STARK INNOVATIVE

4400 NE 77th Avenue, Suite 275
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P: 360.566.7343

STRUCTURAL CALCULATIONS

PREPARED FOR

TERRAFIRMA

FOR

BASEMENT RETROFIT

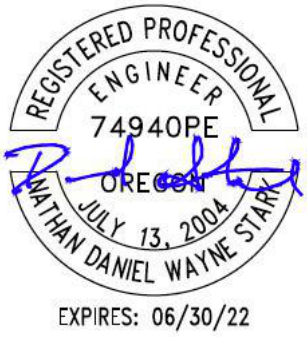
4806 NE 15TH AVENUE

PORTLAND, OR

PROJECT NUMBER: 21012

DATE: 4/24/2021

PROJECT MANAGER: DANIEL STARK, P.E.



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April 25, 2021

SI Project No.: 21012

TerraFirma Foundation Systems
13110 SW Wall Street
Porttland, OR 97223

Re: Basement wall retrofit – 4806 NE 15th Avenue, Portland, OR

PROJECT SUMMARY

We understand that the project involves the voluntary strengthening of the existing basement according to the International Existing Building Code, Section 403.9. The structure is a two-story, single-family residence with a basement.

The back and right elevation wall of the existing basement is to be strengthened with cold-formed steel I-beams and steel decking. Lateral restraint will be provided by attaching the I-beams to the existing floor at the top and encasing them at the bottom in concrete. The existing lateral force resisting system and other structural elements of the structure will remain unaffected.

Image 1: Front Elevation

Determine Equivalent Uniform Load to NP4x6 (for analysis) - Basement (Perpendicular Joists)

Actual Loads:

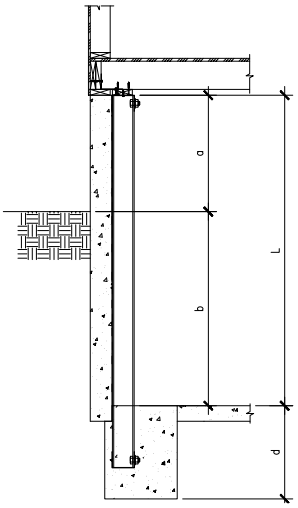


Image for Reference Only

Vertical Loads:

Level	DL (psf)	Trib (ft)	w_{DL} (plf)	SL (psf)	Trib (ft)	w_{SL} (plf)	LL (psf)	Trib (ft)	w_{LL} (plf)
Roof	15	6.5	97.5	25	6.5	162.5			
3rd Floor	12	0	0				40	0	0
2nd Floor	12	6.5	78				40	6.5	260
1st Floor	12	6.5	78				40	6.5	260
		$\sum w_{DL}$ =	253.5		$\sum w_{SL}$ =	163		$\sum w_{LL}$ =	520

$\sum w_{TL} = \sum w_{DL} + 0.75 (\sum w_{SL} + \sum w_{LL})$

$\sum w_{TL}$ = 765 plf

Soil Loads:

a = 1.75 ft b = 5 ft

L = 6.75 ft e = b/3 = 1.67 ft

H+E = 60 pcf H+E

w = b (H+E) = 300 psf/ft (plf)

R_A = wbe / 2L

= 185 plf

R_B = 0.5 wb (1 - e / L)

= 565 plf

$M_{MAX} = R_A (a + (0.67b \sqrt{(e / L)}))$

= 632 ft-lbs/ft

Design Loads (per foot of wall):

$\sum R_A$ =	185	plf/ft	(Reaction @ Top of Wall)
$\sum R_B$ =	565	plf/ft	(Reaction @ Base of Wall)
$\sum M_{MAX}$ =	632	ft-lbs/ft	
$\sum w_{TL}$ =	765	plf	

Design Loads (per NP4x6):

NP4x6 Spacing =	4	ft	
w_{H+E} =	1200	plf	(@ base of NP4x6)
$\sum R_A$ =	741	lbs	(Reaction @ Top of Wall)
$\sum R_B$ =	2259	lbs	(Reaction @ Base of Wall)
$\sum M_{MAX}$ =	2529	ft-lbs	
P_{DL} =	1014	lbs	
P_{SL} =	650	lbs	
P_{LL} =	2080	lbs	Therefore NP4x6 @ 4' o.c. is acceptable - see attached design tables.

Connection Design (Perpendicular to Framing)

Top Connection:

Note: NP4x6 is installed tight against T-Track web/flange. Lateral load is transferred through shear of T-Track to Simpson screws to existing framing. However, check bending of T-Track web (conservative).

$F = \sum R_A$

$= 185$ lbs

$b_{TT} = 48$

$t_{TT} = 0.0713$

$S_{TT\ flange} = 0.041$

$M_{TT\ flange} = 1" F$

$= 185$ in-lbs

$f_b = M / S$

$= 4.55$ ksi, therefore ok

Note: Check connection of track to joists - load transfer to three joists (conservative)

$F = \sum R_A/2$

$= 370$ lbs, therefore use (2) Simpson 1/4" x 3" SDS Screws; $V_{allow} = 420$ lbs / screw

Bottom Connection:

Note: Vertical load of existing structure is transferred through a surcharge lateral load. Therefore, check resistance to lateral load @ base of NP4x6.

$F = \sum R_B$

$= 2259$ lbs

Footing Design (Perpendicular Framing Condition):

Trib, w =	7	ft (rounded)	# of stories:	2
wall ht, L =	7	ft (rounded)	slab?:	yes
soil ht, b =	5	ft (rounded)		

Therefore Use 18 x 18 x 16 footing - see attached design table

VERTICAL DESIGN LOADS (UNFACTORED)

Roof DL =	15	psf	Floor DL =	12	psf
Roof SL =	25	psf	Floor LL =	40	psf

Uniform Loads to Wall

Trib Width (ft)	Roof DL (plf)	2nd Flr DL (plf)	1st Flr DL (plf)	Total DL (plf)	Roof SL (plf)	2nd Flr LL (plf)	1st Flr LL (plf)	1S Total LL (plf)	2S Total LL (plf)
6	90	72	72	234	150	240	240	240	480
7	105	84	84	273	175	280	280	280	560
8	120	96	96	312	200	320	320	320	640

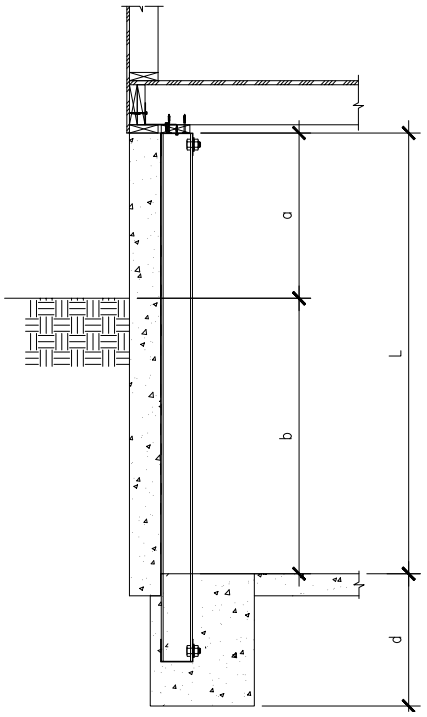
NP4x6 Axial Loads

Trib (ft)	NP4x6 Spc'g (ft)	DL (lb)	SL (lb)	1S LL (lb)	2S LL (lb)	1S P_{TL} (lb)	2S P_{TL} (lb)
6		936	600	960	1920	2106	2826
7	4	1092	700	1120	2240	2457	3297
8		1248	800	1280	2560	2808	3768

SOIL & EQ LOAD ON WALL & NP4X6 POSTS

Wall Data				Uniform Load & Reactions			NP4x6 Spacing (ft) = 4		
L	b	a	e	(psf/ft)	R_A (plf)	R_B (plf)	w_{H+E} (plf)	R_A (lbs)	R_B (lbs)
6	4	2	1.33	240	107	373	960	427	1493
	5	1	1.67	300	208	542	1200	833	2167
7	5	2	1.67	300	179	571	1200	714	2286
	6	1	2.00	360	309	771	1440	1234	3086
8	6	2	2.00	360	270	810	1440	1080	3240
	7	1	2.33	420	429	1041	1680	1715	4165

Legend:



Soil Pressure:

q_{H+E} = 60 pcf

Equations:

= q_{H+E} L

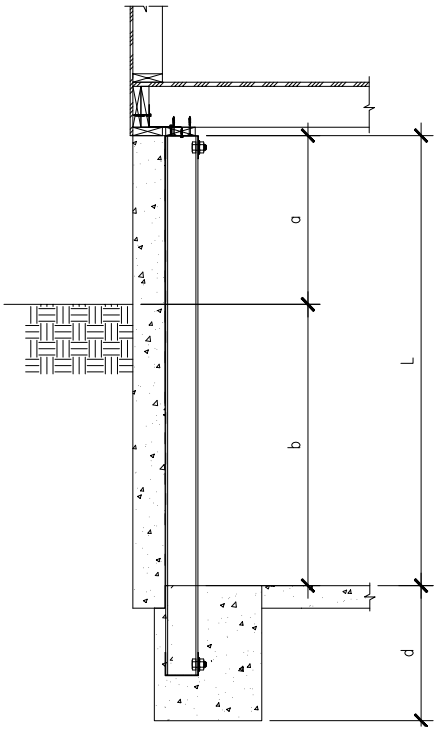
R_A = wbe / 2L, where R_A is the reaction at the top of wall (plf) or NP4x6 (lbs)

R_B = 0.5 wb (1 - e / L), where R_B is the reaction at the bottom of wall (plf) or NP4x6 (lbs)

NP4X6 DESIGN LOADS

Trib Width (ft)	Wall Data		NP4x6 Spc'g (ft) = 4				
	L	b	w_{H+E} (plf)	P_{DL} (lbs)	P_{SL} (lbs)	1S P_{LL} (lbs)	2S P_{LL} (lbs)
6	6	4	960	936	600	960	1920
		5	1200	936	600	960	1920
	7	5	1200	936	600	960	1920
		6	1440	936	600	960	1920
	8	6	1440	936	600	960	1920
		7	1680	936	600	960	1920
7	6	4	960	1092	700	1120	2240
		5	1200	1092	700	1120	2240
	7	5	1200	1092	700	1120	2240
		6	1440	1092	700	1120	2240
	8	6	1440	1092	700	1120	2240
		7	1680	1092	700	1120	2240
8	6	4	960	1248	800	1280	2560
		5	1200	1248	800	1280	2560
	7	5	1200	1248	800	1280	2560
		6	1440	1248	800	1280	2560
	8	6	1440	1248	800	1280	2560
		7	1680	1248	800	1280	2560

Legend:



Soil Pressure:

q_{H+E} = 60 pcf

Equations:

= q_{H+E} L

- combined bending and axial < 1.0

- combined bending and axial < 1.0 (worst case condition, calculation attached)

- not allowed, combined bending and axial > 1.0

FOOTING DESIGN; TWO-STORY HOUSE W/ BASEMENT SLAB

Trib Width	Wall Ht (ft)	Soil Ht (ft)	S_{NP4x6} (ft)	w_{ftg} (in)	d_{ftg} (in)	Passive Pressure & Resistance Check						Bearing Pressure Check		FOOTING SIZE
						w'_{arch} (in)	$F_{ftg\_passive}$	$F_{slab\_passive}$	$\sum F_{passive}$ (lb)	R_B (lb)	F.S.	P_{TL} (lb)	q_{max} (psf)	
6	6	4	4	16	12	48	1800	630	2430	1493	1.6	2826	1590	NG
		5		16	16	48	3022	630	3652	2167	1.7	2826	1590	NG
	7	5		16	16	48	3022	630	3652	2286	1.6	2826	1590	NG
		6		16	18	48	4050	630	4680	3086	1.5	2826	1590	NG
	8	6		16	20	48	4556	630	5186	3240	1.6	2826	1590	NG
		7		16	22	48	5806	630	6436	4165	1.5	2826	1590	NG
7	6	4	4	18	12	48	1800	735	2535	1493	1.7	3297	1465	Use 18 x 18 x 12 footing
		5		18	16	48	3022	735	3757	2167	1.7	3297	1465	Use 18 x 18 x 16 footing
	7	5		18	16	48	3022	735	3757	2286	1.6	3297	1465	Use 18 x 18 x 16 footing
		6		18	18	48	4050	735	4785	3086	1.6	3297	1465	Use 18 x 18 x 18 footing
	8	6		18	18	48	4050	735	4785	3240	1.5	3297	1465	Use 18 x 18 x 18 footing
		7		18	22	48	5806	735	6541	4165	1.6	3297	1465	Use 18 x 18 x 22 footing
8	6	4	4	20	12	48	1800	735	2535	1493	1.7	3768	1356	Use 20 x 20 x 12 footing
		5		20	16	48	3022	735	3757	2167	1.7	3768	1356	Use 20 x 20 x 16 footing
	7	5		20	16	48	3022	735	3757	2286	1.6	3768	1356	Use 20 x 20 x 16 footing
		6		20	18	48	4050	735	4785	3086	1.6	3768	1356	Use 20 x 20 x 18 footing
	8	6		20	18	48	4050	735	4785	3240	1.5	3768	1356	Use 20 x 20 x 18 footing
		7		20	22	48	5806	735	6541	4165	1.6	3768	1356	Use 20 x 20 x 22 footing

Equations:

w'_{arch} = Min (w_{arch}, S_{NP4x6}),

where, $w_{arch} = w_{ftg} \cdot f \cdot n$

f = 2.0 (arch factor, conservative)

n = 1.5 (arch multiplier, conservative)

S_{NP4x6} = Maximum spacing allowed for NP4x6 posts

$F_{passive} = (0.5\,(p_2 - p_1))\,(d_2 - d_1)\,w'_{arch}$

where, d_1 = 0, top of footing

$d_2 = d_{ftg}$, bottom of footing

$p_1 = p_{passive} \cdot b$, passive pressure at top of footing

$p_2 = p_{passive} \cdot (b + d_{ftg})$, passive pressure at bottom of footing

$p_{passive}$ = 100 psf

$F_{passive\_slab} = W_{slab}$

where, μ = 0.35

$W_{slab} = 150 \cdot S_{NP4x6} \cdot t_{slab} \cdot L_{slab}$

t_{slab} = 3 in

L_{slab} = 2 · Trib Width

Section: NP4x6.cfss
NP4x6x0.12
Stark NuPile
Rev. Date: 4/20/21 10:04:51 AM
By: Daniel Stark
Printed: 4/20/21 10:13:10 AM

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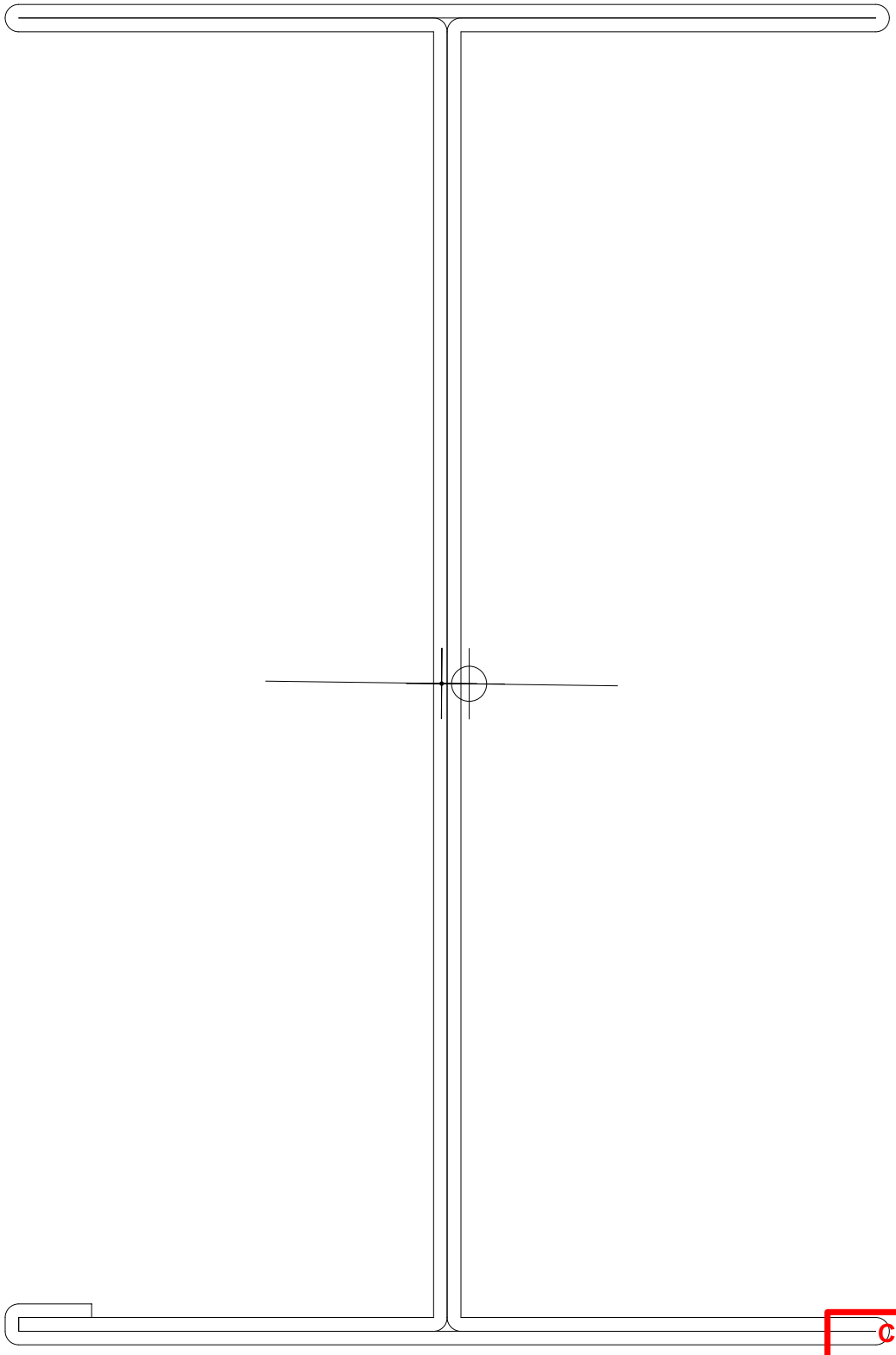

Section: NP4x6.cfss
NP4x6x0.12
Stark NuPile
Rev. Date: 4/20/21 10:04:51 AM
By: Daniel Stark
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Section Inputs

```
Material: A653 HSLAS Grade 70
Apply cold work of forming strength increase.
No inelastic reserve strength increase.
Modulus of Elasticity, E           29500 ksi
Yield Strength, Fy                    70 ksi
Tensile Strength, Fu                  80 ksi
Torsion Constant Override, J           0 in⁴
Warping Constant Override, Cw          0 in⁶

Part 1, Thickness 0.06 in
Placement of Part from Origin:
X to center of gravity           0 in
Y to center of gravity           0 in
Outside dimensions, Open shape
        Length      Angle     Radius  Web      k    Hole Size   Distance
          (in)      (deg)       (in)         Coef.       (in)       (in)
  1     1.8800      0.000     0.0000 Single  0.000     0.0000     0.9400
  2     5.7600     90.000     0.0000 Single  0.000     0.0000     2.8800
  3     1.9400   -180.000     0.0000 Single  0.000     0.0000     0.9700
  4     0.1200     90.000     0.0000 Single  0.000     0.0000     0.0600
  5     3.8800      0.000     0.0000 Single  0.000     0.0000     1.9400
  6     0.1200    -90.000     0.0000 Single  0.000     0.0000     0.0600
  7     1.9400   -180.000     0.0000 Single  0.000     0.0000     0.9700
  8     5.7600    -90.000     0.0000 Single  0.000     0.0000     2.8800
  9     1.9400      0.000     0.0000 Single  0.000     0.0000     0.9700
 10     0.1200    -90.000     0.0000 Single  0.000     0.0000     0.0600
 11     3.8800   -180.000     0.0000 Single  0.000     0.0000     1.9400
 12     0.1800     90.000     0.0000 Single  0.000     0.0000     0.0900
 13     0.3800      0.000     0.0000 Single  0.000     0.0000     0.1900
```

Analysis: Analysis 2.cfsa
8 ft Tall Beam-Column

Rev. Date: 4/20/21 10:12:32 AM
By: Daniel Stark
Printed: 4/20/21 10:13:18 AM

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Analysis Inputs

General
  Member Orientation: Vertical
  Calculate global buckling using specification equations
  Do not include torsion in member checks

Members

	Section File	Revision Date and Time
1	NP4x6.cfss	4/20/21 10:04:51 AM

	Material	Area (in²)	Length (ft)	Weight (k)
1	A653 HSLAS Grade 70	1.6215	8.0000	0.044106
	Total		8.0000	0.044106

	Start Loc. (ft)	End Loc. (ft)	Braced Flange	R	kϕ (k)	Lm (ft)	ex (in)	ey (in)
1	0.0000	8.0000	None	0.0000	0.0000	8.0000	0.000	0.000

Supports

	Type	Location (ft)	Bearing (in)	Fastened	K
1	XYT	0.0000	2.00	No	1.0000
2	XYT	8.0000	2.00	No	1.0000

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8 ft Tall Beam-Column

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Loading: Dead Load

	Type	Angle (deg)	Start Loc. (ft)	End Loc. (ft)	Start Magnitude	End Magnitude	
1	Axial		0.0000	8.0000	0.8640	0.8640	k

Loading: Live Load

	Type	Angle (deg)	Start Loc. (ft)	End Loc. (ft)	Start Magnitude	End Magnitude	
1	Axial		0.0000	8.0000	2.5600	2.5600	k

Loading: Snow Load

	Type	Angle (deg)	Start Loc. (ft)	End Loc. (ft)	Start Magnitude	End Magnitude	
1	Axial		0.0000	8.0000	0.8000	0.8000	k

Loading: Earthquake Load

	Type	Angle (deg)	Start Loc. (ft)	End Loc. (ft)	Start Magnitude	End Magnitude	
1	Distributed	90.000	1.0000	8.0000	0.0000	-1.6800	k/ft

Load Combination: D
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	1.000

Load Combination: D+L
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	1.000
2	Live Load	1.000
3	Product Load	1.000

Load Combination: D+S
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	1.000
2	Snow Load	1.000

Load Combination: D+0.75(L+Lr)
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	1.000
2	Live Load	0.750
3	Product Load	0.750
4	Roof Live Load	0.750

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Load Combination: D+0.75(L+S)
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	1.000
2	Live Load	0.750
3	Product Load	0.750
4	Snow Load	0.750

Load Combination: D+0.7E
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	1.000
2	Earthquake Load	0.700

Load Combination: D+0.75(0.7E+L+S)
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	1.000
2	Live Load	0.750
3	Product Load	0.750
4	Snow Load	0.750
5	Earthquake Load	0.525

Load Combination: 0.6D+0.6W
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	0.600
2	Wind Load	0.600

Load Combination: 0.6D+0.7E
Specification: AISI S100-16/S1-18, US, ASD
Inflection Point Bracing: No

	Loading	Factor
1	Dead Load	0.600
2	Earthquake Load	0.700

Member Check - AISI S100-16/S1-18, US, ASD

Load Combination: D+0.7E
Design Parameters at 4.7804 ft:

Lx	8.0000 ft	Ly	8.0000 ft	Lt	8.0000 ft
Kx	1.0000	Ky	1.0000	Kt	1.0000

Section: NP4x6.cfss
Material Type: A653 HSLAS Grade 70, Fy=70 ksi

Cbx	1.0000	Cby	1.0000	ex	0.0000 in
Cmx	1.0000	Cmy	1.0000	ey	0.0000 in
Braced Flange: None		kϕ	0 k		
Red. Factor, R: 0		Lm	8.0000 ft		

Analysis: Analysis 2.cfsa
8 ft Tall Beam-Column

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Loads:	P (k)	Mx (k-in)	Vy (k)	My (k-in)	Vx (k)
Total	0.864	50.713	0.000	0.000	0.000
Applied	0.864	50.945	0.000	0.000	0.000
Strength	13.078	61.324	6.910	25.927	20.938

Interaction Equations

Eq. H1.2-1	(P, Mx, My)	0.066 + 0.831 + 0.000 = 0.897 <= 1.0
Eq. H2-1	(Mx, Vy)	Sqrt(0.211 + 0.000)= 0.459 <= 1.0
Eq. H2-1	(My, Vx)	Sqrt(0.000 + 0.000)= 0.000 <= 1.0

Part 1 element 2 b/t exceeds 90.

Section: NP4x6.cfss
NP4x6x0.12
Stark NuPile
Rev. Date: 8/23/20 11:34:04 AM
By: Daniel Stark
Printed: 4/20/21 10:13:25 AM

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Elastic Buckling Results

Buckling Mode	Magnitude (k,k-in)	Stress (ksi)	Stress /Yield	Length (ft)	Work Ratio
Pcrl	21.933	13.526	0.1932	0.4901	22.43
Pcrd	20.268	12.499	0.1786	1.0059	3.42
Mcrlx+	0.000	-----	------	------	----
Mcrdx+	66.808	20.695	0.2956	0.4108	8.21
Mcrlx-	0.000	-----	------	------	----
Mcrdx-	44.366	13.743	0.1963	1.0667	3.62
Mcrly+	0.000	-----	------	------	----
Mcrdy+	28.547	46.152	0.6593	0.4901	7.88
Mcrly-	22.400	36.213	0.5173	0.3552	421.67
Mcrdy-	12.733	20.585	0.2941	1.2020	3.46