

Features of SPC

SPC stands for “**Sectional Property Calculator**”.

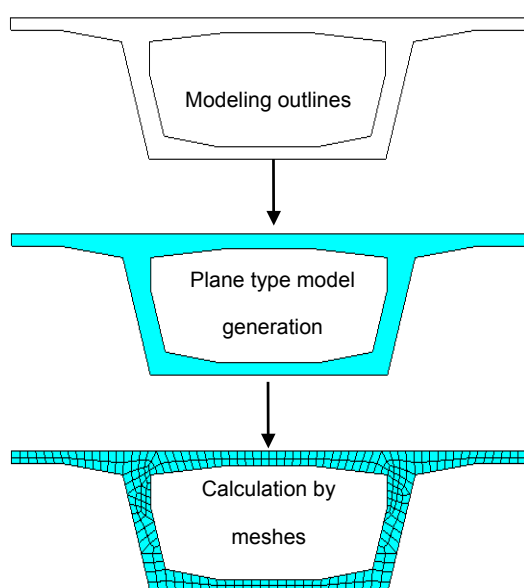
- SPC enables us to freely represent a cross sectional shape in either a plane or lines as an option.

- **Plane type section**

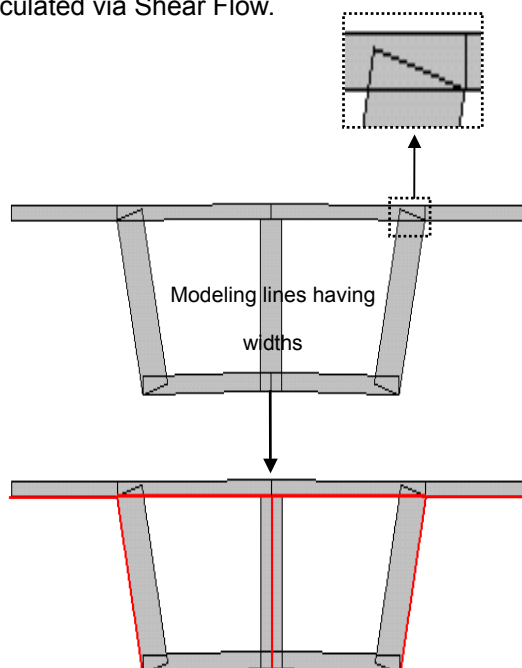
Once the outlines are drafted on the working screen, **Plane Type** is selected in Model > Section > Generate. The program then automatically finds the plane domain defined by the outlines and creates a section. Selecting the plane (section) on the working screen followed by simply clicking on the Apply button instigates the program to auto-generate element meshes within the plane domain and calculate the section properties. When it calculates the torsional constant, it first calculates the Prandtl Stress Function through finite element method, which is subsequently integrated to obtain the constant.

- **Line type section**

Line type section can be applied to thin plates. Having drafted lines with specified widths (thicknesses) on the working screen, **Line Type** is selected in Model > Section > Generate to create a section. The lines must be associated with the corresponding thicknesses. The torsional constant is calculated via Shear Flow.



<Fig. 1-(1)> Work process of plane type



<Fig. 1-(2)> Work process of line type

※ Notes

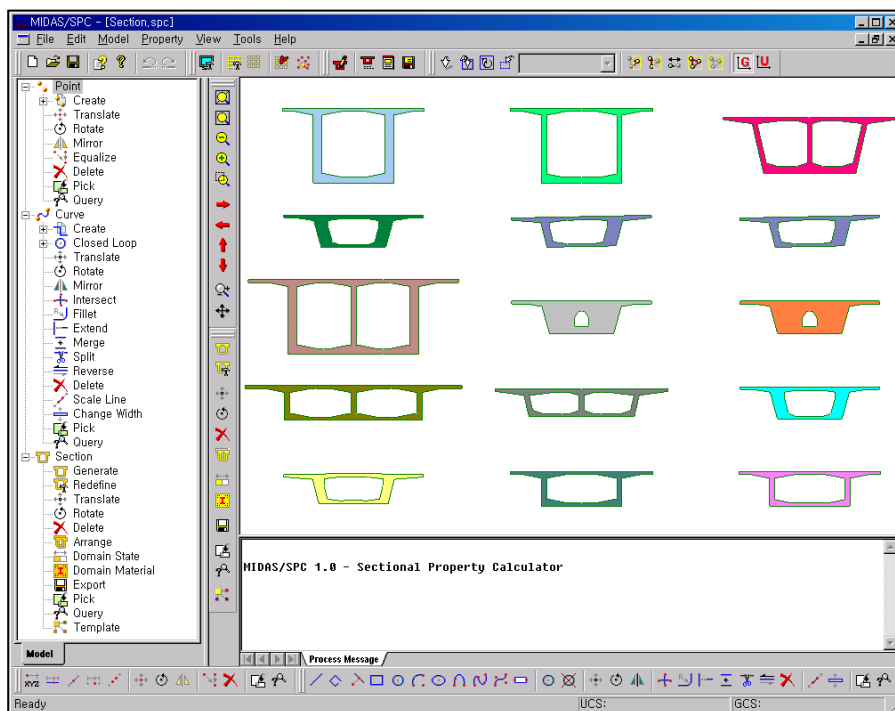
- Prior to using SPC, the user is advised to check the Regular Sections offered in the main programs, MIDAS/Civil and Gen.
- In the case of a Plane Type, torsional constant (J) is approximately calculated by a finite element method. Those approximate methods include Ritz, Galerkin, Trefftz methods, etc, which exhibit the following characteristics:

$$J_{\text{Ritz}} \leq J_{\text{Exact}} \leq J_{\text{Trefftz}}$$

SPC uses the Ritz method for calculating the torsional constant, and as such calculated values may be slightly underestimated. Accuracy can be increased by using dense meshes.

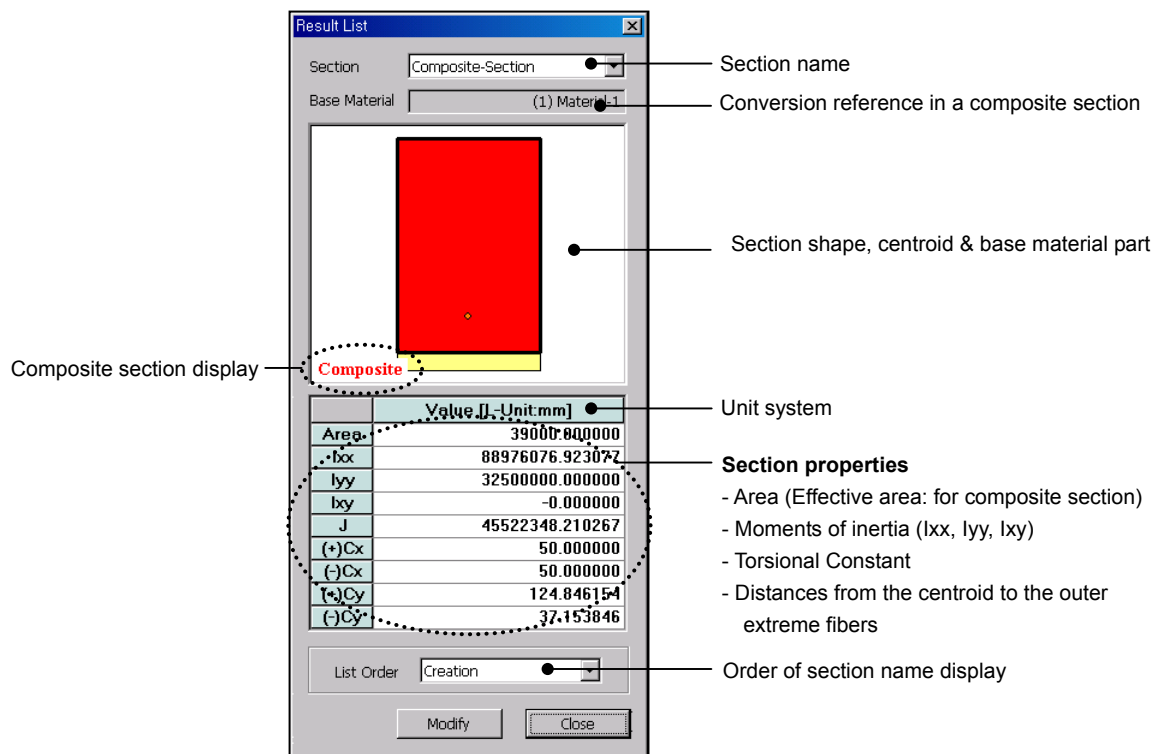
- In the case of a Line Type, torsional constant can be calculated accurately if the line widths are relatively narrow (thin thickness). However, the torsional constant is underestimated if the line widths are wide (thick thickness) in a closed section due to the characteristics of calculating the effective area. It is thus recommended to avoid using SPC in the case of a thick-closed shape section.

- SPC enables us to create an unlimited number of sections on the working screen in a project. Sections can be checked and arranged with respect to the sequence of creation, locations, names and magnitudes of section properties (Model >Section > Arrange Section).



<Fig. 2> After importing DXF files, PSC sections are created and arranged in a project

- SPC calculates the following section properties:



<Fig. 3> Section properties output dialog box

- Sections created in SPC can be output in the following file types:

- MIDAS/Civil – MCT file MIDAS/Gen – MGT file

Section shapes are not transferred but transformed into squares of equivalent effective areas as “**Value Type**”. Perimeter length, effective shear areas, shear factors, etc are not calculated by SPC, but treated as 0.

- AutoCAD DXF file

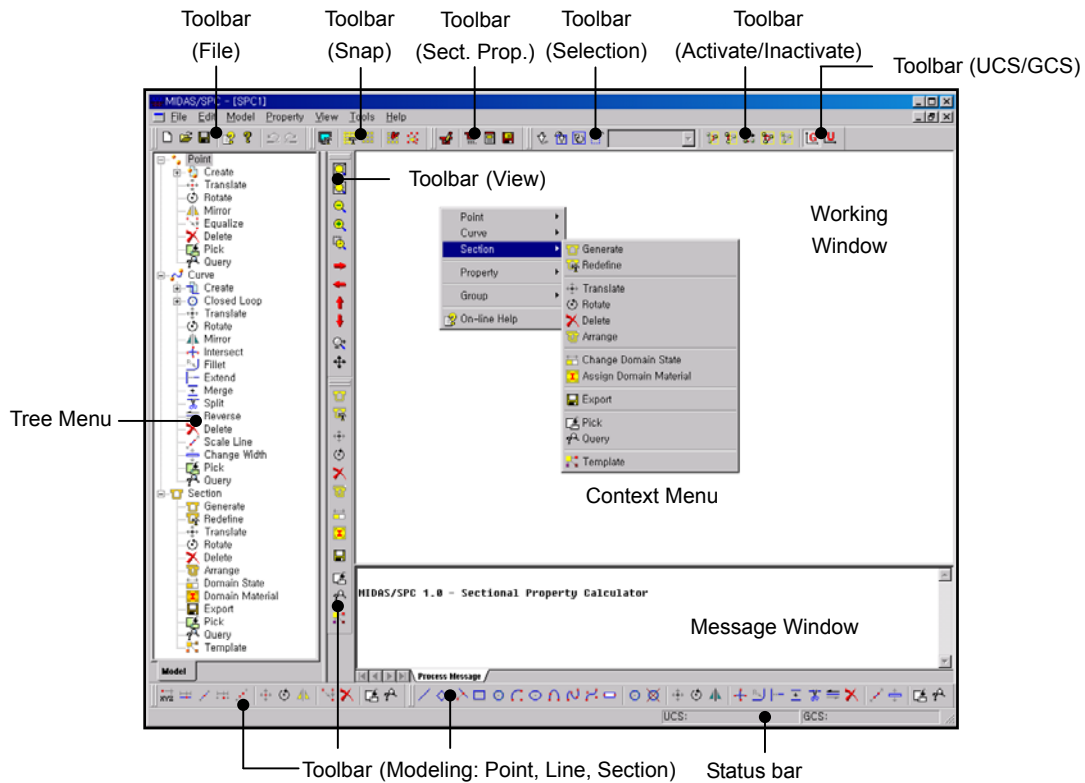
Section shapes created in SPC can be output in the DXF file format. The centroid of a section is automatically created as a Point.

- Text file

Section properties can be output in a tabular format as a text file. In addition to the section properties displayed in Result List of SPC, Section Modulus: I/c is also produced.

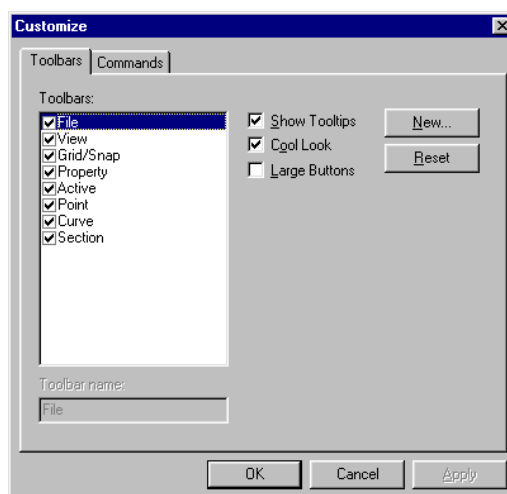
- ☞ The working screen of SPC is in the x-y plane, and the longitudinal direction is in the direction of z-axis. Therefore, the section properties calculated in SPC must be used with care so far as the axis system is concerned, when defining the section in the main program.

Interface




<Fig. 4> Program makeup of SPC

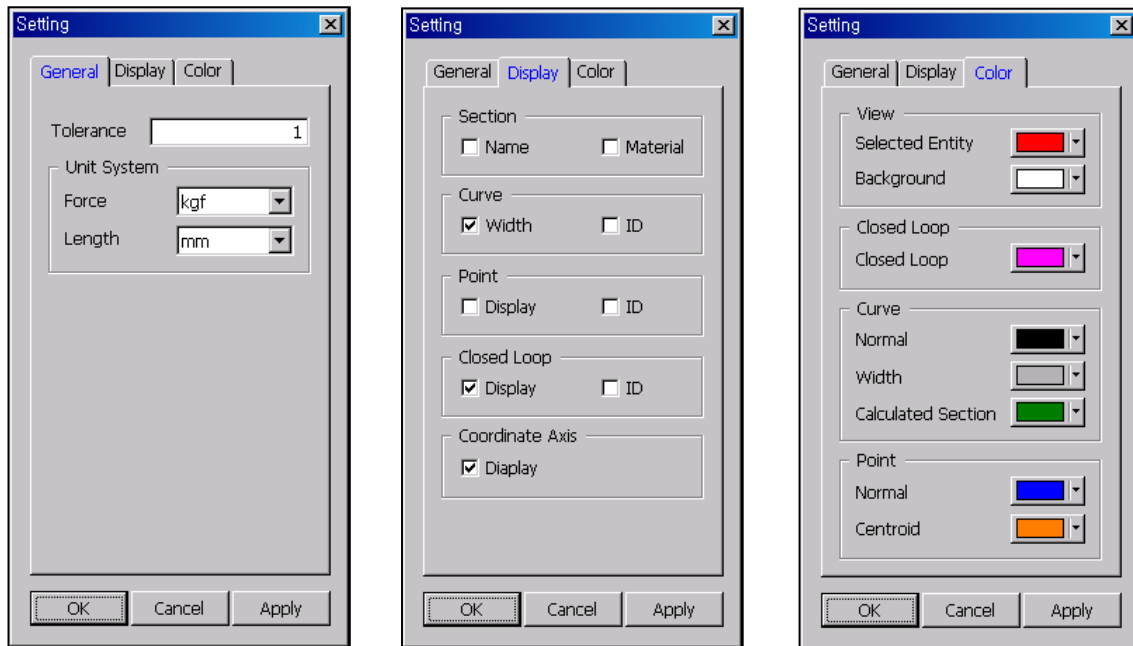
SPC provides various toolbars. We can assign Show/Hide in the **Tools>Customize** menu. Toolbars can be mouse-dragged to different positions for convenience.



<Fig. 5> Dialog box for customizing toolbars

SPC's modeling and section property calculation features are provided by Tree Menu, Toolbars and Context Menu. The user is free to choose any method to prompt relevant features based on personal preference.

The working unit system, display (Show/Hide) of entities and colors can be set by clicking the (Setting)  icon or **Tools>Setting** menu.



<Fig. 6> Setting dialog box

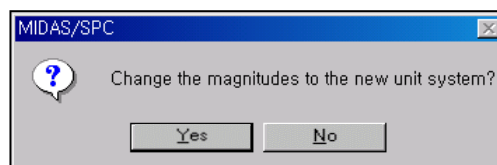
➤ **General tab**

▪ **Tolerance**

Tolerance is assigned, which is appropriately adjusted based on the unit system.

▪ **Unit System**

Unit System is assigned. When the unit system is changed, the dialog box below appears. Upon clicking Yes, all numerical values are automatically converted into the new unit system.

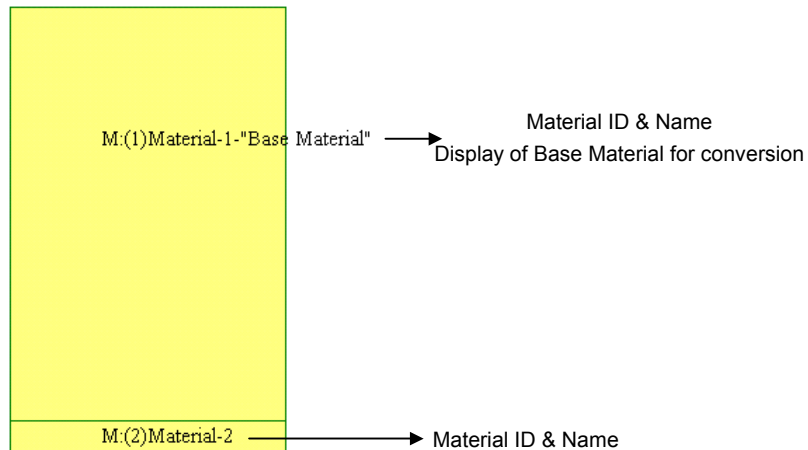


➤ **Display tab**

▪ **Section**

- **Name:** Display of Section Name on the working screen.

- **Material:** In the case of a composite section, all the material information pertaining to different materials is displayed.



<Fig. 7> Material information for a composite section

- **Curve**
 - **Width:** Display of Line thickness on the working screen
 - **ID:** Display of Line ID on the working screen
 - **Point**
 - **Display:** Display of Point on the working screen
 - **ID:** Display of Point ID on the working screen
 - **Closed Loop**
 - **Display:** Display of Closed Loop on the working screen
 - **ID:** Display of Closed Loop ID on the working screen
 - **Coordinate Axis**
 - **Display:** Display of current working coordinate system
- **Color tab**
- **View**
 - **Selected Entity:** Assignment of a color to display Selected Entity
 - **Background:** Assignment of a color for the background of the working screen
 - **Closed Loop**

Assignment of a color for Closed Loop
 - **Curve**
 - **Normal:** Assignment of a line color (color of outlines of lines with thicknesses)
 - **Width:** Color of thicknesses of lines
 - **Calculated Section**

Color of lines defining calculated sections

This color allows us to visually differentiate the sections whose properties have been calculated from the uncalculated sections.

- **Point**

- **Normal:** Assignment of a Point color

- **Centroid**

Assignment of the color of the centroids represented as points on the sections after the properties have been calculated

SPC provides the following Selection features:

-  **Select**

Object entities can be selected, and the selection can be cancelled. A single object entity can be click-selected. Selection with the **[Ctrl]** key pressed allows us to select more than one object entity. Or window-selection by defining the range of the rectangle fully and partially encompassing the object entities can be used. Reselecting the selected entities cancels the selection.


-  **Previous Selection**

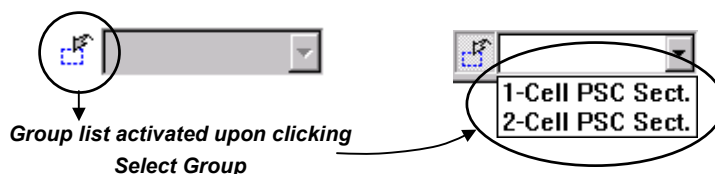
Immediately preceding selection is reselected.

-  **Newcomer Selection**

An entity most recently created is selected.

-  **Select Group**

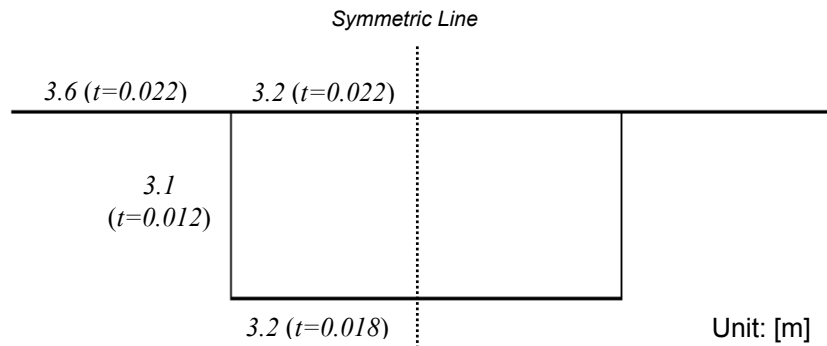
Entities belonging to groups are selected. **Select Group**  icon is clicked to activate the group list from which the corresponding entities are selected.



☞ When using all the selection features of SPC, the selection of entities is determined by the currently active menu. For example, if all the entities are window-selected while a line manipulating menu is in effect, only the lines are selected. As long as a menu is not activated, all the entities can be selected.




☞ SPC provides the Pick function, which allows us to select corresponding entities based on various conditions relative to Point, Line and Section.

SPC Tutorial – Structural steel box girder section

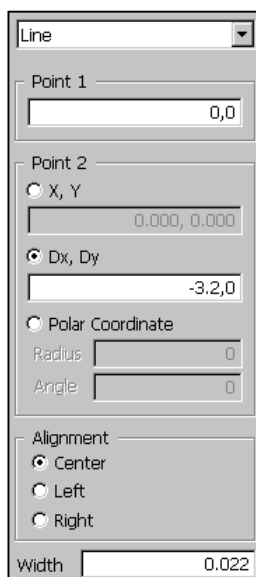


<Fig. 1> Structural steel box girder

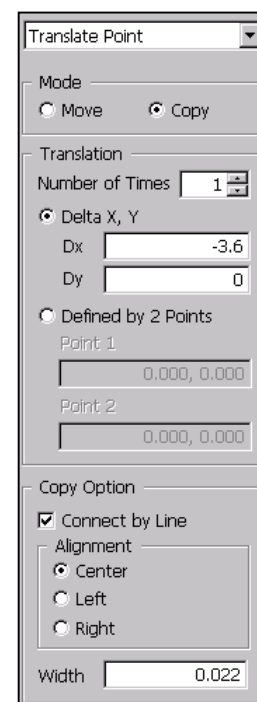
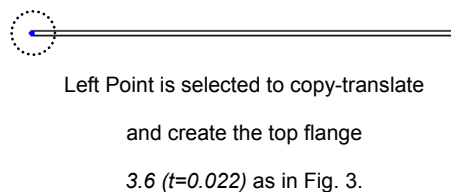
The section shown in <Fig. 1> is made up of thin-sectioned plates, which is more appropriate to define it as a Line Type.

First, click on the (Setting)  icon from which a unit system of **kN, m** is selected under the **General** tab. Under the **Display** tab, turn off **Display** of **Coordinate Axis**. Click now on the (Zoom Auto-Fit)  icon so that the modeled entities can always fit into the working screen. We also set the **Grid Size** to **0.5** using the (Grid Setting)  icon.

Invoke the **Model>Curve>Create>Line** menu <Fig. 2> to create the top flange 3.2 ($t=0.022$).




<Fig. 2> Line creation dialog box




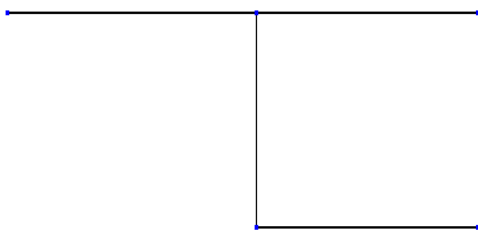
<Fig. 3> Translate Point dialog box

In the Line creation dialog box of <Fig. 2>, we first create the 3.2 ($t=0.022$) portion of the top flange from the center line. We set the center of the line width (thickness) to align with the line being created and click **Apply**.

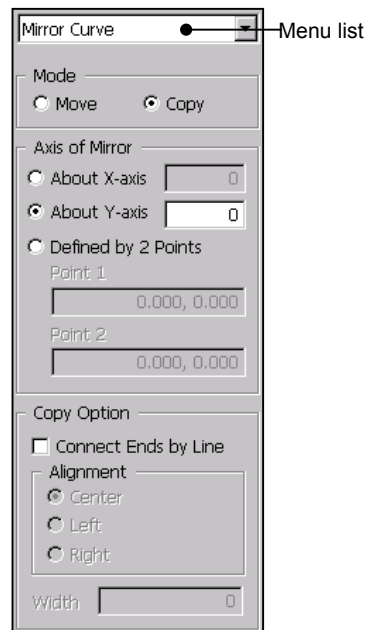
Select the left point of the created line, and translate-copy the point to create the 3.6 ($t=0.022$) portion of the top flange as shown in <Fig. 3>. To do that, we will invoke the **Model>Point>Translate** menu. In **Copy Option**, turn on the **Connect by Line** option to create the line. Similarly, enter **0.022** for **Width** and **Center** for **Alignment**, and click **Apply**.

We are now going to create the web, 3.1 ($t=0.012$). Click  (Select Previous) to reselect the point. From the dialog box of <Fig. 3>, enter **$Dx=0$** and **$Dy=-3.1$** for **Delta X, Y**. And then enter **0.012** for **Width** under **Copy Option**, select **Center** for **Alignment** and click **Apply**.

We now continue on to create the bottom half of the flange. Click the  (Newcomer Selection) icon to select the translate-copied point. From the dialog box of <Fig. 3>, enter **3.2** and **0** for **Dx** and **Dy** respectively in **Delta X, Y**. And enter **0.018** for **Width** under **Copy Option**, select **Center** for **Alignment** and click **Apply**.



<Fig. 4> 1/2 symmetrical section



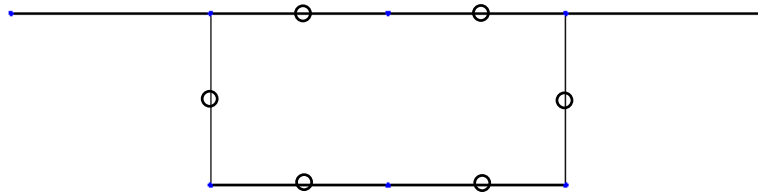
<Fig. 5> Dialog box for Mirror-

Copy about a line

We now create the full section by mirror-copying the half section created thus far.

Invoke the **Model>Curve>Mirror** menu. After window-selecting all the lines created, select **Copy** in **Mode**, check the Axis of reflection (**About Y-axis, 0**) and click **Apply** in the dialog box

of <Fig. 5>.




<Fig. 6> Completed section shape and lines composing a closed loop

The circled lines of the completed section in <Fig. 6> compose a Closed Loop. It is necessary to register the closed loop in a Line Type to properly calculate the torsional constant. From the menu, select **Register Closed Loop** and click **Apply**.

- ☞ Lines composing a closed loop must be connected to one another at the end of each line.
- ☞ Since the line widths (thicknesses) are too small, the lines may appear as thick lines and the selected lines may be indistinguishable. It may be more convenient to turn off Width of Curve under the Display tab of Setting.

Now, invoke the **Model>Section>Generate** menu, and generate a Line Type section defined by the completed lines. Select all the lines first and then select **Line** for **Type** and enter **SB-Sect** for **Name**. Turn on the **Calculate Properties Now** option to immediately calculate the properties and click **Apply**.

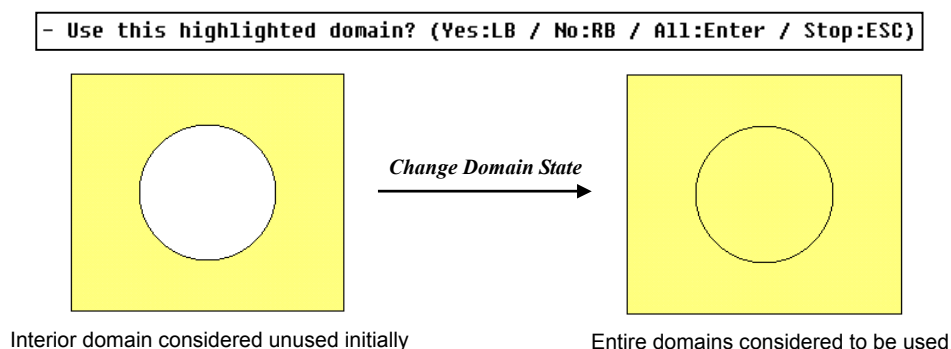
By clicking the  (**Property>List**) icon, we can check the section properties calculated.

- ☞ The Plane Type could have been used in the Generate Section dialog box in this case. However, it is not easy to automatically generate proper meshes in narrow and long domains, and the number of elements may become excessive. Therefore, a Line Type is more appropriate for a thin-sectioned configuration such as this example.

Other pertinent items

- In order to Import an AutoCAD DXF file, the DXF section must exist in the x-y plane with the z coordinate being 0.

- When a section of Plane Type is consisted of more than one domain, interior domains are basically considered unused. In such a case, unused domains can be reverted to a used state through the **Model>Section>Change Domain State** menu. After invoking the menu, we can select the section, which we wish to redefine the state of used/unused of lower domains, and click **Apply**. Then the program highlights each domain contained within the corresponding section and asks whether to use or not-use the domains sequentially. We left-click the mouse (LB) in the working screen to use the highlighted domain and right-click (RB) to not-use the domain. We press the **Enter** key if we wish to use the entire domains. While defining the state of used/unused, we may click the **Esc** key in which case the program stops the questions and maintains the current state for the remaining domains.



- The calculated section properties will not be valid any longer, once additional operations on the section have been subsequently carried out. Some examples are: when use/unused state of lower domains has been changed; when line widths (thicknesses) have been changed; and when the section has been rotated. In such cases, the section properties must be recalculated through the **Calculate Properties** menu.
- When activating and deactivating an entity, all the lower entities subordinated to the main entity are automatically activated or deactivated as the case may be. For example, if a section is deactivated, all the lines and points composing the section are also deactivated. Similarly, if a line is deactivated, all the subordinated points become deactivated as well. And lower entities alone can not be activated or deactivated. For example, lines or points composing a section can not be activated or deactivated by themselves. This limitation has been intentionally imposed to prevent potential operating errors from occurring.