Ing. Software
Dlubal

Version
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Program

RSTAB

Structural Analysis and Design
Dynamic Analysis

Verification Manual

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1. Introduction

1.1 Disclaimer

RSTAB is a software package used by over 7,000 engineers worldwide. It has been developed by a team of highly qualified engineers and programmers. All shipped versions of RSTAB have been extensively tested before delivered to the users. Nevertheless, ING. SOFTWARE DLUBAL does not resume responsibility for the validity of the results obtained from RSTAB and its modules or for the accuracy of this documentation.

The user must verify his own results.

RSTAB is meant to be a tool used in structural analysis and design. The engineer working with RSTAB is responsible for a correct structural model and the interpretation of the results.

ING. SOFTWARE DLUBAL

1.2 Introduction

The following examples were selected to provide a representation of a wide range of model types and analysis options. Yet they are kept simple to be able to manually follow the analysis. This manual compares theoretical analysis results with the results obtained in RSTAB. The examples were taken from available literature.

2. Examples

2.1 Design of Beam for Moment (AISC ASD 9th Edition)

This example is taken from:

Applied Structural Steel Design (Third Edition)
by Leonard SPIEGEL, George F. LIMBRUNNER
ISBN 0-13-381583-8
Pages 120 – 122

Geometry

The structural system is a two bay beam with a span of 14 ft each.

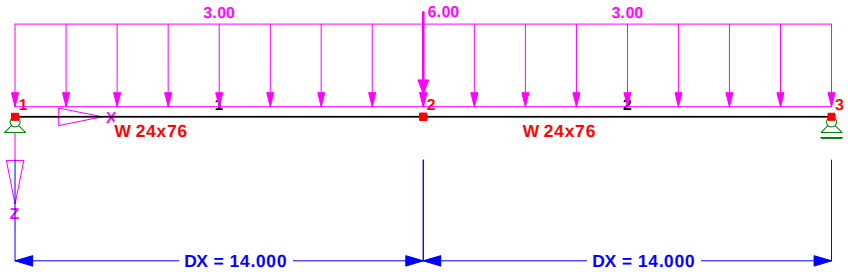
Material: Steel A36

Sections: W 24x76

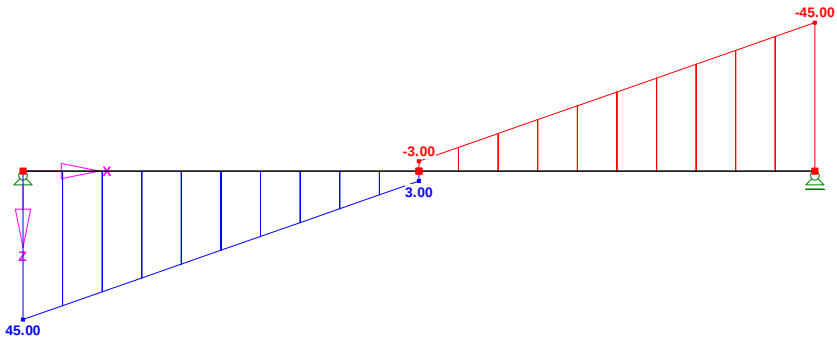
Supports pinned at both ends

Loads: See below

Structural System

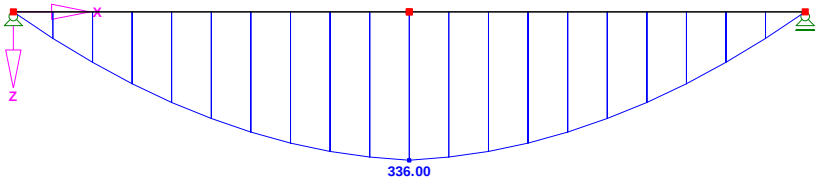


Shear Forces V



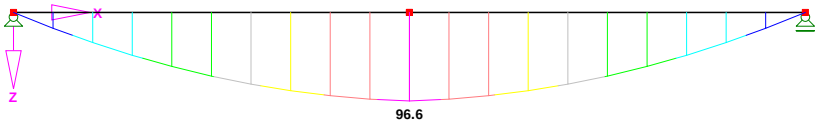
Max V-3: 45.00, Min V-3: -45.00 kip

Bending Moments M



Max M-2: 336.00 kipft

Bending Stress Ratio



Max = 96.6%

This example shows no differences in the results of RSTAB and the analytical results in the literature as can be seen on the following page.

Example 4-7

Select the lightest W shape for the beam shown in Figure 4-16a. Assume full lateral support ($L_b = 0$) and A36 steel. Consider moment only.

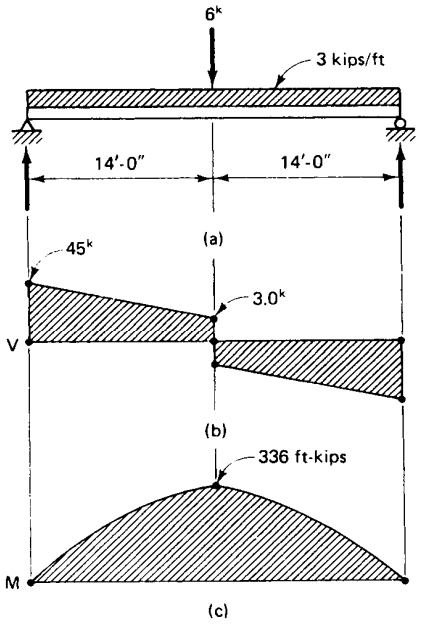


FIGURE 4-16 Load, shear, and moment diagrams.

Solution:

The beam reactions are determined from the load diagram; the shear and moment diagrams are drawn. These are shown in Figure 4-16b and c. Note that no beam weight is included since the beam is unknown. An estimate of the beam weight could be made and its effect on the moment included. This is optional at this point. The beam weight must be included before the final selection of section is made, however. The maximum moment is determined to be 336 ft-kips, as shown in Figure 4-16c.

Select F_b, if possible. In this case the A36 steel beam has full lateral support and F_b almost assuredly equals $0.66F_y$, since virtually all W shapes of A36 steel are compact. Therefore, assume that

$$F_b = 0.66F_y = 0.66(36) = 24 \text{ ksi}$$

Determine the required S_x:

$$\text{required } S_x = \frac{M}{F_b} = \frac{336(12)}{24} = 168.0 \text{ in.}^3$$

From the ASDM, Part 2 (Allowable Stress Design Selection Table), select a W24 × 76 with an $S_x = 176$ in.^{3} It is the lightest W shape that will furnish the required section modulus. Note that the section selected weighs 76 lb/ft. Add in the effect of the beam weight:

$$\text{additional } M = \frac{wL^2}{8} = \frac{0.076(28)^2}{8} = 7.45 \text{ ft-kips}$$

$$\text{new total } M = 336 + 7.45 = 343 \text{ ft-kips}$$

$$\text{new required } S_x = \frac{M}{F_b} = \frac{343(12)}{24} = 171.5 \text{ in.}^3$$

The W24 × 76 is satisfactory since 176 in.^{3} > 171.5 in.^{3} required. Also, now check the assumed F_b; the W24 × 76 is compact, since $F_y' > F_y$, and has adequate lateral support; therefore, the assumed F_b is satisfactory. **Use W24 × 76.**

2.2 Multi-Story Frame (P-Delta)

This example is taken from:

Limits States Design in Structural Steel
by G.L. KULAK, P.F. ADAMS, M.I GILMOR
Canadian Institute of Steel Construction
4th Edition 1990
Chapter 9.4

Geometry

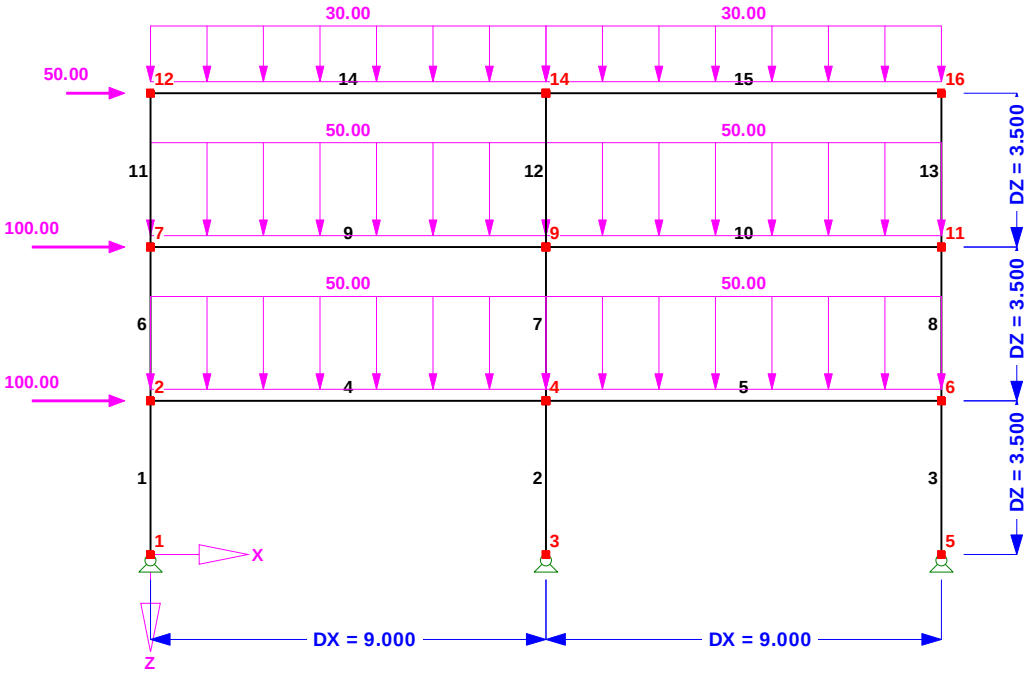
Dimensions: as shown below

Material: Steel with E=20410 kN/cm²

Sections: UB 533x210x122 (British steel I-beam)

Supports: pinned

Structural System



In the reference, the maximum bending moment according second order analysis for the column of element 3 is 388 kNm.

The RSTAB results are as following:

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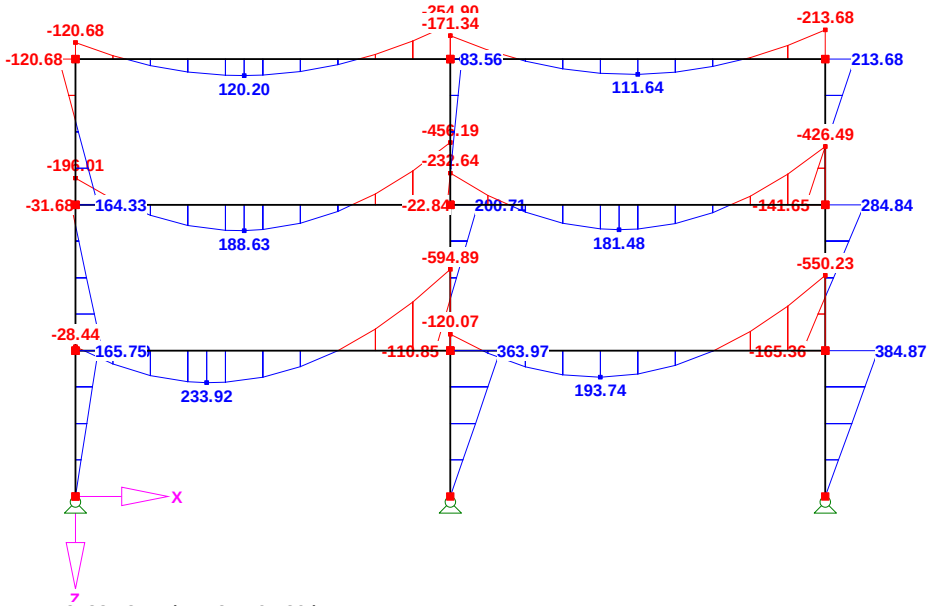


Max M-2: 384.87, Min M-2: -594.89 kNm

The differences in this example to the analytical value in the literature reference are:

384,87/388=0.81%

2.3 Simple Frame (P-Delta)

This example is taken from:

Design of Steel Structures (Third Edition)
by Edwin H. GAYLORD, Jr., Charles N. GAYLORD, James E. STALLMEYER
ISBN 0-07-023054-4
Pages 446-447

Geometry

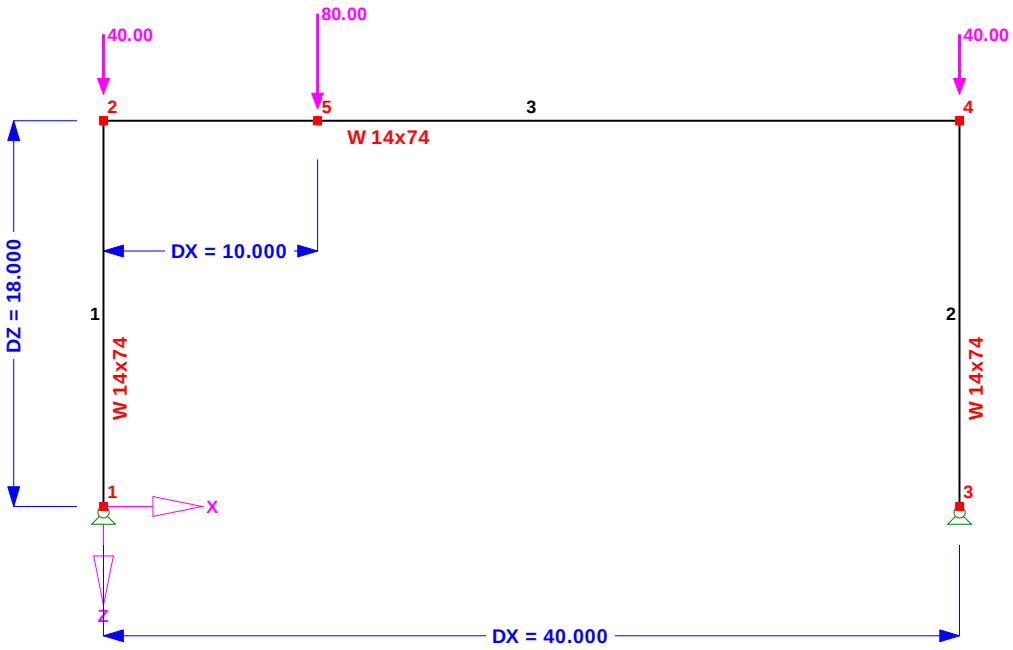
Dimensions: as shown below

Material: Steel A 36

Sections: W 14x74

Supports: pinned

Structural System



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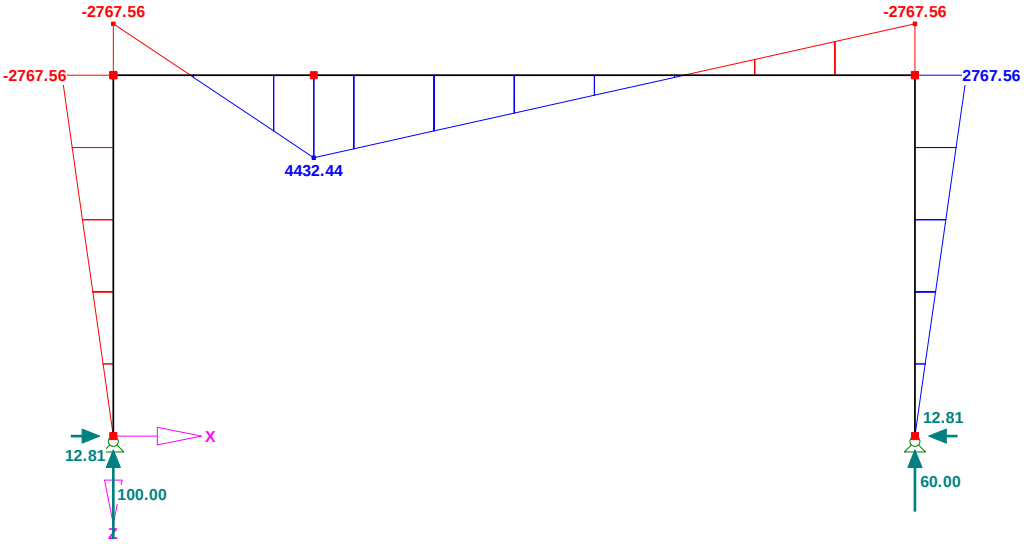
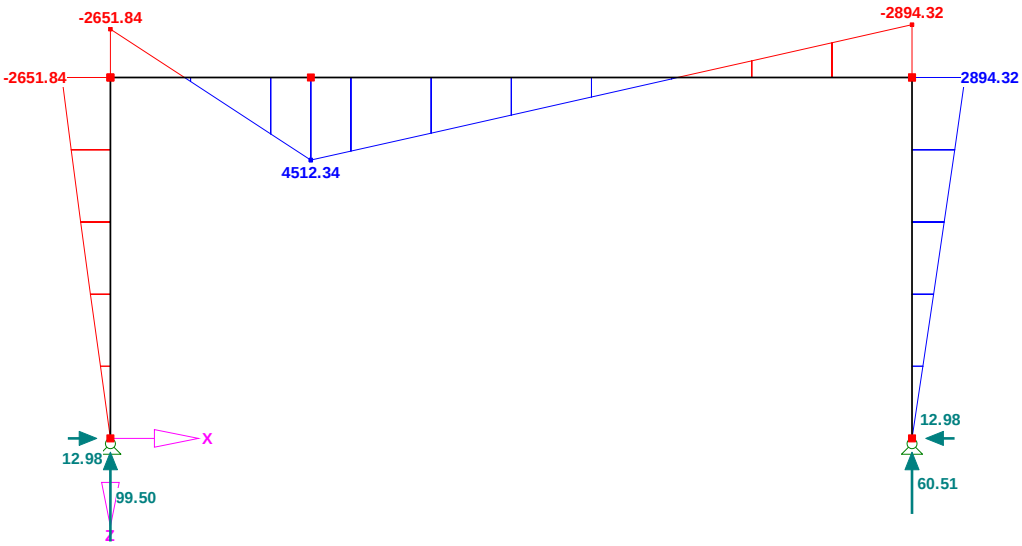
Results Linear Elastic Analysis



Max M-2: 4432.44, Min M-2: -2767.56 kipin

In the literature the maximum bending moment is 2767 kip in. RSTAB gives 2767.56 kip in. The difference is 0.02%.

Results Non-Linear Second-Order Elastic



Max M-2: 4512.34, Min M-2: -2894.32 kipin

In the literature the maximum bending moment is 2889 kip in. RSTAB gives 2894.32 kip in. The difference is 0.18%. The corresponding pages from the literature follow.

Example 6-10-1. The single-bay frame shown in Fig. 6-22*a* is considered in this example. All members are W14 × 74 of A36 steel, with the weak (y) axis in the plane of the frame. The frame is braced in the direction perpendicular to its plane at the top of the column, so $(KL)_y = 18$ ft.

Results of the first- and second-order analyses are shown in the figure.

Solution

***Pδ* effect**

$$\text{Beam: } \frac{I}{L} = \frac{796}{40 \times 12} = 1.66 \qquad \text{Column: } \frac{I}{L} = \frac{796}{18 \times 12} = 3.68$$

$$G_{top} = \frac{3.68}{1.66} = 2.2 \qquad G_{bot} = 10 \text{ for pinned-end} \qquad \text{(Art. 4-11)}$$

From Fig. 4-28, $K = 0.91$,

$$P_E = \frac{\pi^2 \times 29{,}000 \times 796}{(0.91 \times 18 \times 12)^2} = 5897 \text{ kips}$$

From Eq. (6-7)

$$C_m = 0.6 - 0.4 \frac{M_1}{M_2} = 0.6$$

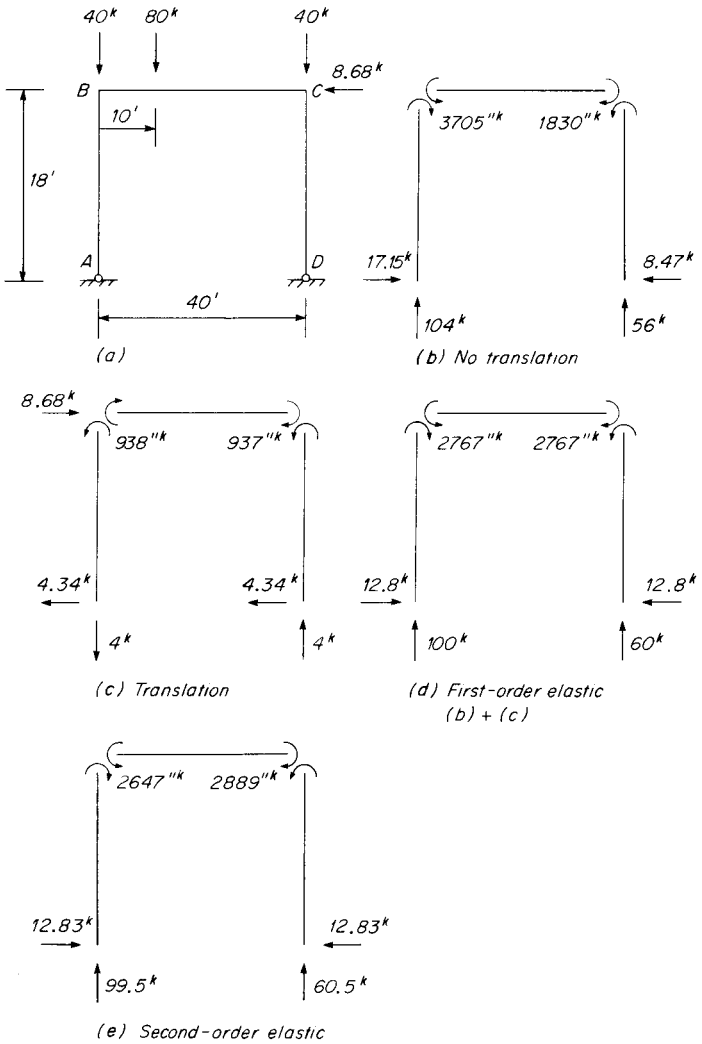


FIGURE 6-22

2.4 Cables

This example is analyzed according:

Statik der Seilkonstruktionen
By Szymon PALKOWSKI
ISBN 0-387-51125-3

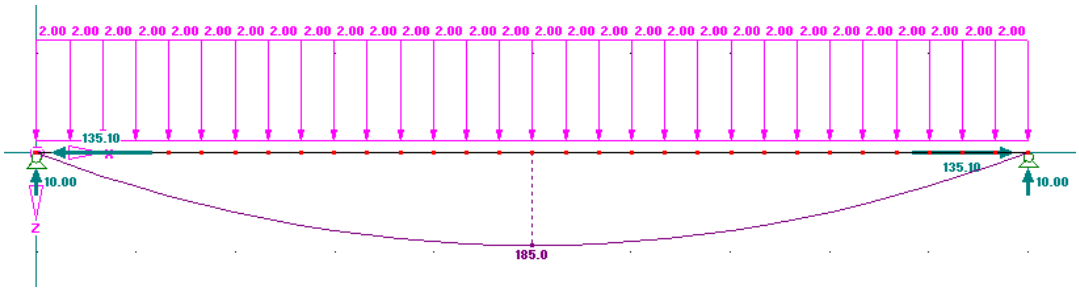
Geometry

Cable with 10 m in length between two horizontally fixed supports

Inelastic cable

Structural System

Distributed load of 2 kN/m



The horizontal reaction in the support nodes is:

$$H = \frac{q * l^2}{8 * f} = \frac{2 * 10^2}{8 * 0.185} = 135.14 kN$$

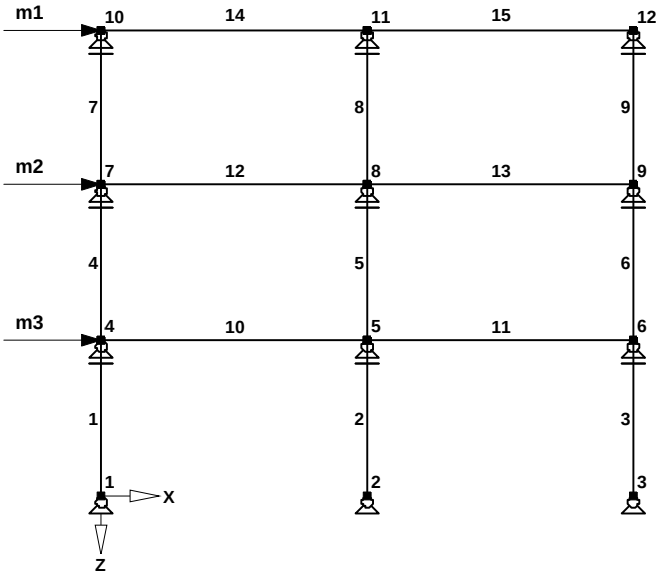
RSTAB calculates 135.10 kN.

The result can be still improved when more intermediate nodes are inserted.

2.5 Modal Analysis of Frame

This example i staken from:

MESKOURIS, Konstantin (1999)
Baudynamik, Modelle Methoden Praxisbeispiele
Ernst & Sohn, Berlin
ISBN 3-433-01326-8



Example according to MESKOURIS, K. (pp. 99 ff. and 117 ff.)

$EI_R = 32{,}000\ kNm^2$

$EI_S = 30{,}000\ kNm^2$

m1 = m2 = 30 t

m3 = 8 t

According to this example, the first three eigenmodes are analyzed. Then the response of the frame to the following excitation is analyzed in nodes 4, 7 and 10.

$$P(t) = \begin{bmatrix} 10.0 \\ 10.0 \\ 5.0 \end{bmatrix} f(t);\ f(t) = (\ 0\ sec = 0\ kN\ ;\ 0.5\ sec = 1\ kN\ ;\ 1\ sec = 0\ kN\ )$$

For all modal participations a damping of 2% is chosen.

The following table compares the RSTAB-DYNAM results to those of the literature.

Eigenmode No.	Eigenperiod [sec]	
	RSTAB-DYNAM	Literature
1	0.761587	0.755128
2	0.189607	0.181723
3	0.105814	0.105522

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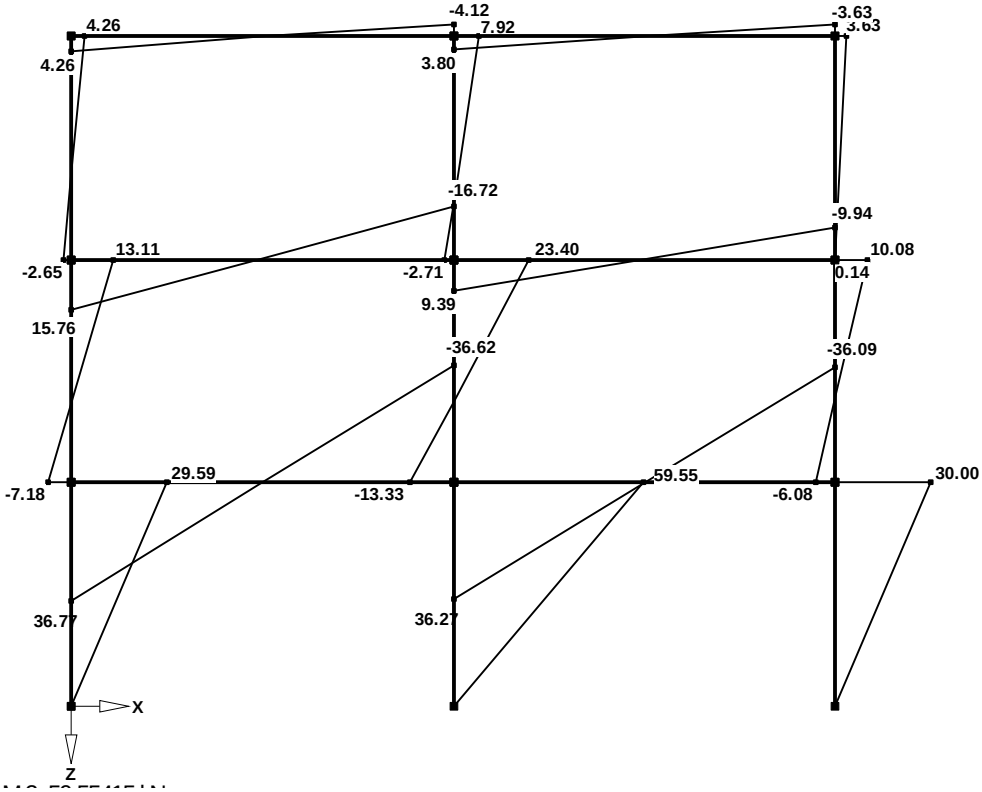
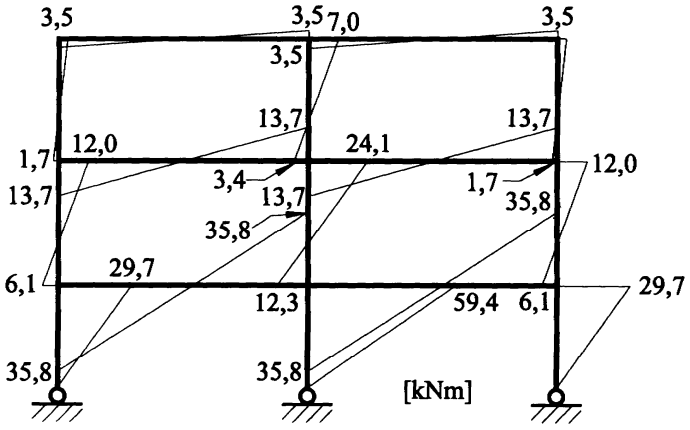
Next there is a comparism of the internal forces in RSTAB and in the literature at the time of 0,61 sec.



Bending moments M-2 in [kNm] in RSTAB- DYNAM at time = 0.61 sec



Bending moments M-2 in literature at time t = 0.61 sec

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☐ Stress Analysis
☐ Dynamic Analysis

☒ 1st Order Analysis
☐ 2nd Order Analysis
☐ Cable Theory

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☐ LS Combinations

☐ Design Cases
☐ Dynamic Cases
☐ Buckling Curves

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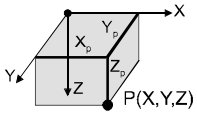
☐ 1D Continuous Beam
☒ 2D Construction Type
☐ 3D Construction Type
☐ Grid

3 Nodes
1 Materials
1 Sections
0 Element Hinges
0 Element Partitions

2 Elements
0 Cables
0 Tapered Elements
0 Elastic Foundations
0 Sets of Elements

STRUCTURE

Cartesian



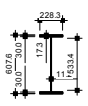
NODES

Node No	Coordinates-System	Ref Nodes	Node Coordinates X [ft]	Y [ft]	Z [ft]
1	Cartesian	-	0.000		0.000
	Gelagert				
2	Cartesian	-	14.000		0.000
3	Cartesian	-	28.000		0.000
	Gelagert				

MATERIALS

Mat No	Material Description	E Modulus [ksi]	Shear Mod [ksi]	Spec Weight [kip/in³]	Coeff Therm [1/°C]
1	Steel A36	2.900E+04	1.115E+04	2.892E-04	1.200E-05

W 24x76



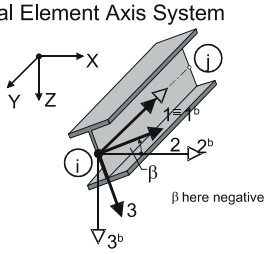
SECTIONS

Sec No	Mat No	Section Description	I_2 [in⁴]	A [in²]	A_3 [in²]
1	1	W 24x76	2100.00000	22.40000	9.85049

ELEMENTS

Elem No	Elem Type	Nodes Begin	Nodes End	Beta [°]	Section Begin	Section End	Hinge Begin	Hinge End	Part No	Length [ft]	Elem Location
1	Beam	1	2	0.0	1	1	-	-	-	14.000	HORI
2	Beam	2	3	0.0	1	1	-	-	-	14.000	HORI

Local Element Axis System



SUPPORTS

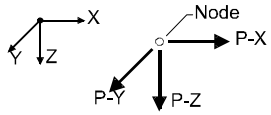
Support No	Supported Nodes	Rotation [°] Alpha	Beta	Fixed Support/Support Spring [kip/ft] [kipft/rad] in X	in Y	in Z	ar X	ar Y	ar Z
1	1	0.0	0.0	Yes	Yes	Yes	Yes	No	Yes
	Gelenkig								
2	3	0.0	0.0	No	Yes	Yes	Yes	No	Yes

LOADS

GENERAL DATA

LS No	LS Description	Factor	Combination Type	Dead Weight
1	Loadcase 1	1.00	Permanent	-

Global Nodal Force

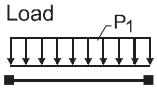


NODAL FORCES

LS 1

No	Loaded Nodes	Nodal Forces PX [kip]	PY [kip]	PZ [kip]
1	2	0.000	0.000	6.000

1- Linear Load

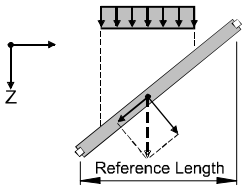


ELEMENT LOADS

LS 1

No	Loaded Elements	Type No	Load Direction	Parameters [kip, kipft, ft, °C, kip/ft, kipft/ft] P1			
1	1,2	1	Z	3.000			

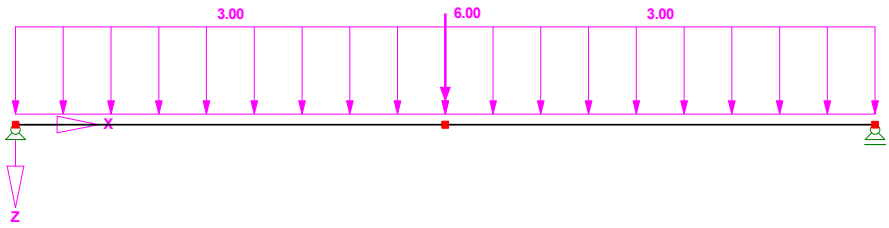
Z - Global in Z-direction



LOADS

LS 1 - Loadcase 1
[kip], [kip/ft]

Opposite Y-direction



2.466 ft

INTERNAL FORCES BY ELEMENT

Elem No	LS/LG No	Node No	x [ft]	Forces [kip] N	V_2	V_3	Moments [kipft] T	M_2	M_3
1	LS1	1	.00	.00	.00	45.00	.00	.00	.00
		2	14.00	.00	.00	3.00	.00	336.00	.00
		Max N	.00	.00	.00	45.00	.00	.00	.00
		Min N	.00	.00	.00	45.00	.00	.00	.00
		Max V-3	.00	.00	.00	45.00	.00	.00	.00
		Min V-3	14.00	.00	.00	3.00	.00	336.00	.00
		Max M-2	14.00	.00	.00	3.00	.00	336.00	.00
		Min M-2	.00	.00	.00	45.00	.00	.00	.00
2	LS1	2	.00	.00	.00	-3.00	.00	336.00	.00
		3	14.00	.00	.00	-45.00	.00	.00	.00
		Max N	.00	.00	.00	-3.00	.00	336.00	.00
		Min N	.00	.00	.00	-3.00	.00	336.00	.00
		Max V-3	.00	.00	.00	-3.00	.00	336.00	.00
		Min V-3	14.00	.00	.00	-45.00	.00	.00	.00
		Max M-2	.00	.00	.00	-3.00	.00	336.00	.00
		Min M-2	14.00	.00	.00	-45.00	.00	.00	.00

SUPPORT FORCES AND SUPPORT MOMENTS

Node No	LS/LG No	Support Forces [kip] P_X	P_Y	P_Z	Support Moments [kipft] M_X	M_Y	M_Z
1	LS1	.000	.000	45.000	.000	.000	.000
3	LS1	.000	.000	45.000	.000	.000	.000
ΣLoads	LS1	.000	.000	90.000			
ΣForces		.000	.000	90.000			

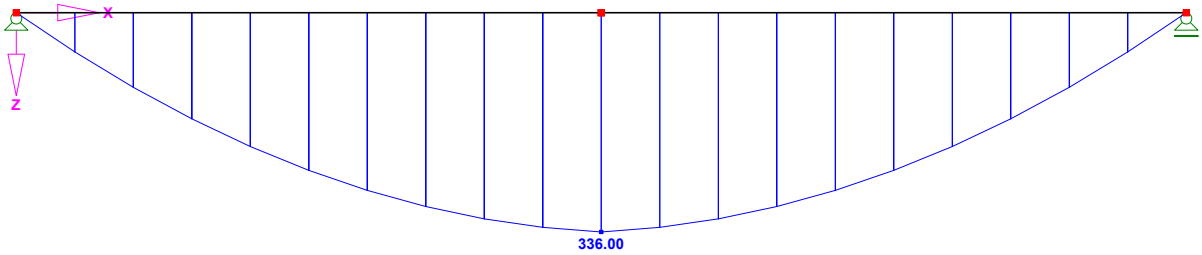
GLOBAL ELEMENT DEFORMATIONS

Elem No	LS/LG No	Node No	x [ft]	Element Deformations [in] u_X	u_Y	u_Z
1	LS1	1	.00	.00000	.00000	.00000
		2	14.00	.00000	.00000	.79583
2	LS1	2	.00	.00000	.00000	.79583
		3	14.00	.00000	.00000	.00000

RESULTS

LS 1 - Loadcase 1
Internal Forces M-2

Opposite Y-direction



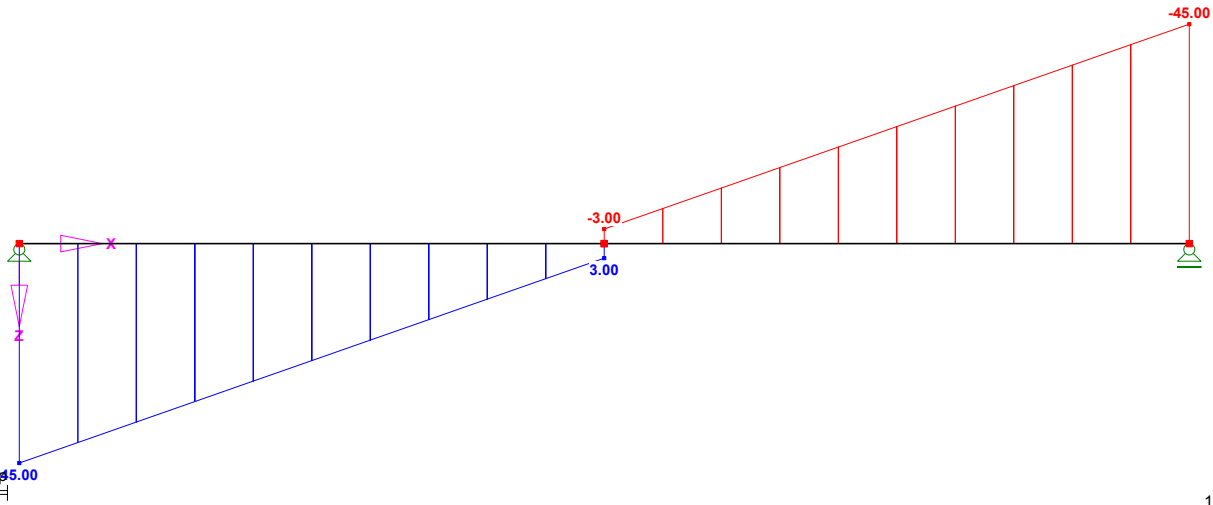
115.800 kipft

Max M-2: 336.00 kipft

1.809 ft

LS 1 - Loadcase 1
Internal Forces V-3

Opposite Y-direction



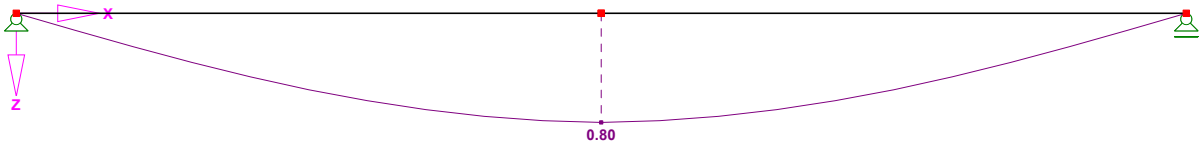
15.509 kip

Max V-3: 45.00, Min V-3: -45.00 kip

1.809 ft

LS 1 - Loadcase 1
Deformations

Opposite Y-direction



Max u: 0.80 in
Factor for Deformations: 39.3701

1.809 ft

ASD1 - STRESS ANALYSIS

GENERAL DATA

ELEMENTS TO DESIGN
All

LOAD SYSTEMS SELECTED FOR DESIGN
LS1 - Loadcase 1

MATERIAL PARAMETERS

Mat No	Material Description	Code	Yield Stress [ksi]	Tensile Stress [ksi]	Modulus of Elasticity [ksi]
1	Steel A36	ASD, 9th edition	36	58	29000

W 24x76

SECTIONS

Sec No	Mat No	Section Description Section Rotation	I-T [cm^4] A [cm^2]	I-2 [cm^4] Alpha pl y	I-3 [cm^4] Alpha pl z
1	1	W 24x76	111.55 144.52	87408.60 1.14	3433.91 1.25

DESIGN PARAMETERS

Elem. No	Effective-length factor K2	K3	Coefficient Cm2	Cm3	Coefficient Cb	Unbraced Lenght Lb2[ft]	Lb3[ft]	Comp. Length Lcomp[ft]	Anet/Agross Ratio
1	1	1	0	0	0	14	14	1	1
2	1	1	0	0	0	14	14	1	1

MAX STRESSES IN ELEMENTS

Stress Type	x Location [ft]	S Point No	LS No	Stress [ksi] existing	allowable	Stress Ratio
Element No 1: Section No 1 - W 24x76						
Tension	0.000	1	LS1	0.00	21.60	0.00
Compression	0.000	1	LS1	0.00	14.49	0.00
Bending Stress 2-2	14.000	1	LS1	-22.96	23.76	0.97
Bending Stress 3-3	0.000	1	LS1	0.00	27.00	0.00
Shear Stress 2	0.000	1	LS1	0.00	14.40	0.00
Shear Stress 3	0.000	13	LS1	-4.87	14.40	0.34
Torsion Stress	0.000	1	LS1	0.00	14.40	0.00
Tension and Bending	14.000	1	LS1			0.97
Compression and Bending	0.000	1	LS1			0.00
Element No 2: Section No 1 - W 24x76						
Tension	0.000	1	LS1	0.00	21.60	0.00
Compression	0.000	1	LS1	0.00	14.49	0.00
Bending Stress 2-2	0.000	1	LS1	-22.96	23.76	0.97
Bending Stress 3-3	0.000	1	LS1	0.00	27.00	0.00
Shear Stress 2	0.000	1	LS1	0.00	14.40	0.00
Shear Stress 3	14.000	13	LS1	4.87	14.40	0.34
Torsion Stress	0.000	1	LS1	0.00	14.40	0.00
Tension and Bending	0.000	1	LS1			0.97
Compression and Bending	0.000	1	LS1			0.00

GOVERNING INTERNAL FORCES

Elem No	x Location [ft]	LS No	Forces [kip] N	V-2	V-3	Moments [kipft] M-T	M-2	M-3
1	0.000	LS1	0.00	0.00	45.00	0.00	0.00	0.00
2	0.000	LS1	0.00	0.00	-3.00	0.00	336.00	0.00

DESIGN DETAILS IN ELEMENTS

Element	Description	Parameter	Value	Unit
1	Element Length	L	14.000	ft
	Effective Length Factor Buckling about 2-2	K-2	1.0000	
	Effective Length Factor Buckling about 3-3	K-3	1.0000	
	Geometric Slenderness about 2-2	K-2*L/r	17.35	
	Geometric Slenderness about 3-3	K-3*L/r	87.54	
	Section Type Table B5.1	Compact		
	Depth of Section	d	60.76	cm
	Flange Width	bf	11.42	cm
	Flange Thickness	tf	1.73	cm
	Area of Compression Flange	Af	40.24	cm^2

DESIGN DETAILS IN ELEMENTS

Element	Description	Parameter	Value	Unit
1	Clear Distance between Flanges	h	57.30	cm
	TENSION			
	Calculated Tension Stress	ft (Point 1)	0.00	ksi
	Allowable Tension Stress (D1, on gross area)	Ft (x: 0.000 ft)	21.60	ksi
	COMPRESSION			
	Critical Slenderness Ratio	Cc	126.10	
	Calculated Compression Stress	fa (Point 1)	0.00	ksi
	Allowable Compression Stress (E2-1)	Fa (x: 0.000 ft)	14.49	ksi
	BENDING			
	Maximum unbraced Length F1-2	Lc	9.489	ft
	Compression Length for Allowable Bending Stress	Lcomp	1.000	ft
	Unbraced Length	Lb	14.000	ft
	Bending Coefficient	Cb	1.3488	
	Calculated Bending Stress about 2-2	fb2-2 (Point 1)	-22.96	ksi
	Allowable Bending Stress about 2-2 (F1-1)	Fb2-2 (x: 4.267 ft)	23.76	ksi
	Calculated Bending Stress about 3-3	fb3-3 (Point 1)	0.00	ksi
	Allowable Bending Stress about 3-3 (F2-1)	Fb3-3 (x: 0.000 ft)	27.00	ksi
	SHEAR			
	Ratio h/tw (beam member)	h/tw	51.27	
	Calculated Shear Stress 2	fv2 (Point 1)	0.00	ksi
	Allowable Shear Stress 2 (F4-1)	Fv2 (x: 0.000 ft)	14.40	ksi
	Calculated Shear Stress 3	fv3 (Point 13)	-4.87	ksi
	Allowable Shear Stress 3 (F4-1)	Fv3 (x: 0.000 ft)	14.40	ksi
	COMBINED STRESS, AXIAL COMPRESSION AND BENDING			
	Calculated Axial Stress	fa	0.00	ksi
	Allowable Axial Stress	Fa	0.00	ksi
	Calculated Bending Stress about 2-2	fb2-2	0.00	ksi
	Allowable Bending Stress about 2-2	Fb2-2	0.00	ksi
	Interaction Coefficient Bending about 2-2	Cm22	1.0000	
	Calculated Bending Stress about 3-3	fb3-3	0.00	ksi
	Allowable Bending Stress about 3-3	Fb3-3	0.00	ksi
	Interaction Coefficient Bending about 3-3	Cm33	1.0000	
	Stress Ratio (H1-3)	(x: 0.000 ft, Point 1)	0.0000	
	COMBINED STRESS, AXIAL TENSION AND BENDING			
	Calculated Axial Stress	fa	0.00	ksi
	Allowable Axial Stress	Fa	21.60	ksi
	Calculated Bending Stress about 2-2	fb2-2	-22.96	ksi
	Allowable Bending Stress about 2-2	Fb2-2	23.76	ksi
	Calculated Bending Stress about 3-3	fb3-3	0.00	ksi
	Allowable Bending Stress about 3-3	Fb3-3	27.00	ksi
	Stress Ratio (H2-1)	(x: 4.267 ft, Point 1)	0.9665	
2	Element Length	L	14.000	ft
	Effective Length Factor Buckling about 2-2	K-2	1.0000	
	Effective Length Factor Buckling about 3-3	K-3	1.0000	
	Geometric Slenderness about 2-2	K-2*L/r	17.35	
	Geometric Slenderness about 3-3	K-3*L/r	87.54	
	Section Type Table B5.1	Compact		
	Depth of Section	d	60.76	cm
	Flange Width	bf	11.42	cm
	Flange Thickness	tf	1.73	cm
	Area of Compression Flange	Af	40.24	cm^2
	Clear Distance between Flanges	h	57.30	cm
	TENSION			
	Calculated Tension Stress	ft (Point 1)	0.00	ksi
	Allowable Tension Stress (D1, on gross area)	Ft (x: 0.000 ft)	21.60	ksi
	COMPRESSION			
	Critical Slenderness Ratio	Cc	126.10	
	Calculated Compression Stress	fa (Point 1)	0.00	ksi
	Allowable Compression Stress (E2-1)	Fa (x: 0.000 ft)	14.49	ksi
	BENDING			
	Maximum unbraced Length F1-2	Lc	9.489	ft
	Compression Length for Allowable Bending Stress	Lcomp	1.000	ft
	Unbraced Length	Lb	14.000	ft
	Bending Coefficient	Cb	1.3277	
	Calculated Bending Stress about 2-2	fb2-2 (Point 1)	-22.96	ksi
	Allowable Bending Stress about 2-2 (F1-1)	Fb2-2 (x: 0.000 ft)	23.76	ksi
	Calculated Bending Stress about 3-3	fb3-3 (Point 1)	0.00	ksi
	Allowable Bending Stress about 3-3 (F2-1)	Fb3-3 (x: 0.000 ft)	27.00	ksi
	SHEAR			
	Ratio h/tw (beam member)	h/tw	51.27	
	Calculated Shear Stress 2	fv2 (Point 1)	0.00	ksi
	Allowable Shear Stress 2 (F4-1)	Fv2 (x: 0.000 ft)	14.40	ksi
	Calculated Shear Stress 3	fv3 (Point 13)	4.87	ksi
	Allowable Shear Stress 3 (F4-1)	Fv3 (x: 4.267 ft)	14.40	ksi
	COMBINED STRESS, AXIAL COMPRESSION AND BENDING			
	Calculated Axial Stress	fa	0.00	ksi
	Allowable Axial Stress	Fa	0.00	ksi
	Calculated Bending Stress about 2-2	fb2-2	0.00	ksi
	Allowable Bending Stress about 2-2	Fb2-2	0.00	ksi
	Interaction Coefficient Bending about 2-2	Cm22	1.0000	
	Calculated Bending Stress about 3-3	fb3-3	0.00	ksi
	Allowable Bending Stress about 3-3	Fb3-3	0.00	ksi
	Interaction Coefficient Bending about 3-3	Cm33	1.0000	
	Stress Ratio (H1-3)	(x: 0.000 ft, Point 1)	0.0000	
	COMBINED STRESS, AXIAL TENSION AND BENDING			
	Calculated Axial Stress	fa	0.00	ksi
	Allowable Axial Stress	Fa	21.60	ksi

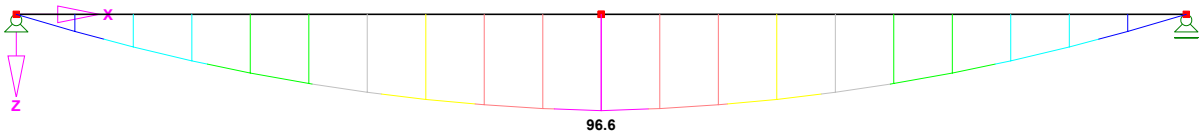
DESIGN DETAILS IN ELEMENTS

Element	Description	Parameter	Value	Unit
2	Calculated Bending Stress about 2-2	fb2-2	-22.96	ksi
	Allowable Bending Stress about 2-2	Fb2-2	23.76	ksi
	Calculated Bending Stress about 3-3	fb3-3	0.00	ksi
	Allowable Bending Stress about 3-3	Fb3-3	27.00	ksi
	Stress Ratio (H2-1)	(x: 0.000 ft, Point 1)	0.9665	

STRESS CONTOUR

ASD1 - Stress Analysis
Bending Stress 2-2

Opposite Y-direction



Max = 96.6%

1.809 ft

CONTENTS

GENERAL DATA

COMPUTING METHOD

☒ Structural Analysis
☐ Stress Analysis
☐ Dynamic Analysis

☒ 1st Order Analysis
☒ 2nd Order Analysis
☐ Cable Theory

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☒ LS Groups
☐ LS Combinations

☐ Design Cases
☐ Dynamic Cases
☐ Buckling Curves

STRUCTURAL DATA PARAMETERS

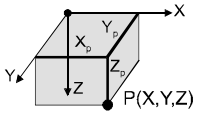
☐ 1D Continuous Beam
☒ 2D Construction Type
☐ 3D Construction Type
☐ Grid

12 Nodes
1 Materials
1 Sections
0 Element Hinges
0 Element Partitions

15 Elements
0 Cables
0 Tapered Elements
0 Elastic Foundations
0 Sets of Elements

STRUCTURE

Cartesian



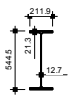
NODES

Node No	Coordinates-System	Ref Nodes	Node Coordinates X [m]	Y [m]	Z [m]
1	Cartesian	-	0.000		0.000
	Supported				
2	Cartesian	-	0.000		-3.500
3	Cartesian	-	9.000		0.000
	Supported				
4	Cartesian	-	9.000		-3.500
5	Cartesian	-	18.000		0.000
	Supported				
6	Cartesian	-	18.000		-3.500
7	Cartesian	-	0.000		-7.000
9	Cartesian	-	9.000		-7.000
11	Cartesian	-	18.000		-7.000
12	Cartesian	-	0.000		-10.500
14	Cartesian	-	9.000		-10.500
16	Cartesian	-	18.000		-10.500

MATERIALS

Mat No	Material Description	E Modulus [kN/cm²]	Shear Mod [kN/cm²]	Spec Weight [kN/cm³]	Coeff Therm [1/°C]
1	Steel	2.041E+04	8.100E+03	7.850E-05	1.200E-05

UB 533x210x122



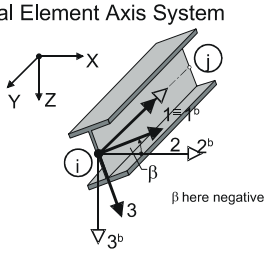
SECTIONS

Sec No	Mat No	Section Description	I_2 [cm⁴]	A [cm²]	A_3 [cm²]
1	1	UB 533x210x122	76040.00	155.400	

ELEMENTS

Elem No	Elem Type	Nodes Begin	Nodes End	Beta [°]	Section Begin	Section End	Hinge Begin	Hinge End	Part No	Length [m]	Elem Location
1	Beam	1	2	0.0	1	1	-	-	-	3.500	VERT
2	Beam	3	4	0.0	1	1	-	-	-	3.500	VERT

Local Element Axis System



ELEMENTS

Elem No	Elem Type	Nodes Begin	Nodes End	Beta [°]	Section Begin	Section End	Hinge Begin	Hinge End	Part No	Length [m]	Elem Location
3	Beam	5	6	0.0	1	1	-	-	-	3.500	VERT
4	Beam	2	4	0.0	1	1	-	-	-	9.000	HORI
5	Beam	4	6	0.0	1	1	-	-	-	9.000	HORI
6	Beam	2	7	0.0	1	1	-	-	-	3.500	VERT
7	Beam	4	9	0.0	1	1	-	-	-	3.500	VERT
8	Beam	6	11	0.0	1	1	-	-	-	3.500	VERT
9	Beam	7	9	0.0	1	1	-	-	-	9.000	HORI
10	Beam	9	11	0.0	1	1	-	-	-	9.000	HORI
11	Beam	7	12	0.0	1	1	-	-	-	3.500	VERT
12	Beam	9	14	0.0	1	1	-	-	-	3.500	VERT
13	Beam	11	16	0.0	1	1	-	-	-	3.500	VERT
14	Beam	12	14	0.0	1	1	-	-	-	9.000	HORI
15	Beam	14	16	0.0	1	1	-	-	-	9.000	HORI

SUPPORTS

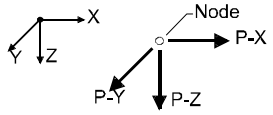
Support No	Supported Nodes	Rotation [°] Alpha	Rotation [°] Beta	Fixed Support/Support Spring [kN/m] [kNm/rad] in X	in Y	in Z	ar X	ar Y	ar Z
1	1,3,5 Hinged	0.0	0.0	Yes	Yes	Yes	Yes	No	Yes

LOADS

GENERAL DATA

LS No	LS Description	Factor	Combination Type	Dead Weight
1	Full loading	1.00	Permanent	-

Global Nodal Force

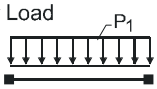


NODAL FORCES

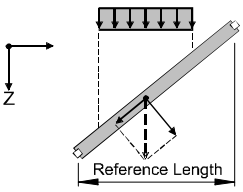
LS 1

No	Loaded Nodes	Nodal Forces P_X [kN]	P_Y [kN]	P_Z [kN]
1	2	100.000	0.000	0.000
2	7	100.000	0.000	0.000
3	12	50.000	0.000	0.000

1- Linear Load



Z - Global in Z-direction



ELEMENT LOADS

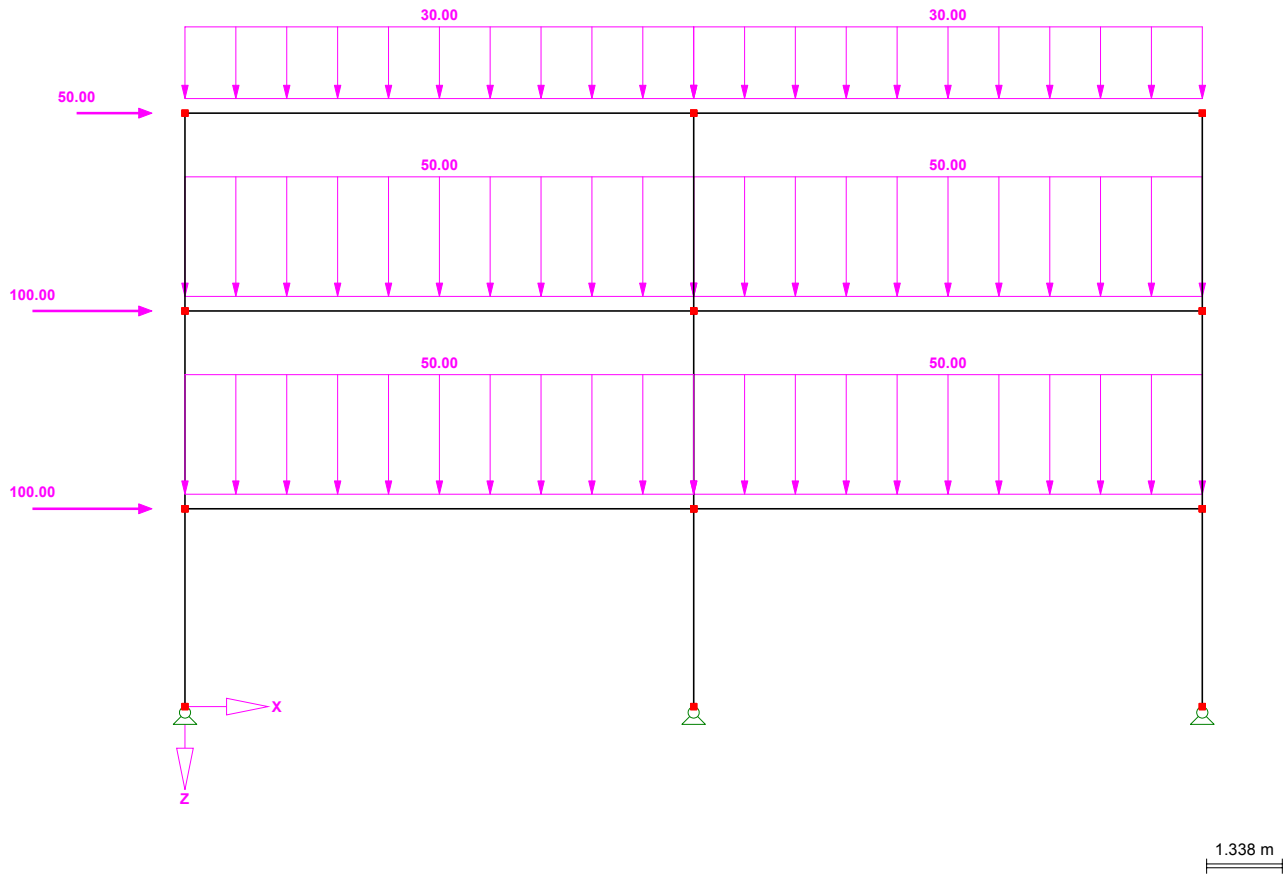
LS 1

No	Loaded Elements	Type No	Load Direction	Parameters [kN, kNm, m, °C, kN/m, kNm/m] P_1
1	14,15	1	Z	30.000
2	4,5,9,10	1	Z	50.000

LOADS

LS 1 - Full loading
[kN], [kN/m]

Opposite Y-direction



LS GROUPS

LG No	LG Description	Factor	Coefficient Gamma$_M$	Load Systems in LG
1	P-Delta analysis of LS 1	1.00	1.00	LS1

2ND ORDER ANALYSIS DATA

LG-No	Factor Ny	Number Iterations	Eps-Convergence Existing	Eps-Convergence Wanted	Ny-fold Results	Tension Force Effect
LG1	1.000	2	.11E-04	0.01	Yes	Yes

INTERNAL FORCES BY ELEMENT

Elem No	LS/LG No	Node No	x [m]	Forces [kN] N	V_2	V_3	Moments [kNm] T	M_2	M_3
1	LS1	1	.00	-481.16	.00	43.78	.00	.00	.00
		2	3.50	-481.16	.00	43.78	.00	153.21	.00
		Max N	.00	-481.16	.00	43.78	.00	.00	.00
		Min N	.00	-481.16	.00	43.78	.00	.00	.00
		Max V-3	.00	-481.16	.00	43.78	.00	.00	.00
		Min V-3	.00	-481.16	.00	43.78	.00	.00	.00
		Max M-2	3.50	-481.16	.00	43.78	.00	153.21	.00
		Min M-2	.00	-481.16	.00	43.78	.00	.00	.00
	LG1	1	.00	-478.21	.00	47.64	.00	.00	.00
		2	3.50	-478.21	.00	46.75	.00	165.75	.00
		Max N	3.50	-478.21	.00	46.75	.00	165.75	.00
		Min N	.00	-478.21	.00	47.64	.00	.00	.00
		Max V-3	.00	-478.21	.00	47.64	.00	.00	.00
		Min V-3	3.50	-478.21	.00	46.75	.00	165.75	.00
		Max M-2	3.50	-478.21	.00	46.75	.00	165.75	.00
		Min M-2	.00	-478.21	.00	47.64	.00	.00	.00
2	LS1	3	.00	-1202.69	.00	99.71	.00	.00	.00
		4	3.50	-1202.69	.00	99.71	.00	349.00	.00
		Max N	3.50	-1202.69	.00	99.71	.00	349.00	.00
		Min N	.00	-1202.69	.00	99.71	.00	.00	.00
		Max V-3	3.50	-1202.69	.00	99.71	.00	349.00	.00
		Min V-3	.00	-1202.69	.00	99.71	.00	.00	.00
		Max M-2	3.50	-1202.69	.00	99.71	.00	349.00	.00
		Min M-2	.00	-1202.69	.00	99.71	.00	.00	.00
	LG1	3	.00	-1202.77	.00	105.66	.00	.00	.00
		4	3.50	-1202.77	.00	100.68	.00	363.97	.00
		Max N	3.50	-1202.77	.00	100.68	.00	363.97	.00
		Min N	.00	-1202.77	.00	105.66	.00	.00	.00
		Max V-3	.00	-1202.77	.00	105.66	.00	.00	.00
		Min V-3	3.50	-1202.77	.00	100.68	.00	363.97	.00
		Max M-2	3.50	-1202.77	.00	100.68	.00	363.97	.00
		Min M-2	.00	-1202.77	.00	105.66	.00	.00	.00
3	LS1	5	.00	-656.16	.00	106.51	.00	.00	.00
		6	3.50	-656.16	.00	106.51	.00	372.79	.00
		Max N	.00	-656.16	.00	106.51	.00	.00	.00
		Min N	.00	-656.16	.00	106.51	.00	.00	.00
		Max V-3	3.50	-656.16	.00	106.51	.00	372.79	.00
		Min V-3	.00	-656.16	.00	106.51	.00	.00	.00
		Max M-2	3.50	-656.16	.00	106.51	.00	372.79	.00
		Min M-2	.00	-656.16	.00	106.51	.00	.00	.00
	LG1	5	.00	-659.03	.00	110.94	.00	.00	.00
		6	3.50	-659.03	.00	108.06	.00	384.87	.00
		Max N	3.50	-659.03	.00	108.06	.00	384.87	.00
		Min N	.00	-659.03	.00	110.94	.00	.00	.00
		Max V-3	.00	-659.03	.00	110.94	.00	.00	.00
		Min V-3	3.50	-659.03	.00	108.06	.00	384.87	.00
		Max M-2	3.50	-659.03	.00	108.06	.00	384.87	.00
		Min M-2	.00	-659.03	.00	110.94	.00	.00	.00
4	LS1	2	.00	8.59	.00	164.13	.00	-38.32	.00
		4	9.00	8.59	.00	-285.87	.00	-586.16	.00
		Max N	9.00	8.59	.00	-285.87	.00	-586.16	.00
		Min N	.00	8.59	.00	164.13	.00	-38.32	.00
		Max V-3	.00	8.59	.00	164.13	.00	-38.32	.00
		Min V-3	9.00	8.59	.00	-285.87	.00	-586.16	.00
		Max M-2	3.15	8.59	.00	6.63	.00	230.62	.00
		Min M-2	9.00	8.59	.00	-285.87	.00	-586.16	.00
	LG1	2	.00	10.28	.00	162.02	.00	-28.44	.00
		4	9.00	10.28	.00	-287.96	.00	-594.89	.00
		Max N	9.00	10.28	.00	-287.96	.00	-594.89	.00
		Min N	.00	10.28	.00	162.02	.00	-28.44	.00
		Max V-3	.00	10.28	.00	162.02	.00	-28.44	.00
		Min V-3	9.00	10.28	.00	-287.96	.00	-594.89	.00
		Max M-2	3.15	10.28	.00	4.56	.00	233.92	.00
		Min M-2	9.00	10.28	.00	-287.96	.00	-594.89	.00
5	LS1	4	.00	21.75	.00	179.25	.00	-128.83	.00
		6	9.00	21.75	.00	-270.75	.00	-540.61	.00
		Max N	9.00	21.75	.00	-270.75	.00	-540.61	.00
		Min N	.00	21.75	.00	179.25	.00	-128.83	.00
		Max V-3	.00	21.75	.00	179.25	.00	-128.83	.00
		Min V-3	9.00	21.75	.00	-270.75	.00	-540.61	.00
		Max M-2	3.60	21.75	.00	-.75	.00	192.46	.00
		Min M-2	9.00	21.75	.00	-270.75	.00	-540.61	.00
	LG1	4	.00	21.03	.00	177.16	.00	-120.07	.00
		6	9.00	21.03	.00	-272.84	.00	-550.23	.00
		Max N	9.00	21.03	.00	-272.84	.00	-550.23	.00
		Min N	.00	21.03	.00	177.16	.00	-120.07	.00
		Max V-3	.00	21.03	.00	177.16	.00	-120.07	.00
		Min V-3	9.00	21.03	.00	-272.84	.00	-550.23	.00
		Max M-2	3.60	21.03	.00	-2.80	.00	193.74	.00
		Min M-2	9.00	21.03	.00	-272.84	.00	-550.23	.00

INTERNAL FORCES BY ELEMENT

Elem No	LS/LG No	Node No	x [m]	Forces [kN] N	V_2	V_3	Moments [kNm] T	M_2	M_3
6	LS1	2	.00	-317.03	.00	-64.81	.00	191.53	.00
		7	3.50	-317.03	.00	-64.81	.00	-35.31	.00
		Max N	3.50	-317.03	.00	-64.81	.00	-35.31	.00
		Min N	.00	-317.03	.00	-64.81	.00	191.53	.00
		Max V-3	.00	-317.03	.00	-64.81	.00	191.53	.00
		Min V-3	.00	-317.03	.00	-64.81	.00	191.53	.00
		Max M-2	.00	-317.03	.00	-64.81	.00	191.53	.00
		Min M-2	3.50	-317.03	.00	-64.81	.00	-35.31	.00
	LG1	2	.00	-316.14	.00	-64.11	.00	194.19	.00
		7	3.50	-316.14	.00	-64.69	.00	-31.68	.00
		Max N	.00	-316.14	.00	-64.11	.00	194.19	.00
		Min N	.00	-316.14	.00	-64.11	.00	194.19	.00
		Max V-3	.00	-316.14	.00	-64.11	.00	194.19	.00
		Min V-3	2.98	-316.14	.00	-64.71	.00	2.29	.00
		Max M-2	.00	-316.14	.00	-64.11	.00	194.19	.00
		Min M-2	3.50	-316.14	.00	-64.69	.00	-31.68	.00
7	LS1	4	.00	-737.57	.00	86.55	.00	-108.34	.00
		9	3.50	-737.57	.00	86.55	.00	194.57	.00
		Max N	.00	-737.57	.00	86.55	.00	-108.34	.00
		Min N	.00	-737.57	.00	86.55	.00	-108.34	.00
		Max V-3	.00	-737.57	.00	86.55	.00	-108.34	.00
		Min V-3	.00	-737.57	.00	86.55	.00	-108.34	.00
		Max M-2	3.50	-737.57	.00	86.55	.00	194.57	.00
		Min M-2	.00	-737.57	.00	86.55	.00	-108.34	.00
	LG1	4	.00	-737.63	.00	88.96	.00	-110.85	.00
		9	3.50	-737.63	.00	88.21	.00	200.71	.00
		Max N	3.50	-737.63	.00	88.21	.00	200.71	.00
		Min N	.00	-737.63	.00	88.96	.00	-110.85	.00
		Max V-3	1.23	-737.63	.00	89.29	.00	-1.61	.00
		Min V-3	3.50	-737.63	.00	88.21	.00	200.71	.00
		Max M-2	3.50	-737.63	.00	88.21	.00	200.71	.00
		Min M-2	.00	-737.63	.00	88.96	.00	-110.85	.00
8	LS1	6	.00	-385.40	.00	128.27	.00	-167.82	.00
		11	3.50	-385.40	.00	128.27	.00	281.11	.00
		Max N	3.50	-385.40	.00	128.27	.00	281.11	.00
		Min N	.00	-385.40	.00	128.27	.00	-167.82	.00
		Max V-3	.00	-385.40	.00	128.27	.00	-167.82	.00
		Min V-3	.00	-385.40	.00	128.27	.00	-167.82	.00
		Max M-2	3.50	-385.40	.00	128.27	.00	281.11	.00
		Min M-2	.00	-385.40	.00	128.27	.00	-167.82	.00
	LG1	6	.00	-386.23	.00	128.57	.00	-165.36	.00
		11	3.50	-386.23	.00	128.04	.00	284.84	.00
		Max N	3.50	-386.23	.00	128.04	.00	284.84	.00
		Min N	.00	-386.23	.00	128.57	.00	-165.36	.00
		Max V-3	1.23	-386.23	.00	128.83	.00	-7.66	.00
		Min V-3	3.50	-386.23	.00	128.04	.00	284.84	.00
		Max M-2	3.50	-386.23	.00	128.04	.00	284.84	.00
		Min M-2	.00	-386.23	.00	128.57	.00	-165.36	.00
9	LS1	7	.00	-83.46	.00	196.74	.00	-198.70	.00
		9	9.00	-83.46	.00	-253.26	.00	-453.00	.00
		Max N	.00	-83.46	.00	196.74	.00	-198.70	.00
		Min N	.00	-83.46	.00	196.74	.00	-198.70	.00
		Max V-3	.00	-83.46	.00	196.74	.00	-198.70	.00
		Min V-3	9.00	-83.46	.00	-253.26	.00	-453.00	.00
		Max M-2	4.05	-83.46	.00	-5.76	.00	188.05	.00
		Min M-2	9.00	-83.46	.00	-253.26	.00	-453.00	.00
	LG1	7	.00	-83.69	.00	196.22	.00	-196.01	.00
		9	9.00	-83.69	.00	-253.83	.00	-456.19	.00
		Max N	9.00	-83.69	.00	-253.83	.00	-456.19	.00
		Min N	.00	-83.69	.00	196.22	.00	-196.01	.00
		Max V-3	.00	-83.69	.00	196.22	.00	-196.01	.00
		Min V-3	9.00	-83.69	.00	-253.83	.00	-456.19	.00
		Max M-2	4.05	-83.69	.00	-6.42	.00	188.63	.00
		Min M-2	9.00	-83.69	.00	-253.83	.00	-456.19	.00
10	LS1	9	.00	-26.86	.00	204.12	.00	-235.49	.00
		11	9.00	-26.86	.00	-245.88	.00	-423.42	.00
		Max N	9.00	-26.86	.00	-245.88	.00	-423.42	.00
		Min N	.00	-26.86	.00	204.12	.00	-235.49	.00
		Max V-3	.00	-26.86	.00	204.12	.00	-235.49	.00
		Min V-3	9.00	-26.86	.00	-245.88	.00	-423.42	.00
		Max M-2	4.05	-26.86	.00	1.62	.00	181.13	.00
		Min M-2	9.00	-26.86	.00	-245.88	.00	-423.42	.00
	LG1	9	.00	-26.41	.00	203.49	.00	-232.64	.00
		11	9.00	-26.41	.00	-246.52	.00	-426.49	.00
		Max N	9.00	-26.41	.00	-246.52	.00	-426.49	.00
		Min N	.00	-26.41	.00	203.49	.00	-232.64	.00
		Max V-3	.00	-26.41	.00	203.49	.00	-232.64	.00
		Min V-3	9.00	-26.41	.00	-246.52	.00	-426.49	.00
		Max M-2	4.05	-26.41	.00	.96	.00	181.48	.00
		Min M-2	9.00	-26.41	.00	-246.52	.00	-426.49	.00
11	LS1	7	.00	-120.29	.00	-81.35	.00	163.39	.00
		12	3.50	-120.29	.00	-81.35	.00	-121.35	.00
		Max N	3.50	-120.29	.00	-81.35	.00	-121.35	.00
		Min N	.00	-120.29	.00	-81.35	.00	163.39	.00
		Max V-3	3.50	-120.29	.00	-81.35	.00	-121.35	.00
		Min V-3	.00	-120.29	.00	-81.35	.00	163.39	.00
		Max M-2	.00	-120.29	.00	-81.35	.00	163.39	.00
		Min M-2	3.50	-120.29	.00	-81.35	.00	-121.35	.00
	LG1	7	.00	-120.07	.00	-81.34	.00	164.33	.00

INTERNAL FORCES BY ELEMENT

Elem No	LS/LG No	Node No	x [m]	Forces [kN] N	V_2	V_3	Moments [kNm] T	M_2	M_3
11	LG1	12	3.50	-120.07	.00	-81.40	.00	-120.68	.00
		Max N	3.50	-120.07	.00	-81.40	.00	-120.68	.00
		Min N	.00	-120.07	.00	-81.34	.00	164.33	.00
		Max V-3	.00	-120.07	.00	-81.34	.00	164.33	.00
		Min V-3	2.10	-120.07	.00	-81.47	.00	-6.66	.00
		Max M-2	.00	-120.07	.00	-81.34	.00	164.33	.00
		Min M-2	3.50	-120.07	.00	-81.40	.00	-120.68	.00
12	LS1	9	.00	-280.19	.00	29.95	.00	-22.94	.00
		14	3.50	-280.19	.00	29.95	.00	81.88	.00
		Max N	3.50	-280.19	.00	29.95	.00	81.88	.00
		Min N	.00	-280.19	.00	29.95	.00	-22.94	.00
		Max V-3	.00	-280.19	.00	29.95	.00	-22.94	.00
		Min V-3	.00	-280.19	.00	29.95	.00	-22.94	.00
		Max M-2	3.50	-280.19	.00	29.95	.00	81.88	.00
		Min M-2	.00	-280.19	.00	29.95	.00	-22.94	.00
	LG1	9	.00	-280.24	.00	30.44	.00	-22.84	.00
		14	3.50	-280.24	.00	30.25	.00	83.56	.00
		Max N	.00	-280.24	.00	30.44	.00	-22.84	.00
		Min N	.00	-280.24	.00	30.44	.00	-22.84	.00
		Max V-3	.70	-280.24	.00	30.46	.00	-1.52	.00
		Min V-3	3.50	-280.24	.00	30.25	.00	83.56	.00
		Max M-2	3.50	-280.24	.00	30.25	.00	83.56	.00
		Min M-2	.00	-280.24	.00	30.44	.00	-22.84	.00
13	LS1	11	.00	-139.52	.00	101.40	.00	-142.31	.00
		16	3.50	-139.52	.00	101.40	.00	212.60	.00
		Max N	3.50	-139.52	.00	101.40	.00	212.60	.00
		Min N	.00	-139.52	.00	101.40	.00	-142.31	.00
		Max V-3	.00	-139.52	.00	101.40	.00	-142.31	.00
		Min V-3	.00	-139.52	.00	101.40	.00	-142.31	.00
		Max M-2	3.50	-139.52	.00	101.40	.00	212.60	.00
		Min M-2	.00	-139.52	.00	101.40	.00	-142.31	.00
	LG1	11	.00	-139.69	.00	101.49	.00	-141.65	.00
		16	3.50	-139.69	.00	101.37	.00	213.68	.00
		Max N	.00	-139.69	.00	101.49	.00	-141.65	.00
		Min N	.00	-139.69	.00	101.49	.00	-141.65	.00
		Max V-3	1.40	-139.69	.00	101.58	.00	.52	.00
		Min V-3	3.50	-139.69	.00	101.37	.00	213.68	.00
		Max M-2	3.50	-139.69	.00	101.37	.00	213.68	.00
		Min M-2	.00	-139.69	.00	101.49	.00	-141.65	.00
14	LS1	12	.00	-131.35	.00	120.29	.00	-121.35	.00
		14	9.00	-131.35	.00	-149.71	.00	-253.78	.00
		Max N	9.00	-131.35	.00	-149.71	.00	-253.78	.00
		Min N	.00	-131.35	.00	120.29	.00	-121.35	.00
		Max V-3	.00	-131.35	.00	120.29	.00	-121.35	.00
		Min V-3	9.00	-131.35	.00	-149.71	.00	-253.78	.00
		Max M-2	4.05	-131.35	.00	-1.21	.00	119.77	.00
		Min M-2	9.00	-131.35	.00	-149.71	.00	-253.78	.00
	LG1	12	.00	-131.55	.00	120.23	.00	-120.68	.00
		14	9.00	-131.55	.00	-149.89	.00	-254.90	.00
		Max N	.00	-131.55	.00	120.23	.00	-120.68	.00
		Min N	.00	-131.55	.00	120.23	.00	-120.68	.00
		Max V-3	.00	-131.55	.00	120.23	.00	-120.68	.00
		Min V-3	9.00	-131.55	.00	-149.89	.00	-254.90	.00
		Max M-2	4.05	-131.55	.00	-1.41	.00	120.20	.00
		Min M-2	9.00	-131.55	.00	-149.89	.00	-254.90	.00
15	LS1	14	.00	-101.40	.00	130.48	.00	-171.89	.00
		16	9.00	-101.40	.00	-139.52	.00	-212.60	.00
		Max N	9.00	-101.40	.00	-139.52	.00	-212.60	.00
		Min N	.00	-101.40	.00	130.48	.00	-171.89	.00
		Max V-3	.00	-101.40	.00	130.48	.00	-171.89	.00
		Min V-3	9.00	-101.40	.00	-139.52	.00	-212.60	.00
		Max M-2	4.50	-101.40	.00	-4.52	.00	111.50	.00
		Min M-2	9.00	-101.40	.00	-139.52	.00	-212.60	.00
	LG1	14	.00	-101.40	.00	130.35	.00	-171.34	.00
		16	9.00	-101.40	.00	-139.71	.00	-213.68	.00
		Max N	9.00	-101.40	.00	-139.71	.00	-213.68	.00
		Min N	.00	-101.40	.00	130.35	.00	-171.34	.00
		Max V-3	.00	-101.40	.00	130.35	.00	-171.34	.00
		Min V-3	9.00	-101.40	.00	-139.71	.00	-213.68	.00
		Max M-2	4.50	-101.40	.00	-4.71	.00	111.64	.00
		Min M-2	9.00	-101.40	.00	-139.71	.00	-213.68	.00

SUPPORT FORCES AND SUPPORT MOMENTS

Node No	LS/LG No	Support Forces [kN] P_X	P_Y	P_Z	Support Moments [kNm] M_X	M_Y	M_Z
1	LS1	43.775	.000	481.157	.000	.000	.000
	LG1	45.037	.000	478.207	.000	.000	.000
3	LS1	99.713	.000	1202.686	.000	.000	.000
	LG1	98.181	.000	1202.768	.000	.000	.000
5	LS1	106.512	.000	656.157	.000	.000	.000
	LG1	106.781	.000	659.025	.000	.000	.000
ΣLoads	LS1	250.000	.000	2340.000			
ΣForces		250.000	.000	2340.000			
ΣLoads	LG1	250.000	.000	2340.000			
ΣForces		250.000	.000	2340.000			

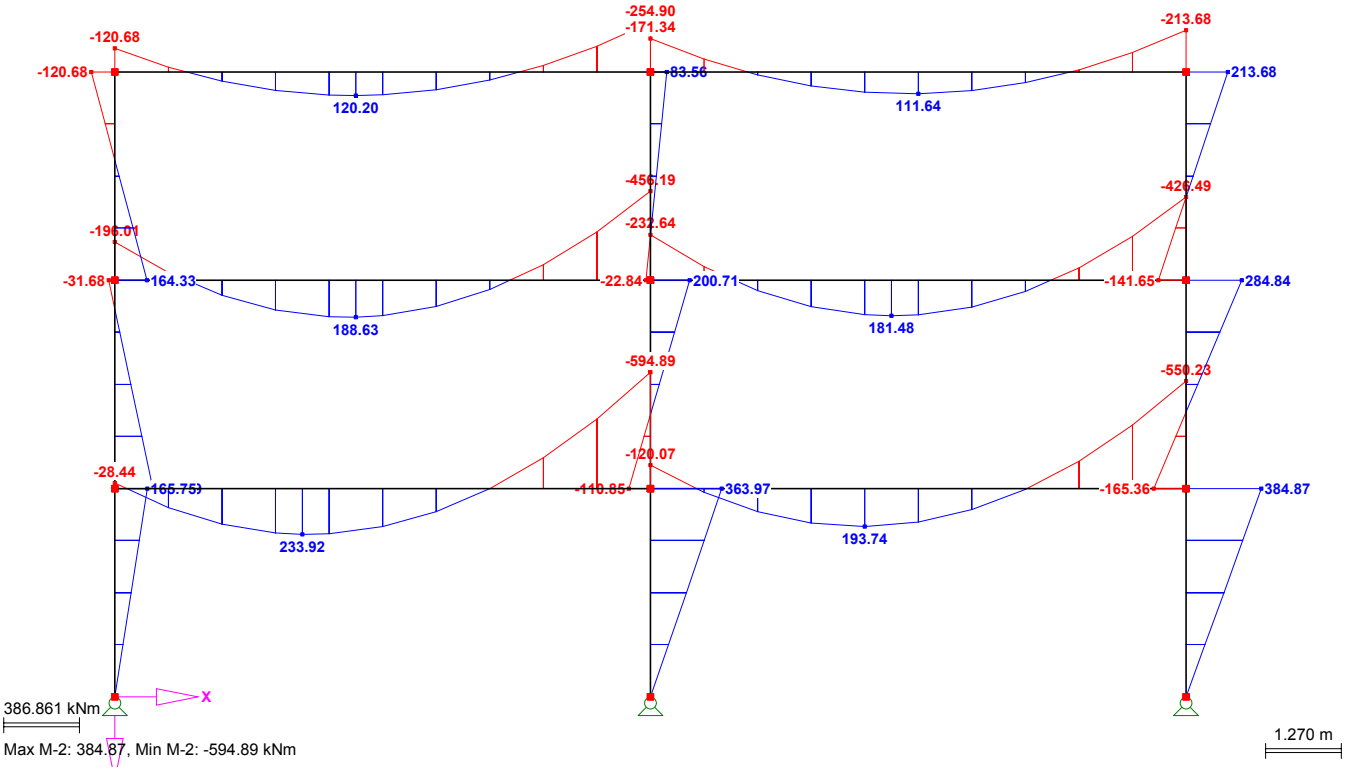
GLOBAL ELEMENT DEFORMATIONS

Elem No	LS/LG No	Node No	x [m]	Element Deformations [mm] ux	uy	uz
1	LS1	Max u-Z	3.50	16.17032	.00000	.53096
		Min u-Z	.00	.00000	.00000	.00000
	LG1	Max u-Z	3.50	16.88137	.00000	.52770
		Min u-Z	.00	.00000	.00000	.00000
2	LS1	Max u-Z	3.50	16.19469	.00000	1.32717
		Min u-Z	.00	.00000	.00000	.00000
	LG1	Max u-Z	3.50	16.91054	.00000	1.32726
		Min u-Z	.00	.00000	.00000	.00000
3	LS1	Max u-Z	3.50	16.25642	.00000	.72407
		Min u-Z	.00	.00000	.00000	.00000
	LG1	Max u-Z	3.50	16.97022	.00000	.72724
		Min u-Z	.00	.00000	.00000	.00000
4	LS1	Max u-Z	3.60	16.18007	.00000	8.64814
		Min u-Z	.00	16.17032	.00000	.53096
	LG1	Max u-Z	3.60	16.89304	.00000	8.72025
		Min u-Z	.00	16.88137	.00000	.52770
5	LS1	Max u-Z	3.60	16.21938	.00000	7.19275
		Min u-Z	8.55	16.25333	.00000	.22178
	LG1	Max u-Z	3.60	16.93441	.00000	7.20072
		Min u-Z	8.55	16.96724	.00000	.18731
6	LS1	Max u-Z	3.50	23.73474	.00000	.88080
		Min u-Z	.00	16.17032	.00000	.53096
	LG1	Max u-Z	3.50	24.69063	.00000	.87657
		Min u-Z	.00	16.88137	.00000	.52770
7	LS1	Max u-Z	3.50	23.49792	.00000	2.14108
		Min u-Z	.00	16.19469	.00000	1.32717
	LG1	Max u-Z	3.50	24.45313	.00000	2.14123
		Min u-Z	.00	16.91054	.00000	1.32726
8	LS1	Max u-Z	3.50	23.42169	.00000	1.14937
		Min u-Z	.00	16.25642	.00000	.72407
	LG1	Max u-Z	3.50	24.37819	.00000	1.15344
		Min u-Z	.00	16.97022	.00000	.72724
9	LS1	Max u-Z	4.05	23.62817	.00000	7.86917
		Min u-Z	.00	23.73474	.00000	.88080
	LG1	Max u-Z	4.05	24.58376	.00000	7.88262
		Min u-Z	.00	24.69063	.00000	.87657
10	LS1	Max u-Z	4.05	23.46361	.00000	7.81161
		Min u-Z	8.55	23.42550	.00000	1.14795
	LG1	Max u-Z	4.05	24.41941	.00000	7.82062
		Min u-Z	8.55	24.38194	.00000	1.14049
11	LS1	Max u-Z	3.50	27.00608	.00000	1.01354
		Min u-Z	.00	23.73474	.00000	.88080
	LG1	Max u-Z	3.50	28.03560	.00000	1.00906
		Min u-Z	.00	24.69063	.00000	.87657
12	LS1	Max u-Z	3.50	26.63336	.00000	2.45027
		Min u-Z	.00	23.49792	.00000	2.14108
	LG1	Max u-Z	3.50	27.66232	.00000	2.45048
		Min u-Z	.00	24.45313	.00000	2.14123
13	LS1	Max u-Z	3.50	26.34562	.00000	1.30333
		Min u-Z	.00	23.42169	.00000	1.14937
	LG1	Max u-Z	3.50	27.37458	.00000	1.30759
		Min u-Z	.00	24.37819	.00000	1.15344
14	LS1	Max u-Z	4.50	26.81972	.00000	6.00917
		Min u-Z	.00	27.00608	.00000	1.01354
	LG1	Max u-Z	4.50	27.84896	.00000	6.01975
		Min u-Z	.00	28.03560	.00000	1.00906
15	LS1	Max u-Z	4.05	26.50387	.00000	5.87704
		Min u-Z	9.00	26.34562	.00000	1.30333
	LG1	Max u-Z	4.05	27.53284	.00000	5.88339
		Min u-Z	9.00	27.37458	.00000	1.30759

RESULTS

LG 1 - P-Delta analysis of LS 1
Internal Forces M-2

Opposite Y-direction



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1 Sections
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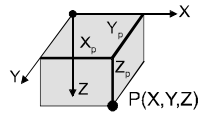
STRUCTURE

Cartesian



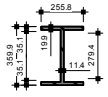
NODES

Node No	Coordinates-System	Ref Nodes	Node Coordinates X [ft]	Y [ft]	Z [ft]
1	Cartesian	-	0.000		0.000
	Supported				
2	Cartesian	-	0.000		-18.000
3	Cartesian	-	40.000		0.000
	Supported				
4	Cartesian	-	40.000		-18.000
5	Cartesian	-	10.000		-18.000

MATERIALS

Mat No	Material Description	E Modulus [ksi]	Shear Mod [ksi]	Spec Weight [kip/in³]	Coeff Therm [1/°C]
1	Steel A36	2.900E+04	1.115E+04	2.892E-04	1.200E-05

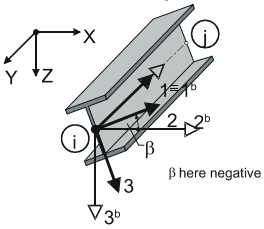
W 14x74



SECTIONS

Sec No	Mat No	Section Description	I_2 [in⁴]	A [in²]	A_3 [in²]
1	1	W 14x74	796.00000	21.80000	

Local Element Axis System



ELEMENTS

Elem No	Elem Type	Nodes Begin	Nodes End	Beta [°]	Section Begin	Section End	Hinge Begin	Hinge End	Part No	Length [ft]	Elem Location
1	Beam	1	2	0.0	1	1	-	-	-	18.000	VERT
2	Beam	3	4	0.0	1	1	-	-	-	18.000	VERT
3	Beam	2	4	0.0	1	1	-	-	-	40.000	HORI

SUPPORTS

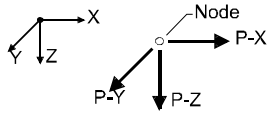
Support No	Supported Nodes	Rotation [°] Alpha	Rotation [°] Beta	Fixed Support/Support Spring [kip/ft] [kipft/rad] in X	in Y	in Z	ar X	ar Y	ar Z
1	1,3 Hinged	0.0	0.0	Yes	Yes	Yes	Yes	No	Yes

LOADS

GENERAL DATA

LS No	LS Description	Factor	Combination Type	Dead Weight
1	All vertical loads	1.00	Permanent	-

Global Nodal Force

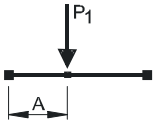


NODAL FORCES

LS 1

No	Loaded Nodes	Nodal Forces PX [kip]	PY [kip]	PZ [kip]
1	2,4	0.000	0.000	40.000

2 - Single Load

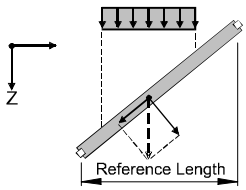


ELEMENT LOADS

LS 1

No	Loaded Elements	Type No	Load Direction	Parameters [kip, kipft, ft, °C, kip/ft, kipft/ft] P1	A
1	3	2	Z	80.000	10.000

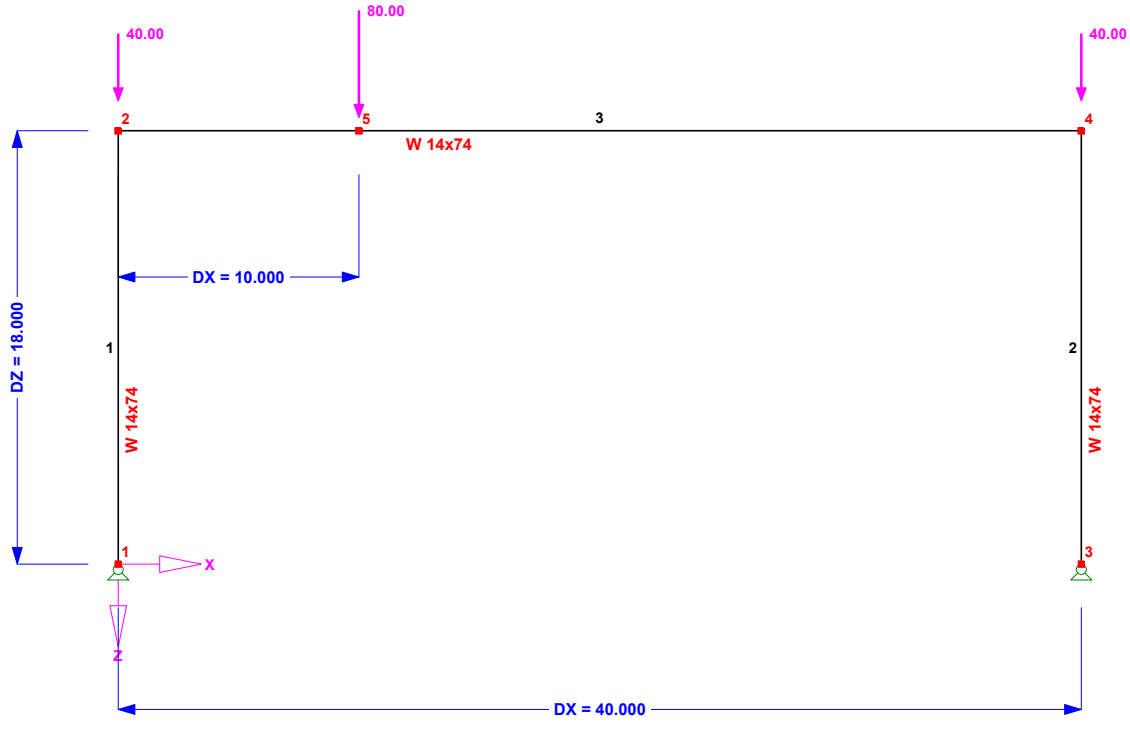
Z - Global in Z-direction



LOADS

LS 1 - All vertical loads
[kip]

Opposite Y-direction



3.140 ft

LS GROUPS

LG No	LG Description	Factor	Coefficient Gamma$_M$	Load Systems in LG
1	Second order results	1.00	1.00	LS1

2ND ORDER ANALYSIS DATA

LG-No	Factor Ny	Number Iterations	Eps-Convergence Existing	Eps-Convergence Wanted	Ny-fold Results	Tension Force Effect
LG1	1.000	2	.11E-02	0.01	Yes	Yes

INTERNAL FORCES BY ELEMENT

Elem No	LS/LG No	Node No	x [ft]	Forces [kip] N	V_2	V_3	Moments [kipin] T	M_2	M_3
1	LS1	1	.00	-100.00	.00	-12.81	.00	.00	.00
		2	18.00	-100.00	.00	-12.81	.00	-2767.56	.00
		Max N	.00	-100.00	.00	-12.81	.00	.00	.00
		Min N	.00	-100.00	.00	-12.81	.00	.00	.00
		Max V-3	18.00	-100.00	.00	-12.81	.00	-2767.56	.00
		Min V-3	.00	-100.00	.00	-12.81	.00	.00	.00
		Max M-2	.00	-100.00	.00	-12.81	.00	.00	.00
		Min M-2	18.00	-100.00	.00	-12.81	.00	-2767.56	.00
	LG1	1	.00	-99.50	.00	-12.70	.00	.00	.00
		2	18.00	-99.50	.00	-11.45	.00	-2651.84	.00
		Max N	.00	-99.50	.00	-12.70	.00	.00	.00
		Min N	.00	-99.50	.00	-12.70	.00	.00	.00
		Max V-3	18.00	-99.50	.00	-11.45	.00	-2651.84	.00
		Min V-3	.00	-99.50	.00	-12.70	.00	.00	.00
		Max M-2	.00	-99.50	.00	-12.70	.00	.00	.00
		Min M-2	18.00	-99.50	.00	-11.45	.00	-2651.84	.00
2	LS1	3	.00	-60.00	.00	12.81	.00	.00	.00
		4	18.00	-60.00	.00	12.81	.00	2767.56	.00
		Max N	.00	-60.00	.00	12.81	.00	.00	.00
		Min N	.00	-60.00	.00	12.81	.00	.00	.00
		Max V-3	.00	-60.00	.00	12.81	.00	.00	.00
		Min V-3	.00	-60.00	.00	12.81	.00	.00	.00
		Max M-2	18.00	-60.00	.00	12.81	.00	2767.56	.00
		Min M-2	.00	-60.00	.00	12.81	.00	.00	.00
	LG1	3	.00	-60.50	.00	13.68	.00	.00	.00
		4	18.00	-60.50	.00	12.85	.00	2894.32	.00
		Max N	.00	-60.50	.00	13.68	.00	.00	.00
		Min N	.00	-60.50	.00	13.68	.00	.00	.00
		Max V-3	.00	-60.50	.00	13.68	.00	.00	.00
		Min V-3	18.00	-60.50	.00	12.85	.00	2894.32	.00
		Max M-2	18.00	-60.50	.00	12.85	.00	2894.32	.00
		Min M-2	.00	-60.50	.00	13.68	.00	.00	.00
3	LS1	2	.00	-12.81	.00	60.00	.00	-2767.56	.00
		left	10.00	-12.81	.00	60.00	.00	4432.44	.00
		right	10.00	-12.81	.00	-20.00	.00	4432.43	.00
		4	40.00	-12.81	.00	-20.00	.00	-2767.56	.00
		Max N	40.00	-12.81	.00	-20.00	.00	-2767.56	.00
		Min N	.00	-12.81	.00	60.00	.00	-2767.56	.00
		Max V-3	.00	-12.81	.00	60.00	.00	-2767.56	.00
		Min V-3	40.00	-12.81	.00	-20.00	.00	-2767.56	.00
		Max M-2	10.00	-12.81	.00	60.00	.00	4432.44	.00
		Min M-2	.00	-12.81	.00	60.00	.00	-2767.56	.00
	LG1	2	.00	-12.98	.00	59.70	.00	-2651.84	.00
		left	10.00	-12.98	.00	59.63	.00	4512.34	.00
		right	10.00	-12.98	.00	-20.37	.00	4512.34	.00
		4	40.00	-12.98	.00	-20.53	.00	-2894.32	.00
		Max N	40.00	-12.98	.00	-20.53	.00	-2894.32	.00
		Min N	.00	-12.98	.00	59.70	.00	-2651.84	.00
		Max V-3	4.00	-12.98	.00	59.73	.00	214.49	.00
		Min V-3	28.00	-12.98	.00	-20.65	.00	73.24	.00
		Max M-2	10.00	-12.98	.00	59.63	.00	4512.34	.00
		Min M-2	40.00	-12.98	.00	-20.53	.00	-2894.32	.00

SUPPORT FORCES AND SUPPORT MOMENTS

Node No	LS/LG No	Support Forces [kip] P_X	P_Y	P_Z	Support Moments [kipin] M_X	M_Y	M_Z
1	LS1	-12.813	.000	100.000	.000	.000	.000
	LG1	-12.980	.000	99.495	.000	.000	.000
3	LS1	12.813	.000	60.000	.000	.000	.000
	LG1	12.980	.000	60.505	.000	.000	.000
ΣLoads	LS1	.000	.000	160.000			
ΣForces		.000	.000	160.000			
ΣLoads	LG1	.000	.000	160.000			
ΣForces		.000	.000	160.000			

GLOBAL ELEMENT DEFORMATIONS

Elem No	LS/LG No	Node No	x [ft]	Element Deformations [in] u_X	u_Y	u_Z
1	LS1	Max u-Z	18.00	1.34614	.00000	.03417
		Min u-Z	.00	.00000	.00000	.00000
	LG1	Max u-Z	18.00	1.51919	.00000	.03399
		Min u-Z	.00	.00000	.00000	.00000

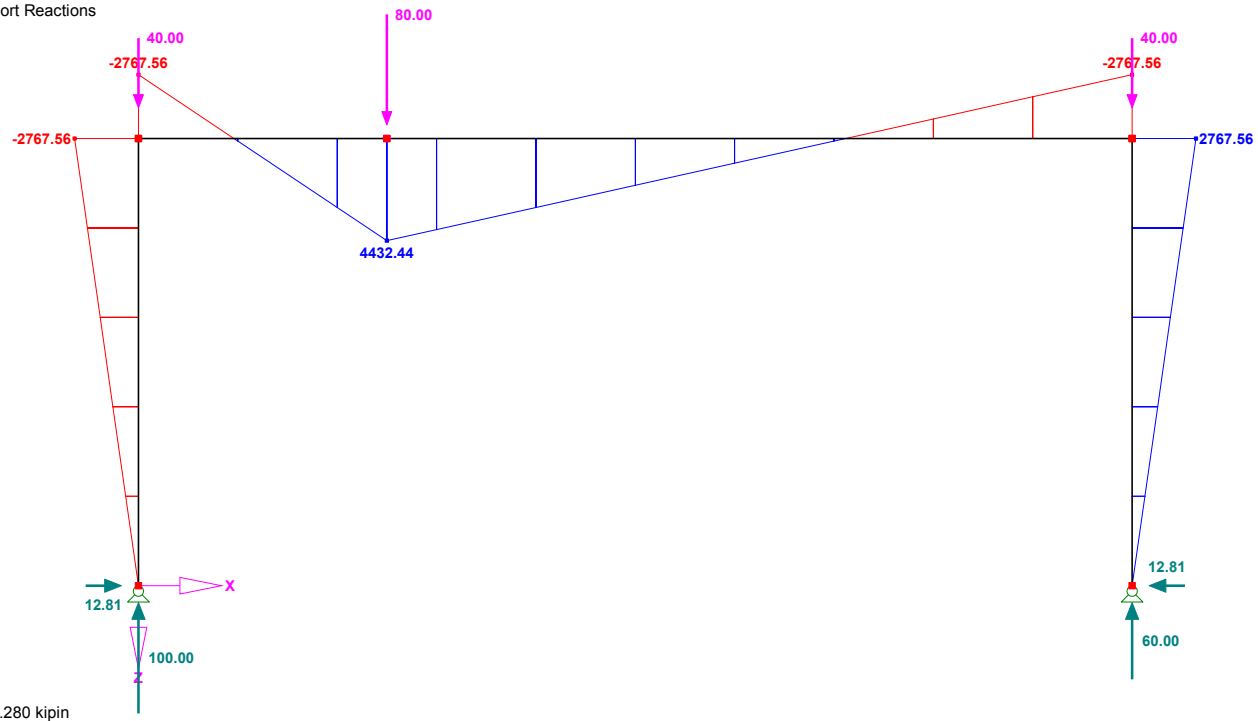
GLOBAL ELEMENT DEFORMATIONS

Elem No	LS/LG No	Node No	x [ft]	Element Deformations [in] ux	uy	uz
2	LS1	Max u-Z	18.00	1.33641	.00000	.02050
		Min u-Z	.00	.00000	.00000	.00000
	LG1	Max u-Z	18.00	1.50934	.00000	.02067
		Min u-Z	.00	.00000	.00000	.00000
3	LS1	Max u-Z	16.00	1.34225	.00000	2.24739
		Min u-Z	40.00	1.33641	.00000	.02050
	LG1	Max u-Z	16.00	1.51525	.00000	2.27633
		Min u-Z	40.00	1.50934	.00000	.02067

RESULTS - FIRST-ORDER ELASTIC

LS 1 - All vertical loads
Internal Forces M-2
Support Reactions

Opposite Y-direction



3280.280 kipin

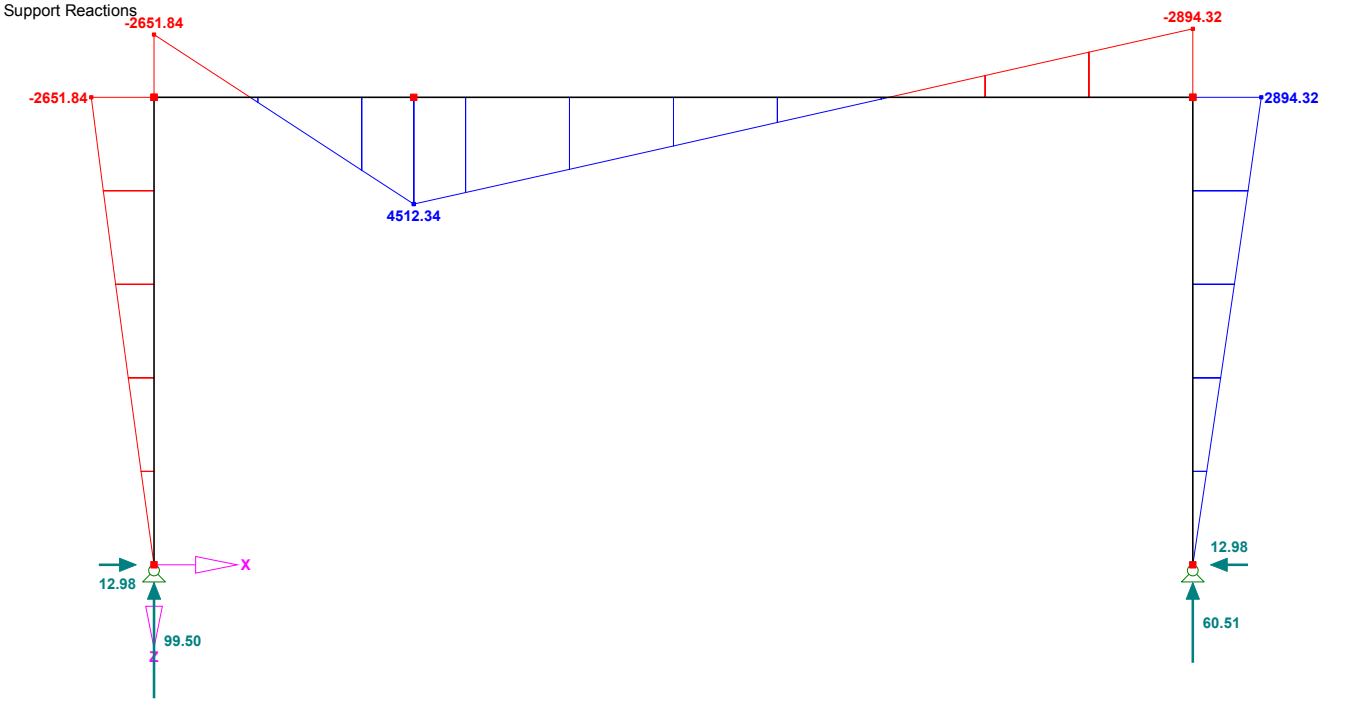
Max M-2: 4432.44, Min M-2: -2767.56 kipin

3.043 ft

RESULTS - SECOND-ORDER ELASTIC

LG 1 - Second order results
Internal Forces M-2
Support Reactions

Opposite Y-direction



3194.740 kipin

Max M-2: 4512.34, Min M-2: -2894.32 kipin

2.911 ft