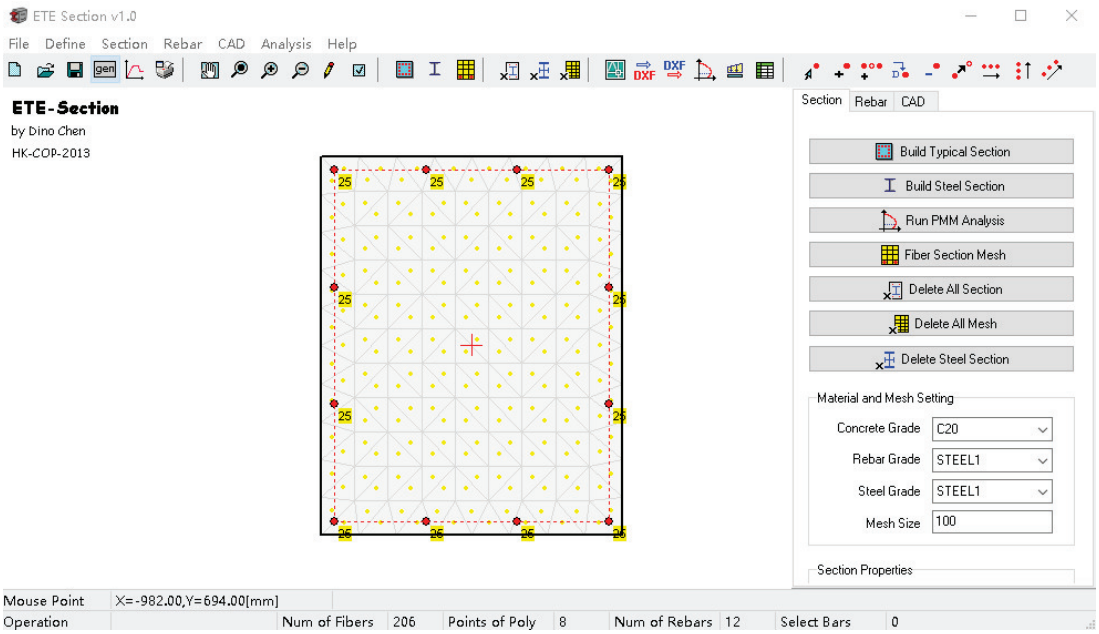
Chapter 4 - Operation Manual

Main Window

The module's operation window is shown as in the image below:



Main operation window of ETE Section

The module's main button bar contains following buttons.

The feature of each command button is shown below:

Create a new ETE Section task

Open an existing ETE Section model (*.sec)

Save the ETE Section model (*.sec)

General Setting:
Parameter setting for analysis, such as number of envelope nodes for P-M and M-M analysis

Material Setting:
Modify the constitutive model of the material including concrete, reinforcement, and steel

Print

Pan view

Zoom to fit

Zoom in

Zoom out

Re-draw the section

Modify the display settings, such as show/hide outline of the section, or re-bars, etc.

Generate outline of the concrete section and layout of reinforcement bars based on input parameters

Generate outline of the steel section based on input parameters

Meshing the section

Delete all the concrete section, steel section, and reinforcement bars

Delete all the steel section

Delete all the mesh

Import AutoCAD file

Export model to .dxf file

Import section from .dxf file

Generate P-M or M-M curve

Import internal forces of member

Generate .csv file of the model

Select reinforcement bars

Add a single reinforcement bar

Add multiple reinforcement bars

Modify diameter of reinforcement bars

Delete selected reinforcement bar


Move/copy reinforcement bar

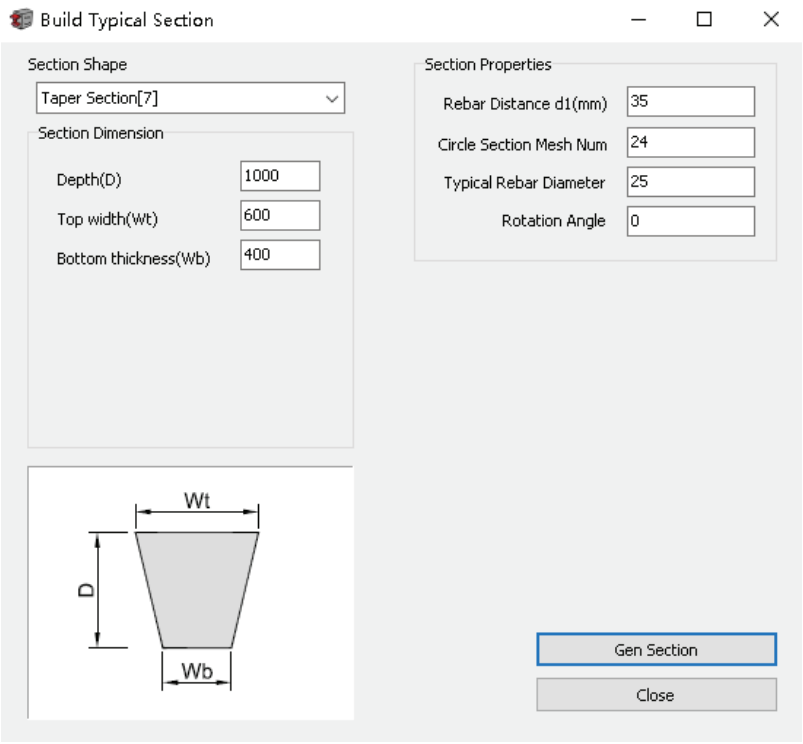

Align reinforcement bars in X direction


Align reinforcement bars in Y direction


Align reinforcement bars in defined direction

Build Typical Section


Click the button **Build Typical Section** to create concrete section with pre-defined shapes. The window below will pop-up. Click the button **Gen Section** to generate the concrete section as the parameters input.

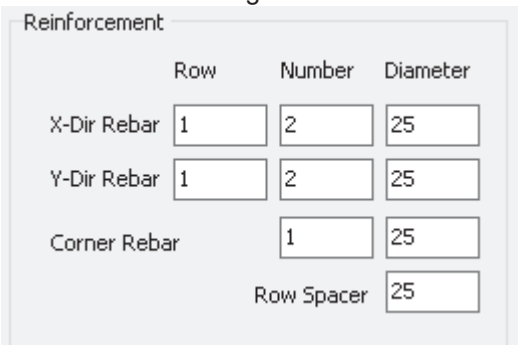


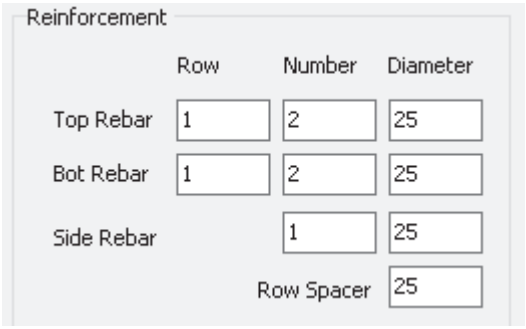
Build typical section operation window

ETE-Section provides several pre-defined section shapes. The key parameters to define a shape are explained in the table below:

Rebar Distance d1	Distance from reinforcement bars to the edge of concrete
Circle Section Mesh Num	Number of mesh cells for meshing circular section
Typical Rebar Diameter	Diameter of rebars
Rotation Angle	Rotational angle based on default orientation of the section

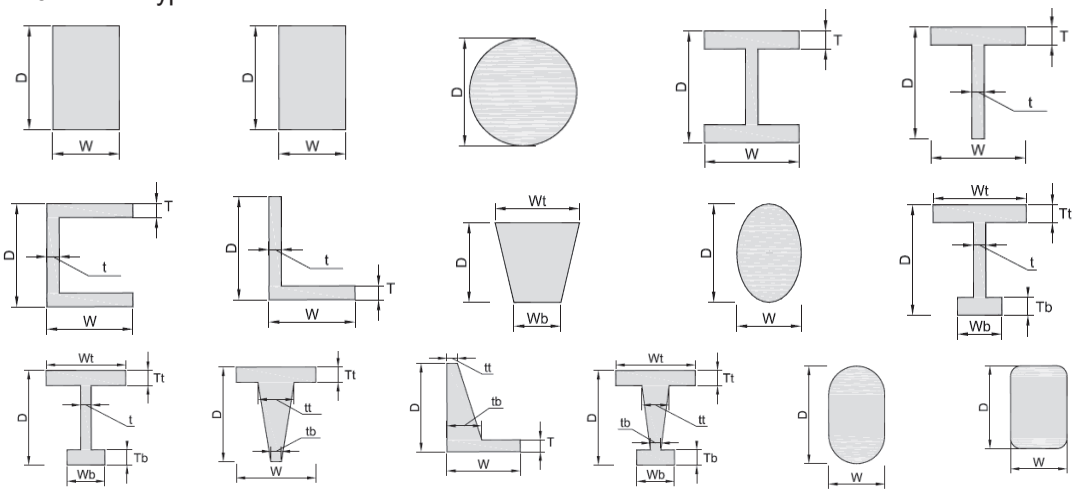
ETE-Section parameter setting examples to typical rectangular beam/column, or circular column is as following:





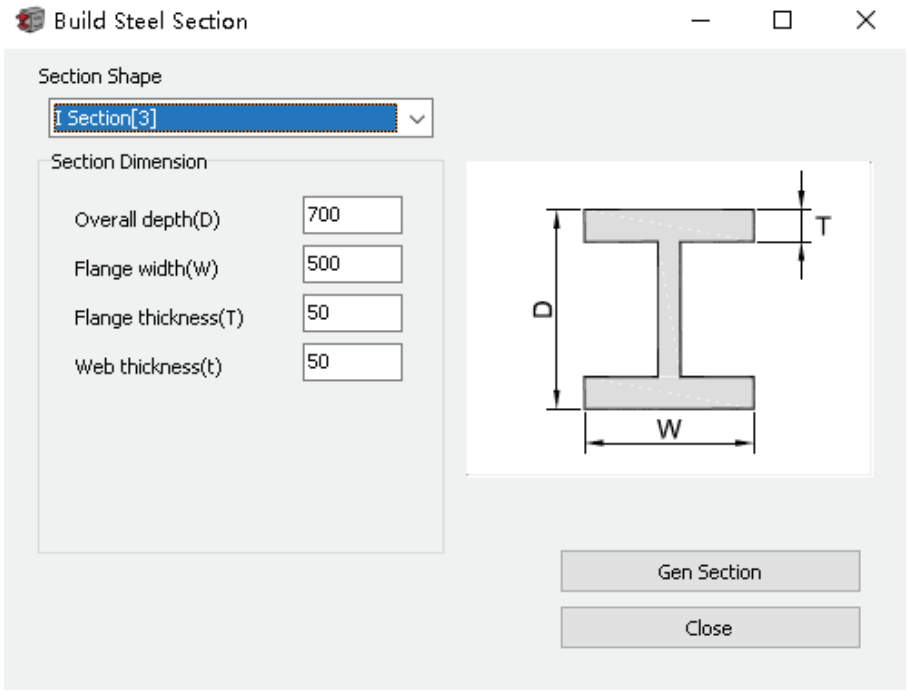
X-Dir Rebar	Number of layers, number of rebars per layer, and diameter for the rebars in global X direction
Y-Dir Rebar	Number of layers, number of rebars per layer, and diameter for the rebars in global Y direction
Top Rebar	Number of layers, number of rebars per layer, and diameter for the rebars at the top side
Bot Rebar	Number of layers, number of rebars per layer, and diameter for the rebars at the bottom side
Corner	Number of rebars and diameter for the rebars at the corner
Row Spacer	Distance between adjacent two layers of reinforcement

1-16 section types are listed below:



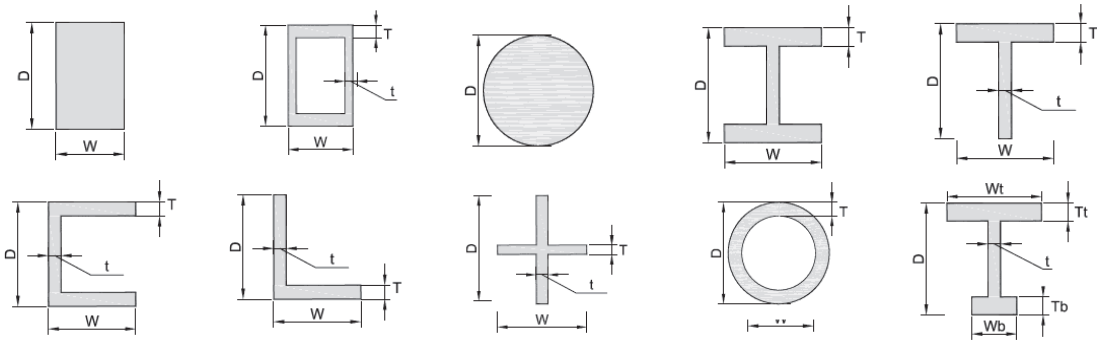
Build Steel Section

Click the button **Build Steel Section** to create steel section. The following window will pop-up. Click the button **Gen Section** to generate the steel section as the parameters input.

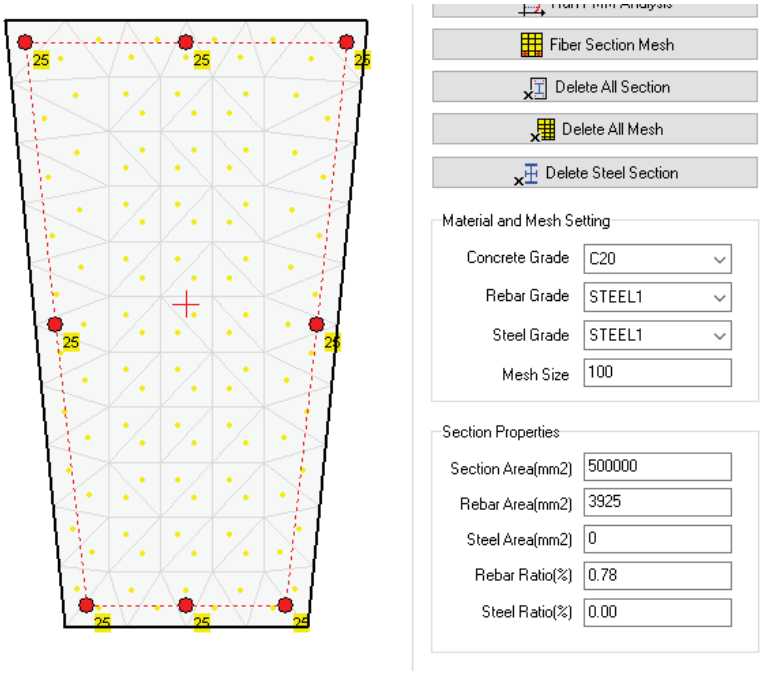


Build steel section operation window

ETE-Section has 10 types of pre-defined steel section shape as shown in the figure below:



Section Mesh Operation



Meshing settings in the main operation window

 Click the button **Fibre Section Mesh** to create fibre meshing for the cross-section, so that the user can carry out P-M-M analysis.

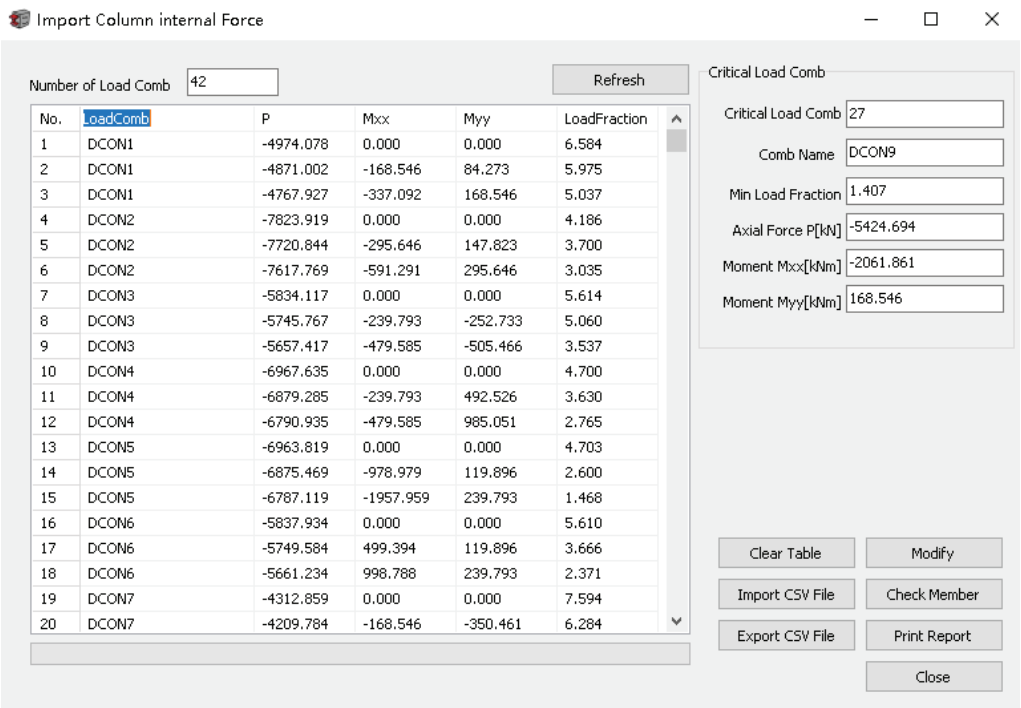
Concrete Grade	Material grade of concrete（C20~C100）
Rebar Grade	Material grade of reinforcement bars（Steel1~Steel5）
Steel Grade	Material grade of steel sections（Steel1~Steel5）
Mesh Size	Control size of mesh（default is 100mm）

After meshing, the program automatically computes the area by material type and reinforcement ratio

Section Area	Area of concrete cross-section (mm2)
Rebar Area	Total area of reinforcement in cross-section (mm2)
Steel Area	Total area of steel section in cross-section (mm2)
Rebar Ratio	Reinforcement ratio
Steel Ratio	Steel ratio

Import Member Internal Force

 Click the button to import the internal forces of the element, including the information of load combination numbers and names, axial forces, x-x and y-y bending moments. The information imported should be saved as .csv format.



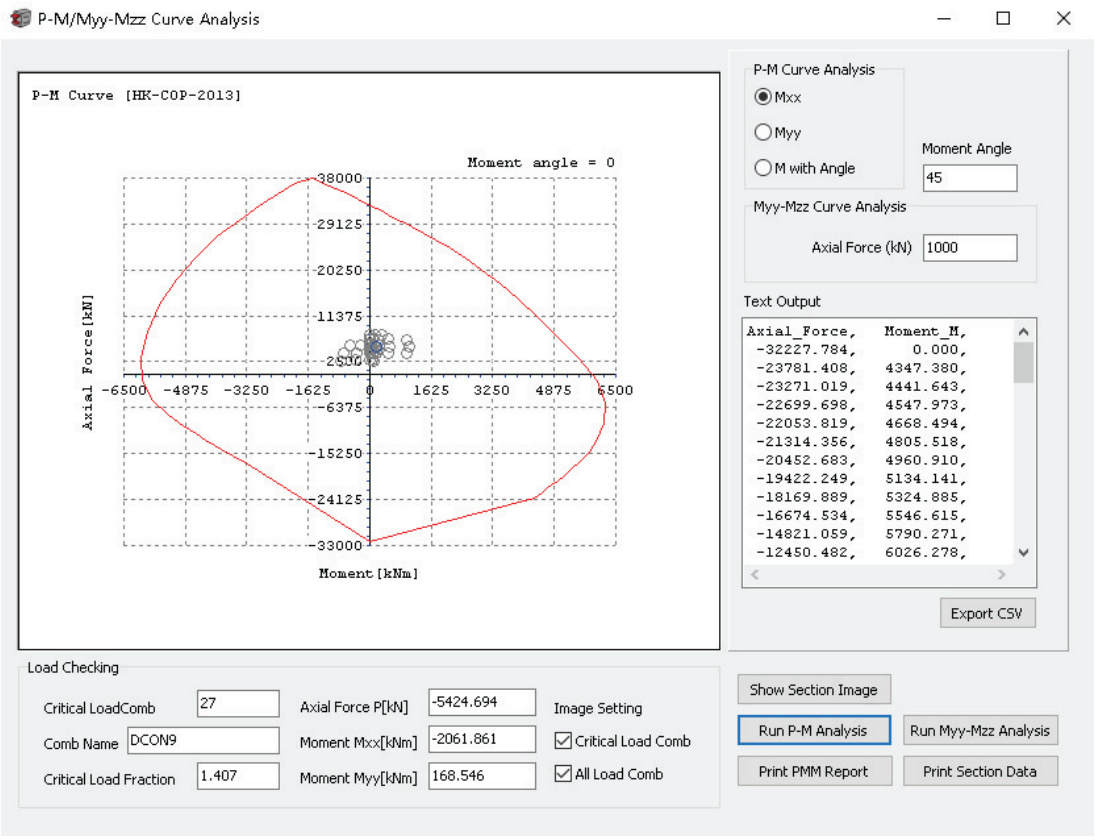
No.	LoadComb	P	Mxx	Myy	LoadFraction
1	DCON1	-4974.078	0.000	0.000	6.584
2	DCON1	-4871.002	-168.546	84.273	5.975
3	DCON1	-4767.927	-337.092	168.546	5.037
4	DCON2	-7823.919	0.000	0.000	4.186
5	DCON2	-7720.844	-295.646	147.823	3.700
6	DCON2	-7617.769	-591.291	295.646	3.035
7	DCON3	-5834.117	0.000	0.000	5.614
8	DCON3	-5745.767	-239.793	-252.733	5.060
9	DCON3	-5657.417	-479.585	-505.466	3.537
10	DCON4	-6967.635	0.000	0.000	4.700
11	DCON4	-6879.285	-239.793	492.526	3.630
12	DCON4	-6790.935	-479.585	985.051	2.765
13	DCON5	-6963.819	0.000	0.000	4.703
14	DCON5	-6875.469	-978.979	119.896	2.600
15	DCON5	-6787.119	-1957.959	239.793	1.468
16	DCON6	-5837.934	0.000	0.000	5.610
17	DCON6	-5749.584	499.394	119.896	3.666
18	DCON6	-5661.234	998.788	239.793	2.371
19	DCON7	-4312.859	0.000	0.000	7.594
20	DCON7	-4209.784	-168.546	-350.461	6.284

Import column internal force operation window

LoadComb - Load combination names
P - Axial force of the member (unit: kN, +ve as tension, -ve as compression)
Mxx - Bending moment about x-x axis (kNm)
Myy - Bending moment about y-y axis (kNm)
LoadFraction - The redundancy of the given cross-section under the load. If the load fraction is greater than 1.0, then the member is safe; if less than 1.0, the capacity of the cross-section is not enough.
Critical Load Comb - The most adverse load combination, which has the lowest value in load fraction
Check Member - Check the capacity of the section under imported load combinations, and computes the load fraction values
Clear Table - Clear the data in the table
Modify - Modify the value in the table
Import CSV File - Import .csv file
Export CSV File - Export .csv file
Print Report - Generate the calculation report file in .pdf format

P-M-M Section Analysis

 Click the button to carry out the section analysis. The window as below will pop-up. User can use this function to calculate and obtain the P-Mx, P-My. or P-Mx-My curves with load combination conditions overlaid on the diagram.

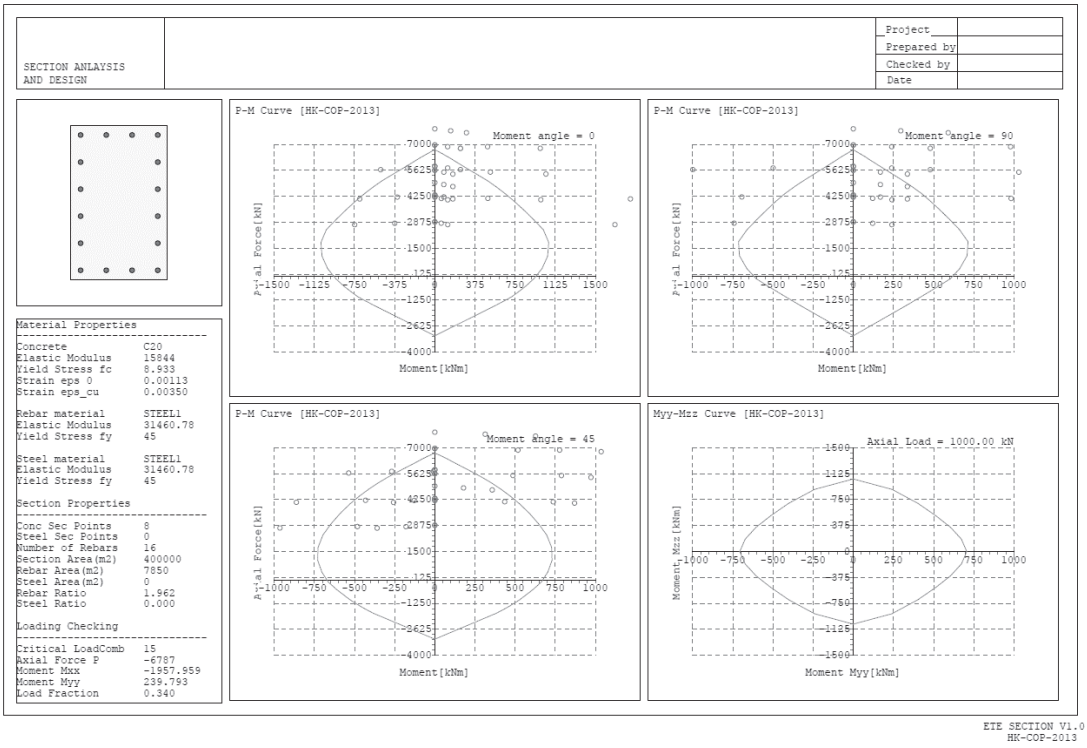


P-M-M analysis operation window

P-M Curve Analysis - Settings for P-M curve display. Select Mxx to display P-Mxx curve; Select Myy to display P-Myy curve; Select M with Angle to display rotated P-M curve; Moment Angle is the angle to rotate the axis
Myy-Mxx Curve Analysis - Parameter for M-M curve display. Axial Force(kN) is the level of axial force to trim the Mxx-Myy curve from P-M-M profile
Text Output - Display the data of the P-M curve or M-M curve
Show Section Image - Display the brief image of the cross-section
Run P-M Analysis - Calculate and display P-M curve
Run Mxx-Myy Analysis - Calculate and display Mxx-Myy curve
Print PMM Report - Generate P-M-M analysis report in .pdf format
CriticalLoadComb - The number of the most adverse load combination
CombName - The name of the most adverse load combination
Axial Force P[kN] - Axial force under the most adverse load combination

Moment Mxx[kNm] - Bending moment about x-x axis under the most adverse load combination
Moment Myy[kNm] - Bending moment about y-y axis under the most adverse load combination
Critical LoadComb - Display the point of the most adverse load combination overlaid to the P-M curve diagram
All LoadComb - Display the points of all the load combinations overlaid to the P-M curve diagram
Export CSV - The program output the content in “Text Ouput” to a .csv file

Click the button **Print PMM Report** to create the calculation report in .pdf format as the example below:



Typical report generated by ETE Section

Chapter 5 - Tutorial

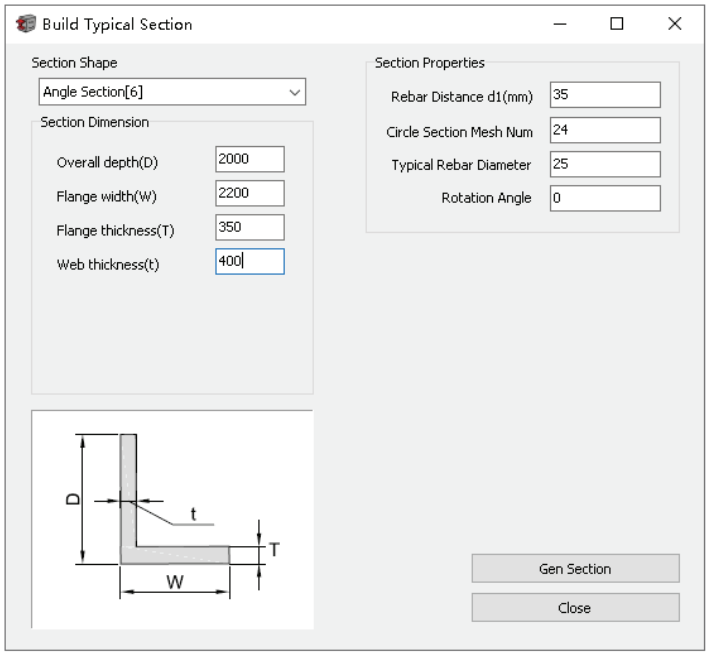
Example1: L Shape Shear Wall Section Analysis

Example Specification:

To create a L shape concrete section with control parameter of 2000(D)x2200(W)x350(T)x400(t)。Concrete material grade is C35, reinforcement strength is fy=500MPa, reinforcement layout is 26T32 as shown in the diagram below. And reinforcement ratio is 1.46%.

Step1 - Build Typical Section

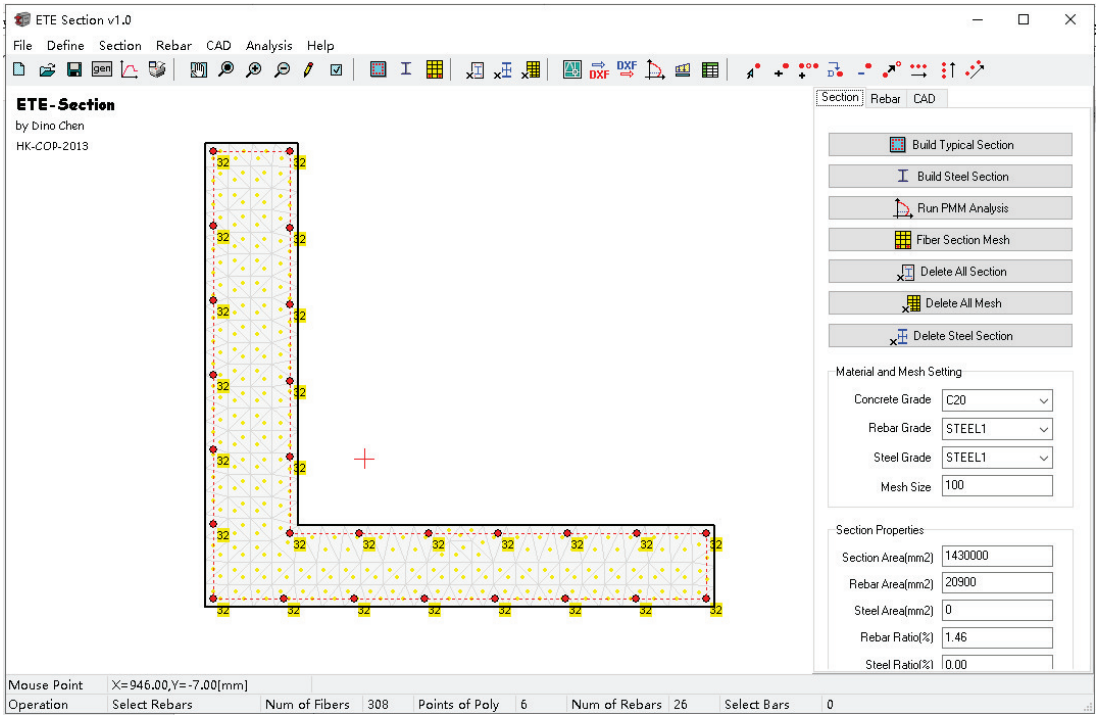
Click the button【Build Typical Section】, then select【Angle Section [6] 】as section shape. Input the section dimension 2000x2200x350x400，finally click the button【Gen Section】to generate L shape concrete section.



Build typical section settings

Step2 - Build Reinforcement

Click the **Rebar** from the menu panel, use the tools in the sub-menu to draw the reinforcement arrangement as shown in the diagram below, 26T32.



The appearance of the built L-shape section

Step3 - Section Meshing

In the operation panel on the right, **Mesh Size** to be set as 100mm; Select Steel1 for **Rebar Grade**, which is the reinforcement property having strength fy=500MPa; Select C35 for **Concrete Grade**. Then click **Fiber Section Mesh** button to mesh the section.

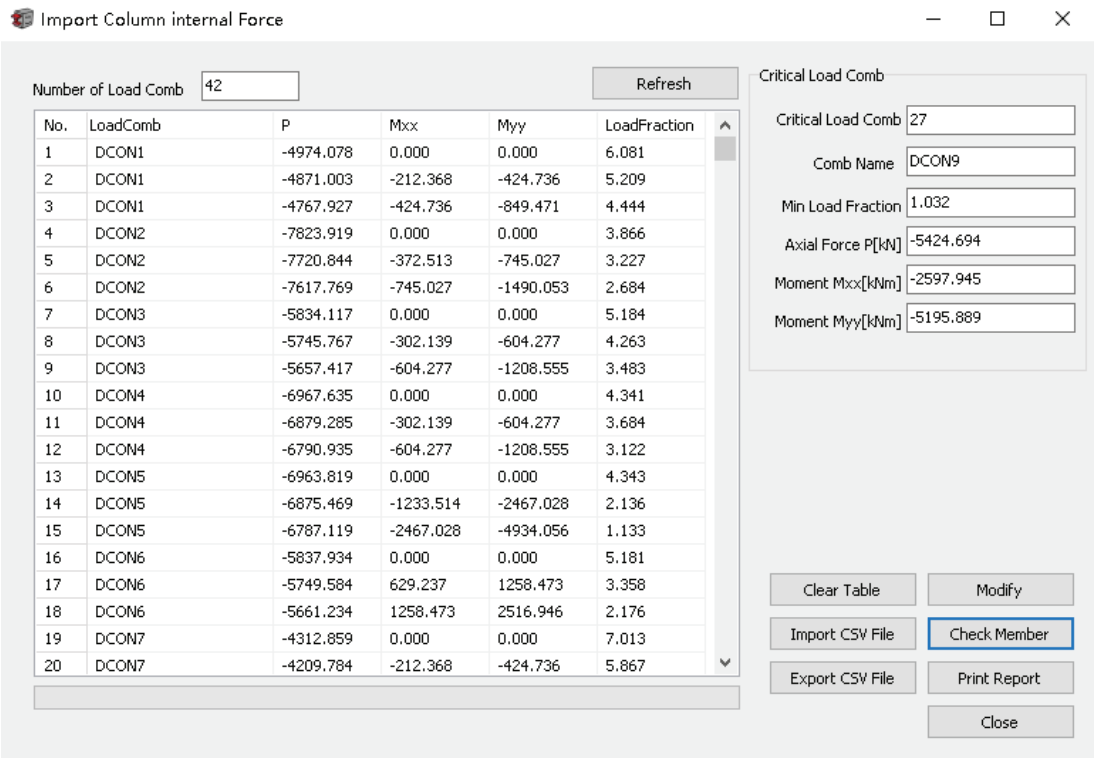
Step4 - Import Member Internal Force

Click **Import member internal force** button, to import the internal forces of multiple load combinations for the member.

Click **Import csv file** to load the .csv format of internal forces into the program. Below is an example of 42 load combinations being loaded.

Click **Check Member** to calculate the load fractions based on the internal forces for all the load combinations. In the example below, the program automatically found the most adverse load combination is the 27th, which has an axial force of -5424.694 kN, Mx of -2597.945 kNm, and My of -5195.889 kNm. The minimum load fraction value is 1.032, which is just slightly above 1.0 and the member is safe.

Click **Print Report** button, then the program will automatically generate the report of the load fraction calculation for all the load combinations.



No.	LoadComb	P	Mxx	Myy	LoadFraction
1	DCON1	-4974.078	0.000	0.000	6.081
2	DCON1	-4871.003	-212.368	-424.736	5.209
3	DCON1	-4767.927	-424.736	-849.471	4.444
4	DCON2	-7823.919	0.000	0.000	3.866
5	DCON2	-7720.844	-372.513	-745.027	3.227
6	DCON2	-7617.769	-745.027	-1490.053	2.684
7	DCON3	-5834.117	0.000	0.000	5.184
8	DCON3	-5745.767	-302.139	-604.277	4.263
9	DCON3	-5657.417	-604.277	-1208.555	3.483
10	DCON4	-6967.635	0.000	0.000	4.341
11	DCON4	-6879.285	-302.139	-604.277	3.684
12	DCON4	-6790.935	-604.277	-1208.555	3.122
13	DCON5	-6963.819	0.000	0.000	4.343
14	DCON5	-6875.469	-1233.514	-2467.028	2.136
15	DCON5	-6787.119	-2467.028	-4934.056	1.133
16	DCON6	-5837.934	0.000	0.000	5.181
17	DCON6	-5749.584	629.237	1258.473	3.358
18	DCON6	-5661.234	1258.473	2516.946	2.176
19	DCON7	-4312.859	0.000	0.000	7.013
20	DCON7	-4209.784	-212.368	-424.736	5.867

Import column internal force operation window

Step5 - Generate P-Mx Curve and P-My Curve

Click the button **Run PMM Analysis**， the P-M-M analysis window will pop-up

Select Mx-x to carry out analysis for P-Mxx curve, the obtained curve is shown as below

Select My-y to carry out analysis for P-Myy curve

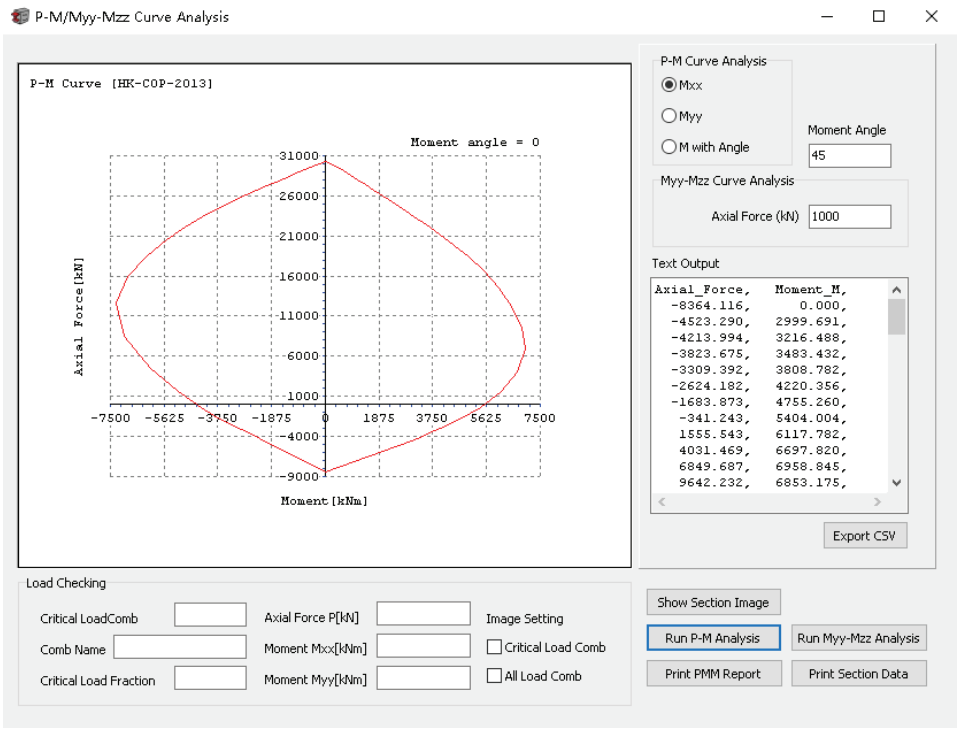
Select M with Angle, then input 45 for the **Moment Angle** which means that the program will generate the M-M curve by trimming the P-M-M envelope with the plane rotated about the axis of axial force P by the angle of input 45 degree

Step6 - Generate Mx-My Curve

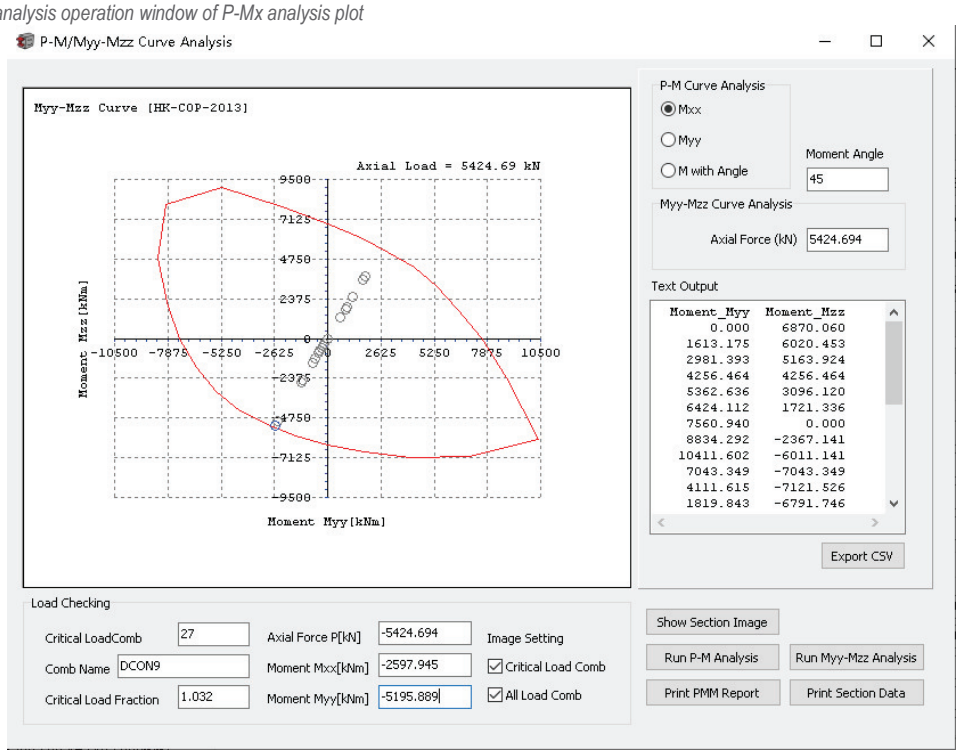
User could input axial force at **Axial Force[kN]**, for example 5424kN, to obtain the Mx-My curve when the axial force is 5424kN.

Step7 - Print PDF Report

Click the button **Print PMM Report** to generate the calculation report in .pdf format. The report includes the calculation of load fraction value, cross-sectional properties, P-M curve and/or M-M.



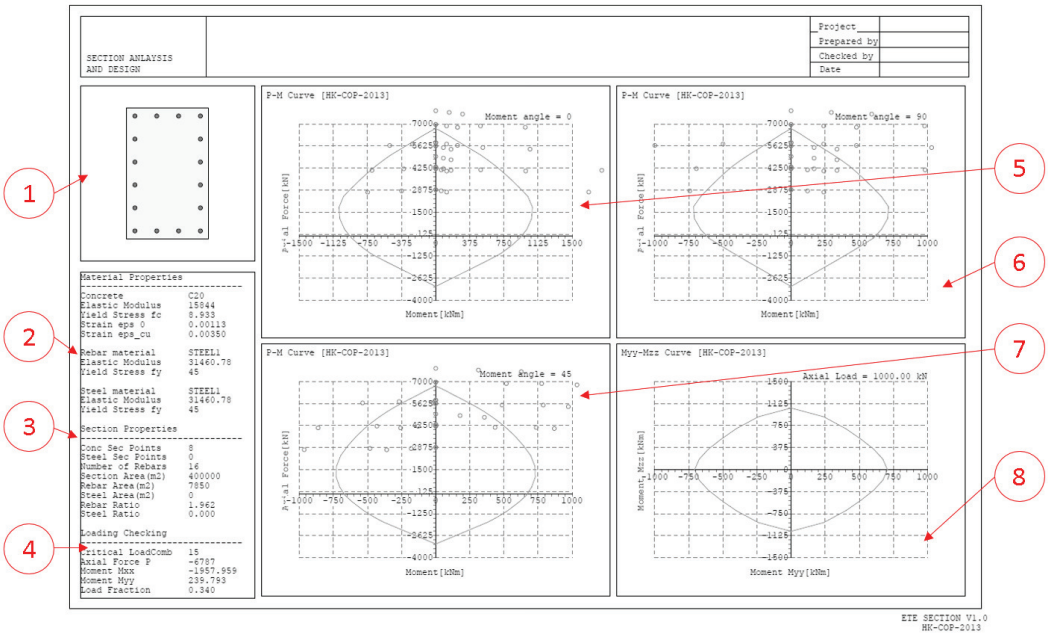
P-M-M analysis operation window of P-Mx analysis plot



P-M-M analysis operation window of P-Mx plot under user defined internal forces

Chapter 6 - Interpretation of Analysis and Design Results

Explanation of P-M, M-M Analysis Report



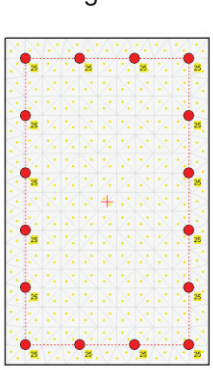
Typical analysis report from ETE Section

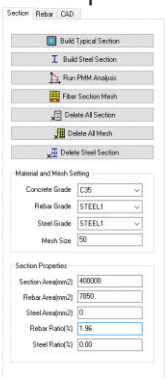
1. Brief diagram of cross-sectional geometry
2. Material properties used for the cross-section, such as concrete grade, reinforcement grade, steel grade
3. Cross-sectional properties, such as area of concrete, area of reinforcement, reinforcement ratio
4. Summarisation of capacity check shows the most adverse internal forces and the load fraction value
5. P-Mx curve (could overlay multiple points represent load combinations)
6. P-My curve (could overlay multiple points represent load combinations)
7. The P-M curve with user defined exerting angle (could overlay multiple points represent load combinations)
8. Mx-My curve under user defined axial force (could overlay multiple points represent load combinations)

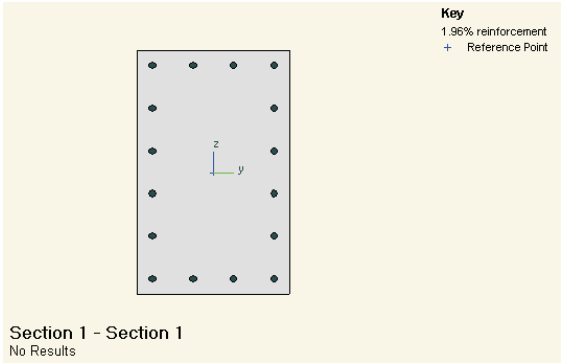
Chapter 7 - Program Verification

Example 1 P-M and M-M Curve Analysis for Rectangular Column

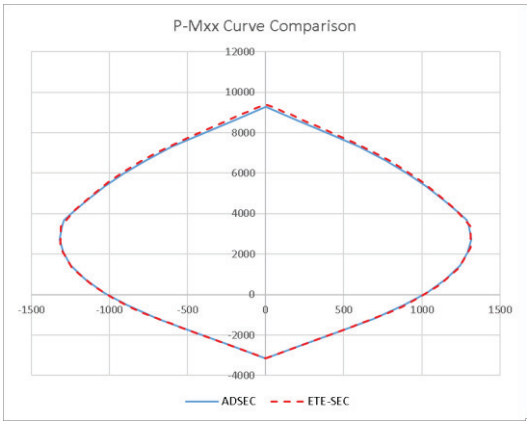
Task description:
Concrete grade is C35; Cross-sectional dimension is 500X800; Distance from the reinforcement bars to the edge of concrete is 50mm; material strength for reinforcement is 460MPa; Reinforcement bars are arranged as 16T25; Reinforcement ratio is 1.96%. The following charts are the comparison of the results between ETE Section and Oasys AdSec.



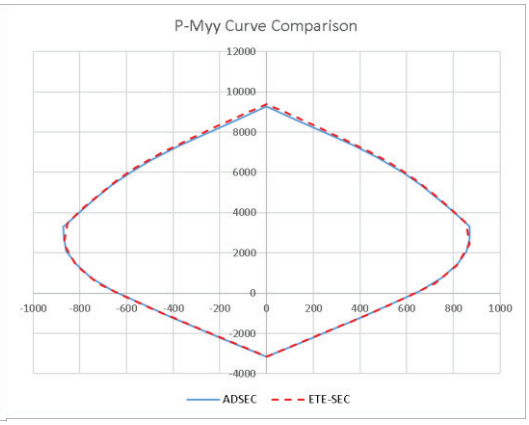




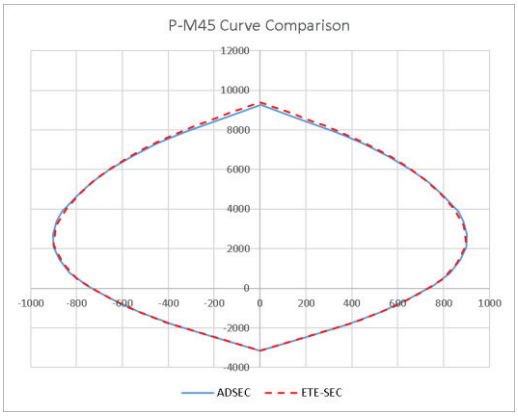
ETE Section *Oasys AdSec*



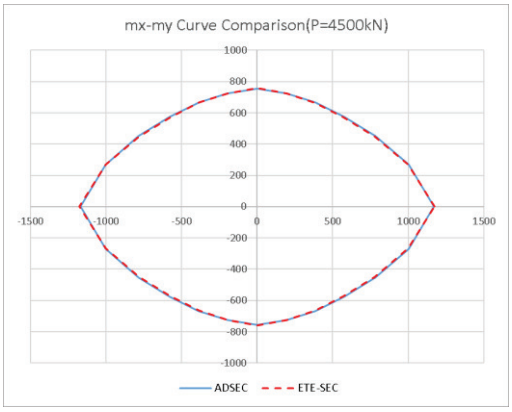
a) P-Mx curve



b) P-My curve



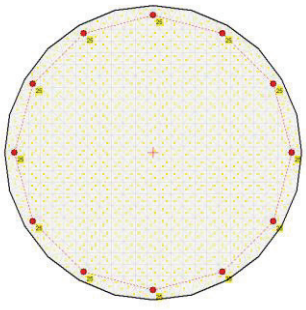
c) P-M curve (with 45 degree angle)



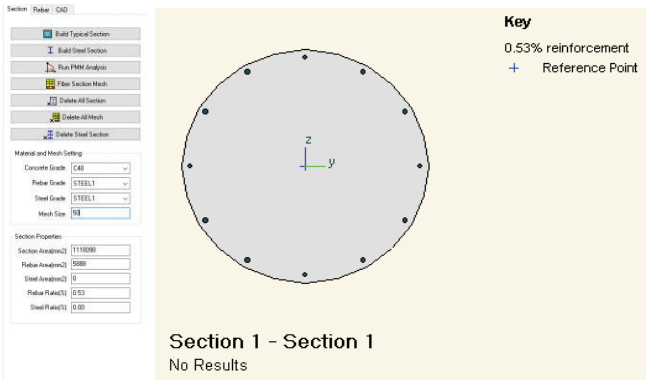
d) P-M curve (with axial force 4500kN)

Example 2 P-M and M-M Curve Analysis for Circular Column

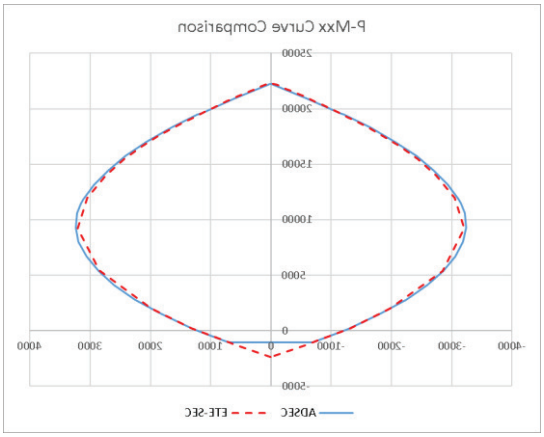
Task description:
Concrete grade is C40; Cross-sectional dimension is 1200mm diameter; Distance from the reinforcement bars to the edge of concrete is 40mm; material strength for reinforcement is 460MPa; Reinforcement bars are arranged as 12T25; Reinforcement ratio is 0.53%. The following charts are the comparison of the results between ETE Section and Oasys AdSec.



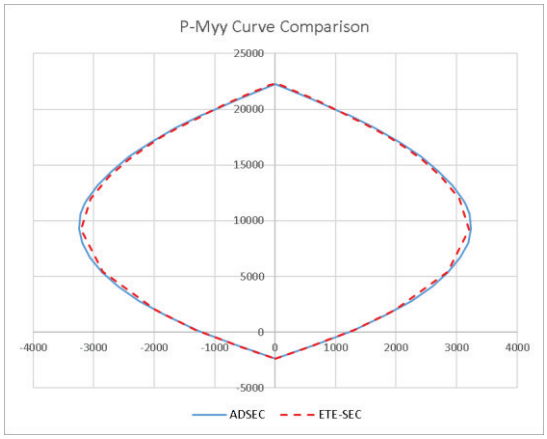
ETE Section



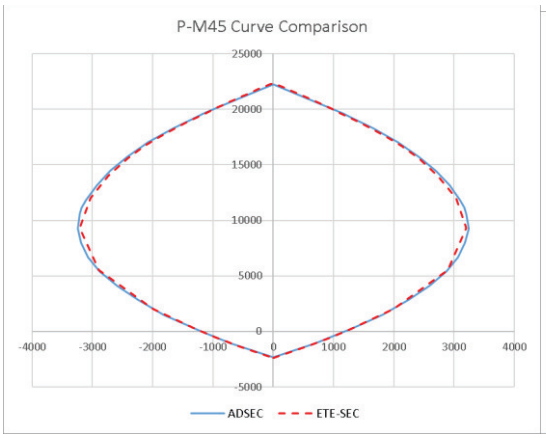
Oasys AdSec



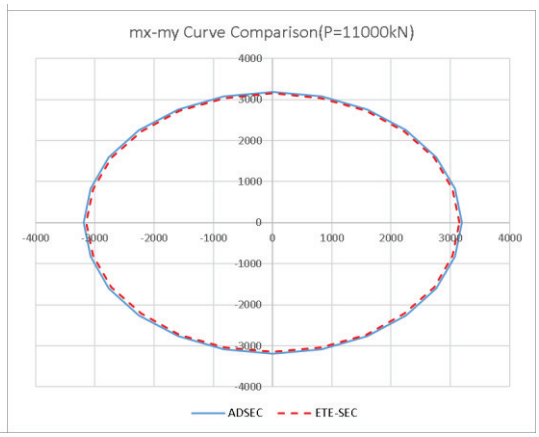
a) P-Mx curve



b) P-My curve



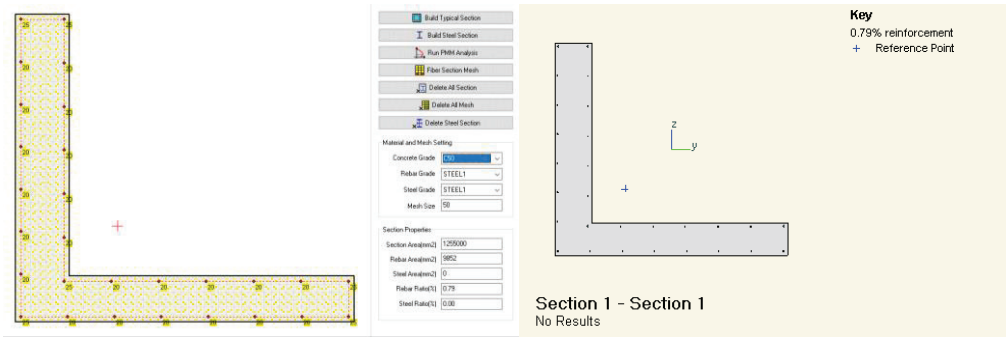
c) P-M curve (with 45 degree angle)



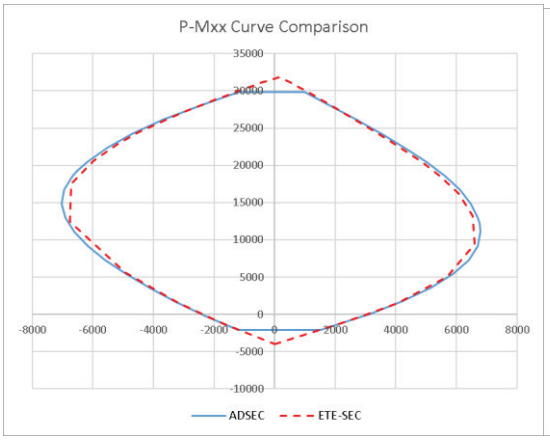
d) P-M curve (with axial force 11000kN)

Example 3 P-M and M-M Curve Analysis for L-shape Wall

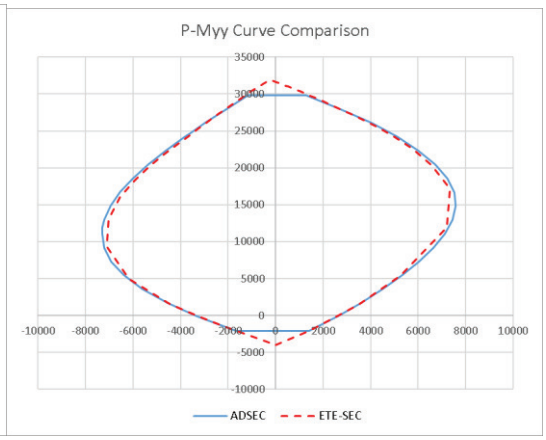
Task description:
Concrete grade is C50; Cross-sectional dimension is 2000x2200x300x350; Distance from the reinforcement bars to the edge of concrete is 35mm; Material strength for reinforcement is 460MPa; Reinforcement bars are arranged as 6T25 + 22T20; Reinforcement ratio is 0.79%. The following charts are the comparison of the results between ETE Section and Oasys AdSec.



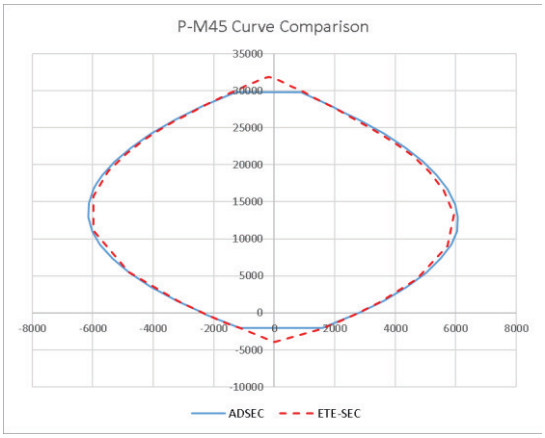
ETE Section *Oasys AdSec*



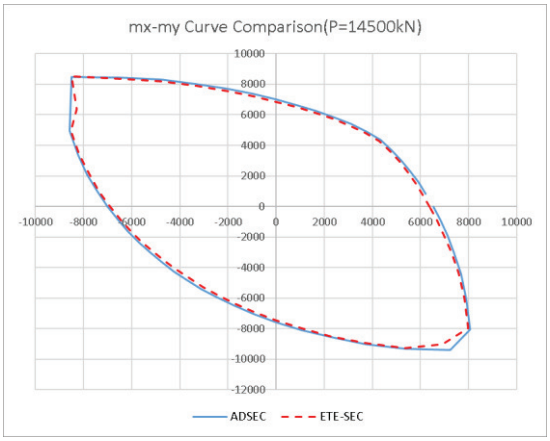
a) P-Mx curve



b) P-My curve



c) P-M curve (with 45 degree angle)



d) Mx-My curve (with axial force 14500kN)