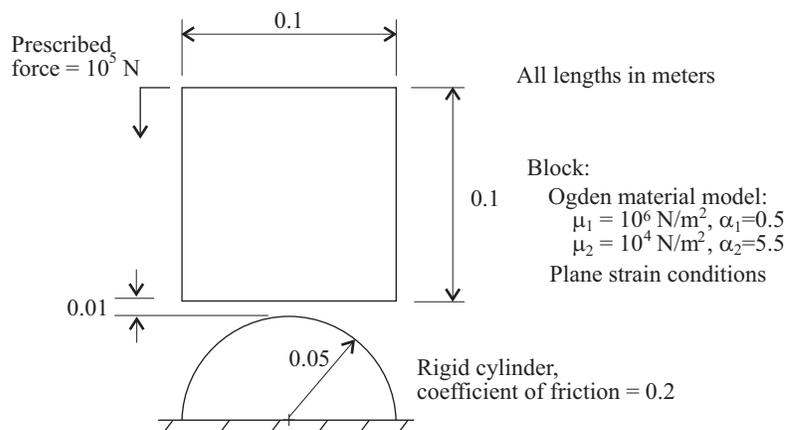


Problem description

A block is pushed onto a rigid cylinder as shown:



We would like to determine the displacements and contact tractions for the given load application. However, we do not want to explicitly specify time steps or time functions.

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

- Using the TLA and-TLA-S methods
- Plotting contact tractions as bands

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.

This problem cannot be solved with the 900 nodes version of the ADINA System because there are 1077 nodes in the model.

Much of the input for this problem is stored in file prob43_1.in. You need to copy file prob43_1.in from the folder samples\primer into a working directory or folder before beginning this analysis.

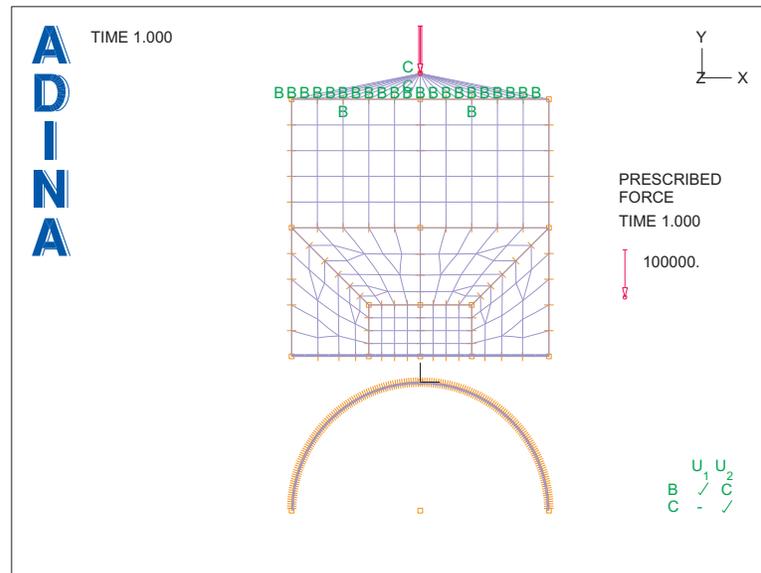
Invoking the AUI and choosing the finite element program

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

Model definition

We have prepared a batch file (prob43_1.in) which contains all of the model definition except for the specification of the TLA method.

Choose File→Open Batch, navigate to the working directory or folder, select the file prob43_1.in and click Open. The graphics window should look something like this:



If you look at the commands in prob43_1.in, you will notice that there is no specification of the time function or the number of time steps. The time function used is the default time function, and the number of time steps is automatically set by the TLA method.

Choosing the TLA method

Click the Analysis Options icon  to the right of the Analysis Type drop-down list, set the “Automatic Time Stepping Scheme” to “Use Total Load Application (TLA)” and click OK.

Generating the ADINA Structures data file, running ADINA Structures, examining the output file

First click the Save icon  and save the database to file prob43. Click the Data File/Solution icon , set the file name to prob43, make sure that the Run Solution button is checked and click Save.

Depending upon round-off, ADINA Structures either runs, or stops with the message

```
*** Program stopped abnormally ***
```

Click the View Output button in the ADINA Structures window and find the text

```
STEP NUMBER =          1
```

You will notice that the minimum abs diag element of the factorized matrix is very small. This is because the model has a rigid body mode in the y translational direction. This rigid body mode is present because we specified a prescribed force on the block, and when the block is not in contact with the cylinder, there is nothing to restrain the motion of the block.

Close the text editor window and the ADINA Structures window, and all other windows.

One way to obtain a solution is to prescribe the displacement of the block. However then it is difficult to determine the exact amount of displacement needed to obtain the specified prescribed force. So instead we add stabilization to the model using the TLA-S method.

Choosing the TLA-S method

Click the Analysis Options icon  to the right of the Analysis Type drop-down menu, set the “Automatic Time Stepping Scheme” to “Use TLA with Stabilization (TLA-S)” and click OK.

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

Click the Save icon  to save the database file. Now click the Data File/Solution icon , set the file name to prob43, make sure that the Run Solution button is checked and click Save. You can replace the existing prob43.dat file.

ADINA Structures solves the model using 7 solution steps.

Click the View Output button in the ADINA Structures window, scroll to the end of the file, then scroll backwards until you find the table with heading

Problem 43: Contact between a block and a rigid cylinder, TLA-S method

S O L U T I O N A C C U R A C Y I N D I C A T O R S

In this table, notice that

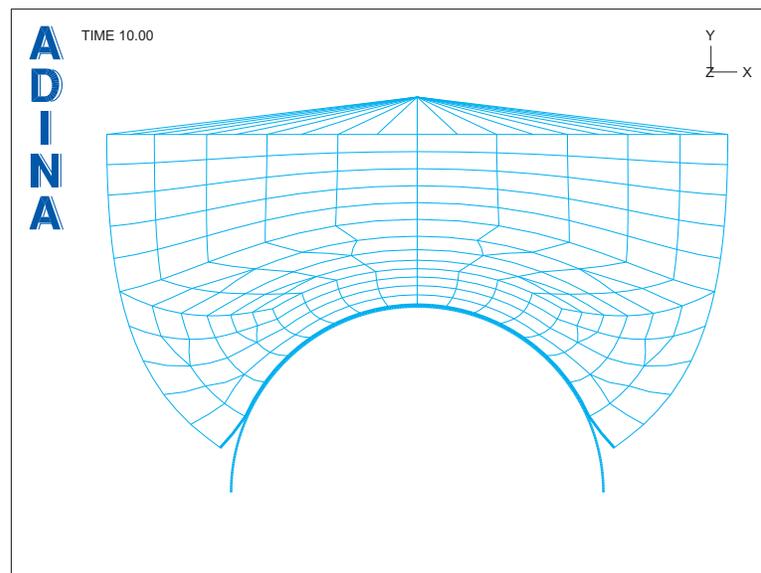
```
EXTERNAL FORCES = 1.132E+02
DAMPING FORCES = 2.709E-01
INERTIA FORCES = 0.000E+00
CONTACT DAMP. FORCES = 5.007E-03
STIFFNESS STABIL = 2.276E-05
```

These numbers are force indicators (not forces) and have units of energy (force units times displacement units).

For this problem, the stabilization comes from low-speed dynamics damping, contact damping and stiffness stabilization. Low-speed dynamics inertia is not used because we did not specify the density of the material in the model definition.

Since the damping force indicator, the contact damping force indicator and the stiffness stabilization indicator are much smaller than the external force indicator, we conclude that the stabilization does not affect the solution significantly.

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 prob43. The graphics window should look something like this:

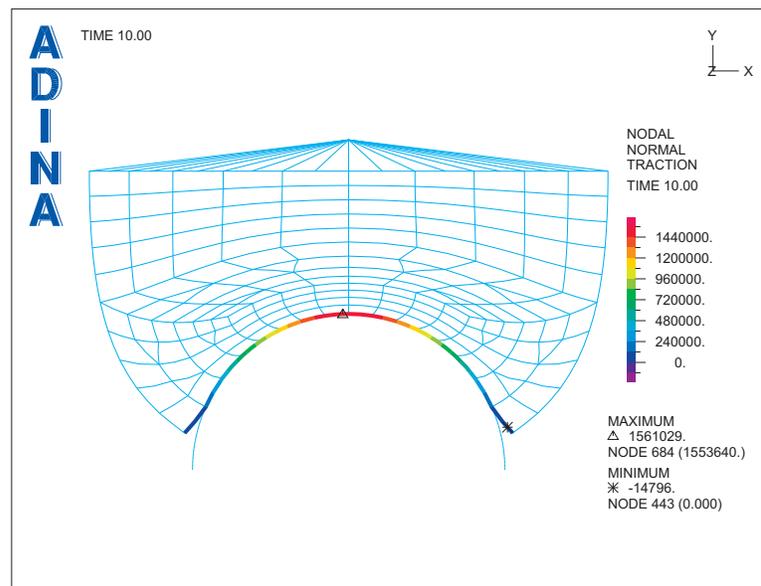


Post-processing

Although ADINA Structures solves the model in 7 solution steps, ADINA Structures only saves the solution for the last time step. So you cannot examine the solution at different load levels, create animations or create a force-deflection curve.

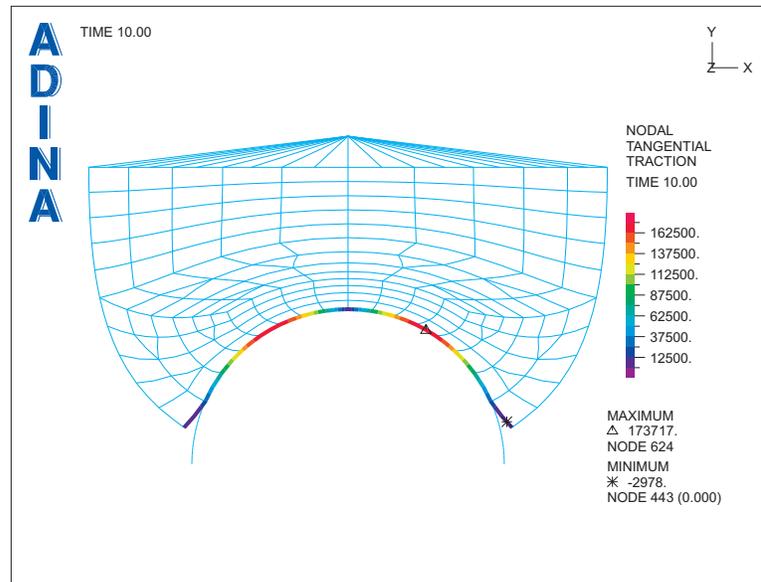
You can examine the solution for the given prescribed force in detail. Here we demonstrate how to show the contact tractions as bands.

Click the Create Band Plot icon , set the Band Plot Variable to (Traction: NODAL_NORMAL_TRACTION) and click OK. It is difficult to see the traction bands because the thick contact segment lines obscure the traction bands. Click the Modify Mesh Plot icon , click the Element Depiction... button, click the “Contact, etc” tab, set the Contact Surface Line Width to 0 and click OK to close both dialog boxes. It is easier to see the traction bands, but it would be better to thicken them some more. Click the Modify Band Plot icon , click the Band Rendering... button, set the Line Width Value to 6 and click OK twice to close both dialog boxes. The graphics window should look something like this:



Since there is friction in the model, we can also plot the tangential tractions. Click the Modify Band Plot icon , set the Band Plot Variable to (Traction: NODAL_TANGENTIAL_TRACTION) and click OK. The graphics window should look something like the figure on the next page.

Problem 43: Contact between a block and a rigid cylinder, TLA-S method



Exiting the AUI: Choose File→Exit to exit the AUI. You can discard all changes.

Note

The TLA-S method uses four stabilization factors: the stiffness matrix stabilization factor, the damping factor, the inertia factor and the contact damping factor. Since there is no density assigned to the model, the model has no mass and the inertia factor has no effect. If you assign a density to the model, you should turn off the stiffness matrix stabilization factor. Otherwise the convergence will be slow while the model is not in contact.