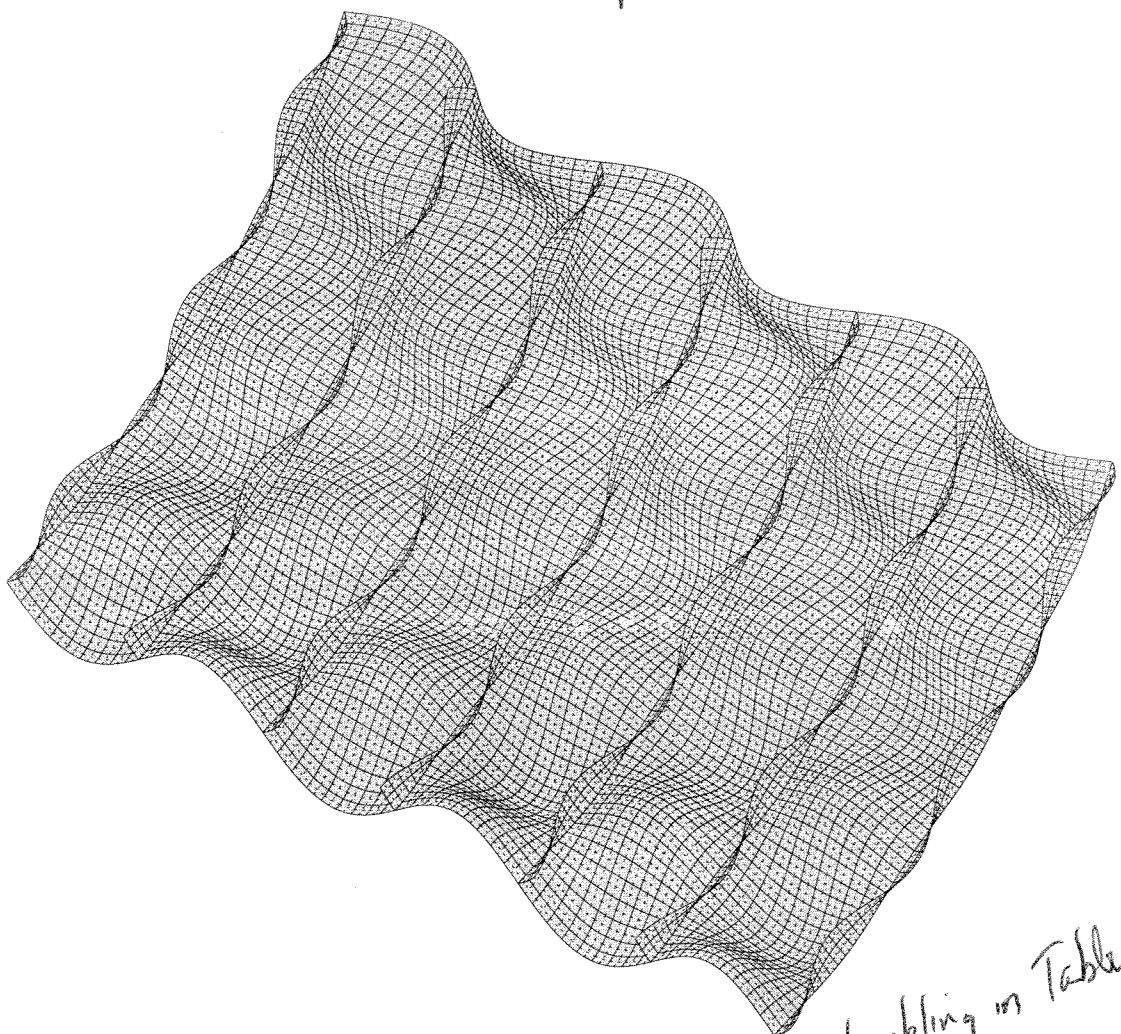


STAGS inter-ring buckling  
(Stringers are smeared out)

Compare with Fig. 20



solution scale = 0.4189E+01

mode 1, pcr = 0.25149E+01

step 0 eigenvector deformed geometry  
linear buckling of perfect shell from STAGS

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Compare with inter-ring buckling in Table 23.

$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

1.336E+01

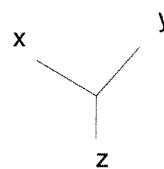
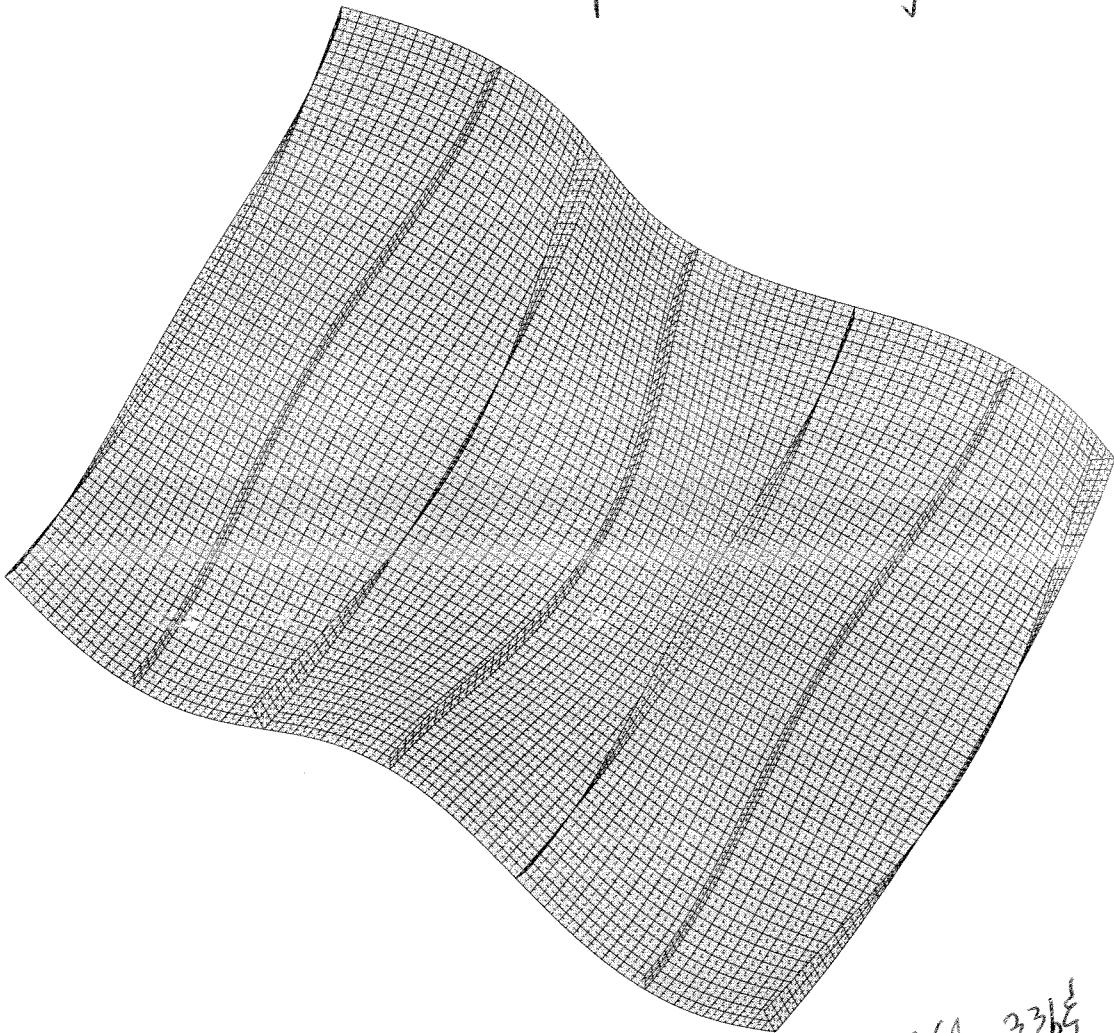


Fig. 26

STAGS general buckling  
(stringers are smeared out)

Compare with Fig. 24.



solution scale = 0.4206E+01

mode 4, pcr = 0.25646E+01

step 0 eigenvector deformed geometry  
linear buckling of perfect shell from STAGS

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← Compare with PANDA2: Tables 33b<sup>1</sup>  
Margin 13

$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

1.336E+01

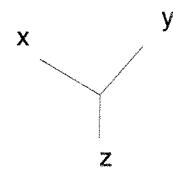


Fig. 27

# Table 41 nasaorth0, STG

```

n      $ Do you want a tutorial session and tutorial output?
1      $ Choose type of STAGS analysis (1,3,4,5,6), INDIC
0      $ Restart from ISTARTth load step (0=1st nonlinear soln), ISTART
1.000000 $ Local buckling load factor from PANDA2, EIGLOC
y      $ Are the dimensions in this case in inches?
→ 1    $ Nonlinear (0) or linear (1) kinematic relations?, ILIN
0      $ Type 1 for closed (360-deg) cyl. shell, 0 otherwise, ITOTAL
68.75   $ X-direction length of the STAGS model of the panel: XSTAGS
50.26548 $ Panel length in the plane of the screen, L2
y      $ Is the nodal point spacing uniform along the stringer axis?
101    $ Number of nodes in the X-direction: NODEX
-2219   $ Resultant (e.g. lb/in) normal to the plane of screen, Nx
0      $ Resultant (e.g. lb/in) in the plane of the screen, Ny
0      $ In-plane shear in load set A, Nxy
0      $ Normal pressure in STAGS model in Load Set A, p
0      $ Resultant (e.g. lb/in) normal to the plane of screen, Nx0
0      $ Resultant (e.g. lb/in) in the plane of the screen, Ny0
0      $ Normal pressure in STAGS model in Load Set B, p0
1.000000 $ Starting load factor for Load System A, STLD(1)
0.000000 $ Load factor increment for Load System A, STEP(1)
1.000000 $ Maximum load factor for Load System A, FACM(1)
0      $ Starting load factor for Load System B, STLD(2)
0      $ Load factor increment for Load System B, STEP(2)
0      $ Maximum load factor for Load System B, FACM(2)
1      $ How many eigenvalues do you want? NEIGS
480    $ Choose element type (410 or 411 or 480) for panel skin
n      $ Have you obtained buckling modes from STAGS for this case?
162    $ Number of stringers in STAGS model of 360-deg. cylinder
7      $ Number of rings in the STAGS model of the panel
y      $ Are there rings at the ends of the panel?
2      $ Number of finite elements between adjacent stringers
9      $ Number of finite elements between adjacent rings
3      $ Stringer model: 1 or 2 or 3 or 4 or 5 (Type H(elp))
3      $ Ring model: 1 or 2 or 3 or 4 or 5 (Type H(elp))
-1     $ Reference surface of cyl: 1=outer, 0=middle, -1=inner
n      $ Do you want to use fasteners (they are like rigid links)?
→ y    $ Are the stringers to be "smeared out"?
→ n    $ Are the rings to be "smeared out"?
5      $ Number of nodes over height of stiffener webs, NODWEB
5      $ Number of nodes over width of stringer flange, NDFLGS
5      $ Number of nodes over width of ring flange, NDFLGR
n      $ Do you want stringer(s) with a high nodal point density?
n      $ Do you want ring(s) with a high nodal point density?
n      $ Is there plasticity in this STAGS model?
y      $ Do you want to use the "least-squares" model for torque?
y      $ Is stiffener sidesway permitted at the panel edges?
y      $ Do you want symmetry conditions along the straight edges?
0      $ Edges normal to screen (0) in-plane deformable; (1) rigid

```

## Input for STAGSUNIT

note: Usually the STAGS user should use zero here,  
as has been done previously in this report.  
However, using 1 tends to filter out some of  
the local buckling modes.

60-degree STAGS model

Table 42 nasaerth.00f2

shift = 2.5, no negative roots

| NO. | EIGENVALUE   | CRITICAL LOAD FACTOR COMBINATION |               |       |
|-----|--------------|----------------------------------|---------------|-------|
|     |              | LOAD SYSTEM A                    | LOAD SYSTEM B | @DOF  |
| 1   | 2.570047E+00 | 2.570047E+00                     | 0.000000E+00  | 6213  |
| 2   | 2.582880E+00 | 2.582880E+00                     | 0.000000E+00  | 76513 |
| 3   | 2.598762E+00 | 2.598762E+00                     | 0.000000E+00  | 65397 |
| 4   | 2.605576E+00 | 2.605576E+00                     | 0.000000E+00  | 65397 |
| 5   | 2.657557E+00 | 2.657557E+00                     | 0.000000E+00  | 65397 |
| 6   | 2.727976E+00 | 2.727976E+00                     | 0.000000E+00  | 65109 |
| 7   | 2.731735E+00 | 2.731735E+00                     | 0.000000E+00  | 62133 |
| 8   | 2.762029E+00 | 2.762029E+00                     | 0.000000E+00  | 64749 |

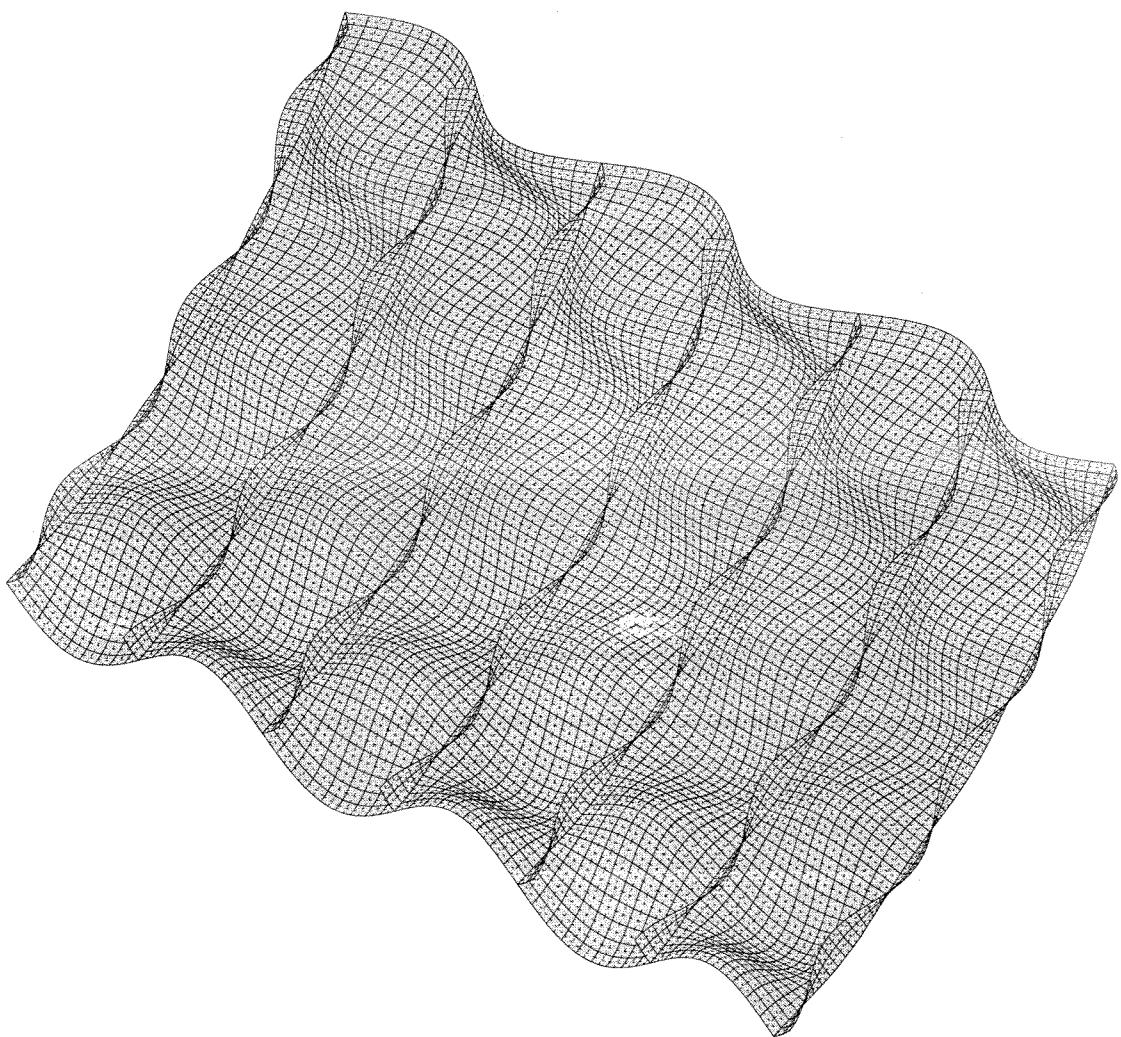
← internal buckling; Fig. 28  
← general buckling; Fig. 29

STAGS output (abridged)

Compare with Table 40 .

STAGS interring buckling with  
 $ILIN=1$

Compare with Fig. 26



solution scale = 0.4189E+01

mode 1, pcr = 0.25700E+01

step 0 eigenvector deformed geometry

linear buckling of perfect shell from STAGS

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$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

+ 1.336E+01 +

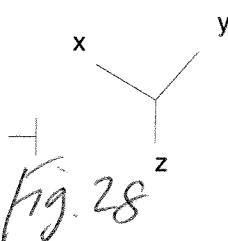
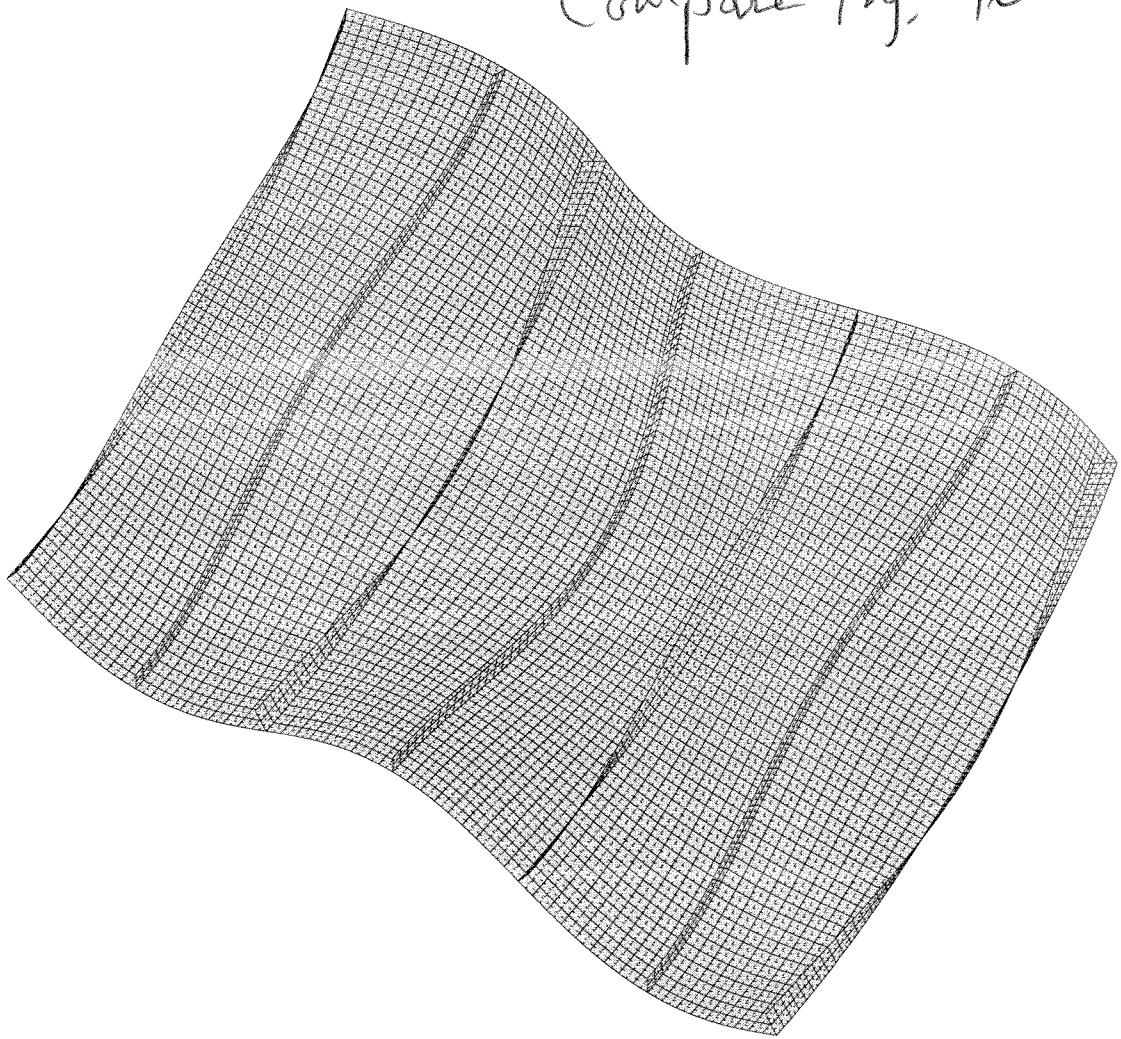


Fig. 28

STAG5 general buckling  
with ILIN=1

Compare Fig. 27

Compare Fig. 46



solution scale = 0.4207E+01

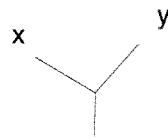
mode 2, pcr = 0.25829E+01

step 0 eigenvector deformed geometry  
linear buckling of perfect shell from STAGS

Compare Fig. 27 & 46

$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

1.336E+01



106

Fig. 29

## Table 43 nasaortho, STG

```

n      $ Do you want a tutorial session and tutorial output?
1      $ Choose type of STAGS analysis (1,3,4,5,6), INDIC
0      $ Restart from ISTARTth load step (0=1st nonlinear soln), ISTART
1.000000 $ Local buckling load factor from PANDA2, EIGLOC
Y      $ Are the dimensions in this case in inches?
→ 1   $ Nonlinear (0) or linear (1) kinematic relations?, ILIN
0      $ Type 1 for closed (360-deg) cyl. shell, 0 otherwise, ITOTAL
68.75  $ X-direction length of the STAGS model of the panel: XSTAGS
50.26548 $ Panel length in the plane of the screen, L2
Y      $ Is the nodal point spacing uniform along the stringer axis?
101    $ Number of nodes in the X-direction: NODEX
-2219  $ Resultant (e.g. lb/in) normal to the plane of screen, Nx
0      $ Resultant (e.g. lb/in) in the plane of the screen, Ny
0      $ In-plane shear in load set A, Nxy
0      $ Normal pressure in STAGS model in Load Set A, p
0      $ Resultant (e.g. lb/in) normal to the plane of screen, Nx0
0      $ Resultant (e.g. lb/in) in the plane of the screen, Ny0
0      $ Normal pressure in STAGS model in Load Set B, p0
1.000000 $ Starting load factor for Load System A, STLD(1)
0.000000 $ Load factor increment for Load System A, STEP(1)
1.000000 $ Maximum load factor for Load System A, FACM(1)
0      $ Starting load factor for Load System B, STLD(2)
0      $ Load factor increment for Load System B, STEP(2)
0      $ Maximum load factor for Load System B, FACM(2)
1      $ How many eigenvalues do you want? NEIGS
480    $ Choose element type (410 or 411 or 480) for panel skin
n      $ Have you obtained buckling modes from STAGS for this case?
162    $ Number of stringers in STAGS model of 360-deg. cylinder
7      $ Number of rings in the STAGS model of the panel
Y      $ Are there rings at the ends of the panel?
2      $ Number of finite elements between adjacent stringers
9      $ Number of finite elements between adjacent rings
3      $ Stringer model: 1 or 2 or 3 or 4 or 5 (Type H(elp))
3      $ Ring model: 1 or 2 or 3 or 4 or 5 (Type H(elp))
-1     $ Reference surface of cyl: 1=outer, 0=middle, -1=inner
n      $ Do you want to use fasteners (they are like rigid links)?
→ n   $ Are the stringers to be "smeared out"?
→ n   $ Are the rings to be "smeared out"?
5      $ Number of nodes over height of stiffener webs, NODWEB
5      $ Number of nodes over width of stringer flange, NDFLGS
5      $ Number of nodes over width of ring flange, NDFLGR
n      $ Do you want stringer(s) with a high nodal point density?
n      $ Do you want ring(s) with a high nodal point density?
n      $ Is there plasticity in this STAGS model?
y      $ Do you want to use the "least-squares" model for torque?
y      $ Is stiffener sidesway permitted at the panel edges?
y      $ Do you want symmetry conditions along the straight edges?
0      $ Edges normal to screen (0) in-plane deformable; (1) rigid

```

## Input for STAGSUN1T

60-degree STAGS model with all  
stiffeners as branches (shell units).

There must be a tedious search for the  
general buckling mode because it is  
"hidden" among a "thicket" of local buckling  
modes. Table 44 shows an unsuccessful part  
of that search.

# Table 44 (9 pages) Search for general buckling with the 60-degree x 6-ring-bay STAGS model.

STAGS run no.

OUTPUT FROM STAGS FOR LINEAR BUCKLING RUNS  
IN SEARCH OF THE GENERAL BUCKLING MODE AND  
LOAD FACTOR: ILIN = 1. STAGS 60-DEGREE x 6-RING-BAY MODEL

| 2 nasaortho.out2 (abridged)                               |              |               |               |        |      |
|---|--------------|---------------|---------------|--------|------|
| shift = 2.575, 629 negative roots                         |              |               |               |        |      |
| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8 |              |               |               |        |      |
| CRITICAL LOAD FACTOR COMBINATION                          |              |               |               |        |      |
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1   | 2.568383E+00 | 2.568383E+00  | 0.000000E+00  | 85545  | 625  |
| 2   | 2.568990E+00 | 2.568990E+00  | 0.000000E+00  | 141753 | 626  |
| 3   | 2.574022E+00 | 2.574022E+00  | 0.000000E+00  | 65727  | 627  |
| 4   | 2.574298E+00 | 2.574298E+00  | 0.000000E+00  | 6867   | 628  |
| 5   | 2.574499E+00 | 2.574499E+00  | 0.000000E+00  | 94209  | 629  |
| 6   | 2.577491E+00 | 2.577491E+00  | 0.000000E+00  | 141753 | 630  |
| 7   | 2.579629E+00 | 2.579629E+00  | 0.000000E+00  | 132945 | 631  |
| 8   | 2.580404E+00 | 2.580404E+00  | 0.000000E+00  | 74289  | 632  |

| 3 nasaortho2.out2 (abridged)   |  |  |  |  |  |
|--|--|--|--|--|--|
| shift = 2.585, 633 negative roots  |  |  |  |  |  |
| MAXIMUM NUMBER OF ITERATIONS   |  |  |  |  |  |
| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 7                |  |  |  |  |  |
| CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 8 THROUGH 8 |  |  |  |  |  |
| CRITICAL LOAD FACTOR COMBINATION   |  |  |  |  |  |

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.583058E+00 | 2.583058E+00  | 0.000000E+00  | 132513 | 633  |
| 2   | 2.586725E+00 | 2.586725E+00  | 0.000000E+00  | 82353  | 634  |
| 3   | 2.587624E+00 | 2.587624E+00  | 0.000000E+00  | 140817 | 635  |
| 4   | 2.587676E+00 | 2.587676E+00  | 0.000000E+00  | 30459  | 636  |
| 5   | 2.588239E+00 | 2.588239E+00  | 0.000000E+00  | 52599  | 637  |
| 6   | 2.588525E+00 | 2.588525E+00  | 0.000000E+00  | 83241  | 638  |
| 7   | 2.588745E+00 | 2.588745E+00  | 0.000000E+00  | 18687  | 639  |
| 8   | 2.589098E+00 | 2.589098E+00  | 0.000000E+00  | 42231  | 640  |

<--not fully converged

| 4 nasaortho.out2 (abridged) |   |                |                |                |  |
|-----------------------------|---|----------------|----------------|----------------|--|
| 22                          | 1 | 0.25797296E+01 | 0.77587714E-03 | 0.25797294E+01 |  |
| 22                          | 2 | 0.25796285E+01 | 0.00000000E+00 | 0.25796285E+01 |  |
| 22                          | 3 | 0.25804043E+01 | 0.00000000E+00 | 0.25804043E+01 |  |
| 22                          | 4 | 0.25789125E+01 | 0.56983471E-02 | 0.25789063E+01 |  |
| 22                          | 5 | 0.25774906E+01 | 0.28138430E-10 | 0.25774906E+01 |  |
| 22                          | 6 | 0.25830576E+01 | 0.23514411E-09 | 0.25830576E+01 |  |
| 22                          | 7 | 0.25849246E+01 | 0.17876540E+00 | 0.25840443E+01 |  |
| 22                          | 8 | 0.25744993E+01 | 0.40810326E-07 | 0.25744993E+01 |  |
| 22                          | 9 | 0.25742982E+01 | 0.85167975E-09 | 0.25742982E+01 |  |

| shift = 2.580, 631 negative roots  |              |               |               |        |               |
|--|--------------|---------------|---------------|--------|---------------|
| MAXIMUM NUMBER OF ITERATIONS   |              |               |               |        |               |
| CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 1 THROUGH 8 |              |               |               |        |               |
| CRITICAL LOAD FACTOR COMBINATION   |              |               |               |        |               |
| NO.  | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root          |
| 1  | 2.574499E+00 | 2.574499E+00  | 0.000000E+00  | 116361 | 629           |
| 2  | 2.577491E+00 | 2.577491E+00  | 0.000000E+00  | 74049  | 630           |
| 3  | 2.578912E+00 | 2.578912E+00  | 0.000000E+00  | 92361  | not converged |
| 4  | 2.579629E+00 | 2.579629E+00  | 0.000000E+00  | 132945 | 631           |
| 5  | 2.579730E+00 | 2.579730E+00  | 0.000000E+00  | 76329  | not converged |
| 6  | 2.580404E+00 | 2.580404E+00  | 0.000000E+00  | 141513 | 632           |
| 7  | 2.583058E+00 | 2.583058E+00  | 0.000000E+00  | 132513 | 633           |
| 8  | 2.584925E+00 | 2.584925E+00  | 0.000000E+00  | 53643  | not converged |

| 5 nasaortho.out2 (abridged) |        |                |                |                |  |
|-----------------------------|--------|----------------|----------------|----------------|--|
| ITERATION                   | VECTOR | EIGENVALUE     | RELATIVE ERROR |                |  |
| 22                          | 1      | 0.25940604E+01 | 0.25521083E+03 | 0.25786432E+01 |  |
| 22                          | 2      | 0.25947730E+01 | 0.76508034E+00 | 0.25941816E+01 |  |
| 22                          | 3      | 0.25947907E+01 | 0.11232525E-11 | 0.25947907E+01 |  |
| 22                          | 4      | 0.25926670E+01 | 0.33315283E-12 | 0.25926670E+01 |  |
| 22                          | 5      | 0.25953508E+01 | 0.00000000E+00 | 0.25953508E+01 |  |
| 22                          | 6      | 0.25971006E+01 | 0.88945219E-10 | 0.25971006E+01 |  |
| 22                          | 7      | 0.25908142E+01 | 0.31363884E-10 | 0.25908142E+01 |  |
| 22                          | 8      | 0.25979513E+01 | 0.12567481E-07 | 0.25979513E+01 |  |
| root 641? 22                | 9      | 0.25894098E+01 | 0.39424569E-05 | 0.25894098E+01 |  |

shift = 2.594, 643 negative roots  
MAXIMUM NUMBER OF ITERATIONS  
CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 1 THROUGH 8

Table 44 (p. 2 of 9)

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root             |
|-----|--------------|---------------|---------------|--------|------------------|
| 1   | 2.590814E+00 | 2.590814E+00  | 0.000000E+00  | 117705 | 642              |
| 2   | 2.592667E+00 | 2.592667E+00  | 0.000000E+00  | 132537 | 643              |
| 3   | 2.594060E+00 | 2.594060E+00  | 0.000000E+00  | 28791  | <--not converged |
| 4   | 2.594773E+00 | 2.594773E+00  | 0.000000E+00  | 38571  | <--not converged |
| 5   | 2.594791E+00 | 2.594791E+00  | 0.000000E+00  | 132009 | 644              |
| 6   | 2.595351E+00 | 2.595351E+00  | 0.000000E+00  | 38571  | 645              |
| 7   | 2.597101E+00 | 2.597101E+00  | 0.000000E+00  | 50343  | 646              |
| 8   | 2.597951E+00 | 2.597951E+00  | 0.000000E+00  | 139689 | 647              |

6 nasaortho.out2 (abridged)

shift = 2.590, 641 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root                           |
|-----|--------------|---------------|---------------|--------|--------------------------------|
| 1   | 2.587624E+00 | 2.587624E+00  | 0.000000E+00  | 74985  | 635                            |
| 2   | 2.587676E+00 | 2.587676E+00  | 0.000000E+00  | 30363  | 636                            |
| 3   | 2.588239E+00 | 2.588239E+00  | 0.000000E+00  | 52599  | 637                            |
| 4   | 2.588525E+00 | 2.588525E+00  | 0.000000E+00  | 132561 | 638                            |
| 5   | 2.588745E+00 | 2.588745E+00  | 0.000000E+00  | 52599  | 639                            |
| 6   | 2.589102E+00 | 2.589102E+00  | 0.000000E+00  | 42135  | 640                            |
| 7   | 2.589410E+00 | 2.589410E+00  | 0.000000E+00  | 114057 | 641 <--needed to get this root |
| 8   | 2.590814E+00 | 2.590814E+00  | 0.000000E+00  | 98097  | 642                            |

7 nasaortho.out2 (abridged)

shift = 2.600, 648 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.594791E+00 | 2.594791E+00  | 0.000000E+00  | 83793  | 644  |
| 2   | 2.595351E+00 | 2.595351E+00  | 0.000000E+00  | 33147  | 645  |
| 3   | 2.597101E+00 | 2.597101E+00  | 0.000000E+00  | 50343  | 646  |
| 4   | 2.597951E+00 | 2.597951E+00  | 0.000000E+00  | 74289  | 647  |
| 5   | 2.598945E+00 | 2.598945E+00  | 0.000000E+00  | 15027  | 648  |
| 6   | 2.600388E+00 | 2.600388E+00  | 0.000000E+00  | 31887  | 649  |
| 7   | 2.602196E+00 | 2.602196E+00  | 0.000000E+00  | 132105 | 650  |
| 8   | 2.603086E+00 | 2.603086E+00  | 0.000000E+00  | 93657  | 651  |

8 nasaortho.out2 (abridged)

|          |    |                |                |                |
|----------|----|----------------|----------------|----------------|
| 22       | 1  | 0.25198697E+01 | 0.52014670E+00 | 0.25198019E+01 |
| 22       | 2  | 0.25203064E+01 | 0.00000000E+00 | 0.25203064E+01 |
| 22       | 3  | 0.25205552E+01 | 0.00000000E+00 | 0.25205552E+01 |
| 22       | 4  | 0.25214131E+01 | 0.20113593E-10 | 0.25214131E+01 |
| 22       | 5  | 0.25215318E+01 | 0.11596563E-11 | 0.25215318E+01 |
| 22       | 6  | 0.25173542E+01 | 0.16465456E-07 | 0.25173542E+01 |
| 22       | 7  | 0.25235893E+01 | 0.15465594E-10 | 0.25235893E+01 |
| 22       | 8  | 0.25155166E+01 | 0.18291714E-08 | 0.25155166E+01 |
| root 583 | 22 | 9              | 0.25146545E+01 | 0.90966984E-06 |

shift = 2.520, 585 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root             |
|-----|--------------|---------------|---------------|--------|------------------|
| 1   | 2.515517E+00 | 2.515517E+00  | 0.000000E+00  | 114249 | 584              |
| 2   | 2.517354E+00 | 2.517354E+00  | 0.000000E+00  | 114105 | 585              |
| 3   | 2.519870E+00 | 2.519870E+00  | 0.000000E+00  | 93465  | <--not converged |
| 4   | 2.520306E+00 | 2.520306E+00  | 0.000000E+00  | 75345  | 586              |
| 5   | 2.520555E+00 | 2.520555E+00  | 0.000000E+00  | 32763  | 587              |
| 6   | 2.521413E+00 | 2.521413E+00  | 0.000000E+00  | 102057 | 588              |
| 7   | 2.521532E+00 | 2.521532E+00  | 0.000000E+00  | 131601 | 589              |
| 8   | 2.523589E+00 | 2.523589E+00  | 0.000000E+00  | 113769 | 590              |

9 nasaortho.out2 (abridged)

shift = 2.527, 592 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.521413E+00 | 2.521413E+00  | 0.000000E+00  | 102057 | 588  |
| 2   | 2.521532E+00 | 2.521532E+00  | 0.000000E+00  | 131601 | 589  |
| 3   | 2.523589E+00 | 2.523589E+00  | 0.000000E+00  | 102033 | 590  |
| 4   | 2.526106E+00 | 2.526106E+00  | 0.000000E+00  | 41187  | 591  |
| 5   | 2.526714E+00 | 2.526714E+00  | 0.000000E+00  | 52959  | 592  |

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|   |              |              |              |        |     |
|---|--------------|--------------|--------------|--------|-----|
| 6 | 2.527417E+00 | 2.527417E+00 | 0.000000E+00 | 17643  | 593 |
| 7 | 2.527933E+00 | 2.527933E+00 | 0.000000E+00 | 42495  | 594 |
| 8 | 2.529810E+00 | 2.529810E+00 | 0.000000E+00 | 113889 | 595 |

10 nasaortho.out2 (abridged)

|    |   |                |                |                |
|----|---|----------------|----------------|----------------|
| 22 | 1 | 0.25358182E+01 | 0.20735281E+02 | 0.25527847E+01 |
| 22 | 2 | 0.25361190E+01 | 0.39684890E-11 | 0.25361190E+01 |
| 22 | 3 | 0.25337988E+01 | 0.36971395E-12 | 0.25337988E+01 |
| 22 | 4 | 0.25365879E+01 | 0.24052085E-10 | 0.25365879E+01 |
| 22 | 5 | 0.25399639E+01 | 0.86140214E+00 | 0.25356880E+01 |
| 22 | 6 | 0.25298101E+01 | 0.27553865E-06 | 0.25298101E+01 |

| ITERATION | VECTOR | EIGENVALUE     | RELATIVE ERROR |
|-----------|--------|----------------|----------------|
| 22        | 7      | 0.25406682E+01 | 0.61749635E-06 |
| 22        | 8      | 0.25408504E+01 | 0.58286344E-05 |
| 22        | 9      | 0.25415804E+01 | 0.14258865E-06 |
| 22        | 10     | 0.25279305E+01 | 0.13787108E-03 |
| 22        | 11     | 0.25274160E+01 | 0.69405913E-04 |

shift = 2.535, 596 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 1 THROUGH 8  
CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF                    |
|-----|--------------|---------------|---------------|-------------------------|
| 1   | 2.529810E+00 | 2.529810E+00  | 0.000000E+00  | 101913 595              |
| 2   | 2.533799E+00 | 2.533799E+00  | 0.000000E+00  | 101169 596              |
| 3   | 2.535818E+00 | 2.535818E+00  | 0.000000E+00  | 40731 <--not converged  |
| 4   | 2.536119E+00 | 2.536119E+00  | 0.000000E+00  | 121809 597              |
| 5   | 2.536588E+00 | 2.536588E+00  | 0.000000E+00  | 74529 598               |
| 6   | 2.539964E+00 | 2.539964E+00  | 0.000000E+00  | 106665 <--not converged |
| 7   | 2.540668E+00 | 2.540668E+00  | 0.000000E+00  | 101577 599              |
| 8   | 2.540850E+00 | 2.540850E+00  | 0.000000E+00  | 65991 600               |

11 nasaortho.out2 (abridged)

shift = 2.545, 602 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 7  
CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.540668E+00 | 2.540668E+00  | 0.000000E+00  | 101145 | 599  |
| 2   | 2.540850E+00 | 2.540850E+00  | 0.000000E+00  | 5247   | 600  |
| 3   | 2.541580E+00 | 2.541580E+00  | 0.000000E+00  | 3939   | 601  |
| 4   | 2.543623E+00 | 2.543623E+00  | 0.000000E+00  | 102009 | 602  |
| 5   | 2.549177E+00 | 2.549177E+00  | 0.000000E+00  | 93153  | 603  |
| 6   | 2.549329E+00 | 2.549329E+00  | 0.000000E+00  | 33027  | 604  |
| 7   | 2.551077E+00 | 2.551077E+00  | 0.000000E+00  | 50031  | 605  |

12 nasaortho.out2 (abridged)

|    |   |                |                |                |
|----|---|----------------|----------------|----------------|
| 22 | 1 | 0.25567833E+01 | 0.00000000E+00 | 0.25567833E+01 |
| 22 | 2 | 0.25569938E+01 | 0.64846639E+01 | 0.25634385E+01 |
| 22 | 3 | 0.25548861E+01 | 0.23920340E-11 | 0.25548861E+01 |
| 22 | 4 | 0.25548518E+01 | 0.11602665E-11 | 0.25548518E+01 |
| 22 | 5 | 0.25574421E+01 | 0.15767030E-09 | 0.25574421E+01 |
| 22 | 6 | 0.25545113E+01 | 0.71862362E-09 | 0.25545113E+01 |
| 22 | 7 | 0.25579916E+01 | 0.91420458E-11 | 0.25579916E+01 |
| 22 | 8 | 0.25585892E+01 | 0.47853151E-06 | 0.25585892E+01 |

shift = 2.556, 610 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 1

CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 2 THROUGH 8  
CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF                    | root |
|-----|--------------|---------------|---------------|-------------------------|------|
| 1   | 2.554511E+00 | 2.554511E+00  | 0.000000E+00  | 31719                   | 608  |
| 2   | 2.554852E+00 | 2.554852E+00  | 0.000000E+00  | 100857                  | 609  |
| 3   | 2.554886E+00 | 2.554886E+00  | 0.000000E+00  | 113457                  | 610  |
| 4   | 2.556783E+00 | 2.556783E+00  | 0.000000E+00  | 77265                   | 611  |
| 5   | 2.556994E+00 | 2.556994E+00  | 0.000000E+00  | 126153 <--not converged |      |
| 6   | 2.557442E+00 | 2.557442E+00  | 0.000000E+00  | 40875                   | 612  |
| 7   | 2.557992E+00 | 2.557992E+00  | 0.000000E+00  | 18639                   | 613  |
| 8   | 2.558589E+00 | 2.558589E+00  | 0.000000E+00  | 52647                   | 614  |

13 nasaortho.out2 (abridged)

shift = 2.562, 620 negative roots

Table 44 (p. 4 of 9)

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |      |
|---|--------------|---------------|---------------|--------|------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1   | 2.558589E+00 | 2.558589E+00  | 0.000000E+00  | 52647  | 614  |
| 2   | 2.558963E+00 | 2.558963E+00  | 0.000000E+00  | 102441 | 615  |
| 3   | 2.559017E+00 | 2.559017E+00  | 0.000000E+00  | 42183  | 616  |
| 4   | 2.560360E+00 | 2.560360E+00  | 0.000000E+00  | 2943   | 617  |
| 5   | 2.560698E+00 | 2.560698E+00  | 0.000000E+00  | 136737 | 618  |
| 6   | 2.561049E+00 | 2.561049E+00  | 0.000000E+00  | 140409 | 619  |
| 7   | 2.561104E+00 | 2.561104E+00  | 0.000000E+00  | 68343  | 620  |
| 8   | 2.565198E+00 | 2.565198E+00  | 0.000000E+00  | 140817 | 621  |

14 nasaortho.out2 (abridged) Go back and pick up missing roots 606 and 607.  
shift = 2.552, 605 negative roots

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |      |
|---|--------------|---------------|---------------|--------|------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1   | 2.549177E+00 | 2.549177E+00  | 0.000000E+00  | 93153  | 603  |
| 2   | 2.549329E+00 | 2.549329E+00  | 0.000000E+00  | 33027  | 604  |
| 3   | 2.551077E+00 | 2.551077E+00  | 0.000000E+00  | 50031  | 605  |
| 4   | 2.552654E+00 | 2.552654E+00  | 0.000000E+00  | 101745 | 606  |
| 5   | 2.553006E+00 | 2.553006E+00  | 0.000000E+00  | 14715  | 607  |
| 6   | 2.554511E+00 | 2.554511E+00  | 0.000000E+00  | 31719  | 608  |
| 7   | 2.554852E+00 | 2.554852E+00  | 0.000000E+00  | 100857 | 609  |
| 8   | 2.554886E+00 | 2.554886E+00  | 0.000000E+00  | 102345 | 610  |

15 nasaortho.out2 (abridged)  
shift = 2.495, 564 negative roots

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |                            |
|---|--------------|---------------|---------------|--------|----------------------------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root                       |
| 1   | 2.492601E+00 | 2.492601E+00  | 0.000000E+00  | 84273  | 562                        |
| 2   | 2.494194E+00 | 2.494194E+00  | 0.000000E+00  | 30411  | 563                        |
| 3   | 2.494967E+00 | 2.494967E+00  | 0.000000E+00  | 52647  | 564                        |
| 4   | 2.495429E+00 | 2.495429E+00  | 0.000000E+00  | 116697 | 565                        |
| 5   | 2.495716E+00 | 2.495716E+00  | 0.000000E+00  | 53955  | 566                        |
| 6   | 2.495878E+00 | 2.495878E+00  | 0.000000E+00  | 93009  | 567                        |
| 7   | 2.496408E+00 | 2.496408E+00  | 0.000000E+00  | 29103  | 568                        |
| 8   | 2.498247E+00 | 2.498247E+00  | 0.000000E+00  | 6405   | 569 <--inter-ring buckling |

16 nasaortho.out2 (abridged)  
shift = 2.502, 572 negative roots

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |      |
|---|--------------|---------------|---------------|--------|------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1   | 2.498247E+00 | 2.498247E+00  | 0.000000E+00  | 65265  | 569  |
| 2   | 2.498879E+00 | 2.498879E+00  | 0.000000E+00  | 115641 | 570  |
| 3   | 2.500772E+00 | 2.500772E+00  | 0.000000E+00  | 102465 | 571  |
| 4   | 2.500882E+00 | 2.500882E+00  | 0.000000E+00  | 84297  | 572  |
| 5   | 2.503694E+00 | 2.503694E+00  | 0.000000E+00  | 27531  | 573  |
| 6   | 2.505069E+00 | 2.505069E+00  | 0.000000E+00  | 31455  | 574  |
| 7   | 2.505231E+00 | 2.505231E+00  | 0.000000E+00  | 102009 | 575  |
| 8   | 2.506501E+00 | 2.506501E+00  | 0.000000E+00  | 15759  | 576  |

17 nasaortho.out2 (abridged)  
shift = 2.510, 577 negative roots

MAXIMUM NUMBER OF ITERATIONS

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 7<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |      |
|---|--------------|---------------|---------------|--------|------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1   | 2.506501E+00 | 2.506501E+00  | 0.000000E+00  | 16287  | 576  |
| 2   | 2.506670E+00 | 2.506670E+00  | 0.000000E+00  | 31983  | 577  |
| 3   | 2.511095E+00 | 2.511095E+00  | 0.000000E+00  | 64419  | 578  |
| 4   | 2.512566E+00 | 2.512566E+00  | 0.000000E+00  | 76113  | 579  |
| 5   | 2.513121E+00 | 2.513121E+00  | 0.000000E+00  | 117009 | 580  |
| 6   | 2.513798E+00 | 2.513798E+00  | 0.000000E+00  | 84297  | 581  |
| 7   | 2.514389E+00 | 2.514389E+00  | 0.000000E+00  | 9219   | 582  |

18 nasaortho.out2 (abridged)  
shift = 2.516, 584 negative roots

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |            |               |               |      |      |
|---|------------|---------------|---------------|------|------|
| NO.   | EIGENVALUE | LOAD SYSTEM A | LOAD SYSTEM B | @DOF | root |

Table 44 (P5 of 9)

|   |              |              |              |        |     |
|---|--------------|--------------|--------------|--------|-----|
| 1 | 2.512566E+00 | 2.512566E+00 | 0.000000E+00 | 139689 | 579 |
| 2 | 2.513121E+00 | 2.513121E+00 | 0.000000E+00 | 140553 | 580 |
| 3 | 2.513798E+00 | 2.513798E+00 | 0.000000E+00 | 131505 | 581 |
| 4 | 2.514389E+00 | 2.514389E+00 | 0.000000E+00 | 62067  | 582 |
| 5 | 2.514655E+00 | 2.514655E+00 | 0.000000E+00 | 2679   | 583 |
| 6 | 2.515517E+00 | 2.515517E+00 | 0.000000E+00 | 101553 | 584 |
| 7 | 2.517354E+00 | 2.517354E+00 | 0.000000E+00 | 101025 | 585 |
| 8 | 2.520306E+00 | 2.520306E+00 | 0.000000E+00 | 75345  | 586 |

19 nasaortho.out2 (abridged)

|    |   |                |                |                |
|----|---|----------------|----------------|----------------|
| 22 | 1 | 0.24876748E+01 | 0.13654749E-11 | 0.24876748E+01 |
| 22 | 2 | 0.24872883E+01 | 0.00000000E+00 | 0.24872883E+01 |
| 22 | 3 | 0.24889886E+01 | 0.75019751E-10 | 0.24889886E+01 |
| 22 | 4 | 0.24869556E+01 | 0.00000000E+00 | 0.24869556E+01 |
| 22 | 5 | 0.24866234E+01 | 0.32260891E-12 | 0.24866234E+01 |
| 22 | 6 | 0.24862739E+01 | 0.13280911E+00 | 0.24865032E+01 |
| 22 | 7 | 0.24855822E+01 | 0.15612487E-10 | 0.24855822E+01 |

| ITERATION | VECTOR | EIGENVALUE     | RELATIVE ERROR |                |
|-----------|--------|----------------|----------------|----------------|
| 22        | 8      | 0.24915653E+01 | 0.94440636E-08 | 0.24915653E+01 |
| 22        | 9      | 0.24926009E+01 | 0.55179742E-05 | 0.24926009E+01 |
| 22        | 10     | 0.24818281E+01 | 0.21115141E-04 | 0.24818282E+01 |
| 22        | 11     | 0.24942040E+01 | 0.35644475E-03 | 0.24942062E+01 |
| 22        | 12     | 0.24947629E+01 | 0.26637502E+01 | 0.24767483E+01 |
| 22        | 13     | 0.24957332E+01 | 0.41262707E-01 | 0.24960523E+01 |
| 22        | 14     | 0.24790130E+01 | 0.78323438E-01 | 0.24797169E+01 |
| 22        | 15     | 0.24972246E+01 | 0.16747755E+00 | 0.24956797E+01 |
| 22        | 16     | 0.24990399E+01 | 0.22320682E-01 | 0.24992863E+01 |
| 22        | 17     | 0.24756146E+01 | 0.17059476E+00 | 0.24777275E+01 |

shift = 2.488, 559 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 5

CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 6 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root             |
|-----|--------------|---------------|---------------|--------|------------------|
| 1   | 2.485582E+00 | 2.485582E+00  | 0.000000E+00  | 78177  | 555              |
| 2   | 2.486274E+00 | 2.486274E+00  | 0.000000E+00  | 56787  | <--not converged |
| 3   | 2.486623E+00 | 2.486623E+00  | 0.000000E+00  | 76185  | 556              |
| 4   | 2.486956E+00 | 2.486956E+00  | 0.000000E+00  | 76017  | 557              |
| 5   | 2.487288E+00 | 2.487288E+00  | 0.000000E+00  | 125697 | 558              |
| 6   | 2.487675E+00 | 2.487675E+00  | 0.000000E+00  | 92529  | 559              |
| 7   | 2.488989E+00 | 2.488989E+00  | 0.000000E+00  | 74289  | 560              |
| 8   | 2.491565E+00 | 2.491565E+00  | 0.000000E+00  | 131289 | 561              |

20 nasaortho.out2 (abridged)

shift = 2.48, 553 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 7

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root                       |
|-----|--------------|---------------|---------------|--------|----------------------------|
| 1   | 2.476793E+00 | 2.476793E+00  | 0.000000E+00  | 56787  | 548                        |
| 2   | 2.476934E+00 | 2.476934E+00  | 0.000000E+00  | 131289 | 549                        |
| 3   | 2.477579E+00 | 2.477579E+00  | 0.000000E+00  | 14715  | 550                        |
| 4   | 2.477732E+00 | 2.477732E+00  | 0.000000E+00  | 63375  | 551                        |
| 5   | 2.477755E+00 | 2.477755E+00  | 0.000000E+00  | 7911   | 552                        |
| 6   | 2.479450E+00 | 2.479450E+00  | 0.000000E+00  | 64755  | 553 <--inter-ring buckling |
| 7   | 2.481828E+00 | 2.481828E+00  | 0.000000E+00  | 74961  | 554                        |

21 nasaortho.out2 (bridged)

shift = 2.47, 544 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 7

CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 8 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF  | root |
|-----|--------------|---------------|---------------|-------|------|
| 1   | 2.464007E+00 | 2.464007E+00  | 0.000000E+00  | 15759 | 541  |
| 2   | 2.464804E+00 | 2.464804E+00  | 0.000000E+00  | 29367 | 542  |
| 3   | 2.469610E+00 | 2.469610E+00  | 0.000000E+00  | 2943  | 543  |
| 4   | 2.469767E+00 | 2.469767E+00  | 0.000000E+00  | 68127 | 544  |
| 5   | 2.472669E+00 | 2.472669E+00  | 0.000000E+00  | 82665 | 545  |
| 6   | 2.473381E+00 | 2.473381E+00  | 0.000000E+00  | 38043 | 546  |
| 7   | 2.475022E+00 | 2.475022E+00  | 0.000000E+00  | 26271 | 547  |
| 8   | 2.476799E+00 | 2.476799E+00  | 0.000000E+00  | 56787 | 548  |

# Table 44 (p. 6 of 9)

22 nasaortho.out2 (abridged)  
 shift = 2.46, 537 negative roots

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |       |      |
|---|--------------|---------------|---------------|-------|------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF  | root |
| 1   | 2.456720E+00 | 2.456720E+00  | 0.000000E+00  | 75873 | 534  |
| 2   | 2.456836E+00 | 2.456836E+00  | 0.000000E+00  | 94137 | 535  |
| 3   | 2.457148E+00 | 2.457148E+00  | 0.000000E+00  | 31719 | 536  |
| 4   | 2.457474E+00 | 2.457474E+00  | 0.000000E+00  | 92889 | 537  |
| 5   | 2.462008E+00 | 2.462008E+00  | 0.000000E+00  | 31983 | 538  |
| 6   | 2.462307E+00 | 2.462307E+00  | 0.000000E+00  | 75681 | 539  |
| 7   | 2.462923E+00 | 2.462923E+00  | 0.000000E+00  | 20211 | 540  |
| 8   | 2.464007E+00 | 2.464007E+00  | 0.000000E+00  | 15759 | 541  |

23 nasaortho.out2 (abridged)  
 shift = 2.453, 531 negative roots

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |                            |
|---|--------------|---------------|---------------|--------|----------------------------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   |                            |
| 1   | 2.449622E+00 | 2.449622E+00  | 0.000000E+00  | 116865 | 528                        |
| 2   | 2.451951E+00 | 2.451951E+00  | 0.000000E+00  | 113769 | 529                        |
| 3   | 2.452034E+00 | 2.452034E+00  | 0.000000E+00  | 6213   | 530 <--inter-ring buckling |
| 4   | 2.452906E+00 | 2.452906E+00  | 0.000000E+00  | 122025 | 531                        |
| 5   | 2.453282E+00 | 2.453282E+00  | 0.000000E+00  | 82977  | 532                        |
| 6   | 2.455348E+00 | 2.455348E+00  | 0.000000E+00  | 42399  | 533                        |
| 7   | 2.456720E+00 | 2.456720E+00  | 0.000000E+00  | 92841  | 534                        |
| 8   | 2.456836E+00 | 2.456836E+00  | 0.000000E+00  | 94137  | 535                        |

24 nasaortho.out2 (abridged)  
 shift = 2.448, 525 negative roots

MAXIMUM NUMBER OF ITERATIONS

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 7<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |      |
|---|--------------|---------------|---------------|--------|------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1   | 2.445086E+00 | 2.445086E+00  | 0.000000E+00  | 115689 | 522  |
| 2   | 2.446401E+00 | 2.446401E+00  | 0.000000E+00  | 75057  | 523  |
| 3   | 2.446626E+00 | 2.446626E+00  | 0.000000E+00  | 75249  | 524  |
| 4   | 2.447011E+00 | 2.447011E+00  | 0.000000E+00  | 117561 | 525  |
| 5   | 2.448442E+00 | 2.448442E+00  | 0.000000E+00  | 65727  | 526  |
| 6   | 2.448577E+00 | 2.448577E+00  | 0.000000E+00  | 5775   | 527  |
| 7   | 2.449622E+00 | 2.449622E+00  | 0.000000E+00  | 140793 | 528  |

25 nasaortho.out2 (abridged)

|    |   |                |                |                |
|----|---|----------------|----------------|----------------|
| 22 | 1 | 0.24403496E+01 | 0.33956561E+02 | 0.24284798E+01 |
| 22 | 2 | 0.24418325E+01 | 0.00000000E+00 | 0.24418325E+01 |
| 22 | 3 | 0.24358749E+01 | 0.15111493E-07 | 0.24358749E+01 |
| 22 | 4 | 0.24443733E+01 | 0.14361051E-07 | 0.24443733E+01 |
| 22 | 5 | 0.24450856E+01 | 0.13820242E-07 | 0.24450856E+01 |
| 22 | 6 | 0.24464002E+01 | 0.64741633E-04 | 0.24464006E+01 |
| 22 | 7 | 0.24334861E+01 | 0.94255871E-04 | 0.24334855E+01 |
| 22 | 8 | 0.24466181E+01 | 0.12267851E-02 | 0.24466262E+01 |

shift = 2.440, 519 negative roots

MAXIMUM NUMBER OF ITERATIONS

| CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |                            |
|--|--------------|---------------|---------------|--------|----------------------------|
| NO.  | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root                       |
| 1  | 2.433486E+00 | 2.433486E+00  | 0.000000E+00  | 116145 | 518                        |
| 2  | 2.435875E+00 | 2.435875E+00  | 0.000000E+00  | 5997   | 519 <--inter-ring buckling |
| 3  | 2.440350E+00 | 2.440350E+00  | 0.000000E+00  | 7083   | <--not converged           |
| 4  | 2.441833E+00 | 2.441833E+00  | 0.000000E+00  | 74817  | 520                        |
| 5  | 2.444373E+00 | 2.444373E+00  | 0.000000E+00  | 115689 | 521                        |
| 6  | 2.445086E+00 | 2.445086E+00  | 0.000000E+00  | 115689 | 522                        |
| 7  | 2.446400E+00 | 2.446400E+00  | 0.000000E+00  | 75345  | 523                        |
| 8  | 2.446618E+00 | 2.446618E+00  | 0.000000E+00  | 135753 | <--not converged           |

26 nasaortho.out2 (abridged)

shift = 2.432, 514 negative roots

| CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8<br>CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |      |
|---|--------------|---------------|---------------|--------|------|
| NO.   | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1   | 2.431235E+00 | 2.431235E+00  | 0.000000E+00  | 74193  | 511  |
| 2   | 2.431312E+00 | 2.431312E+00  | 0.000000E+00  | 139593 | 512  |

Table 44 (p. 749)

|   |              |              |              |        |     |                        |
|---|--------------|--------------|--------------|--------|-----|------------------------|
| 3 | 2.431432E+00 | 2.431432E+00 | 0.000000E+00 | 6261   | 513 | <--inter-ring buckling |
| 4 | 2.431860E+00 | 2.431860E+00 | 0.000000E+00 | 61779  | 514 |                        |
| 5 | 2.432114E+00 | 2.432114E+00 | 0.000000E+00 | 141609 | 515 |                        |
| 6 | 2.432183E+00 | 2.432183E+00 | 0.000000E+00 | 9459   | 516 |                        |
| 7 | 2.433165E+00 | 2.433165E+00 | 0.000000E+00 | 39351  | 517 |                        |
| 8 | 2.433486E+00 | 2.433486E+00 | 0.000000E+00 | 74289  | 518 |                        |

27 nasaortho.out2 (abridged)

shift = 2428, 505 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF  | root |
|-----|--------------|---------------|---------------|-------|------|
| 1   | 2.425375E+00 | 2.425375E+00  | 0.000000E+00  | 82233 | 503  |
| 2   | 2.426506E+00 | 2.426506E+00  | 0.000000E+00  | 68367 | 504  |
| 3   | 2.427146E+00 | 2.427146E+00  | 0.000000E+00  | 76449 | 505  |
| 4   | 2.428146E+00 | 2.428146E+00  | 0.000000E+00  | 74241 | 506  |
| 5   | 2.428747E+00 | 2.428747E+00  | 0.000000E+00  | 28011 | 507  |
| 6   | 2.428989E+00 | 2.428989E+00  | 0.000000E+00  | 92721 | 508  |
| 7   | 2.430052E+00 | 2.430052E+00  | 0.000000E+00  | 33003 | 509  |
| 8   | 2.430066E+00 | 2.430066E+00  | 0.000000E+00  | 19947 | 510  |

28 nasaortho.out2 (abridged)

shift = 2.420, 499 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.414980E+00 | 2.414980E+00  | 0.000000E+00  | 139785 | 496  |
| 2   | 2.415638E+00 | 2.415638E+00  | 0.000000E+00  | 101721 | 497  |
| 3   | 2.416739E+00 | 2.416739E+00  | 0.000000E+00  | 64443  | 498  |
| 4   | 2.416796E+00 | 2.416796E+00  | 0.000000E+00  | 6891   | 499  |
| 5   | 2.422104E+00 | 2.422104E+00  | 0.000000E+00  | 26511  | 500  |
| 6   | 2.423213E+00 | 2.423213E+00  | 0.000000E+00  | 124833 | 501  |
| 7   | 2.424509E+00 | 2.424509E+00  | 0.000000E+00  | 56547  | 502  |
| 8   | 2.425376E+00 | 2.425376E+00  | 0.000000E+00  | 133569 | 503  |

29 nasaortho.out2 (abridged)

|          |    |                |                |                |
|----------|----|----------------|----------------|----------------|
| 22       | 1  | 0.24089202E+01 | 0.20563473E-11 | 0.24089202E+01 |
| 22       | 2  | 0.24085683E+01 | 0.16823494E+04 | 0.00000000E+00 |
| 22       | 3  | 0.24069299E+01 | 0.45303756E-09 | 0.24069299E+01 |
| 22       | 4  | 0.24068633E+01 | 0.22169605E-07 | 0.24068633E+01 |
| 22       | 5  | 0.24133638E+01 | 0.12726835E-07 | 0.24133638E+01 |
| 22       | 6  | 0.24061615E+01 | 0.47776985E-06 | 0.24061615E+01 |
| 22       | 7  | 0.24053647E+01 | 0.27354157E-05 | 0.24053647E+01 |
| 22       | 8  | 0.24052494E+01 | 0.20687472E-04 | 0.24052493E+01 |
| root 496 | 22 | 9              | 0.24149796E+01 | 0.54295356E-04 |
| root 497 | 22 | 10             | 0.24156378E+01 | 0.81583410E-04 |

shift = 2.410, 494 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 1

CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 2 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root             |
|-----|--------------|---------------|---------------|--------|------------------|
| 1   | 2.405249E+00 | 2.405249E+00  | 0.000000E+00  | 106521 | 489              |
| 2   | 2.405365E+00 | 2.405365E+00  | 0.000000E+00  | 40851  | 490              |
| 3   | 2.406162E+00 | 2.406162E+00  | 0.000000E+00  | 42159  | 491              |
| 4   | 2.406863E+00 | 2.406863E+00  | 0.000000E+00  | 53931  | 492              |
| 5   | 2.406930E+00 | 2.406930E+00  | 0.000000E+00  | 40851  | 493              |
| 6   | 2.408568E+00 | 2.408568E+00  | 0.000000E+00  | 64299  | <--not converged |
| 7   | 2.408920E+00 | 2.408920E+00  | 0.000000E+00  | 107097 | 494              |
| 8   | 2.413364E+00 | 2.413364E+00  | 0.000000E+00  | 76665  | 495              |

30 nasaortho.out2 (abridged)

shift = 2.40, 485 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.396908E+00 | 2.396908E+00  | 0.000000E+00  | 75849  | 483  |
| 2   | 2.398325E+00 | 2.398325E+00  | 0.000000E+00  | 75417  | 484  |
| 3   | 2.399135E+00 | 2.399135E+00  | 0.000000E+00  | 74721  | 485  |
| 4   | 2.400553E+00 | 2.400553E+00  | 0.000000E+00  | 46395  | 486  |
| 5   | 2.402624E+00 | 2.402624E+00  | 0.000000E+00  | 101745 | 487  |
| 6   | 2.403723E+00 | 2.403723E+00  | 0.000000E+00  | 99657  | 488  |
| 7   | 2.405249E+00 | 2.405249E+00  | 0.000000E+00  | 106521 | 489  |

Table 44 (p 8 of 9)

8 2.405365E+00 2.405365E+00 0.000000E+00 40851 490

31 nasaortho.out2 (abridged)

shift = 2.39, 477 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF  | root |
|-----|--------------|---------------|---------------|-------|------|
| 1   | 2.386827E+00 | 2.386827E+00  | 0.000000E+00  | 33027 | 474  |
| 2   | 2.387407E+00 | 2.387407E+00  | 0.000000E+00  | 65727 | 475  |
| 3   | 2.387614E+00 | 2.387614E+00  | 0.000000E+00  | 65727 | 476  |
| 4   | 2.389079E+00 | 2.389079E+00  | 0.000000E+00  | 74481 | 477  |
| 5   | 2.390072E+00 | 2.390072E+00  | 0.000000E+00  | 50031 | 478  |
| 6   | 2.390227E+00 | 2.390227E+00  | 0.000000E+00  | 26487 | 479  |
| 7   | 2.390274E+00 | 2.390274E+00  | 0.000000E+00  | 76665 | 480  |
| 8   | 2.391208E+00 | 2.391208E+00  | 0.000000E+00  | 33027 | 481  |

32 nasaortho.out2 (abridged) Needed to capture root no. 482, which was missed last time.

ITERATION VECTOR EIGENVALUE RELATIVE ERROR

|    |   |                |                |                |
|----|---|----------------|----------------|----------------|
| 22 | 1 | 0.23932728E+01 | 0.00000000E+00 | 0.23932728E+01 |
| 22 | 2 | 0.23912080E+01 | 0.11151709E-10 | 0.23912080E+01 |
| 22 | 3 | 0.23948278E+01 | 0.49388741E+01 | 0.24038548E+01 |
| 22 | 4 | 0.23902738E+01 | 0.14857727E-08 | 0.23902738E+01 |
| 22 | 5 | 0.23902269E+01 | 0.15125050E-07 | 0.23902269E+01 |
| 22 | 6 | 0.23900722E+01 | 0.10452079E-07 | 0.23900722E+01 |
| 22 | 7 | 0.23969083E+01 | 0.21221463E-06 | 0.23969083E+01 |
| 22 | 8 | 0.23890789E+01 | 0.17192505E-07 | 0.23890789E+01 |

shift = 2.393, 481 negative roots

MAXIMUM NUMBER OF ITERATIONS

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 2

CONVERGENCE CRITERION HAS NOT BEEN SATISFIED FOR EIGENVALUES 3 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root              |
|-----|--------------|---------------|---------------|--------|-------------------|
| 1   | 2.389079E+00 | 2.389079E+00  | 0.000000E+00  | 75921  | 477               |
| 2   | 2.390072E+00 | 2.390072E+00  | 0.000000E+00  | 21255  | 478               |
| 3   | 2.390227E+00 | 2.390227E+00  | 0.000000E+00  | 44799  | 479               |
| 4   | 2.390274E+00 | 2.390274E+00  | 0.000000E+00  | 76665  | 480               |
| 5   | 2.391208E+00 | 2.391208E+00  | 0.000000E+00  | 33027  | 481               |
| 6   | 2.393273E+00 | 2.393273E+00  | 0.000000E+00  | 74481  | 482               |
| 7   | 2.394828E+00 | 2.394828E+00  | 0.000000E+00  | 123537 | <-- not converged |
| 8   | 2.396908E+00 | 2.396908E+00  | 0.000000E+00  | 74553  | 483               |

33 nasaortho.out2 (abridged)

shift = 2.38, 465 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.378909E+00 | 2.378909E+00  | 0.000000E+00  | 75345  | 463  |
| 2   | 2.379069E+00 | 2.379069E+00  | 0.000000E+00  | 75489  | 464  |
| 3   | 2.379979E+00 | 2.379979E+00  | 0.000000E+00  | 26487  | 465  |
| 4   | 2.380436E+00 | 2.380436E+00  | 0.000000E+00  | 63111  | 466  |
| 5   | 2.381824E+00 | 2.381824E+00  | 0.000000E+00  | 125409 | 467  |
| 6   | 2.381832E+00 | 2.381832E+00  | 0.000000E+00  | 140889 | 468  |
| 7   | 2.382045E+00 | 2.382045E+00  | 0.000000E+00  | 99537  | 469  |
| 8   | 2.382160E+00 | 2.382160E+00  | 0.000000E+00  | 9483   | 470  |

34 nasaortho.out2 (abridged) (to go back and capture roots 471, 472, 473

shift = 2.383, 470 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.380436E+00 | 2.380436E+00  | 0.000000E+00  | 63111  | 466  |
| 2   | 2.381824E+00 | 2.381824E+00  | 0.000000E+00  | 91401  | 467  |
| 3   | 2.381832E+00 | 2.381832E+00  | 0.000000E+00  | 140889 | 468  |
| 4   | 2.382045E+00 | 2.382045E+00  | 0.000000E+00  | 117849 | 469  |
| 5   | 2.382160E+00 | 2.382160E+00  | 0.000000E+00  | 9483   | 470  |
| 6   | 2.384607E+00 | 2.384607E+00  | 0.000000E+00  | 76449  | 471  |
| 7   | 2.384750E+00 | 2.384750E+00  | 0.000000E+00  | 99993  | 472  |
| 8   | 2.385578E+00 | 2.385578E+00  | 0.000000E+00  | 75801  | 473  |

35 nasaortho.out2 (abridged)

shift = 2.373, 456 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

Table 44 (p. 9 of 9)

| CRITICAL LOAD FACTOR COMBINATION |              |               |               |        |      |
|----------------------------------|--------------|---------------|---------------|--------|------|
| NO.                              | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
| 1                                | 2.371452E+00 | 2.371452E+00  | 0.000000E+00  | 139641 | 455  |
| 2                                | 2.371559E+00 | 2.371559E+00  | 0.000000E+00  | 74241  | 456  |
| 3                                | 2.373095E+00 | 2.373095E+00  | 0.000000E+00  | 97929  | 457  |
| 4                                | 2.374368E+00 | 2.374368E+00  | 0.000000E+00  | 40875  | 458  |
| 5                                | 2.374415E+00 | 2.374415E+00  | 0.000000E+00  | 52647  | 459  |
| 6                                | 2.374665E+00 | 2.374665E+00  | 0.000000E+00  | 18639  | 460  |
| 7                                | 2.375268E+00 | 2.375268E+00  | 0.000000E+00  | 42183  | 461  |
| 8                                | 2.375703E+00 | 2.375703E+00  | 0.000000E+00  | 82377  | 462  |

NOTE: THE FOLLOWING STAGS RUNS WERE MADE AFTER THE "SMALL" STAGS MODEL WAS CONSTRUCTED AND THE GENERAL BUCKLING MODE FOUND FROM THAT "SMALL" MODEL. THE RESULTS FROM THE "SMALL" MODEL STUDY ARE GIVEN IN TABLES 45 - 48 AND FIGURES 36 - 45. FROM THOSE RESULTS WE KNOW WE SHOULD EXPLORE MORE IN THE HIGH-EIGENVALUE RANGE WITH USE OF THE 60-DEGREE X 6 RING BAY STAGS MODEL.

36 nasaortho.out2 (abridged)

shift = 2.600, 648 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.594791E+00 | 2.594791E+00  | 0.000000E+00  | 83793  | 644  |
| 2   | 2.595351E+00 | 2.595351E+00  | 0.000000E+00  | 33147  | 645  |
| 3   | 2.597101E+00 | 2.597101E+00  | 0.000000E+00  | 50343  | 646  |
| 4   | 2.597951E+00 | 2.597951E+00  | 0.000000E+00  | 74289  | 647  |
| 5   | 2.598945E+00 | 2.598945E+00  | 0.000000E+00  | 15027  | 648  |
| 6   | 2.600388E+00 | 2.600388E+00  | 0.000000E+00  | 31887  | 649  |
| 7   | 2.602196E+00 | 2.602196E+00  | 0.000000E+00  | 132105 | 650  |
| 8   | 2.603086E+00 | 2.603086E+00  | 0.000000E+00  | 93657  | 651  |

37 nasaortho.out2 (abridged)

shift = 2.595, 644 negative roots (go back to find roots 640-644)  
roots 640 and 641 still missing)

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.590814E+00 | 2.590814E+00  | 0.000000E+00  | 98097  | 642  |
| 2   | 2.592667E+00 | 2.592667E+00  | 0.000000E+00  | 132969 | 643  |
| 3   | 2.594791E+00 | 2.594791E+00  | 0.000000E+00  | 83793  | 644  |
| 4   | 2.595351E+00 | 2.595351E+00  | 0.000000E+00  | 33339  | 645  |
| 5   | 2.597101E+00 | 2.597101E+00  | 0.000000E+00  | 21279  | 646  |
| 6   | 2.597951E+00 | 2.597951E+00  | 0.000000E+00  | 76113  | 647  |
| 7   | 2.598945E+00 | 2.598945E+00  | 0.000000E+00  | 15027  | 648  |
| 8   | 2.600388E+00 | 2.600388E+00  | 0.000000E+00  | 39327  | 649  |

38 nasaortho.out2 (abridged)

shift = 2.590, 641 negative roots (go back to find roots 640 & 641)

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.587624E+00 | 2.587624E+00  | 0.000000E+00  | 74985  | 635  |
| 2   | 2.587676E+00 | 2.587676E+00  | 0.000000E+00  | 30363  | 636  |
| 3   | 2.588239E+00 | 2.588239E+00  | 0.000000E+00  | 52599  | 637  |
| 4   | 2.588525E+00 | 2.588525E+00  | 0.000000E+00  | 132561 | 638  |
| 5   | 2.588745E+00 | 2.588745E+00  | 0.000000E+00  | 52599  | 639  |
| 6   | 2.589102E+00 | 2.589102E+00  | 0.000000E+00  | 42135  | 640  |
| 7   | 2.589410E+00 | 2.589410E+00  | 0.000000E+00  | 114057 | 641  |
| 8   | 2.590814E+00 | 2.590814E+00  | 0.000000E+00  | 98097  | 642  |

39 nasaortho.out2 (abridged)

shift = 2.606, 654 negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

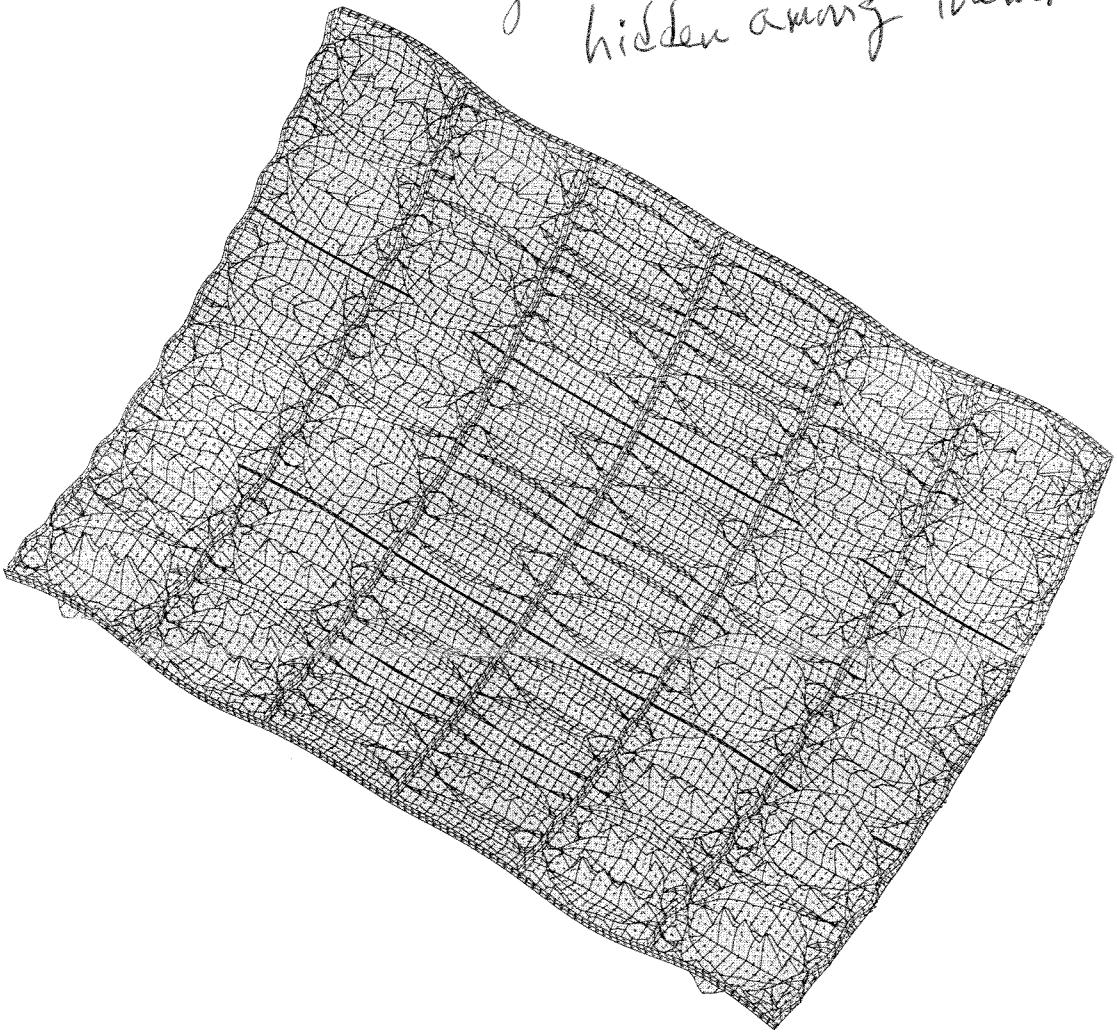
CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF   | root |
|-----|--------------|---------------|---------------|--------|------|
| 1   | 2.603086E+00 | 2.603086E+00  | 0.000000E+00  | 122145 | 651  |
| 2   | 2.605339E+00 | 2.605339E+00  | 0.000000E+00  | 131385 | 652  |
| 3   | 2.605610E+00 | 2.605610E+00  | 0.000000E+00  | 65679  | 653  |
| 4   | 2.605843E+00 | 2.605843E+00  | 0.000000E+00  | 6819   | 654  |
| 5   | 2.607102E+00 | 2.607102E+00  | 0.000000E+00  | 3255   | 655  |
| 6   | 2.607272E+00 | 2.607272E+00  | 0.000000E+00  | 2631   | 656  |
| 7   | 2.608130E+00 | 2.608130E+00  | 0.000000E+00  | 84033  | 657  |
| 8   | 2.608979E+00 | 2.608979E+00  | 0.000000E+00  | 149761 | 658  |

<--general buckling at last!

See Fig. 46

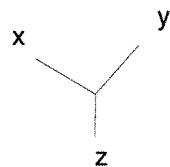
There are lots of  
 local buckling modes like this!  
 They make it hard to find the one  
 critical general buckling mode  
 hidden among them.



solution scale = 0.4589E+01  
 mode 1, pcr = 0.24946E+01  
 step 0 eigenvector deformed geometry  
 linear buckling of perfect shell from STAGS

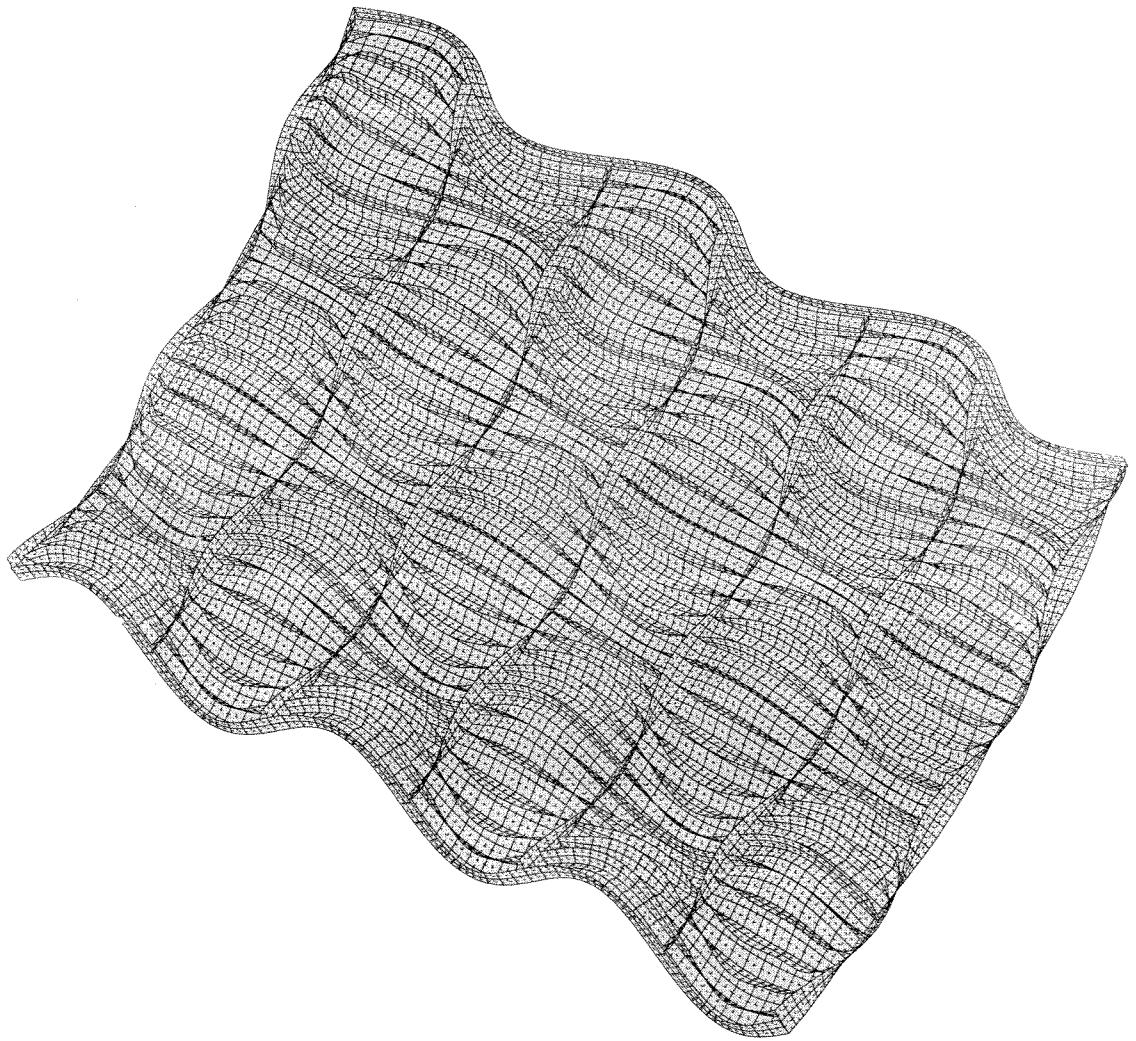
$\Theta_x$  -35.84  
 $\Theta_y$  -179.86  
 $\Theta_z$  35.63

1.336E+01



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Fig.36

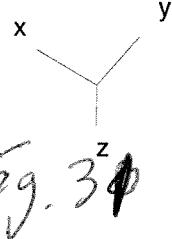


solution scale = 0.4264E+01  
mode 8, pcr = 0.24982E+01  
step 0 eigenvector deformed geometry  
linear buckling of perfect shell from STAGS

Compare Fig. 28

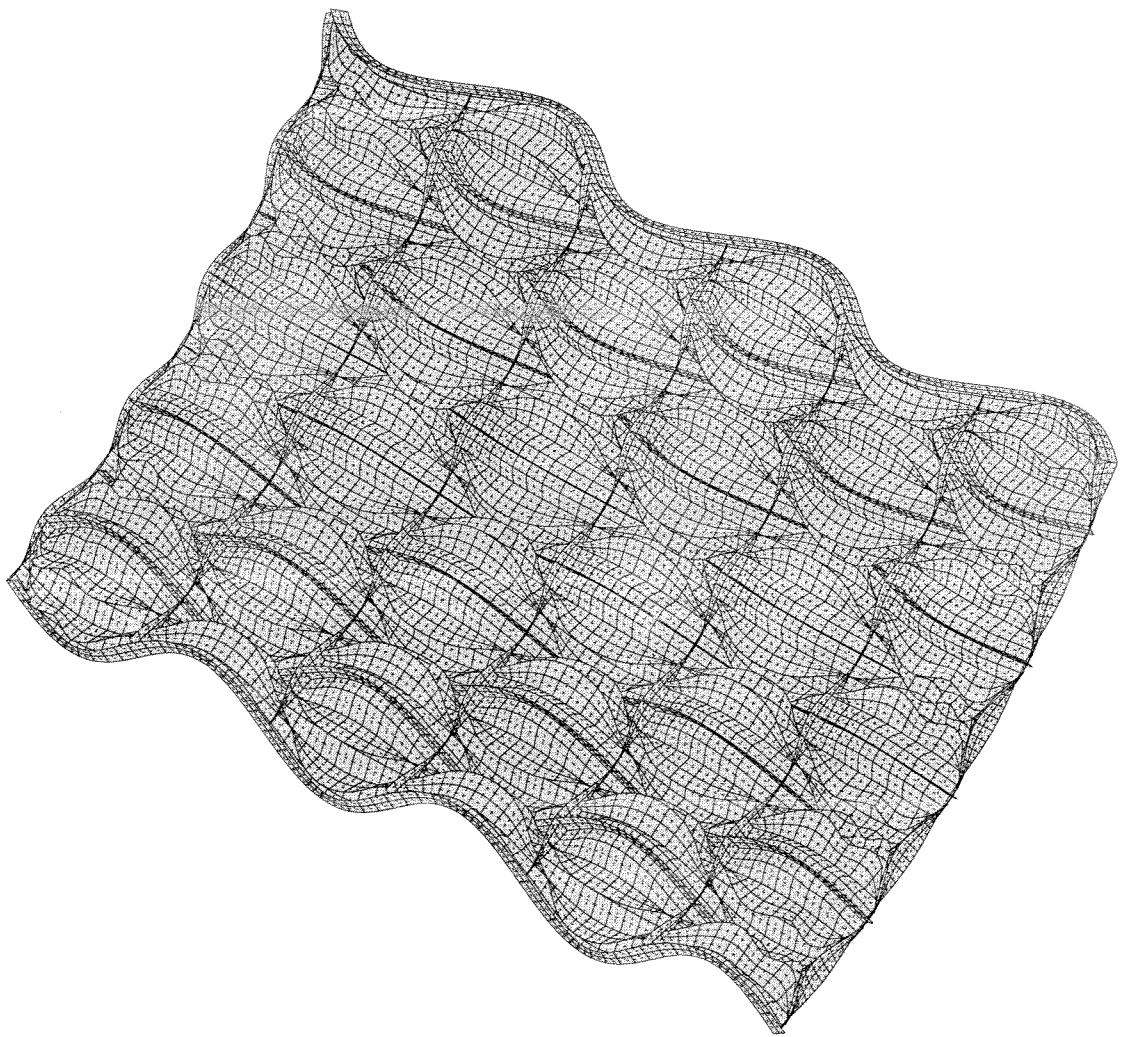
$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

$1.336E+01$



118

Fig. 34



solution scale = 0.4208E+01  
 mode 6, pcr = 0.24795E+01 ← compare Fig. 28  
 step 0 eigenvector deformed geometry  
 linear buckling of perfect shell from STAGS

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$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

1.336E+01

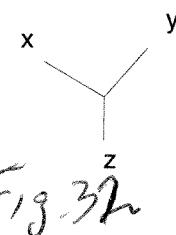
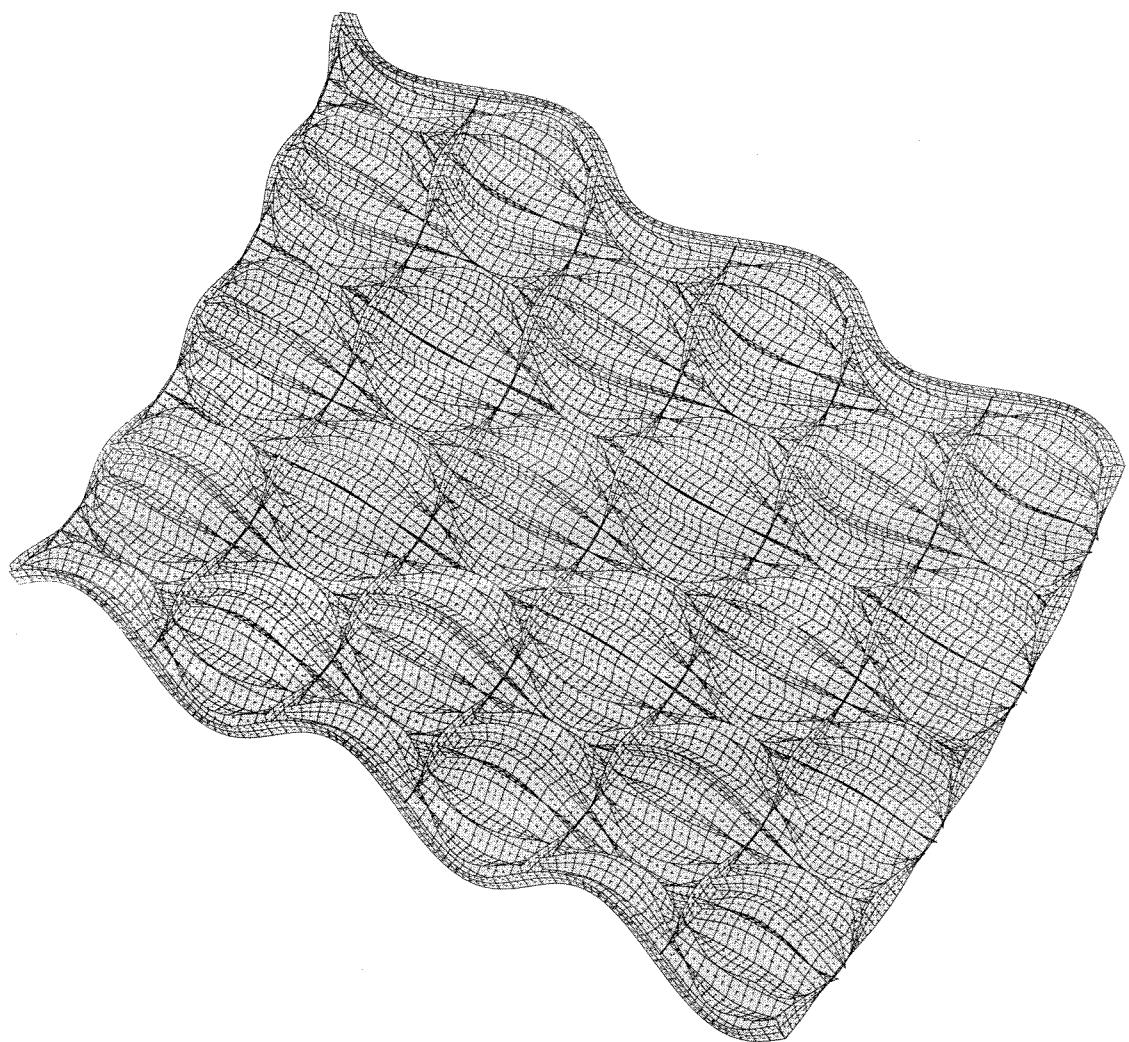


Fig. 32n



solution scale =  $0.4203E+01$

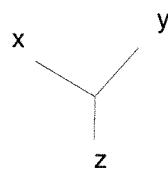
mode 3,  $p_{cr} = 0.24520E+01$

step 0 eigenvector deformed geometry  
linear buckling of perfect shell from STAGS

compare with Fig.28

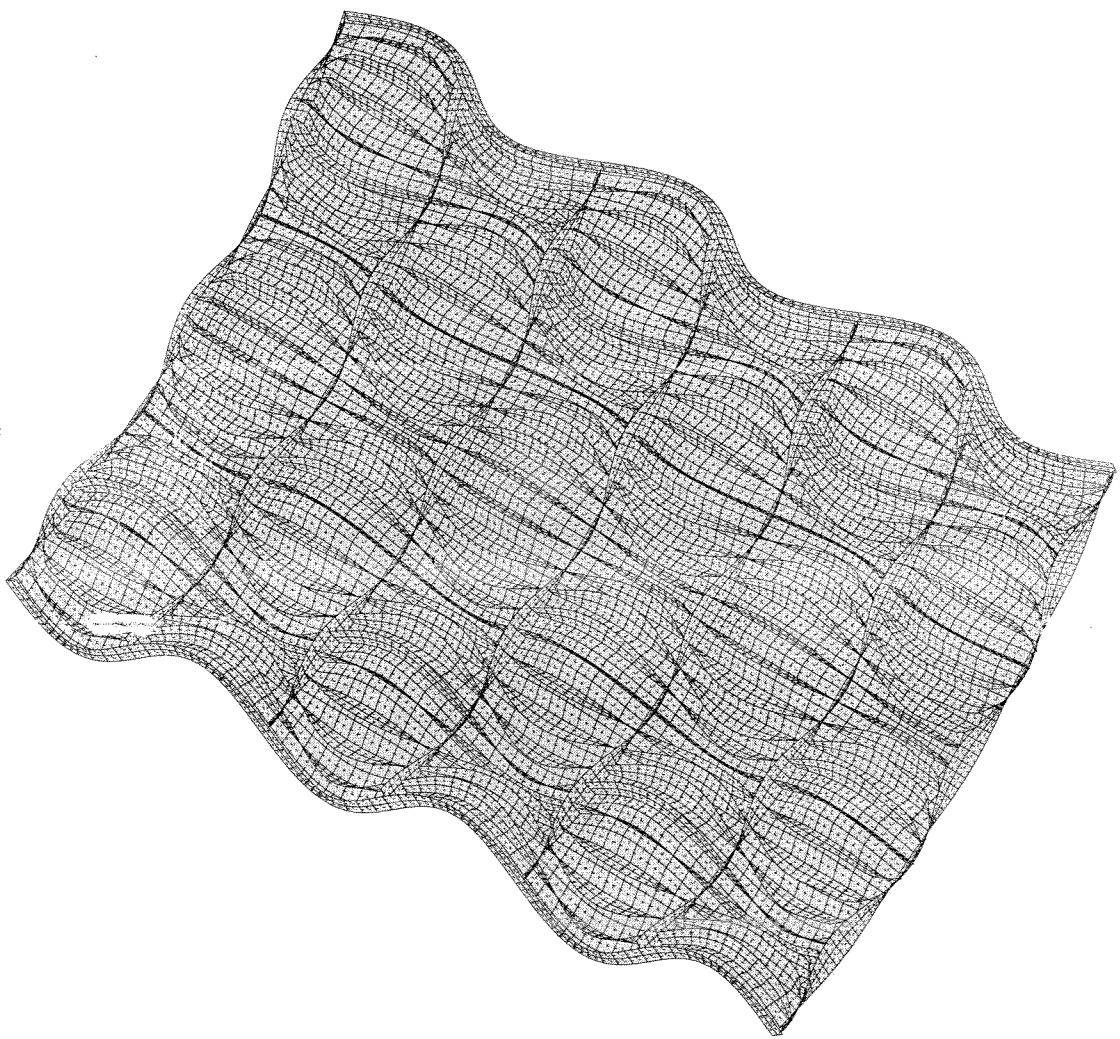
$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

$1.336E+01$



120

Fig. 33a



solution scale = 0.4192E+01

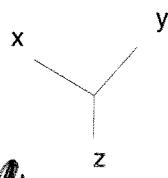
mode 2, |pcr = 0.24359E+01

step 0 eigenvector deformed geometry  
linear buckling of perfect shell from STAGS

compare with Fig. 28

$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

1.336E+01

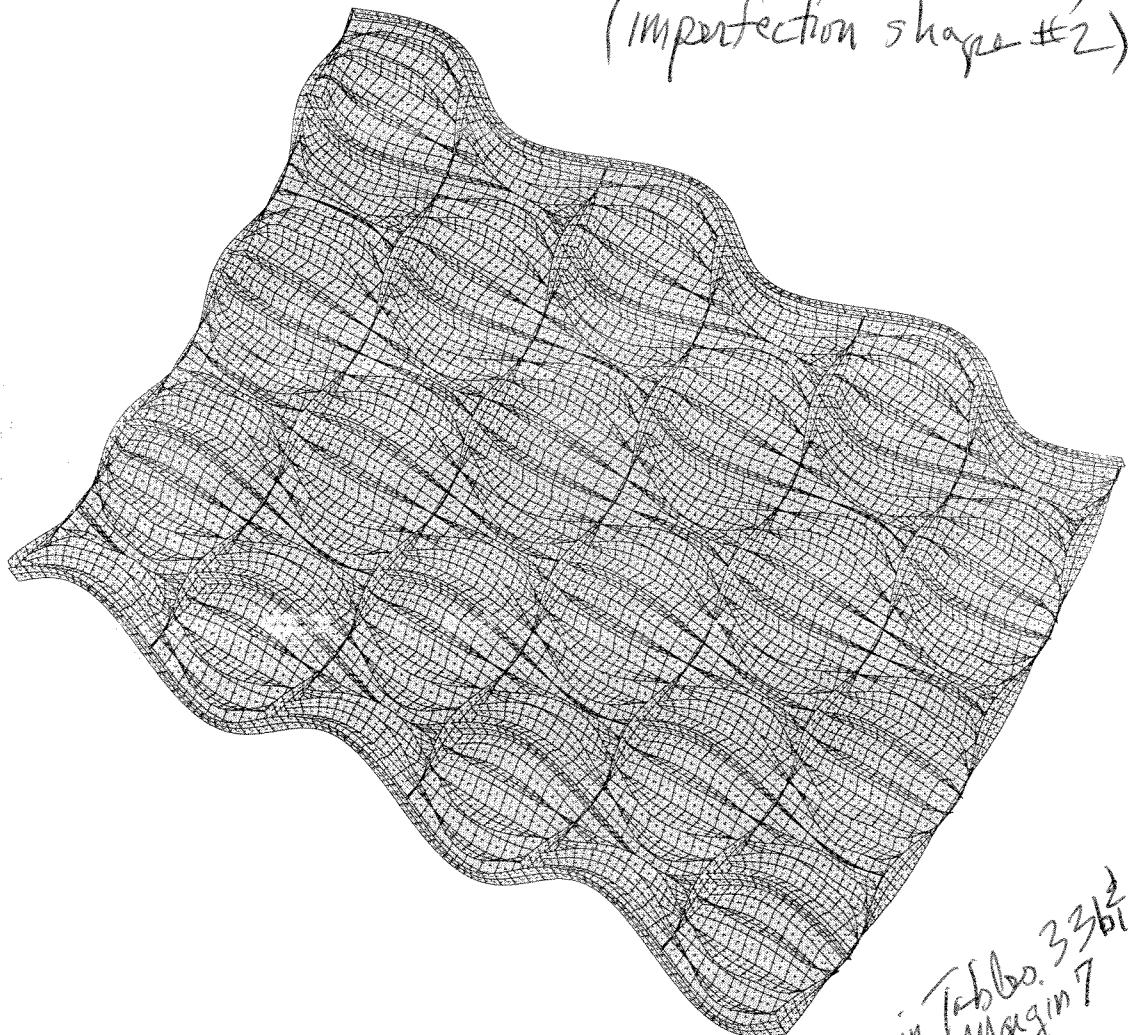


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Fig. 38

Linear buckling.

This mode shape is used  
as in imperfection "trigger"  
(Table 53)  
(imperfection shape #2)



solution scale = 0.4205E+01  
mode 3, pcr = 0.24314E+01  
step 0 eigenvector deformed geometry  
linear buckling of perfect shell from STAGS

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$\Theta_x$  -35.84  
 $\Theta_y$  -179.86  
 $\Theta_z$  35.63

+ 1.336E+01 +



Fig. 35

# Table 45 Nasantho, STG

n 1 \$ Do you want a tutorial session and tutorial output?  
 1 \$ Choose type of STAGS analysis (1,3,4,5,6), INDIC  
 0 \$ Restart from ISTARTth load step (0=1st nonlinear soln), ISTART  
 1.000000 \$ Local buckling load factor from PANDA2, EIGLOC  
 y \$ Are the dimensions in this case in inches?  
 note → 1  
 22.916667 \$ Nonlinear (0) or linear (1) kinematic relations?, ILIN  
 26.063582 \$ Type 1 for closed (360-deg) cyl. shell, 0 otherwise, ITOTAL  
 y \$ X-direction length of the STAGS model of the panel: XSTAGS  
 101 \$ Panel length in the plane of the screen, L2  
 -2219 \$ Is the nodal point spacing uniform along the stringer axis?  
 0 \$ Number of nodes in the X-direction: NODEX  
 0 \$ Resultant (e.g. lb/in) normal to the plane of screen, Nx  
 0 \$ Resultant (e.g. lb/in) in the plane of the screen, Ny  
 0 \$ In-plane shear in load set A, Nxy  
 0 \$ Normal pressure in STAGS model in Load Set A, p  
 0 \$ Resultant (e.g. lb/in) normal to the plane of screen, Nx0  
 0 \$ Resultant (e.g. lb/in) in the plane of the screen, Ny0  
 0 \$ Normal pressure in STAGS model in Load Set B, p0  
 1.000000 \$ Starting load factor for Load System A, STLD(1)  
 0.000000 \$ Load factor increment for Load System A, STEP(1)  
 1.000000 \$ Maximum load factor for Load System A, FACM(1)  
 0 \$ Starting load factor for Load System B, STLD(2)  
 0 \$ Load factor increment for Load System B, STEP(2)  
 0 \$ Maximum load factor for Load System B, FACM(2)  
 1 \$ How many eigenvalues do you want? NEIGS  
 480 \$ Choose element type (410 or 411 or 480) for panel skin  
 n \$ Have you obtained buckling modes from STAGS for this case?  
 162 \$ Number of stringers in STAGS model of 360-deg. cylinder  
 3 \$ Number of rings in the STAGS model of the panel  
 y \$ Are there rings at the ends of the panel?  
 2 \$ Number of finite elements between adjacent stringers  
 9 \$ Number of finite elements between adjacent rings  
 3 \$ Stringer model: 1 or 2 or 3 or 4 or 5 (Type H(elp))  
 3 \$ Ring model: 1 or 2 or 3 or 4 or 5 (Type H(elp))  
 -1 \$ Reference surface of cyl: 1=outer, 0=middle, -1=inner  
 n \$ Do you want to use fasteners (they are like rigid links)?  
 y \$ Are the stringers to be "smeared out"?  
 n \$ Are the rings to be "smeared out"?  
 5 \$ Number of nodes over height of stiffener webs, NODWEB  
 5 \$ Number of nodes over width of stringer flange, NDFLGS  
 5 \$ Number of nodes over width of ring flange, NDFLGR  
 n \$ Do you want stringer(s) with a high nodal point density?  
 n \$ Do you want ring(s) with a high nodal point density?  
 n \$ Is there plasticity in this STAGS model?  
 y \$ Do you want to use the "least-squares" model for torque?  
 y \$ Is stiffener sidesway permitted at the panel edges?  
 y \$ Do you want symmetry conditions along the straight edges?  
 0 \$ Edges normal to screen (0) in-plane deformable; (1) rigid

Input to STAGSUNIT

2 ring bays (22.916667") × 14 stringer bays:

$$14 \times 1.8617" \text{ (Table 33b)}$$

$$= 26.063582"$$

Stringers smeared out

Linear buckling

Table 46 Output from STAGS (linear buckling)

nasaortho.out2 (abridged)  
shift = 2.0, no negative roots

CONVERGENCE HAS BEEN OBTAINED FOR EIGENVALUES 1 THROUGH 8

CRITICAL LOAD FACTOR COMBINATION

| NO. | EIGENVALUE   | LOAD SYSTEM A | LOAD SYSTEM B | @DOF  |
|-----|--------------|---------------|---------------|-------|
| 1   | 2.568013E+00 | 2.568013E+00  | 0.000000E+00  | 9573  |
| 2   | 2.604414E+00 | 2.604414E+00  | 0.000000E+00  | 15385 |
| 3   | 2.634207E+00 | 2.634207E+00  | 0.000000E+00  | 3417  |
| 4   | 2.767517E+00 | 2.767517E+00  | 0.000000E+00  | 9237  |
| 5   | 2.797382E+00 | 2.797382E+00  | 0.000000E+00  | 3249  |
| 6   | 2.905307E+00 | 2.905307E+00  | 0.000000E+00  | 3249  |
| 7   | 3.046426E+00 | 3.046426E+00  | 0.000000E+00  | 3225  |
| 8   | 3.207642E+00 | 3.207642E+00  | 0.000000E+00  | 9489  |

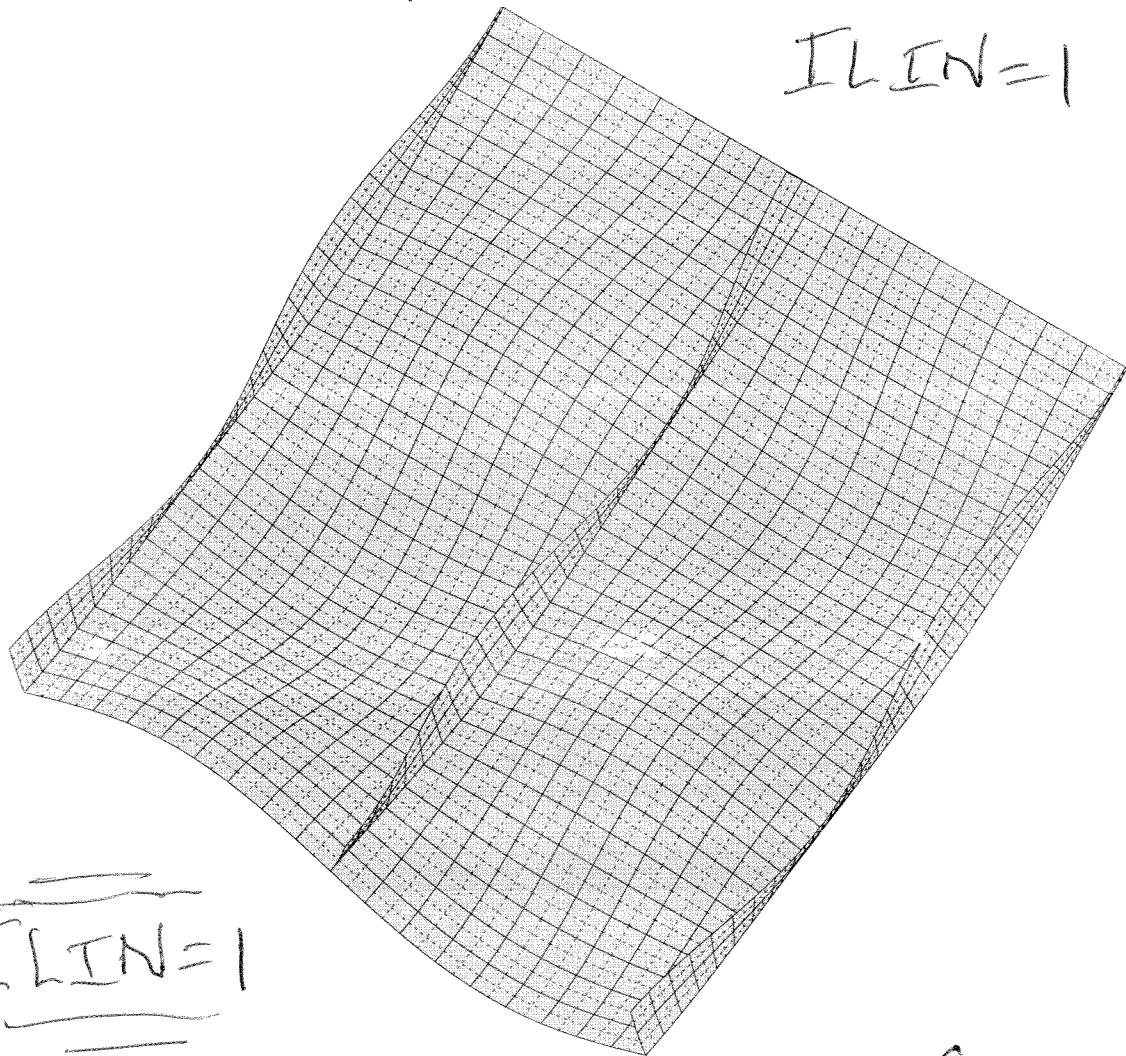
← inter-ring (Fig. 36)  
general buckling  
(Figs. 37 & 38)

Strings are smeared out.

Inter-ring buckling

Compare with Figs. 20 & 26 & 28

ILIN=1



ILIN=1

solution scale = 0.1729E+01

mode 1, pcr = 0.25680E+01

step 0 eigenvector deformed geometry

linear buckling of perfect shell from STAGS

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Compare with Fig. 28

$\Theta_x -35.84$   
 $\Theta_y -179.86$   
 $\Theta_z 35.63$

+ 5.514E+00 +

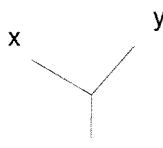


Fig. 36