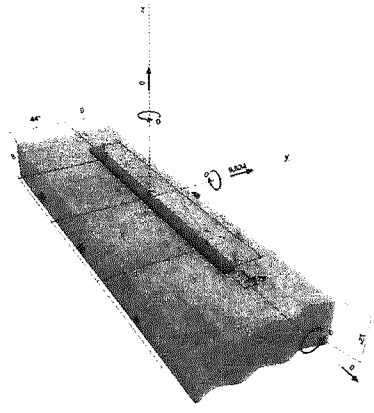
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: 300 HP BOILER ANCHORAGE (shear only)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 7.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 48.000 in. x 2.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 12.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	-	-	-	- / -	-
Shear	Concrete edge failure in direction y+	9824	16815	- / 59	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	-

3 Warnings

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

NBZ
Consulting Engineers
ph: 971.222.4378
fx: 503.848.8748

JOB:	PSU WHP		
SHEET NO.:	198	OF	
CALCULATED BY:	DS	DATE	10/21/12
CHECKED BY:		DATE	
PROJECT NO.:			

DESIGN OF CONNECTIONS FOR EQUIPMENT ANCHORAGE

EQUIPMENT INFORMATION: **600 HP Boiler**

Equipment weight, Wp =	**75537**	lbs
Length, L =	**186.75**	in
Width, w =	**71.88**	in
Height, h =	**134**	in
Height to C.G., Hc.g. =	**67**	in

SEISMIC FORCE:

Fph =	**1.0**	x	Wp x 1.3	=	98198 lbs
Fpv =	**0.11**	x	Wp x 1.3	=	10802 lbs

ANALYSIS:

M(overturning) = Fph x Hc.g. =	6579273	in-lbs
M(resisting) = (0.9Wp - Fpv) x (w/2) =	2055103	in-lbs
Tension per side, Ts = (Mo - Mr)/w =	62941	lbs (if negative Ts = 0)
Shear per side, Vs = Fph/2 =	49099	lbs

Tension per foot, T = Ts/L =	**4044 lb/ft**
Shear per foot, V = Vs/L =	**3155 lb/ft**

ANCHOR SPACING = 16"

CK GROUP OF (3) ANCHORS.

$T = 1.33' \times 3 \times 4044\ plf = 16{,}176\#$

$V = 1.33' \times 3 \times 3155\ plf = 12{,}617\#$

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Profis Anchor 2.3.2

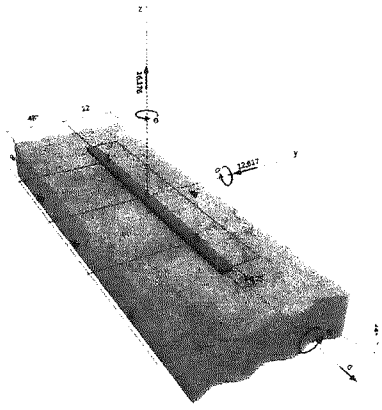
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: 600 HP BOILER ANCHORAGE (tension and shear)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 11.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 48.000 in. x 2.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 14.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Bond Strength	16176	23200	70 / -	OK
Shear	Steel Strength	4206	7165	- / 59	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.697	0.587	5/3	96	OK

3 Warnings

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

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Profis Anchor 2.3.2

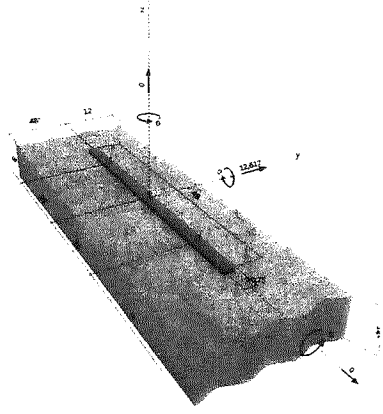
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	10/26/2012
E-Mail:			

Specifier's comments: 600 HP BOILER ANCHORAGE (shear only)

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 3/4**
Effective embedment depth:	$h_{ef,act}$ = 11.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 48.000 in. x 2.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 14.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	-	-	-	- / -	-
Shear	Concrete edge failure in direction y+	12617	19604	- / 65	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	-	-	-	-	-

3 Warnings

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

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JOB:	PSU WHP		
SHEET NO.:	131	OF	
CALCULATED BY:	DS	DATE	11/1/12
CHECKED BY:		DATE	
PROJECT NO.:			

DESIGN OF CONNECTIONS FOR EQUIPMENT ANCHORAGE

EQUIPMENT INFORMATION: **IF-2 FAN**

Equipment weight, Wp =	**1875**	lbs
Length, L =	**68.5**	in
Width, w =	**57.75**	in
Height, h =	**83**	in
Height to C.G., Hc.g. =	**42**	in

SEISMIC FORCE:

Fph =	**1.0**	x	Wp x 1.3	=	2438 lbs
Fpv =	**0.11**	x	Wp x 1.3	=	268 lbs

ANALYSIS:

M(overturning) = Fph x Hc.g. =	102375	in-lbs
M(resisting) = (0.9Wp - Fpv) x (w/2) =	40984	in-lbs
Tension per side, Ts = (Mo - Mr)/w =	1063	lbs (if negative Ts = 0)
Shear per side, Vs = Fph/2 =	1219	lbs
Number of Connections per side, n =	**2**	
Tension per connection, T = Ts/n =	**532**	**lbs**
Shear per connection, V = Vs/n =	**609**	**lbs**

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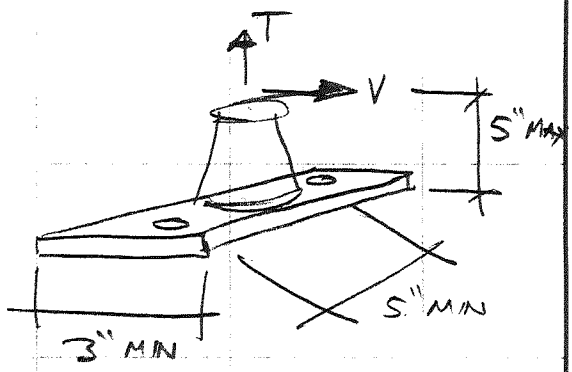
Project:		Sheet # 138
Location:		
Client:		Job #
Date:	By:	

IF-2 ISOLATOR ANCHORAGE

$$T_{MAX} = \frac{532^{\#} \times 5''}{(3''/2)} = 1773^{\#}$$

$$V_{MAX} = 609^{\#}$$



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Profis Anchor 2.3.3

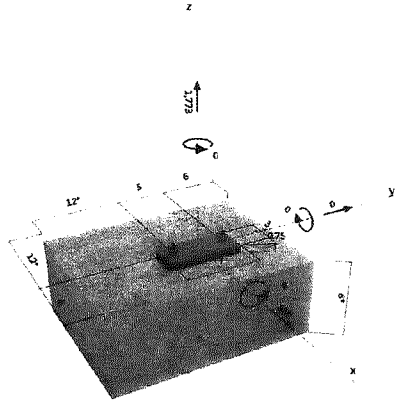
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	I	Date:	11/1/2012
E-Mail:			

Specifier's comments: IF-2 ANCHORAGE TO FLOOR

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 5/8**
Effective embedment depth:	$h_{ef,act}$ = 5.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 3.000 in. x 7.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 8.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Bond Strength	1773	3405	53 / -	OK
Shear	Concrete edge failure in direction x+	609	3581	- / 18	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.521	0.170	5/3	39	OK

3 Warnings

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

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JOB:	**PSU WHP**		
SHEET NO.:	133 A	OF	
CALCULATED BY:	**DS**	DATE	*11/14/12*
CHECKED BY:		DATE	
PROJECT NO.:			

DESIGN OF CONNECTIONS FOR EQUIPMENT ANCHORAGE

EQUIPMENT INFORMATION: **STACKED TANKS**

Equipment weight, Wp =	**6584**	lbs
Length, L =	**54**	in
Width, w =	**30**	in
Height, h =	**120**	in
Height to C.G., Hc.g. =	**81**	in

SEISMIC FORCE:

Fph =	**1.0**	x Wp x 1.3 =	8559	lbs
Fpv =	**0.11**	x Wp x 1.3 =	942	lbs

ANALYSIS:

M(overturning) = Fph x Hc.g. =	693295	in-lbs
M(resisting) = (0.9Wp - Fpv) x (w/2) =	74761	in-lbs
Tension per side, Ts = (Mo - Mr)/w =	20618	lbs (if negative Ts = 0)
Shear per side, Vs = Fph/2 =	4280	lbs
Number of Connections per side, n =	**2**	
Tension per connection, T = Ts/n =	**10309**	**lbs**
Shear per connection, V = Vs/n =	**2140**	**lbs**

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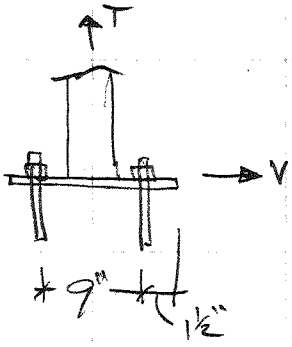
Project: PSU WHP		Sheet # 133B
Location:		
Client:		Job #
Date:	By:	

CONNECTION DESIGN - STACKED TANKS



$T = 10309^{\#} / 1.3 = 7930^{\#}$

$V = 2140^{\#} / 1.3 = 1646^{\#}$

$$M_{max} = \frac{7.93^{k} \times 9"}{4} = 17.84^{"k}$$

$$t = 3/4" \rightarrow S = \frac{12" \times (3/4")^2}{6} = 1.125\ in^3$$

$$f_b = \frac{M_{max}}{S} = 15.85^{"k}$$

$F_b = 27\ ksi > f_b \therefore 5/8"$ Pl OK

=> SEE PROFIS OUTPUT FOR ANCHOR DESIGN

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Profis Anchor 2.3.3

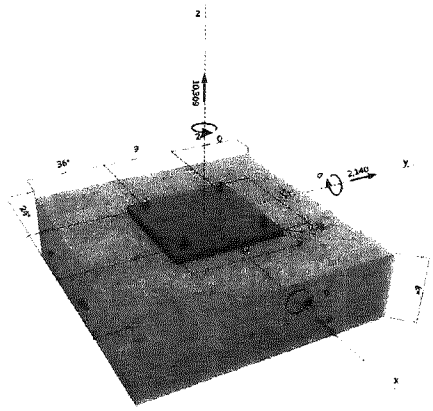
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	I	Date:	11/14/2012
E-Mail:			

Specifier's comments: STACKED TANKS ANCHORAGE

1 Input data

Anchor type and diameter:	**HIT-RE 500-SD + HAS-R 304/316 5/8**
Effective embedment depth:	$h_{ef,act}$ = 6.500 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM F 593
Evaluation Service Report::	ESR 2322
Issued I Valid:	4/1/2010 | 4/1/2012
Proof:	design method ACI 318 / AC308
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate:	l_x x l_y x t = 12.000 in. x 12.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 8.000 in., Temp. short/long: 32/32 °F
Installation:	hammer drilled hole, installation condition: dry
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Bond Strength	10309	11205	93 / -	OK
Shear	Concrete edge failure in direction y+	2140	12354	- / 18	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.920	0.173	1.0	92	OK

3 Warnings

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

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Project:		Sheet # 134
Location:		
Client:		Job #
Date:	By:	

EQUIPMENT DATA — SUSPENDED EQUIPMENT

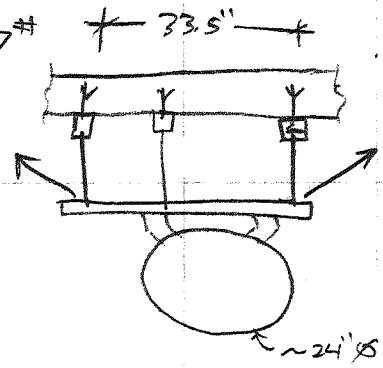
1) EF-1 FAN:

$W_p = (190^{\#} + 93^{\#} + 41^{\#}) \times 1.1 = 357^{\#}$

L = 33.5" (@ HANGING RAIL)

w = 31"

h = 28" ±



2) IF-1 FAN:

$W_p = (470^{\#} + 57^{\#} + 95^{\#}) \times 1.1 = 684^{\#}$

L = 49" (@ HANGING RAIL)

w = 45"

h = 46" ±

DETAIL SIMILAR TO EF-1

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Project:		Sheet # 135
Location:		
Client:		Job #
Date:	By:	

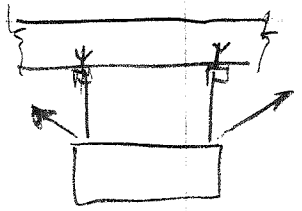
TYPICAL FAN SUPPORT DESIGN (EF-1 & IF-1)

$W_{P(MAX)} = 684^{\#}$

$F_{PH} = 1.0 \times 684 = 684^{\#}$

$F_{PV} = 0.11 \times 684 = 75^{\#}$

$W_P + F_{PV} = 759^{\#}$



DESIGN FOR (4) RODS ← CONSERVATIVE

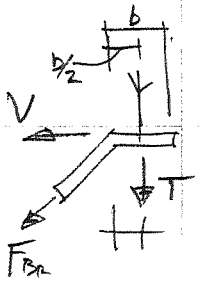
$P_{ROD} = \frac{759^{\#}}{4} = 190^{\#}$

½" ROD, $P_{ALLOW} = 1350^{\#} > P_{ROD}$ OK.

$F_{BR} = 684^{\#} / \cos 45^{\circ} = 967^{\#}$ ⇒ USE 3/16" CABLE W/ PIS 46

OK PER CALC PAGE

BRACE ANCHORAGE



$V_{BOLT} = 967 \times \cos 45 \times 1.3 = 889^{\#}$

$T_{BOLT} = 2 \times 889^{\#} = 1778^{\#}$ ← Prying factor

⇒ SEE PROFIS OUTPUT

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Profis Anchor 2.3.3

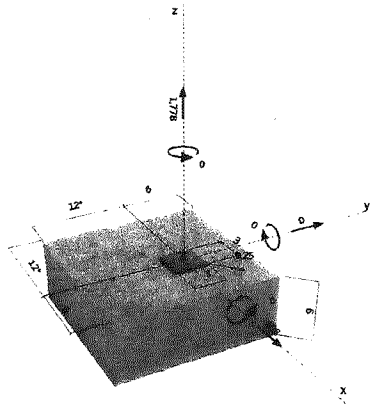
Company:		Page:	1
Specifier:		Project:	
Address:		Sub-Project I Pos. No.:	
Phone I Fax:	|	Date:	11/2/2012
E-Mail:			

Specifier's comments: SUSPENDED FAN BRACE ANCHORS

1 Input data

Anchor type and diameter:	**Kwik Bolt TZ - CS 1/2 (3 1/4)**
Effective embedment depth:	h_{ef} = 3.250 in., h_{nom} = 3.625 in.
Material:	Carbon Steel
Evaluation Service Report::	ESR 1917
Issued I Valid:	4/1/2012 | 5/1/2013
Proof:	design method ACI 318 / AC193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.250 in.
Anchor plate:	l_x x l_y x t = 3.000 in. x 3.000 in. x 0.250 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 3000, f_c' = 3000 psi; h = 6.000 in.
Reinforcement:	tension: condition A, shear: condition A; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	yes (D.3.3.6)

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



2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Pullout Strength	1778	2625	68 / -	OK
Shear	Concrete edge failure in direction x+	888	1996	- / 45	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.677	0.445	5/3	79	OK

3 Warnings

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

4). ASCE7 6.5.13, Design Wind Load on Open Buildings and Others Structures

$F = q_z G C_f A_f$			Eq. 6-25
$q_z = .00256 K_z K_{zt} K_d V^2 I$			Eq. 6-15
Ht. z at the centroid of area Af =	30	ft	Exp = B
Exposure coefficient K_z =	0.70		6.5.6.6, T-6-3 for MWFR
Topography factor K_{zt} =	1.00		6.5.7.2
Directionality factor K_d =	0.95		Table 6-4
Wind Speed V =	94.5	mph	
Importance factor I_w =	1.15		Table 6-1
q_z =	17.48	psf	
Gust Effect factor G =	0.85		6.5.8
Force coeff C_f =	1		Figure 6-18 through 6-22
Design wind pressure, F/A_f =	14.86	psf	

$F/A_f = 14.86 \times 1.9 = 28.3$ psf

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Project:		Sheet # 138
Location:		
Client:		Job #
Date:	By:	

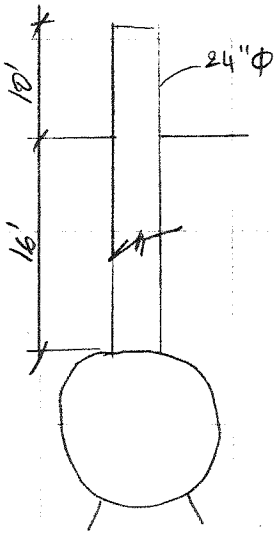
Roof stacks support design:

24"Φ Stack $D_L = 29.3 \times 18' = 528$ Lbs

wind pressure = 28.3 psf

$W_w = 28.3 \times 2 \times 10 = 566$ Lbs

Seismic $F_p = 1.0G = 528$ Lbs



wind controls:

Reaction @ roof:

$D_L = 528$ Lbs

$W_p = 566$ Lbs

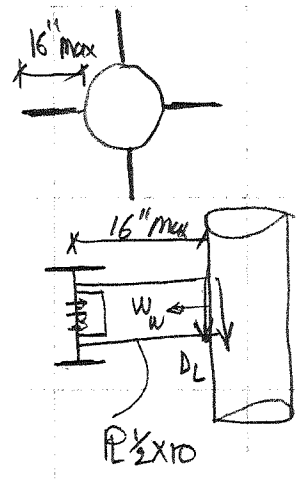
$M_w = 566 \times 5 = 2830$ Lb'

Reaction / support

$D_L = \frac{528}{4} = 132$ Lbs

Tension = comp $= \frac{Ww}{2} = \frac{566}{2} = 283\#$

couple ↓ ↑ $= \frac{2830}{2} = 1415\#$



Check ½" x 10" plate

$M = (.132 + 1.415)16 = 24.75$ k"

$f_b = \frac{24.75}{10^2 \times 1/2/6} = 3$ ksi

$f_a = \frac{.283}{10 \times .5} = .0566$ ksi

$K\ell/r = \frac{16 \times 2}{.288 \times 1/2} = 222 \rightarrow F_a = \frac{12\pi^2 E}{23(K\ell/r)^2} = 3$ ksi

$C_c = \sqrt{\frac{2\pi^2 E}{F_y}} = 126 < \frac{K\ell}{r}$

$\frac{f_a}{F_a} + \frac{f_b}{F_b} = \frac{.0566}{3} + \frac{3}{.6 \times 36} = .3 < 1$ OK

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Project:		Sheet # 139
Location:		
Client:		Job #
Date:	By:	

Check welds to stack

$\downarrow f_{w_1} = \frac{1.415 + .132}{2 \times 10} = .077\ k/in$

$\rightarrow f_{w_2} = \frac{.283}{2 \times 10} = .014\ k/in$

$f_w = \sqrt{.077^2 + .014^2} = .08\ k/in < F_w = 3.7\ k/in$

Check welds L3x3 to PL ½ x 10

$\downarrow f_{w_1} = \frac{.132}{10} = .0132\ k/in$

$\rightarrow f_{w_2} = \frac{.283}{10} = .0283\ k/in$

$\rightarrow f_{w_3} = \frac{24.75}{9 \times 2} = 1.375\ k/in$

$f_w = 1.4\ k/in < F_w = 3.7\ k/in$

Check bolts (3) 5/8" ϕ A325

$\text{Shear/bolt} = \frac{1.452 + .132}{3} = .528\ k$ Ok

$\text{Tension/bolt} = \frac{.283}{3} + \frac{(1.452 + .132)3}{1.5 \times 3} = 1.15\ k$

Check L3x3x3/8

$M_x = (1.452 + .132) \times 16 = 25.35\ k''$

$f_{bx} = \frac{25.35}{9^2 \times 3/8/6} = 5\ ksi$

$M_y = .283 \times 1.5 = .425\ k''$

$f_{by} = \frac{.425}{9 \times (3/8)^2/6} = 2\ ksi$

$\frac{5}{.6 \times 36} + \frac{2}{.75 \times 36} = .3 < 1$ Ok

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Project:		Sheet # 140
Location:		
Client:		Job #
Date:	By:	

Stairs & Platforms Design

Design criteria

Framing + 1¾" Grating Dead load = 10 psf

Live Loads:

1) Platforms 60 psf

2) Stairs
- Individual treads 100 psf uniform or 300 Lbs concentrated load @ any point.
- Stringers = 100 psf
- Handrail = 50 plf horizontal or 200 Lbs in any direction

A] Platform:

Trib = $\frac{3'3''}{2}$ = 1.625'

$w_{DL_1} = 10 \times 1.625 = 16.25$ plf

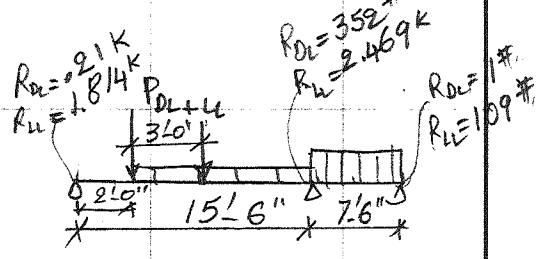
$w_{LL_1} = 60 \times 1.625 = 98$ plf

$P_{DL} = 10 \times \frac{3}{2} \times \frac{13}{2} = 98\#$

$P_{LL} = 100 \times \frac{3}{2} \times \frac{13}{2} = 975\#$

$w_{DL_2} = 10 \times 4/2 = 20$ plf

$w_{LL_2} = 60 \times 4/2 = 120$ plf



C10X15.3
See Risa output "PSU Beam1"

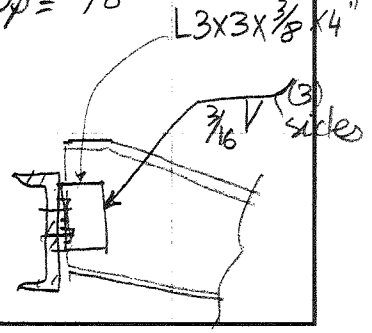
Seismic force: $F_p = .19\, w_p$ stairs $w_p = 98\#$

$F_p = .19 \times 98 = 19$ Lbs

Check stringer to C10 connection:

$\downarrow R_y = 98 + 975 = 1073\#$; $R_x = 19$ Lbs

$f_w = \frac{1.073}{2 \times 3 + 4} = .108$ k/in $f_{w_x} \approx$ negl.



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Project:		Sheet # 141
Location:		
Client:		Job #
Date:	By:	

Check bolts (2) 3/4" ϕ A307

Shear/bolt $= \frac{1.073}{2} = .54K$ OK

Tension $= \frac{19 \times 3}{1.5} = 38 Lbs$

Check (N) C10 to (E) C10 connection:

$R = \frac{(10+60)1.5 \times 135}{2} = 709 Lbs$

$f_v = \frac{.709}{2 \times 3 + 5} = .07K/in$ OK

(2) 3/4" ϕ bolt OK by inspection

Check connection to (E) concrete wall

$R_{DL} = .21 \times 1.2 \times 1.3 = .328K$
$R_{LL} = 1.814 \times 1.6 \times 1.3 = 3.773K$ } 4106#

$M = (.328 + 3.773)2 = 8.2 K"$

Use (2) 3/4" ϕ Hilti KB-TZ w/ 4" embed (see Profis output)

Check HSS4x4x1/4 Post

$P_{max} = (.352 + 2.469) + \frac{.709 \times 1}{4} = 3k$

$L_{unb} = 8'6"$ $P_{ALL} = 70K$ OK

Check base plate PL 1/2 x 6 x 0'-9"

$f_b = \frac{3}{6 \times 9} = .055 ksi$

$t_{req} = 2 \times 1.625 \sqrt{\frac{.055}{36}} = .13"$ OK

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Project:		Sheet # 142
Location:		
Client:		Job #
Date:	By:	

B) Stairs

Check (E) stringer C10X15.3

$w = (10+100)\frac{3}{2} = .165$ K/LF

$M = .165 \times \frac{13.5^2}{8} = 3.76$ K"

$f_b = \frac{3.76 \times 12}{13.5} = 3.34$ ksi $< F_b = \frac{12000}{8.81 \times 13.5 \times 12} = 8.4$ ksi

Check handrail 1½"Φ STD pipe:

$M = .05 \times 4^2/8 = .1$ K'

or $M = \frac{.2 \times 4}{4} = .2$ K' ← controls

$f_b = \frac{.2 \times 12}{1.326} = 7.4$ ksi OK

Post: 1½" Φ pipe

$M = .2 \times 3 = .6$ K'

$f_b = \frac{.6 \times 12}{.412} = 17.5$ ksi $< F_b = .6 \times 30 = 18$ ksi

Check weld:

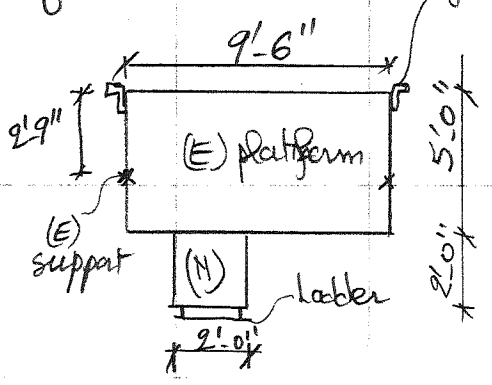
$f_w = \frac{.6 \times 12}{\pi (1.9)^2/4} = 2.54$ K/in $< F_w = 14.8 \times 3/16 = 2.7$ ksi

C] Platform & ladder @ existing boiler

Check hanger:

$R = (10+60)\frac{2.75}{2} \times \frac{9.5}{2} = 457\#$

L3x3x3/8 $F_E = .6 \times 36 \times 2.11 = 45.5$k (area)



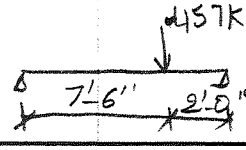
Check connection:

$f_w = \frac{.457}{2 \times 3} = .08$ K/in OK

Check L 4x4x3/8 support:

$M = .457 \times 2 \times 7.5/9.5 = .72$ K'

$f_b = \frac{.72 \times 12}{1.52} = 5.7$ ksi OK



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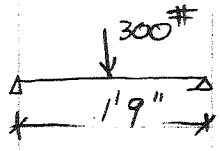
Project:		Sheet # 143
Location:		
Client:		Job #
Date:	By:	

Check ladder:

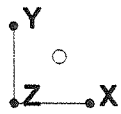
a) 3/4" ϕ Rod "A36"

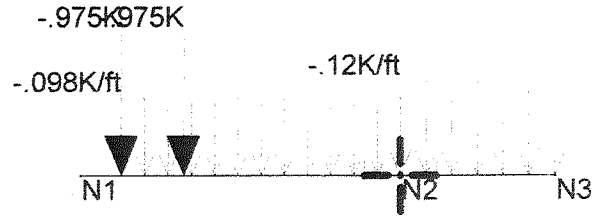


$$m = \frac{.3 \times 1.75}{8} = .065k'$$

$$f_b = \frac{.065 \times 12}{\pi (3/4)^3/32} = 19 ksi < F_b = .66 \times 36 = 23.76 ksi \quad ok$$

weld: $f_w = \frac{.3}{\pi \times 3/4} = .127 k/in$ ok





Loads: BLC 2, LL
Solution: LC 1, DL+LL

NBZ	PSU Stairs/Platform	October 20, 2012
NZ		PSUbeam1.r3d

Company : NBZ
Designer : NZ
Job Number :

October 20, 2012

PSU Stairs/Platform

Checked By:_____

Materials (General)

Material Label	Young's Modulus (Ksi)	Shear Modulus (Ksi)	Poisson's Ratio	Thermal Coef. (per 10^5 F)	Weight Density (K/ft^3)	Yield Stress (Ksi)
STL	29000	11154	.3	.65	.49	36

Sections

Section Label	Database Shape	Material Label	Area (In)^2	SA(yy)	SA(zz)	I y-y (In^4)	I z-z (In^4)	J (Torsion) (In^4)	T/C Only
SEC1	C12X20.7	STL	6.09	1.2	1.2	3.88	129	.37	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	15.5	0	0	0
N3	23	0	0	0

Boundary Conditions

Joint Label	X Translation (K/in)	Y Translation (K/in)	Z Translation (K/in)	MX Rotation (K-ft/rad)	MY Rotation (K-ft/rad)	MZ Rotation (K-ft/rad)
N1	Reaction	Reaction	Reaction			
N2	Reaction	Reaction	Reaction	Reaction		
N3	Reaction	Reaction	Reaction			

Member Data

Member Label	I Node	J Node	K Node	X-Axis Rotate (degrees)	Section Set	End Releases I-End xyz xyz	End Releases J-End xyz xyz	End Offsets I-End (In)	End Offsets J-End (In)	Inactive Code	Member Length (Ft)
M1	N1	N2			SEC1						15.5
M2	N2	N3			SEC1						7.5

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	DL	DL	Dead Load		2	2	
2	LL	LL	Live Load		2	2	

Load Combinations

Num	Description	Env	WS	PD	SRSS	CD	BLC	Factor	BLC	Factor	BLC	Factor	BLC	Factor
1	DL+LL	y				1	1	1	2	1				
2	DL	y				1	1	1						

Distributed Load Patterns

Pattern Label	Direction	Start Magnitude (K/ft, F)	End Magnitude (K/ft, F)	Start Location (Ft or %)	End Location (Ft or %)
UNIFORM	Y	-1	-1	2	15.5
PAT2	Y	-1	-1	0	0

Member Deflections, LC 1 : DL+LL, (continued)

Member Label	Section	x-Translation (In)	y-Translation (In)	z-Translation (In)	x-Rotation (radians)	(n) L/y Ratio	(n) L/z Ratio
	5	0	0	0	0	NC	NC
M2	1	0	0	0	0	NC	NC
	2	0	0.005	0	0	NC	NC
	3	0	0.005	0	0	NC	NC
	4	0	0.003	0	0	NC	NC
	5	0	0	0	0	NC	NC

Member AISC ASD 9th Code Checks, LC 1 : DL+LL

Member Label	Code Chk	Loc (Ft)	Shear Chk	Loc (Ft)	Dir	Fa (Ksi)	Fb y-y (Ksi)	Fb z-z (Ksi)	ASD Eqn.
M1	0.444	5.167	0.05	0	y	2.75	27	7.924	H1-2
M2	0.162	0	0.029	0	y	11.298	27	16.377	H1-2

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PROFIS Anchor 2.2.1

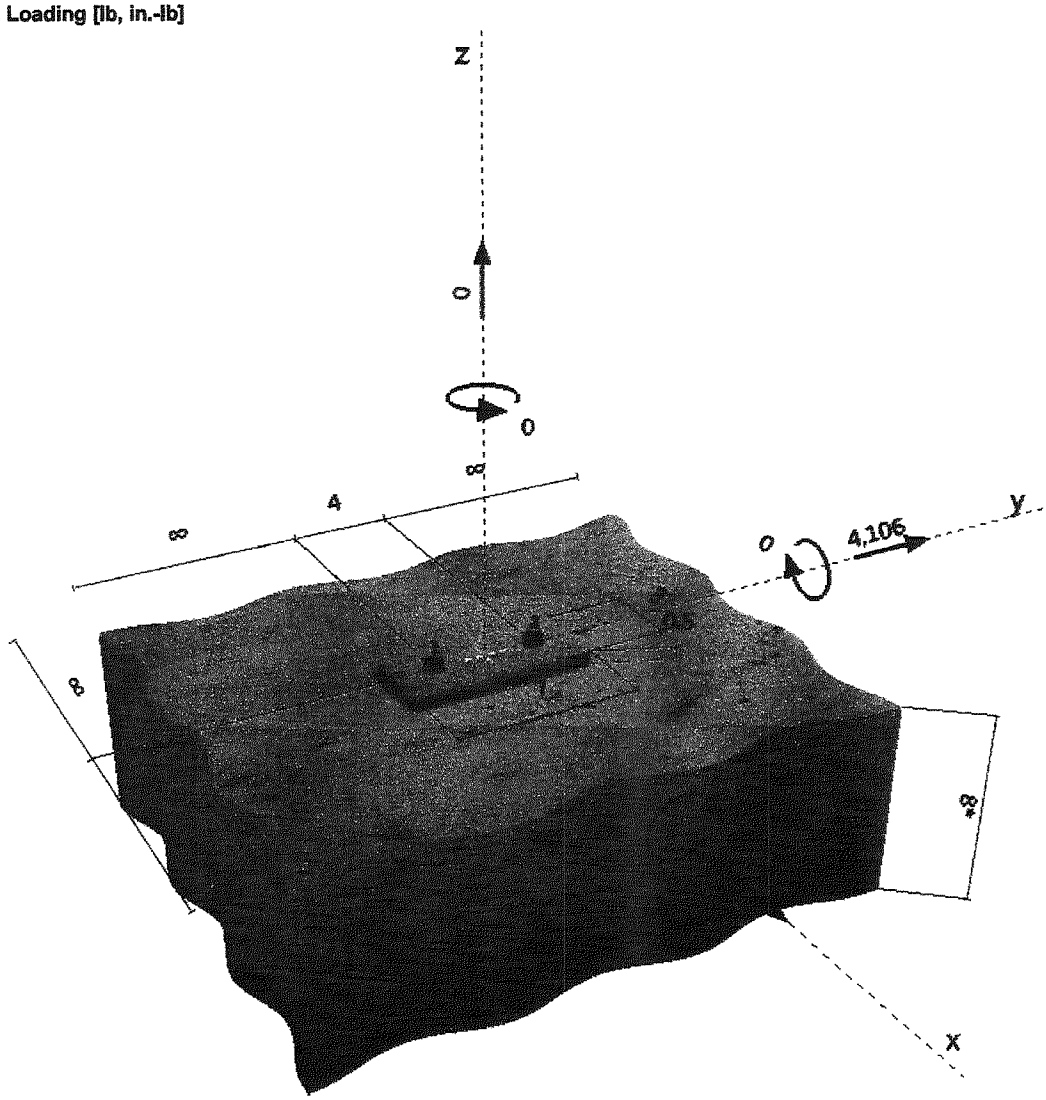
Company:		Page:	1
Specifier:		Project:	PSU Platform
Address:		Sub-Project I Pos. No.:	Beam to (E) Wall Conn
Phone I Fax:	-|-	Date:	10/20/2012
E-Mail:			

Specifier's comments:

1. Input data

Anchor type and diameter:	**Kwik Bolt TZ - CS, 3/4 (4 3/4)**
Effective embedment depth:	h_{ef} = 4.750 in., h_{nom} = 5.750 in.
Material:	Carbon Steel
Evaluation Service Report::	ESR 1917
Issued I Valid:	5/1/2011 | -
Proof:	design method ACI 318 / AC 193
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate:	l_x x l_y x t = 3.000 x 7.000 x 0.500 in. (Recommended plate thickness: not calculated)
Profile	no profile
Base material:	cracked concrete , 2500, f_c' = 2500 psi; h = 8.000 in.
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F):	no

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



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

Page: 2
Project: PSU Platform
Sub-Project I Pos. No.: Beam to (E) Wall Conn
Date: 10/20/2012

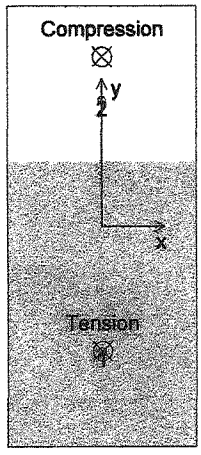
2. Load case/Resulting anchor forces

Load case (governing):

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

Anchor	Tension force	Shear force	Shear force x	Shear force y
1	1750	2053	0	2053
2	0	2053	0	2053

max. concrete compressive strain [‰]: 0.11
max. concrete compressive stress [psi]: 476
resulting tension force in (x/y)=(0.000/-2.008) [lb]: 1750
resulting compression force in (x/y)=(0.000/2.684) [lb]: 1750



3. Tension load

Proof	Load N_{ua} [lb]	Capacity ϕN_n [lb]	Utilization β_N [%] = $N_{ua}/\phi N_n$	Status
Steel Strength*	1750	18840	9	OK
Pullout Strength*	N/A	N/A	N/A	N/A
Concrete Breakout Strength**	1750	5720	31	OK

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

Steel Strength

Equations

N_{sa} = ESR value	refer to ICC-ES ESR 1917
$\phi N_{steel} \geq N_{ua}$	ACI 318-08 Eq. (D-1)

Variables

n	$A_{se,N}$ [in.^{2}]	f_{uta} [psi]
1	0.24	106000

Calculations

N_{sa} [lb]
25120

Results

N_{sa} [lb]	ϕ_{steel}	ϕN_{sa} [lb]	N_{ua} [lb]
25120	0.750	18840	1750

Company:		Page:	3
Specifier:		Project:	PSU Platform
Address:		Sub-Project I Pos. No.:	Beam to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/20/2012
E-Mail:			

Concrete Breakout Strength

Equations

$N_{cbg} = \left(\frac{A_{Nc}}{A_{Nc0}}\right) \psi_{ec,N}\, \psi_{ed,N}\, \psi_{c,N}\, \psi_{cp,N}\, N_b$ ACI 318-08 Eq. (D-5)

$\phi\, N_{cbg} \geq N_{ua}$ ACI 318-08 Eq. (D-1)

A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\, h_{ef}^2$ ACI 318-08 Eq. (D-6)

$\psi_{ec,N} = \left(\frac{1}{1 + \frac{2\, e'_N}{3\, h_{ef}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-9)

$\psi_{ed,N} = 0.7 + 0.3 \left(\frac{c_{a,min}}{1.5 h_{ef}}\right) \leq 1.0$ ACI 318-08 Eq. (D-11)

$\psi_{cp,N} = \text{MAX}\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5 h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-08 Eq. (D-13)

$N_b = k_c\, \lambda\, \sqrt{f'_c}\, h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c	λ
4.750	0.000	0.000	3936.969	1.000	9.000	17	1

f'_c [psi]
2500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
203.06	203.06	1.000	1.000	1.000	1.000	8799

Results

N_{cbg} [lb]	$\phi_{concrete}$	$\phi\, N_{cbg}$ [lb]	N_{ua} [lb]
8799	0.650	5720	1750

Company:		Page:	4
Specifier:		Project:	PSU Platform
Address:		Sub-Project I Pos. No.:	Beam to (E) Wall Conn
Phone I Fax:	- | -	Date:	10/20/2012
E-Mail:			

4. Shear load

Proof	Load V_{ua} [lb]	Capacity ϕV_n [lb]	Utilization β_V [%] = $V_{ua}/\phi V_n$	Status
Steel Strength*	2053	8888	23	OK
*Steel failure (with lever arm)**	N/A	N/A	N/A	N/A
Pryout Strength**	4106	15777	26	OK
Concrete edge failure in direction**	N/A	N/A	N/A	N/A

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

Steel Strength

Equations

V_{sa} = ESR value — refer to ICC-ES ESR 1917

$\phi V_{steel} \geq V_{ua}$ — ACI 318-08 Eq. (D-1)

Variables

n	$A_{se,V}$ [in.^{2}]	f_{uta} [psi]
1	0.24	106000

Calculations

V_{sa} [lb]
13674

Results

V_{sa} [lb]	ϕ_{steel}	ϕV_{sa} [lb]	V_{ua} [lb]
13674	0.650	8888	2053

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

Page: 5
Project: PSU Platform
Sub-Project I Pos. No.: Beam to (E) Wall Conn
Date: 10/20/2012

Pryout Strength (Concrete Breakout Strength controls)

Equations

$V_{cpg} = k_{cp}\left[\left(\frac{A_{Nc}}{A_{Nc0}}\right)\psi_{ec,N}\,\psi_{ed,N}\,\psi_{c,N}\,\psi_{cp,N}\,N_b\right]$ ACI 318-08 Eq. (D-31)

$\phi\,V_{cpg} \geq V_{ua}$ ACI 318-08 Eq. (D-1)

A_{Nc} see ACI 318-08, Part D.5.2.1, Fig. RD.5.2.1(b)

$A_{Nc0} = 9\,h_{ef}^2$ ACI 318-08 Eq. (D-6)

$\psi_{ec,N} = \left(\frac{1}{1+\frac{2\,e_N}{3\,h_{ef}}}\right) \leq 1.0$ ACI 318-08 Eq. (D-9)

$\psi_{ed,N} = 0.7 + 0.3\left(\frac{c_{a,min}}{1.5h_{ef}}\right) \leq 1.0$ ACI 318-08 Eq. (D-11)

$\psi_{cp,N} = MAX\left(\frac{c_{a,min}}{c_{ac}}, \frac{1.5h_{ef}}{c_{ac}}\right) \leq 1.0$ ACI 318-08 Eq. (D-13)

$N_b = k_c\,\lambda\,\sqrt{f'_c}\,h_{ef}^{1.5}$ ACI 318-08 Eq. (D-7)

Variables

k_{cp}	h_{ef} [in.]	$e_{c1,N}$ [in.]	$e_{c2,N}$ [in.]	$c_{a,min}$ [in.]	$\psi_{c,N}$	c_{ac} [in.]	k_c
2	4.750	0.000	0.000	-	1.000	-	17

λ	f'_c [psi]
1	2500

Calculations

A_{Nc} [in.^{2}]	A_{Nc0} [in.^{2}]	$\psi_{ec1,N}$	$\psi_{ec2,N}$	$\psi_{ed,N}$	$\psi_{cp,N}$	N_b [lb]
260.06	203.06	1.000	1.000	1.000	1.000	8799

Results

V_{cpg} [lb]	$\phi_{concrete}$	$\phi\,V_{cpg}$ [lb]	V_{ua} [lb]
22539	0.700	15777	4106

5. Combined tension and shear loads

$\beta_N = N_u/\phi N_n$	$\beta_V = V_u/\phi V_n$	ζ	Utilization $\beta_{N,V}$ [%]	Status
0.306	0.260	5/3	24	OK

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

6. Warnings

- 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 ACI 318, Part D.4.4(c).
- Refer to the manufacturer's product literature for cleaning and installation instructions.
- Checking the transfer of loads into the base material and the shear resistance are required in accordance with ACI318 or the relevant standard!
- The anchor plate is assumed to be sufficiently stiff in order to be not deformed when subjected to the actions!

Fastening meets the design criteria!

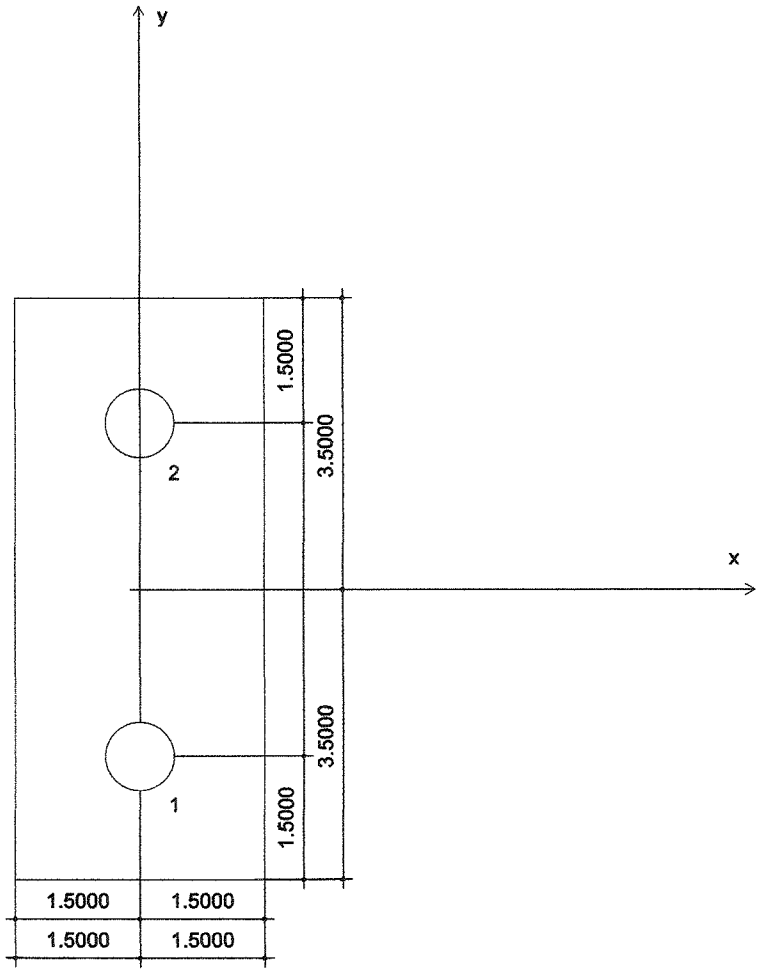
Company:
Specifier:
Address:
Phone I Fax: - | -
E-Mail:

Page: 6
Project: PSU Platform
Sub-Project I Pos. No.: Beam to (E) Wall Conn
Date: 10/20/2012

7. Installation data

Anchor plate, steel: -
Profile: no profile
Hole diameter in the fixture: d_f = 0.813 in.
Plate thickness (input): 0.500 in.
Recommended plate thickness: not calculated

Anchor type and diameter: Kwik Bolt TZ - CS, 3/4 (4 3/4)
Installation torque: 1320.002 in.-lb
Hole diameter in the base material: 0.750 in.
Hole depth in the base material: 5.750 in.
Minimum thickness of the base material: 8.000 in.



Coordinates Anchor [in.]

Anchor	x	y	c_{-x}	c_{+x}	c_{-y}	c_{+y}
1	0.000	-2.000	-	-	-	-
2	0.000	2.000	-	-	-	-

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Project:		Sheet # 154
Location:		
Client:		Job #
Date:	By:	

Check (E) 12" Slab w/ #4 @ 12" o.c T & B @ WHP

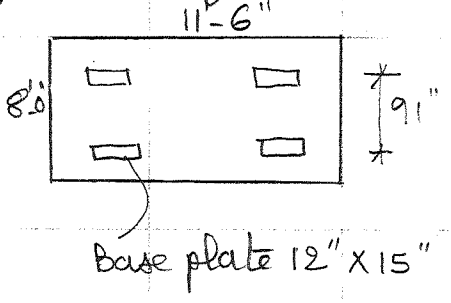
A] Slab under deaerator: "see equip't anchorage calcs"

Max weight w/water = 22,000 Lbs

D_L/support $= \frac{22000}{4} = 5500$ Lbs

$\uparrow\downarrow F_p = \frac{22000 \times 105}{91 \times 2} = 12692$ Lbs (Y_{cg})

$\uparrow\downarrow F_v = \frac{.11 \times 22000}{4} = 605$ Lbs



Max Compression = 5500 + 12692 + 605 = 18797 Lbs

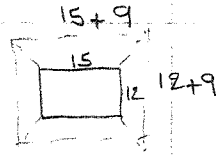
Max Tension $= \frac{15724}{1.3} = 12096$ Lbs (see equi. anchorage calcs)

1) Check punching shear.

$\phi V_c = .75 \times 4 \sqrt{f'_c}\, b_o\, d$

$= .75 \times 4 \sqrt{3000} \times 90 \times 9$

$\phi V_c = 133$ k ok



$d = 12 - 3 = 9"$

$b_o = (15+9+12+9)2 = 90"$

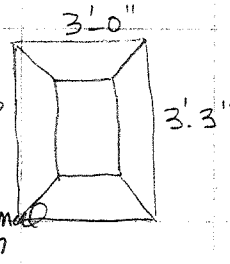
2) Check bearing pressure:

12" SOG + 3½" housekeeping pad = 194 psf

P_{max} = 18797 Lbs

Bearing area = $3 \times 3.25 = 9.75\ ft^2$

$f_p = \frac{18797}{9.75} + 194 = 2129$ psf < 2500 psf ok



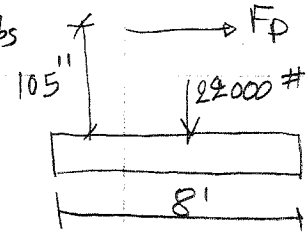
Per original design

Check slab stability:

$M_R = [.9 \times 22 + 8 \times .15 \times 11.5 \times 1]4 = 134.4$ k'

$F_p = .15 \times 22000 = 3300$ Lbs; $F_v = 2420$ Lbs

$M_{overt} = 3.3 \times 8.75 + 2.42 \times 4 = 36.1$ k'



$\frac{M_R}{M_{OV}} = \frac{134.4}{36.1} = 3.7 > 1.5$ ok

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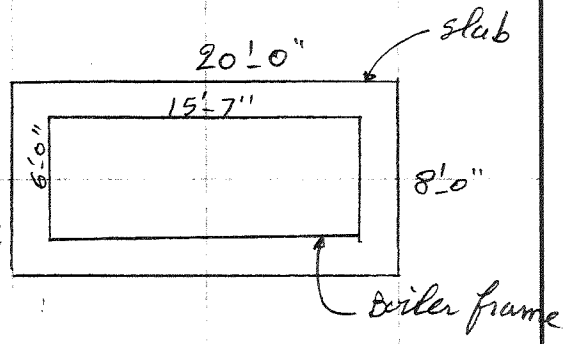
Project:		Sheet # 155
Location:		
Client:		Job #
Date:	By:	

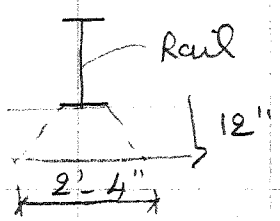
B] Slab under boilers:

Dead load = $\frac{75.537}{(15.58+6)2} = 1.75$ klf

12" slab + 5" housekeeping = 213 psf



$\uparrow\downarrow$ $F_p = \frac{75.537 \times 67}{71.88} / 15'7"$ (see equip^t calcs) $= 4.52$ klf



$F_v = .11 \times 1.75 = .193$ klf

Max compression = $1.75 + 4.52 + .193$
$= 6.46$ klf

* $f_{bearing} = \frac{6.46}{1 \times 2.33} + .213 = 2985$ psf $< 2500 \times 1.33 = 3325$ psf OK

* Check one way shear:

$\Phi V_c = .75 \times 2 \sqrt{f'_c}\, b_w d = .75 \times 2 \sqrt{3000} \times 12 \times 9 = 11.83$ k/ft
> 6.46 OK

* Check stability:

$M_{Resist} = \left[.9 \times 75.6 + 8 \times 20 \times .15 \times \frac{17}{12}\right] 4 = 408$ k'

$F_p = .15 \times 75.537 = 11.33$ k

$F_v = .11 \times 75.537 = 8.3$ k

$M_{overt} = 11.33 \times 5.58 + 8.3 \times 4 = 74$ k'

$\frac{408}{74} = 5.5 >> 1.5$ OK

Project:

Title :
Engineer:
Project Desc.:

Job # 156

Printed: 1 NOV 2012, 11:56PM

Beam on Elastic Foundation

ENERCALC, INC. 1983-2012, Build:6.12.8.21, Ver:6.12.9.30

Lic. # : KW-06009328

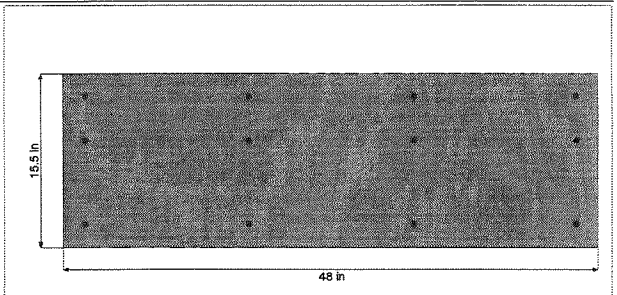
Description : (E) 12" Slab with 3.5" Housekeeping Pad
DEAERATOR

CODE REFERENCES

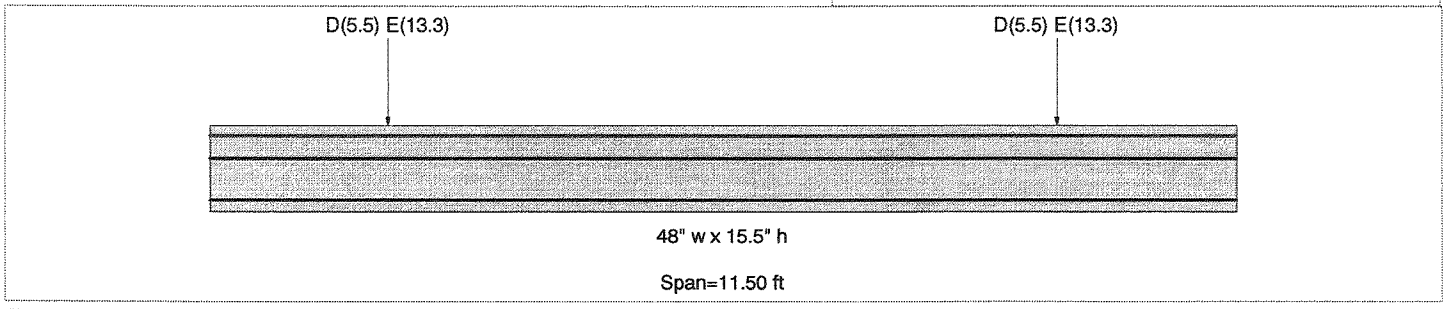
Calculations per, ASCE 7-05
Load Combinations Used : IBC 2009

Material Properties

f'c	= 3.0 ksi	ϕ Phi Values	Flexure :	0.90	
fr = f'c$^{1/2}$ * 7.50	= 410.792 psi		Shear :	0.750	
ψ Density	= 150.0 pcf	β_1	=	0.850	
λ Lt Wt Factor	= 1.0				
Elastic Modulus	= 3,122.02 ksi				
Load Combination IBC 2009					
fy - Main Rebar	= 40.0 ksi	Fy - Stirrups	=	40.0 ksi	
E - Main Rebar	= 29,000.0 ksi	E - Stirrups	=	29,000.0 ksi	
		Stirrup Bar Size #	=	# 3	
		Number of Resisting Legs Per Stirrup		2	



Beam is supported on an elastic foundation.



Cross Section & Reinforcing Details

Rectangular Section, Width = 48.0 in, Height = 15.50 in
Span #1 Reinforcing....
4-#4 at 2.0 in from Bottom, from 0.0 to 11.50 ft in this span
4-#4 at 6.0 in from Top, from 0.0 to 11.50 ft in this span
4-#4 at 2.0 in from Top, from 0.0 to 11.50 ft in this span

Applied Loads

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

Point Load : D = 5.50, E = 13.30 k @ 2.0 ft
Point Load : D = 5.50, E = 13.30 k @ 9.50 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio = **0.267**: 1
Section used for this span **Typical Section**
Mu : Applied -15.243 k-ft
Mn * Phi : Allowable 57.176 k-ft
Load Combination +1.20D+0.50L+0.20S+E
Location of maximum on span 5.818 ft
Span # where maximum occurs Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in
Max Upward L+Lr+S Deflection	0.000 in
Max Downward Total Deflection	0.025 in
Max Upward Total Deflection	-4.643 in

Maximum Soil Pressure = **0.911** ksf at 11.50 ft

Vertical Reactions - Unfactored

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Overall MAXimum	-0.578	-0.578
D Only	0.136	0.136
D+E	0.466	0.466
D-E Only	-0.578	-0.578

Shear Stirrup Requirements

Entire Beam Span Length : Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
MAXimum BENDING Envelope					
Span # 1	1	9.471	7.18	48.78	0.15

Printed: 1 NOV 2012, 11:56PM

Beam on Elastic Foundation

Lic. # : KW-06009328

Description : (E) 12" Slab with 3.5" Housekeeping Pad

Load Combination / Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
+1.20D+0.50L+0.20S+E					
Span # 1	1	9.471	7.18	48.78	0.15
+1.20D+0.50L+0.20S-1.0E					
Span # 1	1	5.818	5.13	48.78	0.11
+0.90D+E+1.60H					
Span # 1	1	9.471	6.58	48.78	0.13
+0.90D-1.0E+1.60H					
Span # 1	1	5.818	6.40	48.78	0.13

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
	1	0.0000	0.000	Span 1	-4.6429	11.500

Project:

Title :
Engineer:
Project Desc.:

Job # 158

Printed: 1 NOV 2012, 11:53PM

Beam on Elastic Foundation

ENERCALC, INC. 1983-2012, Build:6.12.8.21, Ver:6.12.9.30

Lic. # : KW-06009328

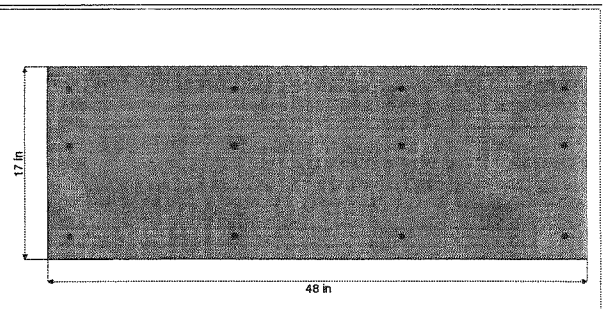
Description : (E) 12" Slab with 5" Housekeeping Pad
BOILER

CODE REFERENCES

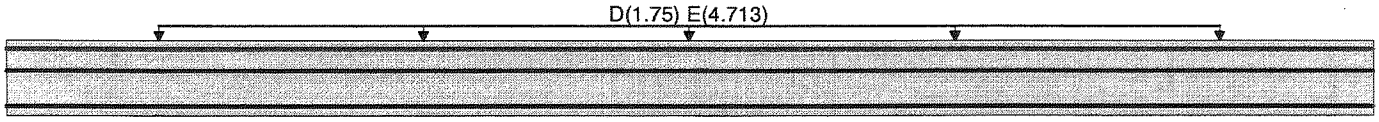
Calculations per, ASCE 7-05
Load Combinations Used : IBC 2009

Material Properties

f'c	= 3.0 ksi	ϕ Phi Values	Flexure :	0.90
fr = f'c $^{1/2}$ * 7.50	= 410.792 psi		Shear :	0.750
ψ Density	= 150.0 pcf	β_1	=	0.850
λ Lt Wt Factor	= 1.0			
Elastic Modulus	= 3,122.02 ksi			
Load Combination IBC 2009				
fy - Main Rebar	= 40.0 ksi	Fy - Stirrups	=	40.0 ksi
E - Main Rebar	= 29,000.0 ksi	E - Stirrups	=	29,000.0 ksi
		Stirrup Bar Size #	=	# 3
		Number of Resisting Legs Per Stirrup		2



Beam is supported on an elastic foundation.



48" w x 17" h

Span=20.0 ft

Cross Section & Reinforcing Details

Rectangular Section, Width = 48.0 in, Height = 17.0 in
Span #1 Reinforcing....
4-#4 at 2.0 in from Bottom, from 0.0 to 20.0 ft in this span
4-#4 at 7.0 in from Top, from 0.0 to 20.0 ft in this span
4-#4 at 2.0 in from Top, from 0.0 to 20.0 ft in this span

Applied Loads

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

Load for Span Number 1
Uniform Load : D = 1.750, E = 4.713 k/ft, Extent = 2.250 -->> 17.750 ft, Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	**0.425**: 1	Maximum Deflection	
Section used for this span	**Typical Section**	Max Downward L+Lr+S Deflection	0.000 in
Mu : Applied	23.277 k-ft	Max Upward L+Lr+S Deflection	0.000 in
Mn * Phi : Allowable	54.776 k-ft	Max Downward Total Deflection	0.045 in
Load Combination	+1.20D+0.50L+0.20S+E	Max Upward Total Deflection	0.005 in
Location of maximum on span	10.118 ft		
Span # where maximum occurs	Span # 1		

Maximum Soil Pressure = **1.604** ksf at 10.00 ft

Vertical Reactions - Unfactored

Support notation : Far left is #1

Load Combination	Support 1	Support 2
Overall MAXimum	0.552	0.552
D Only	0.149	0.149
D+E	0.552	0.552

Shear Stirrup Requirements

Entire Beam Span Length : Vu < PhiVc/2, Req'd Vs = Not Reqd, use stirrups spaced at 0.000 in

Maximum Forces & Stresses for Load Combinations

Load Combination / Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
MAXimum BENDING Envelope					
Span # 1	1	10.118	23.28	54.78	0.42
+1.20D+0.50L+0.20S+E					

Printed: 1 NOV 2012, 11:53PM

Beam on Elastic Foundation

Lic. # : KW-06009328

Description : (E) 12" Slab with 5" Housekeeping Pad

Load Combination / Segment Length	Span #	Location (ft) in Span	Bending Stress Results (k-ft) Mu : Max	Phi*Mnx	Stress Ratio
Span # 1	1	10.118	23.28	54.78	0.42
+0.90D+E+1.60H					
Span # 1	1	9.882	21.48	54.78	0.39

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
Span 1	1	0.0446	10.000		0.0000	0.000

JOB: PSU
SHEET NO.: ____ OF ____
CALCULATED BY: ____ DATE 10/6/12
CHECKED BY: ____ DATE ____
PROJECT NO.: ____

LATERAL ANALYSIS

BOILERS

THE LATERAL LOADS DUE TO SEISMIC FORCES ARE DETERMINED USING

THE REQUIREMENTS OF THE 2009 INTERNATIONAL BUILDING CODE (2009 IBC)

$Fp^* = 0.4\ ap * Ip * Sds / Rp * [\ 1 + 2 * \{z/h\}\ ] * Wp * 0.7$

$Fp\ min = 0.3 * Sds * Ip * Wp * 0.7$

$Fp\ max = 1.6 * Sds * Ip * Wp * 0.7$

0.7 factor for allowable stress design

$Fv = 0.2 * Sds * Wp * 0.7$

INPUT DATA

ap:	in-structure component amplification factor =	1
Sds:	seismic coefficient =	0.736
Ip:	importance factor =	1
Rp:	component response modification factor =	2.5
z:	component attachment elevation from grade =	0
h:	structure roof elevation from grade =	1
	z/h =	0

CALCULATIONS

Fp^* =	0.082 Wp
Fp min =	0.155 Wp
Fp max=	0.824 Wp

Fp = 0.15 Wp controlling Fp (ASD)

Fv = 0.10 Wp (ASD)

STEEL PIPE DATA: SCHEDULE 40							
Pipe Dia. Inch	Schedule	Pipe Weight Empty Lbs/Lf	Weight of Water Lbs/Lf	Pipe Weight Full Lbs/Lf	Insulation Thickness* inch	Insulation Weight Lbs/Lf	Pipe Weight Full & Insulated Lbs/Lf
1/2	40	0.85	0.13	0.98	1"	0.46	1.45
3/4	40	1.13	0.23	1.36	1"	0.43	1.79
1	40	1.70	0.37	2.07	1"	0.6	2.67
1 1/2	40	2.70	0.88	3.58	1"	0.66	4.24
2	40	3.60	1.45	5.05	3½"	0.84	7
2 1/2	40	5.80	2.07	7.87	1"	0.96	8.84
3	40	7.60	3.20	10.80	1"	1.06	11.86
4	40	10.80	5.51	16.31	3½"	3.18	22
5	40	14.62	8.66	23.28	2"	3.61	26.89
6	40	19.00	12.51	31.51	3½"	4.21	39
8	40	28.50	21.60	50.10	2"	5.14	55.24
10	40	40.50	34.10	74.60	2"	6.35	80.95
12	STD	49.70	48.50	98.20	3½"	7.33	111
14	STD	54.70	58.50	113.20	2"	7.42	120.62
16	STD	62.70	76.50	139.20	3½"	8.34	154
18	STD	70.80	97.20	168.00	2"	9.20	177.2
20	STD	78.80	120.40	199.20	2"	10.10	209.3
24	STD	86.80	174.20	261.00	2"	11.87	272.87
26	STD	94.90	183.80	278.70	2"	12.78	291.48
28	STD	102.90	216.80	319.70	2"	13.69	333.39
30	STD	110.90	252.60	363.50	2"	14.53	378.03

w/10% INCREASE

8

24

43

122

169

* Fiber Glass Pipe Insulation With ASJ

STEEL PIPE DATA: SCHEDULE 80							
Pipe Dia. Inch	Schedule	Pipe Weight Empty Lbs/Lf	Weight of Water Lbs/Lf	Pipe Weight Full Lbs/Lf	Insulation Thickness* inch	Insulation Weight Lbs/Lf	Pipe Weight Full & Insulated Lbs/Lf
1/2"	80	1.09	0.10	1.19	1"	0.46	1.65
3/4"	80	1.47	0.19	1.66	1"	0.43	2.09
1"	80	2.17	0.31	2.48	1"	0.6	3.08
1 1/2"	80	3.63	0.77	4.40	1"	0.66	5.06
2"	80	5.02	1.28	6.30	1"	0.84	7.14
2 1/2"	80	7.66	1.83	9.49	1"	0.96	10.46
3"	80	10.25	2.86	13.11	1"	1.06	14.17
4"	80	14.98	4.98	19.96	2"	3.18	23.14
5"	80	20.78	7.87	28.65	2"	3.61	32.26
6"	80	28.57	11.29	39.86	2"	4.21	44.07
8"	80	43.39	19.80	63.19	2"	5.14	68.33
10"	80	64.42	31.11	95.53	2"	6.35	101.88

* Fiber Glass Pipe Insulation With ASJ

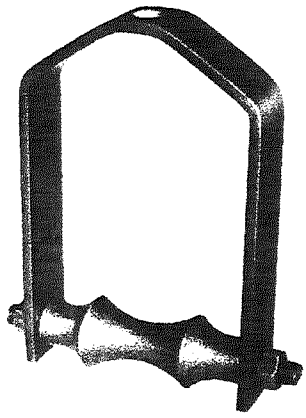
BASIC ELEMENT WEIGHTS FOR STEEL PIPE

International Seismic Application Technology
14848 E. Northam Street, La Mirada, CA 90638
877-999-4728 (Toll Free) 714-523-0845 (fax)
www.isatsb.com

Model Law Structural Engineer
NCEES No. 20675

Fig. 181

Adjustable Steel Yoke Pipe Roll



Size Range: 2 1/2" through 24"
Material: Cast iron roll; carbon steel yoke, roll rod and hex nuts
Finish: ❑ Plain, ❑ Galvanized or ❑ Resilient Coated
Service: For suspension of pipe from a single rod where longitudinal movement may occur because of expansion or contraction.
Maximum Temperature: 450° F at roller, 300° F at resilient coated roller.
Approvals: Complies with Federal Specification A-A-1192A (Type 43), *WW-H-171-E (Type 44)*, ANSI/MSS SP-69 and MSS SP-58 (Type 43).
Features: Advantages of pipe rollers with a protective resilient coated covering.

- Non conductive pipe rollers - prevent the passing of current from pipeline to structure.
- Corrosion resistant - for protection against severe weather conditions, moderate corrosive conditions such as marine atmospheres and weather resistant to ultra-violet radiation.
- Low coefficient of friction between pipe and resilient coated pipe roller.

How to size: If the roll is to support bare pipe, select the size directly from nominal pipe size (see below). If used with pipe covering protection saddle, see page 118 for size of pipe roll to be used.
Ordering: Specify pipe roll size, figure number, name and finish. Be certain to order oversized rolls when insulation and protection saddles are required.

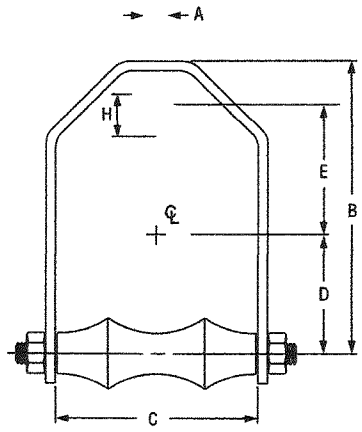


FIG. 181: LOADS (LBS) • WEIGHT (LBS) • DIMENSIONS (IN)

Pipe Size	Max O.D. of Covering	Max Load	Wgt.	Rod Size A	B	C	D	Rod Take Out E	H
2½	3	225	1.7	½	5¾	3¼	1 15/16	2⅞	1 11/16
3	3⅝	310	2.2		6⅜	3⅞	2¼	3⅛	1⅝
3½	4⅛	390	2.5		7	4⅜	2 9/16	3½	1 11/16
4	4 11/16	475	3.2	⅝	7 9/16	4 15/16	2 13/16	3⅝	1⅝
5	5¾	685	6.3		9⅛	6	3 7/16	4½	1 15/16
6	6⅞	780	9.3	¾	10 5/16	7⅛	4	5	1⅞
8	9		14.5		12 11/16	9¼	5⅛	6⅛	2
10	11	965	18.8	⅞	15 1/16	11¼	6⅜	7¼	2 1/16
12	13		27.7		17 7/16	13¼	7 7/16	8⅜	2¼
14	14¼	1,200	39.1	1	18⅞	14½	8⅜	8¾	2
16	16¼		49.1		20 13/16	16½	9⅜	9 11/16	1 15/16
18	18¼	1,400	57.8		23¾	18½	10 7/16	11 7/16	2 13/16
20	20¼	1,600	75.9	1¼	26	20½	11⅝	12¼	2½
24	24¼	1,800	119.3	1½	32 5/16	24⅝	13 15/16	15¾	4⅜

DI/CI ROLL SIZING

DI/CI Pipe Size	Fig. 181 Roller Size
3	4
4	5
6	6
8	8
10	10
12	14
14	16
16	18
18	20
20	24

PROJECT INFORMATION	APPROVAL STAMP
Project:	❑ **Approved**
Address:	❑ **Approved as noted**
Contractor:	❑ **Not approved**
Engineer:	**Remarks:**
Submittal Date:	
Notes 1:	
Notes 2:	

atkore INTERNATIONAL

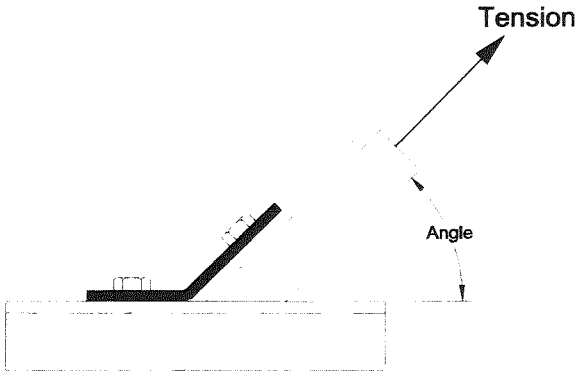
Unistrut International
16100 S. Lathrop Ave.
Harvey, IL 60426

Phone: 708-339-1610
800-882-5543
Fax: 708-339-7814

www.unistrut.com

DESIGN LOAD REPORT

Part Description: Angular Fittings P2094 – P2100 & P1546
Report Date: August 29, 2005



Part Number	Angle	Ave. Ultimate Tension (lbs)	Design Tension Load (lbs)	Ave. Deflection at Design Tension Load
P2094	82 ½°	7,000	1,500	0.046"
P2095	75°	7,200	1,500	0.081"
P2096	67 ½°	6,900	1,500	0.046"
P2097	60°	6,500	1,500	0.079"
P2098	52 ½°	6,300	1,500	0.059"
P1546	45°	6,200	1,500	0.081"
P2099	37 ½°	6,800	1,500	0.171"
P2100	37 ½°	5,700	1,500	0.169"

NOTES

1. Average Ultimate Loads from Test T-068
2. Testing Based on 1/2"-13 Channel Nut & Cap Screw Torqued to 50 ft-lbs
3. Average Safety Factor = 4
4. Design Loads Limited to 1,500 lbs Slip Load of 1/2"-13 Channel Nuts, SF = 3
5. Deflection is the Average of Straight Line Interpolations of the Deflection Readings at 1,000 lbs and 2,000 lbs Tension Load.
6. Deflection is Measured In the Direction of the Tension Load

Unistrut Engineering

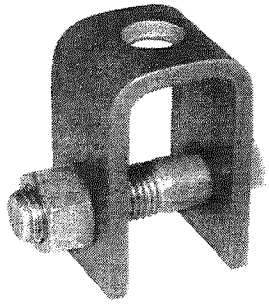
Fig: 66

Welded Beam Attachment

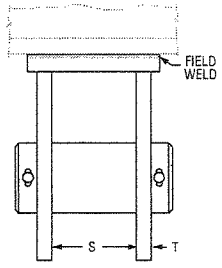
Size Range: 3/8" through 3 1/2"
Material: Carbon Steel
Finish: ❑ Plain or ❑ Galvanized
Service: Recommended for attachment to bottom of beams, especially where loads are considerable and rod sizes are large.
Maximum Temperature: Plain 750° F, Galvanized 450° F
Approvals: Complies with Federal Specification A-A-1192A (Type 22), *WW-H-171-E (Type 22)*, ANSI/MSS SP-69 and MSS SP-58 (Type 22).
Installation: If flexibility at the beam is desired, use with bolt and eye rod Fig. 278, page 93, or with weldless eye nut Fig. 290, page 97. If vertical adjustment is desired, use with threaded rod and nut and weld the attachment in an inverted position to the beam.
Features:

- Will accommodate very heavy loads and rod sizes through 3 1/2".
- Can be installed so as to provide for either flexibility or for vertical adjustment.
- Versatility affords economical stocking and erection.
- Beam size need not be considered.

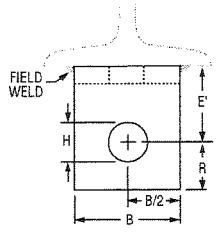
Ordering: Specify rod size, figure number, name and finish. Sizes 1" and smaller are typically supplied with a bolt and nut. Sizes 1 1/4" and larger are typically supplied with a pin and cotters.



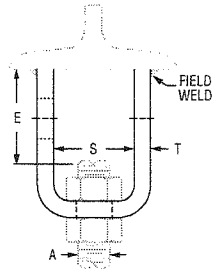
Using Hanger Rod with Attachment in Inverted Position.



2" Rod Dia. and Larger are Fabricated.



1 3/4" Rod Dia. and Smaller are Formed using Bolt or Pin and Eye Rod.



1 1/4" Rod Dia. and Smaller Only.

FIG: 66: LOAD (LBS) • WEIGHT (LBS) • DIMENSIONS (IN)

Rod Size A	Pin or Bolt Size	Max Load		Weight		Rod Take Out		B	H	R	S	T
		650° F	750° F	Without Bolt and Nut	With Bolt and Nut	E	E'					
3/8	1/2 x 2 1/2	730	572	0.96	1.2	1 7/8	2	2	9/16	7/8	1 1/4	1/4
1/2	5/8 x 2 1/2	1,350	1,057		1.3	1 3/4			11/16			
5/8	3/4 x 2 3/4	2,160	1,692		1.6				13/16			
3/4	7/8 x 4	3,230	2,530	1.9	2.8			2 1/2	15/16	1 1/8	1 7/8	3/8
7/8	1 x 4	4,480	3,508	2.5	3.9	2 5/8	3		1 1/8	1 1/4	2	
1	1 1/8 x 5	5,900	4,620	4.3	6.3	2 3/4		3	1 1/4	1 1/2	2 1/2	1/2
1 1/4	1 3/8 x 5 3/8	9,500	7,440	8.1	10.2	2 7/8		4	1 1/2	2		5/8
1 1/2	1 5/8 x 6	13,800	10,807	–	19.0	–	4	5	1 3/4	2 1/2	3	3/4
1 3/4	1 7/8 x 6 7/8	18,600	14,566	–	24.2	–	5		2	2 3/4	3 3/4	
2	2 1/4 x 6 7/8	24,600	19,265	–	30.6	–		6	2 3/8	3 1/4	3 1/2	1/2
2 1/4	2 1/2 x 7 3/8	32,300	25,295	–	36.8	–	5 3/4		2 5/8	3 1/2		
2 1/2	2 3/4 x 7 5/8	39,800	31,169	–	39.7	–			2 7/8	3 3/4	3 3/4	5/8
2 3/4	3 x 7	49,400	38,687	–	40.8	–			3 1/8	4		
3	3 1/4 x 7	60,100	47,066	–	46.7	–	6 1/4	7	3 3/8			
3 1/4	3 1/2 x 7 3/4	71,900	56,307	–	62.1	–	7		3 5/8	4 1/2	4 1/4	3/4
3 1/2	3 3/4 x 7 3/4	84,700	66,331	–	72.4	–	7 1/2	8	3 7/8			

PROJECT INFORMATION	APPROVAL STAMP
Project:	❑ Approved
Address:	❑ Approved as noted
Contractor:	❑ Not approved
Engineer:	**Remarks:**
Submittal Date:	
Notes 1:	
Notes 2:	

Square Nuts

Part No.	Size	Wt/100 pcs Lbs (kg)
HSQN025EG	¼"	0.9 (0.4)
HSQN031EG	5/16"	1.6 (0.7)
HSQN037EG	⅜"	2.7 (1.2)
HSQN050EG	½"	5.8 (2.6)
HSQN062EG	⅝"	10.7 (4.9)
HSQN075EG	¾"	15.4 (6.9)
HSQN087EG	⅞"	24.9 (11.3)
HSQN100EG	1"	36.3 (16.5)

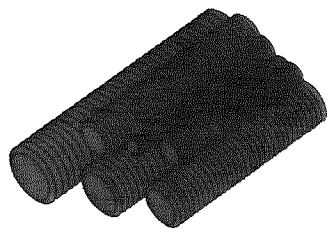
Hexagon Nuts

Part No.	Size	Wt/100 pcs Lbs (kg)
HHXN025EG	¼"	0.6 (0.3)
HHXN031EG	5/16"	1.2 (0.5)
HHXN037EG	⅜"	1.6 (0.7)
HHXN050EG	½"	4.8 (2.2)
HHXN062EG	⅝"	7.3 (3.3)
HHXN075EG	¾"	11.9 (5.4)
HHXN087EG	⅞"	19.0 (8.6)
HHXN100EG	1"	28.3 (12.8)

Flat Washers

Part No.	Size	Wt/100 pcs Lbs (kg)
HFLW025EG	¼"	0.8 (0.4)
HFLW031EG	5/16"	1.0 (0.5)
HFLW037EG	⅜"	1.5 (0.7)
HFLW050EG	½"	3.5 (1.6)
HFLW062EG	⅝"	7.7 (3.5)
HFLW075EG	¾"	11.0 (5.0)
HFLW087EG	⅞"	15.3 (6.9)
HFLW100EG	1"	18.8 (8.5)

Steel Threaded Rod



Standard Length 12' (3.7m)

Low Carbon Steel Grade 1006 - 1010
F_y = 36,000 psi minimum
F_t = 58,000 psi minimum

Part No.	Size	Wt/100 Ft. Lbs (kg)
HTHR025	¼" x 20	13 (5.9)
HTHR031	5/16" x 18	20 (9.1)
HTHR037	⅜" x 16	30 (13.6)
HTHR044	7/16" x 14	30 (13.6)
HTHR050	½" x 13	53 (24.0)
HTHR062	⅝" x 11	84 (38.1)
HTHR075	¾" x 10	124 (56.2)
HTHR087	⅞" x 9	170 (77.1)
HTHR100	1" x 8	223 (101.2)

Lock Washers

Part No.	Size	Wt/100 pcs Lbs (kg)
HLKW025EG	¼"	0.25 (0.1)
HLKW031EG	5/16"	0.41 (0.2)
HLKW037EG	⅜"	0.63 (0.3)
HLKW050EG	½"	1.32 (0.60)
HLKW062EG	⅝"	2.20 (1.0)
HLKW075EG	¾"	3.80 (1.7)
HLKW087EG	⅞"	6.00 (2.7)
HLKW100EG	1"	8.80 (4.0)

Load Carrying Capacity Of Threaded Hot Rolled Steel Conforming To ASTM A575 And A576

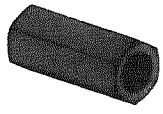
Threaded Rod Loads for Piping Applications (based on MSS SP-58)

Nominal Dia.	Root Area in² (mm²)	Max. Safe Load at 650°F (343°C) Lbs (kN)
⅜	0.068 (43.9)	730 (3.25)
½	0.126 (81.3)	1,350 (6.01)
⅝	0.202 (130.3)	2,160 (9.61)
¾	0.302 (194.8)	3,230 (14.37)
⅞	0.419 (270.3)	4,480 (19.93)
1	0.552 (356.1)	5,900 (26.24)

Threaded Rod Loads for Structural Applications
(Based on AISC, Steel Construction Manual, ASD, 9th Edition. Per AISC, Allowed Tensile Stress = 0.33 * F_u)

Nominal Dia.	Nominal Area in² (mm²)	Allowed Tension Load Lbs (kN)
¼	0.049 (31.6)	930 (4.14)
⅜	0.110 (71.0)	2,110 (9.39)
7/16	0.150 (96.8)	2,870 (12.77)
½	0.196 (126.5)	3,750 (16.68)
⅝	0.307 (198.2)	5,870 (26.11)
¾	0.442 (285.4)	8,450 (37.59)
⅞	0.601 (388.0)	11,500 (51.15)
1	0.785 (506.6)	15,030 (66.86)

Steel Coupler Nuts



Part Number	Size	Length in (mm)	Wt/100 pcs Lbs (kg)
HRCN025	¼" - 20	⅞" (22)	1.9 (0.9)
HRCN031	5/16" - 18	1¾" (45)	7.5 (3.4)
HRCN037	⅜" - 16	1¾" (45)	9.0 (4.1)
HRCN044	7/16" - 14	1¾" (45)	10.4 (4.7)
HRCN050	½" - 13	1¾" (45)	10.0 (4.5)
HRCN062	⅝" - 11	2⅛" (54)	18.0 (8.2)
HRCN075	¾" - 10	2¼" (57)	28.0 (12.7)
HRCN087	⅞" - 9	2½" (64)	55.0 (24.9)
HRCN100	1" - 8	2¾" (70)	73.0 (33.1)

Warnings and Application Instructions For U-Bolt Clips

Efficiency ratings for wire rope end terminations are based upon the catalog breaking strength of wire rope. The efficiency rating of a properly prepared loop or thimble-eye termination for clip sizes 1/8″ through 7/8″ is 80%, and for sizes 1″ through 3-1/2″ is 90%.

The number of clips shown (see Table 1) is based upon using RRL or RLL wire rope, 6 x 19 or 6 x 37 Class, FC or IWRC; IPS or XIP. If Seale construction or similar large outer wire type construction in the 6 x 19 Class is to be used for sizes 1″ and larger, add one additional clip. If a pulley (sheave) is used for turning back the wire rope, add one additional clip.

The number of clips shown also applies to rotation-resistant RRL wire rope, 8 x 19 Class, IPS, XIP, sizes 1-1/2″ and smaller; and to rotation-resistant RRL wire rope, 19 x 7 Class, IPS, XIP, sizes 1-3/4 inch and smaller.

For other classes of wire rope not mentioned above, we recommend contacting Crosby Engineering at the address or telephone number on the back cover to ensure the desired efficiency rating.

For elevator, personnel hoist, and scaffold applications, refer to ANSI A17.1 and ANSI A10.4. These standards do not recommend U-Bolt style wire rope clip terminations. The style wire rope termination used for any application is the obligation of the user.

For OSHA (Construction) applications, see OSHA 1926.251.

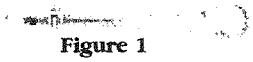


Figure 1

1. Refer to Table 1 in following these instructions. Turn back specified amount of rope from thimble or loop. Apply first clip one base width from dead end of rope. Apply U-Bolt over dead end of wire rope—live end rests in saddle (Never saddle a dead horse!). Tighten nuts evenly, alternate from one nut to the other until reaching the recommended torque.

Figure 2

2. When two clips are required, apply the second clip as near the loop or thimble as possible. Tighten nuts evenly, alternating until reaching the recommended torque. When more than two clips are required, apply the second clip as near the loop or thimble as possible, turn nuts on second clip firmly, but do not tighten. Proceed to Step 3.

Figure 3

3. When three or more clips are required, space additional clips equally between first two—take up rope slack—tighten nuts on each U-Bolt evenly, alternating from one nut to the other until reaching recommended torque.

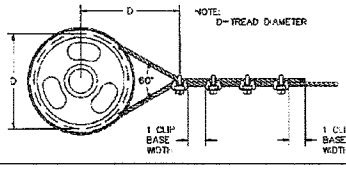


Figure 4

4. If a pulley (sheave) is used, in place of a thimble add one additional clip. Clip spacing should be as shown.

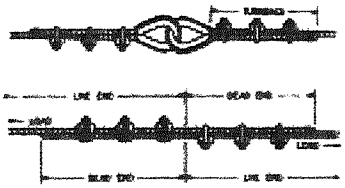


Figure 5

Figure 6

5. WIRE ROPE SPLICING PROCEDURES:

The preferred method of splicing two wire ropes together is to use interlocking turnback eyes with thimbles, using the recommended number of clips on each eye (See Figure 5).

An alternate method is to use twice the number of clips as used for a turnback termination. The rope ends are placed parallel to each other, overlapping by twice the turnback amount shown in the application instructions. The minimum number of clips should be installed on each dead end (See Figure 6). Spacing, installation torque, and other instructions still apply.

6. IMPORTANT

Apply first load to test the assembly. This load should be of equal or greater weight than loads expected in use. Next, check and retighten nuts to recommended torque.

In accordance with good rigging and maintenance practices, the wire rope end termination should be inspected periodically for wear, abuse, and general adequacy.

Table 1

Clip Size (Inches)	Rope Size (Inches)	Minimum No. of Clips	Amount of Rope to Turn Back in Inches	†Torque in Ft. Lbs.
1/8	1/8	2	3-1/4	4.5
3/16	3/16	2	3-3/4	7.5
1/4	1/4	2	4-3/4	15
5/16	5/16	2	5-1/4	30
3/8	3/8	2	6-1/2	45
7/16	7/16	2	7	65
1/2	1/2	3	11-1/2	65
9/16	9/16	3	12	95
5/8	5/8	3	12	95
3/4	3/4	4	18	130
7/8	7/8	4	19	225
1	1	5	26	225
1-1/8	1-1/8	6	34	225
1-1/4	1-1/4	7	44	360
1-3/8	1-3/8	7	44	360
1-1/2	1-1/2	8	54	360
1-5/8	1-5/8	8	58	430
1-3/4	1-3/4	8	61	590
2	2	8	71	750
2-1/4	2-1/4	8	73	750
2-1/2	2-1/2	9	84	750
2-3/4	2-3/4	10	100	750
3	3	10	106	1200
3-1/2	3-1/2	12	149	1200

If a pulley (sheave) is used for turning back the wire rope, add one additional clip. See Figure 4.

† If a greater number of clips are used than shown in the table, the amount of turnback should be increased proportionately.

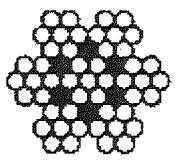
*The tightening torque values shown are based upon the threads being clean, dry, and free of lubrication.

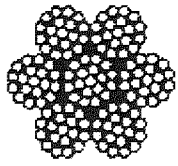
WARNING

- Failure to read, understand, and follow these instructions may cause death or serious injury.
- Read and understand these instructions before using clips.
- Match the same size clip to the same size wire rope.
- Prepare wire rope end termination only as instructed.
- Do not use with plastic coated wire rope.
- Apply first load to test the assembly. This load should be of equal or greater weight than loads expected in use. Next, check and retighten nuts to recommended torque (See Table 1, this page).

AIRCRAFT CABLE STRENGTH

GALVANIZED





7X7

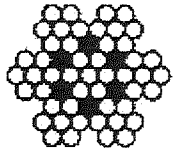
SIZE in inches	WEIGHT per 1000' in lbs	NOMINAL BREAKING STRENGTH in lbs.
1/16	7.5	480
3/32	16	920
1/8	28	1,700
5/32	43	2,600
3/16	62	3,700
1/4	105	6,100

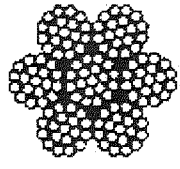
7X19

SIZE in inches	WEIGHT per 1000' in lbs	NOMINAL BREAKING STRENGTH in lbs.
1/8	29	2,000
5/32	45	2,800
3/16	65	4,200 ← 2-6" PIPE
7/32	86	5,600
1/4	110	7,000
5/16	173	9,800 ← 12-16" PIPE
3/8	243	14,400

STAINLESS STEEL

TYPE 302 - 304





7X7

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7X19

SIZE in inches	WEIGHT per 1000' in lbs	NOMINAL BREAKING STRENGTH in lbs.
1/8	29	1,760
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3/16	65	3,700
1/4	110	6,400
5/16	173	9,000
3/8	243	12,000