

Section Maker

Windows and Macintosh Version 5.1

User Manual

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Section Maker Program

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Section Maker User Manual

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About this Manual

This manual is about Section Maker, a section properties calculation and design system. Section Maker works with the Multiframe range of structural design software.

Chapter 1 Learning Section Maker gets you started drawing, calculating properties and installing a section in the Multiframe Sections Library. It is a series of exercises designed to help you learn the basics of Section Maker and become confident in using it to design your own custom sections.

Once you are familiar with the basic concepts used, you may refer to the step-by-step instructions in Chapter 2.

Chapter 2 Using Section Maker will explain most of the tasks you will carry out in designing and installing a section.

Chapter 3 Section Maker Reference gives an overview of the operations of Section Maker and a summary of the commands used.

Chapter 4 Sections Calculations discusses the numerical methods used by Section Maker. It is important for you to understand these methods and their limitations before using Section Maker for sections properties calculations. The chapter ends with a summary of the capabilities and limitations of Section Maker.

Chapter 1

Learning Section Maker

This chapter provides a tutorial to help you learn the basics of working with Section Maker.

Getting Started

Before you get started using Section Maker, you will need to learn some of the basic concepts of using your computer. If terms like windows, menus and scroll bars are not familiar to you, now is a good time to read your owners' guide which will explain the basic concept. If you are familiar with the standard operations continue reading.

If you are not familiar with the calculation of sections properties of structural shapes, it will be necessary for you to review the concepts outlined in Chapter 4. If you are familiar with the analysis, you can proceed at your own pace.

Section Maker may be used to calculate the sectional properties of arbitrary structural shapes and install them as sections in the Multiframe Sections Library.

If you are running Section Maker on a Windows computer, be careful when using Section Maker with Multiframe or Steel Designer. If you have both Section Maker and Multiframe open at the same time, any changes you make to the Section Library with Section Maker will not be reflected in the sections available to Multiframe. To make the new sections available to Multiframe you will have to quit Multiframe and restart the program.

On Macintosh computers, Section Maker and Multiframe will automatically exchange information to keep the library up to date.

Multiframe will run on any Macintosh computer with at least 8 Mb of memory, or any Windows 95/98/NT computer with at least 16 Mb of memory.

Installing Section Maker on Windows

Insert Disk 1 into your floppy drive. Select Run from the Start menu (Windows NTv3.51 users choose Run from the File menu of the Program Manager). A dialog box will appear asking you to enter the name of the program to run. Type 'A:\SETUP' in the space provided, then click on OK, and then follow the instruction on screen.

After installation, Section Maker should be accessible through the Start Menu. Simply select Section Maker from the Multiframe menu under the Start menu. Section Maker is automatically installed in the Multiframe folder in the Program Files directory unless you specify otherwise.

Installing Section Maker on Macintosh

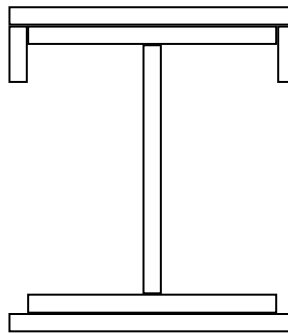
Insert the Section Maker disk and double click on the Installer program. This will prompt you to specify a location on your hard disk where Section Maker will be installed. You should install Section Maker into the same folder as the Multiframe program on your hard disk.

Starting Section Maker

Start up the Section Maker program and then use the Drawing Layout command from the Window menu to lay out three windows on the screen titled Shape, Properties and Data. This will provide you with the most convenient window arrangement for creating new sections.

Drawing a Shape

To introduce you to the concepts and techniques you will use in Section Maker, this chapter will describe the creation of a structural section step by step. The section you will draw is shown below.

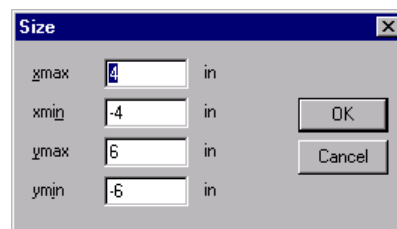


First, you will draw the section to scale, inside the Shape window. First insure that your units are set up correctly by using the Units command from the View menu. This example is carried out in American units, you can use other units if you wish.

It is necessary to set up the sizes for drawing in the Shape window.

- **Choose Size... from the View menu.**

A dialog box will appear with four fields in it specifying the maximum dimensions of the section.



- **Type 4 for the maximum x coordinate and then press the Tab key to move to the second field**
- **Type in -4 for the minimum x coordinate and then use the Tab key to move to the next two fields entering 6 and -6 for the maximum and minimum y coordinates.**
- **Click the OK button when you have finished entering the values.**

If you make a mistake entering the numbers, you can use the backspace or delete key to delete the character just to the left of the blinking cursor and you can use the Tab key to move from one field to the next.

Placing a Shape

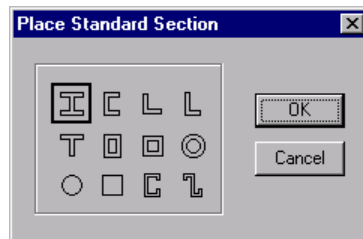
To create the I beam which forms the basis of the section, you can use Section Maker's commands for automatically generating a common structural shape.

A note on terminology:

Section Maker uses the term "section" to refer to a structural cross sectional shape and its associated sectional properties which is stored in the Multiframe Sections Library. The term "shape" is used to refer to a geometric shape such as a polygon, circle or rectangle or an assemblage of these shapes. A section is made up of one or more shapes.

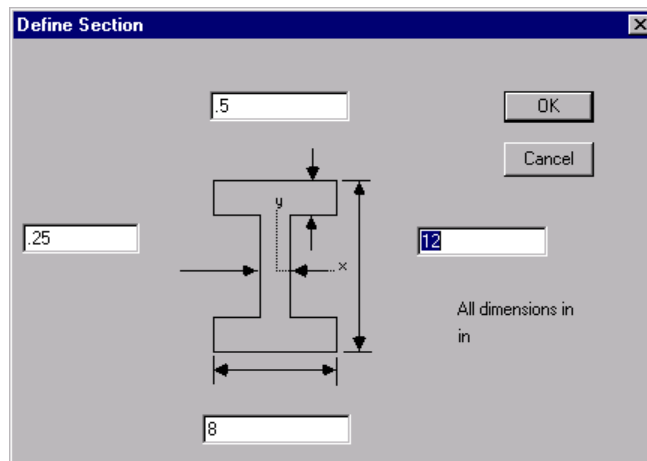
- **Choose Place Shape from the Shape menu.**

A dialog will appear with icons for the common structural shapes



- **Click on the I beam icon**
- **Click OK**

A second dialog will appear with a picture of an I shape and fields where you can enter the dimensions of the shape.



- **Type in 12 for the depth then enter 8 for the width, 0.25 for the web thickness and 0.5 for the flange thickness.**
- **Click the OK button**

The I shape will be drawn on the screen centered in the Shape window. The I shape is generated as an assembly of three rectangles. The corners of the rectangles will be highlighted with small black boxes (called handles) to indicate that the rectangles are selected.

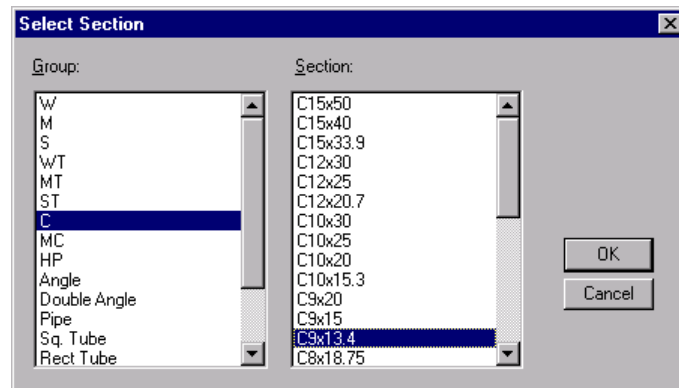
Notice also that the properties for the section are displayed in the Properties window. Some of the properties will be negative because as yet no material types have been assigned to the shape. Any shape, which does not have a material type, is assumed to be a hole and is subtracted from the property calculations.

Placing a Section

To place the channel on the top of the I shape, you can take an existing channel from the Sections Library.

- **Choose Place Section... from the Shape menu**

A dialog will appear allowing you to select a section from the Sections Library



- **Click on the C name in the list of groups**

The names of the channel sections stored in this group will be displayed in the list on the right

- **Click on the name C9x13.4 to select this section**

- **Click the OK button**

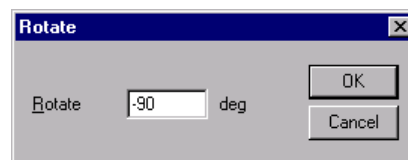
The dimensions of the section will be taken from the library and the section will be drawn in the center of the Shape window. This C shape will be made up of three rectangles modeling the web and two flanges. The corners of the rectangles will be highlighted to indicate that the rectangles are selected.

Rotating the Shape

Before you can place this C shape on top of the I shape, you need to rotate it by 90 degrees

- **Choose Rotate ... from the Shape menu**

A dialog will appear allowing you to enter the number of degrees to rotate the shape. The angle of rotation is measured in degrees with positive being anti-clockwise



- **Type in -90 for the angle of rotation**

- **Click the OK button**

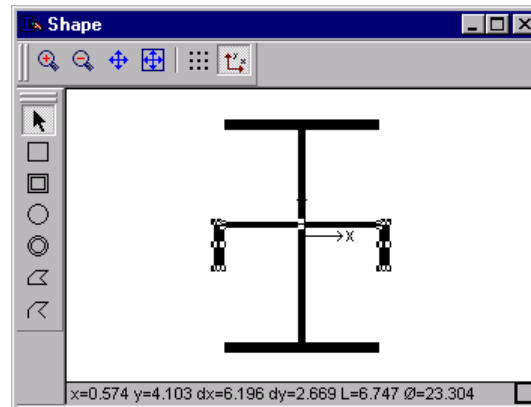
The C shape will be rotated so that it is oriented ready to move on to the top of the I shape.

Dragging the Shape

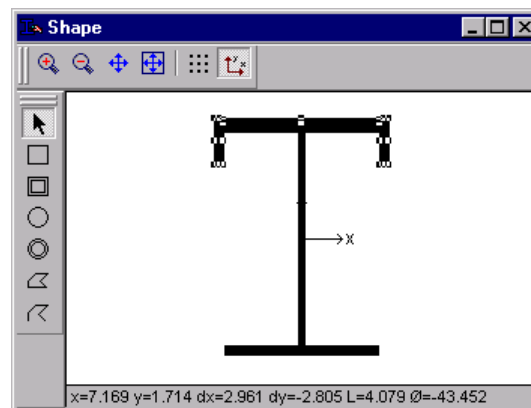
You can move shapes in Section Maker by dragging them with the mouse.

To drag the C shape

- **Point anywhere inside the C shape but away from the black boxes, which show that it is selected.**
- **Press and hold down the mouse button.**



- **Drag the shape until it sits evenly on top of the I shape**



- **Release the mouse button.**

As you drag the shape it will be redrawn at its new position

At every change that you make to the section, the new section properties will be automatically recalculated and updated in the Data window.

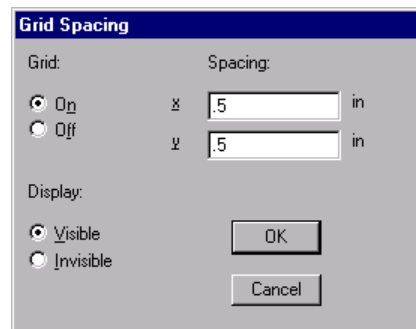
Drawing a Shape

Now you can draw the additional plate on the bottom flange of the section.

To make it easier for you to draw the frame, you can use Section Maker's Grid option to make drawing automatically align to a grid with regular spacing.

- **Choose Grid... from the View menu.**

A dialog box will appear with values for the x (horizontal) and y (vertical) spacing of the grid.



- Type 0.5 for the x spacing, use the Tab key to move to the y spacing and type 0.5 for it also
- Click on the On radio button to make subsequent drawing align with the grid.

This will also turn on the Visible button to make the grid visible in the Shape window.

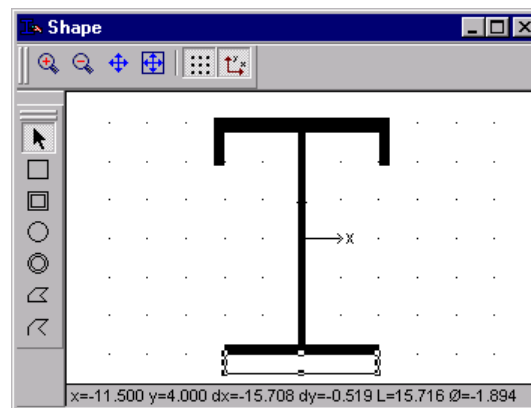
- Click on the OK button to confirm your settings.

Now move the pointer inside the Shape window and notice that as you move the mouse, the coordinates of the pointer are shown at the bottom left hand corner of the window. The coordinates are shown in the same units as Deflection in the Units dialog. The coordinates will automatically align to the nearest point on the grid. You can now begin to draw the shape to scale in the Shape window.

- Click on the Rectangle tool to select it



- Press the mouse button at the bottom left corner of the I shape
- Drag down and to the right to draw the bottom plate



- Release the mouse button when the plate is the correct size, i.e. when the coordinates read $x=4$, $y=-6.5$

Selecting Materials

In order to compute the deflections in a structure, Multiframe needs to know the Young's Modulus and Shear Modulus for the materials in the section. You can choose what type of material each shape in the section is made of by choosing from the range of materials properties stored in the Sections Library.

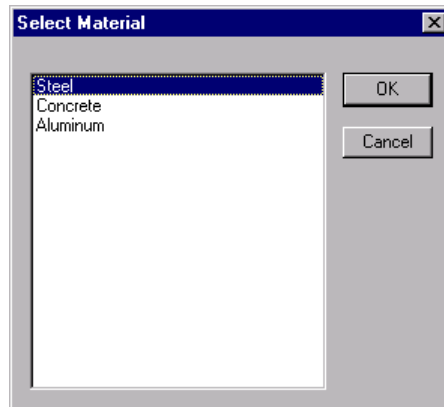
To set the material types for the shapes in this section

- **Choose Select All from the Select sub-menu under the Edit menu**

This will select all the shapes in the section, all the shapes in this section are made from steel.

- **Choose Select Material from the Material menu**

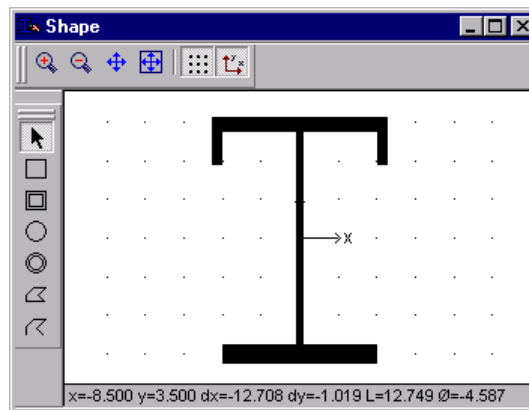
A dialog box will appear with a list of the materials in the library.



- **Click on the name Steel in the list**

- **Click the OK button**

This will define all the shapes in the section to take their material properties from those for steel stored in the library.



The shapes will be drawn filled with the pattern for their material, black for steel in this case.

Aligning to the
Centroid

Before you install your section in the Sections Library you will probably want to align the Centroid of its area with the x-y axes so that all properties will be calculated relative to the Centroid.

To align the Centroid of the section with the axes

- **Choose Select All from the Select sub-menu under the Edit menu**

This will select all the shapes in the section

- **Choose Align To Centroid from the Shape menu**

All of the selected shapes in the Shape window will be moved so that their common Centroid is aligned with the x-y axes.

- **Choose Size To Fit from the View menu**

This will make the whole section visible in the window.

Once the shapes move the properties will be automatically recalculated and displayed in the Properties window. You can check that the section is aligned with the axes by verifying that the coordinates of its Centroid (xc, yc) are 0.000,0.000.

Installing the Section

Now that you have created the section you want, you can install it in the Sections Library.

Macintosh

If Section Maker finds a library named "Sections Library" in the same folder as Section Maker or in the System Folder, it will automatically open it on startup.

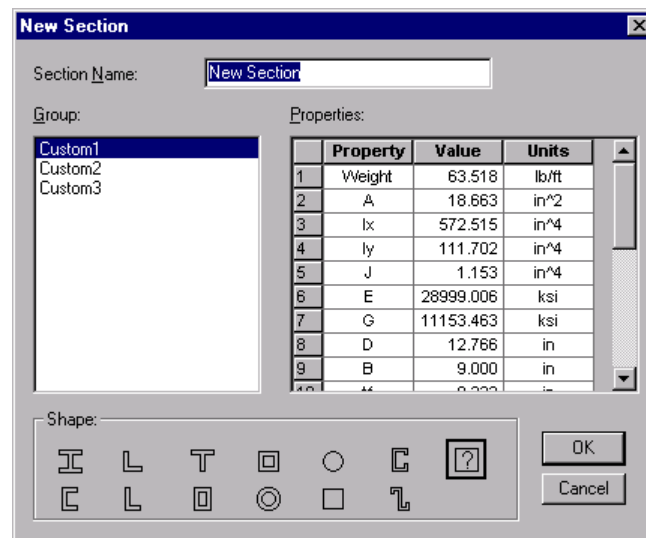
Windows

If Section Maker finds a library named "SectionsLibrary.slb" in the same directory as Section Maker, it will automatically open it on startup.

If you have installed Section Maker correctly, this library should automatically have been opened.

- **Choose Install... from the Shape menu**

A dialog box will appear with the properties of the section, a list of groups and a list of symbols indicating the shape of the section. The section's properties displayed in the table will be the same as those calculated in the Data window. If you wish you can change them before installing the section in the library. In this case we will leave them set to the calculated values.



- Click on the name of the group where you would like to store the section.
 - Type in a name for the section
 - Click on the icon that indicates the shape of the section
- Since it is not one of the standard shapes, in this case just leave the shape set to the question mark icon.
- Click the OK button

Viewing Sections

You can verify that your section has been correctly installed into the library by checking its properties in the Section window.

- **Choose Section from the Window menu**

The Section window will be brought to the front. Tables of sections are displayed in this window. One group at a time is displayed.

To choose which group to display

- **Choose Select Group... from the Section menu**

A dialog box will appear with a list of the names of the groups in the library.

- **Click on the name of the group you stored your section in**
- **Click the OK button**

The table of sections for that group will be displayed in the Sections window. You can check the name and properties are correctly stored by scrolling through the table to view the section's name and properties.

Saving your Work

You can save the changes you have made to the Section Library by using the Save command from the File menu.

- **Choose Save Library from the File menu**

The Sections Library will be saved to disk complete with the section you added to it.

Printing your work

You can print the shape and properties you have created

- **Bring the Shape window to the front**
- **Choose Page Setup from the File menu and choose your paper size**
- **Choose Print Window from the File menu**
- **Click OK or Print to print out the shape or its properties**

Chapter 2

Using Section Maker

This chapter describes the use of all of the commands available in Section Maker.

Introduction

If you have read Chapter 1 you are now familiar with some of the features of creating a section using Section Maker. This chapter presents a series of step-by-step instructions to the tasks covered in Chapter 1 as well as other procedures you will want to know about.

The chapter begins with a summary of basic skills and this is followed by a description of the tasks involved in creating a section using Section Maker. The following sections describe working with materials and working with groups and sections in the Sections Library.

Summary of Mouse Techniques

You will use the following mouse techniques to do just about all of the tasks in this chapter.

- Click to select or activate something
- Press to cause a continuous action
- Drag to select, choose from a menu or move something
- Shift-Click to select or to extend or reduce a selection
- Double-Click to choose from a dialog box

To Click

Position the pointer on what you want to select or activate
Press and quickly release the mouse button

To Press

Position the pointer on something
Without moving the mouse, press and hold down the mouse button.

The effects of pressing continue as long as the mouse button is held down. Pressing on a scroll arrow results in continuous scrolling. Pressing on a menu title pulls down the menu and keeps it down until you release the mouse button.

To Drag

Position the pointer on something
Press and hold down the mouse button and move the mouse
Release the mouse button

To Shift-Click or Command-Click

Command-Click (or Shift-Click or Macintosh) is used to extend or reduce the selection of joints and members.
Hold down the shift or command key and click on the joints or members you wish to add to the selection or which you wish to remove from the selection

To Double-Click

Summary of Keyboard Techniques

Double click is used as a short cut equivalent to clicking OK in a dialog box.

Point to the item you wish to double click and then click twice quickly in succession without moving the mouse.

This section describes keyboard techniques you can use as shortcuts when using Section Maker.

Tab

You can use the Tab key to move horizontally within a table or to move from one field in a dialog to the next.

Return

(Macintosh Only)

The Return key can be used to move to the next entry down in a table or the next line down in the CalcSheet and is the same as clicking on the OK button in a dialog.

Enter

The Enter key can be used to confirm the entry of numbers into a table and is the same as clicking OK in a dialog.

Arrow Keys

The keys may be used to move the selection in their respective directions in the Data or Result tables.

Delete

(or Backspace on earlier Macintosh models)

The Delete key may be used to delete the current selection. If nothing is selected and you are typing text or numbers, it will delete the character to the left of the blinking cursor. In the Shape window it will delete the currently selected shapes.

Command/Control

The Command/Ctrl key may be held down while typing another key to choose a command from a menu without using the mouse. Menu items, which have a key to the right of the name, may be chosen in this way. For example, to choose Undo from the Edit Menu you could hold down the Ctrl key and type Z.

Shift

You can hold down the shift key while clicking on something to add it to the current selection or remove it from the selection if it is already selected.

Holding down the shift while drawing a member, dragging a member or dragging a joint will constrain the movement to be horizontal, vertical or at a 45 degree angle.

Scrolling

Scrolling is a technique for moving a table of data up, down, left or right in a window so that you can bring any part of the table into view.

To scroll a table one line up or down

Click the appropriate arrow at the top or bottom of the vertical scroll bar

To scroll a table one column left or right

Click the appropriate arrow at the left or right of the horizontal scroll bar

To scroll a table continuously line by line

Press the appropriate arrow at the top or bottom of the vertical scroll bar

To scroll a table continuously column by column

Press the appropriate arrow at the left or right of the horizontal scroll bar

To scroll up or down by the windowful

Click in the gray area above or below the scroll box in the vertical scroll bar.

To scroll left or right by the windowful

Click in the gray area to the left or right of the scroll box in the horizontal scroll bar.

To go to the beginning or the end of the table

Drag the scroll box to the top or the bottom of the vertical scroll bar.

To go to the left or right hand edge of the table

Drag the scroll box to the left or the right of the horizontal scroll bar.

To go to any part of a large table

Drag the scroll box to a place in the scroll bar that's about equivalent to where the data is in the table.

Working with Windows

A window frames and displays its contents. There are five windows in Section Maker; they are titled Shape, Properties, Data, Group and Section.

Zoom, Pan, Shrink and Size To Fit

The Zoom, Pan, Shrink and Size To Fit commands in the View Menu may be used to control the scale of the graphics displayed in the Shape window

Zoom

Zoom allows you to increase the size of the drawing in the Shape window.

- **Choose Zoom from the View Menu**
- **Move the pointer to the top left hand corner of the area you wish to view in close detail**
- **Drag a rectangle down and to the right, which encloses the area of interest, and release the mouse button**

The window's contents will be re-drawn to display the part of the shape contained in the rectangle you have drawn.

Pan

Pan allows you to shift the display of the shape within the window upwards, downwards, to the left or right.

- **Choose Pan from the View Menu.**
- The cursor will change to a hand.
- **Press inside the window and hold down the mouse button**
 - **Drag the drawing to its new location.**
 - **Release the mouse button to re-draw the contents of the window.**

If not enough memory is available to move the image, a rectangle the size of the window will be moved around as you move the mouse.

Shrinking the View

Shrink allows you to decrease the size of the drawing on the screen by 50%.

- **Choose Shrink from the View Menu**

The drawing will shrink down to 50% of its current size and be re-drawn.

Sizing To Fit

Size To Fit automatically resizes the drawing in the Shape window so that the section just fits inside the window in the current view. This is most useful after you have been zooming, panning or shrinking as it returns you to a viewing scale that just fits the section inside the window.

Working With Shapes

Creating a section with Section Maker involves defining the geometry of the shapes by drawing in the Shape window. You can also use the pre-defined generation aids to automatically place common structural shapes into the section.

The next part of this chapter describes the drawing techniques you can use to create a section. This is followed by a summary of how to select shapes in the section and how to use Section Maker's capabilities to assist in generating commonly used shapes.

Drawing

The shapes, which make up a section, may be drawn directly in the Shape window.

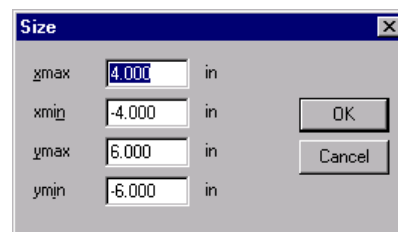
The scale at which this drawing is carried out may be specified by choosing the Size... command from the View Menu. The maximum and minimum coordinates to be used in the x and y directions may be entered and Section Maker will scale these coordinates to the current size of the Shape window. All movements in the window are accompanied by a display of the current pointer coordinates in the lower left hand corner of the window. All coordinates are shown in the current units. You can change units using the Units command from the View menu.

Setting the Size

Before starting drawing, you will need to set up the drawing area for the size of section you intend working with. To do this

- **Choose Size... from the View Menu**

A dialog box will appear with the dimensions of the section

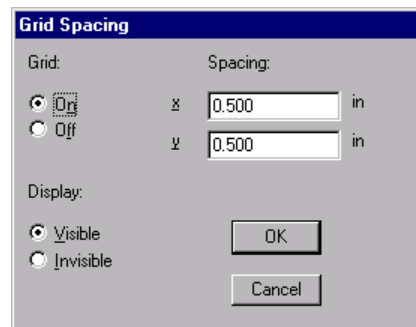


- **Enter the maximum and minimum coordinates you wish to use in each direction**
- **Click the OK button**

Using the Grid

Section Maker has a built-in facility to allow you to have your drawing automatically align with an evenly spaced grid. You can control the spacing, display and use of this grid with the Grid command from the View Menu.

- **Choose Grid... from the View Menu**
- **Type in values for the x and y spacing of the grid**
- **Click on the On button if you want drawing to align to the grid**
This will switch on the Visible button to make the grid to visible.
- **Click the OK button**



If you want to have the shapes automatically align with the grid but don't want to see the grid, simply click on the Invisible button before clicking OK. Similarly you can click on the Visible button to have the grid displayed as a visual guide but click on the Off button to disable the automatic alignment with the grid.

All drawing and dragging in the Shape window will align to the grid while the grid is switched on.

Drawing Tools

Section Maker has six drawing tools for drawing different types of shapes. A gray or black background surrounding the tool's icon indicates the drawing tool, which is currently active. If the Arrow tool is selected this allows you to select, move and resize shapes with the mouse.

Before you start drawing a new section, if there are any shapes in the Shape window Choose Select All from the Select sub-menu under the Edit menu and press the Delete (or Backspace key). This will remove the existing shapes.

Rectangle Tool

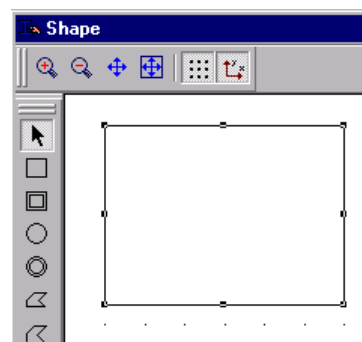
The rectangle tool can be used for drawing solid rectangular shapes or for drawing rectangular holes in a section.

To draw a rectangle

- Click on the rectangle tool to select it



- Press at the position of the top left corner of the rectangle you wish to draw
- Drag down to the right until the mouse points to the bottom right corner of your rectangle



Hollow Rectangle Tool

- **Release the mouse button**

If you have the Grid turned on then the corners of the rectangle will align to the grid. The new shape will be immediately added to the list of shapes displayed in the Data window.

The hollow rectangle tool can be used for drawing hollow rectangular shapes (rectangular or square structural tubing).

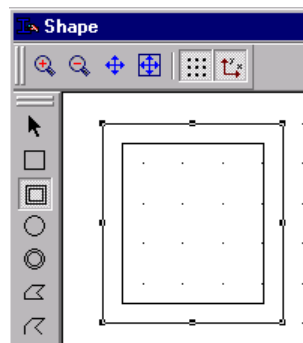
To draw a hollow rectangle

- **Click on the hollow rectangle tool to select it**



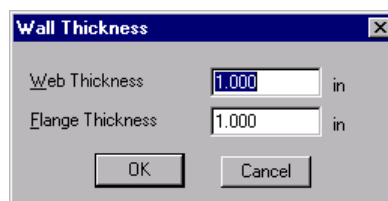
- **Press at the position of the top left corner of the rectangle you wish to draw**
- **Drag down to the right until the mouse points to the bottom right corner of your rectangle**

If you have the Grid turned on then the corners of the rectangle will align to the grid.

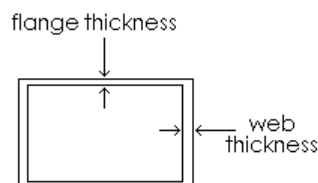


- **Release the mouse button**

When you release the mouse button a dialog will appear allowing you to enter the wall thicknesses of the shape you have drawn



- **Type in values for the web and flange thicknesses**
- **Click the OK button**



The new shape will be immediately added to the list of shapes displayed in the Data window.

Circle Tool

The circle tool can be used for drawing solid circular shapes or for drawing circular holes in a section.

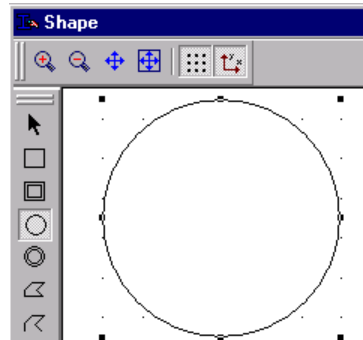
To draw a circle

- **Click on the circle tool to select it**



- **Press at the position of the center of the circle you wish to draw**
- **Drag down outwards from the center until the mouse points to the radius you require**

If you have the Grid turned on then the center and radius of the circle will align to the grid.



- **Release the mouse button**

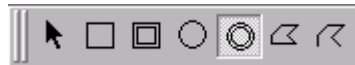
The new shape will be immediately added to the list of shapes displayed in the Data window.

Tube Tool

The tube tool can be used for drawing hollow circular shapes or tubes.

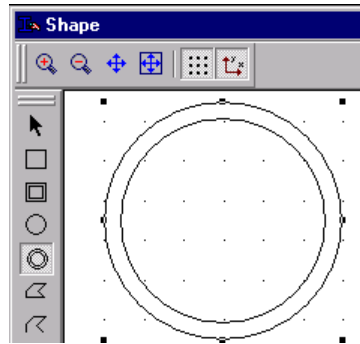
To draw a tube

- **Click on the tube tool to select it**



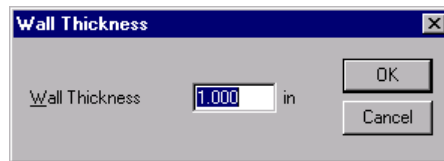
- **Press at the position of the center of the tube you wish to draw**
- **Drag down outwards from the center until the mouse points to the radius you require**

If you have the Grid turned on then the center of the circle and the position of the circle will align to the grid.

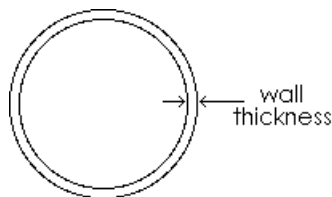


- **Release the mouse button**

A dialog will appear allowing you to enter a wall thickness for the tube.



- **Type in a value for the wall thickness**
- **Click the OK button**



The new shape will be immediately added to the list of shapes displayed in the Data window.

Polygon Tool

The polygon tool can be used for drawing solid polygonal shapes or for drawing polygonal holes in a section. Note that the calculation of sections properties for a polygon will be accurate for all properties except for the torsion constant J . For convex polygons the calculation of J will be a reasonable approximation however for any polygon with one or more re-entrant corners the calculation of J can not be relied upon.

To draw a polygon

- **Click on the polygon tool to select it**



- **Click at the location of the first vertex of the polygon**

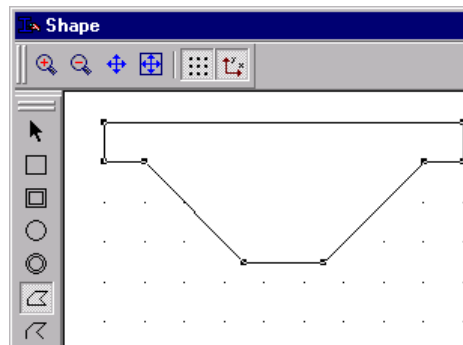
The first side of the polygon will be drawn as you move the mouse

- **Click at the location of each of the other vertices of the polygon**

- **Double click at the location of the last vertex to close the polygon or ...**

- **Press Return or Enter to close the polygon or ...**

- **Click close to the first vertex to close the polygon**



If you have the Grid turned on then the vertices of the polygon will align to the grid. The new shape will be immediately added to the list of shapes displayed in the Data window.

Open Polygon Tool

The open polygon tool can be used for drawing polygonal shapes made of thin material. Thin means the thickness of the material is very small compared with the size of the shape. This is most useful for modeling structural shapes made from cold rolled thin steel or aluminum.

To draw an open polygon

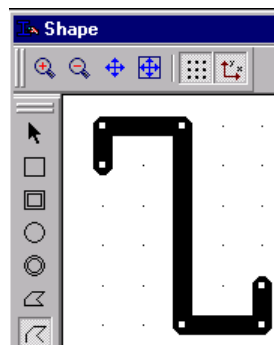
- Click on the open polygon tool to select it



- Click at the location of the first vertex of the polygon

The first side of the polygon will be drawn as you move the mouse

- Click at the location of each of the other vertices of the polygon
- Double click at the location of the last vertex to complete the polygon or ...
- Press Return or Enter to complete the polygon



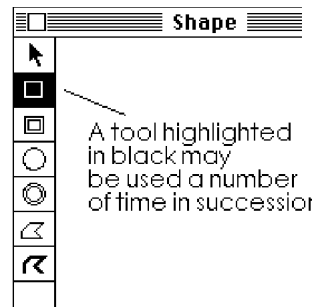
If you have the Grid turned on then the vertices of the polygon will align to the grid. The new shape will be immediately added to the list of shapes displayed in the Data window.

Drawing Multiple Shapes

(Macintosh Only)

Each time after you have drawn a shape, the current drawing tool will revert to the arrow tool. If you wish to draw a number of shapes of the same type in succession, you can double click on the drawing

tool. This will highlight the tool in black rather than gray and will let you use it any number of times until you select a different tool.



Moving a Shape

You can move a shape by dragging it with the mouse in the Shape window

To move a shape

- **Point anywhere inside the shape**
- **Press the mouse button**
- **Drag the shape to the new location**
- **Release the mouse button**

Moving a Number of Shapes

You can move a number of shapes at once by selecting them and dragging them to the new location with the mouse.

To select a shape

- **Click on or in the shape with the mouse**

If you have turned off the display of materials, you must click on the boundary of the shape rather than inside it. The shapes handles will be highlighted to indicate that it is selected.

To add a shape to the current selection

- **Shift-click on or in the shape**

To move a number of shapes

- **Select the shapes to be moved**
- **Press on or inside any one of the selected shapes**

If you have turned off the display of materials, you must click on the boundary of a shape rather than inside one

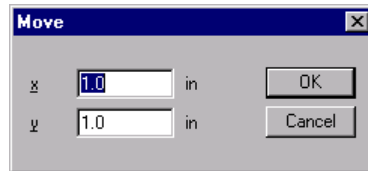
- **Drag the shapes to their new location**
- **Release the mouse button**

The shapes will be re-drawn in their new position.

Moving Shapes Accurately

You can also move the selected shapes with great accuracy by using the Move command from the Shape menu.

- **Choose Move...from the Shape menu**



- **Type in the distance to move in each direction**
- **Click the OK button**

Resizing a Shape

You can change the size of a shape by dragging its handles (the small black boxes which appear when it is selected).

To resize a shape

- **Press on the handle closest to the part of the shape you want to move**
- **Drag the handle to its new location**
- **Release the mouse button**

When you resize a polygon each of the vertices moves independently of the others.

Deleting a Shape

To delete a shape or shapes from the section

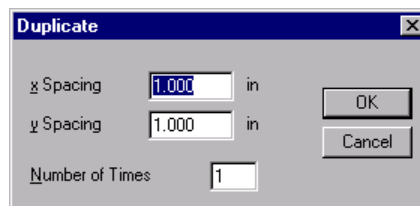
- **Select the shape or shapes to be deleted**
- **Press the Delete (or Backspace) key or ...**
- **Choose Clear from the Edit menu**

Duplicating a Shape

To duplicate a shape or shapes in the section

- **Select the shape or shapes to be duplicated**
- **Choose Duplicate from the Shape menu**

A dialog box will appear allowing you to specify the spacing of the duplicated shapes and how many are to be created



- **Type in the spacing in each direction and the number of duplicates**
- **Click the OK button**

The duplicated shapes will be drawn and selected in the Shape window.

Rotating a Shape

Section Maker allows you to rotate shapes that you have already drawn. Shapes are rotated about the axes at an angle measured positive in the anti-clockwise direction. Rectangles may only be rotated in increments of 90 degrees.

To rotate a shape or shapes

- **Select the shape or shapes to be rotated**
- **Choose Rotate from the Shape menu**

A dialog box will appear with a field for the angle of rotation



- **Type in the angle of rotation**
- **Click the OK button**

The selected shapes will be rotated about the origin of the axes and re-drawn in the Shape window

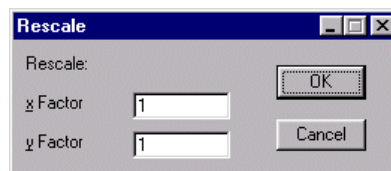
Rescaling a Shape

Section Maker allows you to rescale shapes that you have already drawn. The coordinates of the shapes are multiplied by a scaling factor in each direction to rescale the shape.

To rescale a shape or shapes

- **Select the shape or shapes to be rescaled**
- **Choose Rescale from the Shape menu**

A dialog box will appear with two fields for the scaling factor in each direction



- **Type in the x and y scaling factors**
- **Click the OK button**

The selected shapes will be rescaled and redrawn in the Shape window

Reflecting Shapes

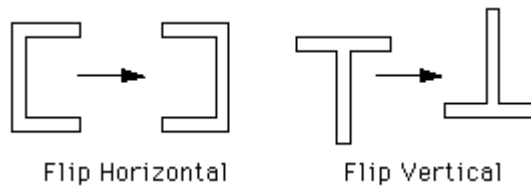
You can reflect shapes in Section Maker by using the Flip Horizontal and Flip Vertical commands from the Shape menu

To reflect the selected shapes about a vertical axis passing through the center of area of the selected shapes

- **Choose Flip Horizontal from the Shape menu**

To reflect the selected shapes about a horizontal axis passing through the center of area of the selected shapes

- **Choose Flip Vertical from the Shape menu**



Aligning to Centroid

Most times when you create a section you will want to calculate its properties relative to a set of axes at the centroid of its area. The Align To Centroid command moves all of the selected shapes so that their common center of area is aligned with the origin of the axes. After using Align To Centroid the coordinates of the centroid of the selected shapes will always be $x=0, y=0$.

To align the centroid of a shape or shapes with the axis origin

- **Select the shape or shapes to be aligned**
- **Choose Align To Centroid from the Shape menu.**

The shapes will be moved as a group to center their area about the axis origin

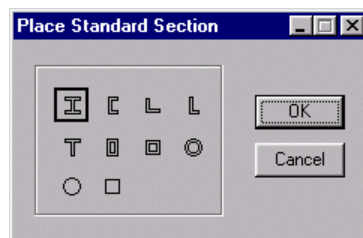
Generating Standard Shapes

Rather than having to draw common structural shapes such as I beams, channels and angles, Section Maker lets you generate such shapes by typing in a few key dimensions.

To generate a standard shape

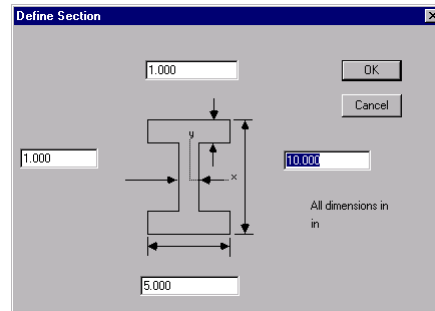
- **Choose Place Shape from the Shape menu**

A dialog box will appear with a list of icons representing the standard shapes



- **Click on the icon you require**
- **Click the OK button**

A dialog box will appear with a diagram of the shape and its key dimensions



- **Type in the dimensions of the shape**
- **Click the OK button**

The generated shape will be placed in the Shape window centered about the origin of the x-y axes.

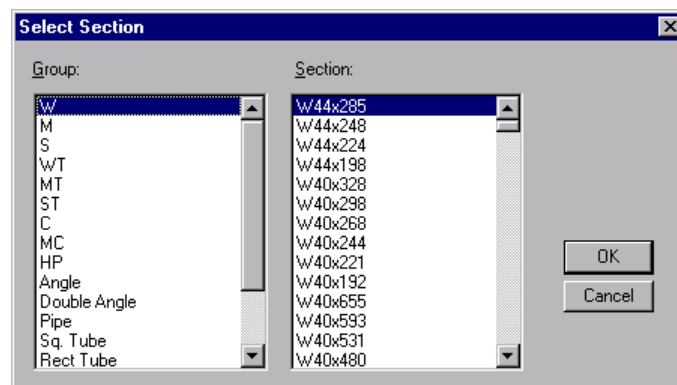
Using Existing Sections

If you want to create a section, which is made up from other sections, you can place the existing sections using the Place Section command from the Shape menu. You can place standard sections from the Sections Library as well as sections you have drawn and stored previously.

To place a section

- **Choose Place Section from the Shape menu**

A dialog box will appear allowing you to pick the section you wish to place



- **Click on the group and section name of the required section**
- **Click the OK button**

The chosen section will be placed in the Shape window. If the chosen section is one of the standard Sections Library sections, an approximate shape will be generated. For example, if you choose an I section, the generated shape will not have the small fillets that the real section has. This will result in a slight discrepancy between the calculated and actual properties however for structural analysis purposes, the accuracy of the properties calculation should be quite sufficient.

Importing a Shape

You can import a shape into Section Maker in two ways, either by pasting a picture from the clipboard or by placing a DXF file.

To paste a picture

- **Copy the picture to the clipboard in the originating program**
- **Choose Paste from the Edit menu in Section Maker**

All rectangles, circles and polygons in the picture will be placed in the Shape window. Because the accuracy of pictures in the clipboard is limited to 1/72nd of an inch, pasting pictures is not a very accurate way of importing data into Section Maker.

If you have a shape in another CAD system you can import it into Section Maker by way of a DXF file.

- **(Windows) Choose Import DXF from the File menu**
- **(Macintosh) Choose Place DXF from the Shape menu**

The standard file dialog will appear and you can choose the DXF file. Section Maker will extract all the rectangles, circles and polygons from the DXF file and place them in the Shape window. If there are lines in the DXF file which form a polygonal shape, Section Maker will joint them together at the ends during the import process.

Setting Materials

To enable Multiframe to calculate deflections in structures, values for Young's Modulus and Shear Modulus need to be stored with sections in the Sections Library. Section Maker takes these values from the materials you choose for the various shapes, which make up a section. Section Maker allows you to use a number of different materials within the one section. Materials are stored in the Sections Library, standard steel and concrete data is included and you can add your own custom materials to the library.

If you do not assign a material to a shape, Section Maker will assume the shape is a hole and will deduct its properties from the overall properties of the section. Shapes, which are holes, will have negative properties displayed in the Data window.

When shapes you have drawn lie inside each other, you may find it difficult to see which is which, especially when the material patterns are displayed in the shapes. You can control the order in which the shapes are displayed by using the commands under the Arrange sub-menu under the Shape menu.

To move the selected shapes to the front of all the others

- **Choose Move To Front from the Arrange menu**

To send the select shapes behind all the others

- **Choose Move To Back from the Arrange menu**

To move the selected shapes just in front of the ones currently in front of them

- **Choose Move Forwards from the Arrange menu**

To move the selected shapes just behind the shapes behind it

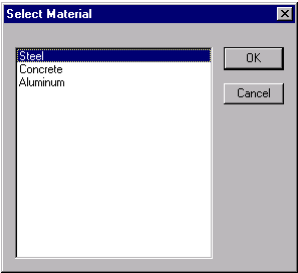
- **Choose Move Backwards from the Arrange menu**

Note that shapes can be contained inside other shape e.g. steel bar inside a concrete beam or a void inside a beam but shapes can not overlap partially. See Overlapping Shapes in Chapter 4 for more information.

Setting Material Types

To set the material type of a shape

- **Select the shape**
- **Choose Select Material from the Material menu**



- **Click on the name of the material you require**
- **Click the OK button**

See "Adding a Material" below for information on how to add materials to the library.

Viewing Properties

When you draw a shape and specify its material properties, as each change is made the sectional properties are automatically recalculated and displayed in the Properties window

Properties			
	Property	Value	Units
1	Weight	0.000	lb/ft
2	Area	-5.500	in^2
3	Ix	-21.792	in^4
4	Iy	-6.667	in^4
5	J	-0.458	in^4
6	E	0.000	ksi
7	G	0.000	ksi
8	Zxt	8.717	in^3
9	Zxb	8.717	in^3
10	Zyl	3.333	in^3
11	Zyr	3.333	in^3
12	rx	1.991	in
13	ry	1.101	in
14	Ixc	-21.792	in^4
15	Iyc	-6.667	in^4
16	Ixyc	-9.000	in^4
17	I1	-2.474	in^4
18	I2	-25.985	in^4
19	Ø	-114.980	deg
20	xc	-0.000	in
21	yc	-0.000	in
22	D	5.000	in
23	B	4.000	in
24	tw	0.500	in
25	tf	0.500	in
26	xl	-2.000	in
27	xr	2.000	in
28	yl	2.500	in
29	yb	-2.500	in
30	Asx	-5.500	in^2
31	Asy	-5.500	in^2

The properties displayed in this table are as follows.

Property	Description
Weight	Weight per unit length
Area	Cross sectional area
Ix	Moment of inertia about x axis
Iy	Moment of inertia about y axis
J	torsion constant
E	Young's Modulus
G	Shear Modulus
Sxt(or Zxt)	Elastic Modulus about x axis at top of section
Sxb(or Zxb)	Elastic Modulus about x axis at bottom of section
Syl(or Zyl)	Elastic Modulus about y axis at left of section

Syr(or Zyr)	Elastic Modulus about y axis at right of section
rx	Radius of gyration about x axis
ry	Radius of gyration about y axis
Ixc	Moment of inertia about x axis passing through centroid
Iyc	Moment of inertia about y axis passing through centroid
Ixyc	Product of inertia about centroid
I1	Moment of inertia about major(strong) axis passing through centroid
I2	Moment of inertia about minor (weak) axis passing through centroid
Ø	Angle of major axis from x axis
xc	x location of centroid
yc	y location of centroid
D	Depth
B	Width (or breadth)
xl	Position of left extent of section
xr	Position of right extent of section
yt	Position of top extent of section
yb	Position of bottom extent of section
Asx	Shear area for shear in the minor (x) direction
Asy	Shear area for shear in the major (y) direction

If you see properties which are negative, this may mean that you have forgotten to specify materials for some of the components of the shape. Also be careful not to overlap shapes unless you are deliberately inserting a hole or reinforcing steel. See the Overlapping Shapes section in Chapter 4 for more details.

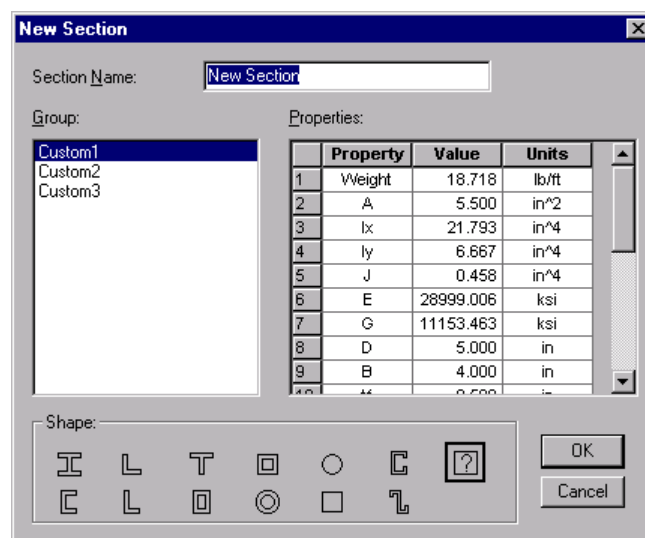
Installing a Section

Once you have drawn a section to your satisfaction you can install it into the Sections Library for later use by Multiframe or Section Maker.

To install your section

- **Choose Install from the Shape menu**

A dialog box will appear with a list of names of groups where the section can be stored, a field for the name of the section, a table with the calculated section properties and radio buttons to indicate the shape of the section.



- **Type in a name for the section**
- **Click on the name of the group where you want to store the section**
- **If you wish you can change the sections properties to override the ones that have been calculated for you. Use the tab key to move to the number to be changed and type in a new value.**

If the section is one of the standard shapes, you should type in values for the web and flange thicknesses at the bottom of the table. This will allow Multiframe3D to render the shape correctly and will also let you place the section in Section Maker at a later date.

- **Click on the radio button which shows the shape of the section**

If the section is not one of the standard shapes, leave this set to the question mark icon.

- **Click the OK button**

The section will be stored in the library in the group you have nominated. Note that the library with the new section included will not be saved permanently on the disk until you choose Save Library from the File menu.

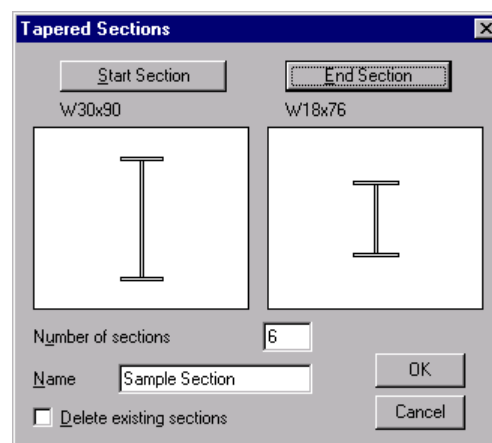
Tapered Sections

Section Maker allows you to automatically create a number of sections, which interpolate between two existing sections. This can be used to model the changing sectional shape in a tapered member. Suppose you were modeling a tapered beam in Multiframe that started with a 12inch (300mm) deep rectangular section and tapered to a 24inch(600mm) deep section. You could draw the first section and install it in the library, then draw the second section and install it. To create the intermediate sections you use the Taper command from the Shape window.

To install a number of intermediate sections between to existing sections

- **Choose Taper from the Shape menu.**

A dialog box will appear which allows you to select the start and finish sections



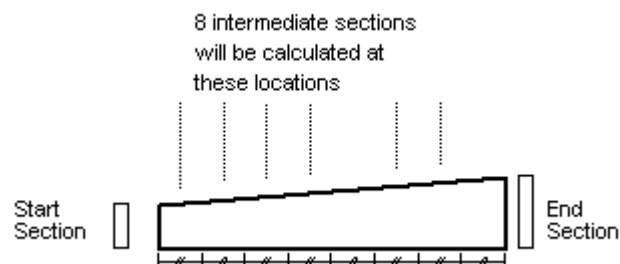
- **Click on the Start Section button**
- A dialog box will appear listing the available groups and sections
- **Click on the group and section names of the starting section**
 - **Click the OK button**

- **Click on the End Section button**
- **Choose the group and section names for the end section and click OK**

The two sections you have chosen will be displayed in the dialog.

- **Type in the number of intermediate sections you want to generate**

The sections properties will be calculated at the mid point of each subdivision of the range between the start and end sections. Section Maker makes an approximation to the intermediate section properties by interpolating between the properties at each end. All the properties except the moments of inertia and the torsion constant are interpolated linearly and will be exactly correct. The moments of inertia and torsion constant are interpolated using a cubic approximation to the variation in property along the tapering member. This will result in a small error in the moments of inertia and torsion constant but in most cases this should not impact significantly on your analysis. If you have a problem, which is sensitive to the value of torsion or moments of inertia, you should determine that this error will not have an adverse impact on your analysis. A quick check of the values at the mid-point will give you a guide to the maximum error.



- **Type in a name for the section**

This name will form the basis of the names for the added sections. If "TestShape" is the name you give to the sections, the intermediate sections will be named TestShape1, TestShape2 ... and so on up to TestShapen where n is the number of intermediate shapes you requested.

- **If you want to remove the original start and end sections check the check box at the bottom of the dialog**

Most times you will want to do this if you have drawn the sections as the original sections will not be used in the Multiframe analysis. The sections will only be deleted if the groups they belong to are not locked.

- **Click the OK button**

The sections will be installed in the group you specified. If you want to view or change the properties of the sections which are created, you can view them in the Sections window (see Viewing Sections below)

Working With Libraries

As well as enabling you to draw and add individual sections to the library, Section Maker has a number of features, which make it easier for you to manage your sections library. You can add and remove groups of sections from the library, add or remove a large number of sections at once, and store custom or commonly used materials in the library so that they are available for use.

You can change the contents of the library in the Group and Section windows. One group at a time is displayed in these two windows. The group currently on display is referred to below as the current group. In the Group window you can view and change the information about the current group, in the Section window you can view and change any of the section properties for any of the sections in the current group.

You can also create completely new libraries or read, modify and write any number of sections libraries. This means you can keep a number of libraries on your disk and use them for different applications.

Creating a New Library

Section Maker allows you to create a new library for use with any of the Multiframe applications. All you have to do to make the new library be used by the applications is to place it in the same folder as the application and name it "Sections Library". If you already have a sections library in the folder with that name, rename the existing library to a different name and then name your new library "Sections Library".

To create a new library

- **Choose New Library from the File menu**

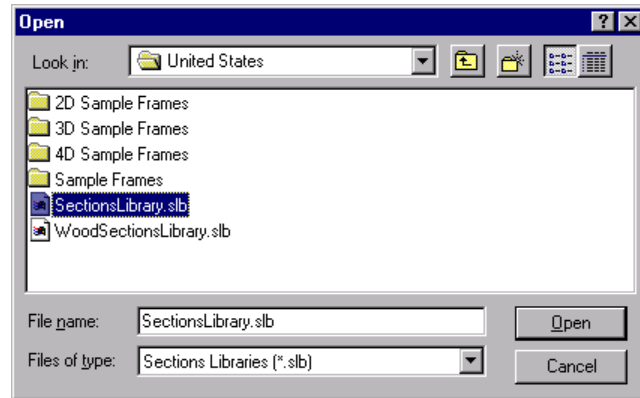
A new library will be created with no groups or sections. You can add groups and sections to the library (see Adding a Group and Adding a Section below) before saving it to disk with the Save As command from the File menu.

Opening a Library

You do not have to work with the sections library which automatically opens when Section Maker starts up. (If Section Maker finds a library named Sections Library in the same folder as Section Maker or in the System Folder, it will automatically open it on startup) If you wish you can open any other library and work with it in the normal way.

To open a sections library

- **Choose Open Library from the File menu**



- **Click on the name of the library you wish to open**
- **Click the Open button**

The contents of the library will be read in and the groups and sections in the library will be displayed in the Group and Section windows respectively.

Saving a Library

If you have installed any sections in the library or you have changed the section or group properties in any way, you will have to save the Sections Library to disk to make the changes permanent.

To save the Sections Library to disk

- **Choose Save Library from the File menu**

To save the Sections Library to disk with a new name

- **Choose Save As from the File menu**
- **Select the folder or disk where you will save the library**
- **Type in a name for the library**
- **Click the Save button**

Saving as Text

Another way to view the data in the library is to save it in text format. Text files can be read into a word processor or you could write your own software which extracts data from a text file of sections.

To save the contents of the library in a text file

- **Choose Export -> Text File from the File menu**

(Macintosh) Use Save As -> Text Format

- **Type in a name for the text file of data**
- **Choose which disk or folder you want to store the data in**
- **Click the Save button**

The complete contents of the sections library will be saved to disk in a text file. The format of this file is documented in Chapter 4.

Working with Tables

The data for the library is displayed in tables in the Group and Section windows. The properties for the section are displayed in the Properties window. You can change data in the group and Section windows by typing in new names and numbers. If there is more data than will fit in a window, you can use the scroll bars to scroll through the table to view rows or columns that are not visible.

Column Widths

If you want to change the width of a column in the table

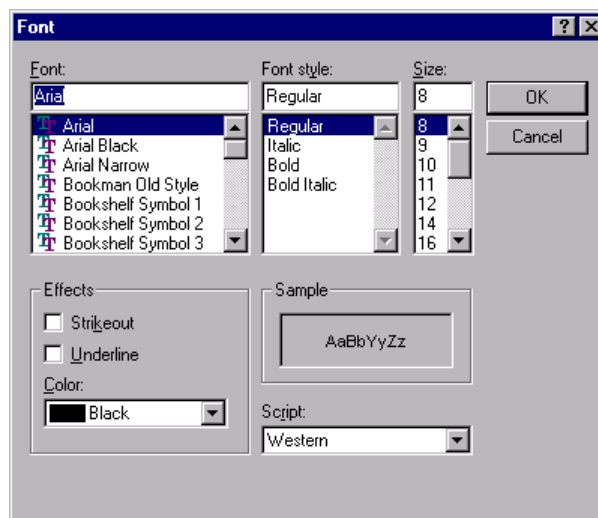
- **Press on the line dividing the column's title from the next column**
- **Drag the column divider to make the column wider**
- **Release the mouse button**

Text Styles

If you wish you can change the font and text size used to display the numbers in the table by using the Font command from the View menu.

To change the font and/or size of the text in a table

- **Choose Font from the View menu**



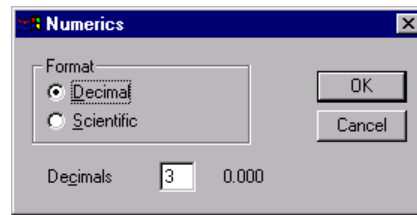
- **Click on the name of the font you require**
- **Click on a font size or type in a size**
- **Click the OK button**

Number Styles

You can also choose what numeric format to use for displaying the numbers by using the Numbers command from the View menu.

To change the number of decimal places or the decimal format of the numbers in a table

- **Choose Numbers from the View menu**



- **Choose Decimal or Scientific notation**
- **Type in the number of decimal places you require**
- **Click the OK button**

Changing Numbers or Name

To change a number or name in a table

- **Click on the name or number to be changed**
- **Type in a new value**
- **Press the Enter key**

Selecting Numbers in Tables

You can also copy and paste data in tables. The copy or paste will act on the current selection in the window. You can select a number or a range of numbers, a row or range of rows, or a column or range of columns.

To select a number

- **Click on the number**

To select a range of numbers

- **Press on the number at the top left of the range to be selected**
- **Drag the mouse until the last number is selected**
- **Release the mouse button.**

If the last number you want to select is outside the window, drag the mouse outside the window and the table will automatically scroll to bring the number into view.

To select a row

- **Click on the number at the left of the row**

To select a range of rows

- **Press in the number at the left of the first row**
- **Drag down until the last row is selected**
- **Release the mouse button**

If the last row is outside the window, drag outside the window and the table will scroll to bring the row into view.

To select a column

- **Click on the title at the top of the column**

To select a range of columns

- **Press in the title of the left hand column in the range**
- **Drag the mouse across until the right hand column is selected**
- **Release the mouse button**

If the right hand column is outside the window, drag outside the window and the table will scroll to bring the column into view.

To select the whole table

- **Click in the box at the top left corner of the table**

Copying and Pasting Numbers

To copy or paste numbers in Section Maker, first select the numbers then choose the command you require.

To copy a number or range of numbers

- **Select the numbers to be copied**
- **Choose Copy from the Edit menu**

The numbers will be placed on the clipboard. Each row of numbers will have a return character at the end and the numbers in the row will be separated by a Tab character. You can transfer data copied from Section Maker into other programs or you can paste them into other tables in Section Maker.

To paste the numbers on the clipboard into a table

- **Select the numbers in the table that will be replaced by the numbers on the clipboard**
- **Choose Paste from the Edit menu**

Working With Groups

Section Maker allows you to add, delete and modify the groups of sections stored in a sections library.

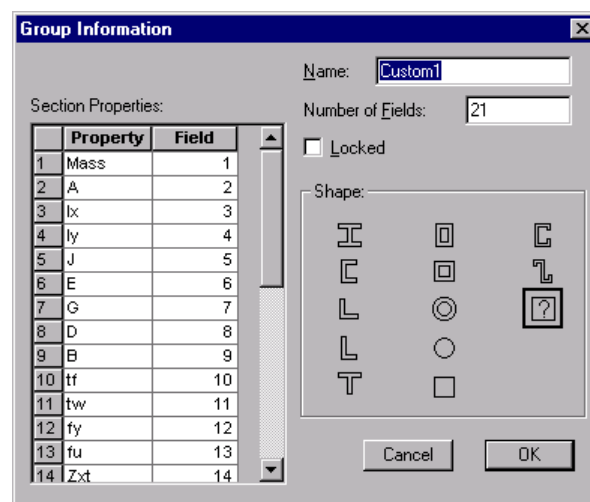
Adding a Group

Section Maker allows you to add groups to or remove groups from the sections library you currently have open. This makes it more convenient for you to choose sections. If there are groups in the library you never use you could remove them or if there is a table of custom sections you often use you could add them in a separate group in the library.

To Add a Group to the Library

- **Choose Add Group from the Section menu**

A dialog box will appear with a field for the group's name, a table showing where key properties will be stored in the group, a text box for the number of fields of data to be stored with each section in the group and a list of icons to indicate the shape of sections in the group.



- **Type in a name for the group**

If you wish you can type in the number of fields you require, normally you will leave this set to 23. If you do add extra fields, you can type a number next to each of the key properties to tell Multiframe in which field that property will be stored otherwise the fields will have the names and properties indicated. (For example the first line of the table indicates that the mass per unit length of the section is stored in a field named Mass and this is the first field of the group). If you do change any of these values it is very important that you keep the naming and units for the property consistent and always store the property in the field indicated. Multiframe relies on this information to do analysis and if you make an error entering the key properties, the results of analysis may be incorrect. If in doubt, leave the group with the 23 standard fields and properties.

- **Click on the icon which represents the shapes stored in this group**

If you have more than one kind of shape or the shape is not one of the standard shapes, leave the icon set to the question mark icon

- **Click the OK button**

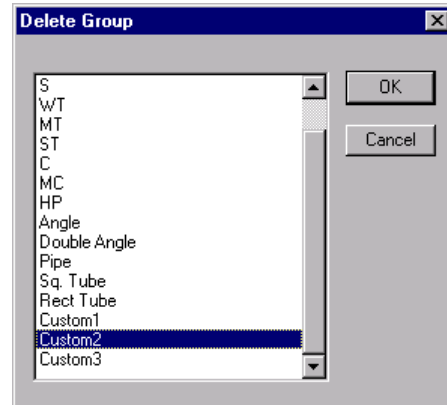
The group will be added to the library and made the current group on display in the Group and Section windows.

Deleting a Group

To remove a group from the Sections Library

- **Choose Delete Group from the Section Menu**

A list of the groups in the library will be displayed



- **Click on the group to be removed**

If you wish to remove more than one group, hold down the shift key while clicking on the names of the other groups

- **Click the OK button**

The groups selected and all the sections stored in them will be removed from the library.

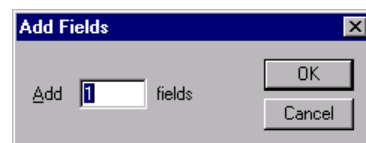
Adding a Field

The properties of each section in a group are stored in a number of fields in the group. When you create a new group the 23 standard properties are placed in the first 23 fields. If you wish you can add more fields to a group. You could do this to make data available for use in Multiframe's CalcSheet or you could store additional data for easy reference.

To add a field to the current group

- **Choose Add Field from the Section menu**

A dialog box will appear allowing you to enter the number of fields you wish to add



- **Type in the number of additional fields you need**

- **Click the OK button.**

The additional fields will be displayed in the Group window and additional columns will be added to the Section window.

Changing a Field

After you have added a field you will need to give it a name and also tell Multiframe what units the data is to be stored in. You can change

the information about fields in the Group window. To change the name of the field, click on its current name, type in a new name and press the enter key.

In the units column, type in the name of the units you want to use to store properties in this field. For example, if you added a field named Iw for a warping constant your units might be in⁶ (inches to the sixth power) so you should type this into the units column. You should also type in a factor to convert the fields values into Multiframe's internal units system. This will allow you or another user to change units and still have the properties displayed correctly. The factor is the number the entered value must be multiplied by to convert it into a Newton, meter, kilogram units system. i.e. in the case where Iw will be entered in units of in⁶, the factor will be 6.820907E-12 (i.e. 1/39.37 to the power of six as there are 39.37 inches in a meter)

Some common units factors are

Name	Property	Units Metric Unit	Factor	English Unit	Factor
Mass	Mass per unit length	kg/m	1.0	lb/ft	1.488
A,Asx,Asy	Cross sectional area	mm ²	1E-6	in ²	6.452E-4
Ix	Major moment of inertia	mm ⁴	1E-12	in ⁴	1.638E-5
Iy	Minor moment of inertia	mm ⁴	1E-12	in ⁴	1.638E-5
J	Torsion constant	mm ⁴	1E-12	in ⁴	1.638E-5
E	Young's Modulus	MPa	1E-6	ksi	6895000
G	Shear Modulus	MPa	1E-6	ksi	6895000
D	Depth	mm	0.001	in	0.0254
B	Breadth or Width	mm	0.001	in	0.0254
tf	Flange thickness	mm	0.001	in	0.0254
tw	Web thickness	mm	0.001	in	0.0254

Deleting a Field

You can delete fields that you have added by using the Delete Field command from the Section menu.

To delete a field or fields from the current group

- **Choose Delete Field from the Section menu**
- **Click in the name of the field to be removed**

If you wish to remove more than one field, shift click on the additional field names

- **Click the OK button**

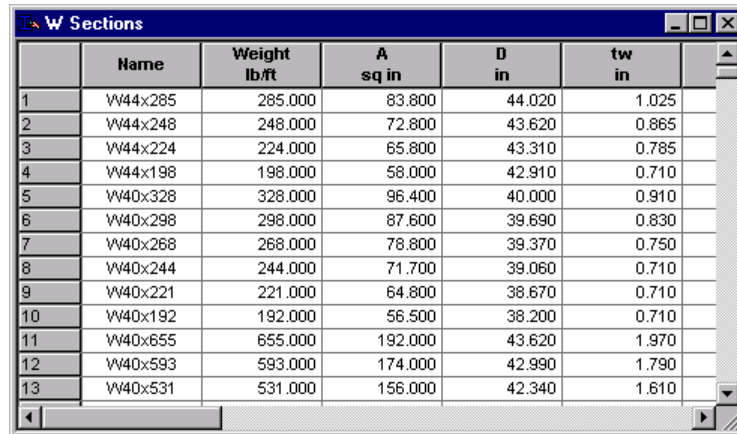
WARNING: Do NOT delete any of first eleven standard fields in a group as Multiframe uses them in its analysis.

Viewing Sections

The sections stored in the Sections Library can be viewed and changed in the Section window of Section Maker. The sections are displayed, a group at a time, in a table in this window.

To make the Sections window visible

- **Choose Sections from the Window menu**



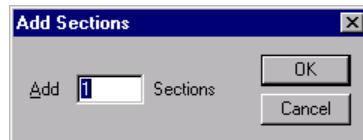
	Name	Weight lb/ft	A sq in	D in	tw in
1	W44x285	285.000	83.800	44.020	1.025
2	W44x248	248.000	72.800	43.620	0.865
3	W44x224	224.000	65.800	43.310	0.785
4	W44x198	198.000	58.000	42.910	0.710
5	W40x328	328.000	96.400	40.000	0.910
6	W40x298	298.000	87.600	39.690	0.830
7	W40x268	268.000	78.800	39.370	0.750
8	W40x244	244.000	71.700	39.060	0.710
9	W40x221	221.000	64.800	38.670	0.710
10	W40x192	192.000	56.500	38.200	0.710
11	W40x655	655.000	192.000	43.620	1.970
12	W40x593	593.000	174.000	42.990	1.790
13	W40x531	531.000	156.000	42.340	1.610

Adding a Section

To add a section or a number of sections to the current group in the library

- **Choose Add Section from the Section menu**

A dialog box will appear allowing you to specify how many sections you wish to add.



- **Type in the number of sections to be added**
- **Click the OK button**

A number of sections titled Section1, Section2 and son on will be added to the current group. They will initially have all their properties set to zero. You can view and edit the added sections in the Section window.

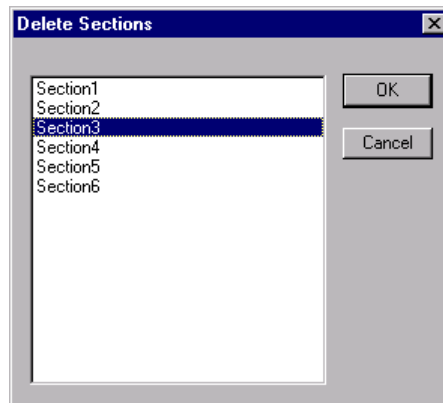
You will only be able to add sections to a group that is unlocked.

Deleting a Section

To remove a section or a number of sections from the library

- **Choose Delete Section from the Section menu**

A dialog box will appear with a list of the names of the sections in the current group



- **Click on the name of the section to be removed**

If you want to remove more than one section, hold down the shift key and click or drag over the additional sections to be removed

- **Click the OK button**

The sections will be removed from the library. Remember that the changes will not be made permanent until you save the library to disk using the Save Library command from the File menu.

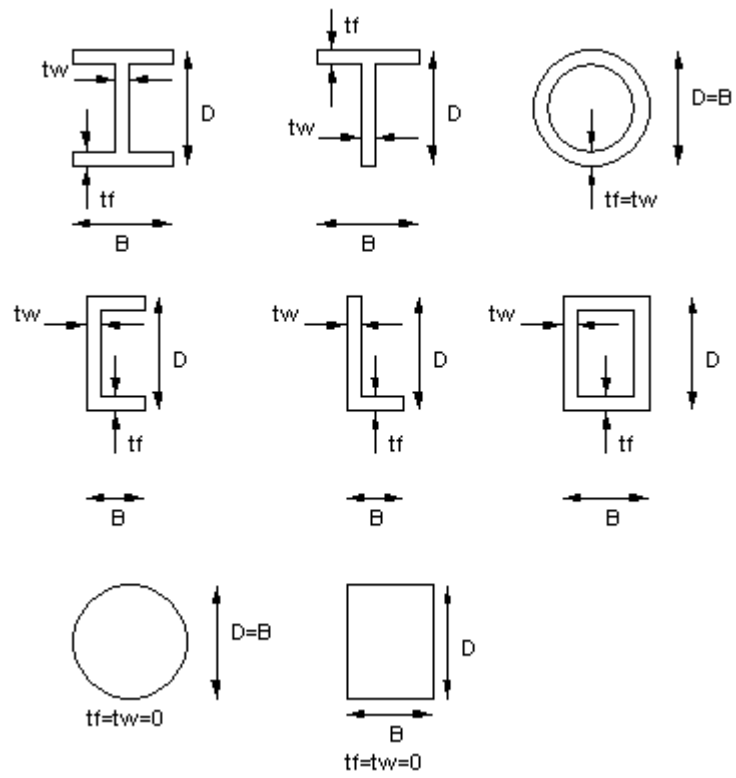
Changing Section Properties To change the value of a property stored with a section

- **Click on the property to be changed**
- **Type in a new value**
- **Press the Enter key**

When you change the properties of a section, you must use the units indicated at the top of the column for the property displayed in that column of the table. The standard properties stored in a new group are

Name	Property	Example Units	
		Metric	English
Mass	Mass per unit length	kg/m	lb/ft
A	Cross sectional area	mm ²	in ²
Ix	Major moment of inertia	mm ⁴	in ⁴
Iy	Minor moment of inertia	mm ⁴	in ⁴
J	Torsion constant	mm ⁴	in ⁴
E	Young's Modulus	MPa	ksi
G	Shear Modulus	MPa	ksi
D	Depth	mm	in
B	Breadth or Width	mm	in
tf	Flange thickness	mm	in
tw	Web thickness	mm	in
fy	Yield Strength	MPa	ksi
fu	Ultimate Strength	MPa	ksi
Sxt (or Zxt)	Elastic Modulus about x at top	mm ³	in ³
Syl (or Zyl)	Elastic Modulus about y at left	mm ³	in ³
Syr (or Zyr)	Elastic Modulus about y at right	mm ³	in ³
rx	radius of gyration about x	mm	in
ry	radius of gyration about y	mm	in
Sx (or Zx)	Plastic Modulus about x	mm ³	in ³
Sy (or Zy)	Plastic Modulus about y	mm ³	in ³
Iw	Warping constant	mm ³	in ³
rz	radius of gyration about weakest axis	mm	in
Asx	Shear area in weak axis direction (x)	mm ²	in ²
Asx	Shear area in strong axis direction (y)	mm ²	in ²

The following diagram will help you determine the dimensional properties. These properties are used by Multiframe for rendering and display of member details and stresses and by Section Maker for placing standard shapes and existing sections.



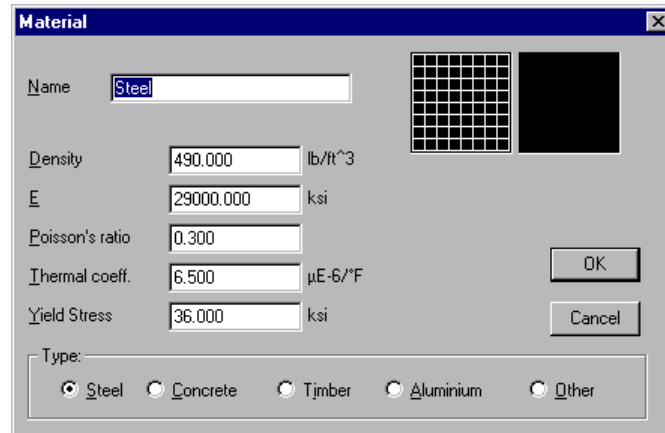
Working With Materials

Adding a Material

To add a material to the library

- **Choose Add Material from the Material menu**

The material properties dialog will appear.

The 'Material' dialog box is shown with a blue title bar. It contains several input fields for material properties: 'Name' (Steel), 'Density' (490.000 lb/ft^3), 'E' (29000.000 ksi), 'Poisson's ratio' (0.300), 'Thermal coeff.' (6.500 μE-6/*F), and 'Yield Stress' (36.000 ksi). To the right of these fields is a pattern design area with a 10x10 grid of dots and a preview window showing a solid black square. At the bottom, there is a 'Type:' section with radio buttons for Steel (selected), Concrete, Timber, Aluminium, and Other. 'OK' and 'Cancel' buttons are located on the right side of the dialog.

- **Type in a name for the material**
- **Draw in the pattern box to design a pattern for the material**

You can change the pattern by clicking in the left hand box. Clicking on a dot in the pattern turns it off, clicking on an empty space adds a dot to the pattern. A sample of the pattern is drawn in the right hand box.

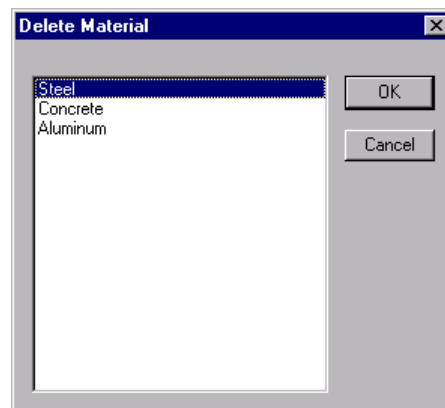
- **Type in values for the material's properties**
- **Click on the radio button which applies to the material's type**
- **Click the OK button**

The material will be added to the list of materials stored in the Sections Library.

Deleting a Material

To delete a material from the library

- **Choose Delete Material from the Material menu**

The 'Delete Material' dialog box has a blue title bar. It features a list box on the left containing the names 'Steel', 'Concrete', and 'Aluminum', with 'Steel' currently selected. To the right of the list box are 'OK' and 'Cancel' buttons.

- **Click on the name of the material you want to delete**

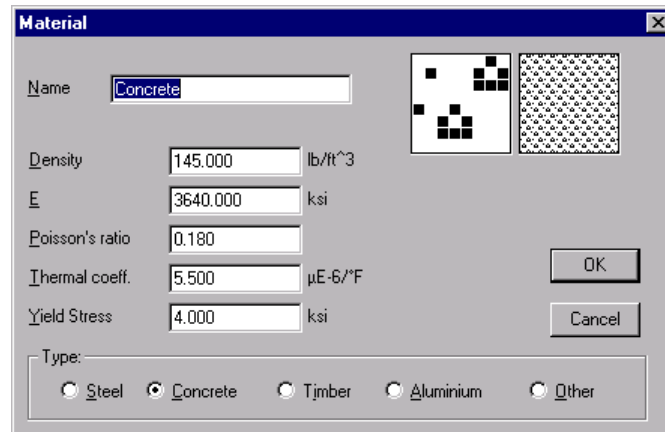
- Click the OK button

Changing a Material

To change the name, pattern or properties of a material

- Choose Edit Material from the Material menu

The material properties dialog will appear.



- Click on the name of the material you want to edit
- Type in a new name, change the pattern or type in new values for the material's properties
- Click the OK button

Printing

The contents of any of the windows in Section Maker can be printed and you can also print out a complete table of every section in the Sections Library. When printing tables they will be printed over multiple pages as there will generally not be enough room on one page for all the rows and columns in the table.

(Macintosh Only)

When you print the Shape window, Section Maker will also print out a summary table of properties alongside the printed shape.

Setting up the Printer

Before printing you should set up the printer with the page size and orientation that you wish to use.

To Set up the Printer

- Choose Page Setup from the File menu

The standard page setup dialog will appear allowing you to enter the appropriate information. You may also enter text to be displayed at the head and foot of each page and set the width of the margins on the page.

Printing a Window

To print the contents of the frontmost window

- Choose Print Window from the File menu

The standard print dialog will appear.

If you wish you can check the Preview button to preview your printed output on screen.

Printing the Library

To print the entire contents of the Sections Library

- **Choose Print Library from the File menu**

The standard print dialog will appear.

The tables of sections for each group in the library will be printed. If there are more rows and columns than will fit one a page the printout will be spread over a number of pages.

Chapter 3

Section Maker Reference

This chapter summarises the overall structure and menu commands of Section Maker.

Windows

Shape Window

Section Maker uses a range of graphical, tabular, graph and report windows.

This window is used for drawing a sections comprising one or more shapes prior to installing it in the sections library.

Data Window

This window is used for viewing and editing the data describing the shapes in the Shape window. It can display tables of section properties or dimensions of the shapes which make up a section.

Group Window

This window is used for viewing and editing the data stored for each group in the Sections Library. One group at a time can be viewed in this window.

Section Window

This window is used for viewing and editing the data for the sections in the library. One group of sections at a time can be viewed in this window.

Properties Window

This window is used for displaying the calculated sectional properties for the shape in the Shape window.

Toolbars

Users of the Windows version of Section Maker can use the icons on the toolbars to speed up access to some commonly used functions. You can hold your mouse over an icon to reveal a pop-up tip of what the icon does.

File Toolbar



The File toolbar contains icons for open, and saving files.

New Library - Open Library - Save Library - Cut - Copy - Paste - Print Preview - About

Group Toolbar



The Group toolbar contains icons for changing the current group.

Previous Group - Next Group

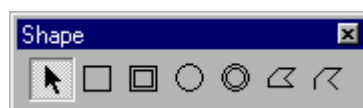
View Toolbar



The View toolbar contains icons for changing the view in the Shape window.

Zoom - Shrink - Pan - Size To Fit - Toggle Grid - Toggle Axes

Shape Toolbar



The Shape toolbar contains icons for drawing shapes in the Shape window.

Select - Rectangle - Hollow Rectangle - Circle - Tube - Closed Polygon - Open Polygon

Menus

Section Maker uses the standard set of Macintosh or Windows menu commands for File, Edit and Windows operations. It also has a range of menus for working with sections and groups of sections.

File Menu

The File menu contains commands for opening and saving files as well as import and export and printing.

New Library

(Windows: Ctrl N / Macintosh: Command N)

Use this to start work on a new library. If you have any changes to the current library unsaved, Section Maker will prompt you to save any changes before starting the new work.

Open Library

(Windows: Ctrl O / Macintosh: Command O)

Open a library which has previously been saved on disk.

If you have any changes to the current library unsaved, Section Maker will prompt you to save any changes before opening the new file.

Import

(Windows Only)

See “Import Submenu”

Export

(Windows Only)

See “Export Submenu”

Close Library

Closes the library and removes all groups and sections from display.

Save Library

(Windows: Ctrl S / Macintosh: command S)

Save the current library data with the same name you saved with last time or the same name the file had when you opened it.

Save Library As

Save the current library in a file with a new name. You can also choose to save the library in a text file format. This can then be read by word processors or other programs.

Page Setup

Set up the printer for printing.

Allows you to set margins, header and footer titles and options on printing the date, time and page numbers.

Print Window

Windows users: Print the contents of the front window on the screen. Allows you to set margins, header and footer titles and options on printing the date, time and page numbers.

Print Library

Print the entire contents of the Sections Library.

Recent File	(Windows Only) Recently opened files will appear at the bottom of the File menu. You can choose them as a shortcut to open them.
Exit/Quit	(Macintosh: Ctrl Q) Leave the Section Maker program. If you have any work unsaved, Section Maker will prompt you to save any changes to the library before quitting.
Import Submenu	(Windows Only) The Import submenu provides you with options to import sections and sections libraries.
DXF	Imports the shapes in a DXF file into the Shape window. See Place DXF for Macintosh equivalent.
FORTTRAN Text	Import the text version of the sections library.
Export Submenu	(Windows Only) The Export submenu allows you to export a sections library.
FORTTRAN Text	Save the sections library in a text file format.
Edit Menu	The Edit menu contains commands for copying and pasting tabular data, selecting objects and working in tables.
Undo	(Windows: Ctrl Z / Macintosh: command Z) Undo the last action you carried out. The name of this item will change to reflect the command that can be undone.
Redo	(Windows Only) Not currently active in Section Maker
Cut	(Windows: Ctrl X / Macintosh: command X) Remove the current selection and place it on the clipboard
Copy	(Windows: Ctrl C / Macintosh: command C) Copy the current selection to the clipboard
Paste	(Windows: Ctrl V / Macintosh: command V) Paste the contents of the clipboard into the current selection
Clear	Remove the current selection without placing it on the clipboard.

Select

The Select menu has commands for automatically selecting parts of the drawing in the Shape window.
See “Select Submenu”

Show Clipboard

Make the clipboard visible/invisible.

Fill Down

(Windows: Ctrl Down Arrow / Macintosh: Ctrl D)
Repeat the cell at the top of the list of selected cells in the Data window down the list of selected cells.

Fill Right

(Windows: Ctrl Right Arrow / Macintosh: Ctrl R)
Repeat the cell at the left of the list of selected cells in the Data window across the list of selected cells.

Select Submenu

The Select menu has commands for automatically selecting parts of the drawing in the Shape window.

Select All

(Windows: Ctrl A / Macintosh: command A)
Automatically selects all the shapes in the Shape window

Select Polygons

Automatically selects all the polygonal shapes in the Shape window.

Select Circles

Automatically selects all the circular shapes in the Shape window

Select Rectangles

Automatically selects all the rectangular shapes in the Shape window

View Menu

The View menu contains commands for controlling the display in the Shape window.

Zoom

(Windows: Ctrl W / Macintosh: command W)
Zoom in on part of the current display. A cross-hair will appear and the view to be viewed in close-up may be selected by pressing the mouse button and dragging a rectangle surrounding the area of interest. Release the button to draw the zoomed view.

Shrink

(Windows: Ctrl E / Macintosh: command E)
Reduce the size of the drawing in the Shape window to half its current size.

Pan

(Windows: Ctrl R / Macintosh: command R)
Pan across the drawing displayed in the Shape window. Press and drag in the window to move the drawing.

Size To Fit

(Windows: Ctrl T / Macintosh: command T)
Scale the drawing in the Shape window so that it just fits inside the window.

Size	Set the maximum and minimum coordinates available in the Shape window. Use this to set up the overall coordinates before you begin drawing a section.
Grid	Switch on or off the use of the grid in the Shape window and set the spacing of the grid.
Axes	Turn on or off the display of axes in the Shape window
Principal Axes	Turn on or off the display of the principal axes of the section in the Shape window
Font	Set the font size and style for the text in the frontmost window.
Numbers	Set the type of numeric format you would like to use to display numbers in the frontmost window. You can choose to use decimal or scientific notation and specify how many digits of precision you wish to display.
Units	Choose to work in Metric (mm) or English (inches) units.
Status Bar	(Windows Only) Allows you to turn on or off the display of the status bar
Toolbar	(Windows Only) Allows you to turn on or off the display of the toolbar at the top of the Section Maker program window. See "Toolbar Section" for more information on the toolbars available in Section Maker.
Shape Menu	The Shape menu contains commands for working with Shapes in the Shape window.
Place Section	Place an existing section from the Sections Library into the Shape window. You can use this to build up a section out of existing sections. If the section you select is one of the standard structural shapes which come with Multiframe, an approximate shape will be created.
Place Shape	Place a standard structural shape in the Shape window. This provides an easy and precise way of automatically placing an I, C, L or T section or a rectangular or circular tube or a rectangular or circular bar. You can type in dimensions on a sketch of the shape to create it.
Place DXF	(Macintosh Only)

	Places the shapes in a DXF file into the Shape window. See Import DXF for Windows equivalent.
Install	(Windows: Ctrl I/ Macintosh: command I) Install the shapes in the Shape window as a section in the Sections Library. You do this to make the sections data available to Multiframe for analysis or so you can use the section with other shapes in Section Maker in the future.
Taper	Create a number of sections from two existing sections by interpolating the sections properties. This is useful for modeling the sections needed to simulate a tapered sections with a number of intermediate sections. You can use this in conjunction with the subdivide command in Multiframe for modeling tapered members.
Duplicate	(Windows: Ctrl D / Macintosh: command D) Duplicates all the selected shapes in the Shape window a given number of times in a specified direction. A dialog allows you to enter the spacing in each direction and the number of duplicates to be created.
Rotate	Rotates all the selected shapes in the Shape window a specified number of degrees about the origin of the axes. A dialog allows you to enter the number of degrees of rotation. Rotation is positive anti-clockwise.
Rescale	Multiplies the coordinates of all the selected shapes in the Shape window by a specified scaling factor in each axis direction. This has the effect of rescaling the selected shapes by the specified amounts.
Move	Allows you to move the selected shapes in the Shape window a specified distance This provides a more accurate way of moving shapes rather than dragging them with the mouse.
Flip Horizontal	Reflects the selected shapes in the Shape window about a vertical axis passing through the centroid of the area of the selected shapes.
Flip Vertical	Reflects the selected shapes in the Shape window about a horizontal axis passing through the centroid of the area of the selected shapes.
Align	Align the selected shapes in the Shape window. A dialog will let you specify whether to align the objects to the grid or to each other and whether the align is done vertically or horizontally.
Align To Centroid	(Windows Only) See "Align To Centroid Submenu"
Arrange Menu	See "Arrange Submenu"

Align to Centroid Submenu

(Windows Only)

The Align to Centroid submenu moves the selected shapes in the Shape window as a group so that the centroid of the area of the selected shapes is aligned with the origin of either or both of the x and y axes. You will usually use this command prior to installing the section in the Sections Library as it will make the calculation of all the sections properties relative to a set of axes passing through the centroid of the section.

Centroid

Aligns both x and y centroids to the x and y axes.

X Axis Only

Aligns the x centroid to the x axis

Y Axis Only

Aligns the y centroid to the y axis

Arrange Submenu

The Arrange submenu has commands for controlling the order in which shapes are drawn in the Shape window. If you have the display of material patterns turned on, the shapes drawn last may obscure the shapes drawn first.

Move To Front

Moves the selected shapes forward so that they are drawn last and will be in front of all other shapes.

Move To Back

Moves the selected shapes backward so that they are drawn first and may be obscured by other shapes.

Move Forwards

Moves the selected shapes just in front of the shapes in front of them so that they are drawn after those shapes and will be displayed in front of them on the screen.

Move Backwards

Moves the selected shapes just behind the shapes behind them so that they are drawn before those shapes and may be obscured by them.

Material Menu

The Material menu contains commands for working with materials in the sections library.

Add Material

Add a material to the Sections Library. This material will then be available for use in any of the sections you draw. You enter the properties for the material and can design a pattern to be used in shapes made from this material

Delete Material

Remove a material or a number of materials from the Sections Library.

Edit Material

Change the name, properties or pattern of a material stored in the Sections Library.

Select Material

Choose a material from the Sections Library to be used for the selected shapes in the Shape window. When the section properties for the section are calculated, these shapes will take their Young's Modulus and Shear Modulus from the data stored with the material. The pattern of the material will be displayed in the shapes which are selected when you use this command.

Remove Material

Removes the material types from the selected shapes in the Shape window. Section Maker then treats these shapes as holes or voids.

Section Menu

The Section Menu contains commands for working with sections and groups of sections.

Add Group

Add a group to the Sections Library. A new group can be used to store a number of related sections together. You enter a name and type for the group. It will be made the current group and displayed in the Group and Section windows.

Delete Group

Remove a group or a number of groups from the Sections Library.

Add Field

Add a field to the current group in the Sections Library. A field can be used for storing additional properties for a section. After adding a field, you should enter the name, units and units factor for the field in the Group window.

Delete Field

Delete a field or number of fields from the current group in the Sections Library. You should NOT delete any of the first eleven standard fields as Multiframe requires them for analysis.

Select Group

Choose which group is to be displayed in the Group and Section windows. This group is referred to in this manual as the current group.

Group Info

Displays a dialog allowing you to specify the properties and name of the current group.

Add Section

Add a section or a number of sections to the current group. The sections will be displayed in the Section window where you can type in values for the sections' names and properties..

Delete Section

Delete a section or a number of sections from the current group.

Group Organiser

(Windows Only)

Displays a dialog allowing you to move groups of sections from one sections library to another.

Display Menu

The items in the Display menu control the display of tables in the Data window and symbols in the Shape window.

Properties

(Macintosh Only)
Display the table of calculated section properties for the shapes in the Shape window

Polygons

Display the table of polygon coordinates, material types and thicknesses for the polygons in the Shape window

Circles

Display the table of circle coordinates, material types and thicknesses for the circles in the Shape window

Rectangles

Display the table of rectangle coordinates, material types and thicknesses for the rectangles in the Shape window

Materials

Turn on or off the display of materials in the Shape window. If this item is checked, the patterns for the appropriate materials will be displayed inside the shapes in the Shape window. If this item is unchecked, the patterns will not be displayed.

Shape Numbers

Turns on and off the display of the number of each shape in the Shape window. The number is displayed in the center of the shape and is prefixed by a letter code for the type of shape, p for polygon, c for circle and r for rectangle. You can use these numbers to refer to the shapes in the Data window.

Polygon Numbers

Turns on and off the display of the number of each vertex of each polygon in the Shape window. You can use these numbers to refer to the polygon coordinates displayed in the Data window.

Window Menu

The items in the Window menu control the display of windows in Section Maker

Tile Horizontal

Arranges the currently visible windows down the screen to fill the screen.

Tile Vertical

Arranges the currently visible windows across the screen to fill the screen.

Arrange Icons

(Windows Only)
Tidies up the display of window icons in the program window.

Shape

Make the Shape window visible and bring it to the front

Data	Make the Data window visible and bring it to the front
Group	Make the Group window visible and bring it to the front
Section	Make the Section window visible and bring it to the front
Properties	Make the Properties window visible and bring it to the front
Tile	(Macintosh Only) Lay out the windows so that they fit together to fill the screen.
Stack	(Macintosh Only) Stack up the windows on the screen from top left to bottom right so that the windows are near to their maximum size.
Drawing Layout	(Macintosh Only) Resizes the windows so that the Shape, Properties and Data windows are conveniently located for drawing new sections and viewing their properties.
Help Menu	(Windows Only) The Help menu contains commands for accessing Section Maker's on-line help system.
Table of Contents	Displays the Table of Contents for the on-line help system.
About Section Maker	Displays version information for this version of Section Maker.

Chapter 4

Sections Calculations

This chapter describes the methods that Section Maker uses to calculate section properties.

Properties for Analysis

Multiframe uses the matrix stiffness method of solution for solving a system of simultaneous equations to determine the forces and deflections in a structure. As part of this analysis it uses sections properties stored in the Sections Library. The key analysis properties used by Multiframe are

Name	Property	Units Metric	English
Mass	Mass per unit length	kg/m	lb/ft
A	Cross sectional area	mm ²	in ²
Ix	Major moment of inertia	mm ⁴	in ⁴
Iy	Minor moment of inertia	mm ⁴	in ⁴
J	Torsion constant	mm ⁴	in ⁴
E	Young's Modulus	MPa	ksi
G	Shear Modulus	MPa	ksi

If you use the option to include the affects of shear deformation, then Multiframe will also use

Asx	Shear area in minor direction	mm ²	in ²
Asy	Shear area in major direction	mm ²	in ²

For display of rendered shapes and section orientation and for placing sections into Section Maker the following dimensional properties are also required

D	Depth	mm	in
B	Breadth or Width	mm	in
tf	Flange thickness	mm	in
tw	Web thickness	mm	in

When you add a section to the Sections Library you must insure that all of the analysis properties are correctly entered and are all non-zero. If you want to render in Multiframe or place the section in Section Maker you must also insure that the dimensional properties are correctly entered.

Steel Designer also uses additional properties from the Sections Library. If you add any sections to the library you should insure that the following properties are entered correctly.

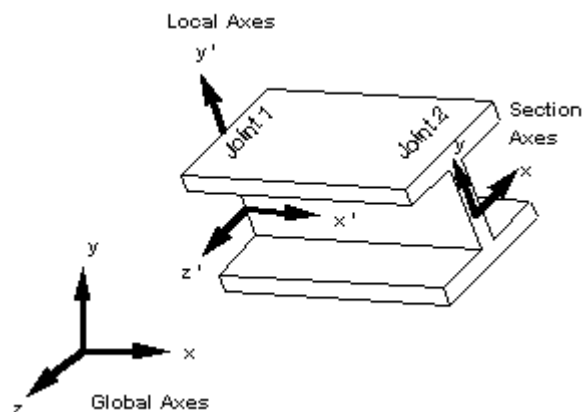
Name	Property
Zx (or Sx)	Section modulus about x axis
Zy (or Sy)	Section modulus about y axis
rx	Major radius of gyration

r_y	Minor radius of gyration
r_z	Radius of gyration about weakest axis

When you add a section to the Sections Library you must ensure that all of the properties above are correctly entered and are all non-zero.

Axes and Sign Convention

Section Maker uses a simple two dimensional coordinate system for defining structural shapes. When the shape is used in Multiframe3D it will be placed in the local coordinate system of the member so that the x axis in Section Maker aligns with the local z' axis of the member. This means that in the stiffness matrix of Multiframe3D (see Chapter 4 of the Multiframe3D user manual) the moment of inertia $I_{z'}$ corresponds to the moment of inertia I_x calculated in Section Maker. Similarly $I_{y'}$ corresponds to I_y in Section Maker.



The orientation of the section relative to the position of the member is set using the orientation command in Multiframe 3D. The orientation is the angle between the y' axis (the y axis of the section) and a vertical plane passing through the ends of the member.

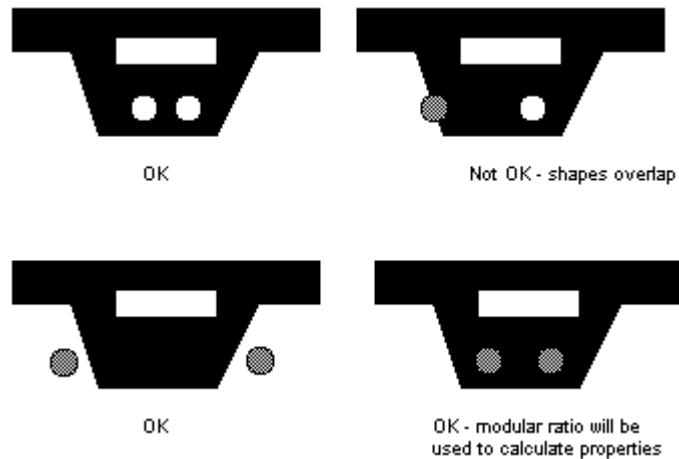
Overlapping Shapes

If you create a section which is composed of a number of overlapping shapes you should be aware of how Section Maker treats these for calculation purposes.

First, don't partially overlap shapes, the properties won't be computed correctly. You may have a shape completely inside another or completely separate but they may not partially overlap.

When you have one shape inside another shape and the inner shape is not a hole, the properties of any shape made from a material which is not the reference material will be factored by the ratio of the Young's Modulus of the material to the Young's Modulus of the reference material (modular ratio).

For sections made from steel and concrete, Section Maker assumes that concrete is the reference material and the properties of the steel shapes will be factored by the modular ratio E_s/E_c where E_s is the Young's Modulus of the steel and E_c is the Young's Modulus of the concrete.



Capacity

The absolute maximum capacities for Section Maker are as follows

Number of groups in a library	500
Number of sections in a group	800

The size of your library will also be limited by the amount of disk space you have. As a rough guide, each section in the library will require about 85 bytes of disk space. This means you can store a total of approximately 8000 sections on an 800k floppy disk. The standard sections libraries which come with Multiframe are usually no more than 200k in size.

Text File Format

When you save a sections library in text format the data is formatted according to the following procedure

```

Number of groups in the file
For each group
1 if the group is locked or 0 otherwise
Name of the group
Number of the group in the library
Kind of material 1 for steel, 2 for concrete, 3 for timber, 4
for aluminum, 0 otherwise
Shape of sections in the group I=1, C=2, equal L=3, unequal L
=4, T=5, RHS=6, SHS=7, Tube=8, Circle=9, bar=10, round bar=11.
No of sections, no of fields and no of analysis properties in
the group
Position of the analysis properties in the fields of the group
For the number of fields
Name of the field
For the number of fields
Units of the field
For the number of fields
Factor of the field
For the number of sections
Name of the section
For the number of fields
Value of the field for this section
  
```

The easiest way to understand the format is to use the Export command to save a text file from a sample library and to review or modify that text file.

References

You may find the following books useful to refer to if you need information on the methods used to calculate sections properties.

- **Roark's Formulas for Stress and Strain, 6th Edition**

W C Young, McGraw Hill, New York, 1989

- **The Behavior and Design of Steel Structures**

N S Trahair and M A Bradford, Chapman and Hall, London, 1988

- **Elements of Strength of Materials**

S P Timoshenko and D H Young, Van Nostrand, 1968

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