

OSU FIRE ESCAPES

500 SW JEFFERSON WAY
CORVALLIS, OREGON

OCTOBER 4, 2023
JOB# 22-0669

STRUCTURAL CALCULATIONS
BY

STABILITY 
ENGINEERING INC.

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10/4/2023



EXPIRES: 06/30/ 24

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Fire Escape Load Testing Analysis:

Scope of Work: Calculations for load testing requirements for fire escape located at Autzen House

Building Code: 2002 OBC

Design Loads: $LL = 100 \text{ psf}$
 $DL = 10 \text{ psf}$ } Total Load = 110 psf

Calculate Brace Loads:Stair Loads:

$$LL = (100 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(11 \text{ treads}) = 606 \text{ lb}$$

↙ Tread Width
↖ Tread Length

$$DL = (10 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(11 \text{ treads}) = 61 \text{ lb}$$

[Load at Each Support]

$$LL = 606 \text{ lb} / 4 = 152 \text{ lb}$$

$$DL = 61 \text{ lb} / 4 = 15 \text{ lb}$$

Hang Rod:

$$LL = (100 \text{ psf})(3 \text{ ft})(1.83 \text{ ft}) = 549 \text{ lb}$$

$$DL = (10 \text{ psf})(3 \text{ ft})(1.83 \text{ ft}) = 55 \text{ lb}$$

Worst Case Brace → Lower Level

$$L = 3.7 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(2.5 \text{ ft} + 1.83 \text{ ft}) = 433 \text{ plf}$$

$$DL = (10 \text{ psf})(2.5 \text{ ft} + 1.83 \text{ ft}) = 44 \text{ plf}$$

Stair Load @ L = 0.3 ft, 1.9 ft

Calculate Brace Loads: (cont.)

Upper Level Brace → Left Side

$$L = 3.7 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(2.5 \text{ ft}) = 250 \text{ plf}$$

$$DL = (10 \text{ psf})(2.5 \text{ ft}) = 25 \text{ plf}$$

Hang Rod Load @ $L = 0.5 \text{ ft}$

Upper Level Brace → Right Side

$$L = 3.7 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(2 \text{ ft}) = 200 \text{ plf}$$

$$DL = (10 \text{ psf})(2 \text{ ft}) = 20 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf})(1.3 \text{ ft}) = 130 \text{ plf}$$

$$\downarrow \text{ @ } L = 2 \text{ ft} - 3.7 \text{ ft} \quad DL = (10 \text{ psf})(1.3 \text{ ft}) = 13 \text{ plf}$$

Stair Loads @ $L = 0.3 \text{ ft}, 1.9 \text{ ft}$



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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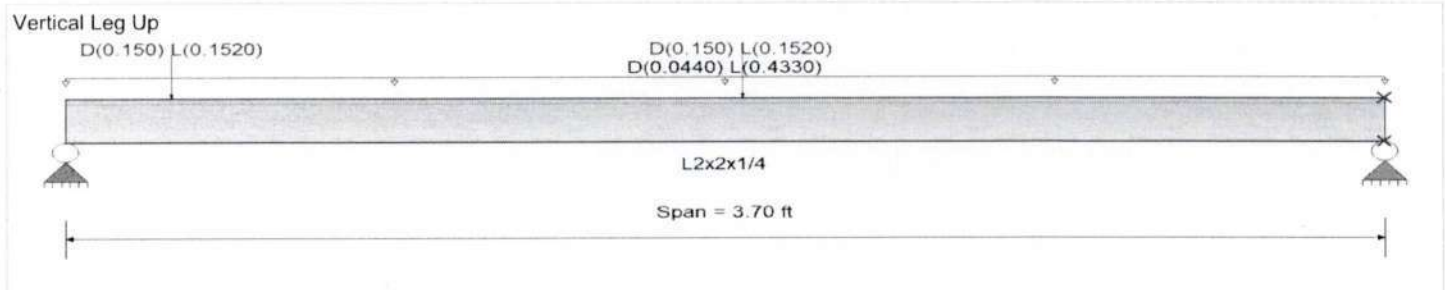
DESCRIPTION: LOWER LEVEL BRACE LOADS (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.0440, L = 0.4330 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)

Point Load : D = 0.150, L = 0.1520 k @ 0.30 ft, (STAIR LOAD)

Point Load : D = 0.150, L = 0.1520 k @ 1.90 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

				Design N.G.			
Maximum Bending Stress Ratio =	1.249 : 1	Maximum Shear Stress Ratio =	0.146 : 1				
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4				
Ma : Applied	1.144 k-ft	Va : Applied	1.313 k				
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k				
Load Combination	+D+L	Load Combination	+D+L				
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft				
		Span # where maximum occurs	Span # 1				
Maximum Deflection							
Max Downward Transient Deflection	0.217 in Ratio = 204 <360	Span: 1 : L Only					
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a					
Max Downward Total Deflection	0.271 in Ratio = 164 <180	Span: 1 : +D+L					
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a					

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	3.70 ft	1	0.263	0.033	0.24		0.24	1.53	0.92	1.00	1.00	0.30	15.00	8.98
+D+L														
Dsgn. L =	3.70 ft	1	1.249	0.146	1.14	<i>M_{max}</i>	1.14	1.53	0.92	1.00	1.00	1.31	15.00	8.98
+D+0.750L														
Dsgn. L =	3.70 ft	1	1.002	0.118	0.92		0.92	1.53	0.92	1.00	1.00	1.06	15.00	8.98
+0.60D														
Dsgn. L =	3.70 ft	1	0.158	0.020	0.14		0.14	1.53	0.92	1.00	1.00	0.18	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.2711	1.850		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.313	1.068
Max Upward from Load Combinations	1.313	1.068



Stability Engineering, Inc.
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 Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
 Engineer: M. FOSTER
 Project ID: 22-0669
 Project Descr: AUTZEN HOUSE

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

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DESCRIPTION: LOWER LEVEL BRACE LOADS (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from Load Cases	1.015	0.891
D Only	0.298	0.176
+D+L	1.313	1.068
+D+0.750L	1.059	0.845
+0.60D	0.179	0.106
L Only	1.015	0.891

$P_1 = 1313 \text{ lb}$
 $P_2 = 1068 \text{ lb}$
} Specify on loading plans



Steel Beam

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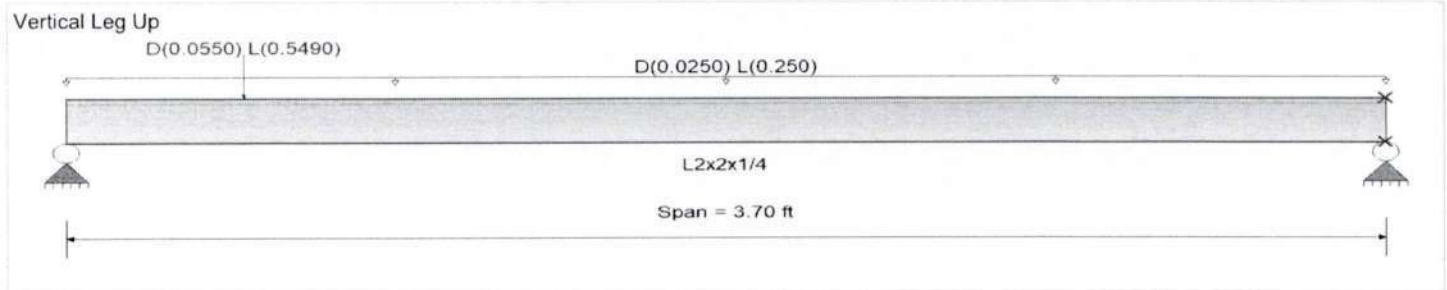
DESCRIPTION: UPPER BRACE LOADS - LEFT SIDE (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.0250, L = 0.250 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)

Point Load : D = 0.0550, L = 0.5490 k @ 0.50 ft, (HANG ROD)

Loads Only

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	0.698 : 1	Maximum Shear Stress Ratio =	0.115 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.639 k-ft	Va : Applied	1.037 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.145 in Ratio = 305 < 360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 < 360	n/a	
Max Downward Total Deflection	0.161 in Ratio = 275 >= 180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 < 180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	3.70 ft	1	0.069	0.011	0.06		0.06	1.53	0.92	1.00	1.00	0.10	15.00	8.98
+D+L														
Dsgn. L =	3.70 ft	1	0.698	0.115	0.64	<i>Mmax</i>	0.64	1.53	0.92	1.00	1.00	1.04	15.00	8.98
+D+0.750L														
Dsgn. L =	3.70 ft	1	0.541	0.089	0.50		0.50	1.53	0.92	1.00	1.00	0.80	15.00	8.98
+0.60D														
Dsgn. L =	3.70 ft	1	0.041	0.007	0.04		0.04	1.53	0.92	1.00	1.00	0.06	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1614	1.787		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.037	0.596
Max Upward from Load Combinations	1.037	0.596
Max Upward from Load Cases	0.937	0.537
D Only	0.100	0.060
+D+L	1.037	0.596



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Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: AUTZEN HOUSE

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

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DESCRIPTION: UPPER BRACE LOADS - LEFT SIDE (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
+D+0.750L	0.803	0.462
+0.60D	0.060	0.036
L Only	0.937	0.537

$P_3 = 1037 \text{ lb}$
 $P_4 = 596 \text{ lb}$ } Specify on loading plans



Steel Beam

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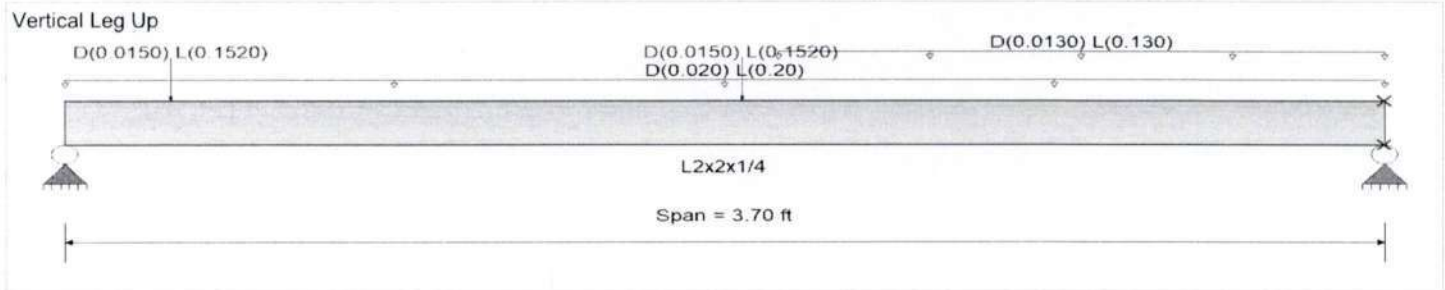
DESCRIPTION: UPPER BRACE LOADS - RIGHT SIDE (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

- Beam self weight calculated and added to loading
Uniform Load : D = 0.020, L = 0.20 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)
- Uniform Load : D = 0.0130, L = 0.130 k/ft, Extent = 2.0 --> 3.70 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)
- Point Load : D = 0.0150, L = 0.1520 k @ 0.30 ft, (STAIR LOAD)
- Point Load : D = 0.0150, L = 0.1520 k @ 1.90 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design: N.G.

Maximum Bending Stress Ratio =	0.728 : 1	Maximum Shear Stress Ratio =	0.078 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.666 k-ft	Va : Applied	0.7035 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.142 in Ratio = 311 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.158 in Ratio = 280 >=180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only	Dsgn. L = 3.70 ft	1	0.071	0.008	0.07		0.07	1.53	0.92	1.00	1.00	0.07	15.00	8.98
+D+L	Dsgn. L = 3.70 ft	1	0.728	0.078	0.67	<i>Mmax</i>	0.67	1.53	0.92	1.00	1.00	0.70	15.00	8.98
+D+0.750L	Dsgn. L = 3.70 ft	1	0.564	0.061	0.52		0.52	1.53	0.92	1.00	1.00	0.54	15.00	8.98
+0.60D	Dsgn. L = 3.70 ft	1	0.043	0.005	0.04		0.04	1.53	0.92	1.00	1.00	0.04	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1583	1.871		0.0000	0.000



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Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

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DESCRIPTION: UPPER BRACE LOADS - RIGHT SIDE (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.703	0.699
Max Upward from Load Combinations	0.703	0.699
Max Upward from Load Cases	0.634	0.631
D Only	0.069	0.069
+D+L	0.703	0.699
+D+0.750L	0.545	0.542
+0.60D	0.041	0.041
L Only	0.634	0.631

$P_5 = 703 \text{ lb}$
 $P_6 = 699 \text{ lb}$
} Specify on load testing plans

Landing Support Braces: Both LevelsBrace Geometry:

$$H = 2.4 \text{ ft}$$

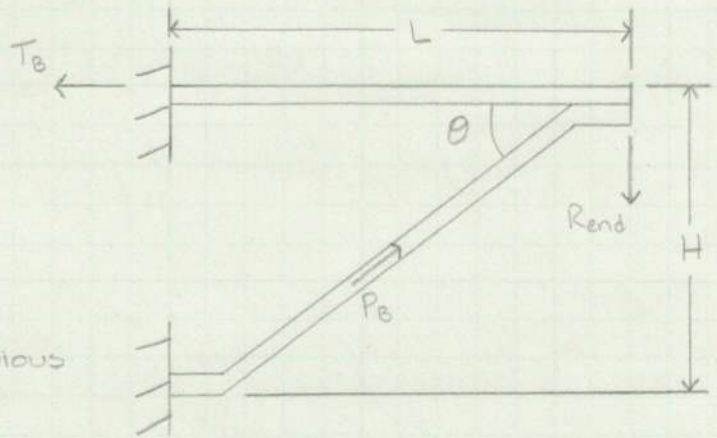
$$L = 3.7 \text{ ft}$$

$$\theta = \tan^{-1}(H/L) = 33^\circ$$

$$\left. \begin{aligned} R_{end} &= 1313 \text{ lb} \\ M_{max} &= 1140 \text{ lb}\cdot\text{ft} \end{aligned} \right\} \text{ See Previous Pages}$$

$$P_B = \frac{R_{end}}{\sin \theta} = 2411 \text{ lb}$$

$$T_B = P_B \cos \theta = 2022 \text{ lb}$$

Brace Section Properties:

(1 1/2" Solid Square Bar)

$$Z_x = Z_y = \frac{bd^3}{4} = 0.843 \text{ in}^3$$

$$\text{Area} = bd = 2.25 \text{ in}^2$$

$$F_y = 36 \text{ ksi}$$

Brace Checks:

$$\frac{M_n}{\Omega} = \frac{F_y Z}{1.67} = \frac{(36 \text{ ksi})(0.843 \text{ in}^3)}{1.67} = 18172 \text{ lb}\cdot\text{in} = 1514 \text{ lb}\cdot\text{ft}$$

$$\frac{T_n}{\Omega} = \frac{F_y A}{1.67} = \frac{(36 \text{ ksi})(2.25 \text{ in}^2)}{1.67} = 48.5 \text{ k}$$

$$\text{Tension Ratio} = \frac{T_B}{T_n/\Omega} = 0.04 < 0.2 \quad \therefore \text{Use AISC Eqn H1-1b}$$

$$\text{Combined Ratio} = \frac{T_B}{\phi(T_n/\Omega)} + \frac{M_B}{M_n/\Omega} = 0.77 < 1 \quad \therefore \text{OK}$$

\therefore Load Testing Req'd for Connections Only

Framing Checks:Decking Bars:

(Worst Case)

$$L = 2.3 \text{ ft}$$

$$\text{Load} = (110 \text{ psf})(0.25 \text{ ft}) = 27.5 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(27.5 \text{ plf})(2.3 \text{ ft})^2}{8} = 18.2 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{\Omega} = \frac{F_y Z}{\Omega}$$

$$Z = \frac{bd^2}{4} = \frac{(2 \text{ in})(0.25 \text{ in})^2}{4} = 0.03125 \text{ in}^3$$

$$\frac{M_n}{\Omega} = \frac{(36000 \text{ psi})(0.03125 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 56 \text{ lb}\cdot\text{ft} > 18.2 \text{ lb}\cdot\text{ft}$$

 $\therefore \text{OK}$

Edge Angle Checks: (L 2x2 x 1/4")

Landing Bars:

$$L = 3.7 \text{ ft}$$

$$LL = (100 \text{ psf})(2.5 \text{ ft}) = 250 \text{ plf}$$

$$DL = (10 \text{ psf})(2.5 \text{ ft}) = 25 \text{ plf}$$

Edge Angle:

$$L = 5 \text{ ft}$$

$$LL = (100 \text{ psf})(1.85 \text{ ft}) = 185 \text{ plf}$$

$$DL = (10 \text{ psf})(1.85 \text{ ft}) = 19 \text{ plf}$$



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: LANDING BARS

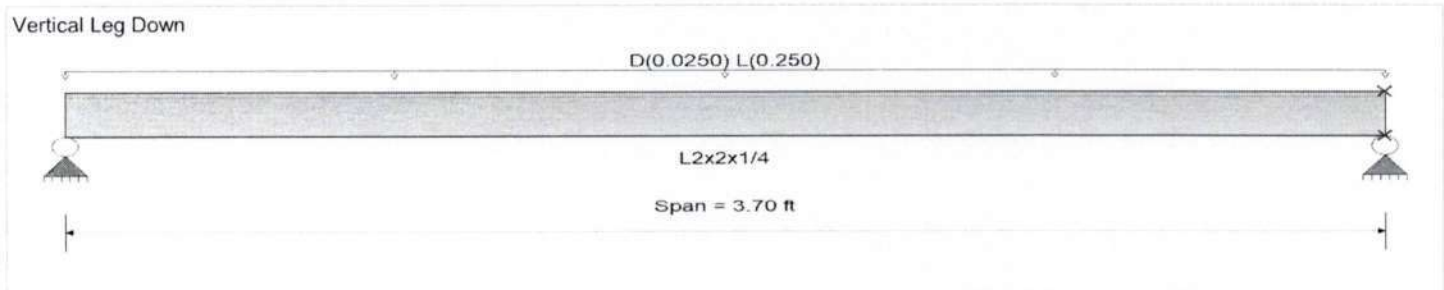
CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi

Vertical Leg Down



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.0250, L = 0.250 k/ft, Tributary Width = 1.0 ft, (UNIFORM LOAD)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.520 : 1	Maximum Shear Stress Ratio =	0.057 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.476 k-ft	Va : Applied	0.5147 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.105 in Ratio = 420	>=360	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio = 0	<360	n/a
Max Downward Total Deflection	0.117 in Ratio = 378	>=240.	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio = 0	<240.0	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L =	3.70 ft	1	0.053	0.006	0.05		0.05	1.53	0.92	1.00	1.00	0.05	15.00	8.98	
+D+L															
Dsgn. L =	3.70 ft	1	0.520	0.057	0.48		0.48	1.53	0.92	1.00	1.00	0.51	15.00	8.98	
+D+0.750L															
Dsgn. L =	3.70 ft	1	0.403	0.044	0.37		0.37	1.53	0.92	1.00	1.00	0.40	15.00	8.98	
+0.60D															
Dsgn. L =	3.70 ft	1	0.032	0.003	0.03		0.03	1.53	0.92	1.00	1.00	0.03	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1174	1.861		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.515	0.515
Max Upward from Load Combinations	0.515	0.515
Max Upward from Load Cases	0.463	0.463
D Only	0.052	0.052
+D+L	0.515	0.515
+D+0.750L	0.399	0.399
+0.60D	0.031	0.031



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 Project Descr: AUTZEN HOUSE

Steel Beam

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DESCRIPTION: LANDING BARS

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.463	0.463



Steel Beam

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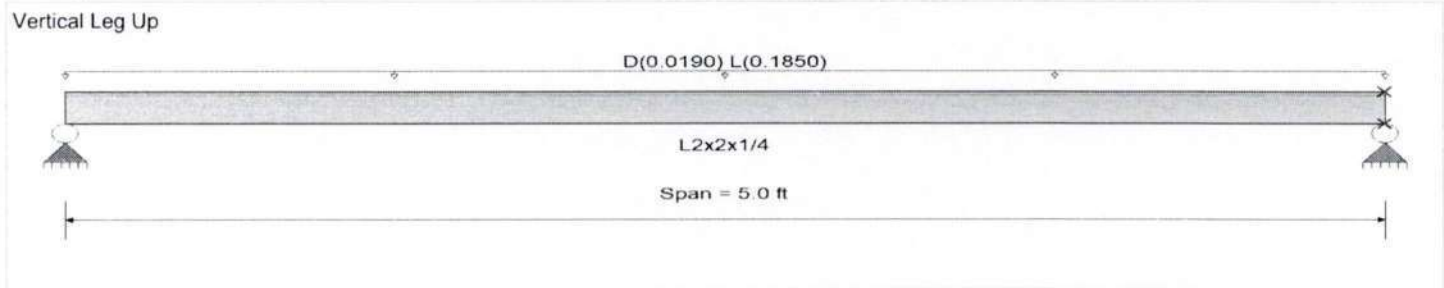
DESCRIPTION: EDGE ANGLE

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.0190, L = 0.1850 k/ft, Tributary Width = 1.0 ft, (UNIFORM LOAD)

∴ Load Tests Req'd

DESIGN SUMMARY

Design n.G.

Maximum Bending Stress Ratio =	0.707 : 1	Maximum Shear Stress Ratio =	0.058 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.647 k-ft	Va : Applied	0.5180 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.260 in Ratio = 230 < 360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 < 360	n/a	
Max Downward Total Deflection	0.292 in Ratio = 206 >= 180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 < 180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	5.00 ft	1	0.076	0.006	0.07		0.07	1.53	0.92	1.00	1.00	0.06	15.00	8.98
+D+L														
Dsgn. L =	5.00 ft	1	0.707	0.058	0.65		0.65	1.53	0.92	1.00	1.00	0.52	15.00	8.98
+D+0.750L														
Dsgn. L =	5.00 ft	1	0.549	0.045	0.50		0.50	1.53	0.92	1.00	1.00	0.40	15.00	8.98
+0.60D														
Dsgn. L =	5.00 ft	1	0.045	0.004	0.04		0.04	1.53	0.92	1.00	1.00	0.03	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.2917	2.514		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.518	0.518
Max Upward from Load Combinations	0.518	0.518
Max Upward from Load Cases	0.463	0.463
D Only	0.055	0.055
+D+L	0.518	0.518
+D+0.750L	0.402	0.402
+0.60D	0.033	0.033



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr:

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: EDGE ANGLE

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.463	0.463

$$M = \frac{PL}{4}$$

$$650 \text{ lb} \cdot \text{ft} = \frac{P(5 \text{ ft})}{4}$$

$$P = 520 \text{ lb}$$

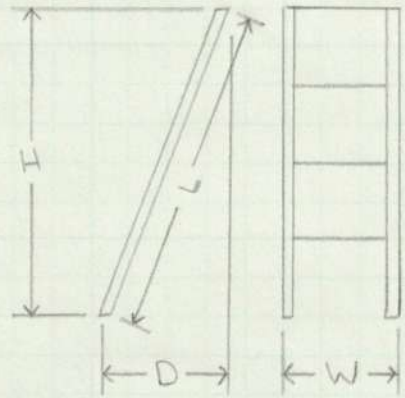
Stair Framing:Stair Dimensions:

$$H = 9.1 \text{ ft}$$

$$D = 4.7 \text{ ft}$$

$$L = 10.2 \text{ ft}$$

$$W = 1.67 \text{ ft}$$

Stair Stringer Loads:

Point Load = 300 lb @ Every Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

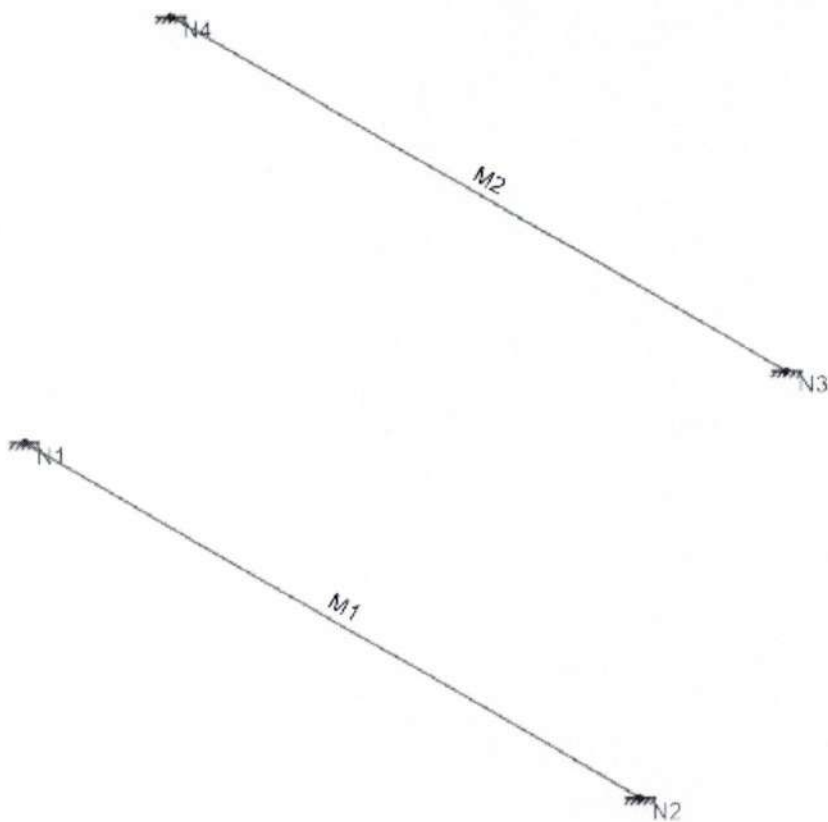
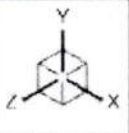
$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$

Stair Tread Loads:

Point Load = 300 lb @ Center

$$LL = (100 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 33 \text{ plf}$$

$$DL = (10 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 3 \text{ plf}$$

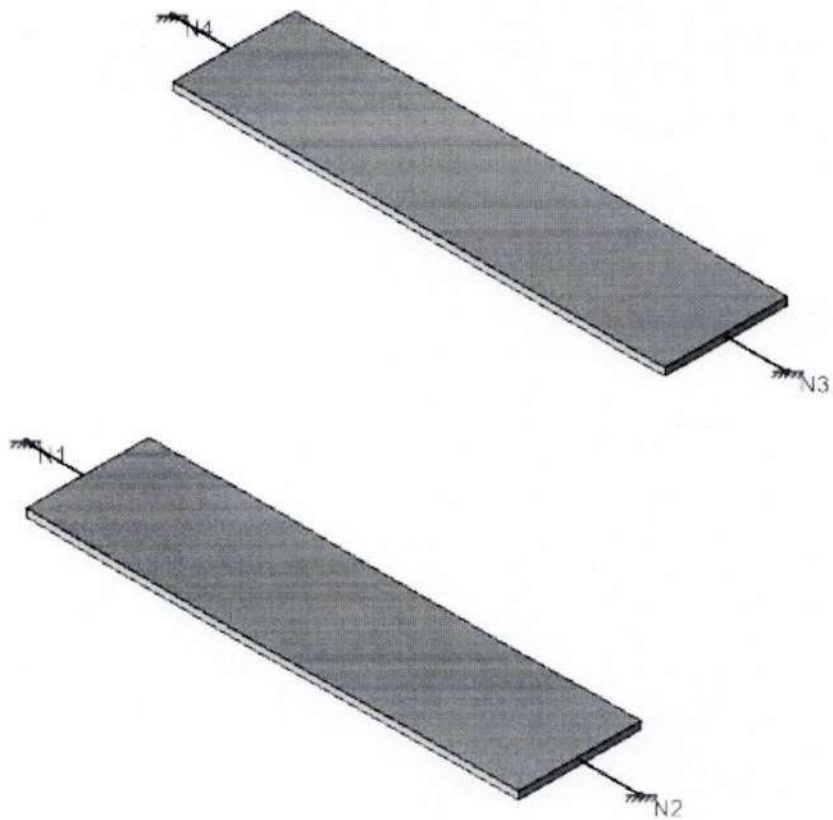
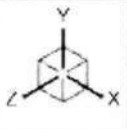


Stability Engineering, Inc.
M. Foster
22-0669 Autzen House

Stair Treads

MEMBER LABELS 2

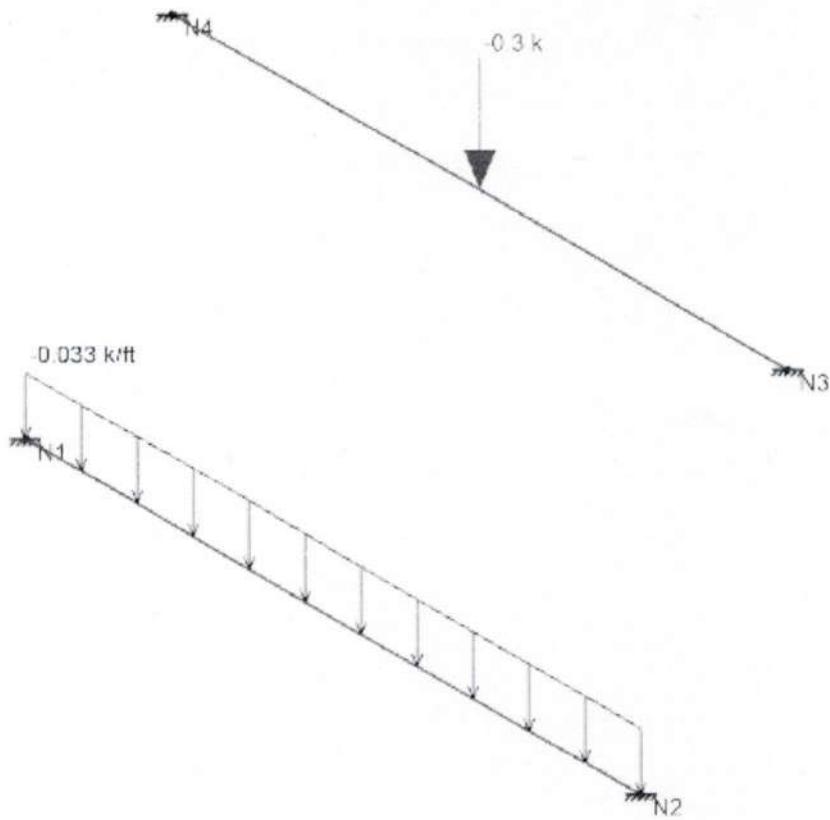
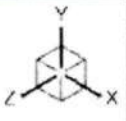
22-0669 Autzen House Tread...



Stability Engineering, Inc.
M. Foster
22-0669 Autzen House

Stair Treads

MEMBER RENDERING 2
22-0669 Autzen House Tread...



Loads: BLC 2, LIVE



Stability Engineering, Inc.
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22-0669 Autzen House

Stair Treads

LIVE LOADS 3
22-0669 Autzen House Tread...



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Autzen House
 Model Name : Stair Treads

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	1.67	0	0	
3	N3	1.67	0.8	-0.4	
4	N4	0	0.8	-0.4	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [$1e^5 F^{-1}$]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	TREAD	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	1	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M2	Y	-0.003	-0.003	0	%100
2	M1	Y	-0.003	-0.003	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.033	-0.033	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Autzen House
 Model Name : Stair Treads

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1 M2	Y	-0.3	%50

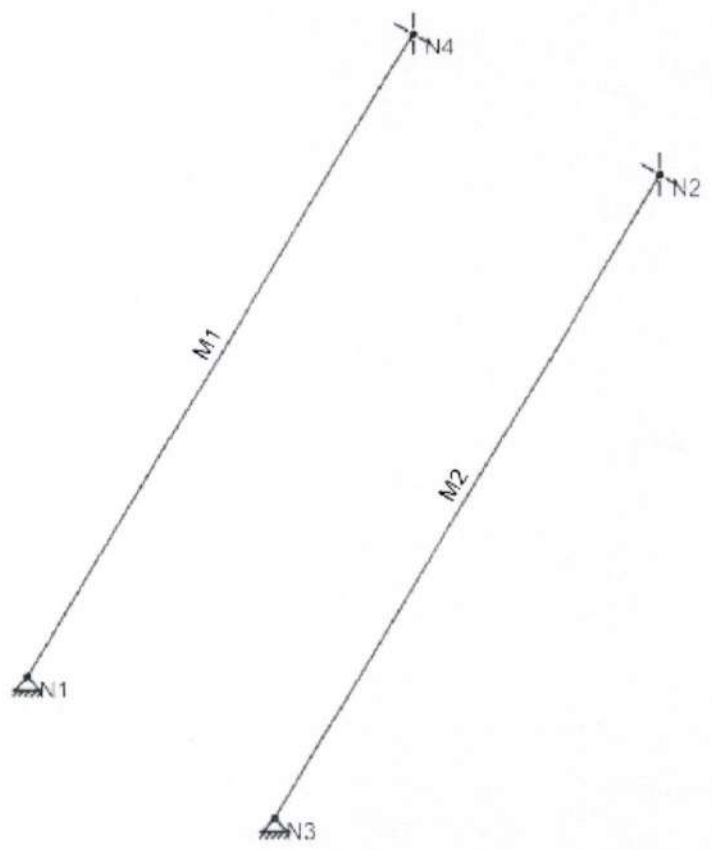
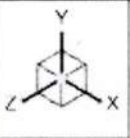
Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	5	0.03	5	0	5	0	5	0	5	0.008	5
1 N1 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
2 N2 max	0	5	0.03	5	0	5	0	5	0	5	-0.001	4
3 N2 min	0	1	0.003	1	0	1	0	1	0	1	-0.008	3
4 N4 max	0	5	0.153	5	0	5	0	5	0	5	0.063	5
5 N4 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
6 N3 max	0	5	0.153	5	0	5	0	5	0	5	-0.001	4
7 N3 min	0	1	0.003	1	0	1	0	1	0	1	-0.063	3
8 Totals: max	0	5	0.365	5	0	5						
9 Totals: min	0	1	0.01	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0 M1	PL4X1/4	0.054	1.67	5	0.002	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b
1 M2	PL4X1/4	0.406	1.67	5	0.008	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b

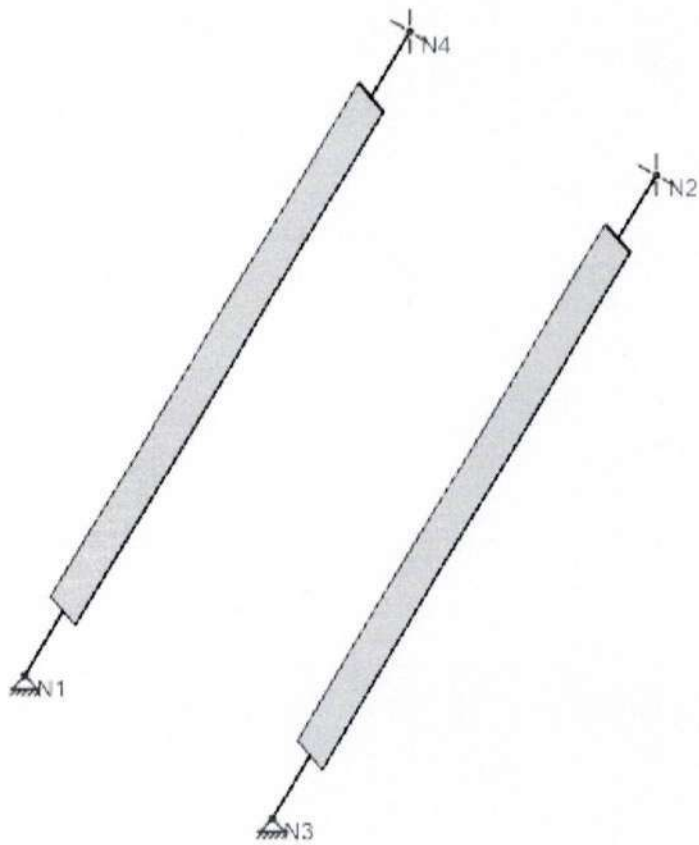
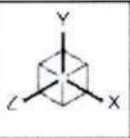
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Stability Engineering, Inc.
M. Foster
22-0669 Autzen House

Stair Stringers

MEMBER LABELS 1
22-0669 Autzen House Stri...

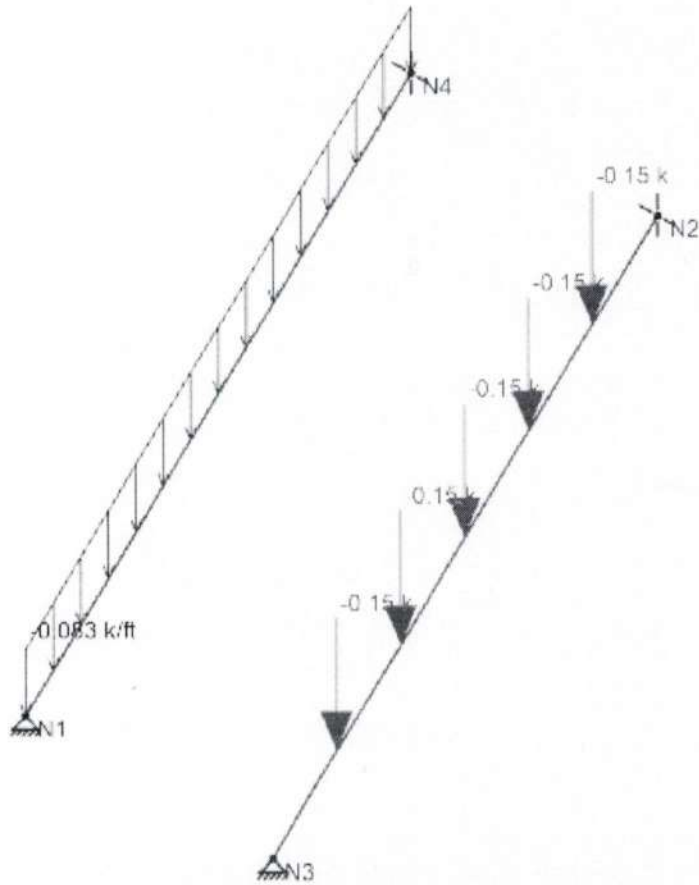
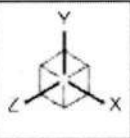


Stability Engineering, Inc.
M. Foster
22-0669 Autzen House

Stair Stringers

MEMBER RENDERING 2

22-0669 Autzen House Stri...



Loads: BLC 2, LIVE



Stability Engineering, Inc.
M. Foster
22-0669 Autzen House

Stair Stringers

LIVE LOADS 3

22-0669 Autzen House Stri...



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Autzen House
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	7.7	9.1	0	
3	N3	3	0	0	
4	N4	4.7	9.1	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [$1e^{-5}F^{-1}$]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	5	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Autzen House
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.15	1.7
2	M2	Y	-0.15	3.4
3	M2	Y	-0.15	5.1
4	M2	Y	-0.15	6.8
5	M2	Y	-0.15	8.5

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	2	0.468	5	0	5	LOCKED		LOCKED		0	5
1 N1 min	0	1	0.043	1	0	1	LOCKED		LOCKED		0	1
2 N3 max	0	2	0.419	5	0	5	LOCKED		LOCKED		0	5
3 N3 min	0	1	0.043	1	0	1	LOCKED		LOCKED		0	1
4 N2 max	0	2	0.416	5	0	5	0	5	0	5	0	5
5 N2 min	0	1	0.043	1	0	1	0	1	0	1	0	1
6 N4 max	0	4	0.468	5	0	5	0	5	0	5	0	5
7 N4 min	0	3	0.043	1	0	1	0	1	0	1	0	1
8 Totals: max	0	2	1.77	5	0	5						
9 Totals: min	0	1	0.17	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	PL4X1/4	0.272	4.908	5	0.018	10.242	y	5	7.891	29.94	0.156	2.027	1 H1-1b
1	M2	PL4X1/4	0.289	5.014	5	0.016	0	y	5	7.891	29.94	0.156	2.027	1 H1-1b

OK

Load Testing Summary:

[BRACE LOADS]

$$P_1 = 1313 \text{ lb}$$

$$P_2 = 1068 \text{ lb}$$

$$P_3 = 1037 \text{ lb}$$

$$P_4 = 596 \text{ lb}$$

$$P_5 = 703 \text{ lb}$$

$$P_6 = 699 \text{ lb}$$

[EDGE ANGLE]

$$P_7 = 520 \text{ lb}$$

Fire Escape Load Testing Analysis:

Scope of Work: Calculations for load testing requirements for the fire escape located at Community Hall - West side.

Building Code: 2002 OBC

Design Loads: $LL = 100 \text{ psf}$
 $DL = 10 \text{ psf}$ } Total Load = 110 psf

Calculate Brace Loads:Stair Loads:

$$LL = (100 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(17 \text{ treads}) = 937 \text{ lb}$$

↖ Tread Width
↗ Tread Length

$$DL = (10 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(17 \text{ treads}) = 94 \text{ lb}$$

[Load at Each Support]

$$LL = 937 \text{ lb} / 4 = 235 \text{ lb}$$

$$DL = 94 \text{ lb} / 4 = 24 \text{ lb}$$

Worst Case Brace → Upper Brace

$$L = 3.7 \text{ ft}$$

$$\text{Uniform LL} = (100 \text{ psf})(4 \text{ ft}) = 400 \text{ plf}$$

$$DL = (10 \text{ psf})(4 \text{ ft}) = 40 \text{ plf}$$

Stair Load @ $L = 0.5 \text{ ft}, 2.2 \text{ ft}$ Worst Case Brace → Lower Brace

$$L = 3.7 \text{ ft}$$

$$\text{Full Uniform LL} = (100 \text{ psf})(3.73 \text{ ft}) = 373 \text{ plf}$$

$$DL = (10 \text{ psf})(3.73 \text{ ft}) = 37 \text{ plf}$$

$$\text{Partial Uniform LL} = (100 \text{ psf})(0.7 \text{ ft}) = 70 \text{ plf}$$

$$\left\{ \begin{array}{l} \text{eL} = 0 - \\ \quad 2.25 \text{ ft} \end{array} \right. \quad DL = (10 \text{ psf})(0.7 \text{ ft}) = 7 \text{ plf}$$

Stair Load @ $L = 0.5 \text{ ft}, 2.2 \text{ ft}$



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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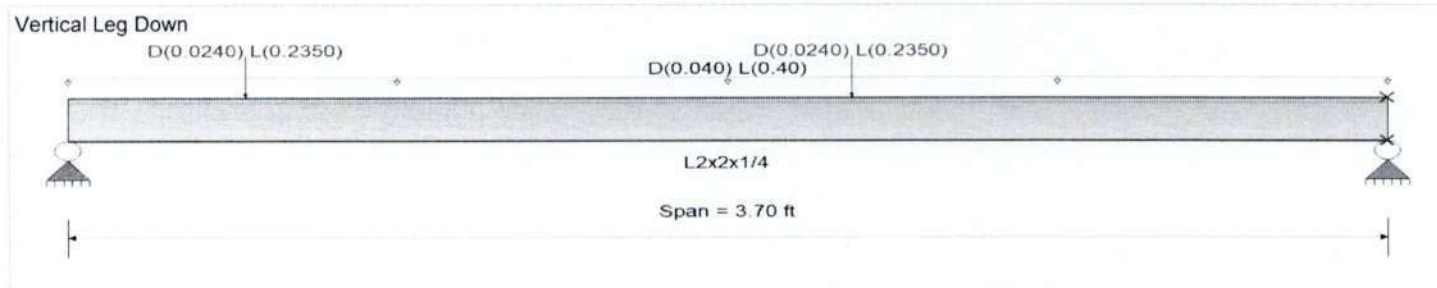
DESCRIPTION: UPPER LEVEL BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.040, L = 0.40 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)

Point Load : D = 0.0240, L = 0.2350 k @ 0.50 ft, (STAIR LOAD)

Point Load : D = 0.0240, L = 0.2350 k @ 2.20 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	1.117 : 1	Maximum Shear Stress Ratio =	0.128 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	1.023 k-ft	Va : Applied	1.149 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.227 in Ratio = 195 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.251 in Ratio = 177 <240.0	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <240.0	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	3.70 ft	1	0.107	0.012	0.10		0.10	1.53	0.92	1.00	1.00	0.11	15.00	8.98
+D+L														
Dsgn. L =	3.70 ft	1	1.117	0.128	1.02	<i>Mmax</i>	1.02	1.53	0.92	1.00	1.00	1.15	15.00	8.98
+D+0.750L														
Dsgn. L =	3.70 ft	1	0.865	0.099	0.79		0.79	1.53	0.92	1.00	1.00	0.89	15.00	8.98
+0.60D														
Dsgn. L =	3.70 ft	1	0.064	0.007	0.06		0.06	1.53	0.92	1.00	1.00	0.07	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.2507	1.861		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.149	1.009
Max Upward from Load Combinations	1.149	1.009



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: **COMMUNITY - WEST**

Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build: 20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: UPPER LEVEL BRACE DESIGN (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from Load Cases	1.039	0.911
D Only	0.110	0.097
+D+L	1.149	1.009
+D+0.750L	0.889	0.781
+0.60D	0.066	0.058
L Only	1.039	0.911

$P_1 = 1039 \text{ lb}$
 $P_2 = 911 \text{ lb}$
} Specify on Loading Plans



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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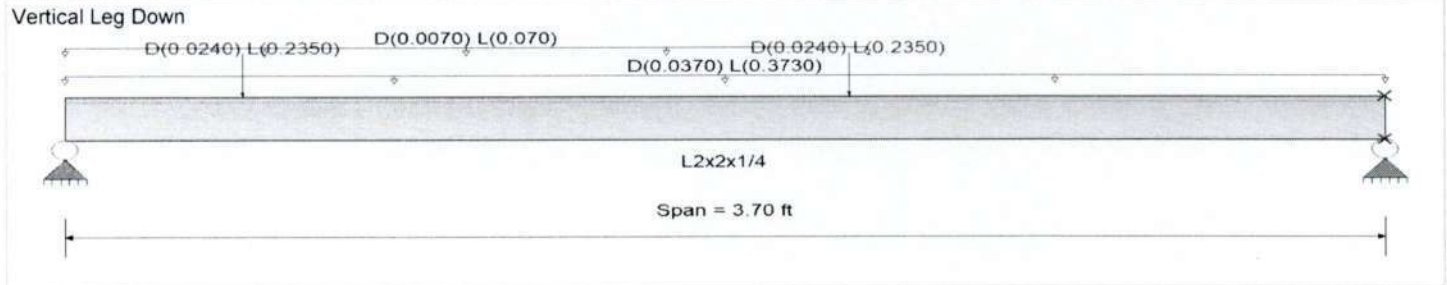
DESCRIPTION: LOWER LEVEL BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

- Beam self weight calculated and added to loading
Uniform Load : D = 0.0370, L = 0.3730 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)
- Point Load : D = 0.0240, L = 0.2350 k @ 0.50 ft, (STAIR LOAD)
- Point Load : D = 0.0240, L = 0.2350 k @ 2.20 ft, (STAIR LOAD)
- Uniform Load : D = 0.0070, L = 0.070 k/ft, Extent = 0.0 --> 2.250 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)

DESIGN SUMMARY

Loads Only
Design N.G.

Maximum Bending Stress Ratio =	1.157 : 1	Maximum Shear Stress Ratio =	0.135 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	1.060 k-ft	Va : Applied	1.214 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.235 in Ratio = 188 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.260 in Ratio = 171 <240.0	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <240.0	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	3.70 ft	1	0.111	0.013	0.10		0.10	1.53	0.92	1.00	1.00	0.12	15.00	8.98
+D+L														
Dsgn. L =	3.70 ft	1	1.157	0.135	1.06		1.06	1.53	0.92	1.00	1.00	1.21	15.00	8.98
+D+0.750L														
Dsgn. L =	3.70 ft	1	0.896	0.105	0.82		0.82	1.53	0.92	1.00	1.00	0.94	15.00	8.98
+0.60D														
Dsgn. L =	3.70 ft	1	0.066	0.008	0.06		0.06	1.53	0.92	1.00	1.00	0.07	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.2598	1.850		0.0000	0.000



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: **COMMUNITY - WEST**

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: LOWER LEVEL BRACE DESIGN (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.214	1.006
Max Upward from Load Combinations	1.214	1.006
Max Upward from Load Cases	1.098	0.909
D Only	0.116	0.097
+D+L	1.214	1.006
+D+0.750L	0.939	0.779
+0.60D	0.069	0.058
L Only	1.098	0.909

$P_3 = 1214 \text{ lb}$
 $P_4 = 1006 \text{ lb}$
} Specify on loading plans

Landing Support Braces: Both LevelsBrace Geometry:

$$H = 2.5 \text{ ft}$$

$$L = 3.7 \text{ ft}$$

$$\theta = \tan^{-1}(H/L) = 34^\circ$$

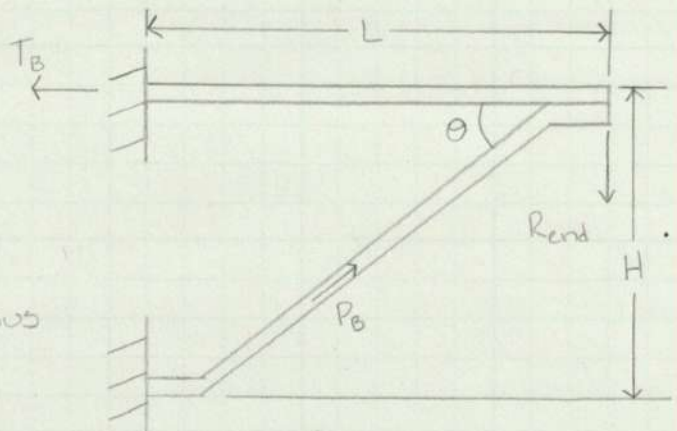
$$R_{end} = 1214 \text{ lb}$$

$$M_{max} = 1060 \text{ lb}\cdot\text{ft}$$

} See Previous Pages

$$P_B = \frac{R_{end}}{\sin \theta} = 2171 \text{ lb}$$

$$T_B = P_B \cos \theta = 1800 \text{ lb}$$

Brace Section Properties: (1" Solid Square Bar)

$$Z_x = \frac{bd^3}{4} = 0.25 \text{ in}^3$$

$$Z_x = Z_y = 0.25 \text{ in}^3$$

$$\text{Area} = bd = 1 \text{ in}^2$$

$$F_y = 36 \text{ ksi}$$

Brace Checks:

$$\frac{M_n}{\Omega} = \frac{F_y Z}{1.67} = \frac{(36 \text{ ksi})(0.25 \text{ in}^3)}{1.67} = 5389 \text{ lb}\cdot\text{in} = 449 \text{ lb}\cdot\text{ft} < 1060 \text{ lb}\cdot\text{ft}$$

\therefore NO GOOD

$$\frac{T_n}{\Omega} = \frac{F_y A}{1.67} = \frac{(36 \text{ ksi})(1 \text{ in}^2)}{1.67} = 21.6 \text{ k}$$

$$\text{Tension Ratio} = \frac{T_B}{T_n/\Omega} = \frac{1800 \text{ lb}}{21600 \text{ lb}} = 0.083 < 0.2 \quad \therefore \text{Use AISC Eqn H1-1b}$$

$$\text{Combined Ratio} = \frac{T_B}{2(T_n/\Omega)} + \frac{M_B}{M_n/\Omega} = 2.4 > 1 \quad \therefore \text{NO GOOD}$$

\therefore Brace is required to be tested

Framing Checks:Decking Bars (Worst Case)

$$L = 5.5 \text{ ft}$$

$$\left. \begin{array}{l} \text{Uniform LL} = 100 \text{ psf} (0.25 \text{ ft}) = 25 \text{ plf} \\ \text{DL} = 10 \text{ psf} (0.25 \text{ ft}) = 2.5 \text{ plf} \end{array} \right\} \text{UL} = 27.5 \text{ plf}$$

$$\text{Point Load} = \frac{110 \text{ psf} (9.25 \text{ ft})(1.67 \text{ ft})}{1.67 \text{ ft}} (0.25 \text{ ft}) = 266 \text{ lb} = \text{PL}$$

$eL = 3 \text{ ft}$

$$M_u = M_{uL} + M_{uP} = \frac{wL^2}{8} + \frac{Pab}{L}$$

$$= \frac{(27.5 \text{ plf})(5.5 \text{ ft})^2}{8} + \frac{(266 \text{ lb})(3 \text{ ft})(2.5 \text{ ft})}{5.5 \text{ ft}}$$

$$M_u = 467 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{S} = \frac{F_y Z}{S}$$

$$Z = \frac{bd^2}{4} = \frac{(1.5 \text{ in})(0.25 \text{ in})^2}{4} = 0.0234 \text{ in}^3$$

$$\frac{M_n}{S} = \frac{(36000 \text{ psi})(0.0234 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 42.1 \text{ lb}\cdot\text{ft} < 467 \text{ lb}\cdot\text{ft}$$

∴ NO GOOD

[Load Test]

$$M_{\text{max}} = \frac{PL}{4}$$

$$P = 340 \text{ lb}$$

$$467 \text{ lb}\cdot\text{ft} = \frac{P(5.5 \text{ ft})}{4}$$

Landing Bars (Worst Case)

$$L = 3.7 \text{ ft}$$

$$\text{LL} = 100 \text{ psf} (2.75 \text{ ft}) = 275 \text{ plf}$$

$$\text{DL} = 10 \text{ psf} (2.75 \text{ ft}) = 27.5 \text{ plf}$$

See Calculation on next page



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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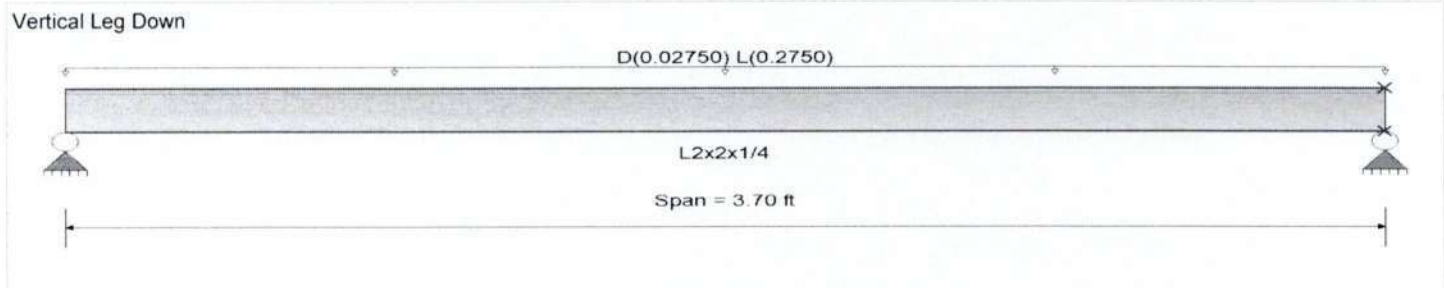
DESCRIPTION: LANDING BARS

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method: Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E: Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.02750, L = 0.2750 k/ft, Tributary Width = 1.0 ft, (UNIFORM LOAD)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.571 : 1	Maximum Shear Stress Ratio =	0.063 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.523 k-ft	Va : Applied	0.5655 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.116 in Ratio = 382	>=360	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio = 0	<360	n/a
Max Downward Total Deflection	0.129 in Ratio = 344	>=240.	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio = 0	<240.0	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only														
Dsgn. L =	3.70 ft	1	0.057	0.006	0.05		0.05	1.53	0.92	1.00	1.00	0.06	15.00	8.98
+D+L														
Dsgn. L =	3.70 ft	1	0.571	0.063	0.52		0.52	1.53	0.92	1.00	1.00	0.57	15.00	8.98
+D+0.750L														
Dsgn. L =	3.70 ft	1	0.443	0.049	0.41		0.41	1.53	0.92	1.00	1.00	0.44	15.00	8.98
+0.60D														
Dsgn. L =	3.70 ft	1	0.034	0.004	0.03		0.03	1.53	0.92	1.00	1.00	0.03	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1291	1.861		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.566	0.566
Max Upward from Load Combinations	0.566	0.566
Max Upward from Load Cases	0.509	0.509
D Only	0.057	0.057
+D+L	0.566	0.566
+D+0.750L	0.438	0.438
+0.60D	0.034	0.034



Stability Engineering, Inc.
 777 NE 2nd St. Suite 280
 Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
 Engineer: M. FOSTER
 Project ID: 22-0669
 Project Descr: COMMUNITY - WEST

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: LANDING BARS

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.509	0.509

Edge Angle Checks:Edge Angle:

L = 5.5 ft

Pt load from stairs @ L = 3 ft

LL = 470 lb

DL = 48 lb



Steel Beam	Project File: 22-0669.ec6
LIC# : KW-06014874, Build:20.23.08.30	(c) ENERCALC INC 1983-2023
Stability Engineering Inc.	

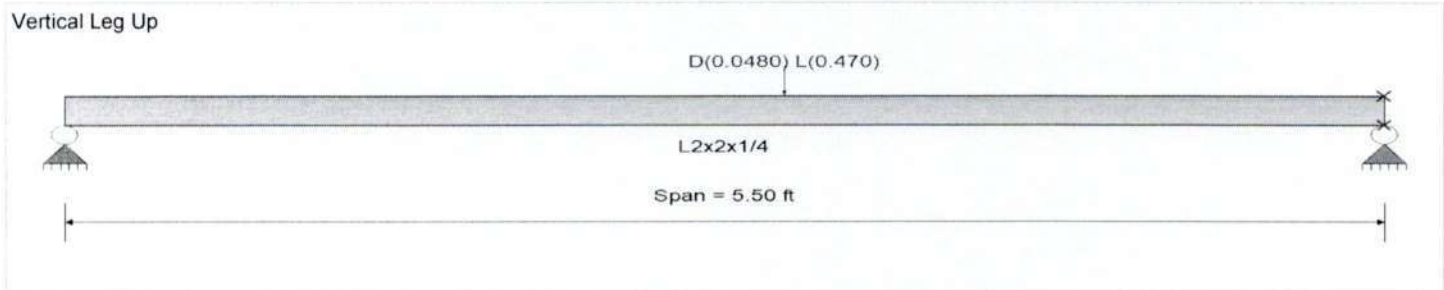
DESCRIPTION: EDGE ANGLE

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design	Fy : Steel Yield :	50.0 ksi
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling	E: Modulus :	29,000.0 ksi
Bending Axis : Major Axis Bending		



Applied Loads

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

Beam self weight calculated and added to loading
Load(s) for Span Number 1
Point Load : D = 0.0480, L = 0.470 k @ 3.0 ft, (STAIR LOAD)

OK, Fails in Deflection

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	0.784 : 1	Maximum Shear Stress Ratio =	0.032 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.718 k-ft	Va : Applied	0.2913 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	5.500 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.278 in Ratio = 236 < 360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 < 360	n/a	
Max Downward Total Deflection	0.314 in Ratio = 210 < 240.0	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 < 240.0	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only	Dsgn. L = 5.50 ft	1	0.084	0.004	0.08		0.08	1.53	0.92	1.00	1.00	0.03	15.00	8.98
+D+L	Dsgn. L = 5.50 ft	1	0.784	0.032	0.72		0.72	1.53	0.92	1.00	1.00	0.29	15.00	8.98
+D+0.750L	Dsgn. L = 5.50 ft	1	0.609	0.025	0.56		0.56	1.53	0.92	1.00	1.00	0.23	15.00	8.98
+0.60D	Dsgn. L = 5.50 ft	1	0.051	0.002	0.05		0.05	1.53	0.92	1.00	1.00	0.02	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.3137	2.829		0.0000	0.000

Vertical Reactions

Load Combination	Support notation : Far left is #		Values in KIPS	
	Support 1	Support 2		
Max Upward from all Load Conditions	0.244	0.291		
Max Upward from Load Combinations	0.244	0.291		
Max Upward from Load Cases	0.214	0.256		
D Only	0.031	0.035		
+D+L	0.244	0.291		
+D+0.750L	0.191	0.227		



Stability Engineering, Inc.
 777 NE 2nd St. Suite 280
 Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
 Engineer: M. FOSTER
 Project ID: 22-0669
 Project Descr: COMMUNITY WEST

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: EDGE ANGLE

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
+0.60D	0.018	0.021
L Only	0.214	0.256

Stair Framing:Stair Dimensions

$$H = 18.5 \text{ ft}$$

$$D = 9.7 \text{ ft}$$

$$L = 21 \text{ ft}$$

$$W = 1.67 \text{ ft}$$

Stair Stringer Loads

Point Load = 300 lb @ Every Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

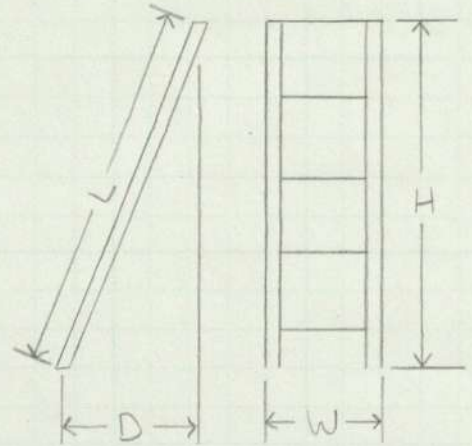
$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$

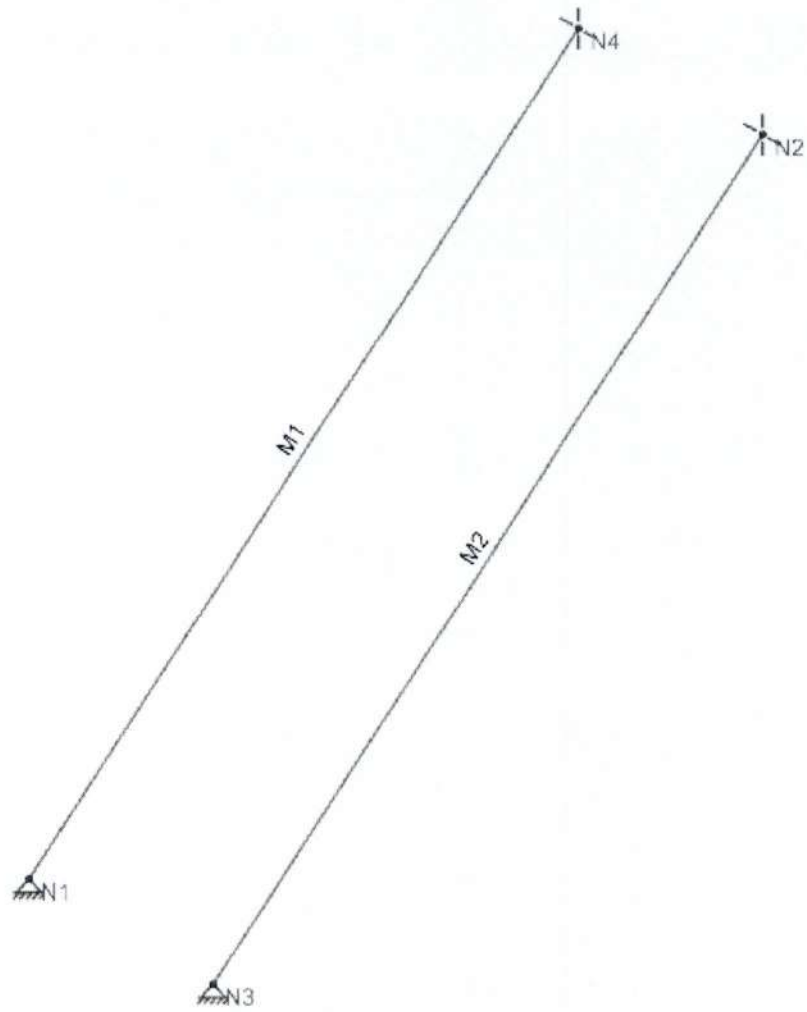
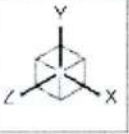
Stair Tread Loads

Point Load = 300 lb @ Center

$$LL = (100 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 33 \text{ plf}$$

$$DL = (10 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 3 \text{ plf}$$



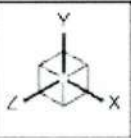


Stability Engineering, Inc.
M. Foster
22-0669 Community - West

Stair Stringers

MEMBER LABELS 1

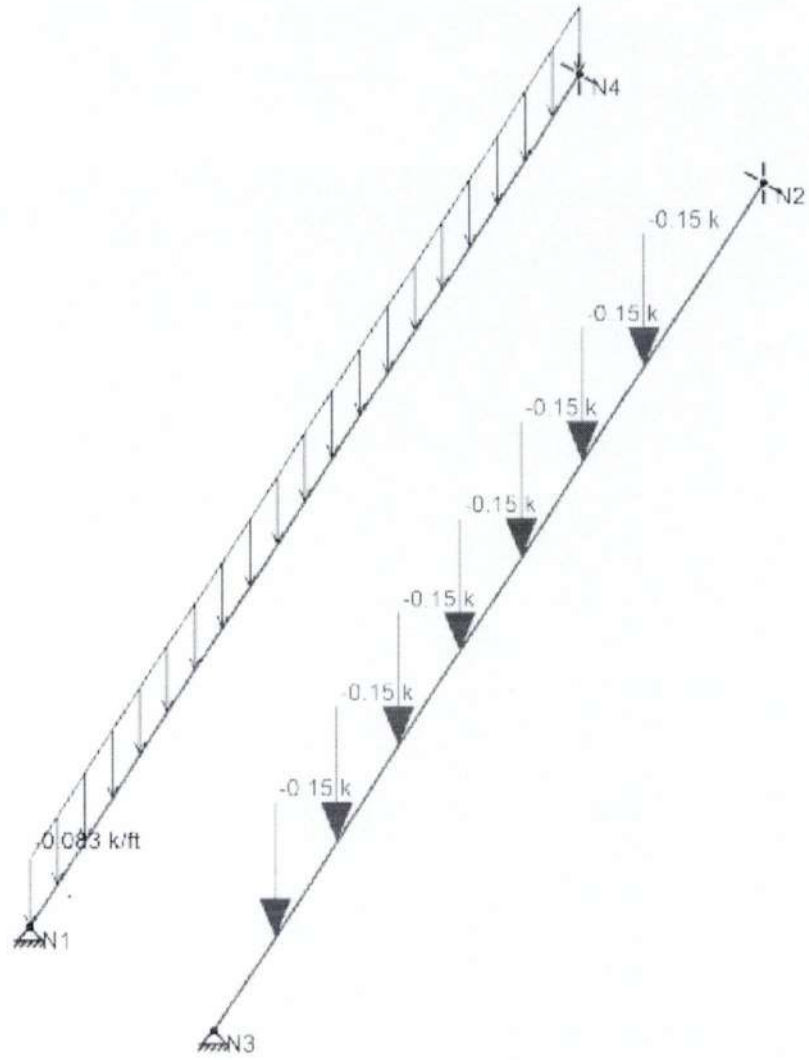
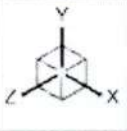
22-0669 Community Stringer...



Stability Engineering, Inc.
M. Foster
22-0669 Community - West

Stair Stringers

MEMBER RENDERING 2
22-0669 Community Stringer...



Loads: BLC 2, LIVE



Stability Engineering, Inc.
 M. Foster
 22-0669 Community - West

Stair Stringers

LIVE LOADS3
 22-0669 Community Stringer...



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Community - West
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	12	16.5	0	
3	N3	3	0	0	
4	N4	9	16.5	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	7	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Community - West
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.15	2.1
2	M2	Y	-0.15	4.2
3	M2	Y	-0.15	6.3
4	M2	Y	-0.15	8.4
5	M2	Y	-0.15	10.5
6	M2	Y	-0.15	12.6
7	M2	Y	-0.15	14.7

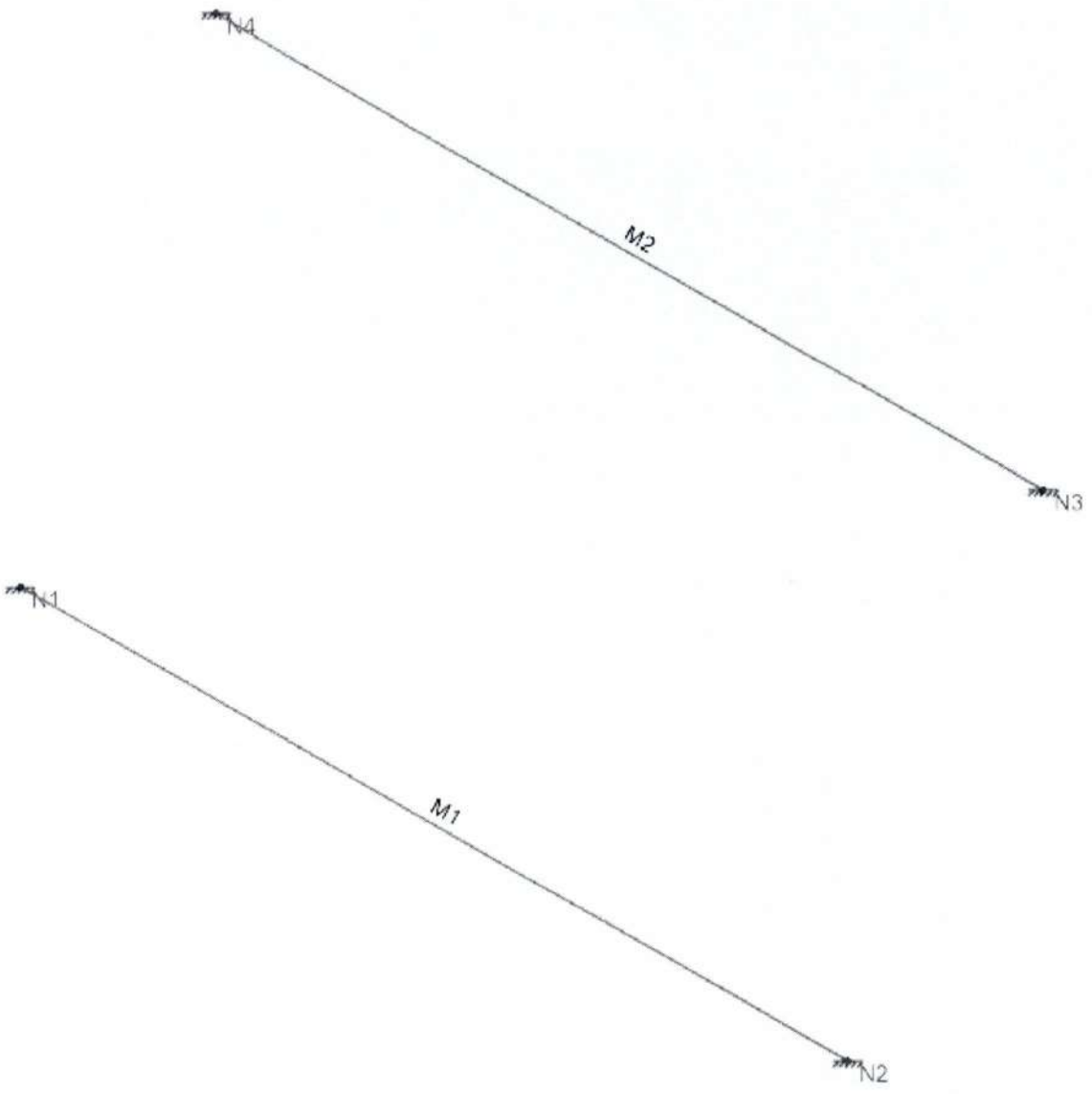
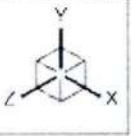
Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	4	0.858	5	0	5	LOCKED		LOCKED		0	5
1 min	0	3	0.078	1	0	1	LOCKED		LOCKED		0	1
2 N3 max	0	4	0.659	5	0	5	LOCKED		LOCKED		0	5
3 min	0	2	0.078	1	0	1	LOCKED		LOCKED		0	1
4 N2 max	0	4	0.547	5	0	5	0	5	0	5	0	5
5 min	0	2	0.078	1	0	1	0	1	0	1	0	1
6 N4 max	0	2	0.858	5	0	5	0	5	0	5	0	5
7 min	0	1	0.078	1	0	1	0	1	0	1	0	1
8 Totals: max	0	4	2.922	5	0	5						
9 min	0	2	0.312	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	PL4X1/4	0.955	9.006	5	0.034	18.795	y	5	3.94	29.94	0.156	2.027	1 H1-1b
1	M2	PL4X1/4	0.801	8.223	5	0.026	0	y	5	3.94	29.94	0.156	2.027	1 H1-1b

<1 ∴ OK

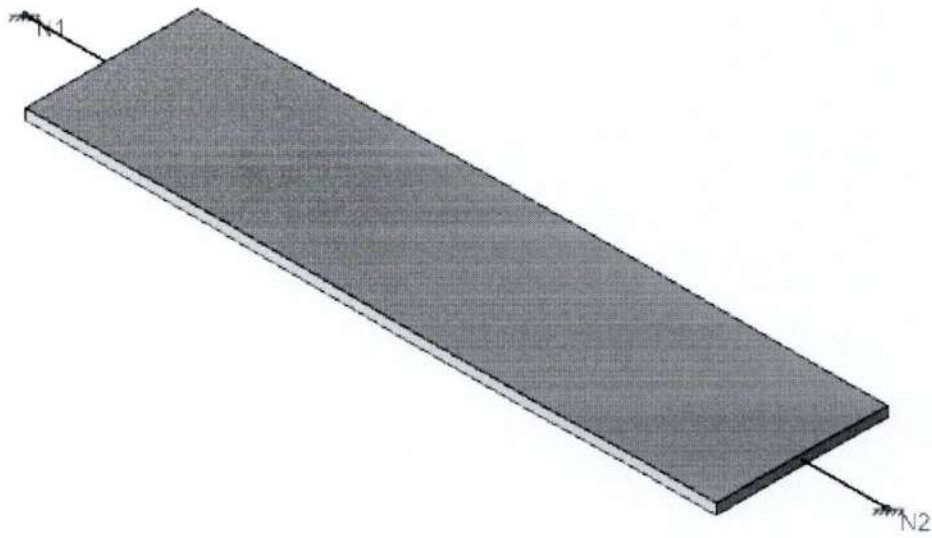
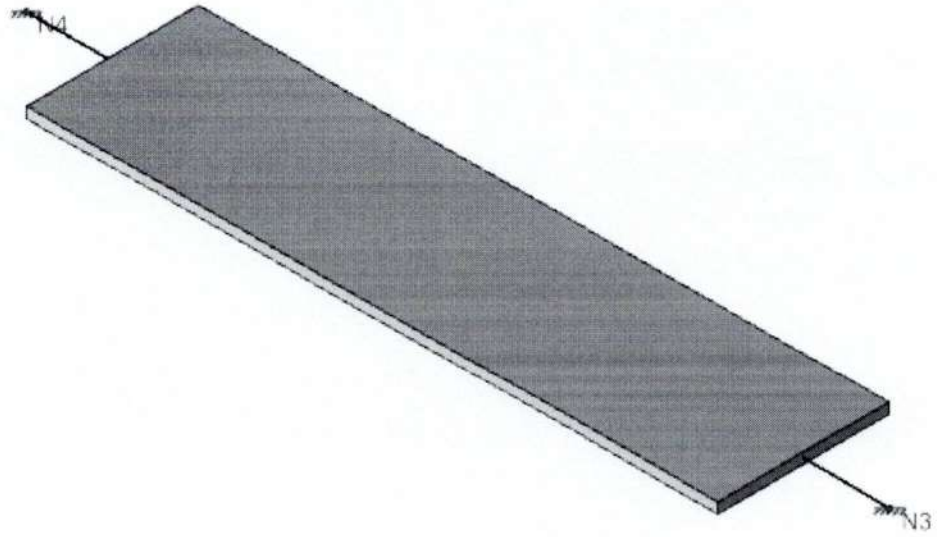
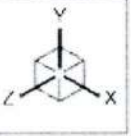


Stability Engineering, Inc.
M. Foster
22-0669 Community - West

Stair Treads

MEMBER LABELS 1

22-0669 Community West ...

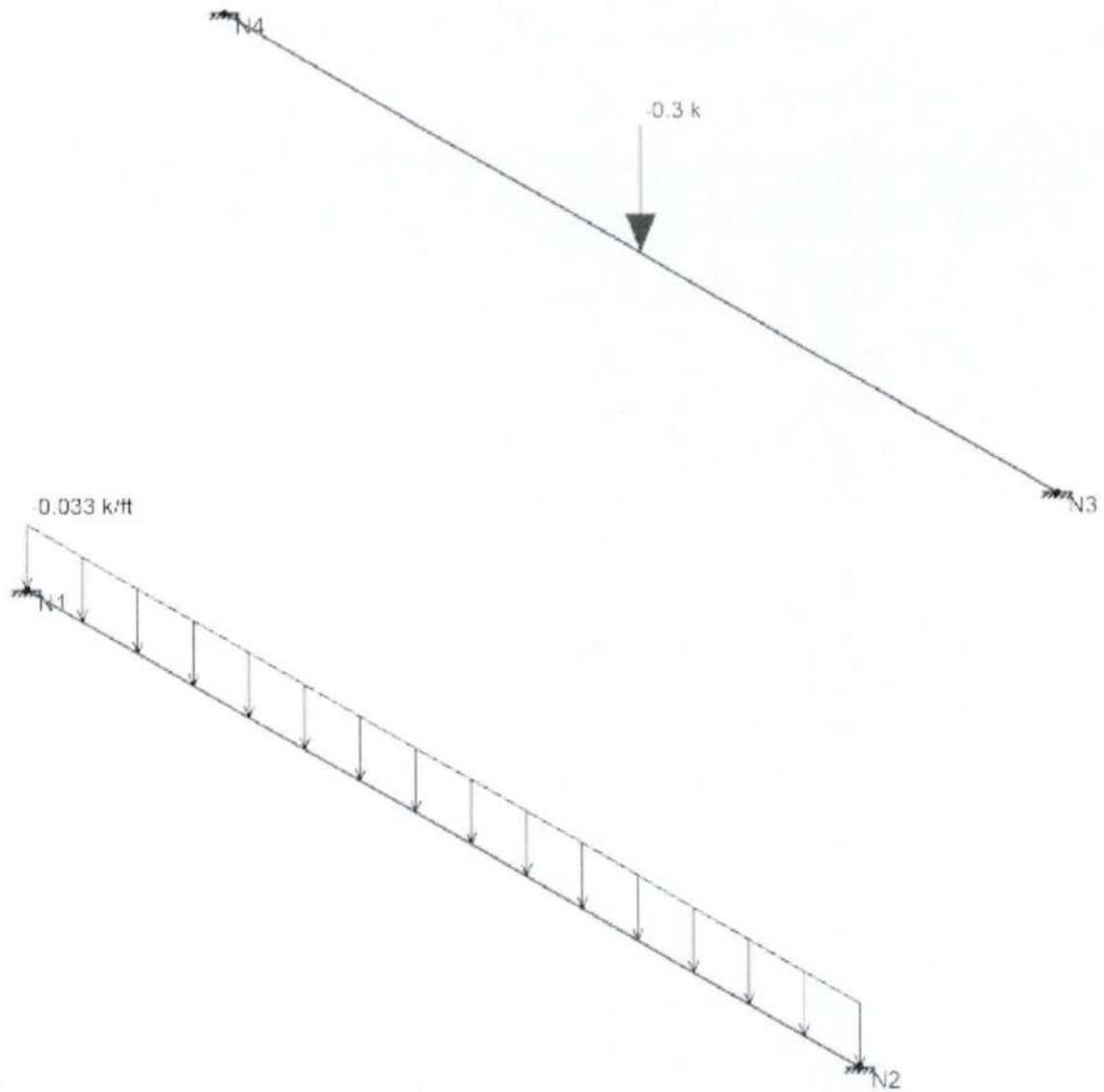
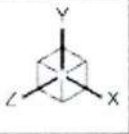


Stability Engineering, Inc.
M. Foster
22-0669 Community - West

Stair Treads

MEMBER RENDERING 2

22-0669 Community West ...



Loads: BLC 2, LIVE

	Stability Engineering, Inc.	Stair Treads	LIVE LOADS 3
	M. Foster		22-0669 Community West ...
	22-0669 Community - West		



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Community - West
 Model Name : Stair Treads

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	1.67	0	0	
3	N3	1.67	0.8	-0.4	
4	N4	0	0.8	-0.4	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	TREAD	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	1	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M2	Y	-0.003	-0.003	0	%100
2	M1	Y	-0.003	-0.003	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.033	-0.033	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Community - West
 Model Name : Stair Treads

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1 M2	Y	-0.3	%50

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	5	0.03	5	0	5	0	5	0	5	0.008	5
1 N1 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
2 N2 max	0	5	0.03	5	0	5	0	5	0	5	-0.001	4
3 N2 min	0	1	0.003	1	0	1	0	1	0	1	-0.008	3
4 N4 max	0	5	0.153	5	0	5	0	5	0	5	0.063	5
5 N4 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
6 N3 max	0	5	0.153	5	0	5	0	5	0	5	-0.001	4
7 N3 min	0	1	0.003	1	0	1	0	1	0	1	-0.063	3
8 Totals: max	0	5	0.365	5	0	5						
9 Totals: min	0	1	0.01	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0 M1	PL4X1/4	0.054	1.67	5	0.002	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b
1 M2	PL4X1/4	0.406	1.67	5	0.008	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b

<1 ∴ OK

Load Testing Summary:

[BRACE LOADS]

$$P_1 = 1039 \text{ lb}$$

$$P_2 = 911 \text{ lb}$$

$$P_3 = 1214 \text{ lb}$$

$$P_4 = 1006 \text{ lb}$$

[DECKING BARS]

$$P_5 = 340 \text{ lb}$$

Fire Escape Load Testing Analysis

Scope of Work: Calculations for load testing requirements for fire escape located at Covell Hall

Building Code: ~~2002~~ 055C

Design Loads: $LL = 100 \text{ psf}$
 $DL = 10 \text{ psf}$ } Total Load = 110 psf

Calculate Landing Loads:Stair Loads:

[First]

$$LL = (100 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(10 \text{ treads}) = 551 \text{ lb}$$

↳ 280 lb

[Second + Third]

$$LL = (100 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(16 \text{ treads}) = 882 \text{ lb}$$

↳ 445 lb

[Fourth]

$$LL = (100 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(8 \text{ treads}) = 441 \text{ lb}$$

↳ 225 lb

Landing Loads:

[Level 1]

$$LL = (100 \text{ psf})[(4 \text{ ft})(11.4 \text{ ft})] = 4560 \text{ lb}$$

[Level 2]

$$LL = (100 \text{ psf})[(4 \text{ ft})(16.8 \text{ ft}) - (7.75 \text{ ft})(1.9 \text{ ft})]$$

$$LL = 5248 \text{ lb}$$

[Level 3]

$$LL = (100 \text{ psf})[(1.92 \text{ ft})(4 \text{ ft})] = 768 \text{ lb}$$

[Level 4]

$$LL = (100 \text{ psf})[(2.75 \text{ ft})(5.6 \text{ ft})] = 1540 \text{ lb}$$

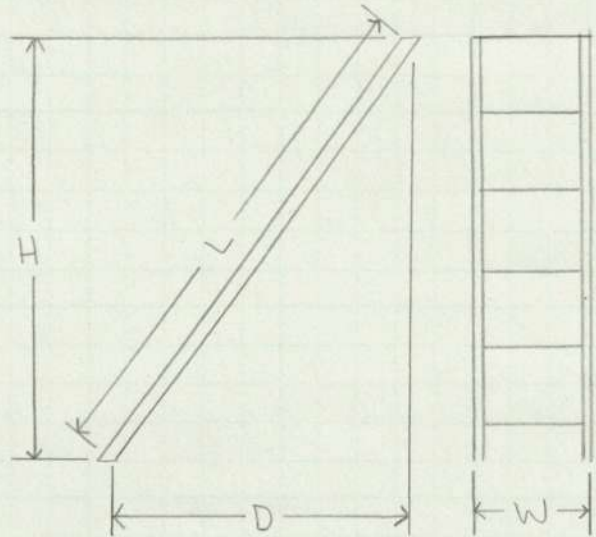
Stair Framing:Stair Dimensions:

$$H = 14.2 \text{ ft}$$

$$D = 7.7 \text{ ft}$$

$$L = 16 \text{ ft}$$

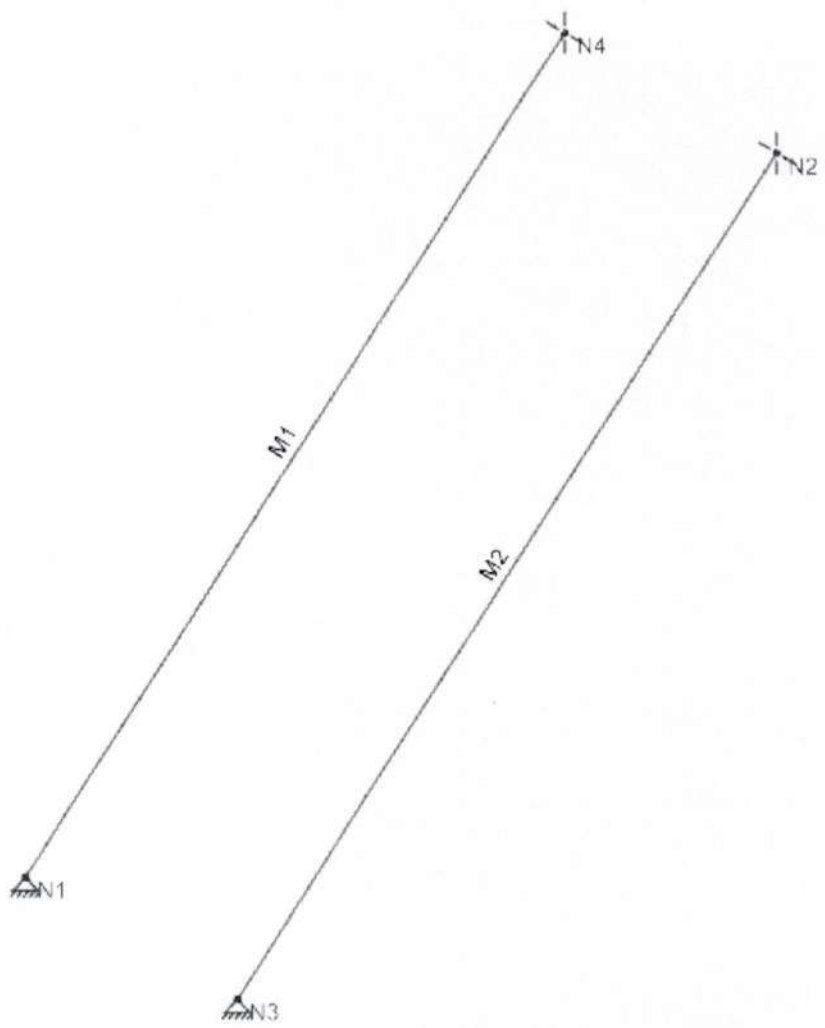
$$W = 1.67 \text{ ft}$$


Stair Stringer Loads:

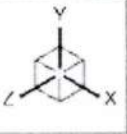
Point Load = 300 lb @ Every Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$



	Stability Engineering, Inc.	Stair Stringers	MEMBER LABELS 1
	M. Foster		22-0669 Covell Stringers.r3d
	22-0669 Covell		

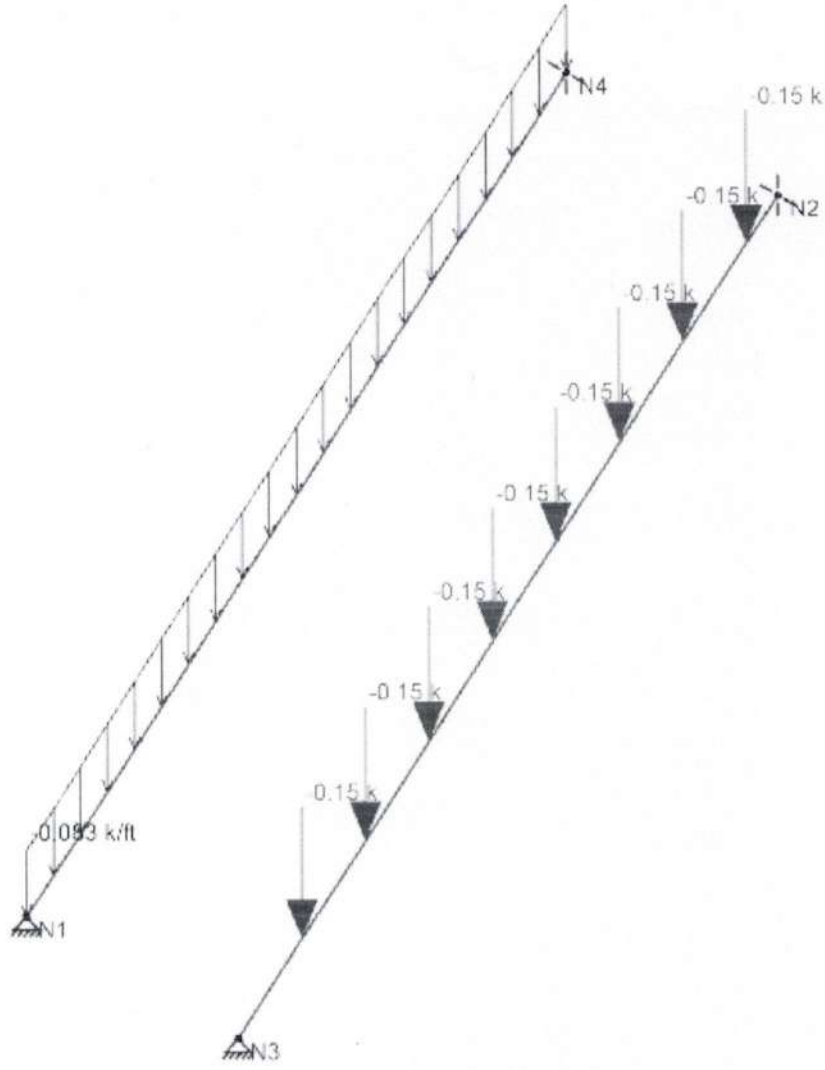
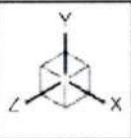


Stability Engineering, Inc.
M. Foster
22-0669 Covell

Stair Stringers

MEMBER RENDERING 2

22-0669 Covell Stringers.r3d



Loads: BLC 2, LIVE



Stability Engineering, Inc.
M. Foster
22-0669 Covell

Stair Stringers

LIVE LOADS 3

22-0669 Covell Stringers.r3d



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Covell
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	10.7	14.2	0	
3	N3	3	0	0	
4	N4	7.7	14.2	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [$1e^{50}F^{-1}$]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	8	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Covell
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.15	1.9
2	M2	Y	-0.15	3.8
3	M2	Y	-0.15	5.7
4	M2	Y	-0.15	7.6
5	M2	Y	-0.15	9.5
6	M2	Y	-0.15	11.4
7	M2	Y	-0.15	13.3
8	M2	Y	-0.15	15.2

Envelope Node Reactions

Node Label		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0	N1	max	0	5	0.737	5	0	5	LOCKED	LOCKED		0	5
1		min	0	1	0.067	1	0	1	LOCKED	LOCKED		0	1
2	N3	max	0	2	0.632	5	0	5	LOCKED	LOCKED		0	5
3		min	0	1	0.067	1	0	1	LOCKED	LOCKED		0	1
4	N2	max	0	2	0.702	5	0	5	0	0	5	0	5
5		min	0	1	0.067	1	0	1	0	0	1	0	1
6	N4	max	0	5	0.737	5	0	5	0	0	5	0	5
7		min	0	2	0.067	1	0	1	0	0	1	0	1
8	Totals:	max	0	5	2.809	5	0	5					
9		min	0	1	0.268	1	0	1					

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	PL4X1/4	0.701	7.74	5	0.029	16.153	y	5	5.334	29.94	0.156	2.027	1 H1-1b
1	M2	PL4X1/4	0.68	7.572	5	0.028	16.153	y	5	5.334	29.94	0.156	2.027	1 H1-1b

<1 :OK

Fire Escape Load Testing Analysis:

Scope of Work: Calculations for load testing requirements for fire escapes located at Dryden Hall

Building Code: 2022 OSBC

Design Loads: $\left. \begin{array}{l} LL = 100 \text{ psf} \\ DL = 10 \text{ psf} \end{array} \right\} \text{ Total Load} = 110 \text{ psf}$

Calculate Brace Loads:Stair Loads:

$$LL = (100 \text{ psf}) (0.33 \text{ ft}) (1.67 \text{ ft}) (18 \text{ treads}) = 992 \text{ lb}$$

↖ Tread Width
↗ Tread Length

$$DL = (10 \text{ psf}) (0.33 \text{ ft}) (1.67 \text{ ft}) (18 \text{ treads}) = 100 \text{ lb}$$

[Load at Each Support]

$$LL = 992 \text{ lb} / 4 = 248 \text{ lb}$$

$$DL = 100 \text{ lb} / 4 = 25 \text{ lb}$$

Worst Case Brace → Lower Level

$$L = 4.75 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf}) (3 \text{ ft}) = 300 \text{ plf}$$

$$DL = (10 \text{ psf}) (3 \text{ ft}) = 30 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf}) (6.2 \text{ ft}) = 620 \text{ plf}$$

$$\begin{array}{l} \text{↙ @ } L = 2.1 \text{ ft} - \\ \quad \quad \quad 4.75 \text{ ft} \end{array} \quad DL = (10 \text{ psf}) (6.2 \text{ ft}) = 62 \text{ plf}$$

$$\text{Stair Load @ } L = 0.5 \text{ ft}, 2 \text{ ft}, 2.5 \text{ ft}, 4.5 \text{ ft}$$

Calculate Brace Loads: (continued)Worst Case Brace → Upper Level

$$L = 3.7 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(2.75 \text{ ft}) = 275 \text{ plf}$$

$$DL = (10 \text{ psf})(2.75 \text{ ft}) = 27.5 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf})(6.5 \text{ ft}) = 650 \text{ plf}$$

$$\downarrow \text{ @ } L = 2.25 \text{ ft} \quad DL = (10 \text{ psf})(6.5 \text{ ft}) = 65 \text{ plf}$$

$$\quad \quad \quad - 3.7 \text{ ft}$$

Stair Load @ $L = 0.5 \text{ ft}, 2 \text{ ft}$ Cantilevered Beam

$$\text{Load } P5 = (100 \text{ psf} + 10 \text{ psf})(5.4 \text{ ft}^2) = 594 \text{ lb}$$



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: LOWER LEVEL BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

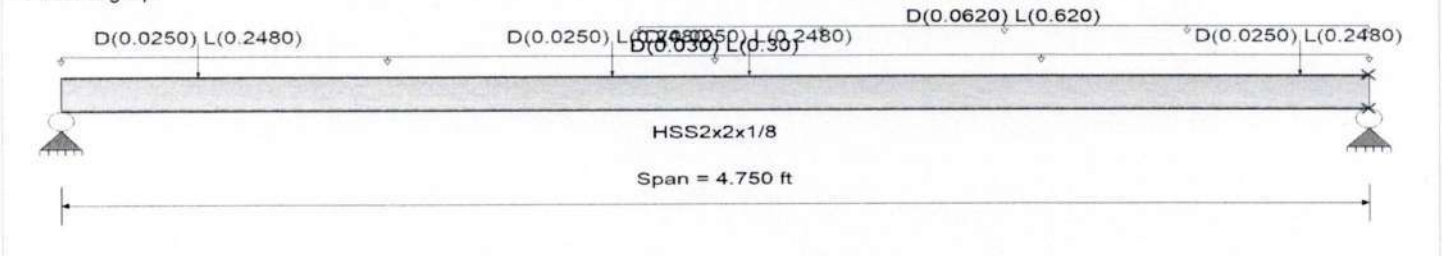
Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending

Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi

Vertical Leg Up



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.030, L = 0.30 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)

Uniform Load : D = 0.0620, L = 0.620 k/ft, Extent = 2.10 --> 4.750 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)

Point Load : D = 0.0250, L = 0.2480 k @ 0.50 ft, (STAIR LOAD)

Point Load : D = 0.0250, L = 0.2480 k @ 2.0 ft, (STAIR LOAD)

Point Load : D = 0.0250, L = 0.2480 k @ 2.50 ft, (STAIR LOAD)

Point Load : D = 0.0250, L = 0.2480 k @ 4.50 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	1.938 : 1	Maximum Shear Stress Ratio =	0.383 : 1
Section used for this span	HSS2x2x1/8	Section used for this span	HSS2x2x1/8
Ma : Applied	2.824 k-ft	Va : Applied	2.640 k
Mn / Omega : Allowable	1.457 k-ft	Vn/Omega : Allowable	6.885 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	4.750 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.704 in Ratio = 80	<240.0	Span: 1: L Only
Max Upward Transient Deflection	0 in Ratio = 0	<240.0	n/a
Max Downward Total Deflection	0.784 in Ratio = 73	<180	Span: 1: +D+L
Max Upward Total Deflection	0 in Ratio = 0	<180	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	4.75 ft	1	0.182	0.036	0.27		0.27	2.43	1.46	1.00	1.00	0.25	11.50	6.88
+D+L														
Dsgn. L =	4.75 ft	1	1.938	0.383	2.82		2.82	2.43	1.46	1.00	1.00	2.64	11.50	6.88
+D+0.750L														
Dsgn. L =	4.75 ft	1	1.499	0.297	2.18		2.18	2.43	1.46	1.00	1.00	2.04	11.50	6.88
+0.60D														
Dsgn. L =	4.75 ft	1	0.109	0.022	0.16		0.16	2.43	1.46	1.00	1.00	0.15	11.50	6.88



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: LOWER LEVEL BRACE DESIGN (LOADS ONLY)

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.7842	2.429		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.841	2.640
Max Upward from Load Combinations	1.841	2.640
Max Upward from Load Cases	1.667	2.393
D Only	0.174	0.247
+D+L	1.841	2.640
+D+0.750L	1.424	2.042
+0.60D	0.105	0.148
L Only	1.667	2.393

$P1 = 1841 \text{ lb}$
 $P2 = 2640 \text{ lb}$

} Specify on loading plans



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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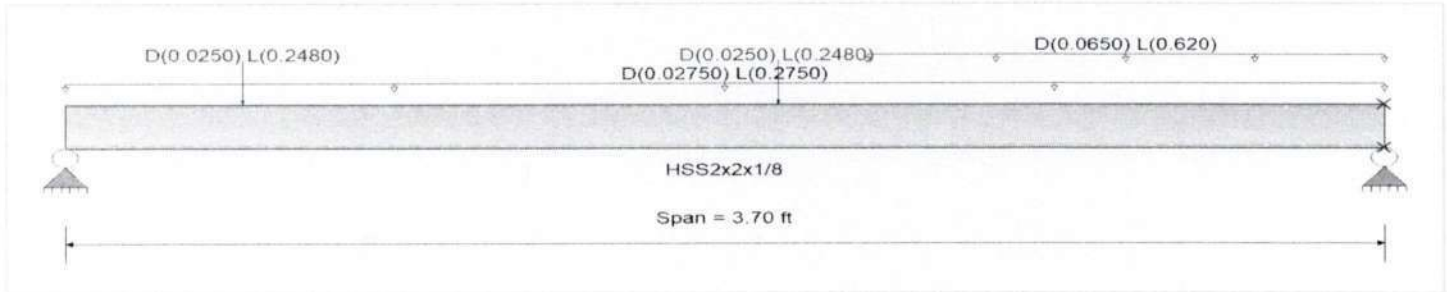
DESCRIPTION: UPPER LEVEL BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

- Beam self weight calculated and added to loading
Uniform Load : D = 0.02750, L = 0.2750 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)
- Uniform Load : D = 0.0650, L = 0.620 k/ft, Extent = 2.250 -->> 3.70 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)
- Point Load : D = 0.0250, L = 0.2480 k @ 0.50 ft, (STAIR LOAD)
- Point Load : D = 0.0250, L = 0.2480 k @ 2.0 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	0.839 : 1	Maximum Shear Stress Ratio =	0.225 : 1
Section used for this span	HSS2x2x1/8	Section used for this span	HSS2x2x1/8
Ma : Applied	1.222 k-ft	Va : Applied	1.548 k
Mn / Omega : Allowable	1.457 k-ft	Vn/Omega : Allowable	6.885 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	3.700 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.189 in Ratio = 234 <240.0	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <240.0	n/a	
Max Downward Total Deflection	0.209 in Ratio = 212 >=180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only	Dsgn. L = 3.70 ft	1	0.081	0.022	0.12		0.12	2.43	1.46	1.00	1.00	0.15	11.50	6.88
+D+L	Dsgn. L = 3.70 ft	1	0.839	0.225	1.22		1.22	2.43	1.46	1.00	1.00	1.55	11.50	6.88
+D+0.750L	Dsgn. L = 3.70 ft	1	0.649	0.174	0.95		0.95	2.43	1.46	1.00	1.00	1.20	11.50	6.88
+0.60D	Dsgn. L = 3.70 ft	1	0.048	0.013	0.07		0.07	2.43	1.46	1.00	1.00	0.09	11.50	6.88

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.2093	1.913		0.0000	0.000



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: DRYDEN

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: UPPER LEVEL BRACE DESIGN (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.121	1.548
Max Upward from Load Combinations	1.121	1.548
Max Upward from Load Cases	1.013	1.399
D Only	0.108	0.149
+D+L	1.121	1.548
+D+0.750L	0.868	1.199
+0.60D	0.065	0.090
L Only	1.013	1.399

$P_3 = 1121 \text{ lb}$

$P_4 = 1548 \text{ lb}$

} Specify on loading plans

Landing Support Braces: Both LevelsBrace Geometry:

$$H = 2.5 \text{ ft}$$

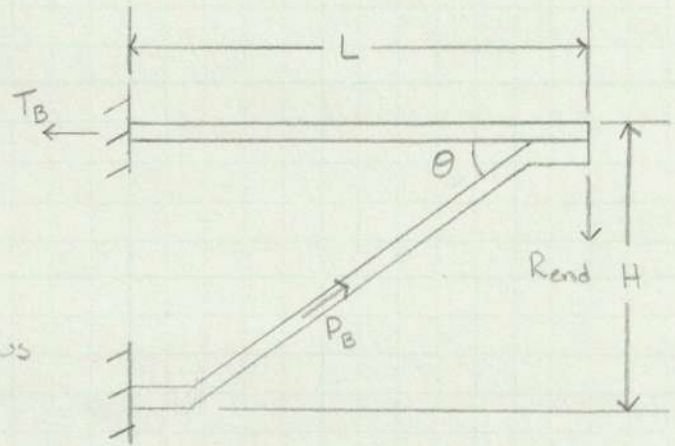
$$L = 4.75 \text{ ft}$$

$$\theta = \tan^{-1}(H/L) = 27.75^\circ$$

$$\left. \begin{aligned} R_{end} &= 1841 \text{ lb} \\ M_{max} &= 2820 \text{ lb}\cdot\text{ft} \end{aligned} \right\} \text{ See Previous Pages}$$

$$P_B = \frac{R_{end}}{\sin(\theta)} = 3954 \text{ lb}$$

$$T_B = P_B \cos \theta = 3500 \text{ lb}$$

Brace Section Properties: (1 1/4" Solid Square Bar)

$$Z_x = \frac{bd^3}{4} = 0.488 \text{ in}^3$$

$$Z_y = Z_x = 0.488 \text{ in}^3$$

$$\text{Area} = 1.5625 \text{ in}^2$$

$$F_y = 36 \text{ ksi}$$

Brace Checks:

$$\frac{M_n}{\Omega} = \frac{F_y Z}{1.67} = \frac{(36 \text{ ksi})(0.488 \text{ in}^3)}{1.67} = 10520 \text{ lb}\cdot\text{in} = 876 \text{ lb}\cdot\text{ft} < 2820 \text{ lb}\cdot\text{ft}$$

$$\frac{T_n}{\Omega} = \frac{F_y A}{1.67} = \frac{(36 \text{ ksi})(1.5625 \text{ in}^2)}{1.67} = 48.5 \text{ k}$$

\therefore NO GOOD

$$\text{Tension Ratio} = \frac{T_B}{T_n/\Omega} = \frac{3500 \text{ lb}}{48500 \text{ lb}} = 0.072 < 0.2 \quad \therefore \text{Use AISC Eqn H1-1b}$$

$$\text{Combined Ratio} = \frac{T_B}{2(T_n/\Omega)} + \frac{M_B}{M_n/\Omega} = 3.3 > 1 \quad \therefore \text{NO GOOD}$$

\therefore Brace is required to be tested

Framing ChecksDecking Bars

$$L = 3.4 \text{ ft} \quad \text{Load} = (110 \text{ psf})(0.25 \text{ ft}) = 27.5 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(27.5 \text{ plf})(3.4 \text{ ft})^2}{8} = 39.7 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{\Omega} = \frac{F_y Z}{\Omega}$$

$$Z = \frac{bd^2}{4} = \frac{(1.5 \text{ in})(0.25 \text{ in})^2}{4} = 0.0234 \text{ in}^3$$

$$\frac{M_n}{\Omega} = \frac{(36000 \text{ psi})(0.0234 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 42.1 \text{ lb}\cdot\text{ft} > 39.7 \text{ lb}\cdot\text{ft} \quad \therefore \text{OK}$$

Landing Bars (Worst Case)

$$L = 2.33 \text{ ft} \quad \begin{aligned} LL &= (100 \text{ psf})(3 \text{ ft}) = 300 \text{ plf} \\ DL &= (10 \text{ psf})(3 \text{ ft}) = 30 \text{ plf} \end{aligned}$$

Center Landing Bar

$$L = 5.5 \text{ ft} \quad \begin{aligned} LL &= (100 \text{ psf})(2.375 \text{ ft}) = 237.5 \text{ plf} \\ DL &= (10 \text{ psf})(2.375 \text{ ft}) = 23.75 \text{ plf} \end{aligned}$$

See Calc
on Next
Pages



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

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DESCRIPTION: LANDING BARS

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16

Load Combination Set : ASCE 7-16

Material Properties

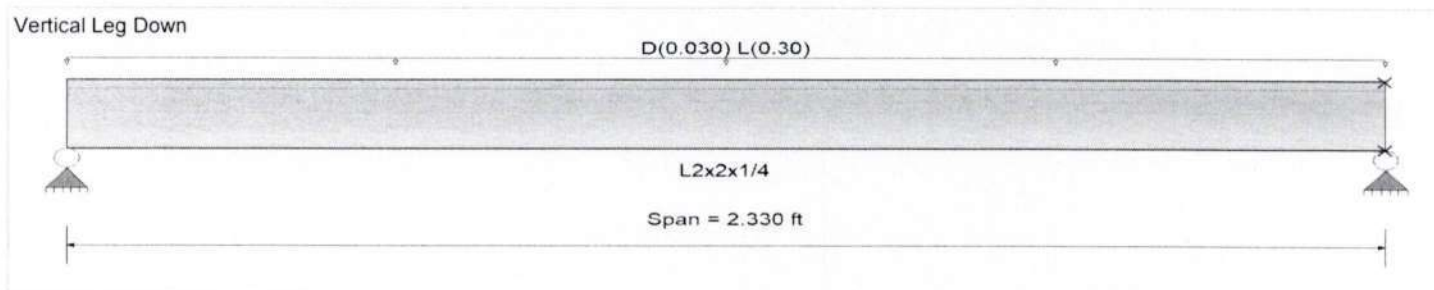
Analysis Method: Allowable Strength Design

Fy : Steel Yield : 50.0 ksi

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

E: Modulus : 29,000.0 ksi

Bending Axis : Major Axis Bending



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.030, L = 0.30 k/ft, Tributary Width = 1.0 ft, (LOADING)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.247 : 1	Maximum Shear Stress Ratio =	0.043 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.226 k-ft	Va : Applied	0.3882 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	2.330 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.020 in Ratio = 1,403 >=360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.022 in Ratio = 1264 >=180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	2.33 ft	1	0.025	0.004	0.02		0.02	1.53	0.92	1.00	1.00	0.04	15.00	8.98
+D+L														
Dsgn. L =	2.33 ft	1	0.247	0.043	0.23		0.23	1.53	0.92	1.00	1.00	0.39	15.00	8.98
+D+0.750L														
Dsgn. L =	2.33 ft	1	0.191	0.033	0.18		0.18	1.53	0.92	1.00	1.00	0.30	15.00	8.98
+0.60D														
Dsgn. L =	2.33 ft	1	0.015	0.003	0.01		0.01	1.53	0.92	1.00	1.00	0.02	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.0221	1.172		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.388	0.388
Max Upward from Load Combinations	0.388	0.388
Max Upward from Load Cases	0.350	0.350
D Only	0.039	0.039
+D+L	0.388	0.388
+D+0.750L	0.301	0.301
+0.60D	0.023	0.023



Stability Engineering, Inc.
 777 NE 2nd St. Suite 280
 Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
 Engineer: M. FOSTER
 Project ID: 22-0669
 Project Descr: DRYDEN

Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

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DESCRIPTION: LANDING BARS

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.350	0.350



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

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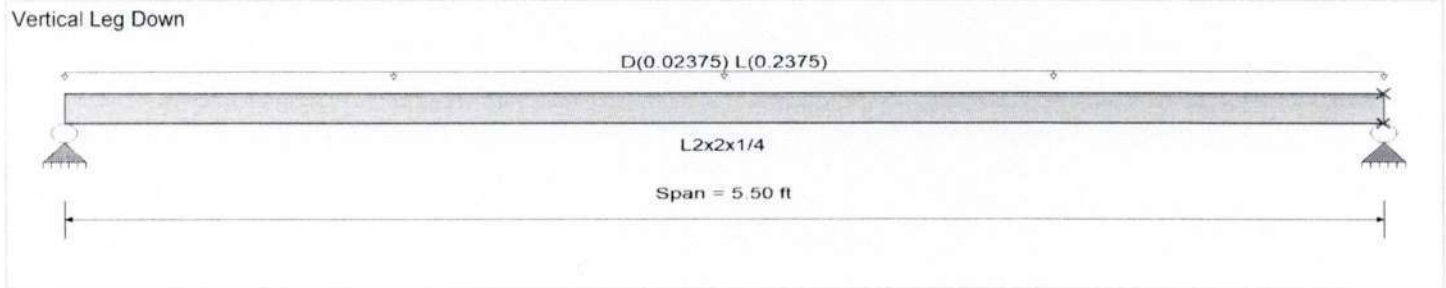
DESCRIPTION: CENTER LANDING BAR

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : ASCE 7-16

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.02375, L = 0.2375 k/ft, Tributary Width = 1.0 ft, (LOADING)

∴ Load Testing Req'd

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	1.092 : 1	Maximum Shear Stress Ratio =	0.081 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	1.000 k-ft	Va : Applied	0.7272 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Location of maximum on span	0.000 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 Transient Deflection	0.489 in Ratio = 134 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.545 in Ratio = 121 <180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L = 5.50 ft	5.50 ft	1	0.111	0.008	0.10		0.10	1.53	0.92	1.00	1.00	0.07	15.00	8.98	
+D+L															
Dsgn. L = 5.50 ft	5.50 ft	1	1.092	0.081	1.00		1.00	1.53	0.92	1.00	1.00	0.73	15.00	8.98	
+D+0.750L															
Dsgn. L = 5.50 ft	5.50 ft	1	0.847	0.063	0.78		0.78	1.53	0.92	1.00	1.00	0.56	15.00	8.98	
+0.60D															
Dsgn. L = 5.50 ft	5.50 ft	1	0.067	0.005	0.06		0.06	1.53	0.92	1.00	1.00	0.04	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.5451	2.766		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.727	0.727
Max Upward from Load Combinations	0.727	0.727
Max Upward from Load Cases	0.653	0.653
D Only	0.074	0.074
+D+L	0.727	0.727
+D+0.750L	0.564	0.564
+0.60D	0.044	0.044



Stability Engineering, Inc.
 777 NE 2nd St. Suite 280
 Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
 Engineer: M. FOSTER
 Project ID: 22-0669
 Project Descr: DRYDEN

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: CENTER LANDING BAR

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.653	0.653

Stair Framing:Stair Dimensions

$$H = 16.5 \text{ ft}$$

$$D = 9 \text{ ft}$$

$$L = 18.8 \text{ ft}$$

$$W = 1.67 \text{ ft}$$

Stair Stringer Loads

Point Load = 290 lb @ Every
Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

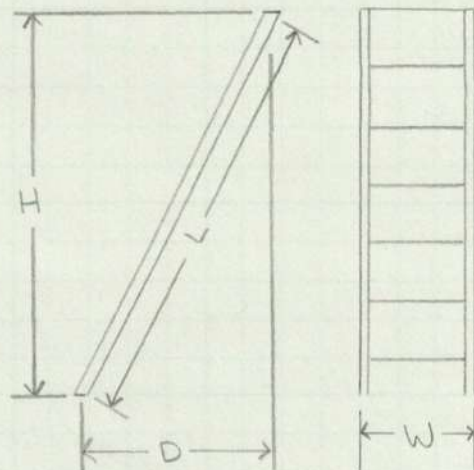
$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$

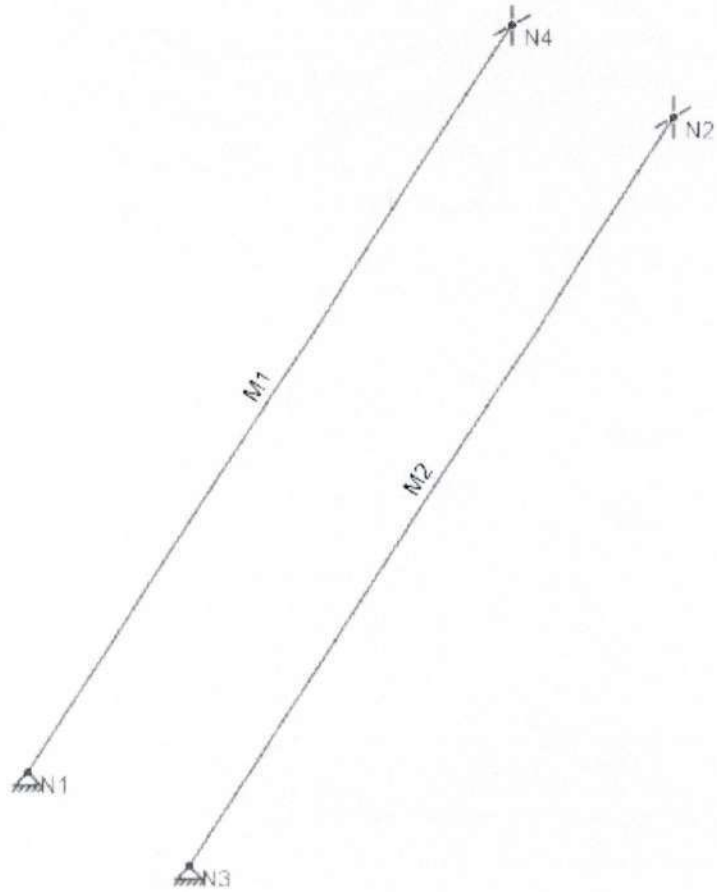
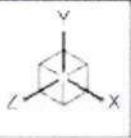
Stair Tread Loads

Point Load = 300 lb @ Center

$$LL = (100 \text{ psf}) (4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 33 \text{ plf}$$

$$DL = (10 \text{ psf}) (4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 3 \text{ plf}$$



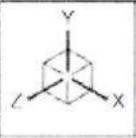



Stability Engineering, Inc.
M. Foster
22-0669 Dryden

Stair Stringers

MEMBER LABELS 1

22-0669 Dryden Stringers.r3d



	Stability Engineering, Inc.	Stair Stringers	MEMBER RENDERING 2
	M. Foster		22-0669 Dryden Stringers.r3d
	22-0669 Dryden		



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Dryden
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	12	16.5	0	
3	N3	3	0	0	
4	N4	9	16.5	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	10	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Dryden
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.145	1.7
2	M2	Y	-0.145	3.4
3	M2	Y	-0.145	5.1
4	M2	Y	-0.145	6.8
5	M2	Y	-0.145	8.5
6	M2	Y	-0.145	10.2
7	M2	Y	-0.145	11.9
8	M2	Y	-0.145	13.6
9	M2	Y	-0.145	15.3
10	M2	Y	-0.145	17

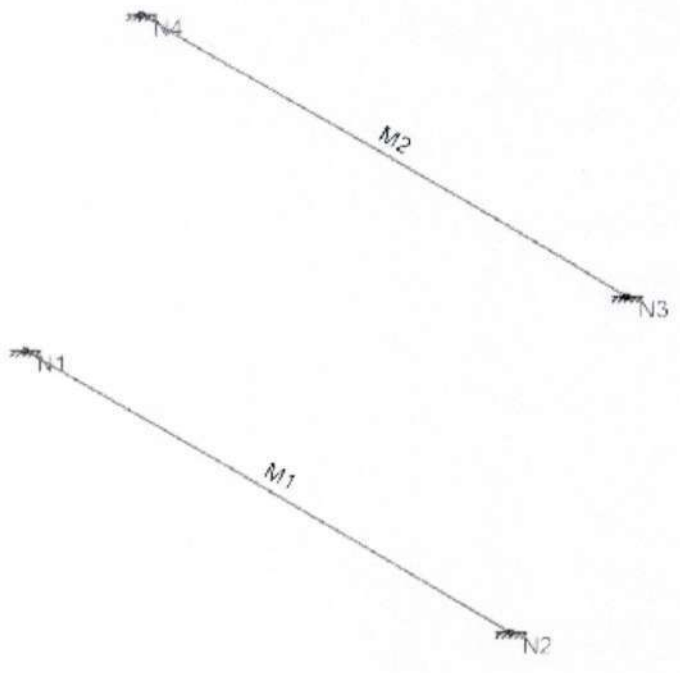
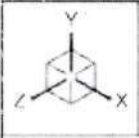
Envelope Node Reactions


Node Label		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0	N1	max	0	4	0.858	5	0	5	LOCKED	LOCKED		0	5
1		min	0	3	0.078	1	0	1	LOCKED	LOCKED		0	1
2	N3	max	0	2	0.807	5	0	5	LOCKED	LOCKED		0	5
3		min	0	1	0.078	1	0	1	LOCKED	LOCKED		0	1
4	N2	max	0	4	0.799	5	0	5	0	5	0	5	5
5		min	0	2	0.078	1	0	1	0	1	0	1	1
6	N4	max	0	4	0.858	5	0	5	0	5	0	5	5
7		min	0	3	0.078	1	0	1	0	1	0	1	1
8	Totals:	max	0	4	3.322	5	0	5					
9		min	0	3	0.312	1	0	1					

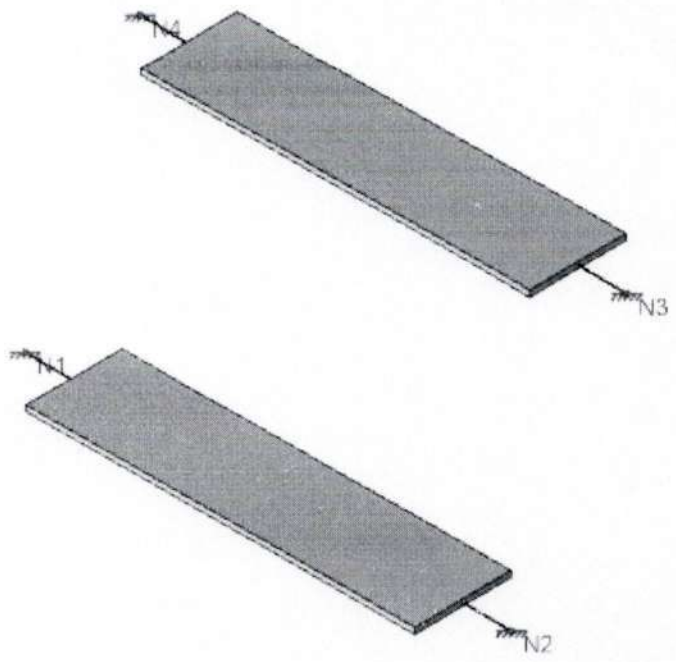
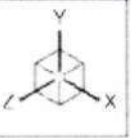
Envelope AISC 15TH (360-16): ASD Member Steel Code Checks


Member	Shape	Code Check	Loc[ft]	LC	Shear	Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	PL4X1/4	0.955	9.006	5	0.034	18.795	y	5	3.94	29.94	0.156	2.027	1	H1-1b
1	M2	PL4X1/4	0.981	8.419	5	0.032	0	y	5	3.94	29.94	0.156	2.027	1	H1-1b

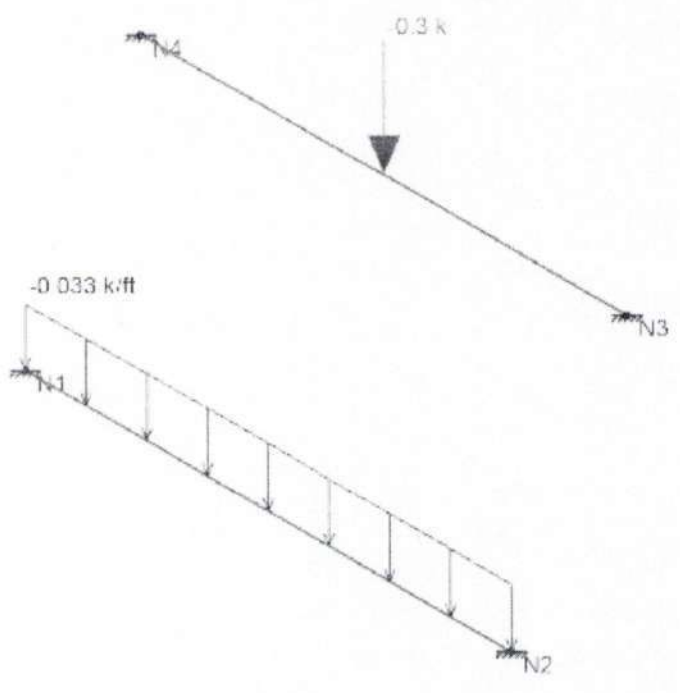
< 1 ∴ OK




	Stability Engineering, Inc.	Stair Treads	MEMBER LABELS 1
	M. Foster		22-0669 Dryden Treads.r3d
	22-0669 Dryden		



	Stability Engineering, Inc.	Stair Treads	MEMBER RENDERING 2
	M. Foster		22-0669 Dryden Treads.r3d
	22-0669 Dryden		



Loads: BLC 2, LIVE

	Stability Engineering, Inc.	Stair Treads	LIVE LOADS 3
	M. Foster		22-0669 Dryden Treads.r3d
	22-0669 Dryden		



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Dryden
 Model Name : Stair Treads

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	1.67	0	0	
3	N3	1.67	0.8	-0.4	
4	N4	0	0.8	-0.4	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁻⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	TREAD	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	1	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M2	Y	-0.003	-0.003	0	%100
2	M1	Y	-0.003	-0.003	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.033	-0.033	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Dryden
 Model Name : Stair Treads

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.3	%50

Envelope Node Reactions

Node Label		X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC	
0	N1	max	0	5	0.03	5	0	5	0	5	0	5	0.008	5
1		min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
2	N2	max	0	5	0.03	5	0	5	0	5	0	5	-0.001	4
3		min	0	1	0.003	1	0	1	0	1	0	1	-0.008	3
4	N4	max	0	5	0.153	5	0	5	0	5	0	5	0.063	5
5		min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
6	N3	max	0	5	0.153	5	0	5	0	5	0	5	-0.001	4
7		min	0	1	0.003	1	0	1	0	1	0	1	-0.063	3
8	Totals:	max	0	5	0.365	5	0	5						
9		min	0	1	0.01	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	PL4X1/4	0.054	1.67	5	0.002	1.67	z	5	1.949	29.94	0.156	1.429	1 H1-1b
1	M2	PL4X1/4	0.406	1.67	5	0.008	1.67	z	5	1.949	29.94	0.156	1.429	1 H1-1b

< 1 ∴ OK



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Dryden
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.3	%50
2	M2	Y	-0.3	%15
3	M2	Y	-0.3	%85

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	5	0.858	5	0	5	0	5	LOCKED		0	5
1 N1 min	0	2	0.078	1	0	1	0	1	LOCKED		0	1
2 N3 max	0	4	0.528	5	0	5	0	5	LOCKED		0	5
3 N3 min	0	2	0.078	1	0	1	0	1	LOCKED		0	1
4 N2 max	0	5	0.528	5	0	5	0	5	0	5	0	5
5 N2 min	0	1	0.078	1	0	1	0	1	0	1	0	1
6 N4 max	0	5	0.858	5	0	5	0	5	0	5	0	5
7 N4 min	0	1	0.078	1	0	1	0	1	0	1	0	1
8 Totals: max	0	4	2.772	5	0	5						
9 Totals: min	0	2	0.312	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	0.963	9.006	5	0.034	18.795	y	5	3.94	29.94	0.156	2.009	1	H1-1b
1	M2	0.642	9.397	5	0.021	18.795	y	5	3.94	29.94	0.156	2.009	1	H1-1b

< 1 .: OK

Load Testing Summary:

[BRACE LOADS]

$$P_1 = 1841 \text{ lb}$$

$$P_3 = 1121 \text{ lb}$$

$$P_2 = 2640 \text{ lb}$$

$$P_4 = 1548 \text{ lb}$$

[CENTER LANDING BAR]

$$M_{\max} = \frac{PL}{4}$$

$$1000 \text{ lb}\cdot\text{ft} = \frac{P(5.5 \text{ ft})}{4}$$

$$P = 728 \text{ lb}$$

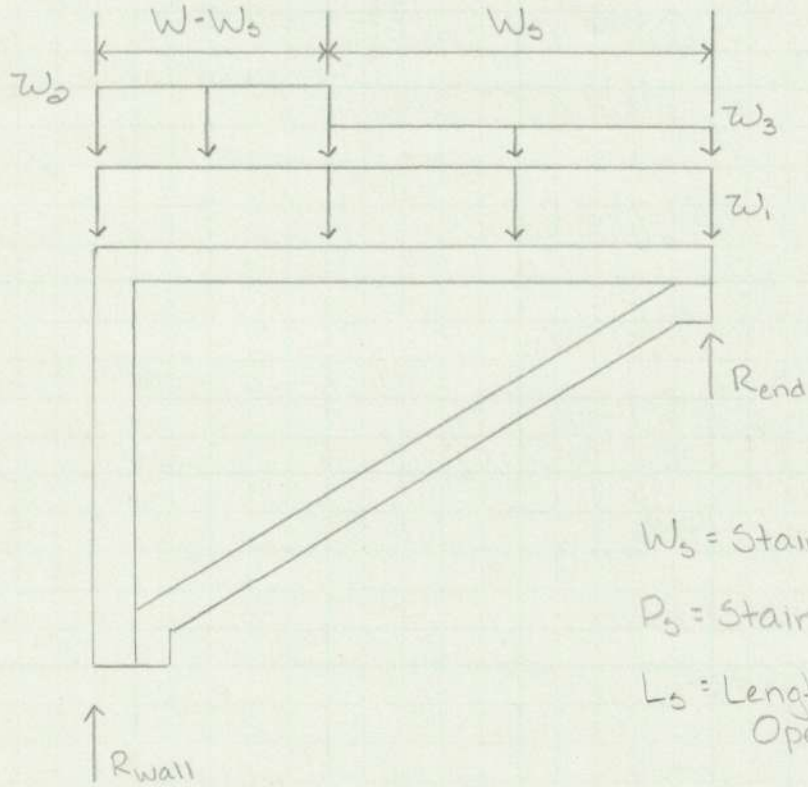
Fire Escape Load Testing Analysis:

Scope of Work: Calculations for load testing requirements for
fire escape located at Houland Hall

Building Code: ~~2002~~ OS5C

Design Loads: $LL = 100 \text{ psf}$
 $DL = 10 \text{ psf}$ } Total Load = 110 psf

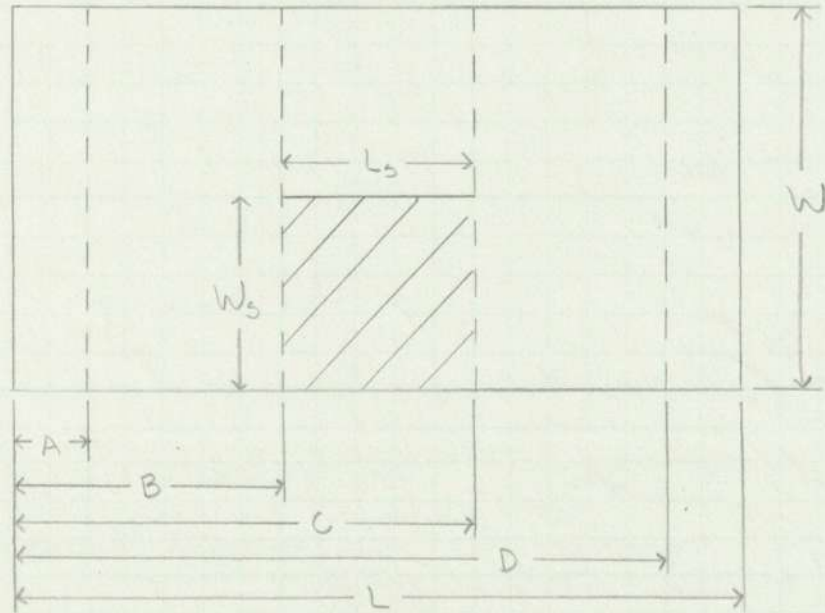
BRACE LOADS WITH STAIRS



W_s = Stair Width

P_s = Stair Point Load

L_s = Length of Stairwell Opening



BRACE LOADS WITH STAIRS (cont.)

* Use the Laws of Superposition *

$$R_{1\text{ wall}} = R_{1\text{ end}} = \frac{w_1 L}{2} \quad \text{AISC Table 3-23, 1}$$

$$R_{2\text{ wall}} = \frac{w_2 (W - W_5)}{2W} (2W - (W - W_5))$$

$$R_{2\text{ end}} = \frac{w_2 (W - W_5)^2}{2W}$$

$$R_{3\text{ wall}} = \frac{w_3 (W_5)^2}{2W}$$

$$R_{3\text{ end}} = \frac{w_3 (W_5)}{2W} (2W - W_5)$$

See AISC Table 3-23, 5

$$R_{\text{wall}} = R_{1\text{ wall}} + R_{2\text{ wall}} + R_{3\text{ wall}} + P_5 \left(\frac{W_5}{W} \right)$$

AISC Table 3-23, 8

$$= \left(\frac{w_1 L}{2} \right) + \left(\frac{w_2 (W - W_5)}{2W} (2W - (W - W_5)) \right) + \left(\frac{w_3 (W_5)^2}{2W} \right) + P_5 \left(\frac{W_5}{W} \right)$$

$$R_{\text{end}} = R_{1\text{ end}} + R_{2\text{ end}} + R_{3\text{ end}} + P_5 \left(\frac{W - W_5}{W} \right)$$

$$= \left(\frac{w_1 L}{2} \right) + \left(\frac{w_2 (W - W_5)^2}{2W} \right) + \left(\frac{w_3 (W_5)}{2W} (2W - W_5) \right) + P_5 \left(\frac{W - W_5}{W} \right)$$

$$M_{1\text{ max}} = \frac{w_1 W^2}{8}$$

$$M_{2/3\text{ max}} = \frac{(w_2 + w_3) W^2}{8}$$

AISC Table 3-23, 8

$$M_{\text{max}} = M_{1\text{ max}} + M_{2/3\text{ max}} + \frac{P_5 (W_5) (W - W_5)}{W}$$

$$M_{\text{max}} = \frac{w_1 W^2}{8} + \frac{(w_2 + w_3) W^2}{8} + \frac{P_5 (W_5) (W - W_5)}{W}$$

$$= \frac{(w_1 + (w_2 + w_3)) W^2}{8} + \frac{P_5 (W_5) (W - W_5)}{W}$$

BRACE LOADS WITHOUT STAIRS

* w_3 , w_5 & L_5 become irrelevant, simplifying reactions and moments

$$R_{\text{wall}} = \frac{(w_1 + w_2)W}{2}$$

$$R_{\text{end}} = \frac{(w_1 + w_2)W}{2}$$

$$M_{\text{max}} = \frac{(w_1 + w_2)W^2}{8}$$

8/15/2023

Project: 22-0669 OSU Fire Escapes - Hovland Hall



By: Max Beaudoin

FIRE ESCAPE - LEVEL 1 LANDING

LANDING SUPPORTS

No. of Supports =	4	supports
A =	0	ft
B =	8	ft
C =	15.6	ft
D =	21.9	ft
L =	21.9	ft
W =	3.55	ft

No. of Treads =	23	treads
Tread Depth =	0.33	ft
P _s =	349	lb
L _s =	5.5	ft
W _s =	1.67	ft
W - W _s =	1.88	ft

Live Load =	100	psf
Dead Load =	10	psf
TL =	110	psf

SUPPORT A

Stair Load?	N
w ₁ =	0 plf
w ₂ =	440 plf
R _{wall} =	781 lb
R _{end} =	781 lb
M _{max} =	693 lb-ft

= A*TL
 = (B-A)/2*TL
 See Derivations
 See Derivations
 See Derivations

SUPPORT B

Stair Load?	Y
w ₁ =	440 plf
w ₂ =	418 plf
w ₃ =	116 plf
R _{wall} =	1568 lb
R _{end} =	2056 lb
M _{max} =	1422 lb-ft

= (B-A)/2*TL
 = (C-B)/2*TL
 = (C-B-L_s)/2*TL
 See Derivations
 See Derivations
 See Derivations

SUPPORT C

Stair Load?	N
w ₁ =	347 plf
w ₂ =	418 plf
w ₃ =	N/A plf
R _{wall} =	1357 lb
R _{end} =	1357 lb
M _{max} =	1204 lb-ft

= (D-C)/2*TL
 = (C-B)/2*TL
 = (C-B-L_s)/2*TL
 See Derivations
 See Derivations
 See Derivations

SUPPORT D

Stair Load?	N
w ₁ =	347 plf
w ₂ =	0 plf
R _{wall} =	615 lb
R _{end} =	615 lb
M _{max} =	546 lb-ft

= (D-C)/2*TL
 = (L-D)*TL
 See Derivations
 See Derivations
 See Derivations

SUMMARY

Support	Wall Reaction (lb)	End Reaction (lb)	Moment (lb-ft)
A	781	781	693
B	1568	2056	1422
C	1357	1357	1204
D	615	615	546

TEST LOADS

Wall Test Load =	P1 = 1568 lb @ B
End Test Load =	P2 = 2056 lb @ B

Specify on loading plans

Landing Support Braces:Brace Geometry:

$$H = 2.5 \text{ ft}$$

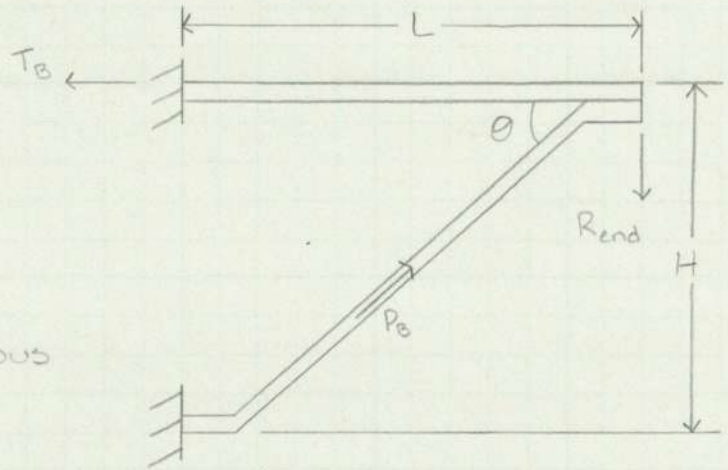
$$L = 3.5 \text{ ft}$$

$$\theta = \tan^{-1}(H/L) = 35.5^\circ$$

$$\left. \begin{array}{l} R_{\text{end}} = 2056 \text{ lb} \\ M_{\text{max}} = 1422 \text{ lb}\cdot\text{ft} \end{array} \right\} \text{ See Previous Page}$$

$$P_B = \frac{R_{\text{end}}}{\sin \theta} = 3540 \text{ lb}$$

$$T_B = P_B \cos \theta = 2882 \text{ lb}$$

Brace Section Properties: (1 1/2" Solid Square Bar)

$$Z_x = Z_y = \frac{bd^3}{4} = 0.844 \text{ in}^3$$

$$\text{Area} = bd = 2.25 \text{ in}^2$$

$$F_y = 36 \text{ ksi}$$

Brace Checks:

$$\frac{M_n}{\Omega} = \frac{F_y Z}{1.67} = \frac{(36 \text{ ksi})(0.844 \text{ in}^3)}{1.67} = 18194 \text{ lb}\cdot\text{in} = 1516 \text{ lb}\cdot\text{ft}$$

$$\frac{T_n}{\Omega} = \frac{F_y A}{1.67} = \frac{(36 \text{ ksi})(2.25 \text{ in}^2)}{1.67} = 48502 \text{ lb}$$

$$\text{Tension Ratio} = \frac{T_B}{T_n/\Omega} = \frac{2882 \text{ lb}}{48502 \text{ lb}} = 0.06 < 0.2 \quad \therefore \text{Use AISC Egn H1-1b}$$

$$\text{Combined Ratio} = \frac{T_B}{2(T_n/\Omega)} + \frac{M_B}{M_n/\Omega} = 0.97 < 1 \quad \therefore \text{OK}$$

\therefore Load Tests for Connections Only

Framing ChecksDecking Bars

$$L = 3.33 \text{ ft}$$

$$\text{Load} = (110 \text{ psf})(0.25 \text{ ft}) = 27.5 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(27.5 \text{ plf})(3.33 \text{ ft})^2}{8} = 38.12 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{\Omega} = \frac{F_y Z}{\Omega}$$

$$Z = \frac{bd^2}{4} = \frac{(1.5 \text{ in})(0.25 \text{ in})^2}{4} = 0.0234 \text{ in}^3$$

$$\frac{M_n}{\Omega} = \frac{(36000 \text{ psi})(0.0234 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 42.1 \text{ lb}\cdot\text{ft} > 38.12 \text{ lb}\cdot\text{ft} \quad \therefore \text{OK}$$

Landing Bars

$$L = 3.5 \text{ ft}$$

$$\text{Load} = (110 \text{ psf})(3.5 \text{ ft}) = 385 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(385 \text{ plf})(3.5 \text{ ft})^2}{8} = 590 \text{ lb}\cdot\text{ft}$$

$$Z = \frac{bd^2}{4} = \frac{(2 \text{ in})(0.25 \text{ in})^2}{4} = 0.03125 \text{ in}^3$$

$$\frac{M_n}{\Omega} = \frac{(36000 \text{ psi})(0.03125 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 56.1 \text{ lb}\cdot\text{ft} < 590 \text{ lb}\cdot\text{ft}$$

\therefore Load Testing
Req'd

Edge Angle Checks: $(L \times 2 \times \frac{1}{4})$

$$L = 7.6 \text{ ft} \quad (1)$$

$$LL = (100 \text{ psf})(1.67 \text{ ft})(0.33 \text{ ft})(23 \text{ treads})/2 = 634 \text{ lb}$$

↙ Tread Width
↖ Stair Width

$$DL = (10 \text{ psf})(1.67 \text{ ft})(0.33 \text{ ft})(23 \text{ treads})/2 = 64 \text{ lb}$$

$$L = 8 \text{ ft} \quad (2)$$

$$LL = (100 \text{ psf})(1.75 \text{ ft}) = 175 \text{ plf}$$

$$DL = (10 \text{ psf})(1.75 \text{ ft}) = 17.5 \text{ plf}$$

* See calculations on next pages



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: EDGE ANGLE 1

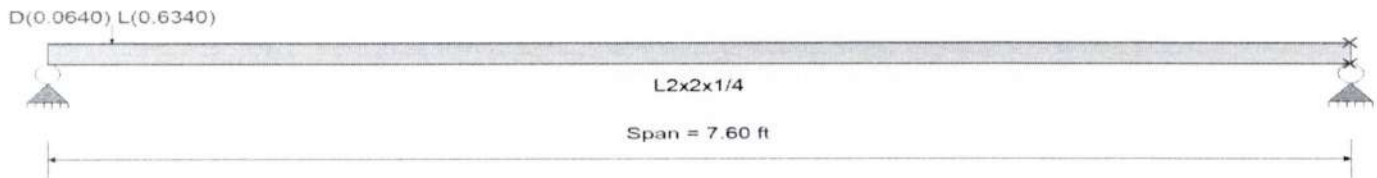
CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E: Modulus : 29,000.0 ksi

Vertical Leg Up



Applied Loads

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

Beam self weight calculated and added to loading
Load(s) for Span Number 1
Point Load : D = 0.0640, L = 0.6340 k @ 0.380 ft, (STAIRS)

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.280 : 1	Maximum Shear Stress Ratio =	0.075 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.256 k-ft	Va : Applied	0.6752 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.154 in Ratio = 591	>=360	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio = 0	<360	n/a
Max Downward Total Deflection	0.193 in Ratio = 472	>=180	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio = 0	<180	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L =	7.58 ft	1	0.040	0.008	0.04		0.04	1.53	0.92	1.00	1.00	0.07	15.00	8.98	
Dsgn. L =	0.02 ft	1	0.000	0.002	0.00		0.00	1.53	0.92	1.00	1.00	0.02	15.00	8.98	
+D+L															
Dsgn. L =	7.58 ft	1	0.280	0.075	0.26		0.26	1.53	0.92	1.00	1.00	0.68	15.00	8.98	
Dsgn. L =	0.02 ft	1	0.001	0.005	0.00		0.00	1.53	0.92	1.00	1.00	0.05	15.00	8.98	
+D+0.750L															
Dsgn. L =	7.58 ft	1	0.217	0.058	0.20		0.20	1.53	0.92	1.00	1.00	0.52	15.00	8.98	
Dsgn. L =	0.02 ft	1	0.001	0.004	0.00		0.00	1.53	0.92	1.00	1.00	0.04	15.00	8.98	
+0.60D															
Dsgn. L =	7.58 ft	1	0.024	0.005	0.02		0.02	1.53	0.92	1.00	1.00	0.04	15.00	8.98	
Dsgn. L =	0.02 ft	1	0.000	0.001	0.00		0.00	1.53	0.92	1.00	1.00	0.01	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1932	3.301		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.675	0.047
Max Upward from Load Combinations	0.675	0.047



Stability Engineering, Inc.
 777 NE 2nd St. Suite 280
 Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
 Engineer: M. FOSTER
 Project ID: 22-0669
 Project Descr:

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

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DESCRIPTION: EDGE ANGLE 1

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from Load Cases	0.602	0.032
D Only	0.073	0.015
+D+L	0.675	0.047
+D+0.750L	0.525	0.039
+0.60D	0.044	0.009
L Only	0.602	0.032



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

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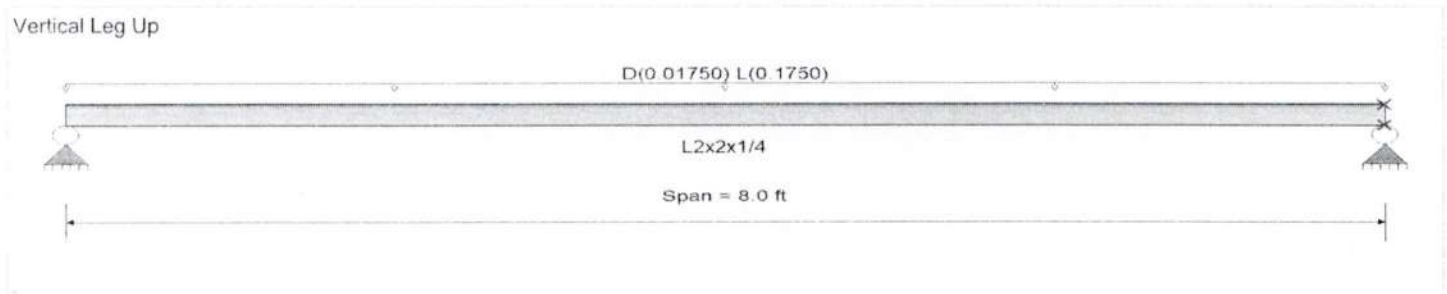
DESCRIPTION: EDGE ANGLE 2

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E: Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.01750, L = 0.1750 k/ft, Tributary Width = 1.0 ft, (LOADING)

∴ Load Tests Req'd

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	1.709 : 1	Maximum Shear Stress Ratio =	0.087 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	1.566 k-ft	Va : Applied	0.7828 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	1.601 in Ratio = 59 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	1.806 in Ratio = 53 <180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values					Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	8.00 ft	1	0.181	0.009	0.17		0.17	1.53	0.92	1.00	1.00	0.08	15.00	8.98
+D+L														
Dsgn. L =	8.00 ft	1	1.709	0.087	1.57		1.57	1.53	0.92	1.00	1.00	0.78	15.00	8.98
+D+0.750L														
Dsgn. L =	8.00 ft	1	1.327	0.068	1.22		1.22	1.53	0.92	1.00	1.00	0.61	15.00	8.98
+0.60D														
Dsgn. L =	8.00 ft	1	0.108	0.006	0.10		0.10	1.53	0.92	1.00	1.00	0.05	15.00	8.98

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	1.8056	4.023		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.783	0.783
Max Upward from Load Combinations	0.783	0.783
Max Upward from Load Cases	0.700	0.700
D Only	0.083	0.083
+D+L	0.783	0.783
+D+0.750L	0.608	0.608
+0.60D	0.050	0.050



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr:

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.07.20

Stability Engineering Inc.

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DESCRIPTION: EDGE ANGLE 2

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.700	0.700

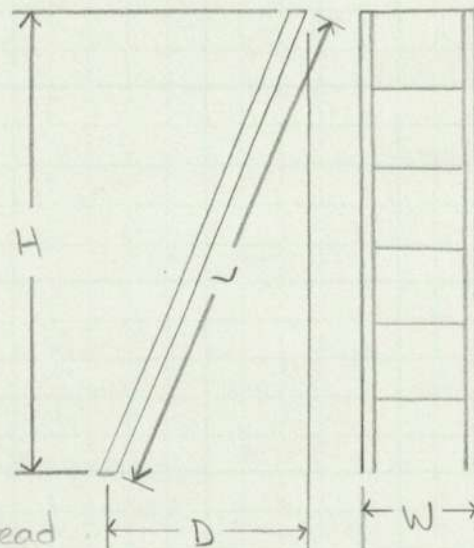
Stair Framing:Stair Dimensions:

$$H = 18.5 \text{ ft}$$

$$D = 8.7 \text{ ft}$$

$$L = 20.44 \text{ ft}$$

$$W = 1.67 \text{ ft}$$

Stair Stringer Loads:

Point Load = 290 lb @ Every Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$

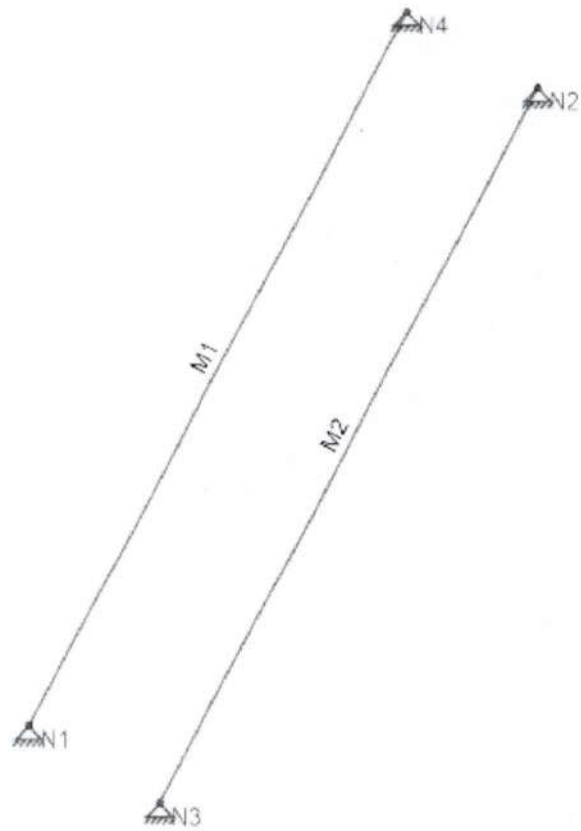
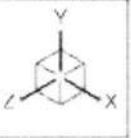
Stair Tread Loads:

Point Load = 300 lb @ Center of Tread

$$LL = (100 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 33 \text{ plf}$$

$$DL = (10 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 3 \text{ plf}$$

} @ Each Tread

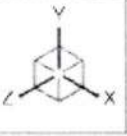


Stability Engineering, Inc.
M. Foster
22-0669 Hovland

Stair Stringers

MEMBER LABELS 1

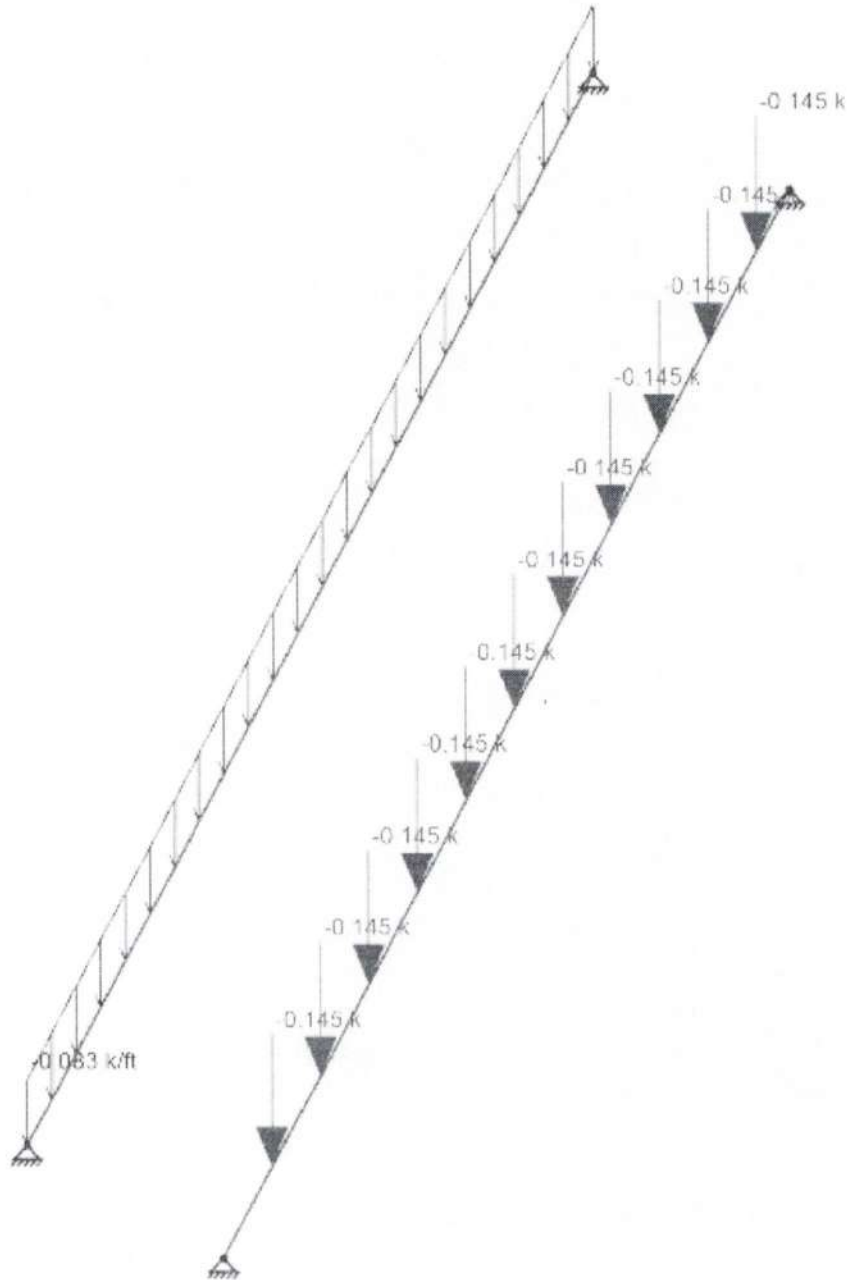
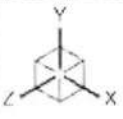
22-0669 Hovland Stringers.r3d



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Stair Stringers

MEMBER RENDERING 2
22-0669 Hovland Stringers.r3d



Loads: BLC 2, LIVE



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Stair Stringers

LIVE LOADS 3

22-0669 Hovland Stringers.r3d



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Hovland
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	11.7	18.5	0	
3	N3	3	0	0	
4	N4	8.7	18.5	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	11	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Hovland
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.145	1.75
2	M2	Y	-0.145	3.5
3	M2	Y	-0.145	5.25
4	M2	Y	-0.145	7
5	M2	Y	-0.145	8.75
6	M2	Y	-0.145	10.5
7	M2	Y	-0.145	12.25
8	M2	Y	-0.145	14
9	M2	Y	-0.145	15.75
10	M2	Y	-0.145	17.5
11	M2	Y	-0.145	19.25

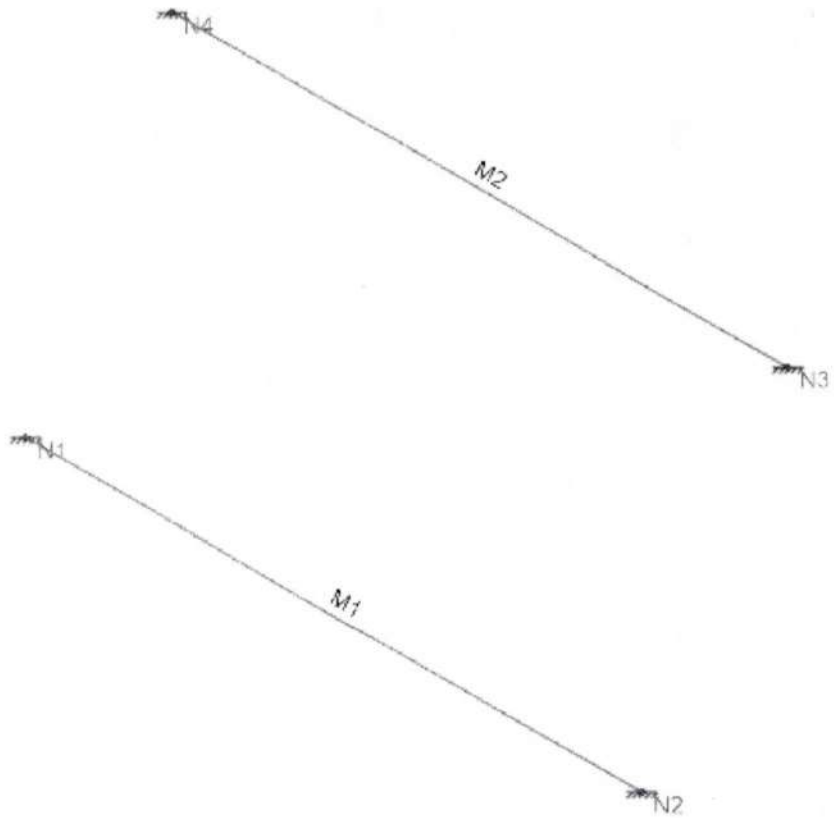
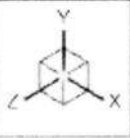
Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1	max	0	4	0.933	5	0	5	0	5	LOCKED	0	5
1	min	0	3	0.085	1	0	1	0	1	LOCKED	0	1
2 N3	max	0	2	0.861	5	0	5	0	5	LOCKED	0	5
3	min	0	1	0.085	1	0	1	0	1	LOCKED	0	1
4 N2	max	0	5	0.904	5	0	5	0	5	0	5	5
5	min	0	1	0.085	1	0	1	0	1	0	1	1
6 N4	max	0	4	0.933	5	0	5	0	5	0	5	5
7	min	0	3	0.085	1	0	1	0	1	0	1	1
8 Totals:	max	0	5	3.631	5	0	5					
9	min	0	1	0.339	1	0	1					

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code-Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	PL4X1/4	0.993	10.009	5	0.033	20.444	y	5	8.494	29.94	0.156	2.045	1 H1-1b
1	M2	PL4X1/4	0.995	10.435	5	0.032	20.444	y	5	8.494	29.94	0.156	2.045	1 H1-1b

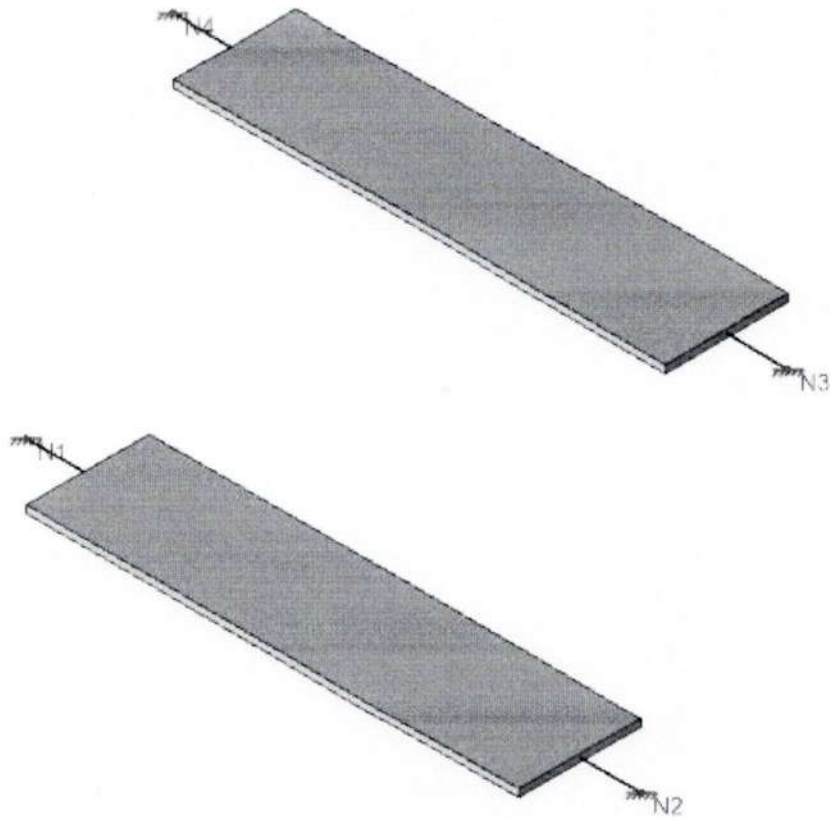
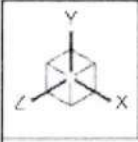
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Stability Engineering, Inc.
M. Foster
22-0669 Hovland

Stair Treads

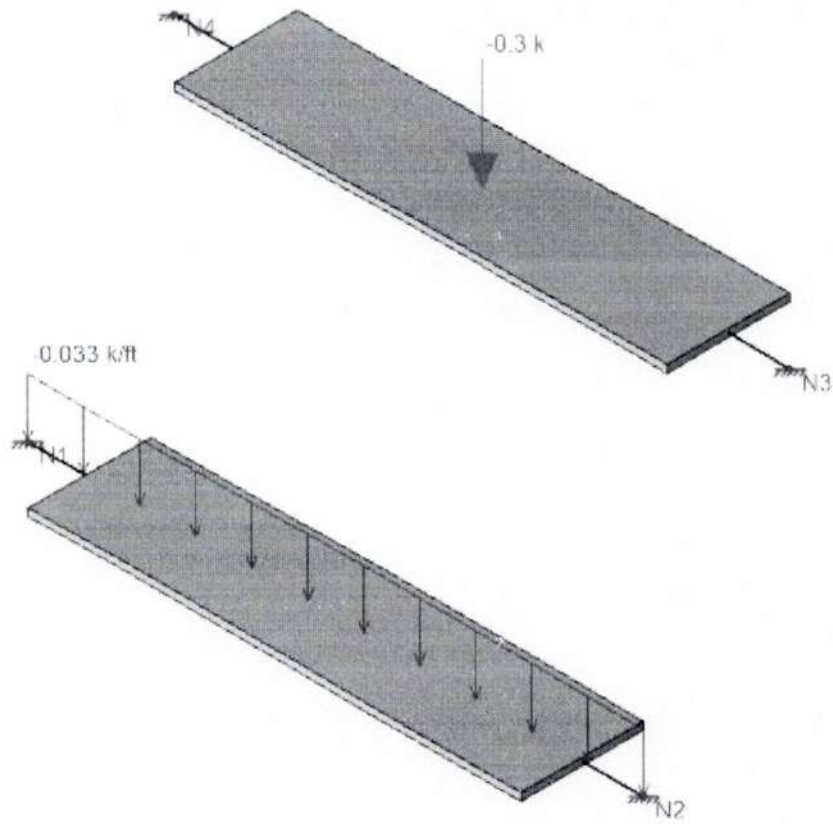
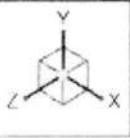
MEMBER LABELS 1
22-0669 Hovland Treads.r3d



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Stair Treads

MEMBER RENDERING 2
22-0669 Hovland Treads.r3d



Loads: BLC 2, LIVE



Stability Engineering, Inc.
 M. Foster
 22-0669 Hovland

Stair Treads

LIVE LOADS 3

22-0669 Hovland Treads.r3d



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Hovland
 Model Name : Stair Treads

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	1.67	0	0	
3	N3	1.67	0.8	-0.4	
4	N4	0	0.8	-0.4	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁻⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	TREAD	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	1	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M2	Y	-0.003	-0.003	0	%100
2	M1	Y	-0.003	-0.003	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.033	-0.033	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Hovland
 Model Name : Stair Treads

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1 M2	Y	-0.3	%50

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	5	0.03	5	0	5	0	5	0	5	0.008	5
1 N1 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
2 N2 max	0	5	0.03	5	0	5	0	5	0	5	-0.001	4
3 N2 min	0	1	0.003	1	0	1	0	1	0	1	-0.008	3
4 N4 max	0	5	0.153	5	0	5	0	5	0	5	0.063	5
5 N4 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
6 N3 max	0	5	0.153	5	0	5	0	5	0	5	-0.001	4
7 N3 min	0	1	0.003	1	0	1	0	1	0	1	-0.063	3
8 Totals: max	0	5	0.365	5	0	5						
9 Totals: min	0	1	0.01	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn	
0	M1	PL4X1/4	0.054	1.67	5	0.002	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b
1	M2	PL4X1/4	0.406	1.67	5	0.008	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b

<1 ∴ OK

Load Testing Summary:

[BRACE LOADS]

$$P_1 = 1568 \text{ lb}$$

$$P_2 = 2056 \text{ lb}$$

[LANDING BARS]

$$M_{\max} = \frac{PL}{4}$$

$$590 \text{ lb}\cdot\text{ft} = \frac{P(3.5\text{ft})}{4}$$

$$P = 675 \text{ lb}$$

[EDGE ANGLE 2]

$$M_{\max} = \frac{PL}{4}$$

$$1570 \text{ lb}\cdot\text{ft} = \frac{P(8\text{ft})}{4}$$

$$P = 785 \text{ lb}$$

Fire Escape Load Testing Analysis:

Scope of Work: Calculations for load testing requirements for fire escape located at Moreland Hall

Building Code: 2022 OBC

Design Loads: $LL = 100 \text{ psf}$
 $DL = 10 \text{ psf}$ } Total Load = 110 psf

Calculate Brace Loads:Stair Loads:

$$LL = (100 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(19 \text{ treads}) = 1047 \text{ lb}$$

Tread Width
Tread Length

$$DL = (10 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(19 \text{ treads}) = 105 \text{ lb}$$

[Load at Each Support]

$$LL = 1047 \text{ lb} / 4 = 262 \text{ lb}$$

$$DL = 105 \text{ lb} / 4 = 27 \text{ lb}$$

Worst Case Brace → Upper Level

$$L = 3.7 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(2.63 \text{ ft}) = 263 \text{ plf}$$

$$DL = (10 \text{ psf})(2.63 \text{ ft}) = 26.3 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf})(3 \text{ ft}) = 300 \text{ plf}$$

$$\begin{aligned} \downarrow @ L &= 2.4 \text{ ft} \\ &- 3.7 \text{ ft} \end{aligned}$$

$$DL = (10 \text{ psf})(3 \text{ ft}) = 30 \text{ plf}$$

$$\text{Stair Load @ } L = 0.5 \text{ ft}, 2.2 \text{ ft}$$

Worst Case Brace → Lower Level

$$L = 4.75 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(2.75 \text{ ft}) = 275 \text{ plf}$$

$$DL = (10 \text{ psf})(2.75 \text{ ft}) = 27.5 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf})(2.75 \text{ ft}) = 275 \text{ plf}$$

$$\begin{aligned} \downarrow @ L &= 0 \text{ ft} - \\ &2.6 \text{ ft} \end{aligned}$$

$$DL = (10 \text{ psf})(2.75 \text{ ft}) = 27.5 \text{ plf}$$

$$\text{Stair Load @ } L = 0.5 \text{ ft}, 2.2 \text{ ft}, 2.8 \text{ ft}, 4.5 \text{ ft}$$



Steel Beam Project File: 22-0669.ec6
 LIC#: KW-06014874, Build:20.23.08.30 Stability Engineering Inc. (c) ENERCALC INC 1983-2023

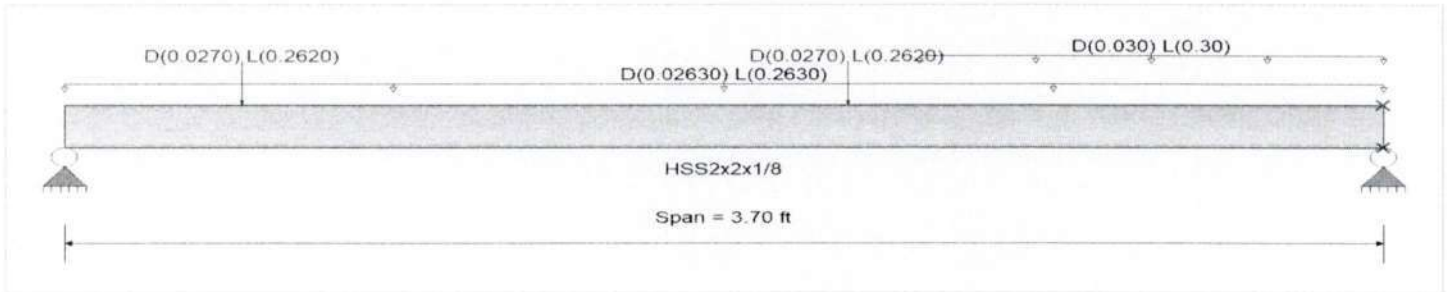
DESCRIPTION: UPPER BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
 Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design Fy : Steel Yield : 50.0 ksi
 Beam Bracing : Beam is Fully Braced against lateral-torsional buckling E: Modulus : 29,000.0 ksi
 Bending Axis : Major Axis Bending



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.02630, L = 0.2630 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)

Uniform Load : D = 0.030, L = 0.30 k/ft, Extent = 2.40 -->> 3.70 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)

Point Load : D = 0.0270, L = 0.2620 k @ 0.50 ft, (STAIR LOAD)

Point Load : D = 0.0270, L = 0.2620 k @ 2.20 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	0.662 : 1	Maximum Shear Stress Ratio =	0.161 : 1
Section used for this span	HSS2x2x1/8	Section used for this span	HSS2x2x1/8
Ma : Applied	0.964 k-ft	Va : Applied	1.105 k
Mn / Omega : Allowable	1.457 k-ft	Vn/Omega : Allowable	6.885 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	3.700 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.149 in Ratio = 297 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.165 in Ratio = 268 >=180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx/Vnx/Omega	
D Only														
Dsgn. L =	3.70 ft	1	0.064	0.015	0.09		0.09	2.43	1.46	1.00	1.00	0.11	11.50	6.88
+D+L														
Dsgn. L =	3.70 ft	1	0.662	0.161	0.96		0.96	2.43	1.46	1.00	1.00	1.11	11.50	6.88
+D+0.750L														
Dsgn. L =	3.70 ft	1	0.512	0.124	0.75		0.75	2.43	1.46	1.00	1.00	0.86	11.50	6.88
+0.60D														
Dsgn. L =	3.70 ft	1	0.038	0.009	0.06		0.06	2.43	1.46	1.00	1.00	0.06	11.50	6.88

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1654	1.892		0.0000	0.000



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: MORELAND

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

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DESCRIPTION: UPPER BRACE DESIGN (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.983	1.105
Max Upward from Load Combinations	0.983	1.105
Max Upward from Load Cases	0.888	0.999
D Only	0.095	0.106
+D+L	0.983	1.105
+D+0.750L	0.761	0.856
+0.60D	0.057	0.064
L Only	0.888	0.999

$P_1 = 983 \text{ lb}$
 $P_2 = 1105 \text{ lb}$
} Specify on loading plans



Steel Beam	Project File: 22-0669.ec6
LIC#: KW-06014874, Build:20.23.08.30	(c) ENERCALC INC 1983-2023

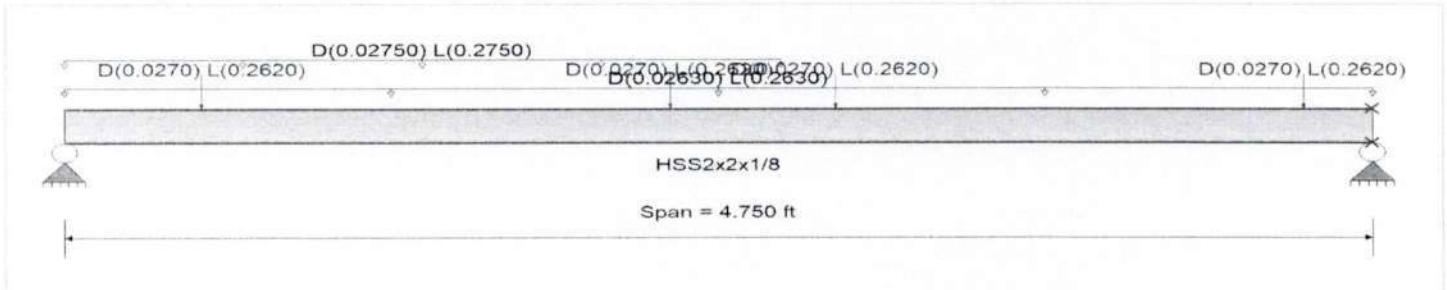
DESCRIPTION: LOWER BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design	Fy : Steel Yield : 50.0 ksi
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling	E: Modulus : 29,000.0 ksi
Bending Axis : Major Axis Bending	



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

- Beam self weight calculated and added to loading
- Uniform Load : D = 0.02630, L = 0.2630 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)
- Uniform Load : D = 0.02750, L = 0.2750 k/ft, Extent = 0.0 -->> 2.60 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)
- Point Load : D = 0.0270, L = 0.2620 k @ 0.50 ft, (STAIR LOAD)
- Point Load : D = 0.0270, L = 0.2620 k @ 2.20 ft, (STAIR LOAD)
- Point Load : D = 0.0270, L = 0.2620 k @ 2.80 ft, (STAIR LOAD)
- Point Load : D = 0.0270, L = 0.2620 k @ 4.50 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

				Design N.G.			
Maximum Bending Stress Ratio =	1.412 : 1	Maximum Shear Stress Ratio =	0.263 : 1				
Section used for this span	HSS2x2x1/8	Section used for this span	HSS2x2x1/8				
Ma : Applied	2.058 k-ft	Va : Applied	1.813 k				
Mn / Omega : Allowable	1.457 k-ft	Vn/Omega : Allowable	6.885 k				
Load Combination	+D+L	Load Combination	+D+L				
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft				
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1				
Maximum Deflection							
Max Downward Transient Deflection	0.514 in Ratio = 110 < 360	Span: 1 : L Only					
Max Upward Transient Deflection	0 in Ratio = 0 < 360	n/a					
Max Downward Total Deflection	0.573 in Ratio = 99 < 180	Span: 1 : +D+L					
Max Upward Total Deflection	0 in Ratio = 0 < 180	n/a					

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values			
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega
D Only	Dsgn. L = 4.75 ft	1	0.135	0.025	0.20		0.20	2.43	1.46	1.00	1.00	0.17	11.50	6.88
+D+L	Dsgn. L = 4.75 ft	1	1.412	0.263	2.06	Mmax	2.06	2.43	1.46	1.00	1.00	1.81	11.50	6.88
+D+0.750L	Dsgn. L = 4.75 ft	1	1.093	0.204	1.59		1.59	2.43	1.46	1.00	1.00	1.40	11.50	6.88
+0.60D	Dsgn. L = 4.75 ft	1	0.081	0.015	0.12		0.12	2.43	1.46	1.00	1.00	0.10	11.50	6.88



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

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DESCRIPTION: LOWER BRACE DESIGN (LOADS ONLY)

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.5730	2.348		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.813	1.518
Max Upward from Load Combinations	1.813	1.518
Max Upward from Load Cases	1.640	1.372
D Only	0.173	0.146
+D+L	1.813	1.518
+D+0.750L	1.403	1.175
+0.60D	0.104	0.088
L Only	1.640	1.372

$P_3 = 1813 \text{ lb}$
 $P_4 = 1518 \text{ lb}$

} Specify on loading plans

Landing Support Braces: Both LevelsBrace Geometry:

$$H = 2.5 \text{ ft}$$

$$L = 4.75 \text{ ft}$$

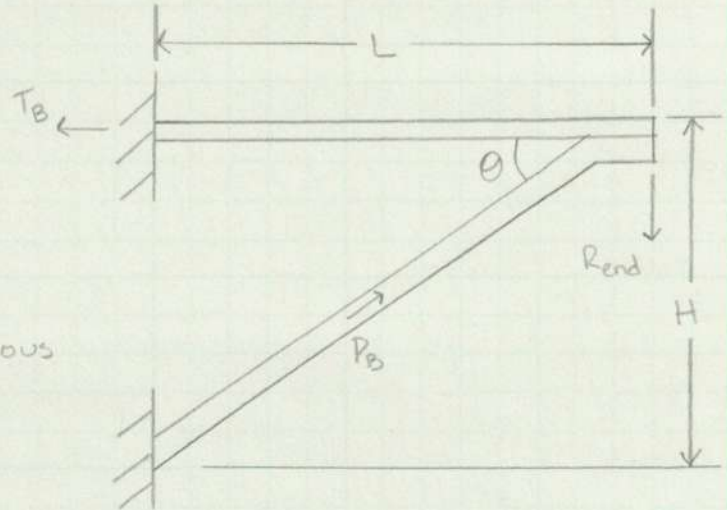
$$\theta = \tan^{-1}(H/L) = 27.75^\circ$$

$$R_{end} = 1518 \text{ lb} \quad \left. \begin{array}{l} \\ \end{array} \right\} \text{ See Previous Pages}$$

$$M_{max} = 2060 \text{ lb}\cdot\text{ft}$$

$$P_B = \frac{R_{end}}{\sin(\theta)} = 3261 \text{ lb}$$

$$T_B = P_B \cos \theta = 2886 \text{ lb}$$

Brace Section Properties: (1 1/4" Solid Square Bar)

$$Z_x = \frac{bd^3}{4} = 0.488 \text{ in}^3$$

$$Z_y = Z_x = 0.488 \text{ in}^3$$

$$\text{Area} = 1.5625 \text{ in}^2$$

$$F_y = 36 \text{ ksi}$$

Brace Checks:

$$\frac{M_n}{\Omega} = \frac{F_y Z}{1.67} = \frac{(36 \text{ ksi})(0.488 \text{ in}^3)}{1.67} = 10520 \text{ lb}\cdot\text{in} = 876 \text{ lb}\cdot\text{ft}$$

$$\frac{T_n}{\Omega} = \frac{F_y A}{1.67} = \frac{(36 \text{ ksi})(1.5625 \text{ in}^2)}{1.67} = 48.5 \text{ k}$$

$$\text{Tension Ratio} = \frac{T_B}{T_n/\Omega} = \frac{2886 \text{ lb}}{48500 \text{ lb}} = 0.06 < 0.2 \quad \therefore \text{Use AISC Egn H1-1b}$$

$$\text{Combined Ratio} = \frac{T_B}{2(T_n/\Omega)} + \frac{M_B}{M_n/\Omega} = 2.41 > 1 \quad \therefore \text{NO GOOD}$$

\therefore Brace is required to be tested

Framing ChecksDecking Bars (Worst Case)

$$L = 2.7 \text{ ft} \quad \text{Load} = (110 \text{ psf})(0.25 \text{ ft}) = 27.5 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(27.5 \text{ plf})(2.7 \text{ ft})^2}{8} = 25.06 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{\Omega} = \frac{F_y Z}{\Omega}$$

$$Z = \frac{bd^2}{4} = \frac{(1.5 \text{ in})(0.25 \text{ in})^2}{4} = 0.0234 \text{ in}^3$$

$$\frac{M_n}{\Omega} = \frac{(36000 \text{ psi})(0.0234 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 42.1 \text{ lb}\cdot\text{ft} > 25.06 \text{ lb}\cdot\text{ft} \quad \therefore \text{OK}$$

Landing Bars (Worst Case)

$$L = 4.7 \text{ ft} \quad \text{Load} = (110 \text{ psf})(2.7 \text{ ft}) = 297 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(297 \text{ plf})(4.7 \text{ ft})^2}{8} = 820 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{\Omega} = \frac{F_y Z}{\Omega}$$

$$Z = \frac{bd^2}{4} = \frac{(2.5 \text{ in})(0.25 \text{ in})^2}{4} = 0.039 \text{ in}^3$$

$$\frac{M_n}{\Omega} = \frac{(36000 \text{ psi})(0.039 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 70.17 \text{ lb}\cdot\text{ft} < 820 \text{ lb}\cdot\text{ft}$$

\therefore NO GOOD,
TESTING REQ'D

$$M_{\max} = \frac{PL}{4}$$

$$820 \text{ lb}\cdot\text{ft} = \frac{P(4.7 \text{ ft})}{4}$$

$$P = 698 \text{ lb}$$

Edge Angle Checks: (L₂ × 2 × 1/4")

$$L = 5.5 \text{ ft}$$

$$LL = (100 \text{ psf})(2.35 \text{ ft}) = 235 \text{ plf}$$

$$DL = (10 \text{ psf})(2.35 \text{ ft}) = 23.5 \text{ plf}$$

* See calculations on next pages



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.08.30

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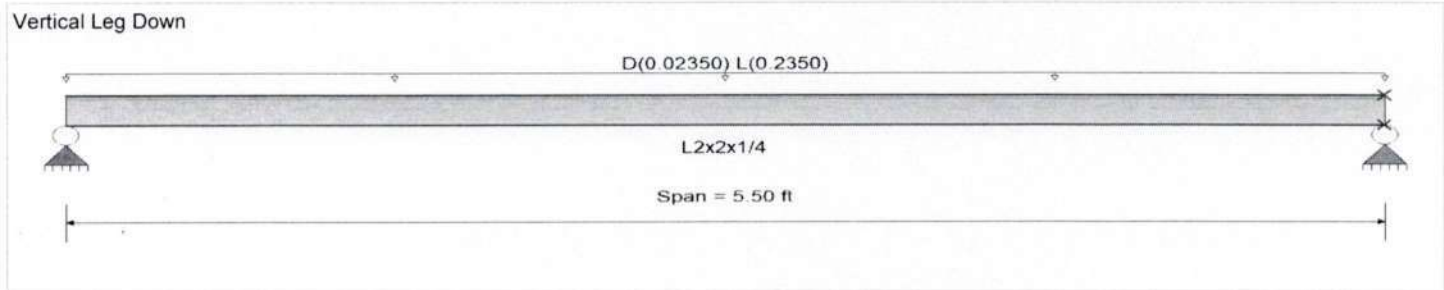
DESCRIPTION: EDGE ANGLE

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.02350, L = 0.2350 k/ft, Tributary Width = 1.0 ft, (UNIFORM LOADS)

∴ Load Testing Req'd

DESIGN SUMMARY

				Design N.G.	
Maximum Bending Stress Ratio =	1.081 : 1	Maximum Shear Stress Ratio =	0.080 : 1		
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4		
Ma : Applied	0.990 k-ft	Va : Applied	0.7196 k		
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k		
Load Combination	+D+L	Load Combination	+D+L		
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft		
		Span # where maximum occurs	Span # 1		
Maximum Deflection					
Max Downward Transient Deflection	0.482 in Ratio = 136 < 360	Span: 1 : L Only			
Max Upward Transient Deflection	0 in Ratio = 0 < 360	n/a			
Max Downward Total Deflection	0.539 in Ratio = 122 < 240.0	Span: 1 : +D+L			
Max Upward Total Deflection	0 in Ratio = 0 < 240.0	n/a			

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L =	5.50 ft	1	0.110	0.008	0.10		0.10	1.53	0.92	1.00	1.00	0.07	15.00	8.98	
+D+L															
Dsgn. L =	5.50 ft	1	1.081	0.080	0.99		0.99	1.53	0.92	1.00	1.00	0.72	15.00	8.98	
+D+0.750L															
Dsgn. L =	5.50 ft	1	0.838	0.062	0.77		0.77	1.53	0.92	1.00	1.00	0.56	15.00	8.98	
+0.60D															
Dsgn. L =	5.50 ft	1	0.066	0.005	0.06		0.06	1.53	0.92	1.00	1.00	0.04	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.5394	2.766		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.720	0.720
Max Upward from Load Combinations	0.720	0.720
Max Upward from Load Cases	0.646	0.646
D Only	0.073	0.073
+D+L	0.720	0.720
+D+0.750L	0.558	0.558
+0.60D	0.044	0.044



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: MORELAND

Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: EDGE ANGLE

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.646	0.646

$$M = \frac{PL}{4}$$

$$990 \text{ lb}\cdot\text{ft} = \frac{P(5.5 \text{ ft})}{4}$$

$$P = 720 \text{ lb}$$

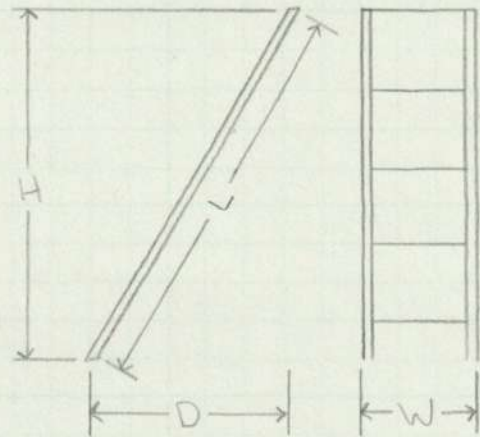
Stair Framing:Stair Dimensions:

$$H = 14.1 \text{ ft}$$

$$D = 7.4 \text{ ft}$$

$$L = 15.7 \text{ ft}$$

$$W = 1.67 \text{ ft}$$

Stair Stringer Loads:

Point Load = 300 lb @ Every
Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

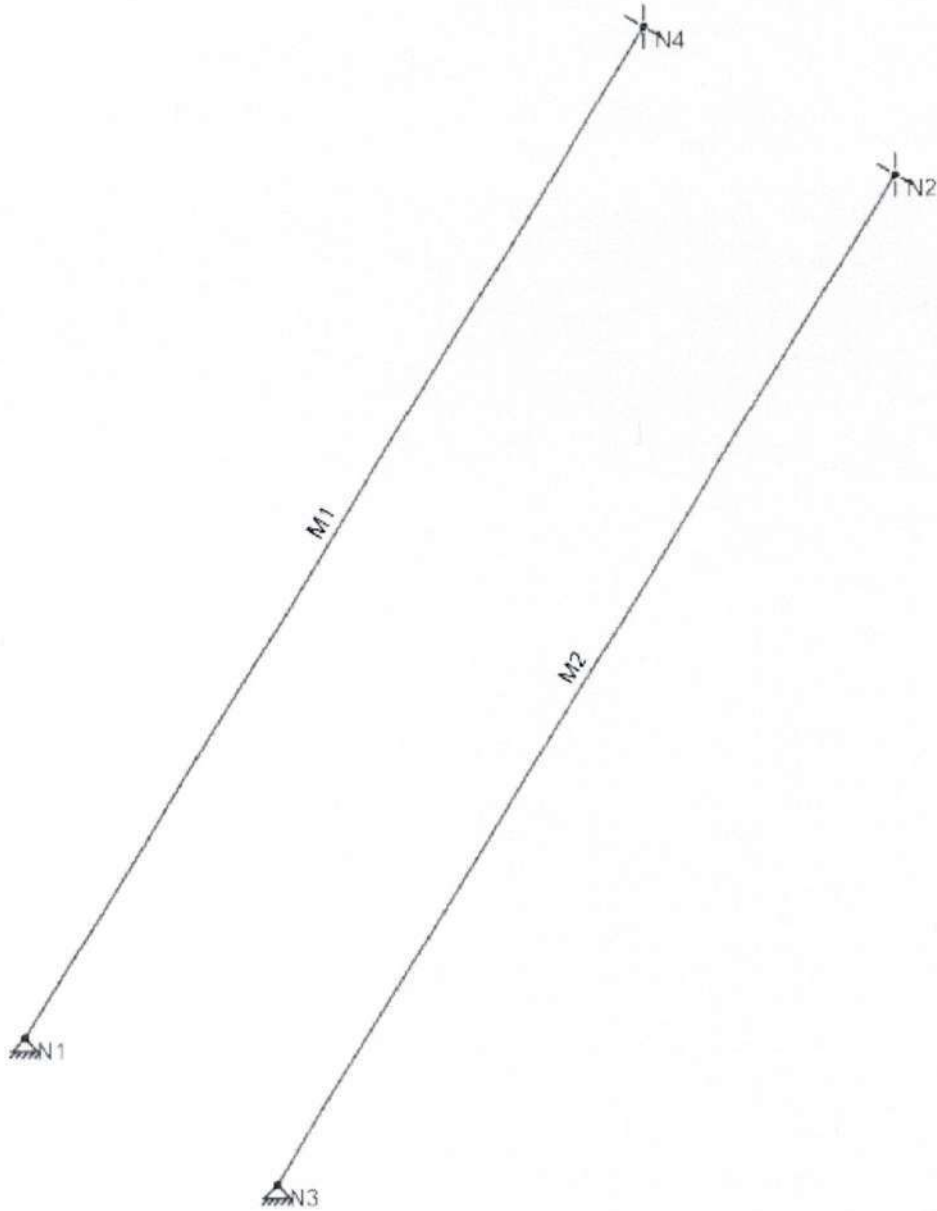
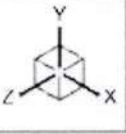
$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$

Stair Tread Loads

Point Load = 300 lb @ Center

$$LL = (100 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 33 \text{ plf}$$

$$DL = (10 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 3 \text{ plf}$$

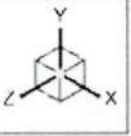


Stability Engineering, Inc.
M. Foster
22-0669 Moreland

Stair Stringers

MEMBER LABELS 1

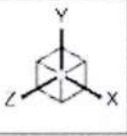
22-0669 Moreland Stringers.r...



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M. Foster
22-0669 Moreland

Stair Stringers

MEMBER RENDERING 2
22-0669 Moreland Stringers.r...



Loads: BLC 2, LIVE



Stability Engineering, Inc.
M. Foster
22-0669 Moreland

Stair Stringers

LIVE LOADS 3
22-0669 Moreland Stringers.r...



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Moreland
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	10.4	14.1	0	
3	N3	3	0	0	
4	N4	7.4	14.1	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	9	1

Member Distributed Loads (BLC 1 : DEAD)

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Moreland
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.145	1.7
2	M2	Y	-0.145	3.4
3	M2	Y	-0.145	5.1
4	M2	Y	-0.145	6.8
5	M2	Y	-0.145	8.5
6	M2	Y	-0.145	10.2
7	M2	Y	-0.145	11.9
8	M2	Y	-0.145	13.6
9	M2	Y	-0.145	15.3

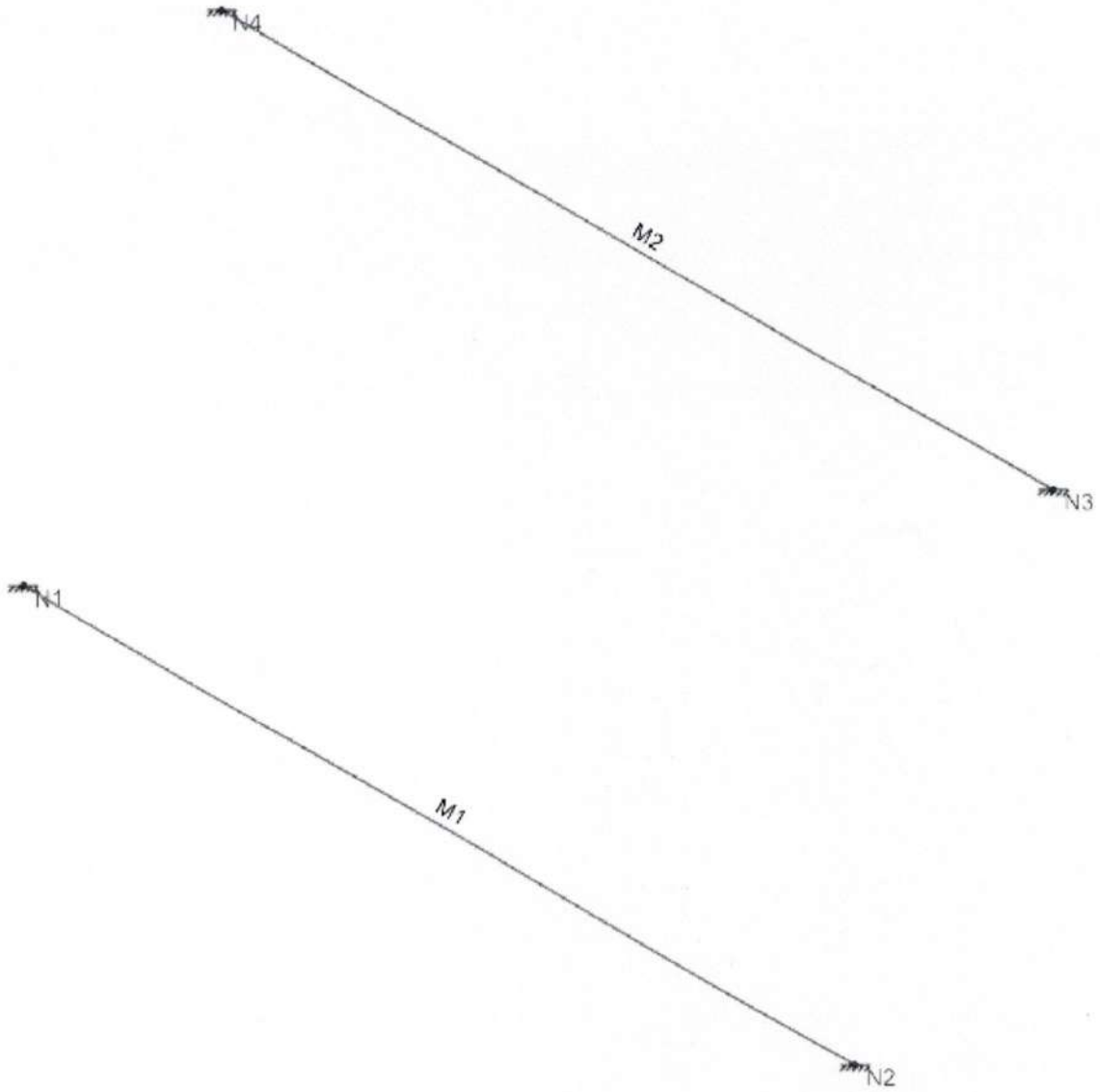
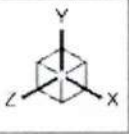
Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC		
0	N1	max	0	4	0.727	5	0	5	LOCKED		LOCKED		0	5
1		min	0	3	0.066	1	0	1	LOCKED		LOCKED		0	1
2	N3	max	0	4	0.674	5	0	5	LOCKED		LOCKED		0	5
3		min	0	3	0.066	1	0	1	LOCKED		LOCKED		0	1
4	N2	max	0	2	0.763	5	0	5	0	5	0	5	0	5
5		min	0	1	0.066	1	0	1	0	1	0	1	0	1
6	N4	max	0	2	0.727	5	0	5	0	5	0	5	0	5
7		min	0	1	0.066	1	0	1	0	1	0	1	0	1
8	Totals:	max	0	2	2.891	5	0	5						
9		min	0	1	0.264	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn	
0	M1	PL4X1/4	0.665	7.63	5	0.028	15.924	y	5	5.489	29.94	0.156	2.027	1	H1-1b
1	M2	PL4X1/4	0.682	8.46	5	0.03	15.924	y	5	5.489	29.94	0.156	2.027	1	H1-1b

<1 ∴ OK

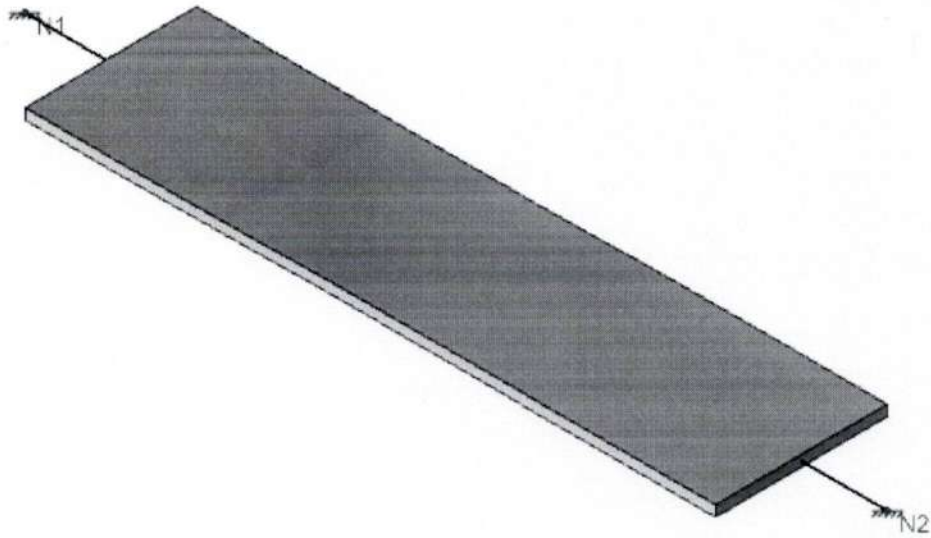
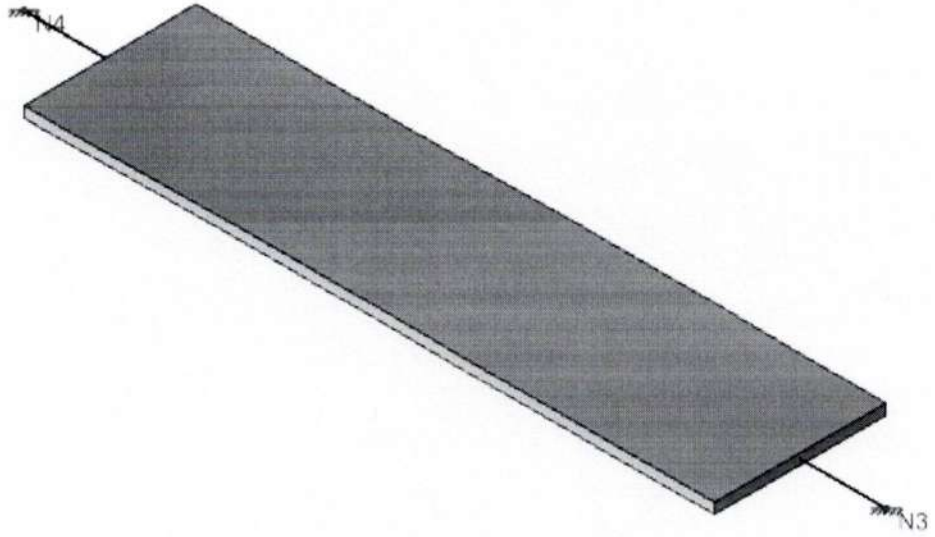
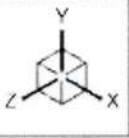


Stability Engineering, Inc.
M. Foster
22-0669 Moreland

Stair Treads

MEMBER LABELS1

22-0669 Dryden Treads.r3d

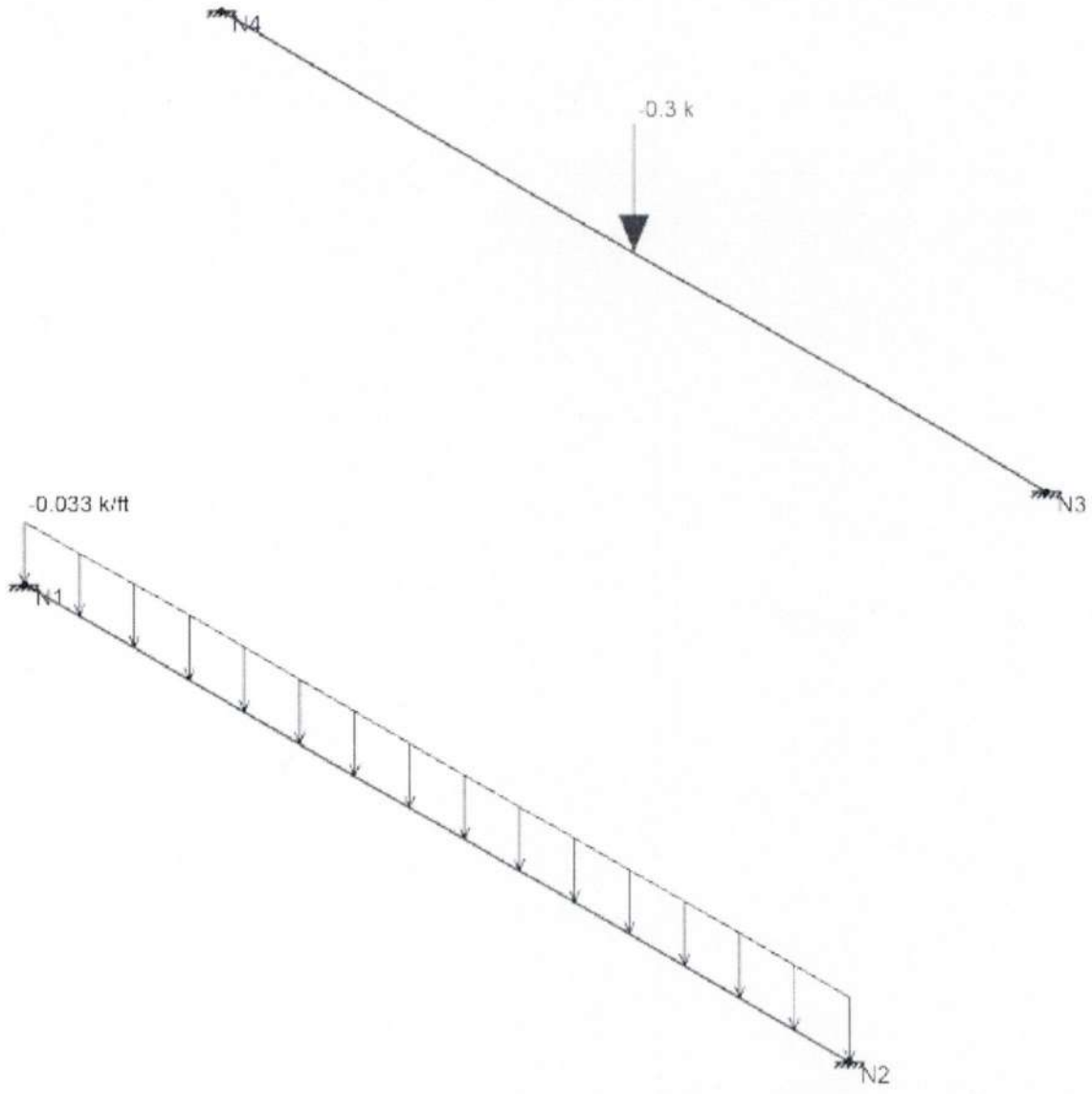
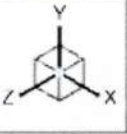


Stability Engineering, Inc.
M. Foster
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Stair Treads

MEMBER RENDERING 2

22-0669 Dryden Treads.r3d



Loads: BLC 2, LIVE



Stability Engineering, Inc.
M. Foster
22-0669 Moreland

Stair Treads

LIVE LOADS 3
22-0669 Dryden Treads.r3d



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Moreland
 Model Name : Stair Treads

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	1.67	0	0	
3	N3	1.67	0.8	-0.4	
4	N4	0	0.8	-0.4	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [$1e^{-5}F^{-1}$]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	TREAD	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	1	1

Member Distributed Loads (BLC 1 : DEAD)

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M2	Y	-0.003	-0.003	0	%100
2	M1	Y	-0.003	-0.003	0	%100

Member Distributed Loads (BLC 2 : LIVE)

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.033	-0.033	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Moreland
 Model Name : Stair Treads

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1 M2	Y	-0.3	%50

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	5	0.03	5	0	5	0	5	0	5	0.008	5
1 N1 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
2 N2 max	0	5	0.03	5	0	5	0	5	0	5	-0.001	4
3 N2 min	0	1	0.003	1	0	1	0	1	0	1	-0.008	3
4 N4 max	0	5	0.153	5	0	5	0	5	0	5	0.063	5
5 N4 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
6 N3 max	0	5	0.153	5	0	5	0	5	0	5	-0.001	4
7 N3 min	0	1	0.003	1	0	1	0	1	0	1	-0.063	3
8 Totals: max	0	5	0.365	5	0	5						
9 Totals: min	0	1	0.01	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0 M1	PL4X1/4	0.054	1.67	5	0.002	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b
1 M2	PL4X1/4	0.406	1.67	5	0.008	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b

<1 :OK

Load Testing Summary:

[BRACE LOADS]

$$P_1 = 983 \text{ lb}$$

$$P_2 = 1105 \text{ lb}$$

$$P_3 = 1813 \text{ lb}$$

$$P_4 = 1518 \text{ lb}$$

[LANDING BARS]

$$P = 698 \text{ lb}$$

[EDGE ANGLE]

$$P = 720 \text{ lb}$$

Fire Escape Load Testing Analysis:

Scope of Work: Calculations for load testing requirements for fire escape located at the Pharmacy Building

Building Code: 2022 OBC

Design Loads: $LL = 100 \text{ psf}$
 $DL = 10 \text{ psf}$ } Total Load = 110 psf

Calculate Brace Loads:Stair Loads:

$$LL = (100 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(12 \text{ treads}) = 662 \text{ lb}$$

$$DL = (10 \text{ psf})(0.33 \text{ ft})(1.67 \text{ ft})(12 \text{ treads}) = 66.2 \text{ lb}$$

[Load at Each Support]

$$LL = 662 \text{ lb} / 4 = 166 \text{ lb}$$

$$DL = 66.2 \text{ lb} / 4 = 17 \text{ lb}$$

Worst Case Brace \rightarrow Upper Level

$$L = 3.6 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(1.33 \text{ ft}) = 133 \text{ plf}$$

$$DL = (10 \text{ psf})(1.33 \text{ ft}) = 13.3 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf})(2.5 \text{ ft}) = 250 \text{ plf}$$

$$\downarrow \text{ @ } L = 2.2 \text{ ft} \quad DL = (10 \text{ psf})(2.5 \text{ ft}) = 25 \text{ plf}$$

$$\quad \quad \quad - 3.6 \text{ ft}$$

Stair Load @ $L = 0.5 \text{ ft}, 2.2 \text{ ft}$ Worst Case Brace \rightarrow Lower Level

$$L = 3.6 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(2.67 \text{ ft}) = 267 \text{ plf}$$

$$DL = (10 \text{ psf})(2.67 \text{ ft}) = 26.7 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf})(1.17 \text{ ft}) = 117 \text{ plf}$$

$$\downarrow \text{ @ } L = 2.2 \text{ ft} \quad DL = (10 \text{ psf})(1.17 \text{ ft}) = 11.7 \text{ plf}$$

$$\quad \quad \quad - 3.6 \text{ ft}$$

Stair Load @ $L = 0.5 \text{ ft}, 2.2 \text{ ft}$

Lower Level - Middle Brace:

$$L = 3.6 \text{ ft}$$

$$\text{Full Uniform Load LL} = (100 \text{ psf})(1.6 \text{ ft}) = 160 \text{ plf}$$

$$\text{DL} = (10 \text{ psf})(1.6 \text{ ft}) = 16 \text{ plf}$$

$$\text{Partial Uniform Load LL} = (100 \text{ psf})(3.8 \text{ ft}) = 380 \text{ plf}$$

$$\downarrow \text{ @ } L = 2.2 \text{ ft} - \quad \text{DL} = (10 \text{ psf})(3.8 \text{ ft}) = 38 \text{ plf}$$

3.6 ft

$$\text{Stair Load @ } L = 0.5 \text{ ft}, 2.2 \text{ ft}$$



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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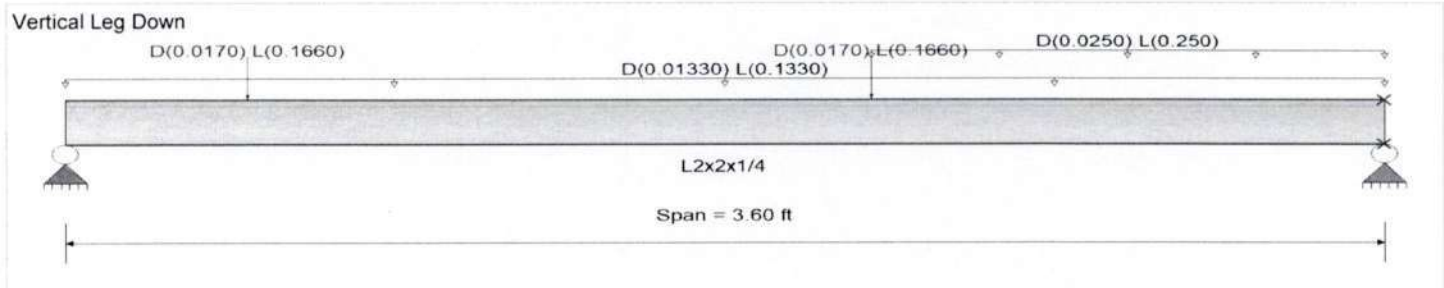
DESCRIPTION: UPPER BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

- Beam self weight calculated and added to loading
Uniform Load : D = 0.01330, L = 0.1330 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)
- Uniform Load : D = 0.0250, L = 0.250 k/ft, Extent = 2.20 -->> 3.60 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)
- Point Load : D = 0.0170, L = 0.1660 k @ 0.50 ft, (STAIR LOAD)
- Point Load : D = 0.0170, L = 0.1660 k @ 2.20 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design OK

Maximum Bending Stress Ratio =	0.641 : 1	Maximum Shear Stress Ratio =	0.080 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.587 k-ft	Va : Applied	0.7165 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	3.600 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.118 in Ratio = 364	>=360	Span: 1 : L Only
Max Upward Transient Deflection	0 in Ratio = 0	<360	n/a
Max Downward Total Deflection	0.132 in Ratio = 328	>=240	Span: 1 : +D+L
Max Upward Total Deflection	0 in Ratio = 0	<240.0	n/a

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L =	3.60 ft	1	0.064	0.008	0.06		0.06	1.53	0.92	1.00	1.00	0.07	15.00	8.98	
+D+L															
Dsgn. L =	3.60 ft	1	0.641	0.080	0.59		0.59	1.53	0.92	1.00	1.00	0.72	15.00	8.98	
+D+0.750L															
Dsgn. L =	3.60 ft	1	0.497	0.062	0.45		0.45	1.53	0.92	1.00	1.00	0.56	15.00	8.98	
+0.60D															
Dsgn. L =	3.60 ft	1	0.038	0.005	0.03		0.03	1.53	0.92	1.00	1.00	0.04	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1318	1.862		0.0000	0.000



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build: 20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: UPPER BRACE DESIGN (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.573	0.716
Max Upward from Load Combinations	0.573	0.716
Max Upward from Load Cases	0.515	0.646
D Only	0.058	0.071
+D+L	0.573	0.716
+D+0.750L	0.444	0.555
+0.60D	0.035	0.042
L Only	0.515	0.646

$P_1 = 573 \text{ lb}$
 $P_2 = 716 \text{ lb}$
} Specify on loading plans



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: LOWER BRACE DESIGN (LOADS ONLY)

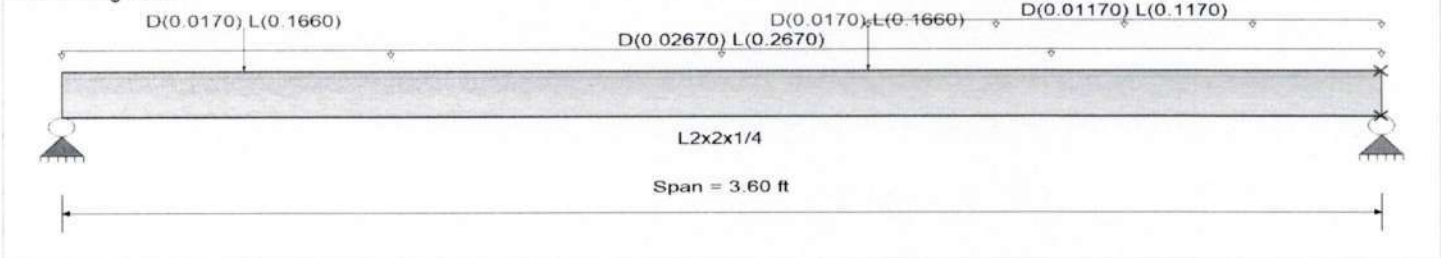
CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi

Vertical Leg Down



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.02670, L = 0.2670 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)

Uniform Load : D = 0.01170, L = 0.1170 k/ft, Extent = 2.20 --> 3.60 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)

Point Load : D = 0.0170, L = 0.1660 k @ 0.50 ft, (STAIR LOAD)

Point Load : D = 0.0170, L = 0.1660 k @ 2.20 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design: N.G.

Maximum Bending Stress Ratio =	0.796 : 1	Maximum Shear Stress Ratio =	0.091 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.729 k-ft	Va : Applied	0.8168 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	3.600 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.153 in Ratio = 282 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.169 in Ratio = 255 >=240	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <240.0	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values						
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega			
D Only	Dsgn. L = 3.60 ft	1	0.078	0.009	0.07												
+D+L	Dsgn. L = 3.60 ft	1	0.796	0.091	0.73												
+D+0.750L	Dsgn. L = 3.60 ft	1	0.616	0.070	0.56												
+0.60D	Dsgn. L = 3.60 ft	1	0.047	0.005	0.04												

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1694	1.831		0.0000	0.000



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: PHARMACY

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: LOWER BRACE DESIGN (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.798	0.817
Max Upward from Load Combinations	0.798	0.817
Max Upward from Load Cases	0.720	0.737
D Only	0.078	0.080
+D+L	0.798	0.817
+D+0.750L	0.618	0.633
+0.60D	0.047	0.048
L Only	0.720	0.737

$P_3 = 798 \text{ lb}$
 $P_4 = 817 \text{ lb}$
} Specify on loading plans



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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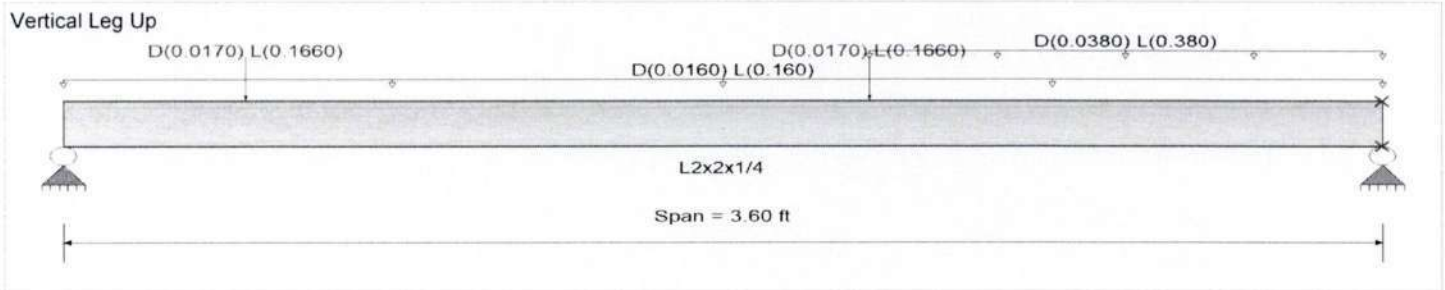
DESCRIPTION: LOWER LEVEL - MIDDLE BRACE (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E: Modulus : 29,000.0 ksi



Applied Loads

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

- Beam self weight calculated and added to loading
Uniform Load : D = 0.0160, L = 0.160 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM)
- Uniform Load : D = 0.0380, L = 0.380 k/ft, Extent = 2.20 --> 3.60 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)
- Point Load : D = 0.0170, L = 0.1660 k @ 0.50 ft, (STAIR LOAD)
- Point Load : D = 0.0170, L = 0.1660 k @ 2.20 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	0.784 : 1	Maximum Shear Stress Ratio =	0.104 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.718 k-ft	Va : Applied	0.9312 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	3.600 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.145 in Ratio = 297 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.161 in Ratio = 269 >=240	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <240.0	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L =	3.60 ft	1	0.077	0.010	0.07		0.07	1.53	0.92	1.00	1.00	0.09	15.00	8.98	
+D+L															
Dsgn. L =	3.60 ft	1	0.784	0.104	0.72		0.72	1.53	0.92	1.00	1.00	0.93	15.00	8.98	
+D+0.750L															
Dsgn. L =	3.60 ft	1	0.607	0.080	0.56		0.56	1.53	0.92	1.00	1.00	0.72	15.00	8.98	
+0.60D															
Dsgn. L =	3.60 ft	1	0.046	0.006	0.04		0.04	1.53	0.92	1.00	1.00	0.05	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1608	1.872		0.0000	0.000



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: PHARMACY

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: LOWER LEVEL - MIDDLE BRACE (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.665	0.931
Max Upward from Load Combinations	0.665	0.931
Max Upward from Load Cases	0.599	0.841
D Only	0.066	0.090
+D+L	0.665	0.931
+D+0.750L	0.515	0.721
+0.60D	0.040	0.054
L Only	0.599	0.841

P7 = 931 lb
P8 = 665 lb } Specify on Loading Plans

Landing Support Braces: Both LevelsBrace Geometry:

$$H = 2.5 \text{ ft}$$

$$L = 3.7 \text{ ft}$$

$$\theta = \tan^{-1}(H/L) = 34^\circ$$

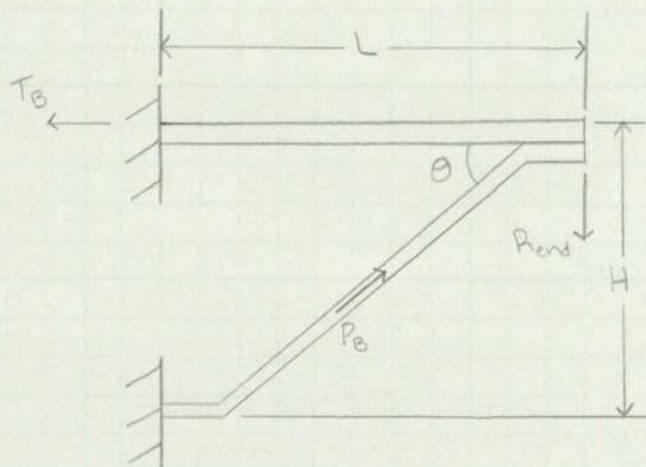
$$R_{\text{end}} = 817 \text{ lb}$$

$$M_{\text{max}} = 730 \text{ lb}\cdot\text{ft}$$

} See Previous
Pages

$$P_B = \frac{R_{\text{end}}}{\sin(\theta)} = 1461 \text{ lb}$$

$$T_B = P_B \cos \theta = 1212 \text{ lb}$$

Brace Section Properties:

(1" Solid Square Bar)

$$Z_x = \frac{bd^3}{4} = 0.25 \text{ in}^3$$

$$Z_y = Z_x = 0.25 \text{ in}^3$$

$$\text{Area} = bd = 1 \text{ in}^2$$

$$F_y = 36 \text{ ksi}$$

Brace Checks:

$$\frac{M_n}{\Omega} = \frac{F_y Z}{1.67} = \frac{(36 \text{ ksi})(0.25 \text{ in}^3)}{1.67} = 5389 \text{ lb}\cdot\text{in} = 449 \text{ lb}\cdot\text{ft} <$$

$$\frac{T_n}{\Omega} = \frac{F_y A}{1.67} = \frac{(36 \text{ ksi})(1 \text{ in}^2)}{1.67} = 21556 \text{ lb}$$

730 lb·ft ∴ NO
GOOD

$$\text{Tension Ratio} = \frac{T_B}{T_n/\Omega} = \frac{1212 \text{ lb}}{21556 \text{ lb}} = 0.06 < 0.2 \quad \therefore \text{Use AISC Egn H1-1b}$$

$$\text{Combined Ratio} = \frac{T_B}{2(T_n/\Omega)} + \frac{M_B}{M_n/\Omega} = 1.65 > 1 \quad \therefore \text{NO GOOD}$$

∴ Load Testing Req'd Brace and Connections

Framing ChecksDecking Bars

(Worst Case)

$$L = 5.3 \text{ ft}$$

$$\text{Load} = (110 \text{ psf})(0.25 \text{ ft}) = 27.5 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(27.5 \text{ plf})(5.3 \text{ ft})^2}{8} = 96.6 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{S} = \frac{F_y Z}{S}$$

$$Z = \frac{bd^2}{4} = \frac{(1.5 \text{ in})(0.25 \text{ in})^2}{4} = 0.0234 \text{ in}^3$$

$$\frac{M_n}{S} = \frac{(36000 \text{ psi})(0.0234 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 42.1 \text{ lb}\cdot\text{ft} < 96.6 \text{ lb}\cdot\text{ft}$$

 \therefore Load Testing Req'd

$$M_{\max} = \frac{PL}{4}$$

$$96.6 \text{ lb}\cdot\text{ft} = \frac{P(5.3 \text{ ft})}{4}$$

$$P = 73 \text{ lb}$$

Landing Bars

(Worst Case)

$$L = 3.6 \text{ ft}$$

$$\text{Load} = (110 \text{ psf})(1.5 \text{ ft}) = 165 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(165 \text{ plf})(3.6 \text{ ft})^2}{8} = 267.3 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{S} = \frac{F_y Z}{S}$$

$$Z = \frac{bd^2}{4} = \frac{(2 \text{ in})(0.25 \text{ in})^2}{4} = 0.03125 \text{ in}^3$$

$$\frac{M_n}{S} = \frac{(36000 \text{ psi})(0.03125 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 56.1 \text{ lb}\cdot\text{ft} < 267.3 \text{ lb}\cdot\text{ft}$$

 \therefore NO GOOD,
TESTING REQ'D

$$M_{\max} = \frac{PL}{4}$$

$$267.3 \text{ lb}\cdot\text{ft} = \frac{P(3.6 \text{ ft})}{4}$$

$$P = 297 \text{ lb}$$

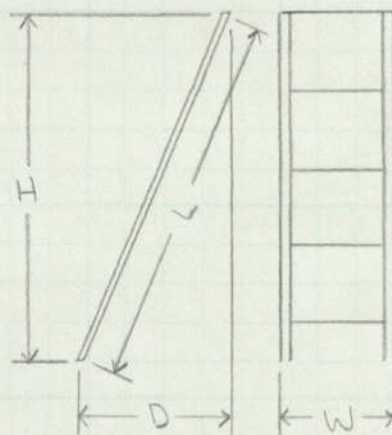
Stair Framing:Stair Dimensions:

$$H = 14.1 \text{ ft}$$

$$D = 6 \text{ ft}$$

$$L = 15.1 \text{ ft}$$

$$W = 1.67 \text{ ft}$$

Stair Stringer Loads:

Point Load = 300 lb @ Every
Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

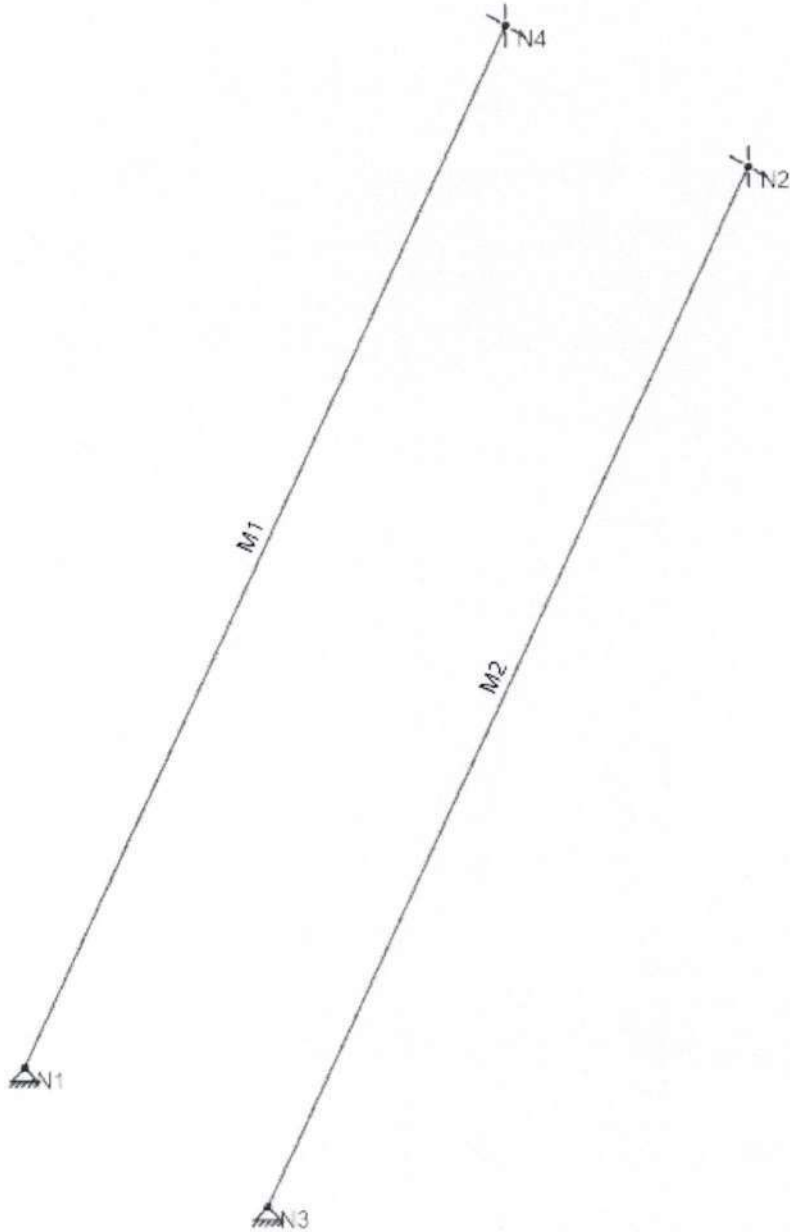
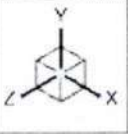
$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$

Stair Tread Loads:

Point Load = 300 lb @ Center

$$LL = (100 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 33 \text{ plf}$$

$$DL = (10 \text{ psf})(4 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 3 \text{ plf}$$

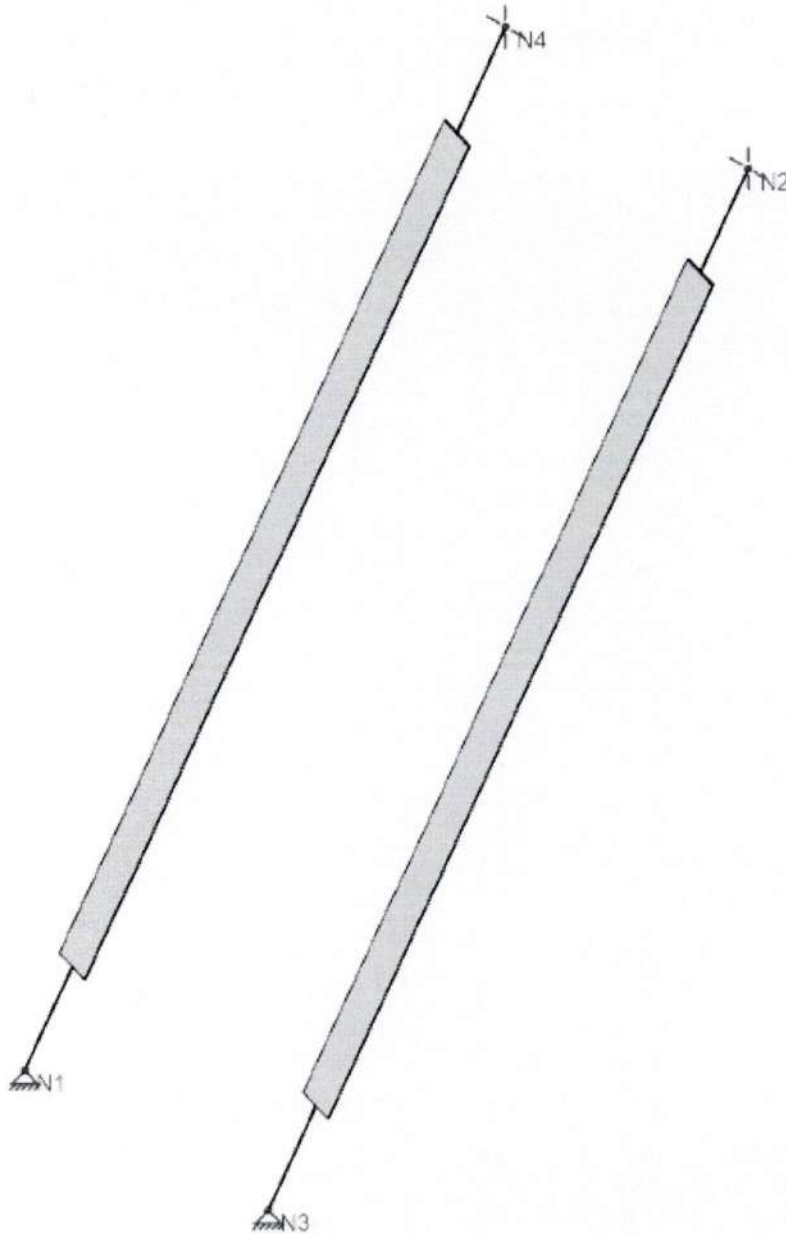
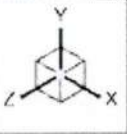


Stability Engineering, Inc.
 M. Foster
 22-0669 Pharmacy

Stair Stringers

MEMBER LABELS 1

22-0669 Pharmacy Stringers....

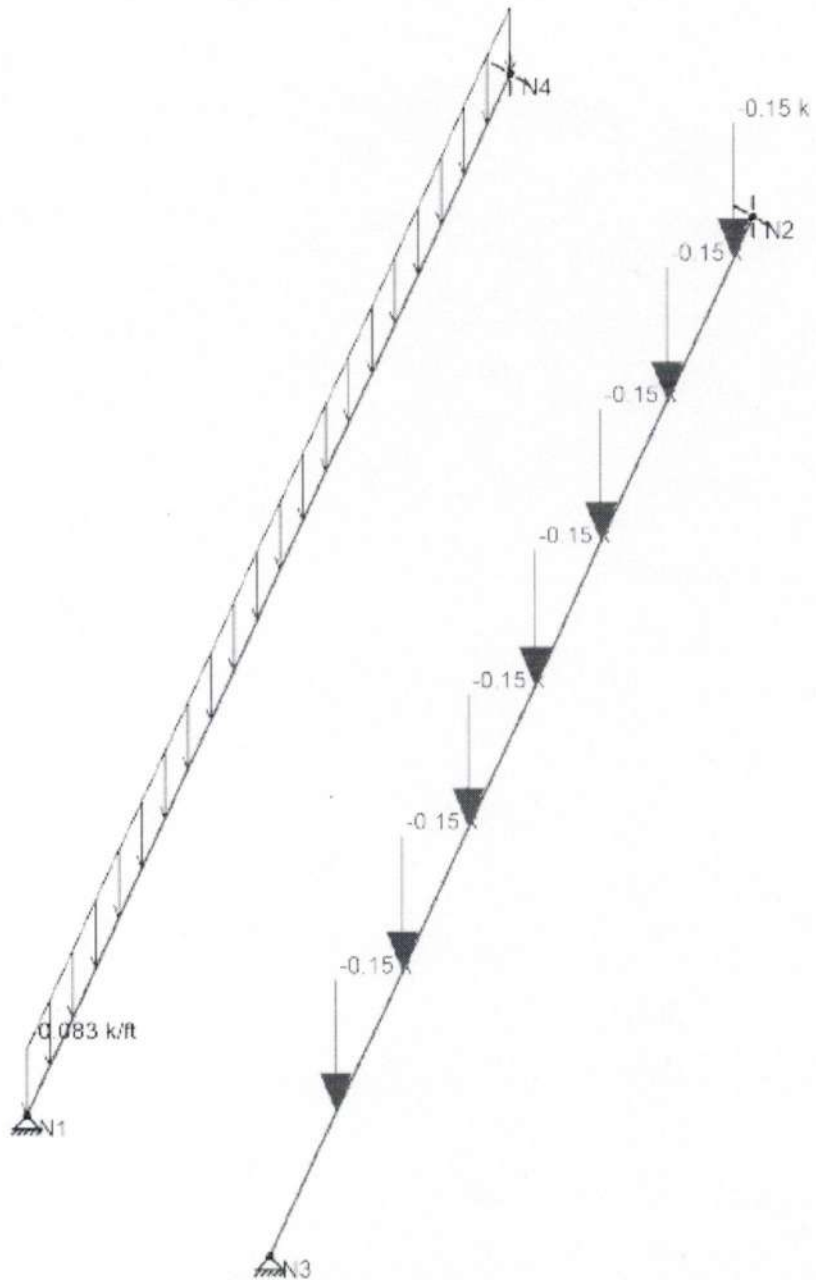
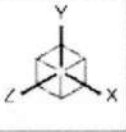



Stability Engineering, Inc.
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22-0669 Pharmacy

Stair Stringers

MEMBER RENDERING 2

22-0669 Pharmacy Stringers...



Loads: BLC 2, LIVE		Stair Stringers	LIVE LOADS 3
 Stability Engineering, Inc. M. Foster 22-0669 Pharmacy	22-0669 Pharmacy Stringers....		



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Pharmacy
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	9	14.1	0	
3	N3	3	0	0	
4	N4	6	14.1	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	7	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Pharmacy
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.15	2.1
2	M2	Y	-0.15	4.2
3	M2	Y	-0.15	6.3
4	M2	Y	-0.15	8.4
5	M2	Y	-0.15	10.5
6	M2	Y	-0.15	12.6
7	M2	Y	-0.15	14.7

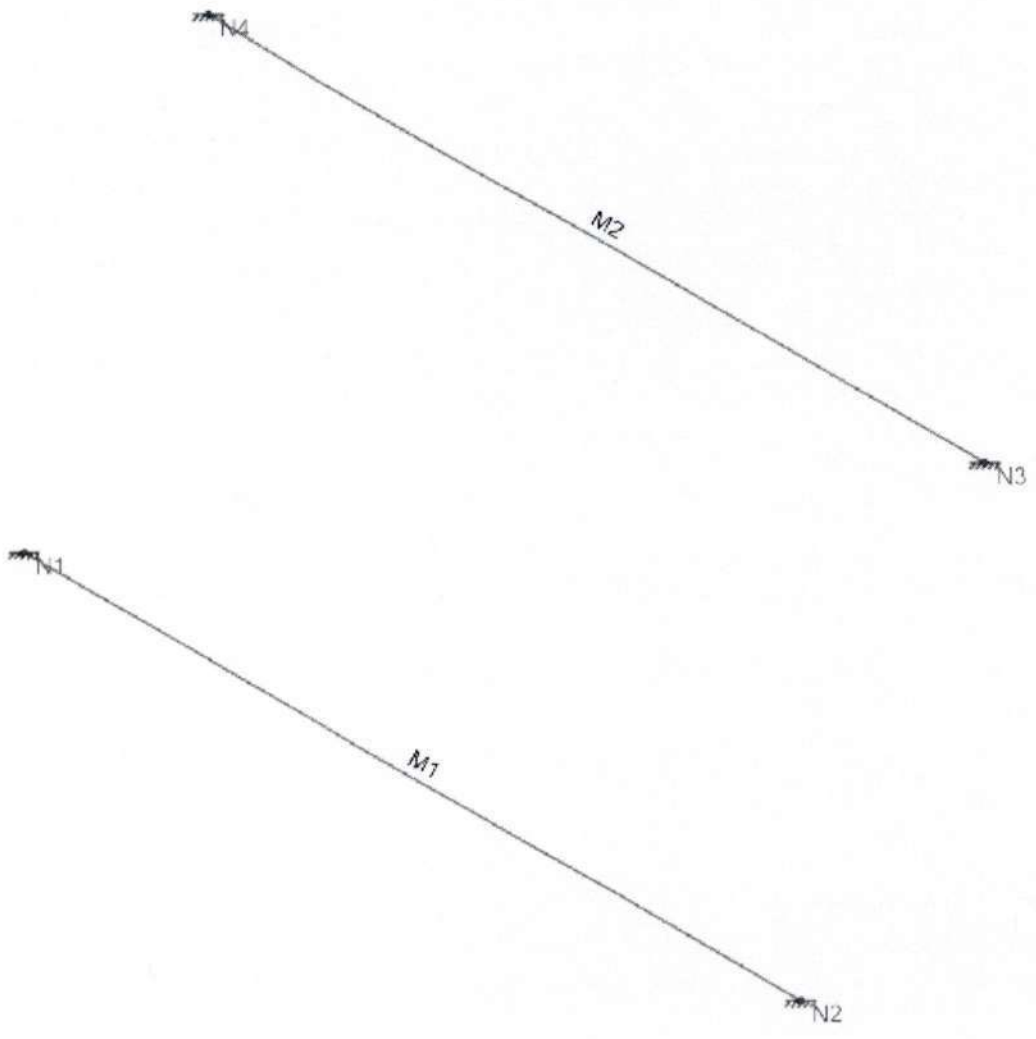
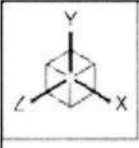
Envelope Node Reactions


Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC		
0	N1	max	0	4	0.7	5	0	5	LOCKED		LOCKED		0	5
1		min	0	3	0.064	1	0	1	LOCKED		LOCKED		0	1
2	N3	max	0	2	0.538	5	0	5	LOCKED		LOCKED		0	5
3		min	0	3	0.064	1	0	1	LOCKED		LOCKED		0	1
4	N2	max	0	5	0.639	5	0	5	0	5	0	5	0	5
5		min	0	2	0.064	1	0	1	0	1	0	1	0	1
6	N4	max	0	2	0.7	5	0	5	0	5	0	5	0	5
7		min	0	1	0.064	1	0	1	0	1	0	1	0	1
8	Totals:	max	0	5	2.576	5	0	5						
9		min	0	2	0.254	1	0	1						

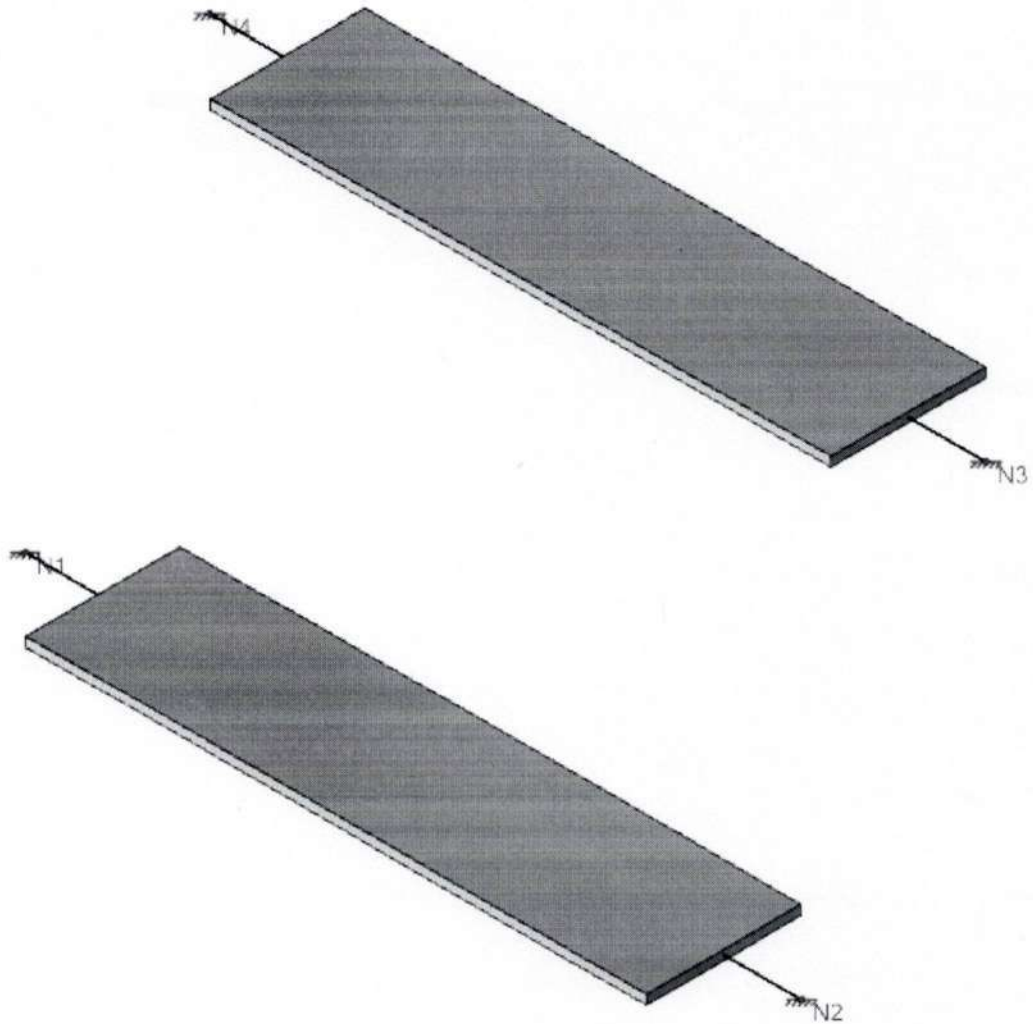
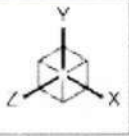
Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn	
0	M1	PL4X1/4	0.519	7.183	5	0.023	15.324	y	5	5.927	29.94	0.156	2.027	1	H1-1b
1	M2	PL4X1/4	0.452	8.3	5	0.021	15.324	y	5	5.927	29.94	0.156	2.027	1	H1-1b

< 1 ∴ OK



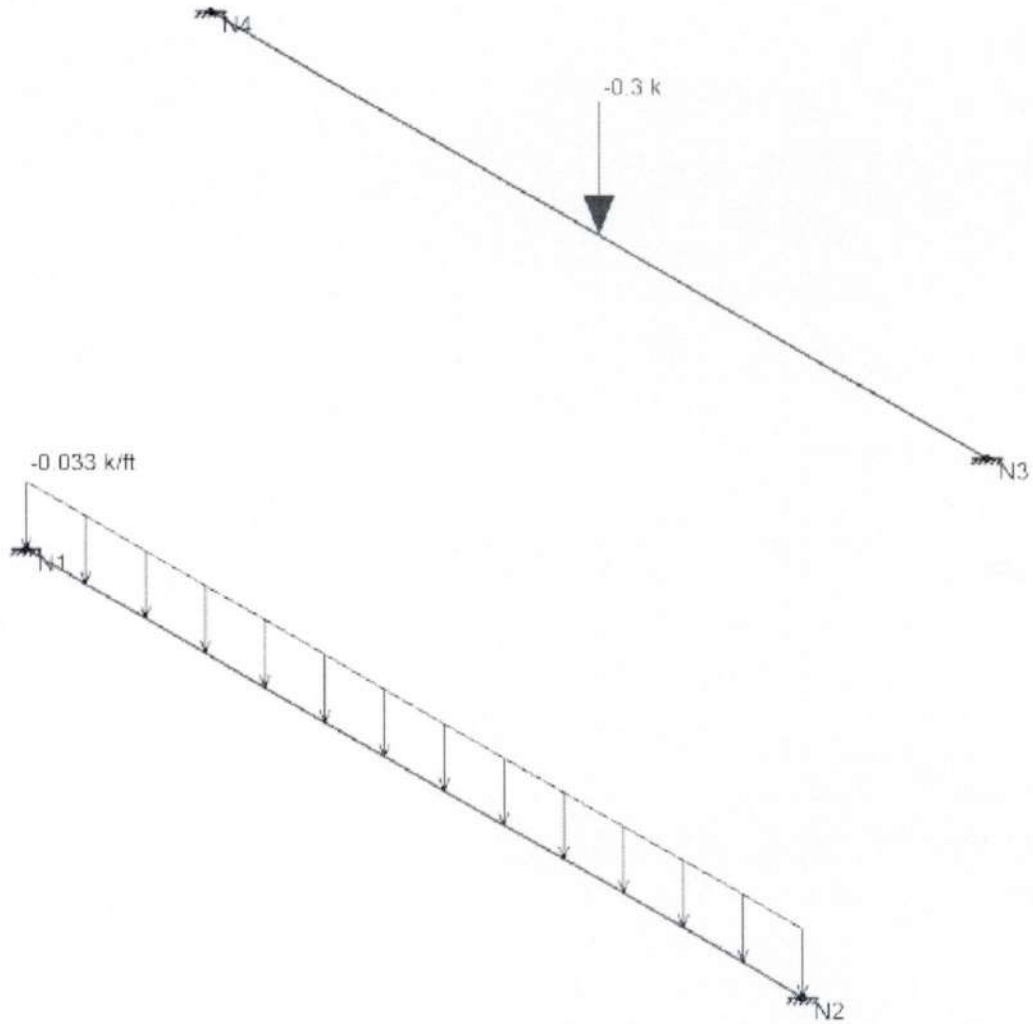
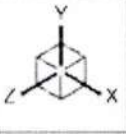
	Stability Engineering, Inc.	Stair Treads	MEMBER LABELS 1
	M. Foster		22-0669 Pharmacy Treads....
	22-0669 Pharmacy		



Stability Engineering, Inc.
M. Foster
22-0669 Pharmacy

Stair Treads

MEMBER RENDERING 2
22-0669 Pharmacy Treads....



Loads: BLC 2, LIVE



Stability Engineering, Inc.
 M. Foster
 22-0669 Pharmacy

Stair Treads

LIVE LOADS 3
 22-0669 Pharmacy Treads....



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Pharmacy
 Model Name : Stair Treads

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	1.67	0	0	
3	N3	1.67	0.8	-0.4	
4	N4	0	0.8	-0.4	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	TREAD	PL4"X1/4"	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	1	1

Member Distributed Loads (BLC 1 : DEAD)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M2	Y	-0.003	-0.003	0	%100
2	M1	Y	-0.003	-0.003	0	%100

Member Distributed Loads (BLC 2 : LIVE)

	Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.033	-0.033	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Pharmacy
 Model Name : Stair Treads

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1 M2	Y	-0.3	%50

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	5	0.03	5	0	5	0	5	0	5	0.008	5
1 N1 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
2 N2 max	0	5	0.03	5	0	5	0	5	0	5	-0.001	4
3 N2 min	0	1	0.003	1	0	1	0	1	0	1	-0.008	3
4 N4 max	0	5	0.153	5	0	5	0	5	0	5	0.063	5
5 N4 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
6 N3 max	0	5	0.153	5	0	5	0	5	0	5	-0.001	4
7 N3 min	0	1	0.003	1	0	1	0	1	0	1	-0.063	3
8 Totals: max	0	5	0.365	5	0	5						
9 Totals: min	0	1	0.01	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0 M1	PL4"x1/4"	0.054	1.67	5	0.002	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b
1 M2	PL4"x1/4"	0.406	1.67	5	0.008	1.67	z	5	1.949	29.94	0.156	1.429	1	H1-1b

<1 ∴ OK

Ladder Framing: (PL 2" x 1/4" Rails, 3/4" Dia. Rungs)

Ladder Vertical Loads:

$$LL = (100 \text{ pof})(1.34375 \text{ ft}) = 134 \text{ pLF}$$

$$P_{\text{test}} = (134 \text{ pLF})(25 \text{ ft}) = 3350 \text{ lb} \rightarrow \text{Specify } 3400 \text{ lb}$$

* Ladder rungs OK by inspection *

Ladder Lateral Loads:

$$LL = 50 \text{ pLF} / 2 \text{ rails} = (25 \text{ pLF})(14 \text{ ft}) = 350 \text{ lb}$$

$$PL = 200 \text{ lb} / 2 \text{ rails} = 100 \text{ lb} < 350 \text{ lb} \quad \therefore \text{Distributed Load Controls}$$

Load Testing Summary:

[BRACE LOADS]

$$P_1 = 573 \text{ lb}$$

$$P_2 = 716 \text{ lb}$$

$$P_3 = 798 \text{ lb}$$

$$P_4 = 817 \text{ lb}$$

[DECKING BARS]

$$P_5 = 73 \text{ lb}$$

[LANDING BARS]

$$P_6 = 297 \text{ lb}$$

[LADDER]

$$\text{Vertical } P = 3400 \text{ lb}$$

$$\text{Lateral } P = 350 \text{ lb}$$

WATER BARREL (OR SIMILAR) TESTING

[LEVEL 2]

$$LL = (100 \text{ psf}) [(12 \text{ ft})(3.6 \text{ ft}) - (3.4 \text{ ft})(1.8 \text{ ft})]$$

$$LL = 3710 \text{ lb}$$

[LEVEL 1]

$$LL = (100 \text{ psf}) [(12 \text{ ft})(3.6 \text{ ft}) - (5.3 \text{ ft})(1.8 \text{ ft})]$$

$$LL = 3370 \text{ lb}$$

[STAIR LOAD]

$$LL = (100 \text{ psf})(7.5 \text{ ft})(1.67 \text{ ft}) = 1253 \text{ lb} \rightarrow \text{Spec } 1260 \text{ lb on plans}$$

Fire Escape Load Testing Analysis:

Scope of Work: Calculations for load testing requirements for fire escape located at Shepard Hall

Building Code: 2009 O55C

Design Loads: $LL = 100 \text{ psf}$
 $DL = 10 \text{ psf}$ } Total Load = 110 psf

Calculate Brace Loads:Stair Loads:

$$LL = (100 \text{ psf})(0.417 \text{ ft})(1.67 \text{ ft})(24 \text{ treads}) = 1672 \text{ lb}$$

↙ Tread Width
↖ Tread Length

$$DL = (10 \text{ psf})(0.417 \text{ ft})(1.67 \text{ ft})(24 \text{ treads}) = 168 \text{ lb}$$

[Load at Each Support]

$$LL = 1672 \text{ lb} / 4 = 418 \text{ lb}$$

$$DL = 168 \text{ lb} / 4 = 42 \text{ lb}$$

Worst Case Brace:

$$L = 4 \text{ ft}$$

$$\text{Full Uniform Load } LL = (100 \text{ psf})(1.75 \text{ ft} + 2.75 \text{ ft}) = 450 \text{ plf}$$

$$DL = (10 \text{ psf})(1.75 \text{ ft} + 2.75 \text{ ft}) = 45 \text{ plf}$$

$$\text{Partial Uniform Load } LL = (100 \text{ psf})(1.375 \text{ ft}) = 137.5 \text{ plf}$$

$$\downarrow \text{ @ } L = 0 - 1.83 \text{ ft} \quad DL = (10 \text{ psf})(1.375 \text{ ft}) = 13.75 \text{ plf}$$

Stair Load @ $L = 1.83 \text{ ft}, 3.5 \text{ ft}$



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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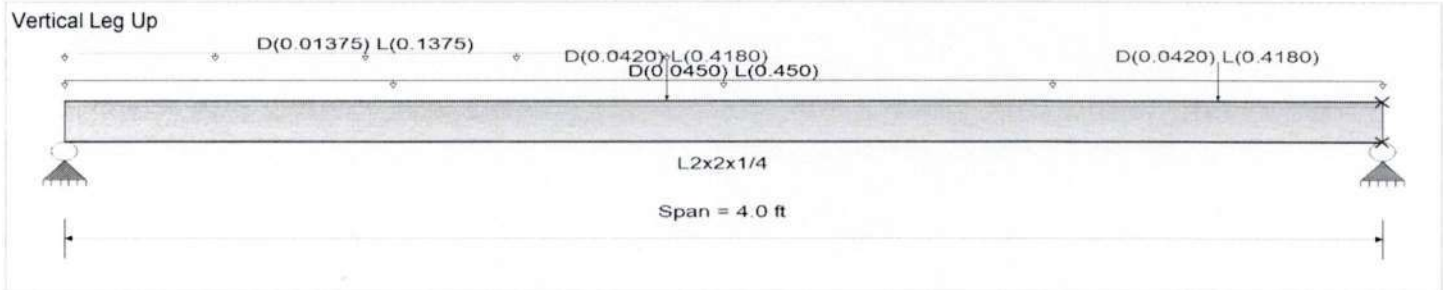
DESCRIPTION: BRACE DESIGN (LOADS ONLY)

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E: Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading

Uniform Load : D = 0.0450, L = 0.450 k/ft, Tributary Width = 1.0 ft, (FULL UNIFORM LOAD)

Uniform Load : D = 0.01375, L = 0.1375 k/ft, Extent = 0.0 --> 1.830 ft, Tributary Width = 1.0 ft, (PARTIAL UNIFORM LOAD)

Point Load : D = 0.0420, L = 0.4180 k @ 1.830 ft, (STAIR LOAD)

Point Load : D = 0.0420, L = 0.4180 k @ 3.50 ft, (STAIR LOAD)

Loads Only

DESIGN SUMMARY

Design: N.G.

Maximum Bending Stress Ratio =	1.843 : 1	Maximum Shear Stress Ratio =	0.186 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	1.688 k-ft	Va : Applied	1.673 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	4.000 ft
Span # where maximum occurs	Span # 1	Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.421 in Ratio = 113 <360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a	
Max Downward Total Deflection	0.469 in Ratio = 102 <180	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 <180	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L =	4.00 ft	1	0.174	0.018	0.16		0.16	1.53	0.92	1.00	1.00	0.16	15.00	8.98	
+D+L															
Dsgn. L =	4.00 ft	1	1.843	0.186	1.69		1.69	1.53	0.92	1.00	1.00	1.67	15.00	8.98	
+D+0.750L															
Dsgn. L =	4.00 ft	1	1.426	0.144	1.31		1.31	1.53	0.92	1.00	1.00	1.29	15.00	8.98	
+0.60D															
Dsgn. L =	4.00 ft	1	0.104	0.011	0.10		0.10	1.53	0.92	1.00	1.00	0.09	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.4689	2.000		0.0000	0.000



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build: 20.23.08.30

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: BRACE DESIGN (LOADS ONLY)

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	1.517	1.673
Max Upward from Load Combinations	1.517	1.673
Max Upward from Load Cases	1.373	1.515
D Only	0.144	0.158
+D+L	1.517	1.673
+D+0.750L	1.174	1.294
+0.60D	0.086	0.095
L Only	1.373	1.515

$P_1 = 1517 \text{ lb}$

$P_2 = 1673 \text{ lb}$

} Specify loading on plans

Landing Support Braces:Brace Geometry:

$$H = 2.5 \text{ ft}$$

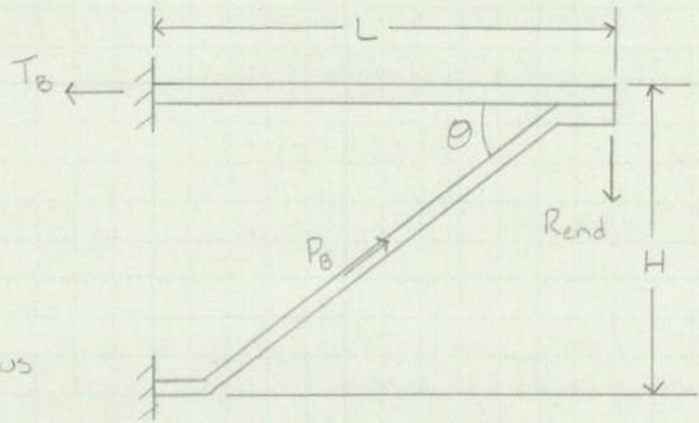
$$L = 4 \text{ ft}$$

$$\theta = \tan^{-1}(H/L) = 32^\circ$$

$$\left. \begin{aligned} R_{end} &= 1673 \text{ lb} \\ M_{max} &= 1690 \text{ lb}\cdot\text{ft} \end{aligned} \right\} \text{ See Previous Pages}$$

$$P_B = \frac{R_{end}}{\sin(\theta)} = 3157 \text{ lb}$$

$$T_B = P_B \cos \theta = 2678 \text{ lb}$$

Brace Section Properties: (1 1/4" Solid Square Bar)

$$Z_x = \frac{bd^2}{4} = 0.488 \text{ in}^3$$

$$Z_y = Z_x = 0.488 \text{ in}^3$$

$$\text{Area} = 1.5625 \text{ in}^2$$

$$F_y = 36 \text{ ksi}$$

Brace Checks:

$$\frac{M_n}{\Omega} = \frac{F_y Z}{1.67} = \frac{(36 \text{ ksi})(0.488 \text{ in}^3)}{1.67} = 10520 \text{ lb}\cdot\text{ft}$$

$$\frac{T_n}{\Omega} = \frac{F_y A}{1.67} = \frac{(36 \text{ ksi})(1.5625 \text{ in}^2)}{1.67} = 48500 \text{ lb}$$

$$\text{Tension Ratio} = \frac{T_B}{T_n/\Omega} = \frac{2678 \text{ lb}}{48500 \text{ lb}} = 0.056 < 0.2 \quad \therefore \text{Use AISC Egn H1-1b}$$

$$\text{Combined Ratio} = \frac{T_B}{2(T_n/\Omega)} + \frac{M_B}{M_n/\Omega} = 0.188 < 1 \quad \therefore \text{OK}$$

\therefore Load Tests Req'd for Connections Only

Framing ChecksDecking Bars

$$L = 2.9 \text{ ft}$$

$$\text{Load} = (110 \text{ psf})(0.25 \text{ ft}) = 27.5 \text{ plf}$$

$$M_u = \frac{wL^2}{8} = \frac{(27.5 \text{ plf})(2.9 \text{ ft})^2}{8} = 28.9 \text{ lb}\cdot\text{ft}$$

$$\frac{M_n}{\Omega} = \frac{F_y Z}{\Omega}$$

$$Z = \frac{bd^2}{4} = \frac{(1.5 \text{ in})(0.25 \text{ in})^2}{4} = 0.0234 \text{ in}^3$$

$$\frac{M_n}{\Omega} = \frac{(36000 \text{ psi})(0.0234 \text{ in}^3)}{1.67} \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 42.1 \text{ lb}\cdot\text{ft} > 28.9 \text{ lb}\cdot\text{ft} \quad \therefore \text{OK}$$

Landing Bars (Worst Case)

$$L = 4 \text{ ft}$$

$$LL = (100 \text{ psf})(2.75 \text{ ft}) = 275 \text{ plf}$$

$$DL = (10 \text{ psf})(2.75 \text{ ft}) = 27.5 \text{ plf}$$

} See Calc
on Next
Page



Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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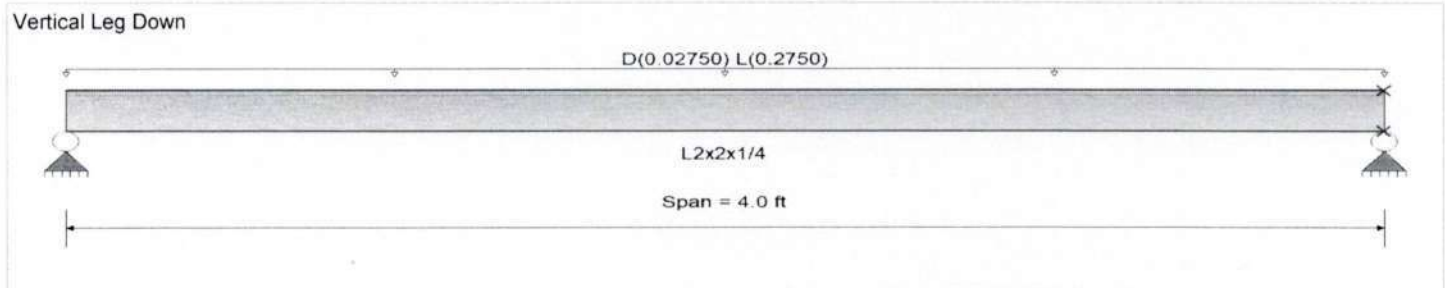
DESCRIPTION: LANDING BARS

CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method: Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.02750, L = 0.2750 k/ft, Tributary Width = 1.0 ft, (UNIFORM LOAD)

∴ Load Tests Req'd

DESIGN SUMMARY

Design N.G.

Maximum Bending Stress Ratio =	0.668 : 1	Maximum Shear Stress Ratio =	0.068 : 1
Section used for this span	L2x2x1/4	Section used for this span	L2x2x1/4
Ma : Applied	0.611 k-ft	Va : Applied	0.6114 k
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable	8.982 k
Load Combination	+D+L	Load Combination	+D+L
Span # where maximum occurs	Span # 1	Location of maximum on span	0.000 ft
		Span # where maximum occurs	Span # 1
Maximum Deflection			
Max Downward Transient Deflection	0.158 in Ratio = 302 < 360	Span: 1 : L Only	
Max Upward Transient Deflection	0 in Ratio = 0 < 360	n/a	
Max Downward Total Deflection	0.176 in Ratio = 272 >= 240	Span: 1 : +D+L	
Max Upward Total Deflection	0 in Ratio = 0 < 240.0	n/a	

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L =	4.00 ft	1	0.067	0.007	0.06		0.06	1.53	0.92	1.00	1.00	0.06	15.00	8.98	
+D+L															
Dsgn. L =	4.00 ft	1	0.668	0.068	0.61		0.61	1.53	0.92	1.00	1.00	0.61	15.00	8.98	
+D+0.750L															
Dsgn. L =	4.00 ft	1	0.517	0.053	0.47		0.47	1.53	0.92	1.00	1.00	0.47	15.00	8.98	
+0.60D															
Dsgn. L =	4.00 ft	1	0.040	0.004	0.04		0.04	1.53	0.92	1.00	1.00	0.04	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.1763	2.011		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.611	0.611
Max Upward from Load Combinations	0.611	0.611
Max Upward from Load Cases	0.550	0.550
D Only	0.061	0.061
+D+L	0.611	0.611
+D+0.750L	0.474	0.474
+0.60D	0.037	0.037



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: SHEPARD

Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

(c) ENERCALC INC 1983-2023

DESCRIPTION: LANDING BARS

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.550	0.550

$$M = \frac{PL}{4}$$

$$610 \text{ lb}\cdot\text{ft} = \frac{P(4 \text{ ft})}{4}$$

$$P = 610 \text{ lb}$$

Edge Angle Checks:

(L 2 x 2 x 1/4")

$$L = 6 \text{ ft}$$

$$LL = (100 \text{ psf})(6 \text{ ft}) = 200 \text{ plf}$$

$$DL = (10 \text{ psf})(6 \text{ ft}) = 20 \text{ plf}$$

* See calculations on next pages *



Steel Beam

Project File: 22-0669.ec6

LIC# : KW-06014874, Build:20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: EDGE ANGLE

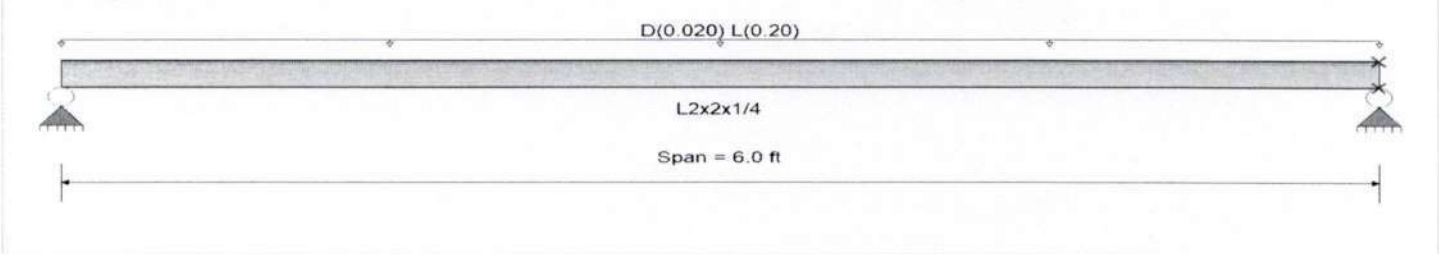
CODE REFERENCES

Calculations per AISC 360-16, IBC 2018, CBC 2019, ASCE 7-16
Load Combination Set : IBC 2021

Material Properties

Analysis Method : Allowable Strength Design
Beam Bracing : Beam is Fully Braced against lateral-torsional buckling
Bending Axis : Major Axis Bending
Fy : Steel Yield : 50.0 ksi
E : Modulus : 29,000.0 ksi

Vertical Leg Down



Applied Loads

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

Beam self weight calculated and added to loading
Uniform Load : D = 0.020, L = 0.20 k/ft, Tributary Width = 1.0 ft, (UNIFORM LOAD)

∴ Load Tests Req'd

DESIGN SUMMARY

				Design N.G.	
Maximum Bending Stress Ratio =	1.097 : 1	Maximum Shear Stress Ratio =		0.075 : 1	
Section used for this span	L2x2x1/4	Section used for this span		L2x2x1/4	
Ma : Applied	1.004 k-ft	Va : Applied		0.6696 k	
Mn / Omega : Allowable	0.916 k-ft	Vn/Omega : Allowable		8.982 k	
Load Combination	+D+L	Load Combination		+D+L	
Span # where maximum occurs	Span # 1	Location of maximum on span		0.000 ft	
Span # where maximum occurs	Span # 1	Span # where maximum occurs		Span # 1	
Maximum Deflection					
Max Downward Transient Deflection	0.581 in Ratio = 123 <360	Span: 1 : L Only			
Max Upward Transient Deflection	0 in Ratio = 0 <360	n/a			
Max Downward Total Deflection	0.652 in Ratio = 111 <240.0	Span: 1 : +D+L			
Max Upward Total Deflection	0 in Ratio = 0 <240.0	n/a			

Maximum Forces & Stresses for Load Combinations

Load Combination	Segment Length	Span #	Max Stress Ratios		Summary of Moment Values						Summary of Shear Values				
			M	V	Mmax +	Mmax -	Ma Max	Mnx	Mnx/Omega	Cb	Rm	Va Max	Vnx	Vnx/Omega	
D Only															
Dsgn. L = 6.00 ft	6.00 ft	1	0.114	0.008	0.10		0.10	1.53	0.92	1.00	1.00	0.07	15.00	8.98	
+D+L															
Dsgn. L = 6.00 ft	6.00 ft	1	1.097	0.075	1.00 <i>M_{max}</i>		1.00	1.53	0.92	1.00	1.00	0.67	15.00	8.98	
+D+0.750L															
Dsgn. L = 6.00 ft	6.00 ft	1	0.851	0.058	0.78		0.78	1.53	0.92	1.00	1.00	0.52	15.00	8.98	
+0.60D															
Dsgn. L = 6.00 ft	6.00 ft	1	0.068	0.005	0.06		0.06	1.53	0.92	1.00	1.00	0.04	15.00	8.98	

Overall Maximum Deflections

Load Combination	Span	Max. "-" Defl	Location in Span	Load Combination	Max. "+" Defl	Location in Span
+D+L	1	0.6516	3.017		0.0000	0.000

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
Max Upward from all Load Conditions	0.670	0.670
Max Upward from Load Combinations	0.670	0.670
Max Upward from Load Cases	0.600	0.600
D Only	0.070	0.070
+D+L	0.670	0.670
+D+0.750L	0.520	0.520
+0.60D	0.042	0.042



Stability Engineering, Inc.
777 NE 2nd St. Suite 280
Corvallis, Oregon 97339

Project Title: OSU FIRE ESCAPES
Engineer: M. FOSTER
Project ID: 22-0669
Project Descr: SHEPARD

170

Steel Beam

Project File: 22-0669.ec6

LIC#: KW-06014874, Build: 20.23.08.30

Stability Engineering Inc.

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DESCRIPTION: EDGE ANGLE

Vertical Reactions

Support notation : Far left is #

Values in KIPS

Load Combination	Support 1	Support 2
L Only	0.600	0.600

$$M = \frac{PL}{4}$$

$$1000 \text{ lb}\cdot\text{ft} = \frac{P(6\text{ft})}{4}$$

$$P = 667 \text{ lb}$$

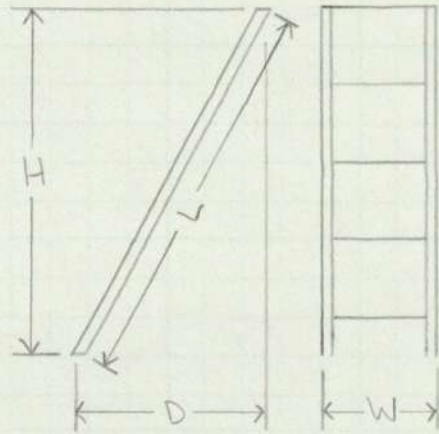
Stair Framing:Stair Dimensions:

$$H = 19.1 \text{ ft}$$

$$D = 9.5 \text{ ft}$$

$$L = 21.4 \text{ ft}$$

$$W = 1.67 \text{ ft}$$

Stair Stringer Loads:

Point Load = 300 lb @ Every Other Tread

$$LL = 100 \text{ psf} (0.83 \text{ ft}) = 83 \text{ plf}$$

$$DL = 10 \text{ psf} (0.83 \text{ ft}) = 8.3 \text{ plf}$$

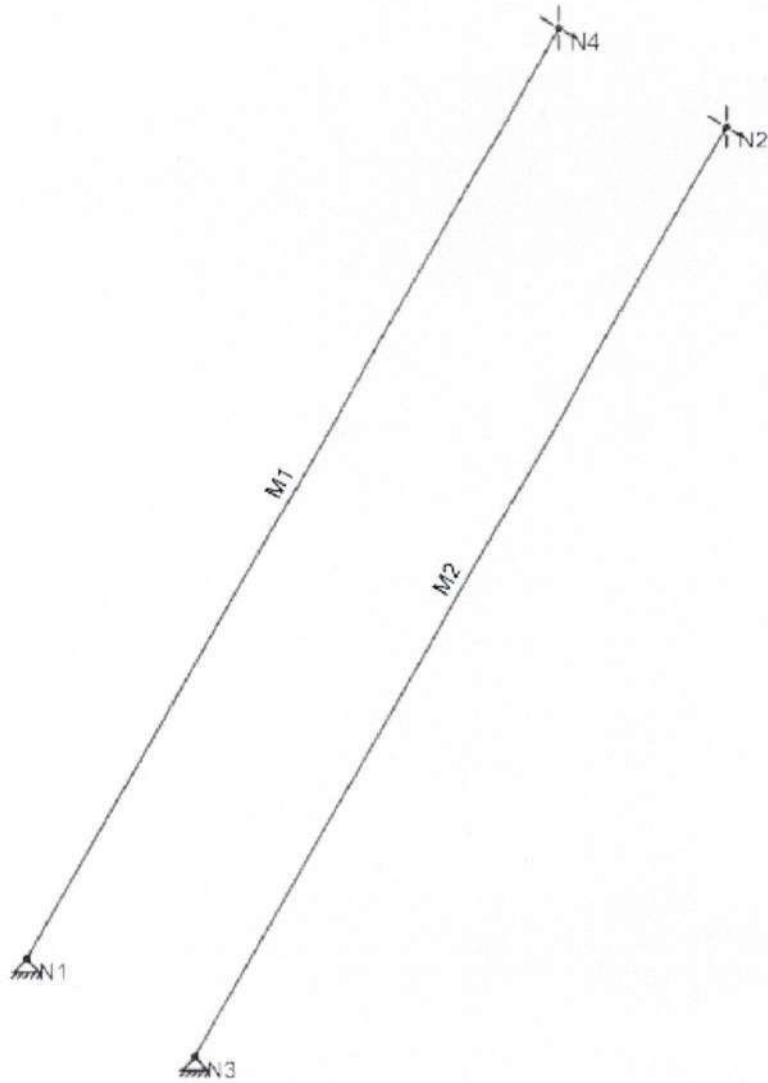
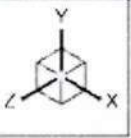
Stair Tread Loads:

Point Load = 300 lb @ Center of Tread

$$LL = (100 \text{ psf})(5 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 41.7 \text{ plf}$$

$$DL = (10 \text{ psf})(5 \text{ in}) \left(\frac{1 \text{ ft}}{12 \text{ in}} \right) = 4.17 \text{ plf}$$

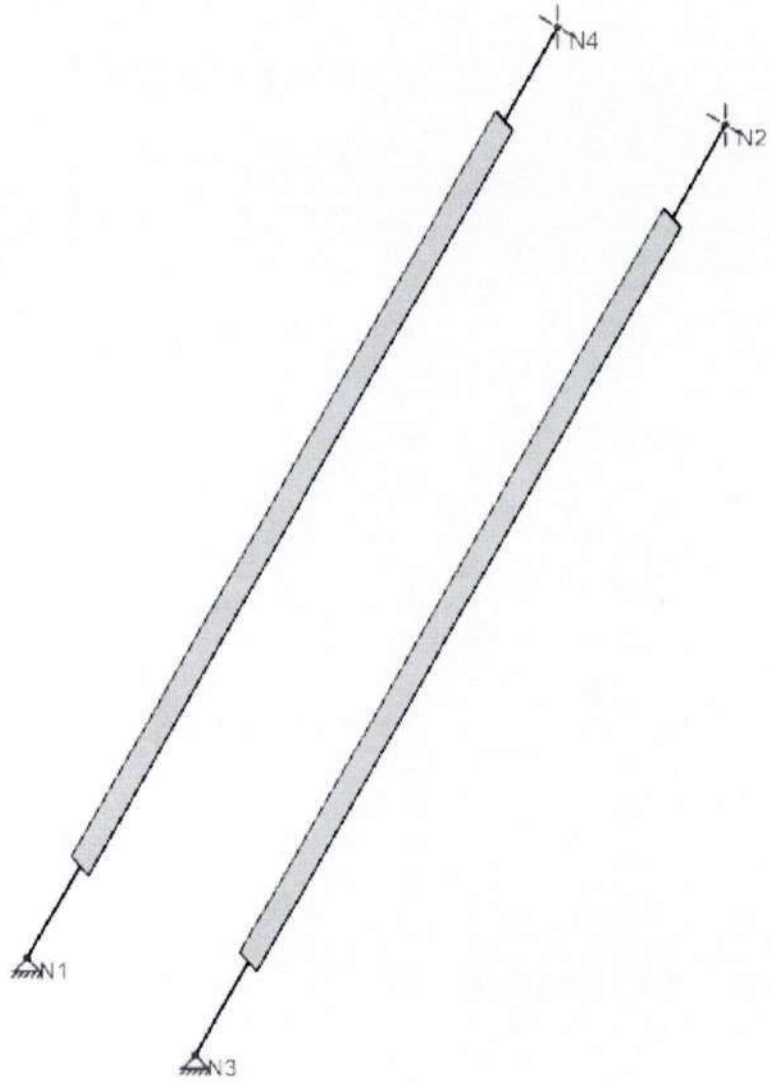
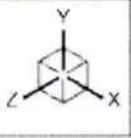
} @ Each Tread



Stability Engineering, Inc.
M. Foster
22-0669 Shepard

Stair Stringers

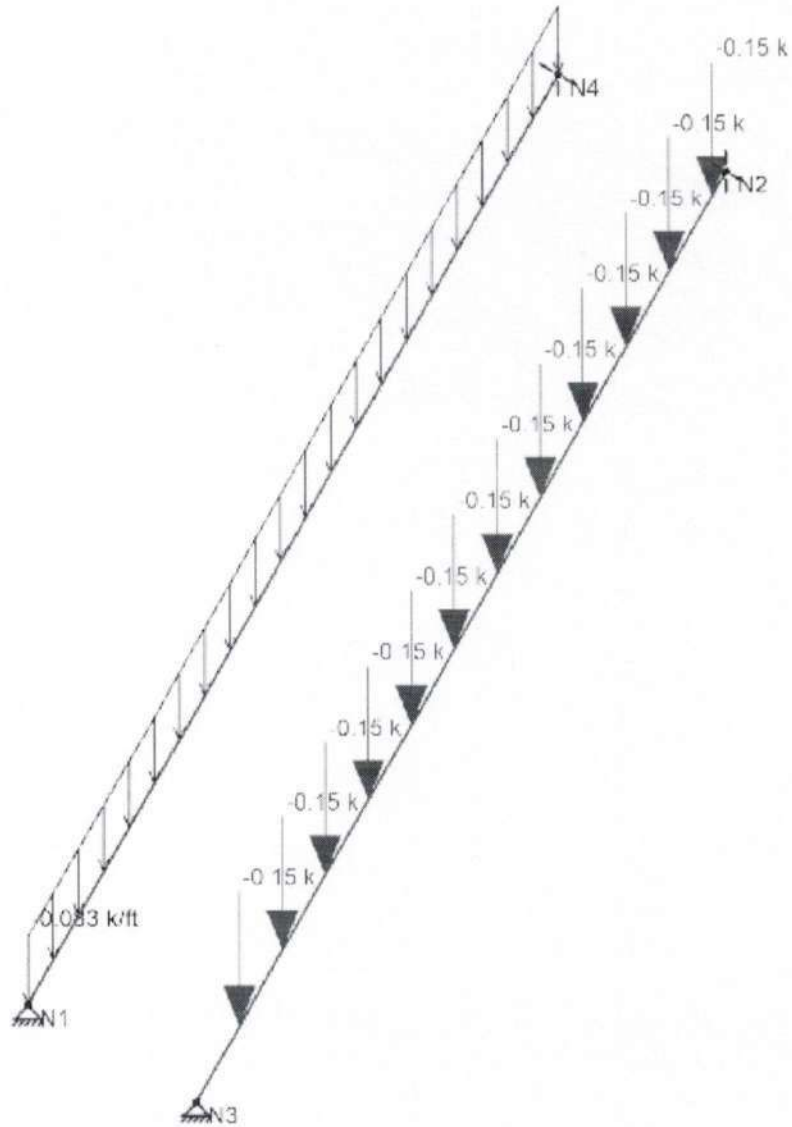
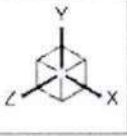
MEMBER LABELS 1
22-0669 Shepard Stringers.r3d



Stability Engineering, Inc.
M. Foster
22-0669 Shepard

Stair Stringers

MEMBER RENDERING 2
22-0669 Shepard Stringers.r3d



Loads: BLC 2, LIVE



Stability Engineering, Inc.
 M. Foster
 22-0669 Shepard

Stair Stringers

MEMBER RENDERING 3
 22-0669 Shepard Stringers.r3d



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Shepard
 Model Name : Stair Stringers

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	12.5	19.1	0	
3	N3	3	0	0	
4	N4	9.5	19.1	0	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	STRINGER	PL4X1/4	Beam	RECT	A992	Typical	1	0.005	1.333	0.02

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	12	1

Member Distributed Loads (BLC 1 : DEAD)

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.008	-0.008	0	%100
2	M2	Y	-0.008	-0.008	0	%100

Member Distributed Loads (BLC 2 : LIVE)

Member	Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.083	-0.083	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Shepard
 Model Name : Stair Stringers

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

	Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1	M2	Y	-0.15	1.73
2	M2	Y	-0.15	3.46
3	M2	Y	-0.15	5.19
4	M2	Y	-0.15	6.92
5	M2	Y	-0.15	8.65
6	M2	Y	-0.15	10.38
7	M2	Y	-0.15	12.11
8	M2	Y	-0.15	13.84
9	M2	Y	-0.15	15.57
10	M2	Y	-0.15	17.3
11	M2	Y	-0.15	19.03
12	M2	Y	-0.15	20.76

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1	max	0	4	0.974	5	0	5	LOCKED	LOCKED		0	5
1	min	0	3	0.089	1	0	1	LOCKED	LOCKED		0	1
2 N3	max	0	5	0.94	5	0	5	LOCKED	LOCKED		0	5
3	min	0	1	0.089	1	0	1	LOCKED	LOCKED		0	1
4 N2	max	0	4	1.037	5	0	5	0	5	0	5	5
5	min	0	2	0.089	1	0	1	0	1	0	1	1
6 N4	max	0	4	0.974	5	0	5	0	5	0	5	5
7	min	0	3	0.089	1	0	1	0	1	0	1	1
8 Totals:	max	0	4	3.925	5	0	5					
9	min	0	2	0.354	1	0	1					

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

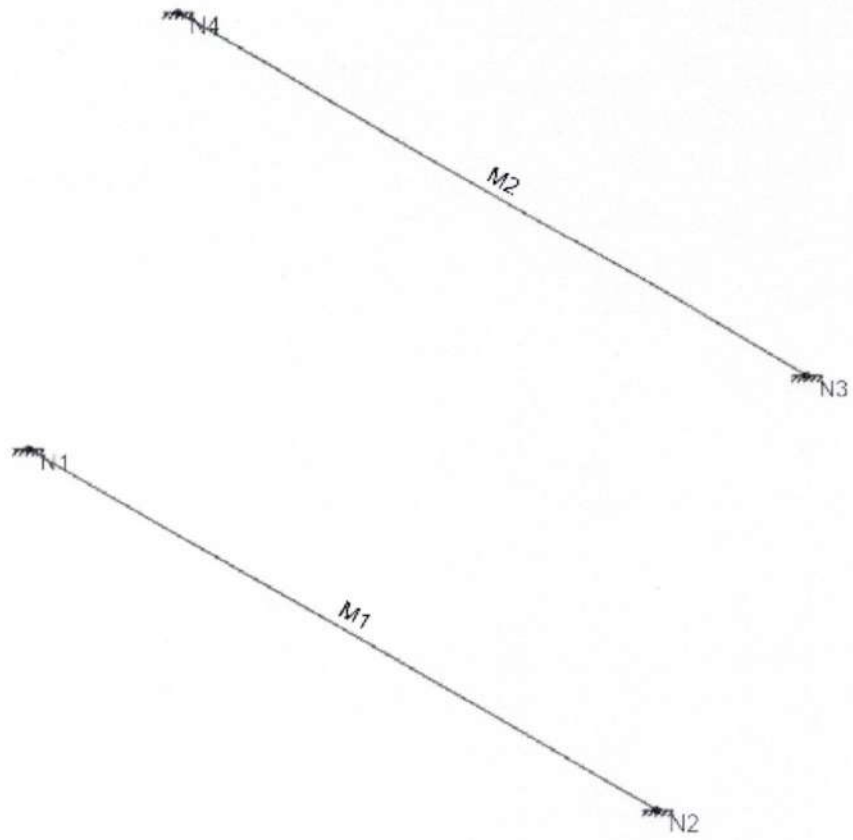
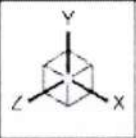
Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn.	
0	M1	PL4X1/4	1.145	9.999	5	0.036	21.332	y	5	3.058	29.94	0.156	2.027	1	H1-1b
1	M2	PL4X1/4	1.201	10.222	5	0.039	21.332	y	5	3.058	29.94	0.156	2.027	1	H1-1b

> 1 ∴ Testing Req'd

$$M = \frac{PL}{4}$$

$$2405 \text{ lb}\cdot\text{ft} = \frac{P(21.4\text{ft})}{4}$$

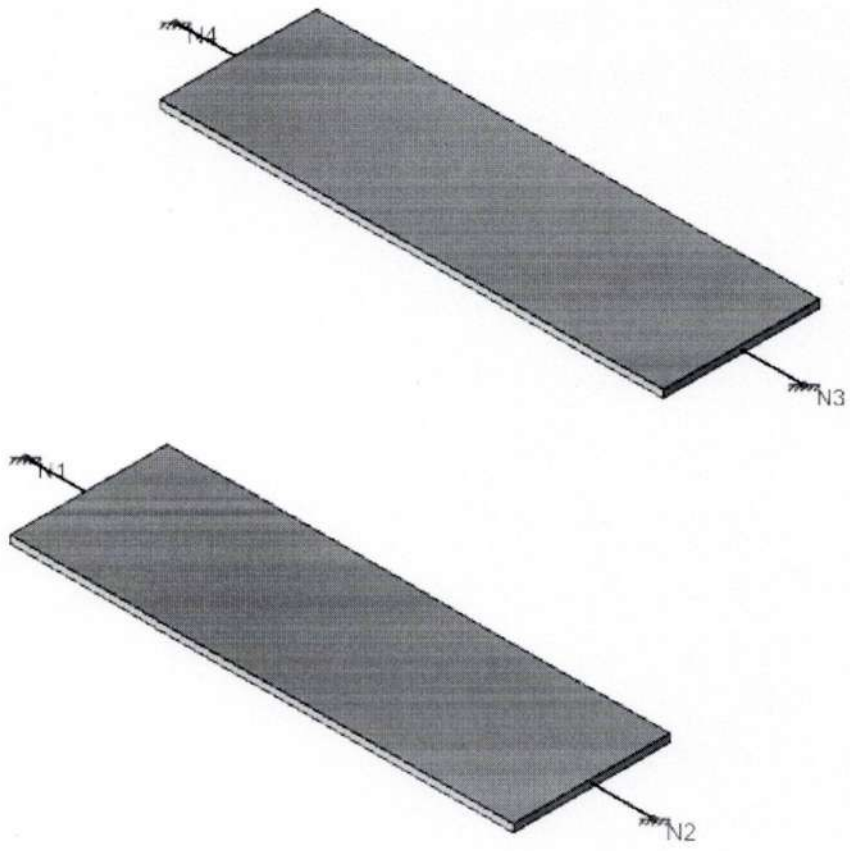
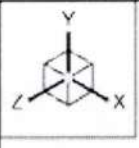
$$P = 450 \text{ lb}$$



Stability Engineering, Inc.
M. Foster
22-0669 Shepard

Stair Treads

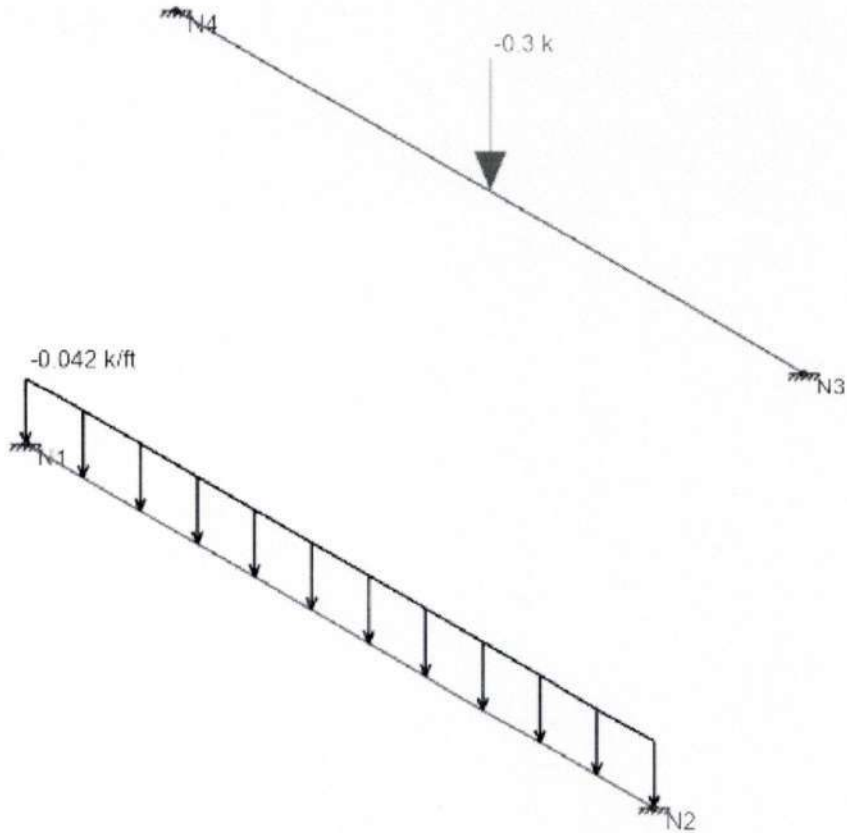
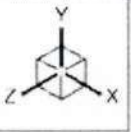
MEMBER LOADS 1
22-0669 Shepard Treads.r3d



Stability Engineering, Inc.
M. Foster
22-0669 Shepard

Stair Treads

MEMBER RENDERING 2
22-0669 Shepard Treads.r3d



Loads: BLC 2, LIVE



Stability Engineering, Inc.
M. Foster
22-0669 Shepard

Stair Treads

LIVE LOADS 3
22-0669 Shepard Treads.r3d



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Shepard
 Model Name : Stair Treads

Checked By : _____

Load Combinations

	Description	Solve	P-Delta	BLC	Factor	BLC	Factor	BLC	Factor
1	Deflection 1	Yes	Y	DL	1				
2	Deflection 2	Yes	Y	LL	1				
3	Deflection 3	Yes	Y	DL	1	LL	1		
4	ASCE ASD 1	Yes	Y	DL	1				
5	ASCE ASD 2	Yes	Y	DL	1	LL	1	LLS	1

Node Coordinates

	Label	X [ft]	Y [ft]	Z [ft]	Detach From Diaphragm
1	N1	0	0	0	
2	N2	1.67	0	0	
3	N3	1.67	0.8	-0.4	
4	N4	0	0.8	-0.4	

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm. Coeff. [1e ⁵ F ⁻¹]	Density [k/ft ³]	Yield [ksi]	Ry	Fu [ksi]	Rt
1	A992	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
2	A36 Gr.36	29000	11154	0.3	0.65	0.49	36	1.5	58	1.2
3	A572 Gr.50	29000	11154	0.3	0.65	0.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	0.3	0.65	0.527	42	1.4	58	1.3
5	A500 Gr.B RECT	29000	11154	0.3	0.65	0.527	46	1.4	58	1.3
6	A500 Gr.C RND	29000	11154	0.3	0.65	0.527	46	1.4	62	1.3
7	A500 Gr.C RECT	29000	11154	0.3	0.65	0.527	50	1.4	62	1.3
8	A53 Gr.B	29000	11154	0.3	0.65	0.49	35	1.6	60	1.2
9	A1085	29000	11154	0.3	0.65	0.49	50	1.4	65	1.3
10	A913 Gr.65	29000	11154	0.3	0.65	0.49	65	1.1	80	1.1

Hot Rolled Steel Section Sets

	Label	Shape	Type	Design List	Material	Design Rule	Area [in ²]	Iyy [in ⁴]	Izz [in ⁴]	J [in ⁴]
1	TREAD	PL5X1/4	Beam	RECT	A992	Typical	1.25	0.007	2.604	0.025

Basic Load Cases

	BLC Description	Category	Point	Distributed
1	DEAD	DL		2
2	LIVE	LL	1	1

Member Distributed Loads (BLC 1 : DEAD)

Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M2	Y	-0.004	0	%100
2	M1	Y	-0.004	0	%100

Member Distributed Loads (BLC 2 : LIVE)

Member Label	Direction	Start Magnitude [k/ft, F, ksf, k-ft/ft]	End Magnitude [k/ft, F, ksf, k-ft/ft]	Start Location [(ft, %)]	End Location [(ft, %)]
1	M1	Y	-0.042	0	%100



Company : Stability Engineering, Inc.
 Designer : M. Foster
 Job Number : 22-0669 Shepard
 Model Name : Stair Treads

Checked By : _____

Member Point Loads (BLC 2 : LIVE)

Member Label	Direction	Magnitude [k, k-ft]	Location [(ft, %)]
1 M2	Y	-0.3	%50

Envelope Node Reactions

Node Label	X [k]	LC	Y [k]	LC	Z [k]	LC	MX [k-ft]	LC	MY [k-ft]	LC	MZ [k-ft]	LC
0 N1 max	0	5	0.038	5	0	5	0	5	0	5	0.011	5
1 N1 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
2 N2 max	0	5	0.038	5	0	5	0	5	0	5	-0.001	4
3 N2 min	0	1	0.003	1	0	1	0	1	0	1	-0.011	3
4 N4 max	0	5	0.153	5	0	5	0	5	0	5	0.064	5
5 N4 min	0	1	0.003	1	0	1	0	1	0	1	0.001	1
6 N3 max	0	5	0.153	5	0	5	0	5	0	5	-0.001	4
7 N3 min	0	1	0.003	1	0	1	0	1	0	1	-0.064	3
8 Totals: max	0	5	0.383	5	0	5						
9 Totals: min	0	1	0.013	1	0	1						

Envelope AISC 15TH (360-16): ASD Member Steel Code Checks

Member	Shape	Code Check	Loc[ft]	LC	Shear Check	Loc[ft]	Dir	LC	Pnc/om [k]	Pnt/om [k]	Mnyy/om [k-ft]	Mnzz/om [k-ft]	Cb	Eqn
0	M1	PL5X1/4	0.054	1.67	5	0.002	1.67	z	5	2.437	37.425	0.195	1.786	1 H1-1b
1	M2	PL5X1/4	0.326	1.67	5	0.007	1.67	z	5	2.437	37.425	0.195	1.786	1 H1-1b

< 1 ∴ OK

Load Testing Summary:

[BRACE LOADS]

$$P_1 = 1517 \text{ lb}$$

$$P_2 = 1673 \text{ lb}$$

[LANDING BARS]

$$P_3 = 610 \text{ lb}$$

[EDGE ANGLE]

$$P_4 = 667 \text{ lb}$$

[STAIR STRINGERS]

$$P_5 = 450 \text{ lb}$$

Bexell Hall

**Sprinkler System Present

Levels	Occupancy Classification	Occupant Load			
		Description	Area (sq. ft.)	OSSC 1004.5	Total
1	A3	Labs	4,231	20	212
	B	Offices	3,714	150	25
	A3	Classrooms	1,951	20	98
2	B	Offices	5,738	150	39
	A3	Classrooms	1,395	20	70
	A3	Conference Rooms	593	20	30
	A3	Lounge/Assembly	2,162	15	145
3	A3	Classrooms	5,492	20	275
	B	Offices	4,352	150	30
4	A3	Classrooms	3,547	20	178
	A3	Conference Rooms	659	20	33
	B	Offices	5,486	150	37

Levels	Occupancy Classification	Egress Width (OSSC 1005.3.2)		
		Required (in)	Provided (in)	Pass?
1	A3	67	192	OK
	B			
	A3			
2	B	57	228	OK
	A3			
	A3			
	A3			
3	A3	61	120	OK
	B			
4	A3	50	120	OK
	A3			
	B			

Levels	Occupancy Classification	Exit Access Travel Distance (Max = 200', OSSC Table 1017.2)		Common Path Travel Distance (Max = 30', OSSC 1030.8)	
		Distance (ft)	Pass?	Distance (ft)	Pass?
1	B, A3	102	OK	28	OK
2	B, A3	96	OK	29	OK
3	B, A3	101	OK	27.5	OK
4	B, A3	93	OK	24.5	OK

Conclusions:

From this analysis, Bexell Hall **does not** require a fire escape.

Recommendations:

On the 3rd floor plan, there needs to be a door added in front of office 308. It exists in the building, but is not shown on the plans. Signs should be placed at all hallway doors that the doors need to remain closed.

Community Hall

**Sprinkler System Present in Most of Building

Levels	Occupancy Classification	Occupant Load			
		Description	Area (sq. ft.)	OSSC 1004.5	Total
1	A3	Classrooms	1,742	20	88
	B	Offices	3,296	150	22
2	A3	Classrooms	3,199	20	160
	B	Offices	2,211	150	15
MEZZANINE	B	Offices	788	150	6
3	A3	Classrooms	1,384	20	70
	B	Offices	3,226	150	22

Levels	Occupancy Classification	Egress Width (OSSC 1005.3.2)		
		Required (in)	Provided (in)	Pass?
1	A3	36	192	OK
	B			
2	A3	36	156	OK
	B			
MEZZANINE	B	36	36	OK
3	A3	36	144	OK
	B			

Levels	Occupancy Classification	Exit Access Travel Distance (Max = 200', OSSC Table 1017.2)		Common Path Travel Distance (Max = 30', OSSC 1030.8)	
		Distance (ft)	Pass?	Distance (ft)	Pass?
1	A3	79	OK	-	-
	B	63	OK	-	-
2	A3	123	OK	29.5	OK
	B	132	OK	-	-
MEZZANINE	B	163	OK	-	-
3	A3	220	NO GOOD	25	OK
	B	199	OK	-	-

Conclusions:

From this analysis, Community Hall does require **at least one** fire escape.

Recommendations:

None