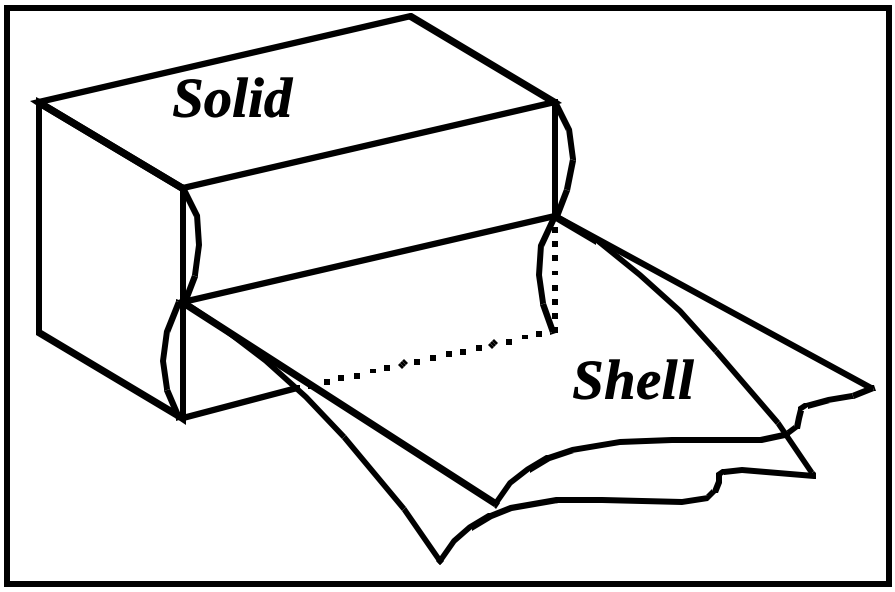
WORKSHOP 11

Shell-to-Solid Element Connector(RSSCON)



The introduction of the RSSCON Shell-to-Solid connector enables MSC.Nastran user to model welded connections of shells to solids. This capability conveniently eliminates the need to define MPC to constrain a shell elementÕs translational and rotational degrees of freedom to a solid elementÕs translational degrees of freedom.

RSSCON generates a multipoint constraint, which puts the shell degrees of freedom in the dependent set (m-set). The three translational degrees of freedom and the two rotational degrees of freedom of the shell edge are connected to the three translational degrees of freedom of the upper and lower solid edge. PoissonÕs ratio effects and temperature loads are modeled correctly. The generated multipoint constraints produce six zero-energy modes for rigid-body motion.

Limitations

For the GRID option, the following limitations apply:

- The GRID option does not verify that the grid points are valid shell or solid grid points
- The hierarchical degrees of freedom of p-element edges are not constrained. The GRID option is therefore not recommended for adaptive p-element
- The grid points in the GRID option can be in different superelements. If so, the shell grid point must be in the upstream superelement because shell degrees of freedom are in the dependent m-set

For the ELEM option, the following limitations apply:

- Elements with midside nodes can not be connected to adaptive p-elements. (this limitation applies to all element connections in MSC.Nastran besides RSSCON).
- If a solid-shell connection has horizontal edges that are curved in the shell plane, MSC.Nastran assumes that the geometry of the shell element is compatible with that of the solid element. In the case of vertical edges, the shell element grid must lie on the line between the upper and lower solid element grid point. An offset tolerance of 5% of the distance between the solid points is allowed.
- Both the shell and solid elements must belong to the same superelement.

Model Description:

A cantilever is clamped to a wall and loaded at the tip. This example demonstrates how accurate the local stress distribution is when a RSSCON entry is used to model the clamped condition. Two different finite element models are used, and their results ar compared with classic beam theory. The bending stress from beam theory is at the clamped end of the cantilever.

Table 11.1 - Model Properties

Thickness:	**0.4 in**
Elastic Modulus:	**30.0E+06 lbs/in^2**
Poisson Ratio:	**0.3**

Theoretical Calculation:

$$\sigma_{max} = \frac{MC}{I}$$

$$= \frac{(20)(30)(0.2)}{\frac{(5)(0.4)^3}{12}}$$

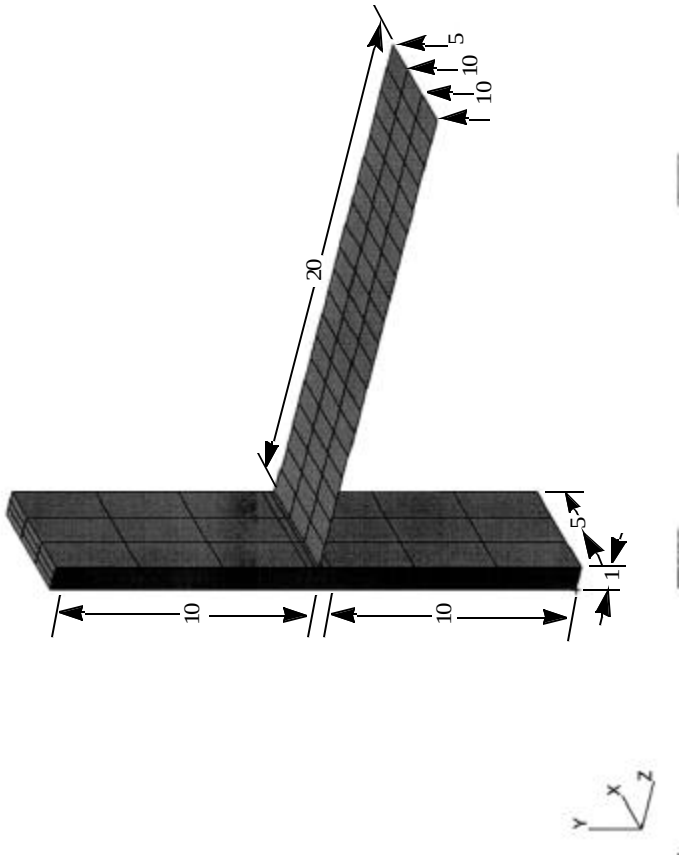
$$= 4{,}500 \text{ psi}$$

$$\Delta_{max} = \frac{PL^3}{3(EI)}$$

$$= \frac{(30)(20)^3(12)}{3(30e6)(5)(0.4)}$$

$$= 0.1$$

Figure 11.1



Suggested Exercise Steps:

- Create baseline geometries (3 solids &1 surface)

Solids	Vector Coordinate List	Origin Coordinate List
1	< 5, 10, 1 >	[0, 0, 0]
2	< 5, 1, 1 >	[0, 10, 0]
3	< 5, 10, 1 >	[0, 11, 0]

Surface	Vector Coordinate List	Origin Coordinate List
1	< 5, 0, 20 >	[0, 10.5, 1]

- Mesh seed 3 elements per parametric directions for each solid
- Mesh seed 20 elements for the long edge of the surface, and 3 elements for the short edge.
- Generate a finite element representation of the model.
  (i.e., the nodes (GRID) and element connectivities (CQUAD4 and CHEXA).)
- Remember to equivalence the model.
- Define material (MAT1) and element (PSHELL and PSOLID) properties.
- Apply the fix boundary constraints (SPC1) at the solid base.
- Apply the concentrated force (30 lbs total) at the free end of plate elements.

Exercise Procedure:

1. Start up MSC.Nastran for Windows 4.0 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. Create the material properties for the plate.

   Model/Material...

ID:	**1**
Title:	**mat_1**
Youngs Modulus, E:	**30.0E6**
Poisson Ratio:	**0.3**

   OK

   C**ancel**

3. Create the solid and shell properties.

   Model/Property...

ID:	**1**
Title:	**shell**
Material:	**1..mat_1**
Thickness, Tavg or T1:	**0.4**

   OK

ID:	**2**
Title:	**solid**

   Element/Property Type...

Volume Elements:	● **solid**

   OK

OK

Cancel

4. Now, create the geometry. First, change to the Standard Geometry engine.

Tools/Advanced Geometry...

● **Standard**

OK

Then create the solids/volumes by first creating its base surfaces.

Geometry/Surface/Plane...

Method^ **CSys Plane**

	X:	*Y:*	*Z:*
Base:	**0**	**0**	**0**

Direction: ● **Positive**

● **XY Plane**

OK

Under Size of Plane Surface.

Width (Along Plane X): **5**

Height (Along Plane Y): **10**

OK

Repeat this to create the other two surfaces (refer to Suggested Exercise Steps)

Base:	*X:*	*Y:*	*Z:*
	0	**10**	**0**

Direction: ● **Positive**

● **XY Plane**

OK

Under Size of Plane Surface.

Width (Along Plane X): **5**

Height (Along Plane Y): **1**

OK

Base:	*X:*	*Y:*	*Z:*
	0	**11**	**0**

Direction: ● **Positive**

● **XY Plane**

OK

Under Size of Plane Surface.

Width (Along Plane X): **5**

Height (Along Plane Y): **10**

OK

Cancel

Extrude these surfaces to make the solid/volume.

Geometry/Volume/Extrude...

Select All

OK

Under Select Vector to Extrude Along,

Base:	*X:*	*Y:*	*Z:*
	0	**0**	**0**
Tip:	*X:*	*Y:*	*Z:*

Base:	*X:*	*Y:*	*Z:*
	0	**0**	**1**

OK

Cancel

Get a better view of the model.

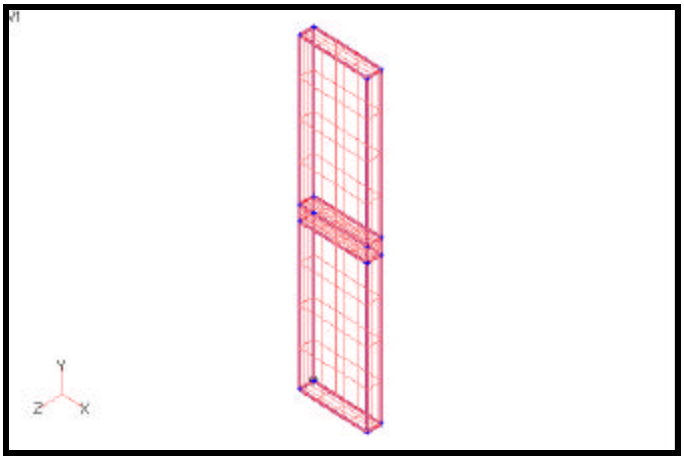
View/Rotate... **<F8>**

Isometric

OK

Your viewport should resemble the following figure.

Figure 11.2



Now, create the 5x20 surface.

Geometry/Surface/Plane...

Method^

CSys Plane

Direction: ● **Positive**

● **ZX Plane**

OK

Under Size of Plane Surface

Base:	*X:*	*Y:*	*Z:*
	0	**10.5**	**1**

Width (Along Plane X): **20**

Height (Along Plane Y): **5**

OK

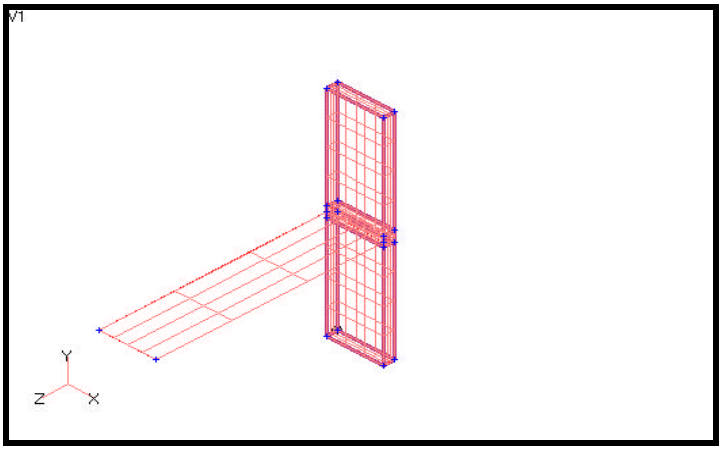
Cancel

Refresh the display.

View/Regenerate... **<Ctrl+G>**

Your display should look like the one shown.

Figure 11.3



5. Specify the mesh size.

First, specify three elements for all parametric directions on each volume.

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

Select All

● **Exclude**

<Pick the 5x20 surface (Surface 19) so that it will be excluded from the mesh>.

	s:	*t:*
Number of Elements	**3**	**3**
Bias	**1**	**1**

Second, specify the mesh control for the 5 x 20 surface (Surface 19)

<Select Surface 19> *(see figure 11.4)*

OK

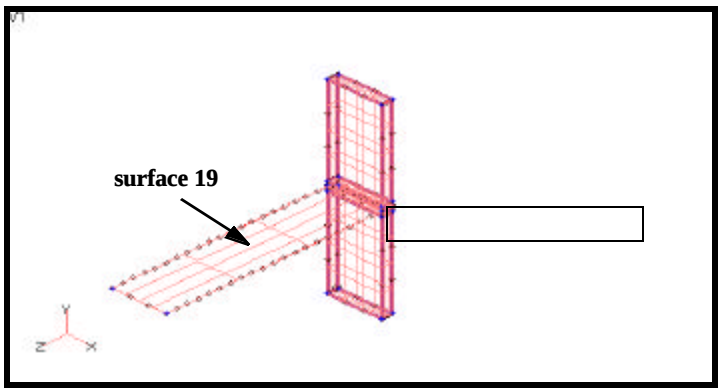
	s:	*t:*
Number of Elements	**20**	**3**
Bias	**1**	**1**

OK

Cancel

Your viewport should look as shown.

Figure 11.4



6. Mesh the geometry.

   First, mesh the volumes.

   Mesh/Geometry/Volume...

   Select All

   OK

   Property: **2..solid**

   Generate: ● **Elements and Nodes**

   Element Shape: ● **Brick**

   OK

   Next, mesh surface 19.

   Mesh/Geometry/Surface...

   <Select Surface 19> *(refer to Figure 11.4)*

   OK

   Property: **1..shell**

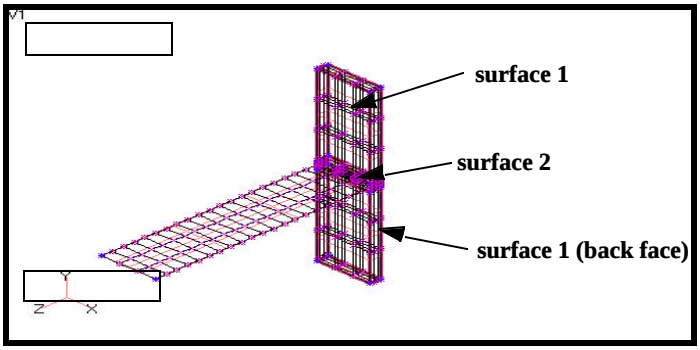
   Generate: ● **Elements and Nodes**

   Element Shape: ● **Quad**

   OK

Your display should look similar to the following.

Figure 11.5



7. Merge the coincident nodes.

Tools/Check/Coincident Nodes...

Select All

OK

Answer ÒNoÓ to ÒSpecify Additional Range of Nodes to MergeÓ

No

Options: ☒ **Merge Coincident Entities**

OK

8. Create the constraint.

Model/Constraint/Set...

ID: **1**

Title: **constraint**

OK

Model/Constraint/On Surface...

<Select the surfaces on the base of the volume (Surfaces 1, 2, and 3)>
(refer to Figure 11.5)

OK

DOF: ● **Fixed**

OK

Cancel

9. Create the load.

Model/Load/Set...

ID: **1**

Title: **load**

OK

Model/Load/On Curve...

<Select the curve at the tip (Curve 38)> *(see Figure 11.6)*

OK

Force **(highlight)**

FX: **0**

FY: **30**

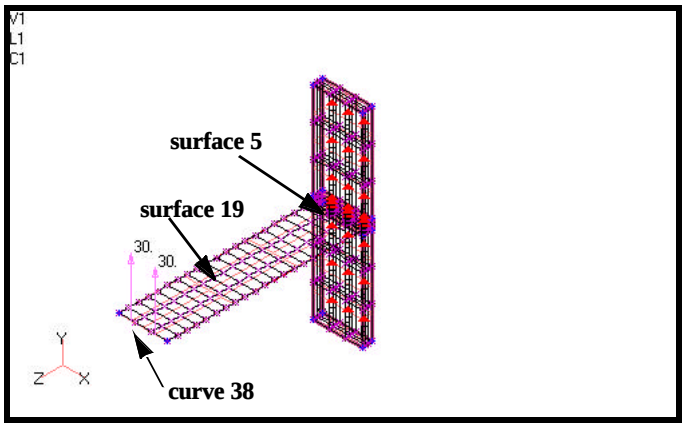
FZ: **0**

OK

Cancel

Your viewport should look as shown.

Figure 11.6



10. Turn on the node labels.

View/Options...

● **Labels, Entities and Color**

Options: **Node**

Label Mode: **1..ID**

Apply

OK

11. Put the nodes on the face of the volume and on the surface into a group. This will allow you to better see the nodes that will be used for RSSCON elements.

Group/Set...

ID: **1**

Title: **Nodes**

OK

Group/Node/on Surface...

<pick the face of the volume and the surface (Surface 5 and 19).>
(see Figure 11.6)

OK

Change the model view to just look at the group created.

View/Select...

Model Data...

Group: ● **Active**

OK

OK

Nodes 193, 214, 235 and 256 will be the independent nodes. The node pairs 121 & 117, 122 & 118, 123 & 119, 124 & 120

Open a new Windows Notepad and enter the following data.

```
RSSCON    1000    GRID    193    121    117
RSSCON    1001    GRID    214    122    118
RSSCON    1002    GRID    235    123    119
RSSCON    1003    GRID    256    124    120
```

12. Write out the analysis model and submit for analysis..

File/Export/Analysis Model...

Analysis Format/Type: **1..Static**

OK

Change to the C:\temp directory

Filename: **shelltosolid.dat**

Write

Additional Info: ☒ **Run Analysis**

Advanced...

OK

OK

Under Nastran Bulk Data,

Include File...

rsscon.dat

Open

OK

When asked ÒOK to Save Model Now?Ó

Yes

Filename: **shelltosolid.mod**

When the MSC.Nastran manager is through running, MSC.Nastran will be restored on your screen, and the *Message Review* form will appear. To read the messages, you could select **Show Details**. Since the analysis ran successfully, we will not bother with the details this time.

Continue

13. Post process the results.

First, view the entire model.

View/Select...

Model Data...

Group: ● **None**

OK

Then select the results to View.

Deformed Style: ● **Deform**

Contour Style: ● **Contour**

Deformed and Contour Data...

Output Set: **1..MSC/NASTRAN Case 1**

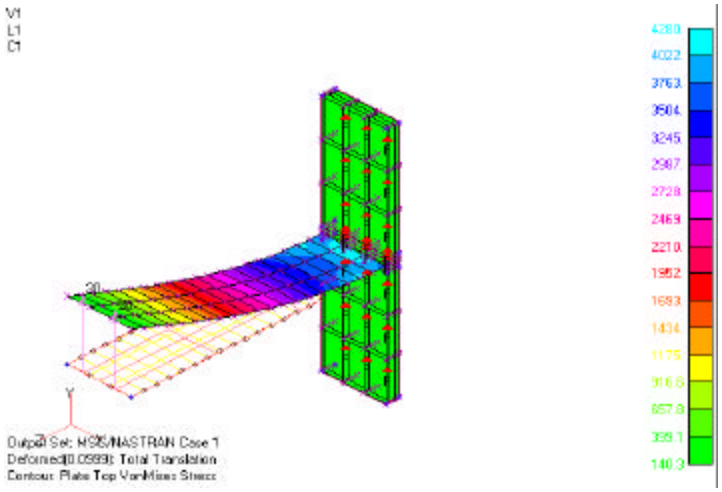
Deformation: **1..Total Translation**

Contour: **1..Plate Top VonMises Stress**

OK

Your viewport should resemble the following figure.

Figure 11.7



14. Look at the .f06 results file. Your output should look similar to the one shown.

```
0                    C A S E   C O N T R O L   D E C K   E C H O
                    CARD
                    COUNT
                      1      ECHO = NONE
                      2    DISPLACEMENT(PLOT) = ALL
                      3     OLOAD(PLOT) = ALL
                      4     SPCFORCE(PLOT) = ALL
                      5    FORCE(PLOT,CORNER) = ALL
                      6    STRESS(PLOT,CORNER) = ALL
                      7       SPC  = 1
                      8       LOAD = 1
                      9    BEGIN BULK
0       INPUT BULK DATA CARD COUNT =     542
0        TOTAL COUNT=       528
0*** USER INFORMATION MESSAGE 4109 (OUTPX2)  THE LABEL IS XXXXXXXX FOR FORTRAN UNIT 12
(MAXIMUM SIZE OF FORTRAN RECORDS WRITTEN =          7 WORDS.)
```

(NUMBER OF FORTRAN RECORDS WRITTEN = 8 RECORDS.) (TOTAL DATA WRITTEN FOR TAPE LABEL = 17 WORDS.)

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0

0 RESULTANTS ABOUT ORIGIN OF SUPERELEMENT BASIC COORDINATE SYSTEM IN SUPERELEMENT BASIC SYSTEM COORDINATES.

0 OLOAD RESULTANT

0	T1	T2	T3	R1	R2	R3
0	1	0.0000000E+00	3.0000000E+01	0.0000000E+00	-6.3000000E+02	0.0000000E+00	7.5000000E+01

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0

0 GRID POINT SINGULARITY TABLE

0 POINT ID	TYPE	FAILED DIRECTION	STIFFNESS RATIO	OLD USET EXCLUSIVE	OLD USET UNION	NEW USET EXCLUSIVE	NEW USET UNION
17	G	4	0.00E+00	B	F	SB	S *
17	G	5	0.00E+00	B	F	SB	S *
17	G	6	0.00E+00	B	F	SB	S *
18	G	4	0.00E+00	B	F	SB	S *
18	G	5	0.00E+00	B	F	SB	S *
18	G	6	0.00E+00	B	F	SB	S *
19	G	4	0.00E+00	B	F	SB	S *
19	G	5	0.00E+00	B	F	SB	S *
19	G	6	0.00E+00	B	F	SB	S *
20	G	4	0.00E+00	B	F	SB	S *
20	G	5	0.00E+00	B	F	SB	S *
20	G	6	0.00E+00	B	F	SB	S *
21	G	4	0.00E+00	B	F	SB	S *
21	G	5	0.00E+00	B	F	SB	S *
21	G	6	0.00E+00	B	F	SB	S *
22	G	4	0.00E+00	B	F	SB	S *
22	G	5	0.00E+00	B	F	SB	S *
22	G	6	0.00E+00	B	F	SB	S *
23	G	4	0.00E+00	B	F	SB	S *
23	G	5	0.00E+00	B	F	SB	S *
23	G	6	0.00E+00	B	F	SB	S *

24	G	4	0.00E+00	B	F	SB	S	*
24	G	5	0.00E+00	B	F	SB	S	*
24	G	6	0.00E+00	B	F	SB	S	*
25	G	4	0.00E+00	B	F	SB	S	*
25	G	5	0.00E+00	B	F	SB	S	*
25	G	6	0.00E+00	B	F	SB	S	*
26	G	4	0.00E+00	B	F	SB	S	*
26	G	5	0.00E+00	B	F	SB	S	*
26	G	6	0.00E+00	B	F	SB	S	*
27	G	4	0.00E+00	B	F	SB	S	*
27	G	5	0.00E+00	B	F	SB	S	*
27	G	6	0.00E+00	B	F	SB	S	*
28	G	4	0.00E+00	B	F	SB	S	*
28	G	5	0.00E+00	B	F	SB	S	*
28	G	6	0.00E+00	B	F	SB	S	*
30	G	4	0.00E+00	B	F	SB	S	*
30	G	5	0.00E+00	B	F	SB	S	*
30	G	6	0.00E+00	B	F	SB	S	*
31	G	4	0.00E+00	B	F	SB	S	*
31	G	5	0.00E+00	B	F	SB	S	*
31	G	6	0.00E+00	B	F	SB	S	*
33	G	4	0.00E+00	B	F	SB	S	*
33	G	5	0.00E+00	B	F	SB	S	*
33	G	6	0.00E+00	B	F	SB	S	*
34	G	4	0.00E+00	B	F	SB	S	*
34	G	5	0.00E+00	B	F	SB	S	*
34	G	6	0.00E+00	B	F	SB	S	*
35	G	4	0.00E+00	B	F	SB	S	*
35	G	5	0.00E+00	B	F	SB	S	*

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0
0 GRID POINT SINGULARITY TABLE

0 POINT ID	TYPE	FAILED DIRECTION	STIFFNESS RATIO	OLD USET EXCLUSIVE		NEW USET UNION		
35	G	6	0.00E+00	B	F	SB	S	*
36	G	4	0.00E+00	B	F	SB	S	*
36	G	5	0.00E+00	B	F	SB	S	*
36	G	6	0.00E+00	B	F	SB	S	*
37	G	4	0.00E+00	B	F	SB	S	*
37	G	5	0.00E+00	B	F	SB	S	*

37	G	6	0.00E+00	B	F	SB	S	*
38	G	4	0.00E+00	B	F	SB	S	*
38	G	5	0.00E+00	B	F	SB	S	*
38	G	6	0.00E+00	B	F	SB	S	*
39	G	4	0.00E+00	B	F	SB	S	*
39	G	5	0.00E+00	B	F	SB	S	*
39	G	6	0.00E+00	B	F	SB	S	*
40	G	4	0.00E+00	B	F	SB	S	*
40	G	5	0.00E+00	B	F	SB	S	*
40	G	6	0.00E+00	B	F	SB	S	*
41	G	4	0.00E+00	B	F	SB	S	*
41	G	5	0.00E+00	B	F	SB	S	*
41	G	6	0.00E+00	B	F	SB	S	*
42	G	4	0.00E+00	B	F	SB	S	*
42	G	5	0.00E+00	B	F	SB	S	*
42	G	6	0.00E+00	B	F	SB	S	*
43	G	4	0.00E+00	B	F	SB	S	*
43	G	5	0.00E+00	B	F	SB	S	*
43	G	6	0.00E+00	B	F	SB	S	*
44	G	4	0.00E+00	B	F	SB	S	*
44	G	5	0.00E+00	B	F	SB	S	*
44	G	6	0.00E+00	B	F	SB	S	*
47	G	4	0.00E+00	B	F	SB	S	*
47	G	5	0.00E+00	B	F	SB	S	*
47	G	6	0.00E+00	B	F	SB	S	*
48	G	4	0.00E+00	B	F	SB	S	*
48	G	5	0.00E+00	B	F	SB	S	*
48	G	6	0.00E+00	B	F	SB	S	*
49	G	4	0.00E+00	B	F	SB	S	*
49	G	5	0.00E+00	B	F	SB	S	*
49	G	6	0.00E+00	B	F	SB	S	*
50	G	4	0.00E+00	B	F	SB	S	*
50	G	5	0.00E+00	B	F	SB	S	*
50	G	6	0.00E+00	B	F	SB	S	*
51	G	4	0.00E+00	B	F	SB	S	*
51	G	5	0.00E+00	B	F	SB	S	*
51	G	6	0.00E+00	B	F	SB	S	*
52	G	4	0.00E+00	B	F	SB	S	*
52	G	5	0.00E+00	B	F	SB	S	*
52	G	6	0.00E+00	B	F	SB	S	*
53	G	4	0.00E+00	B	F	SB	S	*
53	G	5	0.00E+00	B	F	SB	S	*
53	G	6	0.00E+00	B	F	SB	S	*
54	G	4	0.00E+00	B	F	SB	S	*

0
0 GRID POINT SINGULARITY TABLE

0 POINT ID	TYPE	FAILED DIRECTION	STIFFNESS RATIO	OLD USET EXCLUSIVE	OLD USET UNION	NEW USET EXCLUSIVE	NEW USET UNION
54	G	5	0.00E+00	B	F	SB	S *
54	G	6	0.00E+00	B	F	SB	S *
55	G	4	0.00E+00	B	F	SB	S *
55	G	5	0.00E+00	B	F	SB	S *
55	G	6	0.00E+00	B	F	SB	S *
56	G	4	0.00E+00	B	F	SB	S *
56	G	5	0.00E+00	B	F	SB	S *
56	G	6	0.00E+00	B	F	SB	S *
57	G	4	0.00E+00	B	F	SB	S *
57	G	5	0.00E+00	B	F	SB	S *
57	G	6	0.00E+00	B	F	SB	S *
58	G	4	0.00E+00	B	F	SB	S *
58	G	5	0.00E+00	B	F	SB	S *
58	G	6	0.00E+00	B	F	SB	S *
59	G	4	0.00E+00	B	F	SB	S *
59	G	5	0.00E+00	B	F	SB	S *
59	G	6	0.00E+00	B	F	SB	S *
60	G	4	0.00E+00	B	F	SB	S *
60	G	5	0.00E+00	B	F	SB	S *
60	G	6	0.00E+00	B	F	SB	S *
61	G	4	0.00E+00	B	F	SB	S *
61	G	5	0.00E+00	B	F	SB	S *
61	G	6	0.00E+00	B	F	SB	S *
81	G	4	0.00E+00	B	F	SB	S *
81	G	5	0.00E+00	B	F	SB	S *
81	G	6	0.00E+00	B	F	SB	S *
84	G	4	0.00E+00	B	F	SB	S *
84	G	5	0.00E+00	B	F	SB	S *
84	G	6	0.00E+00	B	F	SB	S *
85	G	4	0.00E+00	B	F	SB	S *
85	G	5	0.00E+00	B	F	SB	S *
85	G	6	0.00E+00	B	F	SB	S *
86	G	4	0.00E+00	B	F	SB	S *
86	G	5	0.00E+00	B	F	SB	S *
86	G	6	0.00E+00	B	F	SB	S *
87	G	4	0.00E+00	B	F	SB	S *

87	G	5	0.00E+00	B	F	SB	S	*
87	G	6	0.00E+00	B	F	SB	S	*
88	G	4	0.00E+00	B	F	SB	S	*
88	G	5	0.00E+00	B	F	SB	S	*
88	G	6	0.00E+00	B	F	SB	S	*
89	G	4	0.00E+00	B	F	SB	S	*
89	G	5	0.00E+00	B	F	SB	S	*
89	G	6	0.00E+00	B	F	SB	S	*
90	G	4	0.00E+00	B	F	SB	S	*
90	G	5	0.00E+00	B	F	SB	S	*
90	G	6	0.00E+00	B	F	SB	S	*
91	G	4	0.00E+00	B	F	SB	S	*
91	G	5	0.00E+00	B	F	SB	S	*
91	G	6	0.00E+00	B	F	SB	S	*

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0
0 GRID POINT SINGULARITY TABLE
0 POINT TYPE FAILED STIFFNESS OLD USET NEW USET ID DIRECTION RATIO EXCLUSIVE UNION EXCLUSIVE UNION

92	G	4	0.00E+00	B	F	SB	S	*
92	G	5	0.00E+00	B	F	SB	S	*
92	G	6	0.00E+00	B	F	SB	S	*
95	G	4	0.00E+00	B	F	SB	S	*
95	G	5	0.00E+00	B	F	SB	S	*
95	G	6	0.00E+00	B	F	SB	S	*
96	G	4	0.00E+00	B	F	SB	S	*
96	G	5	0.00E+00	B	F	SB	S	*
96	G	6	0.00E+00	B	F	SB	S	*
97	G	4	0.00E+00	B	F	SB	S	*
97	G	5	0.00E+00	B	F	SB	S	*
97	G	6	0.00E+00	B	F	SB	S	*
98	G	4	0.00E+00	B	F	SB	S	*
98	G	5	0.00E+00	B	F	SB	S	*
98	G	6	0.00E+00	B	F	SB	S	*
101	G	4	0.00E+00	B	F	SB	S	*
101	G	5	0.00E+00	B	F	SB	S	*
101	G	6	0.00E+00	B	F	SB	S	*
102	G	4	0.00E+00	B	F	SB	S	*
102	G	5	0.00E+00	B	F	SB	S	*
102	G	6	0.00E+00	B	F	SB	S	*
103	G	4	0.00E+00	B	F	SB	S	*

103	G	5	0.00E+00	B	F	SB	S	*
103	G	6	0.00E+00	B	F	SB	S	*
104	G	4	0.00E+00	B	F	SB	S	*
104	G	5	0.00E+00	B	F	SB	S	*
104	G	6	0.00E+00	B	F	SB	S	*
105	G	4	0.00E+00	B	F	SB	S	*
105	G	5	0.00E+00	B	F	SB	S	*
105	G	6	0.00E+00	B	F	SB	S	*
106	G	4	0.00E+00	B	F	SB	S	*
106	G	5	0.00E+00	B	F	SB	S	*
106	G	6	0.00E+00	B	F	SB	S	*
107	G	4	0.00E+00	B	F	SB	S	*
107	G	5	0.00E+00	B	F	SB	S	*
107	G	6	0.00E+00	B	F	SB	S	*
108	G	4	0.00E+00	B	F	SB	S	*
108	G	5	0.00E+00	B	F	SB	S	*
108	G	6	0.00E+00	B	F	SB	S	*
109	G	4	0.00E+00	B	F	SB	S	*
109	G	5	0.00E+00	B	F	SB	S	*
109	G	6	0.00E+00	B	F	SB	S	*
111	G	4	0.00E+00	B	F	SB	S	*
111	G	5	0.00E+00	B	F	SB	S	*
111	G	6	0.00E+00	B	F	SB	S	*
114	G	4	0.00E+00	B	F	SB	S	*
114	G	5	0.00E+00	B	F	SB	S	*
114	G	6	0.00E+00	B	F	SB	S	*
115	G	4	0.00E+00	B	F	SB	S	*
115	G	5	0.00E+00	B	F	SB	S	*

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0
0 GRID POINT SINGULARITY TABLE
0 POINT TYPE FAILED STIFFNESS OLD USET NEW USET ID DIRECTION RATIO EXCLUSIVE UNION EXCLUSIVE UNION

115	G	6	0.00E+00	B	F	SB	S	*
116	G	4	0.00E+00	B	F	SB	S	*
116	G	5	0.00E+00	B	F	SB	S	*
116	G	6	0.00E+00	B	F	SB	S	*
117	G	4	0.00E+00	B	F	SB	S	*
117	G	5	0.00E+00	B	F	SB	S	*
117	G	6	0.00E+00	B	F	SB	S	*
118	G	4	0.00E+00	B	F	SB	S	*

118	G	5	0.00E+00	B	F	SB	S	*
118	G	6	0.00E+00	B	F	SB	S	*
119	G	4	0.00E+00	B	F	SB	S	*
119	G	5	0.00E+00	B	F	SB	S	*
119	G	6	0.00E+00	B	F	SB	S	*
120	G	4	0.00E+00	B	F	SB	S	*
120	G	5	0.00E+00	B	F	SB	S	*
120	G	6	0.00E+00	B	F	SB	S	*
121	G	4	0.00E+00	B	F	SB	S	*
121	G	5	0.00E+00	B	F	SB	S	*
121	G	6	0.00E+00	B	F	SB	S	*
122	G	4	0.00E+00	B	F	SB	S	*
122	G	5	0.00E+00	B	F	SB	S	*
122	G	6	0.00E+00	B	F	SB	S	*
123	G	4	0.00E+00	B	F	SB	S	*
123	G	5	0.00E+00	B	F	SB	S	*
123	G	6	0.00E+00	B	F	SB	S	*
124	G	4	0.00E+00	B	F	SB	S	*
124	G	5	0.00E+00	B	F	SB	S	*
124	G	6	0.00E+00	B	F	SB	S	*
145	G	4	0.00E+00	B	F	SB	S	*
145	G	5	0.00E+00	B	F	SB	S	*
145	G	6	0.00E+00	B	F	SB	S	*
146	G	4	0.00E+00	B	F	SB	S	*
146	G	5	0.00E+00	B	F	SB	S	*
146	G	6	0.00E+00	B	F	SB	S	*
149	G	4	0.00E+00	B	F	SB	S	*
149	G	5	0.00E+00	B	F	SB	S	*
149	G	6	0.00E+00	B	F	SB	S	*
150	G	4	0.00E+00	B	F	SB	S	*
150	G	5	0.00E+00	B	F	SB	S	*
150	G	6	0.00E+00	B	F	SB	S	*
151	G	4	0.00E+00	B	F	SB	S	*
151	G	5	0.00E+00	B	F	SB	S	*
151	G	6	0.00E+00	B	F	SB	S	*
152	G	4	0.00E+00	B	F	SB	S	*
152	G	5	0.00E+00	B	F	SB	S	*
152	G	6	0.00E+00	B	F	SB	S	*
153	G	4	0.00E+00	B	F	SB	S	*
153	G	5	0.00E+00	B	F	SB	S	*
153	G	6	0.00E+00	B	F	SB	S	*
154	G	4	0.00E+00	B	F	SB	S	*

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0

0 G R I D P O I N T S I N G U L A R I T Y T A B L E

0 POINT TYPE FAILED STIFFNESS OLD USET NEW USET ID DIRECTION RATIO EXCLUSIVE UNION EXCLUSIVE UNION

154	G	5	0.00E+00	B	F	SB	S	*
154	G	6	0.00E+00	B	F	SB	S	*
155	G	4	0.00E+00	B	F	SB	S	*
155	G	5	0.00E+00	B	F	SB	S	*
155	G	6	0.00E+00	B	F	SB	S	*
156	G	4	0.00E+00	B	F	SB	S	*
156	G	5	0.00E+00	B	F	SB	S	*
156	G	6	0.00E+00	B	F	SB	S	*
157	G	4	0.00E+00	B	F	SB	S	*
157	G	5	0.00E+00	B	F	SB	S	*
157	G	6	0.00E+00	B	F	SB	S	*
158	G	4	0.00E+00	B	F	SB	S	*
158	G	5	0.00E+00	B	F	SB	S	*
158	G	6	0.00E+00	B	F	SB	S	*
159	G	4	0.00E+00	B	F	SB	S	*
159	G	5	0.00E+00	B	F	SB	S	*
159	G	6	0.00E+00	B	F	SB	S	*
160	G	4	0.00E+00	B	F	SB	S	*
160	G	5	0.00E+00	B	F	SB	S	*
160	G	6	0.00E+00	B	F	SB	S	*
162	G	4	0.00E+00	B	F	SB	S	*
162	G	5	0.00E+00	B	F	SB	S	*
162	G	6	0.00E+00	B	F	SB	S	*
164	G	4	0.00E+00	B	F	SB	S	*
164	G	5	0.00E+00	B	F	SB	S	*
164	G	6	0.00E+00	B	F	SB	S	*
165	G	4	0.00E+00	B	F	SB	S	*
165	G	5	0.00E+00	B	F	SB	S	*
165	G	6	0.00E+00	B	F	SB	S	*
166	G	4	0.00E+00	B	F	SB	S	*
166	G	5	0.00E+00	B	F	SB	S	*
166	G	6	0.00E+00	B	F	SB	S	*
167	G	4	0.00E+00	B	F	SB	S	*
167	G	5	0.00E+00	B	F	SB	S	*
167	G	6	0.00E+00	B	F	SB	S	*
168	G	4	0.00E+00	B	F	SB	S	*
168	G	5	0.00E+00	B	F	SB	S	*
168	G	6	0.00E+00	B	F	SB	S	*

169	G	4	0.00E+00	B	F	SB	S	*
169	G	5	0.00E+00	B	F	SB	S	*
169	G	6	0.00E+00	B	F	SB	S	*
170	G	4	0.00E+00	B	F	SB	S	*
170	G	5	0.00E+00	B	F	SB	S	*
170	G	6	0.00E+00	B	F	SB	S	*
171	G	4	0.00E+00	B	F	SB	S	*
171	G	5	0.00E+00	B	F	SB	S	*
171	G	6	0.00E+00	B	F	SB	S	*
172	G	4	0.00E+00	B	F	SB	S	*
172	G	5	0.00E+00	B	F	SB	S	*
172	G	6	0.00E+00	B	F	SB	S	*

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0
0 G R I D P O I N T S I N G U L A R I T Y T A B L E
0 POINT TYPE FAILED STIFFNESS OLD USET NEW USET ID DIRECTION RATIO EXCLUSIVE UNION EXCLUSIVE UNION

173	G	4	0.00E+00	B	F	SB	S	*
173	G	5	0.00E+00	B	F	SB	S	*
173	G	6	0.00E+00	B	F	SB	S	*
174	G	4	0.00E+00	B	F	SB	S	*
174	G	5	0.00E+00	B	F	SB	S	*
174	G	6	0.00E+00	B	F	SB	S	*
175	G	4	0.00E+00	B	F	SB	S	*
175	G	5	0.00E+00	B	F	SB	S	*
175	G	6	0.00E+00	B	F	SB	S	*
176	G	4	0.00E+00	B	F	SB	S	*
176	G	5	0.00E+00	B	F	SB	S	*
176	G	6	0.00E+00	B	F	SB	S	*
177	G	4	0.00E+00	B	F	SB	S	*
177	G	5	0.00E+00	B	F	SB	S	*
177	G	6	0.00E+00	B	F	SB	S	*
178	G	4	0.00E+00	B	F	SB	S	*
178	G	5	0.00E+00	B	F	SB	S	*
178	G	6	0.00E+00	B	F	SB	S	*
179	G	4	0.00E+00	B	F	SB	S	*
179	G	5	0.00E+00	B	F	SB	S	*
179	G	6	0.00E+00	B	F	SB	S	*
180	G	4	0.00E+00	B	F	SB	S	*
180	G	5	0.00E+00	B	F	SB	S	*
180	G	6	0.00E+00	B	F	SB	S	*

181	G	4	0.00E+00	B	F	SB	S	*
181	G	5	0.00E+00	B	F	SB	S	*
181	G	6	0.00E+00	B	F	SB	S	*
182	G	4	0.00E+00	B	F	SB	S	*
182	G	5	0.00E+00	B	F	SB	S	*
182	G	6	0.00E+00	B	F	SB	S	*
183	G	4	0.00E+00	B	F	SB	S	*
183	G	5	0.00E+00	B	F	SB	S	*
183	G	6	0.00E+00	B	F	SB	S	*
184	G	4	0.00E+00	B	F	SB	S	*
184	G	5	0.00E+00	B	F	SB	S	*
184	G	6	0.00E+00	B	F	SB	S	*
185	G	4	0.00E+00	B	F	SB	S	*
185	G	5	0.00E+00	B	F	SB	S	*
185	G	6	0.00E+00	B	F	SB	S	*
186	G	4	0.00E+00	B	F	SB	S	*
186	G	5	0.00E+00	B	F	SB	S	*
186	G	6	0.00E+00	B	F	SB	S	*
187	G	4	0.00E+00	B	F	SB	S	*
187	G	5	0.00E+00	B	F	SB	S	*
187	G	6	0.00E+00	B	F	SB	S	*
188	G	4	0.00E+00	B	F	SB	S	*
188	G	5	0.00E+00	B	F	SB	S	*
188	G	6	0.00E+00	B	F	SB	S	*
189	G	4	0.00E+00	B	F	SB	S	*
189	G	5	0.00E+00	B	F	SB	S	*

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0
0 G R I D P O I N T S I N G U L A R I T Y T A B L E
0 POINT TYPE FAILED STIFFNESS OLD USET
NEW USET ID DIRECTION RATIO EXCLUSIVE
UNION EXCLUSIVE UNION

189	G	6	0.00E+00	B	F	SB	S	*
190	G	4	0.00E+00	B	F	SB	S	*
190	G	5	0.00E+00	B	F	SB	S	*
190	G	6	0.00E+00	B	F	SB	S	*
191	G	4	0.00E+00	B	F	SB	S	*
191	G	5	0.00E+00	B	F	SB	S	*
191	G	6	0.00E+00	B	F	SB	S	*
192	G	4	0.00E+00	B	F	SB	S	*
192	G	5	0.00E+00	B	F	SB	S	*
192	G	6	0.00E+00	B	F	SB	S	*

```
1                                                    JANUARY  30, 2000
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0
0*** USER INFORMATION MESSAGE 5293 FOR DATA BLOCK
KLL

   LOAD SEQ. NO.          EPSILON             EXTERNAL WORK
EPSILONS LARGER THAN 0.001 ARE FLAGGED WITH
ASTERISKS
            1      -3.8726509E-12        1.4975756E+00
1                                                    JANUARY  30, 2000
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0
0 RESULTANTS ABOUT ORIGIN OF SUPERELEMENT BASIC
COORDINATE SYSTEM IN SUPERELEMENT BASIC SYSTEM
COORDINATES.

0        SPCFORCE RESULTANT
0          T1          T2          T3          R1          R2          R3
0           1     6.6613381E-15 -3.0000000E+01   6.3504757E-13
6.3000000E+02 -2.0627944E-12 -7.5000000E+01
1                                                    JANUARY  30, 2000
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0
0


0*** USER INFORMATION MESSAGE 4114 (OUTPX2)
   DATA BLOCK OQG1    WRITTEN ON FORTRAN UNIT 12, TRL
=
         101         0      1952         0         0         0         0
   (MAXIMUM POSSIBLE FORTRAN RECORD SIZE = 4098
WORDS.)
 (MAXIMUM SIZE OF FORTRAN RECORDS WRITTEN = 1952
WORDS.)
(NUMBER OF FORTRAN RECORDS WRITTEN =    20 RECORDS.)
                    (TOTAL DATA WRITTEN FOR DATA BLOCK
=     2131 WORDS.)
0*** USER INFORMATION MESSAGE 4114 (OUTPX2)
```

```
     DATA BLOCK OUGV1    WRITTEN ON FORTRAN UNIT 12,
TRL = 101           0        1952           0           0           0
0  (MAXIMUM POSSIBLE FORTRAN RECORD SIZE =      4098
WORDS.)
 (MAXIMUM SIZE OF FORTRAN RECORDS WRITTEN =     1952
WORDS.)
  (NUMBER OF FORTRAN RECORDS WRITTEN=20 RECORDS.)
 (TOTAL DATA WRITTEN FOR DATA BLOCK =    2131 WORDS.)
1                                          JANUARY  30, 2000
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0
1                                          JANUARY  30, 2000
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0
0*** USER INFORMATION MESSAGE 4114 (OUTPX2)
    DATA BLOCK OEF1X   WRITTEN ON FORTRAN UNIT 12, TRL
=   101          63           1          30           0           0           1
 (MAXIMUM POSSIBLE FORTRAN RECORD SIZE =      4098
WORDS.)
 (MAXIMUM SIZE OF FORTRAN RECORDS WRITTEN =     2820
WORDS.)
(NUMBER OF FORTRAN RECORDS WRITTEN = 20 RECORDS.)
 (TOTAL DATA WRITTEN FOR DATA BLOCK =    2999 WORDS.)
0*** USER INFORMATION MESSAGE 4114 (OUTPX2)
    DATA BLOCK OES1X   WRITTEN ON FORTRAN UNIT 12, TRL
=  101          63           1          30           0           0           1
 (MAXIMUM POSSIBLE FORTRAN RECORD SIZE =      4098
WORDS.)
 (MAXIMUM SIZE OF FORTRAN RECORDS WRITTEN =     4098
WORDS.)
(NUMBER OF FORTRAN RECORDS WRITTEN =  38 RECORDS.)
(TOTAL DATA WRITTEN FOR DATA BLOCK =   21190 WORDS.)
0*** USER INFORMATION MESSAGE 4114 (OUTPX2)
    DATA BLOCK OPG1    WRITTEN ON FORTRAN UNIT 12, TRL
=
         101           0        1952           0           0           0           0
                        (MAXIMUM POSSIBLE FORTRAN RECORD
SIZE =     4098 WORDS.)
(MAXIMUM SIZE OF FORTRAN RECORDS WRITTEN =     1952
WORDS.)
(NUMBER OF FORTRAN RECORDS WRITTEN =  20 RECORDS.)
 (TOTAL DATA WRITTEN FOR DATA BLOCK =    2131 WORDS.)
```

```
0*** USER INFORMATION MESSAGE 4110 (OUTPX2)END-OF-DATA SIMULATION ON FORTRAN UNIT 12
(MAXIMUM SIZE OF FORTRAN RECORDS WRITTEN = 1 WORDS.)
 (NUMBER OF FORTRAN RECORDS WRITTEN =     1 RECORDS.)
 (TOTAL DATA WRITTEN FOR EOF MARKER =     1 WORDS.)
1                                                    JANUARY  30, 2000
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0
 * * * *  D B D I C T   P R I N T  * * * *    SUBDMAP = PRTSUM ,
DMAP STATEMENT NO.    13
0                        * * * *  A N A L Y S I S   S U M M A R Y   T A
B L E  * * * *
0 SEID   PEID PROJ VERS APRCH      SEMG SEMR SEKR SELG
SELR  MODES  DYNRED  SOLLIN  PVALID  SOLNL  LOOPID
DESIGN CYCLE SENSITIVITY
 ----------------------------------------------------------------------------------------
-------------------------------------
    0    0    1    1Ô      Ô    T    T    T    T    T    F    F    T    0    F
-1         0         F
0SEID = SUPERELEMENT ID.
   PEID = PRIMARY SUPERELEMENT ID OF IMAGE SUPERELEMENT.
 PROJ = PROJECT ID NUMBER.
 VERS = VERSION ID.
 APRCH = BLANK FOR STRUCTURAL ANALYSIS.  HEAT FOR HEAT TRANSFER ANALYSIS.
 SEMG = STIFFNESS AND MASS MATRIX GENERATION STEP.
  SEMR = MASS MATRIX REDUCTION STEP (INCLUDES EIGENVALUE SOLUTION FOR MODES).
 SEKR = STIFFNESS MATRIX REDUCTION STEP.
 SELG = LOAD MATRIX GENERATION STEP.
 SELR = LOAD MATRIX REDUCTION STEP.
  MODES = T (TRUE) IF NORMAL MODES OR BUCKLING MODES CALCULATED.
 DYNRED = T (TRUE) MEANS GENERALIZED DYNAMIC AND/OR COMPONENT MODE REDUCTION PERFORMED.
  SOLLIN = T (TRUE) IF LINEAR SOLUTION EXISTS IN DATABASE.
 PVALID = P-DISTRIBUTION ID OF P-VALUE FOR P-ELEMENTS
  LOOPID = THE LAST LOOPID VALUE USED IN THE NONLINEAR ANALYSIS.  USEFUL FOR RESTARTS.
```

SOLNL = T (TRUE) IF NONLINEAR SOLUTION EXISTS IN DATABASE.
DESIGN CYCLE = THE LAST DESIGN CYCLE (ONLY VALID IN OPTIMIZATION).
SENSITIVITY = SENSITIVITY MATRIX GENERATION FLAG.
1 * * * END OF JOB * * *