Problem 1.

(a)

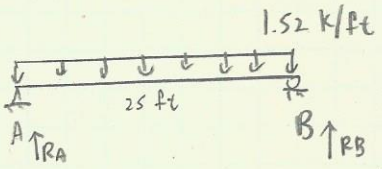
① $1.4 \times$ Dead Load $= 1.4 \times 0.6 = 0.84$ (k/ft) #

② $1.2 \times$ Dead Load $+ 1.6 \times$ Live Load $= 1.2 \times 0.6 + 1.6 \times 0.5$

$= 1.52$ (k/ft) # ✓ controlled

Ans: 1.52 (k/ft) #

(b)



$\Sigma M_B = 0 \Rightarrow R_A \times 25 - 1.52 \times 25 \times \frac{25}{2} = 0$

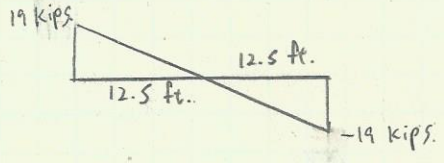
$R_A = 19$ (kips.) # (Ans)

$\Sigma F = 0 \Rightarrow R_A + R_B - 1.52 \times 25 = 0$

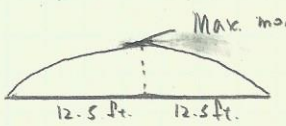
$\Rightarrow 19 + R_B - 1.52 \times 25 = 0$

$R_B = 19$ (kips) # (Ans)

(c) Shear force diagram:



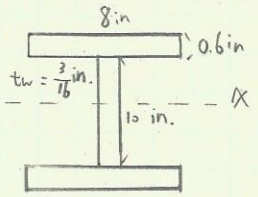
Bending moment diagram



Max. moment $= 19 \times 12.5 - 1.52 \times 12.5 \times \frac{12.5}{2}$

$= 118.75$ (kips-ft) # (Ans)

(d) Max. longitudinal stress $= \frac{M_{max} Y}{I_x}$



$$I_x = \frac{1}{12} \times \frac{3}{16} \times 10^3 + 2 \times \left[\frac{1}{12} \times 8 \times 0.6^3 + 8 \times 0.6 \times \left(\frac{0.6}{2} + \frac{10}{2} \right)^2 \right]$$

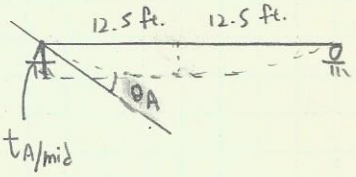
$$= 285.58 \ (in^4)$$

$$Y = \frac{(10 + 0.6 \times 2)}{2} = 5.6 \ (in)$$

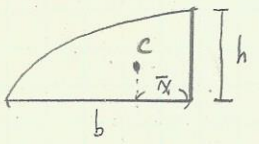
$$\frac{M_{max} Y}{I_x} = \frac{118.75 \times 12 \ (in/ft) \times 5.6}{285.58} = 27.94 \ (ksi) \ \# \ (Ans)$$

(e) Max. Shear stress $= \frac{V_{max}}{A_w} = \frac{19}{\frac{3}{16} \times 10} = 10.13 \ (ksi) \ \# \ (Ans)$

(f)



For semi parabola



Area $= \frac{2}{3} b \cdot h$

$\bar{x} = \frac{3}{8} b$

The deflection at the midspan $= t_{A/mid} = \bar{x}_A \int_0^{12.5} \frac{M}{EI} dx$
(δ_{mid})

$$= \bar{x}_A \times \frac{2}{3} \times 12.5 \times \frac{118.75}{EI}$$

$$= \frac{15}{8} \times 12.5 \times \frac{2}{3} \times 12.5 \times \frac{118.75}{EI}$$

$$= \frac{7731.12}{EI}$$

$$= \frac{7731.12}{29000 \times 12^2 \times 285.58 / 12^4}$$

$$= 0.134 \ (ft)$$

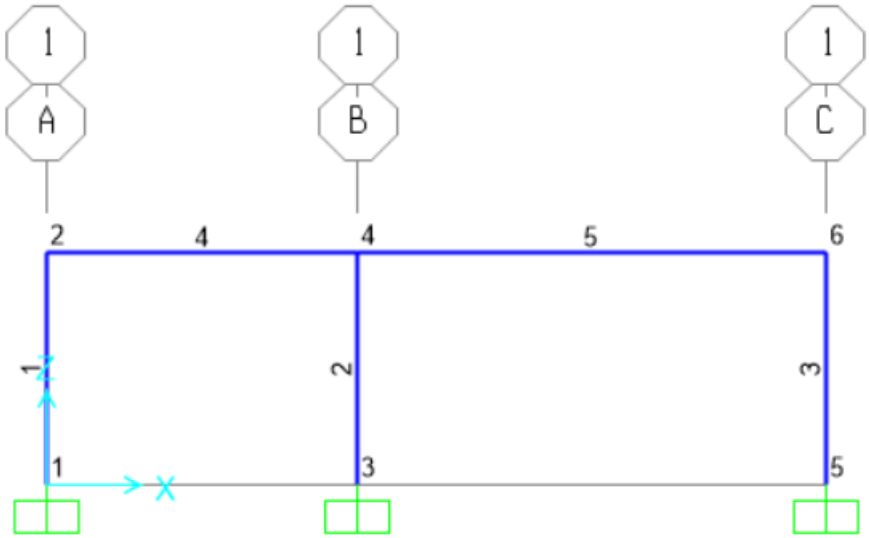
$$= 1.61 \ (in) \downarrow \ \# \ (Ans)$$

(g) For bending stress $\frac{F_y}{F.S.} = \frac{50}{1.5} = 33.33 \ (ksi) > \sigma_{moment} = 27.94 \ (ksi)$ V a.k. #

For shear stress $\frac{0.6 F_y}{F.S.} = \frac{30}{2} = 15.00 \ (ksi) > \sigma_{shear} = 10.13 \ (ksi)$ V # a.k

∴ The design is adequate # (Ans)

Problem No.2:



(a) First Order Analysis

(i)

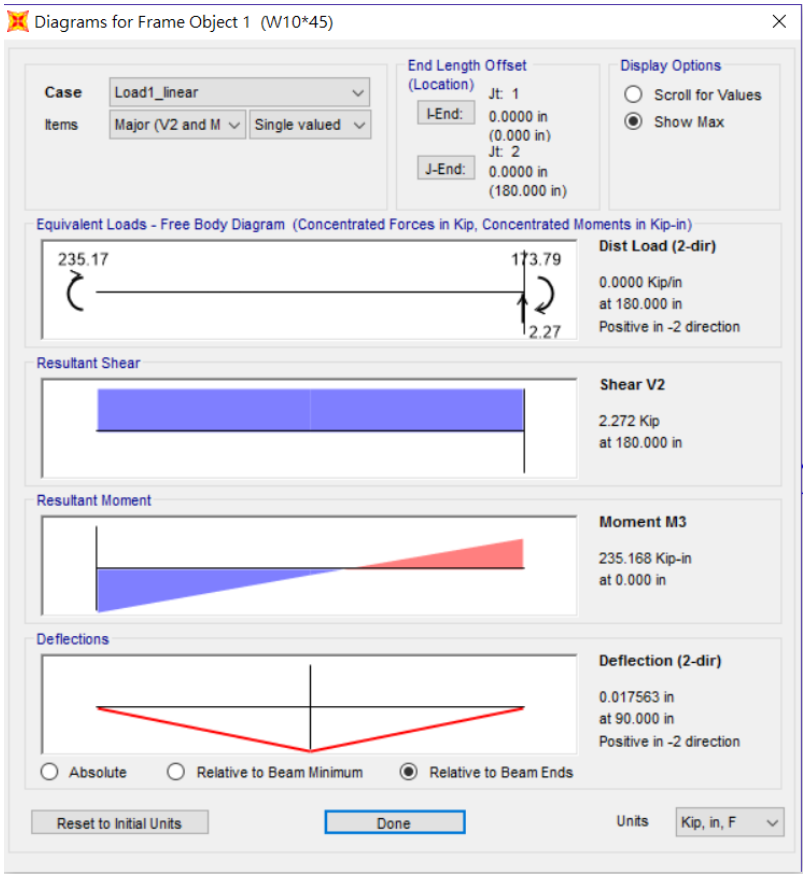
	Joint Reactions		
Joint	**Fx (Kips)**	**Fz (Kips)**	**Moment (Kips-in)**
1	**-2.370**	**71.426**	**-252.730**
3	**-1.985**	**211.617**	**-237.785**
5	**-5.642**	**116.957**	**-446.872**

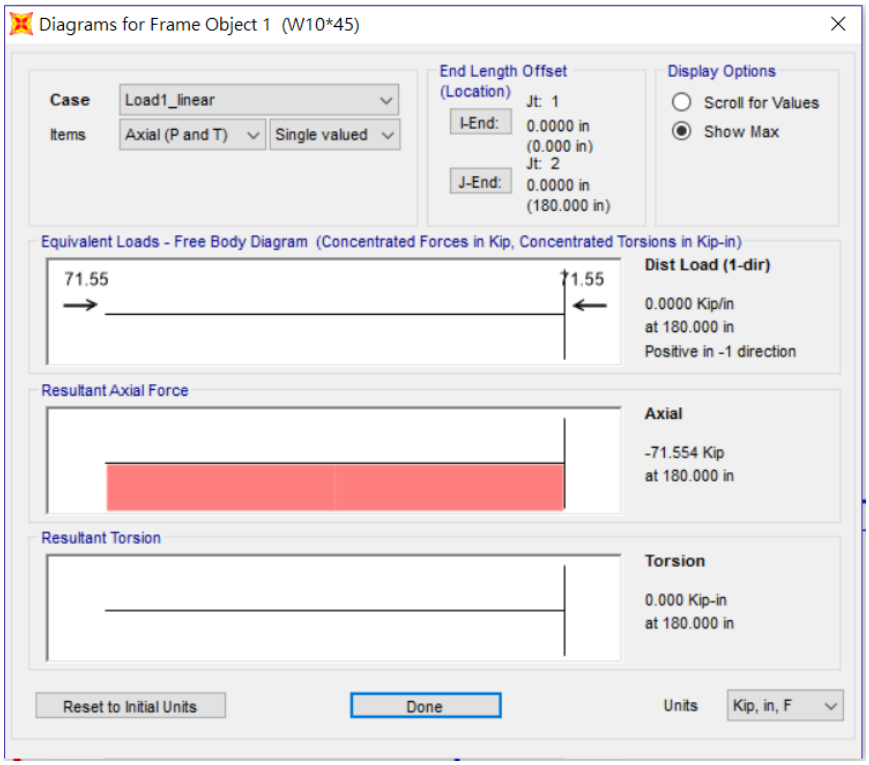
(ii)

	Joint Displacements		
Joint	**Ux (in)**	**Uz (in)**	**Ry (Rads)**
1	**0.000000**	**0.000000**	**0.000000**
2	**0.253331**	**-0.033983**	**0.000794**
3	**0.000000**	**0.000000**	**0.000000**
4	**0.250748**	**-0.100683**	**0.000903**
5	**0.000000**	**0.000000**	**0.000000**
6	**0.247882**	**-0.055646**	**-0.002008**

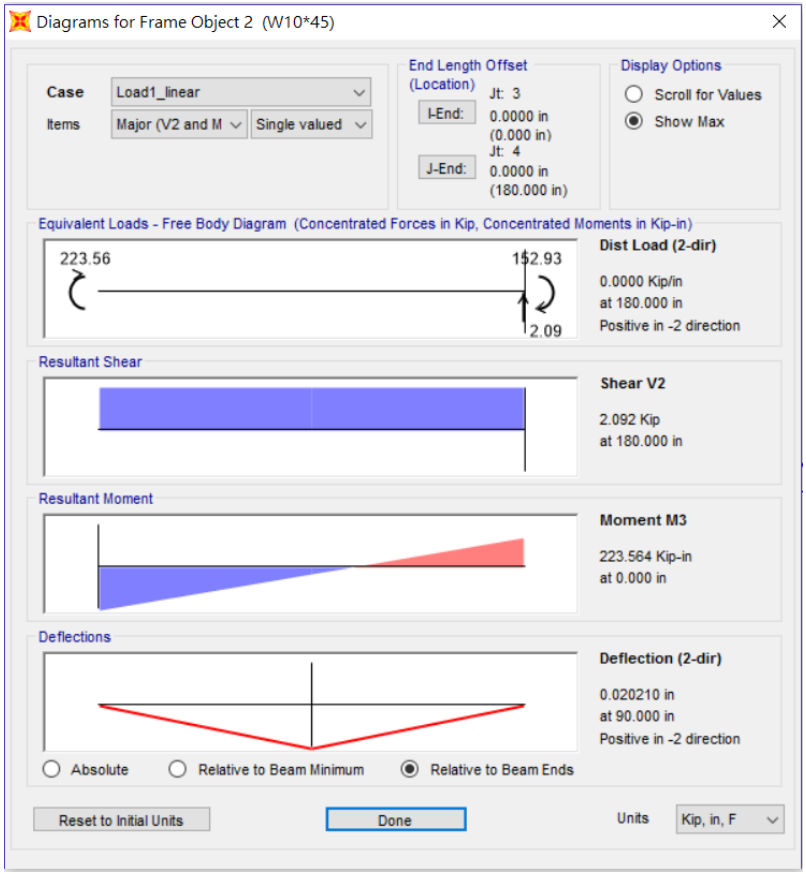
(iii) Shear force, bending moment and axial force diagrams:

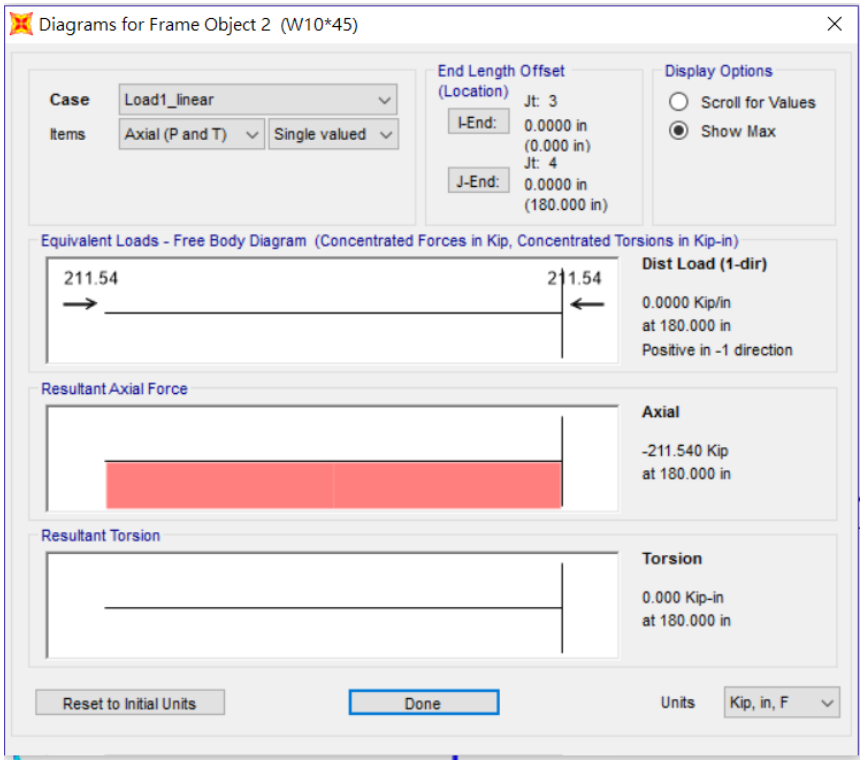
Member_1



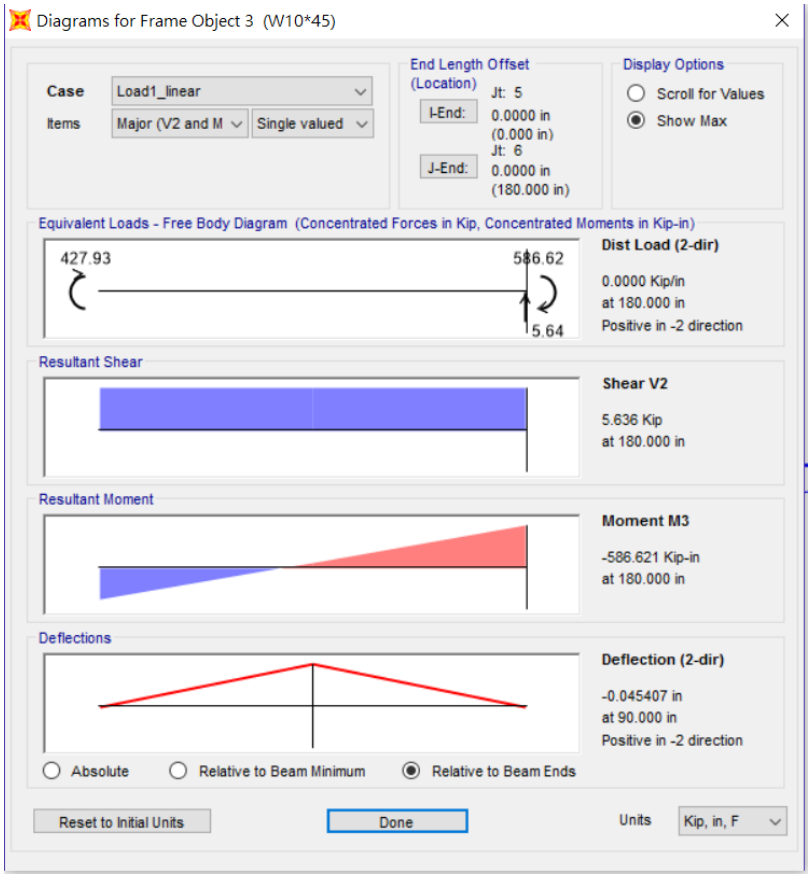


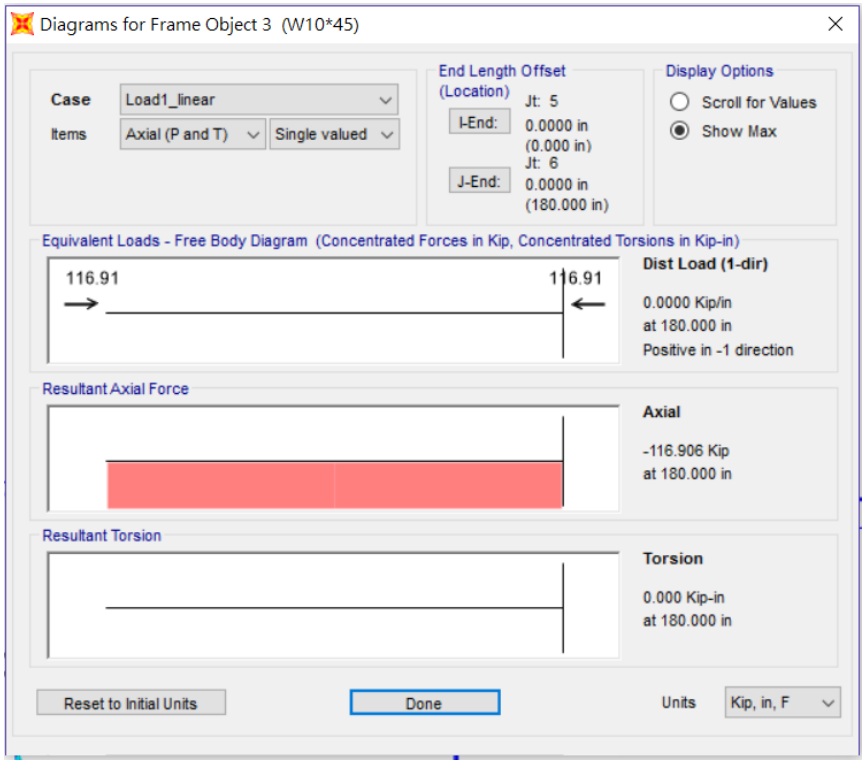
Member_2


Diagrams for Frame Object 2 (W10*45)
Case
Load1_linear
Items
Major (V2 and M
Single valued
End Length Offset
(Location)
I-End:
Jt: 3
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
223.56
152.93
2.09
Dist Load (2-dir)
0.0000 Kip/in
at 180.000 in
Positive in -2 direction
Resultant Shear
Shear V2
2.092 Kip
at 180.000 in
Resultant Moment
Moment M3
223.564 Kip-in
at 0.000 in
Deflections
Deflection (2-dir)
0.020210 in
at 90.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F

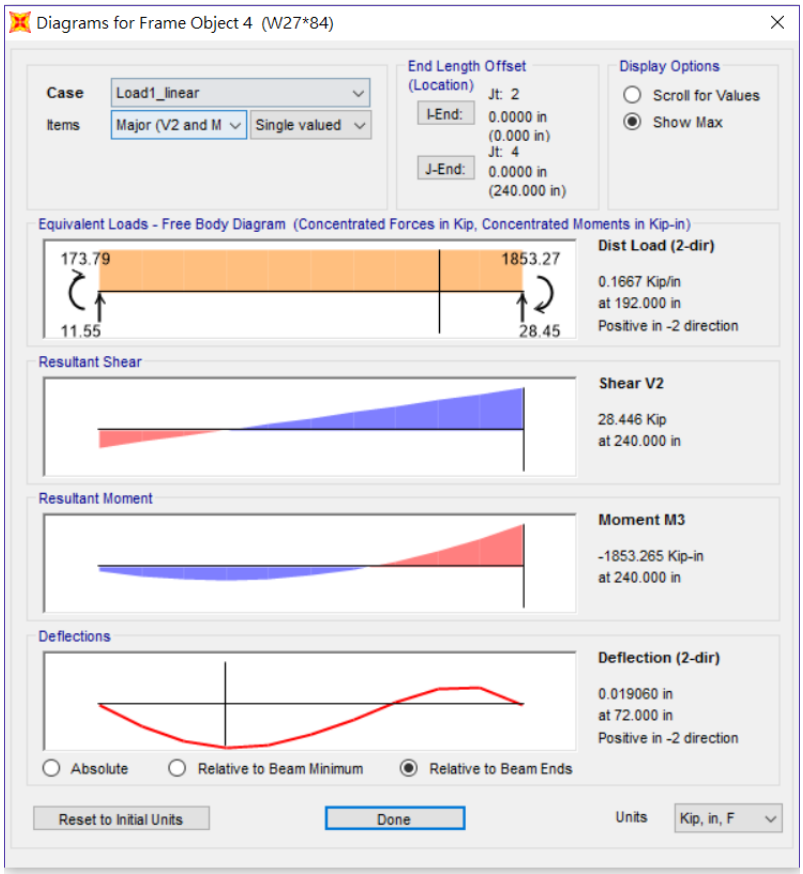

Diagrams for Frame Object 2 (W10*45)
Case
Load1_linear
Items
Axial (P and T)
Single valued
End Length Offset
(Location)
I-End:
Jt: 3
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
211.54
211.54
Dist Load (1-dir)
0.0000 Kip/in
at 180.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-211.540 Kip
at 180.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 180.000 in
Reset to Initial Units
Done
Units
Kip, in, F

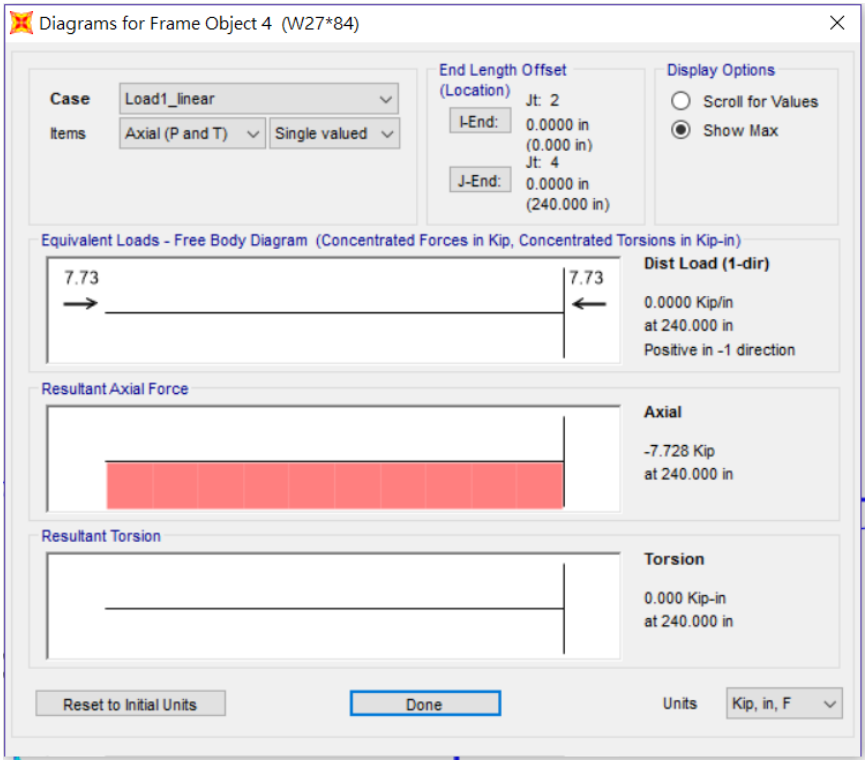
Member_3


Diagrams for Frame Object 3 (W10*45)
Case
Load1_linear
Items
Major (V2 and M
Single valued
End Length Offset
(Location)
I-End:
Jt: 5
0.0000 in
(0.000 in)
Jt: 6
J-End:
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
427.93
586.62
5.64
Dist Load (2-dir)
0.0000 Kip/in
at 180.000 in
Positive in -2 direction
Resultant Shear
Shear V2
5.636 Kip
at 180.000 in
Resultant Moment
Moment M3
-586.621 Kip-in
at 180.000 in
Deflections
Deflection (2-dir)
-0.045407 in
at 90.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F

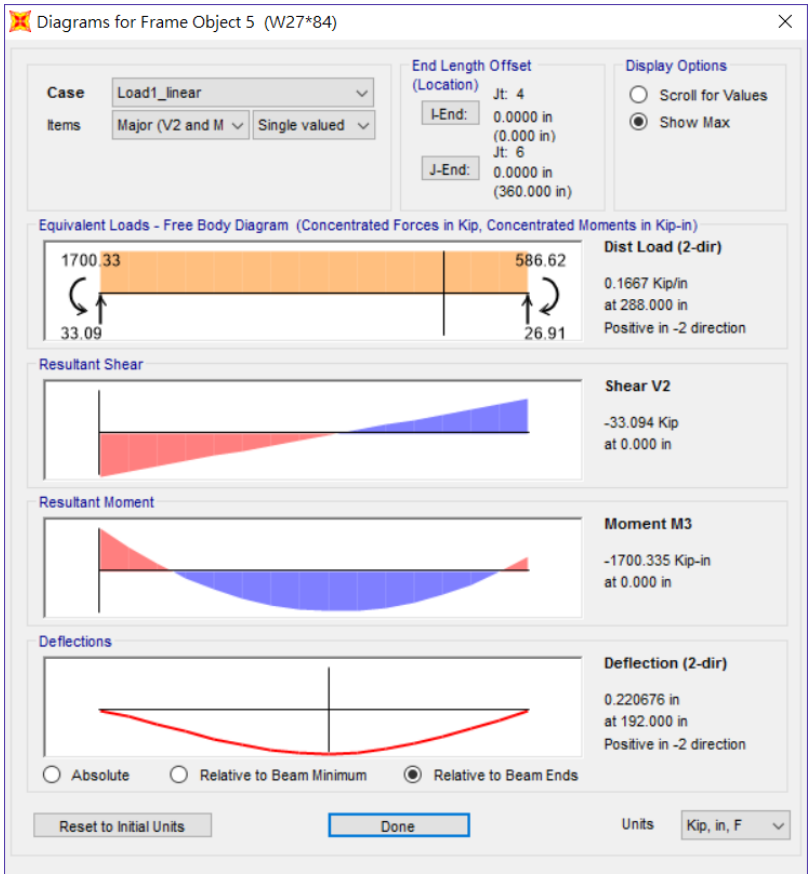

Diagrams for Frame Object 3 (W10*45)
Case
Load1_linear
Items
Axial (P and T)
Single valued
End Length Offset
(Location)
I-End:
Jt: 5
0.0000 in
(0.000 in)
Jt: 6
J-End:
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
116.91
116.91
Dist Load (1-dir)
0.0000 Kip/in
at 180.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-116.906 Kip
at 180.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 180.000 in
Reset to Initial Units
Done
Units
Kip, in, F

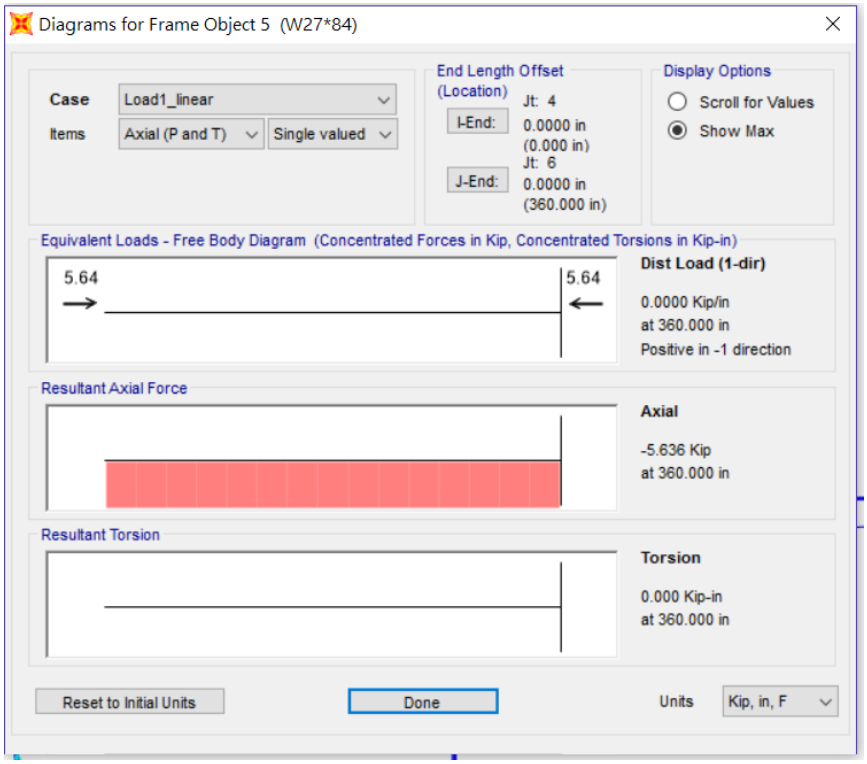
Member_4


Diagrams for Frame Object 4 (W27*84)
Case
Load1_linear
Items
Major (V2 and M
Single valued
End Length Offset (Location)
I-End:
Jt: 2
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(240.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
173.79
1853.27
11.55
28.45
Dist Load (2-dir)
0.1667 Kip/in
at 192.000 in
Positive in -2 direction
Resultant Shear
Shear V2
28.446 Kip
at 240.000 in
Resultant Moment
Moment M3
-1853.265 Kip-in
at 240.000 in
Deflections
Deflection (2-dir)
0.019060 in
at 72.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F


Diagrams for Frame Object 4 (W27*84)
Case
Load1_linear
Items
Axial (P and T)
Single valued
End Length Offset (Location)
I-End:
Jt: 2
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(240.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
7.73
7.73
Dist Load (1-dir)
0.0000 Kip/in
at 240.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-7.728 Kip
at 240.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 240.000 in
Reset to Initial Units
Done
Units
Kip, in, F

Member_5


Diagrams for Frame Object 5 (W27*84)
Case
Load1_linear
Items
Major (V2 and M
Single valued
End Length Offset (Location)
I-End:
Jt: 4
0.0000 in
(0.000 in)
J-End:
Jt: 6
0.0000 in
(360.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
1700.33
586.62
33.09
26.91
Dist Load (2-dir)
0.1667 Kip/in
at 288.000 in
Positive in -2 direction
Resultant Shear
Shear V2
-33.094 Kip
at 0.000 in
Resultant Moment
Moment M3
-1700.335 Kip-in
at 0.000 in
Deflections
Deflection (2-dir)
0.220676 in
at 192.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F


Diagrams for Frame Object 5 (W27*84)
Case
Load1_linear
Items
Axial (P and T)
Single valued
End Length Offset (Location)
I-End:
Jt: 4
0.0000 in
(0.000 in)
J-End:
Jt: 6
0.0000 in
(360.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
5.64
5.64
Dist Load (1-dir)
0.0000 Kip/in
at 360.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-5.636 Kip
at 360.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 360.000 in
Reset to Initial Units
Done
Units
Kip, in, F

(b) Second Order Analysis

(i)

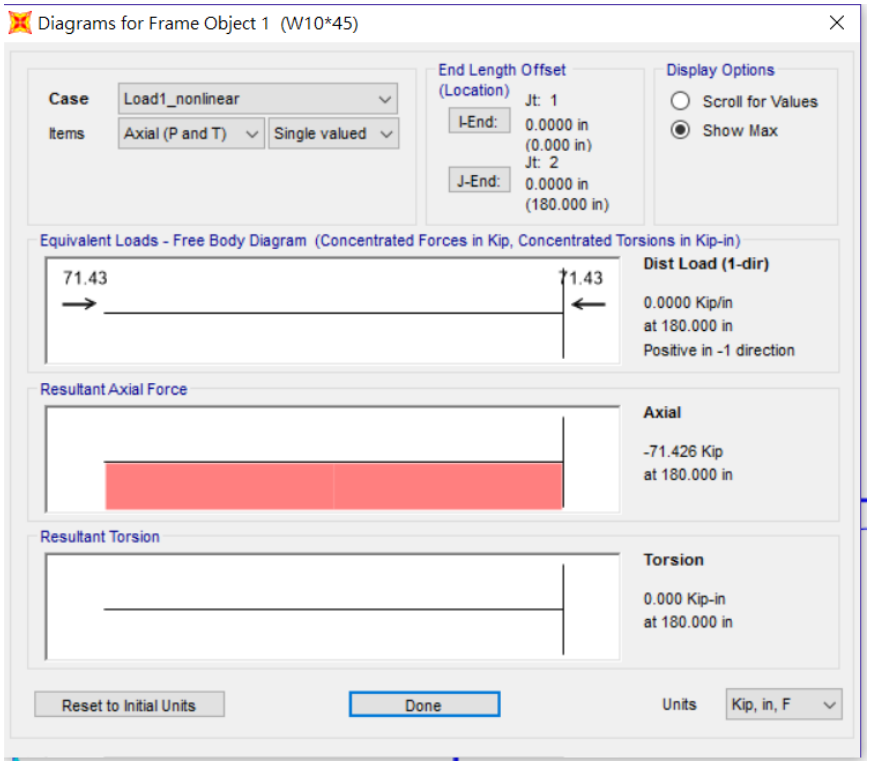
	Joint Reactions		
Joint	**Fx (Kips)**	**Fz (Kips)**	**Moment (Kips-in)**
1	**-2.272**	**71.554**	**-235.168**
3	**-2.092**	**211.54**	**-223.564**
5	**-5.636**	**116.906**	**-427.929**

(ii)

	Joint Displacements		
Joint	**Ux (in)**	**Uz (in)**	**Ry (Rads)**
1	**0.000000**	**0.000000**	**0.000000**
2	**0.236643**	**-0.034044**	**0.000781**
3	**0.000000**	**0.000000**	**0.000000**
4	**0.234027**	**-0.100646**	**0.000898**
5	**0.000000**	**0.000000**	**0.000000**
6	**0.231164**	**-0.055621**	**-0.002018**

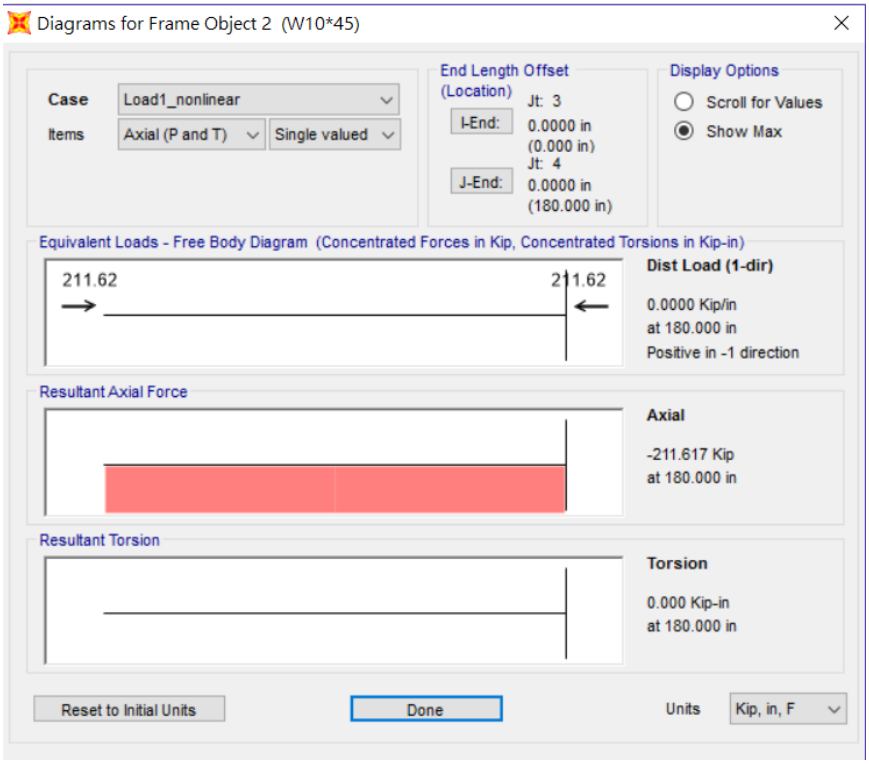
(iii) Shear force, bending moment and axial force diagrams:

Member_1



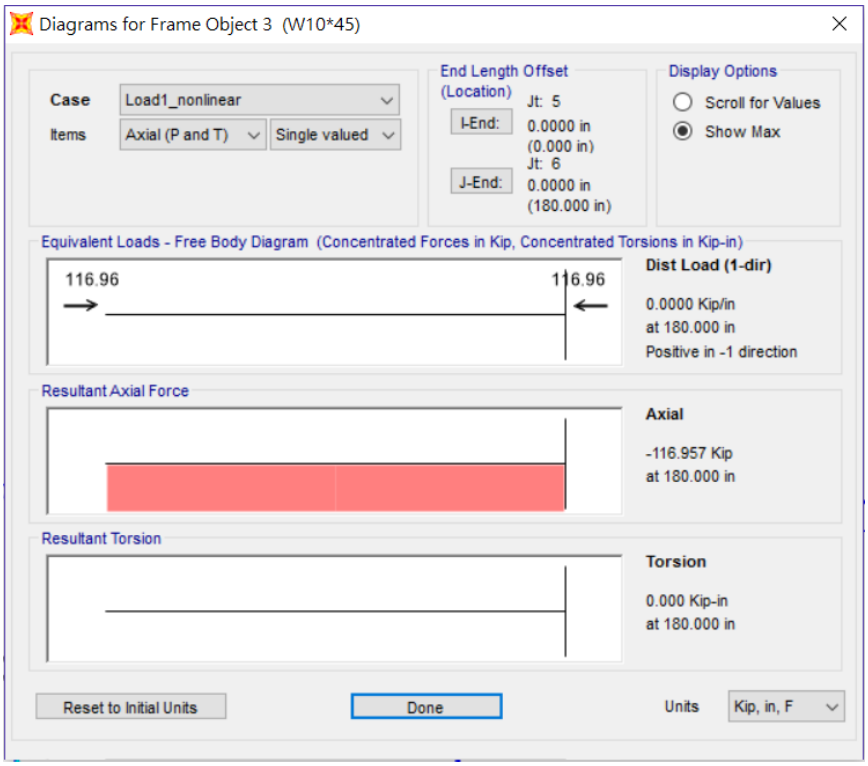
Member_2


Diagrams for Frame Object 2 (W10*45)
Case
Load1_nonlinear
Items
Major (V2 and M
Single valued
End Length Offset
(Location)
I-End:
Jt: 3
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
237.78
172.54
1.98
Dist Load (2-dir)
-0.0228 Kip/in
at 180.000 in
Positive in -2 direction
Resultant Shear
Shear V2
1.985 Kip
at 180.000 in
Resultant Moment
Moment M3
237.785 Kip-in
at 0.000 in
Deflections
Deflection (2-dir)
0.020308 in
at 90.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F

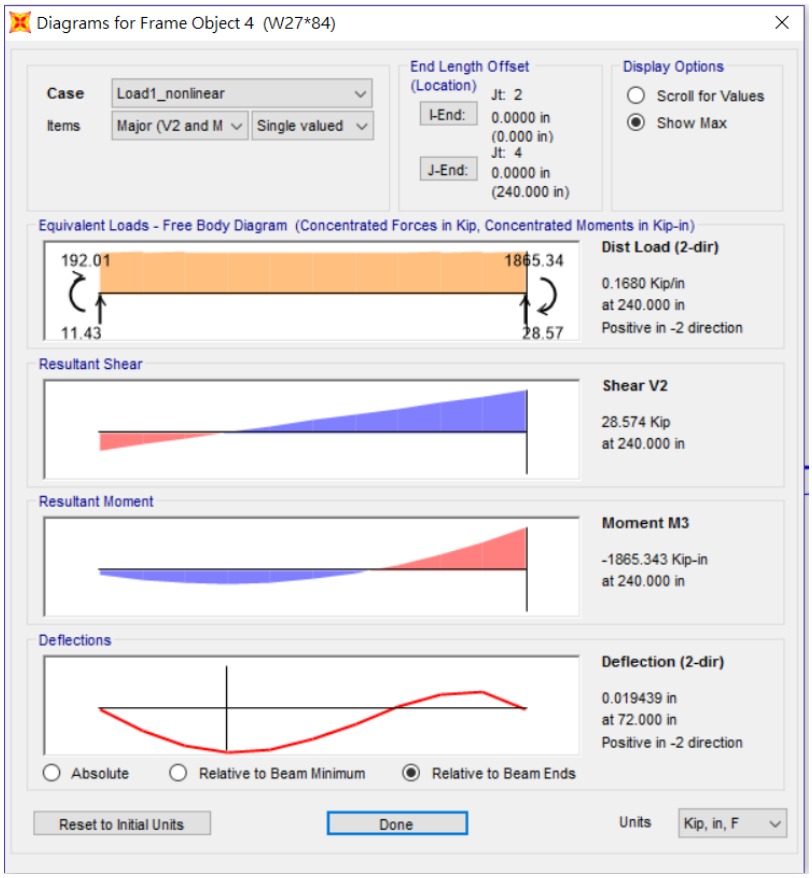

Diagrams for Frame Object 2 (W10*45)
Case
Load1_nonlinear
Items
Axial (P and T)
Single valued
End Length Offset
(Location)
I-End:
Jt: 3
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
211.62
211.62
Dist Load (1-dir)
0.0000 Kip/in
at 180.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-211.617 Kip
at 180.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 180.000 in
Reset to Initial Units
Done
Units
Kip, in, F

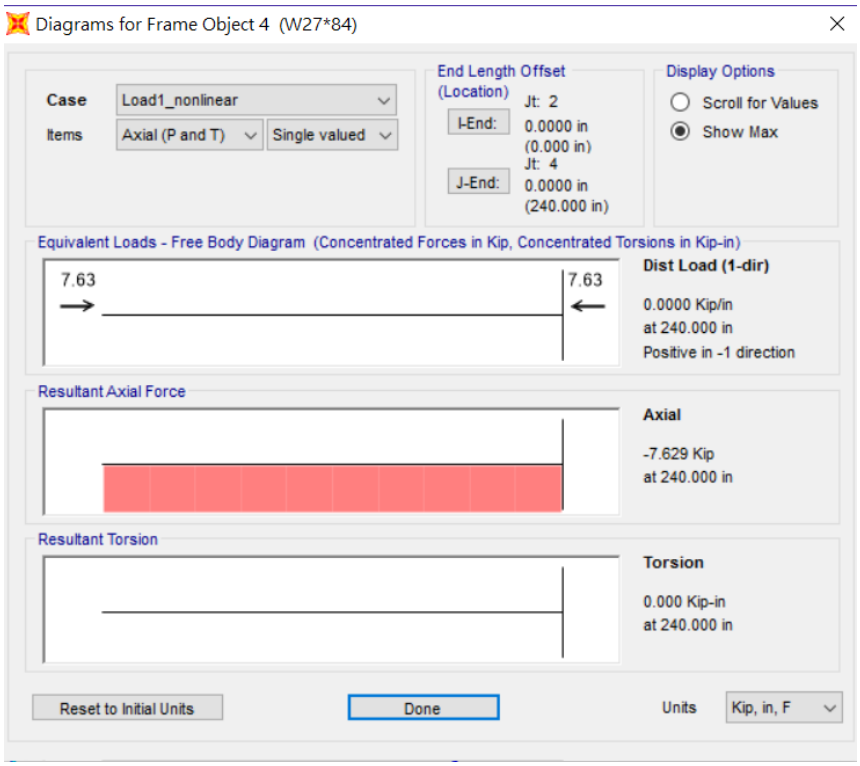
Member_3


Diagrams for Frame Object 3 (W10*45)
Case
Load1_nonlinear
Items
Major (V2 and M
Single valued
End Length Offset
(Location)
I-End:
Jt: 5
0.0000 in
(0.000 in)
J-End:
Jt: 6
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
446.87
597.73
5.64
Dist Load (2-dir)
-0.0147 Kip/in
at 90.000 in
Positive in -2 direction
Resultant Shear
Shear V2
5.642 Kip
at 180.000 in
Resultant Moment
Moment M3
-597.728 Kip-in
at 180.000 in
Deflections
Deflection (2-dir)
-0.045181 in
at 90.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F

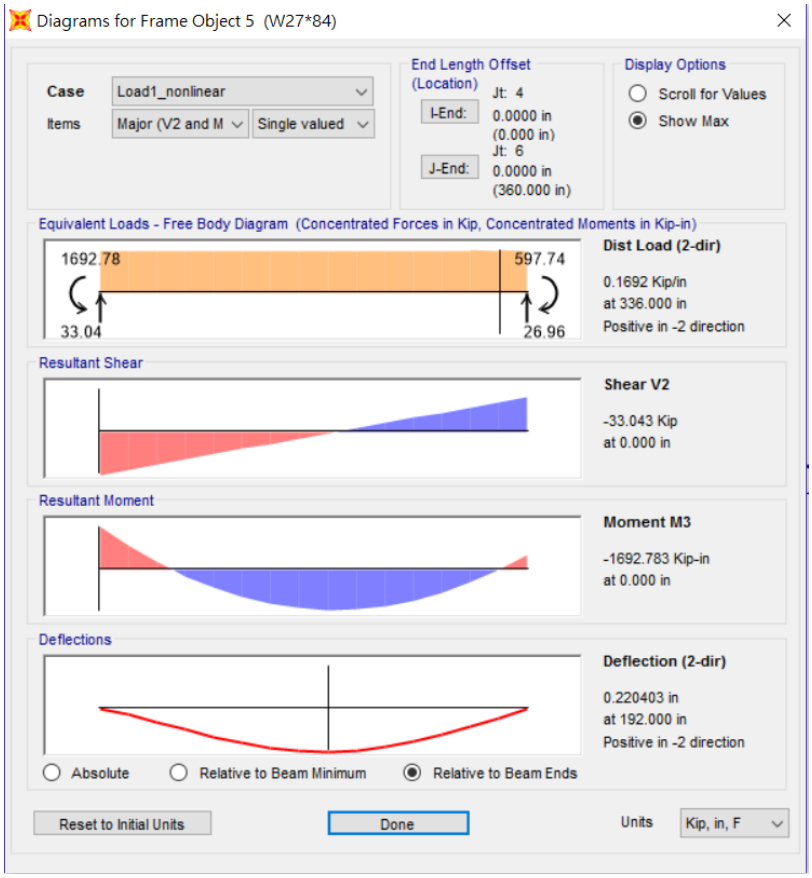

Diagrams for Frame Object 3 (W10*45)
Case
Load1_nonlinear
Items
Axial (P and T)
Single valued
End Length Offset
(Location)
I-End:
Jt: 5
0.0000 in
(0.000 in)
J-End:
Jt: 6
0.0000 in
(180.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
116.96
116.96
Dist Load (1-dir)
0.0000 Kip/in
at 180.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-116.957 Kip
at 180.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 180.000 in
Reset to Initial Units
Done
Units
Kip, in, F

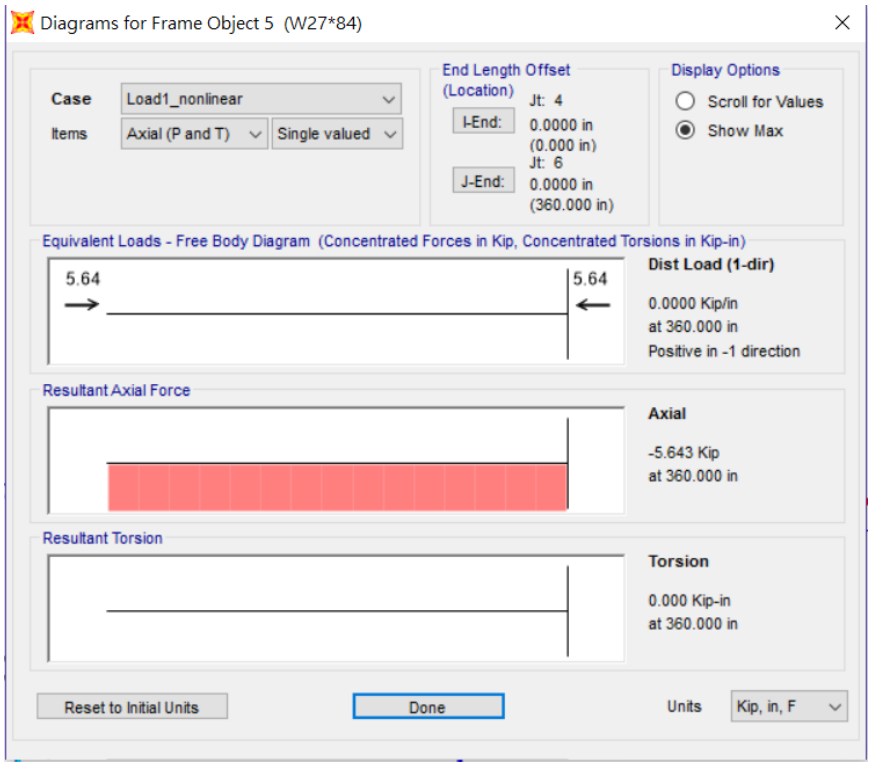
Member_4


Diagrams for Frame Object 4 (W27*84)
Case
Load1_nonlinear
Items
Major (V2 and M
Single valued
End Length Offset
(Location)
I-End:
Jt: 2
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(240.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
192.01
1865.34
11.43
28.57
Dist Load (2-dir)
0.1680 Kip/in
at 240.000 in
Positive in -2 direction
Resultant Shear
Shear V2
28.574 Kip
at 240.000 in
Resultant Moment
Moment M3
-1865.343 Kip-in
at 240.000 in
Deflections
Deflection (2-dir)
0.019439 in
at 72.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F


Diagrams for Frame Object 4 (W27*84)
Case
Load1_nonlinear
Items
Axial (P and T)
Single valued
End Length Offset
(Location)
I-End:
Jt: 2
0.0000 in
(0.000 in)
J-End:
Jt: 4
0.0000 in
(240.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
7.63
7.63
Dist Load (1-dir)
0.0000 Kip/in
at 240.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-7.629 Kip
at 240.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 240.000 in
Reset to Initial Units
Done
Units
Kip, in, F

Member_5


Diagrams for Frame Object 5 (W27*84)
Case
Load1_nonlinear
Items
Major (V2 and M
Single valued
End Length Offset
(Location)
I-End:
Jt: 4
0.0000 in
(0.000 in)
J-End:
Jt: 6
0.0000 in
(360.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Moments in Kip-in)
1692.78
597.74
33.04
26.96
Dist Load (2-dir)
0.1692 Kip/in
at 336.000 in
Positive in -2 direction
Resultant Shear
Shear V2
-33.043 Kip
at 0.000 in
Resultant Moment
Moment M3
-1692.783 Kip-in
at 0.000 in
Deflections
Deflection (2-dir)
0.220403 in
at 192.000 in
Positive in -2 direction
Absolute
Relative to Beam Minimum
Relative to Beam Ends
Reset to Initial Units
Done
Units
Kip, in, F


Diagrams for Frame Object 5 (W27*84)
Case
Load1_nonlinear
Items
Axial (P and T)
Single valued
End Length Offset
(Location)
I-End:
Jt: 4
0.0000 in
(0.000 in)
J-End:
Jt: 6
0.0000 in
(360.000 in)
Display Options
Scroll for Values
Show Max
Equivalent Loads - Free Body Diagram (Concentrated Forces in Kip, Concentrated Torsions in Kip-in)
5.64
5.64
Dist Load (1-dir)
0.0000 Kip/in
at 360.000 in
Positive in -1 direction
Resultant Axial Force
Axial
-5.643 Kip
at 360.000 in
Resultant Torsion
Torsion
0.000 Kip-in
at 360.000 in
Reset to Initial Units
Done
Units
Kip, in, F

(c) Amplification Between First and Second Order Analysis

	Axial Force		
Member	**First Order (Kips)**	**Second Order (Kips)**	**Amplification Factor**
1	**-71.554**	**-71.426**	**0.99821**
2	**-211.540**	**-211.617**	**1.00036**
3	**-116.906**	**-116.957**	**1.00044**
4	**-7.728**	**-7.629**	**0.98719**
5	**-5.636**	**-5.643**	**1.00124**

	Shear Force		
Member	**First Order (Kips)**	**Second Order (Kips)**	**Amplification Factor**
1	**2.272**	**2.370**	**1.04313**
2	**2.092**	**1.985**	**0.94885**
3	**5.636**	**5.642**	**1.00106**
4	**28.446**	**28.574**	**1.00450**
5	**-33.094**	**-33.043**	**0.99846**

	Bending Moment		
Member	**First Order (Kips-in)**	**Second Order (Kips-in)**	**Amplification Factor**
1	**235.168**	**252.730**	**1.07468**
2	**223.564**	**237.785**	**1.06361**
3	**-586.621**	**-597.728**	**1.01893**
4	**-1853.265**	**-1865.343**	**1.00652**
5	**-1700.335**	**-1692.783**	**0.99556**

	Joint Displacement_Ux		
Joint	**First Order (in)**	**Second Order (in)**	**Amplification Factor**
1	**0.000000**	**0.000000**	**N/A**
2	**0.236643**	**0.253331**	**1.07052**
3	**0.000000**	**0.000000**	**N/A**
4	**0.234027**	**0.250748**	**1.07145**
5	**0.000000**	**0.000000**	**N/A**
6	**0.231164**	**0.247882**	**1.07232**

	Joint Displacement_Uz		
Joint	**First Order (in)**	**Second Order (in)**	**Amplification Factor**
1	**0.000000**	**0.000000**	**N/A**
2	**-0.034044**	**-0.033983**	**0.99821**
3	**0.000000**	**0.000000**	**N/A**
4	**-0.100646**	**-0.100683**	**1.00037**
5	**0.000000**	**0.000000**	**N/A**
6	**-0.055621**	**-0.055646**	**1.00045**

	Joint Displacement_Ry		
Joint	**First Order (Rads)**	**Second Order (Rads)**	**Amplification Factor**
1	**0.000000**	**0.000000**	**N/A**
2	**0.000781**	**0.000794**	**1.01665**
3	**0.000000**	**0.000000**	**N/A**
4	**0.000898**	**0.000903**	**1.00557**
5	**0.000000**	**0.000000**	**N/A**
6	**-0.002018**	**-0.002008**	**0.99504**