LARSA Section Composer

for

LARSA 2000
Finite Element Analysis and Design Software

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Features

Sections can be created from a combination of:

- Standard AISC, ARBED, CAND, EURO, and UK shapes
- Basic Parametric Shapes, including types of I-shapes, C-shapes, T-shapes, L-shapes, boxes, and box girders
- User-drawn arbitrary shapes

Shapes can quickly be edited…

- Using the mouse
- Editing the point coordinates numerically
- Editing the shape's parameters, such as depth and flange width
- Using the shape transformation tools, such as align, snap, clip, and rotate

Undo/Redo

Sections can be composed of unlimited number of shapes.

Calculations can be viewed for the whole section or for each individual shape.

Properties are calculated in real time.

Export to DXF

Calculating torsional constant for any arbitrary section.

Moment curvature and yield surface calculations.

Sections & Shapes

A section is a combination of shapes placed together to act as a single cross-section. Properties are computed and design is carried out for an entire section, not for a shape.

A shape is the basic component that can be used to create sections. The properties of an individual shape are determined automatically based on its dimensions. Shapes can be inserted from the parametric shape library, from standard databases, or created as user-drawn arbitrary shapes. The parametric shape library contains over fifty predefined parametric shapes including simple predefined shapes such as I, C,T, L and Box as well as complicated shapes like box girders. You can also draw any arbitrary shapes by using free draw tool.

The different types of sections and shapes possible in Section Composer are outlined below.

Nonprismatic Sections

Normally, a member has the same dimensions along its entire length: It is a prism. Members, however, may vary in depth, width, or in any other dimension(s) along their lengths. Such members are said to have nonprismatic sections. The analytic properties of nonprismatic sections also vary along the length of the member. Varying dimensions and properties are taken into account in LARSA 2000 when modeled in the Section Composer.

Composite Sections

Sections may be made of a composition of multiple pieces (shapes), each having a different material. Such sections are called composite sections. Section Composer will take the composite nature of a section into account when calculating section properties.

Standard Shapes

Standard shapes are those which come from a standard table, such as AISC or EURO. Many section tables are available in Section Composer. The properties of standard shapes cannot be modified in Section Composer: their dimensions and properties are guaranteed to be exactly what is found in the original section table. Because these shapes are fixed, they cannot be used for creating nonprismatic sections.

Parametric Shapes

Section Composer derives most of its power from parametric shapes. These shapes, which come in a variety of flavors, are dimensioned using parameters, not points. Whereas an I-shape has 12 vertices, it only has 4 parameters: d, b, t, and w. Only those parameters need to be given to Section Composer for it to be able to calculate all of the shape's properties and to display it graphically.

In addition, parametric shapes may be given nonprismatic variation by assigning equations of variation to each parameter.

Arbitrary Shapes

When a section requires shapes not found in the standard tables or in the parametric shape library, they may be modeled as user-drawn arbitrary shapes. Arbitrary shapes are like parametric shapes in that they may be given nonprismatic variation and their properties are automatically calculated from their dimensions. Arbitrary shapes, however, are not restricted to the forms that ship with Section Composer.

Using Section Composer

The Section Composer screen is divided into several areas.

At the top is the menu bar and toolbars, which provide access to all of the functionality of the program.

At the top-right, the Section Properties grid shows the current analytical properties for the section being edited. The properties are continuously updated in real time as you make changes to the section.

Below that is the Section Explorer. The Overview tab provides an overview of the contents of the section. You can add, delete, and rename shapes here. The Dimensions tab allows you to view and edit the dimension parameters and coordinates of the vertices of the active shape. (Only the center point can be edited for standard shapes, and parameters are not editable for standard shapes.)

At the bottom is a preview of all of the sections stored in the open database. Click on the picture of the section to edit the section.

In the center of the screen is the drawing canvas. The grid may be optionally displayed on the drawing canvas. To change grid spacing and other drawing options, use the Grid Setup and View Options commands in the View menu. Use the zoom tools in the toolbar to zoom in and out of the drawing canvas, to zoom window, zoom extents, or re-center the drawing canvas at the member centerline.

Coordinates and Centerline

The drawing canvas shows a two-dimensional picture of the section. The x-axis of the member, which goes along the length of the member, is “into the screen.” The y-axis is up/down and the z-axis is left-right. The (0, 0) coordinate of the canvas is the centerline of the member to which the section would be applied. The centerline is the imaginary line drawn between the joints at each end of the member, shifted by member end offsets if applied. If the center of gravity of the section is not placed at the (0, 0) coordinate on the canvas, the COG will fall off-center in the analysis of members to which the section is assigned.

Sections and Databases

Section Composer sections are stored in section database files (.lpsx extension). Multiple sections can be stored in one file. Once saved in Section Composer, a section database can be linked to a LARSA 2000 project to be used in an analysis and rendered graphically. To link a database into a LARSA 2000 project, use the Connected Databases function of LARSA 2000, which is found in the Input Data menu.

To rename the active section, in the Sections menu choose Rename and enter a new name for the section. The section’s name here is how it will be identified in LARSA 2000 later.

Working with Multiple Sections

One section database file can contain many section definitions. The panel at the bottom of the screen shows a diagram of each section in the currently open section database file. Initially, there is only one section in the file.

To add a new section to the file, in the Sections menu choose New Section. An empty drawing canvas will be displayed, and the new section definition will appear in the diagram bar at the bottom. The active section can be removed from the file using the Delete command on that menu.

Creating Shapes

The first step in creating a new section is inserting the section's shapes. The Shapes menu provides three tools, described below.

Insert Standard Shapes

Adds a standard shape to the section. Choose from which database the shape is to come from: AISC, ARBED, CAND, EURO, or UK. Then choose the shape type: C, HE, HL, HD, HP, HP, IPE, IPN, L, M, MC, MT, S, ST, UAP, UB, UC, W, WT, WRF, WTM, WWF, or WWT. The shape types available will depend on the database chosen. Click a section shape to view its dimensions and properties. Double-click it to add it to the section. Double-click other shapes to add those to the section as well. Click OK when done.

Insert Parametric Shape

Adds a parametric shape to the section. A pop-up window will present the different parametric shape types available: I, C, T, L, box, and box girder. Some shape types come in different flavors. Click the plus-sign next to a shape type to view the different flavors. The I-shape type has two flavors: one with 4 parameters (d, b, t, and w) and one with 12 parameters (d1, d2, b1, b2, b3, b4, t1, t2, t3, t4, w1, w2) which allows for the full customization of the shape. Drag a parametric shape type from the pop-up window into the drawing canvas to add the shape into the section.

Draw Free Shape

Allows you to create a user-drawn arbitrary shape. Click each vertex of the arbitrary shape in succession until the last point. Double-click the last point to finish drawing the free shape.

Editing Shapes

Moving Shapes

To move a shape, click-and-drag the shape, using the mouse, to the desired location.

Alternatively, use the Section Explorer to set the shape's origin (generally, the center) manually. First, click the shape to activate it. Click the Points tab in the Section Explorer. If the editing mode is Local, indicating the points are with respect to the shape's origin, change it to Global. Then, in the first row (lalbeled Center), change the x and y coordinates to the desired values.

The shift and rotate tools can also be used to move a shape. Right-click the shape to edit. Choose Shift to translate the shape up/down/left/right on the drawing canvas. Choose one of the rotation tools to rotate the shape by a user-specified amount or by the quick 90o clockwise (CW) or counter-clockwise (CCW) tools.

Changing Shape Dimensions

The dimensions of a shape can be modified graphically, using the mouse, or numerically. (Standard shapes cannot be edited.)

To stretch or shrink a shape graphically, activate the shape by clicking on it. Hover the mouse over one of the shape's vertices until the vertex enlarges and the mouse cursor becomes an arrow. Then, click-and-drag the vertex to the desired location.

If the shape is parametric, then the appropriate parameters will be updated. For instance, if the upper-right vertex of a 4-parameter I-shape is dragged to the right, then that is understood as attempting to increase the b parameter. Because the b parameter affects the width of all four flanges, all four flanges will be enlarged to the same width by dragging just the one vertex.

Use the Parameters tab of the Section Explorer to edit the parameters numerically. (This is only applicable for parametric shapes.) First, click the shape to activate it. Then, edit the cell

in the parameters spreadsheet that you want to change and enter the new value. Hit the Enter key when done.

Both parametric and arbitrary shapes can be redimensioned using the Points tab of the Section Explorer. First, click the shape to activate it. Then, make the appropriate modifications to the points spreadsheet. The points can be edited either with respect to the shape's own center point ("local") or with respect to the "global" member centerline.

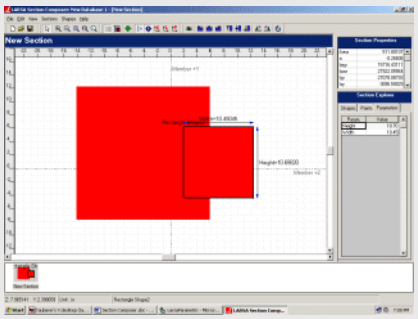
Align and Snap

The align tools are used to align shapes to other shapes or to the member axes. There are six align tools: Align Left, Align Center, Align Right, Align Top, Align Middle, and Align Bottom. They are available on the toolbar.

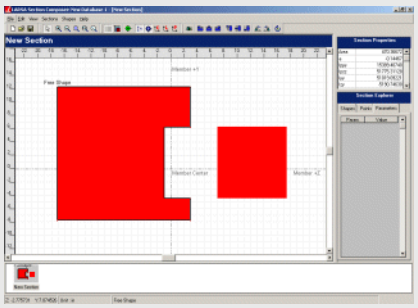
The Align Left tool will move a shape such that its left side is pushed up against something else: either the Member Y Axis or to the left-side of another shape. For example, click a shape to activate it. Then, click the Align Left tool and choose Member Y Axis. The shape will be moved horizontally so that its left side is aligned with the Member Y Axis. The other align tools work in a similar fashion.

When two or more shapes are present in the section, the Snap tool is useful for lining up two arbitrary edges of shapes. For instance, you might want to align the bottom edge of a box shape to the top edge of an I-shape. To do this, click the Snap tool. The mouse cursor will change to a special pointer to indicate it is waiting for you to choose a second edge. Then, click the top edge of the I-shape. The box will be shifted vertically such that its bottom edge is aligned with the I-shape's top edge.

Clipping



Clipping: Step 1: Place one shape over another.



Clipping: Step 2: Apply the Clipping tool. Move the shapes apart to see the effect.

When designing a section, it is important that the edges of two shapes do not intersect. For instance, two box shapes should not overlap as they do in the figure to the right. If the section needs to be modeled in this way, then one of the shapes needs to be “clipped,” that is, cut out so that the overlapping portion of the shape is deleted.

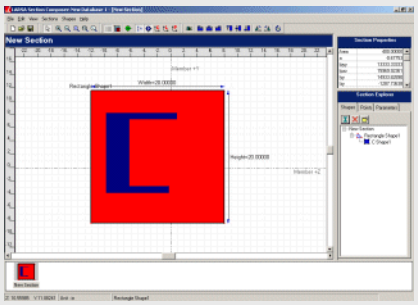
To perform the clipping operation, position the shapes in their final positions. Then, in the Edit menu, choose Clip Intersections. Any parametric shapes which needed clipping are converted into arbitrary shapes with overlapping portions removed. The parameters of parametric shapes cannot be used after the shapes are affected by clipping.

After clipping, the shapes’ edges no longer intersect, and the geometry of the section is not

affected.

Clipping the example above resulted in a change to the left box, as shown in the figure.

Composites



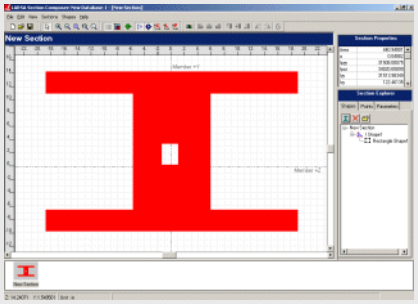
A composite section.

When developing composite sections, one shape may be entirely surrounded by another. In the figure to the right, a box shape completely encloses a C-shape. To create a composite section, simple move the inner shape inside the outer shape, by clicking-and-dragging the inner section for instance.

The inner shape will change color to indicate that it is a composite shape.

Assignment of different material properties to the shapes is discussed later.

Cutouts



A shape with a cutout.

Some sections have holes within their shapes. In Section Composer, these holes are called cutouts. To create a cutout, first create a shape for the cutout. If the cutout is in the shape of a box, create a box shape with the appropriate dimensions. Then, move the box to the location in the outer shape where the cutout is to be. Finally, right-click the shape and choose Make Cutout.

The example to the right shows a box used as a cutout within an I-shape.

After a shape is turned into a cutout, it will disappear, indicating there is no material at that location. To edit or remove the shape, select it from the Section Explorer's Shapes tab.

Nonprismatic Variation

Nonprismatic variation can be assigned to parametric and arbitrary shapes, allowing variation in section dimensions along the length of members to which the section is applied. Variation is defined by simple linear or quadratic equations applied to a shape's parameters (for parametric shapes) or coordinates (for arbitrary shapes).

To add nonprismatic variation, in the Sections menu, choose Properties. The parameters (or coordinates) and values of those parameters are displayed in a spreadsheet. Double-click a parameter to change its value or to assign it an equation of variation. For instance, to have the width of an I-shape vary from 8 inches at the start of a member to 10 inches at the end of the member, double click the parameter I Shape1: b. Change the equation type to Linear, enter 8 for the start and 10 for the end value, and click OK.

To the right of the spreadsheet is a diagram of the section. Under the diagram is a slider which can be used to adjust the diagram to reflect the dimensions at a particular point along the length of a test member. Some variations will depend on the actual physical length of the span, and in those cases a test span length must be entered in that field so the dimensions are calculated appropriately.

Below the parameters in the spreadsheet are the section property computations. When the section has nonprismatic variation, the values of each property at the beginning and end of the test span are shown.

Composite Sections

When designing a composite section, the materials in each shape of the section must be chosen upfront. Without the material properties, a composite section's overall properties cannot be determined. Sections made of only one material do not need to be given a material upfront.

To assign materials to each shape of the section in the Sections menu, choose Properties. Click the Composite Materials tab. Choose a material for each shape, and then click OK.

When composite sections are used in LARSA 2000, materials assigned to members are ignored for the purposes of section property computations.

Computations

Section Properties

The following computations are made for the sections.

- **area.** The cross-sectional area of the section.
- **a.** The angle between the member z-axis and the principle z-axis.
- **Ipyy.** Moment of inertia about the principal y-axis.
- **Ipzz.** Moment of inertia about the principal z-axis.
- **Iyy.** Moment of inertia about the member y-axis.
- **Izy.** Product of inertia for the member y- and z-axes.
- **Izz.** Moment of inertia about the member z-axis.
- **zc, yc.** The coordinates of the centroid of the section, with respect to the position of the member centerline.

When Principal Axes are turned on in the View menu, the direction of the principal axes of the section are drawn at the section's centroid.

Stress Recovery Points

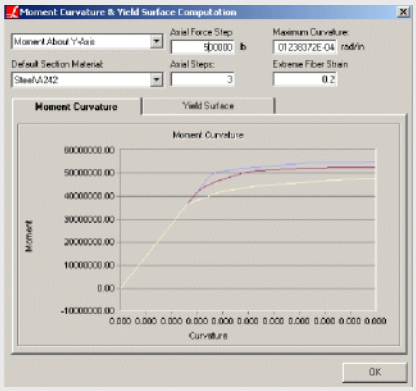
When LARSA 2000 computes member stresses, the user has the option to view stresses at one of four stress recovery points. Stress recovery points are two-dimensional coordinates offset from the member centerline.

Up to four points in a Section Composer section can be set as stress recovery points. To mark a point as a stress recovery point, right-click the point, choose Set as stress point, and choose which stress point (1, 2, 3, or 4) to mark it as. If the View --> Show Stress Points option is selected, the point will have a bubble icon next to it indicating it is a stress point.

Stress points have a special meaning when modeling tendons in LARSA 2000. If tendons will

be modeled inside members using a Section Composer section, be sure to choose stress points 1 and 3 appropriately. See the LARSA 2000 Bridge Analysis documentation for more information on tendons and stress points.

Moment Curvature and Yield Surface



Moment Curvature computation

To view the moment-curvature diagram or yield surfaces for a section, in the Sections menu choose Moment Curvature and Yield Surface. Choose either Y or Z axis moment. Enter the appropriate maximum curvature and extreme fiber strain values. If the section is not composite, choose the section's material. Finally, to evaluate moment-curvature at multiple values of axial force, enter the axial force increment to use and the number of axial force steps to take.

Switch between the Moment Curvature and Yield Surface tabs to see the two diagrams.

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