**Table 2 The prompting file, balloon.PRO, generated automatically by the GENTEXT processor. This file contains the one-line prompts and “help” paragraphs that are created by the GENOPT user and seen by the end user.**

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5.0

This GENOPT case is for a cylindrical balloon

the wall of which is a double-walled sandwich made of cloth.

The case was brought to the attention of the author,

David Bushnell, by Mike Mayo (650-354-5463) on September 21,

1010. In this application, GENOPT works with BIGBOSOR4.

The cylindrical "balloon" has inner pressure

equal to PINNER, outer pressure equal to POUTER, and

pressure inside the double-walled sandwich equal to PMIDDL.

PINNER is the lowest pressure, PMIDDL is the highest

pressure, and POUTER is higher than PINNER but lower than

PMIDDL. PMIDDL must be high enough to provide enough

tension in the membrane segments of the "balloon" to

prevent buckling under the difference, POUTER - PINNER.

Details of the model and results are presented in Ref.[1]:

[1] Bushnell, David, "Use of GENOPT and BIGBOSOR4 to obtain

optimum designs of a double-walled inflatable cylindrical

vacuum chamber", unpublished report dated November, 2010.

Although the BIGBOSOR4 computer program is intended for

use with axisymmetric shell structures with "finite"

bending stiffness, the results obtained from this study of

a balloon that consists of "shell" segments that act like

membranes with essentially zero bending stiffness seem to

be reasonable. It is emphasized that the results presented

in [1] should be verified via models of the optimized

designs from one or more general-purpose finite element

codes such as STAGS or ABAQUS or NASTRAN.

10.1 length of the cylindrical shell: LENGTH

10.2

Use a value of about 6000 inches. It should not

matter what value you use because buckling (or collapse)

with N = zero circumferential waves around the circumference

of the huge torus is expected to be critical as of this

writing. N = 1 is used instead of N = 0 in order to

avoid rigid body "buckling" possible with N = 0.

15.1 inner radius of the cylindrical balloon: RADIUS

15.2

This is the radius to the points on the inner membranes

where these "shell" segments are connected to each other.

See Fig. x of [1].

20.1 number of modules over 90 degrees: NMODUL

20.2

This is the number of triangular "trusses" with two points

on the inner membrane and one point on the outer membrane

over a 90-degree sector of the circumference of the

cylindrical balloon. See Figs. 2 and 5 of [1]. For the

configuration in which the webs are radial rather than

slanted, the number of modules is equal to the number

of radial webs over 90 degrees of the circumference

of the cylindrical balloon. See Figs. 1 and 4 of [1].

25.0

Next you will be asked to provide material properties.

Three different materials are allowed:

1. The material of the outer and inner curved membranes.

2. The material of the outer and inner "truss" members

that run in the circumferential direction.

3. The material out of which the "truss" (slanted, Fig.2)

or radial (Fig. 1) webs are fabricated.

The material is orthotropic with the following properties:

EMOD1 = modulus in the meridional direction, that is,

in the direction along the arc of each shell segment in

the plane of the cross section of the complex wall

of the balloon.

EMOD2 = modulus in the circumferential direction of the

huge torus, that is, the modulus along the axis of the

prismatic shell.

G12 = in-plane shear modulus, that is, in the plane of

the wall of a "shell" segment

G13 = out-of plane shear modulus (not used, input required)

G23 = out-of-plane shear mdoulus (not used, input required)

NU = Poisson ratio

ALPHA1 = coefficient of thermal expansion in the meridional

direction

ALPHA2 = coefficient of thermal expansion in the

circumferential direction (prismatic axial direction)

TEMPER = temperature difference from the temperature at

which the balloon was fabricated (not used, input required)

DENSTY = weight density of the material

(Aluminum = 0.1 lb/in^3)

30.1 Number IEMOD1 of rows in the array EMOD1: IEMOD1

35.1 elastic modulus, meridional direction: EMOD1

40.1 elastic modulus, circumferential direction: EMOD2

45.1 in-plane shear modulus: G12

50.1 out-of-plane (s,z) shear modulus: G13

55.1 out-of-plane (y,z) shear modulus: G23

60.1 Poisson ratio: NU

65.1 meridional coef. thermal expansion: ALPHA1

70.1 circumf.coef.thermal expansion: ALPHA2

75.1 delta-T from fabrication temperature: TEMPER

80.1 weight density of material: DENSTY

85.0

Next, you will be asked to supply the decision variable

candidates. These are as follows:

1. HEIGHT = radial difference between the inner radius, RADIUS,

and the outer radius where the various segments

of the "balloon" are joined together.

2. RINNER = radius of curvature of the inner curved membrane,

the one that "bulges" inward.

3. ROUTER = radius of curvature of the outer curved membrane,

the one that "bulges" outward

4. TINNER = thickness of the inner curved membrane

5. TOUTER = thickness of the outer curved membrane

6. TFINNR = thickness of outer triangular truss segment

7. TFOUTR = thickness of inner triagular truss segment

8, TFWEBS = thickness of the webs

90.1 height from inner to outer membranes: HEIGHT

90.2

This is the difference from inner to outer radii at the

points where the inner segments are joined to eachother

and the outer segments are joined to eachother, that is,

the height between inner and outer walls of the "balloon"

not including the inward "bulging" of the inner wall and

the outward "bulging" of the outer wall.

95.1 radius of curvature of inner membrane: RINNER

100.1 radius of curvature of outer membrane: ROUTER

105.1 thickness of the inner curved membrane: TINNER

110.1 thickness of the outer curved membrane: TOUTER

115.1 thickness of inner truss-core segment: TFINNR

115.2

The three straight segments that form each module of the

truss core have different thicknesses as follows:

1. The outer truss-core member that is oriented in the

circumferential direction has thickness, TFOUTR.

2. The inner truss-core member that is oriented in the

circumferential direction has thickness, TFINNR.

3. The two truss-core webs each have thickness, TFWEBS

120.1 thickness of the outer truss segment: TFOUTR

120.2

The three straight segments that form each module of the

truss core have different thicknesses as follows:

1. The outer truss-core member that is oriented in the

circumferential direction has thickness, TFOUTR.

2. The inner truss-core member that is oriented in the

circumferential direction has thickness, TFINNR.

3. The two truss-core webs each have thickness, TFWEBS

125.1 thickness of each truss-core web: TFWEBS

125.2

The three straight segments that form each module of the

truss core have different thicknesses as follows:

1. The outer truss-core member that is oriented in the

circumferential direction has thickness, TFOUTR.

2. The inner truss-core member that is oriented in the

circumferential direction has thickness, TFINNR.

3. The two truss-core webs each have thickness, TFWEBS

130.0

Next, you will be asked to provide three pressures,

PINNER, PMIDDL, and POUTER, which are different from

each other and which are uniform over the entire structure.

1. PINNER = pressure inside the inner membrane. This is

the lowest of the three pressures.

2. PMIDDL = pressure between the inner membrane and outer

membrane. This is the highest of the three

pressures.

3. POUTER = pressure outside the outer membrane. This

pressure is higher than PINNER and lower than

PMIDDL.

Use positive numbers for PINNER, PMIDDL, and POUTER.

135.1 Number NCASES of load cases (environments): NCASES

140.1 pressure inside the inner membrane: PINNER

145.1 pressure between inner and outer membranes: PMIDDL

150.1 pressure outside the outer membrane: POUTER

155.0

Next, you will be asked to provide the "behaviors" that

might affect the evolution of the design during optimization

cycles. The "behaviors" included here are:

1. general buckling: GENBUK, GENBUKA, GENBUKF

GENBUK = general buckling load factor

GENBUKA= general buckling allowable

GENBUKF= general buckling factor of safety

NOTE: The "GENBUK" mode shape may actually represent

local buckling, not general buckling. In this generic

"balloon" case only the lowest buckling eigenvalue

is computed, whether it correspond to a general

buckling mode shape or whether it correspond to a

local buckling mode shape. Whichever buckling mode

happens to be represented by "GENBUK" will correspond

to the lowest eigenvalue. The other type of buckling

(general buckling if the lowest eigenvalue corresponds

to local buckling and local buckling if the lowest

eigenvalue corresponds to general buckling) will be

higher than the eigenvalue used to generate the

buckling constraint condition.

2. stresses: STRMi(j,k), STRMiA(j,k), STRMiF(j,k)

in which "i" is the material number, "j" is the load case

number, and "k" is the stress component.

STRMi(j,k) is the maximum stress.

STRMiA(j,k) is the stress allowable

STRMiF(j,k) is the stress factor of safety.

There are five stress components:

STRMi(j,1) = maximum tensile stress in the meridional direction

STRMi(j,2) = maximum compressive stress in the meridional direction

STRMi(j,3) = maxiamum tensile stress in the circumfer. direction

STRMi(j,4) = maximum compressive stress in the circumf.direction

STRMi(j,5) = maximum in-plane shear stress.

160.0 general buckling load factor: GENBUK

165.1 allowable for general buckling load factor: GENBUKA

165.2

Usually, you supply 1.0 for GENBUKA because GENBUK is

a buckling load FACTOR, that is, a quantity that is

to be multiplied by the design loads in order to obtain

the buckling load.

170.1 general buckling factor of safety: GENBUKF

170.2

For this problem, use 1.0.

175.1 Number JSTRM1 of columns in the array, STRM1: JSTRM1

180.0 stress component in material 1: STRM1

180.2

For an orthotropic material there are 5 stress components

for which stress constraints may be generated:

1. maximum tensile stess in the meridional direction

2. maximum compressive stress in the meridional direction

3. maximum tensile stress in the circumferential direction

4. maximum compressive stress in the circumferential direction

5. maximum in-plane shear stress

185.1 allowable stress in material 1: STRM1A

185.2

For an orthotropic material there are 5 stress components

for which stress constraints are generated:

1. maximum tensile stress in the meridional direction:

STRM1A(i,1), in which "i" is the load set number

2. maximum compressive stress in the meridional direction:

STRM1A(i,2), in which "i" is the load set number

3. maximum tensile stress in the circumferential direction:

STRM1A(i,3), in which "i" is the load set number

4. maximum compressive stress in the circumferential direction:

STRM1A(i,4), in which "i" is the load set number

5. maximum in-plane shear stress

STRM1A(i,5), in which "i" is the load set number

190.1 factor of safety for stress in material 1: STRM1F

190.2

In this application use a factor of safety of 1.0

195.0 stress component in material 2: STRM2

200.1 allowable for stress in material 2: STRM2A

205.1 factor of safety for stress in material 2: STRM2F

210.0 stress component in material 3: STRM3

215.1 allowable for stress in material 3: STRM3A

220.1 factor of safety for stress in material 3: STRM3F

225.0

Next, you will be asked to provide an objective.

In this case the objective is the weight/(axial length)

of the balloon.

230.0 weight/length of the balloon: WEIGHT

999.0 DUMMY ENTRY TO MARK END OF FILE

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