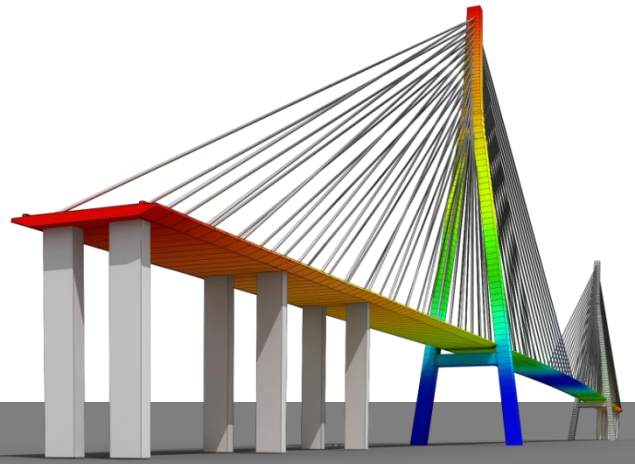
Section Design as per AASHTO-LRFD 2012 using midas GSD



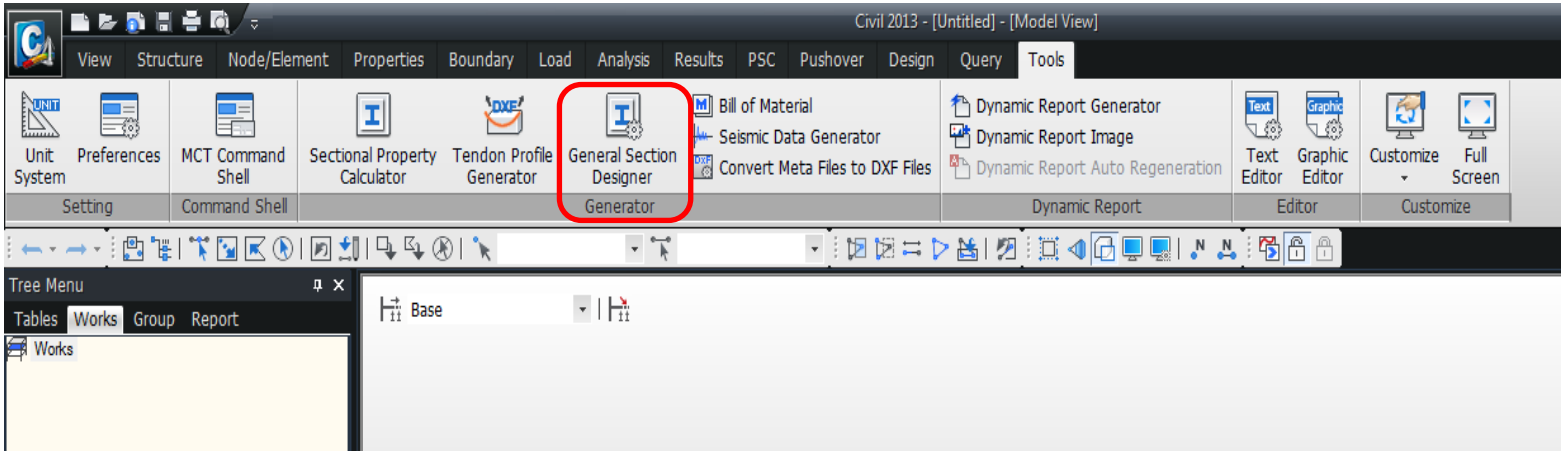
Bridging Your Innovations to Realities

Introduction

In this tutorial, it's shown how to design an irregular hollow reinforced concrete as per AASHTO-LRDF 2012. The section is designed using midas GSD (General Section Designer), which is an add-on module available with midas Civil and midas Gen. Nonlinear material model Mander model for Concrete and bilinear curve for steel are used to meet the AASHTO code requirement. The software develops 2D & 3D interaction diagram and moment curvature curve (with idealized curve), and stress contour for both concrete and steel rebar. This module can be linked to midas Civil and Gen and information (like section properties, materials properties and load combinations) can be exchanged.

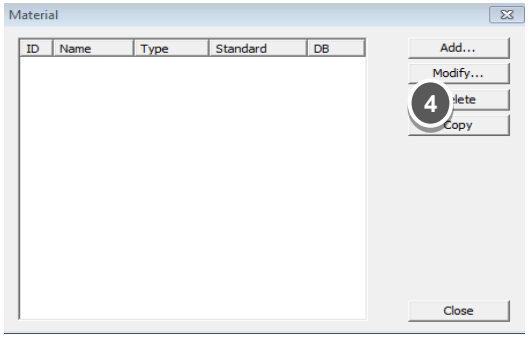
Start

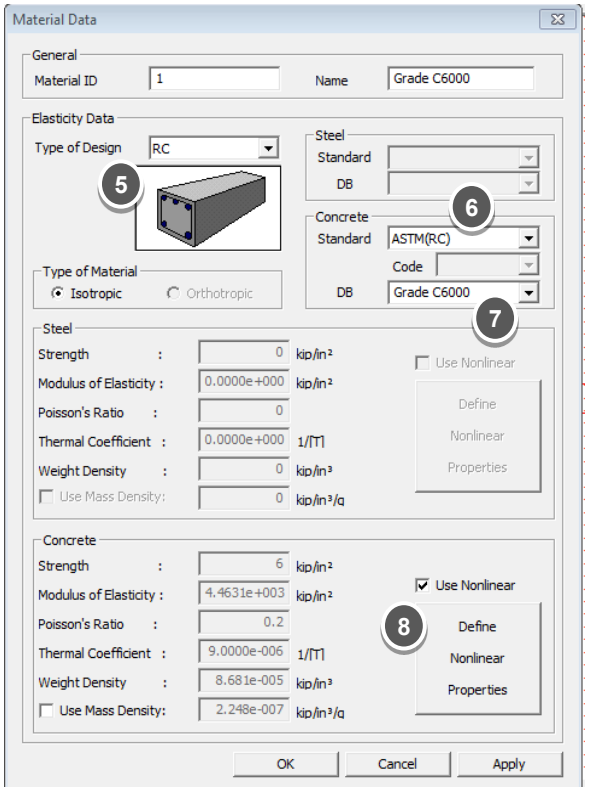
1. Open Midas Civil
2. Under Tool tab click General Section Designer to open a new midas GSD



Material

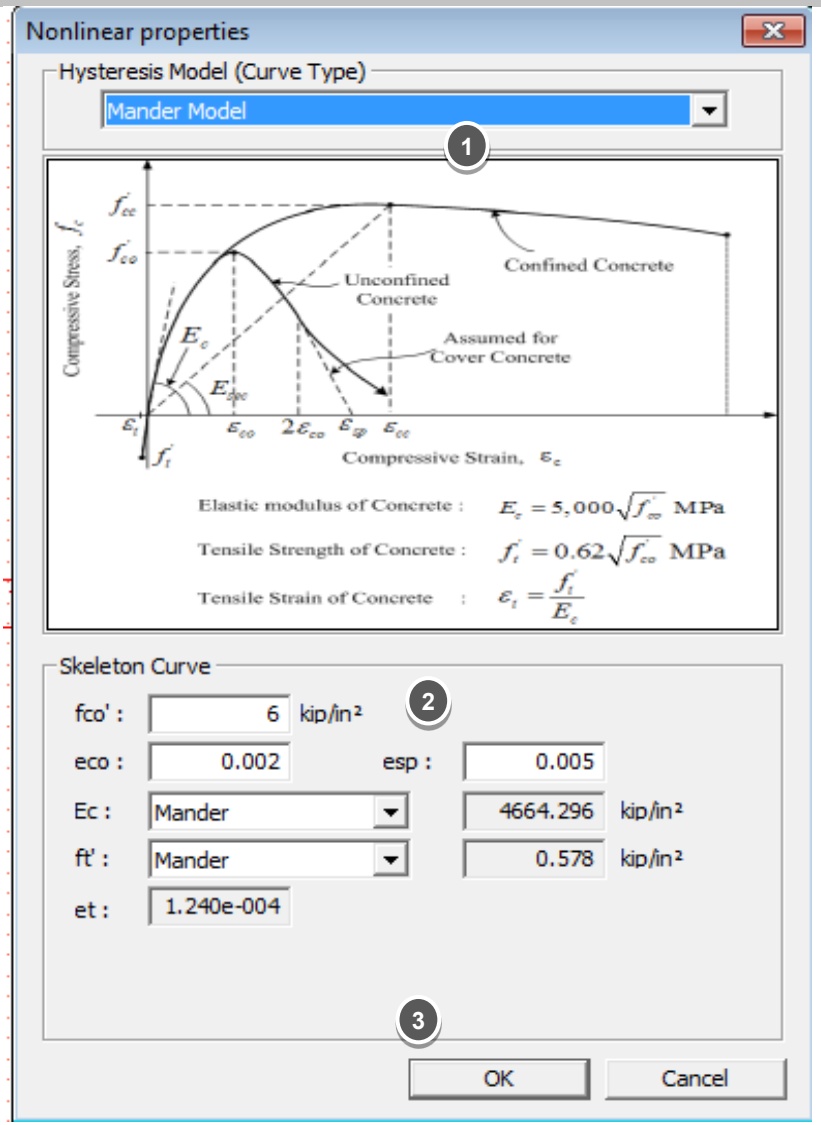
1. In the midas GSD:
2. At the right bottom corner, change units to *kips* and *in*
3. Model > Material
4. Click > Add
5. Select RC from Type of Design
6. Select > ASTM (RC) from Standard
7. Select Grade 6000 from DB
8. Check on Use Nonlinear and click Define Nonlinear Prop.





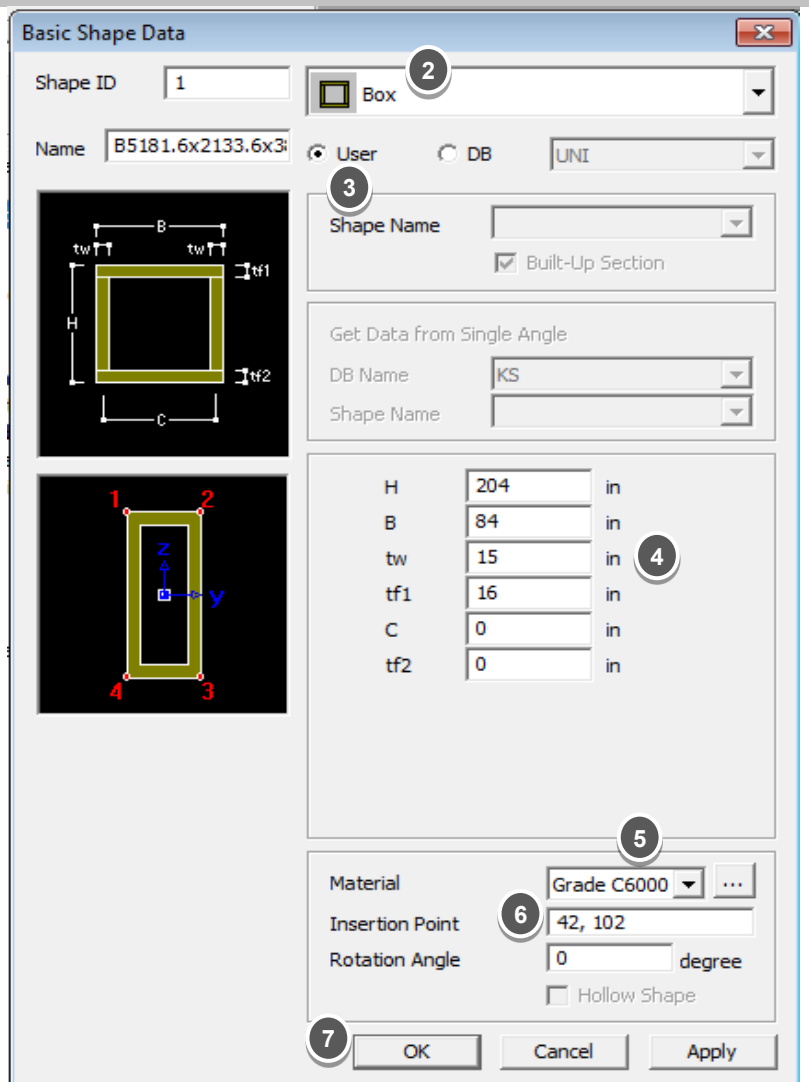
Material

1. Select Mander Model from Hysteresis Model menu
2. Ensure the values in Skeleton Curve section are as shown in the picture alongside, *these are selected based on defined material, but you can change if required*
3. Click > OK
4. Click >OK
5. Close



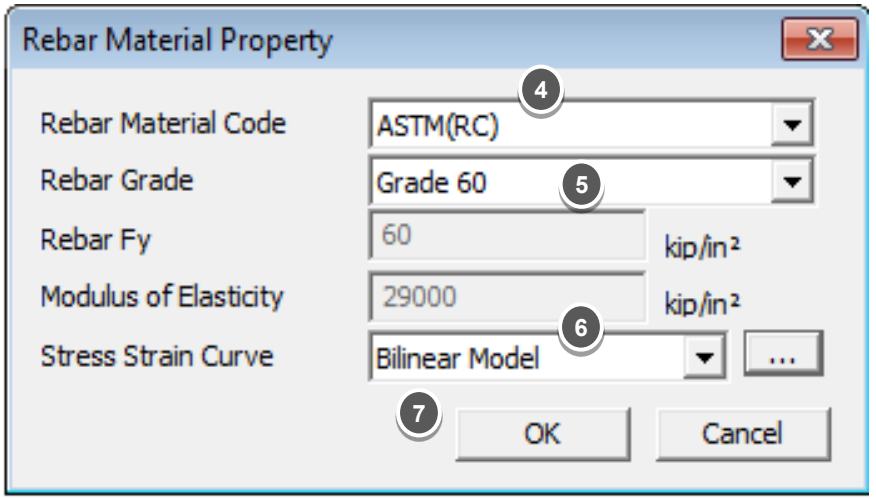
Geometry

1. Model > Shape > Basic Shape
2. Select Box from dropdown menu
3. Select >User
4. H: 204, B: 84, t_w: 15, t_{f1}: 16 in
5. Material: Grade C6000
6. Insertion Point: 42, 102
7. Ok
8. Click  to see entire new shape



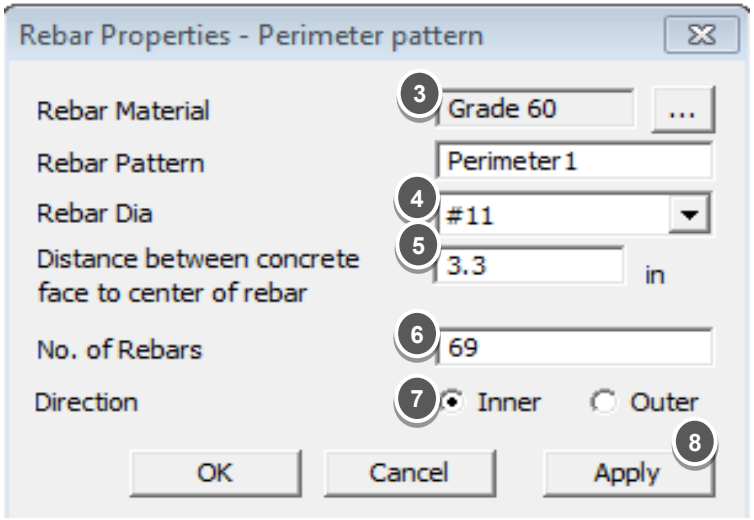
Reinforcement

1. Model > Rebar > Rebar Material Property …
2. Select ASTM
3. Grade 60
4. Select Bilinear Model
5. Ok



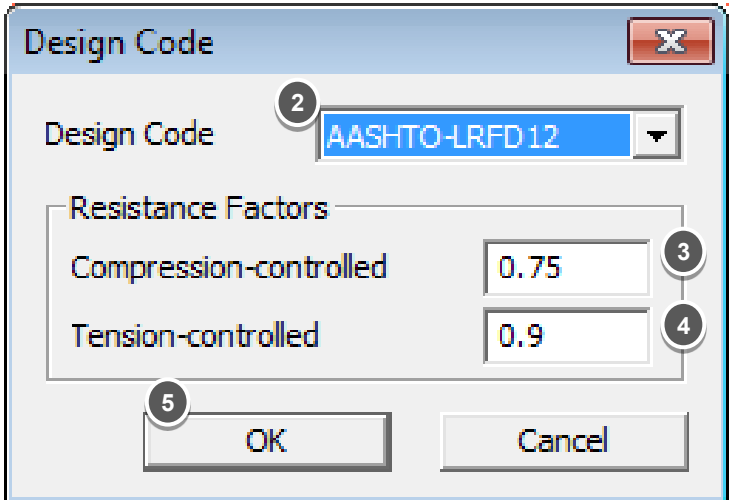
Reinforcement

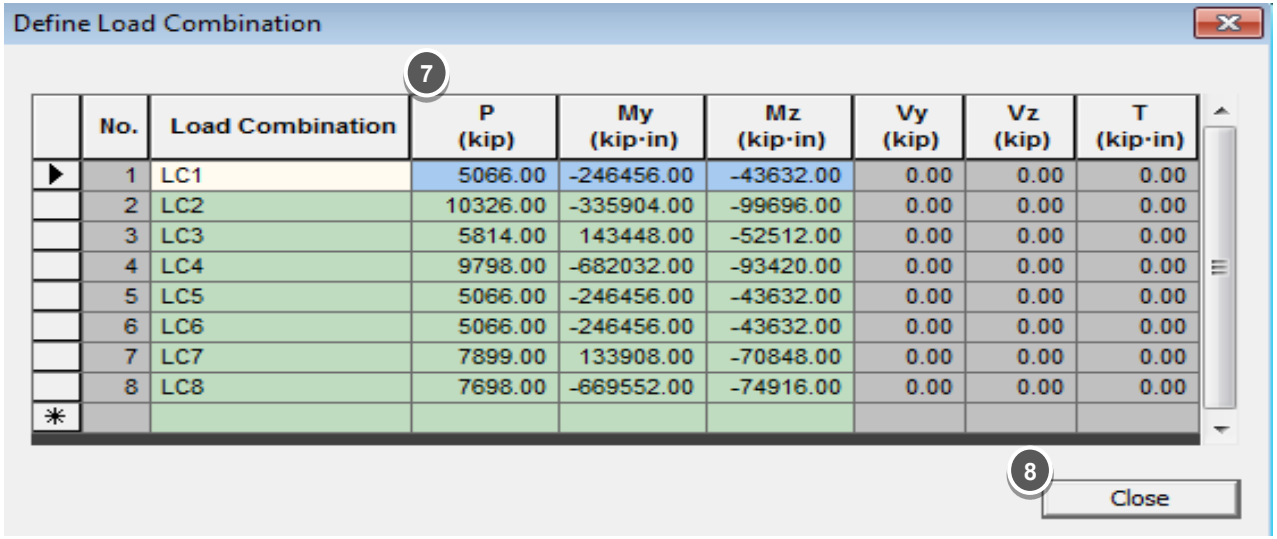
1. Model > Rebar > Rebar- Perimeter Pattern
2. Select Shape 1 from tree menu
3. Rebar Material : Grade 60
4. Rebar Dia: #11
5. Distance 3.3 in
6. No. of rebars: 69
7. Direction: Inner
8. Apply



Design Code & Load Combinations

1. Option > Design Code
2. Design Code: AASHTO-LRFD 12
3. Compression-controlled: 0.75
4. Tension-controlled: 0.9
5. OK
6. Load > Load Combination
7. Enter 8 load combinations as it's shown below
8. Close
9. Click  To perform design





	No.	Load Combination	P (kip)	My (kip·in)	Mz (kip·in)	Vy (kip)	Vz (kip)	T (kip·in)
▶	1	LC1	5066.00	-246456.00	-43632.00	0.00	0.00	0.00
	2	LC2	10326.00	-335904.00	-99696.00	0.00	0.00	0.00
	3	LC3	5814.00	143448.00	-52512.00	0.00	0.00	0.00
	4	LC4	9798.00	-682032.00	-93420.00	0.00	0.00	0.00
	5	LC5	5066.00	-246456.00	-43632.00	0.00	0.00	0.00
	6	LC6	5066.00	-246456.00	-43632.00	0.00	0.00	0.00
	7	LC7	7899.00	133908.00	-70848.00	0.00	0.00	0.00
	8	LC8	7698.00	-669552.00	-74916.00	0.00	0.00	0.00
*								

Results

Interaction Curve

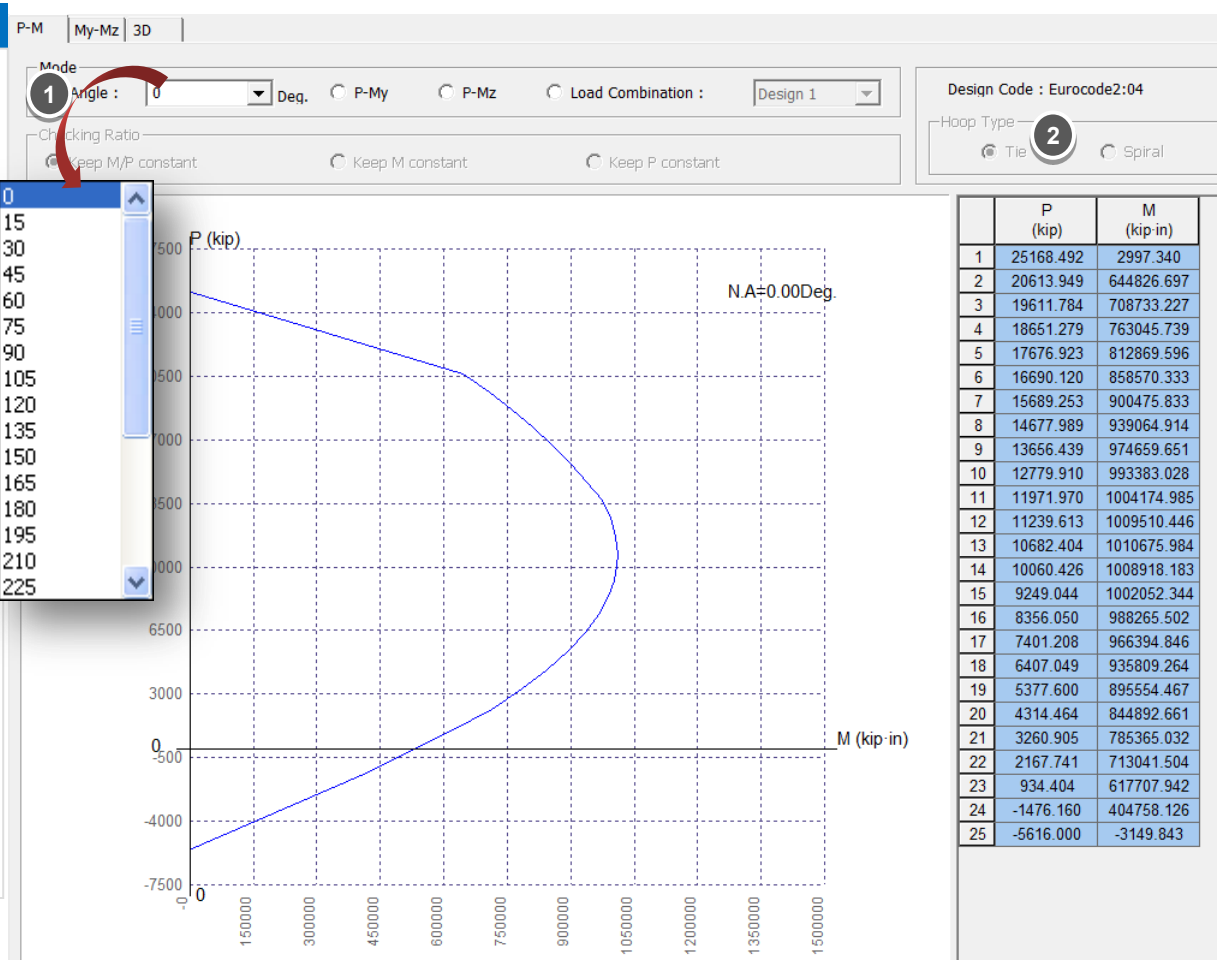
- You can see following interaction curves:
  1. **P-M interaction curve.**
  2. My-Mz interaction curve.
  3. 3D interaction surface.

P-M interaction curve

Result > Interaction Curve

❶ P-M curve can be seen for all the angles from 0 to 360 by 15 degrees. Select 0 from menu

❷ Select tie as type of hoop



	P (kip)	M (kip·in)
1	25168.492	2997.340
2	20613.949	644826.697
3	19611.784	708733.227
4	18651.279	763045.739
5	17676.923	812869.596
6	16690.120	858570.333
7	15689.253	900475.833
8	14677.989	939064.914
9	13656.439	974659.651
10	12779.910	993383.028
11	11971.970	1004174.985
12	11239.613	1009510.446
13	10682.404	1010675.984
14	10060.426	1008918.183
15	9249.044	1002052.344
16	8356.050	988265.502
17	7401.208	966394.846
18	6407.049	935809.264
19	5377.600	895554.467
20	4314.464	844892.661
21	3260.905	785365.032
22	2167.741	713041.504
23	934.404	617707.942
24	-1476.160	404758.126
25	-5616.000	-3149.843

Results

P-M interaction curve

Result > Interaction Curve

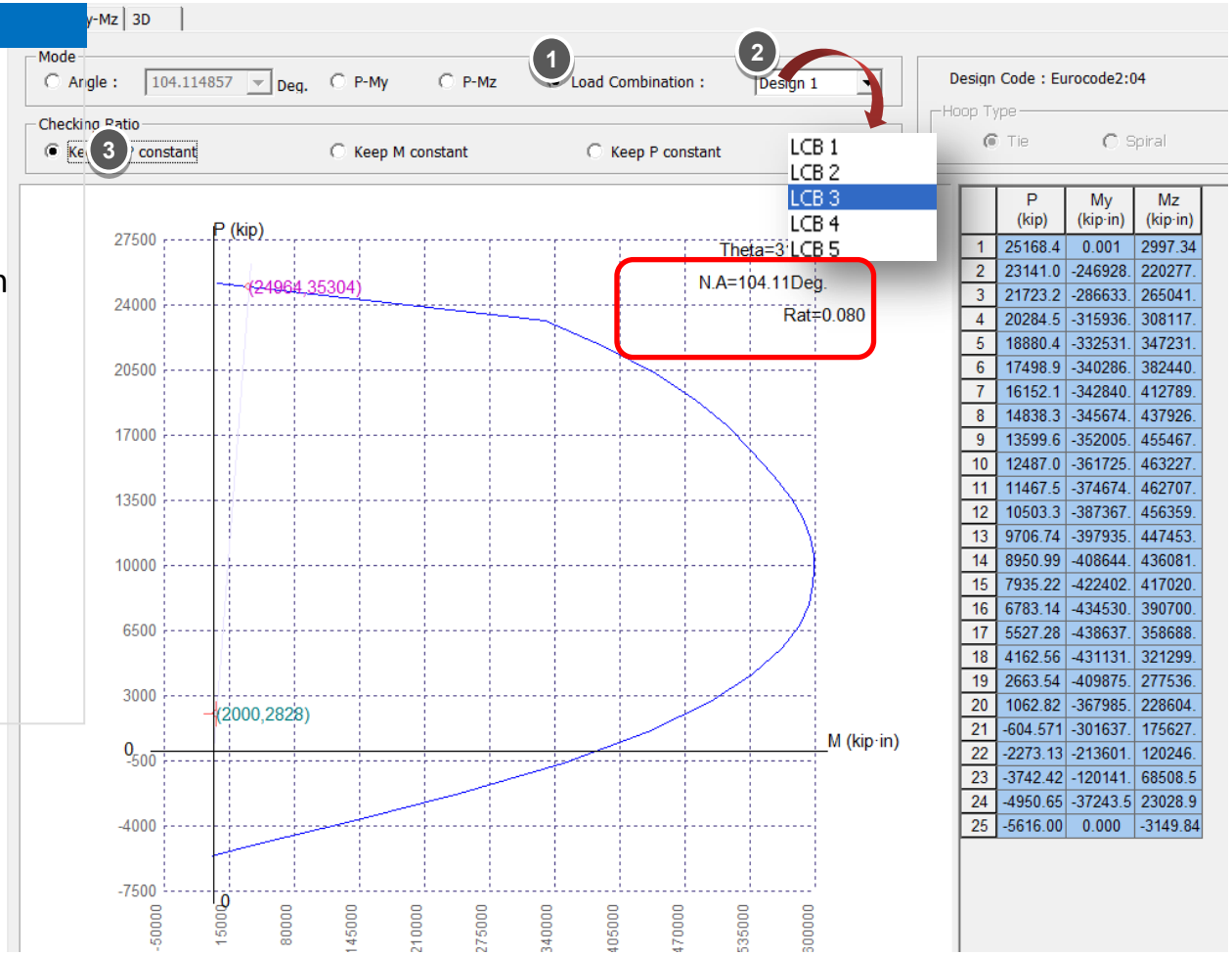
❶ Select Load Combination
load combinations.

❷ Select Design 1
Checking Ratio can be calculated in

❸ three ways:

1.Keep M/P constant
2. Keep M constant
3. Keep P constant

Select Keep M/P constant



	P (kip)	My (kip·in)	Mz (kip·in)
1	25168.4	0.001	2997.34
2	23141.0	-246928.	220277.
3	21723.2	-286633.	265041.
4	20284.5	-315936.	308117.
5	18880.4	-332531.	347231.
6	17498.9	-340286.	382440.
7	16152.1	-342840.	412789.
8	14838.3	-345674.	437926.
9	13599.6	-352005.	455467.
10	12487.0	-361725.	463227.
11	11467.5	-374674.	462707.
12	10503.3	-387367.	456359.
13	9706.74	-397935.	447453.
14	8950.99	-408644.	436081.
15	7935.22	-422402.	417020.
16	6783.14	-434530.	390700.
17	5527.28	-438637.	358688.
18	4162.56	-431131.	321299.
19	2663.54	-409875.	277536.
20	1062.82	-367985.	228604.
21	-604.571	-301637.	175627.
22	-2273.13	-213601.	120246.
23	-3742.42	-120141.	68508.5
24	-4950.65	-37243.5	23028.9
25	-5616.00	0.000	-3149.84

Results

3-D interaction surface

Result > Interaction Curve

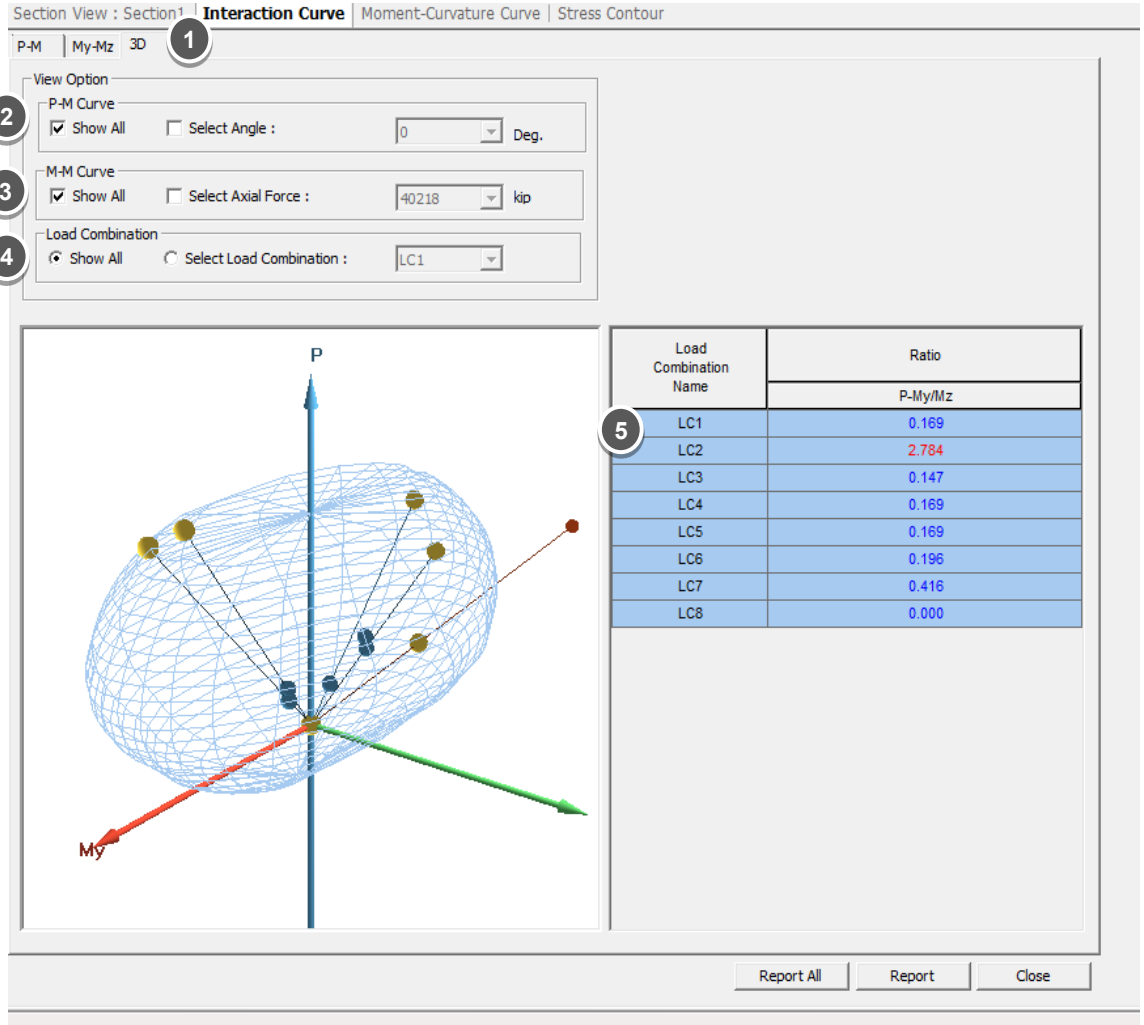
❶ Click on "**3D**" tab

❷ Select Show All in View Option to see all the P-M curves at the same time.

❸ Select Show All in M-M Curve

❹ Select Show All in Load Combination

❺ The Capacity Ratio is shown for all the load combinations. The ratio > 1 is shown in red (LC2)



Results

Moment –Curvature curve

Result > Moment –Curvature Curve

or

❶ Click on "**Moment-Curvature**" tab.

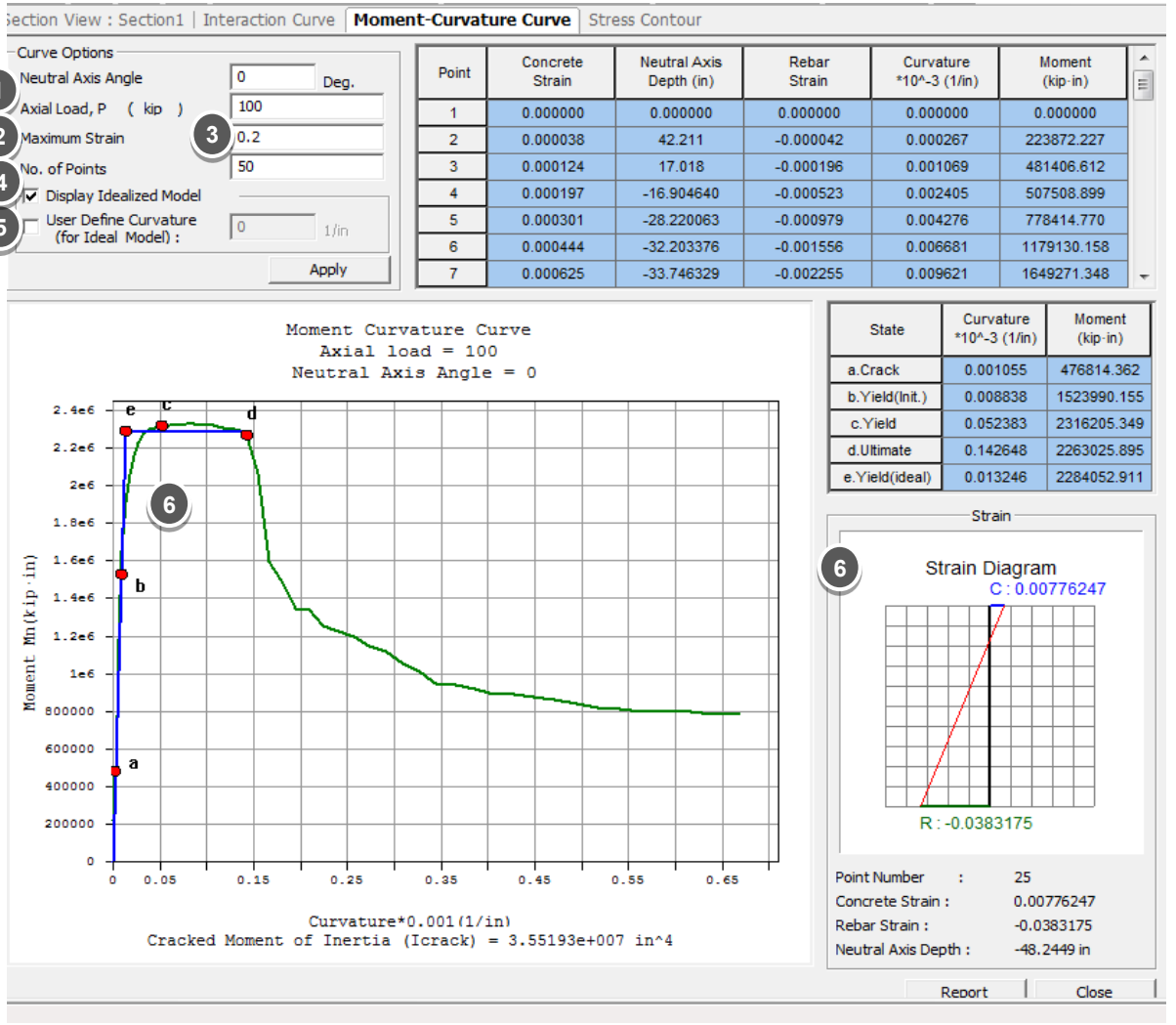
❷ Enter 100 kips as Axial Load P

❸ Enter 0.2 as the Maximum Strain

❹ Number of Points: 50

❺ Display Idealized Model → Apply

❻ Click on different points on curve to see strain diagram for a each point



Results

Stress Contours

Result > Stress Contours

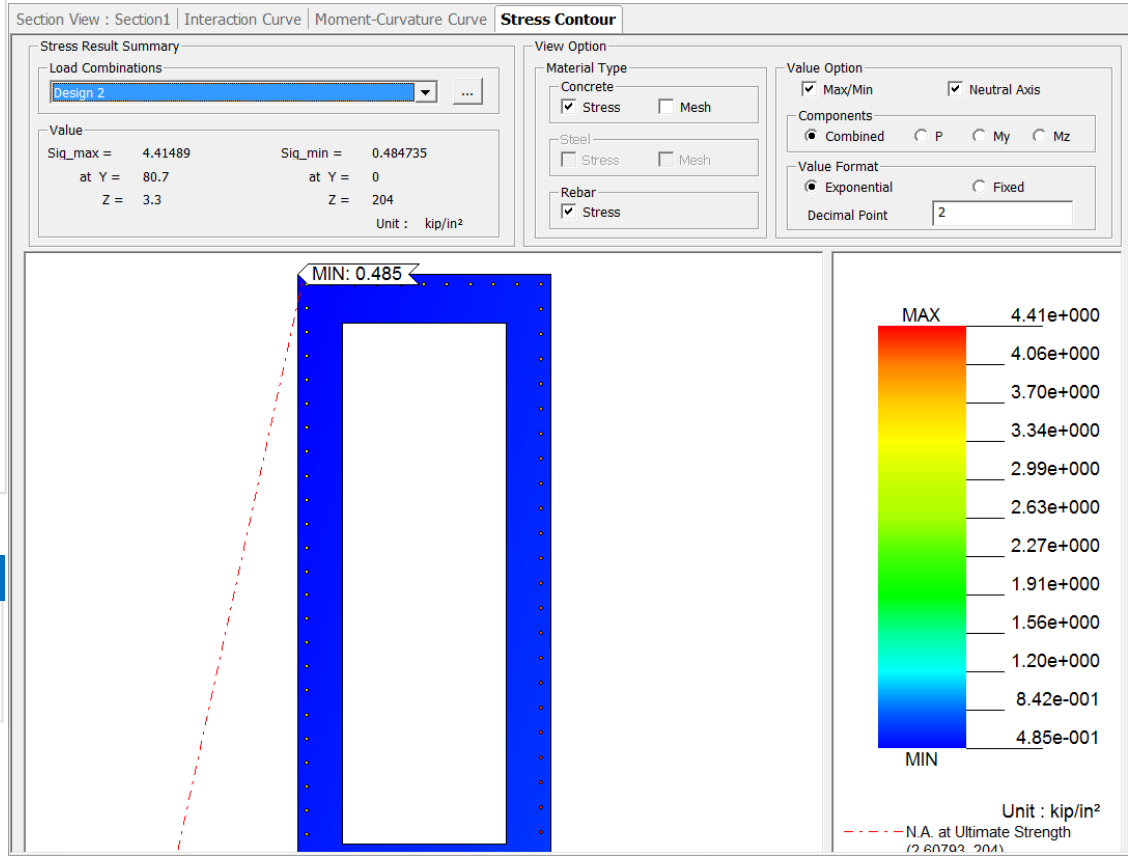
OR

Click on "**Stress Contours**" tab.

❶ Select the Load Combination LCB4

❷ Check Stress for both Concrete and Rebar

❸ Check the Max/Min & N.A value



Sign Convention

- Tension is taken as +ve and compression as –ve.