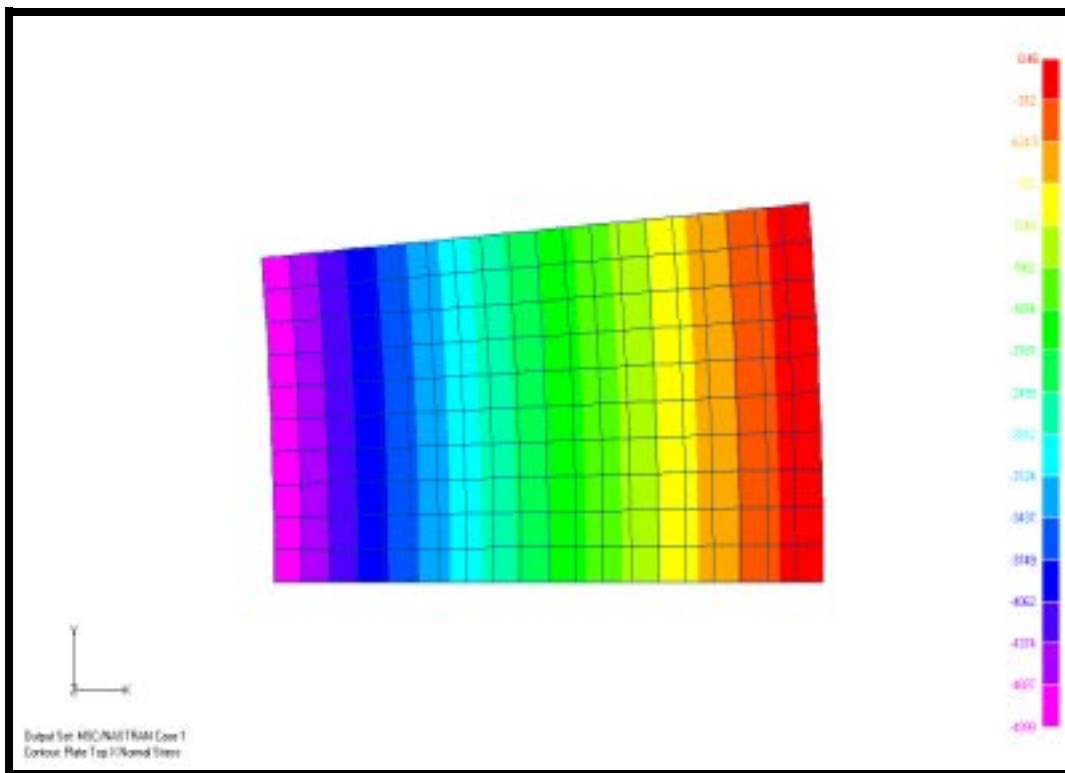


WORKSHOP 21b

Scuba Tank: Plane Strain



Objectives:

- Model a scuba tank and use plane strain elements to calculate stresses in tank wall due to an internal pressure.



Suggested Exercise Steps:

- Create a new file.
- Complete the geometry.
- Create the material and property.
- Mesh the model.
- Apply loads and constraints.
- Run analysis and evaluate results.

Hand Calculations for thick walled cylinder:

Ref. *Advanced Mechanics of Materials*, Boresi/Sidebottom/Seely/Smith, 3rd Edition, p. 479

Formula 11-3.2

$$\sigma_y = \frac{P(r_i)^2}{r_o^2 - r_i^2} + \frac{r_i^2 r_o^2 P}{r^2 (r_o^2 - r_i^2)}$$

- r_i = inside radius
- r_o = outside radius
- P = pressure
- r = position to calculate stress
- $\sigma_y @ r_i = 32,482.43 \text{ psi}$
- $\sigma_y @ r_o = 27,482.43 \text{ psi}$

Exercise Procedure:

1. Start up MSC.Nastran for Windows V4.0 and begin to create a new model.

Double click on the icon labeled **MSC.Nastran for Windows V4.0**.

On the *Open Model File* form, select **New Model**.

Open Model File:

New Model

2. In this exercise, we will only model a 5 degree sector of the tank cross section. We will mesh this cross section with plane strain elements. .

Geometry/Curve-Line/Project Points...

CSys:

1..Basic Cylindrical

R: **7.25/2**

T:

0

Z:

0

OK

R: **3.625-0.521**

T:

0

Z:

0

OK

Cancel

The workplane will not be necessary.

Right Click on screen to invoke the pop up menu.

Workplane...

Uncheck **Draw Workplane**.

Draw Workplane

Done

View/Autoscale <Ctrl+A>

-
3. Revolve this curve to create a 5 degree sector of the cross section.

Geometry/Surface/Revolve...

OK
Methods ^
Global Axis

Direction:

Positive

Z Axis

OK

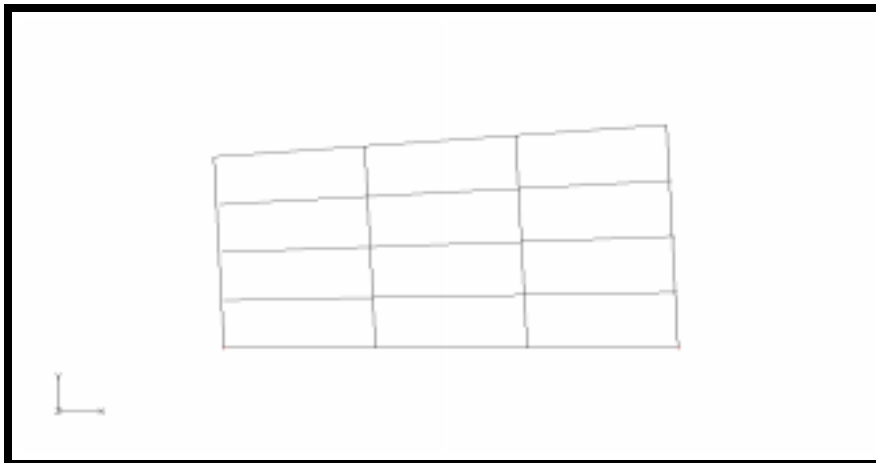
Rotation Angle:

5

OK
Cancel

View/Autoscale <Ctrl+A>

Figure 21b.2



4. Create the material.

Model/Material...

Load...

Library Entry:

17-4PH Stainless H1025

OK

OK
Cancel

5. Create the plane strain element property.

Model/Property...

Elem/Property Type...
<input checked="" type="checkbox"/> Parabolic Elements
<i>Plane Elements:</i>
<input type="checkbox"/> Plane Stress
<input checked="" type="radio"/> Plane Strain

OK
Cancel

Title:

Plane_Strain

Material:

1..17-4PH Stainless H1025

Thicknesses, Tavg or T1:

1.

OK
Cancel

6. Mesh the surface.

Mesh/Mesh Control/Mapped Divisions on Surface...

OK
Cancel

Number of Elements:

s:

20

t:

10

OK
Cancel

Mesh/Geometry/Surface...

OK
Cancel

Property:

1..Plane Strain

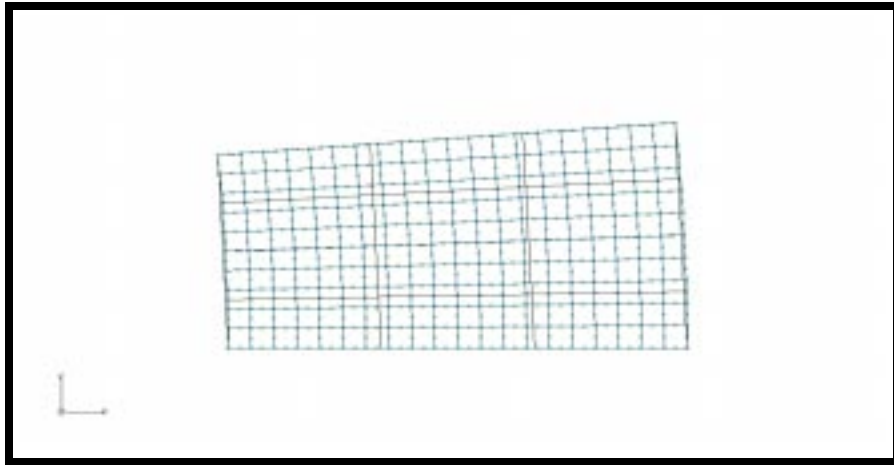
Node Param...
Cancel

Output Coordinate System:

1..Basic Cylindrical

OK
OK

Figure 21b.3



7. Create load set and load.

Model/Load/Set... <Ctrl+F2>

Title:

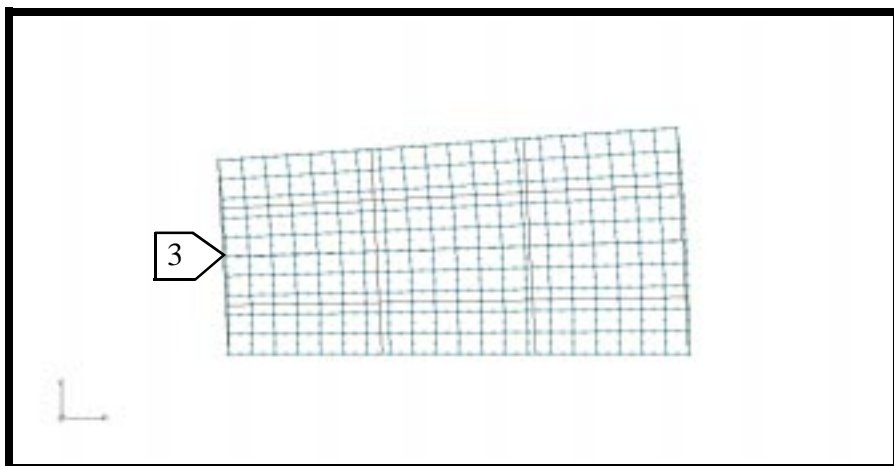
5_Ksi

OK

Model/Load/On Curve...

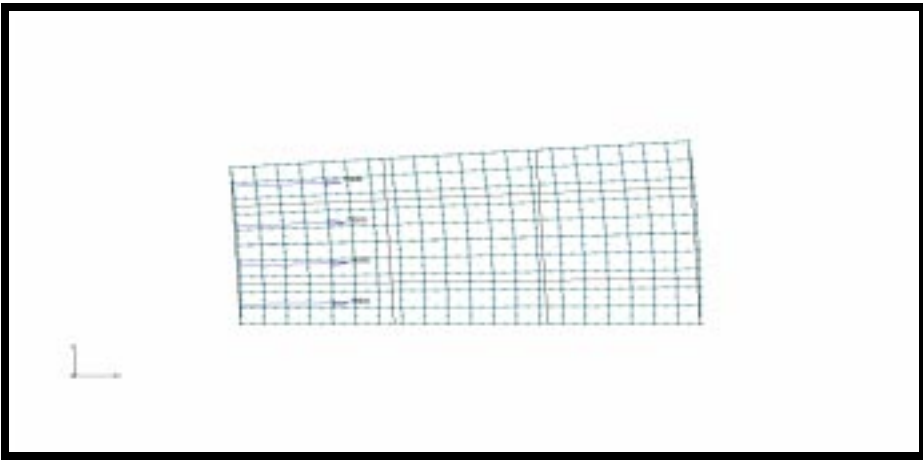
Select Curve 3.

Figure 21b.4



OK	Force Per Length
(highlight)	1..Basic Cylindrical
Coord Sys:	5000
<input checked="" type="checkbox"/> FX	
OK	
Cancel	

Figure 21b.5



8. Apply symmetry boundary conditions.

Model/Constraint/Set... <Shift+F2>

Title: Symmetric

OK

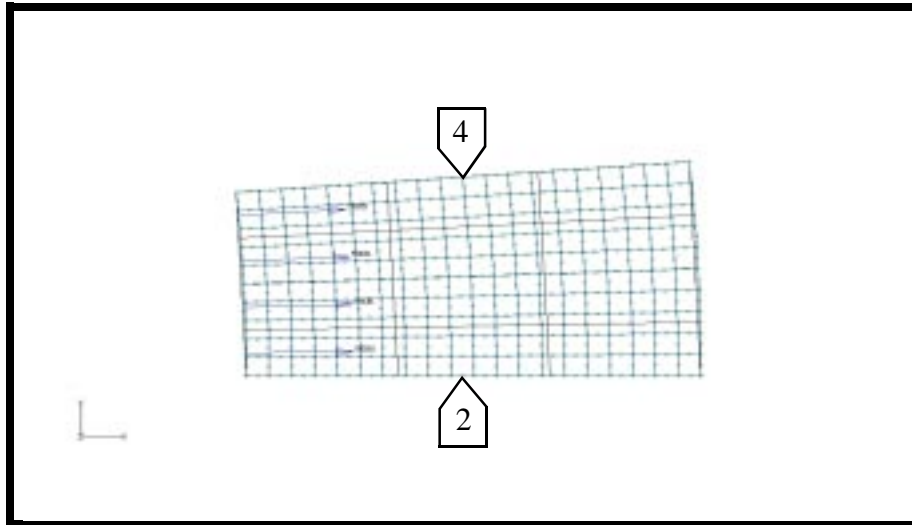
Model/Constraint/Nodal...

Method ^

on Curve

Select the curves in Figure 21b.6.

Figure 21b.6



OK

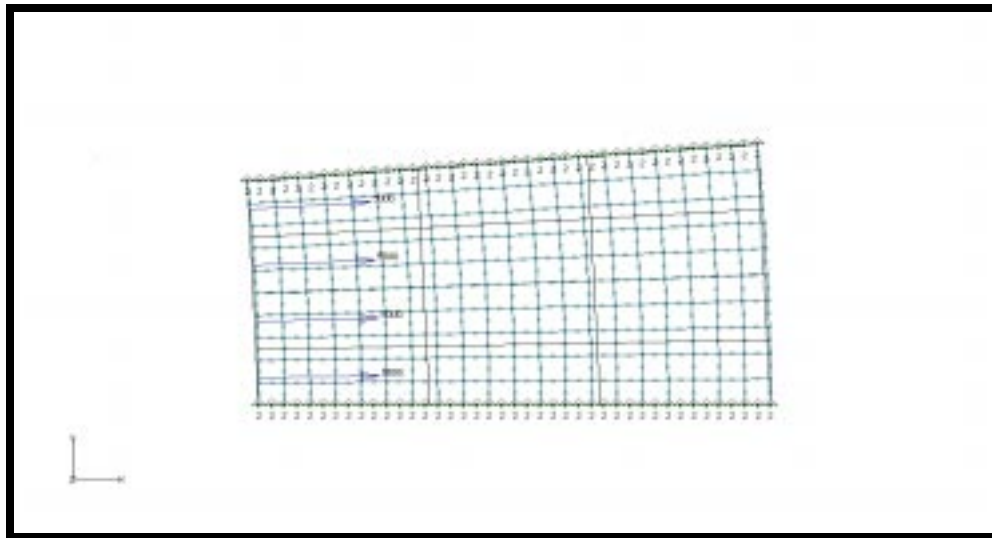
DOF:

TT

OK

Cancel

Figure 21b.7



9. Now run the analysis.

File/Export/Analysis Model... <Ctrl+T>

OK

File Name:

tank_ps

Write

Additional Info:

Run Analysis

OK

Yes

File Name:

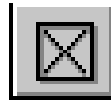
tank_ps

Save

Continue

10. Review the results.

Click the *Quick Options* icon and turn off all of the entities and turn on the elements.



All Entities Off

Element

Done

View/Select... <F5>

Deformed Style:

Deform

Contour Style:

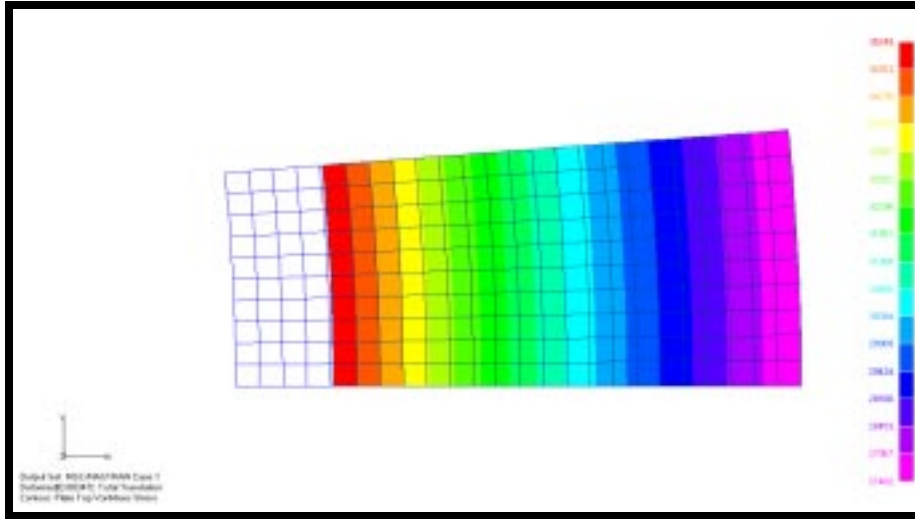
Contour

Deform and Contour Data...

OK

OK

Figure 21b.8



View/Select... <F5>

Deformed Style:

None - Model Only

Contour Style:

Contour

Deform and Contour Data...

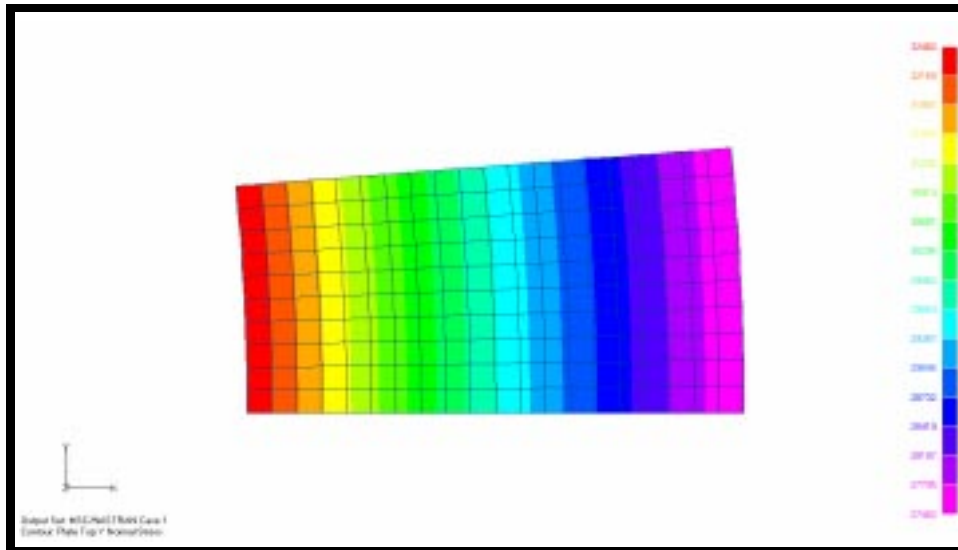
Contour (pull-down):

7021..Plate Top Y Normal Stress

OK

OK

Figure 21b.9



View/Select... <F5>

Deform and Contour Data...

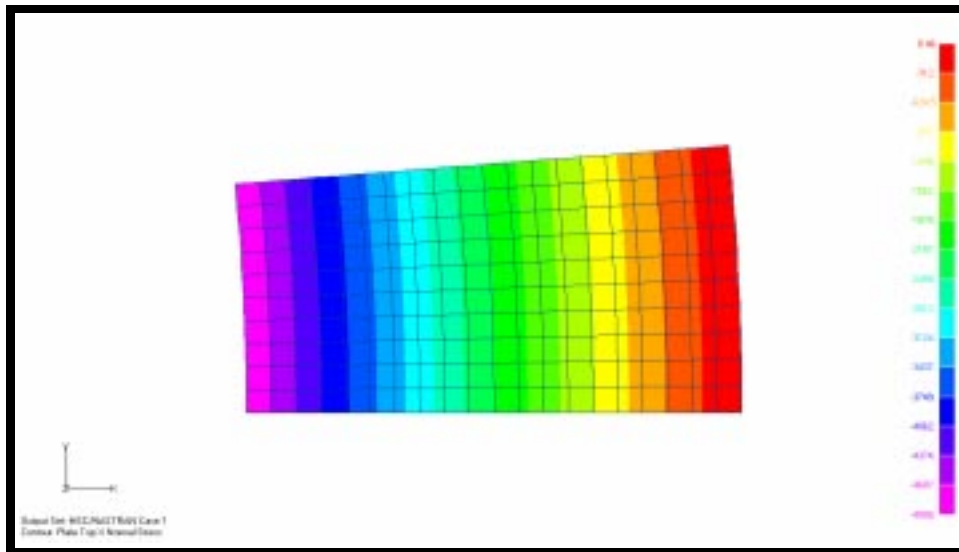
Contour (pull-down):

7020..Plate Top X Normal Stress

OK

OK

Figure 21b.10



This concludes this exercise.

File/Save

File/Exit

