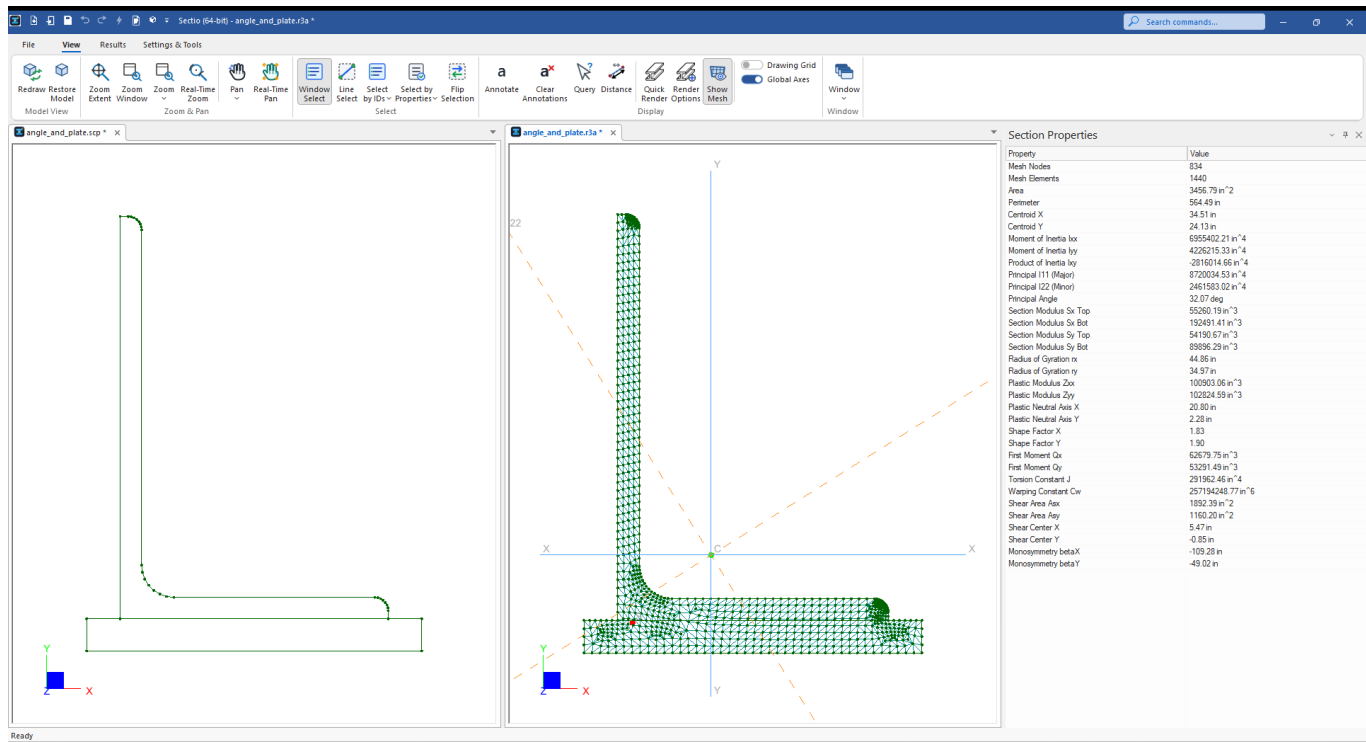


Section

A General Section Properties Calculator



User Manual

Computations & Graphics, Inc.
Highlands Ranch, CO 80130, USA

Email: info@cg-inc.com
Web: www.cg-inc.com

End User License Agreement for CGI Software (Non-SDK)

The Software is protected by United States copyright laws and various international treaties. By installing or using the Software, you agree to be bound by the terms of this Agreement. If you do not agree with the terms of this Agreement, do not install or use the Software. This Agreement is governed by the laws of the United States and the State of Colorado. You may not export the Software in violation of applicable export laws.

1. DEFINITIONS

“Software” means all of the contents of the files, disk(s), CD-ROM(s), or other media with which this Agreement is provided.

“Documentation” means all of the contents of the files, printed materials with which this Agreement is provided. “End User” means you.

“CGI” means Computations & Graphics, Inc.

2. GRANT OF LICENSE

a). The following applies if you have purchased a perpetual Software license:

CGI grants you (the End User) a non-exclusive, non-transferable license to use the Software on a single computer. You may not rent, lease, or resell the Software. You may not disassemble, decompile, reverse engineer, or modify the Software in any way. This License starts from the date you receive the Software and will last as long as the End User complies with the terms of this Agreement.

b). The following applies if you have purchased a subscription Software license:

CGI grants you (the End User) a non-exclusive, non-transferable license to use the Software simultaneously via the internet on a certain number of computers for a certain subscription period. You may not rent, lease, or resell the Software. You may not disassemble, decompile, reverse engineer, or modify the Software in any way. This License starts from the date you purchased the subscription license and will last for the subscription period.

3. SUPPORT

CGI offers limited 30 days of free email technical support related to the installation and use of the most recent version of the Software, starting from the start date of this Agreement. CGI has no obligation to provide support in any form if your version of the Software is not the most recent version. CGI, in its sole discretion, will determine what constitutes a support incident. CGI reserves the right to refuse support service to anyone.

4. COPYRIGHT

The Software and Documentation are the intellectual property of and are owned by CGI. You may make at most one copy of the Software and/or the Documentation for backup purposes.

5. COMMERCIAL USES

The Standard and Professional versions of the Software may be used for commercial purposes.

The Evaluation, Educational, and Beta versions of the Software may not be used for commercial purposes.

6. LIMITATION OF LIABILITY

IN NO EVENT WILL CGI OR ITS SUPPLIERS BE LIABLE TO YOU FOR ANY DAMAGES, CLAIMS, OR COSTS WHATSOEVER OR ANY CONSEQUENTIAL, INDIRECT, INCIDENTAL DAMAGES, OR ANY LOST PROFITS OR LOST SAVINGS, EVEN IF CGI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSS, DAMAGES, CLAIMS, OR COSTS.

7. DISCLAIMER

CGI HAS TAKEN EVERY EFFORT TO MAKE THE SOFTWARE RELIABLE AND ACCURATE. HOWEVER, IT IS THE END USER’S RESPONSIBILITY TO INDEPENDENTLY VERIFY THE ACCURACY AND RELIABILITY OF THE SOFTWARE. NO EXPRESS OR IMPLIED WARRANTY IS PROVIDED BY CGI OR ITS DEVELOPERS ON THE ACCURACY OR RELIABILITY OF THE SOFTWARE.

8. REFUND POLICY

All sales are final and no refunds will be given. If you do not agree to and accept this policy, do not purchase the license of this software.

9. TERMINATION OF THIS LICENSE:

This Agreement becomes effective on the date you accept this Agreement and will continue until terminated as provided for in this Agreement. CGI may terminate this license at any time if you are in breach of any of its terms and conditions. Upon termination, you must immediately return to CGI or destroy the Software and all copies thereof.

Copyright

THE SOFTWARE **SECTIO** AND ALL ITS DOCUMENTATION ARE THE INTELLECTUAL PROPERTY OF AND ARE OWNED BY COMPUTATIONS & GRAPHICS INC. (CGI). ILLEGAL USE OF THE SOFTWARE OR REPRODUCTION OF ITS DOCUMENTATION IS STRICTLY PROHIBITED.

Disclaimer

CGI HAS TAKEN EVERY EFFORT TO MAKE THE SOFTWARE RELIABLE AND ACCURATE. HOWEVER, IT IS THE END USER'S RESPONSIBILITY TO INDEPENDENTLY VERIFY THE ACCURACY AND RELIABILITY OF THE SOFTWARE. NO EXPRESS OR IMPLIED WARRANTY IS PROVIDED BY CGI OR ITS DEVELOPERS ON THE ACCURACY OR RELIABILITY OF THE SOFTWARE.

Notice

SINCE **SECTIO** COMES IN DIFFERENT VERSIONS, SOME FEATURES DESCRIBED IN THIS DOCUMENTATION MAY NOT APPLY TO THE SPECIFIC VERSION OF THE PROGRAM YOU ARE RUNNING.

OpenGL® is a registered trademark of Hewlett Packard Enterprise.
Windows® is a registered trademark of Microsoft Corporation.
Sectio is a trademark of Computations & Graphics, Inc.

Copyright 2002-2026 by Computations & Graphics, Inc. All rights reserved.

Last Revised August 2026

The Use of Dawn WebGPU Library

This software uses the Dawn WebGPU library, which is provided under the following license:

BSD 3-Clause License

Copyright (c) 2019, "WebGPU native" developers
All rights reserved.

Redistribution and use in source and binary forms, with or without modification, are permitted provided that the following conditions are met:

1. Redistributions of source code must retain the above copyright notice, this list of conditions and the following disclaimer.
2. Redistributions in binary form must reproduce the above copyright notice, this list of conditions and the following disclaimer in the documentation and/or other materials provided with the distribution.
3. Neither the name of the copyright holder nor the names of its contributors may be used to endorse or promote products derived from this software without specific prior written permission.

THIS SOFTWARE IS PROVIDED BY THE COPYRIGHT HOLDERS AND CONTRIBUTORS "AS IS" AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE COPYRIGHT HOLDER OR CONTRIBUTORS BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Table of Contents

END USER LICENSE AGREEMENT FOR CGI SOFTWARE (NON-SDK)	I
COPYRIGHT	II
DISCLAIMER	II
NOTICE	II
THE USE OF DAWN WEBGPU LIBRARY	III
INTRODUCTION	8
<i>Section Overview</i>	<i>1</i>
<i>Graphical User Interface (GUI)</i>	<i>1</i>
<i>Command Window</i>	<i>1</i>
<i>Enter Nodal Coordinates</i>	<i>2</i>
<i>Mouse Use</i>	<i>3</i>
<i>Spreadsheet Navigation</i>	<i>3</i>
<i>System Requirements</i>	<i>4</i>
PART 1: USER INTERFACE	6
CHAPTER 1: FILE MENU (BACKSTAGE)	7
New	7
Open	7
Close	7
Save	8
Save As	8
Save All	8
Print Setup	8
Print Current View	8
General Information	8
Capture Current Image	9
Delete All Captured Images	9
View Log File	9
Open Containing Folder	9
CHAPTER 2: HOME RIBBON	10
Drawing Grid	10
Object Snap	10
Draw Node	11
Draw Line	11
Draw Arc	11
Draw Spline	12
Quick Draw Line	12
Quick Draw Arc	12
Quick Draw Spline	12
Rectangular Lines	13
Arc Lines	13
Shape Template Rectangular	14
Shape Template Rectangular Hollow	14
Shape Template Rounded Rectangular Hollow	14
Shape Template Circular	15
Shape Template Circular Hollow	15
Shape Template Elliptical	16
Shape Template Elliptical Hollow	16
Shape Template Regular Polygon	17
Shape Template Regular Polygon Hollow	17
Shape Template Triangular	18
Shape Template Cruciform	18
Shape Template T-Shape	19
Shape Template I-Shape	19
Shape Template Mono I-Shape	20

Shape Template Tapered Flange I-Shape.....	20
Shape Template Channel.....	21
Shape Template Tapered Flange Channel.....	21
Shape Template Angle.....	22
Shape Template Cee.....	22
Shape Template Zed.....	23
Shape Template Box Girder.....	23
Shape Template Bulb.....	24
Zoom Extent.....	24
Zoom Window.....	24
Real-Time Zoom.....	25
Real-Time Pan.....	25
Window Select.....	25
Line Select.....	25
Flip Selection.....	26
Annotate.....	26
Clear Annotations.....	26
Query.....	26
Nodes.....	27
Lines.....	27
Run.....	28
View Log File.....	28
Window New Window.....	29
Window Close.....	29
Window Close All.....	29
Window Tile Horizontal.....	29
Window Tile Vertical.....	29
CHAPTER 3: VIEW RIBBON.....	30
Redraw.....	30
Restore Model.....	30
Zoom Extent.....	30
Zoom Window.....	30
Zoom Zoom Object.....	30
Zoom Zoom Previous.....	30
Zoom Zoom In.....	30
Zoom Zoom Out.....	31
Real-Time Zoom.....	31
Pan Left.....	31
Pan Right.....	31
Pan Up.....	31
Pan Down.....	31
Real-Time Pan.....	31
Window Select.....	31
Line Select.....	32
Select by IDs Nodes.....	32
Select by IDs Lines.....	32
Select by IDs Select All.....	33
Select by IDs Unselect All.....	33
Select by Properties Orphaned Nodes.....	33
Select by Properties Coordinates.....	33
Select by Properties Select All.....	33
Select by Properties Unselect All.....	33
Flip Selection.....	34
Annotate.....	34
Clear Annotations.....	34
Query.....	34
Distance.....	34
Render Quick Render.....	34
Render Render Options.....	34
Drawing Grid.....	35

Global Axes.....	35
CHAPTER 4: MODIFY RIBBON	36
Undo	36
Redo	36
Duplicate	36
Array.....	36
Mirror	37
Move	37
Rotate.....	38
Scale.....	38
Delete.....	39
Merge All Nodes	39
Remove All Orphaned Nodes	39
Clear Undo & Redo	39
Clear Everything.....	39
CHAPTER 5: RESULTS RIBBON	40
Nodes	40
Triangles.....	40
Text Report.....	41
CHAPTER 6: SETTINGS & TOOLS RIBBON.....	43
Units & Precisions.....	43
Data Options.....	43
Graphic Scales.....	44
Colors	44
Preferences	45
Themes	46
Use WebGPU with High Performance	46
Use WebGPU with Low Performance	46
Use OpenGL with Hardware Acceleration.....	46
Use OpenGL without Hardware Acceleration.....	47
Copy Command History.....	47
Clear Command History.....	47
Tabbed Windows.....	47
Command Window.....	47
Status Bar	47
Section Properties.....	47
Window New Window.....	48
Window Close.....	48
Window Close All	48
Window Tile Horizontal.....	48
Window Tile Vertical	48
VERIFICATION EXAMPLES	49
Cruciform.....	49
Elliptical	50
Elliptical_hollow.....	51
I-section-with-fillet.....	52
I-section	54
I-section_rotated.....	55
Angle.....	56
angle_and_plate	57
angle_tube_triangle.....	59
box_girder.....	60
bulb_section.....	61
cee-section	62
channel_with_fillet.....	63
circular_hollow.....	65
Rectangular.....	66
rectangular_hollow.....	67
regular_polygon_hollow.....	68
rounded_rectangular_hollow	69

<i>tapered flange channel</i>	71
<i>tapered flange i section</i>	72
<i>tee with fillets</i>	73
<i>Triangular</i>	74
REFERENCES	77

Introduction

Sectio Overview

Sectio calculates the geometric and structural properties of a cross-section of virtually any shape. A section is defined by a single outer polygon and any number of inner polygons that represent holes, allowing complex and irregular geometries to be modeled. A polygon consists of nodes and lines that connect between nodes.

For properties that cannot be obtained from simple closed-form formulas, Sectio employs the finite element method to deliver accurate results. These include the torsional constant (J), the warping constant (C_w), and the shear areas (A_{sx} and A_{sy}), among others.

Graphical User Interface (GUI)

Sectio has a modern graphical user interface (Figure 0.1). It includes ribbon, quick access toolbar (QAT), global command search, multiple views, section properties side pan, command window, and a status bar.

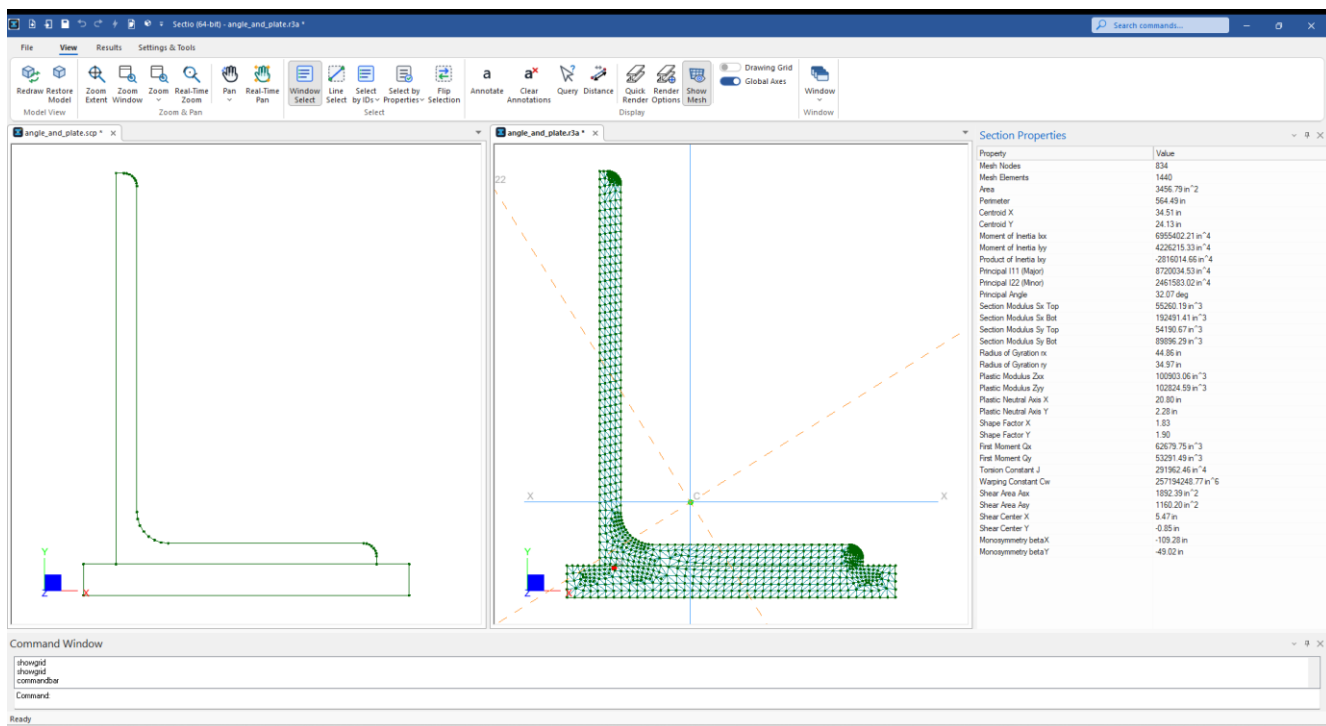


Figure 0.1

Command Window

A command (Figure 0.2) can be entered by using the keyboard. This is especially useful (and efficient) when drawing geometry such as nodes, lines, arc, and splines. For example, you can use “line” command to start draw lines, or “open” command to open a new file. To enter a command using the keyboard, type the command name (e.g.: “line” or “open”) on the command line window and

press Enter or Spacebar key. For example, in the “line” command, type in “line” in the command window, then enter the next nodal coordinates directly and press Enter key.

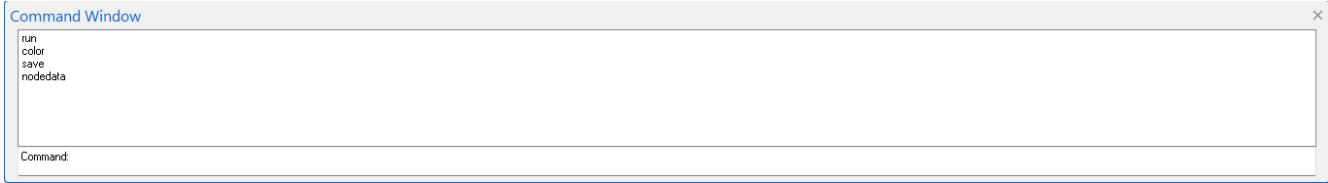


Figure 0.2

To repeat the last command, press Enter or Spacebar at command prompt. You can also invoke the last command by right-clicking your mouse and select Repeat Last.

To cancel a command in progress, press ESC.

By default, the command window is docked. You can undock the command window by dragging it away. You can then resize its width and height. To dock the command window again by double clicking on its caption.

The command window can be turned on or off by pressing F3.

Enter Nodal Coordinates

Nodal coordinates can be specified by either Cartesian or Polar systems through the command window.

Cartesian coordinates can be specified by either absolute or relative X, Y and/or Z values, separated by comma(s). Z value may be omitted, in which case the program will assign $Z = 0$.

By default, the values entered are absolute coordinates, which are based on the origin (0, 0, 0) of the global coordinate system. Relative coordinates are based on the last nodal coordinates entered. To specify relative coordinates, precede the coordinate values with a @ character.

For example, the following will draw three nodes (1, 1, 0), (3, 4, 2) and (2, 8, 3)

Command: node

Specify nodal coordinates: 1,1

Specify nodal coordinates: @2,3,2

Specify nodal coordinates: @-1,4,1

Polar coordinates can be specified by either absolute or relative distance plus an angle, separated by an < character. The angle is degrees measured from the +X direction and is positive in counterclockwise direction around +Z axis.

By default, the value entered is absolute distance, which is based on the origin (0, 0, 0) of the global coordinate system. Relative distance is based on the last nodal coordinates entered. To specify relative distance, precede the distance values with an @ character.

For example, the following will draw three nodes (1, 1, 0), (4.33013, 2.5, 0) and (6.45145, 4.62132, 0)
 Command: node
 Specify nodal coordinates: 1,1
 Specify nodal coordinates: 5<30
 Specify nodal coordinates: @3<45

Mouse Use

You can zoom in or out the model view by rolling middle mouse wheel.
 You can pan the model view by holding down and move the middle mouse button.

Spreadsheet Navigation

The program uses spreadsheets (grid control, see Figure 0.3) for data input and output. It offers multiple ways to navigate within a spreadsheet as specified in the following table.

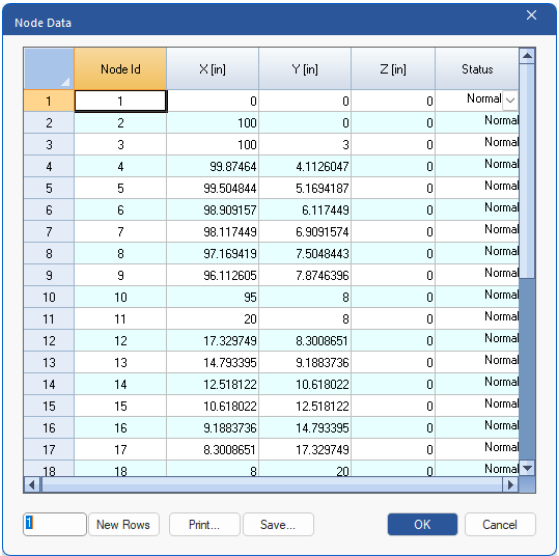


Figure 0.3

Key	Action
up arrow	Moves active cell up one row
down arrow	Moves active cell down one row
right arrow	Moves active cell right one column
left arrow	Moves active cell left one column
Shift+arrow key	Extends selection in direction of arrow key
Page Up	Moves active cell one page up
Page Down	Moves active cell one page down

Ctrl+Page Up	Moves active cell one page left
Ctrl+Page Down	Moves active cell one page right
Home	Moves active cell to first cell in row
End	Moves active cell to last cell in row that contains data
Ctrl+Home	Moves active cell to first row, first column
Ctrl+End	Moves active cell to last row and column that contain data
Tab	Moves active cell to next cell to the right (or at end of row moves to beginning of next row)
Shift+Tab	Moves active cell to next cell to the left (or at beginning of row moves up to end of row above)
Shift+space	Selects current row
Ctrl+space	Selects current column
Shift+Ctrl+space	Selects entire sheet
Ctrl+X or Shift+Del	Cuts current selection or active cell's data to Clipboard
Ctrl+V or Shift+Ins	Pastes Clipboard contents into active cell
Ctrl+C or Ctrl+Ins	Copies current selection or active cell's data to Clipboard
Enter	Active cell moves down
Esc	If sheet is in edit mode, previous cell value replaces new value and edit mode is turned off
F2	If edit mode is on, cell value is cleared

System Requirements

Memory (RAM)	8 GB or more is recommended
Hard Disk	100 GB free disk space
Operating System	x64-based Windows 10, and 11 ARM64-based Windows 11

Part 1: User Interface

Chapter 1: File Menu (Backstage)

The File menu provides commands that are related to files (Figure 1.1). Input data for a model is saved in one single text file (also called a model file in this program) and has the default extension of “scp”. You may however save or open model files with different extensions. The program provides Multiple Document Interface (MDI), that is, you may open and work on multiple files at the same time. After the section is solved, a result file with the extension of “r3a” is generated and displayed.

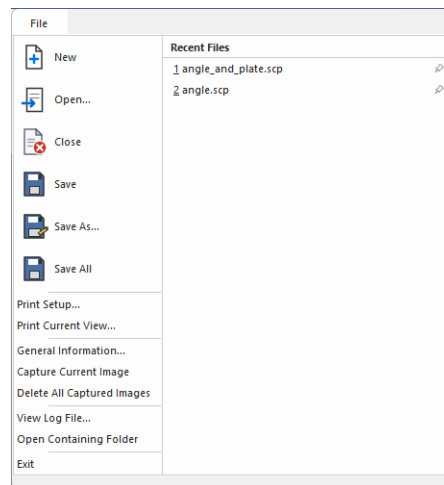


Figure 1.1

New

File | New creates a new Sectio model file.

Open

File | Open opens an existing Sectio model file (scp). You may open one or multiple files at one time. To open multiple files, simply go to the file list in Open dialog box and click the files while pressing CTRL or SHIFT.

Multiple Document Interface (MDI) makes it easy for you to share data and compare results between different models. Multiple windows or views may be associated with a single file. These windows may have different display settings with respect to zooming, panning, and display.

Close

File | Close closes the active Sectio model file (scp). You will be prompted to save the document if changes have been made since it was last saved. You may close all opened documents without exiting the program.

Save

File | Save saves the model file (scp). If the model has not been saved before, the Save As dialog box will be displayed prompting you to enter a file name. When the current window is a report view, File | Save saves the report file.

Save As

File | Save As saves the model or result file under a different name.

Save All

File | Save All will save all the documents currently opened. If a model has not been saved before, the Save As dialog box will be displayed prompting you to enter a file name.

Print Setup

File | Print Setup allows you to set up the page layout (Figure 1.2) before printing current view.

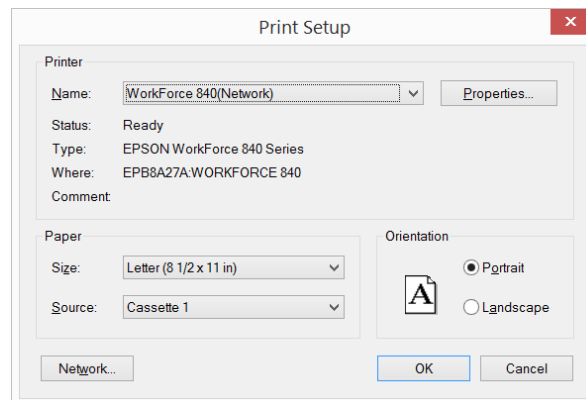


Figure 1.2

Print Current View

File | Print Current View allows you to preview and print the current view.

General Information

File | General Information prompts you with the following dialog box (Figure 1.3). You may enter a model name, your company name, your name and a description about the model (up to 1020 characters long).

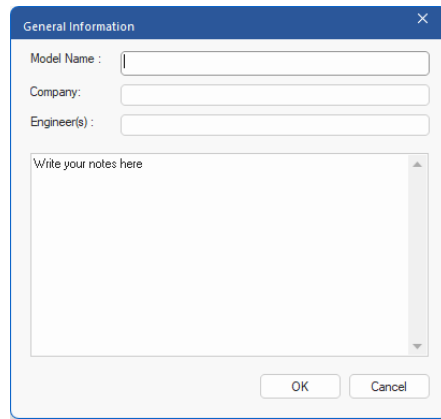
A screenshot of a 'General Information' dialog box. It has a blue title bar with a close button (X). The dialog contains three text input fields: 'Model Name :', 'Company:', and 'Engineer(s) :'. Below these is a larger text area with the placeholder text 'Write your notes here'. At the bottom right are 'OK' and 'Cancel' buttons.

Figure 1.3

Capture Current Image

File | Capture Current Image captures the current graphical view as it appears on screen. Captured images are saved in PNG format under the same directory as the model file.

Delete All Captured Images

File | Delete All Images deletes all captured images. Since image files are usually large, you may want to delete these files when they are no longer needed.

View Log File

File | View Log File allows you to view the log file generated during the solution process

Open Containing Folder

File | Open Containing Folder allows you to open the folder that contains the current model file.

Chapter 2: Home Ribbon

The **Home** ribbon category (Figure 2.1) provides commonly used commands for defining and creating section geometry, viewing the model, and calculating section properties.

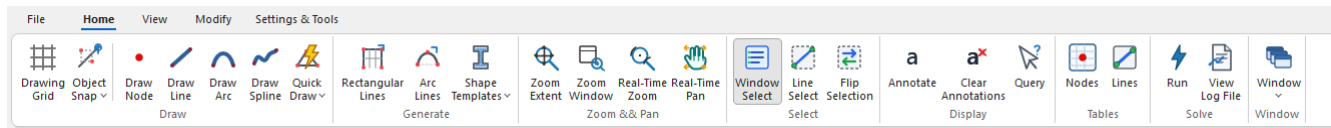


Figure 2.1

Drawing Grid

Home | Drawing Grid prompts you with the following dialog box (Figure 2.2). It allows you to generate a 2D rectangular grid for drawing or guidance. The distance list is a comma separated list that specifies multiple distances. For example, a distance list of “12, 2@14, 3@10” will generate distances of 12, 14, 14, 10, 10 and 10 in length units.

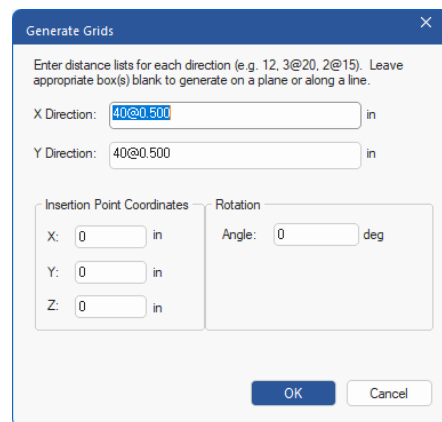


Figure 2.2

You may specify an insertion point to translate and rotation parameters to rotate the grid. The drawing grid may be turned on or off by running the command View | Drawing Grid or by simply pressing F7. You may regard the grid as a user defined coordinate system that can be changed at any time. The coordinates of the grid intersection under the mouse are displayed in the status bar. It helps you to identify correct points when drawing nodes or elements.

Object Snap

Home | Object Snap pop-up menu (Figure 2.3) provides options to snap node locations at 1/2, 1/3, ... 1/9th points on a line under the mouse cursor. If you are drawing lines, you also have the option to snap to the perpendicular point on a line from the last point. It is a good idea to turn off the drawing grid (by pressing F7) to avoid snapping to grid points while any of the snap options is on.

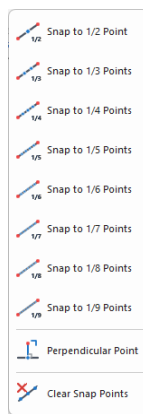


Figure 2.3

Draw Node

Home | Draw Node allows you to draw new nodes in the model. To draw a node, simply move the mouse, point to an intersection of the grid and click the left mouse button. You may also draw a node by entering nodal X, Y, and Z (optional and ignored) coordinates in the command window via the command “node”. This is very useful if you need to draw nodes outside the grid interactions. The command remains in effect until another command is selected, the right mouse button is clicked, or ESC is pressed.

Draw Line

Home | Draw Line allows you to draw new line in the model. To draw a line, simply move the mouse and click the left mouse button from point to point. The clicked points must be intersections on the grid or existing nodes. These points become the line nodes. New nodes are created if necessary. Lines are drawn continuously. Right clicking the mouse once lets you start drawing lines from a new location.

You may also specify a node by entering nodal X, Y and Z (optional and ignored) coordinates in the command window via the command “line”. This is very useful if you need to specify nodes outside the grid interactions. In addition, you may specify a node by entering an existing node number directly. You can combine the use of keyboard and mouse to draw lines.

You may turn on annotations for nodes and members while drawing. To do that, run View | Annotate. The command remains in effect until another command is selected, the right mouse button is clicked twice, or ESC is pressed.

Draw Arc

Home | Draw Arc allow you to draw new arc in the model. It first prompts you to set the number of segments for the arc (Figure 2.4). To draw an arc, simply move the mouse and click the left mouse button from point to point three times. The picked points must not be on the same line. The arc will be converted to multiple lines immediately.

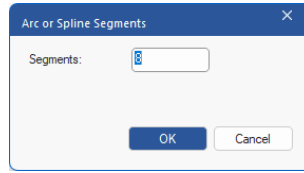


Figure 2.4

You may also specify a node by entering nodal X, Y and Z (optional and ignored) coordinates in the command window via the command “arc”. This is very useful if you need to specify nodes outside the grid interactions. In addition, you may specify a node by entering an existing node number directly. You can combine the use of keyboard and mouse to draw lines.

The command remains in effect until another command is selected, the right mouse button is clicked twice, or ESC is pressed.

Draw Spline

Home | Draw Spline allow you to draw new spline in the model. It first prompts you to set the number of segments for the arc (Figure 2.4). To draw a spline, simply move the mouse and click the left mouse button from point to point at least four times. The spline will be converted to multiple lines immediately.

You may also specify a node by entering nodal X, Y and Z (optional and ignored) coordinates in the command window via the command “spline”. This is very useful if you need to specify nodes outside the grid interactions. In addition, you may specify a node by entering an existing node number directly. You can combine the use of keyboard and mouse to draw lines.

The command remains in effect until another command is selected, the right mouse button is clicked twice, or ESC is pressed.

Quick Draw Line

Geometry | Quick Draw Line allows you to draw a line by specifying two nodes in the command window through the command “qline”.

Quick Draw Arc

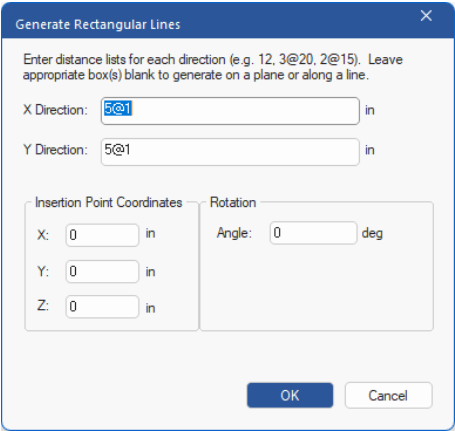
Geometry | Quick Draw Arc allows you to draw an arc by specifying three nodes (not on the same line) in the command window through the command “qarc”. The arc will be converted to multiple lines immediately.

Quick Draw Spline

Geometry | Quick Draw Spline allows you to draw a spline by specifying at least four nodes in the command window through the command “qspline”.

Rectangular Lines

Home | Rectangular Lines prompts you with the following dialog box (Figure 2.5). It allows you to quickly generate 1D lines or 2D lines. The distance list is a comma separated list that specifies multiple distances. For example, a distance list of “12, 2@14, 3@10” will generate distances of 12, 14, 14, 10, 10 and 10 in length unit. You may leave appropriate distance list(s) blank to generate on a plane or along a line.



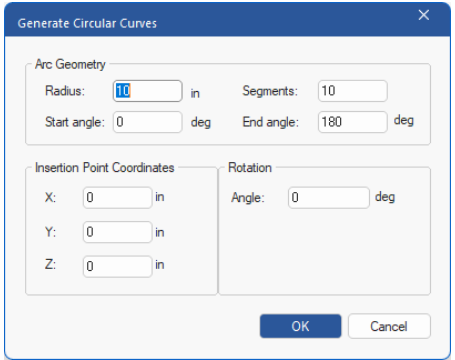
The dialog box is titled "Generate Rectangular Lines" and includes a close button (X) in the top right corner. It contains the following fields and sections:

- Instructions:** "Enter distance lists for each direction (e.g. 12, 3@20, 2@15). Leave appropriate box(s) blank to generate on a plane or along a line."
- X Direction:** A text input field containing "5@1" followed by a unit dropdown menu set to "in".
- Y Direction:** A text input field containing "5@1" followed by a unit dropdown menu set to "in".
- Insertion Point Coordinates:** A section with three input fields for X, Y, and Z, each followed by a unit dropdown menu set to "in". The values are all "0".
- Rotation:** A section with an "Angle:" label and an input field containing "0", followed by a unit dropdown menu set to "deg".
- Buttons:** "OK" and "Cancel" buttons at the bottom right.

Figure 2.5

Arc Lines

Home | Arc Lines prompts you with the following dialog box (Figure 2.6). It allows you to quickly generate lines along an arc. You may specify an arc radius, the start and end angles, and the number of segments. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.



The dialog box is titled "Generate Circular Curves" and includes a close button (X) in the top right corner. It contains the following fields and sections:

- Arc Geometry:** A section with four input fields: "Radius:" (containing "10"), "Segments:" (containing "10"), "Start angle:" (containing "0"), and "End angle:" (containing "180"). Each field is followed by a unit dropdown menu set to "in" or "deg".
- Insertion Point Coordinates:** A section with three input fields for X, Y, and Z, each followed by a unit dropdown menu set to "in". The values are all "0".
- Rotation:** A section with an "Angle:" label and an input field containing "0", followed by a unit dropdown menu set to "deg".
- Buttons:** "OK" and "Cancel" buttons at the bottom right.

Figure 2.6

Shape Template | Rectangular

Home | Shape Template | Rectangular prompts you with the following dialog box (Figure 2.7). It allows you to quickly generate a rectangular shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

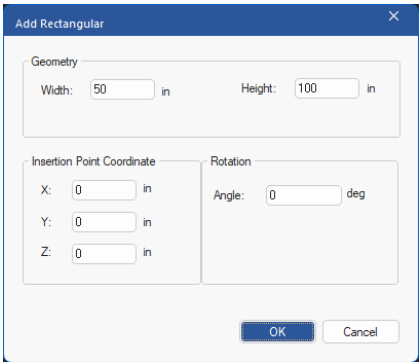


Figure 2.7



Figure 2.8

Shape Template | Rectangular Hollow

Home | Shape Template | Rectangular Hollow prompts you with the following dialog box (Figure 2.9). It allows you to quickly generate a hollow rectangular shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

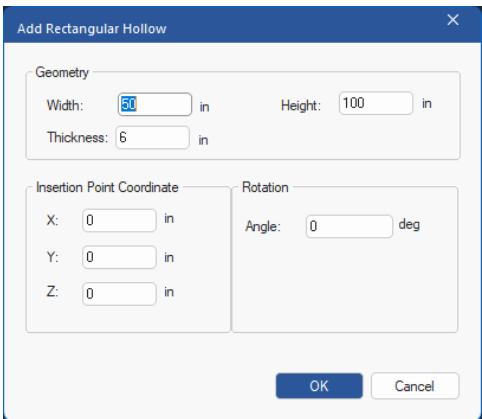


Figure 2.9

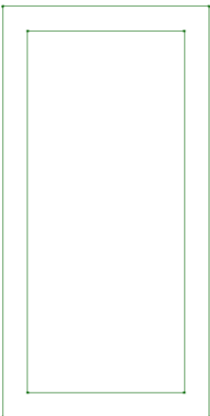


Figure 2.10

Shape Template | Rounded Rectangular Hollow

Home | Shape Template | Rounded Rectangular Hollow prompts you with the following dialog box (Figure 2.11). It allows you to quickly generate a rounded hollow rectangular shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

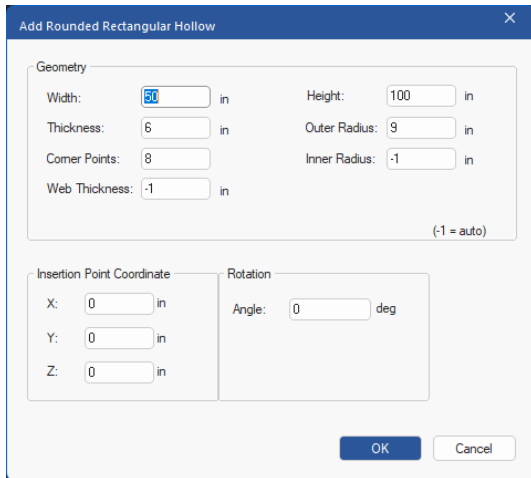


Figure 2.11

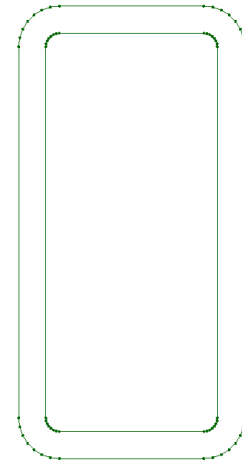


Figure 2.12

Shape Template | Circular

Home | Shape Template | Circular prompts you with the following dialog box (Figure 2.13). It allows you to quickly generate a circular shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

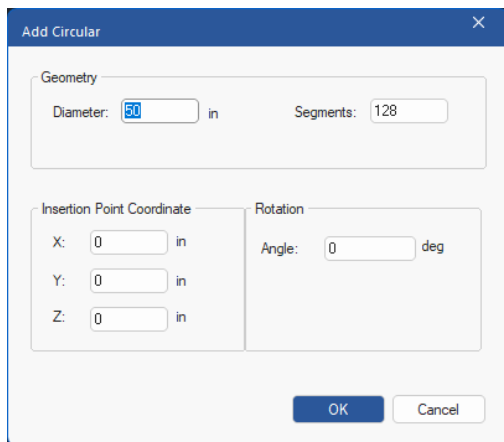


Figure 2.13

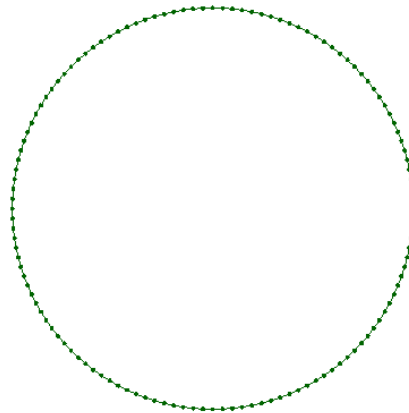


Figure 2.14

Shape Template | Circular Hollow

Home | Shape Template | Circular Hollow prompts you with the following dialog box (Figure 2.15). It allows you to quickly generate a hollow circular shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

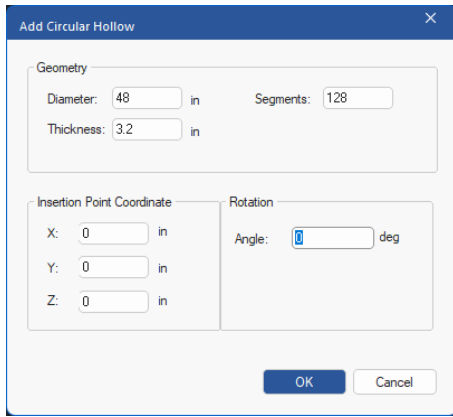


Figure 2.15

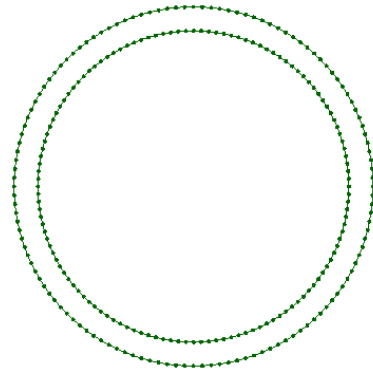


Figure 2.16

Shape Template | Elliptical

Home | Shape Template | Elliptical prompts you with the following dialog box (Figure 2.17). It allows you to quickly generate a elliptical shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

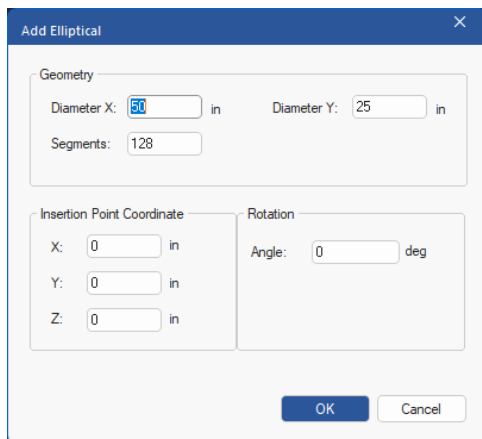


Figure 2.17

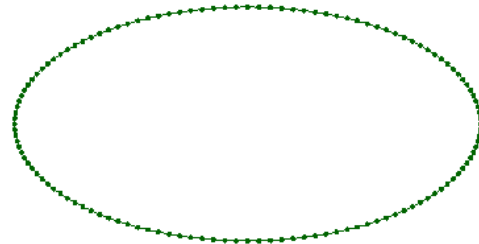


Figure 2.18

Shape Template | Elliptical Hollow

Home | Shape Template | Elliptical Hollow prompts you with the following dialog box (Figure 2.19). It allows you to quickly generate a hollow elliptical shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

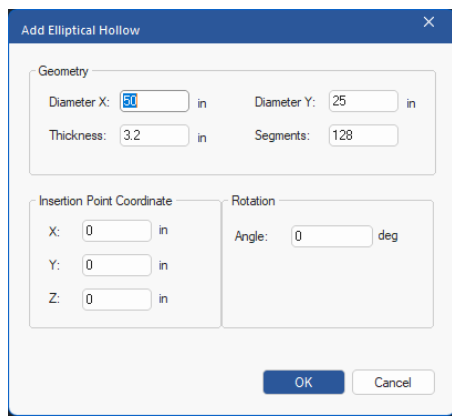


Figure 2.19

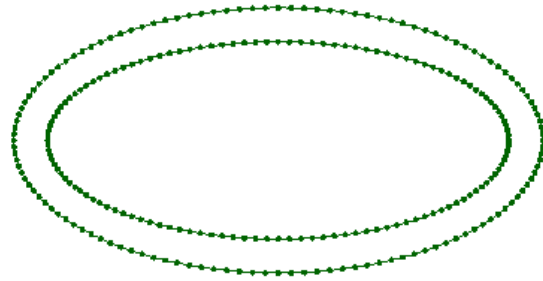


Figure 2.20

Shape Template | Regular Polygon

Home | Shape Template | Regular Polygon prompts you with the following dialog box (Figure 2.21). It allows you to quickly generate a regular polygon shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

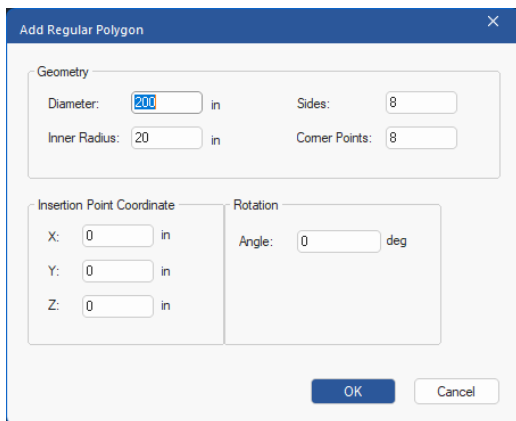


Figure 2.21

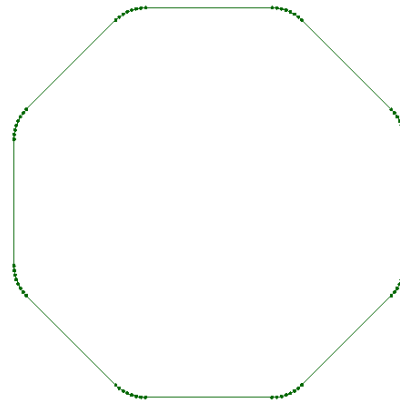


Figure 2.22

Shape Template | Regular Polygon Hollow

Home | Shape Template | Regular Polygon Hollow prompts you with the following dialog box (Figure 2.23). It allows you to quickly generate a hollow regular polygon shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

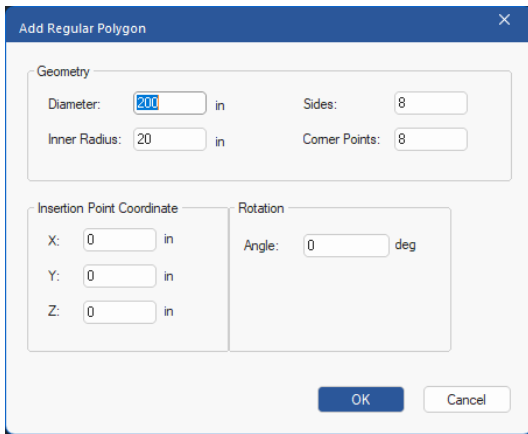


Figure 2.23

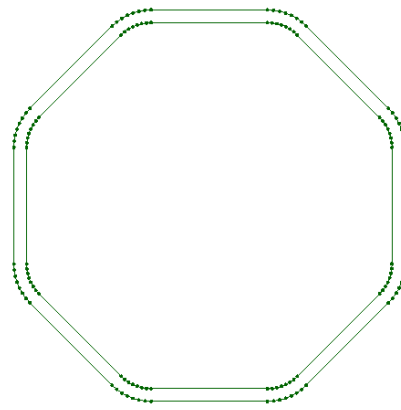


Figure 2.24

Shape Template | Triangular

Home | Shape Template | Triangular prompts you with the following dialog box (Figure 2.25). It allows you to quickly generate a (right) triangular shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

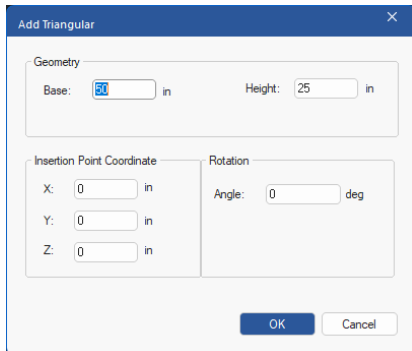


Figure 2.25

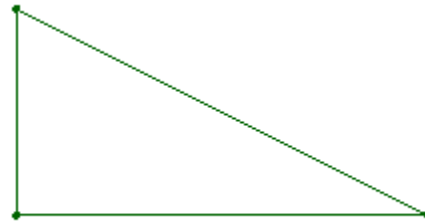
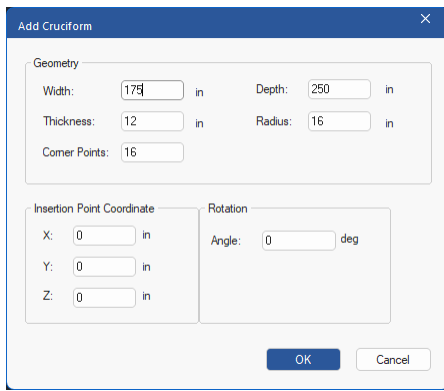


Figure 2.26

Shape Template | Cruciform

Home | Shape Template | Cruciform prompts you with the following dialog box (Figure 2.27). It allows you to quickly generate a cruciform shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.



Add Cruciform

Geometry

Width: 175 in Depth: 250 in

Thickness: 12 in Radius: 16 in

Corner Points: 16

Insertion Point Coordinate

X: 0 in Y: 0 in Z: 0 in

Rotation

Angle: 0 deg

OK Cancel

Figure 2.27

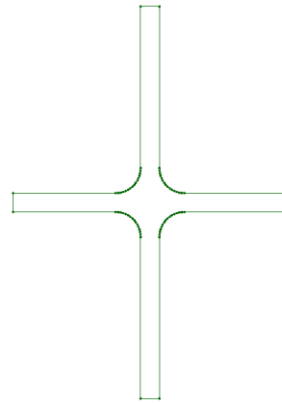
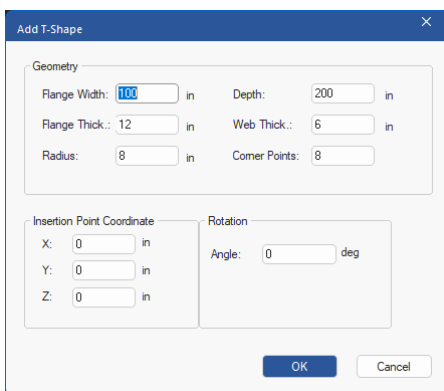


Figure 2.28

Shape Template | T-Shape

Home | Shape Template | T-Shape prompts you with the following dialog box (Figure 2.29). It allows you to quickly generate a Tee shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.



Add T-Shape

Geometry

Flange Width: 100 in Depth: 200 in

Flange Thick.: 12 in Web Thick.: 6 in

Radius: 8 in Corner Points: 8

Insertion Point Coordinate

X: 0 in Y: 0 in Z: 0 in

Rotation

Angle: 0 deg

OK Cancel

Figure 2.29

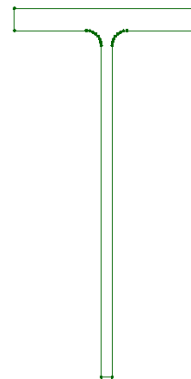
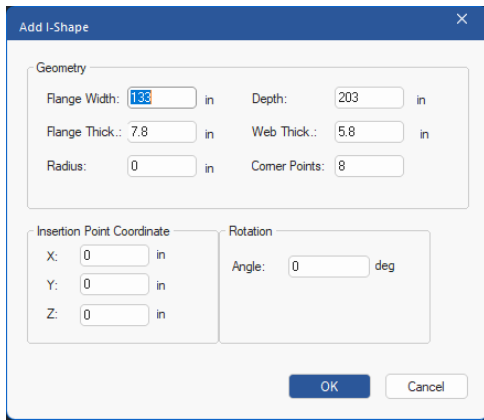


Figure 2.30

Shape Template | I-Shape

Home | Shape Template | I-Shape prompts you with the following dialog box (Figure 2.31). It allows you to quickly generate a I (equal top and bottom flange sizes) shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.



Add I-Shape

Geometry

Flange Width: 188 in Depth: 203 in

Flange Thick.: 7.8 in Web Thick.: 5.8 in

Radius: 0 in Corner Points: 8

Insertion Point Coordinate

X: 0 in Y: 0 in Z: 0 in

Rotation

Angle: 0 deg

OK Cancel

Figure 2.31

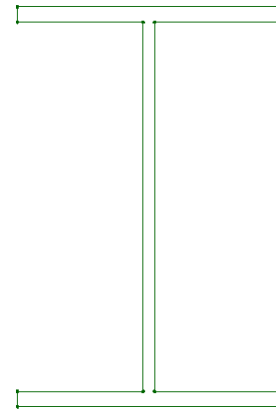
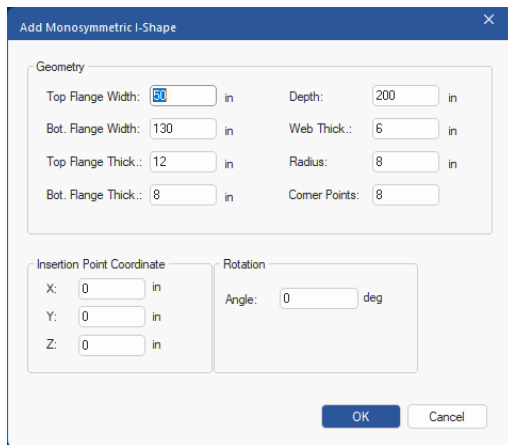


Figure 2.32

Shape Template | Mono I-Shape

Home | Shape Template | Mono I-Shape prompts you with the following dialog box (Figure 2.33). It allows you to quickly generate a Mono I (unequal top and bottom flange sizes) shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.



Add Monosymmetric I-Shape

Geometry

Top Flange Width: 50 in Depth: 200 in

Bot. Flange Width: 130 in Web Thick.: 6 in

Top Flange Thick.: 12 in Radius: 8 in

Bot. Flange Thick.: 8 in Corner Points: 8

Insertion Point Coordinate

X: 0 in Y: 0 in Z: 0 in

Rotation

Angle: 0 deg

OK Cancel

Figure 2.33

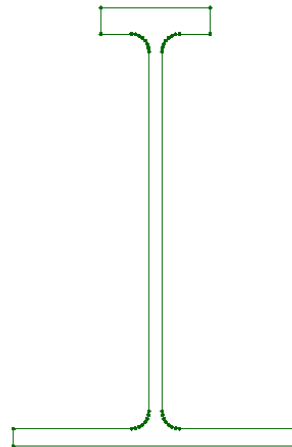
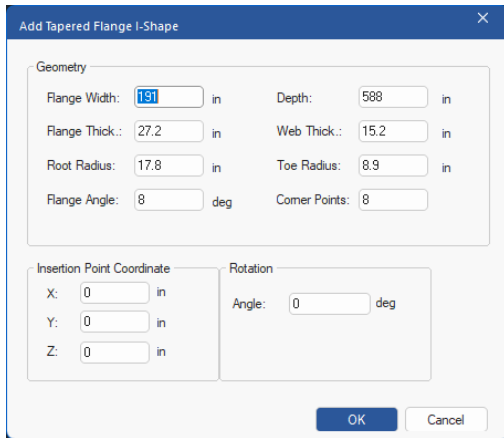


Figure 2.34

Shape Template | Tapered Flange I-Shape

Home | Shape Template | Tapered Flange I-Shape prompts you with the following dialog box (Figure 2.35). It allows you to quickly generate a Tapered Flange I shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.



Add Tapered Flange I-Shape

Geometry

Flange Width: 191 in Depth: 588 in

Flange Thick.: 27.2 in Web Thick.: 15.2 in

Root Radius: 17.8 in Toe Radius: 8.9 in

Flange Angle: 8 deg Corner Points: 8

Insertion Point Coordinate

X: 0 in Y: 0 in Z: 0 in

Rotation

Angle: 0 deg

OK Cancel

Figure 2.35

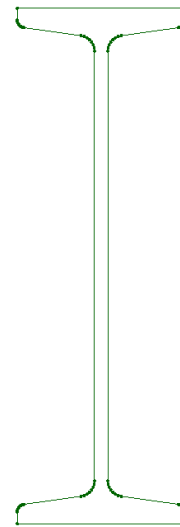
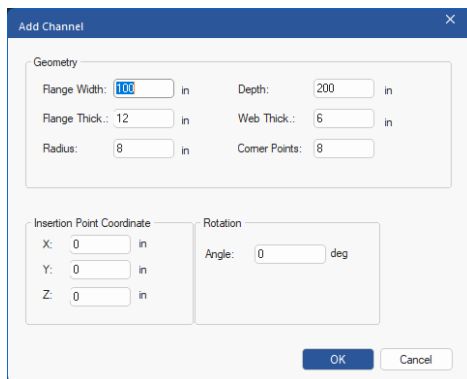


Figure 2.36

Shape Template | Channel

Home | Shape Template | Channel prompts you with the following dialog box (Figure 2.37). It allows you to quickly generate a Channel shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.



Add Channel

Geometry

Flange Width: 100 in Depth: 200 in

Flange Thick.: 12 in Web Thick.: 6 in

Radius: 8 in Corner Points: 8

Insertion Point Coordinate

X: 0 in Y: 0 in Z: 0 in

Rotation

Angle: 0 deg

OK Cancel

Figure 2.37

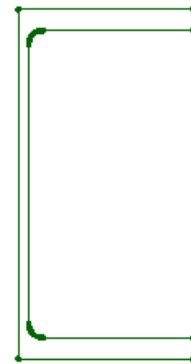


Figure 2.38

Shape Template | Tapered Flange Channel

Home | Shape Template | Tapered Flange Channel prompts you with the following dialog box (Figure 2.39). It allows you to quickly generate a Channel shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

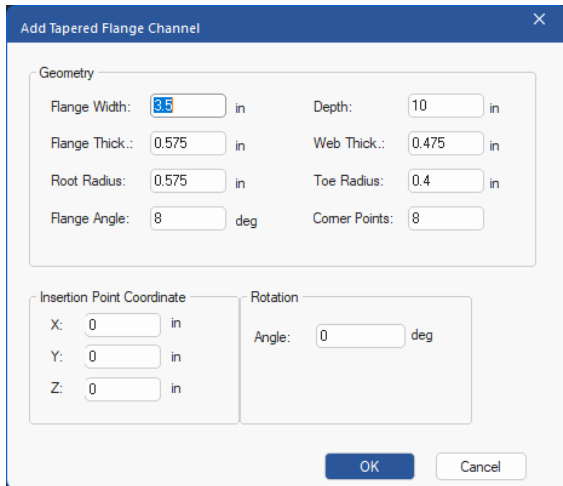


Figure 2.39

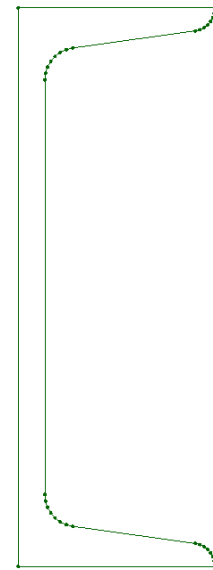


Figure 2.40

Shape Template | Angle

Home | Shape Template | Angle prompts you with the following dialog box (Figure 2.41). It allows you to quickly generate a Angle shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

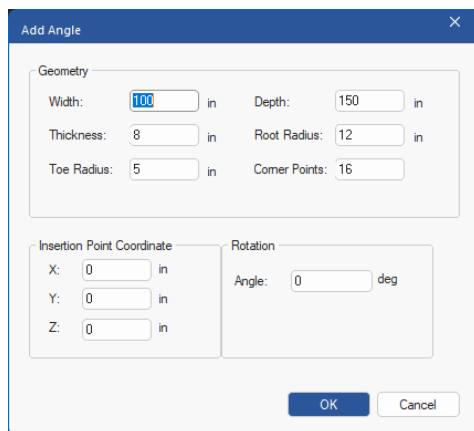


Figure 2.41

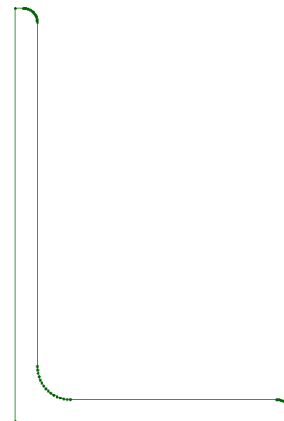


Figure 2.42

Shape Template | Cee

Home | Shape Template | Cee prompts you with the following dialog box (Figure 2.43). It allows you to quickly generate a Cee shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

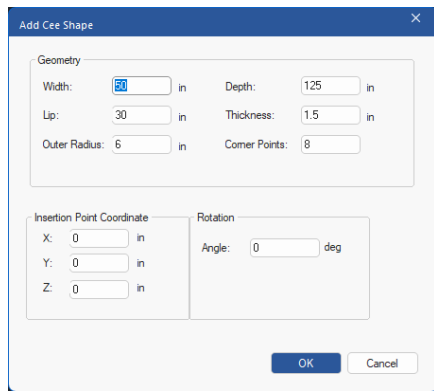


Figure 2.43

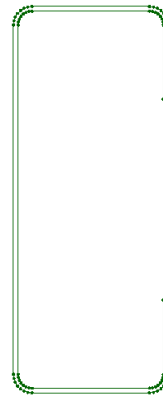


Figure 2.44

Shape Template | Zed

Home | Shape Template | Zed prompts you with the following dialog box (Figure 2.45). It allows you to quickly generate a Zed shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

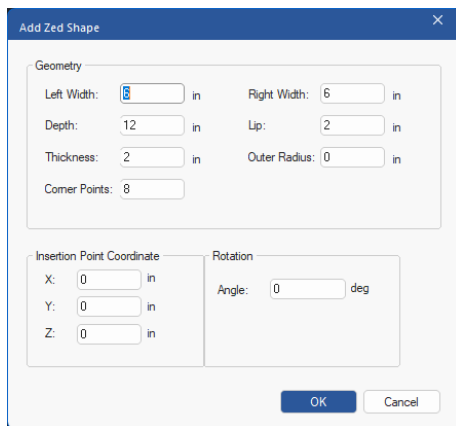


Figure 2.45

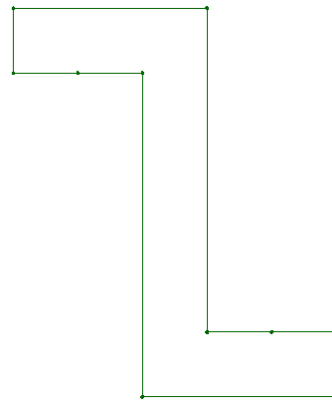


Figure 2.46

Shape Template | Box Girder

Home | Shape Template | Box Girder prompts you with the following dialog box (Figure 2.47). It allows you to quickly generate a Box Girder shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

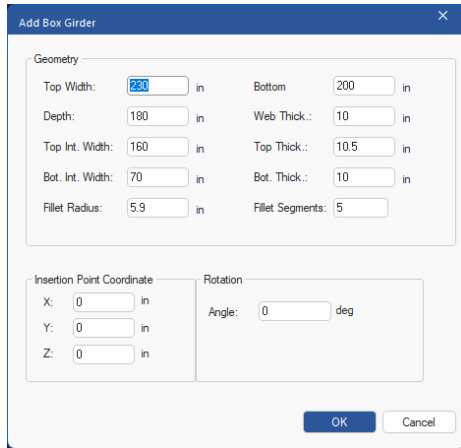


Figure 2.47

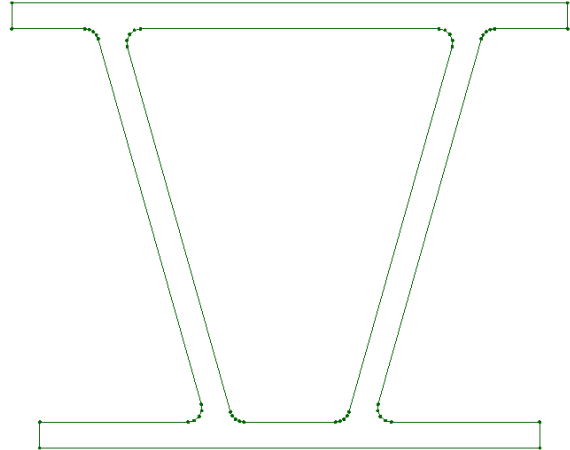


Figure 2.48

Shape Template | Bulb

Home | Shape Template | Bulb prompts you with the following dialog box (Figure 2.49). It allows you to quickly generate a Bulb shape. You may specify an insertion point to translate and rotation parameters to rotate the generate lines.

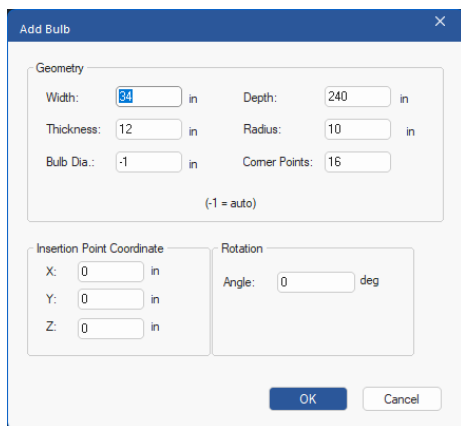


Figure 2.49



Figure 2.50

Zoom Extent

Home | Zoom Extent displays the entire model in the view.

Zoom Window

Home | Zoom Window zooms in on a specific part of the model by clicking and dragging the left mouse button. The command remains in effect until another command is selected, the right mouse button is clicked, or ESC is pressed.

Real-Time Zoom

Home | Real-Time Zoom allows you to zoom in or out on the model view in real time by clicking and dragging the left mouse button up or down. The command remains in effect until another command is selected, the right mouse button is clicked, or ESC is pressed.

Please note that you can achieve real-time zoom at any time by wheeling the middle mouse button.

Real-Time Pan

Home | Real-Time Pan allows you to pan the model view in real time by clicking and dragging the left mouse button. The command remains in effect until another command is selected, the right mouse button is clicked, or ESC is pressed.

Please note that you can achieve real-time pan at any time by pressing and dragging the middle mouse button.

Window Select

Home | Point Select allows you to window-select or point-select nodes and elements by clicking or clicking-dragging the left mouse button. The point-selection selects or unselects at most one node or line. The window-selection selects or unselects a group of nodes or lines within a rectangular selection window. If window-selection starts from the right, elements that are crossed by the selection rectangle will also be selected or unselected. By default, the selection mode is REVERSE SELECT, that is, entities picked will be selected if they are currently unselected and will be unselected if they are currently selected. However, the selection mode will be SELECT if CTRL is pressed while selecting, that is, entities picked will always be selected. The Window/ Point Select command is the default command in the program.

The selection of nodes and lines is an important activity in the program. Most of the commands apply only to selected nodes or lines. For this reason, many selection methods are provided in the program and are explained in the following sections.

Line Select

Home | Line Select allows you to line-select elements by clicking-dragging the left mouse button. The line-selection selects or unselects a group of lines that intersect with the line.

Flip Selection

Home | Flip Selection flips the selection status of all nodes and lines in the entire model. The nodes and lines currently selected will be unselected and vice versa.

Annotate

Home | Annotate prompts you with the above dialog box (Figure 2.51). It allows you to view annotations for nodes, lines, and mesh entities. Three annotation modes are available. You may annotate all entities, annotate selected entities, and erase existing annotations.

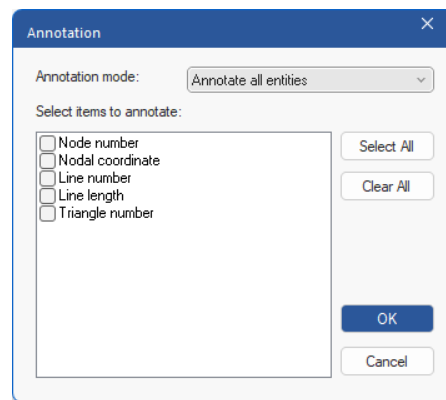


Figure 2.51

Clear Annotations

View | Clear Annotations clear all annotations.

Query

View | Query lets you query information for a single node, lines, or mesh element (Figure 2.52). For example, a node query will list node id, nodal coordinates.

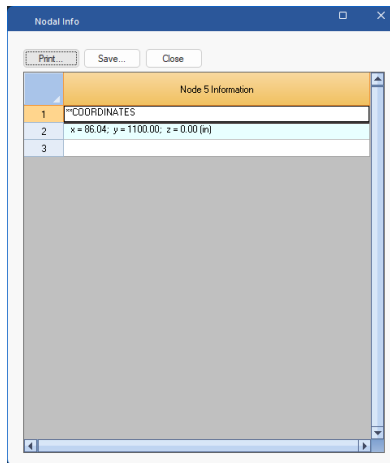


Figure 2.52

Nodes

Home | Nodes prompts you with the following dialog box (Figure 2.53). It allows you to enter nodes in a spreadsheet. Each node includes the nodal coordinates and the selection status. You may not modify the nodal Ids.

An empty row is allowed if all rows below it are empty (except the nodal Id and status fields). You may not delete the existing nodes in the dialog box. To delete the existing nodes, you must dismiss this dialog box and run the command Modify | Delete.

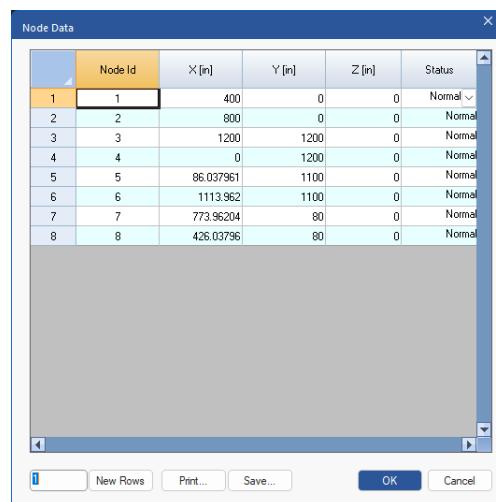


Figure 2.53

Lines

Home | Lines prompts you with the following dialog box (Figure 2.54). It allows you to enter lines in a spreadsheet. Each line includes the curve (line) Id, comma-delimited Ids of line nodes, and the

selection status. You may not modify the line Id. All other Ids must be valid (defined). An empty row is allowed if all rows below it are empty except the line Id and status fields. You may not delete the existing lines in this dialog box. To delete the existing lines, you must dismiss this dialog box and run the command Modify | Delete.

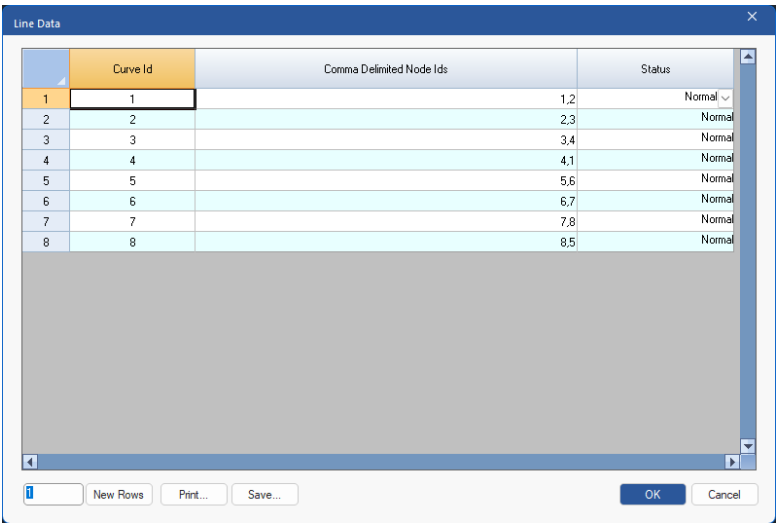


Figure 2.54

Run

Home | Run calculates the section properties. When selected, it displays the dialog (Figure 2.55). The Mesh Size should generally be less than half of the smallest section dimension to obtain accurate section properties that require finite element analysis. A mesh size that is too large may result in failure to generate a valid finite element mesh, while an excessively small mesh size may significantly increase the solution time.

As a general rule of thumb, a mesh that produces approximately **2,000 to 10,000 triangular elements** provides a good balance between accuracy and computational efficiency. Another way to assess mesh adequacy is to progressively refine the mesh and verify that the calculated section properties change only minimally.

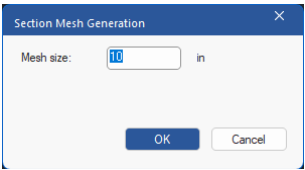


Figure 2.55

View Log File

Home | View Log File allows you to view the log file generated during the solution process.

Window | New Window

Home | Window | New Window creates a new window or view based on the current view. You may create different model views with different display settings with respect to zooming, panning, loading diagram, shear or moment diagrams, contours, etc. For example, you may have one model view to display moment diagram, another view to display shear diagram. You may create as many views as you want. However, too many views may clutter the view area and make graphic display sluggish.

Window | Close

Home | Window | Close closes the current window.

Window | Close All

Home | Window | Close All closes all windows that are currently open. You will be prompted to save file(s) if necessary.

Window | Tile Horizontal

Home | Window | Tile Horizontal arranges all opened windows horizontally.

Window | Tile Vertical

Home | Window | Tile Vertical arranges all opened windows vertically.

Chapter 3: View Ribbon

The **View** ribbon category (Figure 3.1) provides commonly used commands for graphically view inputs such as geometry definition and result meshes.

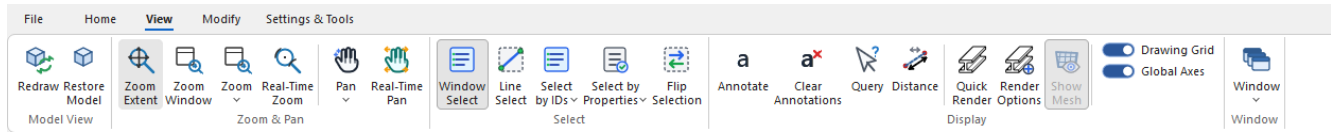


Figure 3.1

Redraw

View | Redraw regenerates and redraws all graphics in the model view.

Restore Model

View | Restore restores original settings for the model view. These settings include zooming = 1.0, panning = 0

Zoom Extent

View | Zoom Extent command is the same as Home | Zoom Extent.

Zoom Window

View | Zoom Window command is the same as Home | Zoom Window

Zoom | Zoom Object

View | Zoom | Zoom Object zooms in on a specific node or line. The command remains in effect until another command is selected, the right mouse button is clicked, or ESC is pressed.

Zoom | Zoom Previous

View | Zoom | Zoom Previous lets you zoom back to the previous view. You may use this command after you zoom in or pan to view a portion of your model in greater detail.

Zoom | Zoom In

View | Zoom | Zoom In zooms in on the model by a preset factor (1.25). You may run this command by pressing CTRL+UP arrow or CTRL+RIGHT arrow.

Zoom | Zoom Out

View | Zoom | Zoom Out zooms out on the model by a preset factor (1.25). You may run this command by pressing CTRL+DOWN arrow or CTRL+LEFT.

Real-Time Zoom

View | Real-Time Zoom command is the same as Home | Real-Time Zoom.

Pan | Left

View | Pan | Left pans the model to the left by a preset screen distance. You may run this command by pressing CTRL+LEFT arrow.

Pan | Right

View | Pan | Right pans the model to the right by a preset screen distance. You may run this command by pressing CTRL+RIGHT arrow.

Pan | Up

View | Pan | Up pans the model to the top by a preset screen distance. You may run this command by pressing CTRL+UP arrow.

Pan | Down

View | Pan | Down pans the model to the bottom by a preset screen distance. You may run this command by pressing CTRL+DOWN arrow.

Real-Time Pan

View | Real-Time Pan command is the same as Home | Real-Time Pan.

Window Select

View | Window Select allows you to window-select or point-select nodes and elements by clicking or clicking-dragging the left mouse button. The point-selection selects or unselects at most one node or line. The window-selection selects or unselects a group of nodes or lines within a rectangular selection window. If window-selection starts from the right, elements that are crossed by the selection rectangle will also be selected or unselected. By default, the selection mode is REVERSE SELECT, that is, entities picked will be selected if they are currently unselected and will be unselected if they are currently selected. However, the selection mode will be SELECT if CTRL is pressed while selecting, that is, entities picked will always be selected. The Window/ Point Select command is the default command in the program.

The selection of nodes and lines is an important activity in the program. Most of the commands apply only to selected nodes or lines. For this reason, many selection methods are provided in the program and are explained in the following sections.

Line Select

View | Line Select allows you to line-select elements by clicking-dragging the left mouse button. The line-selection selects or unselects a group of lines that intersect with the line.

Select by IDs | Nodes

View | Select by IDs | Nodes prompts you with the following dialog box (Figure 3.2). It allows you to select nodes by specifying a range of node IDs.

Three selection modes are provided: “Select”, “Unselect”, “Reverse Select”. The “Select” mode will select nodes. The “Unselect” mode will unselect nodes. The “Reverse Select” mode will select the unselected nodes and unselect the selected nodes.

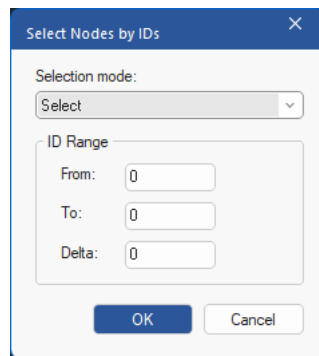


Figure 3.2

Select by IDs | Lines

View | Select by IDs | Lines prompt you with a dialog box that is almost identical to the dialog box used in View | Select by IDs | Nodes. They allow you to select lines by specifying a range of IDs.

Select by IDs | Select All

View | Select by IDs | Select All selects all nodes and elements. You may run this command by pressing CTRL+A.

Select by IDs | Unselect All

View | Select by IDs | Unselect All unselects all nodes and elements. You may run this command by pressing ESC. If you are in the middle of another command such as zooming, press ESC twice to unselect all.

Select by Properties | Orphaned Nodes

View | Select by Properties | Orphaned Nodes selects all orphaned nodes.

Select by Properties | Coordinates

View | Select by Properties | Coordinates prompts you with the above dialog box (Figure 3.3). It allows you to select/unselect nodes and lines based on nodal coordinates. Nodes are selected/unselected if their coordinates are within the boundary of the minimum and maximum coordinates. Lines are selected/unselected if coordinates of their nodes are within the boundary of minimum and maximum coordinates. The selection modes are similar to the ones used in previous sections and are not repeated here.

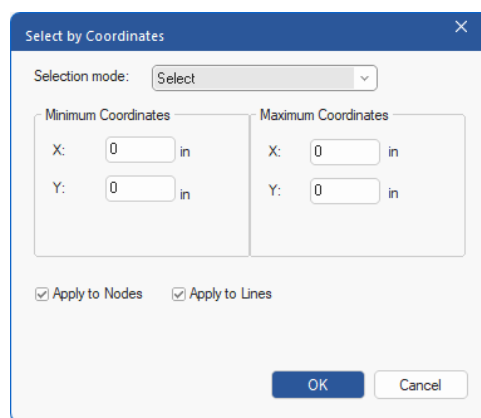


Figure 3.3

Select by Properties | Select All

Select by Properties | Unselect All

View | Select by Properties | Select All, Unselect All are the same as in View | Select by IDs. They are provided here for convenience.

Flip Selection

View | Flip Selection flips the selection status of all nodes and lines in the entire model. The nodes and lines currently selected will be unselected and vice versa.

Annotate

View | Annotate command is the same as Home | Annotate.

Clear Annotations

View | Clear Annotations clear all annotations.

Query

View | Query command is the same as Home | Query.

Distance

View | Distance allows you to graphically pick two nodes and calculate their distance. It also lists the angle in degrees in XY plane and the angle in degrees from XY plane. The result is displayed on the status bar.

Render | Quick Render

View | Quick Render turns rendering on or off. You may run this command by pressing F8.

Render | Render Options

View | Render Options prompts you with the following dialog box (Figure 3.4). It allows you to turn on or off the shading of the surfaces of triangles as though they were illuminated from multiple light sources. It provides a way for you to realistically visualize the image of the model.

You have the option to apply different rendering percentages to different elements. Enter 100% for full rendering, 0% for no rendering, and anything in-between for partial rendering. The partial rendering (e.g. 50-80%) may be useful in identifying connectivity of elements to nodes.

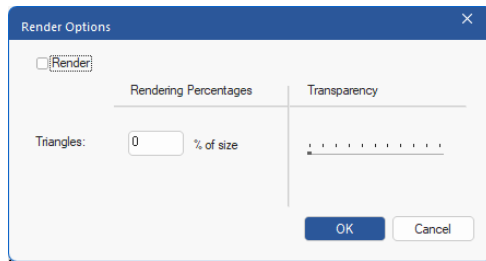


Figure 3.4

Drawing Grid

View | Drawing Grid shows or hides the drawing grid. You may set up the grid by using the command Home | Drawing Grid. The grid coordinates are shown in the status bar while the mouse is moving in the model view. You may run this command by pressing F7.

Global Axes

View | Global Axes shows or hides the legend of the global axes in the bottom-left corner of the window. You may run this command by pressing F5.

Chapter 4: Modify Ribbon

The Modify ribbon category (Figure 4.1) provides commands to edit or modify the model.

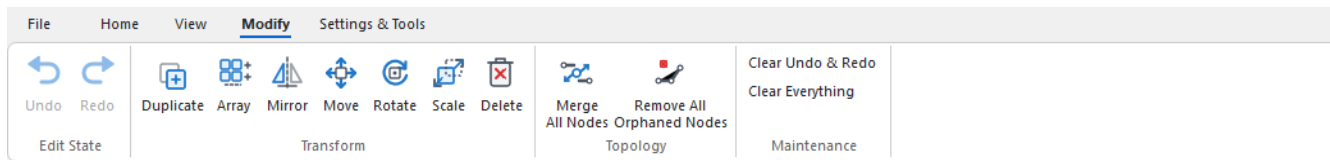


Figure 4.1

Undo

Modify | Undo undoes the previous structural command that affects the model geometry (nodes and lines). By default, you may undo up to 200 levels. You may set a different number of undo levels by running Settings | Data Options. Non-structural commands such as zooming or panning may not be undone. More undo levels requires more computer memory.

Redo

Modify | Redo reverses the previous undo command.

Duplicate

Modify | Duplicate prompts you with the following dialog box (Figure 4.2). It allows you make one copy of the selected nodes and lines of a model to a different location. You may specify copy distances along the X and Y directions. You have the option to automatically merge nodes after copying. You should check this option unless duplicate nodes are explicitly permitted.

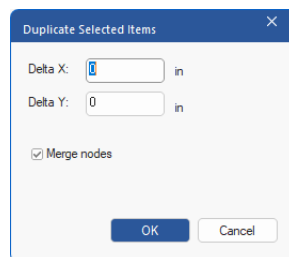


Figure 4.2

Array

Modify | Array prompts you with the following dialog box (Figure 4.3). It allows you make one or more copy of the selected nodes and lines of a model to a different location. You may specify the

step size along the X and Y directions. You have the option to automatically merge nodes after copying. You should check this option unless duplicate nodes are explicitly permitted.

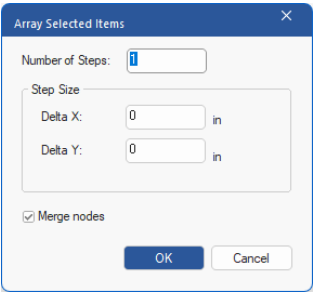


Figure 4.3

Mirror

Modify | Mirror prompts you with the following dialog box (Figure 4.4). It allows you make one mirror copy of the selected nodes and lines of a model about YZ or XZ plane. You have the option to automatically merge nodes after mirroring. You should check this option unless duplicate nodes are explicitly permitted.

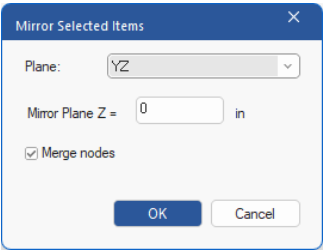


Figure 4.4

Move

Modify | Move prompts you with the above dialog box (Figure 4.5). It lets you move selected nodes and lines of a model to a different location. You may specify move distances along the X or Y directions. You have the option to automatically merge nodes after moving. You should check this option unless duplicate nodes are explicitly permitted.

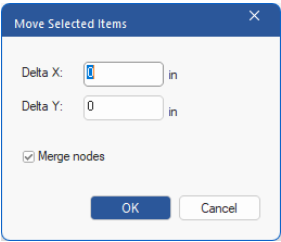


Figure 4.5

Rotate

Modify | Rotate prompts you with the following dialog box (Figure 4.6). It lets you rotate selected nodes and lines of a model by an angle about one of the global axes. You have the option to automatically merge nodes and elements after rotating. You should check this option unless duplicate nodes are explicitly permitted.

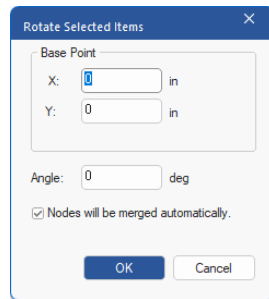


Figure 4.6

Scale

Modify | Scale prompts you with the above dialog box (Figure 4.7). It lets you scale selected nodes and lines of a model in the X or Y directions. You may specify the coordinates of a base point and scales for the three global directions.

The following formula is used to perform the scaling in the program.

$$X_{new} = X_{base} + (X_{old} - X_{base}) * scale$$

Where X_{new} represents the nodal coordinates after scaling, X_{old} represents the nodal coordinates before scaling and X_{base} represents coordinates of the base point.

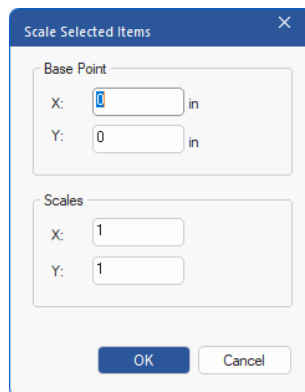


Figure 4.7

Delete

Modify | Delete prompts you with the following dialog box (Figure 4.8). It allows you to delete selected nodes or/and lines.

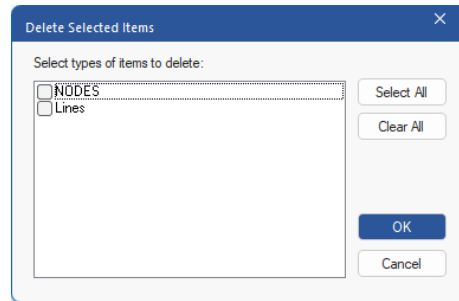


Figure 4.8

Merge All Nodes

Modify | Merge All Nodes merges all nodes that are located within a distance tolerance between two or more nodes. You may set the distance tolerance using the command Settings | Data Options.

Remove All Orphaned Nodes

Modify | Remove All Orphaned Nodes removes all nodes that are not connected to any lines.

Clear Undo & Redo

Modify | Clear Undo & Redo clears the undo/redo buffer, thus frees up computer memory.

Clear Everything

Modify | Clear Everything clears all input from computer memory. You should think twice before running this command.

Chapter 5: Results Ribbon

The Results ribbon category (Figure 5.1) provides commands for viewing the mesh data (nodes and triangles) and generating a text report of the calculated section properties. This category is associated with the result file (.r3a), which is saved automatically once the section has been solved.

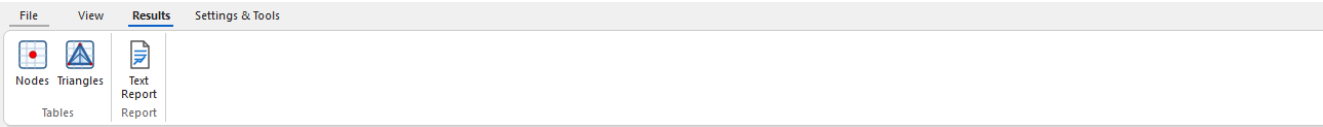


Figure 5.1

Nodes

Results | Nodes displays the read-only node data of the mesh (Figure 5.2).

The image shows a 'Node Data' dialog box with a table of node information. The table has columns for Node Id, X [in], Y [in], Z [in], and Status. The status for all nodes is 'Normal'. The dialog also includes a 'New Rows' button, a 'Print...' button, a 'Save...' button, and 'OK' and 'Close' buttons at the bottom.

	Node Id	X [in]	Y [in]	Z [in]	Status
1	1	400	0	0	Normal
2	2	800	0	0	Normal
3	3	1200	1200	0	Normal
4	4	0	1200	0	Normal
5	5	86.037961	1100	0	Normal
6	6	1113.962	1100	0	Normal
7	7	773.96204	80	0	Normal
8	8	426.03796	80	0	Normal
9	9	600	770.56853	0	Normal
10	10	600.00832	827.89789	0	Normal
11	11	-120	770.56853	0	Normal
12	12	1320	770.56853	0	Normal
13	13	600	-120	0	Normal
14	14	600	1320	0	Normal
15	15	225.00014	524.99966	0	Normal
16	16	228.12515	515.62455	0	Normal
17	17	215.62515	553.12456	0	Normal
18	18	221.87515	534.37456	0	Normal

Figure 5.2

Triangles

Results | Triangles displays the read-only triangle data of the mesh (Figure 5.3).

Triangle Data					
	Shell4 Id	Node-1	Node-2	Node-3	Status
1	1	39	54	40	0
2	2	39	40	28	0
3	3	54	72	55	0
4	4	54	55	40	0
5	5	72	91	73	0
6	6	72	73	55	0
7	7	91	109	92	0
8	8	91	92	73	0
9	9	28	40	29	0
10	10	28	29	20	0
11	11	40	55	41	0
12	12	40	41	29	0
13	13	55	73	56	0
14	14	55	56	41	0
15	15	73	92	74	0
16	16	73	74	56	0
17	17	20	29	21	0
18	18	20	21	16	0

Figure 5.3

Text Report

Results | Text Report generates a report for the section input and calculated properties in a text file. The following is an example:

INPUT GEOMETRY SUMMARY

=====

Item	Count

Polygons	1
Holes	1

POLYGON POINT TABLE

=====

Polygon	Point	X(in)	Y(in)

1	1	400.00	0.00
1	2	800.00	0.00
1	3	1200.00	1200.00
1	4	0.00	1200.00

HOLE POINT TABLE

=====

Hole	Point	X(in)	Y(in)

1	1	426.04	80.00
1	2	86.04	1100.00
1	3	1113.96	1100.00
1	4	773.96	80.00

MESH SUMMARY

=====

Item	Value

MeshNodes	3547
MeshElems	6322

SECTION PROPERTIES

=====

Property	Value	Unit
Area	258317.44	in ²
Perimeter	4129.82	in
Centroid X	600.00	in
Centroid Y	770.57	in
Moment of Inertia Ixx	47957683661.96	in ⁴
Moment of Inertia Iyy	29568463870.25	in ⁴
Product of Inertia Ixy	-0.00	in ⁴
Principal I11 (Major)	47957683661.96	in ⁴
Principal I22 (Minor)	29568463870.25	in ⁴
Principal Angle	0.00	deg
Section Modulus Sx Top	111677151.77	in ³
Section Modulus Sx Bot	62236753.66	in ³
Section Modulus Sy Top	49280773.12	in ³
Section Modulus Sy Bot	49280773.12	in ³
Radius of Gyration rx	430.88	in
Radius of Gyration ry	338.33	in
Plastic Modulus Zxx	95395238.82	in ³
Plastic Modulus Zyy	77497918.04	in ³
Plastic Neutral Axis X	600.00	in
Plastic Neutral Axis Y	981.49	in
Shape Factor X	1.53	-
Shape Factor Y	1.57	-
First Moment Qx	50042335.32	in ³
First Moment Qy	38748959.02	in ³
Torsion Constant J	45601920064.74	in ⁴
Warping Constant Cw	347959935535880.00	in ⁶
Shear Area Asx	115696.60	in ²
Shear Area Asy	98973.05	in ²
Shear Center X	600.01	in
Shear Center Y	827.90	in

Chapter 6: Settings & Tools Ribbon

The Settings & Tools ribbon (Figure 6.1) provides commands related to settings for model data, graphical entities, UI layout, and tools. Some of these settings may be applied beyond the current model, that is, they may be saved for use in future models.

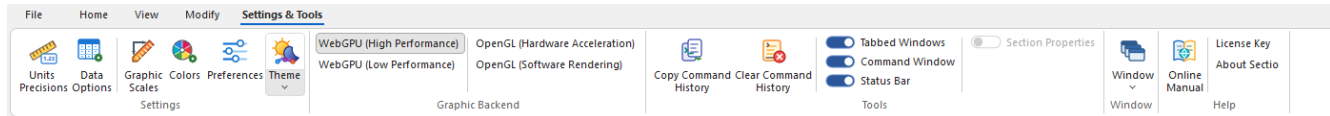


Figure 6.1

Units & Precisions

Settings & Tools | Units & Precisions prompts you with the following dialog box (Figure 6.2). You may select different units and precisions for section dimensions used in the model. You may run this command as many times as you like. You may convert existing data associated with a unit in the model by checking or unchecking the check box to the right of that unit. For example, if you mistakenly enter all nodal coordinates in a wrong length unit, you may select the correct length unit and uncheck the conversion checkbox to correct nodal coordinate input.

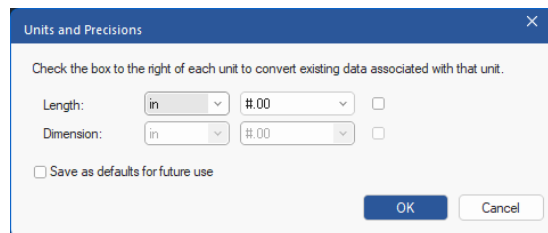


Figure 6.2

You may set the precision for each unit in either decimal or scientific format. Precision settings are used in displaying data in spreadsheets, diagrams, and reports.

By checking “Save as defaults for future use”, units will be saved in the registry for use in future models. It is a good idea to also save graphic scales in the registry at the same time. To do that, just run Settings & Tools | Graphic Scales.

Data Options

Settings & Tools | Data Options prompts you with the following dialog box (Figure 6.3).

Distance tolerance is used for distance comparisons in certain commands such as Modify | Merge Nodes. Distances less than distance tolerance are considered zero by the program.

The “Undo/redo levels” sets the maximum undo/redo levels which the program will perform. The program requires extra computer memory for each undo/redo level. The default undo levels setting is 200. Depending on your computer memory and model sizes, you may want to set undo levels to be smaller.

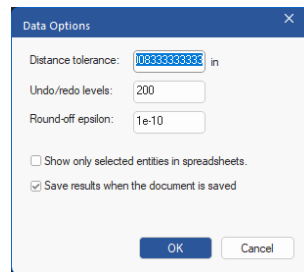


Figure 6.3

Round-off epsilon is used to truncate floating point numbers such as those found in results. For example, a fixed support may have a displacement of $1.077e-10$ when in fact it should be zero. A round-off epsilon of $1e-9$ will do just that.

Graphic Scales

Settings & Tools | Graphic Scales prompts you with the following dialog box (Figure 6.4). You may set scales for graphical entities such as loads, nodes, supports etc. By “Save as defaults for future use”, these scales will be saved in the registry for future uses. It is a good idea to save units to the registry at the same time. To do that, run Settings & Tools | Units & Precisions.

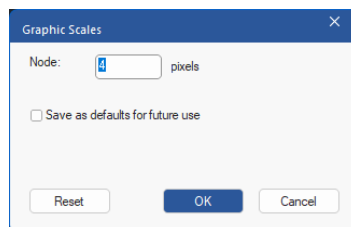


Figure 6.4

Colors

Settings & Tools | Colors prompts you with the following dialog box (Figure 6.5). It allows you to set colors of different graphical entities in the model.

When “Use white background for image captures” is enabled, captured images will use a white background even if a different background color is displayed in the model views. This can reduce the amount of ink required when printing images. This option is ignored when the OpenGL graphics backend without hardware acceleration is selected.

Color settings can be optionally saved to the registry for future use.

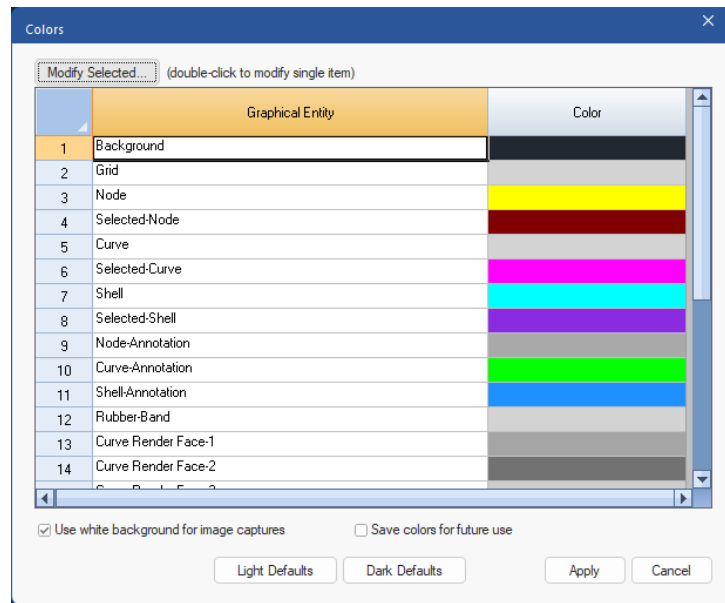


Figure 6.5

Preferences

Settings & Tools | Preferences prompts you with the following dialog box (Figure 6.6). The “Data Folder” determines the default folder or directory when a file is saved or opened.

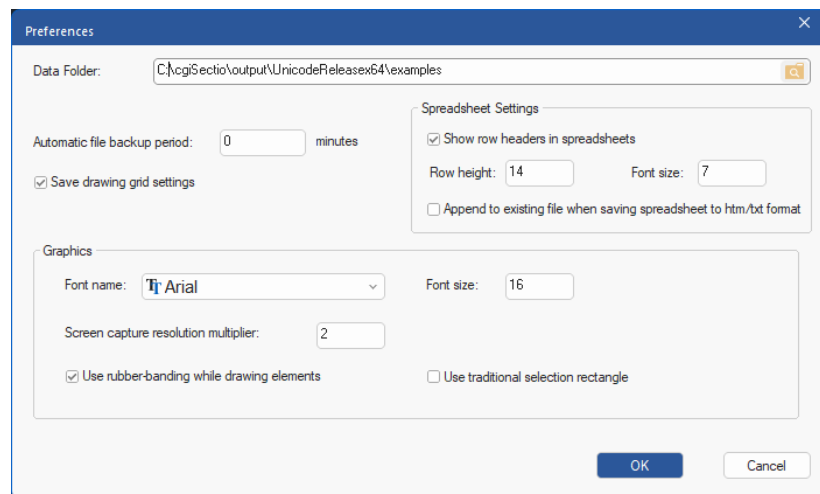


Figure 6.6

The “Automatic file backup period” determines how frequently the model files are saved automatically. Enter 0 for no auto-backups.

The screen capture resolution multiplier can be used to control the quality of the captured images. This setting is only applicable if WebGPU graphic backend is enabled.

By default, rubber-banding is enabled while drawing beams, shells or bricks. You may want to disable this feature if OpenGL backend is enabled and your computer graphic card is not fully OpenGL compatible.

The “Use traditional selection rectangle” option is applicable only to the OpenGL graphics backend. It may be useful in certain virtual machine environments or when OpenGL hardware acceleration is not available.

Preferences are always saved in the registry for future use.

Themes

Settings & Tools | Themes let you choose the UI theme from one of the preset themes (Figure 6.7) for the application. The default theme is “Office Colorful”.



Figure 6.7

Use WebGPU with High Performance

Settings & Tools | Use WebGPU with High Performance selects a high-performance GPU for rendering via WebGPU. This option is useful on systems with multiple GPUs—such as an integrated GPU and a discrete GPU - allowing the application to use the more powerful device for improved graphics performance. This is the default setting. The WebGPU backend is more modern and offers advantages over OpenGL.

Use WebGPU with Low Performance

Settings & Tools | Use WebGPU with Low Performance selects a low-performance GPU for rendering via WebGPU. This option is useful on systems with multiple GPUs—such as an integrated GPU and a discrete GPU - allowing the application to use the less powerful device to reduce power consumption. The WebGPU backend is more modern and offers advantages over OpenGL.

Use OpenGL with Hardware Acceleration

Settings & Tools | Use OpenGL with Hardware Acceleration enables OpenGL hardware acceleration. If you encounter graphics issues - often caused by faulty or incompatible graphics drivers - you can

disable hardware acceleration to improve stability (see the next command). The WebGPU backend is more modern and offers advantages over OpenGL.

Note: This graphic backend is currently not available on Windows Arm64 platform.

Use OpenGL without Hardware Acceleration

Settings & Tools | Use OpenGL without Hardware Acceleration disable OpenGL hardware acceleration. Note that doing so may significantly reduce graphics performance, though it should remain acceptable on most modern systems. This command may also be useful when using virtual Windows on Mac machine, and ARM64-based Windows. The WebGPU backend is more modern and offers advantages over OpenGL.

Copy Command History

Settings & Tools | Copy Command History copies the history in the command window to the clipboard. You may then paste the command history content to a text editor using Ctrl + V. A command history is associated with each open document.

Clear Command History

Settings & Tools | Clear Command History clears the history in the command window. You may want to copy the command history before running this command.

Tabbed Windows

Settings & Tools | Tabbed Windows toggle between using tabbed windows or non-tabbed windows for model views.

Command Window

Settings & Tools | Command Window shows or hides the command window.

Status Bar

Settings & Tools | Status Bar shows or hides the status bar.

Section Properties

Settings & Tools | Section Properties shows or hides the section properties pane.

Window | New Window

Settings & Tools | Window | New Window provides the same functionality as Home | Window | New Window and is included for convenience.

Window | Close

Settings & Tools | Window | Close provides the same functionality as Home | Window | Close and is included for convenience.

Window | Close All

Settings & Tools | Window | Close All provides the same functionality as Home | Window | Close All and is included for convenience.

Window | Tile Horizontal

Settings & Tools | Window | Tile Horizontal provides the same functionality as Home | Window | Tile Horizontal and is included for convenience.

Window | Tile Vertical

Settings & Tools | Window | Tile Vertical provides the same functionality as Home | Window | Tile Vertical and is included for convenience.

Verification Examples

The following verification examples compare the section properties calculated by Sectio with those obtained using the sectionproperties Python library. The results show excellent agreement between the two sets of calculations.

For some examples, the reported percentage difference in the shear center is shown as 100%. This occurs because one value is 0.0 and the other is an extremely small nonzero value. Under these circumstances, the percentage difference is mathematically misleading and does not accurately reflect the actual numerical agreement between the two results.

Cruciform

Item	Value
Sectio input (.scp)	Cruciform.scp
Sectio report (.txt)	Cruciform.txt
Python script	compute_cruciform_properties.py
Python mesh size	4
Sectio mesh nodes	6737
Sectio mesh elements	12624

Property	Sectio	sectionproperties	Difference
Area	5177.220000	5177.221402	-0.0000%
Centroid X	0	0	0.000e+00 (abs)
Centroid Y	0	0	0.000e+00 (abs)
Moment of Inertia Ixx	1.567083e+07	1.567083e+07	-0.0000%
Moment of Inertia Iyy	5.416008e+06	5.416008e+06	-0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	55.020000	55.017097	0.0053%
Radius of Gyration ry	32.340000	32.343818	-0.0118%
Section Modulus Sx Top	125366.660000	125366.663644	-0.0000%
Section Modulus Sx Bot	125366.660000	125366.663644	-0.0000%

Property	Sectio	sectionproperties	Difference
Section Modulus Sy Top	61897.230000	61897.233777	-0.0000%
Section Modulus Sy Bot	61897.230000	61897.233777	-0.0000%
Plastic Modulus Zxx	195489.250000	195489.245302	0.0000%
Plastic Modulus Zyy	102564.250000	102564.245302	0.0000%
Plastic Neutral Axis X	0	0	0.000e+00 (abs)
Plastic Neutral Axis Y	0	0	0.000e+00 (abs)
Torsion Constant J	358224.680000	358244.924317	-0.0057%
Warping Constant Cw	2.474074e+08	2.474082e+08	-0.0003%
Shear Area Asx	2102.710000	2102.730487	-0.0010%
Shear Area Asy	2818.680000	2818.701960	-0.0008%
Shear Center X	0	0	0.000e+00 (abs)
Shear Center Y	0	-2.000000e-06	100.0000%

Elliptical

Item	Value
Sectio input (.scp)	Elliptical.scp
Sectio report (.txt)	Elliptical.txt
Python script	compute_elliptical_properties.py
Python mesh size	3
Sectio mesh nodes	1257
Sectio mesh elements	2376

Property	Sectio	sectionproperties	Difference
Area	977.720000	977.715407	0.0005%
Centroid X	0	0	0.000e+00 (abs)
Centroid Y	0	0	0.000e+00 (abs)
Moment of Inertia Ixx	38035.270000	38035.272401	-0.0000%

Property	Sectio	sectionproperties	Difference
Moment of Inertia Iyy	152141.090000	152141.089605	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	6.240000	6.237162	0.0455%
Radius of Gyration ry	12.470000	12.474324	-0.0347%
Section Modulus Sx Top	3042.820000	3042.821792	-0.0001%
Section Modulus Sx Bot	3042.820000	3042.821792	-0.0001%
Section Modulus Sy Top	6085.640000	6085.643584	-0.0001%
Section Modulus Sy Bot	6085.640000	6085.643584	-0.0001%
Plastic Modulus Zxx	5176.270000	5176.271720	-0.0000%
Plastic Modulus Zyy	10352.540000	10352.543441	-0.0000%
Plastic Neutral Axis X	0	0	0.000e+00 (abs)
Plastic Neutral Axis Y	0	0	0.000e+00 (abs)
Torsion Constant J	121700.750000	121709.181748	-0.0069%
Warping Constant Cw	1.420395e+06	1.420517e+06	-0.0086%
Shear Area Asx	866.590000	866.606220	-0.0019%
Shear Area Asy	789.690000	789.704598	-0.0018%
Shear Center X	0	-1.800000e-05	100.0000%
Shear Center Y	0	2.900000e-05	-100.0000%

Elliptical_hollow

Item	Value
Sectio input (.scp)	Elliptical_hollow.scp
Sectio report (.txt)	Elliptical_hollow.txt
Python script	compute_elliptical_hollow_properties.py
Python mesh size	0.5
Sectio mesh nodes	748

Item	Value		
Sectio mesh elements	1240		
Property	Sectio	sectionproperties	Difference
Area	343.400000	343.404938	-0.0014%
Centroid X	0	0	0.000e+00 (abs)
Centroid Y	0	0	0.000e+00 (abs)
Moment of Inertia Ixx	24376.180000	24376.180643	-0.0000%
Moment of Inertia Iyy	77087.940000	77087.941646	-0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	8.430000	8.425187	0.0571%
Radius of Gyration ry	14.980000	14.982696	-0.0180%
Section Modulus Sx Top	1950.090000	1950.094451	-0.0002%
Section Modulus Sx Bot	1950.090000	1950.094451	-0.0002%
Section Modulus Sy Top	3083.520000	3083.517666	0.0001%
Section Modulus Sy Bot	3083.520000	3083.517666	0.0001%
Plastic Modulus Zxx	2677.770000	2677.771328	-0.0000%
Plastic Modulus Zyy	4495.840000	4495.843597	-0.0001%
Plastic Neutral Axis X	0	0	0.000e+00 (abs)
Plastic Neutral Axis Y	0	0	0.000e+00 (abs)
Torsion Constant J	71785.360000	71784.977429	0.0005%
Warping Constant Cw	327047.530000	327033.565865	0.0043%
Shear Area Asx	253.370000	253.375151	-0.0020%
Shear Area Asy	78.010000	78.010347	-0.0004%
Shear Center X	0	-0.000269	100.0000%
Shear Center Y	0	-1.800000e-05	100.0000%

I-section-with-fillet

Item	Value
Sectio input (.scp)	I-section-with-fillet.scp
Sectio report (.txt)	I-section-with-fillet.txt
Python script	compute_i_section_properties_with_fillet.py
Python mesh size	3
Sectio mesh nodes	4823
Sectio mesh elements	8660

Property	Sectio	sectionproperties	Difference
Area	3230.170000	3230.169013	0.0000%
Centroid X	66.500000	66.500000	0.0000%
Centroid Y	101.500000	101.500000	0.0000%
Moment of Inertia Ixx	2.353133e+07	2.353133e+07	0.0000%
Moment of Inertia Iyy	3.063310e+06	3.063310e+06	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	85.350000	85.351387	-0.0016%
Radius of Gyration ry	30.800000	30.795185	0.0156%
Section Modulus Sx Top	231835.730000	231835.732893	-0.0000%
Section Modulus Sx Bot	231835.730000	231835.732893	-0.0000%
Section Modulus Sy Top	46064.810000	46064.804787	0.0000%
Section Modulus Sy Bot	46064.810000	46064.804787	0.0000%
Plastic Modulus Zxx	259699.710000	259699.712209	-0.0000%
Plastic Modulus Zyy	70898.280000	70898.278421	0.0000%
Plastic Neutral Axis X	66.500000	66.500000	0.0000%
Plastic Neutral Axis Y	101.500000	101.500000	0.0000%
Torsion Constant J	62714.280000	62721.003064	-0.0107%
Warping Constant Cw	2.884393e+10	2.884390e+10	0.0001%
Shear Area Asx	1840.420000	1840.436441	-0.0009%
Shear Area Asy	1119.550000	1119.553203	-0.0003%

Property	Sectio	sectionproperties	Difference
Shear Center X	66.500000	66.500002	-0.0000%
Shear Center Y	101.500000	101.500000	0.0000%

I-section

Item	Value
Sectio input (.scp)	I-section.scp
Sectio report (.txt)	I-section.txt
Python script	compute_i_section_properties.py
Python mesh size	2
Sectio mesh nodes	3763
Sectio mesh elements	6592

Property	Sectio	sectionproperties	Difference
Area	3161.720000	3161.720000	0.0000%
Centroid X	66.500000	66.500000	0.0000%
Centroid Y	101.500000	101.500000	0.0000%
Moment of Inertia Ixx	2.295551e+07	2.295551e+07	0.0000%
Moment of Inertia Iyy	3.061475e+06	3.061475e+06	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	85.210000	85.208267	0.0020%
Radius of Gyration ry	31.120000	31.117426	0.0083%
Section Modulus Sx Top	226162.620000	226162.623668	-0.0000%
Section Modulus Sx Bot	226162.620000	226162.623668	-0.0000%
Section Modulus Sy Top	46037.220000	46037.219535	0.0000%
Section Modulus Sy Bot	46037.220000	46037.219535	0.0000%
Plastic Modulus Zxx	253422.680000	253422.682000	-0.0000%
Plastic Modulus Zyy	70563.140000	70563.134000	0.0000%

Property	Sectio	sectionproperties	Difference
Plastic Neutral Axis X	66.500000	66.500000	0.0000%
Plastic Neutral Axis Y	101.500000	101.500000	0.0000%
Torsion Constant J	53838.990000	53872.423929	-0.0621%
Warping Constant Cw	2.910601e+10	2.910461e+10	0.0048%
Shear Area Asx	1749.290000	1749.830687	-0.0309%
Shear Area Asy	1083.740000	1083.999359	-0.0239%
Shear Center X	66.500000	66.500110	-0.0002%
Shear Center Y	101.500000	101.500080	-0.0001%

I-section_rotated

Item	Value
Sectio input (.scp)	I-section_rotated.scp
Sectio report (.txt)	I-section_rotated.txt
Python script	compute_i_section_rotated_properties.py
Python mesh size	3
Sectio mesh nodes	3763
Sectio mesh elements	6592

Property	Sectio	sectionproperties	Difference
Area	3161.720000	3161.720000	0.0000%
Centroid X	66.500000	66.500000	0.0000%
Centroid Y	101.500000	101.500000	0.0000%
Moment of Inertia Ixx	1.798200e+07	1.798200e+07	-0.0000%
Moment of Inertia Iyy	8.034983e+06	8.034983e+06	0.0000%
Product of Inertia Ixy	-8.614368e+06	-8.614368e+06	-0.0000%
Radius of Gyration rx	75.410000	75.414920	-0.0065%
Radius of Gyration ry	50.410000	50.411634	-0.0032%

Property	Sectio	sectionproperties	Difference
Section Modulus Sx Top	148425.620000	148425.622897	-0.0000%
Section Modulus Sx Bot	148425.620000	148425.622897	-0.0000%
Section Modulus Sy Top	74164.040000	74164.037057	0.0000%
Section Modulus Sy Bot	74164.040000	74164.037057	0.0000%
Plastic Modulus Zxx	219475.170000	219475.174172	-0.0000%
Plastic Modulus Zyy	128150.570000	128150.563809	0.0000%
Plastic Neutral Axis X	66.500000	66.500000	0.0000%
Plastic Neutral Axis Y	101.500000	101.500000	0.0000%
Torsion Constant J	53836.790000	53891.197509	-0.1010%
Warping Constant Cw	2.910628e+10	2.910389e+10	0.0082%
Shear Area Asx	1516.480000	1517.154752	-0.0445%
Shear Area Asy	1197.560000	1198.074686	-0.0430%
Shear Center X	66.500000	66.499994	0.0000%
Shear Center Y	101.500000	101.499651	0.0003%

Angle

Item	Value
Sectio input (.scp)	angle.scp
Sectio report (.txt)	angle.txt
Python script	compute_angle_properties.py
Python mesh size	1
Sectio mesh nodes	3098
Sectio mesh elements	5644

Property	Sectio	sectionproperties	Difference
Area	1956.310000	1956.307433	0.0001%
Centroid X	22.650000	22.647475	0.0111%

Property	Sectio	sectionproperties	Difference
Centroid Y	47.250000	47.249924	0.0002%
Moment of Inertia Ixx	4.531877e+06	4.531877e+06	-0.0000%
Moment of Inertia Iyy	1.638142e+06	1.638142e+06	-0.0000%
Product of Inertia Ixy	-1.580188e+06	-1.580188e+06	0.0000%
Radius of Gyration rx	48.130000	48.130516	-0.0011%
Radius of Gyration ry	28.940000	28.937245	0.0095%
Section Modulus Sx Top	44105.830000	44105.829639	0.0000%
Section Modulus Sx Bot	95912.900000	95912.902539	-0.0000%
Section Modulus Sy Top	21177.610000	21177.610585	-0.0000%
Section Modulus Sy Bot	72332.200000	72332.199543	0.0000%
Plastic Modulus Zxx	80100.390000	80100.388052	0.0000%
Plastic Modulus Zyy	37924.070000	37924.071790	-0.0000%
Plastic Neutral Axis X	6.530000	6.531843	-0.0282%
Plastic Neutral Axis Y	27.060000	27.055675	0.0160%
Torsion Constant J	44780.060000	44780.453917	-0.0009%
Warping Constant Cw	5.453789e+07	5.453782e+07	0.0001%
Shear Area Asx	644.990000	644.987009	0.0005%
Shear Area Asy	1030.570000	1030.568679	0.0001%
Shear Center X	4.270000	4.272570	-0.0602%
Shear Center Y	5.080000	5.083883	-0.0764%

angle_and_plate

Item	Value
Sectio input (.scp)	angle_and_plate.scp
Sectio report (.txt)	angle_and_plate.txt
Python script	compute_angle_and_plate_properties.py

Item	Value		
Python mesh size	1, 1		
Sectio mesh nodes	15114		
Sectio mesh elements	29094		
Property	Sectio	sectionproperties	Difference
Area	3456.790000	3456.790613	-0.0000%
Centroid X	34.510000	34.512120	-0.0061%
Centroid Y	24.130000	24.133571	-0.0148%
Moment of Inertia Ixx	6.955402e+06	6.955402e+06	0.0000%
Moment of Inertia Iyy	4.226215e+06	4.226215e+06	-0.0000%
Product of Inertia Ixy	-2.816015e+06	-2.816015e+06	-0.0000%
Radius of Gyration rx	44.860000	44.856418	0.0080%
Radius of Gyration ry	34.970000	34.965462	0.0130%
Section Modulus Sx Top	55260.190000	55260.185553	0.0000%
Section Modulus Sx Bot	192491.410000	192491.412720	-0.0000%
Section Modulus Sy Top	54190.670000	54190.668521	0.0000%
Section Modulus Sy Bot	89896.290000	89896.292554	-0.0000%
Plastic Modulus Zxx	100903.060000	100903.058822	0.0000%
Plastic Modulus Zyy	102824.590000	102824.593556	-0.0000%
Plastic Neutral Axis X	20.800000	20.803764	-0.0181%
Plastic Neutral Axis Y	2.280000	2.283953	-0.1731%
Torsion Constant J	291805.130000	291883.792869	-0.0270%
Warping Constant Cw	2.571746e+08	2.571911e+08	-0.0064%
Shear Area Asx	1892.320000	1892.363485	-0.0023%
Shear Area Asy	1160.140000	1160.166103	-0.0022%
Shear Center X	5.470000	5.469456	0.0099%
Shear Center Y	-0.850000	-0.849308	-0.0815%

angle_tube_triangle

Item	Value
Section input (.scp)	angle_tube_triangle.scp
Section report (.txt)	angle_tube_triangle.txt
Python script	compute_angle_tube_triangle_properties.py
Python mesh size	3, 3, 3
Section mesh nodes	2739
Section mesh elements	4838

Property	Section	sectionproperties	Difference
Area	13050.000000	13050.000000	0.0000%
Centroid X	115.140000	115.143678	-0.0032%
Centroid Y	116.480000	116.475096	0.0042%
Moment of Inertia Ixx	5.552160e+07	5.552160e+07	0.0000%
Moment of Inertia Iyy	6.116848e+07	6.116848e+07	-0.0000%
Product of Inertia Ixy	-2.483391e+06	-2.483391e+06	0.0000%
Radius of Gyration rx	65.230000	65.226751	0.0050%
Radius of Gyration ry	68.460000	68.463420	-0.0050%
Section Modulus Sx Top	489069.820000	489069.819440	0.0000%
Section Modulus Sx Bot	476682.200000	476682.195724	0.0000%
Section Modulus Sy Top	382646.620000	382646.616035	0.0000%
Section Modulus Sy Bot	531236.120000	531236.118043	0.0000%
Plastic Modulus Zxx	689389.880000	689389.880952	-0.0000%
Plastic Modulus Zyy	733545.990000	733545.994660	-0.0000%
Plastic Neutral Axis X	108.760000	108.761794	-0.0016%
Plastic Neutral Axis Y	142.980000	142.976190	0.0027%
Torsion Constant J	6.509970e+07	6.509746e+07	0.0034%
Warping Constant Cw	1.131694e+10	1.131921e+10	-0.0201%
Shear Area Asx	5371.390000	5370.921630	0.0087%

Property	Sectio	sectionproperties	Difference
Shear Area Asy	3319.600000	3319.438397	0.0049%
Shear Center X	112.530000	112.533763	-0.0033%
Shear Center Y	111.630000	111.622295	0.0069%

box_girder

Item	Value
Sectio input (.scp)	box_girder.scp
Sectio report (.txt)	box_girder.txt
Python script	compute_box_girder_properties.py
Python mesh size	50
Sectio mesh nodes	3547
Sectio mesh elements	6322

Property	Sectio	sectionproperties	Difference
Area	258317.440000	258317.440446	-0.0000%
Centroid X	600.000000	600.000000	0.0000%
Centroid Y	770.570000	770.568528	0.0002%
Moment of Inertia Ixx	4.795768e+10	4.795768e+10	-0.0000%
Moment of Inertia Iyy	2.956846e+10	2.956846e+10	-0.0000%
Product of Inertia Ixy	0	0.000671	-100.0000%
Radius of Gyration rx	430.880000	430.875931	0.0009%
Radius of Gyration ry	338.330000	338.327669	0.0007%
Section Modulus Sx Top	1.116772e+08	1.116772e+08	0.0000%
Section Modulus Sx Bot	6.223675e+07	6.223675e+07	-0.0000%
Section Modulus Sy Top	4.928077e+07	4.928077e+07	0.0000%
Section Modulus Sy Bot	4.928077e+07	4.928077e+07	0.0000%
Plastic Modulus Zxx	9.539524e+07	9.539524e+07	0.0000%

Property	Sectio	sectionproperties	Difference
Plastic Modulus Zyy	7.749792e+07	7.749792e+07	-0.0000%
Plastic Neutral Axis X	600.000000	600.000000	0.0000%
Plastic Neutral Axis Y	981.490000	981.489974	0.0000%
Torsion Constant J	4.560192e+10	4.559940e+10	0.0055%
Warping Constant Cw	3.479599e+14	3.479809e+14	-0.0060%
Shear Area Asx	115696.600000	115694.351677	0.0019%
Shear Area Asy	98973.050000	98965.251119	0.0079%
Shear Center X	600.010000	599.994021	0.0027%
Shear Center Y	827.900000	827.876636	0.0028%

bulb_section

Item	Value
Sectio input (.scp)	bulb_section.scp
Sectio report (.txt)	bulb_section.txt
Python script	compute_bulb_section_properties.py
Python mesh size	3
Sectio mesh nodes	1286
Sectio mesh elements	2306

Property	Sectio	sectionproperties	Difference
Area	3728.400000	3728.403895	-0.0001%
Centroid X	4.590000	4.594645	-0.1011%
Centroid Y	144.160000	144.156990	0.0021%
Moment of Inertia Ixx	2.127074e+07	2.127074e+07	-0.0000%
Moment of Inertia Iyy	374085.830000	374085.830992	-0.0000%
Product of Inertia Ixy	1.425374e+06	1.425374e+06	-0.0000%
Radius of Gyration rx	75.530000	75.531790	-0.0024%

Property	Sectio	sectionproperties	Difference
Radius of Gyration ry	10.020000	10.016688	0.0331%
Section Modulus Sx Top	221933.090000	221933.091792	-0.0000%
Section Modulus Sx Bot	147552.580000	147552.578519	0.0000%
Section Modulus Sy Top	10565.800000	10565.798198	0.0000%
Section Modulus Sy Bot	35308.950000	35308.952221	-0.0000%
Plastic Modulus Zxx	247871.410000	247871.407418	0.0000%
Plastic Modulus Zyy	25020.910000	25020.913712	-0.0000%
Plastic Neutral Axis X	1.770000	1.767508	0.1410%
Plastic Neutral Axis Y	155.350000	155.350162	-0.0001%
Torsion Constant J	329395.330000	329385.846566	0.0029%
Warping Constant Cw	4.862905e+08	4.862905e+08	-0.0000%
Shear Area Asx	566.150000	566.152154	-0.0004%
Shear Area Asy	2473.360000	2473.359790	0.0000%
Shear Center X	-0.130000	-0.131101	0.8398%
Shear Center Y	207.170000	207.175529	-0.0027%

cee-section

Item	Value
Sectio input (.scp)	cee-section.scp
Sectio report (.txt)	cee-section.txt
Python script	compute_cee_section_properties.py
Python mesh size	0.5
Sectio mesh nodes	989
Sectio mesh elements	1384

Property	Sectio	sectionproperties	Difference
Area	404.570000	404.565866	0.0010%

Property	Sectio	sectionproperties	Difference
Centroid X	19.160000	19.155772	0.0221%
Centroid Y	62.500000	62.500000	0.0000%
Moment of Inertia Ixx	937000.000000	936999.998394	0.0000%
Moment of Inertia Iyy	166607.110000	166607.113674	-0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	48.130000	48.125491	0.0094%
Radius of Gyration ry	20.290000	20.293276	-0.0161%
Section Modulus Sx Top	14992.000000	14991.999974	0.0000%
Section Modulus Sx Bot	14992.000000	14991.999974	0.0000%
Section Modulus Sy Top	5401.570000	5401.565435	0.0001%
Section Modulus Sy Bot	8697.490000	8697.488684	0.0000%
Plastic Modulus Zxx	17968.510000	17968.509174	0.0000%
Plastic Modulus Zyy	7243.850000	7243.851701	-0.0000%
Plastic Neutral Axis X	8.750000	8.750000	0.0000%
Plastic Neutral Axis Y	62.500000	62.500000	0.0000%
Torsion Constant J	302.110000	302.145679	-0.0118%
Warping Constant Cw	7.935248e+08	7.935203e+08	0.0006%
Shear Area Asx	98.350000	98.360258	-0.0104%
Shear Area Asy	135.480000	135.485310	-0.0039%
Shear Center X	-28.040000	-28.037682	-0.0083%
Shear Center Y	62.500000	62.500000	0.0000%

channel_with_fillet

Item	Value
Sectio input (.scp)	channel_with_fillet.scp
Sectio report (.txt)	channel_with_fillet.txt

Item	Value		
Python script	compute_channel_section_properties.py		
Python mesh size	3		
Sectio mesh nodes	4195		
Sectio mesh elements	7604		

Property	Sectio	sectionproperties	Difference
Area	3484.310000	3484.310622	-0.0000%
Centroid X	35.410000	35.412860	-0.0081%
Centroid Y	100.000000	100.000000	0.0000%
Moment of Inertia Ixx	2.417142e+07	2.417142e+07	-0.0000%
Moment of Inertia Iyy	3.644900e+06	3.644900e+06	-0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	83.290000	83.289953	0.0001%
Radius of Gyration ry	32.340000	32.343302	-0.0102%
Section Modulus Sx Top	241714.160000	241714.162468	-0.0000%
Section Modulus Sx Bot	241714.160000	241714.162468	-0.0000%
Section Modulus Sy Top	56433.830000	56433.830901	-0.0000%
Section Modulus Sy Bot	102925.880000	102925.880338	-0.0000%
Plastic Modulus Zxx	274503.790000	274503.795363	-0.0000%
Plastic Modulus Zyy	98578.950000	98578.945471	0.0000%
Plastic Neutral Axis X	27.410000	27.410195	-0.0007%
Plastic Neutral Axis Y	100.000000	100.000000	0.0000%
Torsion Constant J	124596.630000	124603.544954	-0.0055%
Warping Constant Cw	2.337825e+10	2.337821e+10	0.0002%
Shear Area Asx	1444.860000	1444.879175	-0.0013%
Shear Area Asy	1053.900000	1053.909604	-0.0009%
Shear Center X	-37.690000	-37.693833	0.0102%
Shear Center Y	100.000000	99.999996	0.0000%

circular_hollow

Item	Value
Section input (.scp)	circular_hollow.scp
Section report (.txt)	circular_hollow.txt
Python script	compute_circular_hollow_properties.py
Python mesh size	1
Section mesh nodes	640
Section mesh elements	1024

Property	Section	sectionproperties	Difference
Area	449.660000	449.655592	0.0010%
Centroid X	0	0	0.000e+00 (abs)
Centroid Y	0	0	0.000e+00 (abs)
Moment of Inertia Ixx	113203.170000	113203.160476	0.0000%
Moment of Inertia Iyy	113203.170000	113203.160476	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	15.870000	15.866797	0.0202%
Radius of Gyration ry	15.870000	15.866797	0.0202%
Section Modulus Sx Top	4716.800000	4716.798353	0.0000%
Section Modulus Sx Bot	4716.800000	4716.798353	0.0000%
Section Modulus Sy Top	4716.800000	4716.798353	0.0000%
Section Modulus Sy Bot	4716.800000	4716.798353	0.0000%
Plastic Modulus Zxx	6417.960000	6417.961255	-0.0000%
Plastic Modulus Zyy	6417.960000	6417.961255	-0.0000%
Plastic Neutral Axis X	0	0	0.000e+00 (abs)
Plastic Neutral Axis Y	0	0	0.000e+00 (abs)
Torsion Constant J	226385.850000	226389.945800	-0.0018%

Property	Sectio	sectionproperties	Difference
Warping Constant Cw	1.350000	0.983102	37.3204%
Shear Area Asx	226.720000	226.721490	-0.0007%
Shear Area Asy	226.720000	226.721262	-0.0006%
Shear Center X	0	5.400000e-05	-100.0000%
Shear Center Y	0	3.700000e-05	-100.0000%

Note: Warping Constant Cw is 0.0 in theory for circular section

Rectangular

Item	Value
Sectio input (.scp)	rectangular.scp
Sectio report (.txt)	rectangular.txt
Python script	compute_rectangular_properties.py
Python mesh size	10
Sectio mesh nodes	5151
Sectio mesh elements	10000

Property	Sectio	sectionproperties	Difference
Area	5000.000000	5000.000000	0.0000%
Centroid X	25.000000	25.000000	0.0000%
Centroid Y	50.000000	50.000000	0.0000%
Moment of Inertia Ixx	4.166667e+06	4.166667e+06	0.0000%
Moment of Inertia Iyy	1.041667e+06	1.041667e+06	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	28.870000	28.867513	0.0086%
Radius of Gyration ry	14.430000	14.433757	-0.0260%
Section Modulus Sx Top	83333.330000	83333.333333	-0.0000%
Section Modulus Sx Bot	83333.330000	83333.333333	-0.0000%

Property	Sectio	sectionproperties	Difference
Section Modulus Sy Top	41666.670000	41666.666667	0.0000%
Section Modulus Sy Bot	41666.670000	41666.666667	0.0000%
Plastic Modulus Zxx	125000.000000	125000.000000	0.0000%
Plastic Modulus Zyy	62500.000000	62500.000000	0.0000%
Plastic Neutral Axis X	25.000000	25.000000	0.0000%
Plastic Neutral Axis Y	50.000000	50.000000	0.0000%
Torsion Constant J	2.858521e+06	2.858564e+06	-0.0015%
Warping Constant Cw	3.175418e+08	3.175429e+08	-0.0004%
Shear Area Asx	4166.670000	4166.688281	-0.0004%
Shear Area Asy	4166.670000	4166.668024	0.0000%
Shear Center X	25.000000	25.000003	-0.0000%
Shear Center Y	50.000000	50.000002	-0.0000%

rectangular_hollow

Item	Value
Sectio input (.scp)	rectangular_hollow.scp
Sectio report (.txt)	rectangular_hollow.txt
Python script	compute_rectangular_hollow_properties.py
Python mesh size	2
Sectio mesh nodes	2116
Sectio mesh elements	3680

Property	Sectio	sectionproperties	Difference
Area	1656.000000	1656.000000	0.0000%
Centroid X	25.000000	25.000000	0.0000%
Centroid Y	50.000000	50.000000	0.0000%
Moment of Inertia Ixx	2.008672e+06	2.008672e+06	0.0000%

Property	Sectio	sectionproperties	Difference
Moment of Inertia Iyy	639272.000000	639272.000000	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	34.830000	34.827664	0.0067%
Radius of Gyration ry	19.650000	19.647743	0.0115%
Section Modulus Sx Top	40173.440000	40173.440000	0.0000%
Section Modulus Sx Bot	40173.440000	40173.440000	0.0000%
Section Modulus Sy Top	25570.880000	25570.880000	0.0000%
Section Modulus Sy Bot	25570.880000	25570.880000	0.0000%
Plastic Modulus Zxx	51432.000000	51432.000000	0.0000%
Plastic Modulus Zyy	30732.000000	30732.000000	0.0000%
Plastic Neutral Axis X	25.000000	25.000000	0.0000%
Plastic Neutral Axis Y	50.000000	50.000000	0.0000%
Torsion Constant J	1.556310e+06	1.556863e+06	-0.0355%
Warping Constant Cw	9.422596e+07	9.438084e+07	-0.1641%
Shear Area Asx	372.740000	373.024644	-0.0763%
Shear Area Asy	1062.940000	1063.168389	-0.0215%
Shear Center X	25.000000	24.999281	0.0029%
Shear Center Y	50.000000	50.003014	-0.0060%

regular_polygon_hollow

Item	Value
Sectio input (.scp)	regular_polygon_hollow.scp
Sectio report (.txt)	regular_polygon_hollow.txt
Python script	compute_regular_polygon_hollow_properties.py
Python mesh size	3
Sectio mesh nodes	5608

Item	Value		
Sectio mesh elements	9968		
Property	Sectio	sectionproperties	Difference
Area	3506.230000	3506.226940	0.0001%
Centroid X	0	0	0.000e+00 (abs)
Centroid Y	0	0	0.000e+00 (abs)
Moment of Inertia Ixx	1.475545e+07	1.475545e+07	-0.0000%
Moment of Inertia Iyy	1.475545e+07	1.475545e+07	-0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	64.870000	64.871844	-0.0028%
Radius of Gyration ry	64.870000	64.871844	-0.0028%
Section Modulus Sx Top	159711.860000	159711.859668	0.0000%
Section Modulus Sx Bot	159711.860000	159711.859668	0.0000%
Section Modulus Sy Top	159711.860000	159711.859668	0.0000%
Section Modulus Sy Bot	159711.860000	159711.859668	0.0000%
Plastic Modulus Zxx	204917.800000	204917.797987	0.0000%
Plastic Modulus Zyy	204917.800000	204917.797987	0.0000%
Plastic Neutral Axis X	0	0	0.000e+00 (abs)
Plastic Neutral Axis Y	0	0	0.000e+00 (abs)
Torsion Constant J	2.864195e+07	2.864204e+07	-0.0003%
Warping Constant Cw	3.491581e+06	3.492739e+06	-0.0331%
Shear Area Asx	1708.960000	1708.966772	-0.0004%
Shear Area Asy	1708.960000	1708.966937	-0.0004%
Shear Center X	0	-5.000000e-06	100.0000%
Shear Center Y	0	9.000000e-06	-100.0000%

rounded_rectangular_hollow

Item	Value
Sectio input (.scp)	rounded_rectangular_hollow.scp
Sectio report (.txt)	rounded_rectangular_hollow.txt
Python script	compute_rounded_rectangular_hollow_properties.py
Python mesh size	1
Sectio mesh nodes	1988
Sectio mesh elements	3408

Property	Sectio	sectionproperties	Difference
Area	1592.300000	1592.301101	-0.0001%
Centroid X	25.000000	25.000000	0.0000%
Centroid Y	50.000000	50.000000	0.0000%
Moment of Inertia Ixx	1.858621e+06	1.858621e+06	0.0000%
Moment of Inertia Iyy	603978.200000	603978.199434	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	34.170000	34.165106	0.0143%
Radius of Gyration ry	19.480000	19.475922	0.0209%
Section Modulus Sx Top	37172.410000	37172.411642	-0.0000%
Section Modulus Sx Bot	37172.410000	37172.411642	-0.0000%
Section Modulus Sy Top	24159.130000	24159.127977	0.0000%
Section Modulus Sy Bot	24159.130000	24159.127977	0.0000%
Plastic Modulus Zxx	48340.610000	48340.611421	-0.0000%
Plastic Modulus Zyy	29233.080000	29233.083886	-0.0000%
Plastic Neutral Axis X	25.000000	25.000000	0.0000%
Plastic Neutral Axis Y	50.000000	50.000000	0.0000%
Torsion Constant J	1.548197e+06	1.548215e+06	-0.0011%
Warping Constant Cw	8.286523e+07	8.286915e+07	-0.0047%
Shear Area Asx	361.210000	361.212540	-0.0007%
Shear Area Asy	1048.750000	1048.753583	-0.0003%

Property	Sectio	sectionproperties	Difference
Shear Center X	25.000000	25.000038	-0.0002%
Shear Center Y	50.000000	50.000063	-0.0001%

tapered_flange_channel

Item	Value
Sectio input (.scp)	tapered_flange_channel.scp
Sectio report (.txt)	tapered_flange_channel.txt
Python script	compute_tapered_flange_channel_properties.py
Python mesh size	0.05
Sectio mesh nodes	1115
Sectio mesh elements	1956

Property	Sectio	sectionproperties	Difference
Area	8.280000	8.281571	-0.0190%
Centroid X	0.880000	0.879534	0.0530%
Centroid Y	5.000000	5.000000	0.0000%
Moment of Inertia Ixx	117.170000	117.171385	-0.0012%
Moment of Inertia Iyy	7.220000	7.222613	-0.0362%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	3.760000	3.761442	-0.0383%
Radius of Gyration ry	0.930000	0.933879	-0.4154%
Section Modulus Sx Top	23.430000	23.434277	-0.0183%
Section Modulus Sx Bot	23.430000	23.434277	-0.0183%
Section Modulus Sy Top	2.760000	2.756232	0.1367%
Section Modulus Sy Bot	8.210000	8.211867	-0.0227%
Plastic Modulus Zxx	28.410000	28.411542	-0.0054%
Plastic Modulus Zyy	5.570000	5.569310	0.0124%

Property	Sectio	sectionproperties	Difference
Plastic Neutral Axis X	0.410000	0.414079	-0.9851%
Plastic Neutral Axis Y	5.000000	5.000000	0.0000%
Torsion Constant J	0.900000	0.902767	-0.3065%
Warping Constant Cw	107.240000	107.235611	0.0041%
Shear Area Asx	2.180000	2.182793	-0.1280%
Shear Area Asy	4.380000	4.375568	0.1013%
Shear Center X	-0.710000	-0.712801	0.3930%
Shear Center Y	5.000000	5.000001	-0.0000%

tapered_flange_i_section

Item	Value
Sectio input (.scp)	tapered_flange_i_section.scp
Sectio report (.txt)	tapered_flange_i_section.txt
Python script	compute_tapered_flange_i_section_properties.py
Python mesh size	5
Sectio mesh nodes	21961
Sectio mesh elements	41992

Property	Sectio	sectionproperties	Difference
Area	18648.250000	18648.248092	0.0000%
Centroid X	95.500000	95.500000	0.0000%
Centroid Y	294.000000	294.000000	0.0000%
Moment of Inertia Ixx	1.018165e+09	1.018165e+09	0.0000%
Moment of Inertia Iyy	2.805709e+07	2.805709e+07	0.0000%
Product of Inertia Ixy	0	-1.000000e-06	100.0000%
Radius of Gyration rx	233.660000	233.663094	-0.0013%
Radius of Gyration ry	38.790000	38.788437	0.0040%

Property	Sectio	sectionproperties	Difference
Section Modulus Sx Top	3.463147e+06	3.463147e+06	0.0000%
Section Modulus Sx Bot	3.463147e+06	3.463147e+06	0.0000%
Section Modulus Sy Top	293791.500000	293791.503756	-0.0000%
Section Modulus Sy Bot	293791.500000	293791.503756	-0.0000%
Plastic Modulus Zxx	4.030295e+06	4.030295e+06	0.0000%
Plastic Modulus Zyy	492697.570000	492697.562877	0.0000%
Plastic Neutral Axis X	95.500000	95.500000	0.0000%
Plastic Neutral Axis Y	294.000000	294.000000	0.0000%
Torsion Constant J	3.742751e+06	3.742796e+06	-0.0012%
Warping Constant Cw	2.125310e+12	2.125307e+12	0.0001%
Shear Area Asx	9686.100000	9686.169445	-0.0007%
Shear Area Asy	8693.150000	8693.170439	-0.0002%
Shear Center X	95.500000	95.499999	0.0000%
Shear Center Y	294.000000	294.000003	-0.0000%

Note: Product of Inertia Ixy is 0.0 in theory for symmetric section.

tee_with_fillets

Item	Value
Sectio input (.scp)	tee_with_fillets.scp
Sectio report (.txt)	tee_with_fillets.txt
Python script	compute_tee_section_properties_with_fillets.py
Python mesh size	2
Sectio mesh nodes	2962
Sectio mesh elements	5324

Property	Sectio	sectionproperties	Difference
Area	2356.310000	2356.310622	-0.0000%

Property	Sectio	sectionproperties	Difference
Centroid X	50.000000	50.000000	0.0000%
Centroid Y	146.030000	146.034591	-0.0031%
Moment of Inertia Ixx	9.197418e+06	9.197418e+06	-0.0000%
Moment of Inertia Iyy	1.004110e+06	1.004110e+06	0.0000%
Product of Inertia Ixy	0	0	0.000e+00 (abs)
Radius of Gyration rx	62.480000	62.476498	0.0056%
Radius of Gyration ry	20.640000	20.643072	-0.0149%
Section Modulus Sx Top	170431.720000	170431.720484	-0.0000%
Section Modulus Sx Bot	62981.090000	62981.088770	0.0000%
Section Modulus Sy Top	20082.190000	20082.194961	-0.0000%
Section Modulus Sy Bot	20082.190000	20082.194961	-0.0000%
Plastic Modulus Zxx	113278.770000	113278.767432	0.0000%
Plastic Modulus Zyy	31828.470000	31828.471201	-0.0000%
Plastic Neutral Axis X	0	50.000000	-100.0000%
Plastic Neutral Axis Y	188.220000	188.218447	0.0008%
Torsion Constant J	74914.75	74919.550968	-0.0063%
Warping Constant Cw	5.450706e+07	5.450699e+07	0.0001%
Shear Area Asx	1058.180000	1058.199172	-0.0018%
Shear Area Asy	1037.450000	1037.459721	-0.0009%
Shear Center X	0	49.999996	-100.0000%
Shear Center Y	193.040000	193.043917	-0.0020%

Triangular

Item	Value
Sectio input (.scp)	triangular.scp
Sectio report (.txt)	triangular.txt

Item	Value		
Python script	compute_triangular_properties.py		
Python mesh size	5		
Sectio mesh nodes	817		
Sectio mesh elements	1500		
Property	Sectio	sectionproperties	Difference
Area	625.000000	625.000000	0.0000%
Centroid X	16.670000	16.666667	0.0200%
Centroid Y	8.330000	8.333333	-0.0400%
Moment of Inertia Ixx	21701.390000	21701.388889	0.0000%
Moment of Inertia Iyy	86805.560000	86805.555556	0.0000%
Product of Inertia Ixy	-21701.390000	-21701.388889	-0.0000%
Radius of Gyration rx	5.890000	5.892557	-0.0434%
Radius of Gyration ry	11.790000	11.785113	0.0415%
Section Modulus Sx Top	1302.080000	1302.083333	-0.0003%
Section Modulus Sx Bot	2604.170000	2604.166667	0.0001%
Section Modulus Sy Top	2604.170000	2604.166667	0.0001%
Section Modulus Sy Bot	5208.330000	5208.333333	-0.0001%
Plastic Modulus Zxx	3050.970000	3050.971029	-0.0000%
Plastic Modulus Zyy	6101.940000	6101.942059	-0.0000%
Plastic Neutral Axis X	14.640000	14.644661	-0.0318%
Plastic Neutral Axis Y	7.320000	7.322330	-0.0318%
Torsion Constant J	35154.670000	35158.591308	-0.0112%
Warping Constant Cw	420269.510000	420244.114837	0.0060%
Shear Area Asx	491.610000	491.614643	-0.0009%
Shear Area Asy	420.780000	420.811078	-0.0074%
Shear Center X	12.370000	12.368189	0.0146%
Shear Center Y	8.820000	8.815822	0.0474%

References

1. Robbie van Leeuwen, sectionproperties python library:
<https://github.com/robbievanleeuwen/section-properties>;
<https://sectionproperties.readthedocs.io/en/stable/>