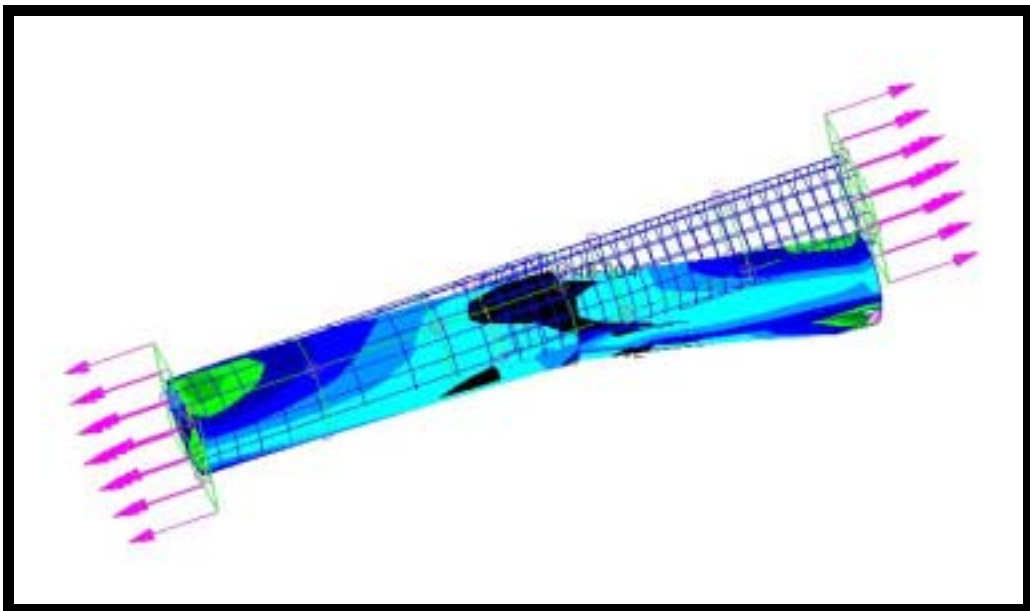

LESSON 15

Sliding Split Tube Telescope



Objectives:

- Shell-to-shell contact -accounting for shell thickness.
- Creating boundary conditions and loads by way of rigid surfaces.
- Simulate large displacements, contact with friction, shape instability.



Model Description:

This model simulates two closely adjusting telescoping tubes. The outer wall of the inner tube fits snugly into the outer tube. Contact between the tubes accounts for friction. The outer tube is glued to a wall - represented by a rigid surface - and the free end of the inner tube is glued to a rigid surface that rotates 10 degrees about the X-X axis (see illustration) thus flexing the assembly. The inner tube is split, thus it rolls onto itself on one end and opens out close to the other end when flexed.

Suggested Exercise Steps:

- Create two concentric cylinders of length $L=15$, and radius $R1=2$ and $R2=1.875$; the smaller cylinder displaced a distance $D=12$. Orient the cylinders as illustrated.
- Create two 5x5 square surfaces at the outer end of each cylinder as illustrated.
- Define materials and shell properties.
- Setup glued rigid surface with appropriate positioning condition including rigid rotation.
- Setup analysis with appropriate options as advised for job to converge.
- Run and monitor analysis.
- Import and post-process results.

Exercise Procedure:

1. Open a new database named **Tube-tube.db**.

File/New ...

Database Name:

Tube-tube.db

OK

Analysis Code:

MSC.Marc

OK

2. Create the Geometry.

Start by creating curves using the 2D Circle method.

■ Geometry

Action:

Create

Object:

Curve

Method:

2D Circle

Circle Radius:

2

Center Point List:

[0, 0, 0]

Apply

Circle Radius:

1.875

Center Point List:

[0, 0, 12]

Apply

Rotate **Curve 2** 180 degrees.

■ Geometry

Action:

Transform

Object:

Curve

Method:

Rotate

Rotation Angle:

180

■ Delete Original Curves

CurveList:

select the inner circle,
Curve 2

Apply

Create cylinders.

■ Geometry

Action:

Create

Object:

Surface

Method:

Extrude

Translation Vector:

<0, 0, 15>

CurveList:

select the outer circle,
Curve 1

Apply

Origin of Scale and Rotate:

[0, 0, 12]

Translation Vector:

<0, 0, 15>

CurveList:

select the inner circle,
Curve 3

Apply

To get a better view, select the **Iso 2 View**, and the **Fit View** options.



Iso 2 View



Fit View

Create the undeformable bodies, as in **Figure 15.1**.

■ Geometry

Action:

Create

Object:

Surface

Method:

XYZ

Vector Coordinates List:

<5, 5, 0>

Origin Coordinates List:

[-2.5, -2.5, 0]

Apply

Vector Coordinates List:

<5, 5, 0>

Origin Coordinates List:

[-2.5, -2.5, 27]

Apply

3. Create the Mesh Seed.

First create the Mesh Seeds on the **Surface 1** length-wise edge.

■ **Elements**

Action:

Create

Object:

Mesh Seed

Type:

Two Way Bias

● **L1 and L2**

L1:

0.6

L2:

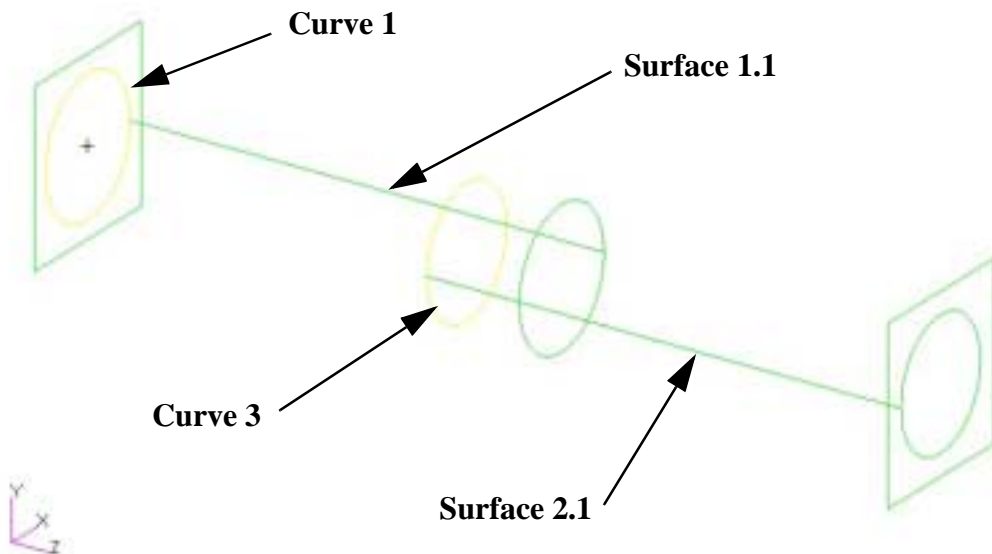
2

Curve List:

see Figure 15.1 to select
Surface 1.1

Apply

Figure 15.1 - Surfaces surrounded by undeformable bodies.



Sliding Split Tube Telescope

<i>Action:</i>	Create
<i>Object:</i>	Mesh Seed
<i>Type:</i>	Uniform
	● Element Length (L)
<i>Length:</i>	0.6
<i>Curve List:</i>	see Figure 15.1 to select Surface 2.1

Apply

<i>Length:</i>	0.8
<i>Curve List:</i>	also see Figure 15.1 to pick Curve 1 and Curve 3

Apply

4. Create the Meshes for the surfaces.

First create the Mesh for **Surface 1**.

<i>Action:</i>	Create
<i>Object:</i>	Mesh
<i>Type:</i>	Surface
<i>Elem Shape:</i>	Quad
<i>Mesher:</i>	IsoMesh
<i>Topology:</i>	Quad4
<i>Surface List:</i>	Surface 1

Apply

Equivalence **Surface 1**.

<i>Action:</i>	Equivalence
<i>Object:</i>	All

Method:

Tolerance Cube

Apply

Now create the **Surface 2 Mesh**.

Action:

Create

Object:

Mesh

Type:

Surface

Elem Shape:

Quad

Mesher:

IsoMesh

Topology:

Quad4

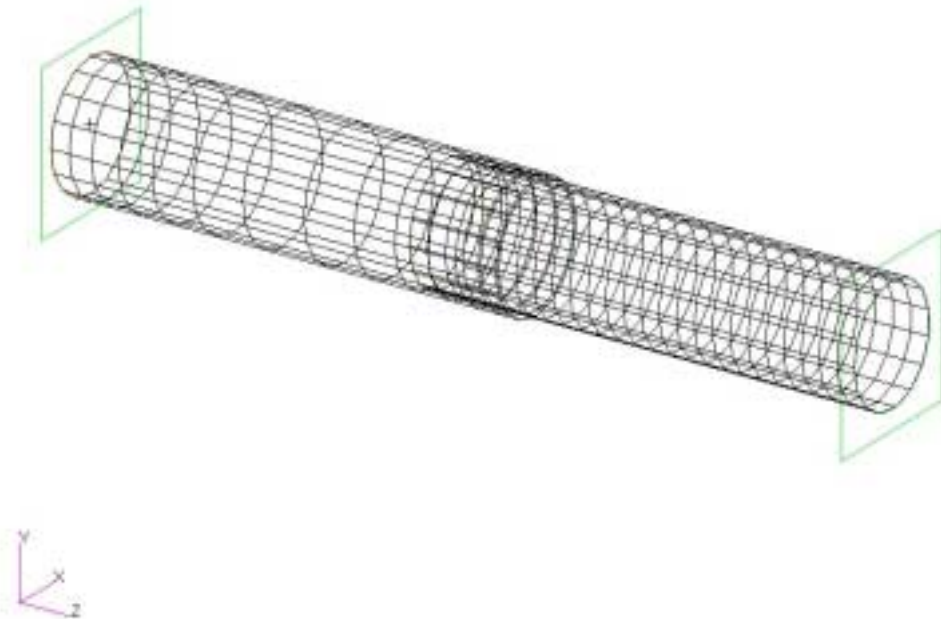
Surface List:

Surface 2

Apply

Your screen should look like Figure 15.2

Figure 15.2 - Meshed model.



Sliding Split Tube Telescope

5. Create a reference node for future use.

<i>Action:</i>	Create
<i>Object:</i>	Node
<i>Method:</i>	Edit
<i>Node ID List:</i>	999
<i>Node Location List:</i>	[0, 0, 0]
Apply	

6. Create the Material property for the tubes.

■ Materials

<i>Action:</i>	Create
<i>Object:</i>	Isotropic
<i>Method:</i>	Manual Input
<i>Material Name:</i>	Mat1
Input Properties...	
<i>Elastic Modulus:</i>	1e6
<i>Poisson Ratio:</i>	0.3
OK	
Apply	

7. Create the element Properties for the tubes.

Begin with the Properties for the inner tube.

■ Properties

<i>Action:</i>	Create
<i>Object:</i>	2D
<i>Type:</i>	Thin Shell
<i>Property Set Name:</i>	inner

Input Properties...

Material Name:

select from *Material Property Sets* listbox below,
Mat1

Thickness:

0.125

OK

Select Members:

Surface 2

Add

Apply

Continue with the outer tube Properties.

Action:

Create

Object:

2D

Type:

Thin Shell

Property Set Name:

outer

Input Properties...

Material Name:

select from the listbox below,
mat1

Thickness:

0.125

OK

Select Members:

Surface 1

Add

Apply

8. Define the tubes as Contact deformable bodies.

■ **Loads/BCs**

Action:

Create

Object:

Contact

Type:

Element Uniform

Option:

Deformable Body

Sliding Split Tube Telescope

New Set Name:

Target Element Type:

Input Data...

Friction Coefficient:

OK

Select Application Region...

Select Surfaces:

Add

OK

Apply

New Set Name:

Target Element Type:

Select Application Region...

Select Surfaces:

Add

OK

Apply

9. Define the walls as Contact rigid bodies.

Action:

Object:

Type:

Option:

New Set Name:

Target Element Type:

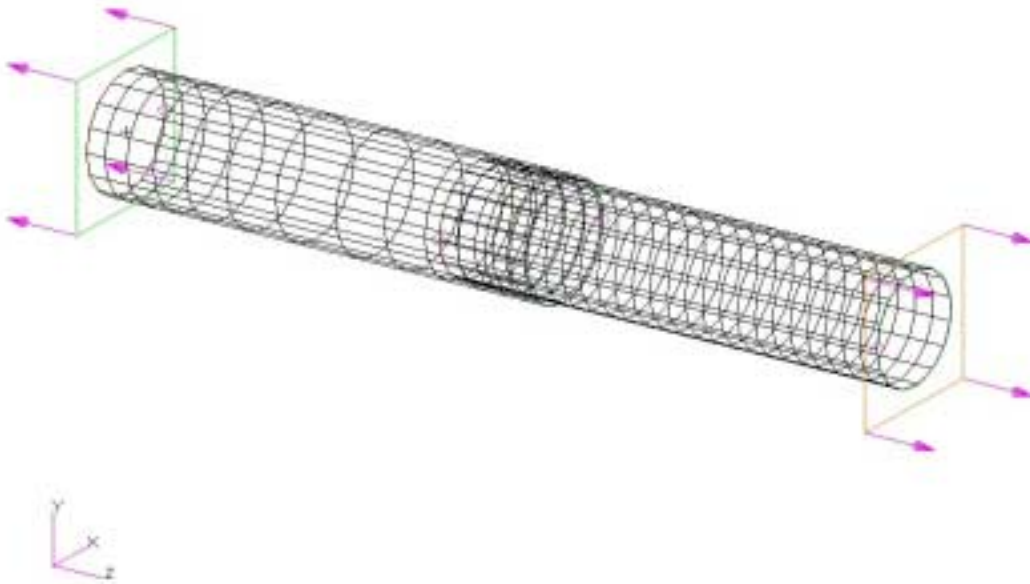
Input Data...

Flip Contact Side (ON)

<i>Motion Control:</i>	<input type="text" value="Position"/>
<i>Displacement (vector):</i>	<input type="text" value="<0, 0, 0>"/>
<input type="button" value="OK"/>	
<input type="button" value="Select Application Region..."/>	
<i>Select Surfaces:</i>	<input type="text" value="Surface 3"/>
<input type="button" value="Add"/>	
<input type="button" value="OK"/>	
<input type="button" value="Apply"/>	
<i>New Set Name:</i>	<input type="text" value="drive"/>
<i>Target Element Type:</i>	<input type="text" value="2D"/>
<input type="button" value="Input Data..."/>	
	<input type="checkbox"/> Flip Contact Side (OFF)
<i>Motion Control:</i>	<input type="text" value="Position"/>
<i>Displacement (vector):</i>	<input type="text" value="<0, 0, 0>"/>
<i>Angular Position (radians):</i>	<input type="text" value="0.174533"/>
<i>Rotation Reference Point:</i>	<input type="text" value="Node 999"/>
<i>Axis of Rotation:</i>	<input type="text" value="<1, 0, 0>"/>
<input type="button" value="OK"/>	
<input type="button" value="Select Application Region..."/>	
<i>Select Surfaces:</i>	<input type="text" value="Surface 4"/>
<input type="button" value="Add"/>	
<input type="button" value="OK"/>	
<input type="button" value="Apply"/>	

Your contact lines should appear as in Figure 15.3.

Figure 15.3 - Finite Element model showing Contact Markers.



10. Display all the Markers.

■ Loads/BCs

Action:

Plot Markers

Assigned Load/BC Sets:

select all Sets in the list.

Select Groups:

Default Group

Apply

Show all the Lines by clicking on the **Display Lines** icon.



Display Lines

11. Setup and launch the two-step Nonlinear Static Analysis

■ Analysis

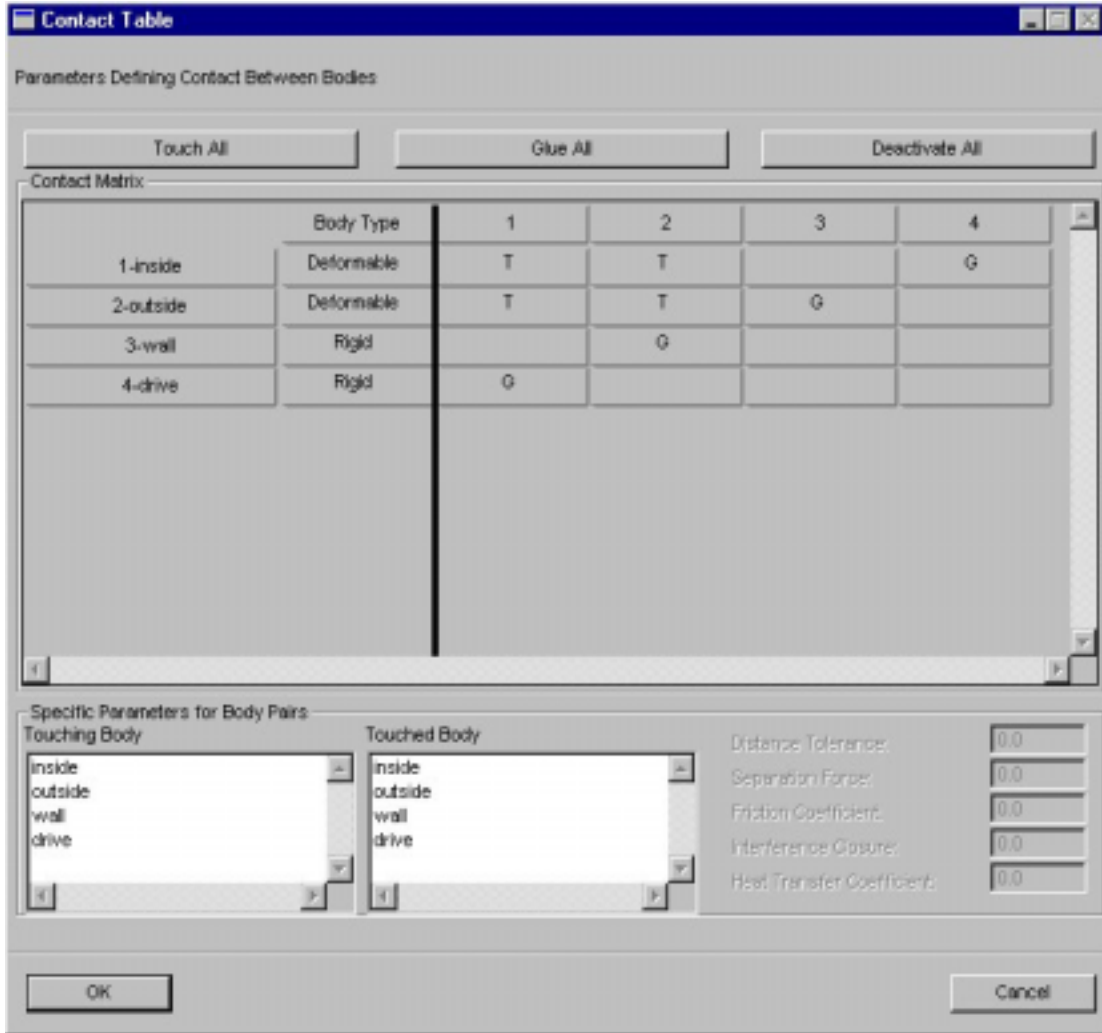
Action:

Analyze

<i>Object:</i>	<input type="text" value="Entire Model"/>
<i>Method:</i>	<input type="text" value="Full Run"/>
<i>Job Name:</i>	<input type="text" value="Tube-tube"/>
<input type="button" value="Translation Parameters..."/>	
<input type="button" value="Solver Options..."/>	
	<input type="checkbox"/> Non-Positive Definite (ON)
<input type="button" value="OK"/>	
<input type="button" value="Contact Parameters..."/>	
<input type="button" value="Contact Detection..."/>	
<i>Bias on Distance Tolerance:</i>	<input type="text" value="0.99"/>
<input type="button" value="OK"/>	
<input type="button" value="OK"/>	
<input type="button" value="OK"/>	
<input type="button" value="Load Step Creation..."/>	
<i>Job Step Name:</i>	<input type="text" value="One"/>
<input type="button" value="Solution Parameters..."/>	
<input type="button" value="Load Increment Parameters..."/>	
<i>Increment Type:</i>	<input type="text" value="Adaptive"/>
<i>Arclength Method:</i>	<input type="text" value="None"/>
<i>Trial Time Step Size:</i>	<input type="text" value="0.1"/>
<i>Time Step Scale Factor:</i>	<input type="text" value="1.2"/>
<input type="button" value="OK"/>	
<input type="button" value="Contact Table..."/>	

Follow the Contact Matrix in Table 15.1 to set up the Contact Table.

Table 15.1 - Use these touching conditions for the Contact Table.



OK

OK

Apply

Cancel

Load Step Selection...

Selected Job Steps:

One

OK

Apply

You can monitor the progression of the job by looking at *necking.log* and *necking.sts* as well as using the *necking.out* file or the **Analysis** option, **Monitor**.

<i>Action:</i>	Monitor
<i>Object:</i>	Job
View Status File...	

A successful run should give the job exit number: **3004**.

12. Read (attach) the Results.

<i>Action:</i>	Read Results
<i>Object:</i>	Result Entities
<i>Method:</i>	Attach
<i>Available Jobs:</i>	Tube-tube
Select Results File...	
<i>Available Files:</i>	necking.t16
OK	
Apply	

13. Display Quick Plot of von Mises Stress and Displacements.

■ Results

<i>Action:</i>	Create
<i>Object:</i>	Quick Plot
<i>Select Result Cases:</i>	One, A1:...Time=0.9
<i>Select Fringe Result:</i>	Strain, Total
<i>Select Deformation:</i>	Displacement, Translation
Apply	
<i>Select Result Cases:</i>	One, A1:...Time=1.0
Apply	

Figure 15.4 - The Plot for 0.9s should appear like this.

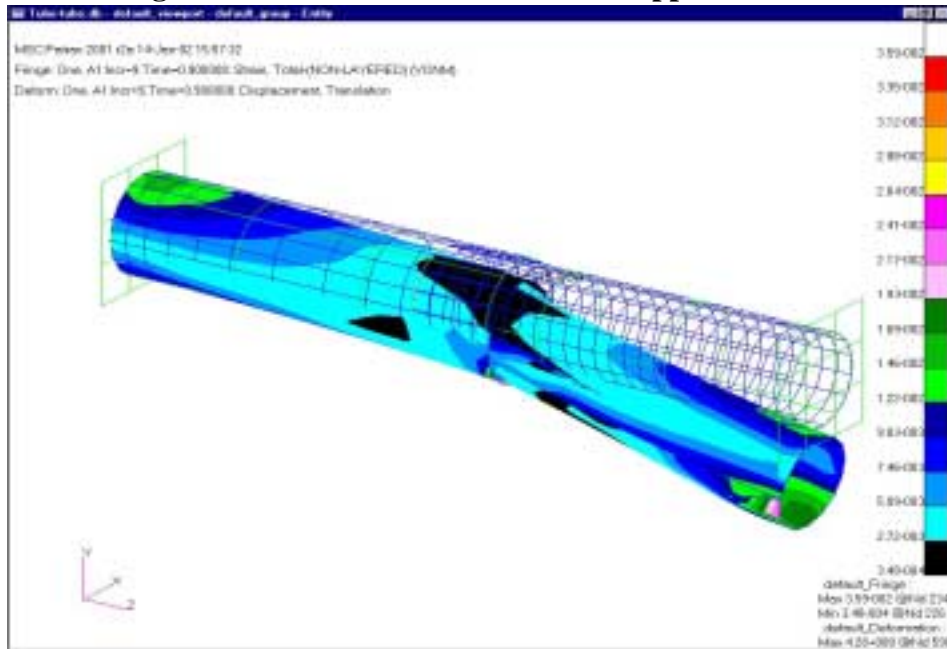
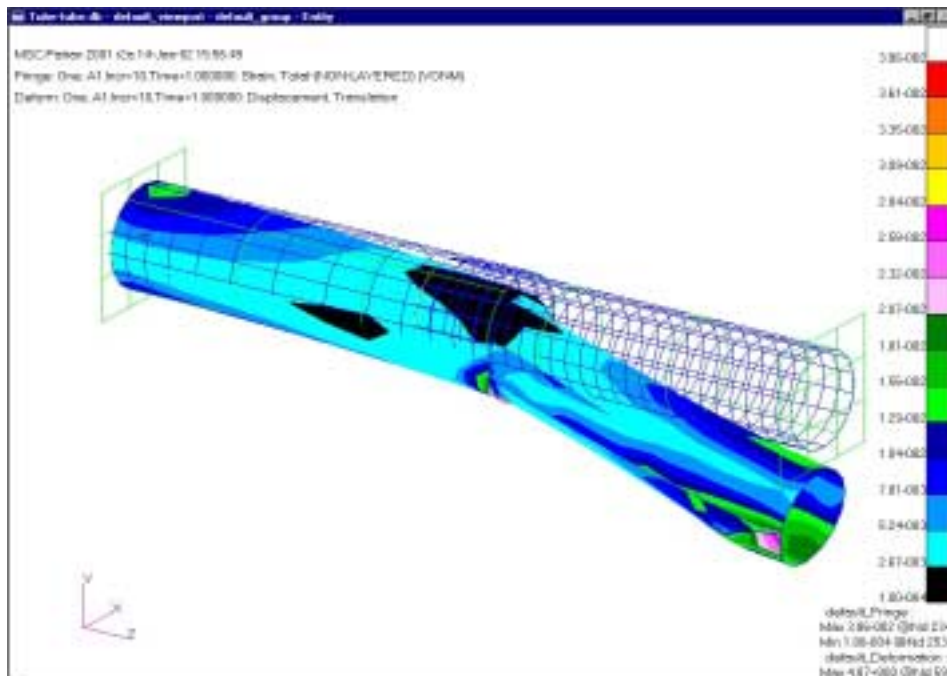


Figure 15.4 - At 1.0s, the plot shows the following.



Close the database and quit PATRAN.

This concludes this exercise.

