9 Feb. 2009
Allen –
This is the second
installment of my
results from your
"substiffener" case.
Dave

9 February, 2009

Dear Allen,

Here is more from the "allen" case.

Results from three cases:

1. The case called "allen" with IQUICK = 0

2. The case called "allen2" with IQUICK = 0

3. The case called "allen3" with IQUICK = 0

"allen" is the same case as with the February 4th mailing, except that I changed IQUICK from IQUICK = 1 to IQUICK = 0

"allen2" is the same case but without substiffeners. I wanted to compare the optimum weights of the shell with and without substiffeners, all else remaining the same.

"allen3" is the same as "allen" except that I specify 4 different material types instead of just 1 material type. no optimizations for this case

---

Next, I want to urge NASA LANGLEY to be able to update PANDA2 (with small updates) without my help (except I will identify the change(s) to be made). !!!

In order to use the option IQUICK=1 when there are substiffeners you will have to update PANDA2, as I wrote to you in the February 4th mailing. You have to eliminate the "bug" for PANDA2 to work with this kind of case.

To make changes to the PANDA2 source code you first have to "cd" to this source code:

cd ...panda2/sources

The "bug" is in the source library called "bucpan1.src". In particular, the "bug" is in the very long SUBROUTINE BUCPAN .

The "bug" in the IQUICK = 1 case with substiffeners is caused by SUBROUTINE RECORD being called when there was no corresponding alternate buckling analysis. (There was no corresponding call to SUBROUTINE ALTSOL).

To correct this error the call to RECORD associated with the string, "altsoln4", has to be proceeded by the "IF" clause, "IF (ISTIFX(1).EQ.0.OR.IQUICK.EQ.0)". Therefore, the line in SUBROUTINE BUCPAN that before the correction reads:

```
            CALL RECORD(0,24,EALTER(4),SPANDA(4),MPANDA(4),
```

has to be changed to the following:

```
            IF (ISTIFX(1).EQ.0.OR.IQUICK.EQ.0)
     1      CALL RECORD(0,24,EALTER(4),SPANDA(4),MPANDA(4),
```

VERY IMPORTANT: THERE ARE MANY CALLS TO "RECORD" IN SUBROUTINE BUCPAN (the name of the subrouiine where this correction is to be made).

*************MAKE SURE YOU HAVE THE CORRECT ONE! *************

YOU WILL GET THE
CORRECT ONE BY FIRST SEARCHING FOR THE STRING, "altsoln4", STARTING FROM THE TOP OF SUBROUTINE BUCPAN. It is the second occurrence of the string, "altsoln4" that you want. Alternatively, you can search for the string, "24,EALTER", which will get you to the correct call to RECORD.

After you make the correction the particular segment of
SUBROUTINE BUCPAN that you are concerned with should be
as follows:

```
C BEG JAN 2005
C  simp-support altsoln4  intermajorpatch
C END JAN 2005
C BEG FEB 2009
           IF (ISTIFX(1).EQ.0.OR.IQUICK.EQ.0)
     1     CALL RECORD(0,24,EALTER(4),SPANDA(4),MPANDA(4),
C END FEB 2009
     1        NPANDA(4),ICONST,CONSTR,WORDB,IFILE,IDESGN,JJJ,1.0,
     1        EIGMAX,IPOINC,INUMTT,FSLOC,ICASE,0,0,VINHOF,
C BEG MAR 2005
     1        MORCON(ILOADS,ICASE),ENDMID,1,4,1)
C END MAR 2005
C BEG FEB 2007
           IF (ITYPE.EQ.1.AND.NNPRT.GE.2)
     1     WRITE(IFILE,*)' AFTER RECORD45: IDESGN,INUMTT,ICONST=',
     1                                     IDESGN,INUMTT,ICONST
C234567890123456789012345678901234567890123456789012345678901234567890123456789012
C END FEB 2007
```

After you make the correction to the FORTRAN coding as just described,
you have to "make" PANDA2. This you do as follows:

```
cd ../execute
make -f makefile.linux |& tee makelinux.log
```

Inspect the makelinux.log file to make sure that everything compiled
successfully. You can look for the string, "bucpan.o" . If "bucpan.o"
esists then SUBROUTINE BUCPAN compiled successfully.

Let me know how it goes, Allen!

Best regards,

Dave

Dave

RUN STREAM USED TO OBTAIN MY RESULTS

```
panda2log
begin              Table 4
setup
decide             Table 5
mainsetup          Table 6
superopt
(inspect the allen.OPP file)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 1
(edit allen.OPT to get fixed design: ITYPE = 2)
mainsetup
pandaopt
(inspect the allen.OPM file.)   Table 7

(Next, change the *.BEG and *.DEC files
 as appropriate and optimize again:
 1, In *.BEG use higher starting values
    for H(STR), H(RNG), TSUB and HSUB (substringer)
 2. In *.BEG change NB2 from 0 to 1
 3. In *.DEC put higher upper bounds on
    H(STR), T(1)(SKN), T(2)(STR), t(3)(RNG)
 4. In *.DEC add H(RNG) as a decision variable
 5. In *.DEC eliminate the peculiar inequality
    constraint.
 6. In *.DEC eliminate the 2nd linking
    expression (where H(RNG) = H(STR)).

begin              Table 8
setup
decide             Table 9
mainsetup          Table 10
superopt
(inspect the allen.OPP file)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 2
(edit allen.OPT to get fixed design: ITYPE = 2)
mainsetup
pandaopt
(inspect the allen.OPM file.)   Table 11
```

February 4th stuff, mailed already

```
(Next, leave *.BEG, *.DEC the same, change *.OPT
 so that IQUICK = 0 instead of IQUICK = 1)

begin              Table 12
setup
decide             Table 13
mainsetup          Table 14
superopt
(inspect the allen.OPP file)
(SUPEROPT bombs at Iteration no. 187. Therefore,
follow the directions given in Table 15,
also in Item 580 of the file .../panda2/doc/panda2.news)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 3
(We still have to complete the SUPEROPT run)
change        p.3 of Table 15(a)
setup
mainsetup
superopt
(inspect the allen.OPP file)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 2
(edit allen.OPT to get fixed design: ITYPE = 2)
mainsetup
pandaopt
(inspect the allen.OPM file.)   Table 15(a)
change ←                        Table 15(b)
```

new stuff (IQUICK = 0)

save the optimum design listed on pages 5 & 6 of Table 15(a).

Table 12 allen.BEG

```
     n          $ Do you want a tutorial session and tutorial output?
    124         $ Panel length normal to the plane of the screen, L1
  622.0353      $ Panel length in the plane of the screen, L2
     r          $ Identify type of stiffener along L1 (N,T,J,Z,R,A,C,G)
       8        $ stiffener spacing, b
 0.6670000      $ width of stringer base, b2 (must be > 0, see Help)
 6.0000000      $ height of stiffener (type H for sketch), h
     n          $ Are the stringers cocured with the skin?
   10000        $ What force/(axial length) will cause web peel-off?
     n          $ Is the next group of layers to be a "default group" (12 layers!)?
       1        $ number of layers in the next group in Segment no.( 1)
     n          $ Can winding (layup) angles ever be decision variables?
       1        $ layer index (1,2,...), for layer no.( 1)
     y          $ Is this a new layer type?
0.6500000E-01   $ thickness for layer index no.( 1)
       0        $ winding angle (deg.) for layer index no.( 1)
       1        $ material index (1,2,...) for layer index no.( 1)
     y          $ Any more layers or groups of layers in Segment no.( 1)
     n          $ Is the next group of layers to be a "default group"?
     y          $ Does one of the additional layers consist of sub-stiffeners?
     n          $ Does this sub-stiffener "layer" form an isogrid?
       0        $ Index, NSURF = 0 or 1, for substiffener "layer"( 1)
       1        $ Index, NB2 = 0 or 1, for substiffener "layer"( 1)
 0.2000000      $ Thickness, TSUB, of substiffener set( 1)
 2.0000000      $ Height, HSUB, of substiffener set( 1)
       0        $ Angle, THSUB (degrees), of substiffener set( 1)
       2        $ Spacing, BSUB, of substiffener set( 1)
       1        $ Material type, MATSUB,  for substiffener set( 1)
     n          $ Are there any more substiffener sets in substiffener "layer"
     n          $ Is the next group of layers to be a "default group" (12 layers!)?
       1        $ number of layers in the next group in Segment no.( 2)
     n          $ Can winding (layup) angles ever be decision variables?
       1        $ layer index (1,2,...), for layer no.( 1)
     n          $ Is this a new layer type?
     n          $ Any more layers or groups of layers in Segment no.( 2)
     n          $ Is the next group of layers to be a "default group" (12 layers!)?
       1        $ number of layers in the next group in Segment no.( 3)
     n          $ Can winding (layup) angles ever be decision variables?
       2        $ layer index (1,2,...), for layer no.( 1)
     y          $ Is this a new layer type?
 0.6500000      $ thickness for layer index no.( 2)
       0        $ winding angle (deg.) for layer index no.( 2)
       1        $ material index (1,2,...) for layer index no.( 2)
     n          $ Any more layers or groups of layers in Segment no.( 3)
       1        $ choose external (0) or internal (1) stringers
     r          $ Identify type of stiffener along L2  (N, T, J, Z, R, A)
       8        $ stiffener spacing, b
       0        $ width of ring base, b2 (zero is allowed)
 4.0000000      $ height of stiffener (type H for sketch), h
     n          $ Are the rings cocured with the skin?
     n          $ Is the next group of layers to be a "default group" (12 layers!)?
       1        $ number of layers in the next group in Segment no.( 3)
     n          $ Can winding (layup) angles ever be decision variables?
       3        $ layer index (1,2,...), for layer no.( 1)
     y          $ Is this a new layer type?
 0.6500000      $ thickness for layer index no.( 3)
       0        $ winding angle (deg.) for layer index no.( 3)
       1        $ material index (1,2,...) for layer index no.( 3)
     n          $ Any more layers or groups of layers in Segment no.( 3)
       1        $ choose external (0) or internal (1) rings
     y          $ Is the panel curved in the plane of the screen (Y for cyls.)?
    198         $ Radius of curvature (cyl. rad.) in the plane of screen, R
     n          $ Is panel curved normal to plane of screen? (answer N)
     y          $ Is this material isotropic (Y or N)?
0.1120000E+08   $ Young's modulus,                  E( 1)
 0.3000000      $ Poisson's ratio,                 NU( 1)
  4307692.      $ transverse shear modulus,       G13( 1)
       0        $ Thermal expansion coeff.,     ALPHA( 1)
       0        $ residual stress temperature (positive),TEMPTUR( 1)
     n          $ Want to supply a stress-strain "curve" for this mat'l? (N)
     y          $ Want to specify  maximum effective stress ?
  66000.00      $ Maximum allowable effective stress in material type( 1)
     n          $ Do you want to take advantage of "bending overshoot"?
0.9800000E-01   $ weight density (greater than 0!) of material type( 1)
     n          $ Is lamina cracking permitted along fibers (type H(elp))?
       0        $ Prebuckling: choose 0=bending included; 2=use membrane theory
       0        $ Buckling: choose 0=simple support or 1=clamping
```

Table 13 allen.DEC

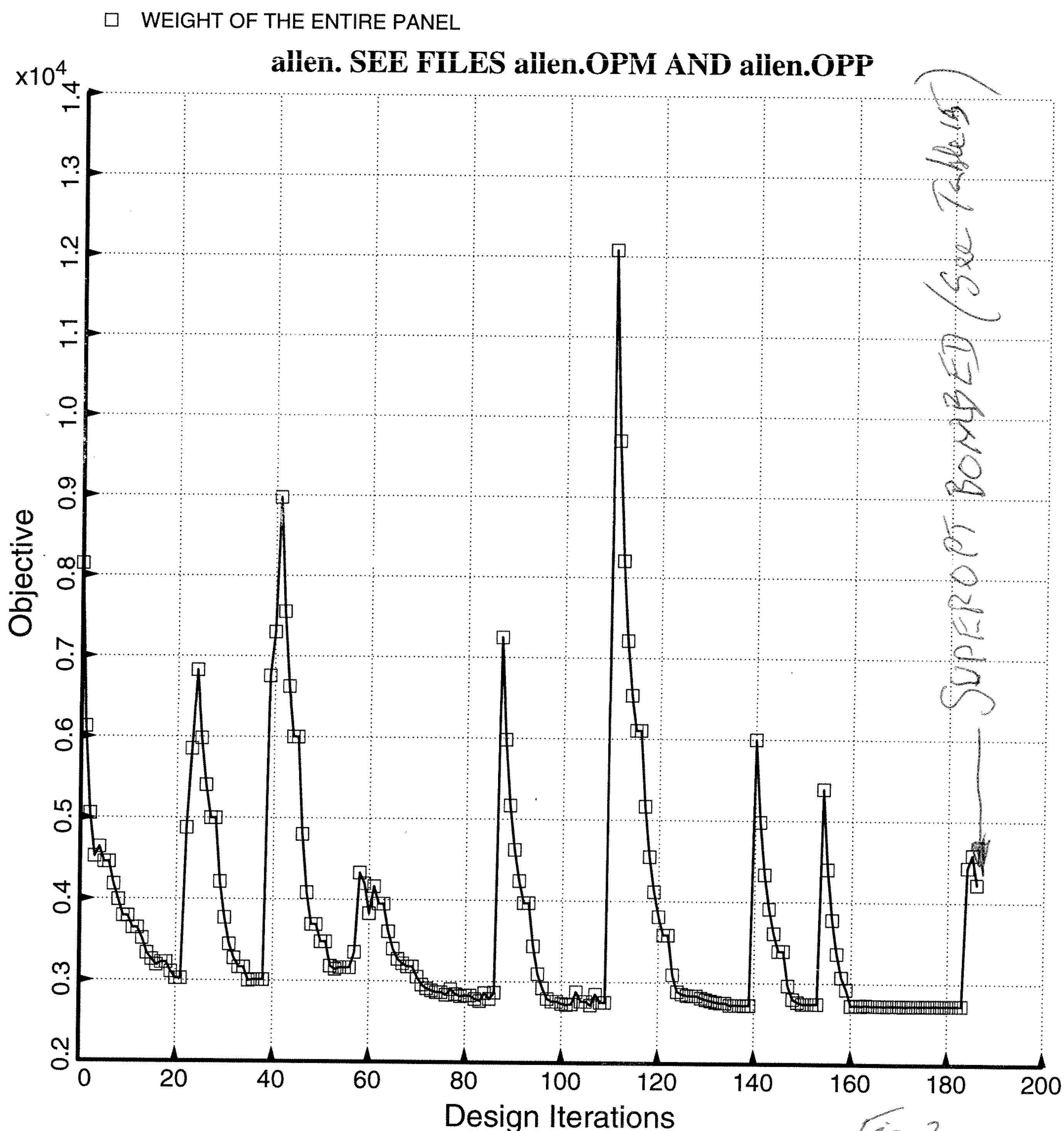
```
    n          $ Do you want a tutorial session and tutorial output?
    n          $ Want to use default for thickness decision variables (type H(elp)?
       4       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 4)
 2.000000      $ Upper bound of variable no.( 4)
    y          $ Any more decision variables (Y or N) ?
       1       $ Choose a decision variable (1,2,3,...)
       2       $ Lower bound of variable no.( 1)
      50       $ Upper bound of variable no.( 1)
    y          $ Any more decision variables (Y or N) ?
       9       $ Choose a decision variable (1,2,3,...)
       2       $ Lower bound of variable no.( 9)
      50       $ Upper bound of variable no.( 9)
    y          $ Any more decision variables (Y or N) ?
       8       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 8)
 3.000000      $ Upper bound of variable no.( 8)
    y          $ Any more decision variables (Y or N) ?
      12       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.(12)
 3.000000      $ Upper bound of variable no.(12)
    y          $ Any more decision variables (Y or N) ?
       3       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 3)
 10.50000      $ Upper bound of variable no.( 3)
    y          $ Any more decision variables (Y or N) ?
       6       $ Choose a decision variable (1,2,3,...)
       0       $ Lower bound of variable no.( 6)
 10.50000      $ Upper bound of variable no.( 6)
    y          $ Any more decision variables (Y or N) ?
       7       $ Choose a decision variable (1,2,3,...)
       0       $ Lower bound of variable no.( 7)
       8       $ Upper bound of variable no.( 7)
    y          $ Any more decision variables (Y or N) ?
       5       $ Choose a decision variable (1,2,3,...)
       0       $ Lower bound of variable no.( 5)
       5       $ Upper bound of variable no.( 5)
    y          $ Any more decision variables (Y or N) ?
      11       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.(11)
 10.50000      $ Upper bound of variable no.(11)
    n          $ Any more decision variables (Y or N) ?
    y          $ Any linked variables (Y or N) ?
       2       $ Choose a linked variable (1,2,3,...)
       1       $ To which variable is this variable linked?
0.3330000      $ Assign a value to the linking coefficient, C(j)
    n          $ Any other decision variables in the linking expression?
    n          $ Any constant C0 in the linking expression (Y or N)?
    n          $ Any more linked variables (Y or N) ?
    n          $ Any inequality relations among variables? (type H)
    y          $ Any escape variables (Y or N) ?
    y          $ Want to have escape variables chosen by default?
```

Table 17 alkn. OPT

```
        n           $ Do you want a tutorial session and tutorial output?
    -8025           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx( 1)
        0           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny( 1)
        0           $ In-plane shear in load set A,                        Nxy( 1)
        n           $ Does the axial load vary in the L2 direction?
        0           $ Applied axial moment resultant (e.g. in-lb/in), Mx( 1)
        0           $ Applied hoop moment resultant (e.g. in-lb/in), My( 1)
        y           $ Want to include effect of transverse shear deformation?
        0           $ IQUICK = quick analysis indicator (0 or 1)
        y           $ Do you want to vary M for minimum local buckling load?
new     n           $ Do you want to choose a starting M for local buckling?
        y           $ Do you want to perform a "low-axial-wavenumber" search?
 2.153846           $ Factor of safety for general instability, FSGEN( 1)
 1.555556           $ Factor of safety for panel (between rings) instability, FSPAN( 1)
 1.555556           $ Minimum load factor for local buckling (Type H for HELP), FSLOC( 1)
 1.555556           $ Minimum load factor for stiffener buckling (Type H), FSBSTR( 1)
        1           $ Factor of safety for stress, FSSTR( 1)
        y           $ Do you want "flat skin" discretized module for local buckling?
        n           $ Do you want wide-column buckling to constrain the design?
        0           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx0( 1)
        0           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny0( 1)
        1           $ Axial load applied along the (0=neutral plane), (1=panel skin)
        0           $ Uniform applied pressure [positive upward. See H(elp)], p( 1)
        0           $ Out-of-roundness, Wimpg1=(Max.diameter-Min.diam)/4, Wimpg1( 1)
        0           $ Initial buckling modal general imperfection amplitude, Wimpg2( 1)
        0           $ Initial buckling modal inter-ring imperfection amplitude,Wpan( 1)
        0           $ Initial local imperfection amplitude (must be positive), Wloc( 1)
        n           $ Do you want PANDA2 to change imperfection amplitudes (see H(elp))?( 1)
        y           $ Do you want PANDA2 to find the general imperfection shape?( 1)
        0           $ Maximum allowable average axial strain (type H for HELP)( 1)
        n           $ Is there any thermal "loading" in this load set (Y/N)?
        y           $ Do you want a "complete" analysis (type H for "Help")?
        y           $ Want to provide another load set ?
    -8025           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx( 2)
        0           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny( 2)
        0           $ In-plane shear in load set A,                        Nxy( 2)
        n           $ Does the axial load vary in the L2 direction?
        0           $ Applied axial moment resultant (e.g. in-lb/in), Mx( 2)
        0           $ Applied hoop moment resultant (e.g. in-lb/in), My( 2)
        y           $ Want to include effect of transverse shear deformation?
        0           $ IQUICK = quick analysis indicator (0 or 1)
        y           $ Do you want to vary M for minimum local buckling load?
new     n           $ Do you want to choose a starting M for local buckling?
        y           $ Do you want to perform a "low-axial-wavenumber" search?
        1           $ Factor of safety for general instability, FSGEN( 2)
        1           $ Factor of safety for panel (between rings) instability, FSPAN( 2)
        1           $ Minimum load factor for local buckling (Type H for HELP), FSLOC( 2)
        1           $ Minimum load factor for stiffener buckling (Type H), FSBSTR( 2)
 1.265753           $ Factor of safety for stress, FSSTR( 2)
        y           $ Do you want "flat skin" discretized module for local buckling?
        n           $ Do you want wide-column buckling to constrain the design?
        0           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx0( 2)
 11266.20           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny0( 2)
        1           $ Axial load applied along the (0=neutral plane), (1=panel skin)
-56.90000           $ Uniform applied pressure [positive upward. See H(elp)], p( 2)
        n           $ Is the pressure part of Load Set A?
        n           $ Is the pressure hydrostatic (Type H for "HELP")?
        0           $ Choose in-plane immovable (IFREE=0) or movable (IFREE=1) b.c.( 2)
        y           $ Are you feeling well today (type H)?
        n           $ Is there a maximum allowable deflection due to pressure?
        0           $ Out-of-roundness, Wimpg1=(Max.diameter-Min.diam)/4, Wimpg1( 2)
        0           $ Initial buckling modal general imperfection amplitude, Wimpg2( 2)
        0           $ Initial buckling modal inter-ring imperfection amplitude,Wpan( 2)
        0           $ Initial local imperfection amplitude (must be positive), Wloc( 2)
        n           $ Do you want PANDA2 to change imperfection amplitudes (see H(elp))?( 2)
        y           $ Do you want PANDA2 to find the general imperfection shape?( 2)
        0           $ Maximum allowable average axial strain (type H for HELP)( 2)
        n           $ Is there any thermal "loading" in this load set (Y/N)?
        y           $ Do you want a "complete" analysis (type H for "Help")?
        n           $ Want to provide another load set ?
        n           $ Do you want to impose minimum TOTAL thickness of any segment?
        n           $ Do you want to impose maximum TOTAL thickness of any segment?
        n           $ Do you want to impose minimum TOTAL thickness of any segment?
        n           $ Do you want to impose maximum TOTAL thickness of any segment?
        n           $ Use reduced effective stiffness in panel skin (H(elp), Y or N)?
        0           $ NPRINT= output index (-1=min. 0=good, 1=ok, 2=more, 3=too much)
        0           $ Index for type of shell theory (0 or 1 or 2), ISAND
        n           $ Does the postbuckling axial wavelength of local buckles change?
```

Table 14 (continued)

```
   n          $ Want to suppress general buckling mode with many axial waves?
   n          $ Do you want to double-check PANDA-type eigenvalues [type (H)elp]?
      1       $ Choose (0=transverse inextensional; 1=transverse extensional)
      1       $ Choose ICONSV = -1 or 0 or 1 or H(elp), ICONSV
      1       $ Choose type of analysis (ITYPE = 1 or 2 or 3 or 4 or 5)
   Y          $ Do you want to prevent secondary buckling (mode jumping)?
   Y          $ Do you want to use the "alternative" buckling solution?
1.000000      $ Factor of safety for "alternative" model of general buckling
      5       $ How many design iterations permitted in this run (5 to 25)?
1.000000      $ MAXMAR. Plot only those margins less than MAXMAR (Type H)
   N          $ Do you want to reset total iterations to zero (Type H)?
      1       $ Index for objective (1=min. weight, 2=min. distortion)
1.000000      $ FMARG (Skip load case with min. margin greater than FMARG)
```



WEIGHT OF THE ENTIRE PANEL
allen. SEE FILES allen.OPM AND allen.OPP
x10^4
Objective
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
20
40
60
80
100
120
140
160
180
200
Design Iterations
SUPEROPT BOMBED (See Table 15)

Fig. 3

Table 15(a) (6 pages) first at Iteration 187

THE IQUICK=0 SUPEROPT RUN BOMBED. WHAT TO DO?

1. Look for the *.ERR file (allen.ERR file for this case)

2. Look near the end of the *.ERR file. Search for the string, MODEL CHANGE REQUIRED

3. If that string occurs it means that PANDA2 automatically changed IQUICK from IQUICK = 0 to IQUICK = 1 . This works for a "fixed" design case ~~or an optimization case when PANDAOPT is used instead of SUPEROPT,~~ but it does not work for a SUPEROPT run. It causes a "bomb" because the *.OPT file (allen.OPT) file in this case) has the wrong sequence of input data for the IQUICK = 1 option. SUPEROPT still tries to use the allen.OPT file appropriate to IQUICK=0 (Table 14)

4. Read ITEM 580 in the file, ...panda2/doc/panda2.news and follow the directions there. (Item 580 is somewhat out-of-date because there have been many changes to PANDA2 since Item 580 was written, but the general ideas presented there are still valid). Depending on the message in the *.ERR file, you may also need to read ITEM 675 in ...panda2/doc/panda2.news.

5. In the "allen" case we have, near the end of the allen.OPP file, the following:

From the allen.OPP file

```
 183 2.7291E+03      FEASIBLE   (0; 5)  (0; 6)  (0; 0)  (0; 0)  (0; 0)   0 0 0 0 0 0 N 0 0 0 0 0»
 0
 184 2.7282E+03  ALMOST FEASIBLE(0; 8)  (0; 6)  (0; 0)  (0; 0)  (0; 0)   0 0 0 0 0 0 N 0 0 0 0 0»
 0
 -----------------------------------------------------AUTOCHANGE
 -------------------------------------------------------PANDAOPT
 185 4.4292E+03   NOT FEASIBLE  (0; 4)  (0; 2)  (0; 0)  (0; 0)  (0; 0)   0 0 0 0 0 0 N 0 0 0 0 0»
 0
 186 4.5847E+03  UNKNOWN FEASIB.(0; 0)  (0; 0)  (0; 0)  (0; 0)  (0; 0)   0 0 0 0 0 0 N 0 0 0 0 0»
 0
 187 4.2226E+03  UNKNOWN FEASIB.(0; 1)  (0; 2)  (0; 0)  (0; 0)  (0; 0)   0 0 0 0 0 0 N 0 0 0 0 0»
 0

 IOBJAL,ITRPLT=    0  187; OBJMN0,OBJPLT(ITRPLT)=  2.7234E+03  4.2226E+03
 ================================================================================
0
  VALUES OF DESIGN VARIABLES CORRESPONDING TO BEST FEASIBLE DESIGN
 VAR. STR/ SEG. LAYER   CURRENT
 NO.  RNG  NO.   NO.     VALUE            DEFINITION
  1         0     0    2.683E+01      B(STR):stiffener spacing, b: STR seg=NA, layer=NA
  2   STR   2     0    8.933E+00     B2(STR):width of stringer base, b2 (must be > 0, see Help)»
: STR seg=2 , lay
  3   STR   3     0    2.423E+00      H(STR):height of stiffener (type H for sketch), h: STR se»
g=3 , layer=NA
  4   SKN   1     1    2.497E-01   T(1 )(SKN):thickness for layer index no.(1 ): SKN seg=1 , lay»
er=1
  5   SKN   1     1    1.012E-01  TSUB,substr:Thickness, TSUB, of substiffener set(1 ): SKN seg=»
1 , layer=1
  6   SKN   1     1    1.220E+00  HSUB,substr:Height, HSUB, of substiffener set(1 ): SKN seg=1 ,»
 layer=1
  7   SKN   1     1    6.849E+00  BSUB,substr:Spacing, BSUB, of substiffener set(1 ): SKN seg=1 »
, layer=1
  8   STR   3     1    2.869E-01   T(2 )(STR):thickness for layer index no.(2 ): STR seg=3 , lay»
er=1
  9         0     0    8.386E+00      B(RNG):stiffener spacing, b: RNG seg=NA, layer=NA
 10   RNG   2     0    0.000E+00     B2(RNG):width of ring base, b2 (zero is allowed): RNG seg=»
2 , layer=NA
 11   RNG   3     0    7.259E+00      H(RNG):height of stiffener (type H for sketch), h: RNG se»
g=3 , layer=NA
 12   RNG   3     1    6.500E-02   T(3 )(RNG):thickness for layer index no.(3 ): RNG seg=3 , lay»
er=1

 **************************************************
 ******************** DESIGN OBJECTIVE *******************
 *************                            ***********
0
  CORRESPONDING VALUE OF THE OBJECTIVE FUNCTION:
 VAR. STR/ SEG. LAYER   CURRENT
 NO.  RNG  NO.   NO.     VALUE           DEFINITION
            0     0    2.725E+03   WEIGHT OF THE ENTIRE PANEL

 *************                         ************
```

SUPEROPT bombed here

Table 15(a) (p. 2 of 6)

```
 ******************* DESIGN OBJECTIVE ******************
 ****************************************************
0
  VALUES OF DESIGN VARIABLES CORRESPONDING TO ALMOST FEASIBLE DESI
 VAR. STR/ SEG. LAYER   CURRENT
 NO.  RNG  NO.   NO.     VALUE              DEFINITION
  1         0     0    2.692E+01        B(STR):stiffener spacing, b: STR seg=NA, layer=NA
  2   STR   2     0    8.965E+00       B2(STR):width of stringer base, b2 (must be > 0, see Help)»
: STR seg=2 , lay
  3   STR   3     0    3.415E+00        H(STR):height of stiffener (type H for sketch), h: STR se»
g=3 , layer=NA
  4   SKN   1     1    2.496E-01    T(1 )(SKN):thickness for layer index no.(1 ): SKN seg=1 , lay»
er=1
  5   SKN   1     1    1.012E-01   TSUB,substr:Thickness, TSUB, of substiffener set(1 ): SKN seg=»
1 , layer=1
  6   SKN   1     1    1.218E+00   HSUB,substr:Height, HSUB, of substiffener set(1 ): SKN seg=1 ,»
 layer=1
  7   SKN   1     1    6.833E+00   BSUB,substr:Spacing, BSUB, of substiffener set(1 ): SKN seg=1 »
, layer=1
  8   STR   3     1    2.850E-01    T(2 )(STR):thickness for layer index no.(2 ): STR seg=3 , lay»
er=1
  9         0     0    8.372E+00        B(RNG):stiffener spacing, b: RNG seg=NA, layer=NA
 10   RNG   2     0    0.000E+00       B2(RNG):width of ring base, b2 (zero is allowed): RNG seg=»
2 , layer=NA
 11   RNG   3     0    7.300E+00        H(RNG):height of stiffener (type H for sketch), h: RNG se»
g=3 , layer=NA
 12   RNG   3     1    6.500E-02    T(3 )(RNG):thickness for layer index no.(3 ): RNG seg=3 , lay»
er=1

 ***********************************************
 ******************* DESIGN OBJECTIVE ******************
 *************                            ***********
0
  CORRESPONDING VALUE OF THE OBJECTIVE FUNCTION:
 VAR. STR/ SEG. LAYER   CURRENT
 NO.  RNG  NO.   NO.     VALUE             DEFINITION
            0     0    2.725E+03   WEIGHT OF THE ENTIRE PANEL

 *************                       ************
 ******************* DESIGN OBJECTIVE ******************
 ****************************************************
0
  VALUES OF DESIGN VARIABLES CORRESPONDING TO MILDLY UNFEASIB DESI
 VAR. STR/ SEG. LAYER   CURRENT
 NO.  RNG  NO.   NO.     VALUE              DEFINITION
  1         0     0    2.711E+01        B(STR):stiffener spacing, b: STR seg=NA, layer=NA
  2   STR   2     0    9.027E+00       B2(STR):width of stringer base, b2 (must be > 0, see Help)»
: STR seg=2 , lay
  3   STR   3     0    3.427E+00        H(STR):height of stiffener (type H for sketch), h: STR se»
g=3 , layer=NA
  4   SKN   1     1    2.503E-01    T(1 )(SKN):thickness for layer index no.(1 ): SKN seg=1 , lay»
er=1
  5   SKN   1     1    9.950E-02   TSUB,substr:Thickness, TSUB, of substiffener set(1 ): SKN seg=»
1 , layer=1
  6   SKN   1     1    1.195E+00   HSUB,substr:Height, HSUB, of substiffener set(1 ): SKN seg=1 ,»
 layer=1
  7   SKN   1     1    6.824E+00   BSUB,substr:Spacing, BSUB, of substiffener set(1 ): SKN seg=1 »
, layer=1
  8   STR   3     1    2.745E-01    T(2 )(STR):thickness for layer index no.(2 ): STR seg=3 , lay»
er=1
  9         0     0    8.261E+00        B(RNG):stiffener spacing, b: RNG seg=NA, layer=NA
 10   RNG   2     0    0.000E+00       B2(RNG):width of ring base, b2 (zero is allowed): RNG seg=»
2 , layer=NA
 11   RNG   3     0    7.356E+00        H(RNG):height of stiffener (type H for sketch), h: RNG se»
g=3 , layer=NA
 12   RNG   3     1    6.500E-02    T(3 )(RNG):thickness for layer index no.(3 ): RNG seg=3 , lay»
er=1

 ***********************************************
 ******************* DESIGN OBJECTIVE ******************

etc.
-----------------------------------------------------------------
```

from the allen.OPP file.

We want to save the "best" design obtained so far by SUPEROPT, but several designs are listed near the bottom of the allen.OPP file. Which one should we save (by using CHANGE)? In most cases it will be the best "ALMOST FEASIBLE" design. However, in this particular case the best "FEASIBLE" design has the same objective (weight) as the "ALMOST FEASIBLE" design. Therefore, we want to use "CHANGE" to save the "FEASIBLE" design.

Usually, the first design listed after the list of design iterations in the *.OPP file will have the following heading:

VALUES OF DESIGN VARIABLES TO BE USED AS NEXT STARTING DESIGN

If so, then that is the design that you should use as input for CHANGE.

6. Use "CHANGE" to save the "best" design obtained by SUPEROPT so far. In this case the input data for "CHANGE" are as follows:

```
-------------------- input data for "CHANGE" ------------------------
      n         $ Do you want a tutorial session and tutorial output?
      y         $ Do you want to change any values in Parameter Set No. 1?
         1      $ Number of parameter to change (1, 2, 3, . .)
   26.83000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         2      $ Number of parameter to change (1, 2, 3, . .)
   8.933000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         3      $ Number of parameter to change (1, 2, 3, . .)
   3.423000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         4      $ Number of parameter to change (1, 2, 3, . .)
  0.2497000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         5      $ Number of parameter to change (1, 2, 3, . .)
  0.1012000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         6      $ Number of parameter to change (1, 2, 3, . .)
   1.220000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         7      $ Number of parameter to change (1, 2, 3, . .)
   6.849000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         8      $ Number of parameter to change (1, 2, 3, . .)
  0.2869000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
         9      $ Number of parameter to change (1, 2, 3, . .)
   8.386000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
        10      $ Number of parameter to change (1, 2, 3, . .)
   0.000000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
        11      $ Number of parameter to change (1, 2, 3, . .)
   7.259000     $ New value of the parameter
      y         $ Want to change any other parameters in this set?
        12      $ Number of parameter to change (1, 2, 3, . .)
  0.6500000E-01 $ New value of the parameter
      n         $ Want to change any other parameters in this set?
      n         $ Do you want to change values of "fixed" parameters?
      n         $ Do you want to change values of allowables?
---------------- end of input data for "CHANGE" ------------------------
```

the first allen.CHG file

7. Execute "SETUP"

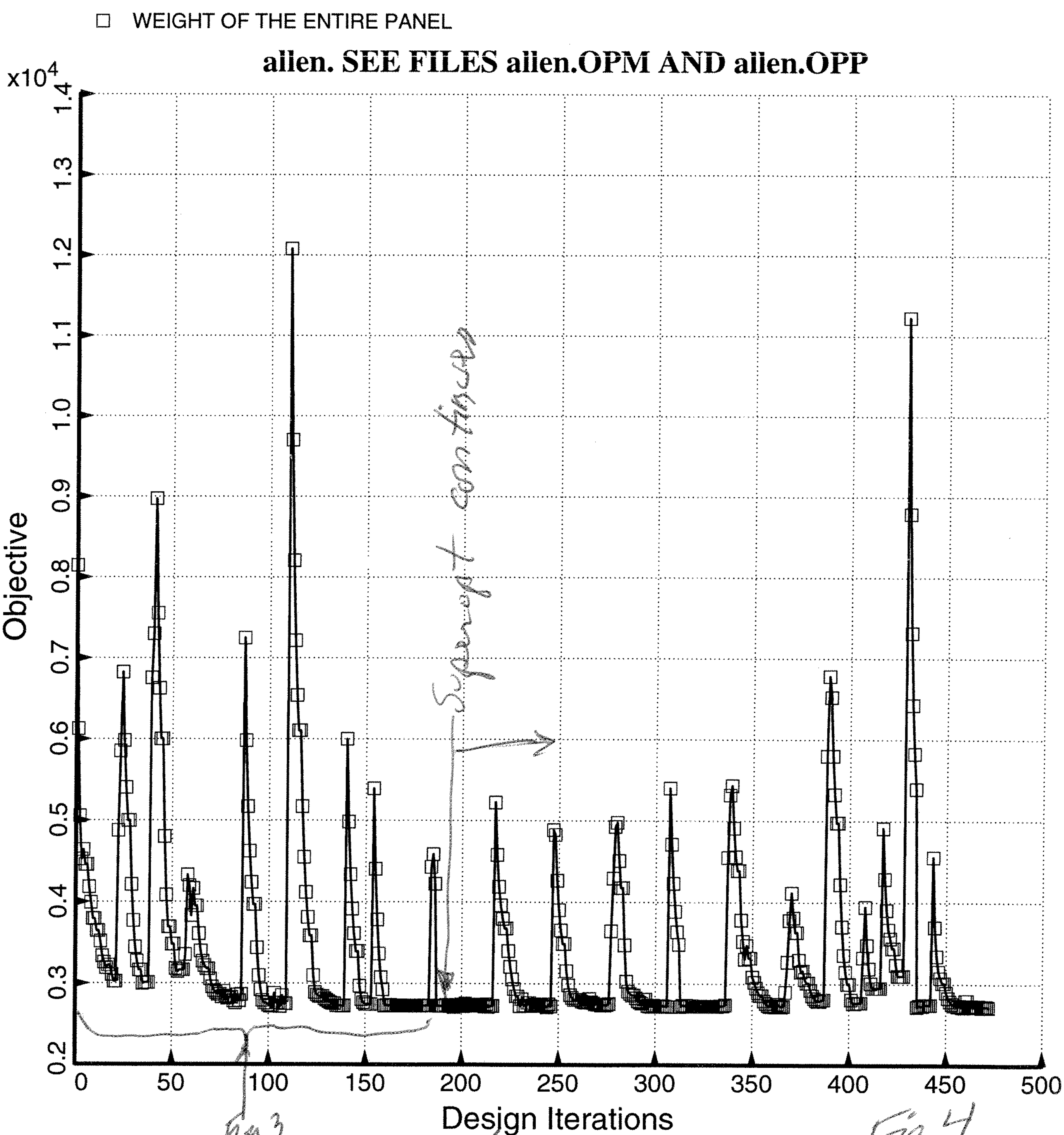
8. Execute "MAINSETUP"

9. Execute "SUPEROPT"

10. SUPEROPT starts from Iteration No. 187 and continues on. It's possible SUPEROPT may bomb again. Then we follow the same procedure again.

11. If SUPEROPT keeps bombing it may be a good idea to introduce a new inequality constraint in DECIDE. For example, we can introduce an inequality constraint in DECIDE that forces the stringer spacing to be less than 5 times the ring spacing.

12. In this case SUPEROPT went the full 470 iterations without



WEIGHT OF THE ENTIRE PANEL
allen. SEE FILES allen.OPM AND allen.OPP
x10^4
Objective
Design Iterations
0 50 100 150 200 250 300 350 400 450 500
0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4
Superopt continued

Fig 3

Fig. 4

Table 15(a) (p. 4 of 6)

bombing again.

The final margins and optimum design are as follows (abridged allen.OPM file) (allen.OPM file, abridged)

```
 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 1;  SUBCASE 1:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  0.00E+00  4.05E-05
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  2.4057E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  2.1248E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 1
 MAR. MARGIN
 NO.  VALUE                DEFINITION
 1  1.25E-01 Local buckling from discrete model-1.,M=1   axial halfwaves;FS=1.55
 2 -1.35E-02 Bending-torsion buckling; M=1  ;FS=2.1538
 3  5.46E-01 Bending-torsion buckling: Koiter theory,M=1   axial halfwav;FS=1.55
 4  1.56E+00 eff.stress:matl=1,STR,Dseg=3,node=11,layer=1,z=0.1359; MID.;FS=1.
 5  1.25E+04 stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.
 6  1.58E+00 matl=1 ; substiffener effective stressSTRTHK MID.;FS=1.
 7  1.70E-01 (m=1   lateral-torsional buckling load factor)/(FS)-1;FS=1.5556
 8  6.65E+00 Inter-ring bucklng, discrete model, n=53  circ.halfwaves;FS=1.5556
 9  1.57E+00 matl=1 ; substiffener effective stressSTRCON MID.;FS=1.
10  1.56E+00 eff.stress:matl=1,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
11  5.83E-01 buck.(DONL);simp-support inter-ring;  (1.00*altsol);FS=1.5556
12 -5.53E-03 buck.(DONL);simp-support general buck;M=2;N=7;slope=0.;FS=2.1538
13  9.14E-01 buck.(DONL);simp-support general buck;(0.85*altsol);FS=1.
14 -7.38E-03 buck.(DONL);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
15  1.28E+00 buck.(DONL);rolling only of stringers;M=23;N=0;slope=0.;FS=1.4
16  1.79E-01 buck.(DONL);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556
17  1.93E-01 buckling:simp-support of substring.M=1;FS=1.
18 -4.44E-02 buckling:simp-support altsoln4  intermajorpatch; FS=1.5556
19  4.36E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
20  5.83E-01 buck.(SAND);simp-support inter-ring;  (1.00*altsol);FS=1.5556
21 -1.22E-02 buck.(SAND);simp-support general buck;M=2;N=7;slope=0.;FS=2.1538
22  9.12E-01 buck.(SAND);simp-support general buck;(0.85*altsol);FS=1.
23 -7.20E-03 buck.(SAND);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
24  1.79E-01 buck.(SAND);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556


 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 1;  SUBCASE 2:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  0.00E+00  4.05E-05
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  2.4227E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  2.1420E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 2
 MAR. MARGIN
 NO.  VALUE                DEFINITION
 1  1.34E-01 Local buckling from discrete model-1.,M=1   axial halfwaves;FS=1.55
 2  3.77E-01 Bending-torsion buckling; M=1  ;FS=1.5556
 3  5.57E-01 Bending-torsion buckling: Koiter theory,M=1   axial halfwav;FS=1.55
 4  1.57E+00 eff.stress:matl=1,STR,Dseg=3,node=1,layer=1,z=0.1359; RNGS;FS=1.
 5  1.27E+04 stringer popoff margin:(allowable/actual)-1, web 1  RNGS;FS=1.
 6  1.57E+00 matl=1 ; substiffener effective stressSTRTHK RNGS;FS=1.
 7  1.80E-01 (m=1   lateral-torsional buckling load factor)/(FS)-1;FS=1.5556
 8  6.65E+00 Inter-ring bucklng, discrete model, n=53  circ.halfwaves;FS=1.5556
 9  1.58E+00 matl=1 ; substiffener effective stressSTRCON RNGS;FS=1.
10  1.58E+00 eff.stress:matl=1,STR,Iseg=3,at:ROOT,layer=1,z=0.;-RNGS;FS=1.
11 -8.50E-03 buck.(DONL);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
12  1.30E+00 buck.(DONL);rolling only of stringers;M=23;N=0;slope=0.;FS=1.4
13  1.77E-01 buck.(DONL);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556
14  1.96E-01 buckling:simp-support of substring.M=1;FS=1.
15  4.36E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
16 -8.32E-03 buck.(SAND);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
17  1.77E-01 buck.(SAND);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556


 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 2;  SUBCASE 1:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  1.13E+04 -5.69E+01
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  2.3917E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  2.0970E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 2, SUBCASE NO. 1
 MAR. MARGIN
```

Table 15(a) (p 5 of 6)

```
 NO.  VALUE                  DEFINITION
 1  5.70E-01 Local buckling from discrete model-1.,M=1   axial halfwaves;FS=1.1
 2  9.06E-01 Bending-torsion buckling; M=1  ;FS=1.1
 3  1.17E+00 Bending-torsion buckling: Koiter theory,M=1   axial halfwav;FS=1.1
 4 -2.01E-04 eff.stress:matl=1,SKN,Dseg=2,node=6,layer=1,z=-0.1268; MID.;FS=1.26
 5  6.99E+03 stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.2658
 6  5.05E-01 matl=1 ; substiffener effective stressSTRTHK MID.;FS=1.2658
 7  6.26E-01 (m=1   lateral-torsional buckling load factor)/(FS)-1;FS=1.1
 8  9.94E+00 Inter-ring bucklng, discrete model, n=34  circ.halfwaves;FS=1.1
 9  4.86E-01 matl=1 ; substiffener effective stressSTRCON MID.;FS=1.2658
10  7.49E-05 eff.stress:matl=1,SKN,Iseg=2,at:n=6,layer=1,z=-0.1268;-MID.;FS=1.26
11  1.45E+00 buck.(DONL);simp-support inter-ring;  (1.00*altsol);FS=1.1
12  1.18E+00 buck.(DONL);simp-support general buck;M=3;N=6;slope=0.;FS=1.1
13  1.27E+00 buck.(DONL);simp-support general buck;(0.85*altsol);FS=1.
14  4.97E-01 buck.(DONL);rolling with smear rings; M=23;N=1;slope=0.;FS=1.1
15  1.02E+00 buck.(DONL);rolling only of stringers;M=23;N=0;slope=0.;FS=1.4
16  1.58E+00 buck.(DONL);rolling with skin buckl.; M=2;N=1;slope=0.;FS=1.1
17 -4.28E-03 buckling:simp-support of substring.M=2;FS=1.
18  9.21E-01 buckling:simp-support altsoln4  intermajorpatch; FS=1.1
19  3.22E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
20  1.45E+00 buck.(SAND);simp-support inter-ring;  (1.00*altsol);FS=1.1
21  1.17E+00 buck.(SAND);simp-support general buck;M=3;N=6;slope=0.;FS=1.1
22  1.27E+00 buck.(SAND);simp-support general buck;(0.85*altsol);FS=1.
23  4.97E-01 buck.(SAND);rolling with smear rings; M=23;N=1;slope=0.;FS=1.1
24  1.58E+00 buck.(SAND);rolling with skin buckl.; M=2;N=1;slope=0.;FS=1.1


 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 2;  SUBCASE 2:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  1.13E+04 -5.69E+01
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  2.4512E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  2.1583E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 2, SUBCASE NO. 2
 MAR. MARGIN
 NO.  VALUE                  DEFINITION
 1  6.16E-01 Local buckling from discrete model-1.,M=1   axial halfwaves;FS=1.1
 2  1.16E+00 Bending-torsion buckling; M=1  ;FS=1.
 3  1.23E+00 Bending-torsion buckling: Koiter theory,M=1   axial halfwav;FS=1.1
 4 -3.08E-03 eff.stress:matl=1,SKN,Dseg=2,node=11,layer=1,z=0.1268; RNGS;FS=1.26
 5  7.87E+03 stringer popoff margin:(allowable/actual)-1, web 1  RNGS;FS=1.2658
 6  4.88E-01 matl=1 ; substiffener effective stressSTRTHK RNGS;FS=1.2658
 7  6.70E-01 (m=1   lateral-torsional buckling load factor)/(FS)-1;FS=1.1
 8  9.94E+00 Inter-ring bucklng, discrete model, n=34  circ.halfwaves;FS=1.1
 9  5.02E-01 matl=1 ; substiffener effective stressSTRCON RNGS;FS=1.2658
10 -1.02E-03 eff.stress:matl=1,SKN,Iseg=2,at:n=6,layer=1,z=0.1268;-RNGS;FS=1.265
11  4.86E-01 buck.(DONL);rolling with smear rings; M=23;N=1;slope=0.;FS=1.1
12  1.05E+00 buck.(DONL);rolling only of stringers;M=23;N=0;slope=0.;FS=1.4
13  1.56E+00 buck.(DONL);rolling with skin buckl.; M=2;N=1;slope=0.;FS=1.1
14  8.61E-03 buckling:simp-support of substring.M=2;FS=1.
15  3.20E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
16  4.86E-01 buck.(SAND);rolling with smear rings; M=23;N=1;slope=0.;FS=1.1
17  1.56E+00 buck.(SAND);rolling with skin buckl.; M=2;N=1;slope=0.;FS=1.1
 ***********  ALL 2 LOAD SETS PROCESSED  ***********
 ****************************************************
```

final optimum design

```
         SUMMARY OF INFORMATION FROM OPTIMIZATION ANALYSIS
 VAR. DEC. ESCAPE LINK. LINKED  LINKING    LOWER    CURRENT    UPPER       DEFINITION
  NO. VAR.  VAR.  VAR.    TO   CONSTANT    BOUND     VALUE     BOUND
   1   Y     N     N      0    0.00E+00  2.00E+00 2.6666E+01  5.00E+01        B(STR):stiffener s»
pacing, b: STR seg=NA, layer=NA
   2   N     N     Y      1    3.33E-01  0.00E+00 8.8796E+00  0.00E+00       B2(STR):width of st»
ringer base, b2 (must be > 0, see
   3   Y     N     N      0    0.00E+00  6.50E-02 3.4627E+00  1.05E+01        H(STR):height of s»
tiffener (type H for sketch), h:
   4   Y     Y     N      0    0.00E+00  6.50E-02 2.5368E-01  2.00E+00     T(1 )(SKN):thickness f»
or layer index no.(1 ): SKN seg=1
   5   Y     N     N      0    0.00E+00  2.00E-03 1.1049E-01  5.00E+00    TSUB,substr:Thickness, »
TSUB, of substiffener set(1 ): SK
   6   Y     N     N      0    0.00E+00  2.00E-02 1.3350E+00  1.05E+01    HSUB,substr:Height, HSU»
B, of substiffener set(1 ): SKN s
   7   Y     N     N      0    0.00E+00  2.00E-02 7.2938E+00  8.00E+00    BSUB,substr:Spacing, BS»
UB, of substiffener set(1 ): SKN
   8   Y     Y     N      0    0.00E+00  6.50E-02 2.7181E-01  3.00E+00     T(2 )(STR):thickness f»
or layer index no.(2 ): STR seg=3
   9   Y     N     N      0    0.00E+00  2.00E+00 9.3642E+00  5.00E+01        B(RNG):stiffener s»
pacing, b: RNG seg=NA, layer=NA
```

Table 15(a) (p.6 of 6)

```
  10    N     N     N      0     0.00E+00  0.00E+00 0.0000E+00  0.00E+00       B2(RNG):width of ri»
ng base, b2 (zero is allowed): RN
  11    Y     N     N      0     0.00E+00  6.50E-02 7.3046E+00  1.05E+01       H(RNG):height of s»
tiffener (type H for sketch), h:
  12    Y     Y     N      0     0.00E+00  6.50E-02 6.5000E-02  3.00E+00    T(3 )(RNG):thickness f»
or layer index no.(3 ): RNG seg=3
0
   CURRENT VALUE OF THE OBJECTIVE FUNCTION:
 VAR. STR/ SEG. LAYER   CURRENT
 NO.  RNG  NO.   NO.     VALUE           DEFINITION
            0     0    2.720E+03   WEIGHT OF THE ENTIRE PANEL

  TOTAL WEIGHT OF SKIN                                  =    1.9175E+03
  TOTAL WEIGHT OF SUBSTIFFENERS                         =    1.5287E+02
  TOTAL WEIGHT OF STRINGERS                             =    2.6680E+02
  TOTAL WEIGHT OF RINGS                                 =    3.8327E+02
  SPECIFIC WEIGHT (WEIGHT/AREA) OF STIFFENED PANEL=    3.5270E-02
 IN ORDER TO AVOID FALSE CONVERGENCE OF THE DESIGN, BE SURE TO
 RUN  PANDAOPT  MANY TIMES DURING AN OPTIMIZATION. INSPECT THE
 allen.OPP  FILE AFTER EACH OPTIMIZATION RUN. OR BETTER YET,
 RUN SUPEROPT.
 ******************** END OF allen.OPM FILE ****************
```

Compare with 2.704 for the IQUICK=1 case on p.25 of the Feb. 4th mailing.

Table 15(b) allen.CHG (for the final optimum design)

```
   n         $ Do you want a tutorial session and tutorial output?
   y         $ Do you want to change any values in Parameter Set No. 1?
      1      $ Number of parameter to change (1, 2, 3, . .)
 26.66660    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      2      $ Number of parameter to change (1, 2, 3, . .)
 8.879600    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      3      $ Number of parameter to change (1, 2, 3, . .)
 3.462700    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      4      $ Number of parameter to change (1, 2, 3, . .)
0.2536800    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      5      $ Number of parameter to change (1, 2, 3, . .)
0.1104900    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      6      $ Number of parameter to change (1, 2, 3, . .)
 1.335000    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      7      $ Number of parameter to change (1, 2, 3, . .)
 7.293800    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      8      $ Number of parameter to change (1, 2, 3, . .)
0.2718100    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
      9      $ Number of parameter to change (1, 2, 3, . .)
 9.364200    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
     10      $ Number of parameter to change (1, 2, 3, . .)
 0.000000    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
     11      $ Number of parameter to change (1, 2, 3, . .)
 7.304600    $ New value of the parameter
   y         $ Want to change any other parameters in this set?
     12      $ Number of parameter to change (1, 2, 3, . .)
0.6500000E-01 $ New value of the parameter
   n         $ Want to change any other parameters in this set?
   n         $ Do you want to change values of "fixed" parameters?
   n         $ Do you want to change values of allowables?
```

These values are obtained from the bottom of Table 15(a) (pages 5 & 6 of 15(a))

p. 39(b)

RUN STREAM

RUN STREAM USED TO OBTAIN MY RESULTS

```
panda2log
begin           Table 4
setup
decide          Table 5
mainsetup       Table 6
superopt
(inspect the allen.OPP file)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 1
(edit allen.OPT to get fixed design: ITYPE = 2)
mainsetup
pandaopt
(inspect the allen.OPM file.)   Table 7

(Next, change the *.BEG and *.DEC files
 as appropriate and optimize again:
 1, In *.BEG use higher starting values
    for H(STR), H(RNG), TSUB and HSUB (substringer)
 2. In *.BEG change NB2 from 0 to 1
 3. In *.DEC put higher upper bounds on
    H(STR), T(1)(SKN), T(2)(STR), t(3)(RNG)
 4. In *.DEC add H(RNG) as a decision variable
 5. In *.DEC eliminate the peculiar inequality
    constraint.
 6. In *.DEC eliminate the 2nd linking
    expression (where H(RNG) = H(STR)).

begin           Table 8
setup
decide          Table 9
mainsetup       Table 10
superopt
(inspect the allen.OPP file)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 2
(edit allen.OPT to get fixed design: ITYPE = 2)
mainsetup
pandaopt
(inspect the allen.OPM file.)   Table 11
```

Feb 4th stuff
Mailed separately

```
(Next, leave *.BEG, *.DEC the same, change *.OPT
 so that IQUICK = 0 instead of IQUICK = 1)

begin           Table 12
setup
decide          Table 13
mainsetup       Table 14
superopt
(inspect the allen.OPP file)
(SUPEROPT bombs at Iteration no. 187. Therefore,
follow the directions given in Table 15,
also in Item 580 of the file .../panda2/doc/panda2.news)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 3
(We still have to complete the SUPEROPT run)
change          Table 15
setup
mainsetup
superopt
(inspect the allen.OPP file)
chooseplot
diplot
(inspect the allen.5.ps file)   Fig. 2
(edit allen.OPT to get fixed design: ITYPE = 2)
mainsetup
pandaopt
(inspect the allen.OPM file.)   Table 15(a)
change                          Table 15(b) ← save the optimum design
```

See pp. 27 – 39

40

(Next, take out the substiffeners and optimize the panel without substiffeners to compare the optimum weight with that for the optimum design of the shell with substiffeners. Use IQUICK = 0 The case is called "allen2".

```
begin           Table 16
setup
decide          Table 17
mainsetup       Table 18
superopt
(inspect the allen2.OPP file)
chooseplot
diplot
(inspect the allen2.5.ps file)   Fig. 5
(edit allen2.OPT to get fixed design: ITYPE = 2)
mainsetup
pandaopt
(inspect the allen2.OPM file.)   Table 19
```

See pp. 42–48

Table 16 allen2.BEG

```
   n         $ Do you want a tutorial session and tutorial output?
  124        $ Panel length normal to the plane of the screen, L1
 622.0353    $ Panel length in the plane of the screen, L2
   r         $ Identify type of stiffener along L1 (N,T,J,Z,R,A,C,G)
     8       $ stiffener spacing, b
0.6670000    $ width of stringer base, b2 (must be > 0, see Help)
6.0000000    $ height of stiffener (type H for sketch), h
   n         $ Are the stringers cocured with the skin?
  10000      $ What force/(axial length) will cause web peel-off?
   n         $ Is the next group of layers to be a "default group" (12 layers!)?
     1       $ number of layers in the next group in Segment no.( 1)
   n         $ Can winding (layup) angles ever be decision variables?
     1       $ layer index (1,2,...), for layer no.( 1)
   y         $ Is this a new layer type?
0.6500000E-01 $ thickness for layer index no.( 1)
     0       $ winding angle (deg.) for layer index no.( 1)
     1       $ material index (1,2,...) for layer index no.( 1)
   n         $ Any more layers or groups of layers in Segment no.( 1)
   n         $ Is the next group of layers to be a "default group" (12 layers!)?
     1       $ number of layers in the next group in Segment no.( 2)
   n         $ Can winding (layup) angles ever be decision variables?
     1       $ layer index (1,2,...), for layer no.( 1)
   n         $ Is this a new layer type?
   n         $ Any more layers or groups of layers in Segment no.( 2)
   n         $ Is the next group of layers to be a "default group" (12 layers!)?
     1       $ number of layers in the next group in Segment no.( 3)
   n         $ Can winding (layup) angles ever be decision variables?
     2       $ layer index (1,2,...), for layer no.( 1)
   y         $ Is this a new layer type?
0.6500000    $ thickness for layer index no.( 2)
     0       $ winding angle (deg.) for layer index no.( 2)
     1       $ material index (1,2,...) for layer index no.( 2)
   n         $ Any more layers or groups of layers in Segment no.( 3)
     1       $ choose external (0) or internal (1) stringers
   r         $ Identify type of stiffener along L2  (N, T, J, Z, R, A)
     8       $ stiffener spacing, b
     0       $ width of ring base, b2 (zero is allowed)
4.0000000    $ height of stiffener (type H for sketch), h
   n         $ Are the rings cocured with the skin?
   n         $ Is the next group of layers to be a "default group" (12 layers!)?
     1       $ number of layers in the next group in Segment no.( 3)
   n         $ Can winding (layup) angles ever be decision variables?
     3       $ layer index (1,2,...), for layer no.( 1)
   y         $ Is this a new layer type?
0.6500000    $ thickness for layer index no.( 3)
     0       $ winding angle (deg.) for layer index no.( 3)
     1       $ material index (1,2,...) for layer index no.( 3)
   n         $ Any more layers or groups of layers in Segment no.( 3)
     1       $ choose external (0) or internal (1) rings
   y         $ Is the panel curved in the plane of the screen (Y for cyls.)?
  198        $ Radius of curvature (cyl. rad.) in the plane of screen, R
   n         $ Is panel curved normal to plane of screen? (answer N)
   y         $ Is this material isotropic (Y or N)?
0.1120000E+08 $ Young's modulus,              E( 1)
0.3000000    $ Poisson's ratio,              NU( 1)
 4307692.    $ transverse shear modulus,      G13( 1)
     0       $ Thermal expansion coeff.,    ALPHA( 1)
     0       $ residual stress temperature (positive),TEMPTUR( 1)
   n         $ Want to supply a stress-strain "curve" for this mat'l? (N)
   y         $ Want to specify  maximum effective stress ?
 66000.00    $ Maximum allowable effective stress in material type( 1)
   n         $ Do you want to take advantage of "bending overshoot"?
0.9800000E-01 $ weight density (greater than 0!) of material type( 1)
   n         $ Is lamina cracking permitted along fibers (type H(elp))?
     0       $ Prebuckling: choose 0=bending included; 2=use membrane theory
     0       $ Buckling: choose 0=simple support or 1=clamping
```

Table17 ...2.DEC

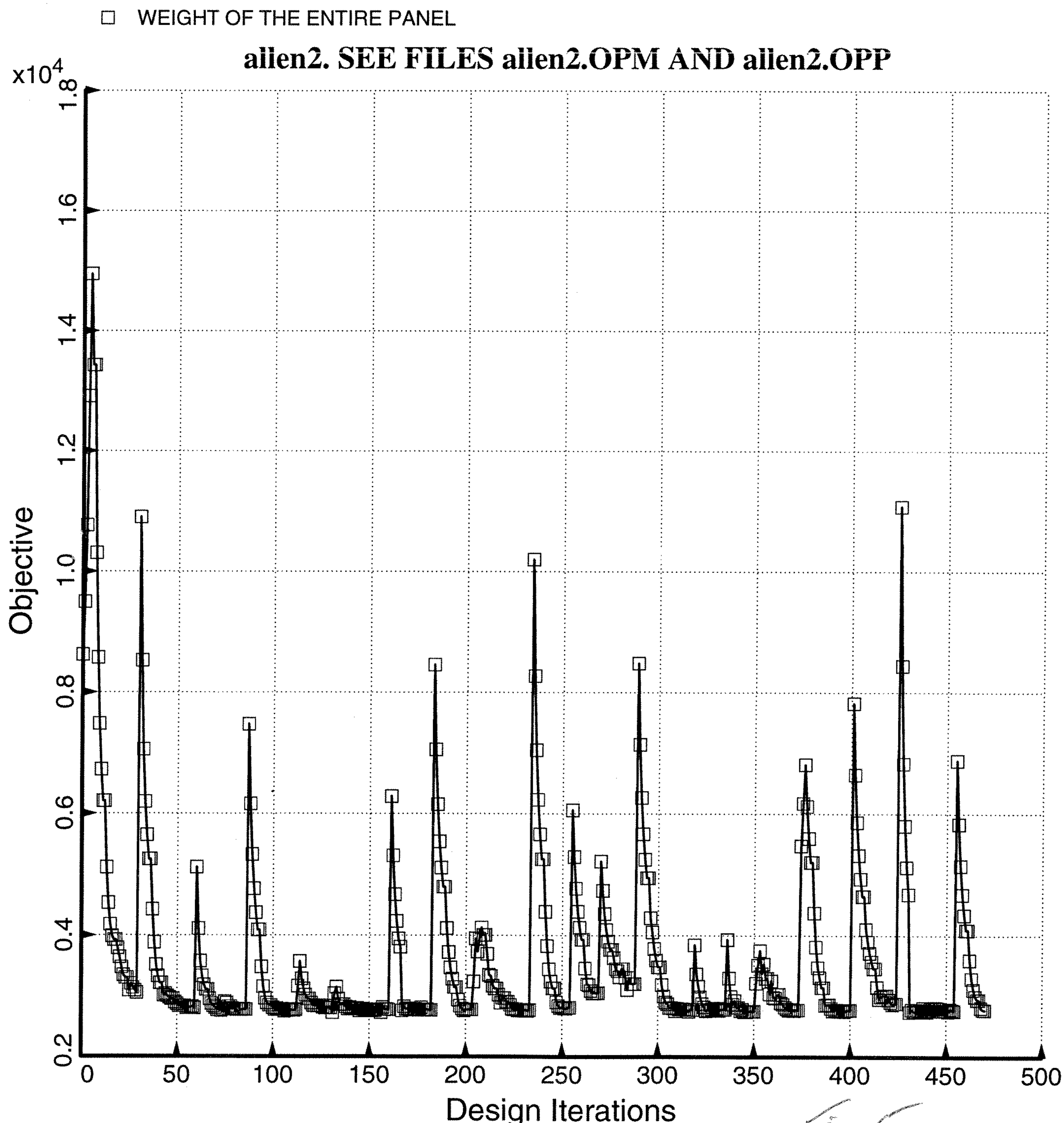
```
    n          $ Do you want a tutorial session and tutorial output?
    n          $ Want to use default for thickness decision variables (type H(elp)?
       1       $ Choose a decision variable (1,2,3,...)
       2       $ Lower bound of variable no.( 1)
      50       $ Upper bound of variable no.( 1)
    y          $ Any more decision variables (Y or N) ?
       3       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 3)
 10.50000      $ Upper bound of variable no.( 3)
    y          $ Any more decision variables (Y or N) ?
       4       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 4)
 2.000000      $ Upper bound of variable no.( 4)
    y          $ Any more decision variables (Y or N) ?
       5       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 5)
 3.000000      $ Upper bound of variable no.( 5)
    y          $ Any more decision variables (Y or N) ?
       6       $ Choose a decision variable (1,2,3,...)
 2.000000      $ Lower bound of variable no.( 6)
 50.00000      $ Upper bound of variable no.( 6)
    y          $ Any more decision variables (Y or N) ?
       8       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 8)
 10.50000      $ Upper bound of variable no.( 8)
    y          $ Any more decision variables (Y or N) ?
       9       $ Choose a decision variable (1,2,3,...)
0.6500000E-01  $ Lower bound of variable no.( 9)
 3.000000      $ Upper bound of variable no.( 9)
    n          $ Any more decision variables (Y or N) ?
    y          $ Any linked variables (Y or N) ?
       2       $ Choose a linked variable (1,2,3,...)
       1       $ To which variable is this variable linked?
0.3330000      $ Assign a value to the linking coefficient, C(j)
    n          $ Any other decision variables in the linking expression?
    n          $ Any constant C0 in the linking expression (Y or N)?
    n          $ Any more linked variables (Y or N) ?
    n          $ Any inequality relations among variables? (type H)
    y          $ Any escape variables (Y or N) ?
    y          $ Want to have escape variables chosen by default?
```

Table 18 allen2.OPT

```
       n           $ Do you want a tutorial session and tutorial output?
   -8025           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx( 1)
       0           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny( 1)
       0           $ In-plane shear in load set A,                    Nxy( 1)
       n           $ Does the axial load vary in the L2 direction?
       0           $ Applied axial moment resultant (e.g. in-lb/in), Mx( 1)
       0           $ Applied hoop moment resultant (e.g. in-lb/in), My( 1)
       y           $ Want to include effect of transverse shear deformation?
       0           $ IQUICK = quick analysis indicator (0 or 1)
       y           $ Do you want to vary M for minimum local buckling load?
       n           $ Do you want to choose a starting M for local buckling?
       y           $ Do you want to perform a "low-axial-wavenumber" search?
2.153846           $ Factor of safety for general instability, FSGEN( 1)
1.555556           $ Factor of safety for panel (between rings) instability, FSPAN( 1)
1.555556           $ Minimum load factor for local buckling (Type H for HELP), FSLOC( 1)
1.555556           $ Minimum load factor for stiffener buckling (Type H), FSBSTR( 1)
       1           $ Factor of safety for stress, FSSTR( 1)
       y           $ Do you want "flat skin" discretized module for local buckling?
       n           $ Do you want wide-column buckling to constrain the design?
       0           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx0( 1)
       0           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny0( 1)
       1           $ Axial load applied along the (0=neutral plane), (1=panel skin)
       0           $ Uniform applied pressure [positive upward. See H(elp)], p( 1)
       0           $ Out-of-roundness, Wimpg1=(Max.diameter-Min.diam)/4, Wimpg1( 1)
       0           $ Initial buckling modal general imperfection amplitude, Wimpg2( 1)
       0           $ Initial buckling modal inter-ring imperfection amplitude,Wpan( 1)
       0           $ Initial local imperfection amplitude (must be positive), Wloc( 1)
       n           $ Do you want PANDA2 to change imperfection amplitudes (see H(elp))?( 1)
       y           $ Do you want PANDA2 to find the general imperfection shape?( 1)
       0           $ Maximum allowable average axial strain (type H for HELP)( 1)
       n           $ Is there any thermal "loading" in this load set (Y/N)?
       y           $ Do you want a "complete" analysis (type H for "Help")?
       y           $ Want to provide another load set ?
   -8025           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx( 2)
       0           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny( 2)
       0           $ In-plane shear in load set A,                    Nxy( 2)
       n           $ Does the axial load vary in the L2 direction?
       0           $ Applied axial moment resultant (e.g. in-lb/in), Mx( 2)
       0           $ Applied hoop moment resultant (e.g. in-lb/in), My( 2)
       y           $ Want to include effect of transverse shear deformation?
       0           $ IQUICK = quick analysis indicator (0 or 1)
       y           $ Do you want to vary M for minimum local buckling load?
       n           $ Do you want to choose a starting M for local buckling?
       y           $ Do you want to perform a "low-axial-wavenumber" search?
       1           $ Factor of safety for general instability, FSGEN( 2)
       1           $ Factor of safety for panel (between rings) instability, FSPAN( 2)
       1           $ Minimum load factor for local buckling (Type H for HELP), FSLOC( 2)
       1           $ Minimum load factor for stiffener buckling (Type H), FSBSTR( 2)
1.265753           $ Factor of safety for stress, FSSTR( 2)
       y           $ Do you want "flat skin" discretized module for local buckling?
       n           $ Do you want wide-column buckling to constrain the design?
       0           $ Resultant (e.g. lb/in) normal to the plane of screen, Nx0( 2)
11266.20           $ Resultant (e.g. lb/in) in the plane of the screen,    Ny0( 2)
       1           $ Axial load applied along the (0=neutral plane), (1=panel skin)
-56.90000          $ Uniform applied pressure [positive upward. See H(elp)], p( 2)
       n           $ Is the pressure part of Load Set A?
       n           $ Is the pressure hydrostatic (Type H for "HELP")?
       0           $ Choose in-plane immovable (IFREE=0) or movable (IFREE=1) b.c.( 2)
       y           $ Are you feeling well today (type H)?
       n           $ Is there a maximum allowable deflection due to pressure?
       0           $ Out-of-roundness, Wimpg1=(Max.diameter-Min.diam)/4, Wimpg1( 2)
       0           $ Initial buckling modal general imperfection amplitude, Wimpg2( 2)
       0           $ Initial buckling modal inter-ring imperfection amplitude,Wpan( 2)
       0           $ Initial local imperfection amplitude (must be positive), Wloc( 2)
       n           $ Do you want PANDA2 to change imperfection amplitudes (see H(elp))?( 2)
       y           $ Do you want PANDA2 to find the general imperfection shape?( 2)
       0           $ Maximum allowable average axial strain (type H for HELP)( 2)
       n           $ Is there any thermal "loading" in this load set (Y/N)?
       y           $ Do you want a "complete" analysis (type H for "Help")?
       n           $ Want to provide another load set ?
       n           $ Do you want to impose minimum TOTAL thickness of any segment?
       n           $ Do you want to impose maximum TOTAL thickness of any segment?
       n           $ Do you want to impose minimum TOTAL thickness of any segment?
       n           $ Do you want to impose maximum TOTAL thickness of any segment?
       n           $ Use reduced effective stiffness in panel skin (H(elp), Y or N)?
       0           $ NPRINT= output index (-1=min. 0=good, 1=ok, 2=more, 3=too much)
       0           $ Index for type of shell theory (0 or 1 or 2), ISAND
       n           $ Does the postbuckling axial wavelength of local buckles change?
```

Table 18 allen2.OPT (continued)

```
        n           $ Want to suppress general buckling mode with many axial waves?
        n           $ Do you want to double-check PANDA-type eigenvalues [type (H)elp]?
           1        $ Choose (0=transverse inextensional; 1=transverse extensional)
           1        $ Choose ICONSV = -1 or 0 or 1 or H(elp), ICONSV
           2        $ Choose type of analysis (ITYPE = 1 or 2 or 3 or 4 or 5)
        Y           $ Do you want to prevent secondary buckling (mode jumping)?
        Y           $ Do you want to use the "alternative" buckling solution?
  1.000000          $ Factor of safety for "alternative" model of general buckling
           5        $ How many design iterations permitted in this run (5 to 25)?
  1.000000          $ MAXMAR. Plot only those margins less than MAXMAR (Type H)
        N           $ Do you want to reset total iterations to zero (Type H)?
           1        $ Index for objective (1=min. weight, 2=min. distortion)
  1.000000          $ FMARG (Skip load case with min. margin greater than FMARG)
```



WEIGHT OF THE ENTIRE PANEL
allen2. SEE FILES allen2.OPM AND allen2.OPP
x10^4
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
Objective
0
50
100
150
200
250
300
350
400
450
500
Design Iterations

46

Fig. 5

Table 19 abridged allen2.OPM

```
Abridged allen2.OPM file corresponding to the optimum design

NALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 1;  SUBCASE 1:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  0.00E+00  4.05E-05
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  1.6493E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  1.6325E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 1
 MAR. MARGIN
 NO.  VALUE                DEFINITION
 1   5.50E-02 Local buckling from discrete model-1.,M=3   axial halfwaves;FS=1.55
 2   6.02E-02 Local buckling from Koiter theory,M=3   axial halfwaves;FS=1.5556
 3   1.76E+00 eff.stress:matl=1,STR,Dseg=3,node=11,layer=1,z=0.1129; MID.;FS=1.
 4   2.38E+06 stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.
 5   7.41E-02 (m=3   lateral-torsional buckling load factor)/(FS)-1;FS=1.5556
 6   9.90E-02 Inter-ring bucklng, discrete model, n=24  circ.halfwaves;FS=1.5556
 7   1.76E+00 eff.stress:matl=1,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
 8   8.38E-02 buckling margin stringer Iseg.3 . Local halfwaves=3  .MID.;FS=1.555
 9   8.38E-02 buckling margin stringer Iseg.3 . Local halfwaves=3  .NOPO;FS=1.555
10  -4.99E-02 buck.(DONL);simp-support general buck;M=3;N=7;slope=0.;FS=2.1538
11   8.92E+00 buck.(DONL);rolling with smear rings; M=62;N=1;slope=0.;FS=1.5556
12   2.25E+00 buck.(DONL);rolling only of stringers;M=29;N=0;slope=0.;FS=1.4
13   4.79E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
14  -5.22E-02 buck.(SAND);simp-support general buck;M=3;N=7;slope=0.;FS=2.1538
15   8.92E+00 buck.(SAND);rolling with smear rings; M=62;N=1;slope=0.;FS=1.5556


 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 1;  SUBCASE 2:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  0.00E+00  4.05E-05
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  1.6476E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  1.6368E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 2
 MAR. MARGIN
 NO.  VALUE                DEFINITION
 1   5.76E-02 Local buckling from discrete model-1.,M=3   axial halfwaves;FS=1.55
 2   5.92E-02 Local buckling from Koiter theory,M=3   axial halfwaves;FS=1.5556
 3   1.81E+00 eff.stress:matl=1,STR,Dseg=4,node=11,layer=1,z=0.1385; RNGS;FS=1.
 4   1.88E+06 stringer popoff margin:(allowable/actual)-1, web 1  RNGS;FS=1.
 5   7.32E-02 (m=3   lateral-torsional buckling load factor)/(FS)-1;FS=1.5556
 6   9.92E-02 Inter-ring bucklng, discrete model, n=24  circ.halfwaves;FS=1.5556
 7   1.83E+00 eff.stress:matl=1,SKN,Iseg=2,at:n=6,layer=1,z=0.1385;-RNGS;FS=1.
 8   1.35E-01 buckling margin stringer Iseg.3 . Local halfwaves=3  .RNGS;FS=1.555
 9   8.87E+00 buck.(DONL);rolling with smear rings; M=62;N=1;slope=0.;FS=1.5556
10   2.37E+00 buck.(DONL);rolling only of stringers;M=29;N=0;slope=0.;FS=1.4
11   4.75E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
12   8.87E+00 buck.(SAND);rolling with smear rings; M=62;N=1;slope=0.;FS=1.5556


 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 2;  SUBCASE 1:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  1.13E+04 -5.69E+01
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  2.4983E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  2.4803E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 2, SUBCASE NO. 1
 MAR. MARGIN
 NO.  VALUE                DEFINITION
 1   1.26E+00 Local buckling from discrete model-1.,M=5   axial halfwaves;FS=1.1
 2   1.25E+00 Bending-torsion buckling; M=5  ;FS=1.1
 3   1.27E+00 Bending-torsion buckling: Koiter theory,M=5   axial halfwav;FS=1.1
 4   9.03E-03 eff.stress:matl=1,SKN,Dseg=2,node=6,layer=1,z=-0.1385; MID.;FS=1.26
 5   1.18E+05 stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.2658
 6   1.30E+00 (m=5   lateral-torsional buckling load factor)/(FS)-1;FS=1.1
 7   1.12E+00 Inter-ring bucklng, discrete model, n=12  circ.halfwaves;FS=1.1
 8   9.03E-03 eff.stress:matl=1,SKN,Iseg=2,at:n=6,layer=1,z=-0.1385;-MID.;FS=1.26
 9   6.16E-01 buckling margin stringer Iseg.3 . Local halfwaves=5  .MID.;FS=1.
10   6.42E-01 buckling margin stringer Iseg.3 . Local halfwaves=5  .NOPO;FS=1.
11   1.12E+00 buck.(DONL);simp-support general buck;M=3;N=6;slope=0.;FS=1.1
12   1.75E+00 buck.(DONL);simp-support general buck;(0.85*altsol);FS=1.
13   1.32E+01 buck.(DONL);rolling with smear rings; M=62;N=1;slope=0.;FS=1.1
14   1.95E+00 buck.(DONL);rolling only of stringers;M=29;N=0;slope=0.;FS=1.4
```

Table #9 (continued)

```
15  3.46E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
16  1.11E+00 buck.(SAND);simp-support general buck;M=3;N=7;slope=0.;FS=1.1
17  1.74E+00 buck.(SAND);simp-support general buck;(0.85*altsol);FS=1.
18  1.32E+01 buck.(SAND);rolling with smear rings; M=62;N=1;slope=0.;FS=1.1


 ANALYSIS: ITYPE=2;  IQUICK=0;  LOAD SET 2;  SUBCASE 2:
 LOADING: Nx, Ny, Nxy, Mx, My =  -8.02E+03 -8.02E-03  4.01E+01  0.00E+00  0.00E+00
          Nxo, Nyo, pressure  =   0.00E+00  1.13E+04 -5.69E+01
 BUCKLING LOAD FACTORS FOR LOCAL BUCKLING FROM KOITER v. BOSOR4 THEORY:
  Local buckling load factor from KOITER theory =  2.5416E+00 (flat skin)
  Local buckling load factor from BOSOR4 theory =  2.5517E+00 (flat skin)
0
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 2, SUBCASE NO. 2
 MAR. MARGIN
 NO.  VALUE              DEFINITION
 1  1.33E+00 Local buckling from discrete model-1.,M=5   axial halfwaves;FS=1.1
 2  1.55E+00 Bending-torsion buckling; M=5  ;FS=1.
 3  1.31E+00 Bending-torsion buckling: Koiter theory,M=5   axial halfwav;FS=1.1
 4  6.03E-04 eff.stress:matl=1,STR,Dseg=4,node=11,layer=1,z=0.1385; RNGS;FS=1.26
 5  2.11E+05 stringer popoff margin:(allowable/actual)-1, web 1  RNGS;FS=1.2658
 6  1.30E+00 (m=5   lateral-torsional buckling load factor)/(FS)-1;FS=1.1
 7  1.11E+00 Inter-ring bucklng, discrete model, n=12  circ.halfwaves;FS=1.1
 8  1.03E-02 eff.stress:matl=1,SKN,Iseg=2,at:n=6,layer=1,z=0.1385;-RNGS;FS=1.265
 9  9.09E-01 buckling margin stringer Iseg.3 . Local halfwaves=5  .RNGS;FS=1.
10  1.28E+01 buck.(DONL);rolling with smear rings; M=62;N=1;slope=0.;FS=1.1
11  2.01E+00 buck.(DONL);rolling only of stringers;M=29;N=0;slope=0.;FS=1.4
12  3.36E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
13  1.28E+01 buck.(SAND);rolling with smear rings; M=62;N=1;slope=0.;FS=1.1
 ***********  ALL 2 LOAD SETS PROCESSED  ***********
 ****************************************************


          SUMMARY OF INFORMATION FROM OPTIMIZATION ANALYSIS
 VAR. DEC. ESCAPE LINK. LINKED  LINKING    LOWER    CURRENT    UPPER        DEFINITION
  NO. VAR.  VAR.  VAR.    TO   CONSTANT    BOUND     VALUE     BOUND
   1   Y     N     N      0    0.00E+00  2.00E+00 8.7902E+00  5.00E+01      B(STR):stiffener s»
pacing, b: STR seg=NA, layer=NA
   2   N     N     Y      1    3.33E-01  0.00E+00 2.9271E+00  0.00E+00      B2(STR):width of st»
ringer base, b2 (must be > 0, see
   3   Y     N     N      0    0.00E+00  6.50E-02 2.4957E+00  1.05E+01      H(STR):height of s»
tiffener (type H for sketch), h:
   4   Y     Y     N      0    0.00E+00  6.50E-02 2.7691E-01  2.00E+00    T(1 )(SKN):thickness f»
or layer index no.(1 ): SKN seg=1
   5   Y     Y     N      0    0.00E+00  6.50E-02 2.2588E-01  3.00E+00    T(2 )(STR):thickness f»
or layer index no.(2 ): STR seg=3
   6   Y     N     N      0    0.00E+00  2.00E+00 2.9775E+01  5.00E+01      B(RNG):stiffener s»
pacing, b: RNG seg=NA, layer=NA
   7   N     N     N      0    0.00E+00  0.00E+00 0.0000E+00  0.00E+00      B2(RNG):width of ri»
ng base, b2 (zero is allowed): RN
   8   Y     N     N      0    0.00E+00  6.50E-02 1.0074E+01  1.05E+01      H(RNG):height of s»
tiffener (type H for sketch), h:
   9   Y     Y     N      0    0.00E+00  6.50E-02 6.5000E-02  3.00E+00    T(3 )(RNG):thickness f»
or layer index no.(3 ): RNG seg=3
0
   CURRENT VALUE OF THE OBJECTIVE FUNCTION:
 VAR. STR/ SEG. LAYER   CURRENT
 NO.  RNG  NO.   NO.     VALUE            DEFINITION
            0     0    2.744E+03   WEIGHT OF THE ENTIRE PANEL

  TOTAL WEIGHT OF SKIN                               =   2.0932E+03
  TOTAL WEIGHT OF SUBSTIFFENERS                      =   0.0000E+00
  TOTAL WEIGHT OF STRINGERS                          =   4.8477E+02
  TOTAL WEIGHT OF RINGS                              =   1.6624E+02
  SPECIFIC WEIGHT (WEIGHT/AREA) OF STIFFENED PANEL=   3.5577E-02
 IN ORDER TO AVOID FALSE CONVERGENCE OF THE DESIGN, BE SURE TO
 RUN  PANDAOPT  MANY TIMES DURING AN OPTIMIZATION. INSPECT THE
 allen2.OPP  FILE AFTER EACH OPTIMIZATION RUN. OR BETTER YET,
 RUN SUPEROPT.
 ******************** END OF allen2.OPM FILE ****************
```


Compare with 2.720 on p. 39

RUN STREAM

```
RUN STREAM USED TO OBTAIN "allen3" RESULTS
(same as "allen" except that 4 materials
 are specified instead of only 1 material)

(First, re-run the "allen" case, no optimization
 just the fixed (optimum) design, as follows:)

panda2log
begin            table 12
change           table 15(b)
setup
decide           table 13
mainsetup        table 14, except ITYPE=2
pandaopt
(Inspect the allen.OPM file.    Table 20)

(Next, set up a new case, "allen3" using 4
 different material types instead of just 1 material type)

cp allen.BEG allen3.BEG   (table 12)
cp allen.DEC allen3.DEC   (table 13)
cp allen.OPT allen3.OPT   (table 14 except ITYPE=2)
cp allen.CHG allen3.CHG   (table 15b)

(edit allen3.BEG to introduce a new material
 for each part of the structure:
  Material 1 = shell skin
  Material 2 = substringers
  Material 3 = major stringers
  Material 4 = major rings
 By this device you see what the stress margins
 are for each part of the structure.)

begin            Table 21 ← Note
change           Table 15((b)
setup
decide           Table 13
mainsetup        Table 14 except ITYPE = 2)
pandaopt
(inspect the allen3.OPM file.)  Tables 22 and 23.
```

NOTE: In this "allen3" case I have specified 4 different materials even though the material properties are the same for each of the 4 material types. Why do I sometimes do this?

1. You know more about the behavior of the structure because you now have a stress margin(s) for each material type. Therefore, you see which part of the structure is most critical with respect to stress.

2. Sometimes during optimization you get an "oscillatory" behavior from design iteration to iteration. This "oscillatory" behavior is very often caused by the maximum stress alternatively occuring at first one and then another part of the structure from one design iteration to the next and then back again. If this maximum stress is critical or near-critical then the current design "flip-flops" from one configuration to an alternate configuration from one design iteration to the next. This "flip-flop" behavior can sometimes be eliminated by using multiple materials (even though the whole structure may be made of only one material). Please see page. 143 of the paper, AIAA-96-1337-CP, from the 37th AIAA SDM Meeting, April, 1996 for a discussion of using multiple material numbers in a structure made of only one actual material, in order to smooth the results from design iteration to design iteration. In particular, compare Fig. 41 with Fig. 35 and Fig. 42 with Fig. 39 of that paper.

There is a disadvantage to this more detailed formulation:
The computer runs are longer
because there are more design margins. Also, you may have a case in which the total number of active margins approaches and exceeds the limit allowed. (I forget what this limit is; 50, I think.).

TABLE 20 First set of margins after "CHANGE" (Table 15(b))

The abridged allen.OPM file obtained
with only one material specified in allen.BEG (Table 12)

```
 MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 1
 MAR. MARGIN
 NO.  VALUE              DEFINITION
 1  1.25E-01 Local buckling from discrete model-1.,M=1   axial halfwaves;FS=1.55
 2 -1.35E-02 Bending-torsion buckling; M=1  ;FS=2.1538
 3  5.47E-01 Bending-torsion buckling: Koiter theory,M=1   axial halfwav;FS=1.55
 4  1.56E+00 eff.stress:matl=1,STR,Dseg=3,node=11,layer=1,z=0.1359; MID.;FS=1.
 5  1.25E+04 stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.
 6  1.58E+00 matl=1 ; substiffener effective stressSTRTHK MID.;FS=1.
 7  1.70E-01 (m=1   lateral-torsional buckling load factor)/(FS)-1;FS=1.5556
 8  6.65E+00 Inter-ring bucklng, discrete model, n=53  circ.halfwaves;FS=1.5556
 9  1.57E+00 matl=1 ; substiffener effective stressSTRCON MID.;FS=1.
10  1.56E+00 eff.stress:matl=1,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
11  5.83E-01 buck.(DONL);simp-support inter-ring;  (1.00*altsol);FS=1.5556
12 -5.51E-03 buck.(DONL);simp-support general buck;M=2;N=7;slope=0.;FS=2.1538
13  9.14E-01 buck.(DONL);simp-support general buck;(0.85*altsol);FS=1.
14 -7.43E-03 buck.(DONL);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
15  1.28E+00 buck.(DONL);rolling only of stringers;M=23;N=0;slope=0.;FS=1.4
16  1.79E-01 buck.(DONL);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556
17  1.93E-01 buckling:simp-support of substring.M=1;FS=1.
18 -4.44E-02 buckling:simp-support altsoln4  intermajorpatch; FS=1.5556
19  4.36E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
20  5.83E-01 buck.(SAND);simp-support inter-ring;  (1.00*altsol);FS=1.5556
21 -1.22E-02 buck.(SAND);simp-support general buck;M=2;N=7;slope=0.;FS=2.1538
22  9.12E-01 buck.(SAND);simp-support general buck;(0.85*altsol);FS=1.
23 -7.25E-03 buck.(SAND);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
24  1.79E-01 buck.(SAND);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556
```

compare with p. 4 Table 15(a).

3 stress margins

Margins with specification of only one material.

Table 21 allen3.BEG (use 4 materials)

Mat'l 1 = skin
" 2 = substringers
" 3 = major stringers
" 4 = major rings

```
      n          $ Do you want a tutorial session and tutorial output?
     124         $ Panel length normal to the plane of the screen, L1
   622.0353      $ Panel length in the plane of the screen, L2
      r          $ Identify type of stiffener along L1 (N,T,J,Z,R,A,C,G)
      8          $ stiffener spacing, b
  0.6670000      $ width of stringer base, b2 (must be > 0, see Help)
   6.000000      $ height of stiffener (type H for sketch), h
      n          $ Are the stringers cocured with the skin?
    10000        $ What force/(axial length) will cause web peel-off?
      n          $ Is the next group of layers to be a "default group" (12 layers!)?
      1          $ number of layers in the next group in Segment no.( 1)
      n          $ Can winding (layup) angles ever be decision variables?
      1          $ layer index (1,2,...), for layer no.( 1)
      y          $ Is this a new layer type?
  0.6500000E-01  $ thickness for layer index no.( 1)
      0          $ winding angle (deg.) for layer index no.( 1)
skin  1          $ material index (1,2,...) for layer index no.( 1)
      y          $ Any more layers or groups of layers in Segment no.( 1)
      n          $ Is the next group of layers to be a "default group"?
      y          $ Does one of the additional layers consist of sub-stiffeners?
      n          $ Does this sub-stiffener "layer" form an isogrid?
      0          $ Index, NSURF = 0 or 1, for substiffener "layer"( 1)
      1          $ Index, NB2 = 0 or 1, for substiffener "layer"( 1)
  0.2000000      $ Thickness, TSUB, of substiffener set( 1)
   2.000000      $ Height, HSUB, of substiffener set( 1)
      0          $ Angle, THSUB (degrees), of substiffener set( 1)
      2          $ Spacing, BSUB, of substiffener set( 1)
substringer 2    $ Material type, MATSUB,  for substiffener set( 1)
      n          $ Are there any more substiffener sets in substiffener "layer"
      n          $ Is the next group of layers to be a "default group" (12 layers!)?
      1          $ number of layers in the next group in Segment no.( 2)
      n          $ Can winding (layup) angles ever be decision variables?
      1          $ layer index (1,2,...), for layer no.( 1)
      n          $ Is this a new layer type?
      n          $ Any more layers or groups of layers in Segment no.( 2)
      n          $ Is the next group of layers to be a "default group" (12 layers!)?
      1          $ number of layers in the next group in Segment no.( 3)
      n          $ Can winding (layup) angles ever be decision variables?
      2          $ layer index (1,2,...), for layer no.( 1)
      y          $ Is this a new layer type?
  0.6500000      $ thickness for layer index no.( 2)
      0          $ winding angle (deg.) for layer index no.( 2)
stringer 3       $ material index (1,2,...) for layer index no.( 2)
      n          $ Any more layers or groups of layers in Segment no.( 3)
      1          $ choose external (0) or internal (1) stringers
      r          $ Identify type of stiffener along L2  (N, T, J, Z, R, A)
      8          $ stiffener spacing, b
      0          $ width of ring base, b2 (zero is allowed)
   4.000000      $ height of stiffener (type H for sketch), h
      n          $ Are the rings cocured with the skin?
      n          $ Is the next group of layers to be a "default group" (12 layers!)?
      1          $ number of layers in the next group in Segment no.( 3)
      n          $ Can winding (layup) angles ever be decision variables?
      3          $ layer index (1,2,...), for layer no.( 1)
      y          $ Is this a new layer type?
  0.6500000      $ thickness for layer index no.( 3)
      0          $ winding angle (deg.) for layer index no.( 3)
ring  4          $ material index (1,2,...) for layer index no.( 3)
      n          $ Any more layers or groups of layers in Segment no.( 3)
      1          $ choose external (0) or internal (1) rings
      y          $ Is the panel curved in the plane of the screen (Y for cyls.)?
     198         $ Radius of curvature (cyl. rad.) in the plane of screen, R
      n          $ Is panel curved normal to plane of screen? (answer N)
      y          $ Is this material isotropic (Y or N)?
  0.1120000E+08  $ Young's modulus,                  E( 1)
  0.3000000      $ Poisson's ratio,                 NU( 1)
   4307692.      $ transverse shear modulus,       G13( 1)
      0          $ Thermal expansion coeff.,     ALPHA( 1)
      0          $ residual stress temperature (positive),TEMPTUR( 1)
      n          $ Want to supply a stress-strain "curve" for this mat'l? (N)
      y          $ Want to specify  maximum effective stress ?
   66000.00      $ Maximum allowable effective stress in material type( 1)
      n          $ Do you want to take advantage of "bending overshoot"?
  0.9800000E-01  $ weight density (greater than 0!) of material type( 1)
      n          $ Is lamina cracking permitted along fibers (type H(elp))?
      y          $ Is this material isotropic (Y or N)?
  0.1120000E+08  $ Young's modulus,                  E( 2)
  0.3000000      $ Poisson's ratio,                 NU( 2)
```

Table 21 (continued)

```
 4307692.      $ transverse shear modulus,      G13( 2)
     0         $ Thermal expansion coeff.,    ALPHA( 2)
     0         $ residual stress temperature (positive),TEMPTUR( 2)
   n           $ Want to supply a stress-strain "curve" for this mat'l? (N)
   y           $ Want to specify  maximum effective stress ?
 66000.00      $ Maximum allowable effective stress in material type( 2)
0.9800000E-01 $ weight density (greater than 0!) of material type( 2)
   n           $ Is lamina cracking permitted along fibers (type H(elp))?
   y           $ Is this material isotropic (Y or N)?
0.1120000E+08 $ Young's modulus,                 E( 3)
0.3000000      $ Poisson's ratio,                NU( 3)
 4307692.      $ transverse shear modulus,      G13( 3)
     0         $ Thermal expansion coeff.,    ALPHA( 3)
     0         $ residual stress temperature (positive),TEMPTUR( 3)
   n           $ Want to supply a stress-strain "curve" for this mat'l? (N)
   y           $ Want to specify  maximum effective stress ?
 66000.00      $ Maximum allowable effective stress in material type( 3)
   n           $ Do you want to take advantage of "bending overshoot"?
0.9800000E-01 $ weight density (greater than 0!) of material type( 3)
   n           $ Is lamina cracking permitted along fibers (type H(elp))?
   y           $ Is this material isotropic (Y or N)?
0.1120000E+08 $ Young's modulus,                 E( 4)
0.3000000      $ Poisson's ratio,                NU( 4)
 4307692.      $ transverse shear modulus,      G13( 4)
     0         $ Thermal expansion coeff.,    ALPHA( 4)
     0         $ residual stress temperature (positive),TEMPTUR( 4)
   n           $ Want to supply a stress-strain "curve" for this mat'l? (N)
   y           $ Want to specify  maximum effective stress ?
 66000.00      $ Maximum allowable effective stress in material type( 4)
   n           $ Do you want to take advantage of "bending overshoot"?
0.9800000E-01 $ weight density (greater than 0!) of material type( 4)
   n           $ Is lamina cracking permitted along fibers (type H(elp))?
     0         $ Prebuckling: choose 0=bending included; 2=use membrane theory
     0         $ Buckling: choose 0=simple support or 1=clamping
```

Table 22 abridged allen3.OPM file

Table 22

abridged allen3.OPM file with 4 materials specified in allen3.BEG

```
MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 1, SUBCASE NO. 1
MAR. MARGIN
NO.  VALUE                  DEFINITION
 1  1.25E-01 Local buckling from discrete model-1.,M=1   axial halfwaves;FS=1.55
 2 -1.35E-02 Bending-torsion buckling; M=1  ;FS=2.1538
 3  5.47E-01 Bending-torsion buckling: Koiter theory,M=1   axial halfwav;FS=1.55
 4  1.60E+00 eff.stress:matl=1,SKN,Dseg=2,node=6,layer=1,z=-0.1268; MID.;FS=1.
 5  1.25E+04 stringer popoff margin:(allowable/actual)-1, web 1  MID.;FS=1.
 6  1.56E+00 eff.stress:matl=3,STR,Dseg=3,node=11,layer=1,z=0.1359; MID.;FS=1.
 7  1.58E+00 matl=2 ; substiffener effective stressSTRTHK MID.;FS=1.
 8  1.70E-01 (m=1   lateral-torsional buckling load factor)/(FS)-1;FS=1.5556
 9  6.65E+00 Inter-ring bucklng, discrete model, n=53  circ.halfwaves;FS=1.5556
10  1.60E+00 eff.stress:matl=1,SKN,Iseg=2,at:n=6,layer=1,z=-0.1268;-MID.;FS=1.
11  1.57E+00 matl=2 ; substiffener effective stressSTRCON MID.;FS=1.
12  1.56E+00 eff.stress:matl=3,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.
13  9.14E+00 eff.stress:matl=4,RNG,Iseg=3,at:TIP,layer=1,z=0.0325;-MID.;FS=1.
14  5.83E-01 buck.(DONL);simp-support inter-ring;  (1.00*altsol);FS=1.5556
15 -5.51E-03 buck.(DONL);simp-support general buck;M=2;N=7;slope=0.;FS=2.1538
16  9.14E-01 buck.(DONL);simp-support general buck;(0.85*altsol);FS=1.
17 -7.43E-03 buck.(DONL);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
18  1.28E+00 buck.(DONL);rolling only of stringers;M=23;N=0;slope=0.;FS=1.4
19  1.79E-01 buck.(DONL);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556
20  1.93E-01 buckling:simp-support of substring.M=1;FS=1.
21 -4.44E-02 buckling:simp-support altsoln4  intermajorpatch; FS=1.5556
22  4.36E+02 (Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
23  5.83E-01 buck.(SAND);simp-support inter-ring;  (1.00*altsol);FS=1.5556
24 -1.22E-02 buck.(SAND);simp-support general buck;M=2;N=7;slope=0.;FS=2.1538
25  9.12E-01 buck.(SAND);simp-support general buck;(0.85*altsol);FS=1.
26 -7.25E-03 buck.(SAND);rolling with smear rings; M=23;N=1;slope=0.;FS=1.5556
27  1.79E-01 buck.(SAND);rolling with skin buckl.; M=1;N=1;slope=0.;FS=1.5556
```

7 stress margins

Margins with specification of 4 materials.

Table 23 abridged allen3.OPM file

Table 23

MARGINS FOR CURRENT DESIGN: LOAD CASE NO. 2 SUBCASE NO. 1

MAR. NO.	MARGIN VALUE	DEFINITION
1	5.70E-01	Local buckling from discrete model-1.,M=1 axial halfwaves;FS=1.1
2	9.06E-01	Bending-torsion buckling; M=1 ;FS=1.1
3	1.17E+00	Bending-torsion buckling: Koiter theory,M=1 axial halfwav;FS=1.1
4	-1.92E-04	eff.stress:matl=1,SKN,Dseg=2,node=6,layer=1,z=-0.1268; MID.;FS=1.26
5	6.99E+03	stringer popoff margin:(allowable/actual)-1, web 1 MID.;FS=1.2658
6	4.62E-01	eff.stress:matl=3,STR,Dseg=3,node=11,layer=1,z=0.1359; MID.;FS=1.26
7	5.05E-01	matl=2 ; substiffener effective stressSTRTHK MID.;FS=1.2658
8	6.26E-01	(m=1 lateral-torsional buckling load factor)/(FS)-1;FS=1.1
9	9.94E+00	Inter-ring bucklng, discrete model, n=34 circ.halfwaves;FS=1.1
10	8.32E-05	eff.stress:matl=1,SKN,Iseg=2,at:n=6,layer=1,z=-0.1268;-MID.;FS=1.26
11	4.86E-01	matl=2 ; substiffener effective stressSTRCON MID.;FS=1.2658
12	4.63E-01	eff.stress:matl=3,STR,Iseg=3,at:TIP,layer=1,z=0.;-MID.;FS=1.2658
13	2.12E-01	eff.stress:matl=4,RNG,Iseg=3,at:TIP,layer=1,z=0.0325;-MID.;FS=1.265
14	1.45E+00	buck.(DONL);simp-support inter-ring; (1.00*altsol);FS=1.1
15	1.18E+00	buck.(DONL);simp-support general buck;M=3;N=6;slope=0.;FS=1.1
16	1.27E+00	buck.(DONL);simp-support general buck;(0.85*altsol);FS=1.
17	4.97E-01	buck.(DONL);rolling with smear rings; M=23;N=1;slope=0.;FS=1.1
18	1.02E+00	buck.(DONL);rolling only of stringers;M=23;N=0;slope=0.;FS=1.4
19	1.58E+00	buck.(DONL);rolling with skin buckl.; M=2;N=1;slope=0.;FS=1.1
20	-4.45E-03	buckling:simp-support of substring.M=2;FS=1.
21	9.21E-01	buckling:simp-support altsoln4 intermajorpatch; FS=1.1
22	3.22E+02	(Max.allowable ave.axial strain)/(ave.axial strain) -1; FS=1.
23	1.45E+00	buck.(SAND);simp-support inter-ring; (1.00*altsol);FS=1.1
24	1.17E+00	buck.(SAND);simp-support general buck;M=3;N=6;slope=0.;FS=1.1
25	1.27E+00	buck.(SAND);simp-support general buck;(0.85*altsol);FS=1.
26	4.97E-01	buck.(SAND);rolling with smear rings; M=23;N=1;slope=0.;FS=1.1
27	1.58E+00	buck.(SAND);rolling with skin buckl.; M=2;N=1;slope=0.;FS=1.1