LINEAR AND NONLINEAR ANALYSIS OF SHELLS OF REVOLUTION WITH ASYMMETRICAL STIFFNESS PROPERTIES

USER'S MANUAL

SPACE TECHNOLOGY REPORT 68 - 65 TO

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA Research Grant NGL 44-001-044

by

J. C. De Andrade

J. A. Stricklin

TEES

TEXAS ENGINEERING EXPERIMENT STATION
TEXAS A&M UNIVERSITY
COLLEGE STATION TEXAS 77843

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Faculty Investigator

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ABSTRACT

Two computer programs have been developed to perform a linear and nonlinear elastic analysis of shells of revolution under arbitrary loading with asymmetrical stiffness properties in the circumferential direction as well as variable thickness properties in the meridional direction. The method of analysis is the matrix displacement method of structural analysis. Input data define the elastic and geometric properties of the elements, the coordinates and constraints of the nodes, and the direction, magnitude and location of the loads. Output data consist mainly of the displacements of the nodes and the strains and stress resultants at the center of each element. The general purpose of this report is to provide a guideline for the preparation of input data for the computer codes.

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CHAPTER I

INTRODUCTION

I.1 GENERAL

Digital computer programs written in FORTRAN IV have been developed to perform the computations required in the linear and nonlinear elastic analysis of shells of revolution under arbitrary loading with asymmetrical thickness properties in the circumferential direction as well as in the meridional direction[1,2]. The purpose of this User's Manual is to provide to the engineer readily understood and easily applied information about the computer codes and the preparation of input data.

I.2 BRIEF REVIEW OF THE THEORY

The method of approach is the matrix displacement method of structural analysis.

The shell of revolution is idealized and discretized as an assemblage of curved elements connected together at their nodal circles or nodes (Fig. 1). The element curvature in the meridional direction is described by the slope between the axis of revolution and a tangent to the shell element in the meridional direction and is represented by a second order polynomial function of the meridional distance. The length of the element, measured along the meridian, is obtained by assuming an arc of a circle passing through the nodes with the specified nodal slopes.

The deformations of the element are represented by three linear displacement components in the normal, meridional and circumferential directions (Fig. 2). These displacements are expressed by polynomials in the meridional distance and a Fourier series in the circumferential angle.

The generalized nodal forces are obtained by concentrating the external forces as line loads applied at the nodes. This is accomplished by equating the virtual work performed by these lumped loads moving through the virtual nodal displacements, to the virtual work produced by the external forces undergoing the specified virtual displacements. The components of the external loading are represented by a Fourier series in the circumferential angle. These external load components are assumed to have a stepwise variation in the circumferential direction (Fig. 3). When there exist concentrated ring loads applied at the nodes, these loads are added to those due to the distributed loading to form the total generalized forces.

The strain-displacement relationships used are those given by Novozhilov[3] retaining for the nonlinear analysis only the terms suggested by von Karman[4].

The element stiffness matrix is obtained by applying Castigliano's theorem and observing the coupling of the harmonics. The coupling of the harmonics is due to the fact that the shell element may have variable thickness properties in the circumferential direction.

The thickness of the shell element is assumed to have a stepwise variati. and is represented by a Fourier series in the circumferential angle (Fig. 4).

The stiffness matrix for the entire shell is formed by summing up the appropriate stiffness matrices for the various finite elements.

The displacements are obtained by solving the system of linear simultaneous equations using Choleski's method.

To account for the geometric nonlinearities, the total internal energy is separated into a sum of two parts

$$U = U_L + U_{NL}$$

where U_L is the expression for the strain energy based on linear theory and U_{NL} is the contribution due to the nonlinear terms. The nonlinear terms are regarded as additional generalized forces. These additional forces are obtained by applying Castigliano's theorem resulting in the following equations of equilibrium

$$\left[K\right]\left\{q\right\} = \left\{Q\right\} - \left\{\frac{\partial}{\partial q} (U_{NL})\right\}$$

where $\left[K\right]$ is the stiffness of the structure, $\left\{q\right\}$ represents the generalized displacements, $\left\{Q\right\}$ describes the generalized forces and $\left\{\frac{\partial}{\partial q} (U_{NL})\right\}$ expresses the additional generalized forces due to nonlinearities.

The solution of the equations of equilibrium is accomplished using one of the three following approaches depending on the type of the problem to be solved:

a) In this method the deformation is analyzed by varying the loading in small increments and performing a linear analysis of the deformation due to each load increment. For the first increment the solution is purely linear. For the second increment a linear extrapolation is used and for the third and succeeding increments a quadratic interpolation is employed to generate the deflections to be used in the calculation of the additional forces for the next increment. The process is repeated until the total loading is applied.

b) In this second method the total loading is applied and an iteration is performed. The first approximation of the nonlinear terms is obtained by using a linear solution. The iteration procedure is used until convergence occurs or the number of iterations performed equals the maximum specified number.

c) In this combined method the load is applied by increments. The solution for each increment is obtained by iterating until convergence occurs. The displacements are then extrapolated, in the same fashion as in the method (a) and the nonlinear terms are evaluated for the next increment. The process is repeated until the total loading is reached.

CHAPTER II

RECOMENDATIONS AND SPECIFICATIONS

II.1 GENERAL

Certain important factors must be taken into account when using this proposed numerical method in order to have a realistic representation of the actual structure. For this matter, it is advisable that the practicing engineer have a reasonable understanding of the structure to be able to discretize the shell in a justifiable manner. In some cases, an inadequate idealization may cause unrealistic results in some areas of the shell, leading to a misunderstanding of the behavior of the structure.

II.2 RECOMENDATIONS

Some recomendations are herein presented to provide an indication of the type of care that the inexperienced user must exercise.

1. Elements should be closely spaced and concentrated in regions where rapid variation in the displacements and stresses may occur. For example, near a clamped boundary where the bending moment may vary rapidly.

2. Elements should be concentrated in regions where there is a rapid change in the material properties.

3. The number of harmonics in the Fourier expansion of the displacement components must be such as to account for all significant modes of deformations. If a shell deforms symmetrically only A harmonics are needed. In the case where it is anticipated that the shell will

deform asymmetrically both A and B harmonics must be used. In most engineering applications satisfactory results may be obtained with only few harmonics.

5. In the solution of the equilibrium equations for the nonlinear analysis use the load increment approach for slightly nonlinear problems and use the combined load increment iteration method to estimate buckling loads.

II.3 SPECIFICATIONS

1. Machine: IBM 7094, IBM 360/65, UNIVAC 1108
2. Language: FORTRAN IV
3. Program capacity (based on machine size):
   (a) 50 elements (NELEMS)
   (b) 17 harmonics (NH = IA + IB)
   (c) 29 Simpson's stations for the numerical integrations (NET)
   (d) 10 angles along the circumference where the displacements, strains and stresses are required (NUNKTH)
   (e) 10 elements restrained (NEREST)
   (f) 20 comment cards
   (g) 50 angles along the circumference where the thickness of the element is specified (NC)
   (h) 74 angles along the circumference where the external loadings are specified (NDP). The thickness of the element as well as the distributed external loads are assumed to have a stepwise variation in the circumferential direction.

4. Each discrete element may be constituted of any homogeneous and isotropic material.
5. The elements may have constant as well as varying thickness properties in the circumferential direction.
6. Symmetrical as well as asymmetrical loads may be applied to the structure.
7. Loads may be of two types:
   (a) Uniform constant load between any two angles along the circumference. Concentrated point loads may be considered as pressure loadings distributed over a small area.
   (b) Concentrated ring loads applied at the nodes.
8. Pressure loadings are described in the shell coordinate system. Concentrated ring loads are described for each harmonic in the cylindrical coordinate system.
9. Displacements are expressed in the cylindrical coordinate system.
10. Restraints:
    (a) Free - unconstrained in a component direction
    (b) Fixed - a rigid support
11. Sandwich type shells may also be analyzed.

CHAPTER III

COMPUTER PROGRAMS

III.1 GENERAL

Based on the storage capacity of the IBM 7094, the computer programs are linked into five overlay segments as shown in Fig. 5 and Fig. 6.

The computer codes accept a description of the structure in terms of the coordinates of the nodes (radial and axial), the slopes at the nodes and the elastic and geometric properties (thickness, Young's modulus and Poisson's ratio) of the elements joining them.

For shells of revolution with a geometry composed of a combination of a spherical cap, fillet and a cylinder the programs are capable of generating the shell geometry internally thus reducing considerably the input data.

The flow charts given in Fig. 7 and Fig. 8 indicate the sequence of the principal operations as they are performed in the programs.

III.2 PRINTOUT GENERATED BY THE PROGRAMS

1. General information. This information is read in as comment cards and output as general information giving a description of the problem being analyzed or any other comment.

2. Nomenclature. This printout defines all symbols used.

3. Elastic and geometric properties. The coordinates (axial and radial) and slopes are listed for each node. The elastic constants (Young's modulus and Poisson's ratio) are listed for each element. In this section are also reported the number of harmonics and the number of Simpson's stations used in the analysis.

4. Table of thicknesses. The thickness variation along the circumference is described for each element.

5. Boundary conditions. This describes the way the structure is restrained.

6. Applied loads on the structure. The pressure components in the shell coordinate system (meridional, normal and tangential) are listed for each loaded element. The concentrated ring load components in the cylindrical coordinate system (tangential, radial and angular) are listed for each loaded element and for each harmonic.

7. Displacement components of nodes. The displacement components in the cylindrical coordinate system (axial, tangential, radial and angular) are listed for each node and for each specified angle along the circumference.

8. Strains and changes in curvature. The strains and changes in curvature (ε_s, ε_θ, $\varepsilon_{s\theta}$, K_s, K_θ and $K_{s\theta}$) are listed at the center of each element and for each specified angle along the circumference.

9. Stress resultants. The stress resultants (N_s, N_θ, $N_{s\theta}$, M_s, M_θ and $M_{s\theta}$) are listed at the center of each element and for each specified angle along the circumference.

10. Maximum computed displacement components and stress resultants. A table summarizing each maximum computed displacement and stress resultant component is presented. This table specifies: (a) the node and the angle along the circumference where each computed displacement component is largest, and (b) the element and the angle along the circumference where each computed stress resultant is largest.

11. For the nonlinear analysis, a printout for each load increment and for each iteration is presented for displacement, strain and stress resultant components.

III.3 INPUT DATA DESCRIPTION

A general description of the input data for the linear as well as for the nonlinear computer programs is presented.

The sequence of information to be provided is as follows:

A. Number of problems to be solved in a single run (NPROBL).

B. Explanatory comments (TITL). As many as 20 cards can be used for general comments as long as punching starts in column 1. If the number of comment cards is less than 20 input a blank card after all comment cards.

C. One card providing information concerning number of harmonics, tape number assignment, etc. The only difference in the input data for the linear and nonlinear programs is in the information given in this card.

C(linear): for the linear program use this card (IA,IB, ISCRA3,

NELEMS, NET, NEREST, NUNKTH, NAMES, HS, NA, NB, IDEN, PROBLE, ISAVE) and omit the card C (nonlinear).

C(nonlinear): for the nonlinear program use this card (IA, IB, ISCRA3, NELEMS, NET, NEREST, NUNKTH, NA, NB, NDELQ, ITER, ITLAST, ISAVE, NAMES, HS, IDEN, PROBLE, EROR, X, NSTRAI, IPLAST, XSM) and omit the card C(linear).

D. If the load is applied over a circular area give information concerning the location of the loaded area, the radius of the circular area, etc. (APPO, THELO, RC, RL, PR). Otherwise, input a blank card and loading is described according to cards L1 and/or L2.

E. Angles (in degrees) measured along the circumference where displacements, strains and stresses are to be evaluated (XTHETA).

F. Define shell geometry:

F1 - Shell has a geometry as described in Fig. 9.

F1.a - Input RCAP, RFILET and RMAX. If there is not a fillet, i.e., the shell is spherical or the sphere is connected directly to the cylinder, RFILET = 0.

There must be continuity in slope between sphere and fillet. If there is a cylinder, RMAX is the radius of the cylinder. If there is not a cylinder RMAX is the maximum radial (cylindrical) coordinate of the shell.

Next, divide the shell into n parts. In the case of Fig. 9, the shell was divided into 8 parts. Define N as NS + NF, where NS represents the number o. parts of the sphere and NF the number of parts of the fillet. .f there is not a fillet, NF = 0.

F1.b - Input NPARTS = N if there is not a cylinder; Input NPARTS = N + 1, if there is a cylinder. (In the case of Fig. 9, NPARTS = 6).

F1.c - Input number of elements in part 1, angle $\phi 1$ and state if there is a cylinder connected at the end of part 1 (NE1, T1, NCYLIN).

F1.d - Input number of elements in part 2, angle $\phi 2$ and coding for the cylinder (NE2, T2, NCYLIN).

F1.e - Repeat for all parts of the sphere and fillet.

F1.f - Input number of elements in part 1 (NE1) of cylinder and distance S1 (NE1, S1).

F1.g - Repeat for all parts of the cylinder.

F2 - If the shell has any surface of revolution shape (Fig. 10), give for each element Z1, Z2, R01, PHY1 and PHY2.

NOTE 1: If the shell has a geometry as described in Fig. 9 input a blank card just after the E cards and the geometry is described by the F1 cards.

NOTE 2: If the shell has any surface of revolution shape, all F1 cards are omitted.

G. - Element thickness. Thickness can be given for one element or for a set of elements if all elements in the set have the same thickness. If an element has a varying thickness, this variation is described by giving the thickness (THI) at various angles (THET) along the circumference. Thicknesses are assumed to be constant from one angle to the next.

H. Element modulus of elasticity (EM). Here again, this information can be given for one element or for a set of elements.

I. Element Poisson's ratio (POISSO). This also can be input for one element or for a set of elements.

J. Elements restrained (IELRES). Specify which elements are restrained.

K. Describe how each element is restrained (REST).

L. Loads on the structure other than loads applied over a circular area. There are two types of loading: (a) uniform load on the element and (b) concentrated ring load at each node of the element.

L1 - Uniform load: Give each load component (meridional, normal and tangential) followed by the angle (in degrees) along the circumference identifying beginning of applied load. Loads are assumed to be constant from one angle to the next (P,R,S,O).

L2 - Ring load: Ring loads are given in the cylindrical coordinate system. Give ring load for each harmonic. Input total load instead of load per unit length.

Card (A)

COLUMNS	VARIABLE NAME	DESCRIPTION
1-5	NPROBL	Number of problems to be solved in a single run. Integer, right justified.

Comment cards (B)

COLUMNS	VARIABLE NAME	DESCRIPTION
1-80	TITL	Any alphanumeric information can be punched in these cards as long as punching starts in column 1. Up to 20 cards can be used. If the number of comments cards is less than 20, input a blank card after all comment cards.

C card (linear)

COLUMNS	VARIABLE NAME	DESCRIPTION
3-4	IA	Number of A (cosine) harmonics
7-8	IB	Number of B (sine) harmonics (Maximum of 17 IA + IB harmonics)
11-12	ISCRA3	This field is used to assign a logical unit number to one binary tape
15-16	NELEMS	Number of elements (50 maximum)
19-20	NET	Number of Simpson's stations to be used in numerical integrations (29 maximum)
23-24	NEREST	Number of restrained elements (10 maximum)

COLUMNS	VARIABLE NAME	DESCRIPTION
27-28	NUNKTH	Number of angles where displacements, strains and stresses are to be evaluated (10 maximum)
29-32	NAMES	If the structure is a sandwich type shell, punch in this field the word "SAND". Otherwise leave blank.
33-42	HS	If the structure is a sandwich type shell punch, anywhere in this field, the distance between face sheets. Use a decimal point.
43-45	NA	Number of cosine terms in the Fourier expansion of the element thickness
46-48	NB	Number of sine terms in the Fourier expansion (maximum of 49 NA + NB)
49-52	IDEN	Punch in this field any alphanumeric information for identification purposes. It can be left blank.
53-56	PROBLE	If the structure to be solved was solved previously and tape ISCRA3 containing shell geometric and elastic properties was saved and is to be used for this problem punch in this field the word

COLUMNS	VARIABLE NAME	DESCRIPTION
		"RRUN". In the case of a RRUN (rerun), the tape from the previous run must be mounted on logical unit ISCRA3 before execution. Be sure to use as ISCRA3 a logical unit which is not used by the system to avoid destruction of information on the tape. If it is not a RRUN, leave this field blank.
57	ISAVE	If this field is left blank, all geometric and elastic properties of the shell are stored on tape ISCRA3 and it can be used later on in a rerun. A message is printed on line to save tape ISCRA3. In the case of a RRUN, input only comment cards (B), card C, card D, card E and loading. Be sure to have in each run an A card. If one does not want to save tape ISCRA3, punch in this field any number different from zero.

NOTE: Except as noted, all variables must be integers, right justified.

C card (nonlinear)

For the nonlinear program use this card instead of the card C previously described. For the linear program omit this card.

COLUMNS	VARIABLE NAME	DESCRIPTION
2-3	IA	Number of A (cosine) harmonics
5-6	IB	Number of B (sine) harmonics
8-9	ISCRA3	This field is used to assign a logical unit number to one binary tape.
11-12	NELEMS	Number of elements (50 maximum)
14-15	NET	Number of Simpson's stations to be used in numerical integrations (29 maximum)
17-18	NEREST	Number of restrained elements (10 maximum)
20-21	NUNKTH	Number of angles where displacement, strains and stresses are to be evaluated (10 maximum)
23-24	NA	Number of cosine terms in the Fourier expansion of the element thickness.
26-27	NB	Number of sine terms in the Fourier expansion (maximum of 49 NA + NB).
28-30	NDELQ	Number of load increments.
31-33	ITER	Maximum number of iterations allowed for each load increment. Depending on the approach chosen to solve the equilibrium equations, the variable ITER may be positive, negative or zero. If ITER is positive, iterations will be performed for each load increment

COLUMNS	VARIABLE NAME	DESCRIPTION
		until convergence is satisfied according to the specified EROR. If the solution does not converge after ITER iterations the program stops. If ITER is negative, the program iterates ITER times for each load increment, without checking for convergence. If ITER = 0, no iteration is performed unless the variable ITLAST is greater than zero, in which case there are ITLAST iterations for the last load increment.
34-36	ITLAST	If ITER is zero or negative and ITLAST is greater than ITER the program will iterate ITLAST times for the last load increment. If ITLAST = 0, the program proceeds according to the value of ITER.
39	ISAVE	If this field is left blank, all geometric and elastic properties of the shell are stored on tape ISCRA3 and they can be used later on in a RRUN (rerun). A message is printed on line to save tape ISCRA3. In the case of a RRUN input only comment cards (B), card C, card D, card E and loading.

COLUMNS	VARIABLE NAME	DESCRIPTION
		Be sure to have in each run an A card. If one does not want to save tape ISCRA3, punch in this field any number different from zero.
40-43	NAMES	If the structure is a sandwich type shell, punch in this field the word "SAND". Otherwise leave it blank.
44-48	HS	If the structure is a sandwich type shell, punch, anywhere in this field, the distance between face sheets. Use a decimal point.
49-52	IDEN	Punch in this field any alphanumeric information for identification purposes. It can be left blank.
53-56	PROBLE	If the structure to be solved was solved previously and tape ISCRA3 containing shell geometric and elastic properties was saved and is to be used for this problem, punch in this field the word "RRUN". In

		the case of a RRUN (rerun), the tape from the previous run must be mounted on logical unit ISCRA3 before execution. Be sure to use as ISCRA3 a logical unit which is not used by the system to avoid destruction of information on the tape. If it is not a RRUN, leave this field blank.
57-62	EROR	If ITER is positive, iteration will be performed for each load increment until convergence is satisfied according to the specified EROR, i.e., $$\frac{q_i - q_{i-1}}{q_i} \leq \text{EROR}$$ where q_i represents the displacement for the ith iteration and q_{i-1} is the displacement for the (i-1)th iteration. If ITER is zero or negative, leave this field blank.
63-68	X	Extrapolation factor to calculate the generalized loads due to nonlinearities. If X = 0, $q_i = q_{i-1}$ and the nonlinear terms are evaluated based on the displacements at the previous loading. If X = 1 the usual quadratic extrapolation occurs.

COLUMNS	VARIABLE NAME	DESCRIPTION
69	NSTRAI	If this field is left blank information concerning the strains and changes in curvature will be printed. If one does not want to have the strains and changes in curvature printed out, punch in this field any number different from zero.
70	IPLAST	If IPLAST is zero, the strains, changes in curvature and stresses are evaluated only when convergence occurs. Otherwise punch any other number in this field and the strains, changes in curvature and stresses are evaluated for each iteration.
71-77	XSM	It may occur that for some problems the displacements in some region of the shell become very small and the convergence criterion $\frac{q_i - q_{i-1}}{q_i} \leq$ EROR may require an extra number of iterations. Punch anywhere in this field the absolute value of the smallest displacement regarded as significant. If the displacements are

COLUMNS	VARIABLE NAME	DESCRIPTION
		smaller than this specified value there is no checking for convergence for these displacements. This field can be left blank.

D card

COLUMNS	VARIABLE NAME	DESCRIPTION
1-4	APPO	If the load is applied over a circular area (Fig. 11), punch the word "APOL".
11-20	THELO	Angle θ in degrees.
21-30	RC	Distance Rc
31-40	RL	Radius RL
41-50	PR	Pressure Pr

NOTE 1: Variables can be punched anywhere in the field. Use a decimal point.

NOTE 2: The center of the load must be situated inside the region regarded as first and second quadrants.

NOTE 3: If the load is not applied over a circular area, input a blank card and the loading is described using cards L1 and/or L2.

E card

COLUMNS	VARIABLE NAME	DESCRIPTION
1-10	XTHETA	Angle (in degrees) where displacements,
11-20		strains and stresses are to be evaluated.
21-30		Use two cards if the number of angles is
31-40		greater than 8. The number can be punched
41-50		anywhere in the field with a decimal point

COLUMNS	VARIABLE NAME	DESCRIPTION
51-60		The number of angles must agree with the
61-70		value of NUNKTH given previously on
71-80		card C.

Geometry card (F1.a)

1-10	RCAP	Radius of the sphere
11-20	RFILET	Radius of the fillet
21-30	RMAX	If there is a cylinder, input the radius of the cylinder, if there is not a cylinder, input the maximum radial (cylindrical) coordinate of the shell. (See Figs. 9 and 12).

NOTE: These variables can be punched anywhere in the field, with a decimal point.

Geometry card (F1.b)

1-5	NPARTS	(See description given previously F1.b) Integer, right justified.

Geometry card (F1.c, F1.d, F1.e)

There will be N of these cards (N = NS + NF). One card for each part of the sphere and

COLUMNS	VARIABLE NAME	DESCRIPTION
		the fillet.
1-5	NE1	Number of elements in the part. Integer right justified.
6-15	T1	Punch anywhere in this field the angle ϕ_1 (in deg), with a decimal point (See Fig. 9).
16	NCYLIN	If there is a cylinder connected at the end of the part punch 1 in this column. Otherwide, leave it blank.
		NOTE: Repeat for all parts of the sphere and fillet.

Geometry card (F1.f, F1.g)

		There will be Ncy cards, where Ncy is the number of parts in the cylinder. If there is not a cylinder, these cards are omitted.
1-5	NE1	Number of elements in the part. Integer, right justified.
6-15	S1	Punch anywhere in this field the distance between subdivisions (See Fig. 9) in the cylinder. Use a decimal point.
		NOTE: Repeat for all parts of the cylinder.

COLUMNS	VARIABLE NAME	DESCRIPTION
		Geometry card (F2)
		See Fig. 10. If the shell has any surface of revolution shape, give for each element the information below in E12.5 FORMAT. Consequently, there will be NELEMS of these cards, where NELEMS represents the number of elements in the shell. In this case all F1 cards are omitted.
1-12	Z1	Axial coordinate of element first node
13-24	Z2	Axial coordinate of element second node
25-36	RO1	Radial (cylindrical) coordinate of element first node
37-48	RO2	Radial (cylindrical) coordinate of element second node
49-60	PHY1	Angle between meridian and the axis of revolution, at the element first node
61-72	PHY2	Angle between meridian and the axis of revolution, at the element second node
		NOTE 1: Repeat for all elements in the shell.
		NOTE 2: If cards F1 are given, cards F2 are omitted and input a blank card after the E cards.

COLUMNS	VARIABLE NAME	DESCRIPTION
		Element thickness (G)
1-4	NAMET	Punch in this field the word "CONS" if the thickness is constant over one element or a set of elements. Otherwise leave it blank.
9-10	IEL1	First element number of a set of elements where the thickness is described (Fig. 4).
14-15	IEL2	Last element number of the set. IEL1 and IEL2 are integers right justified. If the set contains only one element the fields for IEL1 and IEL2 may be left blank.
16-25	THIK	If the thickness is constant over each element of the set, punch anywhere in the field the thickness. Use a decimal point. If the thickness is not constant leave it blank.
29-30	NC	Number of angles where the thickness is specified. If the thickness is constant this field may be left blank. NC is an integer, right justified. If the thickness is not constant, this additional information must be given to describe it.

COLUMNS	VARIABLE NAME	DESCRIPTION
1-10	THET	Punch anywhere in this field the angle in degrees, where the thickness is specified. The first point to be given is at 0.0 degrees.
11-20	THI	Anywhere in this field the thickness corresponding to the angle THET must be given.
21-30	THET	NC values of THET and
31-40	THI	THI (angle and thickness) must be given in
41-50	THET	the subsequent fields. If NC is larger
51-60	THI	than 4, use additional
61-70	THET	cards. A decimal point
71-80	THI	must be always used.

Modulus of elasticity (H)

COLUMNS	VARIABLE NAME	DESCRIPTION
1-4	NAM	Punch in this field the word "CONS" if the modulus of elasticity is the same for a set of elements.
9-10	IEL1	First element number of a set of elements with a constant modulus of elasticity.

COLUMNS	VARIABLE NAME	DESCRIPTION
14-15	IEL2	Last element number of the set. If the set contains only one element the fields for NAM, IEL1 and IEL2 may be left blank. IEL1 and IEL2 are integers, right justified.
16-25	EM	The value of the modulus of elasticity for the set. It can be punched anywhere in this field, with a decimal point. There will be one card if the modulus of elasticity is constant for all elements and several cards if the modulus of elasticity varies with the element.

Poisson's ratio (I)

1-4	NAM	Follow the same instructions as
9-10	IEL1	for the modulus of elasticity
14-15	IEL2	
16-25	POISSO	

Boundary conditions (J) - Which nodes are restrained

1-5	IELRES	Punch in these fields the number
6-10		of each element having a restraint.

COLUMNS	VARIABLE NAME	DESCRIPTION
11-15		One can have up to 10 restrained
16-20		elements. Element number must be
21-25		right justified.
26-30		For example. If the structure has
31-35		50 elements and the last
36-40		node is fixed, punch
41-45		the number 50 in columns 4 and 5.
46-50		

Boundary conditions (K) - Specify types of restrains

		Input one card for each restrained element.
1-5	J	Number of the restrained element. Integer, right justified.
10	REST	If axial component of the first node of element J is restrained, punch 1 in this column. Otherwise leave it blank.
15		Same for the tangential component of the first node.
20		Same for the radial component of the first node.
25		Same for the angular component of the first node.

COLUMNS	VARIABLE NAME	DESCRIPTION
30		These fields are for the displacement
35		components of the second node of
40		element J.
45		

Uniform load (L)

COLUMNS	VARIABLE NAME	DESCRIPTION
1-5	IELL	Element number where load is applied. Integer, right justified.
9-10	NDPP	Number of point loads. Integer, right justified (Fig. 3).
11-14	NSTOP	If load is uniformly distributed over all subsequent elements starting with element IELL, punch in this field the word "CONS". Other wise leave it blank.
16	IXXX	Punch 1 in this field if there is a ring load applied at any node of this element, for the first harmonic. Otherwise leave it blank.
17		Punch 1, if there is a ring load
18		for the second harmonic,
19		for the third harmonic, and so on, for
20		all harmonics.

COLUMNS	VARIABLE NAME	DESCRIPTION
21		
etc.		
32		
	Uniform load (L1)	
1-10	P	Meridional load component per unit area
11-20	R	Normal load " " " "
21-30	S	Tangential load " " " "
31-40	0	Angle in degrees where these loads are applied. The first point to be given is at 0.0 degrees. Variables can be punched anywhere in the field. Use a decimal point. Input as many as NDPP cards. Maximum of 74 point loads If the load is applied over a circular area and it was described by card D, omit these cards.
	Ring load (L2)	
		If there is a ring load applied at the element, give for each harmonic the corresponding ring load. Ring loads are applied in the cylindrical coordinate system. Input the total ring load rather than load per unit length.

COLUMNS	VARIABLE NAME	DESCRIPTION
1-10	FORCE	Axial component at the element first node
11-20		Tangential " " " " " "
21-30		Radial " " " " " "
31-40		Angular " " " " " "
41-50		Axial " " " " second "
51-60		Tangential " " " " " "
61-70		Radial " " " " " "
71-80		Angular " " " " " "
		Variables can be punched anywhere in the field. Use a decimal point.

CHAPTER IV

EXAMPLE PROBLEMS

IV.1 - SAMPLE PROBLEM NO. 1 -

The first example problem is for the nonlinear elastic analysis of the scalloped Apollo aft heat shield. The aft heat shield is of honeycomb construction with scalloped face sheets. The face sheet thicknesses and shell geometry are shown in Fig. 13.

The structure is subjected to a uniform pressure of - 200 psi distributed over a circular area of twenty inches radius and a pitch angle of 15^{o} (Fig. 14). The shell is clamped at the base and 50 elements are used in the analysis. The Poisson's ratio and the Young's modulus are constant over the entire shell. As the loading and the thickness variation are symmetrical about the origin ($\theta = 0^{o}$) only A harmonics are needed. The pressure loading is applied in four increments of fifty psi each and the increment-iteration method is used to solve the equilibrium equations. A maximum of twenty iterations for each load increment is used. The listing of the input data and the corresponding output are given in Appendix A.

IV.2 - SAMPLE PROBLEM NO. 2 -

This sample problem is a hemispherical shell, of five inches radius, under a uniform external pressure of - 100 psi distributed over its entire surface (Fig. 15). The structure is subdivided into thirty elements and it is assumed to be clamped at the base. The Poisson's ratio, Young's modulus and thickness are constant for all elements. As the shell is anticipated to deform symmetrically only A harmonics are needed.

IV. 3 - SAMPLE PROBLEM NO. 3 -

This problem is a re-run of the sample problem no. 2 with a new loading. The shell is subjected to a uniform internal pressure of 10 psi applied on elements 26 through 30. The elastic and geometric properties of the structure are the same as for the previous example and both problems are solved in a single run.

IV. 4 - SAMPLE PROBLEM NO. 4 -

A circular plate with a circular hole under a total ring load of 10 lbs. is analyzed (Fig. 16). The geometry of the plate is input rather than generated by the computer. The radius of the plate is ten inches and the radius of the circular hole is two inches. The structure is subdivided into eight elements and it is assumed to be simply supported at node nine.

IV. 5 - SAMPLE PROBLEM NO. 5 -

Next consider a spherical cap of twenty inches radius with varying thickness properties in the circumferential direction (Fig. 17.) The shell is subjected to a uniform pressure of - 10 psi distributed over a circular area of three inches radius. The center of the circular area where the loading is applied is located at ten inches from the center of the shell and at 45° from the origin ($\theta = 0^{\circ}$). The shell is subdivided into twenty elements and clamped at the base. The structure is anticipated to deflect asymmetrically and both A and B harmonics are required. The displacements, strains and stresses are evaluated at four different angles along the the circumference.

IV. 6 - SAMPLE PROBLEM NO. 6 -

The shell of sample problem no. 5 is re-analyzed with a new loading. The center of the circular area where the loading is applied is moved to the origin ($\theta = 0^{o}$). The displacements, strains and stresses are evaluated at six different angles along the circumference. This example is a re-run of problem no. 5 using the tape ISCRA3 saved from the previous run.

IV. 7 - SAMPLE PROBLEM NO. 7 -

This structure is a combination of a spherical cap and a cylinder (Fig. 18). The radius of the spherical cap is ten inches. The radius of the cylinder is also ten inches and its depth is fifty inches. Both cap and cylinder are divided into 25 elements. Therefore, the total number of elements in the structural idealization is fifty.

As the shell is subjected to a uniform pressure and the structure deforms axisymmetrically only the OA harmonic is needed. The node 26 is restrained in the radial direction and furthermore the structure is clamped at the base.

REFERENCES

1. Stricklin, J.A., Haisler, W.E., MacDougall, H.R. and Stebbins, F.J., Nonlinear Analysis of Shells of Revolution by the Matrix Displacement Method, AIAA Paper No. 68-117, presented at AIAA 6th Aerospace Sciences Meeting, New York, January, 1968.

2. Stricklin, J.A., DeAndrade, J.C., Stebbins, F.J. and Cwiertny, Jr. A.J., Linear and Nonlinear Analysis of Shells of Revolution with Asymmetrical Stiffness Properties, paper to be presented at the Air Force Second Conference on Matrix Methods in Structural Mechanics, Wright Patterson Air Force Base, Ohio, 15-17 October 1968.

3. Novozhilov, V.V., Foundations of the Nonlinear Theory of Elasticity, Graylock Press, Rochester, New York, 1953.

4. Langhaar, H.L., Energy Methods in Applied Mechanics, Chapter V, John Wiley and Sons, 1962.

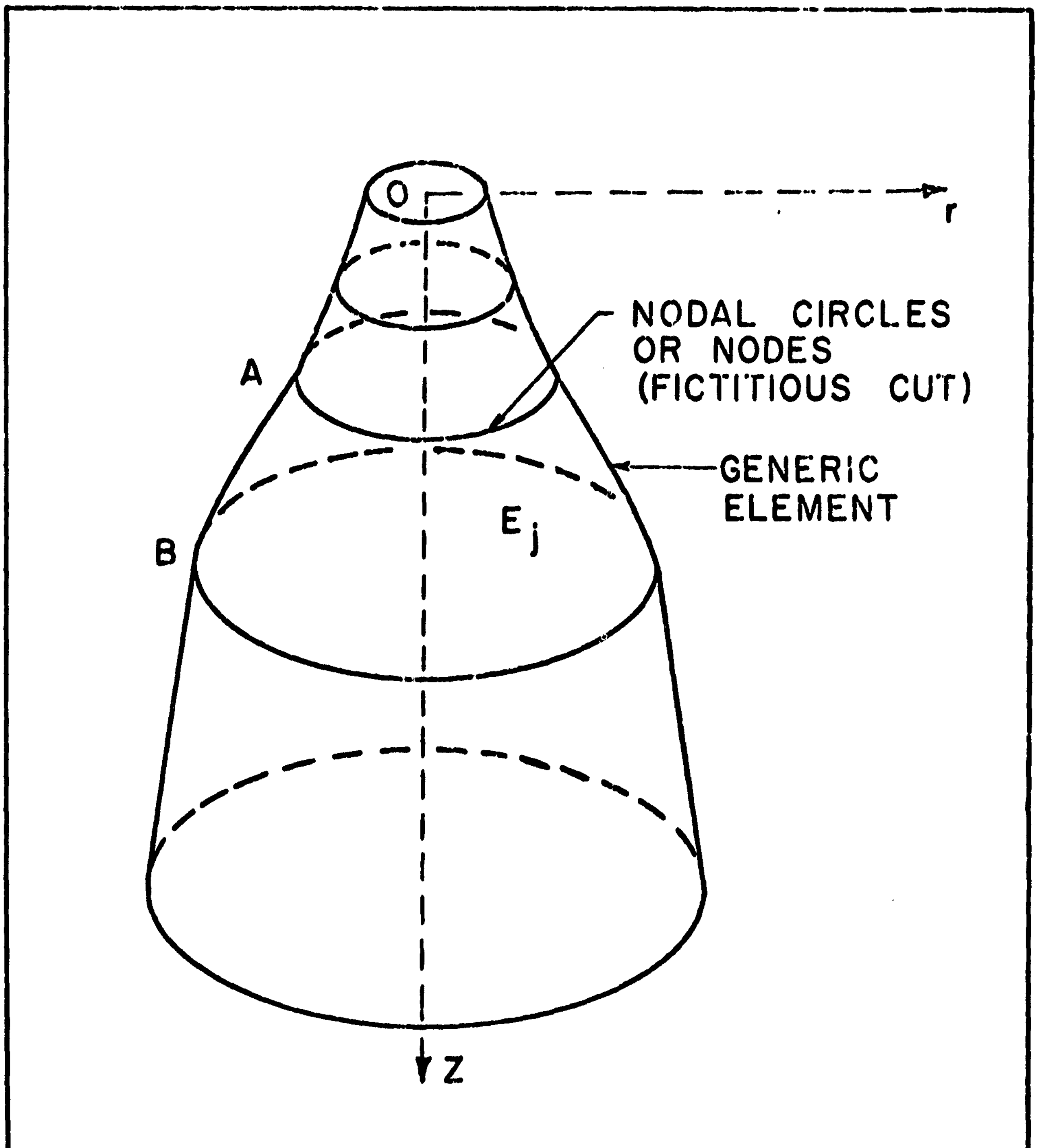


FIG. 1 A SHELL OF REVOLUTION DIVIDED INTO A NUMBER OF CURVED ELEMENTS

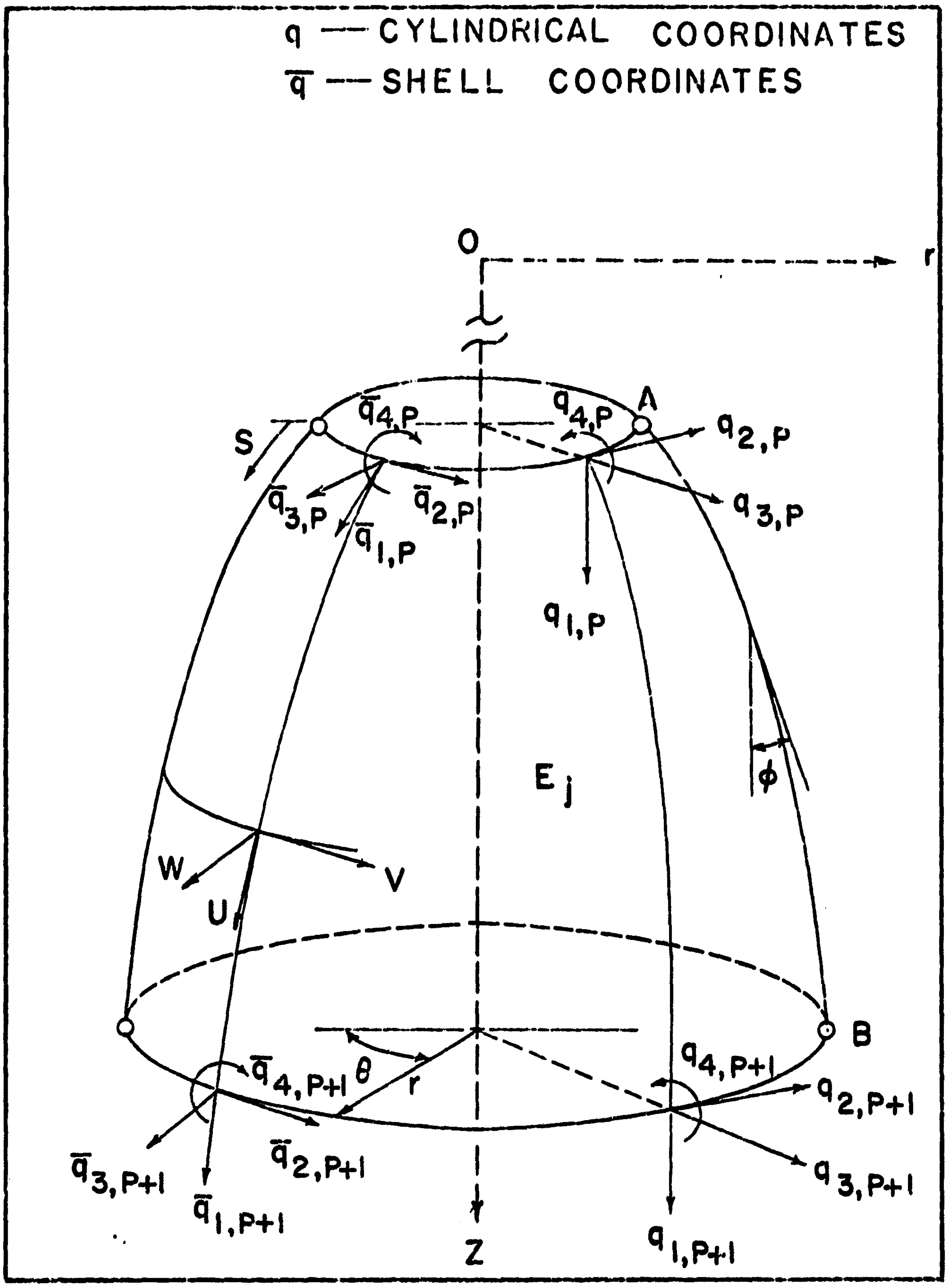
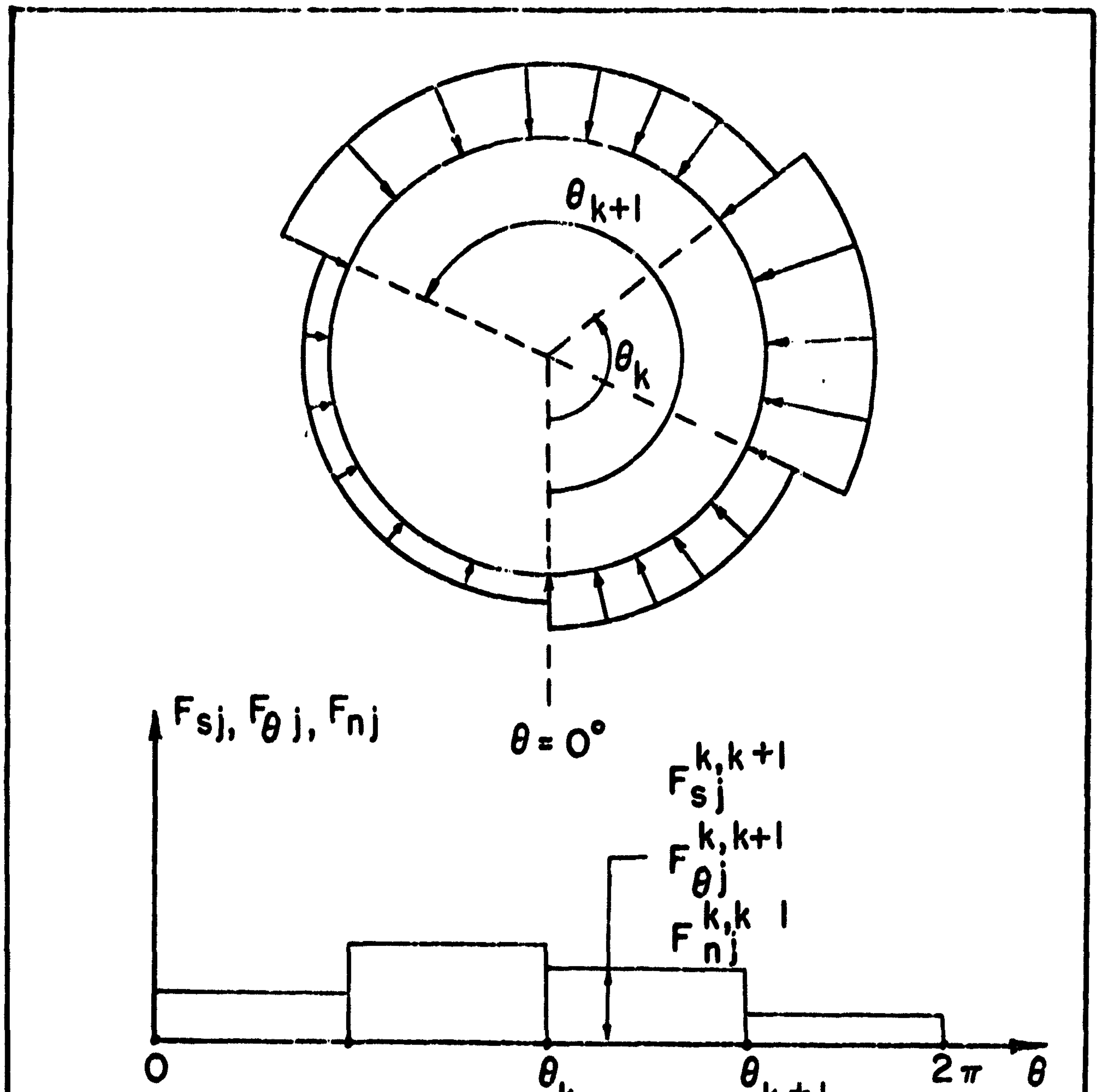


FIG. 2 A GENERIC ELEMENT



F_{sj} = LOAD IN THE MERIDIONAL DIRECTION

$F_{\theta j}$ = LOAD IN THE CIRCUMFERENTIAL DIRECTION

F_{nj} = LOAD IN THE NORMAL DIRECTION

FIG. 3 LOADING VARIATION IN THE CIRCUMFERENTIAL DIRECTION

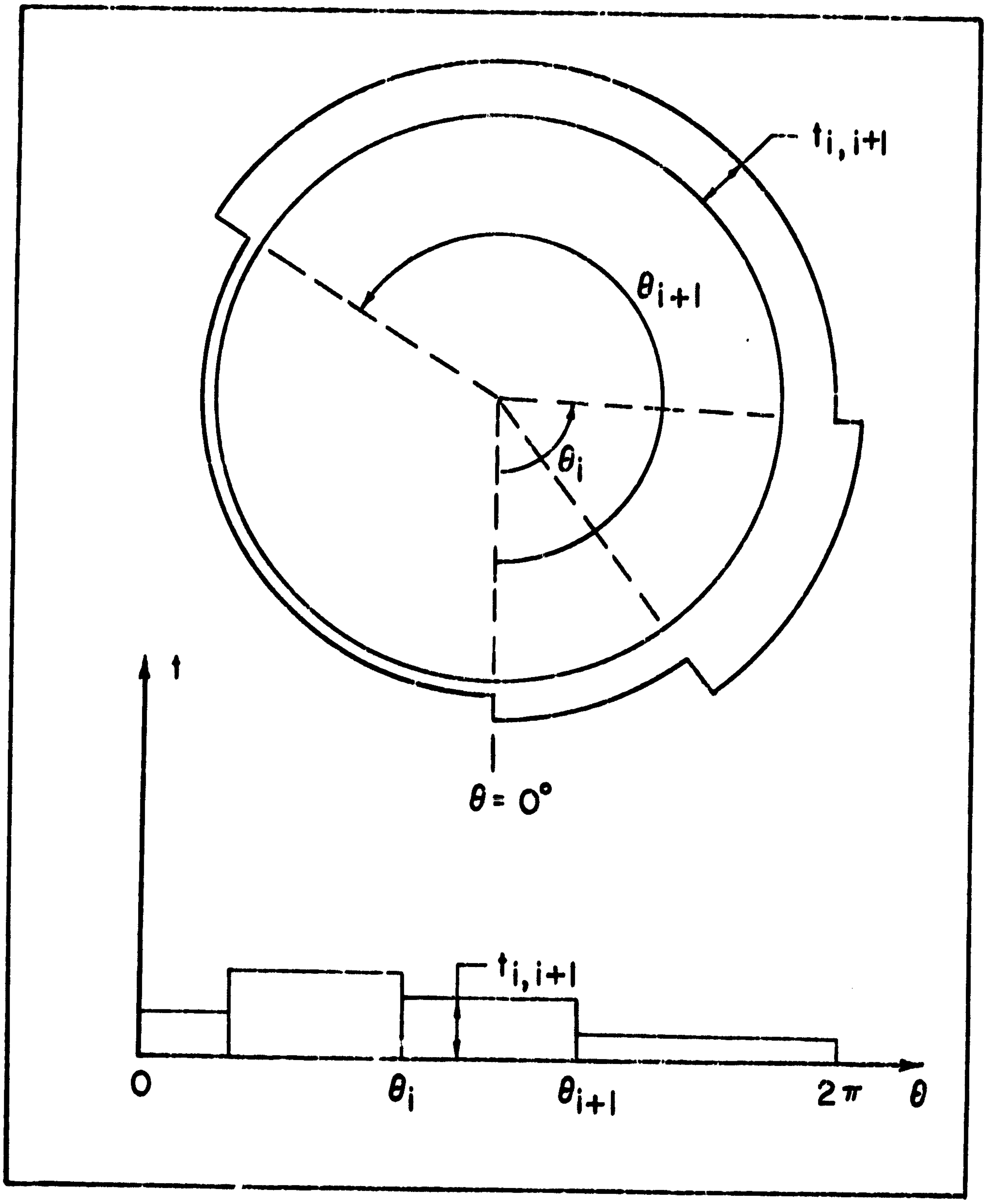


FIG. 4 THICKNESS VARIATION IN THE CIRCUMFERENTIAL DIRECTION

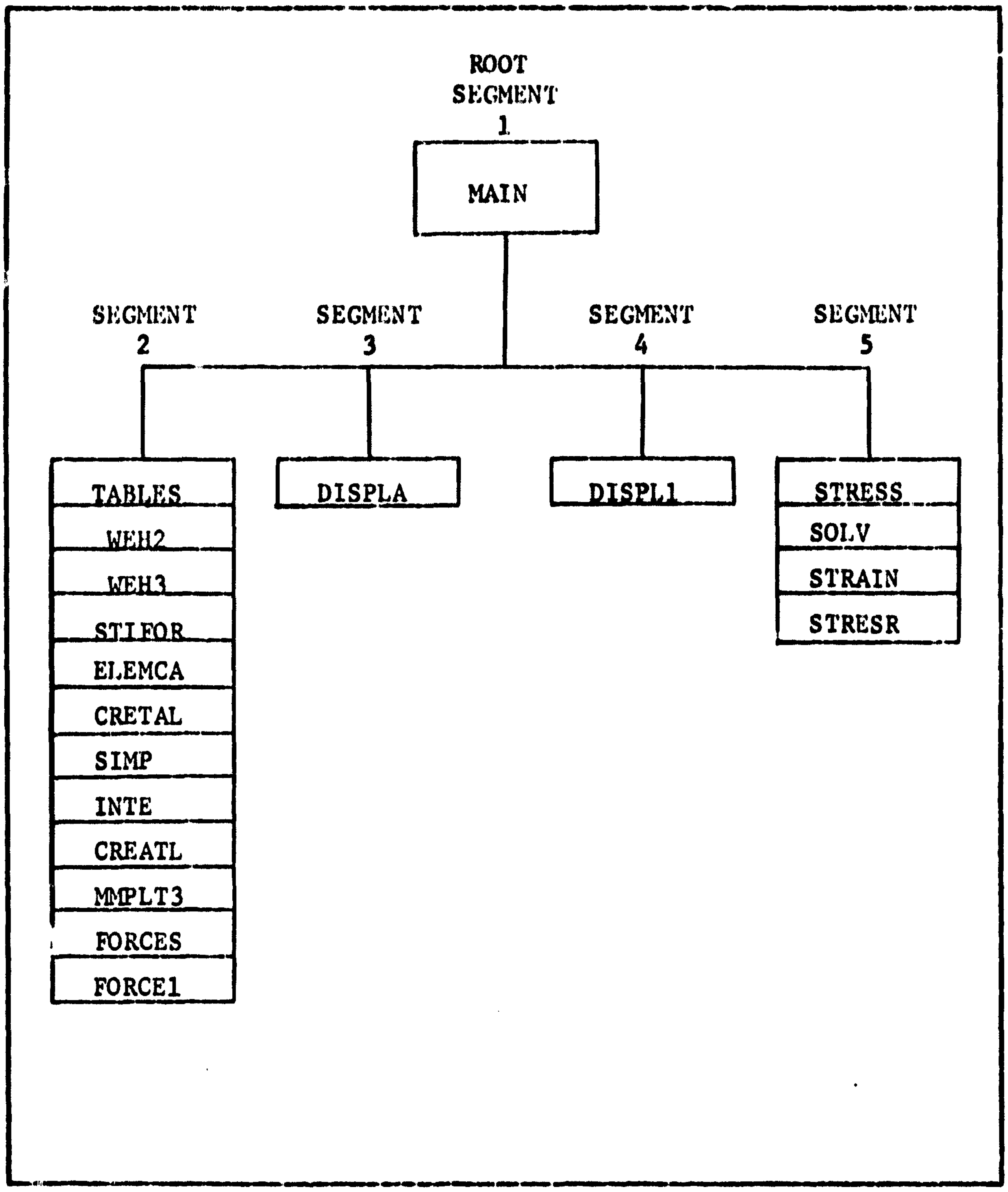


Fig. 5 OVERLAY STRUCTURE LINEAR PROGRAM

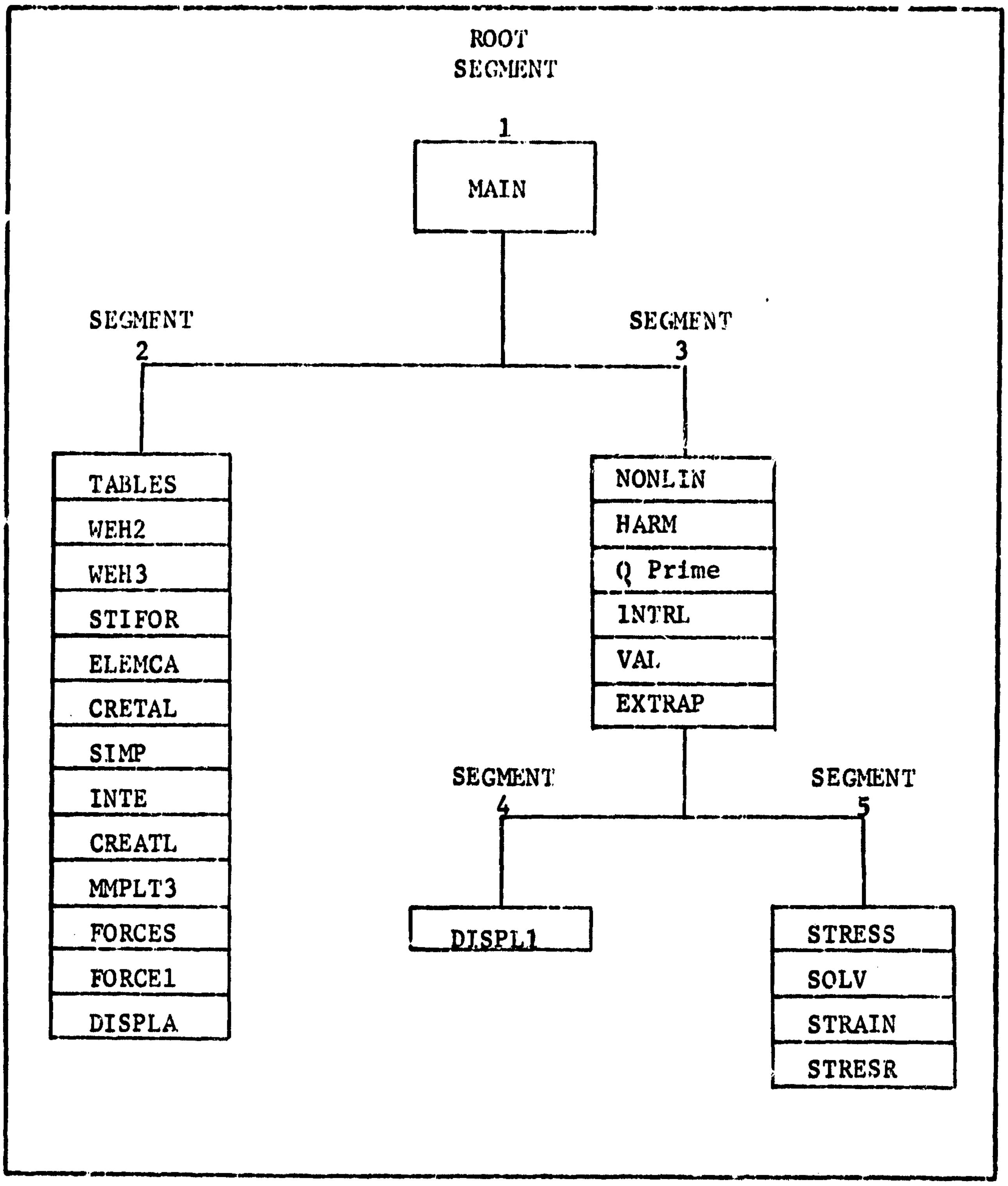


Fig. 6 OVERLAY STRUCTURE
NONLINEAR PROGRAM

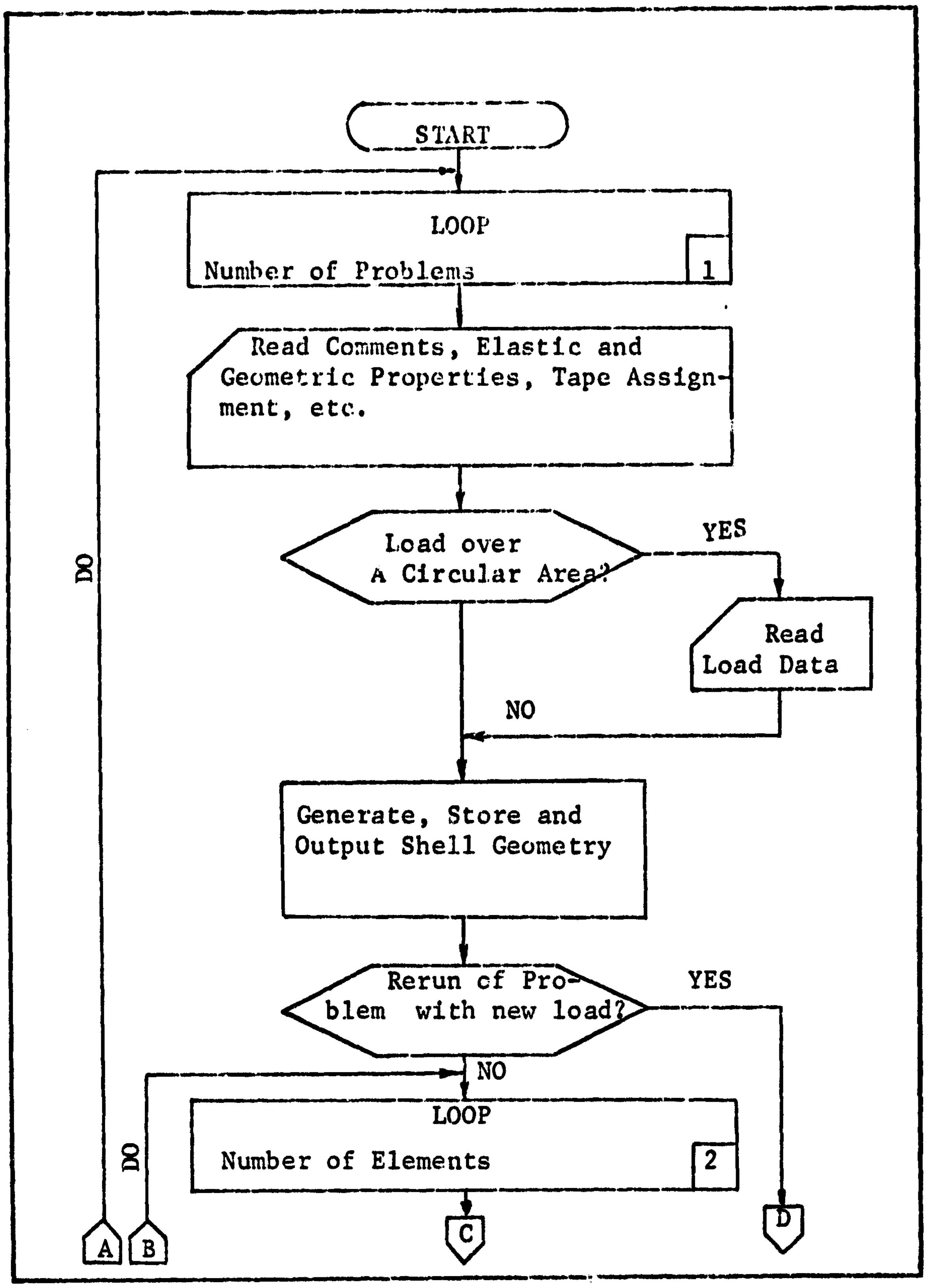


Fig. 7 FLOW CHART FOR THE LINEAR PROGRAM

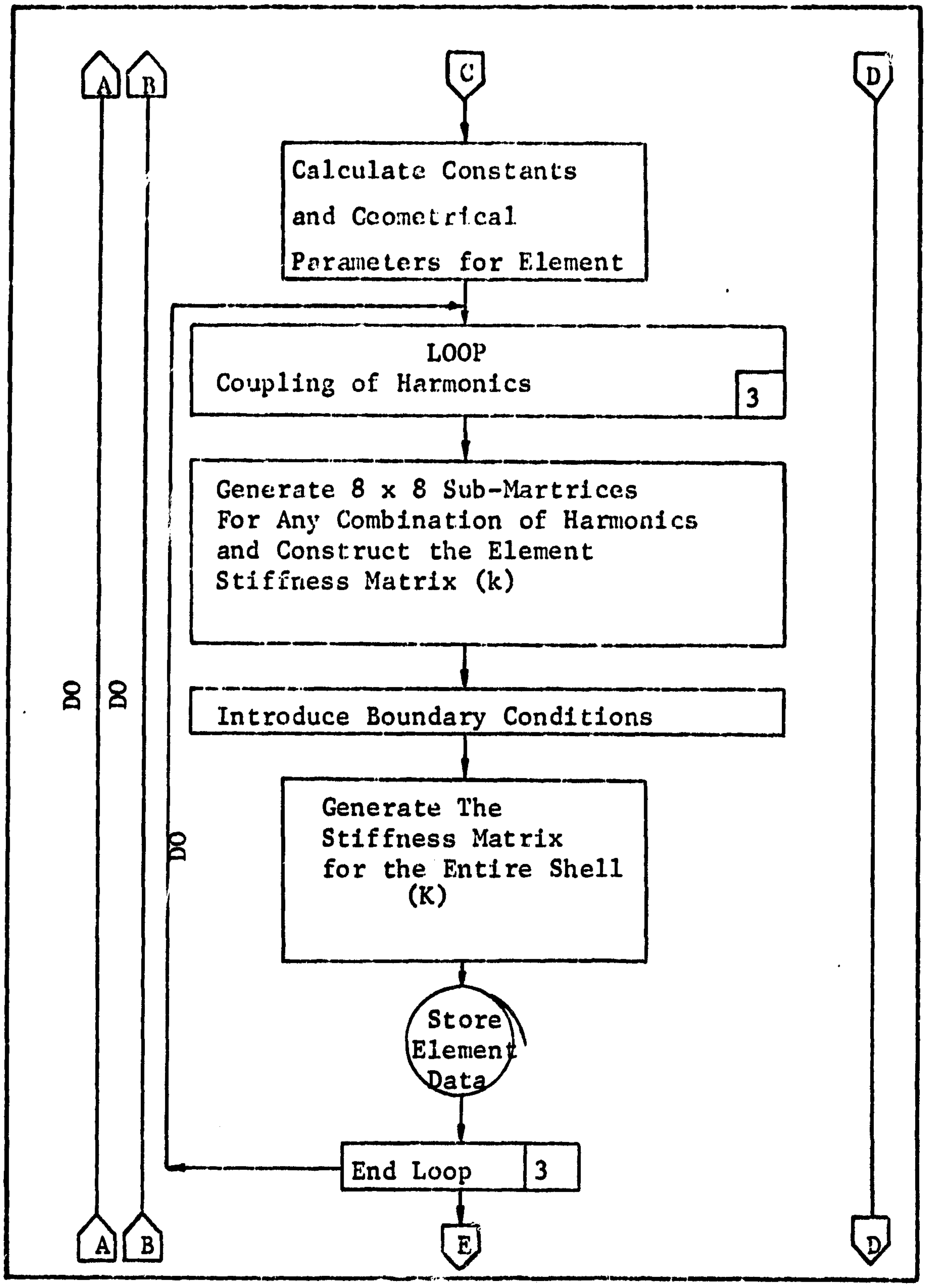


Fig. 7 FLOW CHART FOR THE LINEAR PROGRAM (cont.)

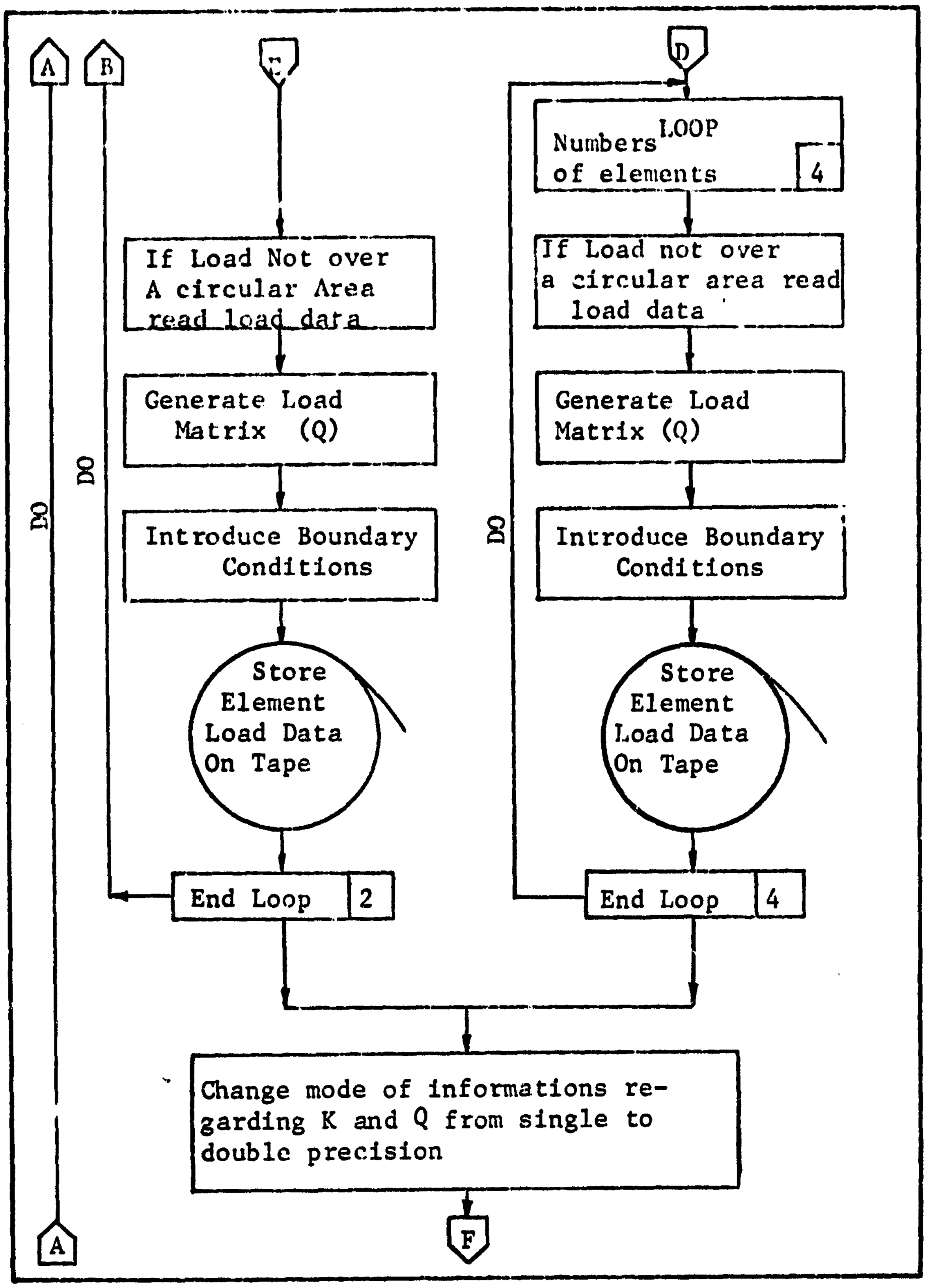


Fig. 7 FLOW CHART FOR THE LINEAR PROGRAM (cont.)

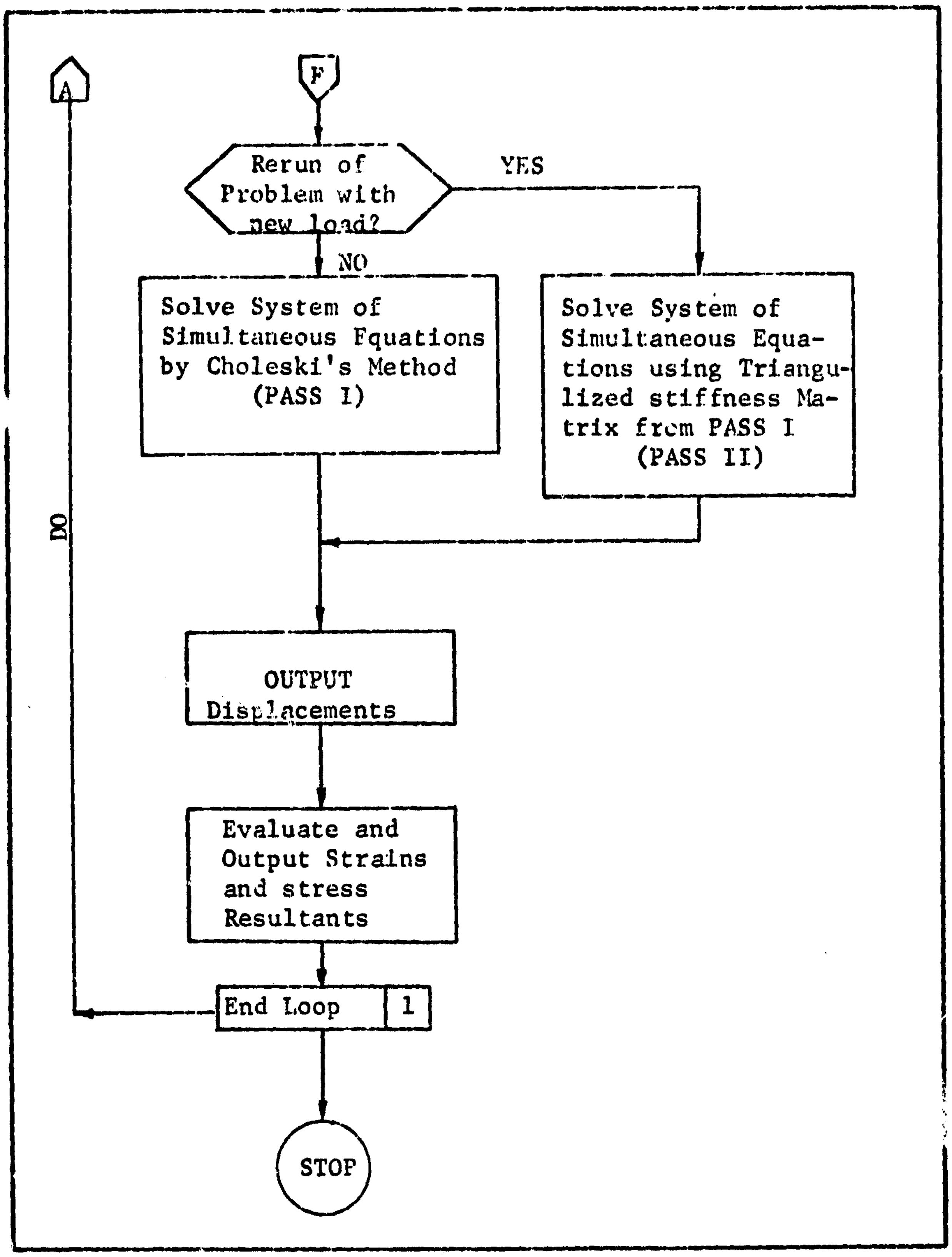


Fig. 7 FLOW CHART FOR THE LINEAR PROGRAM (cont.)

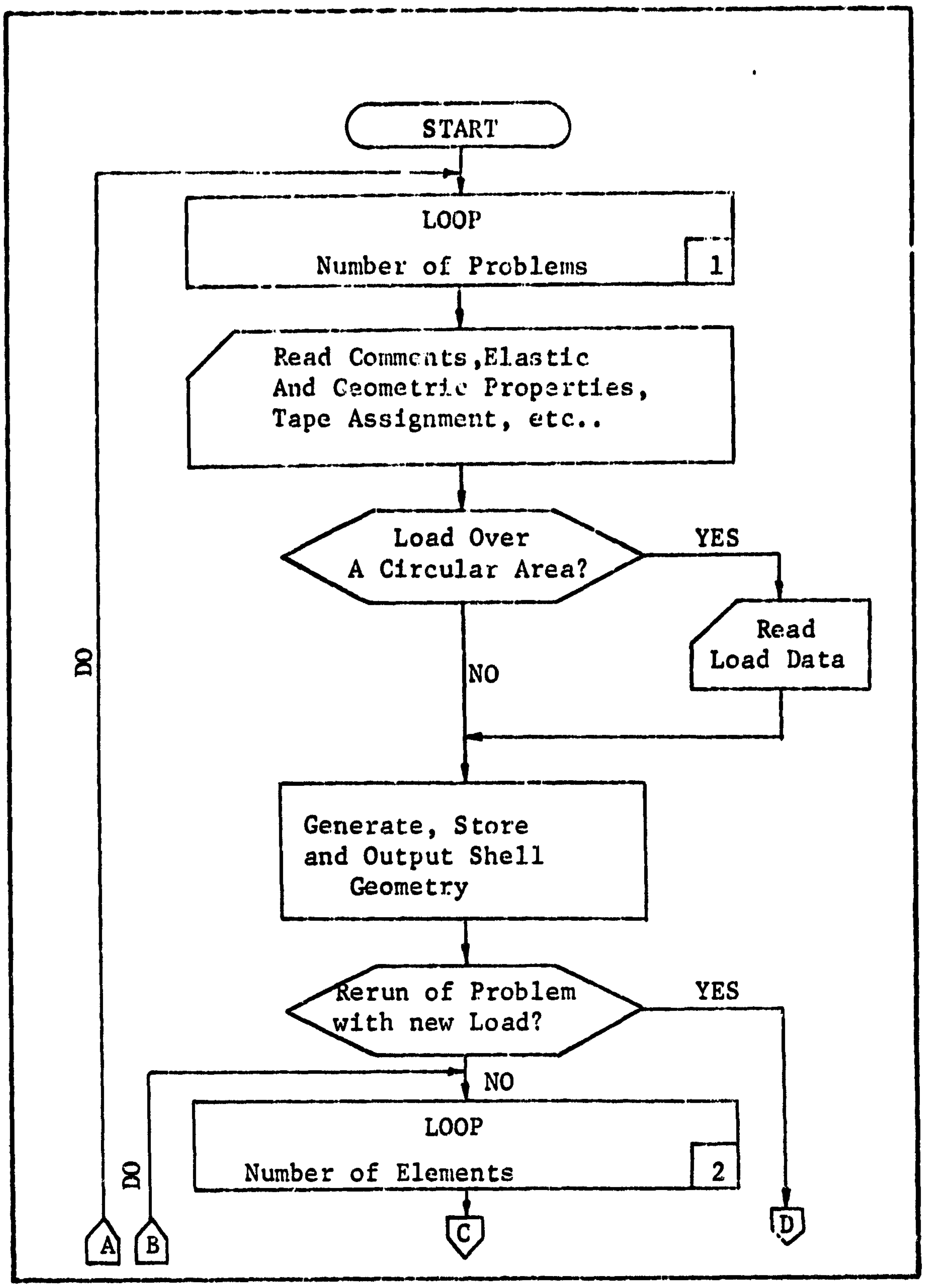


Fig. 8 FLOW CHART FOR THE NONLINEAR PROGRAM

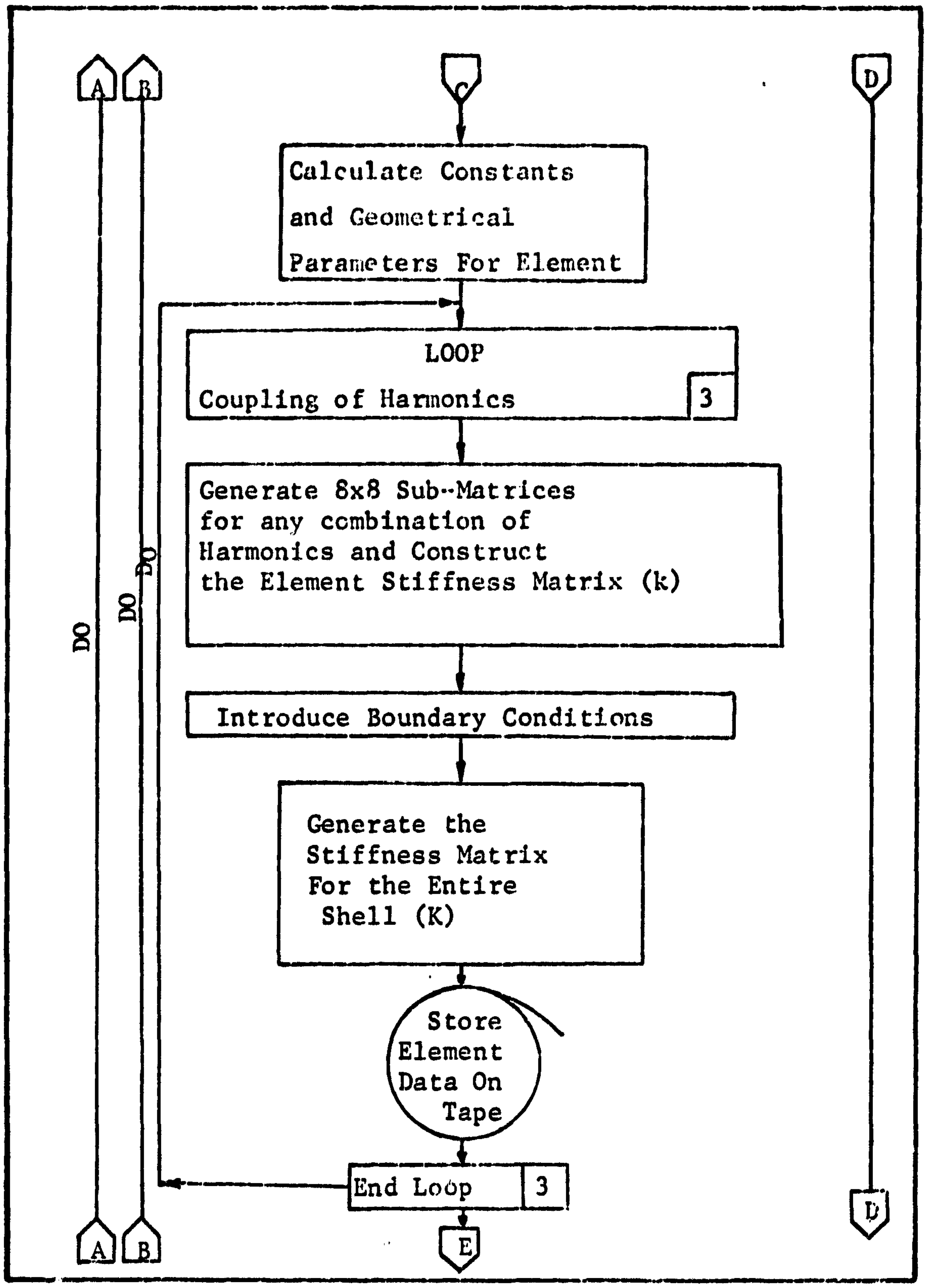


Fig. 8 FLOW CHART FOR THE NONLINEAR PROGRAM (cont.)

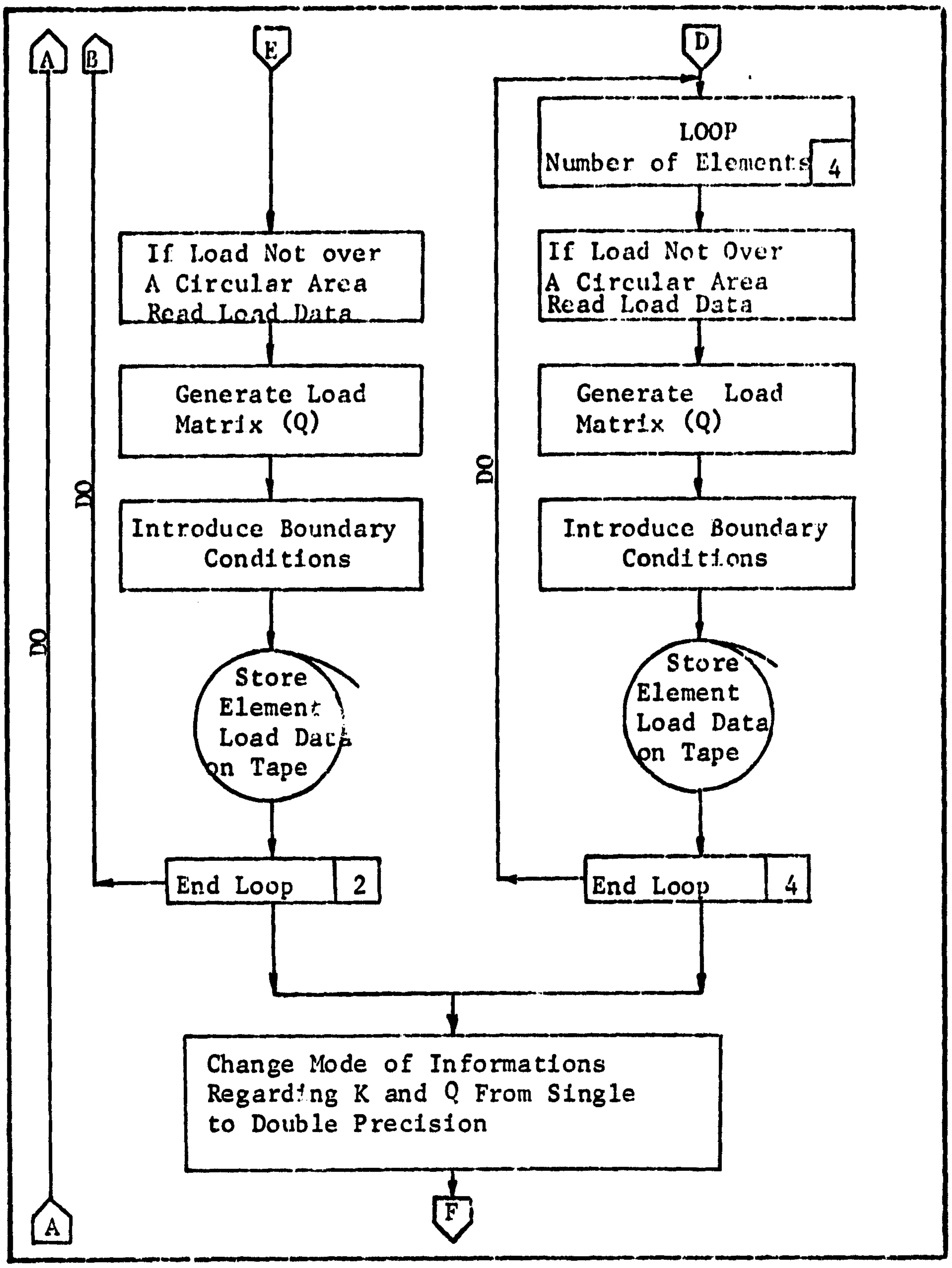


Fig. 8 FLOW CHART FOR THE NONLINEAR PROGRAM (cont.)

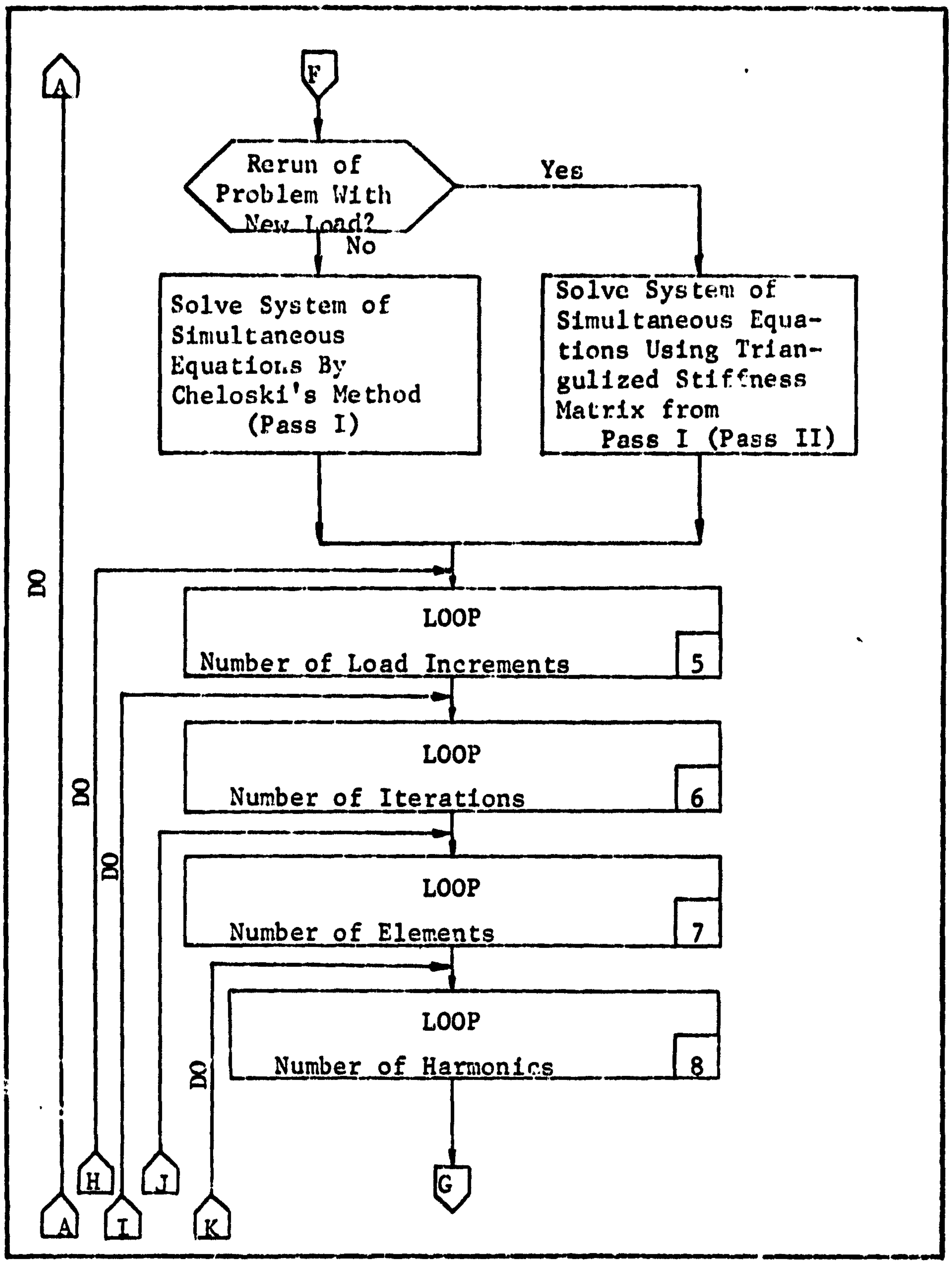


Fig. 8 FLOW CHART FOR THE NONLINEAR PROGRAM (cont.)

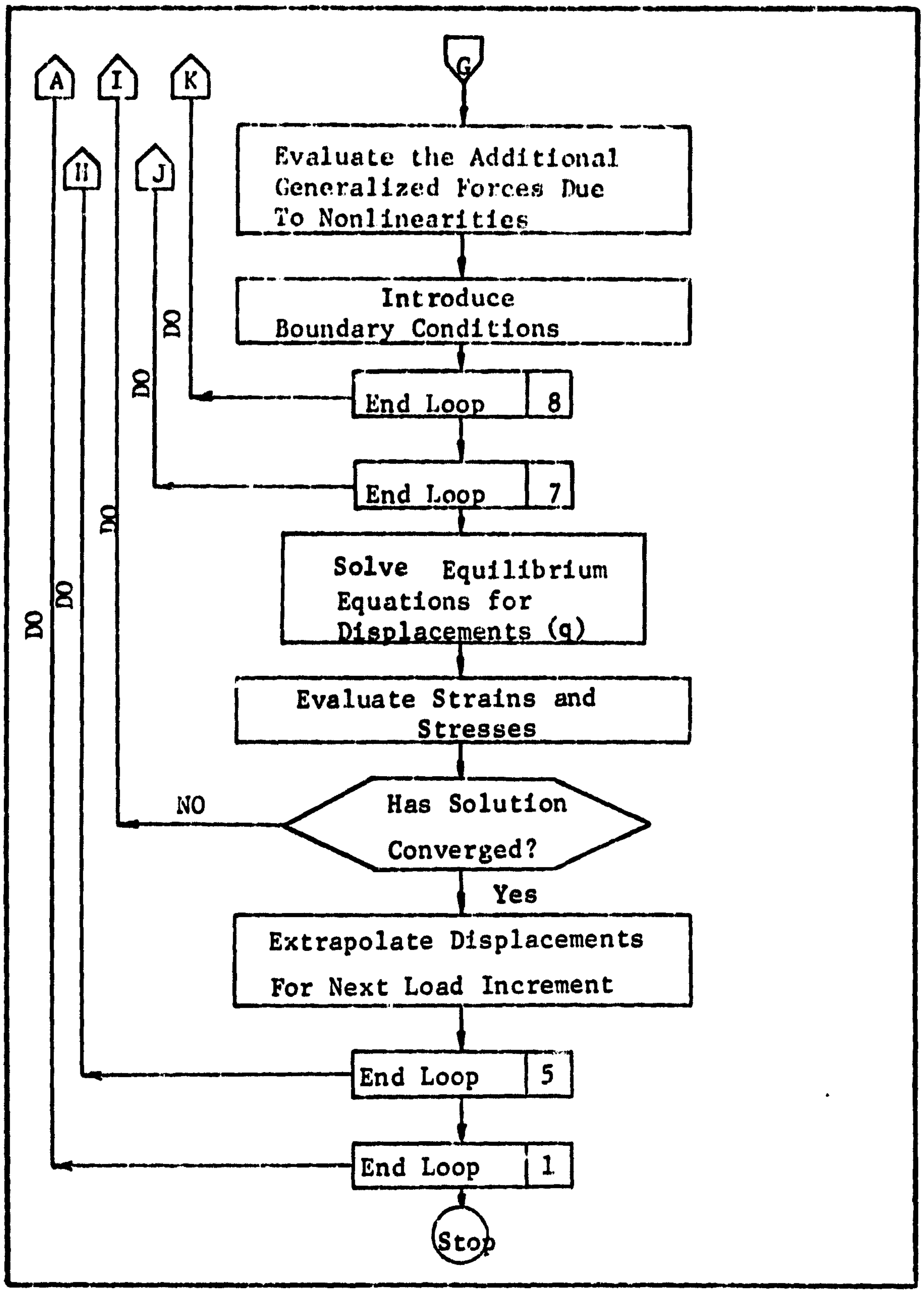


Fig. 8 FLOW CHART FOR THE NONLINEAR PROGRAM (cont.)

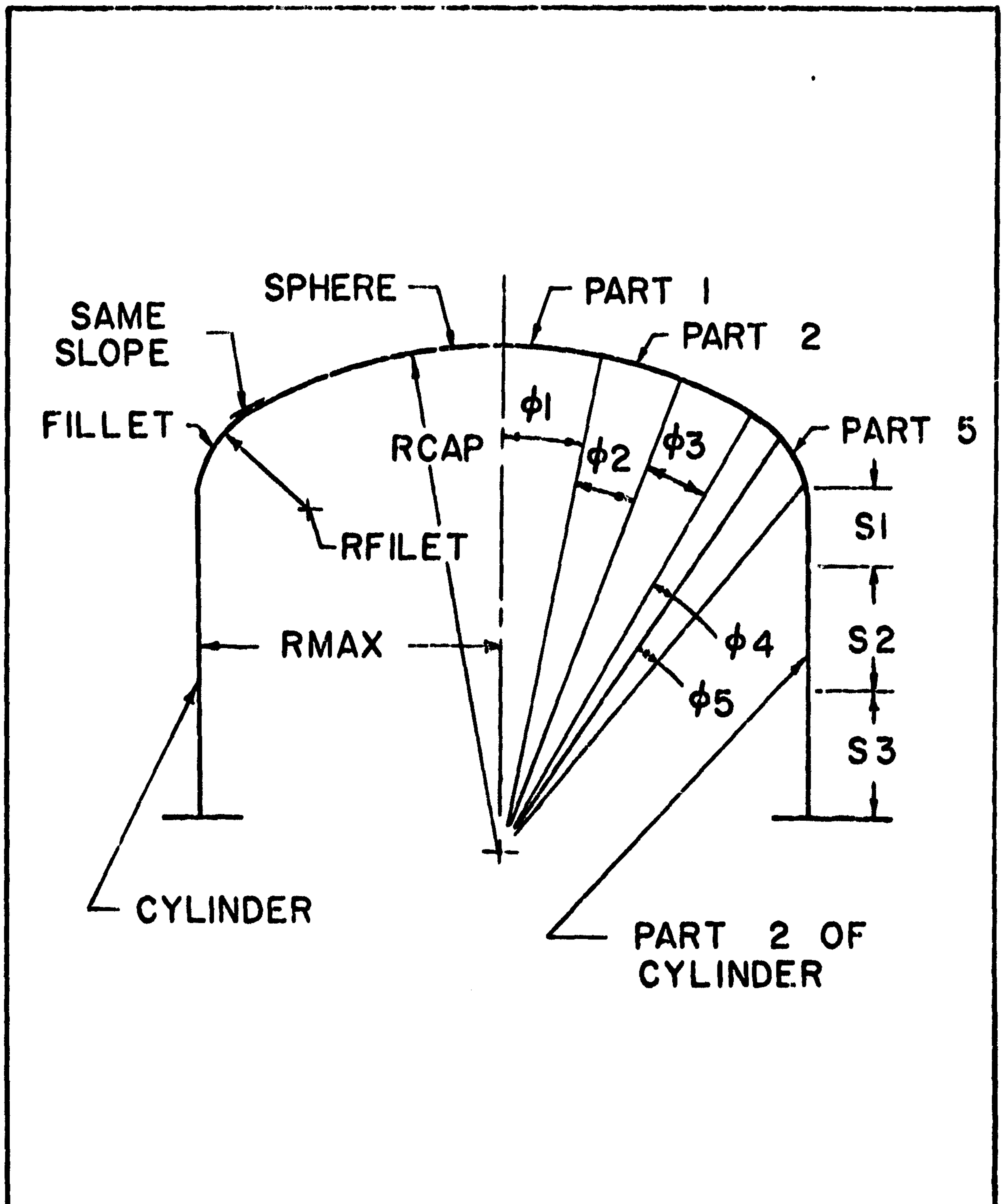


FIG. 9 SHELL IS A COMBINATION OF A CYLINDER, FILLET AND SPHERE

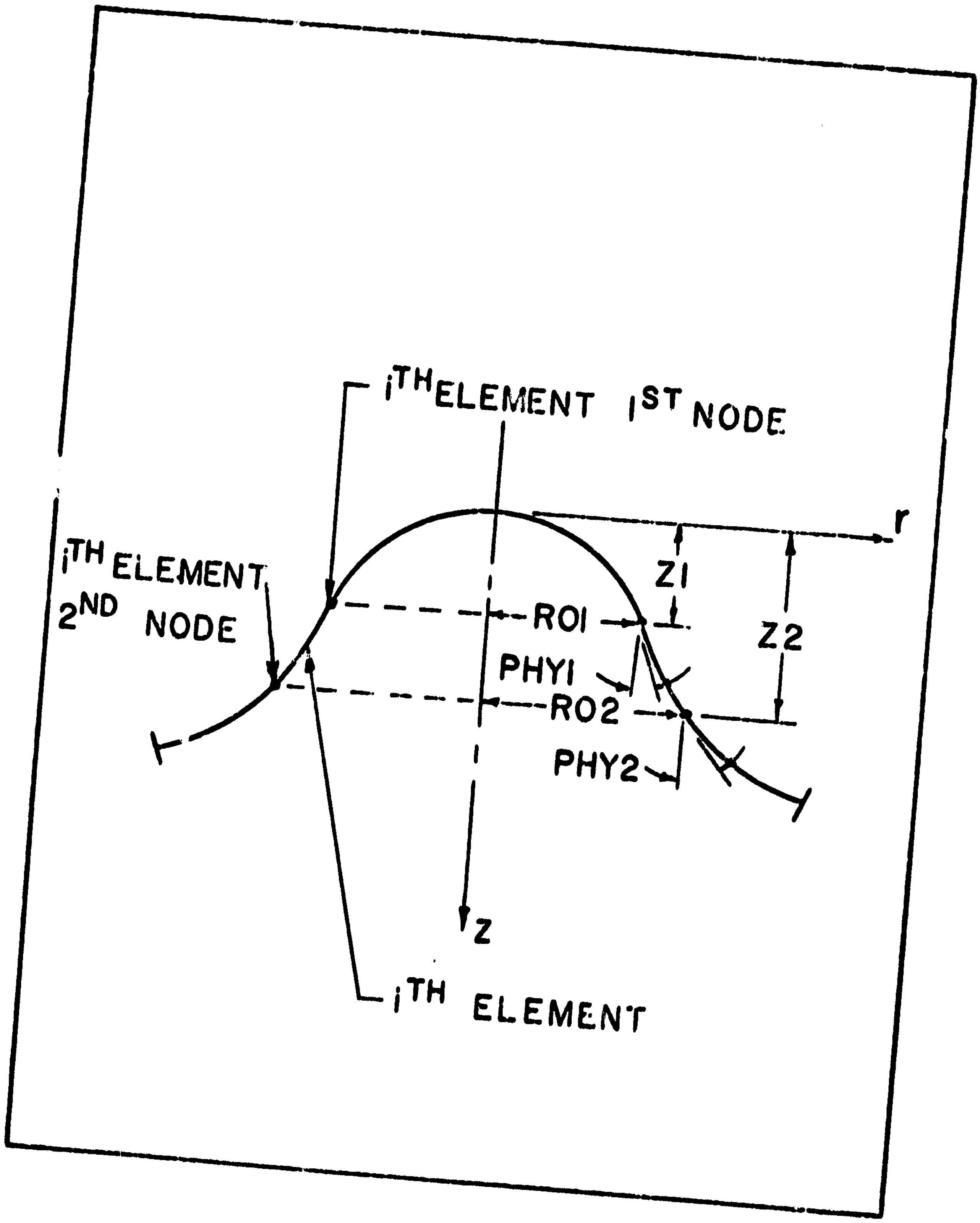


FIG. 10 SHELL WITH GENERAL GEOMETRY

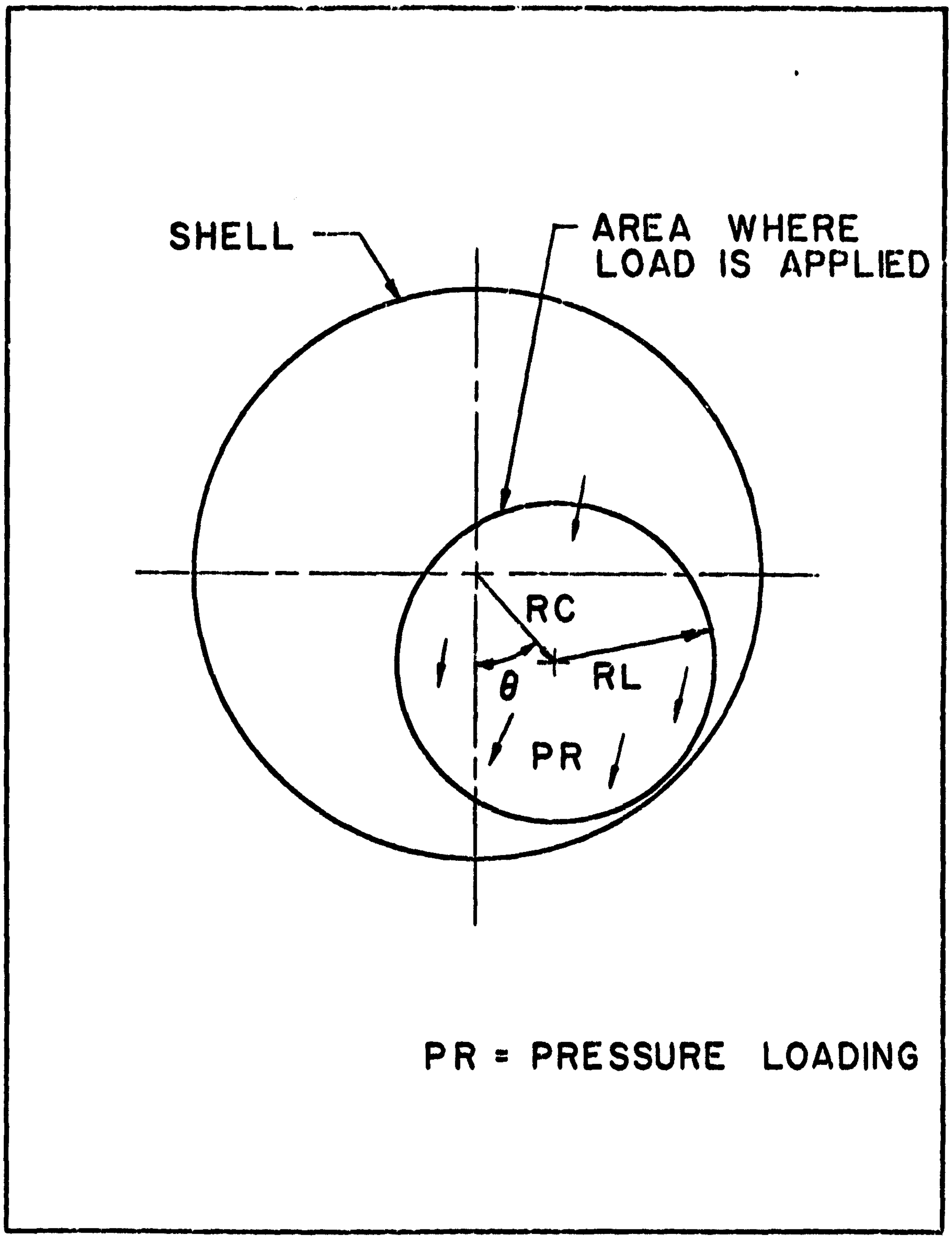


FIG. 11 LOAD APPLIED OVER A CIRCULAR AREA

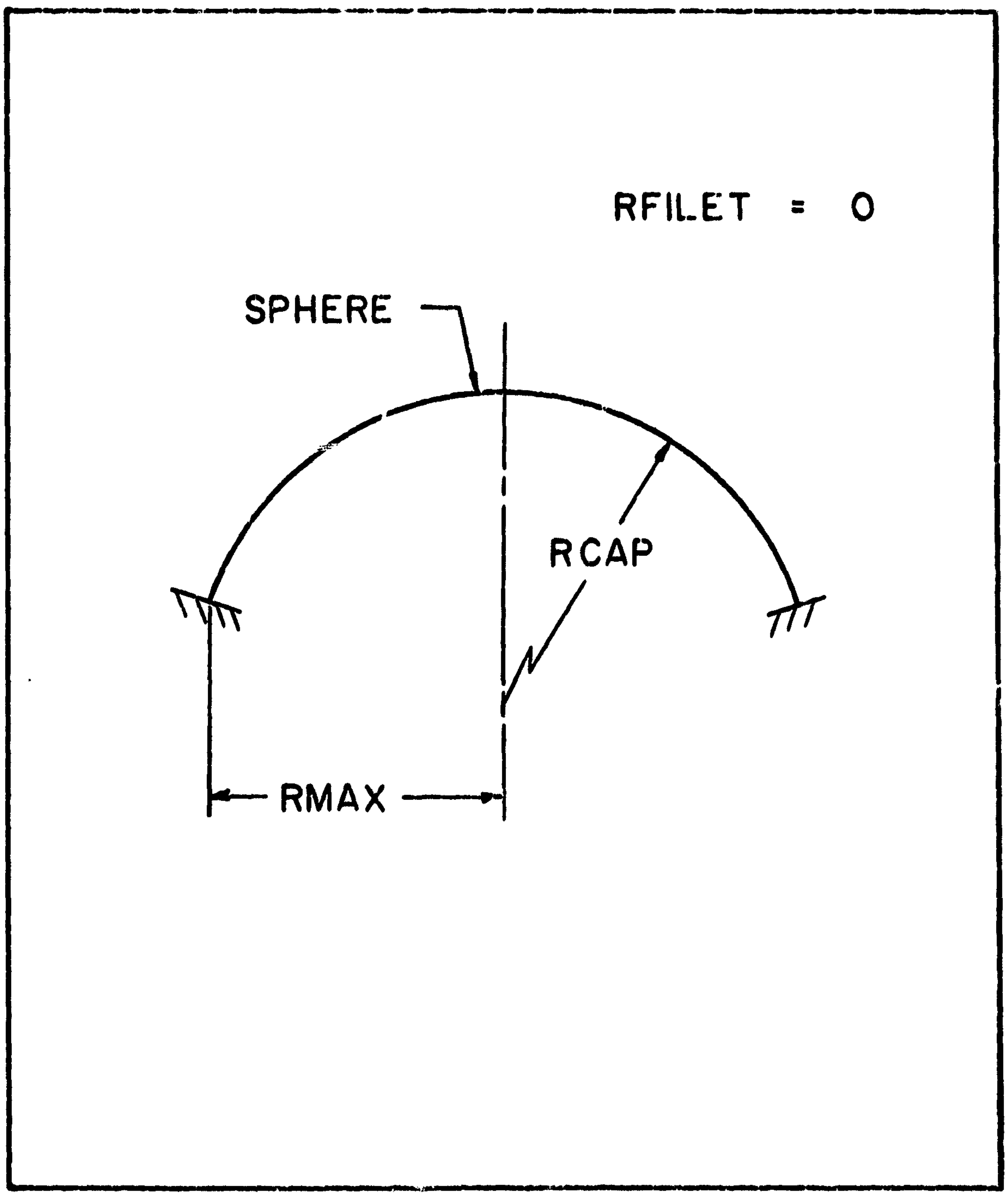


FIG. 12 A SPHERICAL CAP

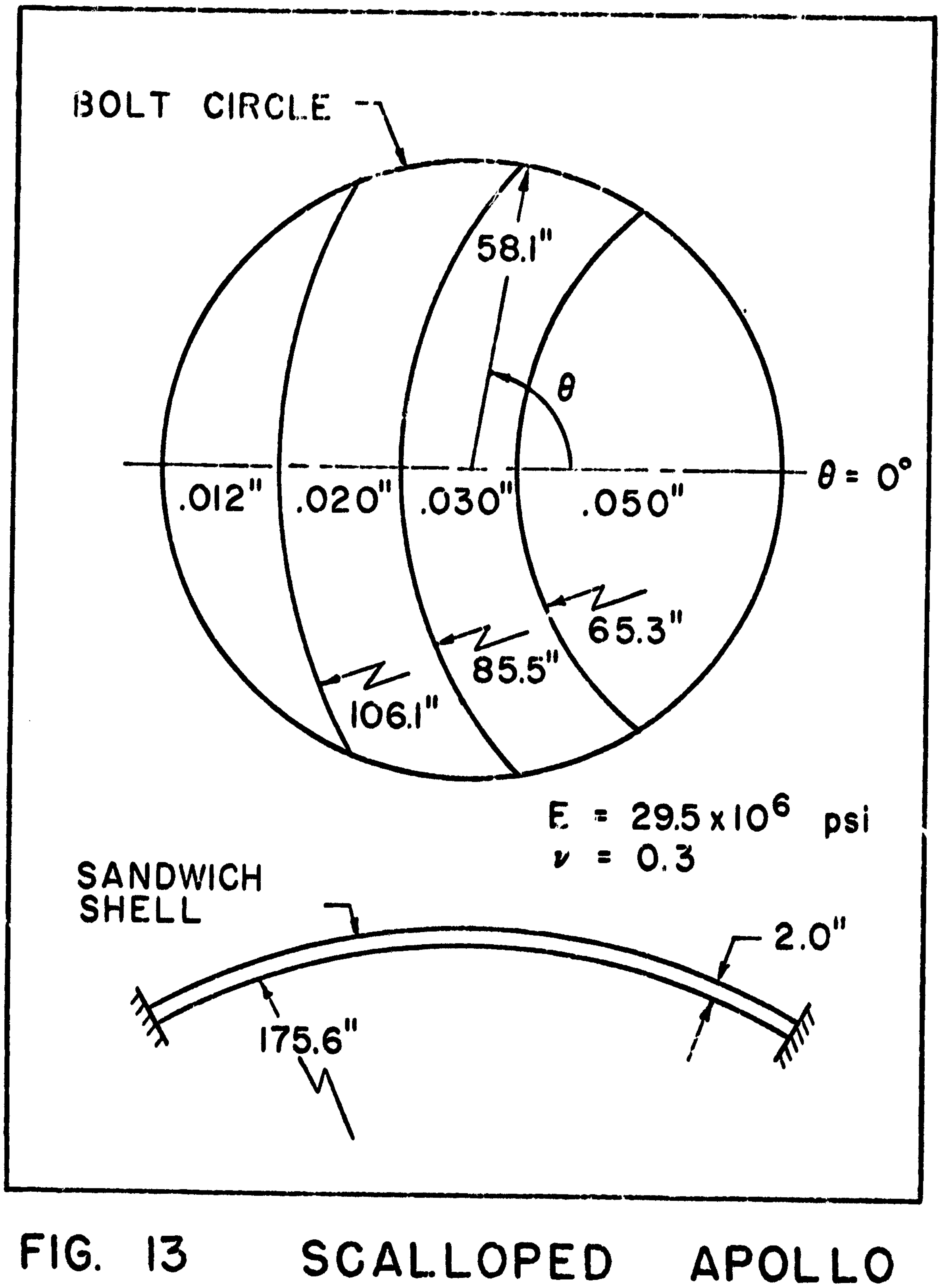


FIG. 13 SCALLOPED APOLLO AFT HEAT SHIELD

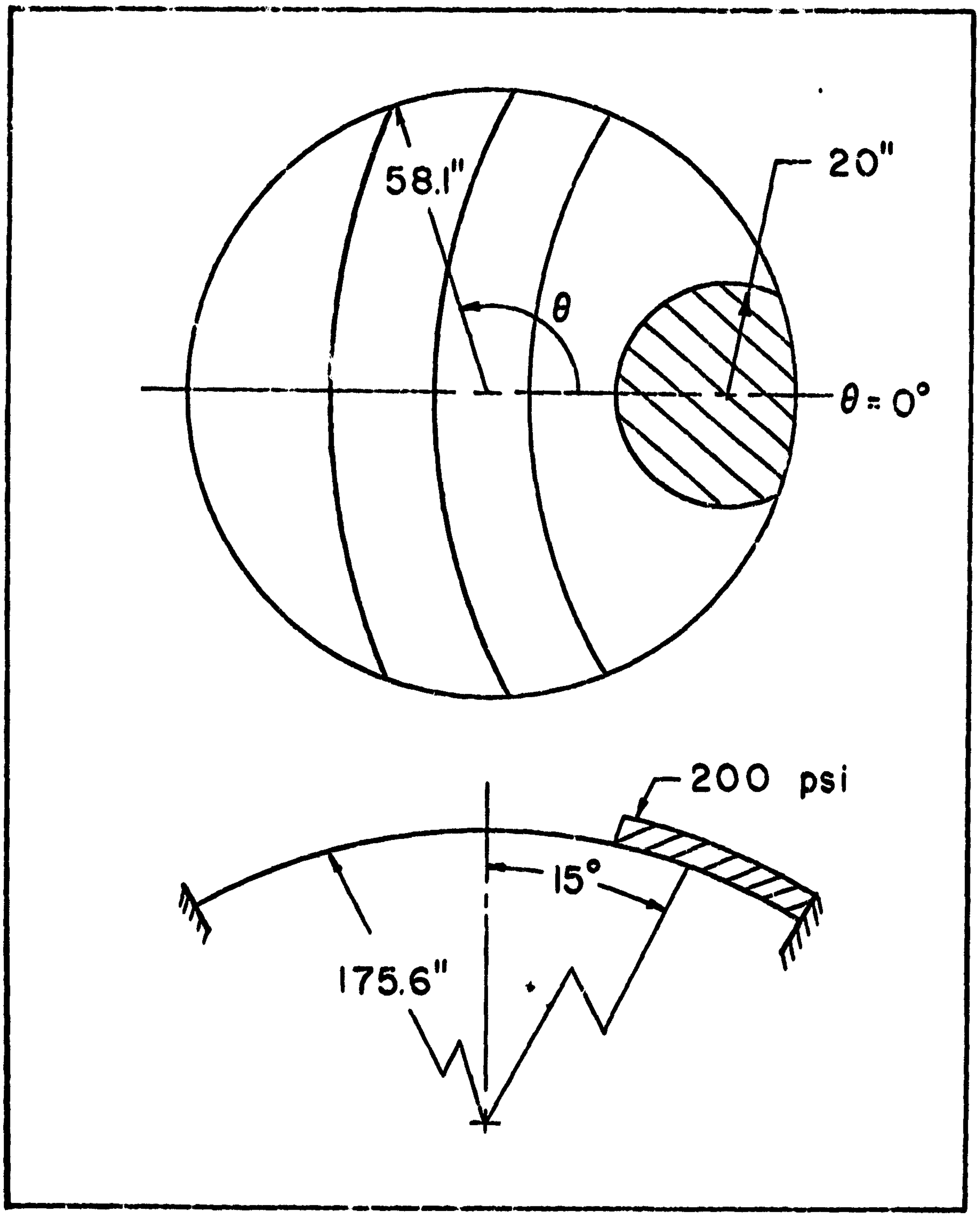


FIG. 14 APOLLO AFT HEAT SHIELD UNDER A UNIFORM PRESSURE APPLIED OVER A CIRCULAR AREA

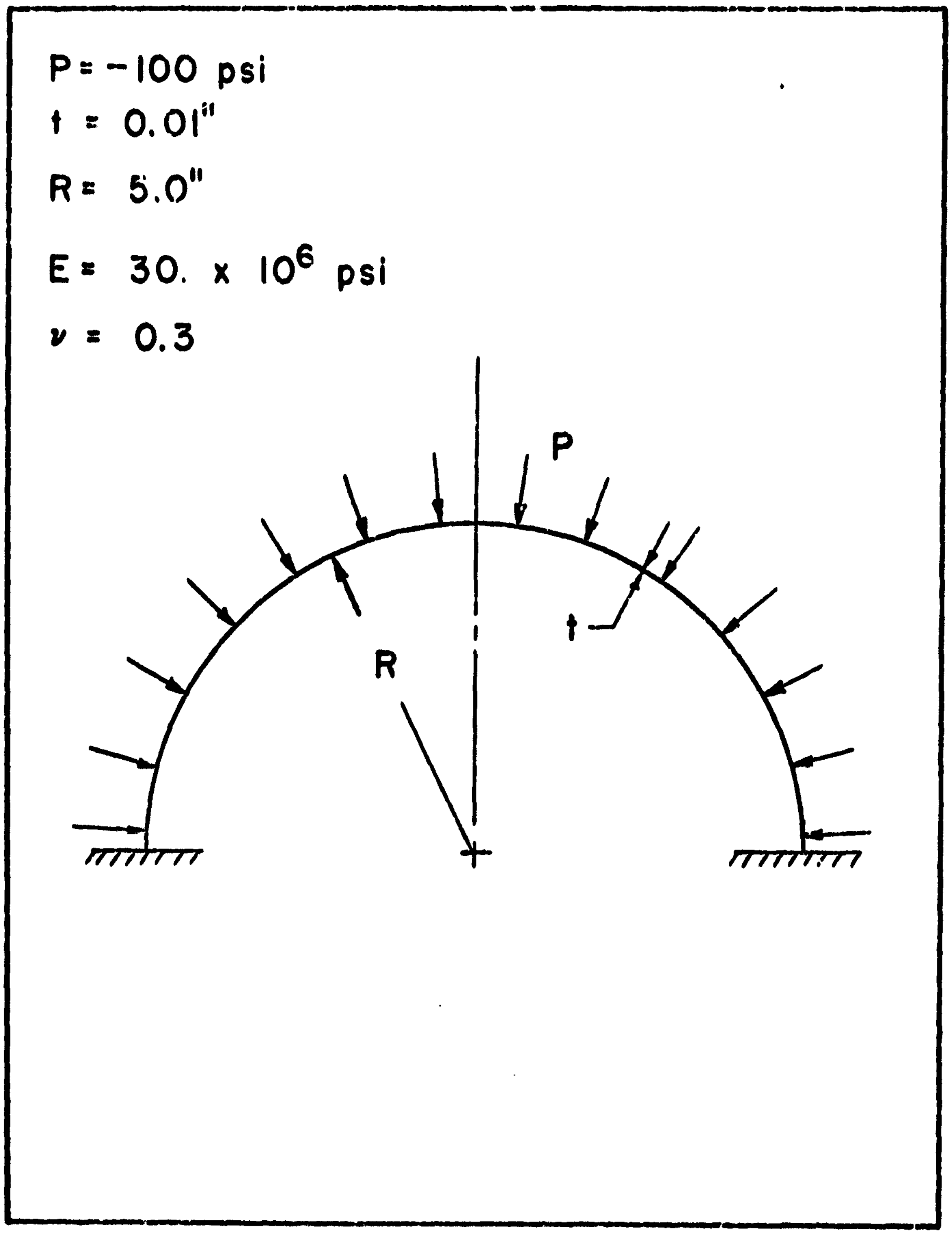


FIG. 15 HEMISPHERICAL SHELL UNDER UNIFORM PRESSURE

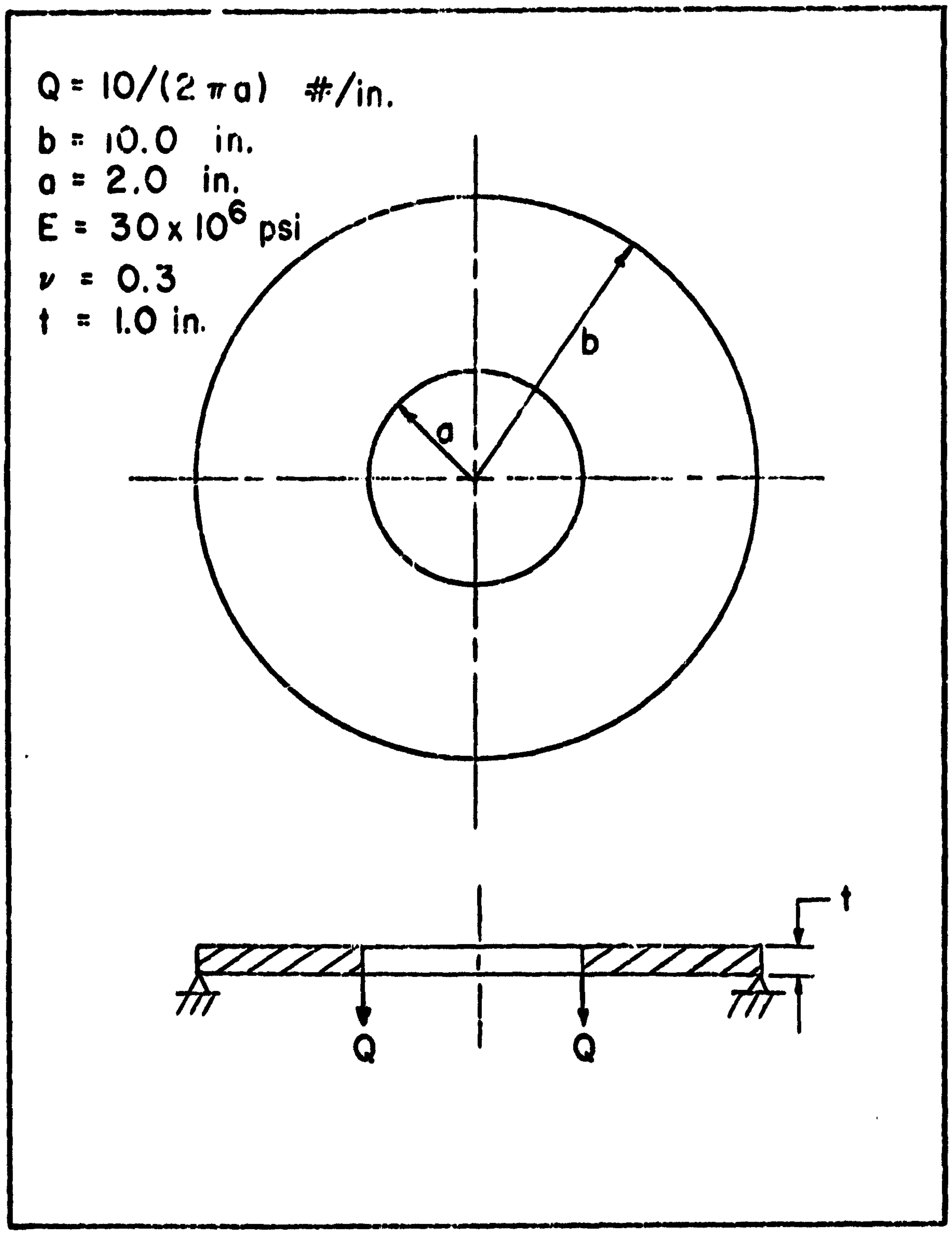


FIG. 16 CIRCULAR PLATE WITH A CIRCULAR HOLE UNDER A UNIFORM RING LOAD

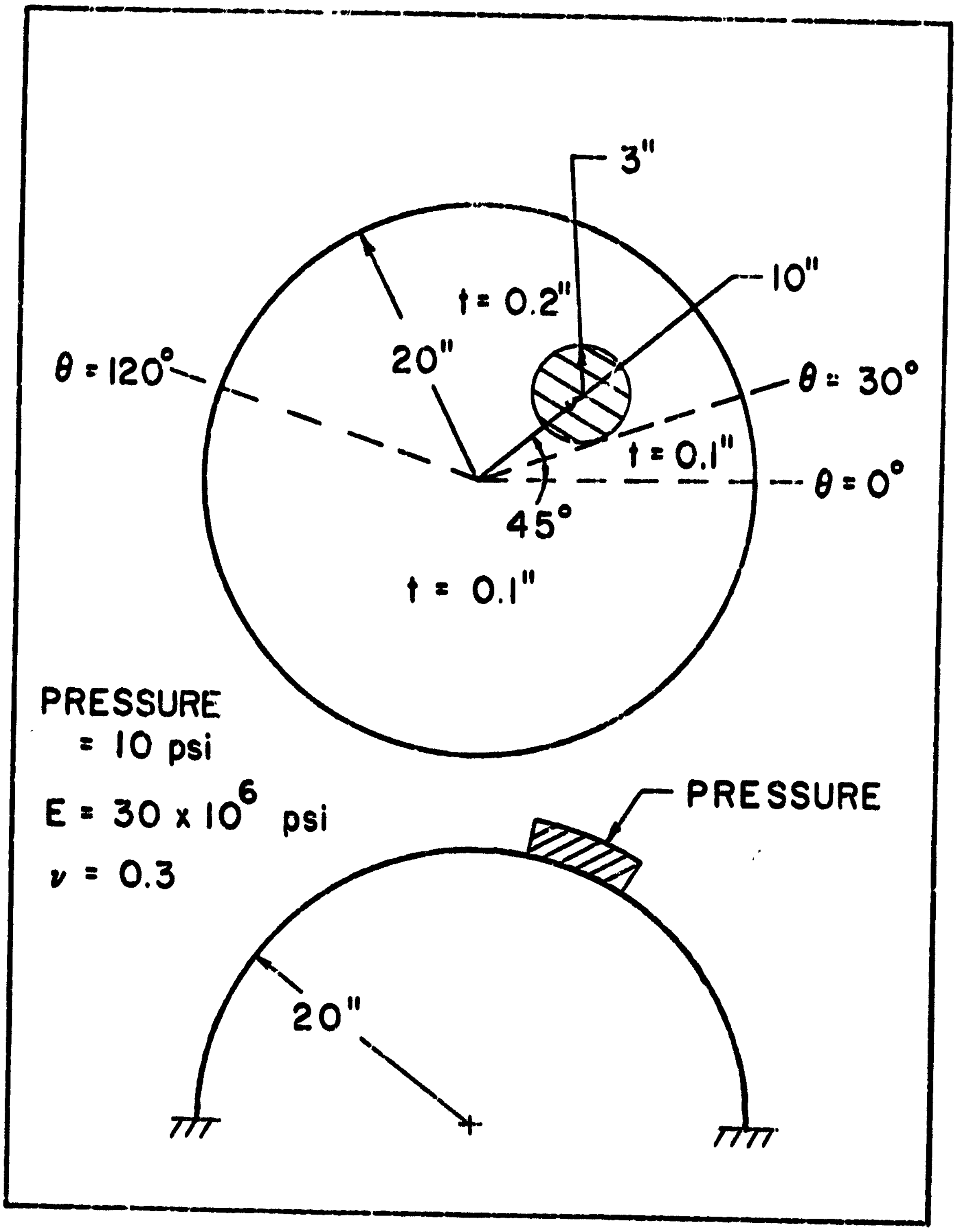


FIG. 17 A SPHERICAL CAP WITH VARYING THICKNESS PROPERTIES

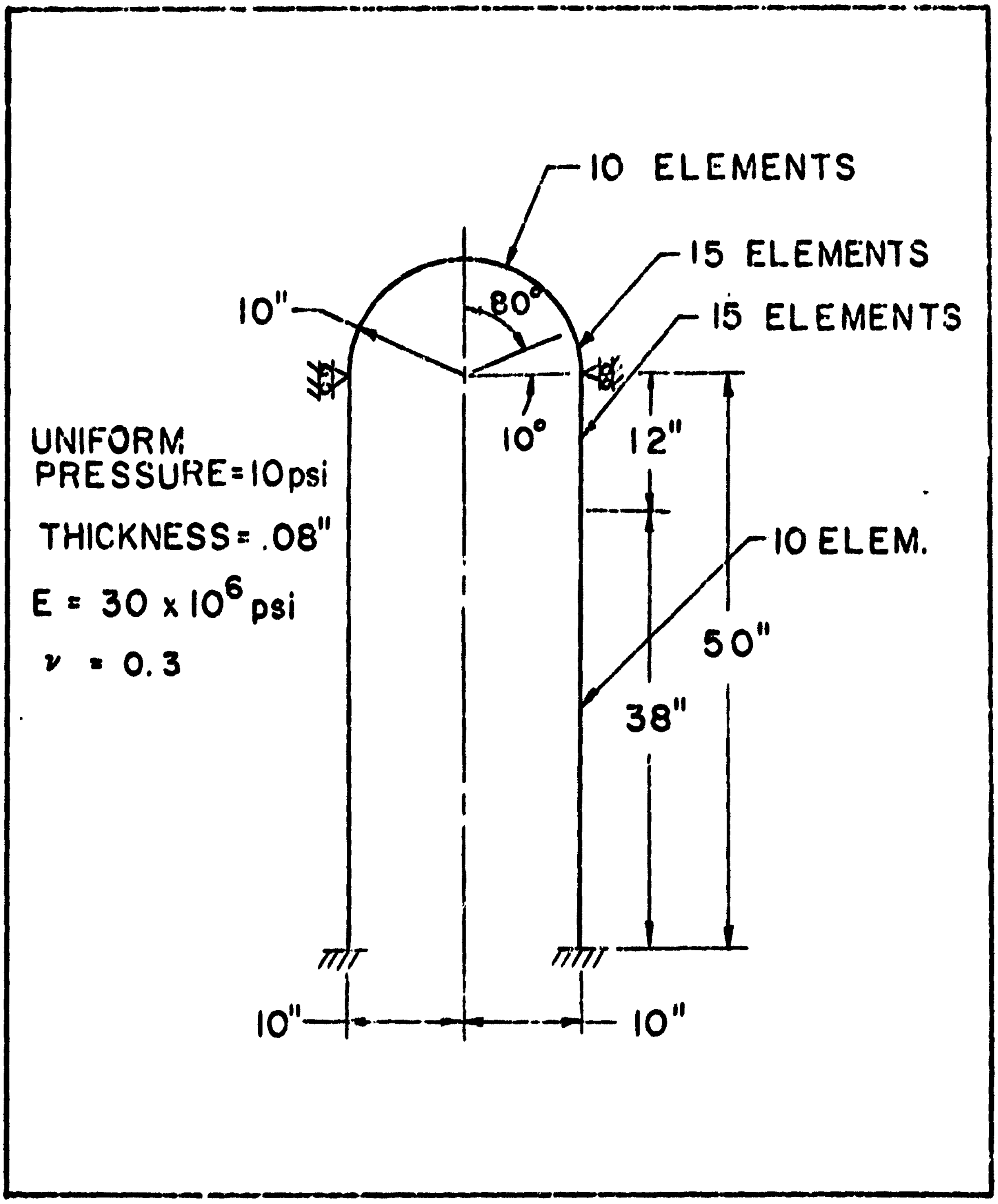


FIG. 18 SPHERICAL CAP AND CYLINDER UNDER A UNIFORM EXTERNAL PRESSURE

APPENDIX A

SAMPLE INPUT DATA AND SAMPLE OUTPUT

PAGE 1

GENERAL INFORMATICN

SAMPLE PRCBLEP NC. 1

NCNLINEAR ANALYSIS CF THE SCALLCPED APCLLC AFT HEAT SHIELC.

THE SHELL IS A STAINLESS SANDWICH STRUCTURE WITH A NOMINAL

THICKNESS CF TWC INCHES.

THE LCAD IS APPLIED CVER A CIRCULAR AREA CF TWENTY INCHES RACIUS.

THE CENTER CF THE CIRCULAR AREA IS LOCATEC AT C.C DEGRESS IN THE

CIRCUMFERENTIAL DIRECTICN ANC AT 15 DEGREES INCLINATICN.

FINC BUCKLING LCAC FOR THE APCLLC AFT HEAT SHIELD

NUMBER CF LCACING INCREMENTS = 4 *** TOTAL LCAC =-2CO PSI *** ERROR = 6 PERCENT

4 A HARMCNICS WERE USED WITH NA = 6 *** NET = 29

••••••••••••••••••••

••••••••••••••

••••••

P R C B L E M BUCK

N O M E N C L A T U R E

Z	.....	SHELL AXIAL COORDINATE
R	.....	SHELL RADIAL COORDINATE(CYLINDRICAL)
E	.....	MODULUS OF ELASTICITY OF SHELL ELEMENT
NU	.....	POISSON,S RATIO OF SHELL ELEMENT
PHI	.....	ANGLE BETWEEN MERIDIAN AND AXIS OF REVOLUTION
S(S)	.....	STRAIN OF THE MIDDLE SURFACE OF THE SHELL ELEMENT ALONG THE MERIDIONAL DIRECTION
E(THETA)	.....	STRAIN OF THE MIDDLE SURFACE OF THE SHELL ELEMENT ALONG THE CIRCUMFERENTIAL DIRECTION
E(S-THETA)	.....	STRAIN OF THE MIDDLE SURFACE OF THE SHELL ELEMENT ALONG THE NORMAL DIRECTION
K(S)	.....	CURVATURE CHANGE OF THE SHELL ELEMENT SURFACE IN MERIDIONAL PLANE
K(THETA)	.....	CURVATURE CHANGE OF THE SHELL ELEMENT SURFACE IN THE PLANE PERPENDICULAR TO MERIDIONAL PLANE
K(S-THETA)	.....	TWIST OF THE SHELL ELEMENT SURFACE
N(S)	.....	NORMAL FORCE PER UNIT LENGTH OF CIRCUMFERENTIAL SECTION OF A SHELL
N(THETA)	.....	NORMAL FORCE PER UNIT LENGTH OF MERIDIONAL SECTION OF A SHELL
N(S-THETA)	.....	SHEARING FORCE PER UNIT LENGTH OF CIRCUMFERENTIAL SECTION OR MERIDIONAL SECTION OF A SHELL
M(S)	.....	BENDING MOMENT PER UNIT LENGTH OF CIRCUMFERENTIAL SECTION OF A SHELL
M(THETA)	.....	BENDING MOMENT PER UNIT LENGTH OF MERIDIONAL SECTION OF A SHELL
M(S-THETA)	.....	TWISTING MOMENT PER UNIT LENGTH OF CIRCUMFERENTIAL SECTION OR MERIDIONAL SECTION OF A SHELL
Q(S)	.....	SHEARING FORCE NORMAL TO THE SHELL PER UNIT LENGTH OF CIRCUMFERENTIAL SECTION
Q(THETA)	.....	SHEARING FORCE NORMAL TO THE SHELL PER UNIT LENGTH OF MERIDIONAL SECTION

....

....

......

PAGE 3

ELASTIC AND GEOMETRIC PROPERTIES OF STRUCTURE

ELEMENT NO.	NODE NOS.	COORDINATES Z	R	ELASTIC CONSTANTS E	NU	PHI
1	1	C.0	0.1CC00E-05	0.295CCE 0E	C.3CCCCE CC	0.9C0C0E C2
	2	0.83923E-02	C.17164E 01			0.89440E C2
2	2	0.83923E-02	C.17164E 01	0.295CCE 0E	C.3CCCCE CC	C.89440F C2
	3	0.33554E-01	0.34325E 01			C.88880E C2
3	3	0.33554E-01	0.34325E 01	0.295CCE 0E	C.3CC00E CC	0.88880E C2
	4	C.75485E-01	0.51482E 01			0.8832CE C2
4	4	C.75485E-01	C.51482E 01	0.295CCE 0E	C.3CCC0E CC	C.8832CE C2
	5	C.13419E 0C	C.68635E 01			C.8776CE C2
5	5	0.13419E 00	0.68635E 01	0.295CCE 0E	C.3CCC0E CC	0.8776CE C2
	6	0.20964E 0C	0.85781E 01			0.872C0E C2
6	6	C.20964E 0C	0.85781E 01	0.295CCE 0E	C.3CCCCE CC	C.872CCE C2
	7	C.30186E 0C	C.1C292E 02			C.8664CE C2
7	7	0.30186E 0C	C.1C292E 02	0.295CCE 0E	C.3CC0CE C0	0.86640E C2
	8	0.41C83E 0C	C.12C05E 02			0.8608CE C2
8	8	C.41C83E 0C	C.12C05E 02	0.295CCE 0E	C.3CCC0E CC	C.86C8CE C2
	9	0.53653E 0C	C.13716E 02			C.85520E C2
9	9	C.53653E 0C	C.13716E 02	0.2950CE 0E	C.3CCC0E C0	0.85520E C2
	10	0.67896E 0C	C.15427E 02			C.8496CE C2
10	10	C.67896E 0C	C.15427E 02	0.295CCE 0E	C.3CCCCE CC	C.8496CE C2
	11	0.83807E 0C	C.17136E 02			C.844CCE C2
11	11	0.83807E 0C	C.17136E 02	0.295CCE CE	C.3CCCCE C0	0.844C0E C2
	12	0.10139E 01	C.18843F 02			C.8384CE C2
12	12	0.10139E 01	C.18843E 02	0.295CCE 0E	C.3CCCCE CC	C.8384CE C2
	13	0.12064E 01	C.20548E 02			C.83280E C2
13	13	0.12C64E 01	.20548E 02	0.295CCE 0E	C.3CCCCE CC	0.8328CE C2
	14	0.14156E 01	0.22252E 02			0.82720E C2
14	14	0.14156E 01	C.22252E 02	0.295CCE 0E	C.3CCCCE CC	C.82720E C2
	15	0.16414E 01	C.23953E 02			C.82160E C2
15	15	0.16414E 01	0.23953E 02	0.295CCE 0E	C.3CCCCE CC	0.82160E C2
	16	0.18838E 01	0.25652E 02			0.816CCE C2
16	16	0.18838E 01	0.25652E 02	0.295CCE CE	C.3CCCCE CC	C.816C0E C2
	17	0.21428E 01	C.27349E 02			0.81C40E C2
17	17	0.21428E 01	C.27349E 02	0.295CCE 0E	C.3CCC0E CC	0.81C40E C2
	18	0.24184E 01	0.29043E 02			C.80480E C2
18	18	C.24184E 01	0.29043E 02	0.295CCE 0E	C.3CCC0E CC	C.8048CE C2
	19	0.27105E 01	0.30734E 02			C.7992CE C2
19	19	0.27105E 01	0.30734E 02	0.2950CE 0E	C.3CCCCE C0	0.79920E C2
	20	0.30192E 01	0.32422E 02			0.7936CE C2
20	20	0.30192E 01	0.32422E 02	0.295CCE 0E	C.3CCC0E CC	0.7936CE C2
	21	0.33443E 01	0.34108E 02			C.7880CE C2
21	21	0.33443E 01	0.34108E 02	0.295CCE 0E	C.3CCC0E C0	0.788CCE C2
	22	0.35403E 01	0.35083E 02			C.78475E C2
22	22	0.35403E 01	C.35083E 02	0.295CCE 0E	C.3CCC0E C0	0.78475E C2
	23	0.37419E 01	C.36058E 02			0.78151E C2
23	23	0.37419E 01	0.36058E 02	0.295CCE 0E	C.3CCC0E C0	0.78151E 02
	24	0.39490E 01	0.37031E 02			0.77826E C2
24	24	0.39490E 01	C.37031E 02	0.2950CE 0E	C.30CC0E C0	0.77826E C2
	25	0.41616E 01	0.38003E 02			C.775C1E C2

ELASTIC ANC GEOMETRIC PROPERTIES CF STRLCTLRE

ELEMENT	NODE	CCORDINATES		ELASTIC CCNSTANTS		
NC.	NOS.	Z	R	E	NL	P
25	25	0.41616E 01	C.38003E 02	0.295CCE 08	C.3CCCCE CC	0.775C1E C2
	26	C.43797E 01	0.38974E 02			C.77177E C2
26	26	0.43797E 01	0.38974E 02	0.255CCE C8	C.3CCCCE CO	0.77177E C2
	27	0.46033E 01	0.39943E 02			C.76852E C2
27	27	0.46C33E 01	0.39943E 02	0.295CCE 08	C.3CCC0E CO	0.76852E C2
	28	0.48323E 01	0.40912E 02			C.76527E C2
28	28	0.48323E 01	0.40912E 02	0.2950CE 08	C.3CCCCE CC	C.76527E C2
	29	0.50669E 01	C.41879E 02			0.762C3E C2
29	29	0.50669E 01	C.41879E 02	0.255CCE 08	C.3CCCCE CO	0.762C3E C2
	30	C.53069E 01	C.42844E 02			C.75878E C2
3C	30	C.53069E 01	0.42844E 02	0.2950CE 08	C.3CCCCE CC	0.75878E C2
	31	0.55524E 01	0.43809E 02			0.75553E C2
31	31	0.55524E 01	0.43809E 02	0.2950CE 08	C.3CCC0E CO	0.75553E C2
	32	C.58034E 01	C.44771E 02			C.75229E C2
32	32	C.58034E 01	0.44771E 02	0.255CCE 08	C.3CCC0E CC	C.75229E C2
	33	C.60598E 01	0.45733E 02			0.749C4E C2
33	33	C.60598E 01	C.45733E 02	0.2950CE 08	C.3CCC0E CC	0.749C4E C2
	34	0.63217E 01	0.46693E 02			C.74579E C2
34	34	0.63217E 01	C.46693E 02	0.255CC: 08	C.3CCCCE CC	C.74579E C2
	35	C.65890E 01	C.47651E 02			0.74255E C2
35	35	C.65890E 01	C.47651E 02	0.2950CE 08	C.3CCC0E CO	0.74255E C2
	36	0.68617E 01	C.48608E 02			0.7393CE C2
36	36	C.68617E 01	C.48608E 02	0.2950CE 08	C.3CCC0E CC	C.7393CE C2
	37	0.70479E 01	C.49250E 02			C.73712E C2
37	37	0.70479E 01	0.49250E 02	0.295CCE 08	C.3CCCCE CC	0.73712E C2
	38	C.72365E 01	0.49891E 02			C.73454E C2
38	38	C.72365E 01	0.49891E 02	0.255CCE 08	C.3CCCCE CC	0.73454E C2
	39	0.74276E 01	C.5C531E 02			0.73276E C2
39	39	C.74276E 01	C.5C531E 02	0.2950CE 08	C.3CCC0E CO	0.73276E C2
	40	0.76210E 01	C.51171E 02			C.73058E C2
40	40	C.76210E 01	C.51171E 02	0.255CCE 08	C.3CCCCE CO	0.73058E C2
	41	C.78170E C1	C.51809E 02			C.7284CE C2
41	41	C.78170E 01	0.51809E 02	0.2950CE 08	C.3CCC0E CC	0.72840E C2
	42	0.80153E 01	0.52447E 02			C.72622E C2
42	42	0.80153E 01	0.52447E 02	0.295CCE 08	C.3CCC0E CO	0.72622E C2
	43	0.82161E 01	0.53085E 02			C.724C4E C2
43	43	0.82161E 01	0.53085E 02	0.2950CE 08	C.3CCCJE CO	0.72404E C2
	44	0.84193E 01	0.53721E 02			C.72186E C2
44	44	0.84193E 01	C.53721E 02	0.255CCE 08	C.3CCC0E CC	0.72186E C2
	45	0.86248E 01	0.54357E 02			0.71968E C2
45	45	0.86248E 01	0.54357E 02	0.2950CE 08	C.3CCC0E CO	0.71968E C2
	46	0.88329E 01	0.54992E 02			C.7175CE C2
46	46	0.88329E 01	0.54992E 02	0.2950CE 08	C.3CCCCE CC	0.7175CE C2
	47	0.90434E 01	0.55626E 02			0.71532E C2
47	47	0.90434E 01	0.55626E 02	0.2950CE 08	C.3CCC0E CO	0.71532E C2
	48	0.92562E 01	0.56259E 02			0.71314E C2
48	48	0.92562E 01	C.56259E 02	0.2950CE 08	C.3CCC0E CO	0.71314E C2
	49	0.94714E 01	0.56892E 02			0.71096E C2

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ELASTIC ANC GEOMETRIC PROPERTIES OF STRUCTURE

ELEMENT NO.	NODE NOS.	CCORDINATES Z	R	ELASTIC CCNSTANTS E	NU	PHI
49	49	0.94714E 01	C.56892E 02	0.29500E 08	C.3CCCOE CO	0.71096E C2
	50	0.96891E 01	C.57523E 02			0.70878E C2
50	50	0.96891E 01	0.57523E 02	0.29500E 08	C.3CCCOE CO	C.70878E C2
	51	0.98902E 01	0.58100E 02			0.70660E C2

NUMBER OF A HARMONICS = 4 NUMBER OF SIMPSCN STATIONS = 29 NUMBER CF B HARMCNICS = C

RADIUS CF SPHERICAL SHELL = 175.6CC

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TABLE OF THICKNESSES

SANCWICH TYPE SHELL WITH FACE SHEETS SPACEC 2.CCC IN FRCM EACH CTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELCW

ELEMENT NO. 1 CCNSTANT THICKNESS = C.C3CCC

ELEMENT NO. 2 CCNSTANT THICKNESS = 0.C3CCC

ELEMENT NO. 3 CCNSTANT TH'CKNESS = C.C3CCC

ELEMENT NO. 4 CCNSTANT THICKNESS = 0.C3CCC

ELEMENT NO. 5 CCNSTANT THICKNESS = C.C3CCC

ELEMENT NO. 6 CCNSTANT THICKNESS = 0.C30CC

ELEMENT NC. 7

THETA(DEGREES)	0.0 TC 30.0C0C0	3C.CCCC0 TO 145.CCCC0	145.0CCCC TC 215.CCCCC	215.C00CC TC 33C.CCCCC
THICKNESS	0.05CCC	C.03CC0	C.C2CC0	C.C3CCC
THETA(DEGREES)	330.0C0C0 TC 360.CC0C0			
THICKNESS	0.05CC0			

ELEMENT NC. 8

THETA(DEGREES)	0.0 TO 40.CC0C0	40.CCCCC TO 145.CCCC0	145.0CCCC TC 215.CCCCC	215.CC00C TC 32C.CCCCC
THICKNESS	0.05CC0	C.03CC0	C.C2CC0	C.C3CCC
THETA(DEGREES)	320.0CCC0 TC 360.0C0C0			
THICKNESS	0.05000			

ELEMENT NC. 9

THETA(DEGREES)	0.0 TC 40.0C0C0	40.CCCC0 TO 127.5CC00	127.5CCCC TC 232.50C0C	232.5C00C TC 32C.CC0CC
THICKNESS	0.05000	0.030C0	C.C2CC0	C.03CCC

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TABLE OF THICKNESSES

SANCWICH TYPE SHELL WITH FACE SHEETS SPACEC 2.CC IN FRCM EACH CTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELOW

ELEMENT NC. 9

THETA(DEGREES)	320.0CCCO TC 360.CCOCO			
THICKNESS	0.05CCC			

ELEMENT NC. 10

THETA(DEGREES)	0.0 TC 50.CCGCO	5C.CCCCC TO 127.5CCCO	127.5CCCC TC 232.5CCCC	232.5CCCC TC 31C.CCCCC
THICKNESS	0.05CCO	C.03CCO	C.C2CCO	C.C3CCC
THETA(DEGREES)	310.0CCCO TC 360.0COCO			
THICKNESS	0.05CCO			

ELEMENT NC. 11

THETA(DEGREES)	0.0 TC 50.0CCCO	5C.CCCCC TO 115.CCCCO	115.0CCCC TC 245.CCCCC	245.CCCCC TC 31C.CCCCC
THICKNESS	0.05CCO	C.03CCO	C.C2CCO	C.C3CCC
THETA(DEGREES)	310.0CCCO TC 360.0COCO			
THICKNESS	0.05CCO			

ELEMENT NC. 12

THETA(DEGREES)	0.0 TO 50.CCOCO	5C.CCCCO TO 115.0CCCO	115.CCCCC TC 245.CCCCC	245.CCCCC TC 31C.CCCCC
THICKNESS	0.05C00	C.030CO	C.C2CCC	C.C3CCC
THETA(DEGREES)	310.CCCCO TO 360.CCOCO			
THICKNESS	0.05CCO			

ELEMENT NC. 13

THETA(DEGREES)	0.0 TO 6C.0COCO	6C.CCCCC TO 105.CCCCO	105.0CCCC TC 255.CCCCC	255.CCCCC TC 3CC.CCCCC
THICKNESS	0.05CCO	0.03CCO	C.C2CCO	C.C3CCC
THETA(DEGREES)	300.CCC00 TO 360.0COCO			
THICKNESS	0.05CCO			

ELEMENT NC. 14

THETA(DEGREES)	0.0 TC 60.0C000	60.CCCCC TO 105.0CCCO	105.0CCCC TC 255.CCCCC	255.0000C TC 3CO.CCCCC
THICKNESS	0.05CCO	0.03CCO	C.C2CCO	C.C3CCC

TABLE OF THICKNESSES

SANDWICH TYPE SHELL WITH FACE SHEETS SPACED 2.CCC IN FROM EACH OTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELOW

ELEMENT NC. 14

THETA(DEGREES) THICKNESS	300.0CC00 TO 360.0C0C0 0.05C00			

ELEMENT NC. 15

THETA(DEGREES) THICKNESS	0.0 TO 6C.0C0C0 0.05CC0	60.CCCC0 TO 105.CC0C0 0.030C0	105.0CCCC TC 255.CCC0C C.C2CCC	255.CCCCC TC 3CC.CCCCC C.C3CCC
THETA(DEGREES) THICKNESS	300.0CC00 TO 360.0C0C0 0.05CC0			

ELEMENT NC. 16

THETA(DEGREES) THICKNESS	0.0 TO 60.0C000 0.05CC0	60.CCCC0 TO 105.CCCC0 0.03000	1C5.CCCC0 TC 255.CC000 C.C2CC0	255.C0CCC TC 3CC.CCCCC C.C3CCC
THETA(DEGREES) THICKNESS	300.0C0C0 TO 360.0C0C0 0.05CC0			

ELEMENT NC. 17

THETA(DEGREES) THICKNESS	0.0 TO 60.0C000 0.05CC0	60.CCCCC TO 105.C0CC0 0.03000	1C5.0CCCC TC 255.CCCC0 C.C2CC0	255.CCCCC TC 3CC.CCCCC C.C3CCC
THETA(DEGREES) THICKNESS	300.0C000 TO 360.0C0C0 0.05CC0			

ELEMENT NC. 18

THETA(DEGREES) THICKNESS	0.0 TO 6C.0C0C0 0.05CC0	6C.CCCCC TO 95.0CC00 C.03C00	95.0CCCC TC 155.CCC0C C.C2CC0	155.CC0CC TC 2C5.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	205.CCC00 TO 265.0C000 0.02CC0	265.CCCC0 TO 30C.C0CC0 0.03000	3CC.0CCCC TO 360.CCC0C C.C5CC0	

ELEMENT NO. 19

THETA(DEGREES) THICKNESS	0.0 TO 60.00000 0.05000	60.CCCCC TO 95.CCC00 C.03000	95.0CCC0 TO 155.CC00C C.C2CC0	155.00000 TC 2C5.CC0C0C C.C12CC

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TABLE OF THICKNESSES

SANDWICH TYPE SHELL WITH FACE SHEETS SPACED 2.CCC IN FRCM EACH OTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELOW

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                                   ELEMENT NC.  19

THETA(DEGREES)   205.0CCCO TC  265.CCOCO   265.CCCCC TO  3CC.CCCCO   3CC.CCCCC TC  360.CCCCC
THICKNESS              0.02CCC                   C.03CCO                   C.C5CCC
                                   ELEMENT NC.  2C

THETA(DEGREES)     0.0     TC   60.0COCO    60.CCCCC TO   95.CCCCO    95.CCCCC TC  155.CCCOC   155.CCCOC TC  2C5.CCCCC
THICKNESS              0.05CCO                   C.03CCO                   C.C2CCO                   C.C12CC
THETA(DEGREES)   205.CCCCO TC  265.CCCCO   265.CCCCC TO  3CC.CCCCO   3CC.CCCCC TC  360.CCCCC
THICKNESS              0.02C00                   C.03CCO                   C.C5CCC
                                   ELEMENT NC.  21

THETA(DEGREES)     0.0     TC   60.CCOCO    6C.CCCCC TO   95.CCCCO    95.CCCCC TC  135.CCCOC   135.CCCCC TC  225.CCCCC
THICKNESS              0.05CCO                   C.03CCO                   C.C2CCO                   C.C12CC
THETA(DEGREES)   225.0CCCO TC  265.CCCCO   265.CCCCC TO  3CC.CCCCO   3CC.CCCCC TC  360.CCCOC
THICKNESS              0.02CCO                   C.03CCO                   C.C5CCO
                                   ELEMENT NC.  22

THETA(DEGREES)     0.0     TC   60.CCOCO    60.CCCCC TO   95.CCCCO    95.CCCCC TC  135.CCCOC   135.CCOOC TC  225.CCCCC
THICKNESS              0.05CCO                   C.03CCO                   C.C2CCO                   C.C12CC
THETA(DEGREES)   225.CCCCO TC  265.CCOCO   265.CCCCC TO  3CC.CCCCO   3CC.CCCCC TC  360.CCCCC
THICKNESS              0.02CCO                   C.03CCC                   C.C5CCO
                                   ELEMENT NC.  23

THETA(DEGREES)     0.0     TC   60.CCOCO    60.CCCCC TO   95.CCCCO    95.CCCCC TC  135.CCCCC   135.CCOOC TC  225.CCCCC
THICKNESS              0.05CCO                   C.03CCO                   C.C2CCO                   C.C12CC
THETA(DEGREES)   225.0CCOO TO  265.CCOCO   265.CCCCC TO  3CC.CCCCO   3CC.CCCCC TO  360.CCCCC
THICKNESS              0.02CCO                   C.03CCO                   C.C5CCO
                                   ELEMENT NC.  24

THETA(DEGREES)     0.0     TO   60.CCOCO    6C.CCCCC TO   95.CCCCO    95.CCCCC TC  135.CCOOC   135.CCOOC TC  225.CCCCC
THICKNESS              0.05CCO                   C.03OCO                   C.C2CCO                   C.C12CC
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TABLE OF THICKNESSES

SANDWICH TYPE SHELL WITH FACE SHEETS SPACED 2.CCC IN FROM EACH OTHER

THICKNESSES OF EACH FACE SHEET ARE GIVEN BELOW

ELEMENT NC. 24

THETA(DEGREES)	225.CCCCC TC 265.CCOCO	265.CCCCC TO 3CC.CCCCC	3CC.CCCCC TC 360.CCCCC	
THICKNESS	C.02CCC	C.03CCO	C.C5CCC	

ELEMENT NC. 25

THETA(CEGREES)	C.0 TC 6C.CCOCO	6C.CCCCC TC 95.CCCCO	95.CCCCC TC 127.5CCCC	127.5CCCC TC 232.5CCCC
THICKNESS	0.05CCC	C.03CCO	C.C2CCC	C.C12CC
THETA(DEGREES)	232.5CCCO TC 265.CCOCO	265.CCCCC TO 3CC.CCCCC	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCC	C.03CCO	C.C5CCO	

ELEMENT NC. 26

THETA(DEGREES)	C.0 TC 6C.CCOCO	60.CCCCC TO 95.CCCCO	95.CCCCC TC 127.5CCCC	127.5CCCC TC 232.5CCCC
THICKNESS	0.05C00	C.03CCO	C.C2CCC	C.C12CC
THETA(DEGREES)	232.5CCCO TC 265.CCOCO	265.CCCCC TO 3CC.CCCCC	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCC	C.03CCO	C.C5CCO	

ELEMENT NC. 27

THETA(DEGREES)	C.0 TC 60.0COCO	60.CCCCC TO 9C.CCCCO	9C.CCCCC TC 127.5CCOC	127.5CCOC TC 232.5CCCC
THICKNESS	0.05C00	C.03CCO	C.C2CCO	C.C12CC
THETA(DEGREES)	232.5CCCO TC 270.CCOCO	270.CCCCC TO 30C.CCCCO	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCO	C.03CCO	C.C5CCO	

ELEMENT NC. 28

THETA(DEGREES)	0.0 TC 6C.0COCO	60.CCCCC TO 9C.CCCCO	9C.0CCCC TC 127.5CCCC	127.5CCOC TC 232.5CCCC
THICKNESS	0.05CC0	C.03CCO	C.C2CCC	C.C12CC
THETA(DEGREES)	232.5C000 TO 270.CCOCO	270.CCCCC TO 30C.CCCCO	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCO	C.03CCO	C.C5CCO	

ELEMENT NC. 29

THETA(DEGREES)	0.0 TC 60.CCOCO	60.CCCCC TO 9C.CCCCO	9C.0CCCC TC 127.5C00C	127.5C00C TC 232.5CCCC
THICKNESS	0.05CC0	C.03CCO	C.C2CCO	C.C12CC

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TABLE OF THICKNESSES

SANDWICH TYPE SHELL WITH FACE SHEETS SPACED 2.CCC IN FRCM EACH CTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELCW

ELEMENT NC. 29

THETA(DEGREES)	232.5CCCC TC 27C.CCCCO	270.CCCCC TO 3CC.CCCCO	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCO	C.03CCO	C.C5CCO	

ELEMENT NC. 3C

THETA(DEGREES)	0.C TC 60.CCOCO	6C.CCCCC TO 9C.CCCCO	9C.CCCCC TC 127.5CCCC	127.5COOC TC 232.5CCCC
THICKNESS	0.05CCO	C.03CCO	C.C2CCO	C.C12CC
THETA(DEGREES)	232.5CCCO TO 27C.CCOCO	27C.CCCCC TO 3CC.CCCCO	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCO	C.03CCO	C.C5CCC	

ELEMENT NC. 31

THETA(DEGREES)	0.0 TC 60.0CCCO	6C.CCCCC TO 9C.CCCCO	90.CCCCC TC 115.CCCOC	115.CCCOC TC 245.CCCCC
THICKNESS	0.05CCO	C.C3CCO	C.C2CCO	C.C12CC
THETA(DEGREES)	245.CCCCO TO 27C.CCOCO	27C.CCCCC TO 3CC.CCCCO	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCO	C.03CCO	C.C5CCO	

ELEMENT NC. 32

THETA(DEGREES)	0.0 TC 60.CCOCO	6C.CCCCC TO 9C.CCCCO	9C.CCCCC TC 115.CCCCC	115.CCCCC TC 245.CCCCC
THICKNESS	C.05CCO	C.03CCO	C.C2CCO	C.C12CC
THETA(DEGREES)	245.CCCCO TO 27C.0CCCO	27C.CCCCC TO 3CC.CCCCO	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCO	C.03CCO	C.C5CCO	

ELEMENT NC. 33

THETA(DEGREES)	0.0 TC 60.CCOCO	6C.CCCCC TO 85.CCCCO	85.CCCCC TC 115.CCCOC	115.CCOOC TC 245.CCCCC
THICKNESS	0.05COO	C.03CCO	C.C2CCO	C.C12CC
THETA(DEGREES)	245.CCCCC TC 275.CCOCO	275.CCCCC TO 3CC.CCCCO	3CC.CCCCC TC 350.CCCCC	
THICKNESS	0.0?CCO	C.03CCO	C.C5CCO	

ELEMENT NC. 34

THETA(DEGREES)	0.0 TO 60.0COCO	60.CCCCC TO 85.CCCCO	85.CCCCC TC 115.CCCCC	115.CC000 TC 245.CCCCC
THICKNESS	0.0?CCO	C.03CCO	C.C2CCO	C.C12CC

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TABLE OF THICKNESSES

SANDWICH TYPE SHELL WITH FACE SHEETS SPACED 2.CCC IN FROM EACH OTHER

THICKNESSES OF EACH FACE SHEET ARE GIVEN BELOW

ELEMENT NC. 34

THETA(DEGREES) THICKNESS	245.0CCCO TC 275.CCOCO 0.02CCO	275.CCCCC TO 3CC.CCCCO C.03CCO	3CC.CCCCC TC 360.CCCCC C.C5CCO	

ELEMENT NC. 35

THETA(DEGREES) THICKNESS	0.0 TC 60.CCOCO 0.05CCO	6C.CCCCC TO 85.CCCCO C.C3CCO	85.CCCCC TC 115.CCCCC C.C2CCO	115.CCCCC TC 245.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	245.0CCCO TC 275.CCOCO 0.02CCO	275.CCCCC TO 3CC.CCCCO C.03CCO	3CC.CCCCC TC 360.CCCCC C.C5CCC	

ELEMENT NC. 36

THETA(DEGREES) THICKNESS	0.0 TC 6C.0COCO 0.05CCO	60.CCCCC TO 85.CCCCO C.03CCO	85.CCCCC TC 110.CCCCC C.C2CCO	11C.CCCCC TC 25C.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	25C.0CCCO TC 275.CCOCO 0.02CCO	275.CCCCC TO 3CC.CCCCO C.03CCO	3CC.CCCCC TC 360.CCCCC C.C5CCC	

ELEMENT NC. 37

THETA(DEGREES) THICKNESS	0.0 TC 60.CCCCO 0.05CCO	6C.CCCCC TO 85.CCCCO C.03CCO	85.CCCCC TC 110.CCCOC C.C2CCC	11C.CCCCC TC 25C.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	250.CCCCO TC 275.CCOCO 0.02CCO	275.CCCCC TO 3CC.CCCCO C.03CCO	3CC.CCCCC TC 360.CCCCC C.C5CCO	

ELEMENT NC. 38

THETA(DEGREES) THICKNESS	0.0 TO 60.CCOCO 0.05CCO	6C.CCCCC TO 85.CCCCO C.03CCO	85.CCCCC TC 110.CCCCC C.C2CCO	11C.CCCOC TC 25C.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	250.CCCCO TC 275.CCOCO 0.02CCO	275.CCCCC TO 3CC.CCCCO 0.030CO	3CC.CCCCC TC 360.CCCCC C.C5CCO	

ELEMEN' NC. 39

THETA(DEGREES) THICKNESS	0.0 TO 60.CCOCO 0.05CCO	60.CCCCO TO 85.0CCCO 0.03CCO	85.0CCCC TC 110.CCCOC C.C2CCO	110.0C0CC TC 25C.CCCCC C.C12CC

TABLE OF THICKNESSES

SANCWICH TYPE SHELL WITH FACE SHEETS SPACEC 2.CCC IN FRCM EACH CTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELCW

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                                   ELEMENT NC.  39

THETA(DEGREES)    25C.CCCCO TC  275.CCOCO    275.CCCCC TO  3CC.CCCCO    3CC.CCCCC TC  360.CCCCC
THICKNESS               0.02CCO                    C.03CCO                    C.C5CCC
                                   ELEMENT NC.  4C

THETA(DEGREES)      0.0     TC   6C.CCCCC    6C.CCCCC TO   85.CCCCO    85.CCCCC TC  110.CCCCC    11C.CCCCC TC  25C.CCCCC
THICKNESS               0.05CCO                    C.03CCO                    C.C2CCO                    C.C12CC
THETA(DEGREES)    250.CCCCO TC  275.CCOCO    275.CCCCC TO  3CC.CCCCO    3CC.CCCCC TC  360.CCCCC
THICKNESS               0.02CCO                    C.03CCO                    C.C5CCO
                                   ELEMENT NC.  41

THETA(DEGREES)      0.0     TC   6C.CCCCO    6C.CCCCC TO   85.CCCCO    85.CCCCC TC  110.CCCCC    11C.CCCCC TC  25C.CCCCC
THICKNESS               C.05CCO                    C.03CCO                    C.C2CCC                    C.C12CC
THETA(DEGREES)    250.CCCCO TC  275.CCOCO    275.CCCCC TO  3CC.CCCCO    3CC.CCCCC TC  360.CCCCC
THICKNESS               0.02CCC                    C.03CCC                    C.C5CCO
                                   ELEMENT NC.  42

THETA(DEGREES)      0.0     TC   60.CCCCC    6C.CCCCC TO   85.CCCCO    85.CCCCC TC  110.CCCCC    11C.CCCCC TC  25C.CCCCC
THICKNESS               0.05CCO                    C.03CCO                    C.C2CCO                    C.C12CC
THETA(DEGREES)    250.CCCCO TC  275.CCOCO    275.CCCCC TO  3CC.CCCCO    3CC.CCCCC TC  360.CCCCC
THICKNESS               0.02CCC                    C.03CCO                    C.C5CCO
                                   ELEMENT NC.  43

THETA(DEGREES)      0.0     TO   60.CCOCO    6C.CCCCC TO   85.CCCCO    85.CCCCC TC  110.CCCCC    11C.CCOCC TC  25C.CCCCC
THICKNESS               0.05CCO                    C.03CCO                    C.C2CCO                    C.C12CC
THETA(DEGREES)    250.CCCCO TO  275.CCOCO    275.CCCCO TO  30C.CCCCO    3CC.CCCCC TC  360.CCCCC
THICKNESS               0.02000                    C.03CCO                    C.C5CCO
                                   ELEMENT NC.  44

THETA(DEGREES)      0.0     TO   60.0COCO    60.CCCCO TO   78.CCCCO    78.CCCCC TC  110.CCCCC    11C.CCCCC TC  25C.CCCCC
THICKNESS               0.050CO                    0.03CCO                    C.C2CCO                    C.C12CC
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TABLE OF THICKNESSES

SANCWICH TYPE SHELL WITH FACE SHEETS SPACEC 2.CCC IN FRCM EACH CTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELCW

ELEMENT NC. 44

THETA(DEGREES) THICKNESS	250.CCCOO TC 282.CCOCO 0.02CCO	282.CCCCC TO 3CC.CCCCO C.03CCO	3CC.CCCCC TC 360.CCCCC C.C5CCO	

ELEMENT NC. 45

THETA(DEGREES) THICKNESS	0.0 TC 60.CCOCO 0.05CCC	6C.CCCCC TO 78.CCCCO C.03CCO	78.CCCCC TC 110.CCCCC C.C2CCO	11C.CCCCC TC 25C.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	250.CCCCO TC 282.0COCO 0.02CCC	282.CCCCC TO 3CC.CCCCO C.03CCO	3CC.0CCCC TC 360.CCCOC C.C5CCO	

ELEMENT NC. 46

THETA(DEGREES) THICKNESS	0.0 TC 60.CCCCO 0.05CCO	60.CCCCO TO 78.CCCCO C.03CCO	78.CCCCC TC 105.CCCCC C.C2CCO	105.CCOOC TC 255.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	255.CCCOO TC 282.CCOCO 0.02CCC	282.CCCCC TO 3CC.CCCCO C.03CCC	3CC.CCCCC TC 360.CCCCC C.05CCO	

ELEMENT NC. 47

THETA(DEGREES) THICKNESS	0.0 TC 60.CCOCO 0.05CCO	60.CCCCC TO 78.CCCCO 0.03CCC	78.CCCCC TC 105.CCCOC C.C2CCO	105.CCCCC TC 255.CCCCC C.C12CC
THETA(DEGREES) THICKNESS	255.CCCCO TC 282.CCOCO G.02CCO	282.CCCCG TO 3CC.CCCCO C.03CCO	3CC.CCCCC TC 360.CCCCC C.C5CCO	

ELEMENT NC. 48

THETA(DEGREES) THICKNESS	0.0 TC 60.CCOCO 0.05CCO	60.CCCCC TO 78.CCCCO C.03CCC	78.0CCCC TC 105.CCCCC C.C2CCC	105.CCOOC TC 255.CCCCC C.C'2CC
THETA(DEGREES) THICKNESS	255.CCCCO TC 282.CCOCO 0.02CCO	282.CCCCG TO 30C.CCCCO C.03CCO	3CC.CCCCC TC 360.CCCCC C.C5CCO	

ELEMENT NC. 49

THETA(DEGREES) THICKNESS	0.0 TC 60.0COCO 0.05CCO	60.CCCCC TO 78.CCCCO 0.03G00	78.CCCCC TC 105.CCCOC C.C2CCO	105.C000C TC 255.CCCCC C.C12CC

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TABLE OF THICKNESSES

SANDWICH TYPE SHELL WITH FACE SHEETS SPACED 2.CCC IN FROM EACH OTHER

THICKNESSES CF EACH FACE SHEET ARE GIVEN BELOW

ELEMENT NC. 49

THETA(DEGREES)	255.0CCCO TC 282.CCOCO	282.CCCCC TO 3CC.CCCCO	3CC.0CCCC TC 360.CCCCC	
THICKNESS	0.02CCO	C.03CCO	C.C5CCO	

ELEMENT NC. 5C

THETA(DEGREES)	0.0 TC 6C.0COCO	6C.CCCCC TO 78.CCCCO	78.0CCCC TC 1C5.CCCCC	105.CCCCC TC 255.CCCCC
THICKNESS	0.05C00	C.03CCO	C.C2CCO	C.C12CC
THETA(DEGREES)	255.CCCCO TC 282.CCOCO	282.CCCCC TO 3CC.CCCCC	3CC.CCCCC TC 360.CCCCC	
THICKNESS	0.02CCC	C.C3CCO	C.C5CCO	

BOUNDARY CONDITIONS

DISPLACEMENT COMPONENTS OF NODES

NODE NO.	AXIAL	TANGENTIAL	RADIAL	ANGULAR
51	FIXED	FIXED	FIXED	FIXED

ALL OTHER NODES ARE FREE TO DISPLACE

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APPLIEC LOADS CN THE STRUCTURE

ELEMENT NC. 15

PRESSURE CCMPCNENTS

MERIDICNAL	NORMAL	TANGENTIAL	FROM THETA TC THETA(DEGREES)	
0.C	-20C.CCC	C.C	0.C	8.831
0.C	C.C	C.C	8.831	351.158
0.C	-20C.CCC	C.C	351.158	36C.CCC
	ELEMENT NC. 16			
0.C	-20C.CCC	C.C	0.C	1C.576
0.C	C.C	C.C	10.576	349.424
0.C	-20C.CCC	C.C	349.424	36C.CCC
	ELEMENT NC. 17			
0.C	-20C.CCC	C.C	0.C	16.129
0.C	C.C	C.C	16.129	343.853
0.C	-20C.CCC	C.C	343.853	36C.CCC
	ELEMENT NC. 18			
0.C	-20C.CCC	C.C	C.C	19.538
0.C	C.C	C.C	19.538	34C.442
0.C	-20C.CCC	C.C	340.442	36C.CCC
	ELEMENT NC. 19			
0.C	-20C.CCC	C.C	0.C	21.848
0.C	C.C	C.C	21.848	338.131
0.C	-20C.CCC	C.C	338.131	36C.CCC
	ELEMENT NC. 20			
0.C	-20C.CCC	C.C	0.C	23.419

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APPLIEC LOADS CN THE STRUCTURE

ELEMENT NC. 2C

PRESSURE COMPONENTS

MERIDIONAL	NORMAL	TANGENTIAL	FROM THETA TC THETA(CEGREES)	
0.C	C.C	C.C	23.419	33E.544
0.C	-20C.CCC	C.C	336.544	36C.CCC
ELEMENT NC. 21				
0.C	-20C.CCC	C.C	0.C	24.457
0.C	C.C	C.C	24.457	335.542
0.C	-20C.CCC	C.C	335.542	36C.CCC
ELEMENT NC. 22				
0.C	-20C.CCC	C.C	0.C	24.8S3
0.C	C.C	C.C	24.893	335.C77
0.C	-20C.CCC	C.C	335.C77	36C.CCC
ELEMENT NC. 23				
0.C	-20C.CCC	C.C	0.C	25.3E3
0.C	C.C	C.C	25.383	334.E17
0.C	-20C.CCC	C.C	334.E17	36C.CCC
ELEMENT NC. 24				
0.C	-20C.CCC	C.C	0.C	25.E12
0.C	C.C	C.C	25.E12	334.359
0.C	-20C.CCO	C.C	334.359	360.CCC
ELEMENT NC. 25				
0.0	-20C.CCO	C.C	0.C	25.830

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APPLIEC LOADS CN THE STRUCTURE

ELEMENT NC. 25

PRESSURE CCMPCNENTS

MERIDIONAL	NORMAL	TANGENTIAL	FROM THETA TC THETA(DEGREES)	
0.C	C.C	C.C	25.830	334.141
0.C	-20C.CCC	C.C	334.141	36C.CCC
ELEMENT NC. 26				
0.C	-20C.CCC	C.C	0.C	26.C4C
0.C	C.C	C.C	26.C40	333.96C
0.C	-20C.CCC	C.C	333.960	36C.CCC
ELEMENT NC. 27				
0.C	-20C.CCC	C.C	0.C	26.C15
G.C	C.C	C.C	26.C15	333.952
0.C	-20C.CCC	C.C	333.952	36C.CCC
ELEMENT NC. 28				
0.C	-20C.CCC	C.C	0.C	26.C46
0.C	C.C	C.C	26.C46	333.935
0.C	-20C.CCC	C.C	333.935	360.CCC
ELEMENT NC. 29				
0.C	-20C.CCC	C.C	0.C	25.958
0.C	C.C	C.C	25.958	334.C16
0.C	-20C.CCC	C.C	334.C16	36C.CCC
ELEMENT NC. 30				
0.C	-20C.CCC	C.C	0.C	25.831

PAGE 2C

APPLIEC LOADS CN THE STRUCTURE

ELEMENT NC. 30

PRESSURE COMPCNENTS

MERIDICNAL	NORMAL	TANGENTIAL	FROM THETA TC THETA(CEGREES)	
0.C	C.C	C.C	25.831	334.144
0.C	-20C.CCC	C.C	334.144	36C.CCC
ELEMENT NC. 31				
0.C	-20C.CCC	C.C	0.C	25.667
0.C	C.C	C.C	25.667	334.316
0.C	-20C.CCC	C.C	334.316	36C.CCC
ELEMENT NC. 32				
0.C	-20C.CCC	C.C	C.C	25.476
0.C	C.0	C.C	25.476	334.524
0.C	-20C.CCC	C.C	334.524	360.CCC
ELEMENT NC. 33				
0.C	-20C.CCC	C.C	0.C	25.143
0.C	C.C	C.C	25.143	334.841
0.C	-20C.CCC	C.C	334.841	36C.CCC
ELEMENT NC. 34				
0.C	-20C.CCC	C.C	0.C	24.806
0.C	C.0	C.C	24.806	335.178
0.C	-20C.C00	C.C	335.178	360.CCC
ELEMENT NC. 35				
0.0	-20C.CCC	C.C	0.C	24.465

APPLIEC LOADS CN THE STRUCTURE

ELEMENT NC. 35

PRESSURE CCPPCNENTS

MERIDICNAL	NORMAL	TANGENTIAL	FROM THETA TC THETA(CEGREES)	
0.C	C.C	C.C	24.465	335.535
0.C	-2CC.CCC	C.C	335.535	36C.CCC
ELEMENT NC. 36				
0.C	-2CC.CCC	C.C	0.C	24.1C7
0.C	C.0	C.C	24.1C7	335.853
0.C	-20C.CCC	C.C	335.893	36C.CCC
ELEMENT NC. 37				
0.C	-20C.CC0	C.C	0.C	23.732
0.C	C.C	C.C	23.732	33C.247
0.C	-2CC.CCC	C.C	336.247	36C.CCC
ELEMENT NC. 38				
0.C	-2CC.CC0	C.C	0.C	23.344
0.C	C.C	C.C	23.344	336.C19
0.C	-20C.CCC	C.C	336.C19	360.CCC
ELEMENT NC. 39				
0.C	-2CC.CCC	C.C	0.C	23.C3C
0.C	C.C	C.C	23.C30	336.947
0.C	-2CC.CCC	C.C	336.947	360.CCC
ELEMENT NC. 4C				
0.C	-2CC.CC0	C.C	0.C	22.653

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APPLIEC LOADS CN THE STRUCTURE

ELEMENT NC. 4C

PRESSURE CCMPONENTS

MERIDICNAL	NORMAL	TANGENTIAL	FROM THETA TC THETA(CEGREES)	
0.C	C.C	C.C	22.653	337.324
0.C	-20C.CCC	C.C	337.324	36C.CCC
ELEMENT NC. 41				
0.C	-20C.CCC	C.C	0.C	22.254
0.C	C.C	C.C	22.254	337.723
0.C	-20C.CCC	C.C	337.723	36C.CCC
ELEMENT NC. 42				
0.C	-20C.CCC	C.C	0.C	21.911
0.C	C.C	C.C	21.911	338.C89
0.C	-20C.CCC	C.C	338.089	36C.CCC
ELEMENT NC. 43				
0.C	-20C.CCC	C.C	0.C	21.376
0.C	C.C	C.C	21.376	338.6CC
0.C	-20C.CCC	C.C	338.6C0	360.CCC
ELEMENT NC. 44				
0.C	-20C.CCC	C.C	C.C	20.856
0.C	C.0	C.C	20.856	339.C77
0.0	-20C.C00	C.0	339.077	360.CC0
ELEMENT NO. 45				
0.0	-200.000	C.0	0.0	20.460

APPLIED LOADS CN THE STRUCTURE

ELEMENT NO. 45

PRESSURE COMPONENTS

MERIDIONAL	NORMAL	TANGENTIAL	FROM THETA TO THETA(DEGREES)	
0.0	C.0	C.0	20.460	339.529
0.0	-200.000	C.C	339.529	360.C00
	ELEMENT NO. 46			
0.0	-20C.C00	C.0	0.0	19.940
0.0	0.0	0.0	19.940	340.049
0.0	-20C.000	C.0	340.049	360.0C0
	ELEMENT NC. 47			
0.0	-200.000	C.0	0.0	19.333
0.0	0.0	C.C	19.333	340.643
0.0	-200.000	C.0	340.643	360.0C0
	ELEMENT NO. 48			
0.0	-200.000	C.0	0.0	18.795
0.0	C.0	C.0	18.795	341.190
0.0	-20C.000	C.C	341.190	360.CC0
	ELEMENT NO. 49			
0.0	-200.000	C.0	0.0	18.135
0.0	C.0	C.0	18.135	341.841
0.0	-200.000	C.0	341.841	360.CC0
	ELEMENT NO. 50			
0.0	-200.000	C.0	0.0	17.643

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APPLIED LOADS ON THE STRUCTURE

ELEMENT NO. 50

PRESSURE COMPONENTS

MERIDIONAL	NORMAL	TANGENTIAL	FROM THETA TO THETA(DEGREES)	
0.0	0.0	C.0	17.643	342.356
0.0	-200.000	C.0	342.356	360.0CC

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DISPLACEMENT COMPONENTS OF NODES
INCREMENT NO. 1 *** 25 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 3
THETA= 0.0 DEGREES

NODE NO.	AXIAL	TANGENTIAL	RACIAL	ANGULAR
1	0.16007554E-01	0.0	-0.12830410E-01	-0.26907007E-02
2	0.20776909E-01	0.0	-0.12998905E-01	-0.28[illegible]39996E-02
3	0.25905017E-01	0.0	-0.13382431E-01	-0.30971738E-02
4	0.31388484E-01	0.0	-0.13888724E-01	-0.33038992E-02
5	0.37208579E-01	0.0	-0.14495194E-01	-0.34950911E-02
6	0.43329056E-01	0.0	-0.15197795E-01	-0.36617300E-02
7	0.49698632E-01	0.0	-0.15995443E-01	-0.37928619E-02
8	0.56256179E-01	0.0	-0.16709320E-01	-0.38806619E-02
9	0.62932312E-01	0.0	-0.17494772E-01	-0.39400235E-02
10	0.69671929E-01	0.0	-0.18359818E-01	-0.39624460E-02
11	0.76400816E-01	0.0	-0.19291390E-01	-0.39374828E-02
12	0.83031952E-01	0.0	-0.20281382E-01	-0.38559851E-02
13	0.89453459E-01	0.0	-0.21316620E-01	-0.37004838E-02
14	0.95523119E-01	0.0	-0.22356205E-01	-0.34523159E-02
15	0.10107177E 00	0.0	-0.23387406E-01	-0.30956920E-02
16	0.10590094E 00	0.0	-0.24364714E-01	-0.26152420E-02
17	0.10980153E 00	0.0	-0.25241464E-01	-0.20127974E-02
18	0.11257684E 00	0.0	-0.25967654E-01	-0.12976155E-02
19	0.11404997E 00	0.0	-0.26486631E-01	-0.48311031E-03
20	0.11408025E 00	0.0	-0.26752960E-01	0.40211808E-03
21	0.11257654E 00	0.0	-0.26721656E-01	0.13300835E-02
22	0.11098343E 00	0.0	-0.26553281E-01	0.18763004E-02
23	0.10885936E 00	0.0	-0.26265956E-01	0.24215288E-02
24	0.10620838E 00	0.0	-0.25854848E-01	0.29604402E-02
25	0.10304147E 00	0.0	-0.25316361E-01	0.34866133E-02
26	0.99374235E-01	0.0	-0.24649419E-01	0.39951354E-02
27	0.95229268E-01	0.0	-0.23852285E-01	0.44783205E-02
28	0.90635180E-01	0.0	-0.22925850E-01	0.49320012E-02
29	0.85623920E-01	0.0	-0.21872737E-01	0.53484850E-02
30	0.80235898E-01	0.0	-0.20698167E-01	0.57229474E-02
31	0.74517190E-01	0.0	-0.19409161E-01	0.60481355E-02
32	0.68516672E-01	0.0	-0.18017568E-01	0.63179098E-02
33	0.62294137E-01	0.0	-0.16532239E-01	0.65248087E-02
34	0.55913594E-01	0.0	-0.14967572E-01	0.66626146E-02
35	0.49447242E-01	0.0	-0.13341818E-01	0.67230500E-02
36	0.42970914E-01	0.0	-0.11674959E-01	0.66986196E-02
37	0.38659103E-01	0.0	-0.10555395E-01	0.66308520E-02
38	0.34409259E-01	0.0	-0.94164275E-02	0.65198010E-02
39	0.30251045E-01	0.0	-0.82973577E-02	0.63605011E-02
40	0.26213132E-01	0.0	-0.71970299E-02	0.61531961E-02
41	0.22328369E-01	0.0	-0.61264448E-02	0.59944486E-02
42	0.18630993E-01	0.0	-0.50970539E-02	0.55018669E-02
43	0.15154134E-01	0.0	-0.41207224E-02	0.52125491E-02
44	0.11935238E-01	0.0	-0.32108594E-02	0.47040290E-02
45	0.90133846E-02	0.0	-0.23089823E-02	0.42932853E-02
46	0.64265132E-02	0.0	-0.16466454E-02	0.37382233E-02
47	0.42159706E-02	0.0	-0.10245033E-02	0.31168230E-02
48	0.24243123E-02	0.0	-0.53120917E-03	0.24266371E-02
49	0.10940870E-02	0.0	-0.10448300E-03	0.16649701E-02
50	0.27064793E-03	0.0	-0.34923796E-05	0.62906057E-03
51	0.0	0.0	0.0	0.0

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STRAINS AND CURVATURES AT THE CENTER OF EACH SHELL ELEMENT
INCREMENT NO. 1 *** 25 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 3
THETA= 0.0 DEGREES

ELEMENT NO.	E(S)	E(THETA)	E(S-THETA)	K(S)	K(THETA)	K(S-THETA)
1	-0.80486148E-04	0.61572224E-04	0.0	0.11840591E-03	-0.93019509E-04	-0.0
2	-0.17489561E-03	0.65564658E-04	0.0	0.12420709E-03	-0.10117216E-03	-0.0
3	-0.21148201E-03	0.66150504E-04	0.0	0.12044066E-03	-0.11339023E-03	-0.0
4	-0.23114825E-03	0.55632729E-04	0.0	0.11137576E-03	-0.12626892E-03	-0.0
5	-0.24557998E-03	0.41450796E-04	0.0	0.97060270E-04	-0.13946700E-03	-0.0
6	-0.25753560E-03	0.25300644E-04	0.0	0.76329845E-04	-0.15287573E-03	-0.0
7	-0.16504907E-03	0.48358024E-05	0.0	0.51137773E-04	-0.16647110E-03	-0.0
8	-0.16381200E-03	-0.22125678E-04	0.0	0.34442302E-04	-0.17875571E-03	-0.0
9	-0.16856533E-03	-0.53356256E-04	0.0	0.13031923E-04	-0.19010376E-03	-0.0
10	-0.16914651E-03	-0.88194545E-04	0.0	-0.14671656E-04	-0.20155536E-03	-0.0
11	-0.17045370E-03	-0.12510935E-03	0.0	-0.47548776E-04	-0.21290504E-03	-0.0
12	-0.16925333E-03	-0.16266704E-03	0.0	-0.90836867E-04	-0.22457769E-03	-0.0
13	-0.16756276E-03	-0.19902596E-03	0.0	-0.14473178E-03	-0.23668002E-03	-0.0
14	-0.16528671E-03	-0.23302359E-03	0.0	-0.20793224E-03	-0.24901354E-03	-0.0
15	-0.16275822E-03	-0.26453356E-03	0.0	-0.27995929E-03	-0.26146742E-03	-0.0
16	-0.16002968E-03	-0.29273378E-03	0.0	-0.35113166E-03	-0.27358509E-03	-0.0
17	-0.15745027E-03	-0.31693978E-03	0.0	-0.41671726E-03	-0.28465339E-03	-0.0
18	-0.15248013E-03	-0.33514979E-03	0.0	-0.47450408E-03	-0.29408582E-03	-0.0
19	-0.15054483E-03	-0.34653582E-03	0.0	-0.51580206E-03	-0.30120765E-03	-0.0
20	-0.14882811E-03	-0.35123015E-03	0.0	-0.54052239E-03	-0.30546496E-03	-0.0
21	-0.14862075E-03	-0.34997077E-03	0.0	-0.54885470E-03	-0.30[illegible]60769E-03	-0.0
22	-0.14773919E-03	-0.34664874E-03	0.0	-0.54808496E-03	-0.30614645E-03	-0.0
23	-0.14708482E-03	-0.34085033E-03	0.0	-0.54141739E-03	-0.30456437E-03	-0.0
24	-0.14650174E-03	-0.33280696E-03	0.0	-0.52896375E-03	-0.30185957E-03	-0.0
25	-0.14716903E-03	-0.32246718E-03	0.0	-0.51087025E-03	-0.29802276E-03	-0.0
26	-0.14678591E-03	-0.30998141E-03	0.0	-0.48563210E-03	-0.29306556E-03	-0.0
27	-0.14616175E-03	-0.29523321E-03	0.0	-0.45564235E-03	-0.28699334E-03	-0.0
28	-0.14573007E-03	-0.27841656E-03	0.0	-0.41885558E-03	-0.27984334E-03	-0.0
29	-0.14562339E-03	-0.25984924E-03	0.0	-0.37609972E-03	-0.27160905E-03	-0.0
30	-0.14556815E-03	-0.23970773E-03	0.0	-0.32655010E-03	-0.26233587E-03	-0.0
31	-0.14872401E-03	-0.21824845E-03	0.0	-0.27087680E-03	-0.25203428E-03	-0.0
32	-0.14870295E-03	-0.19581134E-03	0.0	-0.20777379E-03	-0.24071393E-03	-0.0
33	-0.14881337E-03	-0.17246827E-03	0.0	-0.13817863E-03	-0.22840085E-03	-0.0
34	-0.14954536E-03	-0.14857935E-03	0.0	-0.60529215E-04	-0.21511837E-03	-0.0
35	-0.15030098E-03	-0.12469589E-03	0.0	0.24450535E-04	-0.20087659E-03	-0.0
36	-0.15224240E-03	-0.10494459E-03	0.0	0.10158319E-03	-0.18824835E-03	-0.0
37	-0.15286735E-03	-0.89490874E-04	0.0	0.16726470E-03	-0.17764280E-03	-0.0
38	-0.15379096E-03	-0.74488722E-04	0.0	0.23727318E-03	-0.16663155E-03	-0.0
39	-0.15407783E-03	-0.60166582E-04	0.0	0.31027663E-03	-0.15522169E-03	-0.0
40	-0.15466928E-03	-0.46635512E-04	0.0	0.38713822E-03	-0.14342528E-03	-0.0
41	-0.15492525E-03	-0.34085941E-04	0.0	0.46791416E-03	-0.13125004E-03	-0.0
42	-0.15516173E-03	-0.22705950E-04	0.0	0.55268360E-03	-0.11870210E-03	-0.0
43	-0.15511597E-03	-0.12653134E-04	0.0	0.64134737E-03	-0.10578844E-03	-0.0
44	-0.15344404E-03	-0.40807236E-05	0.0	0.73461980E-03	-0.92517119E-04	-0.0
45	-0.15268385E-03	0.28222867E-05	0.0	0.83068991E-03	-0.78901678E-04	-0.0
46	-0.15211343E-03	0.77591458E-05	0.0	0.92996680E-03	-0.64961161E-04	-0.0
47	-0.15028697E-03	0.10514939E-04	0.0	0.10331923E-02	-0.50716902E-04	-0.0
48	-0.14769404E-03	0.10826237E-04	0.0	0.11399018E-02	-0.36181227E-04	-0.0
49	-0.14423361E-03	0.84503663E-05	0.0	0.12500952E-02	-0.21371525E-04	-0.0
50	-0.14006924E-03	0.34258956E-05	0.0	0.13586767E-02	-0.69599928E-05	-0.0

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STRESS RESULTANTS AT THE CENTER OF EACH SHELL ELEMENT
INCREMENT NO. 1 *** 25 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 3
THETA= 0.0 DEGREES

ELEMENT NO.	N(S)	N(THETA)	N(S-THETA)	M(S)	M(THETA)	M(S-THETA)	Q(S)	Q(THETA)
1	-0.120[illegible]21E 03	0.727963E 02	0.0	0.176028E 03	-0.111836E 03	0.0	0.204159E 02	0.0
2	-0.301923E 03	0.254724E 02	0.0	0.182554E 03	-0.124308E 03	0.0	-0.147115E 02	0.0
3	-0.372744E 03	0.526315E 01	0.0	0.168099E 03	-0.150271E 03	0.0	-0.213583E 02	0.0
4	-0.417133E 93	-0.266700E 02	0.0	0.142952E 03	-0.180610E 03	0.0	-0.277213E 02	0.0
5	-0.453479E 03	-0.626758E 02	0.0	0.107406E 03	-0.214635E 03	0.0	-0.348947E 02	0.0
6	-0.486157E 03	-0.101065E 03	0.0	0.592602E 02	-0.252812E 03	0.0	-0.427834E 02	0.0
7	-0.530345E 03	-0.144838E 03	0.0	0.387860E 01	-0.489926E 03	0.0	-0.591785E 02	0.0
8	-0.552556E 03	-0.231037E 03	0.0	-0.621911E 02	-0.545986E 03	0.0	-0.600387E 02	0.0
9	-0.598337E 03	-0.336902E 03	0.0	-0.142635E 03	-0.603596E 03	0.0	-0.719012E 02	0.0
10	-0.634103E 03	-0.450404E 03	0.0	-0.243580E 03	-0.667662E 03	0.0	-0.790722E 02	0.0
11	-0.674241E 03	-0.571344E 03	0.0	-0.361197E 03	-0.736428E 03	0.0	-0.955494E 02	0.0
12	-0.706875E 03	-0.691930E 03	0.0	-0.512879E 03	-0.816367E 03	0.0	-0.112279E 03	0.0
13	-0.736755E 03	-0.808152E 03	0.0	-0.699363E 03	-0.908014E 03	0.0	-0.131838E 03	0.0
14	-0.762440E 03	-0.916151E 03	0.0	-0.916238E 03	-0.100946E 04	0.0	-0.152955E 03	0.0
15	-0.784888E 03	-0.101584E 04	0.0	-0.116184E 04	-0.111988E 04	0.0	-0.160708E 03	0.0
16	-0.803468E 03	-0.110460E 04	0.0	-0.140435E 04	-0.122838E 04	0.0	-0.152947E 03	0.0
17	-0.818647E 03	-0.118057E 04	0.0	-0.162773E 04	-0.132805E 04	0.0	-0.135155E 03	0.0
18	-0.820245E 03	-0.123476E 04	0.0	-0.182456E 04	-0.141492E 04	0.0	-0.108065E 03	0.0
19	-0.825044E 03	-0.126979E 04	0.0	-0.196504E 04	-0.147807E 04	0.0	-0.739596E 02	0.0
20	-0.824044E 03	-0.128334E 04	0.0	-0.204931E 04	-0.151592E 04	0.0	-0.367171E 02	0.0
21	-0.822148E 03	-0.127906E 04	0.0	-0.207744E 04	-0.152772E 04	0.0	-0.101776E 02	0.0
22	-0.816059E 03	-0.126743E 04	0.0	-0.207449E 04	-0.152548E 04	0.0	0.115353E 02	0.0
23	-0.808299E 03	-0.124800E 04	0.0	-0.205134E 04	-0.151387E 04	0.0	0.354204E 02	0.0
24	-0.798586E 03	-0.122135E 04	0.0	-0.200834E 04	-0.149299E 04	0.0	0.592475E 02	0.0
25	-0.790694E 03	-0.118849E 04	0.0	-0.194595E 04	-0.146295E 04	0.0	0.824601E 02	0.0
26	-0.777309E 03	-0.114764E 04	0.0	-0.185931E 04	-0.142234E 04	0.0	0.105473E 03	0.0
27	-0.760942E 03	-0.109922E 04	0.0	-0.175619E 04	-0.137349E 04	0.0	0.129558E 03	0.0
28	-0.743188E 03	-0.104428E 04	0.0	-0.162998E 04	-0.131453E 04	0.0	0.152579E 03	0.0
29	-0.724785E 03	-0.983990E 03	0.0	-0.148337E 04	-0.124626E 04	0.0	0.178063E 03	0.0
30	-0.705018E 03	-0.918643E 03	0.0	-0.131372E 04	-0.116801E 04	0.0	0.204110E 03	0.0
31	-0.694379E 03	-0.852146E 03	0.0	-0.112323E 04	-0.108047E 04	0.0	0.229683E 03	0.0
32	-0.672490E 03	-0.779390E 03	0.0	-0.907652E 03	-0.982401E 03	0.0	0.254404E 03	0.0
33	-0.650146E 03	-0.703825E 03	0.0	-0.670067E 03	-0.874802E 03	0.0	0.282191E 03	0.0
34	-0.629287E 03	-0.627094E 03	0.0	-0.405429E 03	-0.756227E 03	0.0	0.309873E 03	0.0
35	-0.608509E 03	-0.550405E 03	0.0	-0.116095E 03	-0.627414E 03	0.0	0.338371E 03	0.0
36	-0.595594E 03	-0.488264E 03	0.0	0.146231E 03	-0.511463E 03	0.0	0.359803E 03	0.0
37	-0.582591E 03	-0.438775E 03	0.0	0.369469E 03	-0.413205E 03	0.0	0.379354E 03	0.0
38	-0.570995E 03	-0.391040E 03	0.0	0.607128E 03	-0.309424E 03	0.0	0.400452E 03	0.0
39	-0.557996E 03	-0.344890E 03	0.0	0.854884E 03	-0.201438E 03	0.0	0.419385E 03	0.0
40	-0.546754E 03	-0.301601E 03	0.0	0.111552E 04	-0.884475E 02	0.0	0.438693E 03	0.0
41	-0.535379E 03	-0.261167E 03	0.0	0.138922E 04	0.295784E 02	0.0	0.461232E 03	0.0
42	-0.525078E 03	-0.224506E 03	0.0	0.167622E 04	0.152696E 03	0.0	0.483466E 03	0.0
43	-0.515153E 03	-0.191873E 03	0.0	0.197621E 04	0.280787E 03	0.0	0.501968E 03	0.0
44	-0.501396E 03	-0.162457E 03	0.0	0.229148E 04	0.414520E 03	0.0	0.522412E 03	0.0
45	-0.492219E 03	-0.139340E 03	0.0	0.261616E 04	0.552088E 03	0.0	0.541359E 03	0.0
46	-0.485568E 03	-0.122781E 03	0.0	0.295155E 04	0.693829E 03	0.0	0.560421E 03	0.0
47	-0.476967E 03	-0.112071E 03	0.0	0.330003E 04	0.840395E 03	0.0	0.579195E 03	0.0
48	-0.468259E 03	-0.105540E 03	0.0	0.366010E 04	0.991294E 03	0.0	0.597638E 03	0.0
49	-0.459352E 03	-0.112877E 03	0.0	0.403172E 04	0.114647E 04	0.0	0.615340E 03	0.0
50	-0.450738E 03	-0.125115E 03	0.0	0.439773E 04	0.129879E 04	0.0	0.631946E 03	0.0

MAXIMUM COMPUTED NODE DISPLACEMENT COMPONENTS OF THE STRUCTURE

INCREMENT NO. 1 ••• 25 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 3

AXIAL		TANGENTIAL		RADIAL		ANGULAR	
0.11408025E 00		0.0		-0.26752960E-01		0.67230500E-02	
AT		AT		AT		AT	
THETA	NODE	THETA	NODE	THETA	NODE	THETA	NODE
0.0	20	0.0	51	0.0	20	0.0	35

MAXIMUM COMPUTED STRESS RESULTANT COMPONENTS OF THE STRUCTURE

N(S)		N(THETA)		N(S-THETA)		M(S)		M(THETA)		M(S-THETA)		Q(S)		Q(THETA)	
-0.825044E 03		-0.128334E 04		0.0		0.439773E 04		-0.152772E 04		0.0		0.631946E 03		0.0	
AT		AT		AT		AT		AT		AT		AT		AT	
ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA
19	0.0	20	0.0	50	0.0	50	0.0	21	0.0	50	0.0	50	0.0	50	0.0

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DISPLACEMENT COMPONENTS OF NODES
INCREMENT NO. 2 *** 50 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 2
THETA= 0.0 DEGREES

NODE NO.	AXIAL	TANGENTIAL	RADIAL	ANGULAR
1	0.32795738E-01	0.0	-0.25789775E-01	-0.54688938E-02
2	0.42527579E-01	0.0	-0.26139542E-01	-0.58845691E-02
3	0.52989278E-01	0.0	-0.26925713E-01	-0.63172244E-02
4	0.64170599E-01	0.0	-0.27962402E-01	-0.67350268E-02
5	0.76030254E-01	0.0	-0.29203884E-01	-0.71192719E-02
6	0.88490963E-01	0.0	-0.30641615E-01	-0.74513592E-02
7	0.10144442E 00	0.0	-0.32272704E-01	-0.77087581E-02
8	0.11476642E 00	0.0	-0.33730377E-01	-0.78808218E-02
9	0.12831807E 00	0.0	-0.35332743E-01	-0.79944544E-02
10	0.14198595E 00	0.0	-0.37095137E-01	-0.80322661E-02
11	0.15561825E 00	0.0	-0.38990565E-01	-0.79732463E-02
12	0.16903758E 00	0.0	-0.41001644E-01	-0.77990331E-02
13	0.18201631E 00	0.0	-0.43088760E-01	-0.74744932E-02
14	0.19426620E 00	0.0	-0.45205042E-01	-0.69621615E-02
15	0.20544505E 00	0.0	-0.47287293E-01	-0.62306300E-02
16	0.21515203E 00	0.0	-0.49255088E-01	-0.52493997E-02
17	0.22296637E 00	0.0	-0.51013969E-01	-0.40225498E-02
18	0.22645238E 00	0.0	-0.52463267E-01	-0.25691567E-02
19	0.23137480E 00	0.0	-0.53489447E-01	-0.91659348E-03
20	0.23133206E 00	0.0	-0.54002266E-01	0.87711564E-03
21	0.22818279E 00	0.0	-0.53912684E-01	0.27552391E-02
22	0.22489774E 00	0.0	-0.53557385E-01	0.38597789E-02
23	0.22053903E 00	0.0	-0.52962519E-01	0.49615987E-02
24	0.21511561E 00	0.0	-0.52118726E-01	0.60499236E-02
25	0.20865023E 00	0.0	-0.51019132E-01	0.71117580E-02
26	0.20117545E 00	0.0	-0.49661841E-01	0.81371740E-02
27	0.19273722E 00	0.0	-0.48043735E-01	0.91106407E-02
28	0.18339425E 00	0.0	-0.46166871E-01	0.10023747E-01
29	0.17321169E 00	0.0	-0.44036772E-01	0.10861009E-01
30	0.16227174E 00	0.0	-0.41664109E-01	0.11612680E-01
31	0.15066814E 00	0.0	-0.39063096E-01	0.12244196E-01
32	0.13850039E 00	0.0	-0.36257394E-01	0.12803238E-01
33	0.12588966E 00	0.0	-0.33264954E-01	0.13214823E-01
34	0.11296576E 00	0.0	-0.30114599E-01	0.13486519E-01
35	0.99874914E-01	0.0	-0.26842866E-01	0.13601765E-01
36	0.86770356E-01	0.0	-0.23489714E-01	0.13545580E-01
37	0.78049183E-01	0.0	-0.21217883E-01	0.13404202E-01
38	0.69456160E-01	0.0	-0.18947538E-01	0.13173923E-01
39	0.61051115E-01	0.0	-0.16697329E-01	0.12849651E-01
40	0.52891787E-01	0.0	-0.14484864E-01	0.12427084E-01
41	0.45044396E-01	0.0	-0.12332194E-01	0.11900987E-01
42	0.37577901E-01	0.0	-0.10262232E-01	0.11266615E-01
43	0.30558933E-01	0.0	-0.82987361E-02	0.10518178E-01
44	0.24062764E-01	0.0	-0.64685866E-02	0.96508041E-02
45	0.18167961E-01	0.0	-0.47986929E-02	0.86584538E-02
46	0.12950659E-01	0.0	-0.33209354E-02	0.75370185E-02
47	0.84938444E-02	0.0	-0.20681876E-02	0.62825084E-02
48	0.48827939E-02	0.0	-0.10742373E-02	0.48900594E-02
49	0.22027511E-02	0.0	-0.37484081E-03	0.33543531E-02
50	0.54449751E-03	0.0	-0.87382750E-05	0.16714833E-02
51	0.0	0.0	0.0	0.0

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STRAINS AND CURVATURES AT THE CENTER OF EACH SHELL ELEMENT
INCREMENT NO. 2 *** 50 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 2
THETA= 0.0 DEGREES

ELEMENT NO.	E(S)	E(THETA)	E(S-THETA)	K(S)	K(THETA)	K(S-THETA)
1	-0.15949531E-03	0.12196298E-03	0.0	0.24209607E-03	-0.19081550E-03	-0.0
2	-0.34949393E-03	0.12955705E-03	0.0	0.25208015E-03	-0.20812177E-03	-0.0
3	-0.42287307E-03	0.13032627E-03	0.0	0.24339647E-03	-0.23304809E-03	-0.0
4	-0.46207826E-03	0.10872698E-03	0.0	0.22386618E-03	-0.25931187E-03	-0.0
5	-0.49069454E-03	0.79783189E-04	0.0	0.19346891E-03	-0.28622127E-03	-0.0
6	-0.51431987E-03	0.46940506E-04	0.0	0.14991661E-03	-0.31357375E-03	-0.0
7	-0.32414612E-03	0.55743203E-05	0.0	0.10026926E-03	-0.34111761E-03	-0.0
8	-0.32114750E-03	-0.48797054E-04	0.0	0.66078792E-04	-0.3658847 E-03	-0.0
9	-0.33022114E-03	-0.11183576E-03	0.0	0.21980290E-04	-0.38882252E-03	-0.0
10	-0.33111963E-03	-0.18213103E-03	0.0	-0.34659912E-04	-0.41199033E-03	-0.0
11	-0.33357530E-03	-0.25649485E-03	0.0	-0.10154088E-03	-0.43493719E-03	0.0
12	-0.33126376E-03	-0.33203838E-03	0.0	-0.18933264E-03	-0.45852014E-03	-0.0
13	-0.32845023E-03	-0.40503615E-03	0.0	-0.29869797E-03	-0.48296293E-03	-0.0
14	-0.32467861E-03	-0.47315052E-03	0.0	-0.42635365E-03	-0.50782808E-03	-0.0
15	-0.32072794E-03	-0.53613633E-03	0.0	-0.57162857E-03	-0.53289696E-03	-0.0
16	-0.31656376E-03	-0.59236656E-03	0.0	-0.71488041E-03	-0.55723358E-03	-0.0
17	-0.31272834E-03	-0.64049871E-03	0.0	-0.84684673E-03	-0.57941116E-03	-0.0
18	-0.30382513E-03	-0.67653949E-03	0.0	-0.96286833E-03	-0.59823599E-03	-0.0
19	-0.30059414E-03	-0.69886143E-03	0.0	-0.10449679E-02	-0.61235554E-03	-0.0
20	-0.29702182E-03	-0.70776930E-03	0.0	-0.10937536E-02	-0.62065222E-03	-0.0
21	-0.29568421E-03	-0.70482818E-03	0.0	-0.11094764E-02	-0.62269857E-03	-0.0
22	-0.29297988E-03	-0.69787283E-03	0.0	-0.11079726E-02	-0.62157656E-03	-0.0
23	-0.29046275E-03	-0.68596983E-03	0.0	-0.10935124E-02	-0.61817118E-03	-0.0
24	-0.28772396E-03	-0.66958996E-03	0.0	-0.10681725E-02	-0.61249617E-03	-0.0
25	-0.28723036E-03	-0.64862403E-03	0.0	-0.10304358E-02	-0.60451869E-03	-0.0
26	-0.28444384E-03	-0.62337681E-03	0.0	-0.97866729E-03	-0.59428299E-03	-0.0
27	-0.28102007E-03	-0.59361709E-03	0.0	-0.91676135E-03	-0.58178487E-03	-0.0
28	-0.27792552E-03	-0.55973511E-03	0.0	-0.84210816E-03	-0.56711165E-03	-0.0
29	-0.27548196E-03	-0.52236812E-03	0.0	-0.75475359E-03	-0.55025006E-03	-0.0
30	-0.27320837E-03	-0.48186816E-03	0.0	-0.65421313E-03	-0.53129112E-03	-0.0
31	-0.27739280E-03	-0.43874513E-03	0.0	-0.54099294E-03	-0.51025837E-03	-0.0
32	-0.27565775E-03	-0.39367471E-03	0.0	-0.41329535E-03	-0.48717600E-03	-0.0
33	-0.27452805E-03	-0.34679845E-03	0.0	-0.27298182E-03	-0.46210201E-03	-0.0
34	-0.27515576E-03	-0.29883557E-03	0.0	-0.11555591E-03	-0.43507433E-03	-0.0
35	-0.27640210E-03	-0.25088829E-03	0.0	0.56195742E-04	-0.40612463E-03	-0.0
36	-0.28045336E-03	-0.21123816E-03	0.0	0.21145810E-03	-0.38048276E-03	-0.0
37	-0.28221821E-03	-0.18021086E-03	0.0	0.34459634E-03	-0.35895407E-03	-0.0
38	-0.28492906E-03	-0.15008613E-03	0.0	0.48563816E-03	-0.33661956E-03	-0.0
39	-0.28665946E-03	-0.12132137E-03	0.0	0.63240249E-03	-0.31349296E-03	-0.0
40	-0.28927973E-03	-0.94138217E-04	0.0	0.78748772E-03	-0.28959475E-03	-0.0
41	-0.29149163E-03	-0.69918467E-04	0.0	0.94969687E-03	-0.26494334E-03	-0.0
42	-0.29392866E-03	-0.44038913E-04	0.0	0.11202367E-02	-0.23955207E-03	-0.0
43	-0.29599620E-03	-0.25815621E-04	0.0	0.12979747E-02	-0.21343908E-03	-0.0
44	-0.29488746E-03	-0.85564061E-05	0.0	0.14854458E-02	-0.18661388E-03	-0.0
45	-0.29571750E-03	0.53582235E-05	0.0	0.16783539E-02	-0.15910863E-03	-0.0
46	-0.29686000E-03	0.15330457E-04	0.0	0.18774604E-02	-0.13096326E-03	-0.0
47	-0.29537617E-03	0.20926716E-04	0.0	0.20844252E-02	-0.10222045E-03	-0.0
48	-0.29206160E-03	0.21614556E-04	0.0	0.22983165E-02	-0.72904804E-04	-0.0
49	-0.28655003E-03	0.16902675E-04	0.0	0.25191198E-02	-0.43052525E-04	-0.0
50	-0.27896441E-03	0.68611762E-05	0.0	0.27366115E-02	-0.14017352E-04	-0.0

STRESS RESULTANTS AT THE CENTER OF EACH SHELL ELEMENT
INCREMENT NO. 2 *** 50 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 2
THETA= 0.0 DEGREES

ELEMENT NO.	N(S)	N(THETA)	N(S-THETA)	M(S)	M(THETA)	M(S-THETA)	Q(S)	Q(THETA)
1	-0.239059E 03	0.144156E 03	0.0	0.359546E 03	-0.229879E 03	0.0	0.350487E 02	0.0
2	-0.604186E 03	0.480601E 02	0.0	0.368867E 03	-0.257715E 03	0.0	-0.310902E 02	0.0
3	-0.746463E 03	0.673840E 01	0.0	0.337432E 03	-0.311265E 03	0.0	-0.448489E 02	0.0
4	-0.835323E 03	-0.581502E 02	0.0	0.284119E 03	-0.373746E 03	0.0	-0.576399E 02	0.0
5	-0.907872E 03	-0.131145E 03	0.0	0.209293E 03	-0.443823E 03	0.0	-0.725254E 02	0.0
6	-0.972989E 03	-0.208812E 03	0.0	0.108620E 03	-0.522439E 03	0.0	-0.885794E 02	0.0
7	-0.104538E 04	-0.297170E 03	0.0	-0.669751E 01	-0.100831E 04	0.0	-0.120594E 03	0.0
8	-0.108854E 04	-0.470512E 03	0.0	-0.141621E 03	-0.112185E 04	0.0	-0.122526E 03	0.0
9	-0.117926E 04	-0.683693E 03	0.0	-0.306885E 03	-0.123909E 04	0.0	-0.146852E 03	0.0
10	-0.125054E 04	-0.912447E 03	0.0	-0.513030E 03	-0.136928E 04	0.0	-0.160930E 03	0.0
11	-0.133082E 04	-0.115590E 04	0.0	-0.752158E 03	-0.150871E 04	0.0	-0.193825E 03	0.0
12	-0.139679E 04	-0.139855E 04	0.0	-0.105969E 04	-0.167054E 04	0.0	-0.227603E 03	0.0
13	-0.145866E 04	-0.163245E 04	0.0	-0.143800E 04	-0.185614E 04	0.0	-0.266548E 03	0.0
14	-0.151268E 04	-0.184960E 04	0.0	-0.187601E 04	-0.206089E 04	0.0	-0.308543E 03	0.0
15	-0.156113E 04	-0.204994E 04	0.0	-0.237134E 04	-0.228345E 04	0.0	-0.323256E 03	0.0
16	-0.160231E 04	-0.222817E 04	0.0	-0.285939E 04	-0.250166E 04	0.0	-0.307339E 03	0.0
17	-0.163669E 04	-0.238048E 04	0.0	-0.330876E 04	-0.270189E 04	0.0	-0.271204E 03	0.0
18	-0.164288E 04	-0.248865E 04	0.0	-0.370318E 04	-0.287575E 04	0.0	-0.216047E 03	0.0
19	-0.165411E 04	-0.255787E 04	0.0	-0.398306E 04	-0.300137E 04	0.0	-0.146112E 03	0.0
20	-0.165120E 04	-0.258328E 04	0.0	-0.414928E 04	-0.307571E 04	0.0	-0.710034E 02	0.0
21	-0.164400E 04	-0.257244E 04	0.0	-0.420224E 04	-0.309763E 04	0.0	-0.190542E 02	0.0
22	-0.162847E 04	-0.254726E 04	0.0	-0.419627E 04	-0.309253E 04	0.0	0.246102E 02	0.0
23	-0.160873E 04	-0.250623E 04	0.0	-0.414609E 04	-0.306743E 04	0.0	0.752460E 02	0.0
24	-0.158392E 04	-0.245047E 04	0.0	-0.405842E 04	-0.302439E 04	0.0	0.119944E 03	0.0
25	-0.156193E 04	-0.238202E 04	0.0	-0.392833E 04	-0.296183E 04	0.0	0.165830E 03	0.0
26	-0.152835E 04	-0.229746E 04	0.0	-0.375056E 04	-0.287830E 04	0.0	0.215935E 03	0.0
27	-0.148831E 04	-0.219766E 04	0.0	-0.353772E 04	-0.277758E 04	0.0	0.268322E 03	0.0
28	-0.144532E 04	-0.208481E 04	0.0	-0.328144E 04	-0.265741E 04	0.0	0.308441E 03	0.0
29	-0.140106E 04	-0.196130E 04	0.0	-0.298186E 04	-0.251779E 04	0.0	0.365049E 03	0.0
30	-0.135430E 04	-0.182780E 04	0.0	-0.263749E 04	-0.235856E 04	0.0	0.414425E 03	0.0
31	-0.132593E 04	-0.169208E 04	0.0	-0.225001E 04	-0.218026E 04	0.0	0.466978E 03	0.0
32	-0.127647E 04	-0.154428E 04	0.0	-0.181359E 04	-0.198125E 04	0.0	0.513846E 03	0.0
33	-0.122722E 04	-0.139122E 04	0.0	-0.133435E 04	-0.176350E 04	0.0	0.567911E 03	0.0
34	-0.118261E 04	-0.123635E 04	0.0	-0.797725E 03	-0.152279E 04	0.0	0.625767E 03	0.0
35	-0.114002E 04	-0.108213E 04	0.0	-0.212794E 03	-0.126191E 04	0.0	0.681679E 03	0.0
36	-0.111460E 04	-0.957530E 03	0.0	0.315466E 03	-0.102778E 04	0.0	0.728644E 03	0.0
37	-0.109014E 04	-0.858664E 03	0.0	0.768005E 03	-0.828512E 03	0.0	0.766301E 03	0.0
38	-0.106963E 04	-0.763643E 03	0.0	0.124695E 04	-0.618942E 03	0.0	0.804440E 03	0.0
39	-0.104727E 04	-0.672078E 03	0.0	0.174521E 04	-0.401240E 03	0.0	0.843639E 03	0.0
40	-0.102933E 04	-0.586505E 03	0.0	0.227120E 04	-0.172943E 03	0.0	0.887100E 03	0.0
41	-0.101197E 04	-0.506900E 03	0.0	0.282102E 04	0.647239E 02	0.0	0.925836E 03	0.0
42	-0.997618E 03	-0.435100E 03	0.0	0.339856E 04	0.312891E 03	0.0	0.970766E 03	0.0
43	-0.984653E 03	-0.371552E 03	0.0	0.400014E 04	0.570398E 03	0.0	0.100886E 04	0.0
44	-0.964274E 03	-0.314523E 03	0.0	0.463396E 04	0.839679E 03	0.0	0.104959E 04	0.0
45	-0.953432E 03	-0.270223E 03	0.0	0.528607E 04	0.111645E 04	0.0	0.108699E 04	0.0
46	-0.947438E 03	-0.239007E 03	0.0	0.595890E 04	0.140133E 04	0.0	0.112470E 04	0.0
47	-0.937185E 03	-0.219422E 03	0.0	0.665778E 04	0.169579E 04	0.0	0.116230E 04	0.0
48	-0.925771E 03	-0.213968E 03	0.0	0.737968E 04	0.199883E 04	0.0	0.119838E 04	0.0
49	-0.912486E 03	-0.223883E 03	0.0	0.812450E 04	0.231034E 04	0.0	0.123344E 04	0.0
50	-0.897661E 03	-0.249058E 03	0.0	0.885779E 04	0.261599E 04	0.0	0.126642E 04	0.0

MAXIMUM COMPUTED NODE DISPLACEMENT COMPONENTS OF THE STRUCTURE

INCREMENT NO. 2 *** 50 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 2

AXIAL		TANGENTIAL		RADIAL		ANGULAR	
0.23137480E 00		0.0		-0.54002266E-01		0.13601765E-01	
AT		AT		AT		AT	
THETA	NODE	THETA	NODE	THETA	NODE	THETA	NODE
0.0	19	0.0	51	0.0	20	0.0	35

MAXIMUM COMPUTED STRESS RESULTANT COMPONENTS OF THE STRUCTURE

N(S)		N(THETA)		N(S-THETA)		M(S)		M(THETA)		M(S-THETA)		Q(S)		Q(THETA)	
-0.165411E 04		-0.258328E 04		0.0		0.885779E 04		-0.309763E 04		0.0		0.126642E 04		0.0	
AT		AT		AT		AT		AT		AT		AT		AT	
ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA
19	0.0	20	0.0	50	0.0	50	0.0	21	0.0	50	0.0	50	0.0	50	0.0

DISPLACEMENT COMPONENTS OF NODES
INCREMENT NO. 3 *** 75 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 1
THETA= 0.0 DEGREES

NODE NO.	AXIAL	TANGENTIAL	RADIAL	ANGULAR
1	0.50447226E-01	0.0	-0.38904525E-01	-0.83791204E-02
2	0.65360725E-01	0.0	-0.39450098E-01	-0.90175346E-02
3	0.81389427E-01	0.0	-0.40660761E-01	-0.96768513E-02
4	0.98512113E-01	0.0	-0.42255294E-01	-0.10310665E-01
5	0.11666071E 00	0.0	-0.44164225E-01	-0.10889955E-01
6	0.13571090E 00	0.0	-0.46373907E-01	-0.11385944E-01
7	0.15549099E 00	0.0	-0.48878763E-01	-0.11763897E-01
8	0.17581153E 00	0.0	-0.51113829E-01	-0.12015983E-01
9	0.19646335E 00	0.0	-0.53568307E-01	-0.12177862E-01
10	0.21727192E 00	0.0	-0.56264069E-01	-0.12222826E-01
11	0.23800373E 00	0.0	-0.59159204E-01	-0.12119170E-01
12	0.25838691E 00	0.0	-0.62225703E-01	-0.11839293E-01
13	0.27807426E 00	0.0	-0.65402150E-01	-0.11330195E-01
14	0.29662687E 00	0.0	-0.68616509E-01	-0.10535505E-01
15	0.31352538E 00	0.0	-0.71771264E-01	-0.94083697E-02
16	0.32816303E 00	0.0	-0.74743509E-01	-0.79034865E-02
17	0.33990377E 00	0.0	-0.77389956E-01	-0.60276501E-02
18	0.34815073E 00	0.0	-0.79558432E-01	-0.38103901E-02
19	0.35236907E 00	0.0	-0.81078410E-01	-0.12936164E-02
20	0.35213631E 00	0.0	-0.81815541E-01	0.14343557E-02
21	0.34718180E 00	0.0	-0.81637681E-01	0.42872466E-02
22	0.34209347E 00	0.0	-0.81074953E-01	0.59635490E-02
23	0.33537614E 00	0.0	-0.80150127E-01	0.76346211E-02
24	0.32704413E 00	0.0	-0.78849673E-01	0.92840828E-02
25	0.31713289E 00	0.0	-0.77163815E-01	0.10892194E-01
26	0.30569303E 00	0.0	-0.75090110E-01	0.12443904E-01
27	0.29279530E 00	0.0	-0.72624385E-01	0.13915658E-01
28	0.27852988E 00	0.0	-0.69770157E-01	0.15294731E-01
29	0.26299632E 00	0.0	-0.66536129E-01	0.16557645E-01
30	0.24632061E 00	0.0	-0.62938631E-01	0.17689716E-01
31	0.22864555E 00	0.0	-0.58999415E-01	0.18668905E-01
32	0.21012348E 00	0.0	-0.54753751E-01	0.19476689E-01
33	0.19093859E 00	0.0	-0.50229039E-01	0.20090487E-01
34	0.17128873E 00	0.0	-0.45468554E-01	0.20491656E-01
35	0.15139586E 00	0.0	-0.40527254E-01	0.20655304E-01
36	0.13149285E 00	0.0	-0.35465039E-01	0.20559013E-01
37	0.11825317E 00	0.0	-0.32036033E-01	0.20337347E-01
38	0.10521245E 00	0.0	-0.28609794E-01	0.19981150E-01
39	0.92461407E-01	0.0	-0.25214270E-01	0.19482799E-01
40	0.80087423E-01	0.0	-0.21875903E-01	0.18835932E-01
41	0.68190634E-01	0.0	-0.18627759E-01	0.18032700E-01
42	0.56875095E-01	0.0	-0.15504260E-01	0.17066095E-01
43	0.46241425E-01	0.0	-0.12541097E-01	0.15927467E-01
44	0.36403168E-01	0.0	-0.97787082E-02	0.14609575E-01
45	0.27478728E-01	0.0	-0.72578788E-02	0.13103426E-01
46	0.19582752E-01	0.0	-0.50258040E-02	0.11402946E-01
47	0.12840115E-01	0.0	-0.31329633E-02	0.95022656E-02
48	0.73790289E-02	0.0	-0.16301698E-02	0.73941574E-02
49	0.33275264E-02	0.0	-0.57155173E-03	0.50706677E-02
50	0.82189776E-03	0.0	-0.15846716E-04	0.25260667E-02
51	0.0	0.0	0.0	0.0

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STRAINS AND CURVATURES AT THE CENTER OF EACH SHELL ELEMENT
INCREMENT NO. 3 *** 75 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 1
THETA= 0.0 DEGREES

ELEMENT NO.	E(S)	E(THETA)	E(S-THETA)	K(S)	K(THETA)	K(S-THETA)
1	-0.23688677E-03	0.18113964E-03	0.0	0.37183356E-03	-0.29392587E-03	-0.0
2	-0.52387430E-03	0.19191243E-03	0.0	0.38412260E-03	-0.32150280E-03	-0.0
3	-0.63430564E-03	0.19242706E-03	0.0	0.36922959E-03	-0.35971915E-03	-0.0
4	-0.69292891E-03	0.15911488E-03	0.0	0.33751340E-03	-0.39993948E-03	-0.0
5	-0.73546870E-03	0.11476291E-03	0.0	0.28882199E-03	-0.44118194E-03	-0.0
6	-0.77043637E-03	0.64627849E-04	0.0	0.22032179E-03	-0.48306189E-03	-0.0
7	-0.47679269E-03	0.18662377E-05	0.0	0.14686525E-03	-0.52496674E-03	-0.0
8	-0.47150976E-03	-0.80427766E-04	0.0	0.94029325E-04	-0.56247157E-03	-0.0
9	-0.48447330E-03	-0.17593526E-03	0.0	0.26264112E-04	-0.59724343E-03	-0.0
10	-0.48544398E-03	-0.28239191E-03	0.0	-0.60673221E-04	-0.63241879E-03	-0.0
11	-0.48890850E-03	-0.39481674E-03	0.0	-0.16301757E-03	-0.66725235E-03	-0.0
12	-0.48563373E-03	-0.50883763E-03	0.0	-0.29715500E-03	-0.70303027E-03	-0.0
13	-0.48235455E-03	-0.61880215E-03	0.0	-0.46328129E-03	-0.74005313E-03	-0.0
14	-0.47794729E-03	-0.72118267E-03	0.0	-0.65727136E-03	-0.77768415E-03	-0.0
15	-0.47376053E-03	-0.81562740E-03	0.0	-0.87677711E-03	-0.81551657E-03	-0.0
16	-0.46961638E-03	-0.89971954E-03	0.0	-0.10930940E-02	-0.85218437E-03	-0.0
17	-0.46593323E-03	-0.97149052E-03	0.0	-0.12920974E-02	-0.88549894E-03	-0.0
18	-0.45414362E-03	-0.10249636E-02	0.0	-0.14666095E-02	-0.91366214E-03	-0.0
19	-0.45019388E-03	-0.10577475E-02	0.0	-0.15899586E-02	-0.93463529E-03	-0.0
20	-0.44454914E-03	-0.10703593E-02	0.0	-0.16614634E-02	-0.94671478E-03	-0.0
21	-0.44103782E-03	-0.10652866E-02	0.0	-0.16845919E-02	-0.94940839E-03	-0.0
22	-0.43545570E-03	-0.10543638E-02	0.0	-0.16801732E-02	-0.94737392E-03	-0.0
23	-0.42965729E-03	-0.10360258E-02	0.0	-0.16578340E-02	-0.94188028E-03	-0.0
24	-0.42313896E-03	-0.10109902E-02	0.0	-0.16173844E-02	-0.93293120E-03	-0.0
25	-0.41941274E-03	-0.97908452E-03	0.0	-0.15587094E-02	-0.92048338E-03	-0.0
26	-0.41206391E-03	-0.94076712E-03	0.0	-0.14793776E-02	-0.90460898E-03	-0.0
27	-0.40346524E-03	-0.89570042E-03	0.0	-0.13849789E-02	-0.88529428E-03	-0.0
28	-0.39531942E-03	-0.84446976E-03	0.0	-0.12702520E-02	-0.86268922E-03	-0.0
29	-0.38815686E-03	-0.78803604E-03	0.0	-0.11370189E-02	-0.83675934E-03	-0.0
30	-0.38142828E-03	-0.72692358E-03	0.0	-0.98368060E-03	-0.80766273E-03	-0.0
31	-0.38432609E-03	-0.66188932E-03	0.0	-0.81212563E-03	-0.77542267E-03	-0.0
32	-0.37914026E-03	-0.59394841E-03	0.0	-0.61663333E-03	-0.74007874E-03	-0.0
33	-0.37536235E-03	-0.52330573E-03	0.0	-0.40251552E-03	-0.70172874E-03	-0.0
34	-0.37509413E-03	-0.45103976E-03	0.0	-0.16475396E-03	-0.66044834E-03	-0.0
35	-0.37662289E-03	-0.37880708E-03	0.0	0.96771779E-04	-0.61626174E-03	-0.0
36	-0.38299547E-03	-0.31907484E-03	0.0	0.33180485E-03	-0.57716668E-03	-0.0
37	-0.38655475E-03	-0.27237710E-03	0.0	0.53335098E-03	-0.54436526E-03	-0.0
38	-0.39196899E-03	-0.22693262E-03	0.0	0.74604107E-03	-0.51036174E-03	-0.0
39	-0.39642304E-03	-0.18358031E-03	0.0	0.96813170E-03	-0.47516753E-03	-0.0
40	-0.40264754E-03	-0.14260151E-03	0.0	0.12021970E-02	-0.43682430E-03	-0.0
41	-0.40869392E-03	-0.10456903E-03	0.0	0.14468811E-02	-0.40136115E-03	-0.0
42	-0.41541271E-03	-0.70050970E-04	0.0	0.17040162E-02	-0.36279508E-03	-0.0
43	-0.42189891E-03	-0.39522682E-04	0.0	0.19724285E-02	-0.32315403E-03	-0.0
44	-0.42374758E-03	-0.13447770E-04	0.0	0.22546058E-02	-0.28246199E-03	-0.0
45	-0.42867661E-03	0.75990838E-05	0.0	0.25449740E-02	-0.24076240E-03	-0.0
46	-0.43394021E-03	0.22714506E-04	0.0	0.28445267E-02	-0.19811718E-03	-0.0
47	-0.43508410E-03	0.31241929E-04	0.0	0.31557810E-02	-0.15459285E-03	-0.0
48	-0.43301587E-03	0.32374315E-04	0.0	0.34773191E-02	-0.11022697E-03	-0.0
49	-0.42692828E-03	0.25365225E-04	0.0	0.38090807E-02	-0.65074448E-04	-0.0
50	-0.41669677E-03	0.10309473E-04	0.0	0.41357577E-02	-0.21181899E-04	-0.0

STRESS RESULTANTS AT THE CENTER OF EACH SHELL ELEMENT
INCREMENT NO. 3 *** 75 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 1
THETA= 0.0 DEGREES

ELEMENT NO.	N(S)	N(THETA)	N(S-THETA)	M(S)	M(THETA)	M(S-THETA)	Q(S)	Q(THETA)
1	-0.355059E 03	0.214099E 03	0.0	0.551726E 03	-0.354731E 03	0.0	0.433905E 02	0.0
2	-0.906979E 03	0.675911E 02	0.0	0.559537E 03	-0.401198E 03	0.0	-0.495350E 02	0.0
3	-0.112147E 04	0.415356E 01	0.0	0.508269E 03	-0.484222E 03	0.0	-0.705076E 02	0.0
4	-0.125494E 04	-0.948479E 02	0.0	0.423110E 03	-0.580959E 03	0.0	-0.904763E 02	0.0
5	-0.136356E 04	-0.205938E 03	0.0	0.304338E 03	-0.689590E 03	0.0	-0.113502E 03	0.0
6	-0.146983E 04	-0.323857E 03	0.0	0.146663E 03	-0.811020E 03	0.0	-0.138010E 03	0.0
7	-0.154383E 04	-0.457643E 03	0.0	-0.344429E 02	-0.155898E 04	0.0	-0.185639E 03	0.0
8	-0.160674E 04	-0.719282E 03	0.0	-0.242198E 03	-0.173195E 04	0.0	-0.187588E 03	0.0
9	-0.174165E 04	-0.104150E 04	0.0	-0.495693E 03	-0.191057E 04	0.0	-0.224550E 03	0.0
10	-0.184832E 04	-0.138755E 04	0.0	-0.811732E 03	-0.210915E 04	0.0	-0.246227E 03	0.0
11	-0.196889E 04	-0.175538E 04	0.0	-0.117738E 04	-0.232161E 04	0.0	-0.295079E 03	0.0
12	-0.206916E 04	-0.212182E 04	0.0	-0.164702E 04	-0.256804E 04	0.0	-0.345817E 03	0.0
13	-0.216548E 04	-0.247511E 04	0.0	-0.222157E 04	-0.284962E 04	0.0	-0.404762E 03	0.0
14	-0.225076E 04	-0.280271E 04	0.0	-0.288703E 04	-0.316028E 04	0.0	-0.467439E 03	0.0
15	-0.232903E 04	-0.310481E 04	0.0	-0.363541E 04	-0.349639E 04	0.0	-0.490375E 03	0.0
16	-0.239738E 04	-0.337338E 04	0.0	-0.437231E 04	-0.382564E 04	0.0	-0.463782E 03	0.0
17	-0.245524E 04	-0.360247E 04	0.0	-0.504983E 04	-0.412717E 04	0.0	-0.409010E 03	0.0
18	-0.246903E 04	-0.376435E 04	0.0	-0.564295E 04	-0.438818E 04	0.0	-0.324615E 03	0.0
19	-0.248811E 04	-0.386678E 04	0.0	-0.606321E 04	-0.457613E 04	0.0	-0.220611E 03	0.0
20	-0.248207E 04	-0.390218E 04	0.0	-0.630676E 04	-0.468483E 04	0.0	-0.103689E 03	0.0
21	-0.246576E 04	-0.388232E 04	0.0	-0.638436E 04	-0.471606E 04	0.0	-0.246415E 02	0.0
22	-0.243704E 04	-0.384148E 04	0.0	-0.636805E 04	-0.470517E 04	0.0	0.445438E 02	0.0
23	-0.240041E 04	-0.377639E 04	0.0	-0.629029E 04	-0.466563E 04	0.0	0.115222E 03	0.0
24	-0.235493E 04	-0.368890E 04	0.0	-0.615046E 04	-0.459728E 04	0.0	0.192788E 03	0.0
25	-0.231182E 04	-0.358184E 04	0.0	-0.594814E 04	-0.449987E 04	0.0	0.264784E 03	0.0
26	-0.225073E 04	-0.345048E 04	0.0	-0.567715E 04	-0.437174E 04	0.0	0.331612E 03	0.0
27	-0.217903E 04	-0.329602E 04	0.0	-0.535073E 04	-0.421684E 04	0.0	0.404806E 03	0.0
28	-0.210280E 04	-0.312202E 04	0.0	-0.495683E 04	-0.403199E 04	0.0	0.475841E 03	0.0
29	-0.202470E 04	-0.293211E 04	0.0	-0.449971E 04	-0.381835E 04	0.0	0.554367E 03	0.0
30	-0.194345E 04	-0.272746E 04	0.0	-0.397433E 04	-0.357490E 04	0.0	0.635807E 03	0.0
31	-0.188960E 04	-0.251945E 04	0.0	-0.338683E 04	-0.330354E 04	0.0	0.703575E 03	0.0
32	-0.180671E 04	-0.229416E 04	0.0	-0.271872E 04	-0.299885E 04	0.0	0.782721E 03	0.0
33	-0.172576E 04	-0.206148E 04	0.0	-0.198731E 04	-0.266629E 04	0.0	0.867721E 03	0.0
34	-0.165461E 04	-0.182695E 04	0.0	-0.117640E 04	-0.230124E 04	0.0	0.947616E 03	0.0
35	-0.158932E 04	-0.159428E 04	0.0	-0.285620E 03	-0.190366E 04	0.0	0.103661E 04	0.0
36	-0.155189E 04	-0.140684E 04	0.0	0.514321E 03	-0.154834E 04	0.0	0.110682E 04	0.0
37	-0.151796E 04	-0.125875E 04	0.0	0.119958E 04	-0.124600E 04	0.0	0.116384E 04	0.0
38	-0.149136E 04	-0.111686E 04	0.0	0.192214E 04	-0.928923E 03	0.0	0.122034E 04	0.0
39	-0.146364E 04	-0.980654E 03	0.0	0.267633E 04	-0.598843E 03	0.0	0.12[illegible]644E 04	0.0
40	-0.144397E 04	-0.853864E 03	0.0	0.347046E 04	-0.253393E 03	0.0	0.133852E 04	0.0
41	-0.142658E 04	-0.736453E 03	0.0	0.430010E 04	0.106016E 03	0.0	0.139974E 04	0.0
42	-0.141479E 04	-0.631088E 03	0.0	0.517118E 04	0.481108E 03	0.0	0.146466E 04	0.0
43	-0.140613E 04	-0.538439E 03	0.0	0.607985E 04	0.870653E 03	0.0	0.152130E 04	0.0
44	-0.138676E 04	-0.455700E 03	0.0	0.703418E 04	0.127699E 04	0.0	0.158212E 04	0.0
45	-0.138227E 04	-0.392265E 03	0.0	0.801604E 04	0.169456E 04	0.0	0.163811E 04	0.0
46	-0.138464E 04	-0.348383E 03	0.0	0.902858E 04	0.212413E 04	0.0	0.169361E 04	0.0
47	-0.138005E 04	-0.321852E 03	0.0	0.100799E 05	0.256793E 04	0.0	0.174896E 04	0.0
48	-0.137225E 04	-0.316169E 03	0.0	0.111654E 05	0.302446E 04	0.0	0.180307E 04	0.0
49	-0.135933E 04	-0.332971E 03	0.0	0.122848E 05	0.349349E 04	0.0	0.185454E 04	0.0
50	-0.134080E 04	-0.371828E 03	0.0	0.133865E 05	0.395347E 04	0.0	0.190333E 04	0.0

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MAXIMUM COMPUTED NODE DISPLACEMENT COMPONENTS OF THE STRUCTURE

INCREMENT NO. 3 *** 75 PERCENT OF TOTAL LOAD
I T E R A T I O N N O. 1

AXIAL		TANGENTIAL		RADIAL		ANGULAR	
0.35236907E 00		0.0		-0.81815541E-0?		0.20655304E-01	
AT		AT		AT		AT	
THETA	NODE	THETA	NODE	THETA	NODE	THETA	NODE
0.0	19	0.0	51	0.0	20	0.0	35

MAXIMUM COMPUTED STRESS RESULTANT COMPONENTS OF THE STRUCTURE

N(S)		N(THETA)		N(S-THETA)		M(S)		M(THETA)		M(S THETA)		Q(S)		Q(THETA)	
-0.248811E 04		-0.390218E 04		0.0		0.133865E 05		-0.471606E 04		0.0		0.190333E [illegible]4		0.0	
AT		AT		AT		AT		AT		AT		AT		AT	
ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA	ELEMENT	THETA
19	0.0	20	0.0	50	0.0	50	0.0	21	0.0	50	0.0	50	0.0	50	0.0

```
    1
SAMPLE PROBLEM NO. 1
THE SHELL IS A STAINLESS SANDWICH STRUCTURE WITH A NOMINAL
THICKNESS OF TWO INCHES.
THE LOAD IS APPLIED OVER A CIRCULAR AREA OF TWENTY INCHES RADIUS.
THE CENTER OF THE CIRCULAR AREA IS LOCATED AT 0.0 DEGRESS IN THE
CIRCUMFERENTIAL DIRECTION AND AT 15 DEGREES INCLINATION.
FIND BUCKLING LOAD FOR THE APOLLO AFT HEAT SHIELD
NUMBER OF LOADING INCREMENTS = 4 *** TOTAL LOAD =-200 PSI *** ERROR = 6 PERCENT
4 A HARMONICS WERE USED WITH NA = 6 *** NET = 29
        (BLANK CARD)
  4  0  8 50 29  1  1  6  0  4 20  0  1SAND 2.0 BUCK      0.06  1.0    0.0001
APOL       0.0         45.45      20.0       -200.0
  0.0
        (BLANK CARD)
     175.6        0.0       58.1
    3
   20        11.2
   15        4.87
   15        3.27
CONS      1     6      0.030
                                5
       0.0       0.050      30.0      0.030     145.0     0.020     215.0     0.030
     330.0       0.050
                                5
       0.0       0.050      40.0      0.030     145.0     0.020     215.0     0.030
     320.0       0.050
                                5
       0.0       0.050      40.0      0.030     127.5     0.020     232.5     0.030
     320.0       0.050
                                5
       0.0       0.050      50.0      0.030     127.5     0.020     232.5     0.030
     310.0       0.050
                                5
       0.0       0.050      50.0      0.030     115.0     0.020     245.0     0.030
     310.0       0.050
```

		5					
0.0	0.050	50.0	0.030	115.0	0.020	245.0	0.030
310.0	0.050						
		5					
0.0	0.050	60.0	0.030	105.0	0.020	255.0	0.030
300.0	0.050						
		5					
0.0	0.050	60.0	0.030	105.0	0.020	255.0	0.030
300.0	0.050						
		5					
0.0	0.050	60.0	0.030	105.0	0.020	255.0	0.030
300.0	0.050						
		5					
0.0	0.050	60.0	0.030	105.0	0.020	255.0	0.030
300.0	0.050						
		5					
0.0	0.050	60.0	0.030	105.0	0.020	255.0	0.030
300.0	0.050						
		7					
0.0	0.050	60.0	0.030	95.0	0.020	155.0	0.012
205.0	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	95.0	0.020	155.0	0.012
205.0	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	95.0	0.020	155.0	0.012
205.0	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	95.0	0.020	135.0	0.012
225.0	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	95.0	0.020	135.0	0.012
225.0	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	95.0	0.020	135.0	0.012
225.0	0.020	265.0	0.030	300.0	0.050		
		7					

0.0	0.050	60.0	0.030	95.0	0.020	135.0	0.012
225.0	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	95.0	0.020	127.5	0.012
232.5	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	95.0	0.020	127.5	0.012
232.5	0.020	265.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	90.0	0.020	127.5	0.012
232.5	0.020	270.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	90.0	0.020	127.5	0.012
232.5	0.020	270.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	90.0	0.020	127.5	0.012
232.5	0.020	270.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	90.0	0.020	127.5	0.012
232.5	0.020	270.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	90.0	0.020	115.0	0.012
245.0	0.020	270.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	90.0	0.020	115.0	0.012
245.0	0.020	270.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	115.0	0.012
245.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	115.0	0.012
245.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	115.0	0.012
245.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012

250.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012
250.0	0.020	[illegible]	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012
250.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012
250.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012
250.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012
250.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012
250.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	85.0	0.020	110.0	0.012
250.0	0.020	275.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	78.0	0.020	110.0	0.012
250.0	0.020	282.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	78.0	0.020	110.0	0.012
250.0	0.020	282.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	78.0	0.020	105.0	0.012
255.0	0.020	282.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	78.0	0.020	105.0	0.012
255.0	0.020	282.0	0.030	300.0	0.050		
		7					
0.0	0.050	60.0	0.030	78.0	0.020	105.0	0.012
255.0	0.020	282.0	0.030	300.0	0.050		

```
                                 7
      0.0       0.050          60.0       0.030        78.0       0.020       105.0       0.012
    255.0       0.020         282.0       0.030       300.0       0.050
                                 7
      0.0       0.050          60.0       0.030        78.0       0.020       105.0       0.012
    255.0       0.020         282.0       0.030       300.0       0.050
CONS      1    50 29500000.
CONS      1    50    0.3
   50
   50                            1      1      1      1
```

```
    2
SAMPLE PROBLEM NO. 2
HEMISPHERICAL SHELL UNDER UNIFORM EXTERNAL PRESSURE.
THE THICKNESS IS CONSTANT OVER THE ENTIRE SHELL AS WELL AS
THE POISSON,S RATIO AND THE YOUNG,S MODULUS.
IT IS ASSUMED TO BE CLAMPED AT THE BASE.
ONLY THE 0A HARMONIC IS NEEDED IN THE ANALYSIS.
         (BLANK CARD)
   1       8  30  29   1   1                    SAM2
         (BLANK CARD)
  0.0
         (BLANK CARD)
  5.0                  5.0
    2
   15    70.0
   15    20.0
CONS     1   30  0.01
CONS     1   30 30000000.
CONS     1   30  0.3
   30
   30                        1    1    1    1
    1    1CONS
           -100.0
SAMPLE PROBLEM NO. 3
HEMISPHERICAL SHELL UNDER UNIFORM INTERNAL PRESSURE APPLIED
ON ELEMENTS 26 THROUGH 30.
THE SHELL HAS THE SAME GEOMETRIC AND ELASTIC PROPERTIES AS
THOSE USED IN THE SAMPLE PROBLEM NO. 2.
THIS IS A RERUN OF THE SAMPLE PROBLEM NO. 2 UNDER A NEW LOADING.
         (BLANK CARD)
   1       8  30  29   1   1                    SAM3RRUN
   26    1CONS
            10.0
```

```
    1
SAMPLE PROBLEM NO. 4
CIRCULAR PLATE WITH A CENTRAL CIRCULAR HOLE UNDER A RING LOAD
APPLIED AT NODE 1.
THE GEOMETRY OF THE PLATE IS INPUT RATHER THAN GENERATED BY THE COMPUTER.
THE PLATE IS ASSUMED TO BE SIMPLY SUPPORTED AT NODE 9.
         (BLANK CARD)
   1       8   8  29    1    2                         SAM4     1
         (BLANK CARD)
    0.0       90.0
    0.0            0.0       2.0          3.0          90.0       90.0
    0.0            0.0       3.0          4.0          90.0       90.0
    0.0            0.0       4.0          5.0          90.0       90.0
    0.0            0.0       5.0          6.0          90.0       90.0
    0.0            0.0       6.0          7.0          90.0       90.0
    0.0            0.0       7.0          8.0          90.0       90.0
    0.0            0.0       8.0          9.0          90.0       90.0
    0.0            0.0       9.0         10.0          90.0       90.0
CONS      1     8 1.0
CONS      1     8 30000000.
CONS      1     8   0.3
    8
    8                         1
    1          1
              10.0
    2       CONS
0.0        0.0          0.0
```

```
    1
SAMPLE PROBLEM NO. 5
SPHERICAL SHELL WITH VARYING THICKNESS PROPERTIES.
THE STRUCTURE IS UNDER A UNIFORM PRESSURE DISTRIBUTED
OVER A CIRCULAR AREA OF THREE INCHES RADIUS.
THE CENTER OF THE CIRCULAR AREA WHERE THE LOADING IS APPLIED
IS LOCATED AT TEN INCHES FROM THE CENTER OF THE SHELL AND AT 45
DEGREES FROM THE ORIGIN(THETA 0.0).
         (BLANK CARD)
   4   4   8  20  29   1   4                3  3SAM5
APOL          45.0      10.0      3.0      -10.0
    0.0       30.0     120.0    270.0
         (BLANK CARD)
   20.0                 20.0
    3
    5   30.0
    5  10.0
   10  50.0
         1   20             3
    0.0       0.1       30.0      0.2      120.0      0.1
CONS     1   20 30000000.
CONS     1   20  0.3
   20
   20                       1    1    1    1
```

```
    1
SAMPLE PROBLEM NO. 6
SOLVE THE SHELL STRUCTURE OF SAMPLE PROBLEM NO. 5 WITH NEW LOADING.
THE CENTER OF THE CIRCULAR AREA WHERE THE LOADING IS APPLIED IS
MOVED TO THE ORIGIN(THETA = 0.0)
CALCULATE DISPLACEMENTS AT 6 ANGLES ALONG THE CIRCUMFERENCE
         (BLANK CARD)
   4    4    8  20   29    1    6                  3  3SAM6RRUN
APOL            0.0         10.0       3.0       -10.0
    C.0         30.0       120.0     180.0       225.0      270.0
```

```
    1
SAMPLE PROBLEM NO. 7
THE STRUCTURE IS A COMBINATION OF A SPHERICAL CAP AND A CYLINDER.
THE SHELL IS SUBJECTED TO A UNIFORM INTERNAL PRESSURE.
         (BLANK CARD)
   1         8  50  29   3   1                     SAM7
         (BLANK CARD)
0.0
         (BLANK CARD)
    10.0                10.0
    4
   10   80.0
   15   10.0       1
   15   12.0
   10   38.0
CONS     1    50  0.08
CONS     1    50 30000000.
CONS     1    50  0.3
   25   26    50
   25                        1
   26         1
   50                   1    1    1    1
    1    1CONS
              10.0
```

APPENDIX B

LISTING OF THE COMPUTER PROGRAM FOR THE LINEAR ANALYSIS

```
      COMMON /A3/ NDP,NET,IXX(17)
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES,HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
      COMMON /B30/ NA,NB
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50)
      COMMON /G1/ APPO,THELO,RC,RL,PR
      COMMON /G2/ NCE(50),NAET(50),THETA(50,51),THICKC(50,51)
      COMMON /G4/ ONED(51,68)
      DOUBLE PRECISION ONED
      INTEGER PROBLE,RERUN,RRUN,APOL
      INTEGER APPO
      INTEGER REST
      DATA RERUN/4HRRUN/
      IDISPL=0
      READ(5,101)NPROBL
  101 FORMAT(I5)
      DO 100 IPROBL=1,NPROBL
      CALL TABLES
      CALL STIFOR
      IF(PROBLE.NE.RERUN)CALL DISPLA
      IF(PROBLE.EQ.RERUN)CALL DISPL1
      CALL STRESS
  100 CONTINUE
      IF(ISAVE.EQ.0)PRINT 102,ISCRA3
  102 FORMAT(46X,41HS A V E   T A P E   L O G I C A L   U N I T I2)
      STOP
      END
      SUBROUTINE TABLES
      COMMON /A3/ NDP,NET,IXX(17)
```

```
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES,HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
      COMMON /B30/ NA,NB
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50)
      COMMON /G1/ APPO,THELO,RC,RL,PR
      COMMON /G2/ NCE(50),NAET(50),THETA(50,51),THICKC(50,51)
      DIMENSION THET(51),THI(51)
      DIMENSION RK(4),RRRE(4)
      DIMENSION TITL(40)
      REAL IXED
      INTEGER PROBLE,RERUN,RRUN,APOL
      INTEGER APPO
      INTEGER CONS
      INTEGER TITL
      INTEGER REST
      INTEGER BLAN
      INTEGER CONST
      INTEGER SAND
      DATA SAND/4HSAND/
      DATA CONST/4HCONS/
      DATA RREST1/4HIXED/,RREST2/3HREE/
      DATA NAME/2H  /
      DATA BLAN/4H    /
      DATA RERUN/4HRRUN/
      NTAPE=1
      ISCRA1=2
      IPAGE = 1
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
  604 FORMAT(1H1,62X,4HPAGEI3///)
```

```
      WRITE(6,605)
  605 FORMAT(56X,20HGENERAL  INFORMATION////)
      DO 600 I =1,20
      READ(5,601)(TITL(J),J=1,40)
  601 FORMAT(40A2)
      IF(TITL(1).EQ.NAME)GO TO 603
      WRITE(6,602)(TITL(J),J=1,40)
  602 FORMAT(26X,40A2///)
  600 CONTINUE
  603 WRITE(6,620)
  620 FORMAT(1H0.55X,20H********************/)
      WRITE(6,621)
  621 FORMAT(59X,14H**************/)
      WRITE(6,622)
  622 FORMAT(63X,6H******)
      READ(5,8)IA,IB,ISCRA3,NELEMS,NET,NEREST,NUNKTH,NAMES,HS,NA,NB,
     1IDEN,PROBLE,ISAVE
      READ(5,9)APPO,THELO,RC,RL,PR
    9 FORMAT(A4,6X,4F10.0)
      READ(5,66)(XTHETA(I),I=1,NUNKTH)
   66 FORMAT(8F10.0)
      NH = IA + IB
    8 FORMAT(7I4,A4,F10.0,2I3,2A4,I1)
      IF(PROBLE.EQ.RERUN)WRITE(6,450)IDEN
      IF(PROBLE.EQ.RERUN)RETURN
      REWIND ISCRA1
      REWIND ISCRA3
      WRITE(6,401)IDEN
  401 FORMAT(1H0,54X,22HP  R  O  B  L  E  M   A4)
  450 FORMAT(1H0,28X,31HR E R U N  O F  P R O B L E M  A4,38H  W I T H
     1N E W  F O R C E  I N P U T)
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
      WRITE(6,300)
  300 FORMAT(54X,23HN O M E N C L A T U R E///)
      WRITE(6,301)
  301 FORMAT(16X,40HZ            ***** SHELL AXIAL COORDINATE/)
```

```
      WRITE(6,302)
  302 FORMAT(16X,54HR            ***** SHELL RADIAL COORDINATE(CYLINDRICA
     1L)/)
      WRITE(6,303)
  303 FORMAT(16X,56HE            ***** MODULUS OF ELASTICITY OF SHELL ELE
     1MENT/)
      WRITE(6,304)
  304 FORMAT(16X,50HNU           ***** POISSON,S RATIO OF SHELL ELEMENT/
     1)
      WRITE(6,305)
  305 FORMAT(16X,63HPHI          ***** ANGLE BETWEEN MERIDIAN AND AXIS OF
     1 REVOLUTION/)
      WRITE(6,306)
  306 FORMAT(16X,98HE(S)         ***** STRAIN OF THE MIDDLE SURFACE OF TH
     1E SHELL ELEMENT ALONG THE MERIDIONAL DIRECTION/)
      WRITE(6,307)
  307 FORMAT(16X,103HE(THETA)     ***** STRAIN OF THE MIDDLE SURFACE OF T
     1HE SHELL ELEMENT ALONG THE CIRCUMFERENTIAL DIRECTION/)
      WRITE(6,308)
  308 FORMAT(16X,94HE(S-THETA)   ***** STRAIN OF THE MIDDLE SURFACE OF TH
     1E SHELL ELEMENT ALONG THE NORMAL DIRECTION/)
      WRITE(6,309)
  309 FORMAT(16X,83HK(S)         ***** CURVATURE CHANGE OF THE SHELL ELEM
     1ENT SURFACE IN MERIDIONAL PLANE/)
      WRITE(6,310)
  310 FORMAT(16X,110HK(THETA)     ***** CURVATURE CHANGE OF THE SHELL ELE
     1MENT SURFACE IN THE PLANE PERPENDICULAR TO MERIDIONAL PLANE/)
      WRITE(6,311)
  311 FORMAT(16X,52HK(S-THETA)   ***** TWIST OF THE SHELL ELEMENT SURFACE
     1/)
      WRITE(6,312)
  312 FORMAT(16X,84HN(S)         ***** NORMAL FORCE PER UNIT LENGTH OF CI
     1RCUMFERENTIAL SECTION OF A SHELL/)
      WRITE(6,313)
  313 FORMAT(16X,79HN(THETA)     ***** NORMAL FORCE PER UNIT LENGTH OF ME
     1RIDIONAL SECTION OF A SHELL/)
      WRITE(6,314)
```

```
314 FORMAT(16X,108HN(S-THETA)   ***** SHEARING FORCE PER UNIT LENGTH OF
   1 CIRCUMFERENTIAL SECTION OR MERIDIONAL SECTION OF A SHELL/)
    WRITE(6,315)
315 FORMAT(16X,86HM(S)          ***** BENDING MOMENT PER UNIT LENGTH OF
   1CIRCUMFERENTIAL SECTION OF A SHELL/)
    WRITE(6,316)
316 FORMAT(16X,81HM(THETA)      ***** BENDING MOMENT PER UNIT LENGTH OF
   1MERIDIONAL SECTION OF A SHELL/)
    WRITE(6,317)
317 FORMAT(16X,109HM(S-THETA)   ***** TWISTING MOMENT PER UNIT LENGTH O
   1F CIRCUMFERENTIAL SECTION OR MERIDIONAL SECTION OF A SHELL/)
    WRITE(6,318)
318 FORMAT(16X,95HQ(S)          ***** SHEARING FORCE NORMAL TO THE SHELL
   1 PER UNIT LENGTH OF CIRCUMFERENTIAL SECTION/)
    WRITE(6,319)
319 FORMAT(16X,90HQ(THETA)      ***** SHEARING FORCE NORMAL TO THE SHELL
   1 PER UNIT LENGTH OF MERIDIONAL SECTION/)
    WRITE(6,620)
    WRITE(6,621)
    WRITE(6,622)
    DO 800 I=1,NELEMS
    DO 801 J=1,8
    REST(I,J) = 0
801 CONTINUE
800 CONTINUE
    READ(5,510)Z1(1),Z2(1),RO1(1),RO2(1),PHY1(1),PHY2(1)
510 FORMAT(6F12.5)
    IF(PHY2(1).EQ.0.)GO TO 521
    RCAP=0.
    DO 522 J=2,NELEMS
522 READ(5,510)Z1(J),Z2(J),RO1(J),RO2(J),PHY1(J),PHY2(J)
    GO TO 354
521 CONTINUE
    READ(5,3)RCAP,RFILET,RMAX,ZMAX
    J = 1
    TCR = 0
    CALL WEH2(PHY1,PHY2,J,TCR)
```

```
      NNODES = NELEMS + 1
      DO 54 I=1,NNODES
      CALL WEH3(I,NP,CORD,RADIUS,PHY2,J,NNODES,RCAP,RFILET,RMAX,ZMAX)
      IF(I.EQ.NNODES)GO TO 56
      Z1(I) = CORD
      RO1(I) = RADIUS
      IF(I.EQ.1)GO TO 54
   56 Z2(I -1) = CORD
      RO2(I - 1) = RADIUS
   54 CONTINUE
  354 IELT=0
  252 READ(5,2)NAMET,IEL1,IEL2,THIK,NC
    2 FORMAT(A4,1X,2I5,F10.0,I5)
      IF(NAMET.NE.CONST)GO TO 250
      IF(IEL1.NE.0.AND.IEL2.NE.0)GO TO 781
      IEL1=1
      IEL2=1
  781 DO 251 I=IEL1,IEL2
      IELT=IELT+1
      NCE(I)=1
      NAET(I)=NAMET
      THETA(I,1)=0.
      THICKC(I,1)=THIK
  251 CONTINUE
      IF(IELT.NE.NELEMS)GO TO 252
      GO TO 253
  250 READ(5,98)(THET(I),THI(I),I=1,NC)
      IF(IEL1.EQ.0)IEL1=IELT+1
      IF(IEL2.EQ.0)IEL2=IELT+1
      DO 780 J=IEL1,IEL2
      NCE(J)=NC
      NAET(J)=NAMET
      DO 460 JE=1,NC
      THETA(J,JE)=THET(JE)
      THICKC(J,JE)=THI(JE)
  460 CONTINUE
  780 IELT=IELT+1
```

```
      IF(IELT.NE.NELEMS)GO TO 252
  253 CONTINUE
   98 FORMAT(8F10.0)
      IELT = 0
  262 READ(5,2)NAM,IEL1,IEL2,EM(IEL1)
      IF(NAM.NE.CONST)GO TO 260
      DO 261 I=IEL1,IEL2
      EM(I) = EM(IEL1)
  261 CONTINUE
      IELT = IEL2
      GO TO 265
  260 IELT = IELT + 1
      EM(IELT) = EM(IEL1)
  265 IF(IELT.NE.NELEMS)GO TO 262
      IELT = 0
  272 READ(5,2)NAM,IEL1,IEL2,POISSO(IEL1)
      IF(NAM.NE.CONST)GO TO 270
      DO 271 I=IEL1,IEL2
      POISSO(I) = POISSO(IEL1)
  271 CONTINUE
      IELT = IEL2
      GO TO 275
  270 IELT = IELT + 1
      POISSO(IELT) = POISSO(IEL1)
  275 IF(IELT.NE.NELEMS)GO TO 272
    3 FORMAT(8F10.0)
      LINES = 0
      DO 612 J=1,NELEMS
      IF(J.NE.1.AND.LINES.LT.24)GO TO 609
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
      LINES = 0
      WRITE(6,606)
  606 FORMAT(44X,45HELASTIC AND GEOMETRIC PROPERTIES OF STRUCTURE /)
      WRITE(6,607)
  607 FORMA  15X,7HELEMENT,8X,4HNODE,12X,11HCOORDINATES,18X 17HEL  TIC C
     1ONST   S/)
```

```
      WRITE(6,608)
  608 FORMAT(17X,3HNO.,10X,4HNOS.,10X,1HZ,13X,1HR,17X,1HE,12X,2HNU,18X,3
     1HPHI///)
  609 JJ = J + 1
      WRITE(6,610)J,J,Z1(J),RO1(J),EM(J),POISSO(J),PHY1(J),JJ,Z2(J),
     1RO2(J),PHY2(J)
      LINES = LINES + 1
  610 FORMAT(17X,I2,12X,I2,5X,E12.5,3X,E12.5,5X,E12.5,2X,E12.5,9X,E12.5/
     1(31X,I2,5X,E12.5,3X,E12.5,40X,E12.5))
  612 CONTINUE
    1 FORMAT(10I5)
      WRITE(6,400)IA,NET,IB
  400 FORMAT(1H0,16X,23HNUMBER OF A HARMONICS =I3,9X,28HNUMBER OF SIMPSO
     1N STATIONS =I3,8X,23HNUMBER OF B HARMONICS =I3)
      IF(RCAP.EQ.0.)GO TO 501
      WRITE(6,500)RCAP
  500 FORMAT(48X,30HRADIUS  OF  SPHERICAL  SHELL =F8.3)
  501 WRITE(6,620)
      WRITE(6,621)
      WRITE(6,622)
      READ(5,1)(IELRES(I),I=1,NEREST)
      DO 200 I=1,NEREST
      READ(5,1) J,(REST(J,IJ),IJ=1,8)
  200 CONTINUE
      DO 5555 IEL=1,NELEMS
      NAMET=NAET(IEL)
      NC=NCE(IEL)
      THETA(IEL,NC+1)=360.
      IF(IEL.EQ.1)LLINES=54
      IIFLAG=0
      NCCP=NC
      JJFLAG=0
      IC=0
  717 NCP=NCCP - 4
      IF(NCP)701,701,702
  702 NCP1=IC*4 + 1
      NCP2 = NCP1 + 3
```

```
      IC = IC + 1
      GO TO 703
  701 NCP1 = IC*4 + 1
      NCP2 = NC
      IIFLAG = 1
  703 IF(LLINES.LT.54)GO TO 704
      LLINES = 0
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
      JJFLAG = 0
      WRITE(6,706)
      IF(NAMES.NE.SAND)GO TO 7777
      WRITE(6,7778)HS
 7778 FORMAT(31X,44HSANDWICH TYPE SHELL WITH FACE SHEETS SPACED F7.3,1X,
     13HIN ,15HFROM EACH OTHER/)
      WRITE(6,7779)
 7779 FORMAT(43X,46HTHICKNESSES OF EACH FACE SHEET ARE GIVEN BELOW//)
 7777 CONTINUE
      LLINES = LLINES + 8
  706 FORMAT(56X,20HTABLE OF THICKNESSES/)
  704 CONTINUE
      IF(NC.NE.1)GO TO 716
      WRITE(6,2000)IEL,THICKC(IEL,1)
 2000 FORMAT(1H0,32X,12HELEMENT NO. I3,20X,21HCONSTANT  THICKNESS =F10.5
     1//)
      LLINES = LLINES + 4
      GO TO 2001
  716 IF(JJFLAG.EQ.0)WRITE(6,710)IEL
  710 FORMAT(60X,12HELEMENT NO. I3/)
      LLINES = LLINES + 2
      IF(NAMET.NE.BLAN)GO TO 2002
      WRITE(6,2003)(THETA(IEL,IY),THETA(IEL,IY+1),IY=NCP1,NCP2)
      WRITE(6,709)(THICKC(IEL,IY),IY=NCP1,NCP2)
      GO TO 2004
 2003 FORMAT(1H0,5HTHETA,9H(DEGREES),3X,4(3X,F10.5,4H TO ,F10.5))
 2002 WRITE(6,708)(THETA(IEL,IY),IY=NCP1,NCP2)
      WRITE(6,709)(THICKC(IEL,IY),IY=NCP1,NCP2)
```

```
  708 FORMAT(1H0,5HTHETA,9H(DEGREES),12X,F10.5,3(17X,F10.5))
  709 FORMAT(1X,9HTHICKNESS,4(17X,F10.5))
 2004 LLINES = LLINES + 3
      NCCP= NCP
      JJFLAG = 1
      IF(IIFLAG.EQ.0)GO TO 717
 2001 CONTINUE
 5555 CONTINUE
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
      WRITE(6,900)
  900 FORMAT(56X,20HBOUNDARY  CONDITIONS///)
      WRITE(6,901)
  901 FORMAT(50X,32HDISPLACEMENT COMPONENTS OF NODES/////)
      WRITE(6,902)
  902 FORMAT(23X,8HNODE NO.,10X,5HAXIAL,12X,10HTANGENTIAL,11X,6HRADIAL,
     112X,7HANGULAR////)
      DO 903 IRE=1,NELEMS
      JISE = 0
      DO 904 ISE=1,4
      RK(ISE)= 0.
      IF(REST(IRE,ISE).EQ.0)GO TO 904
      RK(ISE)=1.
      JISE=1
  904 CONTINUE
      IF(JISE.EQ.0)GO TO 903
      DO 905 ISE=1,4
      RRRE(ISE)=RREST2
      IF(RK(ISE).EQ.1.)RRRE(ISE)=RREST1
  905 CONTINUE
      WRITE(6,906)IRE,(RRRE(ISE),ISE=1,4)
  906 FORMAT(26X,I2,13X,1HF,A4,15X,1HF,A4,14X,1HF,A4,13X,1HF,A4/)
  903 CONTINUE
      JISE = 0
      DO 907 ISE=1,4
      RK(ISE)=0.
      ISEE=ISE + 4
```

```
      IF(REST(NELEMS,ISEE).EQ.0)GO TO 907
      RK(ISE)=1.
      JISE = 1
  907 CONTINUE
      IF(JISE.EQ.0)GO TO 908
      DO 909 ISE=1,4
      RRRE(ISE)=RREST2
      IF(RK(ISE).EQ.1.)RRRE(ISE)=RREST1
  909 CONTINUE
      INEL = NELEMS + 1
      WRITE(6,906)INEL,(RRRE(ISE),ISE=1,4)
  908 CONTINUE
      WRITE(6,910)
  910 FORMAT(1H0,47X,36HALL OTHER NODES ARE FREE TO DISPLACE//)
      WRITE(6,620)
      WRITE(6,621)
      WRITE(6,622)
      RETURN
      END
      SUBROUTINE WEH2(P1,P2,J,TCR)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      DIMENSION P1(50),P2(50)
      READ (5,21) NPARTS
      READ (5,21) NE1,T1,NCYLIN
   21 FORMAT (I5,F10.0,I5)
      NP=1
      XE1=NE1
      H=T1/XE1
      P1(1)=90.0
      P2(1)=90.0-H
      DO 31 I=2,NE1
      XI=I
      P1(I)=P2(I-1)
   31 P2(I)=90.0-H*XI
      IF (NPARTS-1) 35,35,32
   32 READ (5,21) NE2,T2,NCYLIN
      IF (NCYLIN) 2,1,2
```

```
    1 NP=NP+1
      XE2=NE2
      H=T2/XE2
      DO 33 I=1,NE2
      XI=I
      J=NE1+I
      P1(J)=P2(J-1)
      P2(J)=P2(NE1)-H*XI
      IF (ABS(P2(J)-TCR)-0.005) 37,37,33
   37 P2(J)=TCR
   33 CONTINUE
      IF (NP-NPARTS) 34,35,35
   34 NE1=NE1+NE2
      GO TO 32
    2 J=NELEMS-NE2+1
      P2(J-1)=T2
      DO 101 K=J,NELEMS
      P1(K)=0.0
  101 P2(K)=0.0
      GO TO 36
   35 J=NELEMS+2
   36 RETURN
      END
      SUBROUTINE WEH3(I,N,C,R,P,J,NNODES,RCAP,RFILET,RMAX,ZMAX)
      DIMENSION P(50)
      TCR=ARCOS((RMAX-RFILET)/(RCAP-RFILET))
      N=I
      IF (I-1) 1,1,2
    1 C=0.0
      R=1.E-6
      K=J
      CKEEP=RCAP-(RCAP-RFILET)*SIN(TCR)
      GO TO 11
    2 IF (I-J) 3,4,4
    3 T=P(I-1)/57.2957795
      IF (T-TCR) 6,5,5
    5 R=RCAP*COS(T)
```

```
      C=RCAP-RCAP*SIN(T)
      GO TO 11
    6 R=(RMAX-RFILET)+RFILET*COS(T)
      C=RCAP-(RCAP-RFILET)*SIN(TCR)-RFILET*SIN(T)
      GO TO 11
    4 R=RMAX
      IF (I-K) 7,7,9
    7 IF (I-NNODES) 8,9,9
    8 READ (5,21) NE1,S1
   21 FORMAT (I5,F10.0)
      XE1=NE1
      H=S1/XE1
    9 XI=I-K
      C=CKEEP+H*XI
      IF (I-K-NE1+1) 11,10,10
   10 CKEEP=CKEEP+S1
      K=I+1
   11 RETURN
      END
      SUBROUTINE STIFOR
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A2/ ONE(68),TWO(68)
      COMMON /A3/ NDP,NET,IXX(17)
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B1/ AL(157)
      COMMON /B2/ AR (30), AS(30), PHP(30), SINE(30), COSINE(30)
      COMMON /B3/ PHPP
      COMMON /B4/ F(8,8)
      COMMON /B5/ISIMP
      COMMON /B6/ AK(8,8)
      COMMON /B7/ PHIMAT(8,8)
      COMMON /B8/ CHECK (8,8)
      COMMON /B9/ IA,IB
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B15/ IELL,NDPP,IXXX(17),LINEL,ICON,ICOO,NSTOP
      COMMON /B18/ NAMES,HS
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      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
      COMMON /B30/ NA,NB
      COMMON /C40/ IPRI
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50)
      COMMON /G1/ APPO,THELO,RC,RL,PR
      COMMON /G2/ NCE(50),NAET(50),THETA(50,51),THICKC(50,51)
      COMMON /G4/ ONED(51,68)
      DOUBLE PRECISION FKK(9316),AAK(8,8)
      DOUBLE PRECISION ONED
      DIMENSION RK(4),RRRE(4)
      DIMENSION TA(2,50)
      INTEGER REST
      INTEGER PROBLE,RERUN,RRUN,APOL
      INTEGER APPO
      INTEGER END
      INTEGER SAND
      DATA RERUN/4HRRUN/
      DATA SAND/4HSAND/
      DATA END/3HEND/
      IPRI=0
      ISIMP = 0
C             EM= MODULUS OF ELASTICY OF SHELL ELEMENT
C             POISSO = POISSON,S RATIO OF SHELL ELEMENT
C             ISOTROPIC SHELL ELEMENT ONLY
C             IELRES IDENTIFIES WHICH NODE IS RESTRAINED
C             REST NOT EQUAL TO ZERO RESTRAINS NODE DISPLACEMENT COMPONENT
C             IA = NO. OF A HARMONICS
C             IB = NO. OF B HARMONICS
C             NTAPE = BIN TAPE WITH STIFFNESS MATRIX
C             NTAPEF = BIN TAPE WITH FORCE MATRIX
C             ISCRA1,ISCRA2=BIN SCRATCH TAPES
C             NELEMS = NO. OF ELEMENTS
C             NEREST = NO. OF RESTRAINED NODES
C             TOTAL NUMBER OF A AND B HARMONICS - NH
```

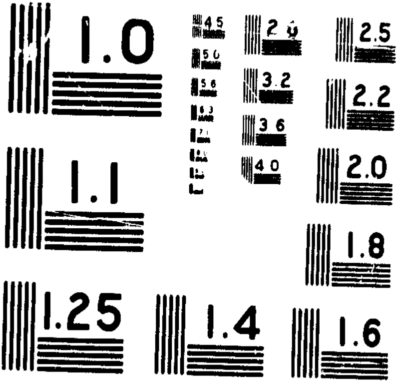
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
3.2
3.6
4.0
4.5
5.0

```
      N = 4*NH
      DO 40 I=1,N
      ONE(I) = 0.0
      TWO(I) = 0.0
   40 CONTINUE
      LINEL = 0
      ICOO=1
      IF(PROBLE.EQ.RERUN)GO TO 613
      REWIND NTAPE
C              NUMBER OF ELEMENTS IN EACH TRIANGLE OF FKK - NN
      IF(ISAVE.EQ.0)WRITE(ISCRA3)NEREST,(IELRES(I) ,I=1,NEREST),
     1((REST(J,K),K=1,8),J=1,NELEMS),(EM(IS),POISSO(IS),IS=1,NELEMS)
      NN = N*(N+1)/2
C              INDEX OF FIRST ELEMENT OF FKK SQUARE - N1
      N1 = 2*NN + 1
C              INDEX OF LAST ELEMENT OF FKK SQUARE - N2
      N2 = 2*NN + N*N
C              INITIALIZE UPPER TRIANGLE OF FKK
      DO 10 I=1,NN
      FKK(I) = 0.0
   10 CONTINUE
      DO 34 IEL=1,NELEMS
C              OBTAIN AR, AS, PHP, SINE, PHPP, AND COSINE FOR EACH ELEMENT
      CALL ELEMCA (RO1(IEL),RO2(IEL),PHY1(IEL),PHY2(IEL),Z1(IEL),
     1Z2(IEL),DS,IEL)
C              CALL CRETAL TO OBTAIN AL ARRAY
      CALL CRETAL(DS,IEL)
      NAMET=NAET(IEL)
      NC=NCE(IEL)
      IF(ISAVE.EQ.0)WRITE(ISCRA3)NCE(IEL),NAET(IEL)
      DO 300 I=1,NC
  300 THETA(IEL,I)=THETA(IEL,I)/57.2957795
      THETA(IEL,NC+1)=6.28318531
      IF(ISAVE.EQ.0)WRITE(ISCRA3)(THETA(IEL,I),THICKC(IEL,I),I=1,NC)
      THICKC(IEL,NC+1)=THICKC(IEL,1)
      PI=3.14159265
      IFO=NA+NB+1
```

```
      DO 731 I1=1,IFO
      TA(1,I1)=0.
  731 TA(2,I1)=0.
      IEXPT=1
      DO 701 I2=1,2
      SUM1=0.
      DO 700 I1=1,NC
  700 SUM1=SUM1+THICKC(IEL,I1)**IEXPT*(THETA(IEL,I1+1)-THETA(IEL,I1))
      TA(I2,1)=SUM1/(2.*PI)
      IF(NC.EQ.1)GO TO 730
      IF(NA.EQ.0)GO TO 740
      DO 702 I1=1,NA
      SUM2=0.
      HII=I1
      DO 703 I3=1,NC
      X=THETA(IEL,I3)
      XX=THETA(IEL,I3+1)
  703 SUM2=SUM2+THICKC(IEL,I3)**IEXPT*(SIN(HII*XX)-SIN(HII*X))
  702 TA(I2,I1+1)=SUM2/(HII*PI)
  740 IF(NB.EQ.0)GO TO 730
      DO 704 I1=1,NB
      SUM3=0.
      HII=I1
      DO 705 I3=1,NC
      X=THETA(IEL,I3)
      XX=THETA(IEL,I3+1)
  705 SUM3=SUM3+THICKC(IEL,I3)**IEXPT*(COS(HII*XX)-COS(HII*X))
      I4=NA+I1+1
  704 TA(I2,I4)=-SUM3/(HII*PI)
  730 IF(NAMES.EQ.SAND)GO TO 706
      IEXPT=3
  701 CONTINUE
  706 IF(NAMES.NE.SAND)GO TO 715
      DO 717 I1=1,IFO
  717 TA(2,I1)=TA(1,I1)
  715 CONTINUE
      DO 32 I=1,NH
```

```
      DO 32 J=I,NH
C             FOLLOWING DETERMINES WHICH VALUES FOR AM AND AN ARE TO BE USED
      IF (I.GT.IA.OR.J.GT.IA) GO TO 12
      M1= I - 1
      N3= J - 1
      MI=M1+1
      NI=N3+1
      KEY1=0
      GO TO 16
   12 IF (I.LE.IA) GO TO 14
      M1= - (I - IA - 1)
      N3= - (J - IA - 1)
      MI=-M1+1
      NI=-N3+1
      KEY1=2
      GO TO 16
   14 M1= I - 1
      N3= - (J - IA - 1)
      MI=M1+1
      NI=-N3+1
      KEY1=1
   16 HM = M1
      HN = N3
      SIMP1=0.
      SIMP2=0.
      SIMP3=0.
      SIMP4=0.
      IF((MI-1).EQ.(NI-1).AND.(MI-1).EQ.0.AND.KEY1.NE.1)GO TO 742
      IF((MI-1).EQ.(NI-1).AND.(MI-1).NE.0.AND.KEY1.NE.1)GO TO 744
      GO TO 741
  742 IF(KEY1.EQ.0)GO TO 760
      SIMP3=TA(1,1)*2.0*PI
      SIMP4=TA(2,1)*2.0*PI
      GO TO 741
  760 SIMP1=TA(1,1)*2.0*PI
      SIMP2=TA(2,1)*2.0*PI
      GO TO 741
```

```
744 SIMP1=TA(1,1)*PI
    SIMP2=TA(2,1)*PI
    SIMP3=SIMP1
    SIMP4=SIMP2
741 IF(NC.EQ.1)GO TO 311
    I2=NA
    I3=1
    IF(I2.NE.0)GO TO 747
    I3=2
    I2=NB
747 DO 745 I1=1,I2
    IF((NI+MI).NE.(I1+2).AND.IABS(NI-MI).NE.I1)GO TO 745
    IF(KEY1.NE.1)GO TO 750
    CALL INTE(MI,I1+1,NI,I3,SIM1)
    CALL INTE(I1+1,NI,MI,I3,SIM2)
    IF(I3.EQ.1)GO TO 751
    ASIM1=SIM1
    SIM1=SIM2
    SIM2=ASIM1
    GO TO 751
750 CALL INTE(MI,NI,I1+1,KEY1+I3-1,SIM1)
    CALL INTE(MI,NI,I1+1,1-KEY1+I3,SIM2)
751 II1=NA*(I3-1)+I1+1
    SIMP1=SIMP1+TA(1,II1)*SIM1
    SIMP2=SIMP2+TA(2,II1)*SIM1
    SIMP3=SIMP3+TA(1,II1)*SIM2
    SIMP4=SIMP4+TA(2,II1)*SIM2
745 CONTINUE
    IF(I3.EQ.2)GO TO 311
    IF(NB.EQ.0)GO TO 311
    I3=2
    I2=NB
    GO TO 747
311 IF(NAMES.NE.SAND)GO TO 314
    SIMP1=2.*SIMP1
    SIMP3=2.*SIMP3
    SIMP2=SIMP2*6.0*HS**2
```

```
      SIMP4=SIMP4*6.0*HS**2
  314 E1=EM(IEL)
      FNU1=POISSO(IEL)
      E2=E1
      GXX=E1/(2.*(1.+FNU1))
      CONST1=E1/(1.-FNU1*FNU1)
      CC1=CONST1*SIMP1
      CC=2.*CONST1*FNU1*SIMP1
      DD1=CONST1*SIMP2/12.
      DD=CONST1*FNU1*SIMP2/6.
      GG1=GXX*SIMP3
      GG2=GXX*SIMP4/12.0
C             CALL SUBROUTINE TO GET FL - AN 8X8 MATRIX
      CALL CREATL(HM,HN,CC1,CC1,CC,DD1,DD1,DD,GG1,GG2)
C             CALL SUBROUTINE TO PRE AND POST MULTIPLY FL TO GET AK
      CALL MMPLT3
C******INTRODUCE BOUNDARY CONDITIONS
      DO 110 IR=1,NEREST
      IF(IELRES(IR).NE.IEL)GO TO 110
      DO 101 JR=1,8
      IF(REST(IEL,JR).EQ.0)GO TO 101
      DO 102 JRR=1,8
      AK(JR,JRR)=0.
      AK(JRR,JR)=0.
  102 CONTINUE
      IF(I.EQ.J)AK(JR,JR)=1.
  101 CONTINUE
  110 CONTINUE
      DO 481 L=1,8
      DO 482 M=1,8
      AAK(L,M)=AK(L,M)
  482 CONTINUE
  481 CONTINUE
C             THE FOLLOWING TAKES EACH ELEMENT OF AK AND PUTS IT IN
C                THE PROPER LOCATION OF FKK
      DO 30 L=1,8
      DO 30 M=1,8
```

```
      IF (I.NE.J) GO TO 18
      IF (L.GT.M) GO TO 30
   18 IF (L.GT.4.OR.M.GT.4) GO TO 20
C             ELEMENT IS IN UPPER LEFT 4X4 OF AK MATRIX.
C             THUS, STORE IN 1ST TRIANGLE OF FKK(I1), I1=1,NN
      INDEX = 4*(I-1) + L
      JNDEX = 4*(J-1) + M
C             SINGLE INDEX OF FKK - KNDEX
      KNDEX = JNDEX*(JNDEX-1)/2 + INDEX
C            ADD 2CD TRIANGLE OF PREVIOUS ELEMENT TO FIRST OF THIS ELEMENT
      FKK(KNDEX)=FKK(KNDEX)+AAK(L,M)
      GO TO 30
   20 IF (L.LE.4.OR.M.LE.4) GO TO 22
C             ELEMENT IS IN LOWER RIGHT 4X4 OF AK MATRIX
C             THUS, STORE IN 2CD TRIANGLE OF FKK(I1),I1=NN+1,2*NN
      INDEX = 4*(I-2) + L
      JNDEX = 4*(J-2) + M
C             SINGLE INDEX OF FKK - KNDEX
      KNDEX = NN + JNDEX*(JNDEX-1)/2 + INDEX
      GO TO 28
   22 IF (M.GT.L) GO TO 24
C             ELEMENT IS IN LOWER LEFT 4X4 OF AK MATRIX.
C             IF ALONG I=J DIAGONAL, DO NOT NEED
C             OTHERWISE, TAKE TRANSPOSE AND STORE IN SQUARE OF
C               FKK(I1), I1=2*NN+1,2*NN+N*N
      INDEX = 4*(J-1) + M
      JNDEX = 4*(I-2) + L
      GO TO 26
   24 INDEX = 4*(I-1) + L
      JNDEX = 4*(J-2) + M
C             SINGLE INDEX OF FKK - KNDEX
   26 KNDEX = 2*NN + (JNDEX-1)*N + INDEX
   28 FKK(KNDEX)=AAK(L,M)
   30 CONTINUE
   32 CONTINUE
      DO 903 I=1,N
      I1=(I*I+I)/2
```

```
      IF(FKK(I1).EQ.0.)FKK(I1)=1.0
  903 CONTINUE
C             WRITE 1ST TRIANGLE OF FKK ON TAPE AS A RECORD
      WRITE(NTAPE)(FKK(I),I=1,NN)
C             WRITE SQUARE OF FKK ON TAPE AS A RECORD
      WRITE(NTAPE)(FKK(I),I=N1,N2)
C             STORE 2CD TRAINGLE IN FIRST
      DO 33 I=1,NN
      I1=I+NN
      FKK(I) = FKK(I1)
   33 CONTINUE
C             WRITE 2CD TRIANGLE ON TAPE ONLY IF LAST ELEMENT
      IF(IEL.NE.NELEMS)GO TO 906
      DO 907 I=1,N
      I1=(I*I+I)/2
      IF(FKK(I1).EQ.0.)FKK(I1)=1.0
  907 CONTINUE
      WRITE(NTAPE)(FKK(I),I=1,NN)
C             CALL SUBROUTINE TO CREATE RIGHT HAND SIDE
  906 CALL FORCES(IEL)
   34 CONTINUE
      IF(PROBLE.NE.RERUN)GO TO 612
  613 REWIND ISCRA3
      READ(ISCRA3)      NEREST,(IELRES(I),I=1,NEREST),((REST(J,K),K=1,8),
     1 J=1,NELEMS),(EM(IS),POISSO(IS),IS=1,NELEMS)
      DO 611 K=1,NELEMS
      READ(ISCRA3)      PHPRIM,RMID,CPMD,SPMD,PHPP,ARCL,((CHECK(I,J),
     1I=1,8),J=1,8),RO2(K)
      PHPRMI(K)=PHPRIM
      RMDI(K)=RMID
      CPDM(K)=CPMD
      SPDM(K)=SPMD
      PPPH(K)=PHPP
      ARLC(K)=ARCL
      DO 4937 IST1=1,8
      DO 4938 IST2=1,8
      CHEKC(K,IST1,IST2)=CHECK(IST1,IST2)
```

```
 4938 CONTINUE
 4937 CONTINUE
      READ(ISCRA3)A1L(K),A2L(K),A3L(K),AL157(K)
      READ(ISCRA3)NCE(K),NAET(K)
      NC=NCE(K)
      NAMET=NAET(K)
      READ(ISCRA3)(THETA(K,I),THICKC(K,I),I=1,NC)
      THETA(K,NC+1)=6.2818531
      THICKC(K,NC+1)=THICKC(K,1)
      CALL FORCES (K)
  611 CONTINUE
  612 DO 410 IR=1,NEREST
      IF(IELRES(IR).NE.NELEMS)GO TO 410
      DO 401 JR=5,8
      IF(REST(NELEMS,JR).EQ.0)GO TO 401
      DO 402 JJR=1,NH
      KR=JR+(JJR-1)*4-4
      TWO(KR)=0.
  402 CONTINUE
  401 CONTINUE
  410 CONTINUE
      NNE=NELEMS+1
      DO 480 KK=1,N
  480 ONED(NNE,KK)=TWO(KK)
C             THE TAPE CREATED IN THIS PROGRAM IN USED FOR INPUT
C                 FOR THE SOLUTION PROGRAM
      RETURN
      END
      SUBROUTINE ELEMCA(R1,R2,P1,P2,Z1,Z2,DSL,IEL)
      COMMON /A3/ NDP,NET,IXX(17)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B2/ AR (30), AS(30), PHP(30), SINE(30), COSINE(30)
      COMMON /B3/ PHPP
      COMMON /B7/ PHIMAT (8,8)
      COMMON /B8/ CHECK(8,8)
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
```

```
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50)
      DIMENSION PH(30), AM(8,8)
      DELZ = ABS (Z2-Z1)
      DELR=R2-R1
      AL=SQRT(DELR**2+DELZ**2)
      DELP=(P1-P2)/.572957795E+02
      P1=P1/.572957795E+02
      P2=P2/.572957795E+02
      IF(DELP)14,15,14
 15   ARCL=AL
      GO TO 10
 14   ARO=AL/(2.0*SIN(DELP/2.0))
      ARCL=ARO*DELP
C     COMPUTE TRANSFORMATION MATRIX
 10   DO 102 I=1,8
      DO 102 J=1,8
  102 PHIMAT(I,J)=0.0
      DO 105 I=1,3,2
      PHIMAT(I,I)=COS(P1)
 105  PHIMAT(I+1,I+1)=1.0
      PHIMAT(3,1)=SIN(P1)
      PHIMAT(1,3)=-PHIMAT(3,1)
      DO 106 I=5,7,2
      PHIMAT(I,I)=COS(P2)
 106  PHIMAT(I+1,I+1)=1.0
      PHIMAT(7,5)=SIN(P2)
      PHIMAT(5,7)=-PHIMAT(7,5)
C     COMPUTE M MATRIX
      DO 101 I=1,8
      DO 101 J=1,8
 101  AM(I,J)=0.0
      AM(1,3)=1.0
      AM(2,4)=1.0
      AM(5,1)=1.0
      AM(7,2)=1.0
      AL1=1.0/ARCL
      AL2=AL1**2
```

```
      AL3=AL2*AL1
      AM(6,1)=-AL1
      AM(8,2)=-AL1
      AM(3,3)=-3.0*AL2
      AM(4,3)=2.0*AL3
      AM(3,4)=-2.0*AL1
      AM(4,4)=AL2
      AM(6,5)=AL1
      AM(8,6)=AL1
      AM(3,7)=3.0*AL2
      AM(4,7)=-2.0*AL3
      AM(3,8)=-AL1
      AM(4,8)=AL2
C     COMPUTE ELEMENTS OF L MATRIX
      IF(DELP)8,9,8
 9    DO 7 I=1,NET
      PH(I)=P1
      PHP(I)=0.0
      COSINE(I)=COS(P1)
 7    SINE(I)=SIN(P1)
      CPMD= COSINE(I)
      SPMD=SINE(I)
      RMID=R2
      AS(1)=0.0
      IF(R1)24,40,24
   40 R1 = .1E-06
 24   CONTINUE
      ARCL=AL
      NET1=NET-1
      DP=AL/FLOAT(NET1)
      DEL=DP
      DO 52 I=2,NET
      J=I-1
 52   AS(I)=FLOAT(J)*DP
      AR(1)=R1
      DO 6 I=2,NET
 6    AR(I)=R1+AS(I)*SINE(1)
```

```
        PHPRIM=0.0                                                  1500
       PHPF=0.0                                                     1510
       GO TO 19
 8     CONTINUE                                                     1530
 28    IF(R1)29,30,29                                               1550
   30 R1 = .1E-06
 29    CONTINUE                                                     1730
       NET1=NET-1                                                   1740
       RZ = (R2-R1)/(Z2-Z1)
       PHL=ATAN(RZ)                                                 1760
       A2=(6.0*PHL-4.0*P1-2.0*P2)/ARCL                              1770
       A3=(3.0*P1+3.0*P2-6.0*PHL)/ARCL**2                           1780
       AM(4,1) = -A2/ARCL**2
       AM(4,5) = - (A2+2.*A3*ARCL)/ARCL**2
       AM(2,1) = -A2
       AM(3,1) = 2.*A2/ARCL
       AM(3,5) = (A2+2.*A3*ARCL)/ARCL
       DSL=ARCL/FLOAT(NET1)                                         1790
 42     AS(1)=0.0                                                   1830
 43     PH(1)=P1                                                    1840
       SINE(1)=SIN(P1)                                              1850
       COSINE(1)=COS(P1)                                            1860
       PHP(1)=A2                                                    1870
       NETP=(NET+1)/2                                               1950
       DO 25 I=2,NET                                                1880
       AS(I)=AS(I-1)+DSL                                            1890
       PH(I)=P1+A2*AS(I)+A3*AS(I)**2                                1900
       PHP(I)=A2+2.0*A3*AS(I)                                       1910
       SINE(I)=SIN(PH(I))                                           1920
       COSINE(I)=COS(PH(I))
       IF(I.NE.NETP)GO TO 25
       SPMD = SINE(I)
       CPMD = COSINE(I)
   25 CONTINUE
       AR(1)=R1                                                     1940
       NETL=NET1/2                                                  1960
       PHPRIM=PHP(NETP)                                             1970
```

```
      PHPP=2.0*A3
      DO 22 I=2,NETP
22    AR(I)=AR(I-1)+(SINE(I)+SINE(I-1))*DSL/2.0
      RMID = AR(NETP)
      AR(NET)=R2
      DO 53 I=1,NETL
      NN=NET-I
53    AR(NN)=AR(NN+1)-(SINE(NN+1)+SINE(NN))*DSL/2.0
   19 DO 1000 I=1,8
      DO 1000 J=1,8
      CHECK(I,J) = 0.0
      DO 1000 K=1,8
      CHECK(I,J) = AM(I,K)*PHIMAT(J,K) + CHECK(I,J)
 1000 CONTINUE
      K=IEL
      PHPRMI(K)=PHPRIM
      RMDI(K)=RMID
      CPDM(K)=CPMD
      SPDM(K)=SPMD
      PPPH(K)=PHPP
      ARLC(K)=ARCL
      DO 4937 IST1=1,8
      DO 4938 IST2=1,8
      CHEKC(K,IST1,IST2)=CHECK(IST1,IST2)
 4938 CONTINUE
 4937 CONTINUE
      IF(ISAVE.EQ.0)WRITE(ISCRA3)PHPRIM,RMID,CPMD,SPMD,PHPP,ARCL,
     1((CHECK(I,J),I=1,8),J=1,8),R2
      RETURN
       END
      SUBROUTINE CRETAL (DS,IEL)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B1/ AL(157)
      COMMON /B2/ AR (30), AS(30), PHP(30), SINE(30), COSINE(30)
      COMMON /B5/ISIMP
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A3/ NDP,NET,IXX(17)
```

```
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL15? 50)
C     INTEGRATION OF L(I,J)'S
      DO 1 I=1,NET
    1 GA(I)=AR(I)
      ISIMP = 1
      AL(1) = SIMP (DS)
      DO 2 I=1,NET
    2 G(I)=GA(I)*AS(I)
      AL(2) = SIMP (DS)
      DO 3 I=1,NET
    3 G(I)=G(I)*AS(I)
      AL(3) = SIMP (DS)
      DO 4 I=1,NET
    4 GA(I)=GA(I)*PHP(I)
      ISIMP = 1
      AL(4) = SIMP (DS)
      DO 5 I=1,NET
    5 G(I)=GA(I)*AS(I)
      AL(5  = SIMP (DS)
      DO 6 I=1,NET
    6 G(I)=G(I)*AS(I)
      AL(6) = SIMP (DS)
      DO 7 I=1,NET
    7 G(I)=G(I)*AS(I)
      AL(7) = SIMP (DS)
      DO 8 I=1,NET
    8 GA(I)=GA(I)*PHP(I)
      ISIMP = 1
      AL(8) = SIMP (DS)
      DO 9 I=1,NET
    9 G(I)=GA(I)*AS(I)
      AL(9) = SIMP (DS)
      DO 10 I=1,NET
   10 G(I)=G(I)*AS(I)
      AL(10) = SIMP (DS)
```

```
      DO 11 I=1,NET
   11 G(I)=G(I)*AS(I)
      AL(11) = SIMP (DS)
      DO 12 I=1,NET
   12 G(I)=G(I)*AS(I)
      AL(12) = SIMP (DS)
      DO 13 I=1,NET
   13 G(I)=G(I)*AS(I)
      AL(13) = SIMP (DS)
      DO 14 I=1,NET
   14 G(I)=G(I)*AS(I)
      AL(14) = SIMP (DS)
      DO 15 I=1,NET
   15 GA(I)=PHP(I)*PHP(I)*SINE(I)
      ISIMP = 1
      AL(42) = SIMP (DS)
      DO 16 I=1,NET
   16 G(I)=GA(I)*AS(I)
      AL(43) = SIMP (DS)
      DO 17 I=1,NET
   17 GA(I)=PHP(I)*SINE(I)
      ISIMP = 1
      AL(37) = SIMP (DS)
      DO 18 I=1,NET
   18 G(I)=GA(I)*AS(I)
      AL(38) = SIMP (DS)
      DO 19 I=1,NET
   19 G(I)=G(I)*AS(I)
      AL(39) = SIMP (DS)
      DO 20 I=1,NET
   20 G(I)=G(I)*AS(I)
      AL(40) = SIMP (DS)
      DO 21 I=1,NET
   21 G(I)=G(I)*AS(I)
      AL(41) = SIMP (DS)
      DO 22 I=1,NET
   22 GA(I)=PHP(I)
```

```
      ISIMP = 1
      AL(25) = SIMP (DS)
      DO 23 I=1,NET
   23 G(I)=GA(I)*AS(I)
      AL(26) = SIMP (DS)
      DO 24 I=1,NET
   24 G(I)=G(I)*AS(I)
      AL(27) = SIMP (DS)
      DO 25 I=1,NET
   25 G(I)=G(I)*AS(I)
      AL(28) = SIMP (DS)
      DO 26 I= 1,NET
   26 G(I)=G(I)*AS(I)
      AL(29) = SIMP (DS)
      DO 27 I=1,NET
   27 G(I)=GA(I)*COSINE(I)
      AL(30) = SIMP (DS)
      DO 28 I=1,NET
   28 G(I)=G(I)*AS(I)
      AL(31) = SIMP (DS)
      DO  29 I=1,NET
   29 G(I)=G(I)*AS(I)
      AL(32) = SIMP (DS)
      DO 30 I=1,NET
   30 G(I)=G(I)*AS(I)
      AL(33) = SIMP (DS)
      DO 31 I=1,NET
   31 G(I)=G(I)*AS(I)
      AL(34) = SIMP (DS)
      DO 32 I=1,NET
   32 G(I) = G(I) * AS(I)
      AL(35) = SIMP (DS)
      DO 155 I = 1,NET
  155 G(I) = G(I) * AS(I)
      AL(36) = SIMP (DS)
      DO 33 I=1,NET
   33 GA(I)=1.
```

```
      ISIMP = 1
      AL(15) = SIMP (DS)
      DO 34 I=1,NET
   34 G(I)=GA(I)*AS(I)
      AL(16) = SIMP (DS)
      DO 35 I=1,NET
   35 G(I)=GA(I)*COSINE(I)
      AL(17) = SIMP (DS)
      DO 36 I=1,NET
   36 G(I)=G(I)*AS(I)
      AL(18) = SIMP (DS)
      DO 37 I=1,NET
   37 G(I)=G(I)*AS(I)
      AL(19) = SIMP (DS)
      DO 38 I=1,NET
   38 G(I)=G(I)*AS(I)
      AL(20) = SIMP (DS)
      DO 39 I=1,NET
   39 G(I)=GA(I)*SINE(I)
      AL(21) = SIMP (DS)
      DO 40 I=1,NET
   40 G(I)=G(I)*AS(I)
      AL(22) = SIMP (DS)
      DO 41 I=1,NET
   41 G(I)=G(I)*AS(I)
      AL(23) = SIMP (DS)
      DO 42 I=1,NET
   42 G(I)=G(I)*AS(I)
      AL(24) = SIMP (DS)
      DO 43 I=1,NET
   43 GA(I)=1./AR(I)
      ISIMP = 1
      AL(44) = SIMP (DS)
      DO 44 I=1,NET
   44 G(I)=GA(I)*AS(I)
      AL(45) = SIMP (DS)
      DO 45 I=1,NET
```

```
45 G(I)=G(I)*AS(I)
   AL(46) = SIMP (DS)
   DO 46 I=1,NET
46 G(I)=G(I)*AS(I)
   AL(47) = SIMP (DS)
   DO 47 I=1,NET
47 G(I)=G(I)*AS(I)
   AL(48) = SIMP (DS)
   DO 48 I=1,NET
48 G(I)=GA(I)*COSINE(I)
   AL(49) = SIMP (DS)
   DO 49 I=1,NET
49 G(I)=G(I)*AS(I)
   AL(50) = SIMP (DS)
   DO 50 I=1,NET
50 G(I)=G(I)*AS(I)
   AL(51) = SIMP (DS)
   DO 51 I=1,NET
51 G(I)=G(I)*AS(I)
   AL(52) = SIMP (DS)
   DO 52 I=1,NET
52 G(I)=G(I)*AS(I)
   AL(53) = SIMP (DS)
   DO 53 I=1,NET
53 G(I)=GA(I)*COSINE(I)*COSINE(I)
   AL(54) = SIMP (DS)
   DO 54 I=1,NET
54 G(I)=G(I)*AS(I)
   AL(55) = SIMP (DS)
   DO 55 I=1,NET
55 G(I)=G(I)*AS(I)
   AL(56) = SIMP (DS)
   DO 56 I=1,NET
56 G(I)=G(I)*AS(I)
   AL(57) = SIMP (DS)
   DO 57 I=1,NET
57 G(I)=G(I)*AS(I)
```

```
      AL(58) = SIMP (DS)
      DO 58 I=1,NET
   58 G(I)=G(I)*AS(I)
      AL(59) = SIMP (DS)
      DO 59 I=1,NET
   59 G(I)=G(I)*AS(I)
      AL(60) = SIMP (DS)
      DO 60 I=1,NET
   60 GA(I)=GA(I)*SINE(I)
      ISIMP = 1
      AL(61) = SIMP (DS)
      DO 61 I=1,NET
   61 G(I)=GA(I)*AS(I)
      AL(62) = SIMP (DS)
      DO 62 I=1,NET
   62 G(I)=G(I)*AS(I)
      AL(63) = SIMP (DS)
      DO 63 I=1,NET
   63 G(I)=GA(I)*COSINE(I)
      AL(64) = SIMP (DS)
      DO 64 I=1,NET
   64 G(I)=G(I)*AS(I)
      AL(65) = SIMP (DS)
      DO 65 I=1,NET
   65 G(I)=G(I)*AS(I)
      AL(66) = SIMP (DS)
      DO 66 I=1,NET
   66 G(I)=G(I)*AS(I)
      AL(67) = SIMP (DS)
      DO 67 I=1,NET
   67 G(I)=G(I)*AS(I)
      AL(68) = SIMP (DS)
      DO 68 I=1,NET
   68 GA(I)=GA(I)*SINE(I)
      ISIMP = 1
      AL(69) = SIMP (DS)
      DO 69 I=1,NET
```

```
 69 G(I)=GA(I)*AS(I)
    AL(70) = SIMP (DS)
    DO 70 I=1,NET
 70 G(I)=G(I)*AS(I)
    AL(71) = SIMP (DS)
    DO 71 I=1,NET
 71 G(I)=G(I)*AS(I)
    AL(72) = SIMP (DS)
    DO 72 I=1,NET
 72 G(I)=G(I)*AS(I)
    AL(73) = SIMP (DS)
    DO 73 I=1,NET
 73 GA(I)=GA(I)*PHP(I)
    ISIMP = 1
    AL(86) = SIMP (DS)
    DO 74 I=1,NET
 74 G(I) = GA(I)*AS(I)
    AL(87) = SIMP (DS)
    DO 75 I=1,NET
 75 G(I)=G(I)*AS(I)
    AL(88) = SIMP (DS)
    DO 76 I=1,NET
 76 G(I)=G(I)*AS(I)
    AL(89) = SIMP (DS)
    DO 77 I=1,NET
 77 GA(I)=PHP(I)*SINE(I)/AR(I)
    ISIMP = 1
    AL(80) = SIMP (DS)
    DO 78 I=1,NET
 78 G(I) = GA(I) * AS(I)
    AL(81) = SIMP (DS)
    DO 156 I = 1,NET
156 G(I) = G(I) * AS(I)
    AL(82) = SIMP (DS)
    DO 79 I=1,NET
 79 G(I)=G(I)*AS(I)
    AL(83) = SIMP (DS)
```

```
      DO 80 I=1,NET
   80 G(I)=GA(I)*COSINE(I)
      AL(84) = SIMP (DS)
      DO 81 I=1,NET
   81 G(I)=G(I)*AS(I)
      AL(85) = SIMP (DS)
      DO 82 I=1,NET
   82 GA(I)=PHP(I)/AR(I)
      ISIMP = 1
      AL(74) = SIMP (DS)
      DO 83 I=1,NET
   83 G(I)=GA(I)*AS(I)
      AL(75) = SIMP (DS)
      DO 84 I=1,NET
   84 G(I)=G(I)*AS(I)
      AL(76) = SIMP (DS)
      DO 85 I=1,NET
   85 G(I)=G(I)*AS(I)
      AL(77) = SIMP (DS)
      DO 86 I=1,NET
   86 G(I)=GA(I)*COSINE(I)
      AL(78) = SIMP (DS)
      DO 87 I=1,NET
   87 G(I)=G(I)*AS(I)
      AL(79) = SIMP (DS)
      DO 88 I=1,NET
   88 GA(I)=GA(I)*PHP(I)
      ISIMP = 1
      AL(90) = SIMP (DS)
      DO 89 I=1,NET
   89 G(I)=GA(I)*AS(I)
      AL(91) = SIMP (DS)
      DO 90 I=1,NET
   90 G(I)=G(I)*AS(I)
      AL(92) = SIMP (DS)
      DO 91 I=1,NET
   91 G(I)=GA(I)*SINE(I)
```

```
      AL(93) = SIMP (DS)
      DO 92 I=1,NET
   92 G(I)=G(I)*AS(I)
      AL(94) = SIMP (DS)
      DO 93 I=1,NET
   93 G(I)=G(I)*AS(I)
      AL(95) = SIMP (DS)
      DO 94 I=1,NET
   94 G(I)=G(I)*SINE(I)
      AL(98) = SIMP (DS)
      DO 95 I=1,NET
   95 G(I)=AS(I)*PHP(I)**2*SINE(I)**2/AR(I)
      AL(97) = SIMP (DS)
      DO 96 I=1,NET
   96 G(I)=PHP(I)**2*SINE(I)**2/AR(I)
      AL(96) = SIMP (DS)
      DO 97 I=1,NET
   97 GA(I)=PHP(I)*SINE(I)/AR(I)**2
      ISIMP = 1
      AL(111) = SIMP (DS)
      DO 98 I=1,NET
   98 G(I)=GA(I)*AS(I)
      AL(112) = SIMP (DS)
      DO 99 I=1,NET
   99 G(I)=G(I)*AS(I)
      AL(113) = SIMP (DS)
      DO 100 I=1,NET
  100 G(I)=G(I)*AS(I)
      AL(114) = SIMP (DS)
      DO 101 I=1,NET
  101 G(I)=G(I)*AS(I)
      AL(115) = SIMP (DS)
      DO 102 I=1,NET
  102 G(I)=GA(I)*COSINE(I)
      AL(116) = SIMP (DS)
      DO 103 I=1,NET
  103 G(I)=G(I)*AS(I)
```

```
      AL(117) = SIMP (DS)
      DO 104 I=1,NET
  104 G(I)=G(I)*AS(I)
      AL(118) = SIMP (DS)
      DO 105 I=1,NET
  105 G(I)=GA(I)*SINE(I)
      AL(119) = SIMP (DS)
      DO 106 I=1,NET
  106 G(I)=G(I)*AS(I)
      AL(120) = SIMP (DS)
      DO 107 I=1,NET
  107 G(I)=G(I)*AS(I)
      AL(121) = SIMP (DS)
      DO 108 I=1,NET
  108 G(I)=G(I)*AS(I)
      AL(122) = SIMP (DS)
      DO 109 I=1,NET
  109 G(I)=G(I)*AS(I)
      AL(123) = SIMP (DS)
      DO 110 I=1,NET
  110 G(I)=GA(I)*SINE(I)*COSINE(I)
      AL(124) = SIMP (DS)
      DO 111 I=1,NET
  111 G(I)=G(I)*AS(I)
      AL(125) = SIMP (DS)
      DO 112 I=1,NET
  112 G(I)=G(I)*AS(I)
      AL(126) = SIMP (DS)
      DO 113 I=1,NET
  113 GA(I)=SINE(I)/AR(I)**2
      ISIMP = 1
      AL(99) = SIMP (DS)
      DO 114 I=1,NET
  114 G(I)=GA(I)*AS(I)
      AL(100) = SIMP (DS)
      DO 115 I=1,NET
  115 G(I)=G(I)*AS(I)
```

```
      AL(101) = SIMP (DS)
      DO 116 I=1,NET
  116 G(I)=G(I)*AS(I)
      AL(102) = SIMP (DS)
      DO 117 I=1,NET
  117 G(I)=G(I)*AS(I)
      AL(103) = SIMP (DS)
      DO 118 I=1,NET
  118 G(I)=G(I)*AS(I)
      AL(104) = SIMP (DS)
      DO 119 I=1,NET
  119 G(I)=GA(I)*COSINE(I)
      AL(105) = SIMP (DS)
      DO 120 I=1,NET
  120 G(I)=G(I)*AS(I)
      AL(106) = SIMP (DS)
      DO 121 I=1,NET
  121 G(I)=G(I)*AS(I)
      AL(107) = SIMP (DS)
      DO 122 I=1,NET
  122 G(I)=G(I)*AS(I)
      AL(108) = SIMP (DS)
      DO 123 I=1,NET
  123 G(I)=GA(I)*COSINE(I)*COSINE(I)
      AL(109) = SIMP (DS)
      DO 124 I=1,NET
  124 G(I)=G(I)*AS(I)
      AL(110) = SIMP (DS)
      DO 125 I=1,NET
  125 GA(I)=SINE(I)**2/AR(I)**3
      ISIMP = 1
      AL(142) = SIMP (DS)
      DO 126 I=1,NET
  126 G(I)=GA(I)*AS(I)
      AL(143) = SIMP (DS)
      DO 127 I=1,NET
  127 G(I)=G(I)*AS(I)
```

```
      AL(144) = SIMP (DS)
      DO 128 I=1,NET
  128 G(I)=G(I)*AS(I)
      AL(145) = SIMP (DS)
      DO 129 I=1,NET
  129 G(I)=G(I)*AS(I)
      AL(146) = SIMP (DS)
      DO 130 I=1,NET
  130 G(I)=G(I)*AS(I)
      AL(147) = SIMP (DS)
      DO 131 I=1,NET
  131 G(I)=G(I)*AS(I)
      AL(148) = SIMP (DS)
      DO 132 I=1,NET
  132 GA(I)=GA(I)*COSINE(I)
      ISIMP = 1
      AL(149) = SIMP (DS)
      DO 133 I=1,NET
  133 G(I)=GA(I)*AS(I)
      AL(150) = SIMP (DS)
      DO 134 I=1,NET
  134 G(I)=G(I)*AS(I)
      AL(151) = SIMP (DS)
      DO 135 I=1,NET
  135 G(I)=G(I)*AS(I)
      AL(152) = SIMP (DS)
      DO 136 I=1,NET
  136 G(I)=G(I)*AS(I)
      AL(153) = SIMP (DS)
      DO 137 I=1,NET
  137 G(I)=GA(I)*COSINE(I)
      AL(154) = SIMP (DS)
      DO 138 I=1,NET
  138 G(I)=G(I)*AS(I)
      AL(155) = SIMP (DS)
      DO 139 I=1,NET
  139 G(I)=G(I)*AS(I)
```

```
      AL(156) = SIMP (DS)
      DO 140 I=1,NET
  140 GA(I)=COSINE(I)/AR(I)**3
      ISIMP = 1
      AL(134) = SIMP (DS)
      DO 141 I=1,NET
  141 G(I)=GA(I)*AS(I)
      AL(135) = SIMP (DS)
      DO 142 I=1,NET
  142 G(I)=G(I)*AS(I)
      AL(136) = SIMP (DS)
      DO 143 I=1,NET
  143 G(I)=G(I)*AS(I)
      AL(137) = SIMP (DS)
      DO 144 I=1,NET
  144 G(I)=G(I)*AS(I)
      AL(138) = SIMP (DS)
      DO 145 I=1,NET
  145 G(I)=GA(I)*COSINE(I)
      AL(139) = SIMP (DS)
      DO 146 I=1,NET
  146 G(I)=G(I)*AS(I)
      AL(140) = SIMP (DS)
      DO 147 I=1,NET
  147 G(I)=G(I)*AS(I)
      AL(141) = SIMP (DS)
      DO 148 I=1,NET
  148 G(I)=1./AR(I)**3
      AL(127) = SIMP (DS)
      DO 149 I=1,NET
  149 G(I)=G(I)*AS(I)
      AL(128) = SIMP (DS)
      DO 150 I=1,NET
  150 G(I)=G(I)*AS(I)
      AL(129) = SIMP (DS)
      DO 151 I=1,NET
  151 G(I)=G(I)*AS(I)
```

```
      AL(130) = SIMP (DS)
      DO 152 I=1,NET
  152 G(I)=G(I)*AS(I)
      AL(131) = SIMP (DS)
      DO 153 I=1,NET
  153 G(I)=G(I)*AS(I)
      AL(132) = SIMP (DS)
      DO 154 I=1,NET
  154 G(I)=G(I)*AS(I)
      AL(133) = SIMP (DS)
      DO 157 I=1,NET
  157 G(I) = AR(I)*AS(I)*AS(I)*AS(I)
      AL(157) = SIMP (DS)
      A1L(IEL)=AL(1)
      A2L(IEL)=AL(2)
      A3L(IEL)=AL(3)
      AL157(IEL)=AL(157)
      IF(ISAVE.EQ.0)WRITE(ISCRA3)AL(1),AL(2),AL(3),AL(157)
      RETURN
      END
      FUNCTION SIMP(DS)
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A3/ NDP,NET,IXX(17)
      COMMON /B5/ISIMP
      NET=NET
      NET3 = NET
      NET1 = NET3 - 1
      NET2 = NET3 - 2
      SUM=0.0                                                      0410
      IF(ISIMP-1)3,4,3
    3 DO 1 I=2,NET1,2
    1 SUM = SUM + 4.0*G(I)
      DO 2 I=3,NET2,2
    2 SUM = SUM + 2.0*G(I)
      AG1 = G(1)
      AG2 = G(NET3)
      GO TO 10
```

```
 4 DO 11 I=2,NET1,2
11 SUM = SUM + 4.0*GA(I)
   DO 22 I=3,NET2,2
22 SUM = SUM + 2.0*GA(I)
   AG1 = GA(1)
   AG2 = GA(NET3)
10 SIMP = (AG1 + SUM + AG2)*DS/3.0
   ISIMP = 0
   RETURN                                                    0470
   END                                                       0480
   SUBROUTINE INTE(I,J,L,KEY,SIMS)
   PI=3.14159265
   SIMS=0.
   IF((I+J).NE.(L+1).AND.IABS(J-I).NE.(L-1))RETURN
   IF(KEY.EQ.0)GO TO 10
   IF(KEY.EQ.2)GO TO 20
   RETURN
10 K=1
   IF(J.EQ.1)K=2
   IF(I.EQ.1)K=K+1
   IF(L.EQ.1)K=K+1
   FK=K
   SIMS=FK*PI/2.0
   RETURN
20 IF(J.EQ.1.OR.I.EQ.1)RETURN
   IF(L.NE.1)GO TO 30
   SIMS=PI
   RETURN
30 SIMS=PI/2.0
   IF(J+I-L.EQ.1)SIMS=-PI/2.0
   RETURN
   END
   SUBROUTINE CREATL (AM,AN,C1,C2,C,D1,D2,D,G1,G2)
   COMMON /B1/ AL(157)
   COMMON /B3/ PHPP
   COMMON /B4/ F(8,8)
   DIMENSION E(8,8)
```

```
      IFLAG = 0
C         THE ABOVE IS A FLAG USED TO DETERMINE WHETHER THE ELEMENTS
C             ABOVE OR BELOW THE DIAGONAL ARE BEING CALCULATED
C         CALCULATE THE DIAGONAL ELEMENTS OF F
      F(1,1) =
     A    C1*AL(8) + C2*AL(54) - C*AL(30) + 4.*G2*AM*AN*AL(142) + D2*AM*
     1    AM*AN*AN*AL(127)
      F(2,2) =
     A    C1*AL(10) + C2*AL(56) - C*AL(32) + D2*AM*AM*AN*AN*AL(129) - D2
     1    *(AM*AM+AN*AN)*AL(100) + D2*AL(69) + 4.*G2*AM*AN*AL(144) - 8.*
     2    G2*AM*AN*AL(100) + 4.*G2*AM*AN*AL(44)
      F(3,3) =
     A    C1*AL(12) + C2*AL(58) - C*AL(34) + 4.*D1*AL(1) + D2*AM*AM*AN*
     1    AN*AL(131) - 2.*D2*(AM*AM+AN*AN)*AL(102) + 4.*D2*AL(71) - D*(
     2    AM*AM+AN*AN)*AL(46) + 4.*D*AL(22) + 4.*G2*AM*AN*AL(146) - 16.*
     3    G2*AM*AN*AL(102) + 16.*G2*AM*AN*AL(46)
      F(4,4)=
     A    C1*AL(14) + C2*AL(60) - C*AL(36) + 36.*D1*AL(3) + D2*AM*AM*AN*
     1    AN*AL(133) - 3.*D2*(AM*AM+AN*AN)*AL(104) - 3.*D*(AM*AM+AN*AN)*
     2    AL(48) + 18.*D*AL(24) + 9.*D2*AL(73) + 4.*G2*AM*AN*AL(148) -
     3 24.*G2*AM*AN*AL(104) + 36.*G2*AM*AN*AL(48)
      F(5,5) =
     A    C2*AL(69) + G1*AM*AN*AL(44) + D1*PHPP**2 *AL(1) + D2*AL(96) +
     1    D*PHPP*AL(37) + G2*AM*AN*AL(90)
      F(6,6) =
     A    C1*AL(1) + C2*AL(71) + C*AL(22) + G1*AM*AN*AL(46) + D1*PHPP**2
     1 *  AL(3) + 2.*D1*PHPP*AL(5) + D1*AL(8) + D2*AL(98) + D*PHPP*
     2    AL(39) + D*AL(43) + G2*AM*AN*AL(92)
      F(7,7) =
     A    C2*AM*AN*AL(44) + G1*AL(69) + D2*AM*AN*AL(139) + 4.*G2*AL(154)
     1    + 4.*G2*AL(124) + G2*AL(96)
      F(8,8) =
     A    C2*AM*AN*AL(46) + G1*AL(71) - 2.*G1*AL(22) + D2*AM*AN*AL(141)
     1    + G1*AL(1) + 4.*G2*AL(156) - 4.*G2*AL(110) + 4.*G2*AL(126) +
     2    G2*AL(54) - 2.*G2*AL(85) + G2*AL(98)
C         CALCULATE ELEMENTS ABOVE THE DIAGONAL AND CALL THEM E
   10 E(1,2) =
```

```
A     C1*AL(9) + C2*AL(55) - C*AL(31) + D2*AM*AM*AN*AN*AL(128) + 4.*
1     G2*AM*AN*AL(143) - D2*AM*AM*AL(99) - 4.*G2*AM*AN*AL(99)
 E(1,3) =
A     C1*AL(10) + C2*AL(56) - C*AL(32) + D2*AM*AM*AN*AN*AL(129)
1     + 4.*G2*AM*AN*AL(144) - 2.*D2*AM*AM*AL(100) - D*AM*AM*AL(44) -
2     8.*G2*AM*AN*AL(100)
 E(1,4) =
A     C1*AL(11) + C2*AL(57) - C*AL(33) + D2*AM*AM*AN*AN*AL(130) - 3.
1     *D2*AM*AM*AL(101) - 3.*D*AM*AM*AL(45) + 4.*G2*AM*AN*AL(145) -
2     12.*G2*AM*AN*AL(101)
 E(1,5) =
A     C2*AL(64) - C/2.*AL(37) - D2*AM*AM*AL(111) - D/2.*AM*AM*PHPP*
1     AL(44) - 2.*G2*AM*AN*AL(111)
 E(1,6) =
A     - C1*AL(4) + C2*AL(65) - C/2.*AL(38) - D2*AM*AM*AL(112) - D/2.
1     *AM*AM*PHPP*AL(45) - D/2.*AM*AM*AL(74) + C/2.*AL(17) - 2.*G2*
2     AM*AN*AL(112)
 E(1,7) =
A     C2*AN*AL(49) - C/2.*AN*AL(25) + D2*AM*AM*AN*AL(134) + 4.*G2*AM
1     *AL(149) + 2.*G2*AM*AL(119)
 E(1,8) =
A     C2*AN*AL(50) - C/2.*AN*AL(26) + D2*AM*AM*AN*AL(135) + 4.*G2*AM
1     *AL(150) - 2.*G2*AM*AL(105) + 2.*G2*AM*AL(120)
 E(2,3) =
A     C1*AL(11) + C2*AL(57) - C*AL(33) + D2*AM*AM*AN*AN*AL(130) - D2
1     *(2.*AM*AM+AN*AN)*AL(101) + 2.*D2*AL(70) - D*AM*AM*AL(45) + D*
2     AL(21) + 4.*G2*AM*AN*AL(145) - 12.*G2*AM*AN*AL(101) + 8.*G2*AM
3     *AN*AL(45)
 E(2,4) =
A     C1*AL(12) + C2*AL(58) - C*AL(34) + D2*AM*AM*AN*AN*AL(131) - D2
1     *(3.*AM*AM+AN*AN)*AL(102) + 3.*D2*AL(71) - 3.*D*AM*AM*AL(46) +
2     3.*D*AL(22) + 4.*G2*AM*AN*AL(146) + 12.*G2*AM*AN*AL(46) - 16.*
3     G2*AM*AN*AL(102)
 E(2,5) =
A     C2*AL(65) - C/2.*AL(38) - D2*AM*AM*AL(112) + D2*AL(86) - D/2.*
1     AM*AM*PHPP*AL(45) + D/2.*PHPP*AL(21) - 2.*G2*AM*AN*AL(112) +
2     2.*G2*AM*AN*AL(74)
```

```
 E(2,6) =
A     - C1*AL(5) + C2*AL(66) - C/2.*AL(39) + C/2.*AL(18) - D2*AM*AM*
1     AL(113) + D2*AL(87) - D/2.*AM*AM*PHPP*AL(46) + D/2.*PHPP*
2     AL(22) - D/2.*AM*AM*AL(75) + D/2.*AL(37) - 2.*G2*AM*AN*AL(113)
3     + 2.*G2*AM*AN*AL(75)
 E(2,7) =
A     C2*AN*AL(50) - C/2.*AN*AL(26) + D2*AM*AM*AN*AL(135) - D2*AN*
1     AL(105) + 4.*G2*AM*AL(150) - 4.*G2*AM*AL(105) - 2.*G2*AM*
2     AL(80) + 2.*G2*AM*AL(120)
 E(2,8) =
A     C2*AN*AL(51) - C/2.*AN*AL(27) + D2*AM*AM*AN*AL(136) - D2*AN*
1     AL(106) + 4.*G2*AM*AL(151) + 2.*G2*AM*AL(121) - 6.*G2*AM*
2     AL(106) + 2.*G2*AM*AL(49) - 2.*G2*AM*AL(81)
 E(3,4) =
A     C1*AL(13) + C2*AL(59) - C*AL(35) + 12.*D1*AL(2) + D2*AM*AM*AN*
1     AN*AL(132) - D2*(3.*AM*AM+2.*AN*AN)*AL(103) + 6.*D2*AL(72) - D
2     *(AN*AN+3.*AM*AM)*AL(47) + 9.*D*AL(23) + 4.*G2*AM*AN*AL(147) -
3     20.*G2*AM*AN*AL(103) + 24.*G2*AM*AN*AL(47)
 E(3,5) =
A     C2*AL(66) - C/2.*AL(39) + 2.*D1*PHPP*AL(1) - D2*AM*AM*AL(113)
1     + 2.*D2*AL(87) + D*AL(37) - D/2.*AM*AM*PHPP*AL(46) + D*PHPP*
2     AL(22) - 2.*G2*AM*AN*AL(113) + 4.*G2*AM*AN*AL(75)
 E(3,6) =
A     - C1*AL(6) + C2*AL(67) - C/2.*AL(40) + 2.*D1*PHPP*AL(2) + 2.*
1     D1*AL(4) - D2*AM*AM*AL(114) + 2.*D2*AL(88) + 2.*D*AL(38) - D/
2     2.*AM*AM*PHPP*AL(47) + D*PHPP*AL(23) - D/2.*AM*AM*AL(76) + C/
3     2.*AL(19) - 2.*G2*AM*AN*AL(114) + 4.*G2*AM*AN*AL(76)
 E(3,7) =
A     C2*AN*AL(51) - C/2.*AN*AL(27) + D2*AM*AM*AN*AL(136) - 2.*D2*AN
1     *AL(106) - D*AN*AL(49) - 4.*G2*AM*AL(81) + 4.*G2*AM*AL(151) +
2     2.*G2*AM*AL(121) - 8.*G2*AM*AL(106)
 E(3,8) =
A     C2*AN*AL(52) - C/2.*AN*AL(28) + D2*AM*AM*AN*AL(137) - 2.*D2*AN
1     *AL(107) - D*AN*AL(50) + 4.*G2*AM*AL(152) - 10.*G2*AM*AL(107)
2     + 2.*G2*AM*AL(122) + 4.*G2*AM*AL(50) - 4.*G2*AM*AL(82)
 E(4,5) =
A     C2*AL(67) - C/2.*AL(40) + 6.*D1*PHPP*AL(2) - D2*AM*AM*AL(114)
```

```
1    + 3.*D2*AL(88) + 3.*D*AL(38) - D/2.*AM*AM*PHPP*AL(47) + 3./2.*
2    D*PHPP*AL(23) - 2.*G2*AM*AN*AL(114) + 6.*G2*AM*AN*AL(76)
 E(4,6) =
A    - C1*AL(7) + C2*AL(68) - C/2.*AL(41) + 6.*D1*PHPP*AL(3) + 6.*
1    D1*AL(5) - D2*AM*AM*AL(115) + 3.*D2*AL(89) - D/2.*AM*AM*PHPP*
2    AL(48) + 3./2.*D*PHPP*AL(24) - D/2.*AM*AM*AL(77) + 9./2.*D*
3    AL(39) + C/2.*AL(20) - 2.*G2*AM*AN*AL(115) + 6.*G2*AM*AN*
4    AL(77)
 E(4,7) =
A    C2*AN*AL(52) - C/2.*AN*AL(28) + D2*AM*AM*AN*AL(137) - 3.*D2*AN
1    *AL(107) - 3.*D*AN*AL(50) + 4.*G2*AM*AL(152) + 2.*G2*AM*
2    AL(122) - 12.*G2*AM*AL(107) - 6.*G2*AM*AL(82)
 E(4,8) =
A    C2*AN*AL(53) - C/2.*AN*AL(29) + D2*AM*AM*AN*AL(138) - 3.*D2*AN
1    *AL(108) - 3.*D*AN*AL(51) + 4.*G2*AM*AL(153) - 14.*G2*AM*
2    AL(108) + 2.*G2*AM*AL(123) + 6.*G2*AM*AL(51) - 6.*G2*AM*AL(83)
 E(5,6) =
A    C2*AL(70) + C/2.*AL(21) + G1*AM*AN*AL(45) + D1*PHPP**2 *AL(2)
1    + D1*PHPP*AL(4) + D2*AL(97) + D*PHPP*AL(38) + D/2.*AL(42) + G2
2    *AM*AN*AL(91)
 E(5,7) =
A    C2*AN*AL(61) + G1*AM*AL(61) - D2*AN*AL(116) - D/2.*AN*PHPP*
1    AL(49) - 2.*G2*AM*AL(116) - G2*AM*AL(93)
 E(5,8) =
A    C2*AN*AL(62) + G1*AM*AL(62) - G1*AM*AL(15) - D2*AN*AL(117) - D
1    /2.*AN*PHPP*AL(50) - 2.*G2*AM*AL(117) + G2*AM*AL(78) - G2*AM*
2    AL(94)
 E(6,7) =
A    C2*AN*AL(62) + C/2.*AN*AL(15) + G1*AM*AL(62) -D2*AN*AL(117) -
1D/2.*AN*PHPP*AL(50)-D/2.*AN*AL(78)-2.*G2*AM*AL(117) - G2*AM*AL(94)
 E(6,8) =
A   C2*AN*AL(63) + C/2.*AN*AL(16) + G1*AM*AL(63) - G1*AM*AL(16) -
1    D2*AN*AL(118) - D/2.*AN*PHPP*AL(51) - D/2.*AN*AL(79) - 2.*G2*
2    AM*AL(118) + G2*AM*AL(79) - G2*AM*AL(95)
 E(7,8) =
A    C2*AM*AN*AL(45) + G1*AL(70) - G1*AL(21) + D2*AM*AN*AL(140) +
1    4.*G2*AL(155) - 2.*G2*AL(109) + 4.*G2*AL(125) - G2*AL(84) + G2
```

```
     2     *AL(97)
      IFLAG = IFLAG + 1
      IF (IFLAG.NE.1) GO TO 20
C         THE ELEMENTS OF F THAT ARE NEEDED ARE THOSE ABOVE THE DIAGONAL
C             THUS F IS IDENTICAL TO E
      DO 15 I=1,7
      II=I+1
      DO 15 J=II,8
      F(I,J) = E(I,J)
   15 CONTINUE
C         INTERCHANGE AM AND AN TO RECALCULATE E FOR THE TERMS OF F
C             BELOW THE DIAGONAL
      TEMP = AM
      AM = AN
      AN = TEMP
      GO TO 10
C         THE F ELEMENTS BELOW THE DIAGONAL ARE SET EQUAL TO E ELEMENTS
C             ABOVE THE DIAGONAL
   20 DO 25 I=2,8
      II = I-1
      DO 25 J=1,II
      F(I,J) = E(J,I)
   25 CONTINUE
      RETURN
      END
      SUBROUTINE MMPLT3
      COMMON /B4/ F(8,8)
      COMMON /B6/ AK(8,8)
      COMMON /B8/ CHECK(8,8)
      DO 1 I=1,8
      DO 1 J=1,8
      AK(I,J)=0.0
      DO 1 K=1,8
    1 AK(I,J)=AK(I,J)+F(I,K)*CHECK(K,J)
      DO 2 I=1,8
      DO 2 J=1,8
      F(I,J)=0.0
```

```
      DO 2 K=1,8
    2 F(I,J)=F(I,J)+CHECK(K,I)*AK(K,J)
      DO 3 I=1,8
      DO 3 J=1,8
    3 AK(I,J)=F(I,J)
      RETURN
      END
      SUBROUTINE FORCES(IEL)
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A2/ ONE(68),TWO(68)
      COMMON /A3/ NDP,NET,IXX(17)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B5/ISIMP
      COMMON /B8/ CHECK(8,8)
      COMMON /B9/ IA,IB
      COMMON /B15/ IELL,NDPP,IXXX(17),LINEL,ICON,ICOO,NSTOP
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
      COMMON /C40/ IPRI
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50)
      COMMON /G1/ APPO,THELO,RC,RL,PR
      COMMON /G4/ ONED(51,68)
      DIMENSION         Q(8),QQ(8)
      DOUBLE PRECISION ONED
      INTEGER CONST
      INTEGER CONS
      INTEGER APOL
      INTEGER APPO
      INTEGER REST
      DATA APOL/4HAPOL/
      DATA CONST/4HCONS/
      IF(APPO.NE.APOL)GO TO 770
      I=IEL
      DO 780 J=1,NH
  780 IXX(J)=0
```

```
      THELO1=THELO/57.2957795
      RA=RC*COS(THELO1)
      RB=RC*SIN(THELO1)
      DO 703 J=1,3
      P(J)=0.
      R(J)=0.
      S(J)=0.
      O(J)=0.
  703 CONTINUE
      RFF=RO2(I)
      IF(RFF.GT.(RC+RL))GO TO 403
      IF(RFF.LE.(RC-RL))GO TO 403
      IF(I.NE.1)GO TO 760
      RF=RO2(1)/2.
      GO TO 761
  760 RF=RFF-(RO2(I)-RO2(I-1))/2.
  761 RR=RA*RA+RF*RF+RB*RB-RL*RL
      RRR=4.*RB*RB*RF*RF-RR*RR
      RRA=4.*RA*RA+4.*RB*RB
      RRB=4.*RR*RA
      X3=SQRT(ABS(RRB*RRB+4.*RRA*RRR))
      X1=(RRB+X3)/(2.*RRA)
      X2=(RRB-X3)/(2.*RRA)
      IF(THELO.NE.0.)GO TO 712
      Y1=SQRT(ABS(RF*RF-X1*X1))
      Y2=-Y1
      GO TO 716
  712 Y1=(RR-2.*X1*RA)/(2.*RB)
      Y2=(RR-2.*X2*RA)/(2.*RB)
  716 THE1=ATAN2(Y1,X1)*57.2957795
      THE2=ATAN2(Y2,X2)*57.2957795
      IF(Y1.GE.0..AND.Y2.GE.0.)GO TO 740
      IF(Y1.LE.0..AND.Y2.LE.0.)GO TO 750
      R(1)=PR
      R(3)=PR
      IF(Y1)721,721,723
  723 O(2)=THE1
```

```
      O(3)=360.+THE2
      GO TO 724
  721 O(2)=THE2
      O(3)=360.+THE1
      IF(X2.LT.0.)O(2)=180.+THE2
      GO TO 724
  740 R(2)=PR
      O(2)=THE1
      O(3)=THE2
      IF(X2.LT.0.)O(3)=180.+THE2
      GO TO 724
  750 R(2)=PR
      O(2)=360.+THE1
      O(3)=360.+THE2
  724 NDP=3
      GO TO 500
  770 ICO=0
      IF(IEL.EQ.1)GO TO 402
      IF(NSTOP.EQ.CONST)GO TO 500
      IF(ICON.EQ.0)GO TO 406
  402 READ(5,100)IELL,NDPP,NSTOP,(IXXX(I),I=1,NH)
  100 FORMAT(2I5,A4,1X,17I1)
  406 IF(IEL.NE.IELL)GO TO 403
  400 ICON=1
      NDP = NDPP
      DO 401 I=1,NH
      IXX(I) = IXXX(I)
  401 CONTINUE
      GO TO 407
  403 ICON=0
      NDP = 0
      DO 404 I=1,NH
      IXX(I)=0
  404 CONTINUE
  407 CONTINUE
      IF(NDP.NE.0)GO TO 77
      P(1)=0.
```

```
      R(1)=0.
      S(1)=0.
      O(1)=0.
      NDP = 1
      GO TO 78
   77 CONTINUE
C ***************************************************************************
C
C          FIRST DATA POINT MUST BE AT 0.0 DEGREES
C
C ***************************************************************************
      READ(5,101)(P(I),R(I),S(I),O(I),I=1,NDP)
  500 DO 3006 IL=1,NDP
      IPRI=IPRI+1
      O(NDP+1)=360.
      LLITT=0
      IF(IPRI.EQ.1.AND.IL.EQ.1)LINEL=50
      IF(LINEL.LT.50)GO TO 3007
      WRITE(6,3000)IPAGE
      IPAGE = IPAGE +1
      LINEL=0
 3000 FORMAT(1H1,62X,4HPAGEI3///)
      LLITT=1
      WRITE(6,3001)
 3001 FORMAT(51X,30HAPPLIED LOADS ON THE STRUCTURE//)
      LINEL=LINEL + 6
      GO TO 3010
 3007 IF(LLITT.EQ.1)GO TO 3020
      IF(IL.NE.1)GO TO 3008
 3010 WRITE(6,3002)IEL
 3002 FORMAT(60X,12HELEMENT NO. I3/)
      LINEL=LINEL+2
      IF(LLITT.EQ.1)GO TO 3020
      IF(ICOO.EQ.0)GO TO 3008
 3020 WRITE(6,3003)
 3003 FORMAT(56X,20HPRESSURE  COMPONENTS/)
      WRITE(6,3004)
```

```
3004 FORMAT(20X,10HMERIDIONAL,20X,6HNORMAL,20X,10HTANGENTIAL,11X,19HFRO
    1M THETA TO THETA,9H(DEGREES)/)
     LINEL=LINEL+3
3008 WRITE(6,3005)P(IL),R(IL),S(IL),O(IL),O(IL+1)
3005 FORMAT(2X,3(18X,F10.3),12X,2(2X,F8.3)/)
     LINEL=LINEL+2
3006 CONTINUE
     ICOO=0
     ICO=1
     DO 50 I=1,NDP
  50 O(I)=O(I)/57.29578
 101 FORMAT(4F10.0)
     P(NDP+1)=P(1)
     S(NDP+1)=S(1)
     R(NDP+1)=R(1)
     O(NDP+1) = 2.*3.1415926
  78 IZ = IA
     INDEX = 0
     CALL FORCE1(IZ,INDEX,1,ICO,IEL)
     INDEX= 4*IA
     IZ=IB
     CALL FORCE1(IZ,INDEX,0,ICO,IEL)
     IAB= (IA+IB)*4
     DO 310 IR=1,NEREST
     IF(IELRES(IR).NE.IEL)GO TO 310
     DO 301 JR=1,4
     IF(REST(IEL,JR).EQ.0)GO TO 301
     DO 302 JJR=1,NH
     KR=JR+(JJR-1)*4
     ONE(KR)=0.
 302 CONTINUE
 301 CONTINUE
 310 CONTINUE
     DO 480 KK=1,IAB
 480 ONED(IEL,KK)=ONE(KK)
     DO 20 JACK = 1,IAB
  20 ONE(JACK) = TWO(JACK)
```

```
      RETURN
      END
      SUBROUTINE FORCE1(IZ,INDE,ICHANG,ICO,IEL)
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A2/ ONE(68),TWO(68)
      COMMON /A3/ NDP,NET,IXX(17)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B5/ISIMP
      COMMON /B8/ CHECK(8,8)
      COMMON /B9/ IA,IB
      COMMON /B15/ IELL,NDPP,IXXX(17),LINEL,ICON,ICOO,NSTOP
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50)
      DIMENSION QQ(8),Q(8),OP(101),FORCE(8)
      DATA NAMEA/1HA/,NAMEB/1HB/
      IF(IZ.EQ.0) RETURN
      JACK = (INDE /4)+1
      DO 1 IAAA=1,IZ
   99 IAA=IAAA-1
      DO 2 KKK=1,8
      FORCE(KKK)=0.
    2 Q(KKK)=0.
      HIA=IAA
      DO 3 I=1,NDP
      IF(NDP.EQ.1)GO TO 105
      X=O(I)*HIA
      XX=O(I+1)*HIA
      IF(ICHANG.EQ.0)GO TO 12
      IF(IAA.NE.0)GO TO 800
      PINT=P(I)*(O(I+1)-O(I))
      SINT=0.
      RINT=R(I)*(O(I+1)-O(I))
      GO TO 101
  800 PINT=P(I)*(SIN(XX)-SIN(X))/HIA
      SINT=-S(I)*(COS(XX)-COS(X))/HIA
      RINT=R(I)*(SIN(XX)-SIN(X))/HIA
      GO TO 101
```

```
 12 IF(IAA.NE.0)GO TO 801
    PINT=0.
    SINT=S(I)*(O(I+1)-O(I))
    RINT=0.
    GO TO 101
801 PINT=-P(I)*(COS(XX)-COS(X))/HIA
    SINT=S(I)*(SIN(XX)-SIN(X))/HIA
    RINT=-R(1)*(COS(XX)-COS(X))/HIA
    GO TO 101
105 IF(IAA.NE.0) GO TO 102
    IF (ICHANG.EQ.0) GO TO 103
    PINT = 2.*3.141592 * P(1)
    SINT = 0.
    RINT = 2.*3.141592 * R(1)
    GO TO 101
103 RINT = 0.
    SINT = 2.*3.141592 * S(1)
    PINT = 0.
    GO TO 101
102 PINT = 0.
    RINT = 0.
    SINT = 0.
101 Q(1)=Q(1)+RINT*A1L(IEL)
    Q(2)=Q(2)+RINT*A2L(IEL)
    Q(3)=Q(3)+RINT*A3L(IEL)
    Q(4)=Q(4)+RINT*AL157(IEL)
    Q(5)=Q(5)+PINT*A1L(IEL)
    Q(6)=Q(6)+PINT*A2L(IEL)
    Q(7)=Q(7)+SINT*A1L(IEL)
  3 Q(8)=Q(8)+SINT*A2L(IEL)
    DO 5 IFLAG = 1,8
    QQ(IFLAG) = 0.
    DO 5 IFL = 1,8
  5 QQ(IFLAG) = QQ(IFLAG) + CHECK(IFL,IFLAG)*Q(IFL)
    IF(IXX(JACK).EQ.0)GO TO 600
    READ(5,500)(FORCE(I),I=1,8)
500 FORMAT(8F10.0)
```

```
      LLIT=0
      NAMEH=NAMEB
      IF(ICHANG.EQ.1)NAMEH=NAMEA
      IF(LINEL.EQ.0)GO TO 4010
      IF(LINEL.LT.50)GO TO 4007
 4010 WRITE(6,4000)IPAGE
 4000 FORMAT(1H1,62X,4HPAGEI3///)
      IPAGE = IPAGE +1
      LINEL=0
      WRITE(6,4020)
 4020 FORMAT(51X,30HAPPLIED LOADS ON THE STRUCTURE//)
      LLIT=1
      LINEL=LINEL+8
      GO TO 4015
 4007 IF(ICO.EQ.0.AND.IAAA.EQ.1)GO TO 4015
      IF(IAAA.NE.1)GO TO 4016
      WRITE(6,4001)
      WRITE(6,4003)
      GO TO 4016
 4015 WRITE(6,4002)IEL
 4002 FORMAT(60X,12HELEMENT NO. I3/)
      IF(LLIT.EQ.1)GO TO 4030
      IF(ICO.EQ.0)GO TO 4016
 4030 WRITE(6,4003)
 4003 FORMAT(20X,5HAXIAL,20X,10HTANGENTIAL,19X,6HRADIAL,20X,7HANGULAR,5X
     1,12HHARMONIC NO./)
      WRITE(6,4001)
 4001 FORMAT(1H0,44X,42HCONCENTRATED LINE LOAD COMPONENTS AT NODES/)
      LINEL = LINEL + 3
 4016 WRITE(6,4004)(FORCE(I),I=1,4),IAA,NAMEH
      WRITE(6,4005)(FORCE(I),I=5,8),IAA,NAMEH
 4004 FORMAT(1X,10HFIRST NODE,10X,F10.3,18X,F10.3,17X,F10.3,16X,F10.3,8X
     1,I2,A2)
 4005 FORMAT(1X,11HSECOND NODE,9X,F10.3,18X,F10.3,17X,F10.3,16X,F10.3,8X
     1,I2,A2)
      LINEL = LINEL + 4
      ICOO=1
```

```
600 INDEX=4*IAA + INDE
 90 ONE(INDEX+1) = QQ(1) + ONE(INDEX+1)   + FORCE(1)
    ONE(INDEX+2) = QQ(2) + ONE(INDEX+2)  + FORCE(2)
    ONE(INDEX+3) = QQ(3) + ONE(INDEX+3)   + FORCE(3)
    ONE(INDEX+4) = QQ(4) + ONE(INDEX+4)   + FORCE(4)
    TWO(INDEX+1) = QQ(5)  + FORCE(5)
    TWO(INDEX+2) = QQ(6)  + FORCE(6)
    TWO(INDEX+3) = QQ(7)    + FORCE(7)
    TWO(INDEX+4) = QQ(8) + FORCE(8)
    JACK = JACK +1
  1 CONTINUE
    RETURN
    END
    SUBROUTINE DISPLA
    COMMON /A7/ ITL,ISOL2,ISCRA3,NELEMS,NH,IPAGE,PROBLE
    COMMON /B9/ IA,IB
    COMMON /D10/ ISAVE,IDISPL
    COMMON /G4/ ONED(51,68)
    DOUBLE PRECISION T(2346),RHS1(68),S(4624),COE(68),RHS2(68)
    DOUBLE PRECISION ONED
    REWIND ITL
    REWIND ISOL2
    IDISPL=1
    IORD=4*NH
    ISIZS = IORD*IORD
    ISIZT = (ISIZS+IORD)/2
    NELP1=NELEMS+1
    READ(ITL)(T(I),I=1,ISIZT)
    DO 600 I=1,IORD
600 RHS1(I)=ONED(1,I)
    DO 1 I=2,IORD
    L = I+1
    K = I-1
    DO 1 J=1,K
    JI = J+(I*I-I)/2
    JJ = (J*J+J)/2
    II = (I*I+I)/2
```

```
      T(JI) = T(JI)/T(JJ)
      T(II) = T(II)-T(JI)*T(JI)*T(JJ)
      IF(I-IORD) 101,1,101
  101 DO 3 M=L,IORD
      IM = I+(M*M-M)/2
      JM = J+(M*M-M)/2
    3 T(IM) = T(IM)-T(JI)*T(JM)
    1 RHS1(I) = RHS1(I)-T(JI)*RHS1(J)
      DO 4 IELEM=1,NELEMS
      READ(ITL)(S(I),I=1,ISIZS)
      DO 5 I=2,IORD
      K=I-1
      DO 5 J=1,K
      JI = J+(I*I-I)/2
      DO 5 M=1,IORD
      MDUM = (M-1)*IORD
      IM = I+MDUM
      JM = J+MDUM
    5 S(IM) = S(IM)-T(JI)*S(JM)
      WRITE(ISOL2)(T(I),I=1,ISIZT)
      NNE=IELEM+1
      DO 800 KK=1,IORD
  800 ONED(IELEM,KK)=RHS1(KK)
      DO 10 I=1,IORD
      II = (I*I+I)/2
   10 COE(I) = T(II)
      READ(ITL)(T(I),I=1,ISIZT)
      DO 601 KK=1,IORD
  601 RHS2(KK)=ONED(NNE,KK)
      DO 11 I=1,IORD
      II = (I*I+I)/2
      LEAD = (I-1)*IORD
      DO 12 M=I,IORD
      LEADM = (M-1)*IORD
      IM = I+(M*M-M)/2
      DO 12 J=1,IORD
      JI = LEAD+J
```

```
      IF(M-I) 105,106,105
  106 T(II) = T(II)-S(JI)*S(JI)/COE(J)
      S(JI) = S(JI)/COE(J)
      GO TO 12
  105 JM = LEADM+J
      T(IM) = T(IM)-S(JI)*S(JM)
   12 CONTINUE
      DO 11 J=1,IORD
      JI = LEAD+J
   11 RHS2(I) = RHS2(I)-S(JI)*RHS1(J)
      DO 15 I=2,IORD
      L = I+1
      K = I-1
      DO 15 J=1,K
      JI = J+(I*I-I)/2
      JJ = (J*J+J)/2
      II = (I*I+I)/2
      T(JI) = T(JI)/T(JJ)
      T(II) = T(II)-T(JI)*T(JI)*T(JJ)
      IF (I-IORD) 109,15,109
  109 DO 17 M=L,IORD
      IM = I+(M*M-M)/2
      JM = J+(M*M-M)/2
   17 T(IM) = T(IM)-T(JI)*T(JM)
   15 RHS2(I) = RHS2(I)-T(JI)*RHS2(J)
      DO 18 I=1,IORD
   18 RHS1(I) = RHS2(I)
    4 WRITE(ISOL2)(S(I),I=1,ISIZS)
      WRITE(ISOL2)(T(I),I=1,ISIZT)
      DO 801 KK=1,IORD
  801 ONED(NELEMS+1,KK)=RHS1(KK)
      BACKSPACE ISOL2
      REWIND ITL
      DO 202 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 803 I=1,IORD
      KKTE=KKK+I
```

```
      S(KKTE)=ONED(IELEM,I)
  803 CONTINUE
  202 CONTINUE
      DO 804 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 820 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  820 CONTINUE
  804 CONTINUE
      DO 805 I=1,IORD
  805 RHS1(I)=ONED(1,I)
      READ(ISOL2)(T(I),I=1,ISIZT)
      ISOLB = ITL
      WRITE(ISOLB)(T(I),I=1,ISIZT)
      BACKSPACE ISOL2
      KORNER = (IORD*IORD+IORD)/2
      RHS1(IORD) = RHS1(IORD)/T(KORNER)
      IOM1 = IORD-1
      DO 21 KK=1,IOM1
      I = IORD-KK
      II = (I*I+I)/2
      RHS1(I) = RHS1(I)/T(II)
      K = I+1
      DO 21 J=K,IORD
      IJ = I+(J*J-J)/2
   21 RHS1(I) = RHS1(I)-RHS1(J)*T(IJ)
      DO 806 I=1,IORD
  806 ONED(1,I)=RHS1(I)
      DO 23 IELEM=1,NELEMS
      DO 24 I=1,IORD
   24 RHS2(I)=RHS1(I)
      NNE=IELEM +1
      DO 807 KK=1,IORD
  807 RHS1(KK)=ONED(NNE,KK)
      BACKSPACE ISOL2
```

```
      BACKSPACE ISOL2
      READ(ISOL2)(T(I),I=1,ISIZT)
      READ(ISOL2)(S(I),I=1,ISIZS)
      WRITE(ISOLB)(S(I),I=1,ISIZS)
      WRITE(ISOLB)(T(I),I=1,ISIZT)
      BACKSPACE ISOL2
      BACKSPACE ISOL2
  602 DO 25 KK=1,IORD
      I=IORD-KK+1
      II=(I*I+I)/2
      RHS1(I)=RHS1(I)/T(II)
      K=I+1
      IF(KK-1)107,108,107
  107 DO 26 J=K,IORD
      IJ=I+(J*J-J)/2
   26 RHS1(I)=RHS1(I)-RHS1(J)*T(IJ)
  108 DO 25 J=1,IORD
      IJ=I+(J-1)*IORD
   25 RHS1(I)=RHS1(I)-RHS2(J)*S(IJ)
      DO 808 KK=1,IORD
  808 ONED(NNE,KK)=RHS1(KK)
   23 CONTINUE
      DO 809 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 810 I=1,IORD
      KKTE=KKK+I
      S(KKTE)=ONED(IELEM,I)
  810 CONTINUE
  809 CONTINUE
      DO 811 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 821 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  821 CONTINUE
  811 CONTINUE
```

```
      REWIND ISOLB
      IF(ISAVE.NE.0)RETURN
      REWIND ISOL2
      READ(ITL)(T(I),I=1,ISIZT)
      WRITE(ISCRA3)(T(I),I=1,ISIZT)
      DO 400 I=1,NELEMS
      READ(ITL)(S(J),J=1,ISIZS)
      WRITE(ISCRA3)(S(J),J=1,ISIZS)
      READ(ITL)(T(J),J=1,ISIZT)
      WRITE(ISCRA3)(T(J),J=1,ISIZT)
  400 CONTINUE
      DO 401 I=1,NELEMS
      READ(ISOL2)(T(J),J=1,ISIZT)
      WRITE(ISCRA3)(T(J),J=1,ISIZT)
      READ(ISOL2)(S(J),J=1,ISIZS)
      WRITE(ISCRA3)(S(J),J=1,ISIZS)
  401 CONTINUE
      READ(ISOL2)(T(J),J=1,ISIZT)
      WRITE(ISCRA3)(T(J),J=1,ISIZT)
      REWIND ITL
      REWIND ISOL2
      RETURN
      END
      SUBROUTINE DISPL1
      COMMON /A7/ ITL,ISOL2,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /D10/ ISAVE,IDISPL
      COMMON /G4/ ONED(51,68)
      DOUBLE PRECISION T(2346),RHS1(68),S(4624),RHS2(68)
      DOUBLE PRECISION ONED
      IF(IDISPL.NE.1)GO TO 501
      NTAA=ITL
      ITL=ISOL2
      ISOL2=NTAA
  501 CONTINUE
      IORD=4*NH
      ISIZS = IORD*IORD
```

```
      ISIZT = (ISIZS+IORD)/2
      NELP1 = NELEMS+1
      IF(IDISPL.NE.0)GO TO 500
      REWIND ITL
      REWIND ISOL2
      READ(ISCRA3)(T(I),I=1,ISIZT)
      WRITE(ITL)(T(I),I=1,ISIZT)
      DO 400 I=1,NELEMS
      READ(ISCRA3)(S(J),J=1,ISIZS)
      WRITE(ITL)(S(J),J=1,ISIZS)
      READ(ISCRA3)(T(J),J=1,ISIZT)
      WRITE(ITL)(T(J),J=1,ISIZT)
  400 CONTINUE
      DO 401 I=1,NELEMS
      READ(ISCRA3)(T(J),J=1,ISIZT)
      WRITE(ISOL2)(T(J),J=1,ISIZT)
      READ(ISCRA3)(S(J),J=1,ISIZS)
      WRITE(ISOL2)(S(J),J=1,ISIZS)
  401 CONTINUE
      READ(ISCRA3)(T(J),J=1,ISIZT)
      WRITE(ISOL2)(T(J),J=1,ISIZT)
      REWIND ITL
      REWIND ISOL2
  500 READ(ISOL2)(T(I),I=1,ISIZT)
      DO 600 I=1,IORD
  600 RHS1(I)=ONED(1,I)
      DO 1 I=2,IORD
      K = I-1
      DO 1 J=1,K
      JI = J+(I*I-I)/2
    1 RHS1(I) = RHS1(I)-T(JI)*RHS1(J)
      DO 3 IELEM=1,NELEMS
      READ(ISOL2)(S(I),I=1,ISIZS)
      NNE=IELEM+1
      DO 800 KK=1,IORD
  800 ONED(IELEM,KK)=RHS1(KK)
      READ(ISOL2)(T(I),I=1,ISIZT)
```

```
      DO 601 KK=1,IORD
  601 RHS2(KK)=ONED(NNE,KK)
      DO 4 I=1,IORD
      LEAD = (I-1)*IORD
      DO 4 J=1,IORD
      JI = LEAD+J
    4 RHS2(I) = RHS2(I)-S(JI)*RHS1(J)
      DO 6 I=2,IORD
      K = I-1
      DO 6 J=1,K
      JI = J+(I*I-I)/2
    6 RHS2(I) = RHS2(I)-T(JI)*RHS2(J)
      DO 3 I=1,IORD
    3 RHS1(I) = RHS2(I)
      DO 801 KK=1,IORD
  801 ONED(NELEMS+1,KK)=RHS1(KK)
      DO 202 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 803 I=1,IORD
      KKTE=KKK+I
      S(KKTE)=ONED(IELEM,I)
  803 CONTINUE
  202 CONTINUE
      DO 804 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 820 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  820 CONTINUE
  804 CONTINUE
      DO 805 I=1,IORD
  805 RHS1(I)=ONED(1,I)
      REWIND ISOL2
      READ(ITL)(T(I),I=1,ISIZT)
      KORNER = (IORD*IORD+IORD)/2
      RHS1(IORD) = RHS1(IORD)/T(KORNER)
```

```
      IOM1 = IORD-1
      DO 11 KK=1,IOM1
      I = IORD-KK
      II = (I*I+I)/2
      RHS1(I) = RHS1(I)/T(II)
      K = I+1
      DO 11 J=K,IORD
      IJ = I+(J*J-J)/2
   11 RHS1(I) = RHS1(I)-RHS1(J)*T(IJ)
      DO 806 I=1,IORD
  806 ONED(1,I)=RHS1(I)
      DO 13 IELEM=1,NELEMS
      DO 14 I=1,IORD
   14 RHS2(I) = RHS1(I)
      NNE=IELEM +1
      DO 807 KK=1,IORD
  807 RHS1(KK)=ONED(NNE,KK)
      READ(ITL)(S(I),I=1,ISIZS)
      READ(ITL)(T(I),I=1,ISIZT)
      DO 15 KK=1,IORD
      I = IORD-KK+1
      II = (I*I+I)/2
      RHS1(I) = RHS1(I)/T(II)
      K = I+1
      IF (KK-1) 101,102,101
  101 DO 16 J=K,IORD
      IJ = I+(J*J-J)/2
   16 RHS1(I) = RHS1(I)-RHS1(J)*T(IJ)
  102 DO 15 J=1,IORD
      IJ = I+(J-1)*IORD
   15 RHS1(I) = RHS1(I)-RHS2(J)*S(IJ)
      DO 808 KK=1,IORD
  808 ONED(NNE,KK)=RHS1(KK)
   13 CONTINUE
      DO 809 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 810 I=1,IORD
```

```
      KKTE=KKK+I
      S(KKTE)=ONED(IELEM,I)
  810 CONTINUE
  809 CONTINUE
      DO 811 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 821 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  821 CONTINUE
  811 CONTINUE
      REWIND ITL
      IDISPL=IDISPL+1
      RETURN
      END
      SUBROUTINE STRESS
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /B10/ C(8,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
      COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES,HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B22/ Q3(51,68)
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50)
      COMMON /G2/ NCE(50),NAET(50),THETE(50,51),THICKC(50,51)
      COMMON /G4/ ONED(51,68)
      DOUBLE PRECISION ONED
      DIMENSION DRE(4)
      REWIND ISCRA3
C NN-TOTAL NO. OF Q'S FOR ONE ELEMENT
      CALL SOLV
      AXT=0.
```

```
      TANT=0.
      RADT=0.
      ANGT=0.
      DO 100 II=1,NUNKTH
      WRITE(6,200)IPAGE
      IPAGE = IPAGE +1
      WRITE(6,501)
  501 FORMAT(50X,32HDISPLACEMENT COMPONENTS OF NODES/)
      WRITE(6,503)XTHETA(II)
      WRITE(6,502)
  502 FORMAT(23X,8HNODE NO.,10X,5HAXIAL,12X,10HTANGENTIAL,11X,6HRADIAL,
     112X,7HANGULAR/)
  503 FORMAT(55X,6HTHETA=F8.3,3X,7HDEGREES/)
      NNODES=NELEMS+1
      DO 10 IJ=1,NNODES
      DO 102 IN=1,4
      DRE(IN)=0.
  102 CONTINUE
  104 INE=IJ
  105 IF(IA.EQ.0)GO TO 106
      DO 107 IG=1,IA
      ID=(IG-1)*4 + 1
      IT=IG - 1
      TI=IT
      TH=TI*XTHETA(II)/57.2957795
      DRE(1)=DRE(1) + Q3(INE,ID)*COS(TH)
      DRE(2)=DRE(2) + Q3(INE,ID+1)*SIN(TH)
      DRE(3)=DRE(3) + Q3(INE,ID+2)*COS(TH)
      DRE(4)=DRE(4) + Q3(INE,ID+3)*COS(TH)
  107 CONTINUE
  106 IF(IB.EQ.0)GO TO 108
      DO 109 IG=1,IB
      ID=(IG-1)*4+1+4*IA
      IT=IG - 1
      TI=IT
      TH=TI*XTHETA(II)/57.2957795
      DRE(1)=DRE(1)+Q3(INE,ID)*SIN(TH)
```

```
      DRE(2)=DRE(2)+Q3(INE,ID+1)*COS(TH)
      DRE(3)=DRE(3)+Q3(INE,ID+2)*SIN(TH)
      DRE(4)=DRE(4)+Q3(INE,ID+3)*SIN(TH)
  109 CONTINUE
  108 IF(ABS(DRE(1)).LT.ABS(AXT))GO TO 170
      AXT=DRE(1)
      W1=XTHETA(II)
      I2=INE
  170 IF(ABS(DRE(2)).LT.ABS(TANT))GO TO 171
      TANT=DRE(2)
      W3=XTHETA(II)
      I4=INE
  171 IF(ABS(DRE(3)).LT.ABS(RADT))GO TO 172
      RADT=DRE(3)
      W5=XTHETA(II)
      I6=INE
  172 IF(ABS(DRE(4)).LT.ABS(ANGT))GO TO 173
      ANGT=DRE(4)
      W7=YTHETA(II)
      I8=INE
  173 CONTINUE
      WRITE(6,110)INE,(DRE(IK),IK=1,4)
  110 FORMAT(26X,I2,4X,4(4X,E15.8))
   10 CONTINUE
  100 CONTINUE
      DO 210 I=1,NUNKTH
      WRITE(6,200)IPAGE
      IPAGE = IPAGE + 1
  200 FORMAT(1H1,62X,4HPAGEI3///)
      WRITE(6,201)
  201 FORMAT(37X,58HSTRAINS AND CURVATURES AT THE CENTER OF EACH SHELL E
     1LEMENT/)
      WRITE(6,202)XTHETA(I)
  202 FORMAT(55X,6HTHETA=F8.3,3X,7HDEGREES/)
      WRITE(6,204)
  204 FORMAT(4X,11HELEMENT NO.,10X,4HE(S),13X,8HE(THETA),10X,10HE(S THET
     1A),12X,4HK(S),13X,8HK(THETA),10X,10HK(S THETA)//)
```

```
      DO 211 J=1,NELEMS
  205 WRITE(6,203)J,(ST(J,I,K),K=1,6)
  203 FORMAT(8X,I2,5X,6(4X,E15.8))
  211 CONTINUE
  210 CONTINUE
      DO 310 I=1,NUNKTH
      WRITE(6,200)IPAGE
      IPAGE = IPAGE + 1
      WRITE(6,301)
  301 FORMAT(39X,53HSTRESS RESULTANTS AT THE CENTER OF EACH SHELL ELEMEN
     1T/)
      WRITE(6,202)XTHETA(I)
      WRITE(6,304)
  304 FORMAT(1X,11HELEMENT NO.,6X,4HN(S),9X,8HN(THETA),6X,10HN(S-THETA),
     18X,4HM(S),9X,8HM(THETA),6X,10HM(S-THETA),8X,4HQ(S),9X,8HQ(THETA)//
     2)
      DO 311 J=1,NELEMS
  305 WRITE(6,208)J,(STR(J,I,K),K=1,8)
  208 FORMAT(5X,I2,4X,8(2X,E13.6))
  311 CONTINUE
  310 CONTINUE
      WRITE(6,200)IPAGE
      IPAGE = IPAGE + 1
      WRITE(6,150)
  150 FORMAT(35X,62HMAXIMUM COMPUTED NODE DISPLACEMENT COMPONENTS OF THE
     1 STRUCTURE////)
      WRITE(6,151)
  151 FORMAT(23X,5HAXIAL,20X,10HTANGENTIAL,19X,6HRADIAL,20X,7HANGULAR//
     1)
      WRITE(6,152)AXT,TANT,RADT,ANGT
  152 FORMAT(6X,4(12X,E15.8)//)
      WRITE(6,153)
  153 FORMAT(4(27H                          AT)/)
      WRITE(6,154)
  154 FORMAT(1H0,5X,4(13X,14HTHETA      NODE)//)
      WRITE(6,155)W1,I2,W3,I4 W5,I6,W7,I8
  155 FORMAT(1H0,4X,4(12X,F8.3,5X I2)////)
```

```
      SN = 0.
      TN = 0.
      TSN= 0.
      SM = 0.
      TM = 0.
      TSM= 0.
      QS=0.
      QST=0.
      DO 180 I=1,NELEMS
      DO 181 J=1,NUNKTH
      IF(ABS(STR(I,J,1)).LT.ABS(SN))GO TO 190
      SN=STR(I,J,1)
      W1=XTHETA(J)
      I2=I
  190 IF(ABS(STR(I,J,2)).LT.ABS(TN))GO TO 191
      TN=STR(I,J,2)
      W3=XTHETA(J)
      I4=I
  191 IF(ABS(STR(I,J,3)).LT.ABS(TSN))GO TO 192
      TSN=STR(I,J,3)
      W5=XTHETA(J)
      I6=I
  192 IF(ABS(STR(I,J,4)).LT.ABS(SM))GO TO 193
      SM=STR(I,J,4)
      W7=XTHETA(J)
      I8=I
  193 IF(ABS(STR(I,J,5)).LT.ABS(TM))GO TO 194
      TM=STR(I,J,5)
      W9=XTHETA(J)
      I10=I
  194 IF(ABS(STR(I,J,6)).LT.ABS(TSM))GO TO 195
      TSM=STR(I,J,6)
      W11=XTHETA(J)
      I12=I
  195 IF(ABS(STR(I,J,7)).LT.ABS(QS))GO TO 196
      QS=STR(I,J,7)
      W13=XTHETA(J)
```

```
      I14=I
  196 IF(ABS(STR(I,J,8)).LT.ABS(QST))GO TO 197
      QST=STR(I,J,8)
      W15=XTHETA(J)
      I16=I
  197 CONTINUE
  181 CONTINUE
  180 CONTINUE
      WRITE(6,156)
  156 FORMAT(1H0,34X,61HMAXIMUM COMPUTED STRESS RESULTANT COMPONENTS OF
     1THE STRUCTURE////)
      WRITE(6,157)
  157 FORMAT(8X,4HN(S),10X,8HN(THETA),7X,10HN(S-THETA),9X,4HM(S),10X,
     18HM(THETA),7X,10HM(S-THETA),9X,4HQ(S),10X,8HQ(THETA)///)
      WRITE(6,158)SN,TN,TSN,SM,TM,TSM,QS,QST
  158 FORMAT(8(3X,E13.6)//)
      WRITE(6,159)
  159 FORMAT(1H0,8X,2HAT,7(14X,2HAT)/)
      WRITE(6,160)
  160 FORMAT(8(3X,13HELEMENT THETA)//)
      WRITE(6,161)I2,W1,I4,W3,I6,W5,I8,W7,I10,W9,I12,W11,I14,W13,I16,W15
  161 FORMAT(1H0,8(4X,I2,2X,F8.3)//)
      RETURN
      END
      SUBROUTINE SOLV
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /B10/ C(8,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
      COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES,HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B22/ Q3(51,68)
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL57(50)
      COMMON /G2/ NCE(50),NAET(50),THETE(50,51),THICKC(50,51)
```

```
      COMMON /G4/ ONED(51,68)
      DOUBLE PRECISION ONED
      DIMENSION Q1(68),Q2(68)
      DIMENSION Q(8),AB(17,8)
      DIMENSION THETA(51),THIC(51)
      NN=4*(IA+IB)
      DO 800 I=1,NN
  800 Q1(I)=ONED(1,I)
      DO 300 II=1,NN
  300 Q3(1,II)=Q1(II)
      DO 10 IJ=1,NELEMS
      DO 801 I=1,NN
  801 Q2(I)=ONED(IJ+1,I)
      DO 301 II=1,NN
      Q3(IJ+1,II)=Q2(II)
  301 CONTINUE
C KA-COUNTER FOR ADDRESSING Q'S IN THE ARRAYS  Q1 AND Q2
C IAB-TOTAL NO. OF HARMONICS FOR ONE NODE
      PHPMID=PHPRMI(IJ)
      RMID=RMDI(IJ)
      CPMD=CPDM(IJ)
      SPMD=SPDM(IJ)
      PHPP=PPPH(IJ)
      ARCL=ARLC(IJ)
      DO 4939 ITS1=1,8
      DO 4940 ITS2=1,8
      C(ITS1,ITS2)=CHEKC(IJ,ITS1,ITS2)
 4940 CONTINUE
 4939 CONTINUE
      KA=1
      IAB=IA+IB
C COMPUTE ALPHAS FOR ALL HARMONICS AT ONE NODE
      DO15 I=1,IAB
C PUT Q1'S AND Q2'S FOR ONE HARMONIC INTO COLUMN MATRIX
      DO 20 K=1,4
      Q(K)=Q1(KA)
      Q(K+4)=Q2(KA)
```

```
      KA=KA+1
   20 CONTINUE
C MULTIPLY GIVEN 8X8 TRANSFORMATION MATRIX C BY COLUMN MATRIX OF ALPHAS
C FOR THE FIRST HARMONIC AND STORE IN ARRAY AB
      DO 25 J=1,8
      SUM=0.
      DO 30 M=1,8
      SUM=C(J,M)*Q(M)+SUM
   30 CONTINUE
      AB(I,J)=SUM
   25 CONTINUE
   15 CONTINUE
      NC=NCE(IJ)
      NAMET=NAET(IJ)
      DO 4937 ITH=1,NC
      THETA(ITH)=THETE(IJ,ITH)
      THIC(ITH)=THICKC(IJ,ITH)
 4937 CONTINUE
C DO COMPUTATION FOR N NUMBER OF THETAS PER ELEMENT
      DO 35 KJ=1,NUNKTH
      IF(NC.NE.1)GO TO 100
      T(KJ) = THIC(1)
      GO TO 101
  100 CONTINUE
      DO 65 J=1,NC
      TH2=THETA(J+1)*57.2957795
      TH1=THETA(J)*57.2957795
      IF(XTHETA(KJ).GE.TH1.AND.XTHETA(KJ).LE.TH2)GO TO 12
   65 CONTINUE
   12 T(KJ)=THIC(J)
C COMPUTE STRAIN RESULTANTS AND RETURN IN ARRAY ST
  101 CONTINUE
      CALL STRAIN(AB,KJ,IAB,IJ)
C COMPUTE STRESS RESULTANTS AND RETURN IN ARRAY STR(I,J,K) WHERE I=ELEMENT
C COMPUTE CAPAS-PARTIAL DERIVATIVES OF THE RADIUS OF CURVATURE
C NO.,J=THETA NO.,K=COLUMN MATRIX 1-8 GIVING VALUES OF NS,NTHETA,NSTHETA,
C MS,MTHETA,MSTHETA,QS,QTHETA RESPECTIVELY
```

```
      CALL STRESR(IJ,KJ)
   35 CONTINUE
C MOVE Q'S FOR NODE P+1 TO NODE P
      DO 40 L=1,NN
      Q1(L)=Q2(L)
   40 CONTINUE
   10 CONTINUE
      RETURN
      END
      SUBROUTINE STRAIN(AB,KJ,IAB,IJ)
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /B9/ IA,IB
      COMMON /B10/ C(8,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
      COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      DIMENSION AB(17,8),U(40)
      S=ARCL/2.
      DO 45 I=1,40
      U(I)=0.
   45 CONTINUE
C TEST FOR A HARMONICS,IF NO,GO TO TEST FOR B HARMONICS
      IF(IA.EQ.0) GO TO 110
C COMPUTE US-OR U(1),VTHETA-U(2),UTHEAT-U(3),VS-U(4),WS-U(5),WSS-U(6),
C WTHETA-U(7),WTHETATHETA-U(8),U-U(9),V-V(10),W-U(11),WSTHETA-U(12),
C WSSS-U(13),WSSTHETA-U(14),WTHETATHETAS-U(15),WTHETATHETATHETA-U(16),
C UTHETATHETA-U(17),USTHETA-U(18),VTHETATHETA-U(19),VSTHETA-U(20) IE
C U,V,W, AND THEIR PARTIAL DERIVATIVES FOR A HARMONICS
      DO 50 I=1,IA
      AI=I-1
      X=AI*XTHETA(KJ)
      X=X/57.2957795
      U(1)=AB(I,6)*COS(X)+U(1)
      U(2)=AI*(AB(I,7)+AB(I,8)*S)*COS(X)+U(2)
      U(3)=-(AI*(AB(I,5)+AB(I,6)*S)*SIN(X))+U(3)
      U(4)=AB(I,8)*SIN(X)+U(4)
      U(5)=(AB(I,2)+2.*AB(I,3)*S+3.*AB(I,4)*S**2)*COS(X)+U(5)
```

```
      U(6)=(2.*AB(I,3)+6.*AB(I,4)*S)*COS(X)+U(6)
      U(7)=-(AI*(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*SIN(X))
     1+U(7)
      U(8)=-((AI**2)*(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*
     1COS(X))+U(8)
      U(9)=(AB(I,5)+AB(I,6)*S)*COS(X)+U(9)
      U(10)=(AB(I,7)+AB(I,8)*S)*SIN(X)+U(10)
      U(11)=(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*COS(X)+U(11)
      U(12)=-AI *(AB(I,2) +2.*AB(I,3)*S+3.*AB(I,4)*S**2)  *SIN(X)+U(12)
      U(13)=6.*AB(I,4)*COS(X)+U(13)
      U(14)=-(AI*(2.*AB(I,3)+6.*AB(I,4)*S)*SIN(X))+U(14)
      U(15)=-((AI**2)*(AB(I,2)+2.*AB(I,3)*S+3.*AB(I,4)*S**2)*COS(X) )+
     1      U(15)
      U(16)=(AI**3)*(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*SIN(X)
     1      +U(16)
      U(17)=-((AI**2)*(AB(I,5)+AB(I,6)*S)*COS(X))+U(17)
      U(18)=-AI*AB(I,6)*SIN(X)+U(18)
      U(19)=-((AI**2)*(AB(I,7)+AB(I,8)*S)*SIN(X))+U(19)
      U(20)=AI*AB(I,8)*COS(X)+U(20)
   50 CONTINUE
C CHECK FOR B HARMONICS
  110 IF(IAB.EQ.IA) GO TO 120
      K=IA+1
C COMPUTE US,VTHETA,ETC. AS ABOVE BUT FOR B HARMONICS
      DO 55 J=K,IAB
      AI=J-IA-1
      Y=AI*XTHETA(KJ)
      Y=Y/57.2957795
      U(21)=AB(J,6)*SIN(Y)+U(21)
      U(22)=-(AI*(AB(J,7)+AB(J,8)*S)*SIN(Y))+U(22)
      U(23)=AI*(AB(J,5)+AB(J,6) *S)*COS(Y)+U(23)
      U(24)=AB(J,8)*COS(Y)+U(24)
      U(25)=(AB(J,2)+2.*AB(J,3)*S+3.*AB(J,4)*S**2)*SIN(Y)+U(25)
      U(26)=(AB(J,3)*2.+6.*AB(J,4)*S)*SIN(Y)+U(26)
      U(27)=AI*(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*COS(Y)+
     1U(27)
      U(28)=-((AI**2)*(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*
```

```
      1SIN(Y))+U(28)
       U(29)=(AB(J,5)+AB(J,6)*S)*SIN(Y)+U(29)
       U(30)=(AB(J,7)+AB(J,8)*S)*COS(Y)+U(30)
       U(31)=(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*SIN(Y)+U(31)
       U(32)=AI*(AB(J,2)+2.*AB(J,3)*S+3.*AB(J,4)*S**2)*COS(Y)+U(32)
       U(33)=6.*AB(J,4)*SIN(Y)+U(33)
       U(34)=AI*(2.*AB(J,3)+6.*AB(J,4)*S)*COS(Y)+U(34)
       U(35)=-((AI**2)*(AB(J,2)+2.*AB(J,3)*S+3.*AB(J,4)*S**2)*SIN(Y))+
      1      U(35)
       U(36)=-((AI**3)*(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*
      1      COS(Y))+U(36)
       U(37)=-((AI**2)*(AB(J,5)+AB(J,6)*S)*SIN(Y))+U(37)
       U(38)=AI*AB(J,6)*COS(Y)+U(38)
       U(39)=-((AI**2)*(AB(J,7)+AB (J,8)*S)*COS(Y)) +U(39)
       U(40)=-AI*AB(J,8)*SIN(Y)+U(40)
   55 CONTINUE
C ADD THE A AND B HARMONICS FOR AN ELEMENT
  120 DO 60 I=1,20
       U(I)=U(I)+U(I+20)
   60 CONTINUE
C USING THE DISPLACEMENT FUNCTIONS AND THEIR PARTIALS, COMPUTE THE NORMAL
C STRAINS AND SHEAR STRAIN FOR AN ELEMENT
       ES=U(1)-PHPMID*U(11)
       ETHETA=1./RMID*(U(2)+U(9)*SPMD+U(11)*CPMD)
       ESTHE=1./RMID*U(3)-U(10)/RMID*SPMD+U(4)
C COMPUTE STRAIN ENERGY USING EQNS. FOR THE STRAINS.
C COMPUTE 3 CURVATURE CHANGES OF SHELL SURFACE.
C ALL EQNS. FOR ONE ANGLE THETA OF ONE ELEMENT.
       ST(IJ,KJ,1) = ES
       ST(IJ,KJ,2) = ETHETA
       ST(IJ,KJ,3) = ESTHE
       ST(IJ,KJ,4) =
      1      -(U(6)+U(9)*PHPP+PHPMID*U(1))
       ST(IJ,KJ,5) =
      1      -1./RMID*(1./RMID*U(8)+U(5)*SPMD+PHPMID*U(9)*SPMD-1./RMID*
      1U(2)*CPMD)
       ST(IJ,KJ,6) =
```

```
1        1./RMID*(2./RMID*U(7)*SPMD-2./RMID*U(10)*SPMD*CPMD-2.*U(12)
1-PHPMID*U(3)+CPMD*U(4)-U(10)*SPMD*PHPMID)
 CAPA(1)=-(U(13)+2.*U(1)*PHPP)
 CAPA(2)=-(U(14)+U(3)*PHPP +U(18)*PHPMID)
 CAPA(3)=(1./RMID**2)*(-U(15)+(2./RMID)*SPMD*U(8)-RMID*SPMD*U(6)-
1        RMID*PHPMID*CPMD*U(5)+SPMD**2*U(5)-PHPP *RMID*SPMD*U(9)
2        +SPMD**2*PHPMID*U(9)-RMID*PHPMID*SPMD*U(1)-PHPMID**2*RMID
3        *CPMD*U(9)+CPMD*U(20)-(2./RMID)*CPMD*SPMD*U(2)-PHPMID*
4        SPMD*U(2))
 CAPA(4)=(1./RMID**2)*(-U(16)-RMID*SPMD*U(12)-RMID*PHPMID*SPMD*
1        U(3)+CPMD*U(19))
 CAPA(5)=(1./RMID**2)*(-(4./RMID)*SPMD**2*U(7)+2.*SPMD*U(12)+2.*
1        PHPMID*CPMD*U(7)+(4./RMID)*SPMD**2*CPMD*U(10)-2.*SPMD*
2        CPMD*U(4)-2.*CPMD**2*PHPMID*U(10)+2.*SPMD**2*PHPMID*
3        U(10)+2.*SPMD*U(12)-2.*RMID*U(14)-RMID*PHPP*U(3)+PHPMID
4        *SPMD*U(3)-PHPMID*RMID*U(18)-PHPMID*RMID*SPMD*U(4)-SPMD
5        *CPMD*U(4)-RMID*SPMD*U(4)*PHPMID-PHPMID**2*RMID*CPMD*
6        U(10)+SPMD**2*PHPMID*U(10)-RMID*SPMD*PHPP*U(10))
 CAPA(6)=(1./RMID)*((2./RMID)*SPMD*U(8)-(2./RMID)*SPMD*CPMD*U(2)
1        -2.*U(15)-PHPMID*U(17)+CPMD*U(20)-SPMD*PHPMID*U(2))
 RETURN
 END
 SUBROUTINE STRESR(IJ,KJ)
 COMMON /A5/ EM(50),POISSO(50)
 COMMON /B9/ IA,IB
 COMMON /B10/ C(8,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
 COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
 COMMON /B14/ XTHETA(10),NUNKTH
 COMMON /B18/ NAMES,HS
 COMMON /B19/ IELRES(10),REST(50,8),NEREST
 INTEGER SAND
 DATA SAND/4HSAND/
 EE1 = EM(IJ)
 FNU1 = POISSO(IJ)
 FNU2 = FNU1
 IF(NAMES.NE.SAND)GO TO 2
 A=2.*(EE1*T(KJ))/(1. - FNU1*FNU2)
```

```
      CXX=(EE1*T(KJ)*HS**2)/(2.*(1.-FNU1*FNU2))
      GO TO 3
    2 A=(EE1*T(KJ))/(1.-FNU1*FNU2)
      CXX=(EE1*T(KJ)**3)/(12.*(1.-FNU1*FNU2))
    3 B=A
      D=CXX
      G = EE1/(2.0*(1.0 + FNU1))
C FOLLOWING ARE PARTIALS OF MS,MTHETA,MSTHETA
      PMSS=CXX*CAPA(1)+FNU1*CXX*CAPA(3)
      PMTT=FNU2*D*CAPA(2)+D*CAPA(4)
      IF(NAMES.NE.SAND)GO TO 4
      PMSTS=G*T(KJ)*HS**2*CAPA(5)/2.
      PMSTT=G*T(KJ)*HS**2*CAPA(6)/2.
      GO TO 5
    4 PMSTS=G*(T(KJ)**3/12.)*CAPA(5)
      PMSTT=G*(T(KJ)**3/12.)*CAPA(6)
C   COMPUTE STRESS RESULTANTS
    5 STR(IJ,KJ,1) = A*ST(IJ,KJ,1) + A*FNU1*ST(IJ,KJ,2)
      STR(IJ,KJ,2) = FNU2*B*ST(IJ,KJ,1) + B*ST(IJ,KJ,2)
      STR(IJ,KJ,4)=CXX*ST(IJ,KJ,4)+FNU1*CXX*ST(IJ,KJ,5)
      STR(IJ,KJ,5) = FNU2*D*ST(IJ,KJ,4) + D*ST(IJ,KJ,5)
      STR(IJ,KJ,7)=(1./RMID)*(RMID*PMSS+PMSTT+(STR(IJ,KJ,4)-
     1             STR(IJ,KJ,5))*SPMD)
      IF(NAMES.NE.SAND)GO TO 6
      STR(IJ,KJ,3)=2.*G*T(KJ)*ST(IJ,KJ,3)
      STR(IJ,KJ,6)=G*T(KJ)*HS**2*ST(IJ,KJ,6)/2.
      STR(IJ,KJ,8)=(1./RMID)*(RMID*PMSTS+PMTT+2.*SPMD*STR(IJ,KJ,6))
      RETURN
    6 STR(IJ,KJ,3) = G*T(KJ)*ST(IJ,KJ,3)
      STR(IJ,KJ,6) = (T(KJ)**3/12.)*ST(IJ,KJ,6)*G
      STR(IJ,KJ,8)=(1./RMID)*(RMID*PMSTS+PMTT+2.*SPMD*STR(IJ,KJ,6))
      RETURN
      END
```

APPENDIX C

LISTING OF THE COMPUTER PROGRAM FOR THE NONLINEAR ANALYSIS

```
      COMMON /A3/ NDP,NET,IXX(12)
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES,HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
      COMMON /B30/ NA,NB
      COMMON /C1/ NDELQ
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      COMMON /F1/ ITER,EROR,X,ITLAST,NSTRAI,IPLAST,XSM
      COMMON /G1/ APPO,THELO,RC,RL,PR
      COMMON /G2/ NCE(50),NAET(50),THETA(50,51),THICKC(50,51)
      COMMON /G4/ ONEDD(51,48)
      COMMON /G5/ ONED(51,48)
      COMMON /G9/ TTA(50,50)
      DOUBLE PRECISION ONED
      INTEGER PROBLE,RERUN,RRUN,APOL,APPO
      DATA RERUN/4HRRUN/
      INTEGER REST
      IDISPL=0
      READ(5,101)NPROBL
  101 FORMAT(I5)
      DO 100 IPROBL=1,NPROBL
      CALL TABLES
      CALL STIFOR
      IF(PROBLE.NE.RERUN)CALL DISPLA
      IF(PROBLE.EQ.RERUN)CALL DISPLI
      CALL NONLIN
  100 CONTINUE
      IF(ISAVE.EQ.0)PRINT 102,ISCRA3
```

```
102 FORMAT(46X,41HS A V E   T A P E   L O G I C A L   U N I T I2)
    STOP
    END
    SUBROUTINE TABLES
    COMMON /A3/ NDP,NET,IXX(12)
    COMMON /A5/ EM(50),POISSO(50)
    COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PRUBLE
    COMMON /B9/ IA,IB
    COMMON /B14/ XTHETA(10),NUNKTH
    COMMON /B18/ NAMES,HS
    COMMON /B19/ IELRES(10),REST(50,8),NEREST
    COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
    COMMON /B30/ NA,NB
    COMMON /C1/ NDELQ
    COMMON /D10/ ISAVE, IDISPL
    COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
   1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
   2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
   3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
    COMMON /[illegible]/ ITER,EROR,X,ITLAST,NSTRAI,IPLAST,XSM
    COMMON /G1/ APPO,THELO,RC,RL,PR
    COMMON /G2/ NCE(50),NAET(50),THETA(50,51),THICKC(50,51)
    DIMENSION THET(51),THI(51)
    DIMENSION RK(4),RRRE(4)
    DIMENSION TITL(40)
    INTEGER TITL
    INTEGER REST
    INTEGER BLAN
    INTEGER CONST
    INTEGER SAND
    INTEGER CONS
    INTEGER PROBLE,RERUN,RRUN,APOL,APPO
    REAL IXED
    DATA SAND/4HSAND/
    DATA CONST/4HCONS/
    DATA RREST1/4HIXED/,RREST2/3HREE/
    DATA NAME/2H  /
```

```
      DATA BLAN/4H    /
      DATA RERUN/4HRRUN/
      NTAPE=1
      ISCRA1=2
      IPAGE = 1
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
  604 FORMAT(1H1,62X,4HPAGEI3///)
      WRITE(6,605)
  605 FORMAT(56X,20HGENERAL  INFORMATION////)
      DO 600 I =1,20
      READ(5,601)(TITL(J),J=1,40)
  601 FORMAT(40A2)
      IF(TITL(1).EQ.NAME)GO TO 603
      WRITE(6,602)(TITL(J),J=1,40)
  602 FORMAT(26X,40A2///)
  600 CONTINUE
  603 WRITE(6,620)
  620 FORMAT(1H0,55X,20H********************/)
      WRITE(6,621)
  621 FORMAT(59X,14H**************/)
      WRITE(6,622)
  622 FORMAT(63X,6H******)
      READ(5,8)IA,IB,ISCRA3,NELEMS,NET,NEREST,NUNKTH,NA,NB,NDELQ,
     1ITER,ITLAST,ISAVE,NAMES,HS,IDEN,PROBLE,EROR,X,NSTRAI,IPLAST
     2,XSM
      READ(5,9)APPO,THELO,RC,RL,PR
    9 FORMAT(A4,6X,4F10.0)
      READ(5,66)(XTHETA(I),I=1,NUNKTH)
   66 FORMAT(8F10.0)
      NH = IA + IB
      IF(PROBLE.EQ.RERUN)WRITE(6,450)IDEN
      IF(PROBLE.EQ.RERUN)RETURN
      REWIND ISCRA1
    8 FORMAT(13I3,A4,F5.0,2A4,2F6.2,2I1,F7.0)
      REWIND ISCRA3
      WRITE(6,401)IDEN
```

```
401 FORMAT(1H0,54X,22HP  R  O  B  L  E  M   A5)
450 FORMAT(1H0,28X,31HR E R U N  O F  P R O B L E M  A5,38H  W I T H
   1N E W  F O R C E  I N P U T)
    WRITE(6,604)IPAGE
    IPAGE = IPAGE + 1
    WRITE(6,300)
300 FORMAT(54X,23HN O M E N C L A T U R E///)
    WRITE(6,301)
301 FORMAT(16X,40HZ             ***** SHELL AXIAL COORDINATE/)
    WRITE(6,302)
302 FORMAT(16X,54HR             ***** SHELL RADIAL COORDINATE(CYLINDRICA
   1L)/)
    WRITE(6,303)
303 FORMAT(16X,56HE             ***** MODULUS OF ELASTICITY OF SHELL ELE
   1MENT/)
    WRITE(6,304)
304 FORMAT(16X,50HNU            ***** POISSON,S RATIO OF SHELL ELEMENT/
   1)
    WRITE(6,305)
305 FORMAT(16X,63HPHI           ***** ANGLE BETWEEN MERIDIAN AND AXIS OF
   1 REVOLUTION/)
    IF(NSTRAI.NE.0)GO TO 480
    WRITE(6,306)
306 FORMAT(16X,98HE(S)          ***** STRAIN OF THE MIDDLE SURFACE OF TH
   1E SHELL ELEMENT ALONG THE MERIDIONAL DIRECTION/)
    WRITE(6,307)
307 FORMAT(16X,103HE(THETA)      ***** STRAIN OF THE MIDDLE SURFACE OF T
   1HE SHELL ELEMENT ALONG THE CIRCUMFERENTIAL DIRECTION/)
    WRITE(6,308)
308 FORMAT(16X,94HE(S-THETA)    ***** STRAIN OF THE MIDDLE SURFACE OF TH
   1E SHELL ELEMENT ALONG THE NORMAL DIRECTION/)
    WRITE(6,309)
309 FORMAT(16X,83HK(S)          ***** CURVATURE CHANGE OF THE SHELL ELEM
   1ENT SURFACE IN MERIDIONAL PLANE/)
    WRITE(6,310)
310 FORMAT(16X,110HK(THETA)      ***** CURVATURE CHANGE OF THE SHELL ELE
   1MENT SURFACE IN THE PLANE PERPENDICULAR TO MERIDIONAL PLANE/)
```

```
      WRITE(6,311)
  311 FORMAT(16X,52HK(S-THETA)   ***** TWIST OF THE SHELL ELEMENT SURFACE
     1/)
  480 WRITE(6,312)
  312 FORMAT(16X,84HN(S)         ***** NORMAL FORCE PER UNIT LENGTH OF CI
     1RCUMFERENTIAL SECTION OF A SHELL/)
      WRITE(6,313)
  313 FORMAT(16X,79HN(THETA)     ***** NORMAL FORCE PER UNIT LENGTH OF ME
     1RIDIONAL SECTION OF A SHELL/)
      WRITE(6,314)
  314 FORMAT(16X,108HN(S-THETA)   ***** SHEARING FORCE PER UNIT LENGTH OF
     1 CIRCUMFERENTIAL SECTION OR MERIDIONAL SECTION OF A SHELL/)
      WRITE(6,315)
  315 FORMAT(16X,86HM(S)         ***** BENDING MOMENT PER UNIT LENGTH OF
     1CIRCUMFERENTIAL SECTION OF A SHELL/)
      WRITE(6,316)
  316 FORMAT(16X,81HM(THETA)     ***** BENDING MOMENT PER UNIT LENGTH OF
     1MERIDIONAL SECTION OF A SHELL/)
      WRITE(6,317)
  317 FORMAT(16X,109HM(S-THETA)  ***** TWISTING MOMENT PER UNIT LENGTH O
     1F CIRCUMFERENTIAL SECTION OR MERIDIONAL SECTION OF A SHELL/)
      WRITE(6,318)
  318 FORMAT(16X,95HQ(S)         ***** SHEARING FORCE NORMAL TO THE SHELL
     1 PER UNIT LENGTH OF CIRCUMFERENTIAL SECTION/)
      WRITE(6,319)
  319 FORMAT(16X,90HQ(THETA)     ***** SHEARING FORCE NORMAL TO THE SHELL
     1 PER UNIT LENGTH OF MERIDIONAL SECTION/)
      WRITE(6,620)
      WRITE(6,621)
      WRITE(6,622)
      DO 800 I=1,NELEMS
      DO 801 J=1,8
      REST(I,J) = 0
  801 CONTINUE
  800 CONTINUE
      READ(5,510)Z1(1),Z2(1),RO1(1),RO2(1),PHY1(1),PHY2(1)
  510 FORMAT(6E12.5)
```

```
      IF(PHY2(1).EQ.0.)GO TO 521
      RCAP=0.
      DO 522 J=2,NELEMS
  522 READ(5,510)Z1(J),Z2(J),RO1(J),RO2(J),PHY1(J),PHY2(J)
      GO TO 354
  521 CONTINUE
      READ(5,3)RCAP,RFILET,RMAX
      J = 1
      TCR = 0
      CALL WEH2(PHY1,PHY2,J,TCR)
      NNODES = NELEMS + 1
      DO 54 I=1,NNODES
      CALL WEH3(I,NP,CORD,RADIUS,PHY2,J,NNODES,RCAP,RFILET,RMAX,ZMAX)
      IF(I.EQ.NNODES)GO TO 56
      Z1(I) = CORD
      RO1(I) = RADIUS
      IF(I.EQ.1)GO TO 54
   56 Z2(I -1) = CORD
      RO2(I - 1) = RADIUS
   54 CONTINUE
  354 IELT=0
  252 READ(5,2)NAMET,IEL1,IEL2,THIK,NC
    2 FORMAT(A4,1X,2I5,F10.0,I5)
      IF(NAMET.NE.CONST)GO TO 250
      IF(IEL1.NE.0.AND.IEL2.NE.0)GO TO 781
      IEL1=1
      IEL2=1
  781 DO 251 I=IEL1,IEL2
      IELT=IELT+1
      NCE(I)=1
      NAET(I)=NAMET
      THETA(I,1)=0.
      THICKC(I,1)=THIK
  251 CONTINUE
      IF(IELT.NE.NELEMS)GO TO 252
      GO TO 253
  250 READ(5,98)(THET(I),THI(I),I=1,NC)
```

```
      IF(IEL1.EQ.0)IEL1=IELT+1
      IF(IEL2.EQ.0)IEL2=IELT+1
      DO 780 J=IEL1,IEL2
      NCE(J)=NC
      NAET(J)=NAMET
      DO 460 JE=1,NC
      THETA(J,JE)=THET(JE)
      THICKC(J,JE)=THI(JE)
  460 CONTINUE
  780 IELT=IELT+1
      IF(IELT.NE.NELEMS)GO TO 252
  253 CONTINUE
   98 FORMAT(8F10.0)
      IELT = 0
  262 READ(5,2)NAM,IEL1,IEL2,EM(IEL1)
      IF(NAM.NE.CONST)GO TO 260
      DO 261 I=IEL1,IEL2
      EM(I) = EM(IEL1)
  261 CONTINUE
      IELT = IEL2
      GO TO 265
  260 IELT = IELT + 1
      EM(IELT) = EM(IEL1)
  265 IF(IELT.NE.NELEMS)GO TO 262
      IELT = 0
  272 READ(5,2)NAM,IEL1,IEL2,POISSO(IEL1)
      IF(NAM.NE.CONST)GO TO 270
      DO 271 I=IEL1,IEL2
      POISSO(I) = POISSO(IEL1)
  271 CONTINUE
      IELT = IEL2
      GO TO 275
  270 IELT = IELT + 1
      POISSO(IELT) = POISSO(IEL1)
  275 IF(IELT.NE.NELEMS)GO TO 272
    3 FORMAT(8F10.0)
      LINES = 0
```

```
      DO 612 J=1,NELEMS
      IF(J.NE.1.AND.LINES.LT.24)GO TO 609
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
      LINES = 0
      WRITE(6,606)
  606 FORMAT(44X,45HELASTIC AND GEOMETRIC PROPERTIES OF STRUCTURE//)
      WRITE(6,607)
  607 FORMAT(15X,7HELEMENT,8X,4HNODE,12X,11HCOORDINATES,18X,17HELASTIC C
     1ONSTANTS/)
      WRITE(6,608)
  608 FORMAT(17X,3HNO.,10X,4HNOS.,10X,1HZ,13X,1HR,17X,1HE,12X,2HNU,18X,3
     1HPHI///)
  609 JJ = J + 1
      WRITE(6,610)J,J,Z1(J),RO1(J),EM(J),POISSO(J),PHY1(J),JJ,Z2(J),
     1RO2(J),PHY2(J)
      LINES = LINES + 1
  610 FORMAT(17X,I2,12X,I2,5X,E12.5,3X,E12.5,5X,E12.5,2X,E12.5,9X,E12.5/
     1(31X,I2,5X,E12.5,3X,E12.5,40X,E12.5))
  612 CONTINUE
    1 FORMAT(10I5)
      WRITE(6,400)IA,NET,IB
  400 FORMAT(1H0,16X,23HNUMBER OF A HARMONICS =I3,9X,28HNUMBER OF SIMPSO
     1N STATIONS =I3,8X,23HNUMBER OF B HARMONICS =I3)
      IF(RCAP.EQ.0.)GO TO 501
      WRITE(6,500)RCAP
  500 FORMAT(48X,30HRADIUS  OF  SPHERICAL  SHELL =F8.3)
  501 WRITE(6,620)
      WRITE(6,621)
      WRITE(6,622)
      READ(5,1)(IELRES(I),I=1,NEREST)
      DO 200 I=1,NEREST
      READ(5,1) J,(REST(J,IJ),IJ=1,8)
  200 CONTINUE
      DO 5555 IEL=1,NELEMS
      NAMET=NAET(IEL)
      NC=NCE(IEL)
```

```
      THETA(IEL,NC+1)=360.
      IF(IEL.EQ.1)LLINES=54
      IIFLAG=0
      NCCP=NC
      JJFLAG=0
      IC=0
  717 NCP=NCCP - 4
      IF(NCP)701,701,702
  702 NCP1=IC*4 + 1
      NCP2 = NCP1 + 3
      IC = IC + 1
      GO TO 703
  701 NCP1 = IC*4 + 1
      NCP2 = NC
      IIFLAG = 1
  703 IF(LLINES.LT.54)GO TO 704
      LLINES = 0
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
      JJFLAG = 0
      WRITE(6,706)
      IF(NAMES.NE.SAND)GO TO 7777
      WRITE(6,7778)HS
 7778 FORMAT(31X,44HSANDWICH TYPE SHELL WITH FACE SHEETS SPACED F7.3,1X,
     13HIN ,15HFROM EACH OTHER/)
      WRITE(6,7779)
 7779 FORMAT(43X,46HTHICKNESSES OF EACH FACE SHEET ARE GIVEN BELOW//)
 7777 CONTINUE
      LLINES = LLINES + 8
  706 FORMAT(56X,20HTABLE OF THICKNESSES/)
  704 CONTINUE
      IF(NC.NE.1)GO TO 716
      WRITE(6,2000)IEL,THICKC(IEL,1)
 2000 FORMAT(1H0,32X,12HELEMENT NO. I3,20X,21HCONSTANT  THICKNESS =F10.5
     1//)
      LLINES = LLINES + 4
      GO TO 2001
```

```
  716 IF(JJFLAG.EQ.0)WRITE(6,710)IEL
  710 FORMAT(60X,12HELEMENT NO. I3/)
      LLINES = LLINES + 2
      IF(NAMET.NE.BLAN)GO TO 2002
      WRITE(6,2003)(THETA(IEL,IY),THETA(IEL,IY+1),IY=NCP1,NCP2)
      WRITE(6,709)(THICKC(IEL,IY),IY=NCP1,NCP2)
      GO TO 2004
 2003 FORMAT(1H0,5HTHETA,9H(DEGREES),3X,4(3X,F10.5,4H TO ,F10.5))
 2002 WRITE(6,708)(THETA(IEL,IY),IY=NCP1,NCP2)
      WRITE(6,709)(THICKC(IEL,IY),IY=NCP1,NCP2)
  708 FORMAT(1H0,5HTHETA,9H(DEGREES),12X,F10.5,3(17X,F10.5))
  709 FORMAT(1X,9HTHICKNESS,4(17X,F10.5))
 2004 LLINES = LLINES + 3
      NCCP= NCP
      JJFLAG = 1
      IF(IIFLAG.EQ.0)GO TO 717
 2001 CONTINUE
 5555 CONTINUE
      REWIND ISCRA1
      WRITE(6,604)IPAGE
      IPAGE = IPAGE + 1
      WRITE(6,900)
  900 FORMAT(56X,20HBOUNDARY  CONDITIONS///)
      WRITE(6,901)
  901 FORMAT(50X,32HDISPLACEMENT COMPONENTS OF NODES/////)
      WRITE(6,902)
  902 FORMAT(23X,8HNODE NO.,10X,5HAXIAL,12X,10HTANGENTIAL,11X,6HRADIAL,
     112X,7HANGULAR////)
      DO 903 IRE=1,NELEMS
      JISE = 0
      DO 904 ISE=1,4
      RK(ISE)= 0.
      IF(REST(IRE,ISE).EQ.0)GO TO 904
      RK(ISE)=1.
      JISE=1
  904 CONTINUE
      IF(JISE.EQ.0)GO TO 903
```

```
      DO 905 ISE=1,4
      RRRE(ISE)=RREST2
      IF(RK(ISE).EQ.1.)RRRE(ISE)=RREST1
  905 CONTINUE
      WRITE(6,906)IRE,(RRRE(ISE),ISE=1,4)
  906 FORMAT(26X,I2,13X,1HF,A4,15X,1HF,A4,14X,1HF,A4,13X,1HF,A4/)
  903 CONTINUE
      JISE = 0
      DO 907 ISE=1,4
      RK(ISE)=0.
      ISEE=ISE + 4
      IF(REST(NELEMS,ISEE).EQ.0)GO TO 907
      RK(ISE)=1.
      JISE = 1
  907 CONTINUE
      IF(JISE.EQ.0)GO TO 908
      DO 909 ISE=1,4
      RRRE(ISE)=RREST2
      IF(RK(ISE).EQ.1.)RRRE(ISE)=RREST1
  909 CONTINUE
      INEL = NELEMS + 1
      WRITE(6,906)INEL,(RRRE(ISE),ISE=1,4)
  908 CONTINUE
      WRITE(6,910)
  910 FORMAT(1H0,47X,36HALL OTHER NODES ARE FREE TO DISPLACE//)
      WRITE(6,620)
      WRITE(6,621)
      WRITE(6,622)
      RETURN
      END
      SUBROUTINE WEH2(P1,P2,J,TCR)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      DIMENSION P1(50),P2(50)
      READ (5,21) NPARTS
      READ (5,21) NE1,T1,NCYLIN
   21 FORMAT (I5,F10.0,I5)
      NP=1
```

```
      XE1=NE1
      H=T1/XE1
      P1(1)=90.0
      P2(1)=90.0-H
      DO 31 I=2,NE1
      XI=I
      P1(I)=P2(I-1)
   31 P2(I)=90.0-H*XI
      IF (NPARTS-1) 35,35,32
   32 READ (5,21) NE2,T2,NCYLIN
      IF (NCYLIN) 2,1,2
    1 NP=NP+1
      XE2=NE2
      H=T2/XE2
      DO 33 I=1,NE2
      XI=I
      J=NE1+I
      P1(J)=P2(J-1)
      P2(J)=P2(NE1)-H*XI
      IF (ABS(P2(J)-TCR)-0.005) 37,37,33
   37 P2(J)=TCR
   33 CONTINUE
      IF (NP-NPARTS) 34,35,35
   34 NE1=NE1+NE2
      GO TO 32
    2 J=NELEMS-NE2+1
      P2(J-1)=T2
      DO 101 K=J,NELEMS
      P1(K)=0.0
  101 P2(K)=0.0
      GO TO 36
   35 J=NELEMS+2
   36 RETURN
      END
      SUBROUTINE WEH3(I,N,C,R,P,J,NNODES,RCAP,RFILET,RMAX,ZMAX)
      DIMENSION P(50)
      TCR=ARCOS((RMAX-RFILET)/(RCAP-RFILET))
```

```
      N=I
      IF (I-1) 1,1,2
    1 C=0.0
      R=1.E-6
      K=J
      CKEEP=RCAP-(RCAP-RFILET)*SIN(TCR)
      GO TO 11
    2 IF (I-J) 3,4,4
    3 T=P(I-1)/57.2957795
      IF (T-TCR) 6,5,5
    5 R=RCAP*COS(T)
      C=RCAP-RCAP*SIN(T)
      GO TO 11
    6 R=(RMAX-RFILET)+RFILET*COS(T)
      C=RCAP-(RCAP-RFILET)*SIN(TCR)-RFILET*SIN(T)
      GO TO 11
    4 R=RMAX
      IF (I-K) 7,7,9
    7 IF (I-NNODES) 8,9,9
    8 READ (5,21) NE1,S1
   21 FORMAT (I5,F10.0)
      XE1=NE1
      H=S1/XE1
    9 XI=I-K
      C=CKEEP+H*XI
      IF (I-K-NE1+1) 11,10,10
   10 CKEEP=CKEEP+S1
      K=I+1
   11 RETURN
      END
      SUBROUTINE STIFOR
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A2/ ONE(48),TWO(48)
      COMMON /A3/ NDP,NET,IXX(12)
      COMMON /A5/ EM(50 ,POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B1/ AL(159)
```

```
      COMMON /B2/ AR (30), AS(30), PHP(30), SINE(30), COSINE(30)
      COMMON /B3/ PHPP
      COMMON /B4/ F(8,8)
      COMMON /B5/ISIMP
      COMMON /B6/ AK(8,8)
      COMMON /B7/ PHIMAT(8,8)
      COMMON /B8/ CHECK(8,8)
      COMMON /B9/ IA,IB
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B15/ IELL,NDPP,IXXX(12),LINEL,ICON,ICOO,NSTOP
      COMMON /B18/ NAMES,HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
      COMMON /B30/ NA,NB
      COMMON /C1/ NDELQ
      COMMON /C40/ IPRI
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      COMMON /G1/ APPO,THELO,RC,RL,PR
      COMMON /G2/ NCE(50),NAET(50),THETA(50,51),THICKC(50,51)
      COMMON /G4/ ONEDD(51,48)
      COMMON /G9/ TTA(50,50)
      DOUBLE PRECISION FKK(4656),AAK(8,8)
      DIMENSION RK(4),RRRE(4)
      DIMENSION TA(2,50)
      INTEGER PROBLE,RERUN,RRUN,APOL,APPO
      INTEGER REST
      INTEGER END
      INTEGER SAND
      DATA SAND/4HSAND/
      DATA END/3HEND/
      DATA RERUN/4HRRUN/
      XNDELQ=NDELQ
      IPRI=0
```

```
      ISIMP = 0
C             EM= MODULUS OF ELASTICY OF SHELL ELEMENT
C             POISSO = POISSON,S RATIO OF SHELL ELEMENT
C             ISOTROPIC SHELL ELEMENT ONLY
C             IELRES IDENTIFIES WHICH NODE IS RESTRAINED
C             REST NOT EQUAL TO ZERO RESTRAINS NODE DISPLACEMENT COMPONENT
C             IA = NO. OF A HARMONICS
C             IB = NO. OF B HARMONICS
C             NTAPE = BIN TAPE WITH STIFFNESS MATRIX
C             NTAPEF = BIN TAPE WITH FORCE MATRIX
C             ISCRA1,ISCRA2=BIN SCRATCH TAPES
C             NELEMS = NO. OF ELEMENTS
C             NEREST = NO. OF RESTRAINED NODES
C             TOTAL NUMBER OF A AND B HARMONICS - NH
      N = 4*NH
      DO 40 I=1,N
      ONE(I) = 0.0
      TWO(I) = 0.0
   40 CONTINUE
      LINEL = 0
      ICOO=1
      IF(PROBLE.EQ.RERUN)GO TO 613
      REWIND NTAPE
C             NUMBER OF ELEMENTS IN EACH TRIANGLE OF FKK - NN
      IF(ISAVE.EQ.0)WRITE(ISCRA3)NEREST,(IELRES(I),I=1,NEREST),
     1((REST(J,K),K=1,8),J=1,NELEMS),(EM(IS),POISSO(IS),IS=1,NELEMS)
      NN = N*(N+1)/2
C             INDEX OF FIRST ELEMENT OF FKK SQUARE - N1
      N1 = 2*NN + 1
C             INDEX OF LAST ELEMENT OF FKK SQUARE - N2
      N2 = 2*NN + N*N
C             INITIALIZE UPPER TRIANGLE OF FKK
      DO 10 I=1,NN
      FKK(I) = 0.0
   10 CONTINUE
      DO 34 IEL=1,NELEMS
C             OBTAIN AR, AS, PHP, SINE, PHPP, AND COSINE FOR EACH ELEMENT
```

```
      CALL ELEMCA (RO1(IEL),RO2(IEL),PHY1(IEL),PHY2(IEL),Z1(IEL),
     1Z2(IEL),DS,IEL)
C              CALL CRETAL TO OBTAIN AL ARRAY
      CALL CRETAL(DS,IEL)
      NC=NCE(IEL)
      NAMET=NAET(IEL)
      IF(ISAVE.EQ.0)WRITE(ISCRA3)NCE(IEL),NAET(IEL)
      DO 300 I=1,NC
  300 THETA(IEL,I)=THETA(IEL,I)/57.2957795
      IF(ISAVE.EQ.0)WRITE(ISCRA3)(THETA(IEL,I),THICKC(IEL,I),I=1,NC)
      THETA(IEL,NC+1)=6.28318531
      THICKC(IEL,NC+1)=THICKC(IEL,1)
      PI=3.14159265
      IFO=NA+NB+1
      DO 731 I1=1,IFO
      TA(1,I1)=0.
  731 TA(2,I1)=0.
      IEXPT=1
      DO 701 I2=1,2
      SUM1=0.
      DO 700 I1=1,NC
  700 SUM1=SUM1+THICKC(IEL,I1)**IEXPT*(THETA(IEL,I1+1)-THETA(IEL,I1))
      TA(I2,1)=SUM1/(2.*PI)
      IF(NC.EQ.1)GO TO 730
      IF(NA.EQ.0)GO TO 740
      DO 702 I1=1,NA
      SUM2=0.
      HII=I1
      DO 703 I3=1,NC
      X=THETA(IEL,I3)
      XX=THETA(IEL,I3+1)
  703 SUM2=SUM2+THICKC(IEL,I3)**IEXPT*(SIN(HII*XX)-SIN(HII*X))
  702 TA(I2,I1+1)=SUM2/(HII*PI)
  740 IF(NB.EQ.0)GO TO 730
      DO 704 I1=1,NB
      SUM3=0.
      HII=I1
```

```
      DO 705 I3=1,NC
      X=THETA(IEL,I3)
      XX=THETA(IEL,I3+1)
  705 SUM3=SUM3+THICKC(IEL,I3)**IEXPT*(COS(HII*XX)-COS(HII*X))
      I4=NA+I1+1
  704 TA(I2,I4)=-SUM3/(HII*PI)
  730 IF(NAMES.EQ.SAND)GO TO 706
      IEXPT=3
  701 CONTINUE
  706 IF(NAMES.NE.SAND)GO TO 715
      DO 717 I1=1,IFO
  717 TA(2,I1)=TA(1,I1)
  715 CONTINUE
      DO 32 I=1,NH
      DO 32 J=I,NH
C             FOLLOWING DETERMINES WHICH VALUES FOR AM AND AN ARE TO BE USED
      IF (I.GT.IA.OR.J.GT.IA) GO TO 12
      M1= I - 1
      N3= J - 1
      MI=M1+1
      NI=N3+1
      KEY1=0
      GO TO 16
   12 IF (I.LE.IA) GO TO 14
      M1= - (I - IA - 1)
      N3= - (J - IA - 1)
      MI=-M1+1
      NI=-N3+1
      KEY1=2
      GO TO 16
   14 M1= I - 1
      N3= - (J - IA - 1)
      MI=M1+1
      NI=-N3+1
      KEY1=1
   16 HM = M1
      HN = N3
```

```
C               CALL SUBROUTINE TO GET FL - AN 8X8 MATRIX
      SIMP1=0.
      SIMP2=0.
      SIMP3=0.
      SIMP4=0.
      IF((MI-1).EQ.(NI-1).AND.(MI-1).EQ.0.AND.KEY1.NE.1)GO TO 742
      IF((MI-1).EQ.(NI-1).AND.(MI-1).NE.0.AND.KEY1.NE.1)GO TO 744
      GO TO 741
  742 IF(KEY1.EQ.0)GO TO 760
      SIMP3=TA(1,1)*2.0*PI
      SIMP4=TA(2,1)*2.0*PI
      GO TO 741
  760 SIMP1=TA(1,1)*2.0*PI
      SIMP2=TA(2,1)*2.0*PI
      GO TO 741
  744 SIMP1=TA(1,1)*PI
      SIMP2=TA(2,1)*PI
      SIMP3=SIMP1
      SIMP4=SIMP2
  741 IF(NC.EQ.1)GO TO 311
      I2=NA
      I3=1
      IF(I2.NE.0)GO TO 747
      I3=2
      I2=NB
  747 DO 745 I1=1,I2
      IF((NI+MI).NE.(I1+2).AND.IABS(NI-MI).NE.I1)GO TO 745
      IF(KEY1.NE.1)GO TO 750
      CALL INTE(MI,I1+1,NI,I3,SIM1)
      CALL INTE(I1+1,NI,MI,I3,SIM2)
      IF(I3.EQ.1)GO TO 751
      ASIM1=SIM1
      SIM1=SIM2
      SIM2=ASIM1
      GO TO 751
  750 CALL INTE(MI,NI,I1+1,KEY1+I3-1,SIM1)
      CALL INTE(MI,NI,I1+1,1-KEY1+I3,SIM2)
```

```
  751 III=NA*(I3-1)+I1+1
      SIMP1=SIMP1+TA(1,III)*SIM1
      SIMP2=SIMP2+TA(2,III)*SIM1
      SIMP3=SIMP3+TA(1,III)*SIM2
      SIMP4=SIMP4+TA(2,III)*SIM2
  745 CONTINUE
      IF(I3.EQ.2)GO TO 311
      IF(NB.EQ.0)GO TO 311
      I3=2
      I2=NB
      GO TO 747
  311 IF(NAMES.NE.SAND)GO TO 314
      SIMP1=2.*SIMP1
      SIMP3=2.*SIMP3
      SIMP2=SIMP2*6.0*HS**2
      SIMP4=SIMP4*6.0*HS**2
  314 E1=EM(IEL)
      FNU1=POISSO(IEL)
      E2=E1
      GXX=E1/(2.*(1.+FNU1))
      CONST1=E1/(1.-FNU1*FNU1)
      CC1=CONST1*SIMP1
      CC=2.*CONST1*FNU1*SIMP1
      DD1=CONST1*SIMP2/12.
      DD=CONST1*FNU1*SIMP2/6.
      GG1=GXX*SIMP3
      GG2=GXX*SIMP4/12.0
      CALL CREATL(HM,HN,CC1,CC1,CC,DD1,DD1,DD,GG1,GG2)
C             CALL SUBROUTINE TO PRE AND POST MULTIPLY FL TO GET AK
      CALL MMPLT3
C******INTRODUCE BOUNDARY CONDITIONS
      DO 110 IR=1,NEREST
      IF(IELRES(IR).NE.IEL)GO TO 110
      DO 101 JR=1,8
      IF(REST(IEL,JR).EQ.0)GO TO 101
      DO 102 JRR=1,8
      AK(JR,JRR)=0.
```

```
      AK(JRR,JR)=0.
  102 CONTINUE
      IF(I.EQ.J)AK(JR,JR)=1.
  101 CONTINUE
  110 CONTINUE
      DO 481 L=1,8
      DO 482 M=1,8
      AAK(L,M)=AK(L,M)
  482 CONTINUE
  481 CONTINUE
C             THE FOLLOWING TAKES EACH ELEMENT OF AK AND PUTS IT IN
C                   THE PROPER LOCATION OF FKK
      DO 30 L=1,8
      DO 30 M=1,8
      IF (I.NE.J) GO TO 18
      IF (L.GT.M) GO TO 30
   18 IF (L.GT.4.OR.M.GT.4) GO TO 20
C             ELEMENT IS IN UPPER LEFT 4X4 OF AK MATRIX.
C             THUS, STORE IN 1ST TRIANGLE OF FKK(I1), I1=1,NN
      INDEX = 4*(I-1) + L
      JNDEX = 4*(J-1) + M
C             SINGLE INDEX OF FKK - KNDEX
      KNDEX = JNDEX*(JNDEX-1)/2 + INDEX
C            ADD 2CD TRIANGLE OF PREVIOUS ELEMENT TO FIRST OF THIS ELEMENT
      FKK(KNDEX)=FKK(KNDEX)+AAK(L,M)
      GO TO 30
   20 IF (L.LE.4.OR.M.LE.4) GO TO 22
C             ELEMENT IS IN LOWER RIGHT 4X4 OF AK MATRIX
C             THUS, STORE IN 2CD TRIANGLE OF FKK(I1),I1=NN+1,2*NN
      INDEX = 4*(I-2) + L
      JNDEX = 4*(J-2) + M
C             SINGLE INDEX OF FKK - KNDEX
      KNDEX = NN + JNDEX*(JNDEX-1)/2 + INDEX
      GO TO 28
   22 IF (M.GT.L) GO TO 24
C             ELEMENT IS IN LOWER LEFT 4X4 OF AK MATRIX.
C             IF ALONG I=J DIAGONAL, DO NOT NEED
```

```
C               OTHERWISE, TAKE TRANSPOSE AND STORE IN SQUARE OF
C                 FKK(I1), I1=2*NN+1,2*NN+N*N
      INDEX = 4*(J-1) + M
      JNDEX = 4*(I-2) + L
      GO TO 26
   24 INDEX = 4*(I-1) + L
      JNDEX = 4*(J-2) + M
C               SINGLE INDEX OF FKK - KNDEX
   26 KNDEX = 2*NN + (JNDEX-1)*N + INDEX
   28 FKK(KNDEX)=AAK(L,M)
   30 CONTINUE
   32 CONTINUE
      DO 903 I=1,N
      I1=(I*I+I)/2
      IF(FKK(I1).EQ.0.0)FKK(I1)=1.0
  903 CONTINUE
C               WRITE 1ST TRIANGLE OF FKK ON TAPE AS A RECORD
      WRITE (NTAPE) (FKK(I),I=1,NN)
C               WRITE SQUARE OF FKK ON TAPE AS A RECORD
      WRITE (NTAPE) (FKK(I),I=N1,N2)
C               STORE 2CD TRAINGLE IN FIRST
      DO 33 I=1,NN
      I1=I+NN
      FKK(I) = FKK(I1)
   33 CONTINUE
C               WRITE 2CD TRIANGLE ON TAPE ONLY IF LAST ELEMENT
      IF(IEL.NE.NELEMS)GO TO 906
      DO 907 I=1,N
      I1=(I*I+I)/2
      IF(FKK(I1).EQ.0.0)FKK(I1)=1.0
  907 CONTINUE
      WRITE(NTAPE)(FKK(I),I=1,NN)
C               CALL SUBROUTINE TO CREATE RIGHT HAND SIDE
  906 CALL FORCES(IEL)
      IF(ISAVE.EQ.0)WRITE(ISCRA3)(TA(1,K),K=1,IFO)
      DO 492 K=1,IFO
  492 TTA(IEL,K)=TA(1,K)
```

```
   34 CONTINUE
      IF(PROBLE.NE.RERUN)GO TO 612
  613 REWIND ISCRA3
      READ(ISCRA3)NEREST,(IELRES(I),I=1,NEREST),((REST(J,K),K=1,8),
     1J=1,NELEMS),(EM(IS),POISSO(IS),IS=1,NELEMS)
      DO 611 K=1,NELEMS
      READ(ISCRA3)PHPRIM,RMID,CPMD,SPMD,PHPP,ARCL,((CHECK(I,J),
     1I=1,8),J=1,8),RO2(K)
      PHPRMI(K)=PHPRIM
      RMDI(K)=RMID
      CPDM(K)=CPMD
      SPDM(K)=SPMD
      PPPH(K)=PHPP
      ARLC(K)=ARCL
      DO 4937 IST1=1,8
      DO 4938 IST2=1,8
      CHEKC(K,IST1,IST2)=CHECK(IST1,IST2)
 4938 CONTINUE
 4937 CONTINUE
      READ(ISCRA3)A1L(K),A2L(K),A3L(K),A4L(K),A5L(K),A6L(K),A7L(K),
     1A15L(K),A16L(K),A17L(K),A18L(K),A19L(K),A20L(K),A21L(K),A22L(K),
     2AL157(K),AL158(K),AL159(K)
      READ(ISCRA3)NCE(K),NAET(K)
      NC=NCE(K)
      NAMET=NAET(K)
      READ(ISCRA3)(THETA(K,I),THICKC(K,I),I=1,NC)
      THETA(K,NC+1)=6.28318531
      THICKC(K,NC+1)=THICKC(K,1)
      READ(ISCRA3)(TA(1,KJ),KJ=1,IFO)
      DO 491 KJ=1,IFO
  491 TTA(K,KJ)=TA(1,KJ)
      CALL FORCES(K)
  611 CONTINUE
  612 DO 410 IR=1,NEREST
      IF(IELRES(IR).NE.NELEMS)GO TO 410
      DO 401 JR=5,8
      IF(REST(NELEMS,JR).EQ.0)GO TO 401
```

```
      DO 402 JJR=1,NH
      KR=JR+(JJR-1)*4-4
      TWO(KR)=0.
  402 CONTINUE
  401 CONTINUE
  410 CONTINUE
      NNE=NELEMS + 1
      DO 480 KK=1,N
  480 ONEDD(NNE,KK)=TWO(KK)/XNDELQ
C             THE TAPE CREATED IN THIS PROGRAM IN USED FOR INPUT
C                 FOR THE SOLUTION PROGRAM
      RETURN
      END
      SUBROUTINE ELEMCA(R1,R2,P1,P2,Z1,Z2,DSL,IEL)
      COMMON /A3/ NDP,NET,IXX(12)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B2/ AR (30), AS(30), PHP(30), SINE(30), COSINE(30)
      COMMON /B3/ PHPP
      COMMON /B7/ PHIMAT (8,8)
      COMMON /B8/ CHECK(8,8)
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      DIMENSION PH(30), AM(8,8)
      DELZ = ABS (Z2-Z1)
      DELR=R2-R1
      AL=SQRT(DELR**2+DELZ**2)
      DELP=(P1-P2)/.572957795E+02
      P1=P1/.572957795E+02
      P2=P2/.572957795E+02
      IF(DELP)14,15,14
 15   ARCL=AL
      GO TO 10
 14   ARO=AL/(2.0*SIN(DELP/2.0))
      ARCL=ARO*DELP
```

```
C     COMPUTE TRANSFORMATION MATRIX
 10   DO 102 I=1,8
      DO 102 J=1,8
  102 PHIMAT(I,J)=0.0
      DO 105 I=1,3,2
      PHIMAT(I,I)=COS(P1)
 105  PHIMAT(I+1,I+1)=1.0
      PHIMAT(3,1)=SIN(P1)
      PHIMAT(1,3)=-PHIMAT(3,1)
      DO 106 I=5,7,2
      PHIMAT(I,I)=COS(P2)
 106  PHIMAT(I+1,I+1)=1.0
      PHIMAT(7,5)=SIN(P2)
      PHIMAT(5,7)=-PHIMAT(7,5)
C     COMPUTE M MATRIX
      DO 101 I=1,8
      DO 101 J=1,8
 101  AM(I,J)=0.0
      AM(1,3)=1.0
      AM(2,4)=1.0
      AM(5,1)=1.0
      AM(7,2)=1.0
      AL1=1.0/ARCL
      AL2=AL1**2
      AL3=AL2*AL1
      AM(6,1)=-AL1
      AM(8,2)=-AL1
      AM(3,3)=-3.0*AL2
      AM(4,3)=2.0*AL3
      AM(3,4)=-2.0*AL1
      AM(4,4)=AL2
      AM(6,5)=AL1
      AM(8,6)=AL1
      AM(3,7)=3.0*AL2
      AM(4,7)=-2.0*AL3
      AM(3,8)=-AL1
      AM(4,8)=AL2
```

```
C      COMPUTE ELEMENTS OF L MATRIX
       IF(DELP)8,9,8
 9     DO 7 I=1,NET
       PH(I)=P1
       PHP(I)=0.0
       COSINE(I)=COS(P1)
 7     SINE(I)=SIN(P1)
       CPMD=COSINE(I)
       SPMD=SINE(I)
       RMID=R2
       AS(1)=0.0
       IF(R1)24,40,24
   40 R1 = .1E-06
 24    CONTINUE
       ARCL=AL
       NET1=NET-1
       DP=AL/FLOAT(NET1)
       DSL=DP
       DO 52 I=2,NET
       J=I-1
 52    AS(I)=FLOAT(J)*DP
       AR(1)=R1
       DO 6 I=2,NET
 6     AR(I)=R1+AS(I)*SINE(1)
        PHPRIM=0.0
       PHPP=0.0
       GO TO 19
 8     CONTINUE
 28    IF(R1)29,30,29
   30 R1 = .1E-06
 29    CONTINUE
       NET1=NET-1
       RZ = (R2-R1)/(Z2-Z1)
       PHL=ATAN(RZ)
       A2=(6.0*PHL-4.0*P1-2.0*P2)/ARCL
       A3=(3.0*P1+3.0*P2-6.0*PHL)/ARCL**2
       AM(4,1) = -A2/ARCL**2
```

```
      AM(4,5) = - (A2+2.*A3*ARCL)/ARCL**2
      AM(2,1) = -A2
      AM(3,1) = 2.*A2/ARCL
      AM(3,5) = (A2+2.*A3*ARCL)/ARCL
      DSL=ARCL/FLOAT(NET1)                                              1790
42     AS(1)=0.0                                                        1830
43     PH(1)=P1                                                         1840
      SINE(1)=SIN(P1)                                                   1850
      COSINE(1)=COS(P1)                                                 1860
      PHP(1)=A2                                                         1870
      NETP=(NET+1)/2                                                    1950
      DO 25 I=2,NET                                                     1880
      AS(I)=AS(I-1)+DSL                                                 1890
      PH(I)=P1+A2*AS(I)+A3*AS(I)**2                                     1900
      PHP(I)=A2+2.0*A3*AS(I)                                            1910
      SINE(I)=SIN(PH(I))                                                1920
      COSINE(I)=COS(PH(I))
      IF(I.NE.NETP)GO TO 25
      SPMD = SINE(I)
      CPMD = COSINE(I)
   25 CONTINUE
      AR(1)=R1                                                          1940
      NETL=NET1/2                                                       1960
      PHPRIM=PHP(NETP)                                                  1970
      PHPP=2.0*A3                                                       1980
      DO 22 I=2,NETP                                                    1990
22    AR(I)=AR(I-1)+(SINE(I)+SINE(I-1))*DSL/2.0                         2000
      RMID = AR(NETP)
      AR(NET)=R2                                                        2010
      DO 53 I=1,NETL                                                    2020
      NN=NET-I                                                          2030
53    AR(NN)=AR(NN+1)-(SINE(NN+1)+SINE(NN))*DSL/2.0                     2040
   19 DO 1000 I=1,8
      DO 1000 J=1,8
      CHECK(I,J) = 0.0
      DO 1000 K=1,8
      CHECK(I,J) = AM(I,K)*PHIMAT(J,K) + CHECK(I,J)
```

```
 1000 CONTINUE
      K=IEL
      PHPRMI(K)=PHPRIM
      RMDI(K)=RMID
      CPDM(K)=CPMD
      SPDM(K)=SPMD
      PPPH(K)=PHPP
      ARLC(K)=ARCL
      DO 4937 IST1=1,8
      DO 4938 IST2=1,8
      CHEKC(K,IST1,IST2)=CHECK(IST1,IST2)
 4938 CONTINUE
 4937 CONTINUE
      IF(ISAVE.EQ.0)WRITE(ISCRA3)PHPRIM,RMID,CPMD,SPMD,PHPP,ARCL,
     1((CHECK(I,J),I=1,8),J=1,8),R2
      RETURN
       END
      SUBROUTINE CRETAL(DS,IEL)
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),D(75)
      COMMON /A3/ NDP,NET,IXX(12)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B1/ AL(159)
      COMMON /B2/ AR (30), AS(30), PHP(30), SINE(30), COSINE(30)
      COMMON /B5/ISIMP
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),R02(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
C     INTEGRATION OF L(I,J) S
      DO 1 I=1,NET
    1 GA(I)=AR(I)
      ISIMP = 1
      AL(1) = SIMP (DS)
      DO 2 I=1,NET
    2 G(I)=GA(I)*AS(I)
      AL(2) = SIMP (DS)
```

```
      DO 3 I=1,NET
    3 G(I)=G(I)*AS(I)
      AL(3) = SIMP (DS)
      DO 4 I=1,NET
    4 GA(I)=GA( )*PHP(I)
      ISIMP = 1
      AL(4) = SIMP (DS)
      DO 5 I=1,NET
    5 G(I)=GA(I)*AS(I)
      AL(5) = SIMP (DS)
      DO 6 I=1,NET
    6 G(I)=G(I)*AS(I)
      AL(6) = SIMP (DS)
      DO 7 I=1,NET
    7 G(I)=G(I)*AS(I)
      AL(7) = SIMP (DS)
      DO 8 I=1,NET
    8 GA(I)=GA(I)*PHP(I)
      ISIMP = 1
      AL(8) = SIMP (DS)
      DO 9 I=1,NET
    9 G(I)=GA(I)*AS(I)
      AL(9) = SIMP (DS)
      DO 10 I=1,NET
   10 G(I)=G(I)*AS(I)
      AL(10) = SIMP (DS)
      DO 11 I=1,NET
   11 G(I)=G(I)*AS(I)
      AL(11) = SIMP (DS)
      DO 12 I=1,NET
   12 G(I)=G(I)*AS(I)
      AL(12) = SIMP (DS)
      DO 13 I=1,NET
   13 G(I)=G(I)*AS(I)
      AL(13) = SIMP (DS)
      DO 14 I=1,NET
   14 G(I)=G(I)*AS(I)
```

```
      AL(14) = SIMP (DS)
      DO 15 I=1,NET
   15 GA(I)=PHP(I)*PHP(I)*SINE(I)
      ISIMP = 1
      AL(42) = SIMP (DS)
      DO 16 I=1,NET
   16 G(I)=GA(I)*AS(I)
      AL(43) = SIMP (DS)
      DO 17 I=1,NET
   17 GA(I)=PHP(I)*SINE(I)
      ISIMP = 1
      AL(37) = SIMP (DS)
      DO 18 I=1,NET
   18 G(I)=GA(I)*AS(I)
      AL(38) = SIMP (DS)
      DO 19 I=1,NET
   19 G(I)=G(I)*AS(I)
      AL(39) = SIMP (DS)
      DO 20 I=1,NET
   20 G(I)=G(I)*AS(I)
      AL(40) = SIMP (DS)
      DO 21 I=1,NET
   21 G(I)=G(I)*AS(I)
      AL(41) = SIMP (DS)
      DO 22 I=1,NET
   22 GA(I)=PHP(I)
      ISIMP = 1
      AL(25) = SIMP (DS)
      DO 23 I=1,NET
   23 G(I)=GA(I)*AS(I)
      AL(26) = SIMP (DS)
      DO 24 I=1,NET
   24 G(I)=G(I)*AS(I)
      AL(27) = SIMP (DS)
      DO 25 I=1,NET
   25 G(I)=G(I)*AS(I)
      AL(28) = SIMP (DS)
```

```
      DO 26 I= 1,NET
   26 G(I)=G(I)*AS(I)
      AL(29) = SIMP (DS)
      DO 27 I=1,NET
   27 G(I)=GA(I)*COSINE(I)
      AL(30) = SIMP (DS)
      DO 28 I=1,NET
   28 G(I)=G(I)*AS(I)
      AL(31) = SIMP (DS)
      DO  29 I=1,NET
   29 G(I)=G(I)*AS(I)
      AL(32) = SIMP (DS)
      DO 30 I=1,NET
   30 G(I)=G(I)*AS(I)
      AL(33) = SIMP (DS)
      DO 31 I=1,NET
   31 G(I)=G(I)*AS(I)
      AL(34) = SIMP (DS)
      DO 32 I=1,NET
   32 G(I) = G(I) * AS(I)
      AL(35) = SIMP (DS)
      DO 155 I = 1,NET
  155 G(I) = G(I) * AS(I)
      AL(36) = SIMP (DS)
      DO 33 I=1,NET
   33 GA(I)=1.
      ISIMP = 1
      AL(15) = SIMP (DS)
      DO 34 I=1,NET
   34 G(I)=GA(I)*AS(I)
      AL(16) = SIMP (DS)
      DO 35 I=1,NET
   35 G(I)=GA(I)*COSINE(I)
      AL(17) = SIMP (DS)
      DO 36 I=1,NET
   36 G(I)=G(I)*AS(I)
      AL(18) = SIMP (DS)
```

```
      DO 37 I=1,NET
   37 G(I)=G(I)*AS(I)
      AL(19) = SIMP (DS)
      DO 38 I=1,NET
   38 G(I)=G(I)*AS(I)
      AL(20) = SIMP (DS)
      DO 39 I=1,NET
   39 G(I)=GA(I)*SINE(I)
      AL(21) = SIMP (DS)
      DO 40 I=1,NET
   40 G(I)=G(I)*AS(I)
      AL(22) = SIMP (DS)
      DO 41 I=1,NET
   41 G(I)=G(I)*AS(I)
      AL(23) = SIMP (DS)
      DO 42 I=1,NET
   42 G(I)=G(I)*AS(I)
      AL(24) = SIMP (DS)
      DO 43 I=1,NET
   43 GA(I)=1./AR(I)
      ISIMP = 1
      AL(44) = SIMP (DS)
      DO 44 I=1,NET
   44 G(I)=GA(I)*AS(I)
      AL(45) = SIMP (DS)
      DO 45 I=1,NET
   45 G(I)=G(I)*AS(I)
      AL(46) = SIMP (DS)
      DO 46 I=1,NET
   46 G(I)=G(I)*AS(I)
      AL(47) = SIMP (DS)
      DO 47 I=1,NET
   47 G(I)=G(I)*AS(I)
      AL(48) = SIMP (DS)
      DO 48 I=1,NET
   48 G(I)=GA(I)*COSINE(I)
      AL(49) = SIMP (DS)
```

```
      DO 49 I=1,NET
   49 G(I)=G(I)*AS(I)
      AL(50) = SIMP (DS)
      DO 50 I=1,NET
   50 G(I)=G(I)*AS(I)
      AL(51) = SIMP (DS)
      DO 51 I=1,NET
   51 G(I)=G(I)*AS(I)
      AL(52) = SIMP (DS)
      DO 52 I=1,NET
   52 G(I)=G(I)*AS(I)
      AL(53) = SIMP (DS)
      DO 53 I=1,NET
   53 G(I)=GA(I)*COSINE(I)*COSINE(I)
      AL(54) = SIMP (DS)
      DO 54 I=1,NET
   54 G(I)=G(I)*AS(I)
      AL(55) = SIMP (DS)
      DO 55 I=1,NET
   55 G(I)=G(I)*AS(I)
      AL(56) = SIMP (DS)
      DO 56 I=1,NET
   56 G(I)=G(I)*AS(I)
      AL(57) = SIMP (DS)
      DO 57 I=1,NET
   57 G(I)=G(I)*AS(I)
      AL(58) = SIMP (DS)
      DO 58 I=1,NET
   58 G(I)=G(I)*AS(I)
      AL(59) = SIMP (DS)
      DO 59 I=1,NET
   59 G(I)=G(I)*AS(I)
      AL(60) = SIMP (DS)
      DO 60 I=1,NET
   60 GA(I)=GA(I)*SINE(I)
      ISIMP = 1
      AL(61) = SIMP (DS)
```

```
      DO 61 I=1,NET
   61 G(I)=GA(I)*AS(I)
      AL(62) = SIMP (DS)
      DO 62 I=1,NET
   62 G(I)=G(I)*AS(I)
      AL(63) = SIMP (DS)
      DO 63 I=1,NET
   63 G(I)=GA(I)*COSINE(I)
      AL(64) = SIMP (DS)
      DO 64 I=1,NET
   64 G(I)=G(I)*AS(I)
      AL(65) = SIMP (DS)
      DO 65 I=1,NET
   65 G(I)=G(I)*AS(I)
      AL(66) = SIMP (DS)
      DO 66 I=1,NET
   66 G(I)=G(I)*AS(I)
      AL(67) = SIMP (DS)
      DO 67 I=1,NET
   67 G(I)=G(I)*AS(I)
      AL(68) = SIMP (DS)
      DO 68 I=1,NET
   68 GA(I)=GA(I)*SINE(I)
      ISIMP = 1
      AL(69) = SIMP (DS)
      DO 69 I=1,NET
   69 G(I)=GA(I)*AS(I)
      AL(70) = SIMP (DS)
      DO 70 I=1,NET
   70 G(I)=G(I)*AS(I)
      AL(71) = SIMP (DS)
      DO 71 I=1,NET
   71 G(I)=G(I)*AS(I)
      AL(72) = SIMP (DS)
      DO 72 I=1,NET
   72 G(I)=G(I)*AS(I)
      AL(73) = SIMP (DS)
```

```
      DO 73 I=1,NET
   73 GA(I)=GA(I)*PHP(I)
      ISIMP = 1
      AL(86) = SIMP (DS)
      DO 74 I=1,NET
   74 G(I) = GA(I)*AS(I)
      AL(87) = SIMP (DS)
      DO 75 I=1,NET
   75 G(I)=G(I)*AS(I)
      AL(88) = SIMP (DS)
      DO 76 I=1,NET
   76 G(I)=G(I)*AS(I)
      AL(89) = SIMP (DS)
      DO 77 I=1,NET
   77 GA(I)=PHP(I)*SINE(I)/AR(I)
      ISIMP = 1
      AL(80) = SIMP (DS)
      DO 78 I=1,NET
   78 G(I) = GA(I) * AS(I)
      AL(81) = SIMP (DS)
      DO 156 I = 1,NET
  156 G(I) = G(I) * AS(I)
      AL(82) = SIMP (DS)
      DO 79 I=1,NET
   79 G(I)=G(I)*AS(I)
      AL(83) = SIMP (DS)
      DO 80 I=1,NET
   80 G(I)=GA(I)*COSINE(I)
      AL(84) = SIMP (DS)
      DO 81 I=1,NET
   81 G(I)=G(I)*AS(I)
      AL(85) = SIMP (DS)
      DO 82 I=1,NET
   82 GA(I)=PHP(I)/AR(I)
      ISIMP = 1
      AL(74) = SIMP (DS)
      DO 83 I=1,NET
```

```
83 G(I)=GA(I)*AS(I)
   AL(75) = SIMP (DS)
   DO 84 I=1,NET
84 G(I)=G(I)*AS(I)
   AL(76) = SIMP (DS)
   DO 85 I=1,NET
85 G(I)=G(I)*AS(I)
   AL(77) = SIMP (DS)
   DO 86 I=1,NET
86 G(I)=GA(I)*COSINE(I)
   AL(78) = SIMP (DS)
   DO 87 I=1,NET
87 G(I)=G(I)*AS(I)
   AL(79) = SIMP (DS)
   DO 88 I=1,NET
88 GA(I)=GA(I)*PHP(I)
   ISIMP = 1
   AL(90) = SIMP (DS)
   DO 89 I=1,NET
89 G(I)=GA(I)*AS(I)
   AL(91) = SIMP (DS)
   DO 90 I=1,NET
90 G(I)=G(I)*AS(I)
   AL(92) = SIMP (DS)
   DO 91 I=1,NET
91 G(I)=GA(I)*SINE(I)
   AL(93) = SIMP (DS)
   DO 92 I=1,NET
92 G(I)=G(I)*AS(I)
   AL(94) = SIMP (DS)
   DO 93 I=1,NET
93 G(I)=G(I)*AS(I)
   AL(95) = SIMP (DS)
   DO 94 I=1,NET
94 G(I)=G(I)*SINE(I)
   AL(98) = SIMP (DS)
   DO 95 I=1,NET
```

```
 95 G(I)=AS(I)*PHP(I)**2*SINE(I)**2/AR(I)
    AL(97) = SIMP (DS)
    DO 96 I=1,NET
 96 G(I)=PHP(I)**2*SINE(I)**2/AR(I)
    AL(96) = SIMP (DS)
    DO 97 I=1,NET
 97 GA(I)=PHP(I)*SINE(I)/AR(I)**2
    ISIMP = 1
    AL(111) = SIMP (DS)
    DO 98 I=1,NET
 98 G(I)=GA(I)*AS(I)
    AL(112) = SIMP (DS)
    DO 99 I=1,NET
 99 G(I)=G(I)*AS(I)
    AL(113) = SIMP (DS)
    DO 100 I=1,NET
100 G(I)=G(I)*AS(I)
    AL(114) = SIMP (DS)
    DO 101 I=1,NET
101 G(I)=G(I)*AS(I)
    AL(115) = SIMP (DS)
    DO 102 I=1,NET
102 G(I)=GA(I)*COSINE(I)
    AL(116) = SIMP (DS)
    DO 103 I=1,NET
103 G(I)=G(I)*AS(I)
    AL(117) = SIMP (DS)
    DO 104 I=1,NET
104 G(I)=G(I)*AS(I)
    AL(118) = SIMP (DS)
    DO 105 I=1,NET
105 G(I)=GA(I)*SINE(I)
    AL(119) = SIMP (DS)
    DO 106 I=1,NET
106 G(I)=G(I)*AS(I)
    AL(120) = SIMP (DS)
    DO 107 I=1,NET
```

```
107 G(I)=G(I)*AS(I)
    AL(121) = SIMP (DS)
    DO 108 I=1,NET
108 G(I)=G(I)*AS(I)
    AL(122) = SIMP (DS)
    DO 109 I=1,NET
109 G(I)=G(I)*AS(I)
    AL(123) = SIMP (DS)
    DO 110 I=1,NET
110 G(I)=GA(I)*SINE(I)*COSINE(I)
    AL(124) = SIMP (DS)
    DO 111 I=1,NET
111 G(I)=G(I)*AS(I)
    AL(125) = SIMP (DS)
    DO 112 I=1,NET
112 G(I)=G(I)*AS(I)
    AL(126) = SIMP (DS)
    DO 113 I=1,NET
113 GA(I)=SINE(I)/AR(I)**2
    ISIMP = 1
    AL(99) = SIMP (DS)
    DO 114 I=1,NET
114 G(I)=GA(I)*AS(I)
    AL(100) = SIMP (DS)
    DO 115 I=1,NET
115 G(I)=G(I)*AS(I)
    AL(101) = SIMP (DS)
    DO 116 I=1,NET
116 G(I)=G(I)*AS(I)
    AL(102) = SIMP (DS)
    DO 117 I=1,NET
117 G(I)=G(I)*AS(I)
    AL(103) = SIMP (DS)
    DO 118 I=1,NET
118 G(I)=G(I)*AS(I)
    AL(104) = SIMP (DS)
    DO 119 I=1,NET
```

```
119 G(I)=GA(I)*COSINE(I)
    AL(105) = SIMP (DS)
    DO 120 I=1,NET
120 G(I)=G(I)*AS(I)
    AL(106) = SIMP (DS)
    DO 121 I=1,NET
121 G(I)=G(I)*AS(I)
    AL(107) = SIMP (DS)
    DO 122 I=1,NET
122 G(I)=G(I)*AS(I)
    AL(108) = SIMP (DS)
    DO 123 I=1,NET
123 G(I)=GA(I)*COSINE(I)*COSINE(I)
    AL(109) = SIMP (DS)
    DO 124 I=1,NET
124 G(I)=G(I)*AS(I)
    AL(110) = SIMP (DS)
    DO 125 I=1,NET
125 GA(I)=SINE(I)**2/AR(I)**3
    ISIMP = 1
    AL(142) = SIMP (DS)
    DO 126 I=1,NET
126 G(I)=GA(I)*AS(I)
    AL(143) = SIMP (DS)
    DO 127 I=1,NET
127 G(I)=G(I)*AS(I)
    AL(144) = SIMP (DS)
    DO 128 I=1,NET
128 G(I)=G(I)*AS(I)
    AL(145) = SIMP (DS)
    DO 129 I=1,NET
129 G(I)=G(I)*AS(I)
    AL(146) = SIMP (DS)
    DO 130 I=1,NET
130 G(I)=G(I)*AS(I)
    AL(147) = SIMP (DS)
    DO 131 I=1,NET
```

```
131 G(I)=G(I)*AS(I)
    AL(148) = SIMP (DS)
    DO 132 I=1,NET
132 GA(I)=GA(I)*COSINE(I)
    ISIMP = 1
    AL(149) = SIMP (DS)
    DO 133 I=1,NET
133 G(I)=GA(I)*AS(I)
    AL(150) = SIMP (DS)
    DO 134 I=1,NET
134 G(I)=G(I)*AS(I)
    AL(151) = SIMP (DS)
    DO 135 I=1,NET
135 G(I)=G(I)*AS(I)
    AL(152) = SIMP (DS)
    DO 136 I=1,NET
136 G(I)=G(I)*AS(I)
    AL(153) = SIMP (DS)
    DO 137 I=1,NET
137 G(I)=GA(I)*COSINE(I)
    AL(154) = SIMP (DS)
    DO 138 I=1,NET
138 G(I)=G(I)*AS(I)
    AL(155) = SIMP (DS)
    DO 139 I=1,NET
139 G(I)=G(I)*AS(I)
    AL(156) = SIMP (DS)
    DO 140 I=1,NET
140 GA(I)=COSINE(I)/AR(I)**3
    ISIMP = 1
    AL(134) = SIMP (DS)
    DO 141 I=1,NET
141 G(I)=GA(I)*AS(I)
    AL(135) = SIMP (DS)
    DO 142 I=1,NET
142 G(I)=G(I)*AS(I)
    AL(136) = SIMP (DS)
```

```
      DO 143 I=1,NET
  143 G(I)=G(I)*AS(I)
      AL(137) = SIMP (DS)
      DO 144 I=1,NET
  144 G(I)=G(I)*AS(I)
      AL(138) = SIMP (DS)
      DO 145 I=1,NET
  145 G(I)=GA(I)*COSINE(I)
      AL(139) = SIMP (DS)
      DO 146 I=1,NET
  146 G(I)=G(I)*AS(I)
      AL(140) = SIMP (DS)
      DO 147 I=1,NET
  147 G(I)=G(I)*AS(I)
      AL(141) = SIMP (DS)
      DO 148 I=1,NET
  148 G(I)=1./AR(I)**3
      AL(127) = SIMP (DS)
      DO 149 I=1,NET
  149 G(I)=G(I)*AS(I)
      AL(128) = SIMP (DS)
      DO 150 I=1,NET
  150 G(I)=G(I)*AS(I)
      AL(129) = SIMP (DS)
      DO 151 I=1,NET
  151 G(I)=G(I)*AS(I)
      AL(130) = SIMP (DS)
      DO 152 I=1,NET
  152 G(I)=G(I)*AS(I)
      AL(131) = SIMP (DS)
      DO 153 I=1,NET
  153 G(I)=G(I)*AS(I)
      AL(132) = SIMP (DS)
      DO 154 I=1,NET
  154 G(I)=G(I)*AS(I)
      AL(133) = SIMP (DS)
      DO 157 I=1,NET
```

```
157 G(I) = AR(I)*AS(I)*AS(I)*AS(I)
    AL(157) = SIMP (DS)
    DO 158 I=1,NET
158 G(I)=AS(I)**2
    AL(158) = SIMP (DS)
    DO 159 I=1,NET
159 G(I)=G(I)*AS(I)
    AL(159) = SIMP (DS)
    A1L(IEL)=AL(1)
    A2L(IEL)=AL(2)
    A3L(IEL)=AL(3)
    A4L(IEL)=AL(4)
    A5L(IEL)=AL(5)
    A6L(IEL)=AL(6)
    A7L(IEL)=AL(7)
    A15L(IEL)=AL(15)
    A16L(IEL)=AL(16)
    A17L(IEL)=AL(17)
    A18L(IEL)=AL(18)
    A19L(IEL)=AL(19)
    A20L(IEL)=AL(20)
    A21L(IEL)=AL(21)
    A22L(IEL)=AL(22)
    AL157(IEL)=AL(157)
    AL158(IEL)=AL(158)
    AL159(IEL)=AL(159)
    IF(ISAVE.EQ.0)WRITE(ISCRA3)AL(1),AL(2),AL(3),AL(4),AL(5),AL(6),
   1AL(7),AL(15),AL(16),AL(17),AL(18),AL(19),AL(20),AL(21),AL(22),
   2AL(157),AL(158),AL(159)
    RETURN
    END
    FUNCTION SIMP(DS)
    COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
    COMMON /A3/ NDP,NET,IXX(12)
    COMMON /B5/ISIMP
    NET=NET
    NET3 = NET
```

```
      NET1 = NET3 - 1
      NET2 = NET3 - 2
      SUM=0.0                                                         0410
      IF(ISIMP-1)3,4,3
    3 DO 1 I=2,NET1,2
    1 SUM = SUM + 4.0*G(I)
      DO 2 I=3,NET2,2
    2 SUM = SUM + 2.0*G(I)
      AG1 = G(1)
      AG2 = G(NET3)
      GO TO 10
    4 DO 11 I=2,NET1,2
   11 SUM = SUM + 4.0*GA(I)
      DC 22 I=3,NET2,2
   22 SUM = SUM + 2.0*GA(I)
      AG1 = GA(1)
      AG2 = GA(NET3)
   10 SIMP = (AG1 + SUM + AG2)*DS/3.0
      ISIMP = 0
      RETURN                                                          0470
      END                                                             0480
      SUBROUTINE INTE(I,J,L,KEY,SIMS)
      PI=3.14159265
      SIMS=0.
      IF(KEY.EQ.0)GO TO 10
      IF(KEY.EQ.2)GO TO 2C
      RETURN
   10 K=1
      IF(J.EQ.1)K=2
      IF(I.EQ.1)K=K+1
      IF(L.EQ.1)K=K+1
      FK=K
      SIMS=FK*PI/2.0
      RETURN
   20 IF(J.EQ.1.OR.I.EQ.1)RETURN
      IF(L.NE.1)GO TO 30
      SIMS=PI
```

```
      RETURN
   30 SIMS=PI/2.0
      IF(J+I-L.EQ.1)SIMS=-PI/2.0
      RETURN
      END
      SUBROUTINE CREATL (AM,AN,C1,C2,C,D1,D2,D,G1,G2)
      COMMON /B1/ AL(159)
      COMMON /B3/ PHPP
      COMMON /B4/ F(8,8)
      DIMENSION E(8,8)
      IFLAG = 0
C         THE ABOVE IS A FLAG USED TO DETERMINE WHETHER THE ELEMENTS
C             ABOVE OR BELOW THE DIAGONAL ARE BEING CALCULATED
C         CALCULATE THE DIAGONAL ELEMENTS OF F
      F(1,1) =
     A    C1*AL(8) + C2*AL(54) - C*AL(30) + 4.*G2*AM*AN*AL(142) + D2*AM*
     1    AM*AN*AN*AL(127)
      F(2,2) =
     A    C1*AL(10) + C2*AL(56) - C*AL(32) + D2*AM*AM*AN*AN*AL(129) - D2
     1    *(AM*AM+AN*AN)*AL(100) + D2*AL(69) + 4.*G2*AM*AN*AL(144) - 8.*
     2    G2*AM*AN*AL(100) + 4.*G2*AM*AN*AL(44)
      F(3,3) =
     A    C1*AL(12) + C2*AL(58) - C*AL(34) + 4.*D1*AL(1) + D2*AM*AM*AN*
     1    AN*AL(131) - 2.*D2*(AM*AM+AN*AN)*AL(102) + 4.*D2*AL(71) - D*(
     2    AM*AM+AN*AN)*AL(46) + 4.*D*AL(22) + 4.*G2*AM*AN*AL(146) - 16.*
     3    G2*AM*AN*AL(102) + 16.*G2*AM*AN*AL(46)
      F(4,4)=
     A    C1*AL(14) + C2*AL(60) - C*AL(36) + 36.*D1*AL(3) + D2*AM*AM*AN*
     1    AN*AL(133) - 3.*D2*(AM*AM+AN*AN)*AL(104) - 3.*D*(AM*AM+AN*AN)*
     2    AL(48) + 18.*D*AL(24) + 9.*D2*AL(73) + 4.*G2*AM*AN*AL(148) -
     3 24.*G2*AM*AN*AL(104) + 36.*G2*AM*AN*AL(48)
      F(5,5) =
     A    C2*AL(69) + G1*AM*AN*AL(44) + D1*PHPP**2 *AL(1) + D2*AL(96) +
     1    D*PHPP*AL(37) + G2*AM*AN*AL(90)
      F(6,6) =
     A    C1*AL(1) + C2*AL(71) + C*AL(22) + G1*AM*AN*AL(46) + D1*PHPP**2
     1 *  AL(3) + 2.*D1*PHPP*AL(5) + D1*AL(8) + D2*AL(98) + D*PHPP*
```

```
     2    AL(39) + D*AL(43) + G2*AM*AN*AL(92)
      F(7,7) =
     A    C2*AM*AN*AL(44) + G1*AL(69) + D2*AM*AN*AL(139) + 4.*G2*AL(154)
     1    + 4.*G2*AL(124) + G2*AL(96)
      F(8,8) =
     A    C2*AM*AN*AL(46) + G1*AL(71) - 2.*G1*AL(22) + D2*AM*AN*AL(141)
     1    + G1*AL(1) + 4.*G2*AL(156) - 4.*G2*AL(110) + 4.*G2*AL(126) +
     2    G2*AL(54) - 2.*G2*AL(85) + G2*AL(98)
C         CALCULATE ELEMENTS ABOVE THE DIAGONAL AND CALL THEM E
   10 E(1,2) =
     A    C1*AL(9) + C2*AL(55) - C*AL(31) + D2*AM*AM*AN*AN*AL(128) + 4.*
     1    G2*AM*AN*AL(143) - D2*AM*AM*AL(99) - 4.*G2*AM*AN*AL(99)
      E(1,3) =
     A    C1*AL(10) + C2*AL(56) - C*AL(32) + D2*AM*AM*AN*AN*AL(129)
     1    + 4.*G2*AM*AN*AL(144) - 2.*D2*AM*AM*AL(100) - D*AM*AM*AL(44) -
     2    8.*G2*AM*AN*AL(100)
      E(1,4) =
     A    C1*AL(11) + C2*AL(57) - C*AL(33) + D2*AM*AM*AN*AN*AL(130) - 3.
     1    *D2*AM*AM*AL(101) - 3.*D*AM*AM*AL(45) + 4.*G2*AM*AN*AL(145) -
     2    12.*G2*AM*AN*AL(101)
      E(1,5) =
     A    C2*AL(64) - C/2.*AL(37) - D2*AM*AM*AL(111) - D/2.*AM*AM*PHPP*
     1    AL(44) - 2.*G2*AM*AN*AL(111)
      E(1,6) =
     A    - C1*AL(4) + C2*AL(65) - C/2.*AL(38) - D2*AM*AM*AL(112) - D/2.
     1    *AM*AM*PHPP*AL(45) - D/2.*AM*AM*AL(74) + C/2.*AL(17) - 2.*G2*
     2    AM*AN*AL(112)
      E(1,7) =
     A    C2*AN*AL(49) - C/2.*AN*AL(25) + D2*AM*AM*AN*AL(134) + 4.*G2*AM
     1    *AL(149) + 2.*G2*AM*AL(119)
      E(1,8) =
     A    C2*AN*AL(50) - C/2.*AN*AL(26) + D2*AM*AM*AN*AL(135) + 4.*G2*AM
     1    *AL(150) - 2.*G2*AM*AL(105) + 2.*G2*AM*AL(120)
      E(2,3) =
     A    C1*AL(11) + C2*AL(57) - C*AL(33) + D2*AM*AM*AN*AN*AL(130) - D2
     1    *(2.*AM*AM+AN*AN)*AL(101) + 2.*D2*AL(70) - D*AM*AM*AL(45) + D*
     2    AL(21) + 4.*G2*AM*AN*AL(145) - 12.*G2*AM*AN*AL(101) + 8.*G2*AM
```

```
3      *AN*AL(45)
 E(2,4) =
A      C1*AL(12) + C2*AL(58) - C*AL(34) + D2*AM*AM*AN*AN*AL(131) - D2
1      *(3.*AM*AM+AN*AN)*AL(102) + 3.*D2*AL(71) - 3.*D*AM*AM*AL(46) +
2      3.*D*AL(22) + 4.*G2*AM*AN*AL(146) + 12.*G2*AM*AN*AL(46) - 16.*
3      G2*AM*AN*AL(102)
 E(2,5) =
A      C2*AL(65) - C/2.*AL(38) - D2*AM*AM*AL(112) + D2*AL(86) - D/2.*
1      AM*AM*PHPP*AL(45) + D/2.*PHPP*AL(21) - 2.*G2*AM*AN*AL(112) +
2      2.*G2*AM*AN*AL(74)
 E(2,6) =
A      - C1*AL(5) + C2*AL(66) - C/2.*AL(39) + C/2.*AL(18) - D2*AM*AM*
1      AL(113) + D2*AL(87) - D/2.*AM*AM*PHPP*AL(46) + D/2.*PHPP*
2      AL(22) - D/2.*AM*AM*AL(75) + D/2.*AL(37) - 2.*G2*AM*AN*AL(113)
3      + 2.*G2*AM*AN*AL(75)
 E(2,7) =
A      C2*AN*AL(50) - C/2.*AN*AL(26) + D2*AM*AM*AN*AL(135) - D2*AN*
1      AL(105) + 4.*G2*AM*AL(150) - 4.*G2*AM*AL(105) - 2.*G2*AM*
2      AL(80) + 2.*G2*AM*AL(120)
 E(2,8) =
A      C2*AN*AL(51) - C/2.*AN*AL(27) + D2*AM*AM*AN*AL(136) - D2*AN*
1      AL(106) + 4.*G2*AM*AL(151) + 2.*G2*AM*AL(121) - 6.*G2*AM*
2      AL(106) + 2.*G2*AM*AL(49) - 2.*G2*AM*AL(81)
 E(3,4) =
A      C1*AL(13) + C2*AL(59) - C*AL(35) + 12.*D1*AL(2) + D2*AM*AM*AN*
1      AN*AL(132) - D2*(3.*AM*AM+2.*AN*AN)*AL(103) + 6.*D2*AL(72) - D
2      *(AN*AN+3.*AM*AM)*AL(47) + 9.*D*AL(23) + 4.*G2*AM*AN*AL(147) -
3      20.*G2*AM*AN*AL(103) + 24.*G2*AM*AN*AL(47)
 E(3,5) =
A      C2*AL(66) - C/2.*AL(39) + 2.*D1*PHPP*AL(1) - D2*AM*AM*AL(113)
1      + 2.*D2*AL(87) + D*AL(37) - D/2.*AM*AM*PHPP*AL(46) + D*PHPP*
2      AL(22) - 2.*G2*AM*AN*AL(113) + 4.*G2*AM*AN*AL(75)
 E(3,6) =
A      - C1*AL(6) + C2*AL(67) - C/2.*AL(40) + 2.*D1*PHPP*AL(2) + 2.*
1      D1*AL(4) - D2*AM*AM*AL(114) + 2.*D2*AL(88) + 2.*D*AL(38) - D/
2      2.*AM*AM*PHPP*AL(47) + D*PHPP*AL(23) - D/2.*AM*AM*AL(76) + C/
3      2.*AL(19) - 2.*G2*AM*AN*AL(114) + 4.*G2*AM*AN*AL(76)
```

```
 E(3,7) =
A     C2*AN*AL(51) - C/2.*AN*AL(27) + D2*AM*AM*AN*AL(136) - 2.*D2*AN
1     *AL(106) - D*AN*AL(49) - 4.*G2*AM*AL(81) + 4.*G2*AM*AL(151) +
2     2.*G2*AM*AL(121) - 8.*G2*AM*AL(106)
 E(3,8) =
A     C2*AN*AL(52) - C/2.*AN*AL(28) + D2*AM*AM*AN*AL(137) - 2.*D2*AN
1     *AL(107) - D*AN*AL(50) + 4.*G2*AM*AL(152) - 10.*G2*AM*AL(107)
2     + 2.*G2*AM*AL(122) + 4.*G2*AM*AL(50) - 4.*G2*AM*AL(82)
 E(4,5) =
A     C2*AL(67) - C/2.*AL(40) + 6.*D1*PHPP*AL(2) - D2*AM*AM*AL(114)
1     + 3.*D2*AL(88) + 3.*D*AL(38) - D/2.*AM*AM*PHPP*AL(47) + 3./2.*
2     D*PHPP*AL(23) - 2.*G2*AM*AN*AL(114) + 6.*G2*AM*AN*AL(76)
 E(4,6) =
A     - C1*AL(7) + C2*AL(68) - C/2.*AL(41) + 6.*D1*PHPP*AL(3) + 6.*
1     D1*AL(5) - D2*AM*AM*AL(115) + 3.*D2*AL(89) - D/2.*AM*AM*PHPP*
2     AL(48) + 3./2.*D*PHPP*AL(24) - D/2.*AM*AM*AL(77) + 9./2.*D*
3     AL(39) + C/2.*AL(20) - 2.*G2*AM*AN*AL(115) + 6.*G2*AM*AN*
4     AL(77)
 E(4,7) =
A     C2*AN*AL(52) - C/2.*AN*AL(28) + D2*AM*AM*AN*AL(137) - 3.*D2*AN
1     *AL(107) - 3.*D*AN*AL(50) + 4.*G2*AM*AL(152) + 2.*G2*AM*
2     AL(122) - 12.*G2*AM*AL(107) - 6.*G2*AM*AL(82)
 E(4,8) =
A     C2*AN*AL(53) - C/2.*AN*AL(29) + D2*AM*AM*AN*AL(138) - 3.*D2*AN
1     *AL(108) - 3.*D*AN*AL(51) + 4.*G2*AM*AL(153) - 14.*G2*AM*
2     AL(108) + 2.*G2*AM*AL(123) + 6.*G2*AM*AL(51) - 6.*G2*AM*AL(83)
 E(5,6) =
A     C2*AL(70) + C/2.*AL(21) + G1*AM*AN*AL(45) + D1*PHPP**2 *AL(2)
1     + D1*PHPP*AL(4) + D2*AL(97) + D*PHPP*AL(38) + D/2.*AL(42) + G2
2     *AM*AN*AL(91)
 E(5,7) =
A     C2*AN*AL(61) + G1*AM*AL(61) - D2*AN*AL(116) - D/2.*AN*PHPP*
1     AL(49) - 2.*G2*AM*AL(116) - G2*AM*AL(93)
 E(5,8) =
A     C2*AN*AL(62) + G1*AM*AL(62) - G1*AM*AL(15) - D2*AN*AL(117) - D
1     /2.*AN*PHPP*AL(50) - 2.*G2*AM*AL(117) + G2*AM*AL(78) - G2*AM*
2     AL(94)
```

```
      E(6,7) =
     A    C2*AN*AL(62) + C/2.*AN*AL(15) + G1*AM*AL(62) -D2*AN*AL(117) -
     1D/2.*AN*PHPP*AL(50)-D/2.*AN*AL(78)-2.*G2*AM*AL(117) - G2*AM*AL(94)
      E(6,8) =
     A   C2*AN*AL(63) + C/2.*AN*AL(16) + G1*AM*AL(63) - G1*AM*AL(16) -
     1    D2*AN*AL(118) - D/2.*AN*PHPP*AL(51) - D/2.*AN*AL(79) - 2.*G2*
     2    AM*AL(118) + G2*AM*AL(79) - G2*AM*AL(95)
      E(7,8) =
     A    C2*AM*AN*AL(45) + G1*AL(70) - G1*AL(21) + D2*AM*AN*AL(140) +
     1    4.*G2*AL(155) - 2.*G2*AL(109) + 4.*G2*AL(125) - G2*AL(84) + G2
     2    *AL(97)
      IFLAG = IFLAG + 1
      IF (IFLAG.NE.1) GO TO 20
C         THE ELEMENTS OF F THAT ARE NEEDED ARE THOSE ABOVE THE DIAGONAL
C             THUS F IS IDENTICAL TO E
      DO 15 I=1,7
      II=I+1
      DO 15 J=II,8
      F(I,J) = E(I,J)
   15 CONTINUE
C         INTERCHANGE AM AND AN TO RECALCULATE E FOR THE TERMS OF F
C             BELOW THE DIAGONAL
      TEMP = AM
      AM = AN
      AN = TEMP
      GO TO 10
C         THE F ELEMENTS BELOW THE DIAGONAL ARE SET EQUAL TO E ELEMENTS
C             ABOVE THE DIAGONAL
   20 DO 25 I=2,8
      II = I-1
      DO 25 J=1,II
      F(I,J) = E(J,I)
   25 CONTINUE
      RETURN
      END
      SUBROUTINE MMPLT3
      COMMON /B4/ F(8,8)
```

```
      COMMON /B6/ AK(8,8)
      COMMON /B8/ CHECK(8,8)
      DO 1 I=1,8
      DO 1 J=1,8
      AK(I,J)=0.0
      DO 1 K=1,8
    1 AK(I,J)=AK(I,J)+F(I,K)*CHECK(K,J)
      DO 2 I=1,8
      DO 2 J=1,8
      F(I,J)=0.0
      DO 2 K=1,8
    2 F(I,J)=F(I,J)+CHECK(K,I)*AK(K,J)
      DO 3 I=1,8
      DO 3 J=1,8
    3 AK(I,J)=F(I,J)
      RETURN
      END
      SUBROUTINE FORCES(IEL)
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A2/ ONE(48),TWO(48)
      COMMON /A3/ NDF,NET,IXX(12)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B5/ISIMP
      COMMON /B8/ CHECK(8,8)
      COMMON /B9/ IA,IB
      COMMON /B15/ IELL,NDPP,IXXX(12),LINEL,ICON,ICOO,NSTOP
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B24/ RO1(50),PHY1(50),PHY2(50),Z1(50),Z2(50)
      COMMON /C1/ NDELQ
      COMMON /C40/ IPRI
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      COMMON /G1/ APPO,THELO,RC,RL,PR
      COMMON /G4/ ONEDD(51,48)
```

```
      DIMENSION         Q(8),QQ(8)
      INTEGER PROBLE,RERUN,RRUN,APOL,APPO
      INTEGER CONS
      INTEGER CONST
      INTEGER REST
      DATA CONST/4HCONS/
      DATA APOL/4HAPOL/
      XNDELQ=NDELQ
      IF(APPO.NE.APOL)GO TO 770
      I=IEL
      DO 780 J=1,NH
  780 IXX(J)=0
      THELO1=THELO/57.2957795
      RA=RC*COS(THELO1)
      RB=RC*SIN(THELO1)
      RLMRC = RL - RC
      DO 703 J=1,3
      P(J)=0.
      R(J)=0.
      S(J)=0.
      O(J)=0.
  703 CONTINUE
      RFF=RO2(I)
      IF(RFF.GT.(RC+RL))GO TO 403
      IF(RFF.LE.(RC-RL))GO TO 403
      IF(I.NE.1)GO TO 760
      RF=RO2(1)/2.
      GO TO 777
  760 RF=RFF-(RO2(I)-RO2(I-1))/2.
  777 IF(RLMRC.LT.0.)GO TO 761
      IF(RF.GE.RLMRC)GO TO 761
      R(1) = PR
      NDP = 1
      GO TO 500
  761 RR=RA*RA+RF*RF+RB*RB-RL*RL
      RRR=4.*RB*RB*RF*RF-RR*RR
      RRA=4.*RA*RA+4.*RB*RB
```

```
      RRB=4.*RR*RA
      X3=SQRT(ABS(RRB*RRB+4.*RRA*RRR))
      X1=(RRB+X3)/(2.*RRA)
      X2=(RRB-X3)/(2.*RRA)
      IF(THELO.NE.0.)GO TO 712
      Y1=SQRT(ABS(RF*RF-X1*X1))
      Y2=-Y1
      GO TO 716
  712 Y1=(RR-2.*X1*RA)/(2.*RB)
      Y2=(RR-2.*X2*RA)/(2.*RB)
  716 THE1=ATAN2(Y1,X1)*57.2957795
      THE2=ATAN2(Y2,X2)*57.2957795
      IF(Y1.GE.0..AND.Y2.GE.0.)GO TO 740
      IF(Y1.LE.0..AND.Y2.LE.0.)GO TO 750
      R(1)=PR
      R(3)=PR
      IF(Y1)721,721,723
  723 O(2)=THE1
      O(3)=360.+THE2
      GO TO 724
  721 O(2)=THE2
      O(3)=360.+THE1
      IF(X2.LT.0.)O(2)=180.+THE2
      GO TO 724
  740 R(2)=PR
      O(2)=THE1
      O(3)=THE2
      IF(X2.LT.0.)O(3)=180.+THE2
      GO TO 724
  750 R(2)=PR
      O(2)=360.+THE1
      O(3)=360.+THE2
  724 NDP=3
      GO TO 500
  770 ICO=0
      IF(IEL.EQ.1)GO TO 402
      IF(NSTOP.EQ.CONST)GO TO 500
```

```
      IF(ICON.EQ.0)GO TO 406
  402 READ(5,100)IELL,NDPP,NSTOP,(IXXX(I),I=1,NH)
  100 FORMAT(2I5,A4,1X,12I1)
  406 IF(IEL.NE.IELL)GO TO 403
  400 ICON=1
      NDP = NDPP
      DO 401 I=1,NH
      IXX(I) = IXXX(I)
  401 CONTINUE
      GO TO 407
  403 ICON=0
      NDP = 0
      DO 404 I=1,NH
      IXX(I)=0
  404 CONTINUE
  407 CONTINUE
      IF(NDP.NE.0)GO TO 77
      P(1)=0.
      R(1)=0.
      S(1)=0.
      O(1)=0.
      NDP = 1
      GO TO 78
   77 CONTINUE
C *****************************************************************************
C
C          FIRST DATA POINT MUST BE AT 0.0 DEGREES
C
C *****************************************************************************
      READ(5,101)(P(I),R(I),S(I),O(I),I=1,NDP)
  500 DO 3006 IL=1,NDP
      IPRI=IPRI+1
      O(NDP+1)=360.
      LLITT=0
      IF(IPRI.EQ.1.AND.IL.EQ.1)LINEL=50
      IF(LINEL.LT.50)GO TO 3007
      WRITE(6,3000)IPAGE
```

```
      IPAGE = IPAGE +1
      LINEL=0
 3000 FORMAT(1H1,62X,4HPAGEI3///)
      LLITT=1
      WRITE(6,3001)
 3001 FORMAT(51X,30HAPPLIED LOADS ON THE STRUCTURE//)
      LINEL=LINEL + 6
      GO TO 3010
 3007 IF(LLITT.EQ.1)GO TO 3020
      IF(IL.NE.1)GO TO 3008
 3010 WRITE(6,3002)IEL
 3002 FORMAT(60X,12HELEMENT NO. I3/)
      LINEL=LINEL+2
      IF(LLITT.EQ.1)GO TO 3020
      IF(ICOO.EQ.0)GO TO 3008
 3020 WRITE(6,3003)
 3003 FORMAT(56X,20HPRESSURE  COMPONENTS/)
      WRITE(6,3004)
 3004 FORMAT(20X,10HMERIDIONAL,20X,6HNORMAL,20X,10HTANGENTIAL,11X,19HFRO
     1M THETA TO THETA,9H(DEGREES)/)
      LINEL=LINEL+3
 3008 WRITE(6,3005)P(IL),R(IL),S(IL),O(IL),O(IL+1)
 3005 FORMAT(2X,3(18X,F10.3),12X,2(2X,F8.3)/)
      LINEL=LINEL+2
 3006 CONTINUE
      ICOO=0
      ICO=1
      DO 50 I=1,NDP
   50 O(I)=O(I)/57.29578
  101 FORMAT(4F10.0)
      P(NDP+1)=P(1)
      S(NDP+1)=S(1)
      R(NDP+1)=R(1)
      O(NDP+1) = 2.*3.1415926
   78 IZ = IA
      INDEX = 0
      CALL FORCE1(IZ,INDEX,1,ICO,IEL)
```

```
      INDEX= 4*IA
      IZ=IB
      CALL FORCE1(IZ,INDEX,0,ICO,IEL)
      IAB= (IA+IB)*4
      DO 310 IR=1,NEREST
      IF(IELRES(IR).NE.IEL)GO TO 310
      DO 301 JR=1,4
      IF(REST(IEL,JR).EQ.0)GO TO 301
      DO 302 JJR=1,NH
      KR=JR+(JJR-1)*4
      ONE(KR)=0.
  302 CONTINUE
  301 CONTINUE
  310 CONTINUE
      DO 480 KK=1,IAB
  480 ONEDD(IEL,KK)=ONE(KK)/XNDELQ
      DO 20 JACK = 1,IAB
   20 ONE(JACK) = TWO(JACK)
      RETURN
      END
      SUBROUTINE FORCE1(IZ,INDE,ICHANG,ICO,IEL)
      COMMON /A1/ G(30),GA(30), P(75),R(75),S(75),O(75)
      COMMON /A2/ ONE(48),TWO(48)
      COMMON /A3/ NDP,NET,IXX(12)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B5/ISIMP
      COMMON /B8/ CHECK(8,8)
      COMMON /B9/ IA,IB
      COMMON /B15/ IELL,NDPP,IXXX(12),LINEL,ICON,ICOO,NSTOP
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      DIMENSION UQ(8),Q(8),OP(101),FORCE(8)
      DATA NAMEA/1HA/,NAMEB/1HB/
      IF(IZ.EQ.0) RETURN
      JACK = (INDE /4)+1
```

```
      DO 1 IAAA=1,IZ
   99 IAA=IAAA-1
      DO 2 KKK=1,8
      FORCE(KKK)=0.
    2 Q(KKK)=0.
      HIA=IAA
      DO 3 I=1,NDP
      IF(NDP.EQ.1)GO TO 105
      X=O(I)*HIA
      XX=O(I+1)*HIA
      IF(ICHANG.EQ.0)GO TO 12
      IF(IAA.NE.0)GO TO 800
      PINT=P(I)*(O(I+1)-O(I))
      SINT=0.
      RINT=R(I)*(O(I+1)-O(I))
      GO TO 101
  800 PINT=P(I)*(SIN(XX)-SIN(X))/HIA
      SINT=-S(I)*(COS(XX)-COS(X))/HIA
      RINT=R(I)*(SIN(XX)-SIN(X))/HIA
      GO TO 101
   12 IF(IAA.NE.0)GO TO 801
      PINT=0.
      SINT=S(I)*(O(I+1)-O(I))
      RINT=0.
      GO TO 101
  801 PINT=-P(I)*(COS(XX)-COS(X))/HIA
      SINT=S(I)*(SIN(XX)-SIN(X))/HIA
      RINT=-R(I)*(COS(XX)-COS(X))/HIA
      GO TO 101
  105 IF(IAA.NE.0) GO TO 102
      IF (ICHANG.EQ.0) GO TO 103
      PINT = 2.*3.141592 * P(1)
      SINT = 0.
      RINT = 2.*3.141592 * R(1)
      GO TO 101
  103 RINT = 0.
      SINT = 2.*3.141592 * S(1)
```

```
      PINT = 0.
      GO TO 101
  102 PINT = 0.
      RINT = 0.
      SINT = 0.
  101 Q(1)=Q(1)+RINT*A1L(IEL)
      Q(2)=Q(2)+RINT*A2L(IEL)
      Q(3)=Q(3)+RINT*A3L(IEL)
      Q(4)=Q(4)+RINT*AL157(IEL)
      Q(5)=Q(5)+PINT*A1L(IEL)
      Q(6)=Q(6)+PINT*A2L(IEL)
      Q(7)=Q(7)+SINT*A1L(IEL)
    3 Q(8)=Q(8)+SINT*A2L(IEL)
      DO 5 IFLAG = 1,8
      QQ(IFLAG) = 0.
      DO 5 IFL = 1,8
    5 QQ(IFLAG) = QQ(IFLAG) + CHECK(IFL,IFLAG)*Q(IFL)
      IF(IXX(JACK).EQ.0)GO TO 600
      READ(5,500)(FORCE(I),I=1,8)
  500 FORMAT(8F10.0)
      NAMEH=NAMEB
      IF(ICHANG.EQ.1)NAMEH=NAMEA
      IF(LINEL.EQ.0)GO TO 4010
      IF(LINEL.LT.50)GO TO 4007
 4010 WRITE(6,4000)IPAGE
 4000 FORMAT(1H1,62X,4HPAGEI3///)
      IPAGE = IPAGE +1
      LINEL=0
      WRITE(6,4020)
 4020 FORMAT(51X,30HAPPLIED LOADS ON THE STRUCTURE//)
      LLIT=1
      LINEL=LINEL+8
      GO TO 4015
 4007 IF(ICO.EQ.0.AND.IAAA.EQ.1)GO TO 4015
      IF(IAAA.NE.1)GO TO 4016
      WRITE(6,4001)
      WRITE(6,4003)
```

```
      GO TO 4016
 4015 WRITE(6,4002)IEL
 4002 FORMAT(60X,12HELEMENT NO. I3/)
      IF(LLIT.EQ.1)GO TO 4030
      IF(ICO.EQ.0)GO TO 4016
 4030 WRITE(6,4003)
 4003 FORMAT(20X,5HAXIAL,20X,10HTANGENTIAL,19X,6HRADIAL,20X,7HANGULAR,5X
     1,12HHARMONIC NO./)
      WRITE(6,4001)
 4001 FORMAT(1H0,44X,42HCONCENTRATED LINE LOAD COMPONENTS AT NODES/)
      LINEL = LINEL + 3
 4016 WRITE(6,4004)(FORCE(I),I=1,4),IAA,NAMEH
      WRITE(6,4005)(FORCE(I),I=5,8),IAA,NAMEH
 4004 FORMAT(1X,10HFIRST NODE,10X,F10.3,18X,F10.3,17X,F10.3,16X,F10.3,8X
     1,I2,A2)
 4005 FORMAT(1X,11HSECOND NODE,9X,F10.3,18X,F10.3,17X,F10.3,16X,F10.3,8X
     1,I2,A2)
      LINEL = LINEL + 4
      ICOO=1
  600 INDEX=4*IAA + INDE
   90 ONE(INDEX+1) = QQ(1) + ONE(INDEX+1)   + FORCE(1)
      ONE(INDEX+2) = QQ(2) + ONE(INDEX+2)  + FORCE(2)
      ONE(INDEX+3) = QQ(3) + ONE(INDEX+3)   + FORCE(3)
      ONE(INDEX+4) = QQ(4) + ONE(INDEX+4)   + FORCE(4)
      TWO(INDEX+1) = QQ(5)  + FORCE(5)
      TWO(INDEX+2) = QQ(6)  + FORCE(6)
      TWO(INDEX+3) = QQ(7)    + FORCE(7)
      TWO(INDEX+4) = QQ(8) + FORCE(8)
      JACK = JACK +1
    1 CONTINUE
      RETURN
      END
      SUBROUTINE DISPLA
      COMMON /A7/ ITL,ISOL2,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /D10/ ISAVE, IDISPL
      COMMON /G4/ ONEDD(51,48)
```

```
      COMMON /G5/ ONED(51,48)
      DOUBLE PRECISION T(1176),RHS1(48),S(2304),COE(48),RHS2(48)
      DOUBLE PRECISION ONED
      REWIND ITL
      REWIND ISOL2
      IORD=4*NH
      IDISPL=1
      ISIZS = IORD*IORD
      ISIZT = (ISIZS+IORD)/2
      NELP1=NELEMS+1
      DO 910 I=1,NELP1
      DO 911 J=1,IORD
      ONED(I,J)=ONEDD(I,J)
  911 CONTINUE
  910 CONTINUE
      READ(ITL)(T(I),I=1,ISIZT)
      DO 600 I=1,IORD
  600 RHS1(I)=ONED(1,I)
      DO 1 I=2,IORD
      L = I+1
      K = I-1
      DO 1 J=1,K
      JI = J+(I*I-I)/2
      JJ = (J*J+J)/2
      II = (I*I+I)/2
      T(JI) = T(JI)/T(JJ)
      T(II) = T(II)-T(JI)*T(JI)*T(JJ)
      IF(I-IORD)101,1,101
  101 DO 3 M=L,IORD
      IM = I+(M*M-M)/2
      JM = J+(M*M-M)/2
    3 T(IM) = T(IM)-T(JI)*T(JM)
    1 RHS1(I) = RHS1(I)-T(JI)*RHS1(J)
      DO 4 IELEM=1,NELEMS
      READ(ITL)(S(I),I=1,ISIZS)
      DO 5 I=2,IORD
      K = I-1
```

```
      DO 5 J=1,K
      JI = J+(I*I-I)/2
      DO 5 M=1,IORD
      MDUM = (M-1)*IORD
      IM = I+MDUM
      JM = J+MDUM
    5 S(IM) = S(IM)-T(JI)*S(JM)
      WRITE(ISOL2)(T(I),I=1,ISIZT)
      NNE=IELEM+1
      DO 800 KK=1,IORD
  800 ONED(IELEM,KK)=RHS1(KK)
      DO 10 I=1,IORD
      II = (I*I+I)/2
   10 COE(I) = T(II)
      READ(ITL)(T(I),I=1,ISIZT)
      DO 601 KK=1,IORD
  601 RHS2(KK)=ONED(NNE,KK)
      DO 11 I=1,IORD
      II = (I*I+I)/2
      LEAD = (I-1)*IORD
      DO 12 M=I,IORD
      LEADM = (M-1)*IORD
      IM = I+(M*M-M)/2
      DO 12 J=1,IORD
      JI = LEAD+J
      IF(M-I) 105,106,105
  106 T(II) = T(II)-S(JI)*S(JI)/COE(J)
      S(JI) = S(JI)/COE(J)
      GO TO 12
  105 JM = LEADM+J
      T(IM) = T(IM)-S(JI)*S(JM)
   12 CONTINUE
      DO 11 J=1,IORD
      JI = LEAD+J
   11 RHS2(I) = RHS2(I)-S(JI)*RHS1(J)
      DO 15 I=2,IORD
      L = I+1
```

```
      K = I-1
      DO 15 J=1,K
      JI = J+(I*I-I)/2
      JJ = (J*J+J)/2
      II = (I*I+I)/2
      T(JI) = T(JI)/T(JJ)
      T(II) = T(II)-T(JI)*T(JI)*T(JJ)
      IF (I-IORD) 109,15,109
  109 DO 17 M=L,IORD
      IM = I+(M*M-M)/2
      JM = J+(M*M-M)/2
   17 T(IM) = T(IM)-T(JI)*T(JM)
   15 RHS2(I) = RHS2(I)-T(JI)*RHS2(J)
      DO 18 I=1,IORD
   18 RHS1(I) = RHS2(I)
    4 WRITE(ISOL2)(S(I),I=1,ISIZS)
      WRITE(ISOL2)(T(I),I=1,ISIZT)
      DO 801 KK=1,IORD
  801 ONED(NELEMS+1,KK)=RHS1(KK)
      REWIND ITL
      BACKSPACE ISOL2
      DO 202 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 803 I=1,IORD
      KKTE=KKK+I
      S(KKTE)=ONED(IELEM,I)
  803 CONTINUE
  202 CONTINUE
      DO 804 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 820 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  820 CONTINUE
  804 CONTINUE
      DO 805 I=1,IORD
```

```
805 RHS1(I)=ONED(1,I)
    READ(ISOL2)(T(I),I=1,ISIZT)
    ISOLB = ITL
    WRITE(ISOLB)(T(I),I=1,ISIZT)
    BACKSPACE ISOL2
    KORNER = (IORD*IORD+IORD)/2
    RHS1(IORD) = RHS1(IORD)/T(KORNER)
    IOM1 = IORD-1
    DO 21 KK=1,IOM1
    I = IORD-KK
    II = (I*I+I)/2
    RHS1(I) = RHS1(I)/T(II)
    K = I+1
    DO 21 J=K,IORD
    IJ = I+(J*J-J)/2
 21 RHS1(I) = RHS1(I)-RHS1(J)*T(IJ)
    DO 806 I=1,IORD
806 ONED(1,I)=RHS1(I)
    DO 23 IELEM=1,NELEMS
    DO 24 I=1,IORD
 24 RHS2(I) = RHS1(I)
    NNE=IELEM+1
    DO 807 KK=1,IORD
807 RHS1(KK)=ONED(NNE,KK)
    BACKSPACE ISOL2
    BACKSPACE ISOL2
    READ(ISOL2)(T(I),I=1,ISIZT)
    READ(ISOL2)(S(I),I=1,ISIZS)
    WRITE(ISOLB)(S(I),I=1,ISIZS)
    WRITE(ISOLB)(T(I),I=1,ISIZT)
    BACKSPACE ISOL2
    BACKSPACE ISOL2
    DO 25 KK=1,IORD
    I= IORD-KK+1
    II = (I*I+I)/2
    RHS1(I) = RHS1(I)/T(II)
    K = I+1
```

```
      IF(KK-1)107,108,107
  107 DO 26 J=K,IORD
      IJ = I+(J*J-J)/2
   26 RHS1(I) = RHS1(I)-RHS1(J)*T(IJ)
  108 DO 25 J=1,IORD
      IJ = I+(J-1)*IORD
   25 RHS1(I) = RHS1(I)-RHS2(J)*S(IJ)
      DO 808 KK=1,IORD
  808 ONED(NNE,KK)=RHS1(KK)
   23 CONTINUE
      REWIND ISOLB
      DO 809 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 810 I=1,IORD
      KKTE=KKK+I
      S(KKTE)=ONED(IELEM,I)
  810 CONTINUE
  809 CONTINUE
      DO 811 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 821 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  821 CONTINUE
  811 CONTINUE
      REWIND ISOLB
      IF(ISAVE.NE.0)RETURN
      REWIND ISOL2
      READ(ITL)(T(I),I=1,ISIZT)
      WRITE(ISCRA3)(T(I),I=1,ISIZT)
      DO 400 I=1,NELEMS
      READ(ITL)(S(J),J=1,ISIZS)
      WRITE(ISCRA3)(S(J),J=1,ISIZS)
      READ(ITL)(T(J),J=1,ISIZT)
      WRITE(ISCRA3)(T(J),J=1,ISIZT)
  400 CONTINUE
```

```
      DO 401 I=1,NELEMS
      READ(ISOL2)(T(J),J=1,ISIZT)
      WRITE(ISCRA3)(T(J),J=1,ISIZT)
      READ(ISOL2)(S(J),J=1,ISIZS)
      WRITE(ISCRA3)(S(J),J=1,ISIZS)
  401 CONTINUE
      READ(ISOL2)(T(J),J=1,ISIZT)
      WRITE(ISCRA3)(T(J),J=1,ISIZT)
      REWIND ITL
      REWIND ISOL2
      RETURN
      END
      SUBROUTINE NONLIN
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ ITL,ISOL2,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B8/ CHECK(8,8)
      COMMON /B9/ IA,IB
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES , HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B30/ NA,NB
      COMMON /C1/ NDELQ
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      COMMON /F1/ ITER,EROR,X,ITLAST,NSTRAI,IPLAST,XSM
      COMMON /F2/ QQ2(51,48),QPR(8,10),QQ0(51,48),QQ1(51,48),QP1(48),
     1QP2(48),Q1(48),Q2(48),Q(48),QP(8,12),ALG2(8,12),CC1,CC2,CC,CG1,
     2ES(10),ET(10),EST(10),E13(10),E23(10),QQ3(48)
      COMMON /F4/ QQ2P(51,48)
      COMMON /G2/ NCE(50),NAET(50),THETA(50,51),THICKC(50,51)
      COMMON /G4/ DELQ(51,48)
      COMMON /G5/ ONED(51,48)
      COMMON /G9/ TA(50,50)
      DOUBLE PRECISION ONED
```

```
      INTEGER REST
      INTEGER SAND
      DATA SAND/4HSAND/
      IFO=NA+NB+1
      NNODES=NELEMS+1
      XNDELQ=NDELQ
      NN = 4*NH
      DO 50 I1=1,NDELQ
      IDISPL=1
      KEY=1
      IT=0
      XI=I1
      IPCF=(XI/XNDELQ)*100.01
      IF(I1.EQ.1)GO TO 770
  711 CONTINUE
      DO 776 I=1,NN
  776 Q1(I)=QQ2P(1,I)
      DO 10 IK=1,NN
      QP1(IK) = 0.0
   10 CONTINUE
      DO 40 I2 = 1,NELEMS
      PHPMID=PHPRMI(I2)
      RMID=RMDI(I2)
      CPMD=CPDM(I2)
      SPMD=SPDM(I2)
      PHPP=PPPH(I2)
      ARCL=ARLC(I2)
      DO 4939 ITS1=1,8
      DO 4940 ITS2=1,8
      CHECK(ITS1,ITS2)=CHEKC(I2,ITS1,ITS2)
 4940 CONTINUE
 4939 CONTINUE
      NC=NCE(I2)
      NAMET=NAET(I2)
      S=ARCL/2.0
      E1=EM(I2)
      FNU1=POISSO(I2)
```

```
      CC1=E1/(1.-FNU1*FNU1)
      CC2=CC1
      CC=2.*CC1*FNU1
      CG1=E1/(2.*(1.+FNU1))
      IF(NAMES.NE.SAND)GO TO 301
      CC1=2.*CC1
      CC2=CC1
      CC=2.*CC
      CG1=2.*CG1
  301 CONTINUE
      DO 777 I=1,NN
  777 Q2(I)=QQ2P(I2+1,I)
      KA=0
      DO 12 I3=1,8
      DO 12 I4=1,NH
      QP(I3,I4) = 0.0
      QPR(I3,I4) = 0.0
   12 CONTINUE
   13 DO 21 I3 = 1,NH
      DO 14 K=1,4
      KA = KA + 1
      Q(K) = Q1(KA)
      Q(K+4) = Q2(KA)
   14 CONTINUE
      DO 20 J = 1,8
      SUM = 0.0
      DO 16 M=1,8
      SUM = SUM + CHECK(J,M)*Q(M)
   16 CONTINUE
   18 ALG2(J,I3) = SUM
   20 CONTINUE
      FI=I3-1
      IF(I3.GT.IA)FI=IA-I3+1
      C1=ALG2(1,I3)+ALG2(2,I3)*S+ALG2(3,I3)*S**2+ALG2(4,I3)*S**3
      C2=ALG2(5,I3)+ALG2(6,I3)*S
      C3=ALG2(7,I3)+ALG2(8,I3)*S
      ES(I3)=ALG2(6,I3)-PHPMID*C1
```

```
      ET(I3)=(FI*C3+C2*SPMD+C1*CPMD)/RMID
      EST(I3)=-(FI*C2+C3*SPMD)/RMID+ALG2(8,I3)
      E13(I3)=ALG2(2,I3)+2.*ALG2(3,I3)*S+3.*ALG2(4,I3)*S**2
     1+C2*PHPMID
      E23(I3)=-(FI*C1+C3*CPMD)/RMID
   21 CONTINUE
      DO 29 I4 = 1,2
      IF (I4.NE.1) GO TO 24
      IF (IA.EQ.0) GO TO 29
   24 DO 28 I5=1,4
      IF (IA.NE.0) GO TO 26
      IF (I5.NE.4) GO TO 28
   26 CALL HARM(I5,I4,I2)
      IF (IB.EQ.0) GO TO 30
   28 CONTINUE
   29 CONTINUE
   30 DO 32 II = 1,8
      DO 32 JJ=1,NH
      SUM = 0.0
      DO 33 LL=1,8
   33 SUM=SUM + CHECK(LL,II)*QPR(LL,JJ)
      QP(II,JJ) = SUM
   32 CONTINUE
      JA=0
      DO 34 II=1,NH
      DO 34 JJ=1,4
      JA = JA + 1
      QP1(JA)=-QP(JJ,II)+QP1(JA) + XI*DELQ(I2,JA)
      QP2(JA) = -QP(JJ+4,II)
   34 CONTINUE
      DO 510 IR=1,NEREST
      IF(IELRES(IR).NE.I2)GO TO 510
      DO 501 JR=1,4
      IF(REST(I2,JR).EQ.0)GO TO 501
      DO 502 JJR=1,NH
      KR=JR+(JJR-1)*4
      QP1(KR)=0.
```

```
  502 CONTINUE
  501 CONTINUE
  510 CONTINUE
      DO 904 I=1,NN
  904 ONED(I2,I)=QP1(I)
      IF (I2.NE.NELEMS) GO TO 36
      DO 35 JA = 1,NN
      QP2(JA)=QP2(JA)+XI*DELQ(I2+1,JA)
   35 CONTINUE
      DO 810 IR=1,NEREST
      IF(IELRES(IR).NE.NELEMS)GO TO 810
      DO 801 JR=5,8
      IF(REST(NELEMS,JR).EQ.0)GO TO 801
      DO 802 JJR=1,NH
      KR=JR+(JJR-1)*4-4
      QP2(KR)=0.
  802 CONTINUE
  801 CONTINUE
  810 CONTINUE
      DO 905 I=1,NN
  905 ONED(NELEMS+1,I)=QP2(I)
      GO TO 40
   36 DO 38 JA = 1,NN
      Q1(JA)=Q2(JA)
      QP1(JA) = QP2(JA)
   38 CONTINUE
   40 CONTINUE
      CALL DISPL1
  770 DO 900 I=1,NNODES
      DO 901 J=1,NN
      QQ2(I,J)=ONED(I,J)
  901 CONTINUE
  900 CONTINUE
      CALL EXTRAP(I1,IT,NN,KEY,NNODES,IPCF)
      IF(KEY.EQ.1)GO TO 711
      IF(I1.EQ.NDELQ.AND.IPLAST.EQ.0)GO TO 50
      CALL STRESS(I1,IPCF,IT)
```

```
50 CONTINUE
   RETURN
   END
   SUBROUTINE HARM(ISUM,LFLAG,I2)
   COMMON /B9/ IA,IB
   COMMON /B14/ XTHETA(10),NUNKTH
   COMMON /B30/ NA,NB
   DIMENSION IS(4),ID(4),JD(4),LD(4)
   ID(1)=0
   JD(1)=0
   LD(1)=0
   ID(2)=0
   JD(2)=1
   LD(2)=1
   ID(3)=1
   JD(3)=1
   LD(3)=0
   ID(4)=1
   JD(4)=0
   LD(4)=1
   GO TO (10,11,15,19),ISUM
10 IM = IA
   JM = IA
   KM = 0
   KKM = 0
   GO TO 26
11 IM = IA
   JM = IB
   KM = 0
   KKM = IA
   DO 14 I3 = 1,4
   IF(JD(I3)) 13,12,13
12 JD(I3) = 1
   GO TO 14
13 JD(I3) = 0
14 CONTINUE
   GO TO 26
```

```
15 IM = IB
   JM = IA
   KM = IA
   KKM = 0
   DO 18 I3 = 1,4
   IF(ID(I3)) 17,16,17
16 ID(I3) = 1
   GO TO 18
17 ID(I3) = 0
18 CONTINUE
   GO TO 26
19 IM = IB
   JM = IB
   KM = IA
   KKM = IA
   DO 25 I3 = 1,4
   IF(ID(I3)) 21,20,21
20 ID(I3) = 1
   GO TO 22
21 ID(I3) = 0
22 IF(JD(I3)) 24,23,24
23 JD(I3) = 1
   GO TO 25
24 JD(I3) = 0
25 CONTINUE
26 IF (LFLAG.EQ.1) GO TO 30
   LM = IB
   KKKM = IA
   DO 29 I3 = 1,4
   IF(LD(I3)) 28,27,28
27 LD(I3) = 1
   GO TO 29
28 LD(I3) = 0
29 CONTINUE
   GO TO 31
30 LM = IA
   KKKM = 0
```

```
31 DO 35 I3 = 1,4
   IS(I3) = ID(I3) + JD(I3) + LD(I3)
35 CONTINUE
   CALL QPRIME(IM,JM,LM,IS,ID,JD,LD,KM,KKM,KKKM     ,I2)
   RETURN
   END
   SUBROUTINE QPRIME(IM,JM,LM,IS,ID,JD,LD,KM,KKM,KKKM     ,I2)
   COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
   COMMON /B9/ IA,IB
   COMMON /B14/ XTHETA(10),NUNKTH
   COMMON /B30/ NA,NB
   COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
  1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
  2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
  3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
   COMMON /F2/ QQ2(51,48),QPR(8,10),QQ0(51,48),QQ1(51,48),QP1(48),
  1QP2(48),Q1(48),Q2(48),Q(48),QP(8,12),ALG2(8,12),CC1,CC2,CC,GG1,
  2ES(10),ET(10),EST(10),E13(10),E23(10),QQ3(48)
   COMMON /G4/ DELQ(51,48)
   COMMON /G9/ TA(50,50)
   DIMENSION IS(4),ID(4),JD(4),LD(4)
   DIMENSION AL(159)
   AL(1)=A1L(I2)
   AL(2)=A2L(I2)
   AL(3)=A3L(I2)
   AL(4)=A4L(I2)
   AL(5)=A5L(I2)
   AL(6)=A6L(I2)
   AL(7)=A7L(I2)
   AL(15)=A15L(I2)
   AL(16)=A16L(I2)
   AL(17)=A17L(I2)
   AL(18)=A18L(I2)
   AL(19)=A19L(I2)
   AL(20)=A20L(I2)
   AL(21)=A21L(I2)
   AL(22)=A22L(I2)
```

```
 AL(157)=AL157(I2)
 AL(158)=AL158(I2)
 AL(159)=AL159(I2)
 DO 99 L=1,LM
 IF (LM.EQ.IA) HL=(L-1)
 IF (LM.EQ.IB) HL=-(L-1)
 DO 99 I=1,IM
 DO 99 J=1,JM
 IF ((J+I).NE.(L+1) .AND. IABS(J-I).NE.(L-1)) GO TO 99
 IKM = I + KM
 JKM = J + KKM
 LKM = L + KKKM
 ID1=I-1
 JD1=J-1
 LD1=L-1
 CALL INTRL(ID1,JD1,LD1,IS(1),ID(1),JD(1),LD(1),SIMP1,I2)
 CALL INTRL(ID1,JD1,LD1,IS(2),ID(2),JD(2),LD(2),SIMP2,I2)
 CALL INTRL(ID1,JD1,LD1,IS(3),ID(3),JD(3),LD(3),SIMP3,I2)
 CALL INTRL(ID1,JD1,LD1,IS(4),ID(4),JD(4),LD(4),SIMP4,I2)
 QPR(1,LKM) = -E13(IKM)*E13(JKM)*CC1*SIMP1*AL(4)/2. - ET(IKM)
1*E23(JKM)*CC2*SIMP2*HL*AL(15) + E23(IKM)*E23(JKM)*CC2*SIMP3*AL(17)
2/2. - ES(IKM)*E23(JKM)*CC*SIMP2*HL*AL(15)/2. - E23(IKM)*E23(JKM)
3*CC*SIMP3*AL(4)/4. + E13(IKM)*E13(JKM)*CC*SIMP1*AL(17)/4.
4-EST(IKM)*E13(JKM)*GG1*SIMP4*HL*AL(15) + QPR(1,LKM)
 QPR(2,LKM) = ES(IKM)*E13(JKM)*CC1*SIMP1*AL(1) - E13(IKM)*E13(JKM)
1*CC1*SIMP1*AL(5)/2. - ET(IKM)*E23(JKM)*CC2*SIMP2*HL*AL(16)
2+E23(IKM)*E23(JKM)*CC2*SIMP3*AL(18)/2. - ES(IKM)*E23(JKM)*CC*SIMP2
3*HL*AL(16)/2. - E23(IKM)*E23(JKM)*CC*SIMP3*AL(5)/4. + ET(IKM)
4*E13(JKM)*CC*SIMP1*AL(1)/2. + E13(IKM)*E13(JKM)*CC*SIMP1*AL(18)/4.
5-EST(IKM)*E13(JKM)*GG1*SIMP4*HL*AL(16) + EST(IKM)*E23(JKM)*GG1
6*SIMP3*AL(1) + QPR(2,LKM)
 QPR(3,LKM) = ES(IKM)*E13(JKM)*2.*CC1*SIMP1*AL(2) - E13(IKM)
1*E13(JKM)*CC1*SIMP1*AL(6)/2. - ET(IKM)*E23(JKM)*CC2*SIMP2*HL
2*AL(158) + E23(IKM)*E23(JKM)*CC2*SIMP3*AL(19)/2. - ES(IKM)
3*E23(JKM)*CC*SIMP2*HL*AL(158)/2. - E23(IKM)*E23(JKM)*CC*SIMP3
4*AL([illegible])/4. + ET(IKM)*E13(JKM)*CC*SIMP1*AL(2) + E13(IKM)*E13(JKM)
5*CC*SIMP1*AL(19)/4. - EST(IKM)*E13(JKM)*GG1*SIMP4*HL*AL(158)
```

```
     6+EST(IKM)*E23(JKM)*2.*GG1*SIMP3*AL(2) + QPR(3,LKM)
      QPR(4,LKM) = ES(IKM)*E13(JKM)*3.*CC1*SIMP1*AL(3) - E13(IKM)
     1*E13(JKM)*CC1*SIMP1*AL(7)/2. - ET(IKM)*E23(JKM)*CC2*SIMP2*HL
     2*AL(159) + E23(IKM)*E23(JKM)*CC2*SIMP3*AL(20)/2. - ES(IKM)
     3*E23(JKM)*CC*SIMP2*HL*AL(159)/2. - E23(IKM)*E23(JKM)*CC*SIMP3
     4*AL(7)/4. + ET(IKM)*E13(JKM)*CC*SIMP1*AL(3)*3./2. + E13(IKM)
     5*E13(JKM)*CC*SIMP1*AL(20)/4. - EST(IKM)*E13(JKM)*GG1*SIMP4*HL
     6*AL(159) + EST(IKM)*E23(JKM)*3.*GG1*SIMP3*AL(3) + QPR(4,LKM)
      QPR(5,LKM) = ES(IKM)*E13(JKM)*CC1*SIMP1*AL(4) + E23(IKM)*E23(JKM)
     1*CC2*SIMP3*AL(21)/2. + ET(IKM)*E13(JKM)*CC*SIMP1*AL(4)/2.
     2+E13(IKM)*E13(JKM)*CC*SIMP1*AL(21)/4. + EST(IKM)*E23(JKM)*GG1
     3*SIMP3*AL(4) - E23(IKM)*E13(JKM)*GG1*SIMP4*HL*AL(15) + QPR(5,LKM)
      QPR(6,LKM) = ES(IKM)*E13(JKM)*CC1*SIMP1*AL(5) + E13(IKM)*E13(JKM)
     1*CC1*SIMP1*AL(1)/2. + E23(IKM)*E23(JKM)*CC2*SIMP3*AL(22)/2.
     2+E23(IKM)*E23(JKM)*CC*SIMP3*AL(1)/4. + ET(IKM)*E13(JKM)*CC*SIMP1
     3*AL(5)/2. + E13(IKM)*E13(JKM)*CC*SIMP1*AL(22)/4. + EST(IKM)
     4*E23(JKM)*GG1*SIMP3*AL(5) - E23(IKM)*E13(JKM)*GG1*SIMP4*HL*AL(16)
     5+QPR(6,LKM)
      QPR(7,LKM) = -ET(IKM)*E23(JKM)*CC2*SIMP2*AL(17) + E23(IKM)
     1*E23(JKM)*CC2*SIMP3*HL*AL(15)/2. - ES(IKM)*E23(JKM)*CC*SIMP2
     2*AL(17)/2. + E13(IKM)*E13(JKM)*CC*SIMP1*HL*AL(15)/4. - EST(IKM)
     3*E13(JKM)*GG1*SIMP4*AL(17) - E23(IKM)*E13(JKM)*GG1*SIMP4*AL(21)
     4+QPR(7,LKM)
      QPR(8,LKM) = -ET(IKM)*E23(JKM)*CC2*SIMP2*AL(18) + E23(IKM)
     1*E23(JKM)*CC2*SIMP3*HL*AL(16)/2. - ES(IKM)*E23(JKM)*CC*SIMP2
     2*AL(18)/2. + E13(IKM)*E13(JKM)*CC*SIMP1*HL*AL(16)/4. - EST(IKM)
     3*E13(JKM)*GG1*SIMP4*AL(18) + E23(IKM)*E13(JKM)*GG1*SIMP4*AL(1)
     4-E23(IKM)*E13(JKM)*GG1*SIMP4*AL(22) + QPR(8,LKM)
   99 CONTINUE
      RETURN
      END
      SUBROUTINE INTRL(I,J,L,IS,ID,JD,LD,HI,M)
      COMMON /B30/ NA,NB
      COMMON /G9/ TA(50,50)
      HI1=0.
      HI2=0.
      HI3=0.
```

```
      IF(IS.EQ-1)GO TO 65
      IF (IS.EQ.0) GO TO 10
      IF(IS-2)65,15,65
15    KEY=3
      IF(LD.EQ.0)GO TO 12
20    IF (ID) 30,35,30
35    IA=L
      LA1=I
      JA=J
      GO TO 11
30    JA=L
      LA1=J
      IA=I
      GO TO 11
10    KEY=1
12    IA=I
      JA=J
      LA1=L
11    LA2=0
      HI1=TA(M,1)*VAL(IA,JA,LA1,LA2,KEY)
      IF(NA.EQ.0)GO TO 55
      DO 40 K=1,NA
      LA2=K
   40 HI2=HI2+TA(M,K+1)*VAL(IA,JA,LA1,LA2,KEY)
   55 IF (IS.EQ.0  .OR.  IS.EQ.2) GO TO 45
   65 IF(NB.EQ.0)GO TO 45
      IF(IS.EQ.3)GO TO 70
      KEY=3
      IF(LD.EQ.0)GO TO 75
      JA=L
      LA1=J
      LA2=I
      GO TO 90
   75 IF(JD)80,85,80
   85 LA2=J
      LA1=L
      JA=I
```

```
      GO TO 90
   70 KEY=5
   80 JA=J
      LA1=L
      LA2=I
   90 DO 50 K=1,NB
      IA=K
      KS=K+NA
   50 HI3=HI3+TA(M,KS   +1)*VAL(IA,JA,LA1,LA2,KEY)
45    HI=HI1+HI2+HI3
      RETURN
      END
      FUNCTION VAL(I,J,L,LA,KEY)
      PI=3.14159265
      VAL=0.0
      GO TO (10,16,10,16,10),KEY
16    RETURN
10    IPJ=IABS(I+J)
      IMJ=IABS(I-J)
      LPLA=IABS(L+LA)
      LMLA=IABS(L-LA)
      IF(IPJ.EQ.LPLA   .OR.    IPJ.EQ.LMLA   .OR.    IMJ.EQ.LPLA   .OR.
     1IMJ.EQ.LMLA)GO TO 11
      RETURN
11    IF (IPJ-LPLA) 20,25,20
25    IF (IPJ) 21,26,21
26    VAL=PI/2.
      GO TO 27
21    VAL=PI/4.
27    IF (KEY.EQ.3) VAL=-VAL
20    IF (IPJ-LMLA) 30,35,30
35    IF (IPJ) 31,36,31
36    FI1=-PI/2.
      GO TO 37
31    FI1=-PI/4.
37    IF (KEY.EQ.1) FI1=-FI1
      VAL=VAL+FI1
```

```
30    IF (IMJ-LPLA) 40,45,40
45    IF (IMJ) 41,46,41
46    FI1=PI/2.
      GO TO 47
41    FI1=PI/4.
47    IF (KEY.EQ.5) FI1=-FI1
      VAL=VAL+FI1
40    IF (IMJ.NE.LMLA) RETURN
55    IF (IMJ) 51,56,51
56    VAL=VAL+PI/2.
      RETURN
51    VAL=VAL+PI/4.
      RETURN
      END
      SUBROUTINE EXTRAP(I1,IT,NN,KEY,NNODES,IPCF)
      COMMON /A7/ ITL,ISOL2,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /C1/ NDELQ
      COMMON /B30/ NA,NB
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES , HS
      COMMON /F1/ ITER,EROR,X,ITLAST,NSTRAI,IPLAST,XSM
      COMMON /F2/ QQ2(51,48),QPR(8,10),QQ0(51,48),QQ1(51,48),QP1(48),
     1QP2(48),Q1(48),Q2(48),Q(48),OP(8,12),ALG2(8,12),CC1,CC2,CC,CG1,
     2ES(10),ET(10),EST(10),E13(10),E23(10),QQ3(48)
      COMMON /F4/ QQ2P(51,48)
      COMMON /G4/ DELQ(51,48)
      IPS=0
      IT=IT+1
      IF(ITER)20,16,19
   19 IF(IT.GT.ITER)GO TO 15
      IF(I1.EQ.1.AND.IT.EQ.1)GO TO 9
      DO 1 INODE=1,NNODES
      DO 1 I=1,NN
      IF(ABS(QQ2(INODE,I))-XSM)1,1,18
   18 CONTINUE
      ARG=ABS((QQ2(INODE,I)-QQ2P(INODE,I))/QQ2(INODE,I
      IF(ARG-EROR)1,1,9
```

```
  1 CONTINUE
    IPS=1
    GO TO 16
 15 IT=IT-1
    WRITE(6,500)I1,EROR,IT
500 FORMAT (//14H INCREMENT NO.,I4/51H SOLUTION DOES NOT CONVERGE TO S
   1PECIFIED ACCURACY (,F6.3,8H ) AFTER,I4,11H ITERATIONS/11H . . . ST
   2OP)
    STOP
 20 IF(IT+ITER)9,9,16
 16 IF(I1.EQ.NDELQ.AND.ITER.EQ.0.AND.IT.LE.ITLAST)GO TO 9
    KEY=0
    IF(I1.EQ.NDELQ)RETURN
    IF(I1.GT.1)GO TO 5
    DO 4 INODE=1,NNODES
    DO 2 I=1,NN
    QQ1(INODE,I)=QQ2(INODE,I)
  2 QQ0(INODE,I)=0.0
    DO 3 I=1,NN
  3 QQ2P(INODE,I)=(1.0 + X)*QQ2(INODE,I)
  4 CONTINUE
    RETURN
  5 DO 7 INODE=1,NNODES
    II=0
    DO 6 I=1,NN
    II=II+1
    QQ3(II)=(1.0+1.5*X+0.5*X**2)*QQ2(INODE,I)-(2.0*X+X**2)*QQ1(INODE,
   1II)+0.5*(X+X**2)*QQ0(INODE,II)
    QQ0(INODE,II)=QQ1(INODE,II)
    QQ1(INODE,II)=QQ2(INODE,II)
  6 QQ2P(INODE,I)=QQ3(II)
  7 CONTINUE
    RETURN
  9 KEY=1
    IF(IPS.EQ.1)CALL STRESS(I1,IPLF,KK)
    DO 10 INODE=1,NNODES
    DO 10 J=1,NN
```

```
10 QQ2P(INODE,J)=QQ2(INODE,J)
   RETURN
   END
   SUBROUTINE DISPL1
   COMMON /A7/ ITL,ISOL2,ISCRA3,NELEMS,NH,IPAGE,PROBLE
   COMMON /B9/ IA,IB
   COMMON /D10/ ISAVE,IDISPL
   COMMON /G4/ ONEDD(51,48)
   COMMON /G5/ ONED(51,48)
   DOUBLE PRECISION T(1176),RHS1(48),RHS2(48),S(2304)
   DOUBLE PRECISION ONED
   IORD=4*NH
   ISIZS = IORD*IORD
   ISIZT = (ISIZS+IORD)/2
   NELP1 = NELEMS+1
   IF(IDISPL.NE.0)GO TO 500
   REWIND ISOL2
   REWIND ITL
   READ(ISCRA3)(T(I),I=1,ISIZT)
   WRITE(ITL)(T(I),I=1,ISIZT)
   DO 400 I=1,NELEMS
   READ(ISCRA3)(S(J),J=1,ISIZS)
   WRITE(ITL)(S(J),J=1,ISIZS)
   READ(ISCRA3)(T(J),J=1,ISIZT)
   WRITE(ITL)(T(J),J=1,ISIZT)
400 CONTINUE
   DO 401 I=1,NELEMS
   READ(ISCRA3)(T(J),J=1,ISIZT)
   WRITE(ISOL2)(T(J),J=1,ISIZT)
   READ(ISCRA3)(S(J),J=1,ISIZS)
   WRITE(ISOL2)(S(J),J=1,ISIZS)
401 CONTINUE
   READ(ISCRA3)(T(J),J=1,ISIZT)
   WRITE(ISOL2)(T(J),J=1,ISIZT)
   REWIND ISOL2
   REWIND ITL
500 READ(ISOL2)(T(I),I=1,ISIZT)
```

```
      DO 600 I=1,IORD
  600 RHS1(I)=ONED(1,I)
      DO 1 I=2,IORD
      K = I-1
      DO 1 J=1,K
      JI = J+(I*I-I)/2
    1 RHS1(I) = RHS1(I)-T(JI)*RHS1(J)
      DO 3 IELEM=1,NELEMS
      READ(ISOL2)(S(I),I=1,ISIZS)
      NNE=IELEM+1
      DO 800 KK=1,IORD
  800 ONED(IELEM,KK)=RHS1(KK)
      READ(ISOL2)(T(I),I=1,ISIZT)
      DO 601 KK=1,IORD
  601 RHS2(KK)=ONED(NNE,KK)
      DO 4 I=1,IORD
      LEAD = (I-1)*IORD
      DO 4 J=1,IORD
      JI = LEAD+J
    4 RHS2(I) = RHS2(I)-S(JI)*RHS1(J)
      DO 6 I=2,IORD
      K = I-1
      DO 6 J=1,K
      JI = J+(I*I-I)/2
    6 RHS2(I) = RHS2(I)-T(JI)*RHS2(J)
      DO 3 I=1,IORD
    3 RHS1(I) = RHS2(I)
      DO 801 KK=1,IORD
  801 ONED(NELEMS+1,KK)=RHS1(KK)
      DO 202 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 803 I=1,IORD
      KKTE=KKK+I
      S(KKTE)=ONED(IELEM,I)
  803 CONTINUE
  202 CONTINUE
      DO 804 IELEM=1,NELP1
```

```
      KKK=(IELEM-1)*IORD
      DO 820 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  820 CONTINUE
  804 CONTINUE
      DO 805 I=1,IORD
  805 RHS1(I)=ONED(1,I)
      REWIND ISOL2
      READ(ITL)(T(I),I=1,ISIZT)
      KORNER = (IORD*IORD+IORD)/2
      RHS1(IORD) = RHS1(IORD)/T(KORNER)
      IOM1 = IORD-1
      DO 11 KK=1,IOM1
      I = IORD-KK
      II = (I*I+I)/2
      RHS1(I) = RHS1(I)/T(II)
      K = I+1
      DO 11 J=K,IORD
      IJ = I+(J*J-J)/2
   11 RHS1(I) = RHS1(I)-RHS1(J)*T(IJ)
      DO 806 I=1,IORD
  806 ONED(1,I)=RHS1(I)
      DO 13 IELEM=1,NELEMS
      DO 14 I=1,IORD
   14 RHS2(I) = RHS1(I)
      NNE=IELEM+1
      DO 807 KK=1,IORD
  807 RHS1(KK)=ONED(NNE,KK)
      READ(ITL)(S(I),I=1,ISIZS)
      READ(ITL)(T(I),I=1,ISIZT)
      DO 15 KK=1,IORD
      I = IORD-KK+1
      II = (I*I+I)/2
      RHS1(I) = RHS1(I)/T(II)
      K = I+1
```

```
      IF (KK-1) 101,102,101
  101 DO 16 J=K,IORD
      IJ = I+(J*J-J)/2
   16 RHS1(I) = RHS1(I)-RHS1(J)*T(IJ)
  102 DO 15 J=1,IORD
      IJ = I+(J-1)*IORD
   15 RHS1(I) = RHS1(I)-RHS2(J)*S(IJ)
      DO 808 KK=1,IORD
  808 ONED(NNE,KK)=RHS1(KK)
   13 CONTINUE
      DO 809 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 810 I=1,IORD
      KKTE=KKK+I
      S(KKTE)=ONED(IELEM,I)
  810 CONTINUE
  809 CONTINUE
      DO 811 IELEM=1,NELP1
      KKK=(IELEM-1)*IORD
      DO 821 I=1,IORD
      KKTE=KKK+I
      KE=NELP1-IELEM + 1
      ONED(KE,I)=S(KKTE)
  821 CONTINUE
  811 CONTINUE
      IDISPL=IDISPL+1
      REWIND ITL
      RETURN
      END
      SUBROUTINE STRESS(I1,IPCF,ITIT)
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /B10/ C(8,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
      COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES,HS
```

```
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B22/ Q3(51,48)
      COMMON /B30/ NA,NB
      COMMON /C1/ NDELQ
      COMMON /D10/ ISAVE,IDISPL
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      COMMON /G2/ NCE(50),NAET(50),THETE(50,51),THICKC(50,51)
      COMMON /G5/ ONED(51,48)
      COMMON /F2/ QQ2(51,48),QPR(8,10),QQO(51,48),QQ1(51,48),QP1(48),
     1QP2(48),Q1(48),Q2(48),Q(48),QP(8,12),ALG2(8,12),CC1,CC2,CC,CG1,
     2ES(10),ET(10),EST(10),E13(10),E23(10),QQ3(48)
      COMMON /F1/ ITER,EROR,X,ITLAST,MSTRAI,IPLAST,XSM
      DOUBLE PRECISION ONED
      DIMENSION DRE(4)
      REWIND ISCRA3
C NN-TOTAL NO. OF Q'S FOR ONE ELEMENT
      CALL SOLV
      AXT=0.
      TANT=0.
      RADT=0.
      ANGT=0.
      DO 100 II=1,NUNKTH
      WRITE(6,200)IPAGE
      IPAGE = IPAGE +1
      WRITE(6,501)
  501 FORMAT(50X,32HDISPLACEMENT COMPONENTS OF NODES)
      WRITE(6,900)I1,IPCF
  900 FORMAT(42X,14HINCREMENT NO. I2,5H *** I4,22H PERCENT OF TOTAL LOAD
     1)
      WRITE(6,901)ITIT
  901 FORMAT(55X,24HI T E R A T I O N  N O. I2)
      WRITE(6,503)XTHETA(II)
      WRITE(6,502)
  502 FORMAT(23X,8HNODE NO.,10X,5HAXIAL,12X,10HTANGENTIAL,11X,6HRADIAL,
```

```
    112X,7HANGULAR/)
503 FORMAT(55X,6HTHETA=F8.3,3X,7HDEGREES/)
    NNODES=NELEMS+1
    DO 10 IJ=1,NNODES
    DO 102 IN=1,4
    DRE(IN)=0.
102 CONTINUE
104 INE=IJ
105 IF(IA.EQ.0)GO TO 106
    DO 107 IG=1,IA
    ID=(IG-1)*4 + 1
    IT=IG - 1
    TI=IT
    TH=TI*XTHETA(II)/57.2957795
    DRE(1)=DRE(1) + Q3(INE,ID)*COS(TH)
    DRE(2)=DRE(2) + Q3(INE,ID+1)*SIN(TH)
    DRE(3)=DRE(3) + Q3(INE,ID+2)*COS(TH)
    DRE(4)=DRE(4) + Q3(INE,ID+3)*COS(TH)
107 CONTINUE
106 IF(IB.EQ.0)GO TO 108
    DO 109 IG=1,IB
    ID=(IG-1)*4+1+4*IA
    IT=IG - 1
    TI=IT
    TH=TI*XTHETA(II)/57.2957795
    DRE(1)=DRE(1)+Q3(INE,ID)*SIN(TH)
    DRE(2)=DRE(2)+Q3(INE,ID+1)*COS(TH)
    DRE(3)=DRE(3)+Q3(INE,ID+2)*SIN(TH)
    DRE(4)=DRE(4)+Q3(INE,ID+3)*SIN(TH)
109 CONTINUE
108 IF(ABS(DRE(1)).LT.ABS(AXT))GO TO 170
    AXT=DRE(1)
    W1=XTHETA(II)
    I2=INE
170 IF(ABS(DRE(2)).LT.ABS(TANT))GO TO 171
    TANT=DRE(2)
    W3=XTHETA(II)
```

```
      I4=INE
  171 IF(ABS(DRE(3)).LT.ABS(RADT))GO TO 172
      RADT=DRE(3)
      W5=XTHETA(II)
      I6=INE
  172 IF(ABS(DRE(4)).LT.ABS(ANGT))GO TO 173
      ANGT=DRE(4)
      W7=XTHETA(II)
      I8=INE
  173 CONTINUE
      WRITE(6,110)INE,(DRE(IK),IK=1,4)
  110 FORMAT(26X,I2,4X,4(4X,E15.8))
   10 CONTINUE
  100 CONTINUE
      IF(NSTRAI.NE.0)GO TO 480
      DO 210 I=1,NUNKTH
      WRITE(6,200)IPAGE
      IPAGE = IPAGE + 1
  200 FORMAT(1H1,62X,4HPAGEI3//)
      WRITE(6,201)
  201 FORMAT(37X,58HSTRAINS AND CURVATURES AT THE CENTER OF EACH SHELL E
     1LEMENT)
      WRITE(6,900)I1,IPCF
      WRITE(6,901)ITIT
      WRITE(6,202)XTHETA(I)
  202 FORMAT(55X,6HTHETA=F8.3,3X,7HDEGREES/)
      WRITE(6,204)
  204 FORMAT(4X,11HELEMENT NO.,10X,4HE(S),13X,8HE(THETA),10X,10HE(S-THET
     1A),12X,4HK(S),13X,8HK(THETA),10X,10HK(S-THETA)//)
      DO 211 J=1,NELEMS
  205 WRITE(6,203)J,(ST(J,I,K),K=1,6)
  203 FORMAT(8X,I2,5X,6(4X,E15.8))
  211 CONTINUE
  210 CONTINUE
  480 DO 310 I=1,NUNKTH
      WRITE(6,200)IPAGE
      IPAGE = IPAGE + 1
```

```
      WRITE(6,301)
  301 FORMAT(39X,53HSTRESS RESULTANTS AT THE CENTER OF EACH SHELL ELEMEN
     1T)
      WRITE(6,900)I1,IPCF
      WRITE(6,901)ITIT
      WRITE(6,202)XTHETA(I)
      WRITE(6,304)
  304 FORMAT(1X,11HELEMENT NO.,6X,4HN(S),9X,8HN(THETA),6X,10HN(S-THETA),
     18X,4HM(S),9X,8HM(THETA),6X,10HM(S-THETA),8X,4HQ(S),9X,8HQ(THETA)//
     2)
      DO 311 J=1,NELEMS
  305 WRITE(6,208)J,(STR(J,I,K),K=1,8)
  208 FORMAT(5X,I2,4X,8(2X,E13.6))
  311 CONTINUE
  310 CONTINUE
      IF(NSTRAI.NE.0)RETURN
      WRITE(6,200)IPAGE
      IPAGE = IPAGE + 1
      WRITE(6,150)
  150 FORMAT(35X,62HMAXIMUM COMPUTED NODE DISPLACEMENT COMPONENTS OF THE
     1 STRUCTURE////)
      WRITE(6,900)I1,IPCF
      WRITE(6,901)ITIT
      WRITE(6,151)
  151 FORMAT(1H0,22X,5HAXIAL,20X,10HTANGENTIAL,19X,6HRADIAL,20X,
     17HANGULAR///)
      WRITE(6,152)AXT,TANT,RADT,ANGT
  152 FORMAT(6X,4(12X,E15.8)//)
      WRITE(6,153)
  153 FORMAT(4(27H                              AT)/)
      WRITE(6,154)
  154 FORMAT(1H0,5X,4(13X,14HTHETA      NODE)//)
      WRITE(6,155)W1,I2,W3,I4,W5,I6,W7,I8
  155 FORMAT(1H0,4X,4(12X,F8.3,5X,I2)////)
      SN = 0.
      TN = 0.
      TSN= 0.
```

```
      SM = 0.
      TM = 0.
      TSM= 0.
      QS=0.
      QST=0.
      DO 180 I=1,NELEMS
      DO 181 J=1,NUNKTH
      IF(ABS(STR(I,J,1)).LT.ABS(SN))GO TO 190
      SN=STR(I,J,1)
      W1=XTHETA(J)
      I2=I
  190 IF(ABS(STR(I,J,2)).LT.ABS(TN))GO TO 191
      TN=STR(I,J,2)
      W3=XTHETA(J)
      I4=I
  191 IF(ABS(STR(I,J,3)).LT.ABS(TSN))GO TO 192
      TSN=STR(I,J,3)
      W5=XTHETA(J)
      I6=I
  192 IF(ABS(STR(I,J,4)).LT.ABS(SM))GO TO 193
      SM=STR(I,J,4)
      W7=XTHETA(J)
      I8=I
  193 IF(ABS(STR(I,J,5)).LT.ABS(TM))GO TO 194
      TM=STR(I,J,5)
      W9=XTHETA(J)
      I10=I
  194 IF(ABS(STR(I,J,6)).LT.ABS(TSM))GO TO 195
      TSM=STR(I,J,6)
      W11=XTHETA(J)
      I12=I
  195 IF(ABS(STR(I,J,7)).LT.ABS(QS))GO TO 196
      QS=STR(I,J,7)
      W13=XTHETA(J)
      I14=I
  196 IF(ABS(STR(I,J,8)).LT.ABS(QST))GO TO 197
      QST=STR(I,J,8)
```

```
      W15=XTHETA(J)
      I16=I
  197 CONTINUE
  181 CONTINUE
  180 CONTINUE
      WRITE(6,156)
  156 FORMAT(1H0,34X,61HMAXIMUM COMPUTED STRESS RESULTANT COMPONENTS OF
     1THE STRUCTURE////)
      WRITE(6,157)
  157 FORMAT(8X,4HN(S),10X,8HN(THETA),7X,10HN(S-THETA),9X,4HM(S),10X,
     18HM(THETA),7X,10HM(S-THETA),9X,4HQ(S),10X,8HQ(THETA)///)
      WRITE(6,158)SN,TN,TSN,SM,TM,TSM,QS,QST
  158 FORMAT(8(3X,E13.6)//)
      WRITE(6,159)
  159 FORMAT(1H0,8X,2HAT,7(14X,2HAT)/)
      WRITE(6,160)
  160 FORMAT(8(3X,13HELEMENT THETA)//)
      WRITE(6,161)I2,W1,I4,W3,I6,W5,I8,W7,I10,W9,I12,W11,I14,W13,I16,W15
  161 FORMAT(1H0,8(4X,I2,2X,F8.3)//)
      RETURN
      END
      SUBROUTINE SOLV
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /A7/ NTAPE,ISCRA1,ISCRA3,NELEMS,NH,IPAGE,PROBLE
      COMMON /B9/ IA,IB
      COMMON /B10/ C(6,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
      COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      COMMON /B18/ NAMES,HS
      COMMON /B22/ Q3(51,48)
      COMMON /B30/ NA,NB
      COMMON /D40/ PHPRMI(50),RMDI(50),CPDM(50),SPDM(50),PPPH(50),
     1ARLC(50),CHEKC(50,8,8),RO2(50),A1L(50),A2L(50),A3L(50),AL157(50),
     2A4L(50),A5L(50),A6L(50),A7L(50),A15L(50),A16L(50),A17L(50),A18L(50
     3),A19L(50),A20L(50),A21L(50),A22L(50),AL158(50),AL159(50)
      COMMON /F2/ QQ2(51,48),QPR(8,10),QQ0(51,48),QQ1(51,48),QP1(48),
```

```
     1QP2(48),Q7(48),Q8(48),R(48),QP(8,12),ALG2(8,12),CC1,CC2,CC,CG1,
     2ES(10),ET(10),EST(10),E13(10),E23(10),QQ3(48)
      COMMON /G2/ NCE(50),NAET(50),THETE(50,51),THICKC(50,51)
      COMMON /G5/ ONED(51,48)
      DOUBLE PRECISION ONED
      DIMENSION AB(12,8)
      DIMENSION THETA(51),THIC(51)
      DIMENSION Q1(48),Q2(48),Q(8)
      INTEGER REST
      NN = 4*(IA + IB)
      IFO=NA+NB+1
      DO 300 I=1,NN
  300 Q1(I)=ONED(1,I)
      DO 800 II=1,NN
  800 Q3(1,II)=Q1(II)
      DO 10 IJ=1,NELEMS
      DO 301 I=1,NN
  301 Q2(I)=ONED(IJ+1,I)
      DO 801 II=1,NN
      Q3(IJ+1,II)=Q2(II)
  801 CONTINUE
C KA-COUNTER FOR ADDRESSING Q'S IN THE ARRAYS  Q1 AND Q2
C IAB-TOTAL NO. OF HARMONICS FOR ONE NODE
      PHPMID=PHPRMI(IJ)
      RMID=RMDI(IJ)
      CPMD=CPDM(IJ)
      SPMD=SPDM(IJ)
      PHPP=PPPH(IJ)
      ARCL=ARLC(IJ)
      DO 4939 ITS1=1,8
      DO 4940 ITS2=1,8
      C(ITS1,ITS2)=CHEKC(IJ,ITS1,ITS2)
 4940 CONTINUE
 4939 CONTINUE
      NC=NCE(IJ)
      NAMET=NAET(IJ)
      DO 4937 ITH=1,NC
```

```
      THETA(ITH)=THETE(IJ,ITH)
      THIC(ITH)=THICKC(IJ,ITH)
 4937 CONTINUE
      KA=1
      IAB=IA+IB
C COMPUTE ALPHAS FOR ALL HARMONICS AT ONE NODE
      DO15 I=1,IAB
C PUT Q1'S AND Q2'S FOR ONE HARMONIC INTO COLUMN MATRIX
      DO 20 K=1,4
      Q(K)=Q1(KA)
      Q(K+4)=Q2(KA)
      KA=KA+1
   20 CONTINUE
C MULTIPLY GIVEN 8X8 TRANSFORMATION MATRIX C BY COLUMN MATRIX OF ALPHAS
C FOR THE FIRST HARMONIC AND STORE IN ARRAY AB
      DO 25 J=1,8
      SUM=0.
      DO 30 M=1,8
      SUM=C(J,M)*Q(M)+SUM
   30 CONTINUE
      AB(I,J)=SUM
   25 CONTINUE
   15 CONTINUE
C DO COMPUTATION FOR N NUMBER OF THETAS PER ELEMENT
      DO 35 KJ=1,NUNKTH
      IF(NC.NE.1)GO TO 100
      T(KJ) = THIC(1)
      GO TO 101
  100 CONTINUE
      DO 65 J=1,NC
      TH1=THETA(J)*57.2957795
      TH2=THETA(J+1)*57.2957795
      IF(XTHETA(KJ).GE.TH1.AND.XTHETA(KJ).LE.TH2)GO TO 12
   65 CONTINUE
   12 T(KJ)=THIC(J)
C COMPUTE STRAIN RESULTANTS AND RETURN IN ARRAY ST
  101 CONTINUE
```

```
      CALL STRAIN(AB,KJ,IAB,IJ)
C COMPUTE STRESS RESULTANTS AND RETURN IN ARRAY STR(I,J,K) WHERE I=ELEMENT
C COMPUTE CAPAS-PARTIAL DERIVATIVES OF THE RADIUS OF CURVATURE
C NO.,J=THETA NO.,K=COLUMN MATRIX 1-8 GIVING VALUES OF NS,NTHETA,NSTHETA,
C MS,MTHETA,MSTHETA,QS,QTHETA RESPECTIVELY
      CALL STRESR(IJ,KJ)
   35 CONTINUE
C MOVE Q'S FOR NODE P+1 TO NODE P
      DO 40 L=1,NN
      Q1(L)=Q2(L)
   40 CONTINUE
   10 CONTINUE
      RETURN
      END
      SUBROUTINE STRAIN(AB,KJ,IAB,IJ)
      COMMON /A5/ EM(50),POISSO(50)
      COMMON /B9/ IA,IB
      COMMON /B10/ C(8,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
      COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      DIMENSION AB(12,8),U(40)
      S=ARCL/2.
      DO 45 I=1,40
      U(I)=0.
   45 CONTINUE
C TEST FOR A HARMONICS,IF NO,GO TO TEST FOR B HARMONICS
      IF(IA.EQ.0) GO TO 110
C COMPUTE US-OR U(1),VTHETA-U(2),UTHEAT-U(3),VS-U(4),WS-U(5),WSS-U(6),
C WTHETA-U(7),WTHETATHETA-U(8),U-U(9),V-V(10),W-U(11),WSTHETA-U(12),
C WSSS-U(13),WSSTHETA-U(14),WTHETATHETAS-U(15),WTHETATHETATHETA-U(16),
C UTHETATHETA-U(17),USTHETA-U(18),VTHETATHETA-U(19),VSTHETA-U(20) IE
C U,V,W, AND THEIR PARTIAL DERIVATIVES FOR A HARMONICS
      DO 50 I=1,IA
      AI=I-1
      X=AI*XTHETA(KJ)
      X=X/57.2957795
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      U(1)=AB(I,6)*COS(X)+U(1)
      U(2)=AI*(AB(I,7)+AB(I,8)*S)*COS(X)+U(2)
      U(3)=-(AI*(AB(I,5)+AB(I,6)*S)*SIN(X))+U(3)
      U(4)=AB(I,8)*SIN(X)+U(4)
      U(5)=(AB(I,2)+2.*AB(I,3)*S+3.*AB(I,4)*S**2)*COS(X)+U(5)
      U(6)=(2.*AB(I,3)+6.*AB(I,4)*S)*COS(X)+U(6)
      U(7)=-(AI*(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*SIN(X))
     1+U(7)
      U(8)=-((AI**2)*(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*
     1COS(X))+U(8)
      U(9)=(AB(I,5)+AB(I,6)*S)*COS(X)+U(9)
      U(10)=(AB(I,7)+AB(I,8)*S)*SIN(X)+U(10)
      U(11)=(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*COS(X)+U(11)
      U(12)=-AI *(AB(I,2) +2.*AB(I,3)*S+3.*AB(I,4)*S**2)  *SIN(X)+U(12)
      U(13)=6.*AB(I,4)*COS(X)+U(13)
      U(14)=-(AI*(2.*AB(I,3)+6.*AB(I,4)*S)*SIN(X))+U(14)
      U(15)=-((AI**2)*(AB(I,2)+2.*AB(I,3)*S+3.*AB(I,4)*S**2)*COS(X) )+
     1      U(15)
      U(16)=(AI**3)*(AB(I,1)+AB(I,2)*S+AB(I,3)*S**2+AB(I,4)*S**3)*SIN(X)
     1      +U(16)
      U(17)=-((AI**2)*(AB(I,5)+AB(I,6)*S)*COS(X))+U(17)
      U(18)=-AI*AB(I,6)*SIN(X)+U(18)
      U(19)=-((AI**2)*(AB(I,7)+AB(I,8)*S)*SIN(X))+U(19)
      U(20)=AI*AB(I,8)*COS(X)+U(20)
   50 CONTINUE
C CHECK FOR B HARMONICS
  110 IF(IAB.EQ.IA) GO TO 120
      K=IA+1
C COMPUTE US,VTHETA,ETC. AS ABOVE BUT FOR B HARMONICS
      DO 55 J=K,IAB
      AI=J-IA-1
      Y=AI*XTHETA(KJ)
      Y=Y/57.2957795
      U(21)=AB(J,6)*SIN(Y)+U(21)
      U(22)=-(AI*(AB(J,7)+AB(J,8)*S)*SIN(Y))+U(22)
      U(23)=AI*(AB(J,5)+AB(J,6) *S)*COS(Y)+U(23)
      U(24)=AB(J,8)*COS(Y)+U(24)
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      U(25)=(AB(J,2)+2.*AB(J,3)*S+3.*AB(J,4)*S**2)*SIN(Y)+U(25)
      U(26)=(AB(J,3)*2.+6.*AB(J,4)*S)*SIN(Y)+U(26)
      U(27)=AI*(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*COS(Y)+
     1U(27)
      U(28)=-((AI**2)*(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*
     1SIN(Y))+U(28)
      U(29)=(AB(J,5)+AB(J,6)*S)*SIN(Y)+U(29)
      U(30)=(AB(J,7)+AB(J,8)*S)*COS(Y)+U(30)
      U(31)=(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*SIN(Y)+U(31)
      U(32)=AI*(AB(J,2)+2.*AB(J,3)*S+3.*AB(J,4)*S**2)*COS(Y)+U(32)
      U(33)=6.*AB(J,4)*SIN(Y)+U(33)
      U(34)=AI*(2.*AB(J,3)+6.*AB(J,4)*S)*COS(Y)+U(34)
      U(35)=-((AI**2)*(AB(J,2)+2.*AB(J,3)*S+3.*AB(J,4)*S**2)*SIN(Y))+
     1      U(35)
      U(36)=-((AI**3)*(AB(J,1)+AB(J,2)*S+AB(J,3)*S**2+AB(J,4)*S**3)*
     1      COS(Y))+U(36)
      U(37)=-((AI**2)*(AB(J,5)+AB(J,6)*S)*SIN(Y))+U(37)
      U(38)=AI*AB(J,6)*COS(Y)+U(38)
      U(39)=-((AI**2)*(AB(J,7)+AB (J,8)*S)*COS(Y)) +U(39)
      U(40)=-AI*AB(J,8)*SIN(Y)+U(40)
   55 CONTINUE
C ADD THE A AND B HARMONICS FOR AN ELEMENT
  120 DO 60 I=1,20
      U(I)=U(I)+U(I+20)
   60 CONTINUE
C USING THE DISPLACEMENT FUNCTIONS AND THEIR PARTIALS, COMPUTE THE NORMAL
C STRAINS AND SHEAR STRAIN FOR AN ELEMENT
      ES=U(1)-PHPMID*U(11)
      ETHETA=1./RMID*(U(2)+U(9)*SPMD+U(11)*CPMD)
      ESTHE=1./RMID*U(3)-U(10)/RMID*SPMD+U(4)
      E13=U(5)+U(9)*PHPMID
      E23=1./RMID*(U(7)-U(10)*CPMD)
C COMPUTE STRAIN ENERGY USING EQNS. FOR THE STRAINS.
C COMPUTE 3 CURVATURE CHANGES OF SHELL SURFACE.
C ALL EQNS. FOR ONE ANGLE THETA OF ONE ELEMENT.
      ST(IJ,KJ,1) =
     1      ES+.5*E13**2
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 ST(IJ,KJ,2) =
1       ETHETA+.5*E23**2
 ST(IJ,KJ,3) =
1       ESTHE+E13*E23
 ST(IJ,KJ,4) =
1       -(U(6)+U(9)*PHPP+PHPMID*U(1))
 ST(IJ,KJ,5) =
1       -1./RMID*(1./RMID*U(8)+U(5)*SPMD+PHPMID*U(9)*SPMD-1./RMID*
*U(2)*CPMD)
 ST(IJ,KJ,6) =
1       1./RMID*(2./RMID*U(7)*SPMD-2./RMID*U(10)*SPMD*CPMD-2.*U(12)
*-PHPMID*U(3)+CPMD*U(4)-U(10)*SPMD*PHPMID)
 CAPA(1)=-(U(13)+2.*U(1)*PHPP)
 CAPA(2)=-(U(14)+U(3)*PHPP +U(18)*PHPMID)
 CAPA(3)=(1./RMID**2)*(-U(15)+(2./RMID)*SPMD*U(8)-RMID*SPMD*U(6)-
1         RMID*PHPMID*CPMD*U(5)+SPMD**2*U(5)-PHPP *RMID*SPMD*U(9)
2         +SPMD**2*PHPMID*U(9)-RMID*PHPMID*SPMD*U(1)-PHPMID**2*RMID
3         *CPMD*U(9)+CPMD*U(20)-(2./RMID)*CPMD*SPMD*U(2)-PHPMID*
4         SPMD*U(2))
 CAPA(4)=(1./RMID**2)*(-U(16)-RMID*SPMD*U(12)-RMID*PHPMID*SPMD*
1         U(3)+CPMD*U(19))
 CAPA(5)=(1./RMID**2)*(-(4./RMID)*SPMD**2*U(7)+2.*SPMD*U(12)+2.*
1         PHPMID*CPMD*U(7)+(4./RMID)*SPMD**2*CPMD*U(10)-2.*SPMD*
2         CPMD*U(4)-2.*CPMD**2*PHPMID*U(10)+2.*SPMD**2*PHPMID*
3         U(10)+2.*SPMD*U(12)-2.*RMID*U(14)-RMID*PHPP*U(3)+PHPMID
4         *SPMD*U(3)-PHPMID*RMID*U(18)-PHPMID*RMID*SPMD*U(4)-SPMD
5         *CPMD*U(4)-RMID*SPMD*U(4)*PHPMID-PHPMID**2*RMID*CPMD*
6         U(10)+SPMD**2*PHPMID*U(10)-RMID*SPMD*PHPP*U(10))
 CAPA(6)=(1./RMID)*((2./RMID)*SPMD*U(8)-(2./RMID)*SPMD*CPMD*U(2)
1         -2.*U(15)-PHPMID*U(17)+CPMD*U(20)-SPMD*PHPMID*U(2))
 RETURN
 END
 SUBROUTINE STRESR(IJ,KJ)
 COMMON /A5/ EM(50),POISSO(50)
 COMMON /B9/ IA,IB
 COMMON /B10/ C(8,8),PHPMID,RMID,CPMD,SPMD,PHPP,ARCL
 COMMON /B11/ ST(50,10,6),STR(50,10,8),T(10),CAPA(6)
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      COMMON /B14/ XTHETA(10),NUNKTH
      COMMON /B18/ NAMES,HS
      COMMON /B19/ IELRES(10),REST(50,8),NEREST
      INTEGER SAND
      DATA SAND/4HSAND/
      EE1 = EM(IJ)
      FNU1 = POISSO(IJ)
      FNU2 = FNU1
      IF(NAMES.NE.SAND)GO TO 2
      A=2.*(EE1*T(KJ))/(1. - FNU1*FNU2)
      CXX=(EE1*T(KJ)*HS**2)/(2.*(1.-FNU1*FNU2))
      GO TO 3
    2 A=(EE1*T(KJ))/(1.-FNU1*FNU2)
      CXX=(EE1*T(KJ)**3)/(12.*(1.-FNU1*FNU2))
    3 B=A
      D=CXX
      G = EE1/(2.0*(1.0 + FNU1))
C FOLLOWING ARE PARTIALS OF MS,MTHETA,MSTHETA
      PMSS=CXX*CAPA(1)+FNU1*CXX*CAPA(3)
      PMTT=FNU2*D*CAPA(2)+D*CAPA(4)
      IF(NAMES.NE.SAND)GO TO 4
      PMSTS=G*T(KJ)*HS**2*CAPA(5)/2.
      PMSTT=G*T(KJ)*HS**2*CAPA(6)/2.
      GO TO 5
    4 PMSTS=G*(T(KJ)**3/12.)*CAPA(5)
      PMSTT=G*(T(KJ)**3/12.)*CAPA(6)
C  COMPUTE STRESS RESULTANTS
    5 STR(IJ,KJ,1) = A*ST(IJ,KJ,1) + A*FNU1*ST(IJ,KJ,2)
      STR(IJ,KJ,2) = FNU2*B*ST(IJ,KJ,1) + B*ST(IJ,KJ,2)
      STR(IJ,KJ,4)=CXX*ST(IJ,KJ,4)+FNU1*CXX*ST(IJ,KJ,5)
      STR(IJ,KJ,5) = FNU2*D*ST(IJ,KJ,4) + D*ST(IJ,KJ,5)
      STR(IJ,KJ,7)=(1./RMID)*(RMID*PMSS+PMSTT+(STR(IJ,KJ,4)-
     1             STR(IJ,KJ,5))*SPMD)
      IF(NAMES.NE.SAND)GO TO 6
      STR(IJ,KJ,3)=2.*G*T(KJ)*ST(IJ,KJ,3)
      STR(IJ,KJ,6)=G*T(KJ)*HS**2*ST(IJ,KJ,6)/2.
      STR(IJ,KJ,8)=(1./RMID)*(RMID*PMSTS+PMTT+2.*SPMD*STR(IJ,KJ,6))
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      RETURN
    6 STR(IJ,KJ,3) = G*T(KJ)*ST(IJ,KJ,3)
      STR(IJ,KJ,6) = (T(KJ)**3/12.)*ST(IJ,KJ,6)*G
      STR(IJ,KJ,8)=(1./RMID)*(RMID*PMSTS+PMTT+2.*SPMD*STR(IJ,KJ,6))
      RETURN
      END
```