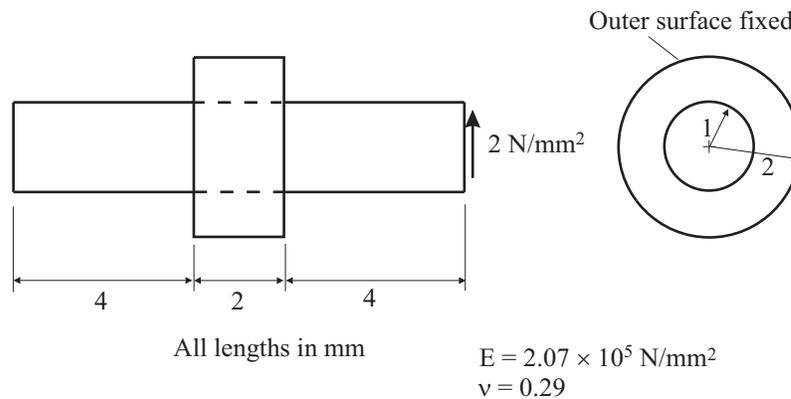


Problem description

It is desired to analyze the shaft and ring shown in the following figure:



The shaft is glued into the ring.

This problem could be modeled using one geometry body. However, in this problem, we use two geometry bodies, one for the shaft and the other for the ring. We use the gluemesh feature to glue the shaft to the ring.

In this problem solution, we will demonstrate the following topics that have not been presented in previous problems:

- Running an unstable model in static analysis.
- Applying a traction load that acts in a specified direction.
- Using the gluemesh feature.
- Using incompatible modes

Before you begin

Please refer to the Icon Locator Tables chapter of the Primer for the locations of all of the AUI icons. Please refer to the Hints chapter of the Primer for useful hints.

Note that you must have an ADINA-M/PS license to do this problem.

This problem cannot be solved with the 900 nodes version of the ADINA System because there are too many nodes in the model.

Much of the input for this problem is stored in file prob40_1.in. You need to copy files prob40_1.in from the folder samples\primer into a working directory or folder before beginning this analysis.

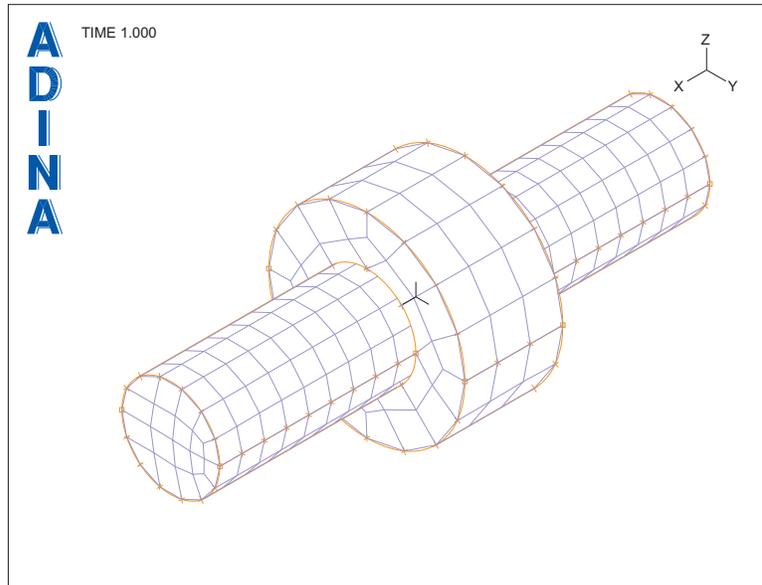
Invoking the AUI and choosing the finite element program

Invoke the AUI and set the Program Module drop-down list to ADINA Structures.

Defining the model

We have prepared a batch file (prob40_1.in) which contains the entire model definition, with the exception of the load and gluemesh definitions.

Choose File→Open Batch, navigate to the working directory or folder, select the file prob40_1.in and click Open. The graphics window should look something like this:



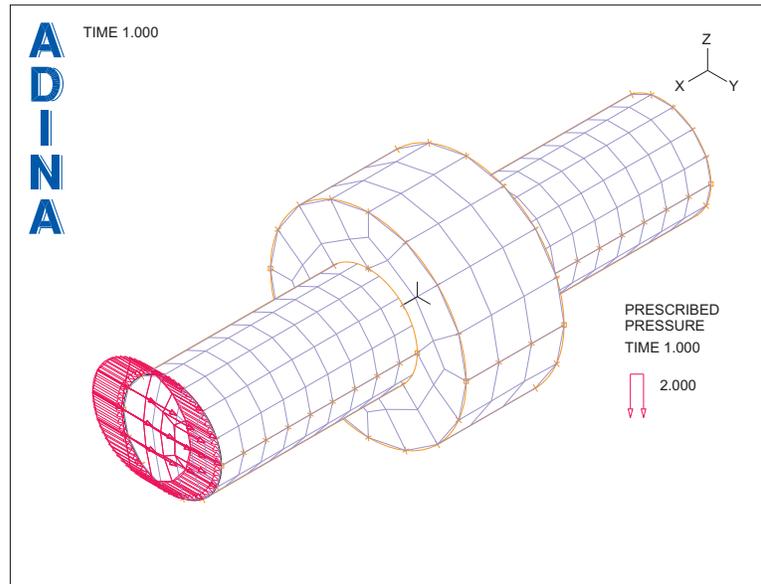
Selection of incompatible modes

Choose Control→Analysis Assumptions→Kinematics, set “Use Incompatible Modes in Element Formulation” to Yes, then click OK.

Traction load definition

Click the Apply Load icon , set the Load Type to Pressure and click the Define... button to the right of the Load Number field. In the Define Pressure dialog box, add pressure 1, set the Magnitude to 2 and click OK. In the Apply Load dialog box, set “Apply to” to Face, and, in the first row of the table, set the Face to 2, the Body to 1 and the Load Direction to Y-Direction. Click OK to close the Apply Load dialog box.

When you click the Load Plot icon , the graphics window should look something like this:



Generating the data file, running ADINA Structures

We now demonstrate the effect of not gluing the parts together.

Click the Save icon  and save the database to file prob40. Click the Data File/Solution icon , set the file name to prob40, make sure that the Run Solution button is checked and click Save.

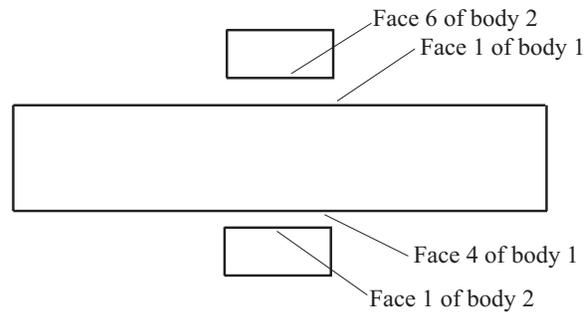
Since the two parts are not connected, the shaft has rigid body modes, so the model is unstable in static analysis. Depending upon round-off, ADINA Structures either stops with the message

```
*** Stiffness matrix not positive definite ***
```

(which indicates that the model is unstable), or ADINA Structures runs to completion. In the latter case, you will find that the shaft undergoes very large displacements.

Using the gluemesh feature

We need to glue the parts together. The following figure shows how the faces of the model line up.



Section through model, parts separated for clarity

We also note that the faces on body 1 should be masters, because each node on a slave should find an element face on the master.

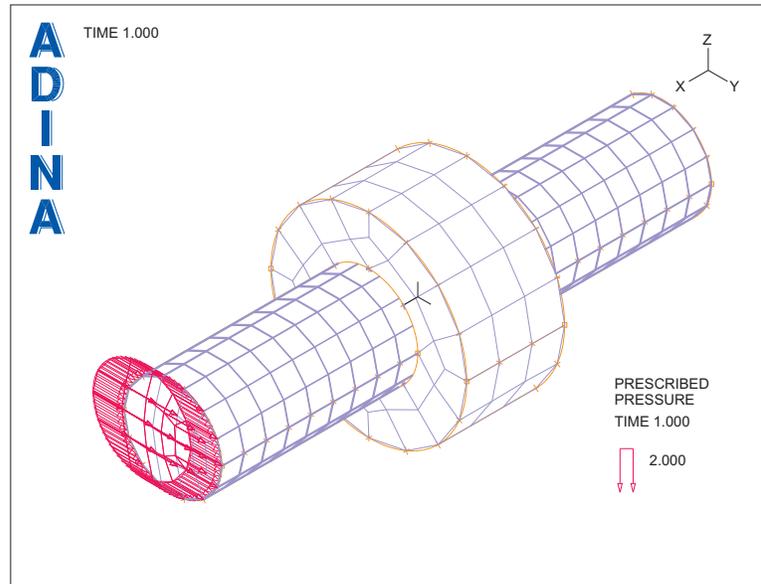
Choose Meshing→Glue Mesh, add Glue Mesh Set 1, make sure that the “Apply To” field is set to Surface/Face, make sure that “Show” is set to Slave, then enter the following information into the table (do not click OK yet).

Surf/Face	Body #
1	2
6	2

Now set “Show” to Master, enter the following information into the table and click OK.

Surf/Face	Body #
1	1
4	1

When you click the Redraw icon, the graphics window should look something like the figure on the next page. Notice that the gluemesh boundary is drawn in thick lines.



Generating the data file, running ADINA Structures, loading the porthole file

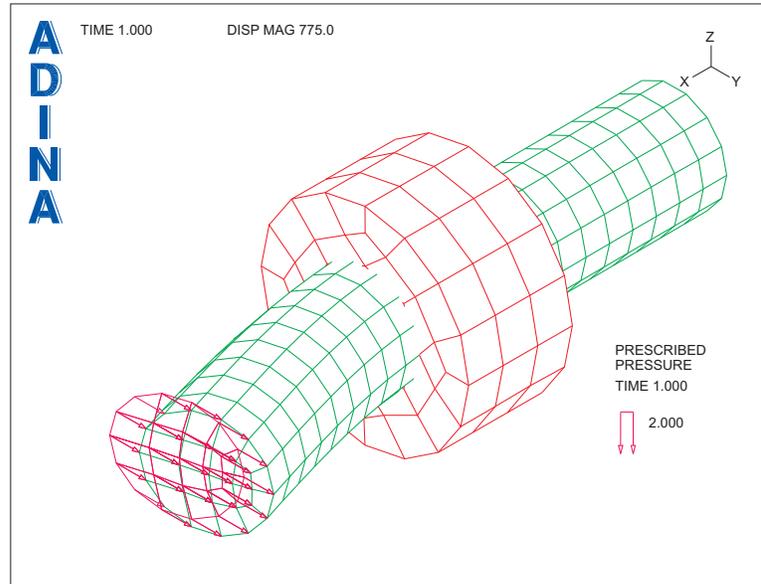
Click the Save icon  to save the database file. Click the Data File/Solution icon , set the file name to prob40, make sure that the Run Solution button is checked and click Save.

When ADINA Structures is finished, close all open dialog boxes, set the Program Module drop-down list to Post-Processing (you can discard all changes), click the Open icon  and open porthole file prob40.

Plotting the deformed mesh

Click the Color Element Groups icon , the Scale Displacements icon  10%, and the Load Plot icon . The graphics window should look something like the figure on the next page.

Problem 40: Analysis of a glued shaft with ADINA-M/PS



The shaft appears to be glued to the ring.

Total reaction force

Choose List→Value List→Zone, set Variable 1 to (Reaction: X-REACTION_SUM), Variable 2 to (Reaction: Y-REACTION_SUM) and Variable 3 to (Reaction: Z-REACTION_SUM), then click Apply. The X and Z reaction sums should be very close to zero, and the Y reaction sum should be close to -6.07437 (N). Notice that the total applied force is a traction of 2 N/mm² applied over a circular area of radius 1 mm, resulting in a total applied force of 6.28318 N. The difference between the computed value of 6.07437 and the theoretical value of 6.28318 is due to the discretization of the shaft; the circular area is approximated by straight-sided quadrilateral element faces.

Exiting the AUI: Choose File→Exit (you can discard all changes).