

Large Telescope Truss - Geometry

Author: Samuel Smith, Cornell University

Problem Specification

1. Pre-Analysis & Start-Up
 2. Geometry
 3. Mesh
 4. Physics Setup
 5. Numerical Solution
 6. Numerical Results
 7. Verification & Validation
- Exercises
Comments

Geometry



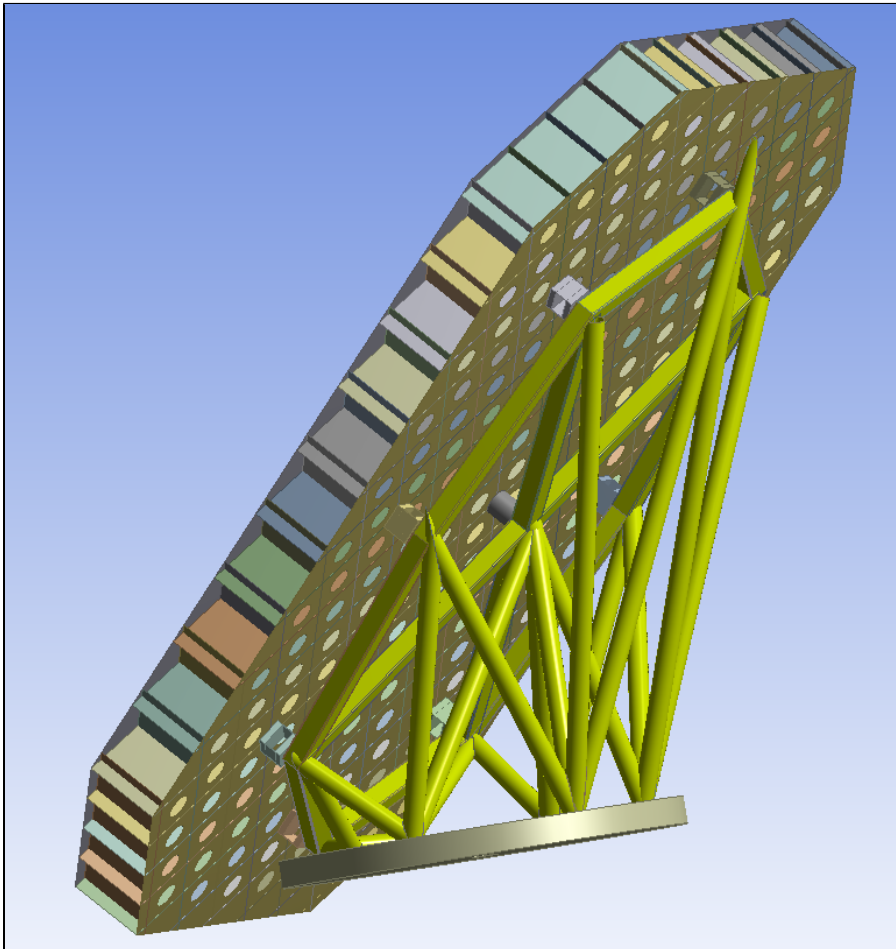
For users of ANSYS 15.0, please check [this link](#) for procedures for turning on the Auto Constraint feature before creating sketches in DesignModeler.

Line Body Truss

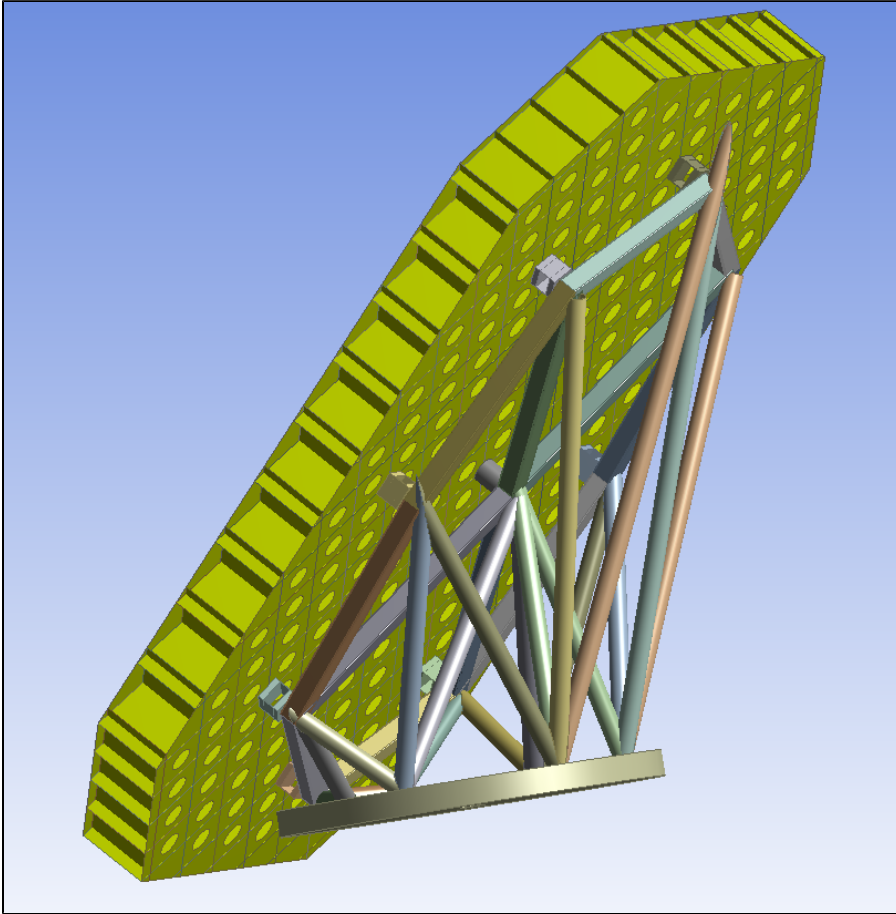
1. Parts

Part groupings are ways for ANSYS to automatically group pieces together and create automatic connections. We should create 2 part groups: the Truss K-1, and the Tertiary Subframe Surface.

Truss



Subframe



The remaining Flexure mounts and Rigid mount pad should remain separate entities.

Thickness

Once the geometries have been assigned into parts, there are a few thicknesses that need to be applied.

The shell models of the entire Subframe Part all need a thickness of 2.75 mm, (2.75e-3 m).

2. Coordinate Files

If we were to directly evaluate the imported geometry, ANSYS would consider the Truss as solid body objects, and generate a highly complex mesh on each of the Truss members by creating a mesh around each circular and rectangular tube. This is wasted computational time. Each of the Truss members is a simple beam, and can be evaluated using beam theory. In order to tell ANSYS to compute it as such, we need to convert these members into line bodies and assign them a cross section.

The first step is to create a coordinate file detailing the end points which the curve of the line bodies will be applied to. We have split this into four files in order to visualize each section easier, rather than having it be a jumbled mess in one file. [The files are provided here](#). Unzip them and place them in an easy-to-find place.

(extra) Deciphering the Coordinate Files

If you open up the files, it might be confusing at first what is going on. Each row is a different point, and each column (separated by a tab) is a property of this point. The property columns are as follows:

1. The Group Property

This property links points together. All Group 1's will be considered in one line or plane, all group 2's in another line, etc.

2. The Point Number

This property denotes the order of the points in the group. It starts at 1 and proceeding upward. For example, a line will start at point 1 and end at point 2. All points in a group need to have a different number, and the order of the numbers affects the directionality of the geometry.

3-5. The Coordinates

These numbers are the x,y,z coordinates of the points. The most straightforward, but also the most tedious part of creating the files. Each point was modeled on the coordinate systems.

3. Creating Line Bodies

Now that the coordinate files have been created, we can use them to create the line bodies. Open up the imported Geometry. Remember to activate the cross sectional view for line bodies. **View> Cross Sectional Solids**. Suppress the existing Truss Part, so there is no overlap.

Concept>3D Curve allows the import of lines from the coordinate file.

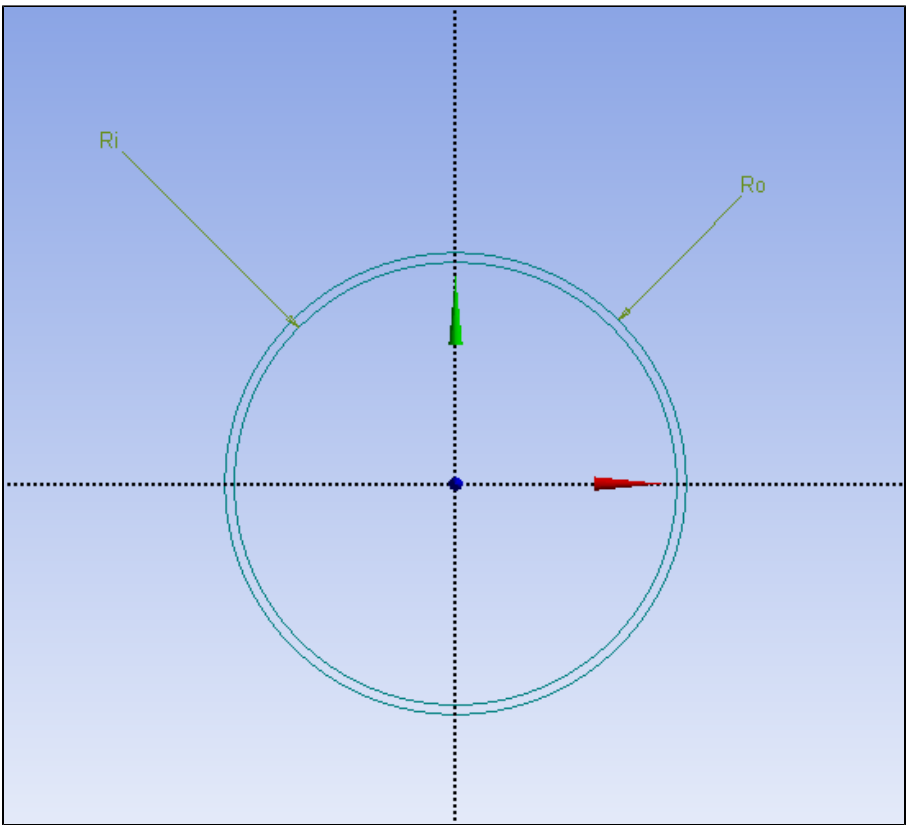
You will need to change the **Definition** to "From Coordinates File", as well as the **Operation** to "Add Frozen," and then select your file and generate. Adding Frozen means that the bodies created will not merge with existing bodies.

Remember to select all the created line bodies and create a new Part out of them. I recommend naming it "Truss Assembly."

4. Cross-Sections

Once the line bodies have been created, we need to assign cross-sections to them. There are two types: the Cylinder Tube and Rectangular Tube.

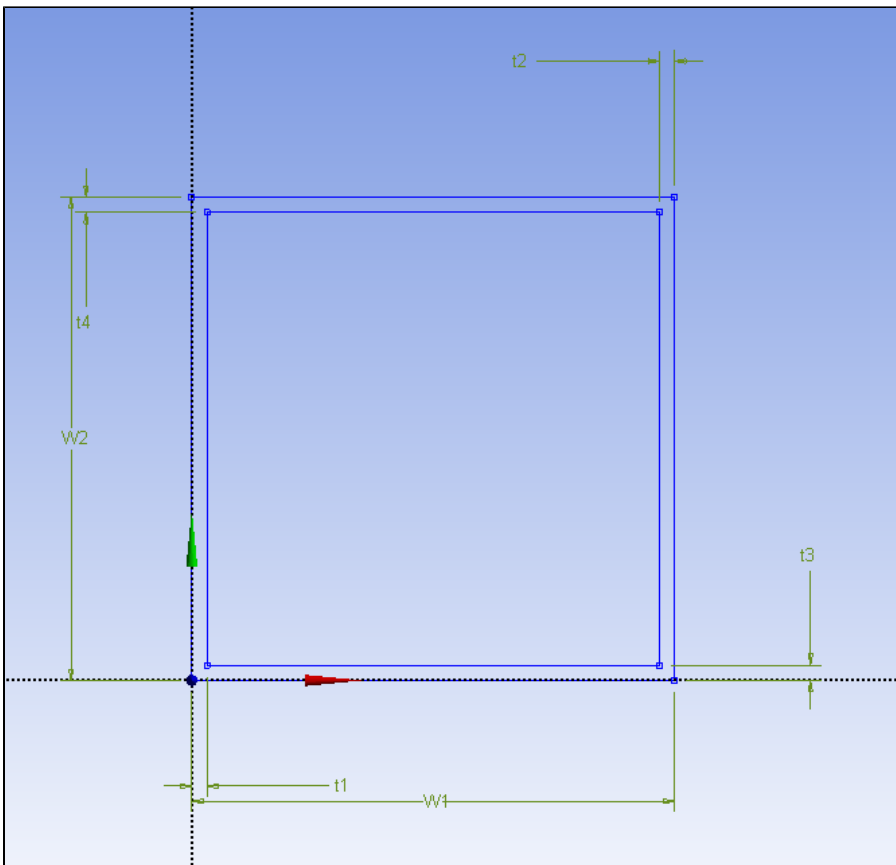
Circular Tube



Details of CircularTube1	
Sketch	CircularTube1
Show Constraints?	No
Dimensions: 2	
<input type="checkbox"/> Ri	0.036525 m
<input type="checkbox"/> Ro	0.0381 m

circleDimensions.PNG

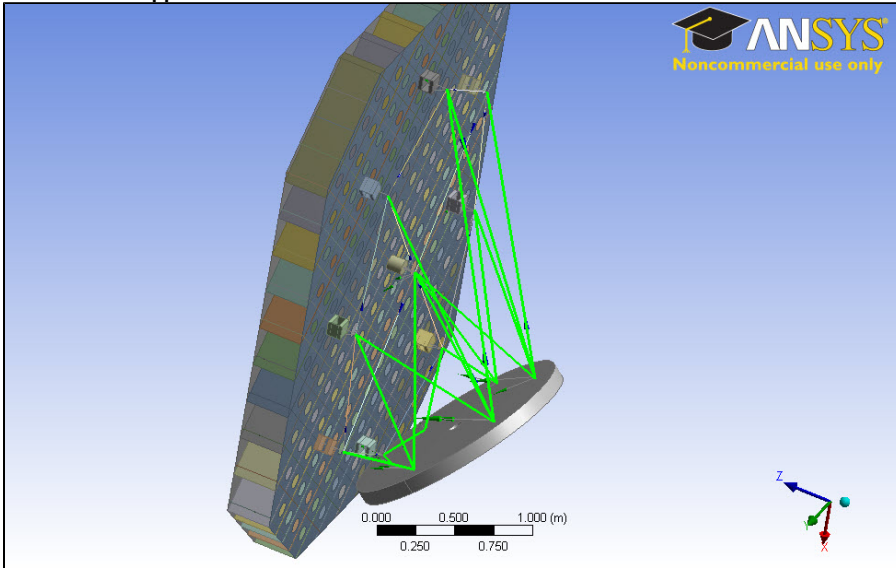
Rectangular Tube



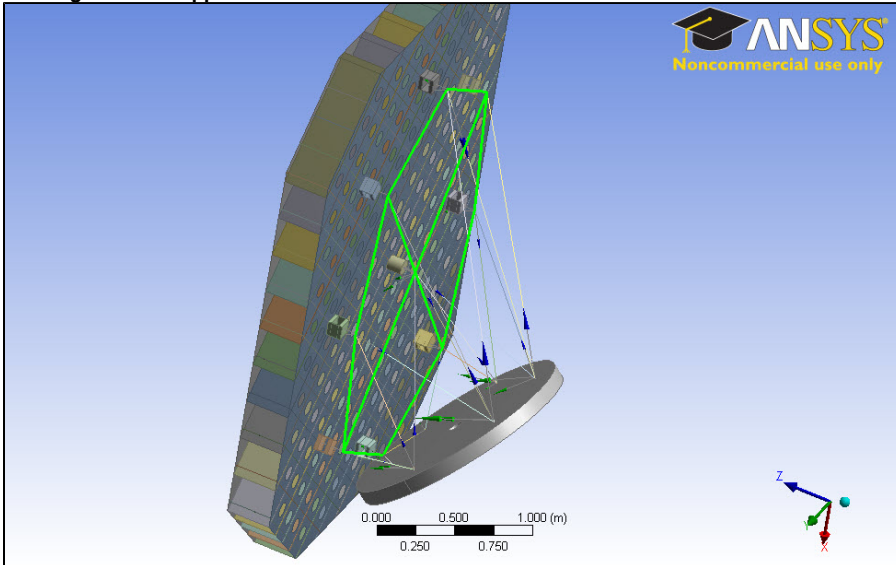
Details of RectTube1	
Sketch	RectTube1
Show Constraints?	No
Dimensions: 6	
<input type="checkbox"/> W1	0.08 m
<input type="checkbox"/> W2	0.08 m
<input type="checkbox"/> t1	0.0025 m
<input type="checkbox"/> t2	0.0025 m
<input type="checkbox"/> t3	0.0025 m
<input type="checkbox"/> t4	0.0025 m

Apply the Circular Tube cross sections to the outside and conical line bodies, and the Rectangular Tube cross section to the horizontal line bodies.

Circular Tube Application



Rectangular Tube Application



Rectangular Offset

If you notice, the rectangular line bodies are not touching the Flexure mounts. We need to offset the cross sections 40mm (.04m) toward the subsurface and Flexure mounts.

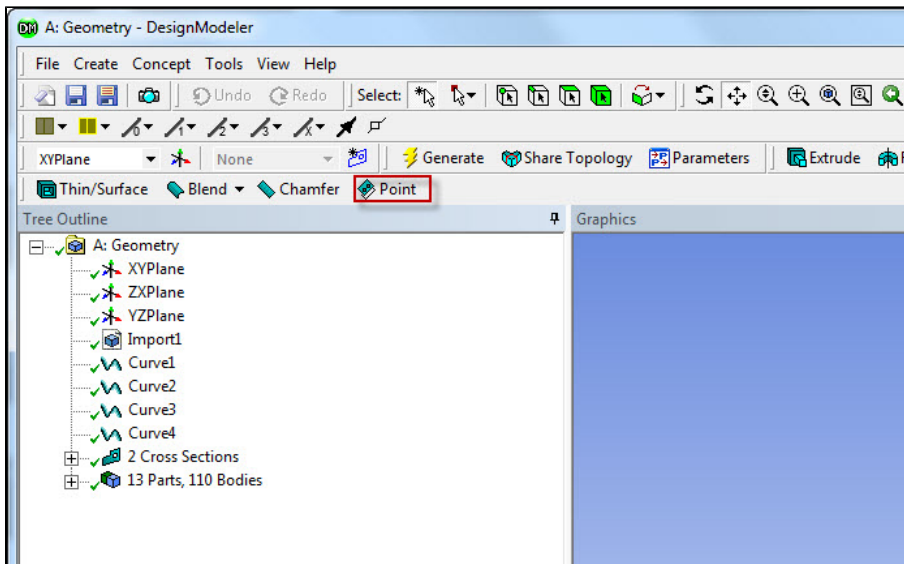
For the 12 Rectangular Tube cross sections, select **Offset Type** and change it to **User Defined**. Due to the directionality of the lines that we input from the coordinate files, the X coordinate has been defined perpendicularly toward the Flexure mounts. Thus, all we need to do is add in .04 to the **X Offset**.

As you can imagine, there are times and geometries that this simple result will not happen. Always check the individual coordinate systems of the line bodies.

5. Geometry Connections

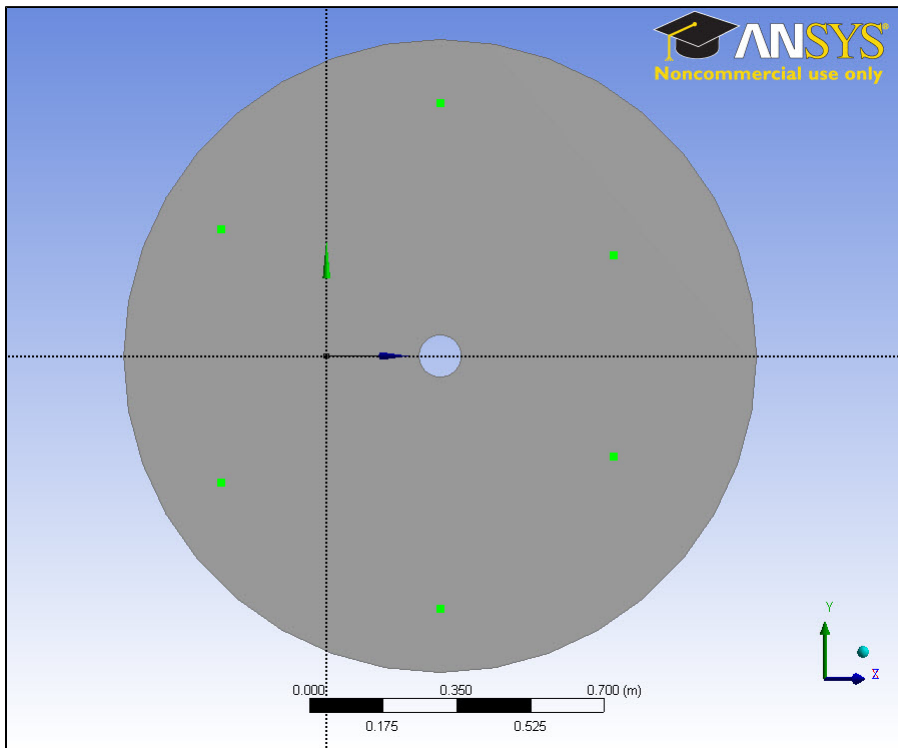
In the Setup portion, we will need to define the connections between the geometry pieces, specifically the line bodies we have defined as the truss supports. The surface areas of the flexure mounts provide a good surface to define a connection between the line body and mounts. However, we need to define the area where the line body connects to the circular mount pad: equivalent to the diameter of the truss' cross-section.

First, we need to construct reference points to center the circular sketches on. [Download this coordinate file](#). Once downloaded, select the "Point" concept, and change the type to "Construction Point." Then define it as a coordinate file and select the downloaded file.



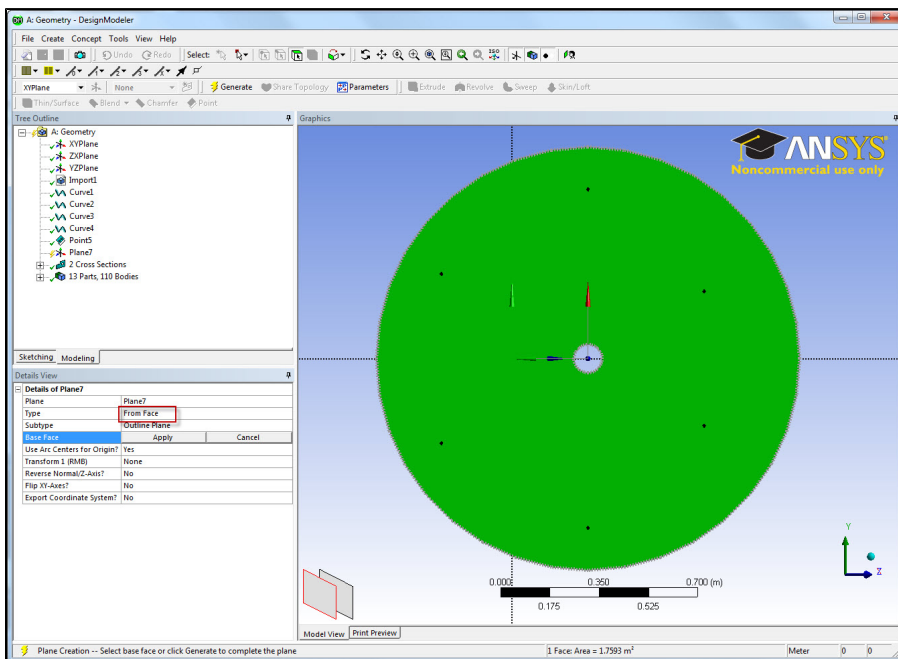
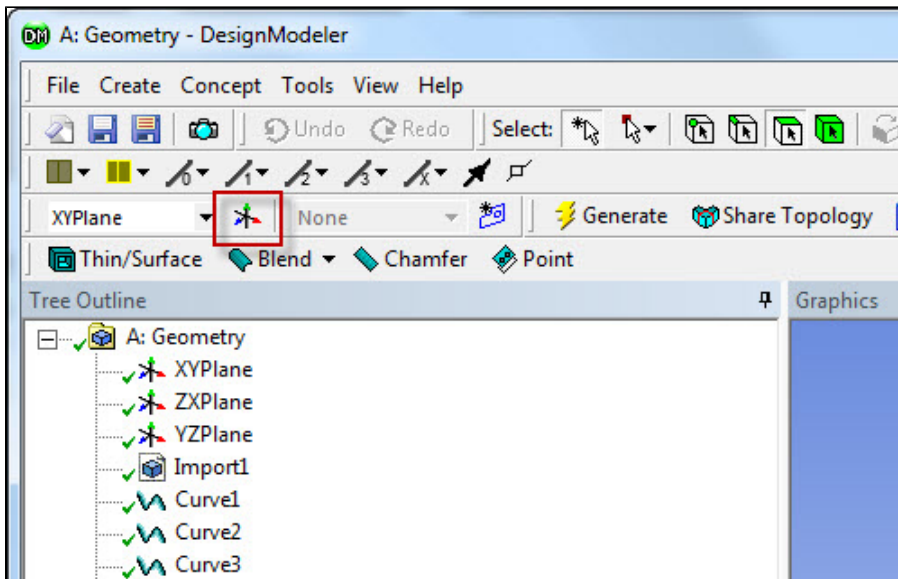
Details of Point5	
Point	Point5
Type	Construction Point
Definition	From Coordinates File
Coordinates File	None
Tolerance	Normal

Generate the points.

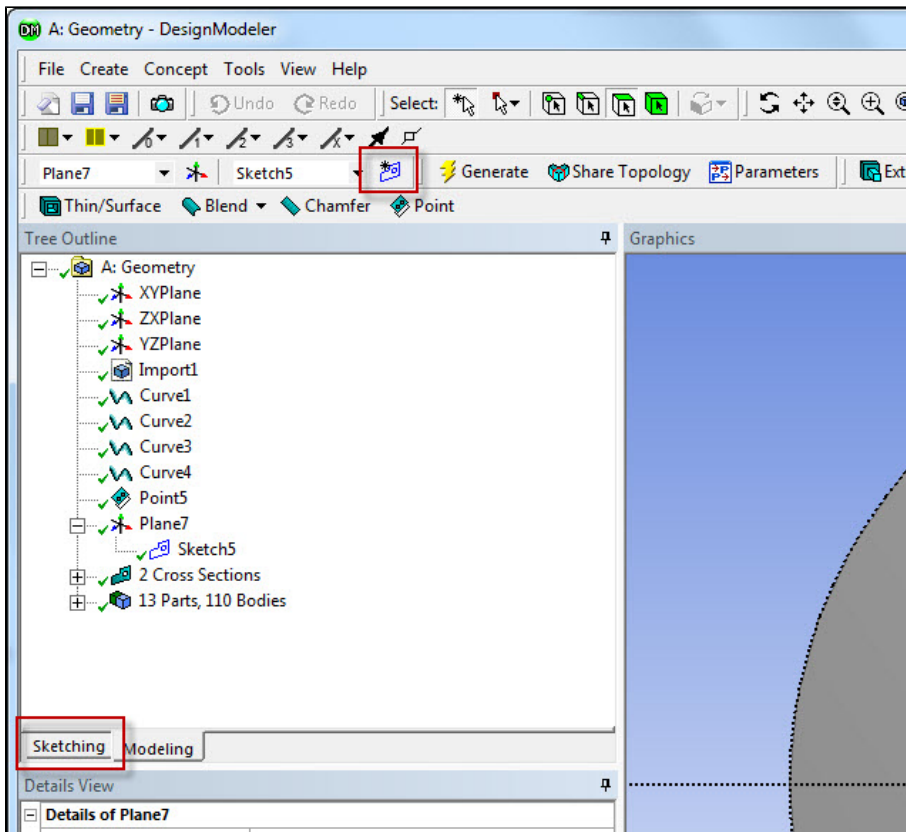


Now that the guiding points are created, we need to create a sketch for the diameter of the truss line bodies. First, we need to create a plane that the sketch is based upon: it needs to be the same plane as the top of the circular base support.

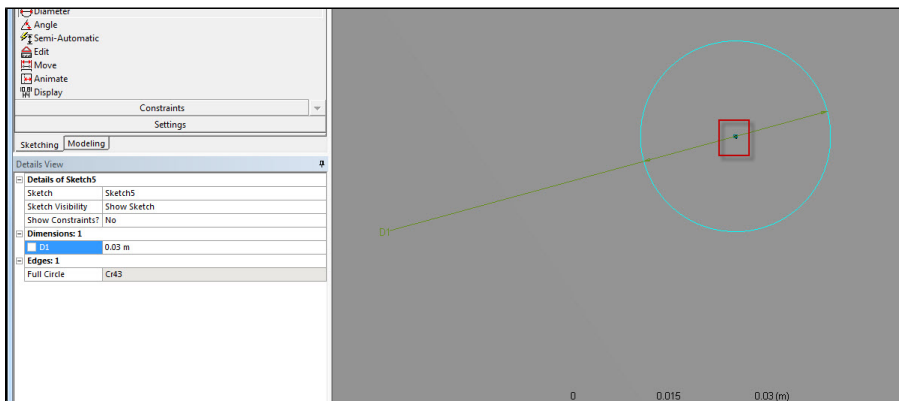
Select "New Plane", then select "From Face" in the type detail. Then select the circular base support plane, and apply.

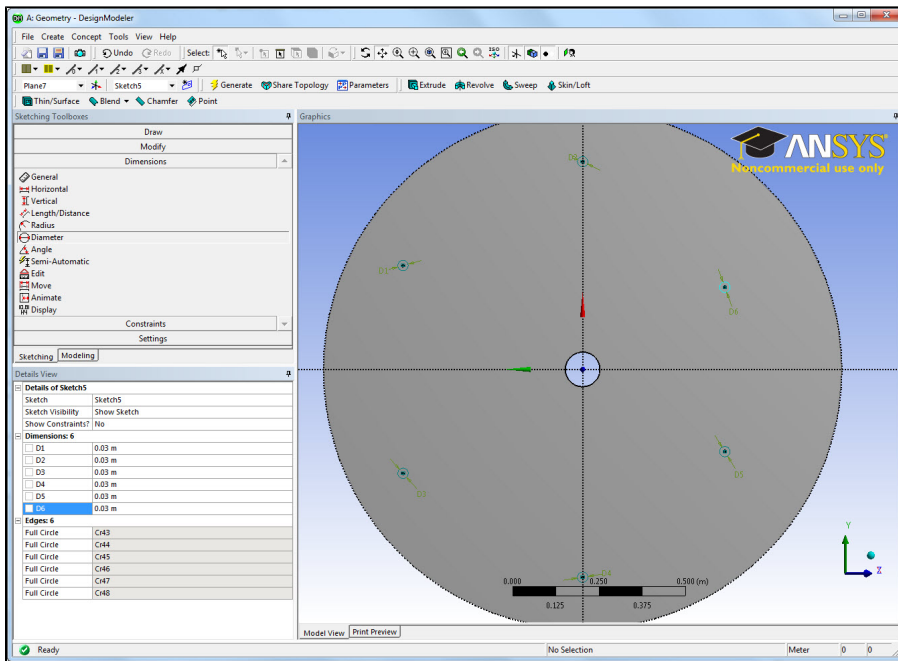


Now that the plane has been created, we will create a sketch for the circular connections. Click the "New Sketch" button with the created plane selected. Once created, click on the "Sketching tab" to start sketching.



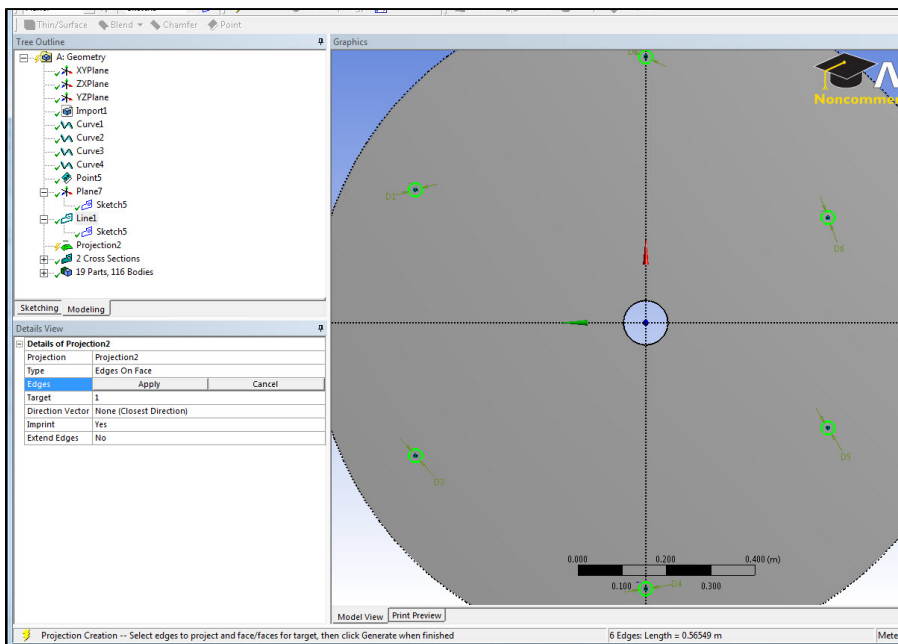
Create a circle of .03m diameter centered around the construction points. There are a total of six circles on this sketch.





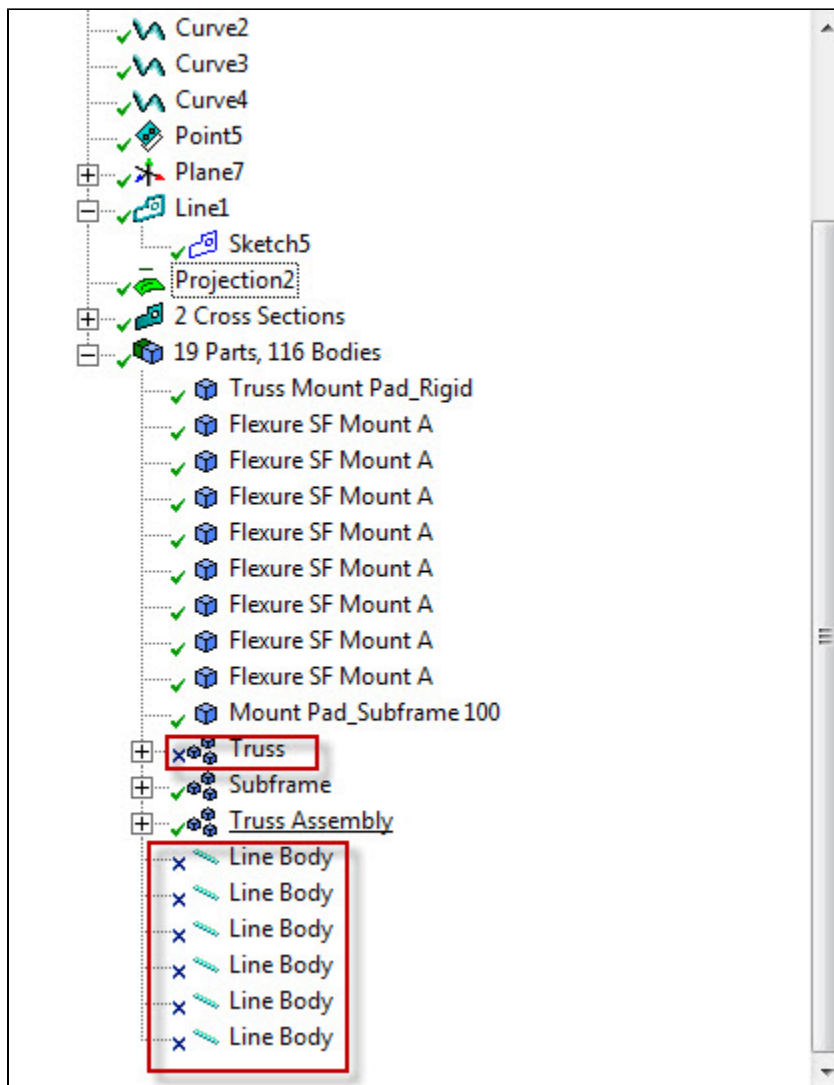
Return to the modelling tab. Now that the sketch has been created, we actually have to apply it to the geometry. Otherwise, it is just an unattached sketch. Since we are just making a surface area to attach a connection to, all we need to do is project some lines into the surface. This requires two steps: 1. Create a Concept > Lines from Sketchs. Select the sketch you created, and Add Frozen.

Generate. Now that the lines are created, we need to "etch" them into the base surface. Create a Tools>Projection. Use Edges onto Face. Select the created lines as the edges, and the surface face for the face. Make sure "Imprint" is selected to "Yes."



Generate the Projection. This now has created lines on the Circular Mount Pad. We can now use the created surface area as a connection surface for the Setup step.

Lastly, remember to show all the hidden parts. Remember to keep the imported Truss (as machined) parts suppressed. Suppress the Line bodies created by the above step.



[Go to Step 3: Mesh](#)

[Go to all ANSYS Learning Modules](#)