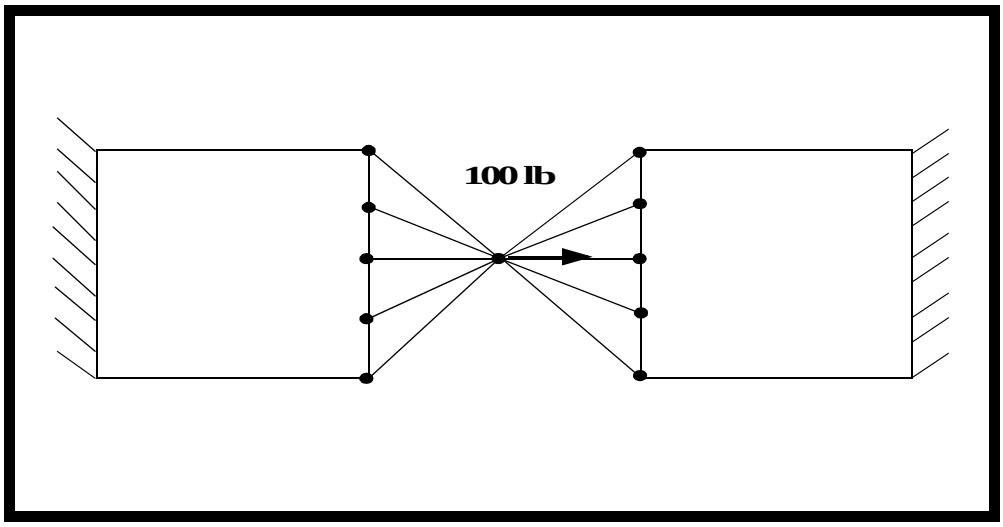
WORKSHOP 10

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.

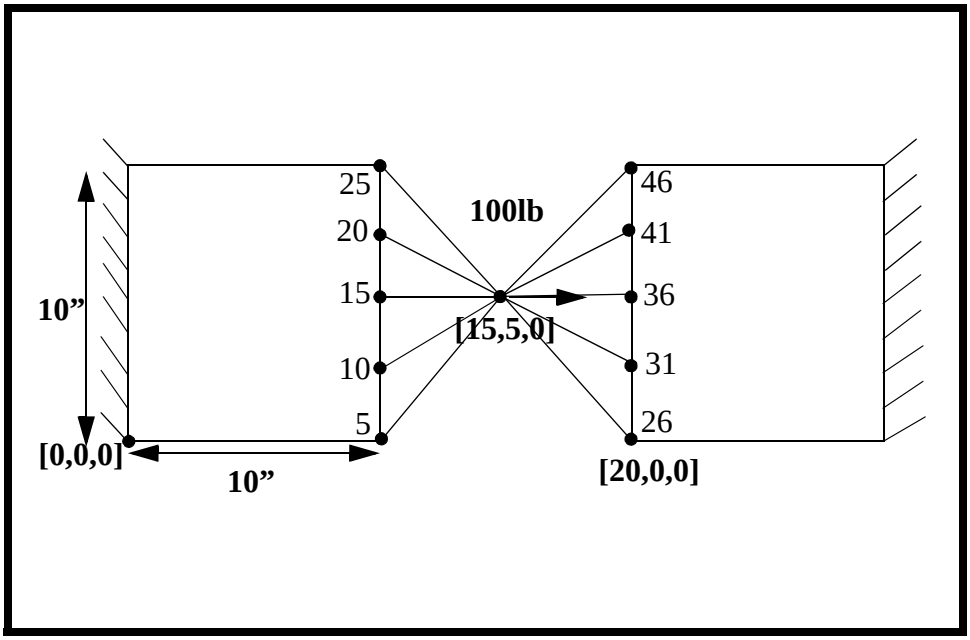


Table 10.1 -Plate Properties.

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.

```
ID SEMINAR,PROB10
```

```
CEND
```

BEGIN BULK

1	2	3	4	5	6	7	8	9	10

ENDDATA

1	2	3	4	5	6	7	8	9	10

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.

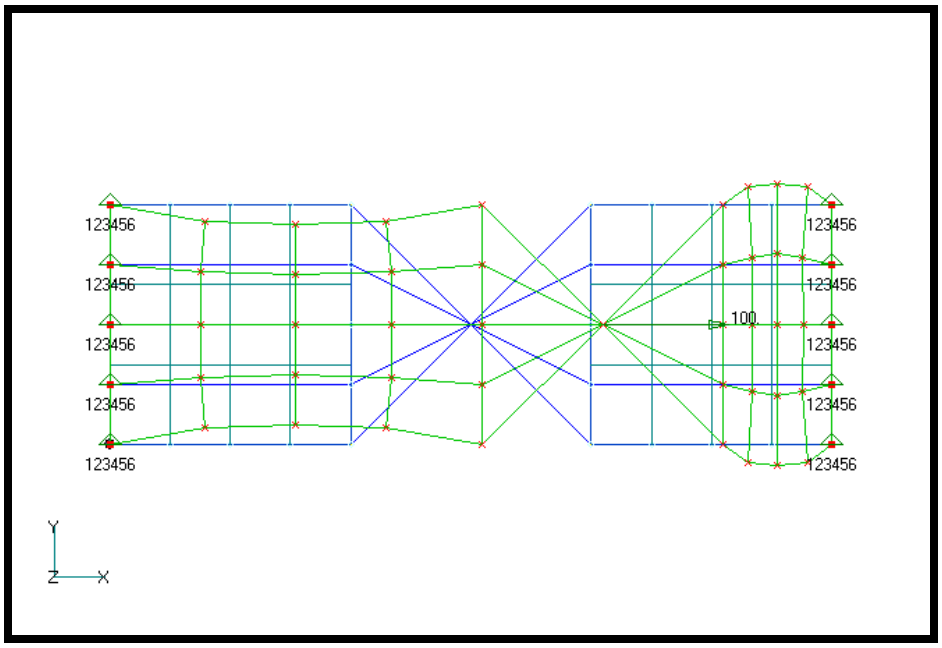
1. MSC.Nastran input file: **Prob10a.dat**

```
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.
```

```
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.

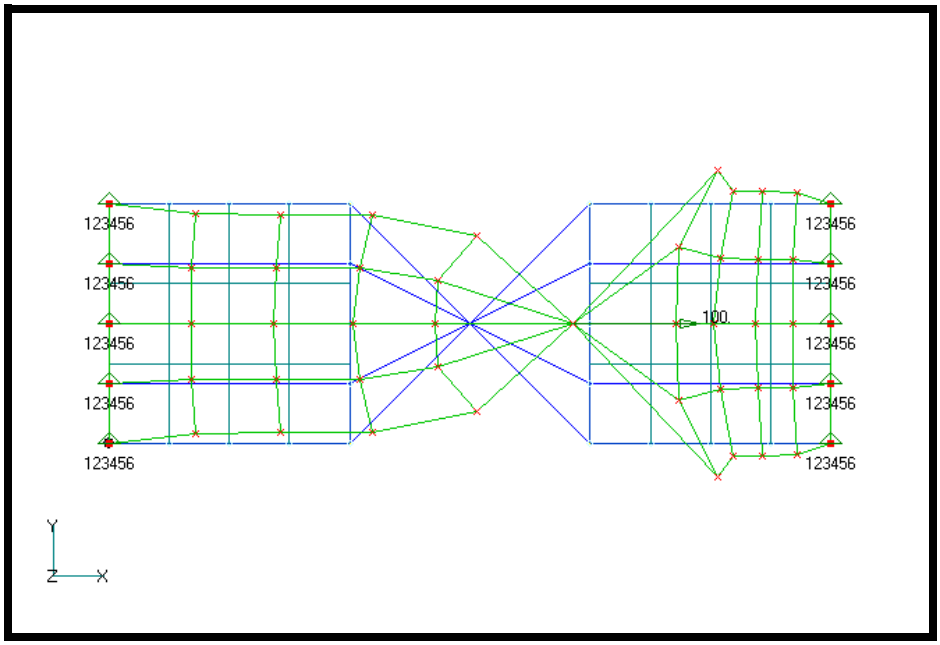
2. MSC.Nastran input file: **10b.dat**

```
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.
```

```
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:

	MPC Forces		**Displacement**	
Node	**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.

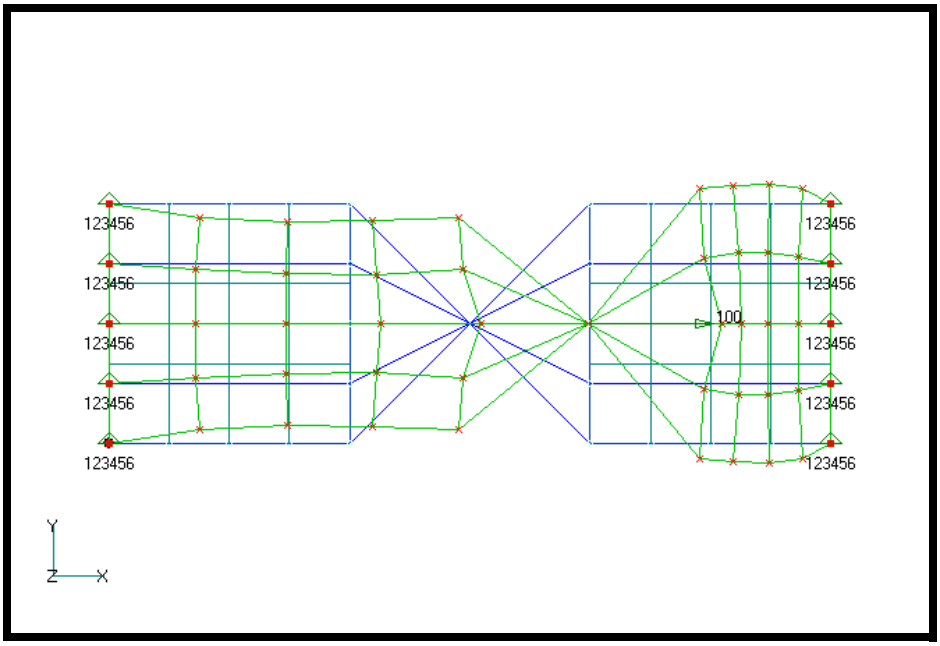
3. MSC.Nastran input file: **10c.dat**

```
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.
```

```
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:

	MPC Forces		**Displacement**	
Node	**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**

Action: **Read Output2**

Object: **Result Entities**

Method **Translate**

Select Results File...

Select Results File **prob10.op2**

OK

Apply

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

◆ **Results**

Form Type: **Advanced**

Select Results Cases **1.1-Default, Static Subcase**

Get Results

Select Result **2.1 Displacements, Translational**

Plot Type **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.