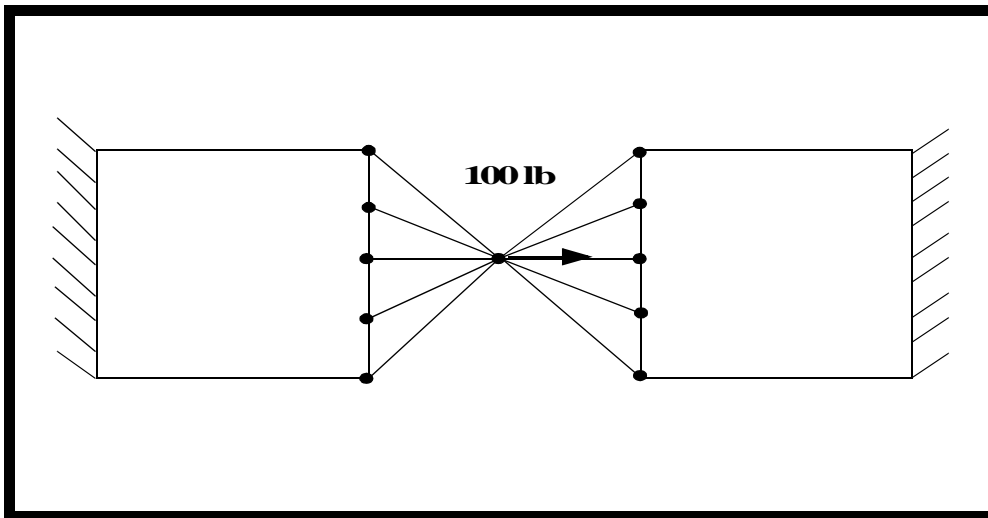

WORKSHOP 10

Comparison of RBE2 vs. RBE3



Objectives

- Demonstrate the difference between two rigid body elements.
- Run a linear static analysis.
- Create a deformation plot of the model.
- Review the results.



Model Description:

The figure below shows two identical plates. One edge of each plate is fixed while a total load of 100 lbs is applied horizontally at the node between the two plates. The load will be distributed to the plates using rigid elements. In the first part of this exercise, the rigid element is an RBE2 (true rigid element). In the second part, the rigid element is an RBE3 (interpolation element). Figure 10.1 displays the schematic of two identical plates. Table 10.1 below displays all the necessary properties of the model.

Figure 10.1 - Schematic of two identical plates.

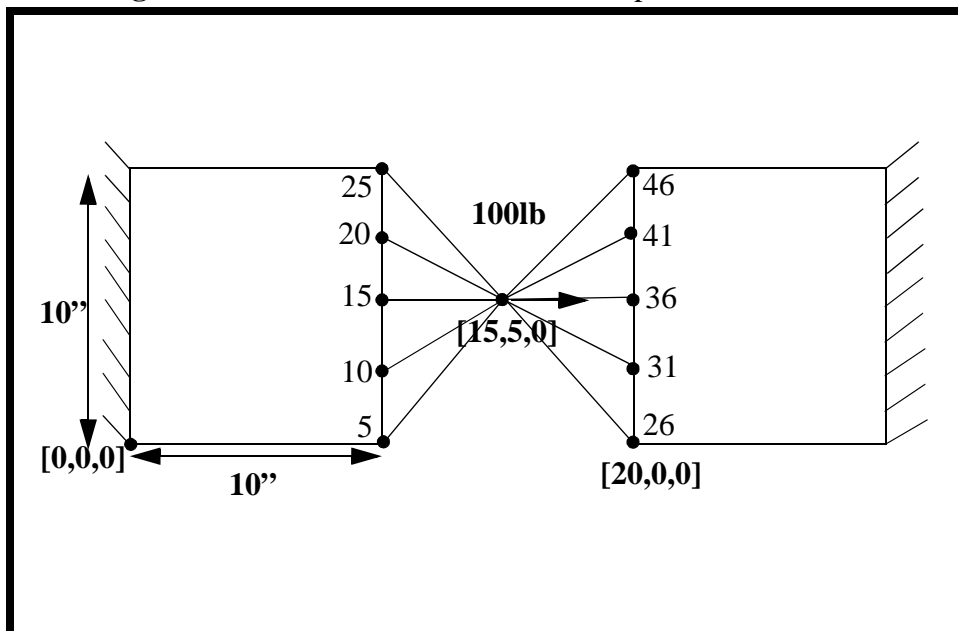


Table 10.1 -Plate Properties.

Area of each plate:	100 sq. in.
Youngs Modulus:	10E+06 psi
Poisson Ratio:	0.3
Applied Force:	100 lb
Plate Thickness:	0.2 in

Suggested Exercise Steps

- Explicitly generate a finite element representation of the plate models (i.e., the nodes (GRID) and element connectivities (QUAD4)).
(Note: Mesh w/ global edge length of 2.5)
- Define load application point (GRID 1000 located at [15,5,0]).
- Define material (MAT 1) and element (PSHELL) properties.
- Apply the fixed boundary constraints (SPC 1) at two extreme (left and right) edges.
- Apply concentrated force of 100 lbs (FORCE) at +x direction.
- Define RBE2 as interface.
- Prepare the model for a linear static analysis (SOL 101).
- Generate an input file and submit it to the MSC.Nastran solver for linear static analysis.
- Review the results.



1	2	3	4	5	6	7	8	9	10

ENDDATA

■ Generating an input file for MSC.Nastran Users:

MSC.Nastran users can generate an input file using the data from Table 10a. The result should be similar to the output below.

1. MSC.Nastran input file: **Prob10a.dat**

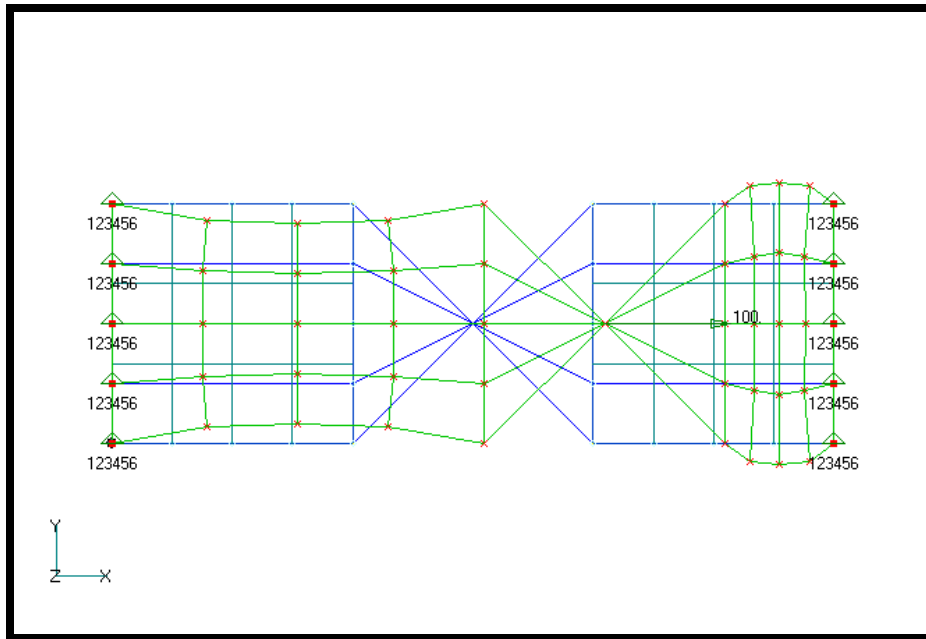
```
SOL 101
CEND
ECHO = NONE
SUBCASE 1
  SPC = 1
  LOAD = 1
  DISPLACEMENT=ALL
  SPCFORCES=ALL
  MPCFORCE=ALL
BEGIN BULK
PARAM  POST  -1
$
PSHELL 1 1 .2 1 1
$
CQUAD4 1 1 1 2 7 6
CQUAD4 2 1 2 3 8 7
CQUAD4 3 1 3 4 9 8
CQUAD4 4 1 4 5 10 9
CQUAD4 5 1 6 7 12 11
CQUAD4 6 1 7 8 13 12
CQUAD4 7 1 8 9 14 13
CQUAD4 8 1 9 10 15 14
CQUAD4 9 1 11 12 17 16
CQUAD4 10 1 12 13 18 17
CQUAD4 11 1 13 14 19 18
CQUAD4 12 1 14 15 20 19
CQUAD4 13 1 16 17 22 21
CQUAD4 14 1 17 18 23 22
CQUAD4 15 1 18 19 24 23
CQUAD4 16 1 19 20 25 24
CQUAD4 17 1 26 27 32 31
CQUAD4 18 1 27 28 33 32
CQUAD4 19 1 28 29 34 33
CQUAD4 20 1 29 30 35 34
CQUAD4 21 1 31 32 37 36
CQUAD4 22 1 32 33 38 37
CQUAD4 23 1 33 34 39 38
CQUAD4 24 1 34 35 40 39
CQUAD4 25 1 36 37 42 41
CQUAD4 26 1 37 38 43 42
CQUAD4 27 1 38 39 44 43
CQUAD4 28 1 39 40 45 44
CQUAD4 29 1 41 42 47 46
CQUAD4 30 1 42 43 48 47
CQUAD4 31 1 43 44 49 48
CQUAD4 32 1 44 45 50 49
```

\$
 MAT1 1 1.+7 .3
 \$
 RBE2 33 1000 123456 5 10 15 20 25 + A
 + A 26 31 36 41 46
 \$
 GRID 1 0. 0. 0.
 GRID 2 2.5 0. 0.
 GRID 3 5. 0. 0.
 GRID 4 7.5 0. 0.
 GRID 5 10. 0. 0.
 GRID 6 0. 2.5 0.
 GRID 7 2.5 2.5 0.
 GRID 8 5. 2.5 0.
 GRID 9 7.5 2.5 0.
 GRID 10 10. 2.5 0.
 GRID 11 0. 5. 0.
 GRID 12 2.5 5. 0.
 GRID 13 5. 5. 0.
 GRID 14 7.5 5. 0.
 GRID 15 10. 5. 0.
 GRID 16 0. 7.5 0.
 GRID 17 2.5 7.5 0.
 GRID 18 5. 7.5 0.
 GRID 19 7.5 7.5 0.
 GRID 20 10. 7.5 0.
 GRID 21 0. 10. 0.
 GRID 22 2.5 10. 0.
 GRID 23 5. 10. 0.
 GRID 24 7.5 10. 0.
 GRID 25 10. 10. 0.
 GRID 26 20. 0. 0.
 GRID 27 22.5 0. 0.
 GRID 28 25. 0. 0.
 GRID 29 27.5 0. 0.
 GRID 30 30. 0. 0.
 GRID 31 20. 2.5 0.
 GRID 32 22.5 2.5 0.
 GRID 33 25. 2.5 0.
 GRID 34 27.5 2.5 0.
 GRID 35 30. 2.5 0.
 GRID 36 20. 5. 0.
 GRID 37 22.5 5. 0.
 GRID 38 25. 5. 0.
 GRID 39 27.5 5. 0.
 GRID 40 30. 5. 0.
 GRID 41 20. 7.5 0.
 GRID 42 22.5 7.5 0.
 GRID 43 25. 7.5 0.
 GRID 44 27.5 7.5 0.
 GRID 45 30. 7.5 0.
 GRID 46 20. 10. 0.
 GRID 47 22.5 10. 0.
 GRID 48 25. 10. 0.
 GRID 49 27.5 10. 0.
 GRID 50 30. 10. 0.

WORKSHOP 10 *RBE2 vs. RBE3*

```
GRID 1000      15.  5.  0.
$
SPC1  1      123456 1   6   11  16  21  30  +  B
+   B 35   40  45  50
$
FORCE 1      1000  0   100.  1.  0.  0.
$
ENDDATA
```

Figure 10.2 - Deformed plot for Case 1.



The nodal results read from the *F06* are as follows:

	MPC Forces		Displacement	
Node	T1	T2	T1	T2
25	7.27	2.02	2.42e5	0
20	11.90	1.03	2.42e5	0
15	11.66	0	2.42e5	0
10	11.90	-1.03	2.42e5	0
5	7.27	-2.02	2.42e5	0
46	7.27	-2.02	2.42e5	0
41	11.90	-1.03	2.42e5	0
36	11.66	0	2.42e5	0
31	11.90	1.03	2.42e5	0
26	7.27	2.02	2.42e5	0

■ **Replace the RBE2 w/ RBE3 using coefficient of 1 for all Independent nodes.**

MSC.Nastran users can generate an input file using the data from Table 10b. The result should be similar to the output below.

2. MSC.Nastran input file: **10b.dat**

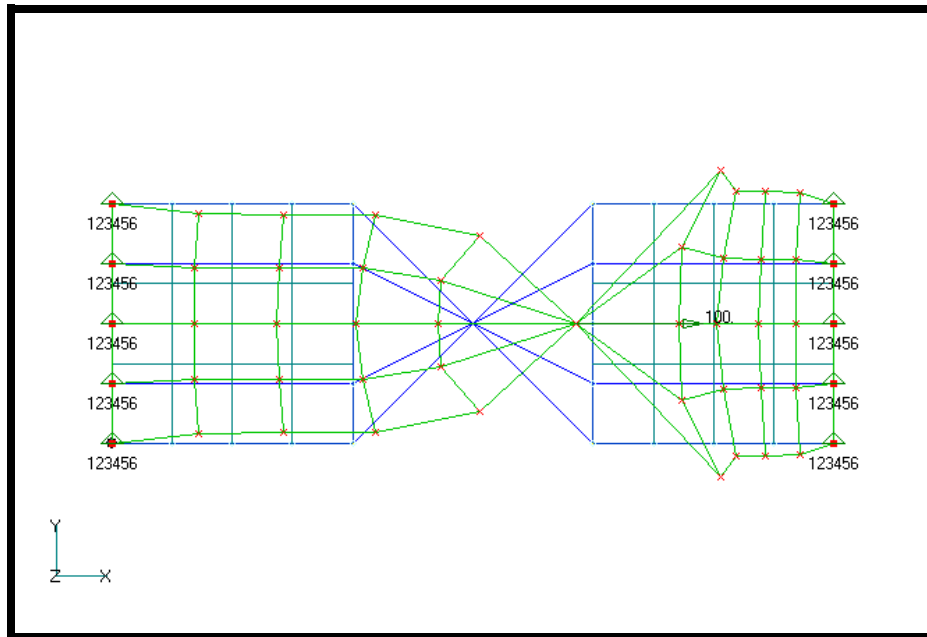
```
SOL 101
CEND
ECHO = NONE
  SPC = 1
  LOAD = 1
  DISPLACEMENT=ALL
  SPCFORCES=ALL
  MPCFORCE=ALL
BEGIN BULK
PARAM  POST  -1
$
PSHELL 1 1 .2 1 1
$
CQUAD4 1 1 1 2 7 6
CQUAD4 2 1 2 3 8 7
CQUAD4 3 1 3 4 9 8
CQUAD4 4 1 4 5 10 9
CQUAD4 5 1 6 7 12 11
CQUAD4 6 1 7 8 13 12
CQUAD4 7 1 8 9 14 13
CQUAD4 8 1 9 10 15 14
CQUAD4 9 1 11 12 17 16
CQUAD4 10 1 12 13 18 17
CQUAD4 11 1 13 14 19 18
CQUAD4 12 1 14 15 20 19
CQUAD4 13 1 16 17 22 21
CQUAD4 14 1 17 18 23 22
CQUAD4 15 1 18 19 24 23
CQUAD4 16 1 19 20 25 24
CQUAD4 17 1 26 27 32 31
CQUAD4 18 1 27 28 33 32
CQUAD4 19 1 28 29 34 33
CQUAD4 20 1 29 30 35 34
CQUAD4 21 1 31 32 37 36
CQUAD4 22 1 32 33 38 37
CQUAD4 23 1 33 34 39 38
CQUAD4 24 1 34 35 40 39
CQUAD4 25 1 36 37 42 41
CQUAD4 26 1 37 38 43 42
CQUAD4 27 1 38 39 44 43
CQUAD4 28 1 39 40 45 44
CQUAD4 29 1 41 42 47 46
CQUAD4 30 1 42 43 48 47
CQUAD4 31 1 43 44 49 48
CQUAD4 32 1 44 45 50 49
```

\$
 MAT1 1 1.+7 .3
 \$
 RBE3 33 1000 123456 1. 123456 5 10 + A
 + A 15 20 25 26 31 36 41 46
 \$
 GRID 1 0. 0. 0.
 GRID 2 2.5 0. 0.
 GRID 3 5. 0. 0.
 GRID 4 7.5 0. 0.
 GRID 5 10. 0. 0.
 GRID 6 0. 2.5 0.
 GRID 7 2.5 2.5 0.
 GRID 8 5. 2.5 0.
 GRID 9 7.5 2.5 0.
 GRID 10 10. 2.5 0.
 GRID 11 0. 5. 0.
 GRID 12 2.5 5. 0.
 GRID 13 5. 5. 0.
 GRID 14 7.5 5. 0.
 GRID 15 10. 5. 0.
 GRID 16 0. 7.5 0.
 GRID 17 2.5 7.5 0.
 GRID 18 5. 7.5 0.
 GRID 19 7.5 7.5 0.
 GRID 20 10. 7.5 0.
 GRID 21 0. 10. 0.
 GRID 22 2.5 10. 0.
 GRID 23 5. 10. 0.
 GRID 24 7.5 10. 0.
 GRID 25 10. 10. 0.
 GRID 26 20. 0. 0.
 GRID 27 22.5 0. 0.
 GRID 28 25. 0. 0.
 GRID 29 27.5 0. 0.
 GRID 30 30. 0. 0.
 GRID 31 20. 2.5 0.
 GRID 32 22.5 2.5 0.
 GRID 33 25. 2.5 0.
 GRID 34 27.5 2.5 0.
 GRID 35 30. 2.5 0.
 GRID 36 20. 5. 0.
 GRID 37 22.5 5. 0.
 GRID 38 25. 5. 0.
 GRID 39 27.5 5. 0.
 GRID 40 30. 5. 0.
 GRID 41 20. 7.5 0.
 GRID 42 22.5 7.5 0.
 GRID 43 25. 7.5 0.
 GRID 44 27.5 7.5 0.
 GRID 45 30. 7.5 0.
 GRID 46 20. 10. 0.
 GRID 47 22.5 10. 0.
 GRID 48 25. 10. 0.
 GRID 49 27.5 10. 0.
 GRID 50 30. 10. 0.

WORKSHOP 10 *RBE2 vs. RBE3*

```
GRID 1000      15.  5.  0.  
$  
SPC1  1      123456 1   6   11  16  21  30  +  B  
+   B 35   40  45  50  
$  
FORCE 1      1000  0   100.  1.  0.  0.  
$  
ENDDATA
```

Figure 10.3 - Deformed plot for Case 2.



The nodal results read from the *F06* are as follows:

Node	MPC Forces		Displacement	
	T1	T2	T1	T2
25	10	0	3.23e-5	-8.11e-6
20	10	0	2.23e-5	-4.14e-5
15	10	0	2.17e-5	0
10	10	0	2.23e-5	4.14e-6
5	10	0	3.23e-5	8.11e-6
46	10	0	3.23e-5	8.11e-6
41	10	0	2.23e-5	4.14e-5
36	10	0	2.17e-5	0
31	10	0	2.23e-5	-4.14e-6
26	10	0	3.23e-5	-8.11e-6

■ Modify the RBE3 and using the following coefficient.

Coefficient	Node ID
1	5, 25, 26, 46
2	10, 20, 31, 41
3	15, 36

MSC.Nastran users can generate an input file using the data from Table 10c. The result should be similar to the output below.

3. MSC.Nastran input file: **10c.dat**

```

SOL 101
CEND
ECHO = NONE
  SPC = 1
  LOAD = 1
  DISPLACEMENT=ALL
  SPCFORCES=ALL
  MPCFORCE=ALL
BEGIN BULK
PARAM  POST  -1
$
PSHELL  1    1    .2    1        1
$
CQUAD4  1    1    1    2    7    6
CQUAD4  2    1    2    3    8    7
CQUAD4  3    1    3    4    9    8
CQUAD4  4    1    4    5   10    9
CQUAD4  5    1    6    7   12   11
CQUAD4  6    1    7    8   13   12
CQUAD4  7    1    8    9   14   13
CQUAD4  8    1    9   10   15   14
CQUAD4  9    1   11   12   17   16
CQUAD4 10    1   12   13   18   17
CQUAD4 11    1   13   14   19   18
CQUAD4 12    1   14   15   20   19
CQUAD4 13    1   16   17   22   21
CQUAD4 14    1   17   18   23   22
CQUAD4 15    1   18   19   24   23
CQUAD4 16    1   19   20   25   24
CQUAD4 17    1   26   27   32   31
CQUAD4 18    1   27   28   33   32
CQUAD4 19    1   28   29   34   33
CQUAD4 20    1   29   30   35   34
CQUAD4 21    1   31   32   37   36
CQUAD4 22    1   32   33   38   37
CQUAD4 23    1   33   34   39   38

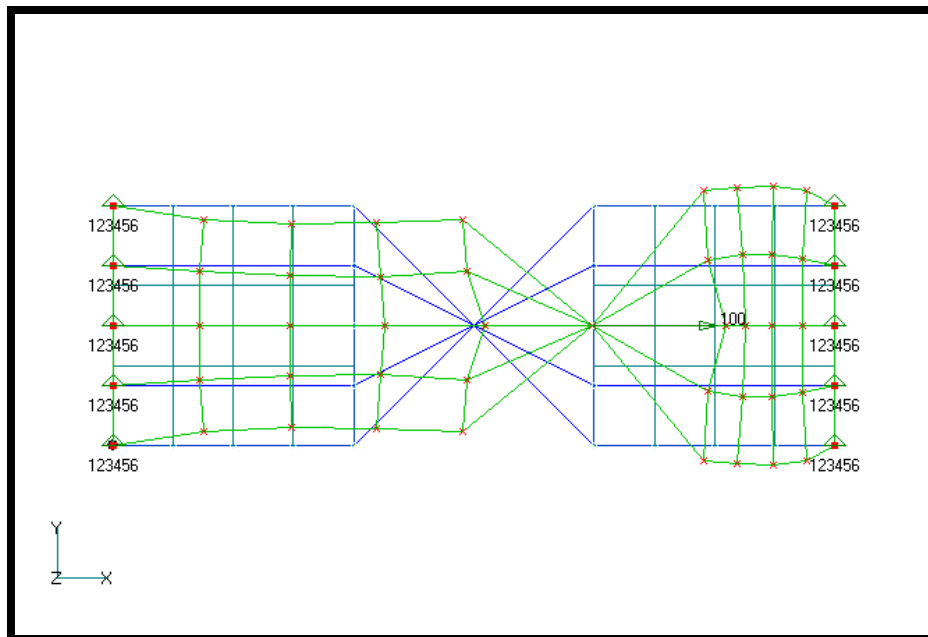
```

CQUAD4 24 1 34 35 40 39
 CQUAD4 25 1 36 37 42 41
 CQUAD4 26 1 37 38 43 42
 CQUAD4 27 1 38 39 44 43
 CQUAD4 28 1 39 40 45 44
 CQUAD4 29 1 41 42 47 46
 CQUAD4 30 1 42 43 48 47
 CQUAD4 31 1 43 44 49 48
 CQUAD4 32 1 44 45 50 49
 \$
 MAT1 1 1.+7 .3
 \$
 RBE3 33 1000 123456 3. 123456 15 36 + A
 + A 2. 123456 10 20 31 41 1. 123456 + B
 + B 5 25 26 46
 \$
 GRID 1 0. 0. 0.
 GRID 2 2.5 0. 0.
 GRID 3 5. 0. 0.
 GRID 4 7.5 0. 0.
 GRID 5 10. 0. 0.
 GRID 6 0. 2.5 0.
 GRID 7 2.5 2.5 0.
 GRID 8 5. 2.5 0.
 GRID 9 7.5 2.5 0.
 GRID 10 10. 2.5 0.
 GRID 11 0. 5. 0.
 GRID 12 2.5 5. 0.
 GRID 13 5. 5. 0.
 GRID 14 7.5 5. 0.
 GRID 15 10. 5. 0.
 GRID 16 0. 7.5 0.
 GRID 17 2.5 7.5 0.
 GRID 18 5. 7.5 0.
 GRID 19 7.5 7.5 0.
 GRID 20 10. 7.5 0.
 GRID 21 0. 10. 0.
 GRID 22 2.5 10. 0.
 GRID 23 5. 10. 0.
 GRID 24 7.5 10. 0.
 GRID 25 10. 10. 0.
 GRID 26 20. 0. 0.
 GRID 27 22.5 0. 0.
 GRID 28 25. 0. 0.
 GRID 29 27.5 0. 0.
 GRID 30 30. 0. 0.
 GRID 31 20. 2.5 0.
 GRID 32 22.5 2.5 0.
 GRID 33 25. 2.5 0.
 GRID 34 27.5 2.5 0.
 GRID 35 30. 2.5 0.
 GRID 36 20. 5. 0.
 GRID 37 22.5 5. 0.
 GRID 38 25. 5. 0.
 GRID 39 27.5 5. 0.
 GRID 40 30. 5. 0.

WORKSHOP 10 *RBE2 vs. RBE3*

```
GRID 41      20.  7.5  0.
GRID 42      22.5 7.5  0.
GRID 43      25.  7.5  0.
GRID 44      27.5 7.5  0.
GRID 45      30.  7.5  0.
GRID 46      20.  10.  0.
GRID 47      22.5 10.  0.
GRID 48      25.  10.  0.
GRID 49      27.5 10.  0.
GRID 50      30.  10.  0.
GRID 1000    15.  5.  0.
$
SPC1  1      123456 1   6   11  16  21  30  +  C
+   C 35   40  45  50
$
FORCE 1      1000  0   100. 1.  0.  0.
$
ENDDATA
```

Figure 10.4 - Deformed plot for Case 3.



The nodal results read from the *F06* are as follows:

Node	MPC Forces		Displacement	
	T1	T2	T1	T2
25	5.55	0	2.31e-5	-2.95e-6
20	11.11	0	2.38e-5	-1.17e-6
15	16.67	0	2.78e-5	0
10	11.11	0	2.38e-5	1.17e-6
5	5.55	0	2.31e-5	2.95e-6
46	5.55	0	2.31e-5	2.95e-6
41	11.11	0	2.38e-5	1.17e-6
36	16.67	0	2.78e-5	0
31	11.11	0	2.38e-5	-1.17e-6
26	5.55	0	2.31e-5	-2.95e-6

1. MSC.Nastran Users have finished this exercise.
MSC.Patran Users should proceed to the next step.
2. Proceed with the Reverse Translation process, that is importing the **prob2a.op2** results file into MSC.Patran. To do this, return to the *Analysis* form and proceed as follows:

◆ **Analysis**

<i>Action:</i>	Read Output2
<i>Object:</i>	Result Entities
<i>Method</i>	Translate
Select Results File...	
<i>Select Results File</i>	prob10.op2
OK	
Apply	

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

◆ **Results**

<i>Form Type:</i>	Advanced
<i>Select Results Cases</i>	1.1-Default, Static Subcase
Get Results	
<i>Select Result</i>	2.1 Displacements, Translational
<i>Plot Type</i>	Vector Plot
Plot	
Display/Results...	
Vectors...	■ Show Result Values
Apply	

To reset the graphics, 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.