How to Calculate the Section Properties of an Irregular Composite Section using SPC

1. Introduction

With the Sectional Property Calculator (SPC) v150 or later, section properties of irregular composite sections can now be calculated. These sections and their properties can then be imported to an analysis model in midas Civil. The cross-sections can also be generated using planes or lines.

2. Generating Composite Sections with SPC

The following explains how to generate a steel box girder and concrete deck using the *Composite Section* function in SPC. Please refer to the example .DXF file “Composte.dxf” when instructed.

2.1 Import an AutoCAD (.DXF) File

With SPC, simple sections can be generated using the program. For complex user-defined section outlines, SPC provides the option of importing AutoCAD (.DXF) files for direct calculation of section properties, saving time.

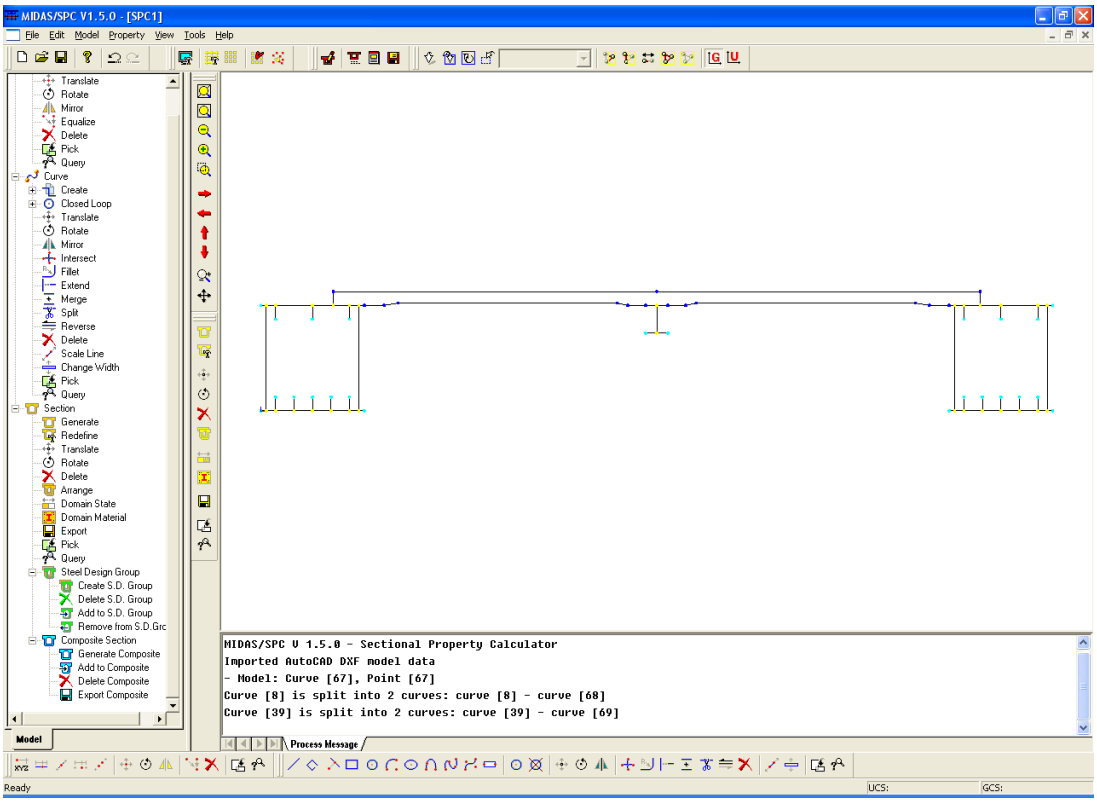


Figure 1: AutoCAD (.DXF) Import

Execute SPC to activate the *Setting* window, and set the same unit system as defined in the CAD file when drawn in AutoCAD. The section outline will not import properly if the SPC unit system differs from the units used to define the AutoCAD drawn section.

Path: *Tools* > *Setting*

Unit System: Force = kN, Length = m

When importing the .DXF file, ensure that the boundary lines for each composite part are shared. If the boundary lines are not shared for each part, the section properties will be calculated on the assumption that the parts are not combined.

Path: *File* > *Import* > *AutoCAD DXF*

Import File: Composite.dxf

2.2 Assign Line Widths

Define the thickness of the cross-sections for the steel box girders and stringer. For section outlines defined with thicknesses, the *Line Type* option must be selected. The section properties of these components will be calculated based on these thicknesses.

Path: *Model* > *Curve* > *Change Width*

Procedure:

① Check on *Width*.

② Select the steel box girders and stringer by clicking selecting each line one by one with left [Ctrl] key pressed. (Refer to the Figure below for Red Lines)

③ Enter “0.02” for the *Width*, then click *Apply.*

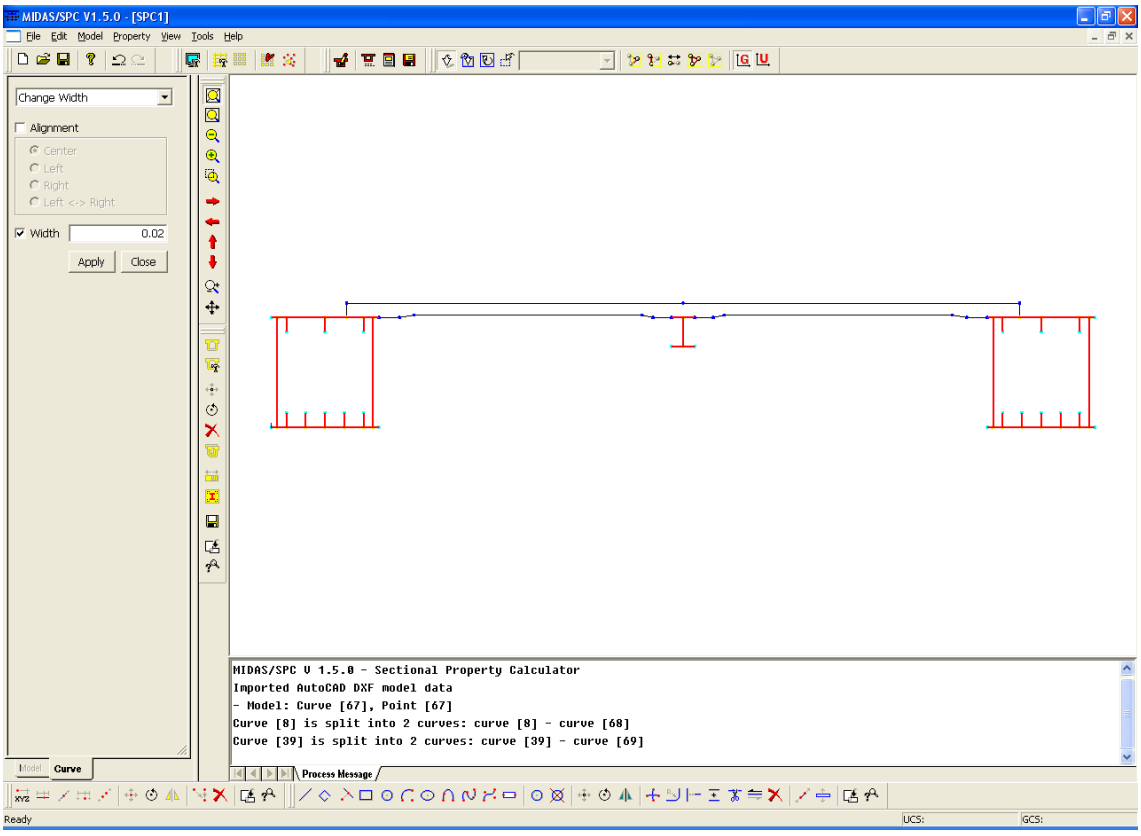


Figure 2: Defining the Thicknesses for the Steel Box Girder and Stringer

2.3 Define Materials

Enter the material properties of the composite section.

Path: *Model* > *Material*

Material Properties: Add

① Steel (S450)

Modulus of Elasticity = 210,000,000 kN/m^2

Poisson's Ratio = 0.3

Density = 76.98 kN/m^3

② Concrete (C25/30)

Modulus of Elasticity = 31,475,000 kN/m^2

Poisson's Ratio = 0.2

Density = 23.54 kN/m^3

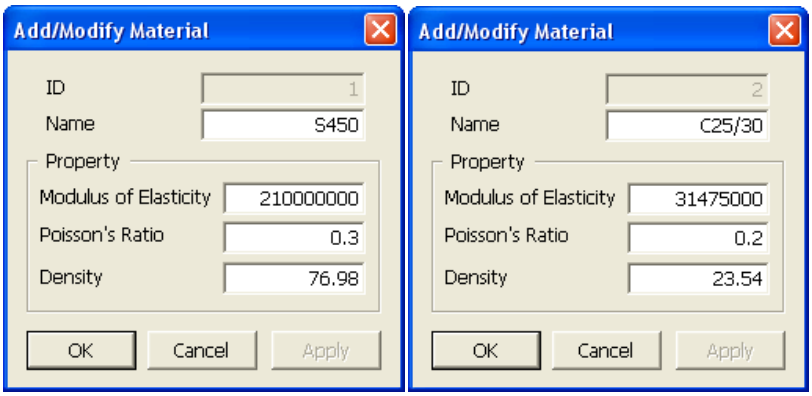


Figure 3: Define Material Properties

2.4 Generate the Composite Section

Indicate the number of composite parts that compose the composite section and set the *Base Material* to find the final composite section properties of the total composite section. The *Base Material* affects the sectional points of interest for reviewing stress results, as well as the final section properties of the total composite section. For more details, refer to section 2.8.

Path: *Model > Section > Composite Section > Generate*

Name: Composite_Box

N(Parts) [1<N<4]: 2

Base Material: S450

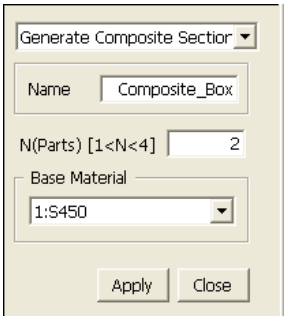


Figure 4: Generate Composite Section

2.5 Assign Composite Parts: Type and Name

Assign the type for each composite part and the name of the cross-section.

Path: *Model > Composite Section > Add Part*

Procedure:

① Enter “1” for *Part ID*

② Enter “Box” for the *Part Name* and select “Line” for *Part Type*.

③ Select “S450” for the *Part Material*.

④ Select the steel box girders and stringer as shown in Figure 5 and click *Apply*.

⑤ Repeat steps with *Part ID:* 2, *Part Name*: Deck, *Part Type*: Plane, *Part Material*: C25/30.

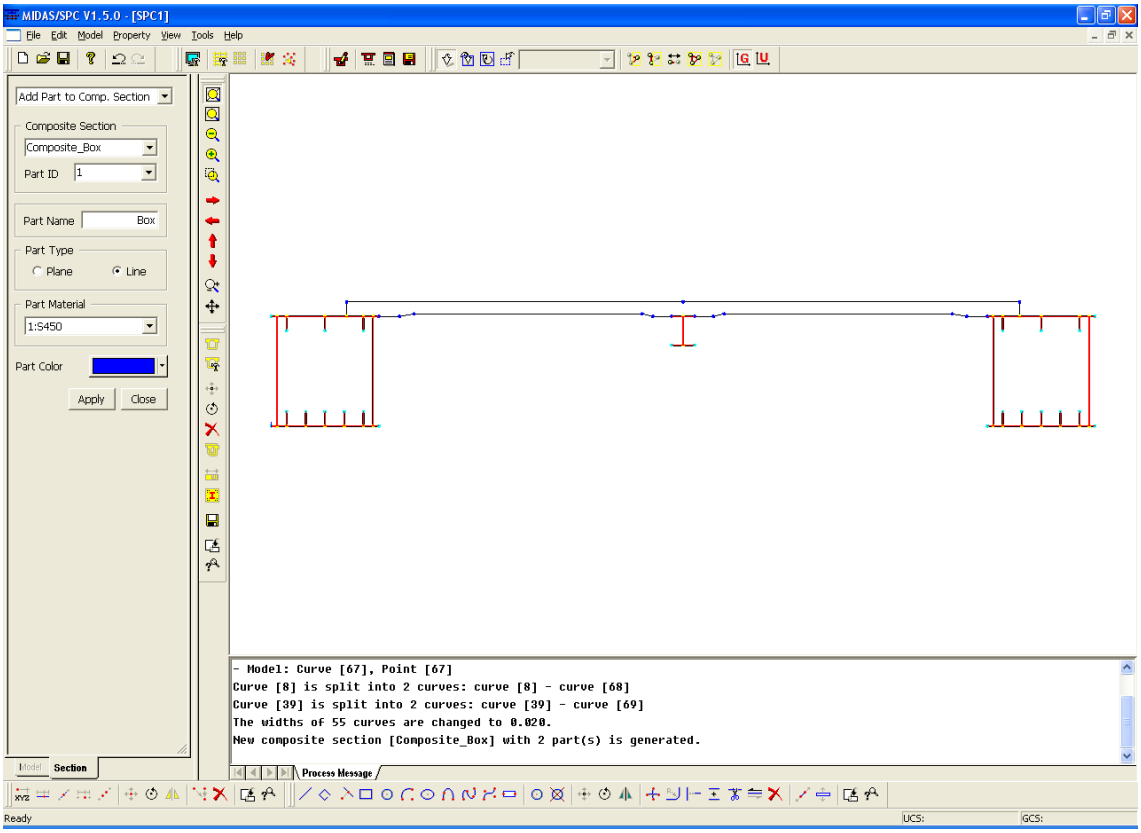


Figure 5: Assigning the Part Type and Name of the Steel Box Girders and Stringer

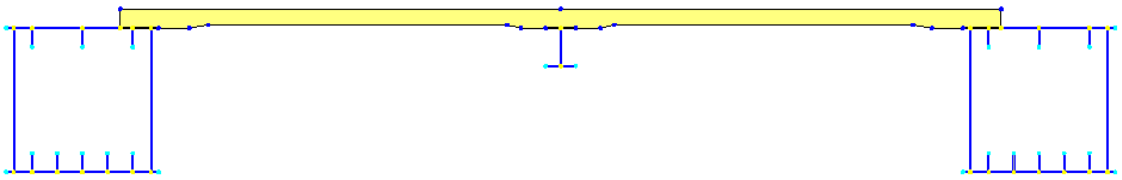


Figure 6: Successful Assignment of the Part Type and Name

2.6 Calculate the Section Properties of the Composite Section

After assigning the composite parts with section types and names, calculate the section properties of the composite section. Define the *Mesh Size*, select the complete composite section, as shown in Figure 7, then click *Apply.* Using a finer mesh density will produce a slightly more accurate result. For this example, set the *Mesh Size* as 1.

Path: *Property > Calculate Composite Property*

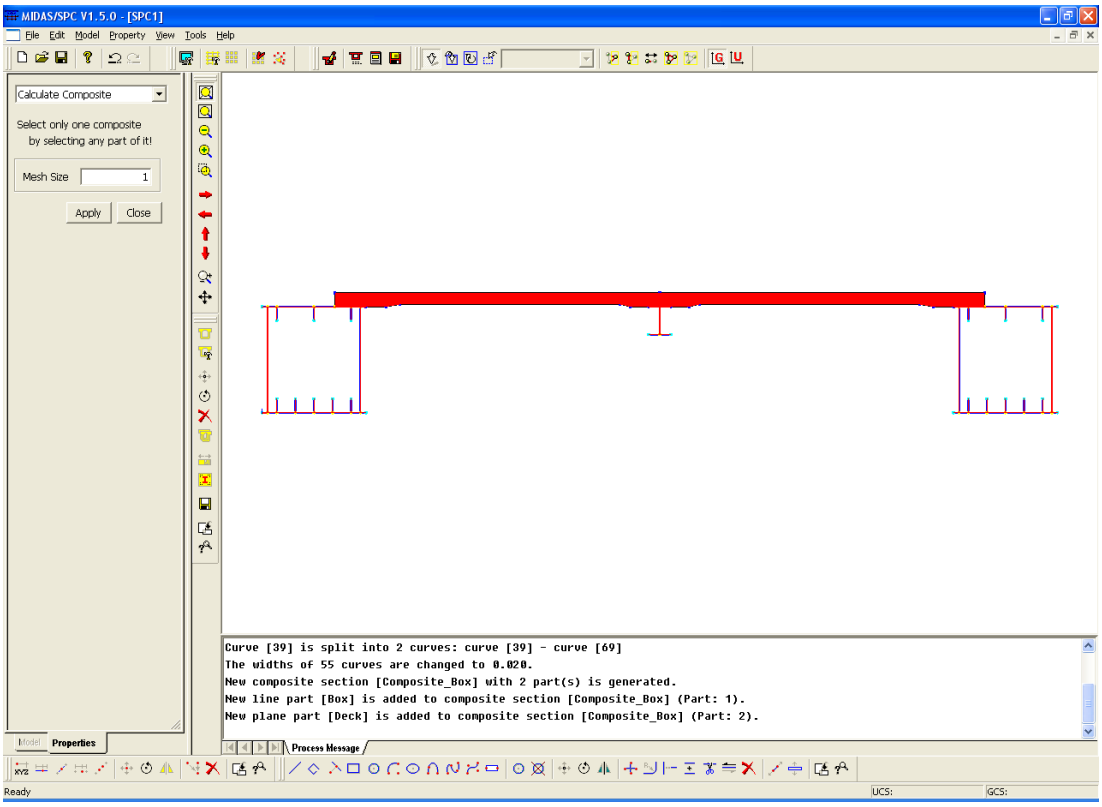
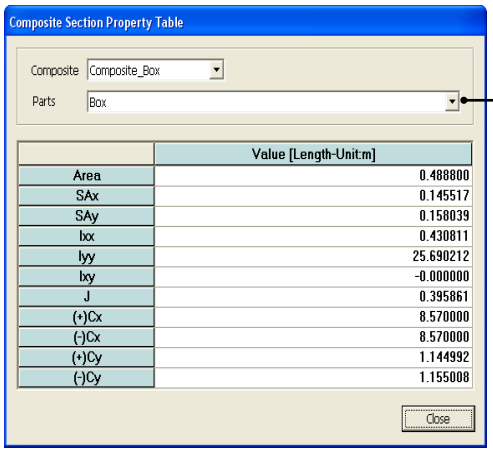


Figure 7: Selecting the Complete Composite Section

To check the calculated the composite parts and total composite section properties:

Path: *Property > Composite Property Table*



Parts List

Cross-Section Properties

- Area (of the total composite section)
- Effective Shear Area (Sax , Say)
- Second Moment (Ixx, Iyy, Ixy)
- Torsion Constant (J)
- Distance between the center and the outermost parts ((+)Cx, (-)Cx, (+)Cy, (-)Cy)

Figure 8: Section Properties for the Steel Box Girders and Stringer

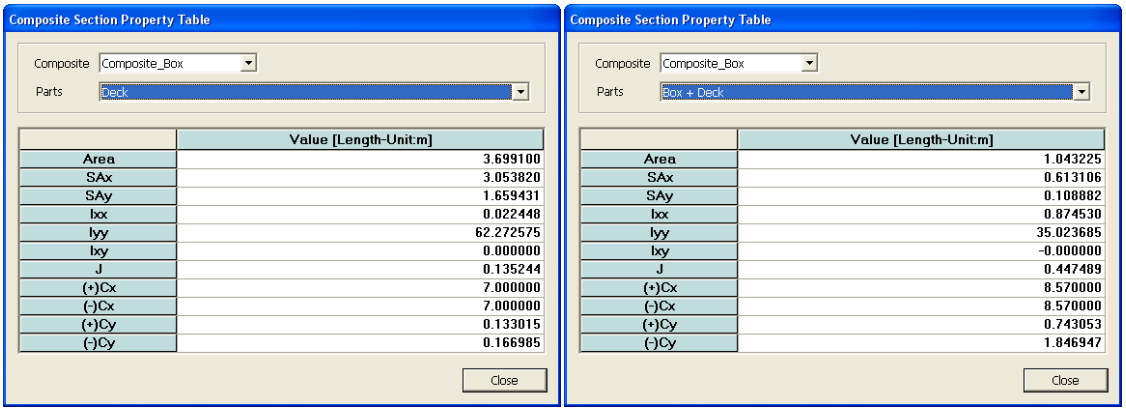


Figure 9: Deck and Composite Section Properties

Area, Ixx and Iyy are calculated using generally known formulas. However, SAx, SAy, and J are calculated using finite element methods built in the software.

2.7 Export the Composite Section to midas Civil

Export the composite section shape and calculated properties.

Path: *Model* > *Section* > *Composite Section* > *Export*

Procedure:

① Assign a *File Name*

② Select the complete composite section, then click *Apply*.

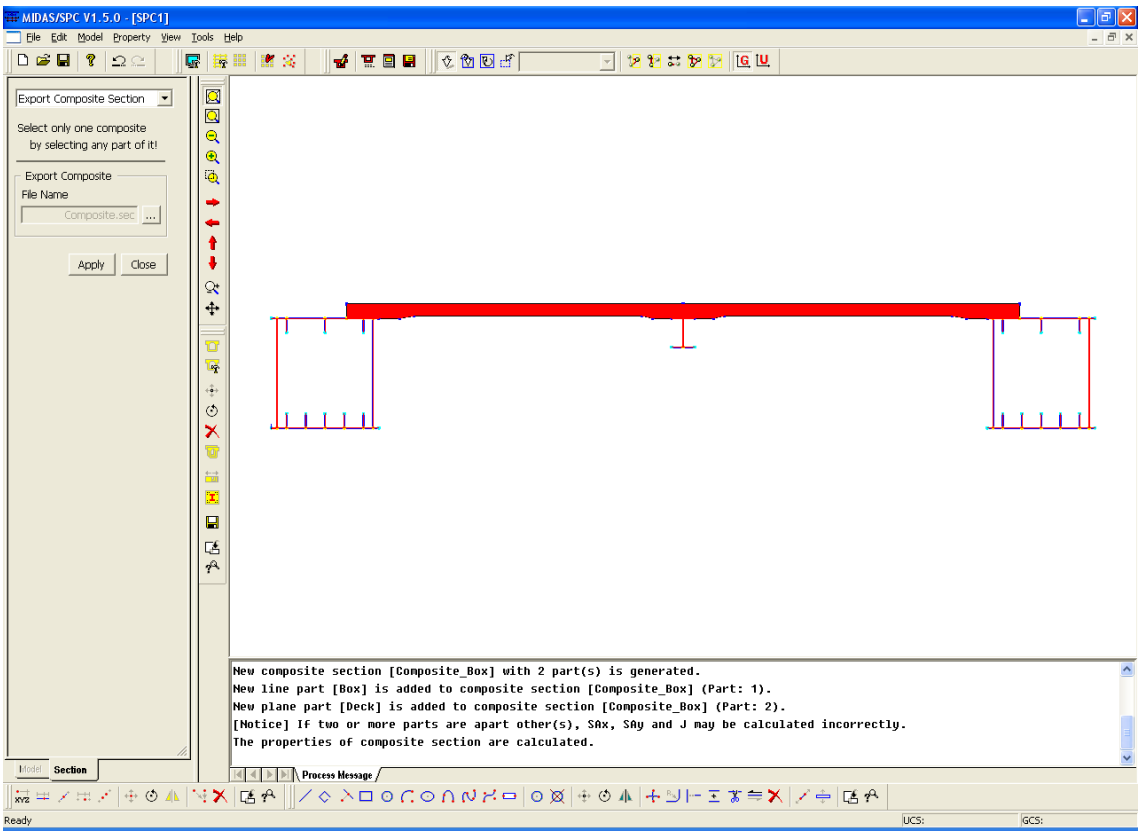


Figure 10: Exporting the Composite Section

2.8 Opening the Composite Section in midas Civil

Open the exported .SEC file using the *Composite-General* section in midas Civil. The section properties of the cross-section, already calculated from SPC, is used in Civil to calculate the stress points of interest. The stress points, Cym, Cyp, Czm, and Czp are determined for the cross-section based on the *Base Material* that was selected in SPC. Figure 11 shows the calculated stress points based on S450 as the *Base Material*.

Path: *Properties > Section Properties > Double-click on the "Composite" item*

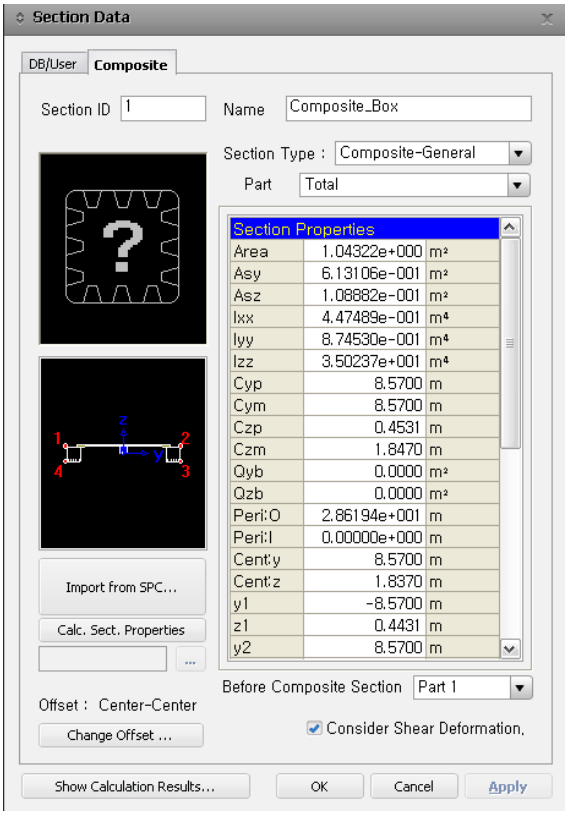


Figure 11: Composite-General