NBZ
CONSULTING ENGINEERS

21617 SW Susan Lane Beaverton, OR 97006
Ph: 971- 222- 4378 Fax: 503- 848- 8748

STRUCTURAL CALCULATIONS

Project: **Portland State University**

Re: **East Hall Ventilation System Supports**

Client: **Mr. Tom Arnich**
Facilities and Planning-FAP
617 SW Montgomery Street
Portland, OR 97201

Job No.: **14-004**

Date: **April 25, 2014**

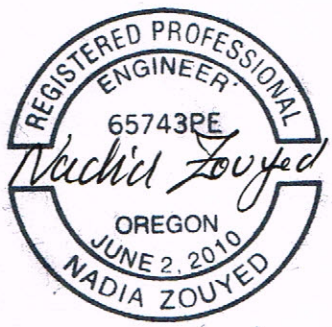
Dear Tom,

Attached please find calculations pages 1 thru 32 which verify the structural adequacy of the East Hall Ventilation System Supports at the Portland State University as shown on drawings S0.0 thru S6.4. Design is based on the requirement of the 2010 Oregon Structural Specialty Code.

Sincerely

Nadia Zouyed

Nadia Zouyed, PE
Principal
NBZ Consulting Engineers



EXPIRES: 06/30/14

JOB:	East Hall		
SHEET NO.:	1	OF	
CALCULATED BY:		DATE	4/10/14
CHECKED BY:		DATE	
PROJECT NO.:	14-004		

LATERAL ANALYSIS

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 =	2.5
Sds:	seismic coefficient =	0.73
Ip:	importance factor =	1
Rp:	component response modification factor =	6
z:	component attachment elevation from grade =	1
h:	structure roof elevation from grade =	1
	z/h =	1

CALCULATIONS

Fp* =	0.256 Wp
Fp min =	0.153 Wp
Fp max=	0.818 Wp

Fp = 0.26 Wp controlling Fp (ASD)

Fv = 0.10 Wp (ASD)

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 97201
Spectral Response Accelerations Ss and S1
Ss and S1 = Mapped Spectral Acceleration Values
Data are based on a 0.05 deg grid spacing

Period (sec)	Centroid Sa (g)	
0.2	0.987	(Ss)
1.0	0.348	(S1)

Period (sec)	Maximum Sa (g)	
0.2	0.990	(Ss)
1.0	0.349	(S1)

Period (sec)	Minimum Sa (g)	
0.2	0.977	(Ss)
1.0	0.345	(S1)

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 97201
Spectral Response Accelerations SMs and SM1
SMs = Fa x Ss and SM1 = Fv x S1
Site Class D

Period (sec)	Centroid Sa (g)	
0.2	1.091	(SMs, Fa = 1.105)
1.0	0.593	(SM1, Fv = 1.704)

Period (sec)	Maximum Sa (g)	
0.2	1.093	(SMs, Fa = 1.104)
1.0	0.594	(SM1, Fv = 1.703)

Period (sec)	Minimum Sa (g)

1.0	0.590	(SM1, Fv = 1.710)

Conterminous 48 States
2003 NEHRP Seismic Design Provisions
Zip Code = 97201
Spectral Response Accelerations SDs and SD1
SDs = 2/3 x SMs and SD1 = 2/3 x SM1
Site Class D

Period (sec)	Centroid Sa (g)	
0.2	0.727	(SDs)
1.0	0.395	(SD1)

Period (sec)	Maximum Sa (g)	
0.2	0.729	(SDs)
1.0	0.396	(SD1)

Period (sec)	Minimum Sa (g)	
0.2	0.723	(SDs)
1.0	0.393	(SD1)

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 =	0.9		Table 6-4
Wind Speed V =	95	mph	
Importance factor I_w =	1.00		Table 6-1
q_z =	14.56	psf	
Gust Effect factor G =	0.85		6.5.8
Force coeff C_f =	1.4		Figure 6-18 through 6-22
Design wind pressure, F/A_f =	17.32	psf	

$W_w = 17.32 \times 1.9 = 33$ psf

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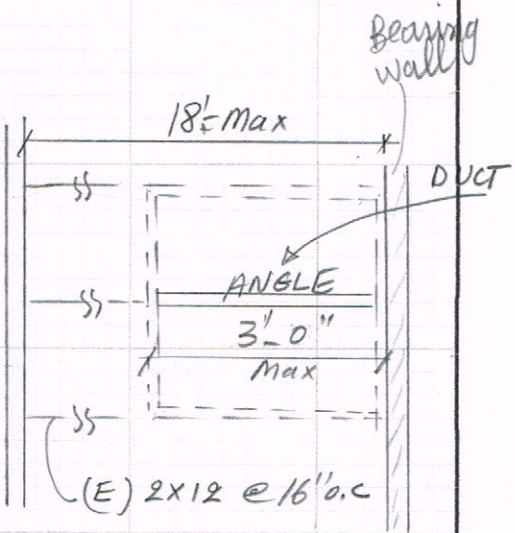
Project: PSU EAST HALL			Sheet # 5
Location: PDX			
Client: PSU			Job # 14-004
Date: 04/25/14	By: NBZ		

DUCTS SUPPORT & FRAMING AT SHAFT

Duct sizes	GAGE	WEIGHT/FT
8X18	24 GA	5.29
12X12	26 GA	3.85
24X14	24 GA	7.61
12X20	24 GA	6.45
12X28	24 GA	8.00

Worst case : 8 PLF
Floor to floor height = 9'6"
$W_t = 8 \times 9'6" = 76$ Lbs

SHAFT a) Check (E) 2X12 @ 16" o.c (3rd Floor)



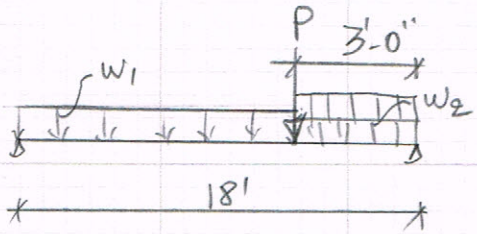
Span = 18'-0" max
Floor dead load = 15 psf
Live load = 50 psf
Reaction from cut joist:
Span = 18 - 3 = 15'

$R_{DL} = 15 \times \frac{16}{12} \times 15/2 = 150$ Lbs

$R_{LL} = 50 \times \frac{16}{12} \times 15/2 = 500$ Lbs

$W_1 \begin{cases} D_L = 15 \times \frac{16}{12} = 20 \text{ PLF} \\ L_L = 50 \times 16/12 = 67 \text{ PLF} \end{cases}$

$W_2 \begin{cases} D_L = 15 \times 8/12 + \underset{\text{psf}}{\overset{4"\text{wall}}{8}} \times 8.5 = 78 \text{ PLF} \\ L_L = 50 \times 8/12 = 33 \text{ PLF} \end{cases}$



See Emercales

$P \begin{cases} D_L = \frac{150}{2} + 8\text{psf} \times \frac{32}{12}/2 + \frac{76}{4} = 105 \text{ Lbs} \\ L_L = 500/2 = 250 \text{ Lbs} \end{cases}$

2"X12" NOT GOOD
Reinforce w/ (N) 2X12

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Project: PSU EAST HALL		Sheet # 6
Location:		
Client:		Job # 14-004
Date: 04/25/14	By: NBZ	

Duct Support at roof: Assume 20 GA

14x16 → 8.69 PLf 16x18 → 9.8 PLf

22x14 → 10.35 PLf

Supports @ 8'-0" o.c

$F_{P_1} = 8.69 \times 8 \times .26 = 18$ Lbs

Seismic

$F_{P_2} = 10.35 \times 8 \times .26 = 22$ Lbs

wind : W = 33 psf

Controls

$F_{W_1} = 33 \times 8' \times \frac{16}{12} = 352$ Lbs

$F_{W_2} = 33 \times 8' \times \frac{14}{12} = 308$ Lbs

Frame design:

case 1

$D_L = \frac{18}{14/12} = 16$ PLf

$F_W = 352$ Lbs

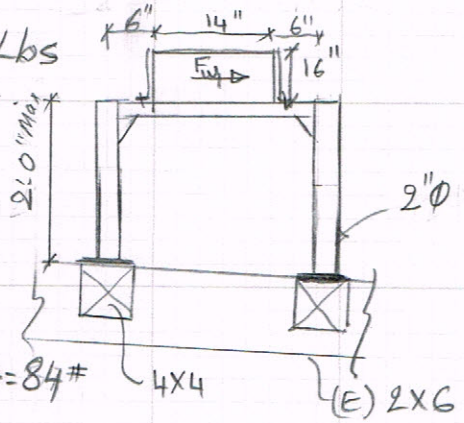
$R_{W_1} = \frac{352 \times 16/2}{14} = 201$ Lbs

Case 2

$D_L = \frac{10.35}{22/12} = 6$ PLf

$F_W = 308$ Lbs

$R_W = \frac{308 \times 12/2}{22} = 84\#$



Case 1 : 14X16 DUCT

See Risa output psueasthall1 & 2

a) Check horizontal L2x2x3/16

$M_{max} = .252$ K' → $f_b = \frac{.252 \times 12"}{.19} = 16$ ksi

$b/t = \frac{2}{3/16} = 10.66$ → $F_b = 36 \times .66 = 23.8$ ksi

$P_{comp} = .178$ K → $f_a = \frac{.178}{.715} = .25$ ksi

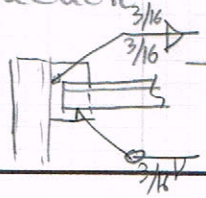
OK

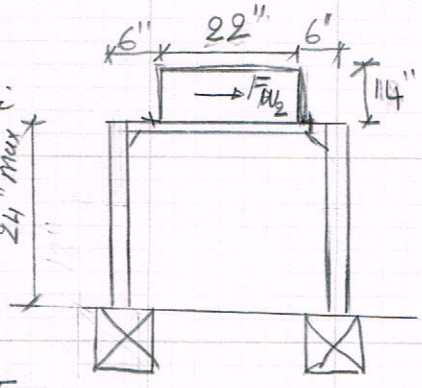
Check angle to post connection

M = .355 K'

$f_w = \frac{.355 \times 12}{2 \times 2} = 1.07$ k/in

OK





Case 2 : 22x14

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Project: PSU EAST HALL		Sheet # 7
Location:		
Client:		Job # 14-004
Date: 04/25/14	By: NBZ	

b) Check (E) 3x12 @ 16" o.c @ 2nd Floor

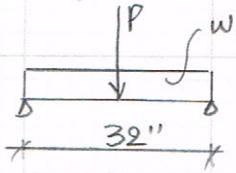
Same loading as previous OK

(E) 3x12 NG See Enercalcs, Reinforce w/ (N) 2x12

c) Check (N) (3) 2x12 Supporting cut joist & angle:

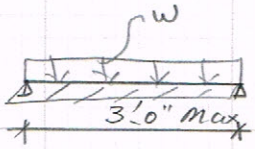
$w_{wall} = 8 \times 8.5 = 68$ PLF

$P \begin{cases} D_L = 113 + \frac{76}{4} = 132 \text{ Lbs} & \text{4 Duct} \\ L_L = 375 \text{ Lbs} \end{cases}$



d) Check L2x2x1/8 supporting duct: "weak axis"

$w_{DL} = \frac{76}{2} / 3 = 13$ PLF



seismic force:

$F_p = .26\,w = .26 \times 13 = 4$ PLF

$F_V = .1\,w = 1.3$ PLF

$M = (.013 + .0013)\, 3^2/8 = .016$ K'

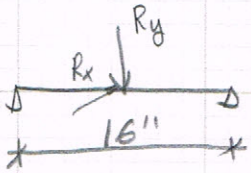
$f_{bx} = \frac{.016 \times 12}{.131} = 1.5$ ksi

$f_{by} = \frac{.004 \times 3^2}{8} = .0045$ K' OK

* Frame in weak axis Cantilever OK by inspection.

e) Check 4x4 supporting frame:

$R_x = .178$K $\quad R_y = .442$K $\quad M_t = .178 \times \frac{3\frac{1}{2}}{2} = .31$ k"



$P_{snow} = 25 \times \frac{28}{12} \times 8/2 = .233$K

4x4 acceptable

d) Check to base Pt connection:

$f_w = \sqrt{\left(\frac{.178}{\pi(2.375)}\right)^2 + \left(\frac{.427}{\pi(2.375)}\right)^2}$

$= .06$ K/in

Shear/Lag screw $= \frac{.178}{2} = .089$K

Tension/Lag screw $= \frac{.427}{2} = .214$K

OK

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Project: PSU EAST HALL		Sheet # 8
Location:		
Client:		Job # 14-004
Date: 04/25/14	By: NBZ	

Check 4x4 connection:

$R_x = \frac{.178}{2} = .089\ K$

$\downarrow R_y = \frac{.442}{2} = .221\ K$

$\uparrow R_y = \frac{.427}{2} = .214\ K$

LUS 4X4
OK

Check 2"x16GA strap:

Tension = .201 K

$f_t = \frac{.201}{.0566} = 3.6\ ksi < F_T = .6 \times 33 = 19.8\ ksi$

* Check strap connection:

a) L2x2x3/16x2" to strap w/(2) #12 SMS

Shear/screw $= \frac{201}{2} = 100\ Lbs < F_v = 394\ Lbs$

b) L2x2 to L2x2x3/16:

Shear $= \frac{352}{4} = 88\ Lbs$ per

Tension $= \frac{201 \times 2}{1 \times 2} = 201\ Lbs$

3/8" Φ bolts OK

* Check L2x2x3/16x2"

$M = .201 \times 1 = .201\ K''$

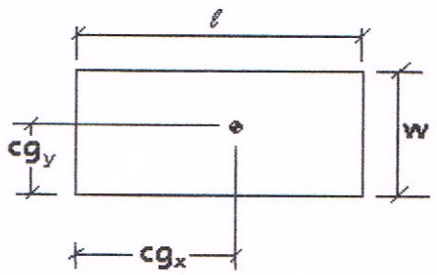
$f_b = \frac{.201}{2 \times (3/16)^2/6} = 17.2\ ksi$ OK

JOB:	PSU EAST HALL		
SHEET NO.:	9	OF	
CALCULATED BY:	NBZ	DATE	4/24/14
CHECKED BY:		DATE	
PROJECT NO.:	14-004		

RTU 1 & 2

Equipment Data

Wtot:	600	lbs
L:	48	in
w:	44	in
h:	51	in
hcg:	19.5	in
Fp:	0.260	Wp
Fv:	0.100	Wp



Anchored to concrete? (Y or N) N

Location of C.G.

Xcg = sum (Wi*xi) / Wtot. = 25.9 in.
Ycg = sum (Wi*yi) / Wtot. = 21.4 in.

Eccentricity

ex = L/2 - Xcg = 1.90 in.
ey = w/2 - Ycg = 0.60 in.
ex, minimum (5%) = 2.40 in.
ey, minimum (5%) = 2.20 in.

Connection Coordinates

x(in.)	y(in.)	stiffness (N)
0	-1	1
16	-1	1
32	-1	1
48	-1	1
0	45	1
16	45	1
32	45	1
48	45	1

Maximum Reactions, from Principal Axis Calculation (ASD)

Cmax = 136 lbs ==> compression
Tmax = 13 lbs ==> tension
Vmax = 22 lbs ==> shear

Maximum Reactions, from Principal Axis Calculation (LRFD)

Cult. = 1.4Cmax = 191 lbs ==> compression
Tult. = 1.4Tmax = 18 lbs ==> tension
Vult. = 1.4Vmax = 31 lbs ==> shear

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Project: PSU EAST HALL		Sheet # 10
Location:		
Client:		Job # 14-004
Date: 04/25/14	By: NBZ	

ROOF TOP UNITS SUPPORT

1) Check unit to curb connection:

seismic { Shear/screw = 22 Lbs
Tension/screw = 13 Lbs

wind: $F_W = 33 \times \frac{51}{12} \times \frac{48}{12} = 561$ Lbs

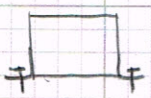
Shear = 561 Lbs

Tension: .60 ∓ W

Tension/side = $\frac{.6 \times 600}{4} \mp \frac{561 \times 51/2}{44} = 235$ Lbs

Shear/screw = $\frac{561}{10} = 56$ Lbs

Tension/screw = $\frac{235}{3} \times \frac{2}{1} = 157$ Lbs

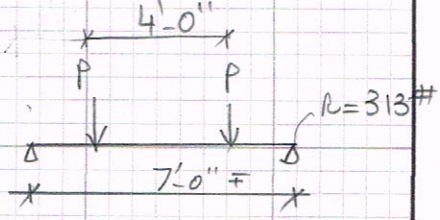


1/4" Φ x 2 1/2" Lag Screws OK

Check (N) (2) 2x10 w/ (6) 16d ea. end

$P_{DL} = \frac{600}{4} = 150$ Lbs

$P_{WL} = \frac{561 \times 51/2}{44} / 2 = 163$ Lbs



OK, see Enercalcs output

(6) 16d nails OK Shear/screw = $\frac{313}{3} = 104$ Lbs

Check pony wall connection: 2x6 @ 16" O.C w/ 10d Toe nails

Tension/side = 235 Lbs

Tension/Toe nail = $\frac{235}{3} = 78$ Lbs OK

Printed: 20 APR 2014, 11:42AM

Wood Beam

File: C:\Users\Nadia\Documents\ENERCALC Data Files\psueasthall.ec6
ENERCALC, INC. 1983-2012, Build:6.12.8.21, Ver:6.12.9.30

Lic. # : KW-06009328 Licensee : [redacted]

Description : Strengthen (E) 2x12

CODE REFERENCES

Calculations per NDS 2005, IBC 2009, CBC 2010, ASCE 7-05
Load Combination Set : IBC 2009

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : IBC 2009

Wood Species : Douglas Fir - Larch
Wood Grade : No.2

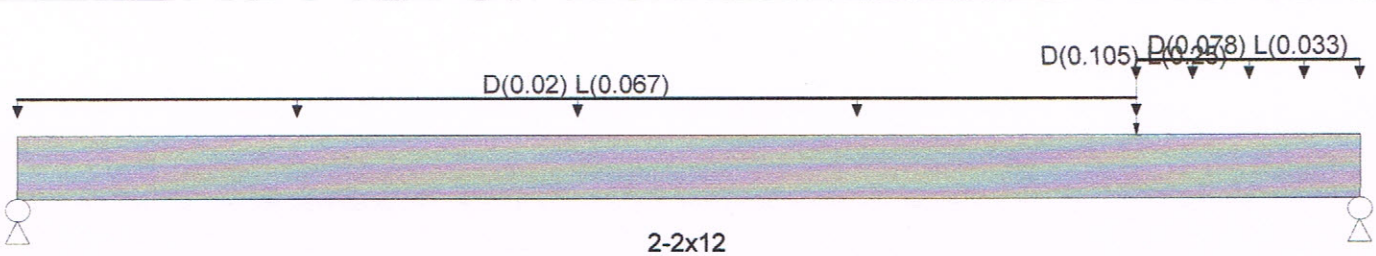
Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	900.0 psi
Fb - Compr	900.0 psi
Fc - Prll	1,350.0 psi
Fc - Perp	625.0 psi
Fv	180.0 psi
Ft	575.0 psi

E : Modulus of Elasticity

Ebend- xx	1,600.0 ksi
Eminbend - xx	580.0 ksi
Density	32.210 pcf

Repetitive Member Stress Increase



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Load for Span Number 1
Uniform Load : D = 0.020, L = 0.0670 k/ft, Extent = 0.0 -->> 15.0 ft, Tributary Width = 1.0 ft
Uniform Load : D = 0.0780, L = 0.0330 k/ft, Extent = 15.0 -->> 18.0 ft, Tributary Width = 1.0 ft
Point Load : D = 0.1050, L = 0.250 k @ 15.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.757 : 1	Maximum Shear Stress Ratio	=	0.258 : 1
Section used for this span		2-2x12	Section used for this span		2-2x12
fb : Actual	=	784.00 psi	fv : Actual	=	46.44 psi
FB : Allowable	=	1,035.00 psi	Fv : Allowable	=	180.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	9.720 ft	Location of maximum on span	=	17.100 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.316 in	Ratio =	684
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.434 in	Ratio =	497
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.4339	9.270		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.848	1.145
D Only	0.212	0.427
L Only	0.636	0.718
D+L	0.848	1.145

Printed: 20 APR 2014, 12:13PM

Wood Beam

File: C:\Users\Nadia\Documents\ENERCALC Data Files\psueasthall.ec6
ENERCALC, INC. 1983-2012, Build:6.12.8.21, Ver:6.12.9.30

Lic. # : KW-06009328 Licensee :

Description : (E) 3x12

CODE REFERENCES

Calculations per NDS 2005, IBC 2009, CBC 2010, ASCE 7-05
Load Combination Set : IBC 2009

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : IBC 2009

Wood Species : Douglas Fir - Larch
Wood Grade : No.2

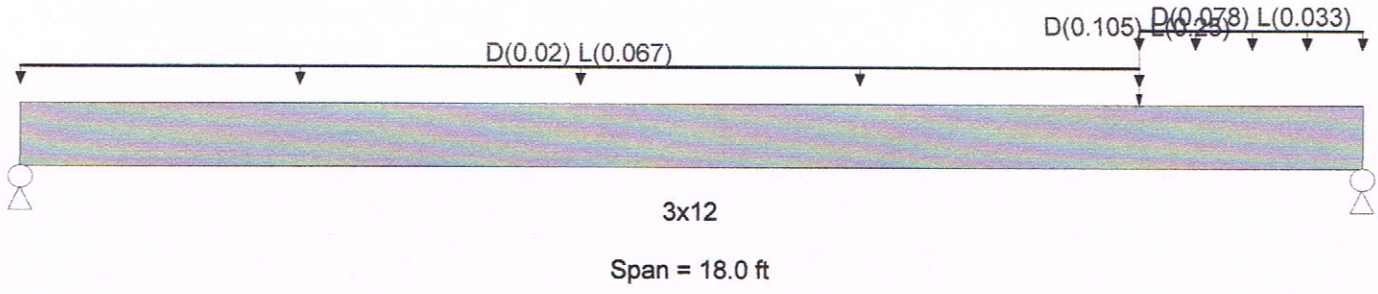
Beam Bracing : Beam is Fully Braced against lateral-torsion buckling

Fb - Tension	900.0 psi
Fb - Compr	900.0 psi
Fc - Prll	1,350.0 psi
Fc - Perp	625.0 psi
Fv	180.0 psi
Ft	575.0 psi

E : Modulus of Elasticity

Ebend- xx	1,600.0 ksi
Eminbend - xx	580.0 ksi
Density	32.210 pcf

Repetitive Member Stress Increase



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Load for Span Number 1
Uniform Load : D = 0.020, L = 0.0670 k/ft, Extent = 0.0 –>> 15.0 ft, Tributary Width = 1.0 ft
Uniform Load : D = 0.0780, L = 0.0330 k/ft, Extent = 15.0 –>> 18.0 ft, Tributary Width = 1.0 ft
Point Load : D = 0.1050, L = 0.250 k @ 15.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.909 : 1	Maximum Shear Stress Ratio	=	0.310 : 1
Section used for this span		3x12	Section used for this span		3x12
fb : Actual	=	940.80 psi	fv : Actual	=	55.73 psi
FB : Allowable	=	1,035.00 psi	Fv : Allowable	=	180.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	9.720 ft	Location of maximum on span	=	17.100 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.379 in	Ratio =	570
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.521 in	Ratio =	414
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.5207	9.270		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.848	1.145
D Only	0.212	0.427
L Only	0.636	0.718
D+L	0.848	1.145

Printed: 20 APR 2014, 12:15PM

Wood Beam

File: C:\Users\Nadia\Documents\ENERCALC Data Files\psueasthall.ec6
ENERCALC, INC. 1983-2012, Build:6.12.8.21, Ver:6.12.9.30

Lic. # : KW-06009328 Licensee :

Description : (N) (3) 2x12 floor joist

CODE REFERENCES

Calculations per NDS 2005, IBC 2009, CBC 2010, ASCE 7-05
Load Combination Set : IBC 2009

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : IBC 2009

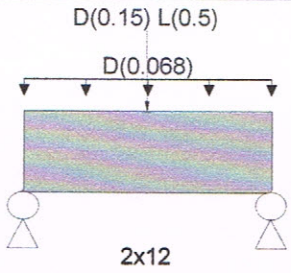
Wood Species : Douglas Fir - Larch
Wood Grade : No.2

Beam Bracing : Completely Unbraced

Fb - Tension	875.0 psi
Fb - Compr	875.0 psi
Fc - Prll	600.0 psi
Fc - Perp	625.0 psi
Fv	170.0 psi
Ft	425.0 psi

E : Modulus of Elasticity

Ebend- xx	1,300.0 ksi
Eminbend - xx	470.0 ksi
Density	32.210 pcf



Span = 2.670 ft

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Point Load : D = 0.150, L = 0.50 k @ 1.330 ft
Uniform Load : D = 0.0680 , Tributary Width = 1.0 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.219 : 1	Maximum Shear Stress Ratio	=	0.186 : 1
Section used for this span		2x12	Section used for this span		2x12
fb : Actual	=	188.19 psi	fv : Actual	=	31.55 psi
FB : Allowable	=	861.24 psi	Fv : Allowable	=	170.00 psi
Load Combination		+D+L+H	Load Combination		+D+L+H
Location of maximum on span	=	1.335 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.001 in	Ratio =	21476
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.002 in	Ratio =	13948
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+L	1	0.0023	1.335		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.422	0.420
D Only	0.171	0.171
L Only	0.251	0.249
D+L	0.422	0.420

Project:

Title :
Engineer:
Project Desc.:

Job #

Printed: 20 APR 2014, 1:24PM

Wood Beam

File: C:\Users\Nadia\Documents\ENERCALC Data Files\psueasthall.ec6
ENERCALC, INC. 1983-2012, Build:6.12.8.21, Ver:6.12.9.30

Lic. # : KW-06009328

Licensee :

Description : 4x4 blocking

CODE REFERENCES

Calculations per NDS 2005, IBC 2009, CBC 2010, ASCE 7-05
Load Combination Set : IBC 2009

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : IBC 2009

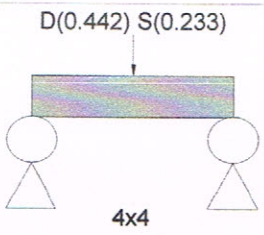
Wood Species : Douglas Fir - Larch
Wood Grade : No.2

Beam Bracing : Completely Unbraced

Fb - Tension	875.0 psi
Fb - Compr	875.0 psi
Fc - Prll	600.0 psi
Fc - Perp	625.0 psi
Fv	170.0 psi
Ft	425.0 psi

E : Modulus of Elasticity

Ebend- xx	1,300.0 ksi
Eminbend - xx	470.0 ksi
Density	32.210 pcf



Span = 1.330 ft

Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Beam self weight calculated and added to loads
Point Load : D = 0.4420, S = 0.2330 k @ 0.670 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.287 : 1	Maximum Shear Stress Ratio	=	0.246 : 1
Section used for this span		4x4	Section used for this span		4x4
fb : Actual	=	376.95 psi	fv : Actual	=	41.76 psi
FB : Allowable	=	1,312.50 psi	Fv : Allowable	=	170.00 psi
Load Combination		+D+S+H	Load Combination		+D+S+H
Location of maximum on span	=	0.672 ft	Location of maximum on span	=	1.044 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.001 in	Ratio =	13050
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.004 in	Ratio =	4489
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

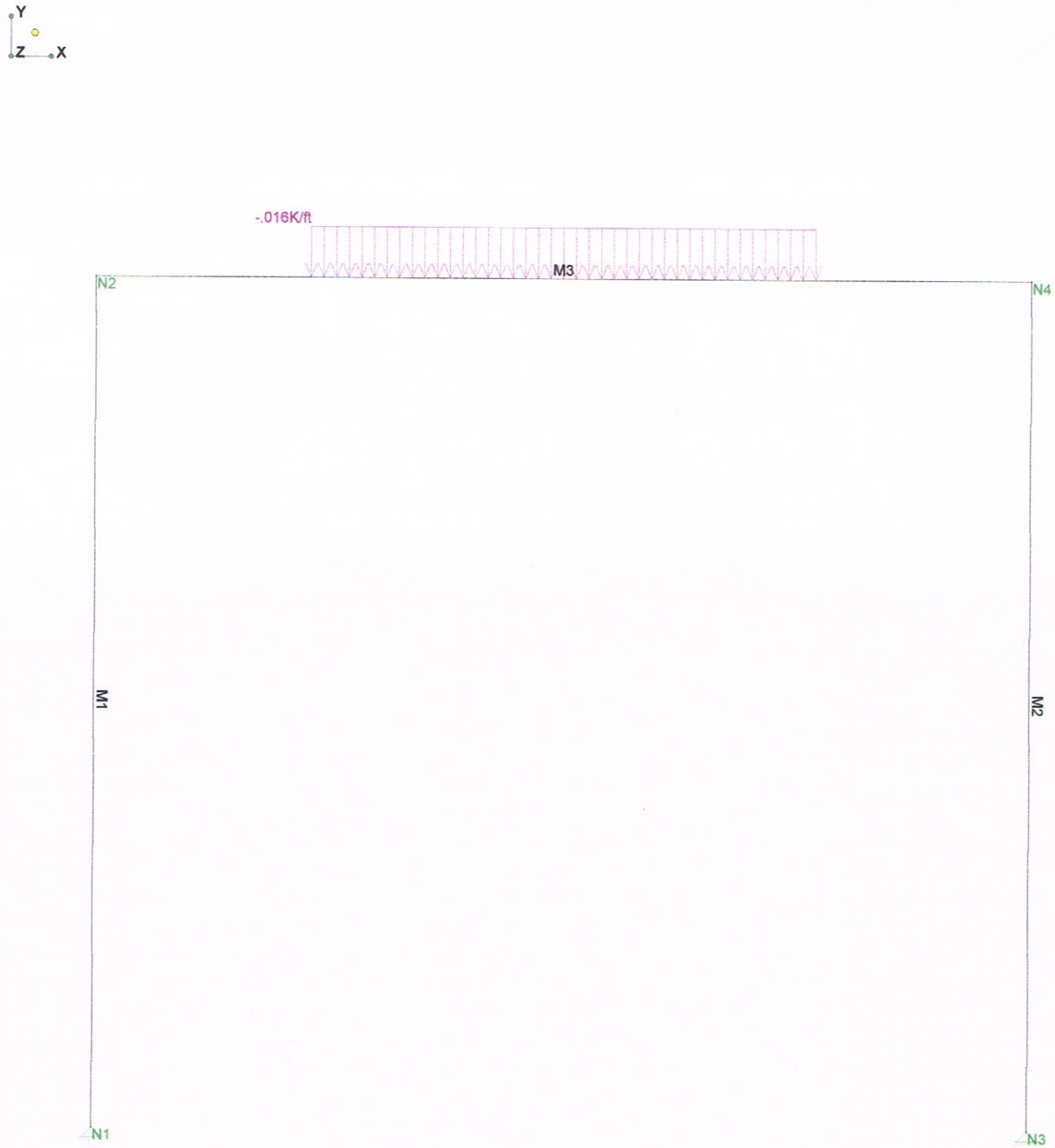
Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+S	1	0.0036	0.672		0.0000	0.000

Vertical Reactions - Unfactored

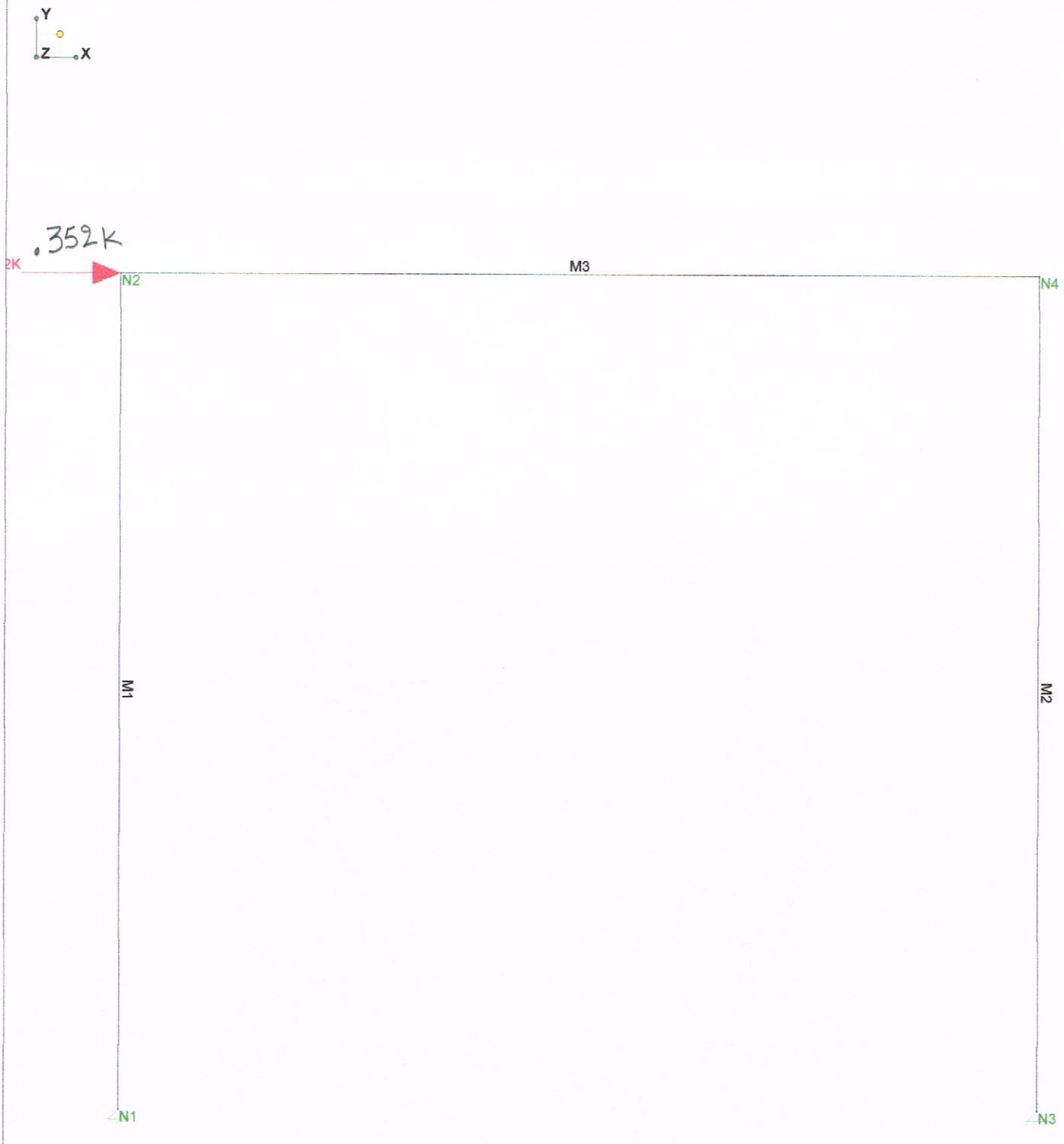
Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.337	0.342
D Only	0.221	0.224
S Only	0.116	0.117
D+S	0.337	0.342



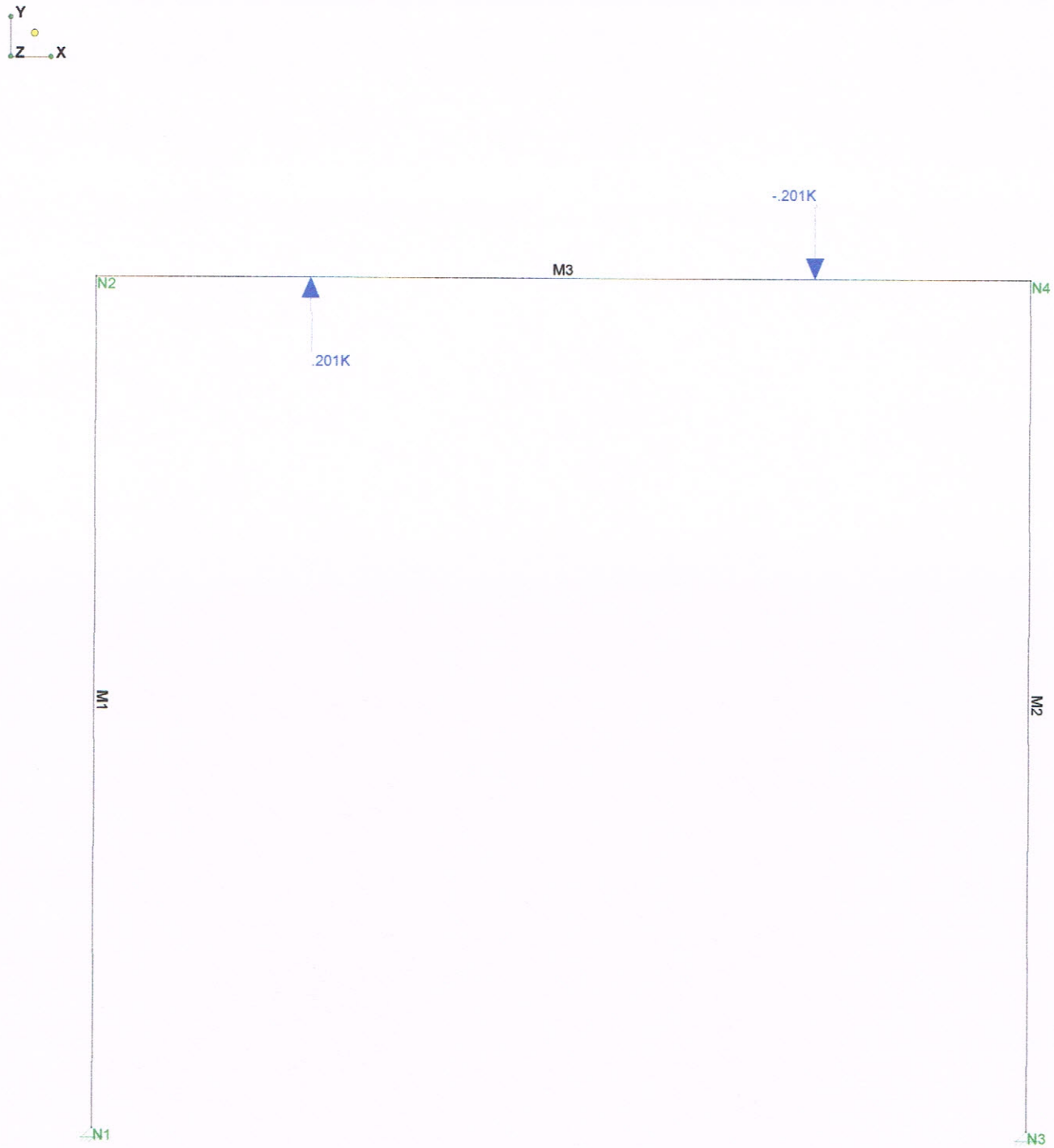
Loads: BLC 1, BLC1
Solution: Envelope

NBZ CONSULTING ENGINEERS	PSU EAST HALL DUCT (14x16) SUPPORT	April 20, 2014
NZ		psueasthall1.r3d
14-004		



Loads: BLC 2, BLC2
Solution: Envelope

NBZ CONSULTING ENGINEERS	PSU EAST HALL DUCT (14x16) SUPPORT	April 20, 2014
NZ		psueasthall1.r3d
14-004		



Loads: BLC 3, BLC3
Solution: Envelope

NBZ CONSULTING ENGINEERS	PSU EAST HALL DUCT (14x16) SUPPORT	April 20, 2014
NZ		psueasthall1.r3d
14-004		

Company : **NBZ CONSULTING ENGINEERS** April 20, 2014
Designer : **NZ**
Job Number : **14-004** **PSU EAST HALL DUCT (14x16) SUPPORT** 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	PIPE_2.0	STL	1.075	1.2	1.2	.666	.666	1.331	
S2	L2X2X3	STL	.715	1.2	1.2	.27	.272	.009	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	0	2	0	0
N3	2.17	0	0	0
N4	2.17	2	0	0

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						2
M2	N3	N4			SEC1						2
M3	N2	N4			S2						2.17

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			
N3	Reaction	Reaction	Reaction			

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	BLC1	DL	Dead Load			1	
2	BLC2	WL	Wind Load	1			
3	BLC3	WL	Wind Load		2		

Member Distributed Loads, Category : DL, BLC 1 : BLC1

Member Label	I Joint	J Joint	Load Pattern Label	Pattern Multiplier
M3	N2	N4	UNIFORM	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	-.016	-.016	.5	1.67

Company : NBZ CONSULTING ENGINEERS
Designer : NZ
Job Number : 14-004
PSU EAST HALL DUCT (14x16) SUPPORT
April 20, 2014
Checked By:_____

Joint Loads/Enforced Displacements, Category : WL, BLC 2 : BLC2

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N2	L	X	.352

Member Point Loads, Category : WL, BLC 3 : BLC3

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M3	N2	N4	Y	.201	.5
M3	N2	N4	Y	-.201	1.67

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+WL	y				1	1	1	2	1	3	1		
3	.6DL+WL	y				1	1	.6	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	0.002	1	0.009	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.175	3	-0.427	3	0.000	1	0.000	1	0.000	1	0.000	1
N3	max	-0.002	1	0.442	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.178	2	0.009	1	0.000	1	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	0.000	1	0.019	1	0.000	1						
	min	-0.352	2	0.011	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	0.009	1	0.175	3	0	1	0	1	0	1	0	1
		min	-0.427	3	-0.002	1	0	1	0	1	0	1	0	1
	2	max	0.009	1	0.175	3	0	1	0	1	0	1	0.001	1
		min	-0.427	3	-0.002	1	0	1	0	1	0	1	-0.087	3
	3	max	0.009	1	0.175	3	0	1	0	1	0	1	0.002	1
		min	-0.427	3	-0.002	1	0	1	0	1	0	1	-0.175	3
	4	max	0.009	1	0.175	3	0	1	0	1	0	1	0.003	1
		min	-0.427	3	-0.002	1	0	1	0	1	0	1	-0.262	3
	5	max	0.009	1	0.175	3	0	1	0	1	0	1	0.004	1
		min	-0.427	3	-0.002	1	0	1	0	1	0	1	-0.35	3
M2	1	max	0.442	2	0.178	2	0	1	0	1	0	1	0	1
		min	0.009	1	0.002	1	0	1	0	1	0	1	0	1
	2	max	0.442	2	0.178	2	0	1	0	1	0	1	-0.001	1
		min	0.009	1	0.002	1	0	1	0	1	0	1	-0.089	2
	3	max	0.442	2	0.178	2	0	1	0	1	0	1	-0.002	1
		min	0.009	1	0.002	1	0	1	0	1	0	1	-0.178	2
	4	max	0.442	2	0.178	2	0	1	0	1	0	1	-0.003	1
		min	0.009	1	0.002	1	0	1	0	1	0	1	-0.267	2
	5	max	0.442	2	0.178	2	0	1	0	1	0	1	-0.004	1
		min	0.009	1	0.002	1	0	1	0	1	0	1	-0.355	2
M3	1	max	0.178	2	0.009	1	0	1	0	1	0.247	3	0.003	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	0.002	1	-0.427	3	0	1	0	1	-0.003	1	-0.248	3
	2	max	0.178	2	0.009	1	0	1	0	1	0.09	2	-0.001	1
		min	0.002	1	-0.227	3	0	1	0	1	0.001	1	-0.09	2
	3	max	0.178	2	0	1	0	1	0	1	0.003	2	-0.002	3
		min	0.002	1	-0.232	2	0	1	0	1	0.002	3	-0.003	2
	4	max	0.178	2	-0.009	1	0	1	0	1	0.001	1	0.088	3
		min	0.002	1	-0.24	2	0	1	0	1	-0.088	3	-0.001	1
	5	max	0.178	2	-0.009	1	0	1	0	1	-0.003	1	0.252	2
		min	0.002	1	-0.442	2	0	1	0	1	-0.251	2	0.003	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	0.009	1	0.195	3	0	1	0	1	0	1	0	1	0	1
		min	-0.398	3	-0.002	1	0	1	0	1	0	1	0	1	0	1
	2	max	0.009	1	0.195	3	0	1	1.873	3	0.02	1	0	1	0	1
		min	-0.398	3	-0.002	1	0	1	-0.02	1	-1.873	3	0	1	0	1
	3	max	0.009	1	0.195	3	0	1	3.746	3	0.039	1	0	1	0	1
		min	-0.398	3	-0.002	1	0	1	-0.039	1	-3.746	3	0	1	0	1
	4	max	0.009	1	0.195	3	0	1	5.619	3	0.059	1	0	1	0	1
		min	-0.398	3	-0.002	1	0	1	-0.059	1	-5.619	3	0	1	0	1
	5	max	0.009	1	0.195	3	0	1	7.491	3	0.078	1	0	1	0	1
		min	-0.398	3	-0.002	1	0	1	-0.078	1	-7.491	3	0	1	0	1
M2	1	max	0.411	2	0.198	2	0	1	0	1	0	1	0	1	0	1
		min	0.009	1	0.002	1	0	1	0	1	0	1	0	1	0	1
	2	max	0.411	2	0.198	2	0	1	1.902	2	-0.02	1	0	1	0	1
		min	0.009	1	0.002	1	0	1	0.02	1	-1.902	2	0	1	0	1
	3	max	0.411	2	0.198	2	0	1	3.804	2	-0.039	1	0	1	0	1
		min	0.009	1	0.002	1	0	1	0.039	1	-3.804	2	0	1	0	1
	4	max	0.411	2	0.198	2	0	1	5.707	2	-0.059	1	0	1	0	1
		min	0.009	1	0.002	1	0	1	0.059	1	-5.707	2	0	1	0	1
	5	max	0.411	2	0.198	2	0	1	7.609	2	-0.078	1	0	1	0	1
		min	0.009	1	0.002	1	0	1	0.078	1	-7.609	2	0	1	0	1
M3	1	max	0.249	2	0.03	1	0	1	9.331	3	0.097	1	18.131	3	0.224	1
		min	0.003	1	-1.367	3	0	1	-0.097	1	-9.302	3	-0.189	1	-21.47	3
	2	max	0.249	2	0.028	1	0	1	3.395	2	-0.037	1	6.597	2	-0.086	1
		min	0.003	1	-0.725	3	0	1	0.038	1	-3.384	2	0.073	1	-7.812	2
	3	max	0.249	2	0	1	0	1	0.105	2	-0.065	3	0.204	2	-0.15	3
		min	0.003	1	-0.742	2	0	1	0.065	3	-0.105	2	0.127	3	-0.242	2
	4	max	0.249	2	-0.028	1	0	1	0.038	1	3.315	3	0.073	1	7.651	3
		min	0.003	1	-0.77	2	0	1	-3.325	3	-0.037	1	-6.461	3	-0.086	1
	5	max	0.249	2	-0.03	1	0	1	-0.097	1	9.447	2	-0.189	1	21.806	2
		min	0.003	1	-1.415	2	0	1	-9.477	2	0.097	1	-18.415	2	0.224	1

Member Deflection

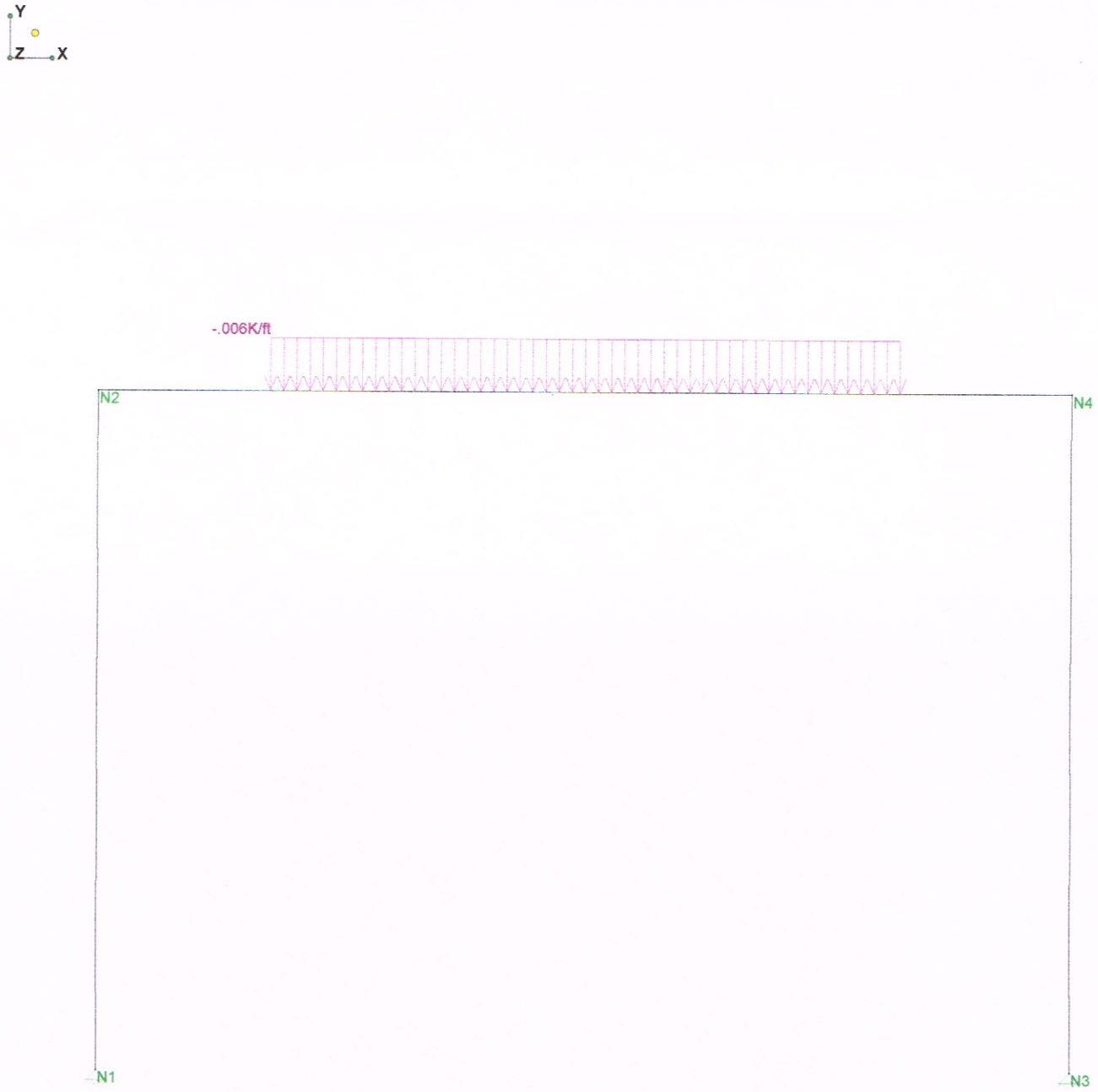
Member Label	Section		x-Translate (In)	Lc	y-Translate (In)	Lc	z-Translate (In)	Lc	x-Rotate (radians)	Lc	(n) L/y Ratio	Lc	(n) L/z Ratio	Lc
M1	1	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0	3	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.028	3	0	1	0	1	4903.398	3	NC	
	3	max	0	3	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.055	3	0	1	0	1	3064.624	3	NC	
	4	max	0	3	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	-0.078	3	0	1	0	1	3502.427	3	NC	
	5	max	0	3	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.094	2	0	1	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	1	0	1	NC		NC	
		min	0	2	-0.028	2	0	1	0	1	4827.816	2	NC	
	3	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	2	-0.055	2	0	1	0	1	3017.385	2	NC	
	4	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	2	-0.078	2	0	1	0	1	3448.44	2	NC	
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	2	-0.094	3	0	1	0	1	NC		NC	
M3	1	max	0.094	2	0	3	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0.094	2	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.005	2	0	1	0	1	5524.581	2	NC	
	3	max	0.094	2	0	3	0	1	0	1	NC		NC	
		min	0	1	0	2	0	1	0	1	NC		NC	
	4	max	0.094	3	0.004	3	0	1	0	1	5939	3	NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	5	max	0.094	3	0	1	0	1	0	1	NC		NC	
		min	0	1	0	2	0	1	0	1	NC		NC	

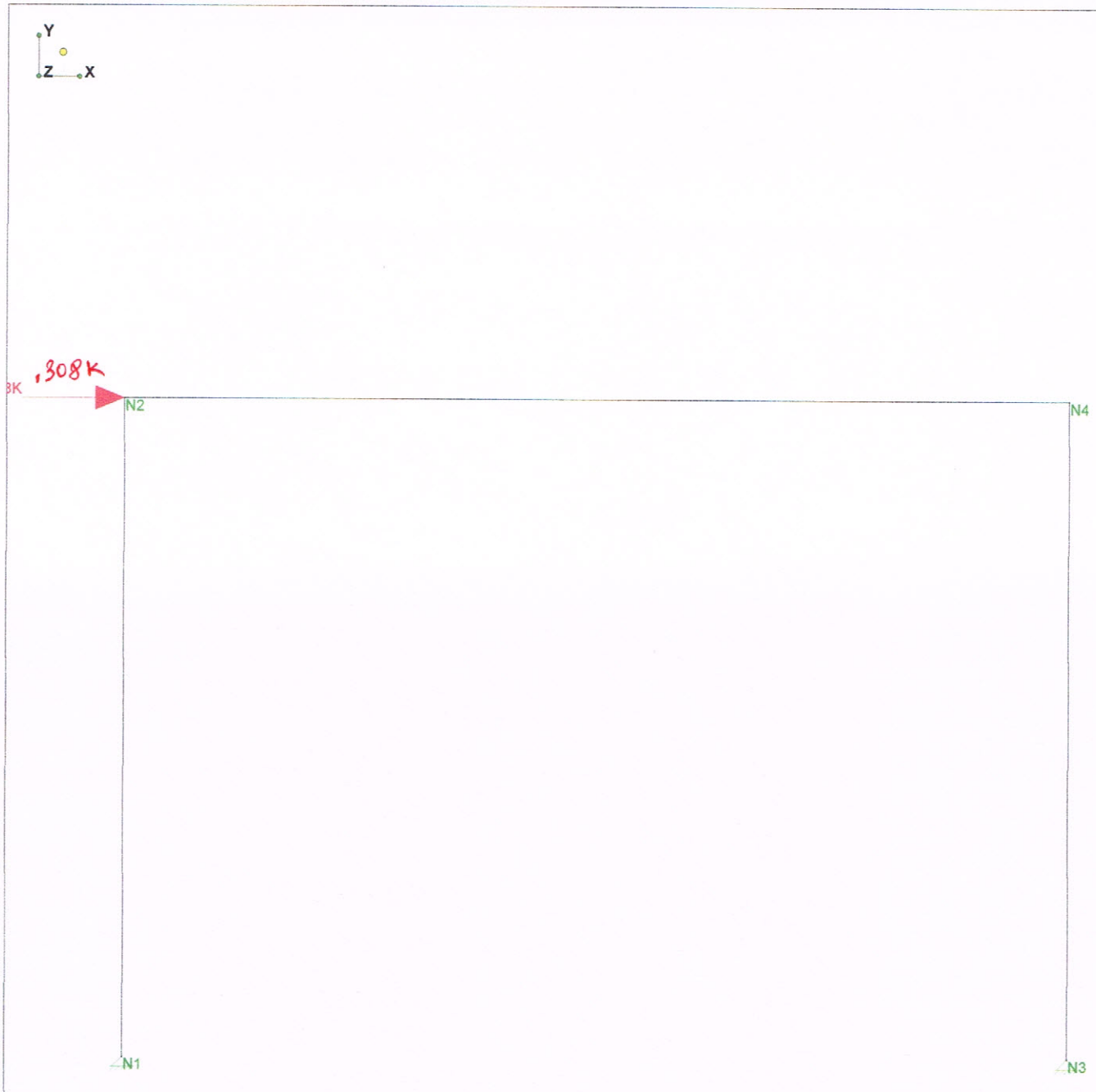
Envelope Member AISC ASD 9th Code Checks

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	0.334	2	3	0.014	0	0	3	19.907	23.76	23.76	H2-1
M2	0.339	2	2	0.014	0	0	2	19.907	23.76	23.76	H1-2
M3	0.015	0	2	0.098	1.688	y	2	16.83	Code check based on z-z Axial ONLY -		



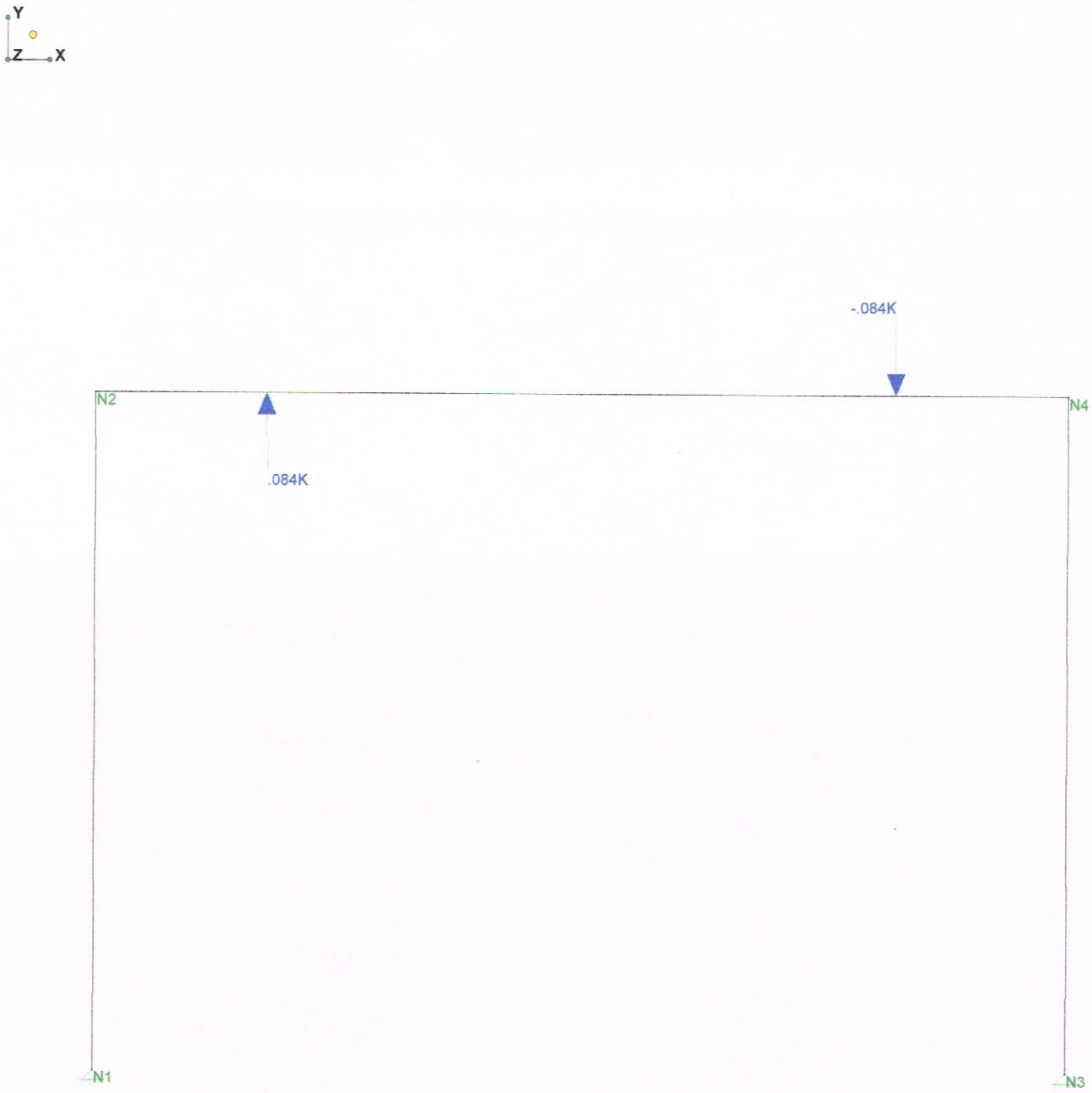
Loads: BLC 1, BLC1

NBZ CONSULTING ENGINEERS	PSU EAST HALL DUCT (22x14) SUPPORT	April 23, 2014
NZ		psueasthall2.r3d
14-004		



Loads: BLC 2, BLC2

NBZ CONSULTING ENGINEERS PSU EAST HALL DUCT (22x14) SUPPORT		April 23, 2014
NZ		psueasthall2.r3d
14-004		



Loads: BLC 3, BLC3

NBZ CONSULTING ENGINEERS	PSU EAST HALL DUCT (22x14) SUPPORT	April 23, 2014
NZ		psueasthall2.r3d
14-004		

Company : **NBZ CONSULTING ENGINEERS** April 23, 2014
Designer : **NZ**
Job Number : **14-004** **PSU EAST HALL DUCT (22x14) SUPPORT** 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	PIPE_2.0	STL	1.075	1.2	1.2	.666	.666	1.331	
S2	L2X2X3	STL	.715	1.2	1.2	.27	.272	.009	

Joint Coordinates

Joint Label	X Coordinate (Ft)	Y Coordinate (Ft)	Z Coordinate (Ft)	Joint Temperature (F)
N1	0	0	0	0
N2	0	2	0	0
N3	2.83	0	0	0
N4	2.83	2	0	0

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						2
M2	N3	N4			SEC1						2
M3	N2	N4			S2						2.83

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			
N3	Reaction	Reaction	Reaction			

Basic Load Case Data

BLC No.	Basic Load Case Description	Category Code	Category Description	Load Type Totals Nodal	Point	Distributed	Surface
1	BLC1	DL	Dead Load	1	1	1	
2	BLC2	WL	Wind Load	1			
3	BLC3	WL	Wind Load		2		

Member Distributed Loads, Category : DL, BLC 1 : BLC1

Member Label	I Joint	J Joint	Load Pattern Label	Pattern Multiplier
M3	N2	N4	UNIFORM	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	-.006	-.006	.5	2.33

Company : **NBZ CONSULTING ENGINEERS** April 23, 2014
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Joint Loads/Enforced Displacements, Category : DL, BLC 1 : BLC1

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N3	L	Y	0

Joint Loads/Enforced Displacements, Category : WL, BLC 2 : BLC2

Joint Label	[L]oad or [D]isplacement	Direction	Magnitude (K, K-ft, In, rad)
N2	L	X	.308

Member Point Loads, Category : DL, BLC 1 : BLC1

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M1	N1	N2	Y	0	0

Member Point Loads, Category : WL, BLC 3 : BLC3

Member Label	I Joint	J Joint	Direction	Magnitude (K, K-ft)	Location (Ft or %)
M3	N2	N4	Y	.084	.5
M3	N2	N4	Y	-.084	2.33

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	0.001	1	0.005	1	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.153	3	-0.269	3	0.000	1	0.000	1	0.000	1	0.000	1
N3	max	-0.001	1	0.277	2	0.000	1	0.000	1	0.000	1	0.000	1
	min	-0.155	2	0.005	1	0.000	1	0.000	1	0.000	1	0.000	1
Reaction Totals :	max	0.000	1	0.011	2	0.000	1						
	min	-0.308	3	0.007	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	0.005	1	0.153	3	0	1	0	1	0	1	0	1
		min	-0.269	3	-0.001	1	0	1	0	1	0	1	0	1
	2	max	0.005	1	0.153	3	0	1	0	1	0	1	0.001	1
		min	-0.269	3	-0.001	1	0	1	0	1	0	1	-0.077	3
	3	max	0.005	1	0.153	3	0	1	0	1	0	1	0.001	1
		min	-0.269	3	-0.001	1	0	1	0	1	0	1	-0.153	3
	4	max	0.005	1	0.153	3	0	1	0	1	0	1	0.002	1
		min	-0.269	3	-0.001	1	0	1	0	1	0	1	-0.23	3
	5	max	0.005	1	0.153	3	0	1	0	1	0	1	0.003	1
		min	-0.269	3	-0.001	1	0	1	0	1	0	1	-0.306	3
M2	1	max	0.277	2	0.155	2	0	1	0	1	0	1	0	1
		min	0.005	1	0.001	1	0	1	0	1	0	1	0	1
	2	max	0.277	2	0.155	2	0	1	0	1	0	1	-0.001	1
		min	0.005	1	0.001	1	0	1	0	1	0	1	-0.078	2
	3	max	0.277	2	0.155	2	0	1	0	1	0	1	-0.001	1
		min	0.005	1	0.001	1	0	1	0	1	0	1	-0.155	2
	4	max	0.277	2	0.155	2	0	1	0	1	0	1	-0.002	1
		min	0.005	1	0.001	1	0	1	0	1	0	1	-0.233	2
	5	max	0.277	2	0.155	2	0	1	0	1	0	1	-0.003	1
		min	0.005	1	0.001	1	0	1	0	1	0	1	-0.311	2

Company : **NBZ CONSULTING ENGINEERS** April 23, 2014
Designer : **NZ**
Job Number : **14-004** **PSU EAST HALL DUCT (22x14) SUPPORT** 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
M3	1	max	0.155	2	0.005	1	0	1	0	1	0.216	3	0.002	1
		min	0.001	1	-0.269	3	0	1	0	1	-0.002	1	-0.217	3
	2	max	0.155	2	0.004	1	0	1	0	1	0.095	2	-0.001	1
		min	0.001	1	-0.185	3	0	1	0	1	0.001	1	-0.095	2
	3	max	0.155	2	0	1	0	1	0	1	0.002	2	-0.001	3
		min	0.001	1	-0.188	2	0	1	0	1	0.001	3	-0.002	2
	4	max	0.155	2	-0.004	1	0	1	0	1	0.001	1	0.094	3
		min	0.001	1	-0.192	2	0	1	0	1	-0.093	3	-0.001	1
	5	max	0.155	2	-0.005	1	0	1	0	1	-0.002	1	0.22	2
		min	0.001	1	-0.277	2	0	1	0	1	-0.219	2	0.002	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	0.005	1	0.171	3	0	1	0	1	0	1	0	1	0	1
		min	-0.25	3	-0.002	1	0	1	0	1	0	1	0	1	0	1
	2	max	0.005	1	0.171	3	0	1	1.64	3	0.015	1	0	1	0	1
		min	-0.25	3	-0.002	1	0	1	-0.015	1	-1.64	3	0	1	0	1
	3	max	0.005	1	0.171	3	0	1	3.28	3	0.03	1	0	1	0	1
		min	-0.25	3	-0.002	1	0	1	-0.03	1	-3.28	3	0	1	0	1
	4	max	0.005	1	0.171	3	0	1	4.92	3	0.045	1	0	1	0	1
		min	-0.25	3	-0.002	1	0	1	-0.045	1	-4.92	3	0	1	0	1
	5	max	0.005	1	0.171	3	0	1	6.56	3	0.06	1	0	1	0	1
		min	-0.25	3	-0.002	1	0	1	-0.06	1	-6.56	3	0	1	0	1
M2	1	max	0.258	2	0.173	2	0	1	0	1	0	1	0	1	0	1
		min	0.005	1	0.002	1	0	1	0	1	0	1	0	1	0	1
	2	max	0.258	2	0.173	2	0	1	1.662	2	-0.015	1	0	1	0	1
		min	0.005	1	0.002	1	0	1	0.015	1	-1.662	2	0	1	0	1
	3	max	0.258	2	0.173	2	0	1	3.324	2	-0.03	1	0	1	0	1
		min	0.005	1	0.002	1	0	1	0.03	1	-3.324	2	0	1	0	1
	4	max	0.258	2	0.173	2	0	1	4.987	2	-0.045	1	0	1	0	1
		min	0.005	1	0.002	1	0	1	0.045	1	-4.987	2	0	1	0	1
	5	max	0.258	2	0.173	2	0	1	6.649	2	-0.06	1	0	1	0	1
		min	0.005	1	0.002	1	0	1	0.06	1	-6.649	2	0	1	0	1
M3	1	max	0.217	2	0.018	1	0	1	8.171	3	0.074	1	15.878	3	0.172	1
		min	0.002	1	-0.86	3	0	1	-0.075	1	-8.146	3	-0.145	1	-18.801	3
	2	max	0.217	2	0.014	1	0	1	3.576	2	-0.025	1	6.949	2	-0.059	1
		min	0.002	1	-0.593	3	0	1	0.026	1	-3.565	2	0.05	1	-8.228	2
	3	max	0.217	2	0	1	0	1	0.07	2	-0.044	3	0.136	2	-0.101	3
		min	0.002	1	-0.602	2	0	1	0.044	3	-0.07	2	0.085	3	-0.161	2
	4	max	0.217	2	-0.014	1	0	1	0.026	1	3.515	3	0.05	1	8.113	3
		min	0.002	1	-0.615	2	0	1	-3.526	3	-0.025	1	-6.852	3	-0.059	1
	5	max	0.217	2	-0.018	1	0	1	-0.075	1	8.256	2	-0.145	1	19.055	2
		min	0.002	1	-0.888	2	0	1	-8.281	2	0.074	1	-16.092	2	0.172	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	3	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.029	3	0	1	0	1	5599.325	3	NC	
	3	max	0	3	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.056	3	0	1	0	1	3499.578	3	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	3	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.079	3	0	1	0	1	3999.518	3	NC	
	5	max	0	3	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.098	2	0	1	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	1	0	1	NC		NC	
		min	0	2	-0.029	2	0	1	0	1	5524.789	2	NC	
	3	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	2	-0.056	2	0	1	0	1	3452.993	2	NC	
	4	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	2	-0.079	2	0	1	0	1	3946.278	2	NC	
	5	max	0	1	0	1	0	1	0	1	NC		NC	
		min	0	2	-0.098	3	0	1	0	1	NC		NC	
M3	1	max	0.098	2	0	3	0	1	0	1	NC		NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	2	max	0.098	2	0	1	0	1	0	1	NC		NC	
		min	0	1	-0.008	2	0	1	0	1	4402.438	2	NC	
	3	max	0.098	2	0	3	0	1	0	1	NC		NC	
		min	0	1	0	2	0	1	0	1	NC		NC	
	4	max	0.098	3	0.007	3	0	1	0	1	4630.187	3	NC	
		min	0	1	0	1	0	1	0	1	NC		NC	
	5	max	0.098	3	0	1	0	1	0	1	NC		NC	
		min	0	1	0	2	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	0.288	2	3	0.012	0	0	3	19.907	23.76	23.76	H2-1
M2	0.292	2	2	0.012	0	0	2	19.907	23.76	23.76	H1-2
M3	0.015	0	2	0.062	2.358	y	2	14.652	Code check based on z-z Axial ONLY -		

Project:

Title :
Engineer:
Project Desc.:

Job # 29

Printed: 24 APR 2014, 8:21PM

Wood Beam

File: C:\Users\Nadia\Documents\ENERCALC Data Files\psueasthall.ec6
ENERCALC, INC. 1983-2012, Build:6.12.8.21, Ver:6.12.9.30

Lic. # : KW-06009328 Licensee : [redacted]

Description : (2) 2x10 Supporting RTU unit

CODE REFERENCES

Calculations per NDS 2005, IBC 2009, CBC 2010, ASCE 7-05
Load Combination Set : IBC 2009

Material Properties

Analysis Method : Allowable Stress Design
Load Combination : IBC 2009

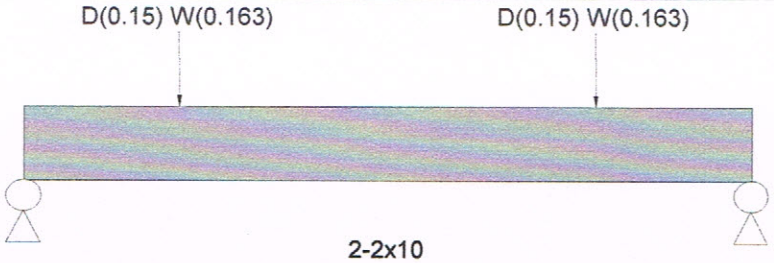
Wood Species : Douglas Fir - Larch
Wood Grade : No.2

Beam Bracing : Completely Unbraced

Fb - Tension	900 psi
Fb - Compr	900 psi
Fc - Prll	1350 psi
Fc - Perp	625 psi
Fv	180 psi
Ft	575 psi

E : Modulus of Elasticity

Ebend- xx	1600 ksi
Eminbend - xx	580 ksi
Density	32.21 pcf



Applied Loads

Service loads entered. Load Factors will be applied for calculations.

Point Load : D = 0.150, W = 0.1630 k @ 1.50 ft
Point Load : D = 0.150, W = 0.1630 k @ 5.50 ft

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio	=	0.134 : 1	Maximum Shear Stress Ratio	=	0.094 : 1
Section used for this span		2-2x10	Section used for this span		2-2x10
fb : Actual	=	131.69 psi	fv : Actual	=	16.92 psi
FB : Allowable	=	983.23 psi	Fv : Allowable	=	180.00 psi
Load Combination		+D+W+H	Load Combination		+D+W+H
Location of maximum on span	=	4.690 ft	Location of maximum on span	=	0.000 ft
Span # where maximum occurs	=	Span # 1	Span # where maximum occurs	=	Span # 1

Maximum Deflection

Max Downward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Upward L+Lr+S Deflection	0.000 in	Ratio =	0 <360
Max Downward Total Deflection	0.015 in	Ratio =	5653
Max Upward Total Deflection	0.000 in	Ratio =	0 <180

Overall Maximum Deflections - Unfactored Loads

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
D+W	1	0.0149	3.535		0.0000	0.000

Vertical Reactions - Unfactored

Support notation : Far left is #1 Values in KIPS

Load Combination	Support 1	Support 2
Overall MAXimum	0.313	0.313
D Only	0.150	0.150
W Only	0.163	0.163
D+W	0.313	0.313

TABLE 2—ALLOWABLE TENSILE PULL-OUT LOADS (P_{NOT}/Ω), pounds-force[1,2,3,4]

Steel F_u = 45 ksi Applied Factor of Safety, Ω = 3.0												
Screw Description	Nominal Diameter (in.)	Design thickness of member not in contact with the screw head (in.)										
		0.015	0.018	0.024	0.030	0.036	0.048	0.060	0.075	0.090	0.105	0.135
Self-drilling Screws for Steel-to-Steel Connections[5]												
#6-20	0.138	-	-	-	-	63	84	106	132	158	185	238
#7-18	0.151	-	-	-	-	69	92	116	144	173	202	260
#8-18	0.164	-	-	-	-	75	100	125	157	188	220	282
#10-12 #10-16 #10-18	0.190	-	-	-	-	87	116	145	182	218	254	327
#12-14 #12-24	0.216	-	-	-	-	99	132	165	207	248	289	373
$^1/_4$-14	0.250	-	-	-	-	115	153	191	239	287	333	430
Self-piercing Screws for Steel-to-Steel Connections[6]												
#8-18S	0.164	37	49	68	86	109	-	-	-	-	-	-
#10-12S	0.190	44	53	77	102	117	150	-	-	-	-	-

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.4 N, 1 ksi = 6.89 MPa.

[1]For tension connections, the lower of the allowable pull-out, pullover, and tension fastener strength of screw found in Tables 2, 3, and 5, respectively must be used for design.

[2]Unless otherwise noted, load values are based upon calculations in accordance with Section E4 of AISI S100. ANSI/ASME standard screw diameters were used in the calculations and are listed in the tables.

[3]The allowable pull-out capacity for intermediate member thicknesses can be determined by interpolating within the table.

[4]To calculate LRFD values, multiply values in table by the ASD safety factor of 3.0 and multiply again with the LRFD Φ factor of 0.5.

[5]For $F_u \geq 65$ ksi steel, multiply values by 1.44.

[6]Load values are based on testing in accordance with AISI S905.

TABLE 3—ALLOWABLE TENSILE PULL-OVER LOADS (P_{NOV}/Ω), FOR HILTI ASTM C1513 SCREWS, pounds-force[1,2,3,4,5]

Steel F_u = 45 ksi Applied Factor of Safety, Ω = 3.0												
Screw Description	Washer or Head Diameter (in.)	Design thickness of member in contact with the screw head (in.)										
		0.015	0.018	0.024	0.030	0.036	0.048	0.060	0.075	0.090	0.105	0.135
Hex Washer Head (HWH) or High Hex Washer Head (HHWH)												
#8-18S	0.315	106	128	170								
#8-18	0.335	113	136	181	225	271	363	453	567	680	790	1020
#10-16 #10-12S	0.399	135	162	215	268	323	430	540	673	807	943	1210
#12-14 #12-24	0.415	140	168	224	279	337	447	560	700	840	980	1260
$^1/_4$-14	0.500	169	203	270	336	407	540	677	843	1010	1180	1520
Phillips Pan Head (PPH)												
#8-18	0.311	105	126	168	210	252	336	420	525	630	735	945
#10-16	0.364	123	147	197	246	295	393	491	614	737	860	1106
Phillips Truss Head (PTH)												
#10-18	0.433	146	175	234	292	351	468	585	731	877	1023	1315
Phillips Pan Framing Head (PPFH)												
#7-18	0.303	102	123	164	205	245	327	409	511	614	716	920
Phillips Pancake Head (PPCH)												
#10-16	0.409	138	166	221	276	331	442	552	690	828	966	1242
Torx Pancake Head (TPCH)												
#12-14	.0409	138	166	221	276	331	442	552	690	828	966	1242
Phillips Flat Truss Head (PFTH)												
#10-12	0.364	123	147	197	246	295	393	491	614	737	860	1106

For **SI:** 1 inch = 25.4 mm, 1 lbf = 4.4 N, 1 ksi = 6.89 MPa.

[1]For tension connections, the lower of the allowable pull-out, pullover, and tension fastener strength of screw found in Tables 2, 3, and 5, respectively must be used for design.

[2]Load values are based upon calculations in accordance with Section E4 of AISI S100. ANSI/ASME standard screw head diameters were used in the calculations and are listed in the tables.

[3]The allowable pull-over capacity for intermediate member thicknesses can be determined by interpolating within the table.

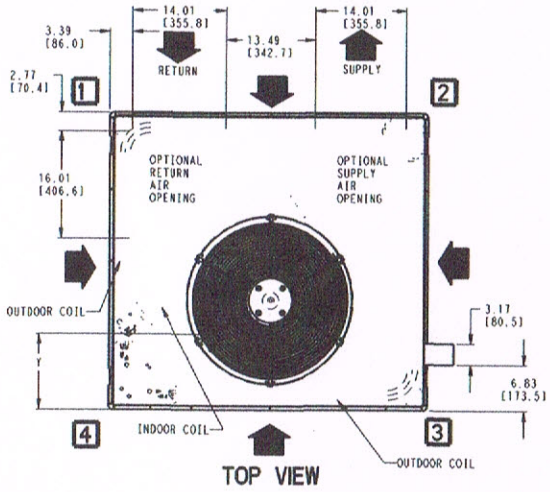
[4]To calculate LRFD values, multiply values in table by the ASD safety factor of 3.0 and multiply again with the LRFD Φ factor of 0.5.

[5]For $F_u \geq 65$ ksi steel, multiply values by 1.44.

TABLE 4A—ALLOWABLE SHEAR (BEARING) CAPACITY OF STEEL-TO-STEEL CONNECTIONS USING HILTI ASTM C1513 SELF-DRILLING SCREWS, pounds-force[1,2,3,4,5]

Steel F_u = 45 ksi Applied Factor of Safety, Ω = 3.0									
Screw Description	**Nominal Diameter (in.)**	**Design thickness of member in contact with screw head, (in.)**	**Design thickness of member not in contact with the screw head (in.)**						
			0.036	**0.048**	**0.060**	**0.075**	**0.090**	**0.105**	**0.135**
#7-18	0.151	0.036	167	220	220	220	220	220	220
		0.048	167	257	294	294	294	294	294
		0.060	167	257	360	367	367	367	367
		0.075	167	257	360	459	459	459	459
		0.090	167	257	360	459	550	550	550
		0.105	167	257	360	459	550	642	642
		0.135	167	257	360	459	550	642	826
#8-18	0.164	0.036	174	239	239	239	239	239	239
		0.048	174	268	319	319	319	319	319
		0.060	174	268	373	400	400	400	400
		0.075	174	268	373	497	497	497	497
		0.090	174	268	373	497	597	597	597
		0.105	174	268	373	497	597	697	697
		0.135	174	268	373	497	597	697	897
#10-12 #10-16 #10-18	0.190	0.036	188	277	277	277	277	277	277
		0.048	188	289	370	370	370	370	370
		0.060	188	289	403	463	463	463	463
		0.075	188	289	403	563	577	577	577
		0.090	188	289	403	563	693	693	693
		0.105	188	289	403	563	693	807	807
		0.135	188	289	403	563	693	807	1040
#12-14 #12-24	0.216	0.036	200	309	315	315	315	315	315
		0.048	200	308	420	420	420	420	420
		0.060	200	308	430	523	523	523	523
		0.075	200	308	430	600	657	657	657
		0.090	200	308	430	600	787	787	787
		0.105	200	308	430	600	787	920	920
		0.135	200	308	430	600	787	920	1180
$^1/_4$-14	0.250	0.036	215	340	363	363	363	363	363
		0.048	215	331	467	487	487	487	487
		0.060	215	331	463	607	607	607	607
		0.075	215	331	463	647	760	760	760
		0.090	215	331	463	647	850	910	910
		0.105	215	331	463	647	850	1060	1060
		0.135	215	331	463	647	850	1060	1370

UNIT DIMENSIONS - 48VL042-060



TOP VIEW

UNIT	ELECTRICAL CHARACTERISTICS	UNIT WT. LB	UNIT WT. KG	UNIT HEIGHT "A"	CENTER OF GRAVITY IN/MM X	Y	Z
48VL042	208/230-1-60,208/230-3-60	435	197.3	46.98[1193]	25.5[647.7]	21.0[533.4]	17.6[447.0]
48VL042	460-3-60	449	203.7	46.98[1193]	25.7[653.2]	20.5[520.7]	17.2[438.6]
48VL048	208/230-1-60,208/230-3-60	453	205.5	46.98[1193]	25.7[652.8]	21.8[553.7]	18.0[457.2]
48VL048	460-3-60	467	211.8	46.98[1193]	25.9[657.9]	21.2[540.9]	17.6[448.8]
48VL060	208/230-1-60,208/230-3-60	481	218.2	50.98[1295]	25.8[655.3]	22.0[558.8]	20.0[508.0]
48VL060	460-3-60	495	224.5	50.98[1295]	25.9[657.9]	21.4[544.8]	19.5[496.7]

UNITS	CORNER WEIGHT LB/KG "1"	"2"	"3"+	"4"++
042	62.8/28.5	166.7/75.6	89.9/40.8	115.6/52.4
048	67.3/30.5	171.2/77.7	94.4/42.8	120.1/54.5
060	68.7/31.2	184/83.5	94.9/43.0	133.4/60.5

\+ ADD 9 LBS [4.1 KG] TO CORNER 3 FOR 460 VOLT UNITS.
++ ADD 5 LBS [2.3 KG] TO CORNER 4 FOR 460 VOLT UNITS.

REQUIRED CLEARANCES TO COMBUSTIBLE MATL.

	INCHES [MM]
TOP OF UNIT	14.00 [355.6]
DUCT SIDE OF UNIT	2.00 [50.8]
SIDE OPPOSITE DUCTS	14.00 [355.6]
BOTTOM OF UNIT	0.00 [0.0]
FLUE PANEL	36.00 [914.4]

NEC. REQUIRED CLEARANCES.

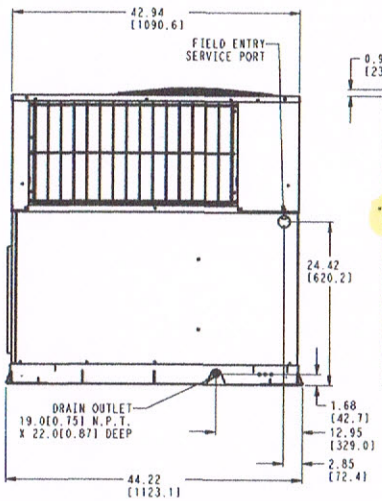
	INCHES [MM]
BETWEEN UNITS, POWER ENTRY SIDE	42.00 [1066.8]
UNIT AND UNGROUNDED SURFACES, POWER ENTRY SIDE	36.00 [914.0]
UNIT AND BLOCK OR CONCRETE WALLS AND OTHER GROUNDED SURFACES, POWER ENTRY SIDE	42.00 [1066.8]

REQUIRED CLEARANCE FOR OPERATION AND SERVICING

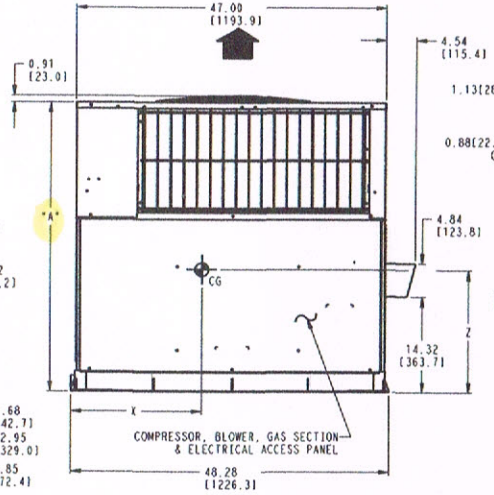
	INCHES [MM]
EVAP. COIL ACCESS SIDE	36.00 [914.0]
POWER ENTRY SIDE (EXCEPT FOR NEC REQUIREMENTS)	42.00 [1066.8]
UNIT TOP	48.00 [1219.2]
SIDE OPPOSITE DUCTS	36.00 [914.0]
DUCT PANEL	12.00 [304.8]*

*MINIMUM DISTANCES: IF UNIT IS PLACED LESS THAN 12.00 [304.8] FROM WALL SYSTEM, THEN SYSTEM PERFORMANCE MAYBE COMPROMISED.

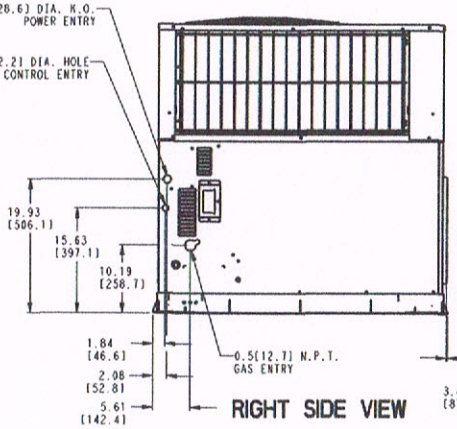
DIMENSIONS IN [] ARE IN MILLIMETERS



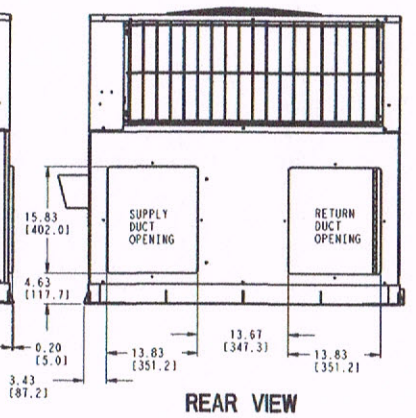
LEFT SIDE VIEW



FRONT VIEW



RIGHT SIDE VIEW



REAR VIEW

48VL500073	REV 4.0

PORTLAND STATE UNIVERSITY
EAST HALL VENTILATION SYSTEM

Structural Calculations
Project No.14-004
April 25, 2014

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