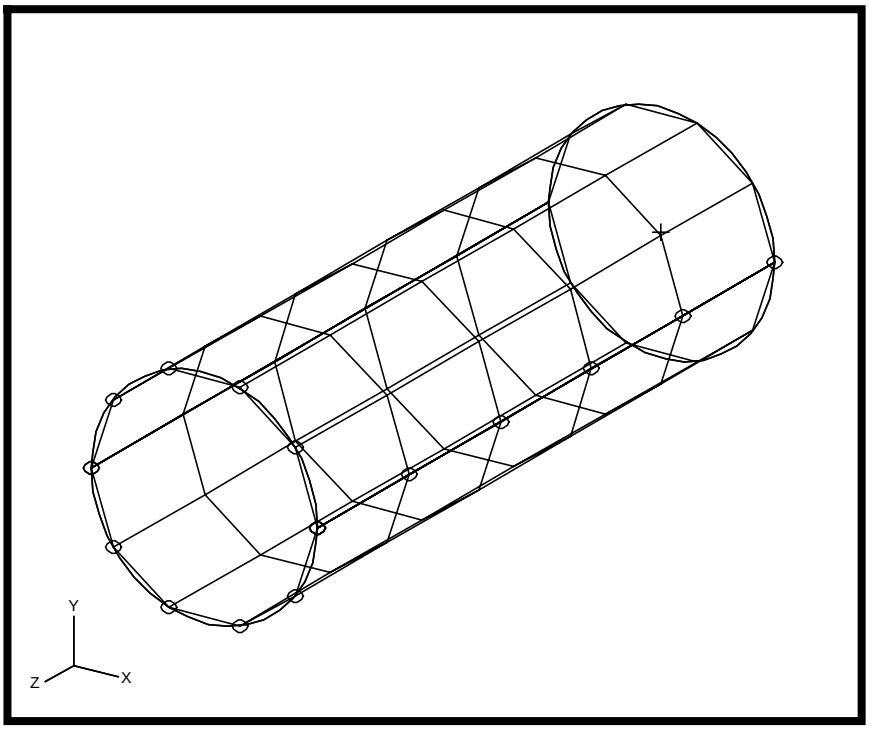
WORKSHOP PROBLEM 5

Rigid Element Analysis with RBE2 and CONM2



Objectives:

- Idealize a rigid end using RBE2 elements.
- Define a concentrated mass, to represent the weight of the rigid enclosure (CONM2).
- Produce a Nastran input file that represents the tube.
- Submit the file for analysis in MSC/NASTRAN.
- Find the displacement vectors.

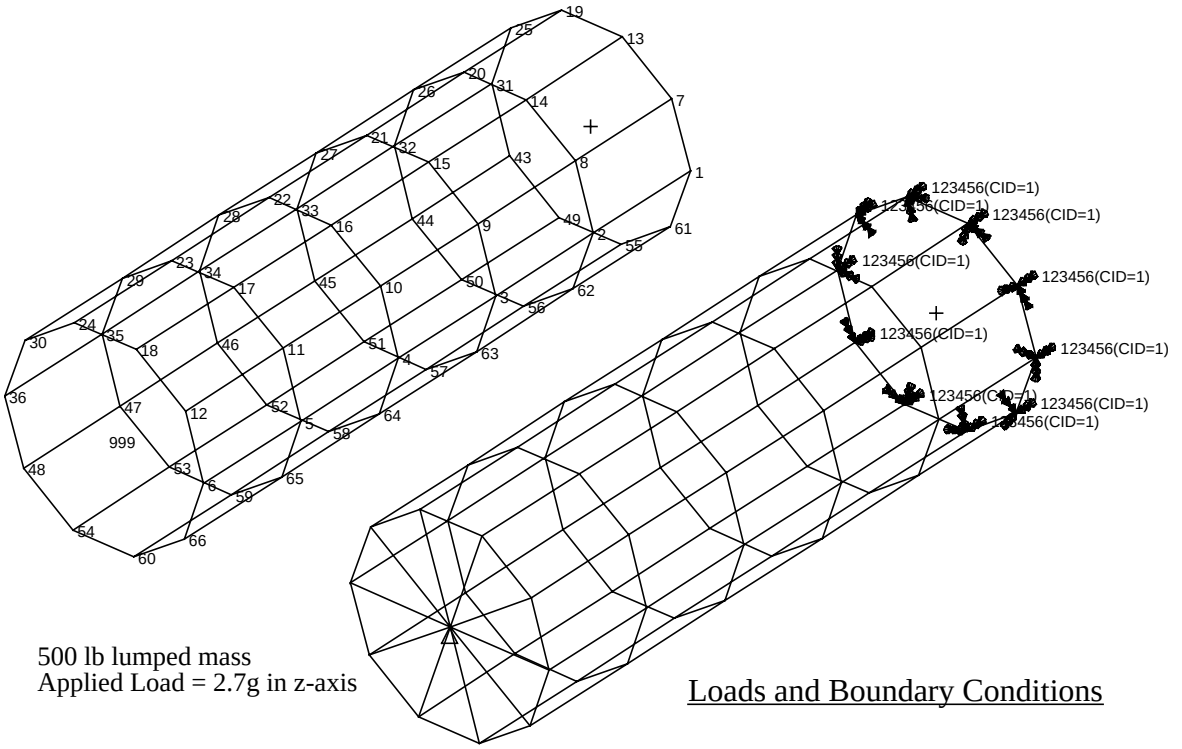
Model Description:

The goal of this example is to maintain a circular cross section at the rigid end of the tube, (using a RBE2 element), while applying a gravitational force of 2.7g in the z-direction.

Additionally, a concentrated mass needs to be defined to represent the weight of the rigid enclosure. It is very important to account for all the weight contribution since inertial loading is used in this problem.

Below is a Finite Element representation of the tube. One end of the tube is considered rigid, and the other end is fixed in all translational and rotational degrees of freedom. Table 5.1 contains all the necessary parameters to construct the input file.

Grid Coordinates and Element Connectivites.



500 lb lumped mass
Applied Load = 2.7g in z-axis

Loads and Boundary Conditions

Table 5.1

Radius	**15 in**
Thickness	**0.125 in**
Length	**90 in**
Elastic Modulus	**10E6 lb/in^2**
Density	**0.101 lbs/in^3**
Poisson's Ratio	**0.3**

Suggested Exercise Steps:

- Explicitly generate a finite element representation of the cylinder structure i.e., the nodes (GRID) and element connectivity (CQUAD4) should be defined manually.
- Define material (MAT1) and element (PSHELL) properties.
- Idealize the top enclosure as a rigid element (RBE2).
- Apply the fixed boundary constraints (SPC1).
- Apply a concentrated mass of 500 lbs at the center of the top enclosure (CONM2), and a gravitational force of 2.7g in the Z-direction (GRAV).
- Generate an Input file and submit it to the MSC/NASTRAN solver for linear static analysis.
- Prepare the model for linear static analysis (SOL 101), and PARAM, WTMASS, 0.00259 (see 6-4 for format).
- Review the results, specifically the displacements along the top edges.

```
ID SEMINAR,PROB5
```

```
CEND
```

```
BEGIN BULK
```

1	2	3	4	5	6	7	8	9	10

1	2	3	4	5	6	7	8	9	10

ENDDATA

Exercise Procedure:

1. Users who are not utilizing MSC/PATRAN for generating an input file should go to Step 10, otherwise, proceed to step 2.

2. Open the database **prob4.db** from the previous exercise.

File/Open Database

Database Name **prob4**

OK

3. Choose a front view using the Front View icon on the toolbar.

Front View

4. First, you must delete the old MPC from the previous exercise. Be careful not to delete any associated nodes.

◆ **Finite Elements**

Action: **Delete**

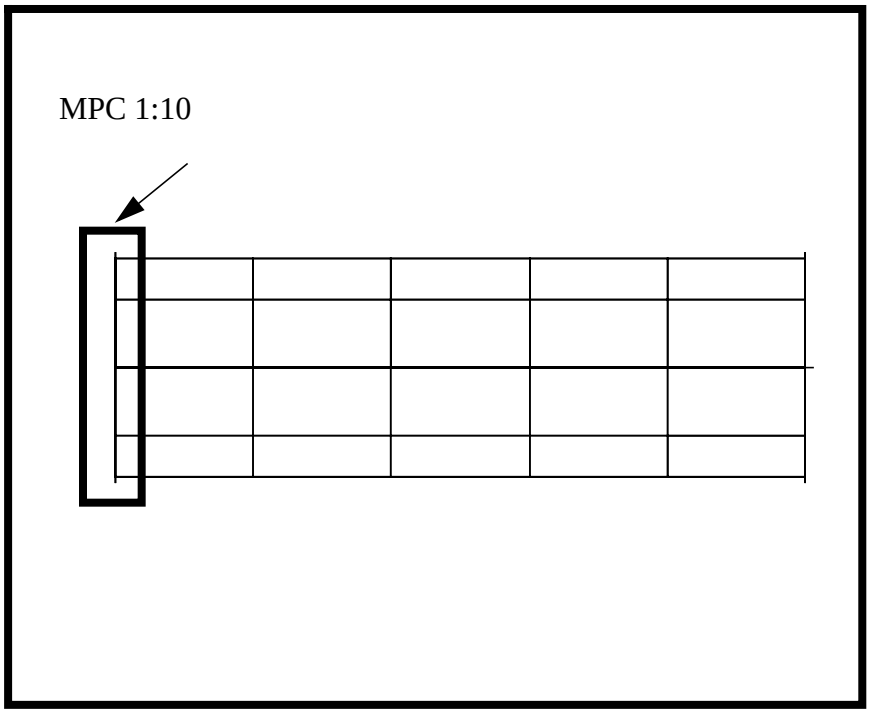
Object: **MPC**

Delete Related: ☐ **Nodes**
(deselect)

List of MPC's: **MPC 1:10**
(see Fig 5.1)

Apply

Figure 5.1- List of MPC's



5. Create the rigid element.

◆ **Finite Elements**

Action:	**Create**
Object:	**MPC**
Type:	**RBE2**

Define Terms...

☐ *Auto Execute*

◆ **Create Dependant**

Node List	**Node 6:36:6, 48:66:6**

You can type the nodes into the list directly or you can screen select it by selecting the nodes on the *left edge* of the model. Be sure to **remove Node 999** from your list. See **figure 5.1**

Select DOFs by holding the Shift key down while clicking with the left mouse button.

DOFs:	**UX** **UY** **UZ**

Apply

◆ **Create Independent**

Node List:	**Node 999**

Apply

Cancel

Apply

6. Now you will create the concentrated mass.

First, create a point element.

◆ **Finite Elements**

Action:	**Create**
Object:	**Element**
Method:	**Edit**
Shape:	**Point**
Node 1 =	**Node 999**

Apply

Now assign the mass a value.

◆ **Properties**

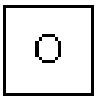
Action:	**Create**
Dimension:	**0D**
Type:	**Mass**
Property Set Name:	**mass**
Option(s):	**Lumped**

Input Properties ...

Mass: **500**

OK

Once you have clicked in the *Select Members* databox select the **Point Element** icon, then screen select **Element 51**.



Point Element

Select Members: **Element 51**

Add

Apply

7. Next you will create a new gravitational load.

◆ **Loads/BCs**

Action: **Create**

Object: **Inertial Load**

Type: **Element Uniform**

New Set Name: **grav_load**

Input Data...

Load/BC Set Scale Factor: **386.4**

Trans Accel <A1 A2 A3> **<0, 0, 2.7>**

OK

Apply

8. Now you must modify the load case by adding **grav_load** and removing **applied_moment** from the *Default load case.*

◆ **Load Cases**

Action: **Modify**

Highlight the **Default** under *Select Load Case to Modify* then unhighlight **Force_applied_moment** under *Assigned Load/BC Sets.*

Select Load Case to Modify **Default**

The **Force_applied_moment** in the spreadsheet can be removed as follows:

Click the Force_applied_moment in the spreadsheet

Remove Selected Rows

OK

Apply

9. Now you are ready to run the analysis.

◆ **Analysis**

Action: **Analyze**

Object: **Entire Model**

Method: **Analysis Deck**

Jobname **prob5**

Solution Type...

Solution Type **Linear Static**

Solution Parameters...

Wt-Mass Conversion = **0.00259**

OK

OK

Apply

An MSC/NASTRAN input file called **prob5.bdf** will be generated. This process of translating your model into an input file is called the Forward Translation. The Forward Translation is complete when the Heartbeat turns green. MSC/PATRAN Users should proceed to step 11.

Generating an input file for MSC/NASTRAN Users:

MSC/NASTRAN users can generate an input file using the data from table 5.1. The result should be similar to the output below.

10. MSC/NASTRAN Input File: **prob5.bdf**

ID SEMINAR, PROB5

```
SOL 101
TIME 600
CEND
SET 1 = 6,12,18,24,30,36,48,54,60,66
ECHO = NONE
MAXLINES = 999999999
SUBCASE 1
   SPC = 1
   LOAD = 1
   DISPLACEMENT(SORT1,REAL)=1
BEGIN BULK
PARAM    WTMASS  .00259
PSHELL   1       1       .125    1               1
CQUAD4   1       1       1       2       8       7
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   6       1       7       8       14      13
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   11      1       13      14      20      19
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   16      1       19      20      26      25
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   21      1       25      26      32      31
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   26      1       31      32      44      43
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   31      1       43      44      50      49
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   36      1       49      50      56      55
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   41      1       55      56      62      61
=        *1      =       *1      *1      *1      *1
=3
CQUAD4   46      1       61      62      2       1
=        *1      =       *1      *1      *1      *1
=3
MAT1     1       10.+6           .3      .101
```

```
RBE2     52      999     123     6       12      18      24      30      +       C
+       C 36     48      54      60      66
CONM2    51      999             500.
GRID     1       1       15.     0.      0.      1
=        *1      =       =       =       *18     =
=4
GRID     7       1       15.     36.     0.      1
=        *1      =       =       =       *18     =
=4
GRID     13      1       15.     72.     0.      1
=        *1      =       =       =       *18     =
=4
GRID     19      1       15.     108.    0.      1
=        *1      =       =       =       *18     =
=4
GRID     25      1       15.     144.    0.      1
=        *1      =       =       =       *18     =
=4
GRID     31      1       15.    -180.    0.      1
=        *1      =       =       =       *18     =
=4
GRID     43      1       15.    -144.    0.      1
=        *1      =       =       =       *18     =
=4
GRID     49      1       15.    -108.    0.      1
=        *1      =       =       =       *18     =
=4
GRID     55      1       15.    -72.     0.      1
=        *1      =       =       =       *18     =
=4
GRID     61      1       15.    -36.     0.      1
=        *1      =       =       =       *18     =
=4
GRID     999     1       0.      0.      90.     1
SPC1     1       123456  1       7       13      19      25      31      +       A
+       A 43     49      55      61
GRAV     1       0       386.4   0.      0.      2.7
CORD2C   1               0.      0.      0.      0.      0.      1.      +       B
+       B 1.     0.      0.
ENDDATA
```

Submit the input file for analysis

11. Submit the input file to MSC/NASTRAN for analysis.

    11a. To submit the MSC/PATRAN **.bdf** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran prob5.bdf scr=yes**. Monitor the run using the UNIX **ps** command.

    11b. To submit the MSC/NASTRAN **.dat** file for analysis, find an available UNIX shell window. At the command prompt enter: **nastran prob5 scr=yes**. Monitor the run using the UNIX **ps** command.

12. When the run is completed, edit the **prob5.f06** file and search for the word **FATAL**. If no matches exist, search for the word **WARNING**. Determine whether existing WARNING messages indicate modeling errors.

13. While still editing prob5.f06, search for the word:

D I S P L A C E M E N T (spaces are necessary)

For Point ID's 6, 12, 18, 24, 30, 36, 48, 54, 60, and 66

T3 = _____

Comparison of Results

14. Compare the results obtained in the **.f06** file with the results on the following page.

D I S P L A C E M E N T V E C T O R

POINT ID.	TYPE	T1	T2	T3	R1	R2	R3
6	G	-8.609607E-18	-7.127617E-18	1.147170E-03	-8.138134E-20	4.927580E-06	-7.295071E-20
12	G	-1.130591E-17	-6.566728E-19	1.147170E-03	6.016707E-21	4.927580E-06	-2.200300E-20
18	G	-9.683741E-18	6.163278E-18	1.147170E-03	-1.089727E-20	4.927580E-06	2.392054E-19
24	G	-4.362711E-18	1.072725E-17	1.147170E-03	-4.496870E-19	4.927580E-06	-2.636522E-19
30	G	2.624726E-18	1.129195E-17	1.147170E-03	6.099430E-20	4.927580E-06	2.010574E-19
36	G	8.609607E-18	7.641696E-18	1.147170E-03	-1.312026E-19	4.927580E-06	3.364971E-20
48	G	1.130591E-17	1.170753E-18	1.147170E-03	2.342655E-20	4.927580E-06	-1.734027E-19
54	G	9.683741E-18	-5.649198E-18	1.147170E-03	4.811336E-20	4.927580E-06	2.731086E-19
60	G	4.362711E-18	-1.021317E-17	1.147170E-03	6.639047E-20	4.927580E-06	-2.257344E-19
66	G	-2.624726E-18	-1.077787E-17	1.147170E-03	2.804783E-19	4.927580E-06	2.126251E-19

15. **MSC/NASTRAN Users have finished this exercise. MSC/PATRAN Users should proceed to the next step.**

16. Proceed with the Reverse Translation process, that is importing the **prob5.op2** results file into MSC/PATRAN. To do this, return to the **Analysis** form and proceed as follows:

◆ **Analysis**

Action:	**Read Output2**
Object:	**Result Entities**
Method:	**Translate**
Select Results File...	
Selected Results File:	**prob5.op2**
OK	
Apply	

Set the **default_group** to current:

Group/Set Current...

Set Current Group:	**default_group**
Cancel	

17. When the translation is complete, bring up the **Results** form.

◆ **Results**

Action:	**Create**
Object:	**Fringe**
Select Result Case(s):	**Default, Static Subcase**
Select Fringe Result:	**Displacement, Translational**
Quantity:	**Magnitude**

To change the target entites of the plot, click on the **Target Entities** icon.

Target Entities

Target Entity:	**Groups**
Select Groups:	**default_group**
Addtl. Display Control:	**Faces**

To change the display attributes of the plot, click on the **Display Attributes** icon.

Display Attributes

Element Shrink Factor:	**0.1**

To change the plot options, click on the **Plot Options** icon.

Plot Options

Coordinate Transformation:	**CID**
Select Coordinate Frame:	**Coord 1**

Apply

17a. Next, add the deformation options to the plot.

◆ **Results**

Action:	**Create**
Object:	**Deformation**
Select Result Case(s):	**Default, Static Subcase**
Select Deformation Result:	**Displacements, Translational**
Show As:	**Resultant**

To change the target entites of the plot, click on the **Target Entities** icon.

Target Entities

Target Entity:	**Groups**
Select Groups:	**default_group**

To change the display attributes of the plot, click on the **Display Attributes** icon.

Display Attributes

■ **Show Undeformed**

Render Style:	**Wireframe**
Line Style:	**- - - - -**

To change the plot options, click on the **Plot Options** icon.

Plot Options

Coordinate Transformation:	**CID**
Select Coordinate Frame:	**Coord 1**

Apply

You may reset the graphics if you click on this icon:

Reset Graphics

You can go back and select any *Results Case*, *Fringe Results or Deformation Results* you are interested in.

Quit MSC/PATRAN when you are finished with this exercise.