Axisymmetric Modeling

Axisymmetric modeling can simplify model preparation and greatly reduce model size. The entire model must be axisymmetric; you cannot mix axisymmetric and non-axisymmetric elements. If you are modeling radiation, you must use the *All Radiation* request type for an axisymmetric model. To use axisymmetric modeling, two conditions must be satisfied:

- The entire physical model must be geometrically symmetric about a single axis.
- The boundary conditions and material properties must be symmetric about the same axis.

Both axisymmetric shells and axisymmetric solids are supported. Axisymmetric shell elements look like beam elements on the screen. However, for the thermal analysis they are revolved about an axis to produce 2-D elements. Similarly, axisymmetric solids look like shell elements, but are revolved about an axis to be solved as 3-D solid elements.

In general, thermal boundary conditions normally applicable to 2-D thin shell elements are applicable to axisymmetric shell elements; those normally applicable to 3-D solid elements are applicable to axisymmetric solid elements. See *Creating Thermal Boundary Conditions* for details.

Creating Geometry for Axisymmetric Modeling

Create 2-D geometry (curves, surfaces or edges) on which you will define axisymmetric elements. The geometry must lie in the XZ plane, and must be positioned so that, if revolved about the global Z axis, it would produce the required 3-D model geometry.

Creating the Axisymmetric Mesh

Specify the number of facets to use in the expanded model. This determines the number the number of elements that will be created when an axisymmetric element is rotated one complete revolution about the Z axis. On the icon panel, pick *Radiation Controls*; on the Radiation Controls form pick *Advanced Radiation Parameters*.

Define appropriate material properties and a thickness physical property to determine the thickness of the axisymmetric shell elements.

Axisymmetric Shells

Use Free Meshing to create axisymmetric shells on curves or edges in the global XZ plane. Use the axisymmetric shell element family on the Define Mesh form. Turn off curvature based meshing under *Free Options* so as to better control the number of elements defined.

If you are using axisymmetric shells for modeling radiation, it is important to know that the active (radiating) side of axisymmetric shells faces in the direction of the cross product of the first edge vector with the global Y axis. In other words, if you define the first edge vector as the primary vector, and the global Y axis as the secondary vector, you can use the right hand rule to ascertain the active face. You must use the *All Radiation* request type for an axisymmetric model.

Axisymmetric Solids

Use Free Meshing to create axisymmetric solids on surfaces in the global XZ plane. Use the

axisymmetric solid element family on the Define Mesh form. Turn off curvature based meshing under *Free Options* so as to better control the number of elements defined.

Including Axisymmetric Solids in the Radiation Model

Axisymmetric solid elements do not participate in the radiation model. If you need to model radiation to these elements, you must do so using the free edges of the axisymmetric solid elements. During the solve, these will be rotated to form temporary axisymmetric shell elements.

An alternative method is to define Axisymmetric shell elements with a thickness of zero, and create them on the perimeter of the axisymmetric solids, so that when rotated by the solver, the axisymmetric shells will cover the surface of the solid. The axisymmetric shell elements must share nodes with the axisymmetric solid elements they adjoin. In this way, heat will be conducted between the shells and the solids.

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