

TOWER Geometry Wizard

Introduction

The Geometry Wizard feature is an abstraction to the standard TOWER interface to simplify the creation of a new tower model. Tower models are created using a graphical interface to create towers configurations including bodies, crossarms, legs, panels and bracing patterns. A live graphical view of the tower is displayed on the screen as the tower is created. Once the tower geometry is created, it is saved as a ***.tow** file and the Wizard is closed. The entire tower model, or portions of the model, can be saved in a Panel component library for reuse in future Geometry Wizard sessions.

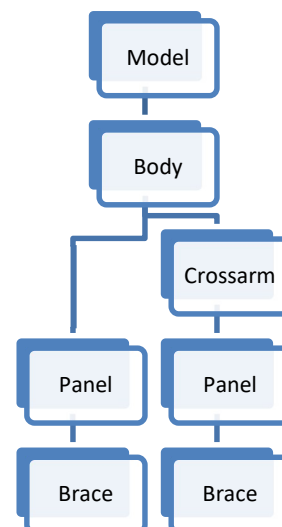
The Geometry Wizard is used to create the tower configuration with joints and members. It is not intended to build a complete and final tower model with all the member properties, sections, insulators, loads, etc. A tower model created using the Geometry Wizard will need to be edited using the features covered in Sections 3, 4 and 5 of the TOWER manual to enter member bracing ratios, Ecc. and Rest. codes, connection information, sections, insulators, and loads.

This Technical Note will cover the different dialogs and commands available in the Geometry Wizard and will walk through the process to build the **ex1codes.tow** example model which ships with the TOWER software.

Getting Started with the Geometry Wizard

Before starting the Geometry Wizard, you should go to **File/Preferences...** and select the appropriate component files for Steel Material Library (***.smp**), Angle Library (***.ang**), Bolt Library (***.blt**), and Panel Library (***.pan**). The first three component files are required to use the Geometry Wizard and the Panel Library is used to save the entire tower model or portions of the model so they can be reused in future Geometry Wizard sessions. To start working with the Geometry Wizard, use the **File/New/Geometry Wizard...** command. If you have not selected valid component library files for the steel material, angle, and bolt component library files, you will be prompted to select them before proceeding with the Geometry Wizard. Once you select the component files, you cannot change them without exiting the Geometry Wizard.

The Geometry Wizard utilizes a hierarchy format consisting of five modeling primitives. It's important to understand the use of each primitive and the relationship between the primitives. Section 4.18.1 of the TOWER manual describes each primitive. The primitive hierarchy is shown to the right.



Creating a Model

After starting the Geometry Wizard, the first step is to create the model in the *Model* tab of the Geometry Wizard Dialog. The *Model* primitive is used to define the model name and the steel and bolt properties which will be utilized by all members in the tower model which is created. If you have more than one type of bolt in the tower, we recommend selecting the most common bolt type in the dialog and then you can edit the bolt types once the TOWER model is created.

One important point to keep in mind when using the Geometry Wizard is the '*Finish*' button on the bottom of the dialog. Pressing this button will create the TOWER model and exit the Geometry Wizard. Therefore, you only want to click the '*Finish*' button when you are done creating the model.

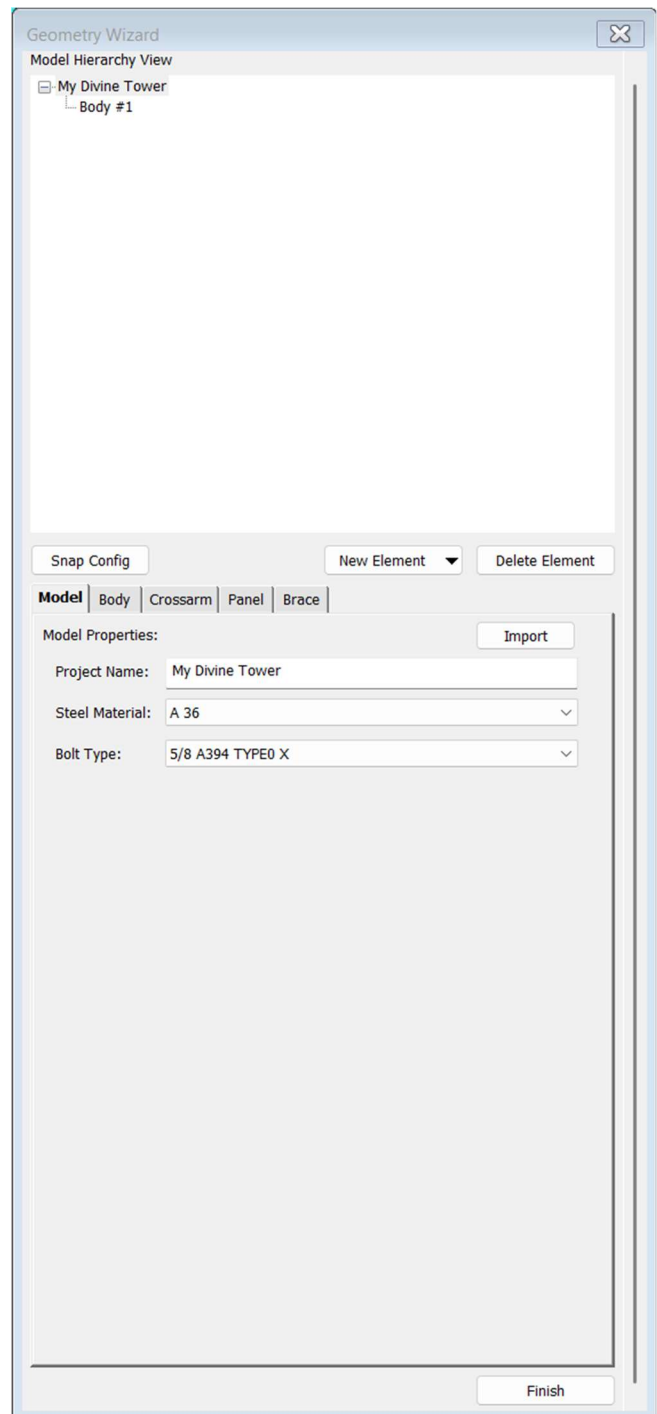
However, it is possible to save your progress in the Geometry Wizard by saving the primitive to the new Panel Component Library. To do so, right click on the Model Name in the Hierarchy View and select the '**Add to Panel Library**' command in the context menu and the model with all of its primitives will be saved.

To open the model in another Geometry Wizard session, click the '*Import*' button in the Geometry Wizard dialog and select the model from the list of saved primitives.

Creating Bodies in a Model

Once you've created a Model, the next step is to define bodies. A *Body* primitive is used to define the general shape of the tower, excluding any crossarms. By default, the first body will be located at the bottom of the tower and have four vertical legs. Subsequent body segments are then stacked on top of each other to complete the tower outline. Body segments can be as short or as large as you like.

The default body segment is titled '*Body #1*' and the properties of the body can be entered by highlighting it in the hierarchy view. Additional body segments can be created by selecting '*Body Segment*' from the '*New Element*' pull down menu or by right-clicking on a body in the hierarchy view and selecting **New/Body Segment**. The right-click context menu includes additional options, such as **Delete**, **Duplicate**, **Autofill**, **Cut**, **Copy**, **Paste**, **Show** and **Hide** that can be useful when building the geometry. The Shape pull down menu in the Body tab includes several template shapes to aid in creating body segments. These are explained in the TOWER manual.



Creating Crossarms in a Model

Crossarm primitives are used to model members which extend outward to the left or right of the tower body. As shown in the primitive hierarchy organization chart, crossarms belong to a body segment. A body segment may contain one or more crossarms although crossarms are not required. Crossarm shapes can be triangular, square, rectangular, or trapezoidal and crossarms may include the vertical support or upper chord members. The shape and size of the crossarm is defined by entering values for the Height, Horizontal Length, Tip Height, and Tip Depth for the lower and upper chords of the crossarms. The '*Lock Dimension*' check box allows you to lock the upper and lower crossarm values to automatically align the dimensions. Explanations of the crossarm data fields are in the TOWER manual.

To create a crossarm, highlight the desired *Body Segment* in the hierarchy view and then either select the '*Crossarm*' option from the '*New Element*' pull down menu or right-click on the *Body Segment* in the hierarchy view and selecting **New/Crossarm**.

Crossarms can be saved in the Panel Library which makes it possible to create standard crossarms and reuse them across different tower models in future Geometry Wizard sessions.

Creating Panels in a Model

The *Panel* primitive in the Geometry Wizard is used as a container to hold one or more *Brace* primitives. You do not add members using the Panel tab but think of a Panel as the area where you want to add bracing within the tower. *Panels* can be added to *Body Segments* and *Crossarms* and multiple *Panels* can be added to a *Body Segment* or *Crossarm*. *Panels* can be saved in the Panel Library which makes it possible to create standard panel bracing configurations and reuse them across different tower models in future Geometry Wizard sessions.

To create a *Panel*, highlight the desired *Body Segment* or *Crossarm* in the hierarchy view and then either select the '*Panel*' option from the '*New Element*' pull down menu or right-click on the *Body Segment* or *Crossarm* in the hierarchy view and selecting **New/Panel**.

The Panel tab contains an optional list of predefined brace patterns that can be applied or you can create a custom brace pattern when you add the braces in the Brace tab.

Adding Braces in a Panel

The *Brace* primitive is used to define brace members in the tower model. Brace members may be load carrying members or redundant members and brace members can only be added within a *Panel*. The majority of the members in a tower model will likely be entered using the *Brace* primitive in the Geometry Wizard.

Brace members are predominantly entered using the graphical interface of the Geometry Wizard. Brace members can be associated with a tower face and two different symmetry options are available to aid in entering brace members.

The '*Snap Config*' button in the Geometry Wizard dialog includes different options that can be selected to make it easier when graphically adding brace members to the tower. Snap commands include:

- *Member distance*: A comma separated list of distance intervals along members
- *Member fraction*: A comma separated list of fraction intervals along members
- *Elevation*: A comma separated list of interval heights
- *Joints*: Snap to the endpoint of any member segment
- *Freehand*: Global coordinates

Braces can be graphically added to the model using either a line segment or a polyline mode. In the line segment mode, pick two joint locations to create a member. Each member is a disjointed line segment that can be dragged independently. In the polyline mode, a new member is created with each joint click, providing an easy way to enter bracing patterns. The members are connected at the joints and are dragged together as a system.

Saving Primitives

The Geometry Wizard can save each of its primitive types, except *Braces*, to a Panel Library file and the saved primitives can be reused in the Geometry Wizard. The Panel Library file is referenced in the ***File/Preferences...*** dialog.

To add a primitive to the library, right click on the primitive in the Model Hierarchy View and select '***Add to Panel Library***'. Assign the primitive a unique name to be stored in the library. The primitive and all of its dependents will be saved, which allows a user to save an entire tower *Model*, a *Body*, a *Crossarm*, or a *Panel*. This ability to save and reuse towers or tower components is a major benefit of using the Geometry Wizard.

To recall a primitive, begin by creating a new primitive of the desired type (i.e. *Model*, *Body*, *Crossarm*, or *Panel*) and click the '***Import***' button. All primitives of the given type will be listed in the dialog. Selecting a primitive to import will replace the current primitive in the model with a copy of the one selected from the Panel Library.

Let's Build a Model

To demonstrate many of the features of the Geometry Wizard, here's a step-by-step guide or worked example to create the joints and members of the **ex1codes.tow** example tower model with the Geometry Wizard.

You may find it helpful to open the **ex1codes.tow** model that ships with the TOWER program in a separate TOWER instance so you can see what the final model will look like.

Step 1) Set the component library files.

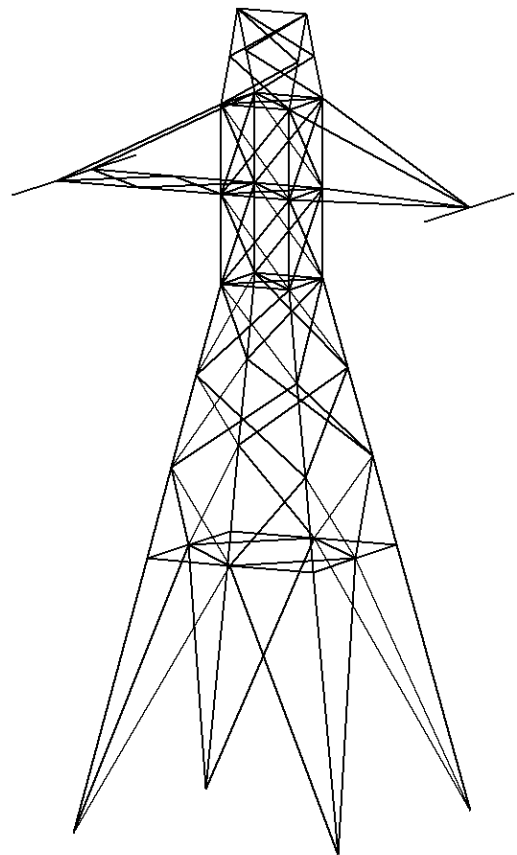
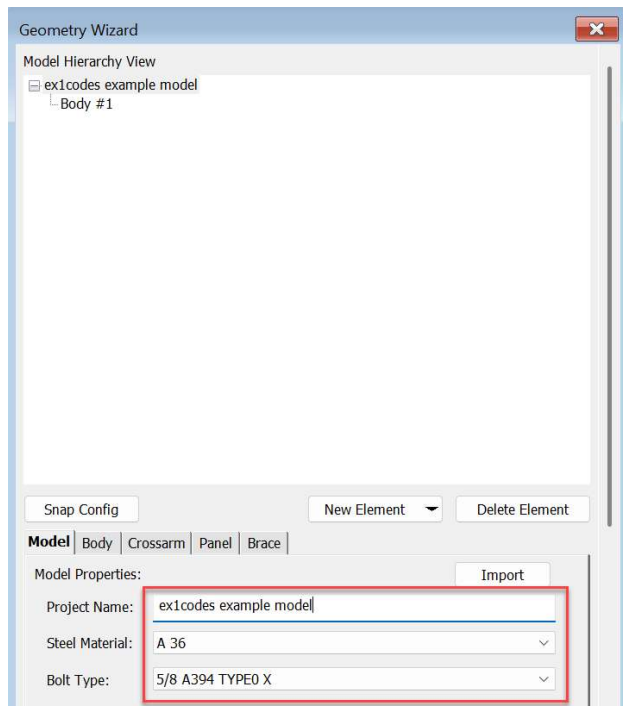
Open TOWER, go to **File/Preferences...** and select the Component Library files for Steel Material, Angles, Bolts, and Panel Library shown below. You can also select the other Component files but those are not utilized for the Geometry Wizard.

	File or Directory	Default for New Projects
4	Part/Assembly Library	C:\Users\Public\Documents\PLS\PLS_CADD\examples\parts\demo.prt
5	Schema File	C:\Users\Public\Documents\PLS\PLS_CADD\examples\parts\demo.prt
6	Steel Material Library	C:\Users\Public\Documents\PLS\TOWER\examples\components\example.smp
7	Angle Library	C:\Users\Public\Documents\PLS\TOWER\examples\components\example.ang
8	Bolt Library	C:\Users\Public\Documents\PLS\TOWER\examples\components\example.blc
9	Cable Library	C:\Users\Public\Documents\PLS\TOWER\examples\components\example.cab
10	Equipment Library	C:\Users\Public\Documents\PLS\TOWER\examples\components\example.eqp
11	Connection and Anchor Library	C:\Users\Public\Documents\PLS\TOWER\examples\components\example.can
12	Insulator Library	C:\Users\Public\Documents\PLS\TOWER\examples\components\example.inl
13	Panel Library	C:\Users\Public\Documents\PLS\TOWER\examples\new.pan

Step 2) Create the Model.

Go to **File/New/Geometry Wizard...**

In the Geometry Wizard dialog, enter the *Project Name*, *Steel Material* and *Bolt Type* as shown below.



Ex1codes.tow model

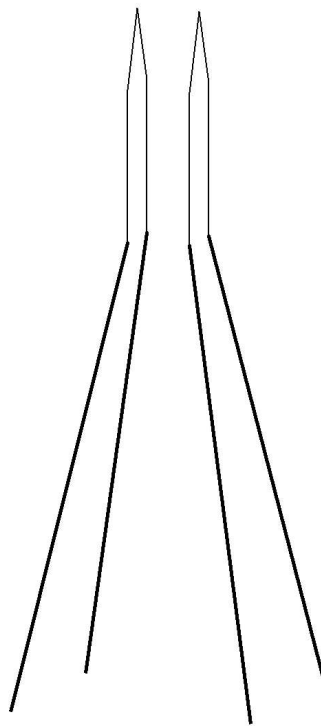
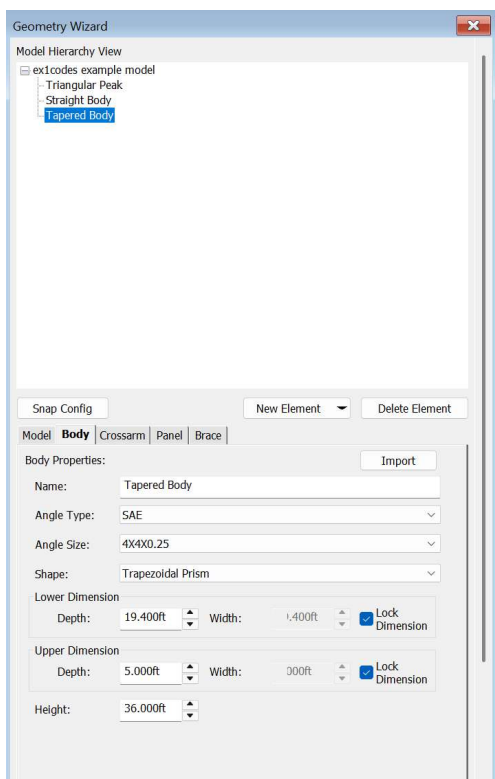
Step 3) Create the Body Segments.

Let's create three body segments for this tower. One for the lower tapered body, one for the middle straight body, and one for the upper triangular peak.

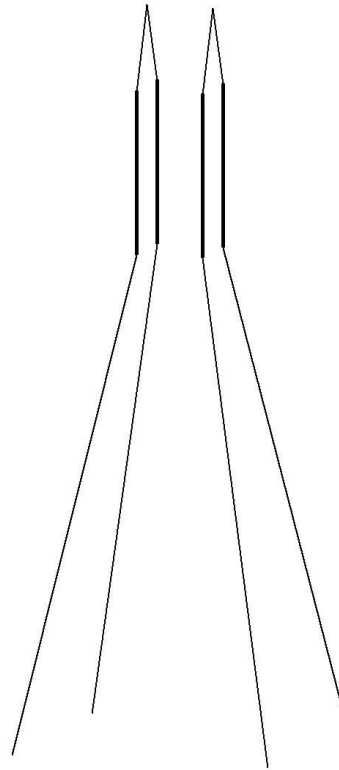
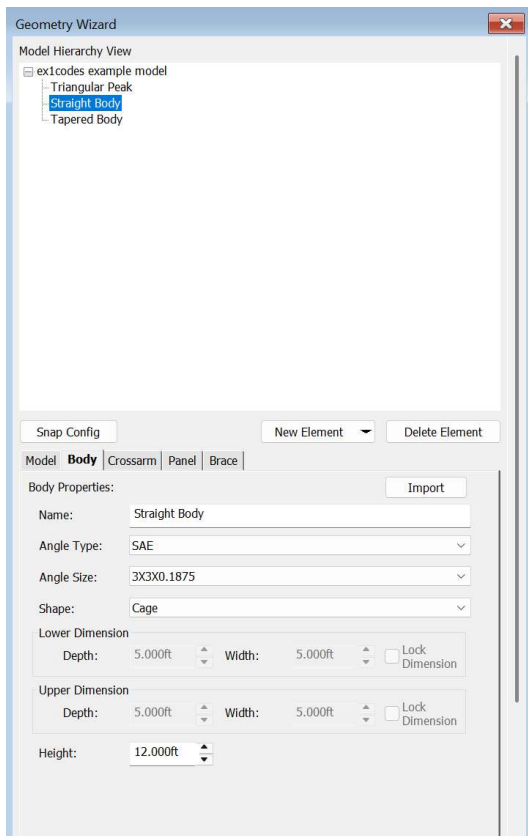
Body #1 is created by default in the Geometry Wizard, so we'll need to create two additional *Body Segments*. You can create two more *Body Segments* by selecting 'Body Segment' from the 'New Element' pull down menu or right-click on the Model in the hierarchy view and selecting **New/Body Segment**.

Once you have three Body Segments created, you can select each one and enter the properties shown in the screenshots below to create the geometry.

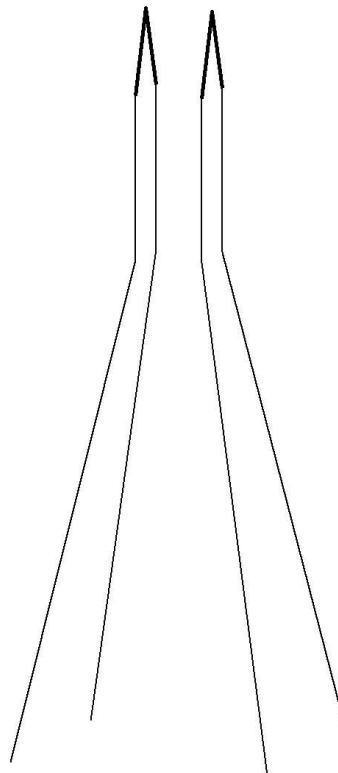
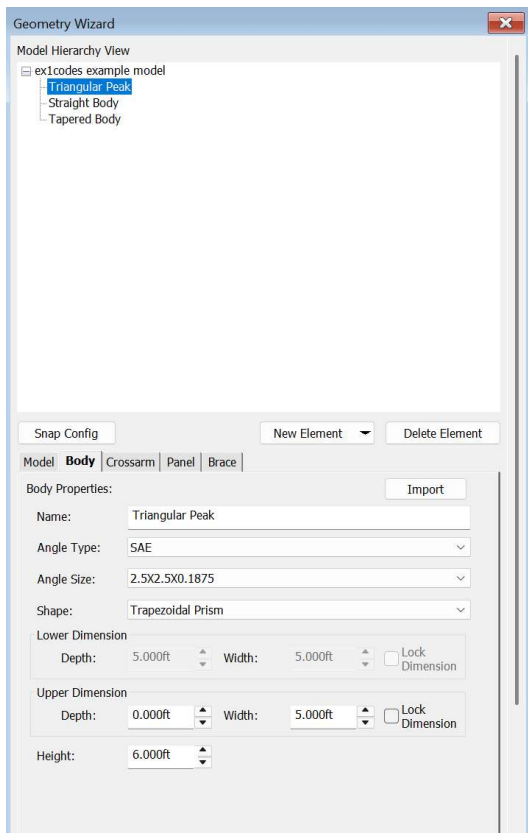
You could decide to use more body segments for this tower, maybe one body segment for each X-brace panel, for example, but we just chose three for this example.



Properties for *Tapered*
Body Segment



Properties for *Straight*
Body Segment



Properties for *Triangular*
Peak Body Segment

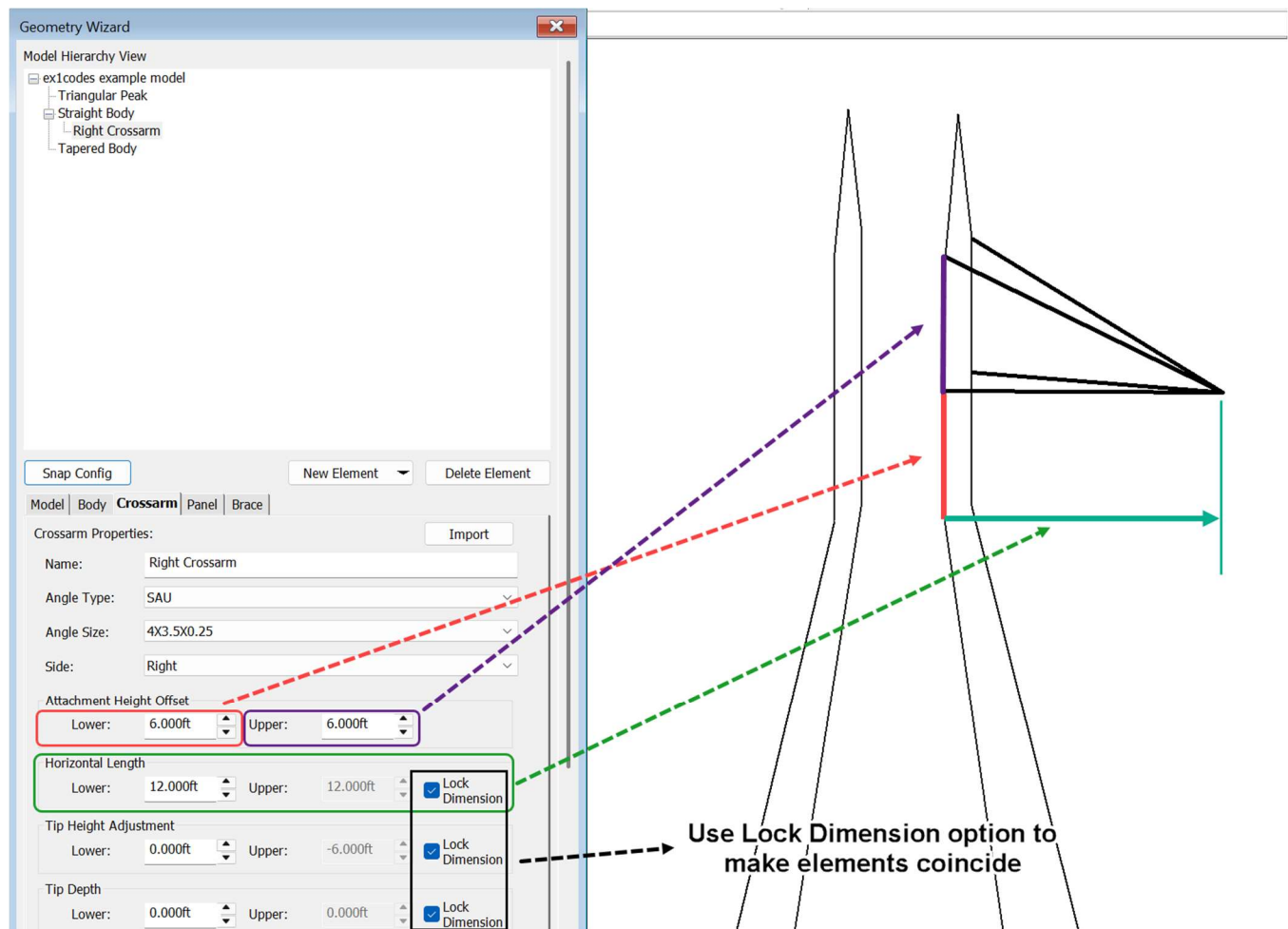
Step 3a) Save the Model.

This step is optional but highly recommended to avoid losing your progress if you need to exit the Geometry Wizard. Right-click on the Model Name in the Model Hierarchy View and select 'Add to Panel Library'. You'll be prompted to enter a name for this primitive. Let's call it 'ex1codes example model with body segments'.

If you need to exit the Geometry Wizard for any reason, you can get back to this spot by opening the TOWER program, go to **File/New/Geometry Wizard**, click the 'Import' button and import the 'ex1codes example model with body segments' from the Panel Library list.

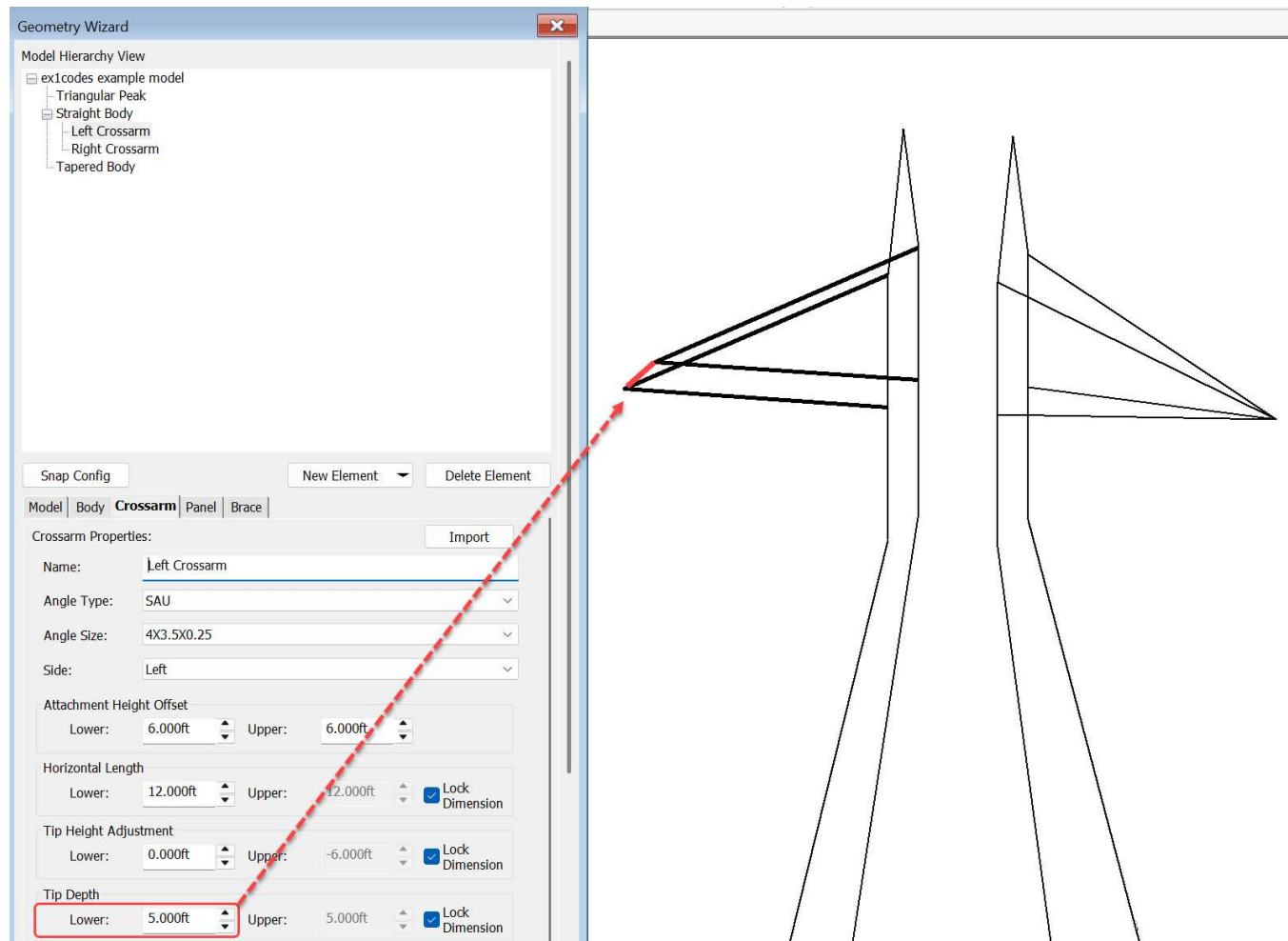
Step 4) Create the Right Crossarm.

To create the pointed crossarm on the right side of the tower, select the Straight Body in the hierarchy view and either right-click and select **New/Crossarm** in the pop-up context menu or select 'Crossarm' in the *New Element* pull down menu. Next enter the Name and Angle information for the crossarm and select the Right side. Then enter the arm dimensions as shown below.



Step 5) Create the Left Crossarm.

Next add a new rectangular crossarm on the left side of the Straight Body segment the same as was done for the right crossarm and using the values shown below.



Notes about *Crossarm* Primitives:

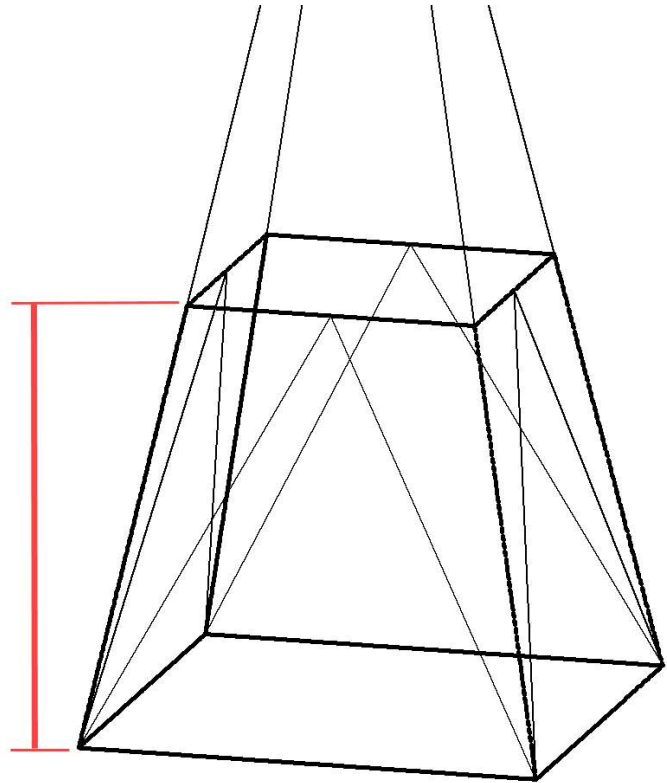
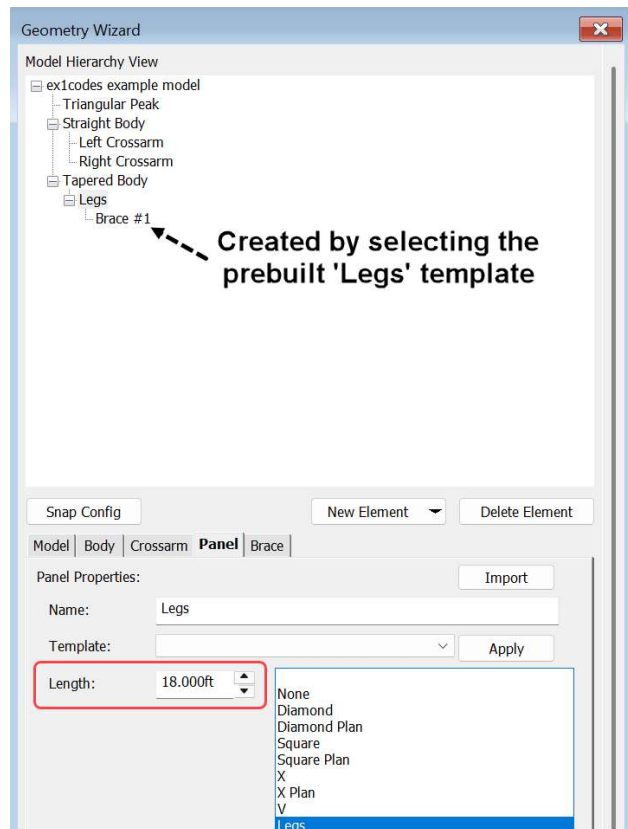
- The Angle Type and Size will be the same for the lower and upper chords of the crossarm. This can be changed once the tower model is saved.
- To eliminate the upper chords, set the upper Attachment Height Offset to zero.
- *Crossarms* extend from the body edges. *Crossarm* members which fall inside body segment will be entered as braces later in the process.
- *Crossarms* can be saved in the Panel Library for reuse in future Geometry Wizard sessions. To save, right click on the Crossarm in the Model Hierarchy View and select 'Add to Panel Library' in the pop-up context menu.

Step 6) Create Panels for *Tapered Body Segment*

Next, we'll create four panels within the *Tapered Body Segment*. These will be used to store the braces for the tapered body. By default, panels begin at the bottom of the Body Segment and are stacked vertically.

To create a panel for the legs of the tower, select the *Tapered Body* in the hierarchy view and either right-click and select **New/Panel** in the pop-up context menu or select '*Panel*' in the *New Element* pull down menu. Next

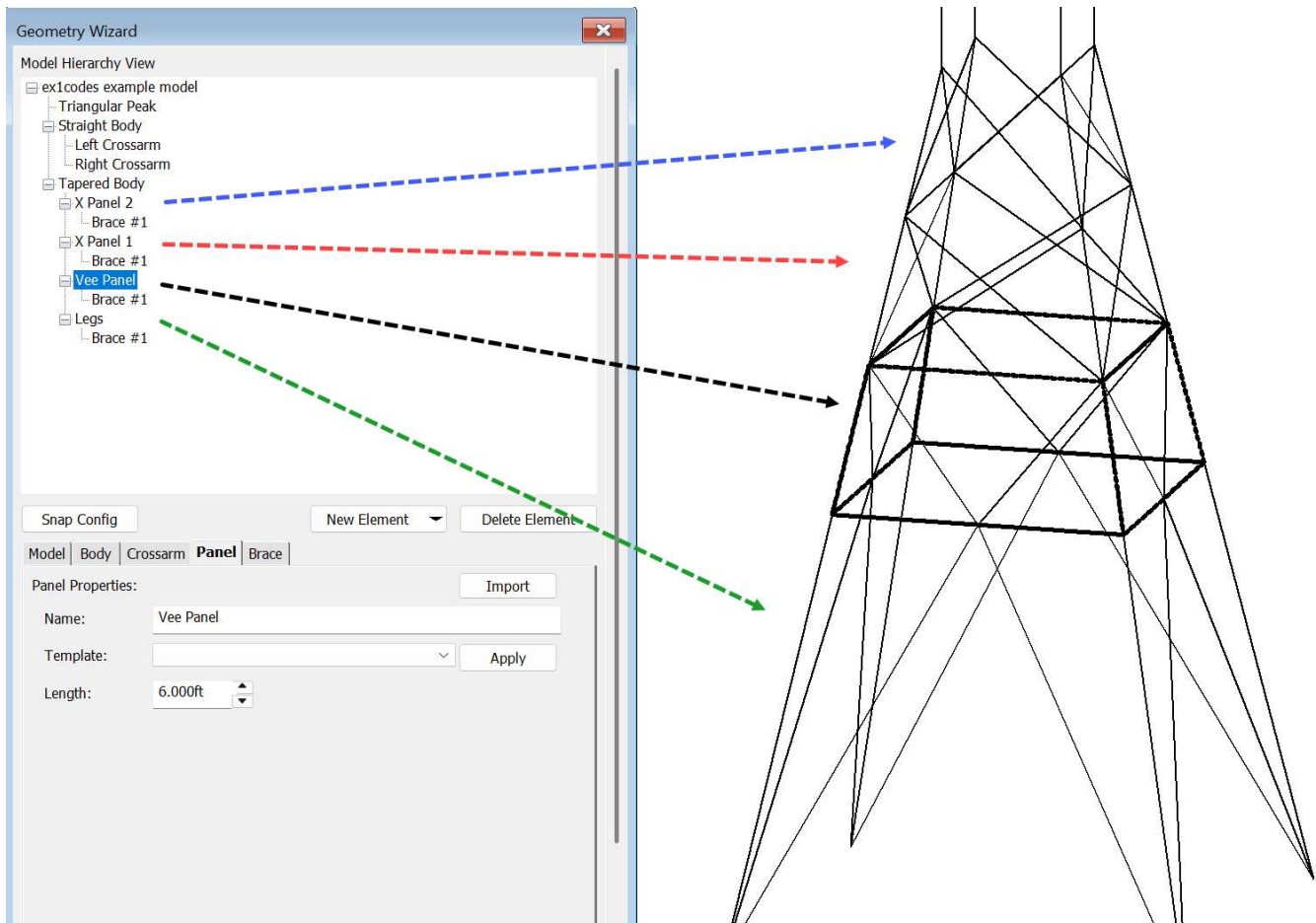
enter the *Name* and the length of the panel. You can also select a prebuilt bracing template for the panel in the *Template* pull down menu and then click 'Apply'. Selecting a bracing template will create a Brace pattern which can be edited later in the process. If you don't select a template at this point, you can add the bracing later. Below are the values for the bottom panel.



Next, we'll create three more Panels in this body segment to store the vee and X-brace panels using a similar process. Each panel will be 6 ft in length. The *Vee Panel* used the 'V' template and the *X Brace panels* used the 'X' template. Below are the completed *Tapered Body* panels, with the Vee panel shown in the figure below.

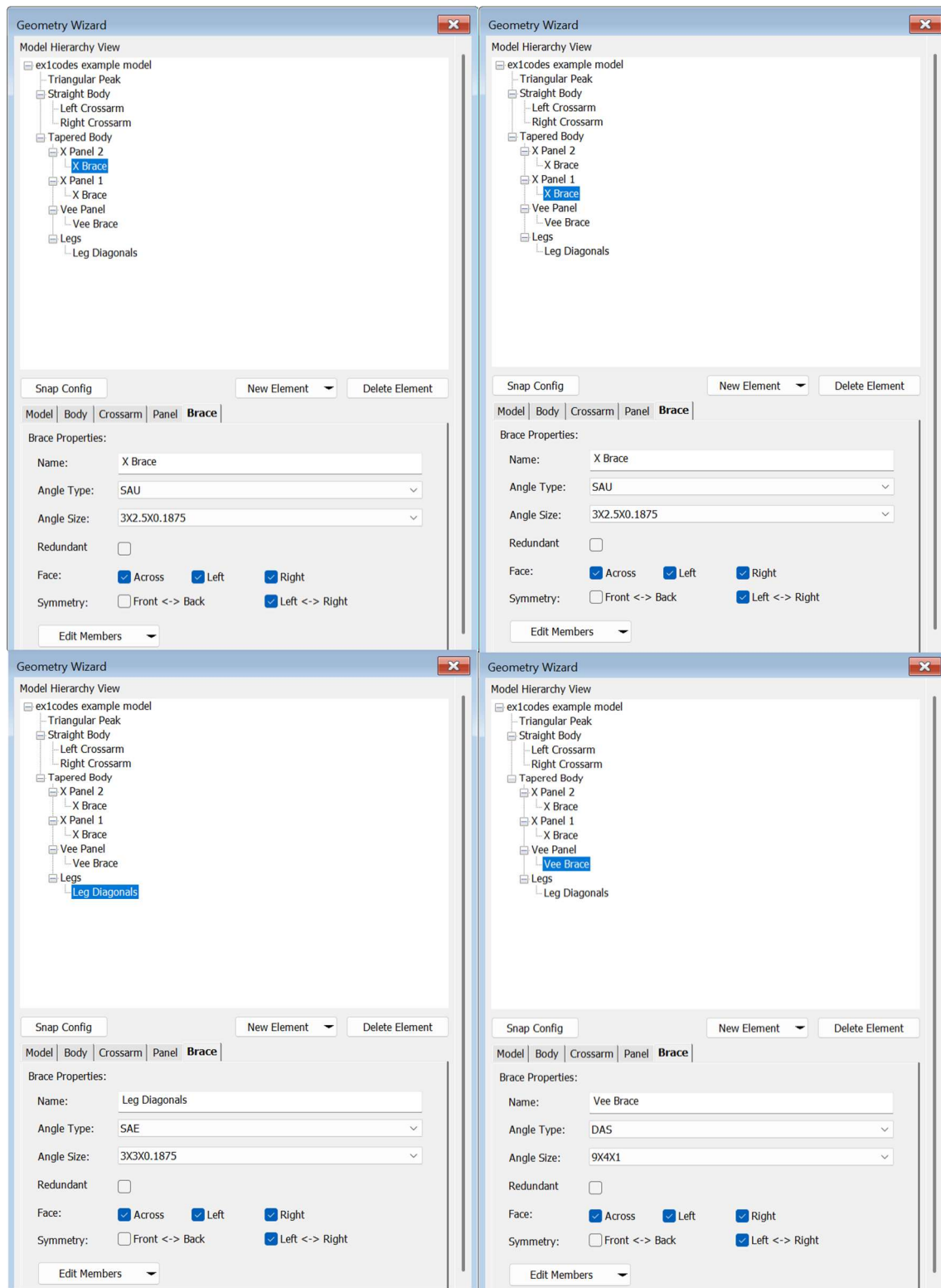
Notes about *Panel* primitives:

- Selecting a prebuilt template for the *Panel* is the most efficient approach. Unique brace patterns can be added as *Brace* primitives later in the process if there is not an appropriate prebuilt template.
- A *Panel* can only contain one prebuilt template.
- The prebuilt template patterns do not contain the horizontal members at the top or bottom of the panel. Those will be added as *Brace* primitives later in the process.
- *Panels* can be saved in the Panel Library for reuse in future Geometry Wizard sessions. To save, right click on the *Panel* in the Model Hierarchy View and select 'Add to Panel Library' in the pop-up context menu.



Step 6a) Edit Prebuilt Brace Patterns in *Tapered Body Segment*

We'll need to edit the prebuilt brace patterns which were created in the previous step, which is a simple and straightforward process. Select the appropriate Brace in the Model Hierarchy View and edit the Name, Angle Type, Angle Size as necessary. You can edit the faces where the members are located and change the member symmetry, if necessary. Members can also be marked as Redundant members. Below are the properties of the four *Braces* in the four *Panels* in the *Tapered Body Segment*.



Step 6b) Create Additional Braces for Tapered Body Segment

The *Tapered Body Segment* contains horizontal strut members and a plan diamond brace system at the top of the leg extensions. These will be created as two new *Brace* primitives. These members can be positioned at the top of the *Legs* Panel or the bottom of the *Vee* Panel in this model.

As mentioned previously, *Brace* members are predominantly entered using the graphical interface of the Geometry Wizard. The '*Snap Config*' button in the Geometry Wizard dialog includes different options that can be

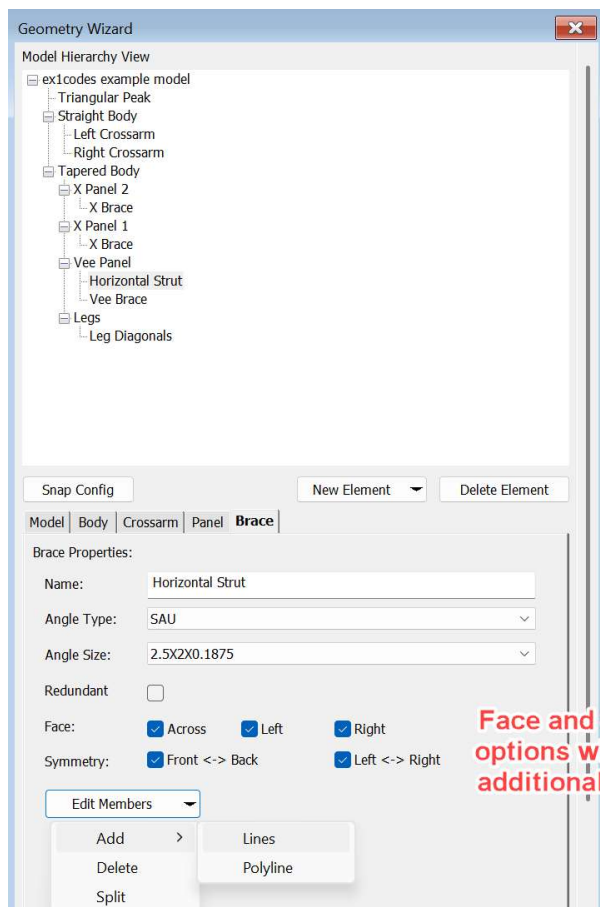
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selected to simplify graphically adding brace members to the tower. Braces are entered using the line segment or polyline mode found in the 'Edit Members' pull down in the *Brace Properties* tab. The Line Segment mode is used to pick a start and end joint to create the brace member. The Polyline Mode can be used to create new brace members with each joint click. For example, you could use the Polyline Mode to create a zig-zag pattern of redundant members in a leg extension by clicking at the ends of each redundant member.

Note that brace symmetry differs from standard TOWER member symmetry in that brace members remain constrained within the face(s) of its parent panel, rather than using a pure reflection about the axis. Brace symmetry and face rotation are additive, making it possible to reflect each brace member for 8 total copies.

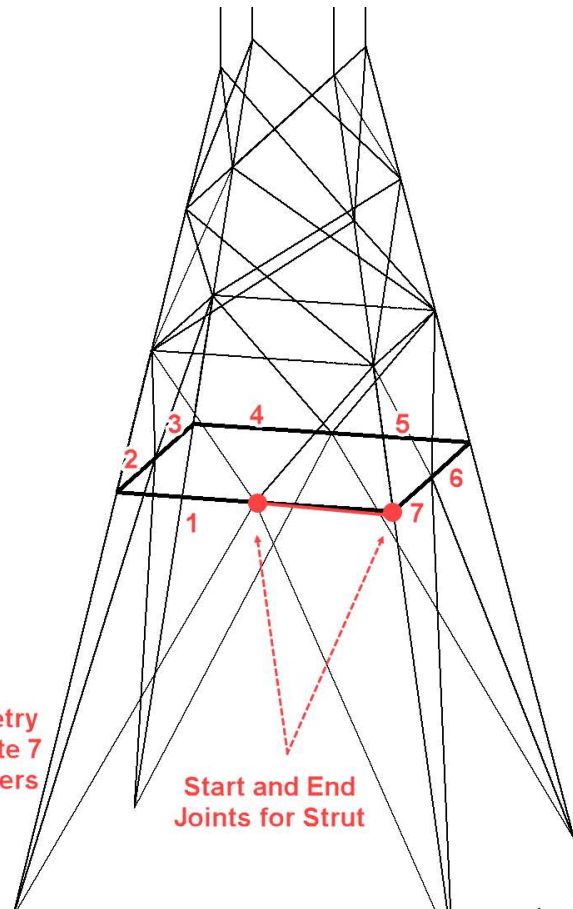
Let's place them at the bottom of the *Vee Panel* for this example. Select the *Vee Panel* in the Model Hierarchy View and either right-click and select **New/Brace** in the pop-up context menu or select 'Brace' in the New Element pull down menu. Select the Joints option in the 'Snap Config' button to connect the struts to the existing joints. Also select all three Face options and both Symmetry options in the Brace Properties tab. Next select the **Edit Members/Add/Line** option and left click on the start and end joints shown in the figure below. After clicking the start and end joints, right-click on the tower view and select the **Finish Brace Pick Points** option from the context menu.

An alternative approach would be to add the horizontal struts using the Polyline Mode, with no symmetry, and clicking on each of the end points of the eight members.



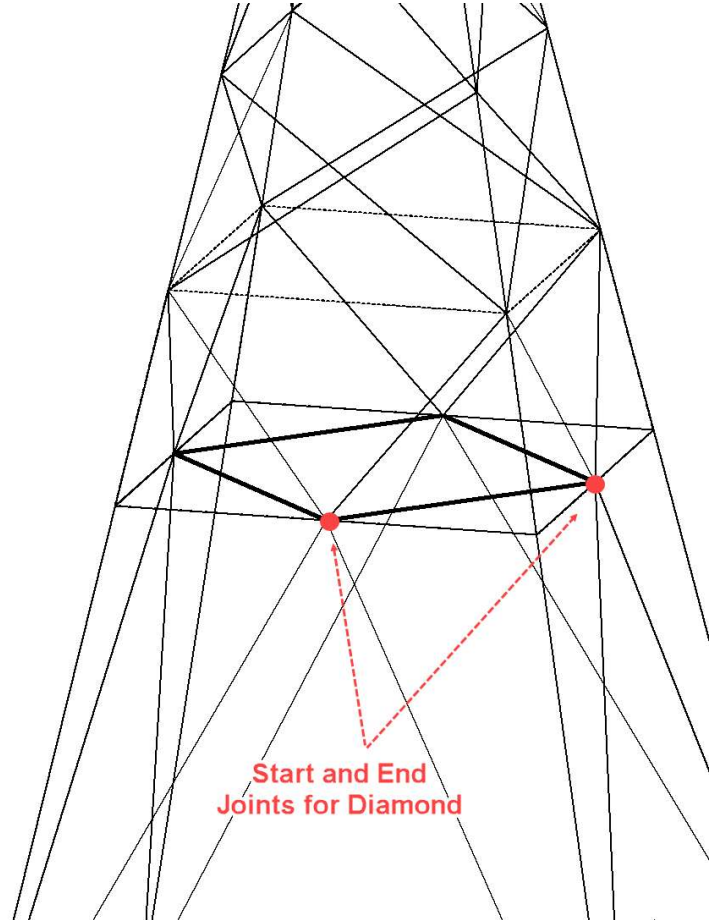
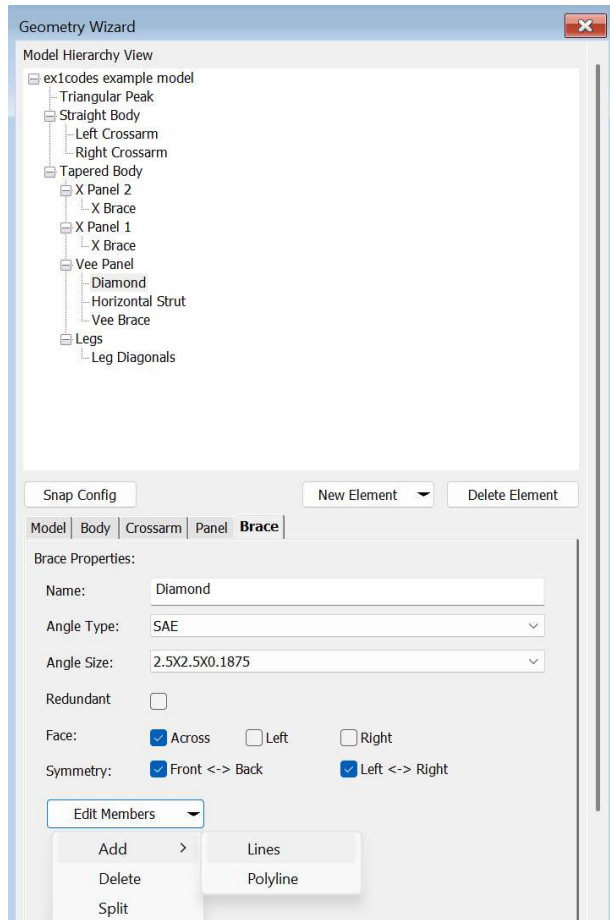
Face and Symmetry options will create 7 additional members

Start and End Joints for Strut



To add the diamond plan brace pattern, add another *Brace* primitive to the *Vee Panel*, select the *Across* Face and both Symmetry options and left click on the start and end joints shown in the figure below. The diamond braces

could also be entered using the Polyline Mode, with no symmetry, and clicking on each of the four joints to create the diamond.

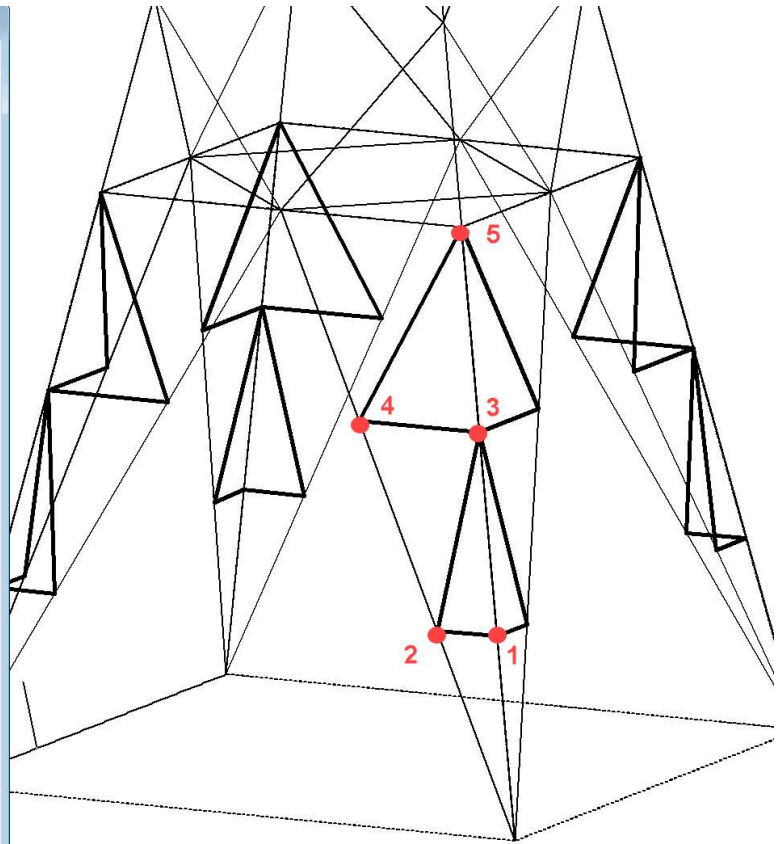
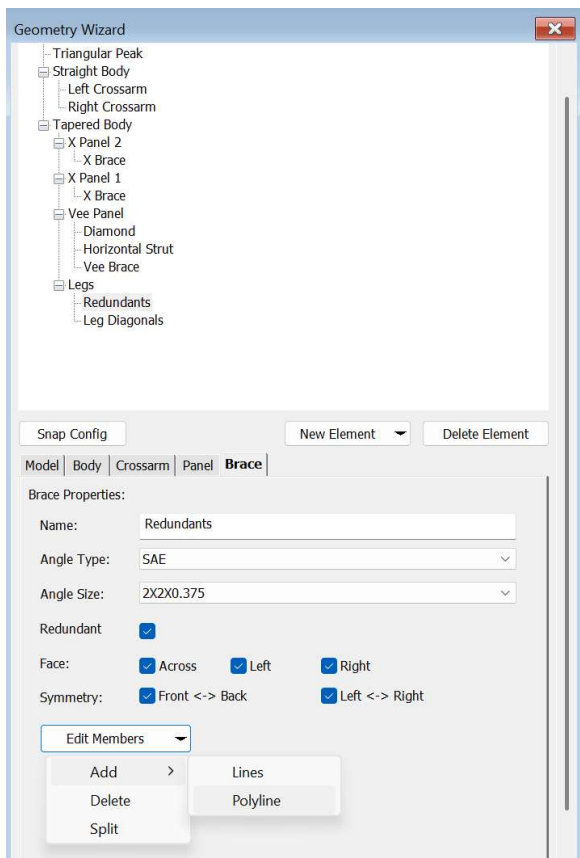


Braces can be deleted by selecting the *Brace* in the Model Hierarchy View and clicking the '*Delete Element*' button. All members in the selected brace primitive will be removed.

While not used in this step, there is also a Split command for Braces which can be used to construct a joint at the intersection of two members. A joint created by the split command will continue to reside at the intersection even if the two members are moved in a way that changes the intersection position. To use the Split command, click on one member then click on a second member that the first one intersects.

Step 6c) Create Redundant Bracing for *Tapered Body Segment*

This step will describe how to enter a redundant bracing system in the *Leg Extension* Panel. Let's create a redundant bracing system which divides the 18ft tall legs into 3 equal segments of 6ft. First select the Edge Fraction (%) option in the 'Snap Config' dialog box and enter 0.333 for the fraction value. Next add a new Brace to the Legs Panel. Enter the data for the new redundant bracing system in the dialog shown below and select the **Edit Members/Add/Polyline** option. Next left click at the joint locations in order from 1 to 5 as shown in the Figure below. By entering a fraction value of 0.333 in the 'Snap Config' dialog box, the cursor will automatically snap to the one third and two third points along the leg and diagonal and create the new joints 1, 2, 3 and 4 when you left click. Checking all of the Face and Symmetry options will create the redundant system on each of the eight faces of the tower legs.

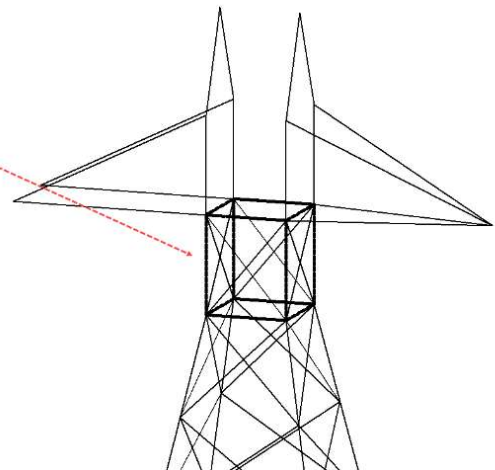
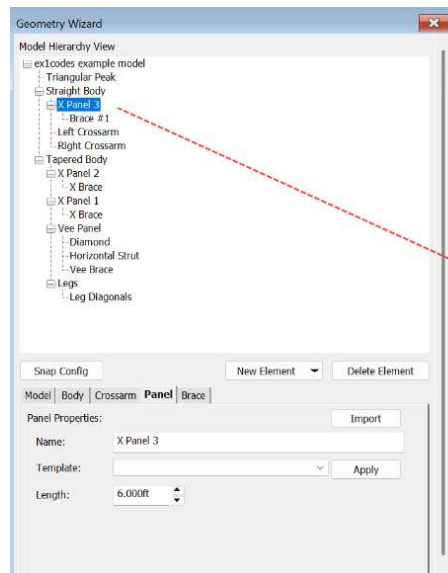


You can use the same method to add redundant bracing to the *Vee* and *X Panels*, if desired.

Step 7) Create Panels for *Straight Body Segment*

We'll need to create two panels within the *Straight Body Segment* to store the braces. Use the same process described in Step 6 to create the lowest of the two panels. Next enter the Name and the length of the lowest panel and select the prebuilt X Panel in the Template pull down menu and click 'Apply'. Below are the values for the lowest panel.

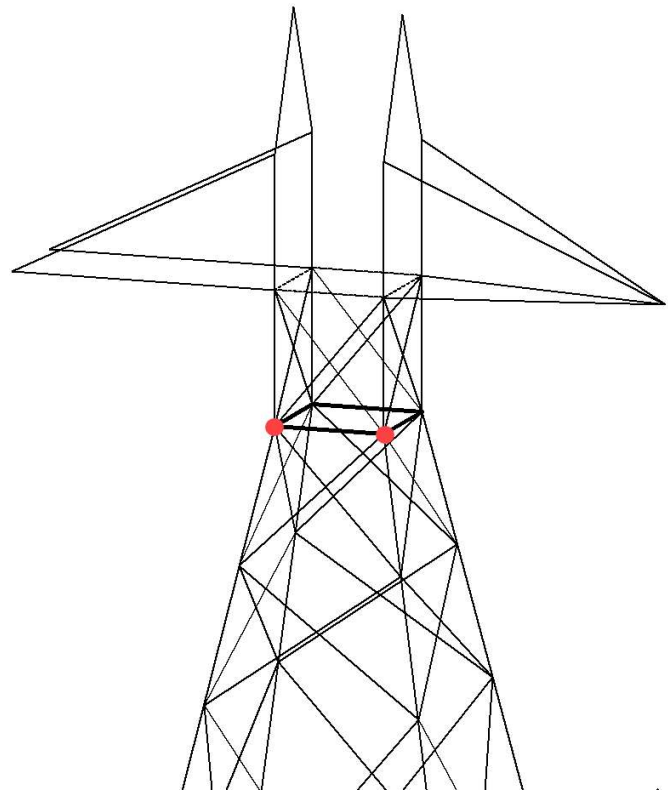
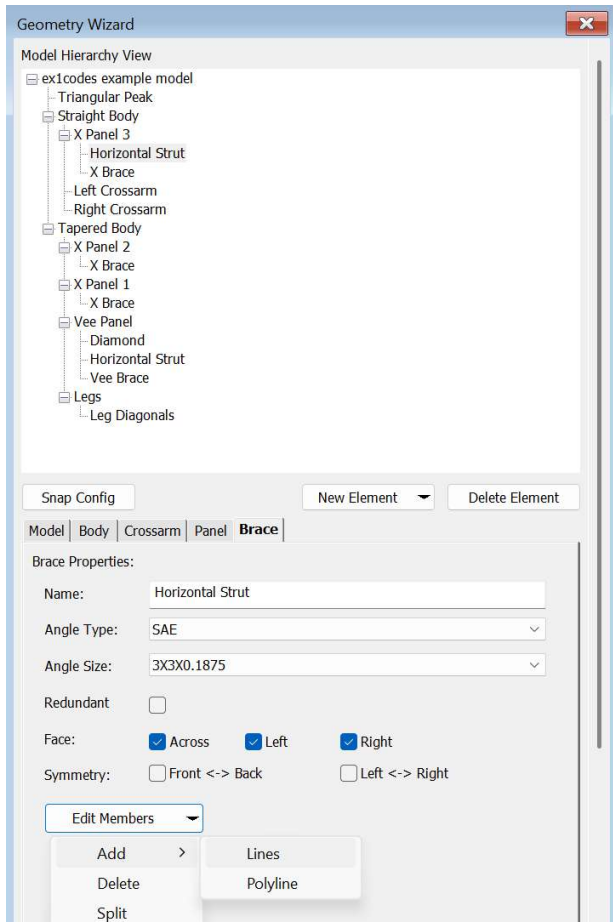
Once the Panel is created; you can select the Brace primitive which was created in the Model Hierarchy View and edit the Brace Name and select the SAE Angle Type and 2.5 x 2.5 x 0.1875 Angle Size to complete the X Braces.



Step 7a) Create Braces for *Straight Body Segment*

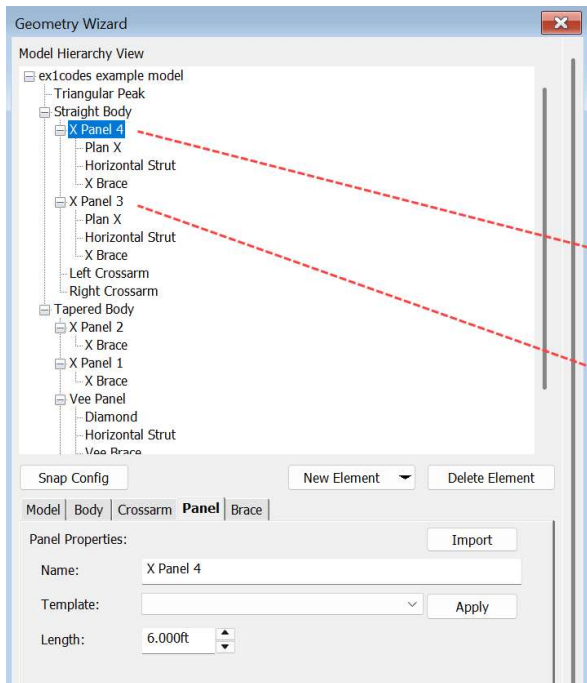
The *X Panel 3* contains horizontal strut members and a plan X-brace system at the bottom of the *Panel*, which is also the tower waist. These will be created as two new *Brace* primitives.

Select *X Panel 3* in the Model Hierarchy View and either right-click and select **New/Brace** in the pop-up context menu or select 'Brace' in the *New Element* pull down menu. Select the *Joints* option in the 'Snap Config' button to connect the struts to the existing joints and select all three Face options in the Brace Properties tab. Next use the **Edit Members/Add/Line** option and left click on the start and end joints shown in the figure below. After clicking the start and end joints, right-click on the tower view and select the Finish Brace Pick Points option from the pop-up context menu.



To add the plan X brace pattern, add another *Brace* primitive to *X Panel 3*, select the *Across Face* and *Front<->Back Symmetry* options, select the **Edit Members/Add/Line** option and left click on the start and end joints of one of the plan X brace members.

To create the upper *Panel* in the *Straight Body Segment*, we can use either the Copy/Paste commands or the Duplicate command to reduce rework. Copy/Paste can be used to replicate a primitive anywhere in the model hierarchy. The Duplicate command is used to replicate a primitive but only within the same primitive in the model hierarchy. For this example, we'll use the Duplicate command to create the upper *Panel*. To do this, right-click on *X Panel 3* and select Duplicate from the context menu. This will create a new *X Panel 4* which is an exact copy of *X Panel 3*, including the braces. Although we don't need to do it on this model, you could select *X Panel 4* or any of its Braces and change any of the properties or add or delete Braces. Below is a view of the completed *Straight Body Segment*.



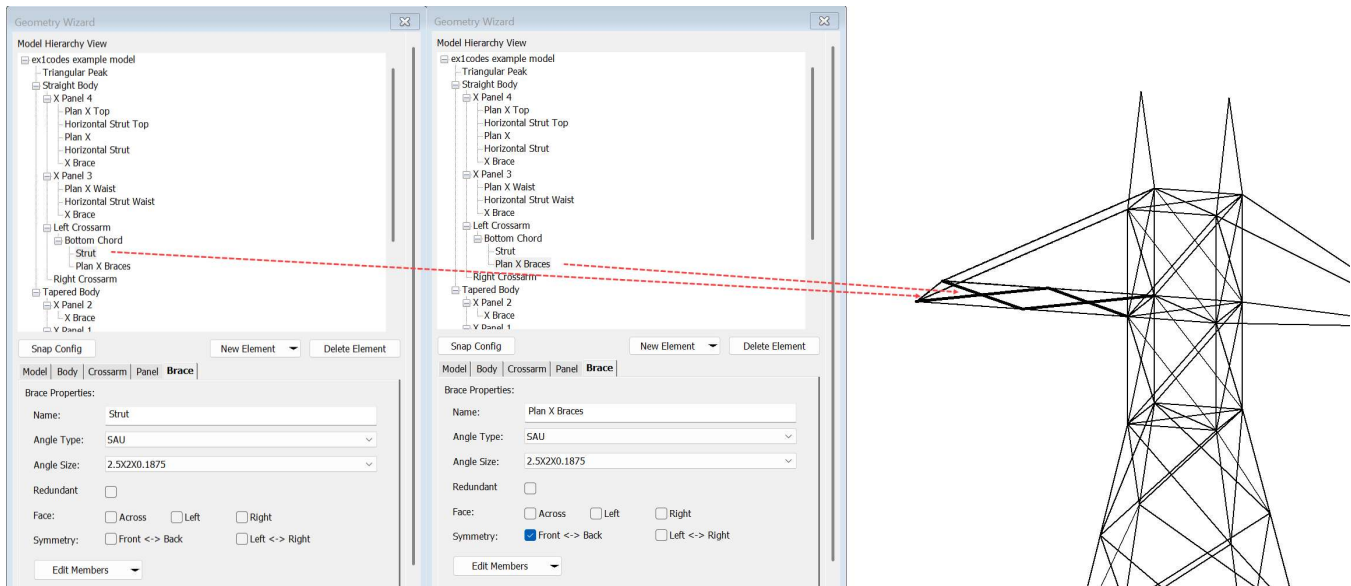
Step 8) Create Panels and Braces for *Left Crossarm*

Next, we'll add two plan X braces and a horizontal strut to the left crossarm. First, we'll need to create a *Panel* and then add the *Braces* to the *Panel*.

Select the *Left Crossarm* in the Model Hierarchy View and add a *Panel*. Enter '*Bottom Chord*' for the Panel Name and enter '12ft' for the Panel Length. Note how the Panel for the crossarm encompasses the entire arm, including the bottom and top chords. We will not be able to use a prebuilt bracing template for this panel.

Once the Panel is created, select the *Bottom Chord* Panel in the Model Hierarchy View and add a *Brace*. Select the *Edge Fraction %* option in the '*Snap Config*' button and enter a fraction value of '0.5' and select the *Front<->Back* Symmetry option the Brace Properties tab. Next use the **Edit Members/Add/Line** option and left click along the bottom crossarm chord to create the two X brace pairs. After clicking the start and end joints, right-click on the tower view and select the *Finish Brace Pick Points* option from the pop-up context menu.

Create another *Brace* primitive for the Bottom Chord Panel and add a single strut member at the end of the crossarm. Use the details shown in the figure below. This will complete the Left Crossarm.



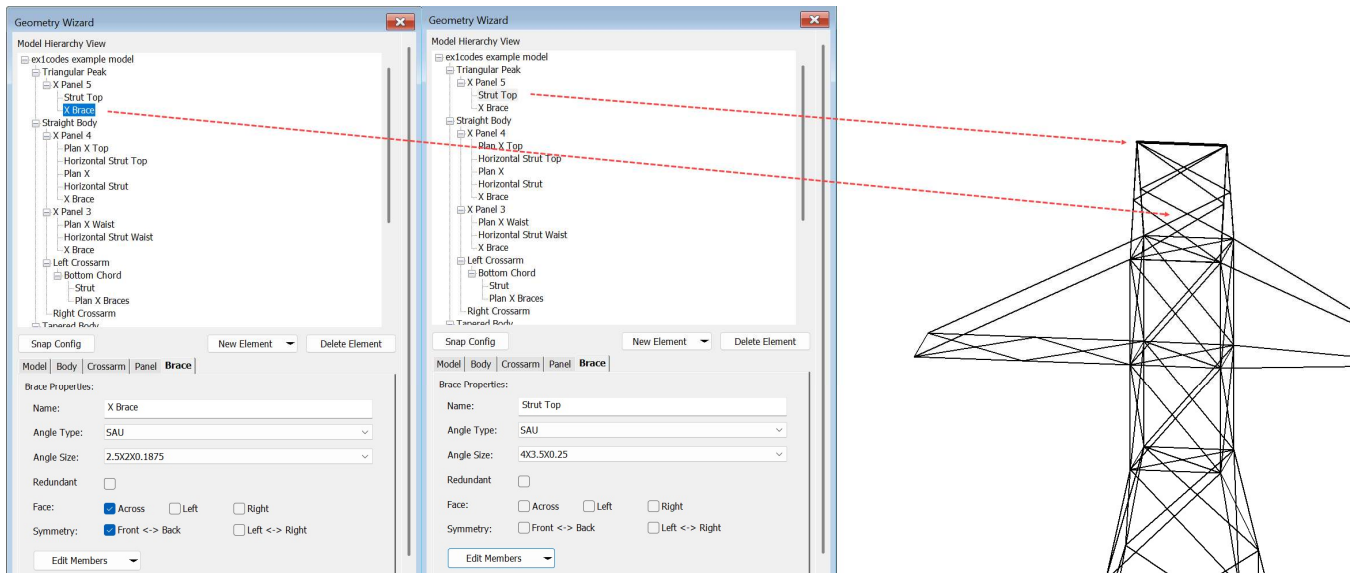
Step 9) Create Panels and Braces for *Triangular Peak*

We'll need to create two sets of X braces on the front and back faces and a horizontal strut at the very top of the triangular peak. First, we'll need to create a *Panel* and then add the *Braces* to the *Panel*.

Select the *Triangular Peak* in the Model Hierarchy View and a *Panel*. Enter '*X Panel 5*' for the Panel Name and enter '6ft' for the Panel Length. We will not be able to use a prebuilt bracing template for this panel because we only want braces on two of the four faces of the panel.

Once the Panel is created, select the *X Panel 5* in the Model Hierarchy View and add a *Brace*. Select the *Edge Fraction %* option in the '*Snap Config*' button and enter a fraction value of '0.5' and select the *Across Face* and the *Front<->Back* Symmetry options in the Brace Properties tab. Next use the **Edit Members/Add/Line** option and left click along the peak leg to create two X brace pairs. After clicking the start and end joints, right-click on the tower view and select the Finish Brace Pick Points option from the pop-up context menu.

Lastly, create another Brace primitive for X Panel 5 and add a single horizontal strut member at the top of the peak. Below is completed the Triangular Peak.



Step 10) Saving the Primitives and Creating the TOWER Model

Before exiting the Geometry Wizard, you can save the entire tower model, body segments, crossarms, or panels to the Panel Library. Braces are the only primitive that cannot be saved to the Panel Library but saving a Panel saves the braces which are associated with the Panel.

To add a primitive to the library, right click on the primitive in the Model Hierarchy View and select 'Add to Panel Library'. Assign the primitive a unique name to be stored in the library. The primitive and all of its dependents will be saved.

Once you've completed the tower in the Geometry Wizard, click the 'Finish' button at the bottom of the Geometry Wizard dialog box to create a *.tow file of the model. The Geometry Wizard will close once you click 'Finish'. At this point you can begin to edit the structure using the normal TOWER commands to complete the model.

If you would like to modify the tower geometry after you've exited the Geometry Wizard dialog, open TOWER, go to **File/Preferences** and confirm the correct Panel Library is referenced on Row 13. Then go to **File/New/Geometry Wizard** to start a new Geometry Wizard session and click the 'Import' button to load in the previously saved model from the Panel Library. Once you've made the necessary modifications, click the 'Finish' button to create a new *.tow file.

