ANALYTICAL AND EXPERIMENTAL DETERMINATION OF LOCALIZED STRUCTURE TO BE USED IN LABORATORY VIBRATION TESTING OF SHELL STRUCTURE-MOUNTED COMPONENTS, SATURN V

NOR 67-19 January 1967

PROGRESS REPORT COVERING

THE PERIOD MAY 1966 TO NOVEMBER 1966

PROCEDURE FOR DESIGNING A LOCALIZED SHELL AND THE APPLICATION OF THE FINITE DIFFERENCE COMPUTER PROGRAM

Prepared For
George C. Marshall Space Flight Center
National Aeronautics and Space Administration
Huntsville, Alabama

NASA CONTRACT NAS8-20025

NORTHROP CORPORATION, Norair Division
3901 West Broadway
Hawthorne, California
Chintsun Hwang, W.S. Pi (Authors)

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ABSTRACT

The progress report covers the work performed for the contract entitled "Analytical and Experimental Determination of Localized Structure to be Used in Laboratory Vibration Testing of Shell Structure-Mounted Components, SATURN V." The work was carried out during the period of May 1966 to November 1966 inclusive. In the report, the detailed procedure in designing a localized shell is described. Also presented is a computer program using the finite difference method which serves to guide the engineers in designing and predicting the vibration responses of the localized shell.

FOREWORD

The progress report was prepared by Northrop Corporation, Norair Division, Hawthorne, California, under contract no. NAS8-20025, "Analytical and Experimental Determination of Localized Structure to be Used in Laboratory Vibration Testing of Shell Structure-Mounted Components, SATURN V."

The subject contract is administered under the direction of the Structures Branch, Propulsion and Vehicle Engineering Laboratory, George C. Marshall Space Flight Center of the National Aeronautics and Space Administration by Mr. J.H. Farrow and Mr. R. Jewell, principal and alternate technical representatives, respectively. Mr. L.D. Saint is the program monitor.

The program manager at Northrop Norair is Dr. Chintsun Hwang, M.T.M., Structures and Dynamics Research Branch. Dr's. W.S. Pi, N.M. Bhatia and Mr. J.R. Yamane participate in the project. Mr. P.E. Finwall is responsible for the experimental tasks of the program.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

SECTION I

INTRODUCTION

During the first year of the contract on localized shell structure to be used in laboratory vibration testing, analytical techniques were used to guide the actual shell design which has been progressing on a trial basis. In the process, it was realized that once a technique has been established, a documented procedure is needed for the test engineers to design and test the localized structures. The present report serves as the document to guide the users in carrying out the design in a rational manner.

The report presents the analytical and experimental techniques in a mixed fashion. They are described in a logical sequence corresponding to the design process. The users are assumed to have available the first year progress report of the same contract which is dated May 1966.

The major supporting computer program for the design procedure is the finite difference program. The basic theory, program mechanization, the program listing and the input-output format are included in the report.

SECTION II

SHELL RESPONSE AND IMPEDANCE STUDY

In order to design a localized shell structure for laboratory vibration testing purposes, preliminary tests are conducted using the complete shell structure such as the Instrument Unit with proper supporting conditions. Applying a frequency sweep technique, the shell responses and the point impedance function are plotted. Typical response data for a scale model is plotted in Figure 1. Typical impedance data are shown in Figure 2. Similar plots may be obtained for a full scale structure. Note that, in general, each peak response of Figure 1 corresponds approximately to a minimum impedance point of Figure 2. The above response and impedance plots are for a specific driving point. In the present case, the driving point is at the center of the localized shell panel. Considering the nodal line distribution, as well as the possibility of certain non-symmetrical patterns of the natural modes, it is advisable to either move the driving point, or to plot the cross-impedance of the shell structure during the test.

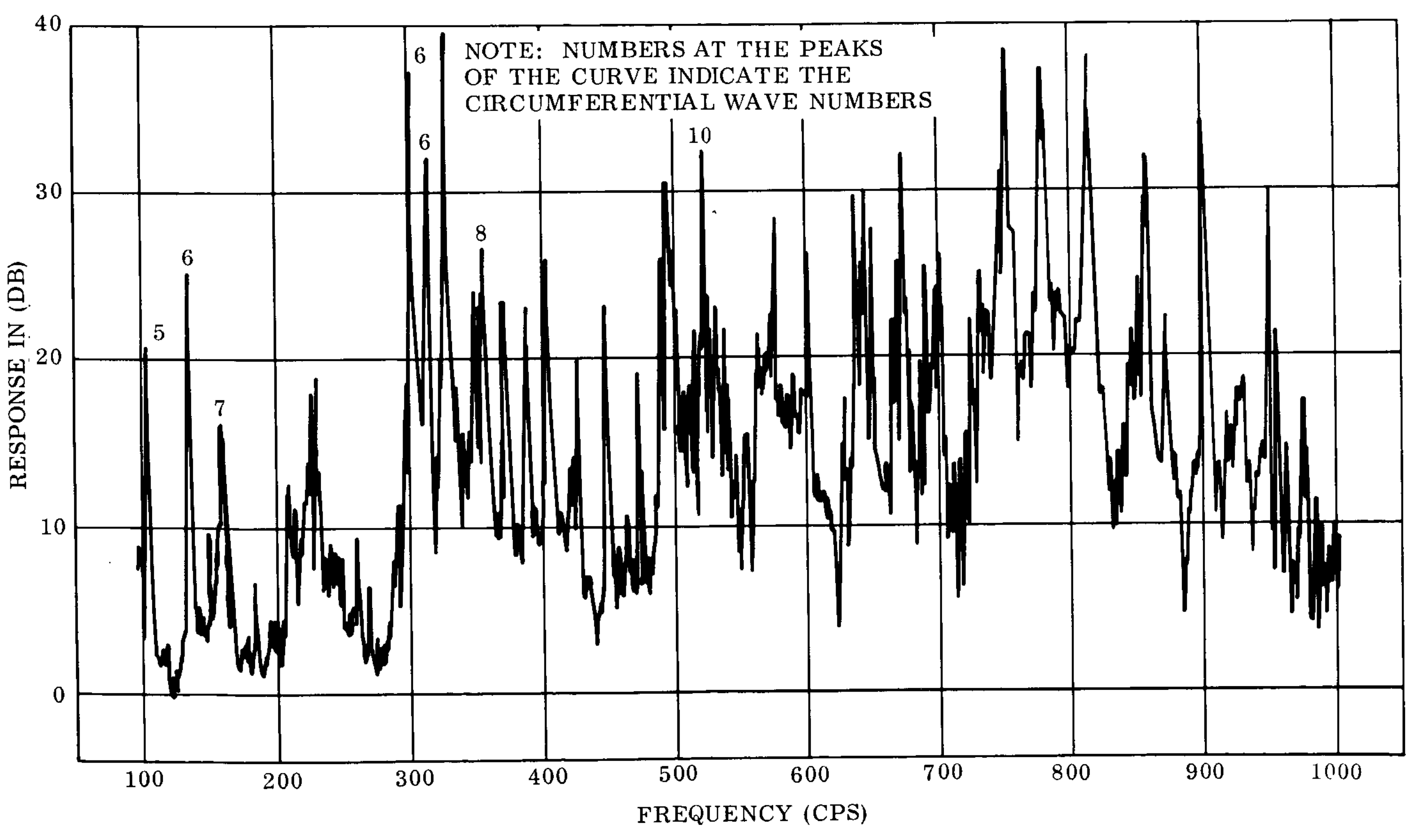

FIGURE 1. MICROPHONE RESPONSE VS FREQUENCY FOR POINT AT CENTER OF INSTRUMENT UNIT 5° FROM ELECTROMAGNETIC DRIVER

The circumferential harmonic number is obtained by a microphone type pickup traversing along the circumference of the shell structure. For convenience in correlating the test data with the analytical data, it is preferable to test the shell with no components attached.

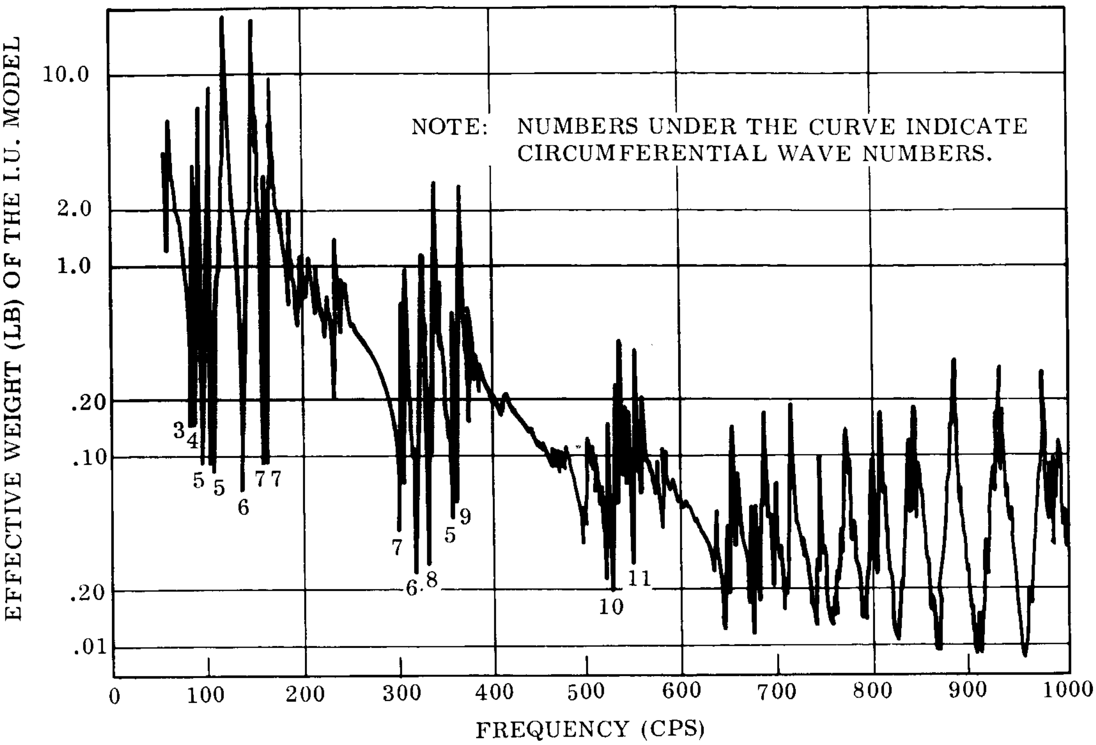

FIGURE 2. TYPICAL DRIVING POINT IMPEDANCES FOR THE I.U. SCALE MODEL

The purpose of the procedure is to design a segmented shell with equivalent dynamic characteristics as the complete shell. Experience has shown that if the segmentation procedure generates a configuration with satisfactory dynamic characteristics for the unloaded shell, then the dynamic response of the same segmented shell with component attachment will be satisfactory. In other words, the segmented shell will simulate the complete shell structure when the components are attached.

Referring to Figure 1, the prominent responses of the complete shell correspond to its natural frequency modes. In order to design a dynamically similar shell segment, the criterion is to retain as many natural frequency modes as possible in the segmented shell. For this purpose, it is necessary to investigate the detailed deformation pattern, the internal stresses, etc. of each major mode. The detailed shell response information collected in this manner is used for segmentation design. In general, the lower the natural frequency, the longer is the characteristic wave length of the deformation. As a result, the corresponding mode response of a specific localized panel is more dependent on the remaining portion of the shell structure. For high frequency modes, the deformation wave lengths are relatively short. The local response of a panel is not overly influenced by the remaining structure. As a result, in designing a localized structure, it takes less elaboration to retain the high frequency modes as compared to the low frequency modes. It is thus advisable to pay more emphasis in retaining the lower frequency modes. For a shell structure of the size of the Instrument Unit, the natural frequency modes under 100 cps are considered most significant and justify special attention.

SECTION III

GENERAL STIFFENED SHELL PROGRAM

In order to investigate the shell detailed deformation pattern and the internal stresses, the general stiffened shell computer program may be used. The program can handle an arbitrarily shaped shell of revolution with a number of ring stiffeners. The modal data corresponding to a circumferential harmonic number is printed out in a table together with the natural frequency. The detailed procedure of using the computer program is given in the contract yearly progress report, NOR 66-201, Vo. II, dated May 1966. The discussion here is limited to the application of the computer program for localized shell design purposes.

The computer output consists essentially of a table of eight variables along the meridian of the ring-stiffener shell. The eight variables are:

$$w_n,\ u_n,\ v_n,\ \beta_n,\ Q_n,\ N_{\varphi n},\ N_n,\ M_{\varphi n}$$

Among the eight variables, u, v, w are the displacement components, β is the angle of rotation of the tangent to the meridian in a meridian plane. The subscript n indicates the circumferential harmonic number, or the number of full wave patterns along the circumference of the shell. The four remaining variables Q, N_φ, N, M_φ are the stress variables. The details of the stress variables will be explained later in the section.

Table 1 is an example of the printout data from the general stiffened shell computer program. The data is for the complete Instrument Unit scale model including the supporting shell structures. It represents the first mode corresponding to circumferential harmonic number n = 4. The natural frequency is 87.245 cps. The tabulated data is set in eight columns representing the eight variables listed above. Each row of the tabulated data refers to a section of the shell structure from one end to the other as defined by the input data. In Table 1, the data referring to the Instrument Unit proper is listed in rows 11-14. The data is in non-dimensional form. The dimensional values used to normalize the variables are listed directly above the table. The data w_{max} in inches has been used to normalize the first through third columns w, u, v. The data β_{max} in radian has been used to normalize β data in the fourth column. The $N_{\varphi max}$ data in (lb./in.) has been used to normalize Q, N_φ, N data in the fifth through seventh columns. The $M_{\varphi max}$ data in (lb. in./in.) has been used to normalize the M_φ data in the eighth column. To obtain a dimensional value of the modal data, the non-dimensional quantity of Table 1 is to be multiplied by the proper normalizing data w_{max}, β_{max}, etc.

BETA LISTING

0.312178E 00	-0.739306E-01	0.122257E 01	-0.604736E-02
-0.739306E-01	0.194476E 00	-0.147675E 00	-0.267588E-03
0.122257E 01	-0.147675E 00	0.490030E 01	-0.247557E-01
-0.604736E-02	-0.267588E-03	-0.247557E-01	0.274801E-03

VALUES THAT NORMALIZATION ARE DONE WITH
OWMAX = 0.140415E-04   BMAX = 0.684696E-06   NFIMAX = 0.151059E-01   MFIMAX = 0.113649E-03

8 * 24 MATRIX OF THE MODE SHAPES

W	U	V	BETA	Q	N-PHI	N	M-PHI
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0.47513054E 00	-0.35560408E-01	-0.11886386E 00	-0.76364861E 00	-0.98100505E-03	0.16725586E 00	-0.29706688E 00	0.19596841E 00
0.55707621E 00	-0.34432812E-01	-0.13983338E 00	-0.68697643E 00	0.31612480E-03	0.30769581E 00	-0.27367548E 00	0.10110404E 00
0.63558159E 00	-0.32619178E-01	-0.15980066E 00	-0.65039027E 00	0.24786035E-03	0.43775138E 00	-0.25290660E 00	0.12297824E 00
0.70884512E 00	-0.30188715E-01	-0.17843080E 00	-0.59993565E 00	0.23050135E-03	0.55682659E 00	-0.22925393E 00	0.13863350E 00
0.77559607E 00	-0.27198534E-01	-0.19539963E 00	-0.53917557E 00	0.20696837E-03	0.66362156E 00	-0.20315324E 00	0.15305052E 00
0.83468316E 00	-0.23712461E-01	-0.21041662E 00	-0.46917097E 00	0.18003680E-03	0.75698284E 00	-0.17484386E 00	0.16577575E 00
0.88509882E 00	-0.19799646E-01	-0.22322749E 00	-0.39121171E 00	0.14984034E-03	0.83588826E 00	-0.14461376E 00	0.17659847E 00
0.92599560E 00	-0.15533981E-01	-0.23361713E 00	-0.30657661E 00	0.12307866E-03	0.89946306E 00	-0.11275743E 00	0.18574532E 00
0.95656800E 00	-0.10991342E-01	-0.24141341E 00	-0.21843326E 00	-0.47629184E-04	0.94705676E 00	-0.80214060E-01	0.18398940E 00
0.97935249E 00	-0.62960319E-02	-0.24645618E 00	-0.98819925E-01	0.31687861E-02	0.97684342E 00	-0.33198067E-01	0.37738385E 00
0.98812903E 00	-0.37376187E-02	-0.24862656E 00	-0.74840998E-01	-0.15883392E-05	0.99390751E 00	-0.31950956E-01	0.56674539E 00
0.99270847E 00	-0.11581917E-02	-0.24964376E 00	-0.51233301E-01	-0.90739394E-03	0.10000000E 01	-0.12248767E-03	0.42459228E 00
0.10000000E 01	0.13112947E-02	-0.24939208E 00	-0.47636922E-01	0.10528009E-01	0.98846141E 00	0.81271929E-01	0.10000000E 01
0.97392344E 00	0.63099488E-02	-0.24130816E 00	0.33119182E 00	-0.37742797E-04	0.99940953E 00	0.52210603E-01	0.19665190E 00
0.92941931E 00	0.11283500E-01	-0.23014984E 00	0.42275442E 00	-0.54761167E-04	0.98457842E 00	0.90011186E-01	0.20582457E 00
0.87292939E 00	0.16137047E-01	-0.21593741E 00	0.52561797E 00	-0.10872826E-03	0.94889513E 00	0.12758945E 00	0.20241015E 00
0.80436394E 00	0.20760800E-01	-0.19871607E 00	0.62545977E 00	-0.16786837E-03	0.89086281E 00	0.16472886E 00	0.19568060E 00
0.72418351E 00	0.25037958E-01	-0.17860166E 00	0.72026771E 00	-0.23298689E-03	0.80910057E 00	0.20108531E 00	0.18479951E 00
0.63315214E 00	0.28844589E-01	-0.15578786E 00	0.80722476E 00	-0.30344990E-03	0.70226524E 00	0.23634095E 00	0.16934802E 00
0.53238814E 00	0.32049784E-01	-0.13055579E 00	0.88320097E 00	-0.37755612E-03	0.56904235E 00	0.27022021E 00	0.14893757E 00
0.42338389E 00	0.34515988E-01	-0.10328442E 00	0.94469375E 00	-0.47848979E-03	0.40813359E 00	0.30239929E 00	0.12209520E 00
0.30852958E 00	0.36089445E-01	-0.74453843E-01	0.10000000E 01	0.26803097E-03	0.21760460E 00	0.33630150E 00	0.14079811E 00
0.18664530E 00	0.36902703E-01	-0.45003852E-01	0.93700373E-01	0.	0.	0.	0.

1
MQ UNDERFLOW AT LOCATION 41701
MQ UNDERFLOW AT LOCATION 42022
MQ UNDERFLOW AT LOCATION 42134
MQ UNDERFLOW AT LOCATION 55662
MQ UNDERFLOW AT LOCATION 42036

TABLE 1. TYPICAL PRINT-OUT OF THE GENERAL STIFFENED SHELL PROGRAM

Among the eight variables, w_n, u_n, β_n, Q_n, $N_{\varphi n}$, $M_{\varphi n}$ are in phase to each other, while v_n and N_n are out of phase. For instance, corresponding to a given meridian location of the shell, the circumferential position with the largest w_n also has largest u_n, β_n, Q_n, $N_{\varphi n}$, $M_{\varphi n}$. The displacement component v_n and the stress component N_n vanish at the same position. Moving one quarter wave length along the circumference of the shell, which corresponds to an angle of $\left(\frac{\pi}{2n}\right)$ radian, w_n, u_n, β_n, etc vanish, while v_n, N_n are at their maximum amplitudes. From the normal displacement point of view, the latter circumferential position is the position where a meridian nodal line passes. Altogether, there are (2n) nodal lines evenly spaced along the circumference of the shell. The nodal line distribution described above has been confirmed in tests with some exceptions. In the exceptional cases, the modal shapes are influenced due to deviation in symmetry of the shell structures or other related reasons. The exceptions include skewed nodal lines or a change of harmonic number from one shell segment to the next where a ring stiffener acts as the barrier.

The four shell stress components Q_n, $N_{\varphi n}$, N_n, $M_{\varphi n}$ deserve further explanation. Q_n is the amplitude of the modified transverse shear along a meridian. Ignoring the periodic time function cos ωt, the transverse shear may be expressed below:

$$Q = Q_\varphi + \frac{1}{r}\frac{\partial M_{\theta\varphi}}{\partial \theta} = Q_n \cos n\theta$$

where Q_φ is the transverse shear force, the term $\left(\frac{1}{r}\frac{\partial M_{\theta\varphi}}{\partial \theta}\right)$ represents the additional transverse shear force needed at an open edge to compensate for the variation of the twisting moment $M_{\theta\varphi}$. In general, when a shell is cut by a plane normal to its axis of revolution, the modified transverse shear force $Q_n \cos n\theta$ is to be supplied by the supporting system in order to retain the response pattern for the segmented shell. In practice, it is not possible to design a supporting system satisfying all the edge conditions. Tests and analyses have shown that in a localized shell with substantial weight attachment along the edges, the mode shapes and natural frequencies of the original shell may be retained. Corresponding to the retained mode shapes, certain internal stresses may vary substantially from the stresses in the original shell. The reason for the deviation is partially due to the variation in boundary conditions such as the transverse shear Q_n described above. On the other hand, the added weights, which are used to retain the modal patterns of the original shell, have substantial inertia during vibration. The inertia forces have a decisive effect on the internal stresses of the localized shell. The inertia effect of the attached weights may be observed from the modal data obtained by the finite difference program described later in the report.

The sixth column of the tabulation gives the in-plane force along the meridian direction:

$$N_\varphi = N_{\varphi n} \cos n\theta$$

The seventh column of the tabulation gives the modified in-plane shear force along a section normal to the meridian

$$N = N_n \sin n\theta$$

$$= \left(N_{\theta\varphi n} + \frac{\sin\varphi}{r} M_{\theta\varphi n}\right) \sin n\theta$$

where the term including $M_{\theta\varphi n}$ represents the additional edge shear force needed to form a couple to balance the twisting moment component due to the shell curvature. The eighth column of the tabulation gives the bending moment in the meridian plane

$$M_\varphi = M_{\varphi n} \cos n\theta$$

The remaining stresses in the shell may be computed using the following formulas:

$$N_{\theta n} = \nu N_{\varphi n} + \frac{Eh}{r} (w_n \sin\varphi + u_n \cos\varphi + n\, v_n)$$

$$M_{\theta n} = \nu M_{\varphi n} + \frac{Eh^3}{12r} \left(\frac{\eta^2}{r} w_n + \beta_n \cos\varphi + \frac{n}{r} \sin\varphi\, v_n\right)$$

$$M_{\theta\varphi n} = \frac{D(1-\nu)}{2r} \left[-2n \cos\varphi \frac{w_n}{r} + nJ\, u_n + H \cos\varphi\, v_n - 2n\beta_n\right] + \frac{\sin\varphi}{Kr} DN_n$$

$$Q_{\theta n} = -\frac{n}{r} M_{\theta n} + \frac{d}{ds} M_{\theta\varphi n} + 2\frac{\cos\varphi}{r} M_{\theta\varphi n} + \frac{\rho\omega^2 h^3}{12r} (nw_n + v_n \sin\varphi)$$

where

$$J = \frac{1}{R_\varphi} + \frac{\sin\varphi}{r}$$

$$H = \frac{1}{R_\varphi} - \frac{\sin\varphi}{r}$$

ρ is the material density, ω is the natural frequency in radian/sec. D is the shell section modulus. The reader is referred to the first year progress report for definitions of the shell geometry.

SECTION IV

LOCALIZED SHELL DESIGN

In designing a localized shell, it may be convenient to start with a major modal pattern of the complete shell structure. Along the circumferential direction, cut a section somewhat less than two half-wave lengths of the major mode. (Each half-wave encompasses an angle of π/n radian.) In case there are more than one major mode under consideration, then if physically possible, select the one with the longer wave length. In this manner, the mode(s) with the shorter wave length(s) may be retained through proper design of the localized shell and its supporting system. Along the meridian direction, the localized shell may be cut along some convenient locations. For a thin shell of the cylindrical shape, it has been found that the interaction of the shell stresses along the meridian and the circumferential directions is weak. As long as the two major dimensions of the localized shell assume a reasonable proportion, the meridian length of the localized shell is flexible. For a conical shell section, the situation is somewhat different. In either case, it is best to design a localized shell with ring stiffeners along the two circumferential edges.

The localized shell is supported by a number of cantilever beam type springs. A typical design for a scale model is shown in Figure 3. The spring has a free hinge connection to the shell structure. The formula for computing the spring linear stiffness at the connection point is:

$$K = \frac{3EI}{\ell^3} \quad \text{lb./in. for a beam with a uniform section}$$

$$K = \frac{E}{\int_0^{\ell} \frac{(\ell - x)^2}{I}\, dx} \quad \text{lb./in. for a beam with a variable section}$$

In either case, the length of the cantilever beam is ℓ. x is measured from the built-in end. The integration for the variable section beam may be carried out using the area-moment method as shown in the numerical example of Section VI. In designing the spring support, it is advisable to leave the beam length ℓ somewhat flexible subject to final adjustment. The number of spring supports used at each edge of the localized shell is arbitrary. At or near the spring supports, it is necessary to attach a number of weights in order to bring the natural frequency of the localized shell down to the level of the original shell. An approximate formula to determine the weight needed for each spring is:

$$W \cong \frac{Kg}{4\pi^2 f^2} \text{ lb.}$$

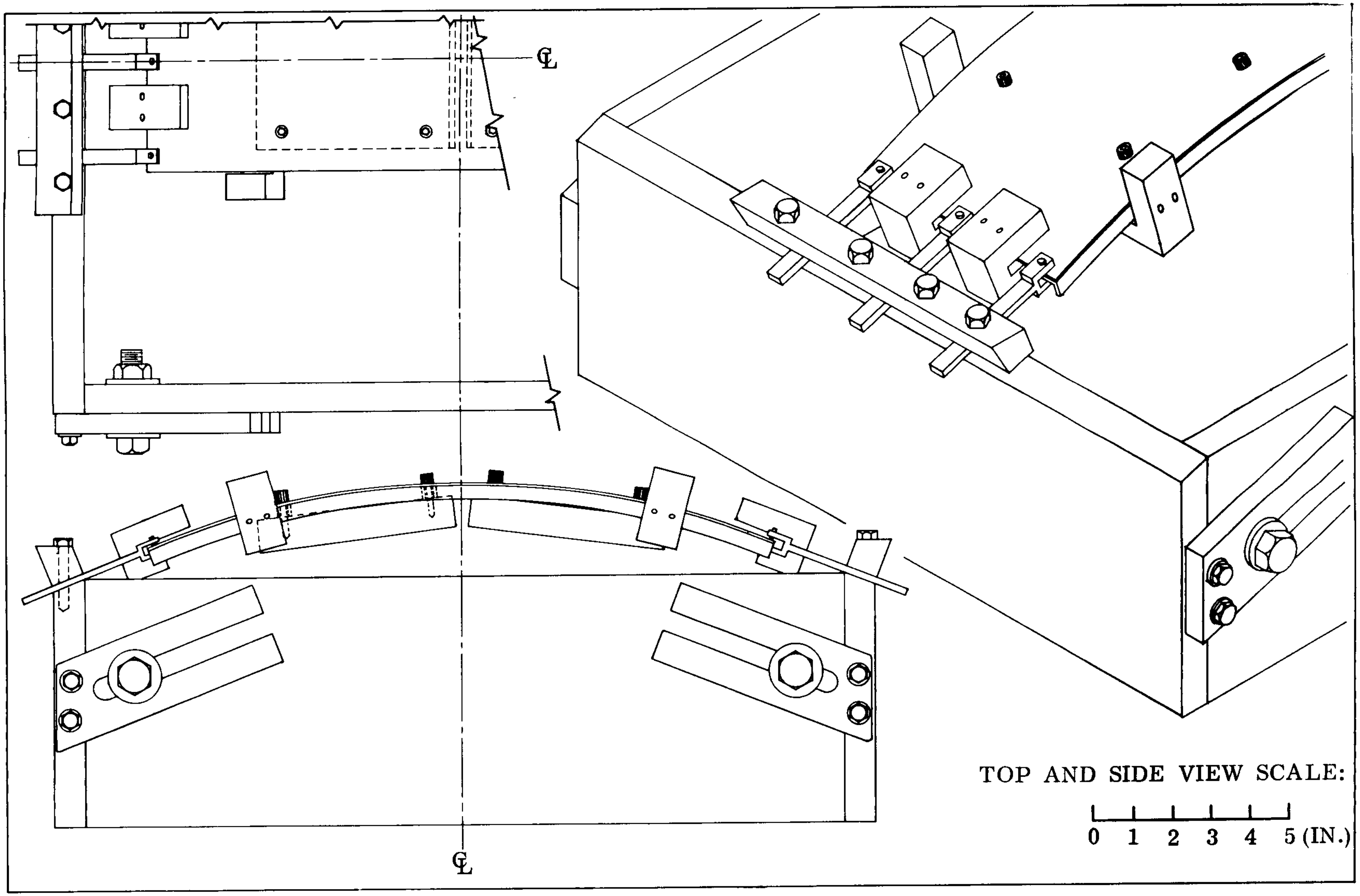


FIGURE 3. VIBRATION FIXTURE FOR S-4B INSTRUMENT UNIT SEGMENT

where K is the linear spring constant computed previously, the g is the gravitational constant, f(cps) is the natural frequency of the major mode of the original shell structure. The above formula is used as a general guide. The actual frequency of the localized shell will be influenced by the shell structure which will be determined by the finite difference computer program described later in the procedure. The weights are usually attached to the edge of the shell near the spring supports. In attaching the weights, consideration should be given to the dynamic stress concentration which may cause damage to the shell structure. For a honeycomb sandwich shell, filler material should be used to replace the honeycomb material along the edge.

The shape of the attached weight is determined essentially through its moment of inertia I_θ about an axis coinciding with the edge of the shell. Again, no precise formula is available. The following formula may be used to determine the approximate sectional dimensions of the attached weight:

$$M_{\theta n} L \cong I_{\theta n} \beta_{\theta n} \omega^2$$

where $M_{\theta n}$ is determined by the equation given in Section III based on the general stiffened shell data. $\beta_{\theta n}$ is the amplitude of the angle of rotation of the shell which may be computed by the following formula

$$\beta_{\theta n} = \frac{n\, w_n}{r} + \frac{\sin \varphi}{r} v_n$$

L is the length of the edge influenced by the attached weight, ω is the natural frequency in rad./sec. For instance, using the data of row 14 of Table 1 and the formula for M_{θ_n} in Section III, the following numerical values are computed:

$$M_{\theta n} = 1.818 \times 0.1136 \times 10^{-3} = 0.206 \times 10^{-3} \text{ lb. in./in.}$$

$$\beta_{\theta n} = 2.70 \times 10^{-6} \text{ rad.}$$

$$L = 2.7 \text{ in.}$$

$$\omega = 2\pi (87.2) = 548 \text{ rad./sec.}$$

which yield an approximate value of the moment of inertia of each attached weight:

$$I_s = I_{\theta n} = 6.85 \times 10^{-4} \text{ lb. in. sec.}^2$$

Because of fabrication considerations etc., the actual value of I_s in the test setup is 5.85×10^{-4} lb. in. sec^2. Along the circumferential edges, additional weights are attached. These weights serve to pull down the natural frequencies of the localized shell as well as to force a nodal line along the meridan direction for certain low frequency modes. Again, the manner in which the mass and the location of the attachment influence the over all modal pattern is obtained through the finite difference computer program.

SECTION V

FINITE DIFFERENCE COMPUTER PROGRAM

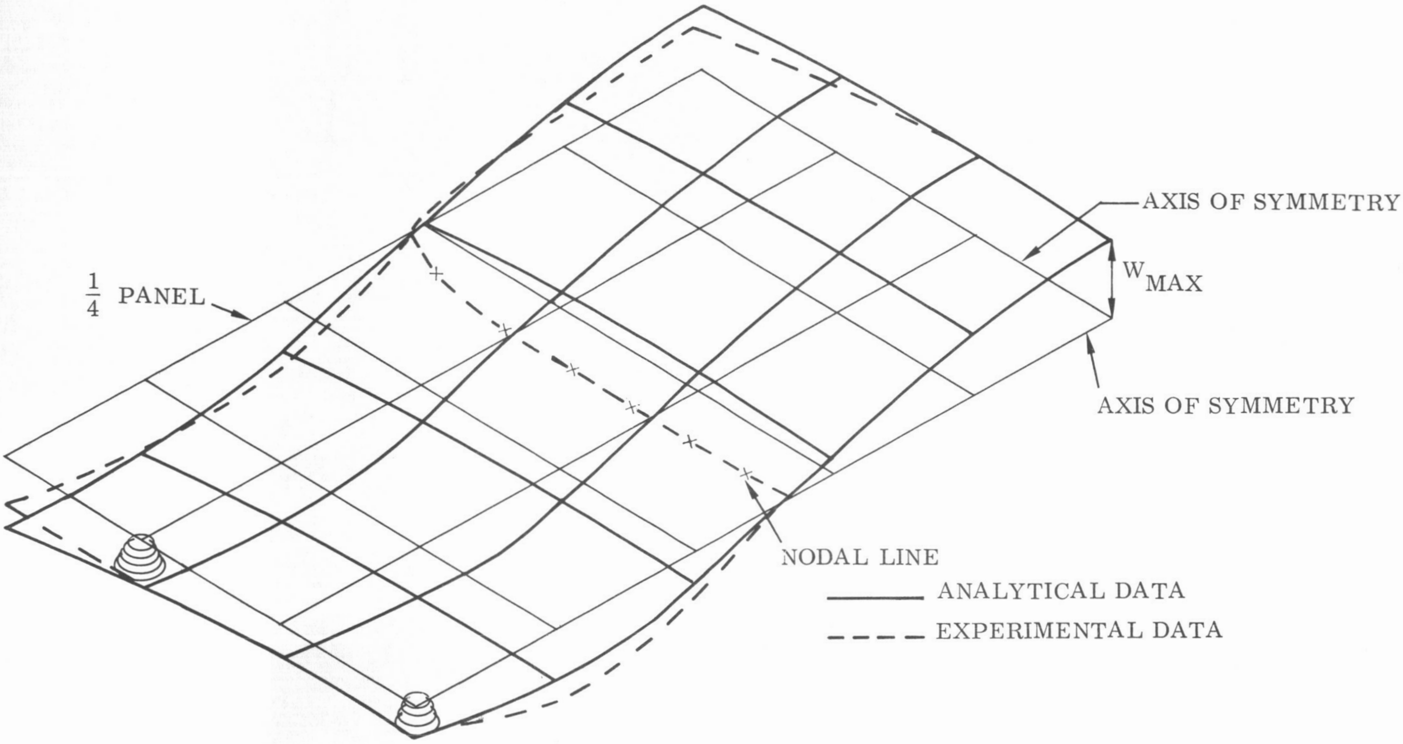
The finite difference approach, based on the coupled shell equations of Vlasov is developed for a curved panel cross-stiffened by two sets of orthogonal stiffeners. The panel considered may have a number of rigid or spring supports at arbitrary points along the edges of the panel.

Any number of concentrated weights may be attached to the edges or the internal points of the shell structure. For a component connected to the shell through a number of attachment points, the moment of inertia of the component is considered.

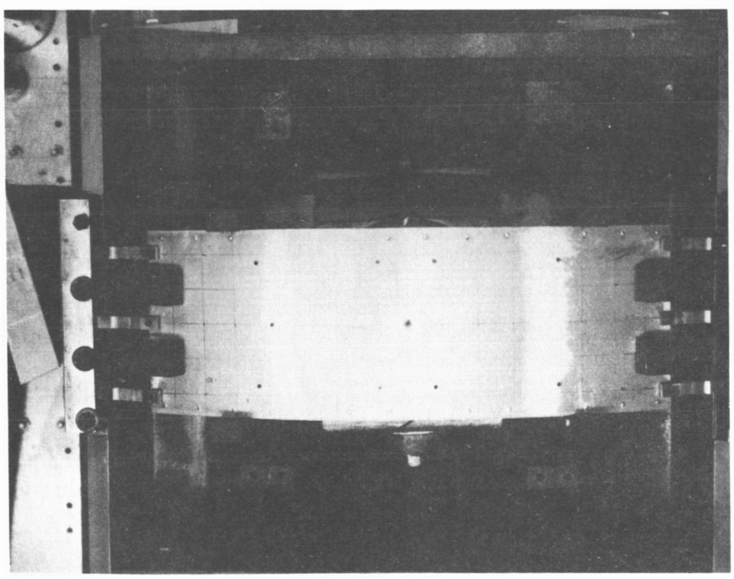
The computer program uses a grid pattern prescribed on the localized shell. The distance between two neighboring grid lines is a constant in each direction. The shell structure data, the spring support data and the attached weight data serve as input to the computer program. The program also interprets the local boundary conditions which are converted into finite difference equations.

All the shell equations are reduced by the program into a matrix form. After a number of internal operations which reduces the size of the eigen-matrix, the natural frequencies and the corresponding modal shapes of the localized shell are obtained using a standard eigenvalue eigen-matrix routine. The program produces the first five (5) natural modes. More modes may be generated as needed. The details of the program and its usage are described in the Appendix.

The modal data generated by the computer program are the basis of the localized shell design. For a given localized shell configuration, the computed data are compared with the test and analytical data of the complete shell structure. If the major modal patterns of the localized shell duplicate those of the complete shell, then the design may be considered satisfactory. Otherwise, the localized shell configuration including the spring supports and the weight attachments may be adjusted in order to reach a better correspondence in the modal patterns. The process may be continued until a satisfactory localized shell design is reached. Typical modal data obtained by this program and the corresponding test data are shown in Figure 4. Experimental results for both mode shape and frequency compared well with the predicted analytical values. Additional deformation data are given in Appendix I.



(a) $f_{computed} = 213.7$ cps



(b) $f_{test} = 214$ cps

FIGURE 4. TYPICAL (a) ANALYTICAL AND (b) TEST MODAL PATTERN OF THE LOCALIZED SHELL STRUCTURE

SECTION VI

USE OF THE SCALE MODEL

The full scale shell structure of SATURN V system is large in size and is expensive. In order to ensure a satisfactory testing technique using localized shell structure, the analytical techniques are developed which are described in the previous sections. Experience indicates that no matter how extensive are the analytical techniques, there will always be some deviation between the predicted analytical data and the test data. Thus, if time and expenses are allowable, it is advisable to use a simple scale model to investigate the dynamic responses of the proposed localized shell design. The work in Northrop has shown that with proper design, the scale model and the corresponding full scale data are quite comparable when proper scale factors are used to interpret the data. The basic technique for a scale model design is given in p. 91, vol. I of Northrop Norair Yearly Progress Report NAS 8-20025. Essentially, the technique is based on the dynamic shell equations which resolve certain important design factors to establish the ratio of the natural frequencies of the scale model and the full scale structure. The same technique is used to correlate the impedance data. For the design of the shell proper, the following equation is used:

$$\frac{\omega_s^2}{\omega_f^2} = \frac{\left(\frac{D}{E}\right)_s \left(\frac{E}{\rho h}\right)_s \left(\frac{1}{L^4}\right)_s}{\left(\frac{D}{E}\right)_f \left(\frac{E}{\rho H}\right)_f \left(\frac{1}{L^4}\right)_f}$$

In the above equation, ω is the frequency in rad./sec. Subscripts s,f indicate the scale model and the full scale structure respectively. On the righthand side of the equation, $\frac{D}{E}$ is a measure of the bending stiffness of the shell. For the Instrument Unit, the scale model is made of a solid sheet, while the actual structure is a honeycomb sandwich. In this case, different formulas are used to compute the shell stiffness D. The factor $\frac{E}{\rho h}$ has a dimension of acceleration. It is a measure of the relative significance of the shell internal forces and the inertia effect of the shell element. For the sandwich shell, the value h is replaced by H which is the compact thickness of the shell. In other words, H is the thickness of the sandwich shell if it is crushed into a solid sheet. The value $\frac{1}{L^4}$ is the contribution due to the overall scaling factor, L being a typical overall dimension. As explained in the Yearly Progress Report, the equation applied to the Instrument Unit scale model yields a frequency ratio as shown below:

$$\frac{\omega_s}{\omega_f} = 3.25$$

The above frequency ratio is based on an overall scaling factor of 6.67. Now that the frequency ratio has been determined, the other design parameters are to be adjusted to reach a consistent design. For instance, the concentrated mass M is scaled according to the following relation:

$$\frac{\omega_s^2}{\omega_f^2} = \frac{D_s \left(\frac{1}{M}\right)_s \left(\frac{1}{L^2}\right)_s}{D_f \left(\frac{1}{M}\right)_f \left(\frac{1}{L^2}\right)_f}$$

The same relation may be established for a concentrated force F applied to the structure:

$$\frac{\omega_s^2}{\omega_f^2} = \frac{D_s \left(\frac{1}{F}\right)_s \left(\frac{1}{L^2}\right)_s}{D_f \left(\frac{1}{F}\right)_f \left(\frac{1}{L^2}\right)_f}$$

where F is the amplitude of the concentrated force with circular frequency ω. The scale model of the segmented Instrument Unit is shown in Figure 3. Based on the above scaling relations, the design of the corresponding full-scale localized shell is shown in Figure 5. In the following, the determination of the attached weights and the spring supports for the full scale structure are explained.

The attached weights to the scale model Instrument Unit segment weigh 1/2 lb. each (see Fig. 3). The width of the weights is 1 in. Based on the actual dimensions of the weights, the polar moment of inertia I_s of each block along an axis parallel to the edge of attachment is:

$$I_s = 5.85 \times 10^{-4} \text{ lb. in. sec.}^2$$

so that

$$gI_s = 0.2258 \text{ lb.-in.}^2$$

Scale relation for the mass moment inertia may be based on the following:

$$\frac{I_f}{I_s} = \frac{(ML^2)_f}{(ML^2)_s}$$

Alternatively, the scale relation may be determined based on edge moment:

$$\text{Edge moment} = \frac{I}{L} \beta \omega^2$$

$$\propto \frac{I\omega^2 w}{L^2} \propto D \frac{w}{L^2}$$

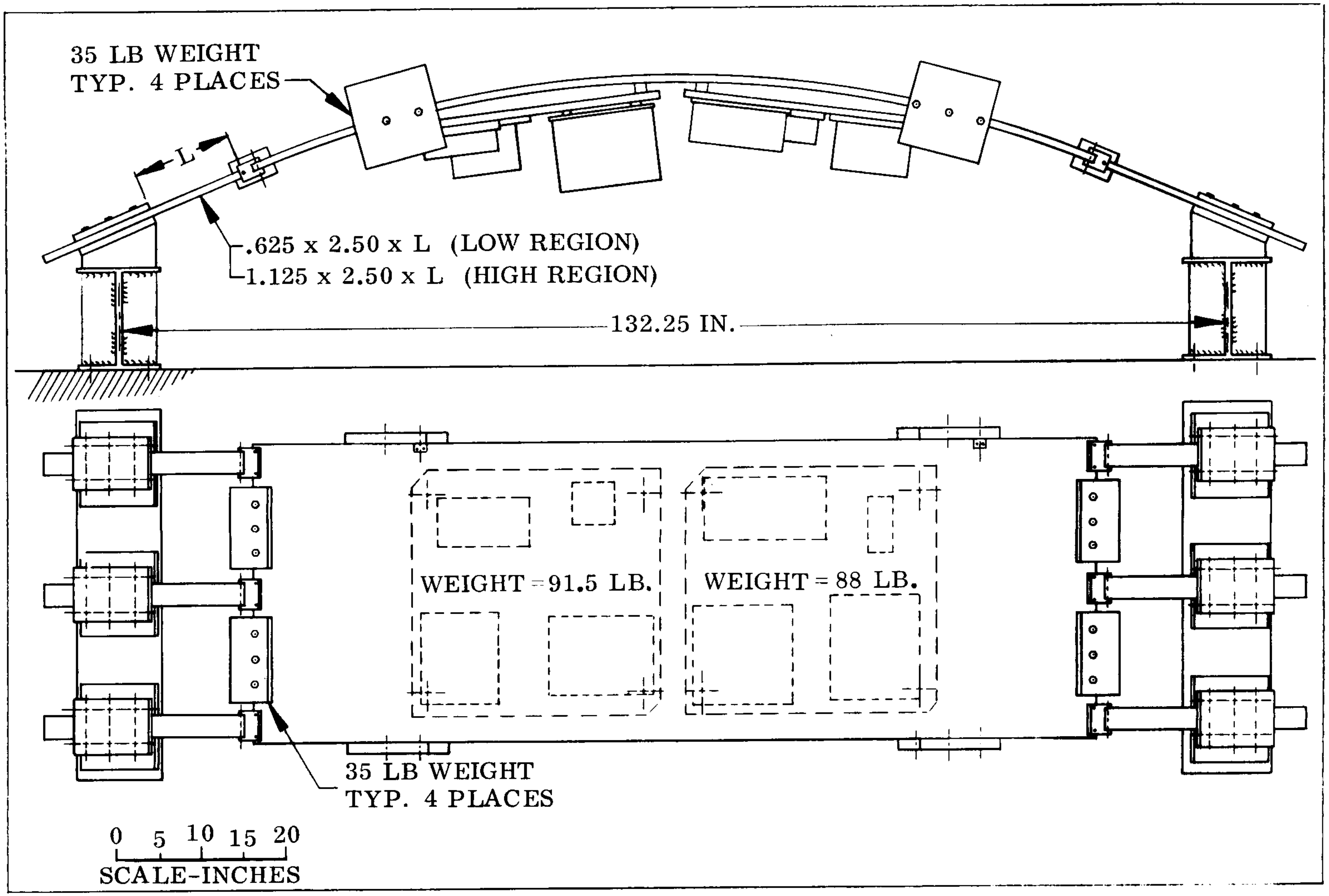


FIGURE 5. VIBRATION JIG FOR S4B 45° INSTRUMENT UNIT SEGMENT

so that

$$\frac{I_f}{I_s} = \left(\frac{D}{\omega^2}\right)_f \Bigg/ \left(\frac{D}{\omega^2}\right)_s = \frac{(ML^2)_f}{(ML^2)_s}$$

For the full scale piece, the attachment weighs 35.25 lb. each. The required ratio between the mass moments of inertia is:

$$\frac{I_f}{I_s} = 70.5 \times 6.67^2 = 3130$$

With no consideration to stress concentration, position of edge stiffener, and convenience in fabrication, the dimensions in Figure 6 are first suggested for the full scale piece attachments using steel blocks. Based on the dimensions shown, the moment of inertia is computed:

$$gI_f = \frac{70.5}{12}\left[1.265^2 + \frac{10.3}{9.3}\quad(10.3)^2 - 1^2\right] = 702 \text{ lb.-in.}^2$$

so that

$$\frac{gI_f}{gI_s} = \frac{702}{.2258} = 3110$$

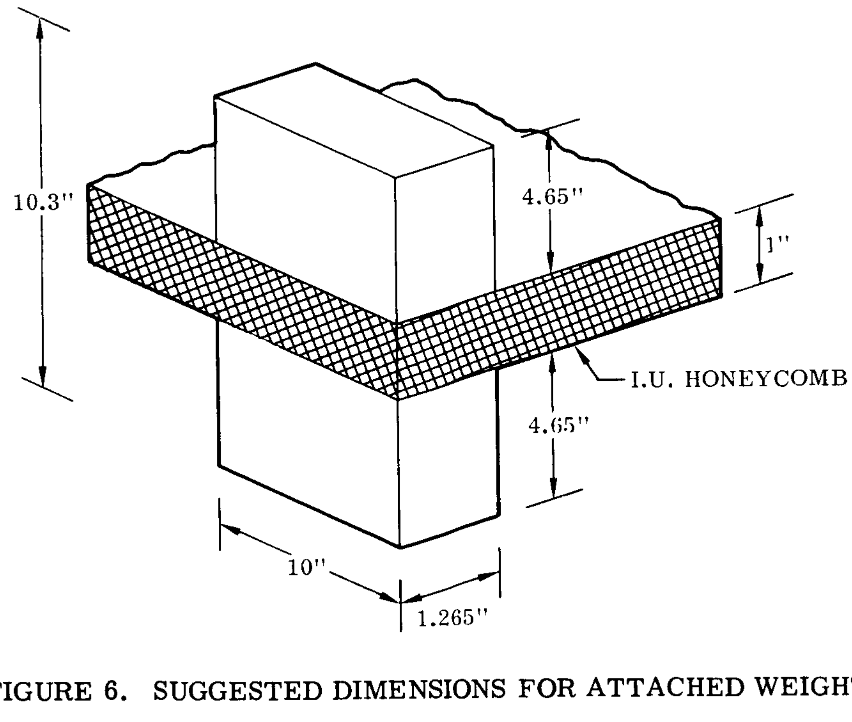


FIGURE 6. SUGGESTED DIMENSIONS FOR ATTACHED WEIGHTS

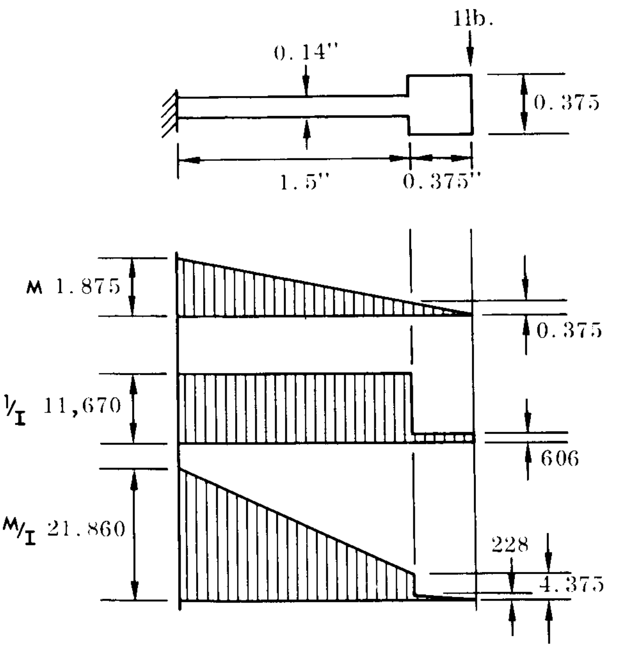
As may be observed from Figure 5, the actual dimensions of the attached weights have been modified from the suggested configuration for the four longitudinal edge pieces. The modification was due to design and fabrication considerations.

The scaling formula for the spring supports of the localized shell is:

$$\frac{K_s}{K_f} = \frac{(\omega^2 M)_s}{(\omega^2 M)_f} = \frac{(D/L^2)_s}{(D/L^2)_f} = \frac{1}{6.67}$$

The spring constants K_s for the I. U. model are obtained in the following manner for a soft spring and a stiff spring.

Case I SOFT SPRING, $50 \leq (\omega_s/2\pi) \leq 250$ CPS.



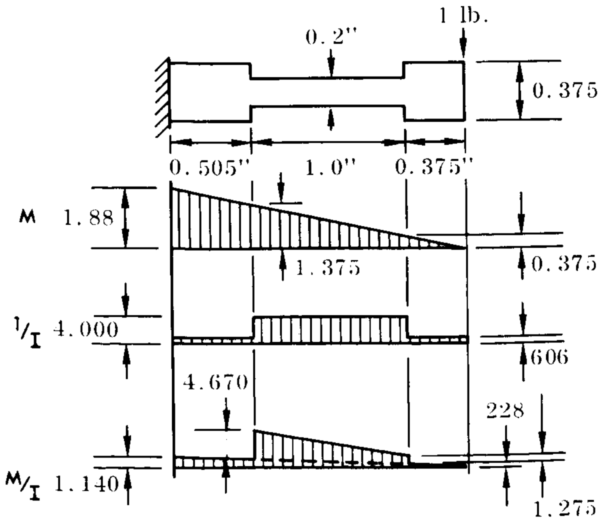
b = 0.375"

E_s 10.3 X 10^6 PSI

$$\frac{E_s}{K_s} = \frac{1}{3} \times 228 \times (0.375)^2 + \frac{1}{2} \times 4375 \times 1.5 \times 0.875 + \frac{1}{2} \times 21860 \times 1.5 \times 1.375 = 25{,}480 \text{ IN.}^{-1}$$

K_s 404.2 LB/IN.

CASE II STIFF SPRING, $(\omega_s/2\pi) > 250$ CPS



b = 0.375"

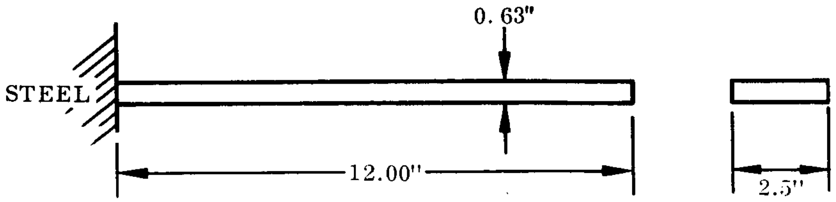
E_s = 10.3 X 10^6 PSI

$$\frac{E_s}{K_s} = \frac{1}{3} \times 1140 \times 1.88^2 + \frac{1}{2} \times 1275 \times 1 \times 0.708 + \frac{1}{2} \times 4670 \times 1 \times 1.042 = 4230 \text{ IN.}^{-1}$$

K_s = 2440 LB/IN.

Based on the scaling formula given previously, two spring supports for the full-scale unit Instrument Unit panel are designated below using carbon steel stock as beam material.

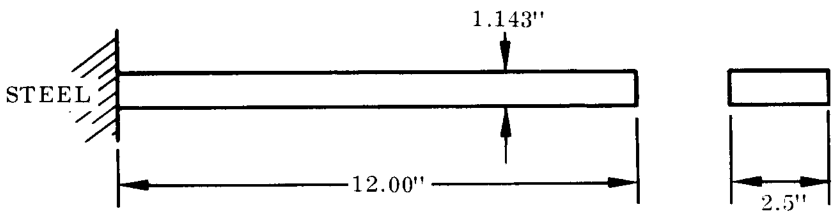
Case I. LOW FREQUENCY REGION $(\omega_f/2\pi) \leq 77$ CPS.



$E_f = 30 \times 10^6$ PSI

$K_f = 2700$ LB./IN. $= 6.67\ K_s$

CASE II, HIGH FREQUENCY REGION. $(\omega_f/2\pi) > 77$ CPS



$K_f = 16250$ LB./IN. $= 6.67\ K_s$

The driving point impedance plot of the full scale shell with component attachments is shown in Figure 7. Also plotted is the corresponding impedance data for the scale model test specimen with proper adjustment in the scales used. From the figure, it may be seen that the general impedance pattern is preserved to an agreeable degree through the dynamic scaling technique. In the high frequency region, the deviation is believed due to the high structural damping of the intricately fabricated full scale shell structure as compared to the simple scale model.

The arrowheads shown in Figure 7 indicate the computed eigenfrequencies of the full scale I. U. segment. The frequencies are computed for mode shapes symmetrical with respect to both center lines of the segment using the finite difference program. Among the computed eigenfrequencies, none corresponds to the test frequency for the first low impedance point. Possible reasons of the omission of the frequency may be due to the non-symmetry of the mode shape, the local vibration coupled to the mechanical excitation device, etc. This point will be further investigated.

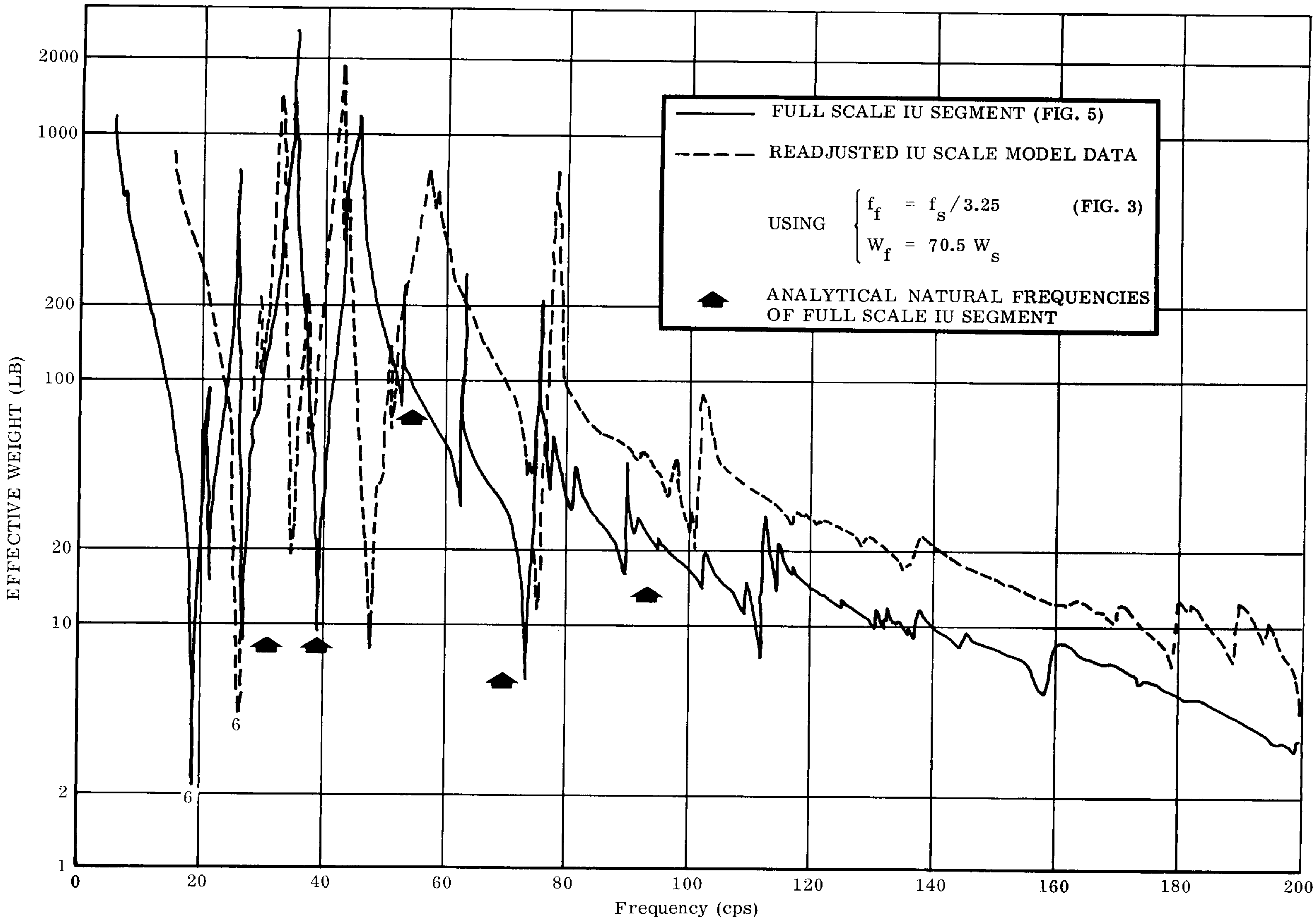


FIGURE 7. DRIVING POINT IMPEDANCE OF INSTRUMENT UNIT SEGMENT WITH COMPONENTS ATTACHED, SUPPORT CONFIGURATION (I)

APPENDIX I

THE FINITE DIFFERENCE COMPUTER PROGRAM USED IN LOCALIZED SHELL VIBRATION TESTS

The finite difference approach is developed for a curved panel cross-stiffened by two sets of equidistant stiffeners. The reinforcement, which is assumed to be symmetrical about an axis normal to the middle surface of the shell, is attached to the skin of the cylindrical panel in either circumferential or axial direction. The panel to be considered may have a number of rigid or spring supports at discrete points along the edge of the panel.

A. BASIC EQUATIONS

1. Strain-Displacement Relations

The extensional strain-displacement relations for the middle surface of a cylindrical shell are given by

$$\epsilon_x = \frac{\partial u}{\partial x} \qquad (1)$$

$$\epsilon_\varphi = \frac{1}{a}\left(\frac{\partial v}{\partial \varphi} + w\right) \qquad (2)$$

$$\gamma_{x\varphi} = \frac{1}{a}\,\frac{\partial u}{\partial \varphi} + \frac{\partial v}{\partial x} \qquad (3)$$

where

u, v, w = displacement components in the axial, circumferential and radial directions.

x = distance along axial direction

φ = cylindrical angle (radian)

a = radius of cylinder (see Figure 8)

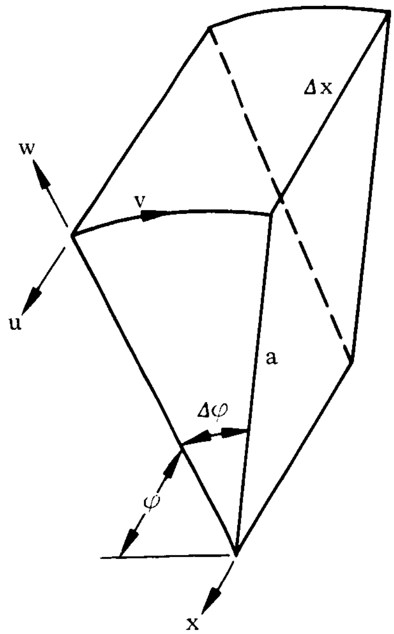


FIGURE 8. ELEMENT OF A CYLINDRICAL SHELL

The changes of curvature of the cylindrical panel may be represented as follows:

$$k_x = -\frac{\partial^2 w}{\partial x^2} \tag{4}$$

$$k_\varphi = -\frac{1}{a^2}\left(\frac{\partial^2 w}{\partial \varphi^2} - \frac{\partial v}{\partial \varphi}\right) \tag{5}$$

$$k_{x\varphi} = -\frac{1}{a}\left(\frac{\partial^2 w}{\partial x \partial \varphi} - \frac{\partial v}{\partial x}\right) \tag{6}$$

For a cylindrical panel, experience has shown that the effect of the v-displacement on the bending moments is negligible. With this simplification, the following expressions are obtained:

$$k_x = -\frac{\partial^2 w}{\partial x^2} \tag{4}$$

$$k_\varphi = -\frac{1}{a^2}\frac{\partial^2 w}{\partial \varphi^2} \tag{5'}$$

$$k_{x\varphi} = -\frac{1}{a}\frac{\partial^2 w}{\partial x \partial \varphi} \tag{6'}$$

2. Stress-Strain Relations

For a cylindrical panel cross-stiffened by two sets of equidistant stiffeners, it is assumed that the reinforcement is symmetrical about an axis normal to the middle surface of the panel. Using the above assumption, the following approximate stress-strain relations (Ref. 1) may be established:

$$N_x = \frac{E A_{sx}}{a \Delta \varphi} \epsilon_x + \frac{Eh}{1-\nu^2}(\epsilon_x + \nu \epsilon_\varphi) \tag{7}$$

$$N_\varphi = \frac{E A_{s\varphi}}{\Delta x} \epsilon_\varphi + \frac{Eh}{1-\nu^2}(\epsilon_\varphi + \nu \epsilon_x) \tag{8}$$

$$N_{x\varphi} = N_{\varphi x} \simeq Gh \gamma_{x\varphi} \tag{9}$$

$$M_x = \frac{E k_x}{a \Delta \varphi} \int_{A_{sx}} z_x^2 \, dA + \frac{E}{1-\nu^2}(k_x + \nu k_\varphi) \int_{panel} z_x^2 \, dz \tag{10}$$

$$M_\varphi = \frac{E k_\varphi}{\Delta x} \int_{A_{s\varphi}} z_\varphi^2 \, dA + \frac{E}{1-\nu^2}(k_\varphi + \nu k_x) \int_{panel} z_\varphi^2 \, dz \tag{11}$$

$$M_{x\varphi} = -M_{\varphi x} \simeq -\frac{Eh^3}{12(1+\nu)} k_{x\varphi} \tag{12}$$

Ref. 1 S. Timoshenko, S. Woinowsky-Krieger, "Theory of Plates and Shells," pp. 364-370.

where

$A_{sx}, A_{s\varphi}$ = cross sectional area of stiffener*

$I_{sx}, I_{s\varphi}$ = moment of inertia of stiffener about its own centroid axis*

z_x, z_φ = distance measured from the neutral axis of shell-stiffener combination (see Figure 9)

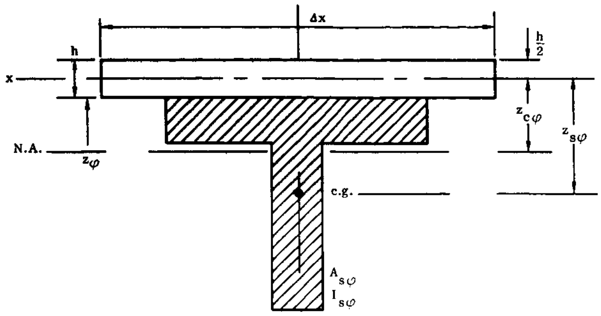


FIGURE 9. CROSS-SECTIONAL VIEW OF A SHELL-STIFFENER COMBINATION

h = thickness of a solid panel or the total facing thickness of a honeycomb sandwich panel

E = Young's modulus

ν = Poisson's ratio

The following sectional rigidity properties are defined:

$$K = \frac{Eh}{1 - \nu^2}$$

$$K_x = K + \frac{E A_{sx}}{a \Delta \varphi}$$

$$K_\varphi = K + \frac{E A_{s\varphi}}{\Delta x}$$

$$D = \begin{cases} \dfrac{Eh^3}{12(1 - \nu^2)} & \text{for solid panel} \\[2ex] \dfrac{Eh(h + 2c)^2}{16(1 - \nu^2)} & \text{for honeycomb sandwich panel} \end{cases} \tag{13}$$

$$D_x' = D + K z_{cx}^2$$

$$D_\varphi' = D + K z_{c\varphi}^2$$

$$D_x = D_x' + \frac{E}{a \Delta \varphi} \left[I_{sx} + A_{sx} (z_{sx} - z_{cx})^2 \right]$$

$$D_\varphi = D_\varphi' + \frac{E}{\Delta x} \left[I_{s\varphi} + A_{s\varphi} (z_{s\varphi} - z_{c\varphi})^2 \right]$$

*Note: For a stiffener which is placed along one boundary of the panel, double the values of the corresponding cross sectional area and the moment of inertia as input.

where

$z_{sx}, z_{s\varphi}$ = distances from c.g.'s of the stiffeners to the middle surface of the panel

$z_{cx}, z_{c\varphi}$ = distances between the centroids of the stiffeners to neutral axis of shell-stiffener combination (see Figure 9).

c = core thickness of a honeycomb sandwich panel

Using the newly defined rigidity expressions, the stress-strain relations may be re-written as:

$$N_x = K_x \epsilon_x + \nu K \epsilon_\varphi \quad (7')$$

$$N_\varphi = K_\varphi \epsilon_\varphi + \nu K \epsilon_x \quad (8')$$

$$N_{x\varphi} = N_{\varphi x} = \frac{(1 - \nu)}{2} K \gamma_{x\varphi} \quad (9')$$

$$M_x = D_x k_x + \nu D'_x k_\varphi \quad (10')$$

$$M_\varphi = D_\varphi k_\varphi + \nu D'_\varphi k_x \quad (11')$$

$$M_{x\varphi} = -M_{\varphi x} = -D(1 - \nu) k_{x\varphi} \quad (12')$$

Figure 10 shows the notation for coordinates, displacements, force and moment components for a cylindrical shell element.

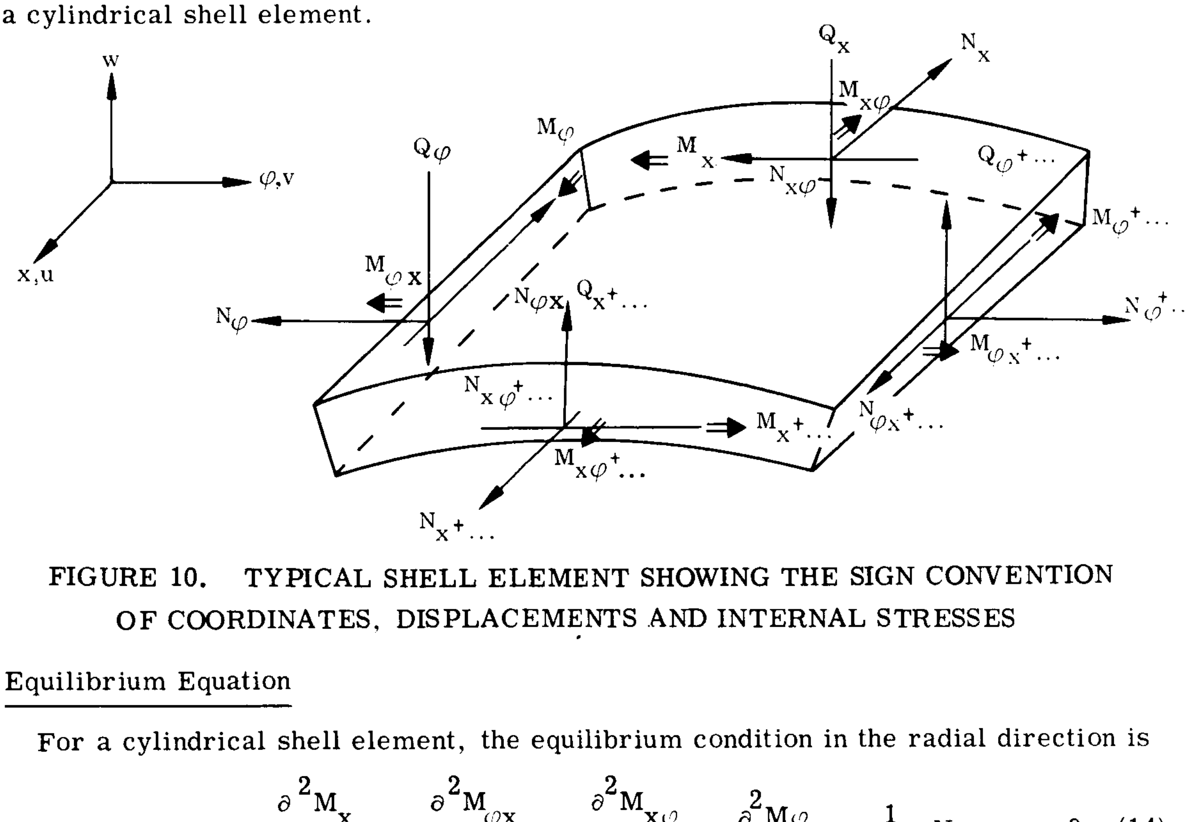


FIGURE 10. TYPICAL SHELL ELEMENT SHOWING THE SIGN CONVENTION OF COORDINATES, DISPLACEMENTS AND INTERNAL STRESSES

3. Equilibrium Equation

For a cylindrical shell element, the equilibrium condition in the radial direction is

$$\frac{\partial^2 M_x}{\partial x^2} + \frac{\partial^2 M_{\varphi x}}{a \partial x \partial \varphi} - \frac{\partial^2 M_{x\varphi}}{a \partial x \partial \varphi} + \frac{\partial^2 M_\varphi}{a^2 \partial \varphi^2} - \frac{1}{a} N_\varphi + q = 0 \quad (14)$$

where q is the external load density applied on the shell element in the radial direction. By substituting equation (10')-(12') into (14), the following expression is reached:

$$D_x \frac{\partial^4 w}{\partial x^4} + 2H \frac{1}{a^2} \frac{\partial^4 w}{\partial x^2 \partial \varphi^2} + D_\varphi \frac{1}{a^4} \frac{\partial^4 w}{\partial \varphi^4} + \frac{1}{a} N_\varphi = q \quad (14')$$

where $2H = \nu (D'_x + D'_\varphi) + 2D(1 - \nu)$

4. Stress Function and Compatibility Condition

A stress function Φ is introduced in this analysis in order to reduce the number of unknowns from three (u, v, and w) to two (w and Φ). The membrane forces N_x, N_φ and $N_{x\varphi}$ can be expressed in terms of the stress function Φ:

$$N_x = - \frac{\partial^2 \Phi}{a^2 \partial \varphi^2} \quad (16)$$

$$N_\varphi = - \frac{\partial^2 \Phi}{\partial x^2} \quad (17)$$

$$N_{x\varphi} = N_{\varphi x} = \frac{\partial^2 \Phi}{a \partial x \partial \varphi} \quad (18)$$

In order to use the stress function approach, an equation of compatibility is needed to define Φ. This is accomplished by combining equations (1)-(3) to obtain the following relation:

$$\frac{\partial^2 \epsilon_\varphi}{\partial x^2} + \frac{1}{a^2} \frac{\partial^2 \epsilon_x}{\partial \varphi^2} - \frac{1}{a} \frac{\partial^2 \gamma_{x\varphi}}{\partial x \partial \varphi} - \frac{1}{a} \frac{\partial^2 w}{\partial x^2} = 0 \quad (19)$$

Using equations (7')-(9') and (16)-(18), the strain components ϵ_x, ϵ_φ and $\gamma_{x\varphi}$ may be expressed as:

$$\epsilon_\varphi = - \frac{1}{K_x K_\varphi - \nu^2 K^2} \left[K_x \frac{\partial^2 \Phi}{\partial x^2} - \nu K \frac{\partial^2 \Phi}{a^2 \partial \varphi^2} \right] \quad (20)$$

$$\epsilon_x = - \frac{1}{K_x K_\varphi - \nu^2 K^2} \left[K_\varphi \frac{\partial^2 \Phi}{a^2 \partial \varphi^2} - \nu K \frac{\partial^2 \Phi}{\partial x^2} \right] \quad (21)$$

$$\gamma_{x\varphi} = \frac{2}{(1 - \nu) K} \frac{\partial^2 \Phi}{a \partial x \partial \varphi} \quad (22)$$

Substituting equations (20)-(22) into equation (19) yields the compatibility condition:

$$K_x \frac{\partial^4 \Phi}{\partial x^4} + \frac{K_x K_\varphi - \nu K^2}{(1 - \nu) K} \frac{2}{a^2} \frac{\partial^4 \Phi}{\partial x^2 \partial \varphi^2} + K_\varphi \frac{\partial^4 \Phi}{a^4 \partial \varphi^4} + \frac{K_x K_\varphi - \nu^2 K^2}{a} \frac{\partial^2 w}{\partial x^2} = 0 \quad (23)$$

The equilibrium equation (14') can be rewritten in the form of

$$D_x \frac{\partial^4 w}{\partial x^4} + 2H \frac{1}{a^2} \frac{\partial^4 w}{\partial x^2 \partial \varphi^2} + D_\varphi \frac{1}{a^4} \frac{\partial^4 w}{\partial \varphi^4} - \frac{1}{a} \frac{\partial^2 \Phi}{\partial x^2} = q \quad (24)$$

Equations (23) and (24) are the two governing differential equations mechanized in the computer program using the finite difference approach. It can be shown that for the special case of a cylindrical shell without any stiffener, the above equations are identical to the coupled shell equations of Vlasov applied to the cylindrical panel. The Vlasov's equations are:

$$\begin{cases} D\nabla^2\nabla^2 w - \frac{1}{a}\frac{\partial^2\Phi}{\partial x^2} = q \\ \nabla^2\nabla^2\Phi + \frac{Eh}{a}\frac{\partial^2 w}{\partial x^2} = 0 \end{cases}$$

where ∇^2 is the Laplace operator.

5. Boundary Conditions for a Panel with Spring Supports

The cylindrical panel under consideration has spring supports at discrete points along the edges of the panel. These springs are assumed to be restrained against deflection but not restrained against rotation. Lateral deflection at spring supporting point may be either restricted or free. The boundary conditions to be considered are:

Along the edge x = constant,

$$M_x = 0 \tag{25}$$

$$V_x = Q_x - \frac{1}{a}\frac{\partial M_{x\varphi}}{\partial \varphi} = \pm \frac{\bar{K}_x}{a\Delta\varphi} w \tag{26}$$

$$N_x = 0 \text{ or } u = 0 \tag{27 a, b}$$

$$S_x = N_{x\varphi} + \frac{1}{a} M_{x\varphi} = 0 \tag{28}$$

Along the edge φ = constant,

$$M_\varphi = 0 \tag{29}$$

$$V\varphi = Q\varphi + \frac{\partial M_{\varphi x}}{\partial x} = \pm \frac{K\varphi}{\Delta x} w \tag{30}$$

$$N\varphi = 0 \text{ or } v = 0 \tag{31 a, b}$$

$$N_{\varphi x} = 0 \tag{32}$$

At the corner point, x = constant, φ = constant,

$$2M_{x\varphi} = +\bar{K}_1 w \tag{33}$$

where V_x, V_φ are the effective transverse shear forces, S_x is the effective in-plane shear force, $\bar{K}_x$, $\bar{K}_\varphi$ and $\bar{K}_1$ are the spring constants for the point supports whose unit is (force/length). The spring constants equal to zero at a point where the edge is free.

The problem at hand is to determine the natural frequencies and the corresponding mode shapes of the panel. Thus, the loading on the panel is the inertial force:

$$q = \bar{m}\,\omega^2\, w \tag{34}$$

where $\bar{m}$ is the mass per unit area of the panel and ω is the natural circular frequency of the panel. For an interior point where a weight W is attached, then the additional loading due to this weight is:

$$q_a = \frac{W\omega^2}{ga\Delta x\Delta\varphi}\, w \tag{35}$$

Similarly, for a boundary point where there is an attached weight W_x, W_φ or W_1, equations (26), (30), and (33) are as shown below:

x = constant,

$$V_x = \pm\left(\bar{K}_x - \frac{W_x}{g}\,\omega^2\right)\frac{w}{a\Delta\varphi} \tag{26'}$$

φ = constant,

$$V_\varphi = \pm\left(\bar{K}_\varphi - \frac{W_\varphi}{g}\,\omega^2\right)\frac{w}{\Delta x} \tag{30'}$$

x = constant, φ = constant,

$$2M_{x\varphi} = \pm\left(\bar{K}_1 - \frac{W_1}{g}\,\omega^2\right) w \tag{33'}$$

The signs used in equations (26'), (30'), and (33') depend on the relative positions between the boundary lines and the directions of the coordinates. Figure 11 shows the sign convention to be used in the equations corresponding to the coordinates system of Figure 10.

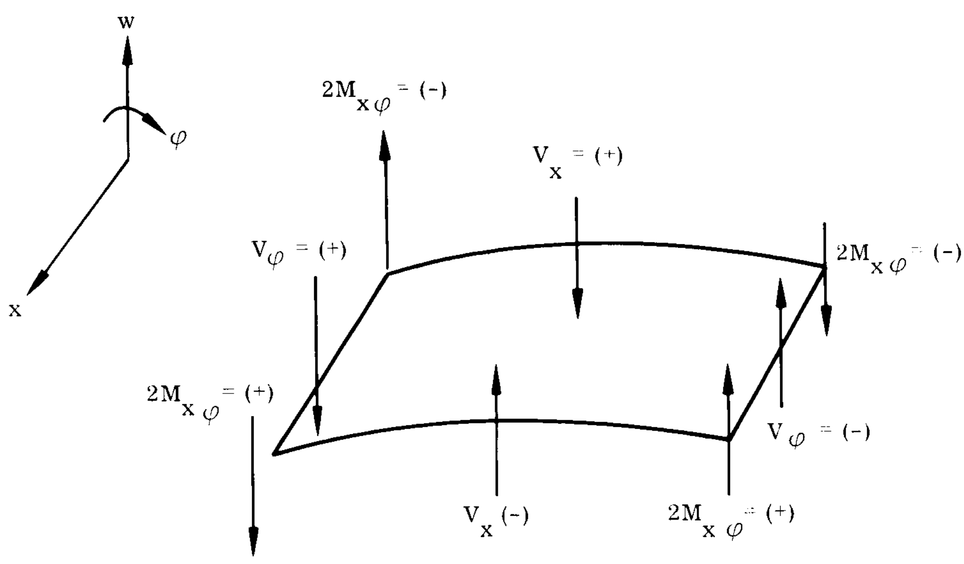


FIGURE 11. SIGN CONVENTION OF TRANSVERSE FORCES

B. FINITE DIFFERENCE EXPRESSIONS

1. Grid Setup and Basic Finite Difference Operators

The geometry of the scaled-down Instrument Unit panel under test is shown in Figure 12. Since the panel is symmetrical with respect to both the $x = \frac{b}{2}$ and $\varphi = \frac{\varphi_o}{2}$ axes, one-quarter of this panel is considered for the finite difference solution. The quarter panel is shown in shade in Figure 12.

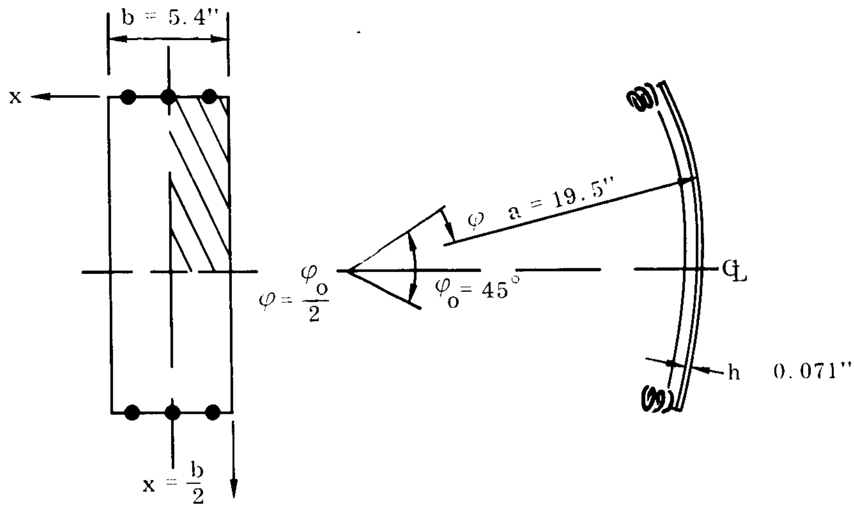


FIGURE 12. GEOMETRY OF SEGMENTED INSTRUMENT UNIT SCALE MODEL

Figure 13 shows the grid pattern with a station numbering system appropriate for finding the modes which are symmetrical about both the $x = \frac{b}{2}$ and $\varphi = \frac{\varphi_o}{2}$ axes. It should be emphasized that the grid pattern used is not a unique and fixed pattern. Different patterns may be used for various specimens, boundary conditions, etc. The computer program is designed with such a flexibility in mind.

Using the grid pattern of Figure 13, it may be visualized that the deformation function w and the auxiliary function Φ may be plotted over the grid as two surfaces. The finite difference computer program translates the coupled equations (23) and (24) into linear equations of w and Φ at various grid points. In order to facilitate the translation, the conversion of the partial derivatives into finite difference relations is first explained.

Using a grid with a grid pitch Δx in the x direction and a $\Delta\varphi$ in the φ direction, the coefficients of the basic finite difference expressions for the partial derivatives of a function at a point i are as follows:

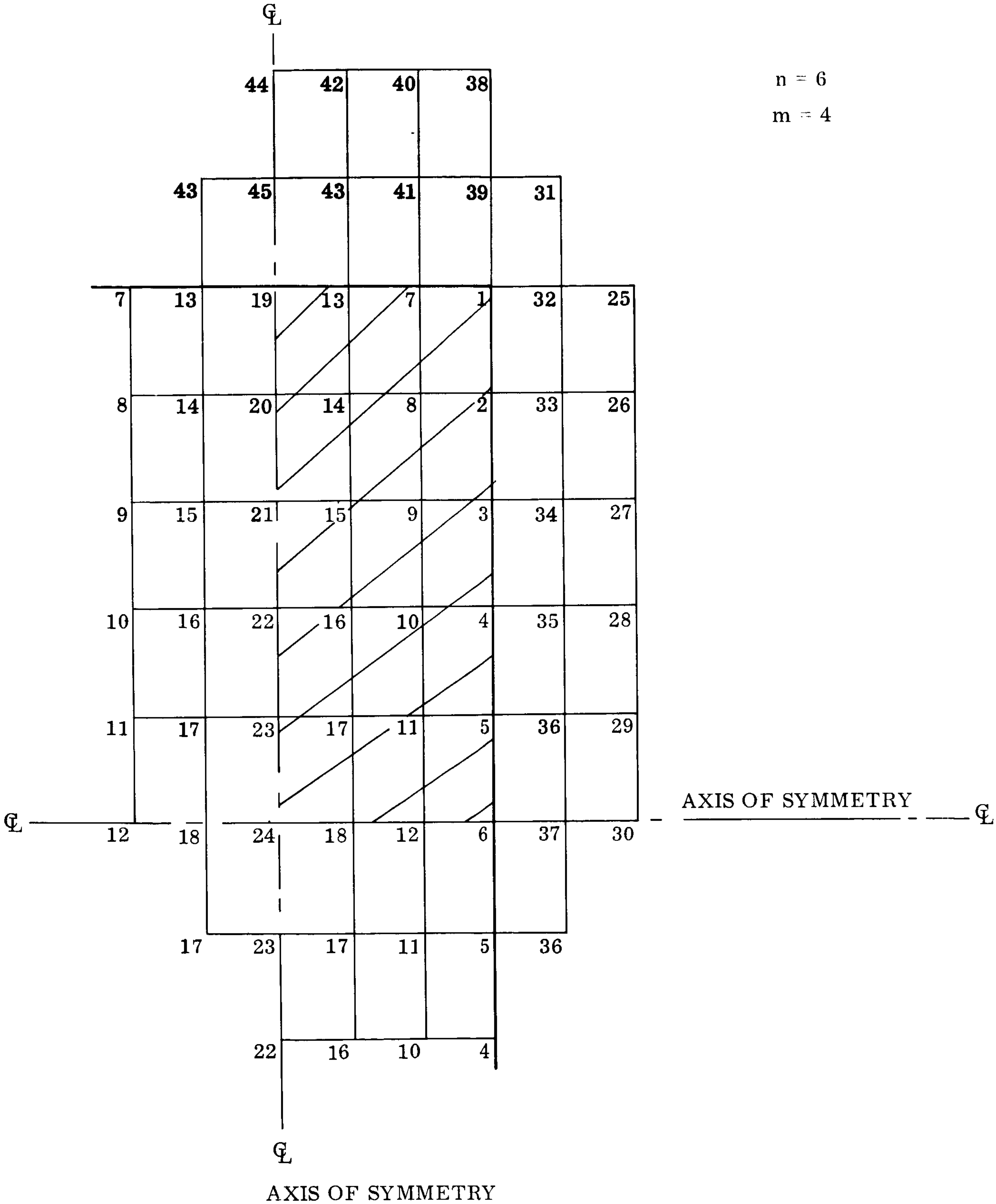


FIGURE 13. GRID PATTERN USED IN THE FINITE DIFFERENCE PROGRAM

$$2(\Delta x)\frac{\partial}{\partial x} = \boxed{\begin{array}{ccc} 1 & \underset{(i)}{0} & -1 \end{array}}$$

$$2(\Delta\varphi)\frac{\partial}{\partial\varphi} = \boxed{\begin{array}{c} -1 \\ \underset{(i)}{0} \\ 1 \end{array}}$$

$$(\Delta x)^2\frac{\partial^2}{\partial x^2} = \boxed{\begin{array}{ccc} 1 & \underset{(i)}{-2} & 1 \end{array}}$$

$$(\Delta\varphi)^2\frac{\partial^2}{\partial\varphi^2} = \boxed{\begin{array}{c} 1 \\ \underset{(i)}{-2} \\ 1 \end{array}}$$

$$(4\Delta x\Delta\varphi)\frac{\partial^2}{\partial x\partial\varphi} = \boxed{\begin{array}{ccc} -1 & 0 & 1 \\ 0 & \underset{(i)}{0} & 0 \\ 1 & 0 & -1 \end{array}}$$

$$2(\Delta x)^3\frac{\partial^3}{\partial x^3} = \boxed{\begin{array}{ccccc} 1 & -2 & \underset{(i)}{0} & 2 & -1 \end{array}}$$

$$2(\Delta\varphi)^3\frac{\partial^3}{\partial\varphi^3} = \boxed{\begin{array}{c} -1 \\ 2 \\ \underset{(i)}{0} \\ -2 \\ 1 \end{array}}$$

$$2(\Delta x)^2(\Delta\varphi)\frac{\partial^3}{\partial x^2\,\partial\varphi} = \boxed{\begin{array}{ccc} -1 & 2 & -1 \\ 0 & \underset{(i)}{0} & 0 \\ 1 & -2 & 1 \end{array}}$$

$$2(\Delta x)(\Delta\varphi)^2\frac{\partial^3}{\partial x\,\partial\varphi^2} = \boxed{\begin{array}{ccc} 1 & 0 & -1 \\ -2 & \underset{(i)}{0} & 2 \\ 1 & 0 & -1 \end{array}}$$

$$(\Delta x)^4\frac{\partial^4}{\partial x^4} = \boxed{\begin{array}{ccccc} 1 & -4 & \underset{(i)}{6} & -4 & 1 \end{array}}$$

$$(\Delta\varphi)^4\frac{\partial^4}{\partial\varphi^4} = \boxed{\begin{array}{c} 1 \\ -4 \\ \underset{(i)}{6} \\ -4 \\ 1 \end{array}}$$

$$(\Delta x\Delta\varphi)^2\frac{\partial^4}{\partial x^2\,\partial\varphi^2} = \boxed{\begin{array}{ccc} 1 & -2 & 1 \\ -2 & \underset{(i)}{4} & -2 \\ 1 & -2 & 1 \end{array}}$$

2. Equilibrium and Compatibility Equations.

Consider Equation (24); it may be rewritten in the following form:

$$\left(\frac{a\Delta\varphi}{\Delta x}\right)^4\left(\frac{D_x}{D}\right)(\Delta x)^4\frac{\partial^4 w}{\partial x^4} + \left(\frac{a\Delta\varphi}{\Delta x}\right)^2\left(\frac{2H}{D}\right)(\Delta x\Delta\varphi)^2\frac{\partial^4 w}{\partial x^2\,\partial\varphi^2} + \left(\frac{D_\varphi}{D}\right)(\Delta\varphi)^4\frac{\partial^4 w}{\partial\varphi^4}$$

$$-\left(\frac{a\Delta\varphi}{\Delta x}\right)^2 \frac{a(\Delta\varphi)^2}{D}(\Delta x)^2 \frac{\partial^2\Phi}{\partial x^2} = \frac{\bar{m}(a\Delta\varphi)^4\omega^2}{D}\left[1+\frac{W}{\bar{m}g\Delta x a\Delta\varphi}\right] w \qquad (36)$$

Using symbols $\lambda = \frac{a\Delta\varphi}{\Delta x}$, $\Omega = \frac{\bar{m}(a\Delta\varphi)^4\omega^2}{D}$, Equation (36) is:

$$\lambda^4 \frac{D_x}{D}(\Delta x)^4 \frac{\partial^4 w}{\partial x^4} + \lambda^2\left(\frac{2H}{D}\right)(\Delta x\Delta\varphi)^2 \frac{\partial^4 w}{\partial x^2\partial\varphi^2} + \left(\frac{D_\varphi}{D}\right)(\Delta\varphi)^4 \frac{\partial^4 w}{\partial\varphi^4}$$

$$-\frac{\lambda^2 a(\Delta\varphi)^2}{D}(\Delta x)^2 \frac{\partial^2\Phi}{\partial x^2} = \Omega\left(1+\frac{W}{\bar{m}g\Delta x a\Delta\varphi}\right) w \qquad (36')$$

Applying the finite difference operators to replace the partial derivatives, the coefficients for various points on the w-grid and Φ-grid are determined in the following manner. Referring to Equation (36'), the partial derivatives are translated into finite differences on the w-grid and the Φ-grid corresponding to a grid point marked by (w_i) or (Φ_i). In the formulation, the inertia term in the equation is omitted for the time being.

		$\frac{D_\varphi}{D}$		
	$\frac{2H}{D}\lambda^2$	$-4\left(\frac{H}{D}\lambda^2+\frac{D_\varphi}{D}\right)$	$\frac{2H}{D}\lambda^2$	
$\frac{D_x}{D}\lambda^4$	$-4\lambda^2\left(\frac{D_x}{D}\lambda^2+\frac{H}{D}\right)$	$6\frac{D_x}{D}\lambda^4 + 8\frac{H}{D}\lambda^2 + 6\frac{D_\varphi}{D}$ (w_i)	$-4\lambda^2\left(\frac{D_x}{D}\lambda^2+\frac{H}{D}\right)$	$\frac{D_x}{D}\lambda^4$
	$\frac{2H}{D}\lambda^2$	$-4\left(\frac{H}{D}\lambda^2+\frac{D_\varphi}{D}\right)$	$\frac{2H}{D}\lambda^2$	
		$\frac{D_\varphi}{D}$		

$-\frac{\lambda^2 (a\Delta\varphi)^2}{aD}$	$2\,\frac{\lambda^2 (a\Delta\varphi)^2}{aD}$ (Φ_i)	$-\frac{\lambda^2 (a\Delta\varphi)^2}{aD}$

The above finite difference operators are applied to all stations on one-quarter of the panel including boundary points (Sta. 1-24). In laying out the coefficients of the finite difference equations in a systematic manner, visualize a square matrix of size (rxr), where r is the number of the total unknown w and Φ values for all the grid points. The columns of the matrix correspond to the coefficients of w_1, w_2.... Φ_1, Φ_2.... arranged in that order. For Equation (36') applied to a grid station, a row of matrix is established listing all the coefficients of the finite difference equation as described above. Other rows are added to fill up the (rxr) matrix representing the equilibrium equation, the compatibility equation and the boundary conditions. The detail of the matrix organization will be further explained later in the section.

The finite difference operators for compatibility equation (23) are illustrated below:

		$\frac{K_\varphi}{K}$		
	$2P\lambda^2$	$-4\left(\frac{K_\varphi}{K} + P\lambda^2\right)$	$2P\lambda^2$	
$\frac{K_x}{K}\lambda^4$	$-4\lambda^2\left(P + \frac{K_x}{D}\lambda^2\right)$	$6\frac{K_\varphi}{K} + 8P\lambda^2 + 6\frac{K_x}{K}\lambda^4$ (Φ_i)	$-4\lambda^2\left(P + \frac{K_x}{K}\lambda^2\right)$	$\frac{K_x}{K}\lambda^4$
	$2P\lambda^2$	$-4\left(\frac{K_\varphi}{K} + P\lambda^2\right)$	$2P\lambda^2$	
		$\frac{K_\varphi}{K}$		

$R(a\Delta\varphi)^2\lambda^2$	$-2R(a\Delta\varphi)^2\lambda^2$ (w_i)	$R(a\Delta\varphi)^2\lambda^2$

(23')

where $P = \dfrac{K_x K_\varphi - \nu K^2}{(1-\nu)K^2}$

$$R = \frac{K_x K_\varphi - \nu^2 K^2}{aK}$$

Experience shows that it is sufficient to apply Equation (23) only to the interior points (sta. 8-12, 14-18, 20-24) in order to fill the final coefficient matrix described above.

3. Boundary Conditions.

Equations (25) - (33) are rewritten in terms of w and Φ for this particular panel as shown below:

$$\left[D_x \frac{\partial^2 w}{\partial x^2} + \nu D_x' \frac{\partial^2 w}{a^2 \partial \varphi^2} \right]_{x=0} = 0 \tag{37}$$

$$\left\{ D_x \frac{\partial^3 w}{\partial x^3} + \frac{1}{a^2} \alpha \frac{\partial^3 w}{\partial x \partial \varphi^2} + \frac{\bar{K}_x w}{a \Delta \varphi} \right\}_{x=0} = \left[\frac{W_x \omega^2}{g a \Delta \varphi} w \right]_{x=0} \tag{38}$$

$$\left. \frac{\partial^2 \Phi}{\partial \varphi^2} \right|_{x=0} = 0 \quad \text{or} \quad u \Big|_{x=0} = 0 \tag{39 a, b}$$

$$\left[\frac{\partial^2 \Phi}{\partial x \partial \varphi} + \frac{D(1-\nu)}{a} \frac{\partial^2 w}{\partial x \partial \varphi} \right]_{x=0} = 0 \tag{40}$$

$$\left[D_\varphi \frac{\partial^2 x}{a^2 \partial \varphi^2} + \nu D_\varphi' \frac{\partial^2 w}{\partial x^2} \right]_{\varphi=0} = 0 \tag{41}$$

$$\left\{ D_\varphi \frac{\partial^3 w}{a^3 \partial \varphi^3} + \frac{1}{a} \beta \frac{\partial^3 w}{\partial x^2 \partial \varphi} + \frac{\bar{K}_\varphi w}{\Delta x} \right\}_{\varphi=0} = \left[\frac{W_\varphi \omega^2}{g \Delta x'} w \right]_{\varphi=0} \tag{42}$$

$$\left. \frac{\partial^2 \Phi}{\partial x^2} \right|_{\varphi=0} = 0 \quad \text{or} \quad v \Big|_{\varphi=0} = 0 \tag{43 a, b}$$

$$\left. \frac{\partial^2 \Phi}{\partial x \partial \varphi} \right|_{\varphi=0} = 0 \tag{44}$$

$$\left[2D(1-\nu) \frac{\partial^2 w}{a \partial x \partial \varphi} + K_1 w \right]_{\substack{x=0 \\ \varphi=0}} = \left[\frac{W_1 \omega^2}{g} w \right]_{\substack{x=0 \\ \varphi=0}} \tag{45}$$

where $\alpha = \nu D_x' + 2(1-\nu)D$

$\beta = \nu D_\varphi' + 2(1-\nu)D$

Since only the mode shapes which are symmetric with respect to both $x = \frac{b}{2}$ and $\varphi = \frac{\varphi_0}{2}$ axes are considered, the following conditions governing u, v, Φ along the axes of symmetry are made use of:

$$v\Big|_{\varphi=\frac{\varphi_o}{2}} = 0 \qquad\qquad \frac{\partial \Phi}{\partial \varphi}\Big|_{\varphi=\frac{\varphi_o}{2}} = 0$$

and

$$u\Big|_{x=\frac{b}{2}} = 0 \qquad\qquad \frac{\partial \Phi}{\partial x}\Big|_{x=\frac{b}{2}} = 0$$

Equation (2) is substituted into (20) which is then integrated from $\varphi = 0$ to $\varphi = \frac{\varphi_o}{2}$. The resulting condition for $v = 0$ at $\varphi = 0$ is:

$$v\Big|_{\substack{\varphi=0\\ x=x^*}} = \int_0^{\varphi_o/2} \left[\frac{a}{K_x K_\varphi - \nu^2 K^2} \left(K_x \frac{\partial^2 \Phi}{\partial x^2} - \nu K \frac{\partial^2 \Phi}{a^2 \partial \varphi^2} \right) + w \right]_{x=x^*} d\varphi$$

$$= \int_0^{\varphi_o/2} \left[\frac{1}{R} \frac{K_x}{K} \frac{\partial^2 \Phi}{\partial x^2} + w \right]_{x=x^*} d\varphi + \frac{\nu}{a^2 R} \left(\frac{\partial \Phi}{\partial \varphi} \right)_{\substack{x=x^*\\ \varphi=0}} = 0 \qquad (46)$$

Similar approach gives:

$$u\Big|_{\substack{x=0\\ \varphi=\varphi^*}} = \int_0^{b/2} \left[\frac{1}{a^2 R} \frac{K_\varphi}{K} \frac{\partial^2 \Phi}{\partial \varphi^2} \right]_{\varphi=\varphi^*} dx + \frac{\nu}{R} \left(\frac{\partial \Phi}{\partial x} \right)_{\substack{x=0\\ \varphi=\varphi^*}} = 0 \qquad (47)$$

The finite difference operators corresponding to equations (37) - (47) and the stations on which each operator will be applied are given below. The inertia terms are excluded.

$\frac{(\Delta x)^2}{D_x} M_x \Big|_{x=0} = 0.$ Apply to points along the edge $x = 0$ (Sta. 1-6).

	$\nu \frac{D_x'}{D_x} \frac{1}{\lambda^2}$	
1	$-2(1 + \nu \frac{D_x'}{D_x} \frac{1}{\lambda^2})$ (w_i)	1
	$\nu \frac{D_x'}{D_x} \frac{1}{\lambda^2}$	

(37')

$$\frac{2(\Delta x)^3}{D_x} V_x \Big|_{x=0} = \frac{2(\Delta x)^3}{D_x} \frac{\bar{K}_x}{a\Delta\varphi} w.$$ Apply to points along the edge x = 0 (Sta. 1-6). Use $\bar{K}_x = 0$ at points where there is no spring support.

$$\boxed{\begin{array}{ccccc} & -\dfrac{\alpha}{D_x\lambda^2} & 0 & \dfrac{\alpha}{D_x\lambda^2} & \\[2ex] -1 & 2\left(1+\dfrac{\alpha}{D_x\lambda^2}\right) & -\dfrac{2\bar{K}_x (a\Delta\varphi)^2}{D_x\lambda^3} & -2\left(1+\dfrac{\alpha}{D_x\lambda^2}\right) & 1 \\ & & (w_i) & & \\[2ex] & -\dfrac{\alpha}{D_x\lambda^2} & 0 & \dfrac{\alpha}{D_x\lambda^2} & \end{array}} \qquad (38')$$

$(a\Delta\varphi)^2 N_x \Big|_{x=0} = 0.$ Apply to points along the edge x = 0 without spring support.

$$\boxed{\begin{array}{c} 1 \\[1ex] -2 \\ (\Phi_i) \\[1ex] 1 \end{array}} \qquad (39')$$

$\dfrac{2K(a\Delta\varphi)\lambda R}{K_\varphi} u \Big|_{x=0} = 0.$ Apply to points along the edge x = 0 with spring supports. This condition is not used for the panel under consideration because no spring support exists along the edge x = 0.

(axis of symmetry)

$$\boxed{\begin{array}{c|cccccc} 1 & 2 & \cdots & 2 & 2 & 1 & \\[1ex] -2 & -4 & \cdots & -4 & \left(-4+\nu\lambda^2\dfrac{K}{K_\varphi}\right) & -2 & -\nu\lambda^2\dfrac{K}{K_\varphi} \\ & & & & & (\Phi_i) & \\[1ex] 1 & 2 & \cdots & 2 & 2 & 1 & \end{array}} \qquad (47')$$

$(4\Delta x\, a\Delta\varphi)\, S_x \Big|_{x=0} = 0.$ Apply to all points along the edge x = 0 except the corner point. For points not on the axis of symmetry (Sta. 2-5)

-1	0	1
0	0 (w_i)	0
1	0	-1

$-\frac{D(1-\nu)}{a}$	0	$\frac{D(1-\nu)}{a}$
0	0 (Φ_i)	0
$\frac{D(1-\nu)}{a}$	0	$-\frac{D(1-\nu)}{a}$

(40'a)

For points on the axis of symmetry (Sta. 6)

-1	0	1
1	0 (w_i)	-1

$-\frac{D(1-\nu)}{a}$	0	$\frac{D(1-\nu)}{a}$
$\frac{D(1-\nu)}{a}$	0 (Φ_i)	$-\frac{D(1-\nu)}{a}$

(40'b)

$\frac{(a\Delta\varphi)^2}{D_\varphi} M_\varphi\Big|_{\varphi=0} = 0.$ Apply to points along the edge $\varphi = 0$ (Sta. 1, 7, 13, 19).

	1	
$\nu\lambda^2 \frac{D_\varphi'}{D_\varphi}$	$-2\left[1 + \nu\lambda^2 \frac{D_\varphi'}{D_\varphi}\right]$ (w_i)	$\nu\lambda^2 \frac{D_\varphi'}{D_\varphi}$
	1	

(41')

$2\frac{(a\Delta\varphi)^3}{D_\varphi} V_\varphi\Big|_{\varphi=0} = 2\frac{(a\Delta\varphi)^3}{D_\varphi} \frac{\overline{K}_\varphi}{\Delta x} w:$ Apply to points along the edge $\varphi = 0$ (Sta. 1, 7, 13, 19).

Use $\overline{K}_\varphi = 0$ for stations with no spring support.

	1	
$\frac{\beta\lambda^2}{D_\varphi}$	$-2\left(1 + \frac{\beta\lambda^2}{D_\varphi}\right)$	$\frac{\beta\lambda^2}{D_\varphi}$
0	$\frac{-2\lambda\overline{K}_\varphi(a\Delta\varphi)^2}{D_\varphi}$ (w_i)	0
$-\frac{\beta\lambda^2}{D_\varphi}$	$2\left(1 + \frac{\beta\lambda^2}{D_\varphi}\right)$	$-\frac{\beta\lambda^2}{D_\varphi}$
	-1	

(42')

$(\Delta x)^2 \, N_\varphi \big|_{\varphi=0} = 0$. Apply to points along the edge $\varphi = 0$ without a spring support.

1	-2	1
	(Φ_i)	

(43')

$2 \frac{K}{K_x} aR(\Delta x) \, v \big|_{\varphi=0} = 0$. Apply to points along the edge $\varphi = 0$ with spring supports.

$\frac{KR\,(\Delta x)^2}{K_x}$
(w_i)
$2 \frac{KR}{K_x} (\Delta x)^2$
.
.
.
$2 \frac{KR}{K_x} (\Delta x)^2$
$\frac{KR}{K_x} (\Delta x)^2$
(axis of symmetry)

	$-\frac{\nu K}{\lambda^2 K_x}$	
1	-2	1
	(Φ_i)	
2	$\left(\frac{\nu}{\lambda^2} \frac{K}{K_x} - 4\right)$	2
2	-4	2
.	.	.
.	.	.
2	-4	2
-1	2	-1
(axis of symmetry)		

(46')

$(4 \Delta x a \Delta\varphi) \, N_{\varphi x} \big|_{\varphi=0} = 0$. Apply to points along the edge $\varphi = 0$ except the corner point (1). For point not on axis of symmetry (Sta. 7, 13)

-1	0	1
0	0	0
	(Φ_i)	
1	0	-1

(44'a)

For point on axis of symmetry (Sta. 19)

-1	1
0 (Φ_i)	0
1	-1

(44'b)

$(4\Delta x a \Delta\varphi)\, 2M_{x\varphi}\Big|_{\substack{x=0\\ \varphi=0}} = -(4\Delta x \Delta\varphi)\, \overline{K}_1 w.$ Apply to the corner point $x = 0$, $\varphi = 0$ (Sta. 1)

-1	0	1
0	$\dfrac{2\overline{K}_1 (a\Delta\varphi)^2}{D\lambda(1-\nu)}$ (w_i)	0
1	0	-1

(45')

Furthermore, Φ is an auxiliary stress function whose second derivatives give corresponding stress values. The value of Φ may be arbitrarily assigned at a certain station without influencing the stress distribution. The condition is represented as:

$$\Phi_c = 0 \qquad (48)$$

1 (Φ_i)

(48')

The above condition is applied to station (24).

4. Finite Difference Expressions in Matrix Form.

Assembling of all of the equations described previously yields a set of homogeneous equations of the following form:

$$\left[A\right] \begin{Bmatrix} \lfloor w_a \rfloor \\ \lfloor w_b \rfloor \\ \lfloor \Phi \rfloor \end{Bmatrix} - \Omega \begin{bmatrix} [M_1] & 0 & 0 \\ [M_2] & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{Bmatrix} \lfloor w_a \rfloor \\ \lfloor w_b \rfloor \\ \lfloor \Phi \rfloor \end{Bmatrix} = 0 \qquad (49)$$

where $\left[A\right]$ = the coefficient matrix.

$\lfloor w_a \rfloor$ = the normal deflection matrix for the stations on the quarter panel.

$\lfloor w_b \rfloor$ = the normal deflection matrix for the exterior stations.

$\lfloor M_1 \rfloor$ = the interior mass matrix representing the mass of the shell proper.

$\lfloor M_2 \rfloor$ = the boundary mass matrix representing masses attached at the edges of the panel.

Consider a quarter panel covered by m equidistant grid points along the x-direction and n equidistant grid points along the φ-direction. A total of (mxn) grid points are located on the panel. A stiffener with sectional area A_{sx} may be located along any grid line parallel to the x-axis. A stiffener with sectional area $A_{s\varphi}$ may be located along the circular grid line parallel to the φ-direction. The number of stiffeners are not limited. Using the above structural panel, and referring to Equation (49), it may be shown that there are (mn) elements for $\lfloor w_a \rfloor$. There are (2m + 2n + 1) elements for $\lfloor w_b \rfloor$ corresponding to the exterior stations extending two grid pitches from the panel edges (Figure 13). The auxiliary function Φ is accounted for extending one grid pitch from the edges. In this manner, $\lfloor (m + 1) (n + 1) - 1 \rfloor$ elements are established for $\lfloor \Phi \rfloor$. Adding the numbers of the elements listed above, a total of $\lfloor 2mn + 3(m + n) + 1 \rfloor$ is counted, which is the order of the square coefficient matrix $\lfloor A \rfloor$. The details of organizing the $\lfloor A \rfloor$ matrix is illustrated in the diagram shown on the next page.

In the matrix shown on page 40, the finite difference equations used to generate the rows of the coefficient matrix are listed which are marked with the equation numbers described in the text. The following procedures may be used to generate the basic pattern. The pattern is used as the input to the computer program which computes the elements of A .

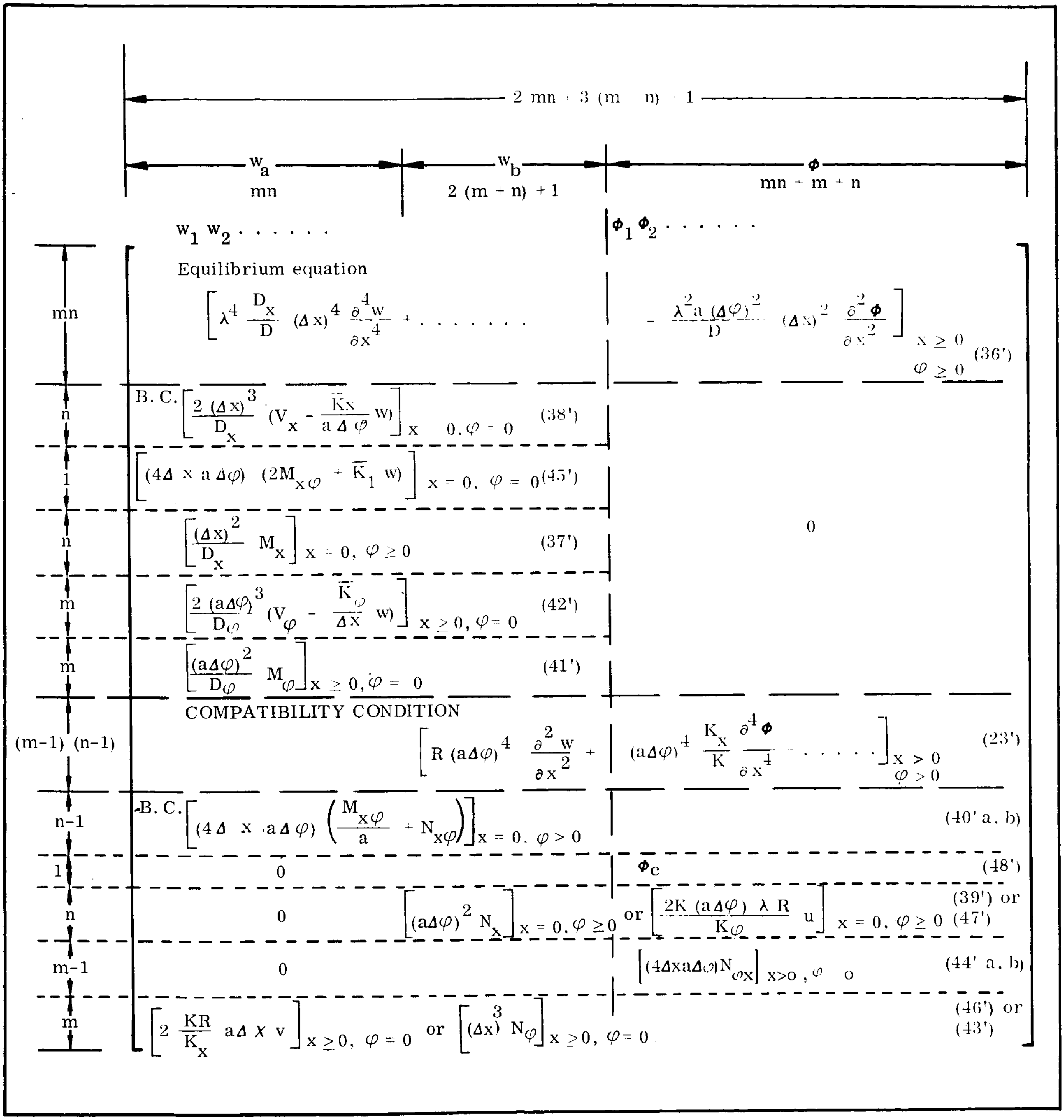
a. Draw the grid pattern and the station numbers on a transparent paper.

b. Simplify the finite difference operators by assigning an index number to each coefficient. Make a list of the index numbers and the corresponding coefficients. A typical index table used to generate the $\lfloor A \rfloor$ matrix for the localized I.U. panel is shown in Table 2 at the end of Section B.

c. Rewrite the finite difference operators by placing corresponding index numbers in position with the grid pattern as shown on the transparent paper.

d. Place the transparent paper over a finite difference operator and keep the center coefficient coinciding with the station for which that operator will be read.

e. Locate the row number as defined in the $\lfloor A \rfloor$ matrix diagram shown on page 40. Read each station number on the transparent paper and the corresponding index number on the bottom sheet representing the differential operators of an equation. Enter the index number as an element of $\lfloor A \rfloor$ whose column number corresponds to the station number read. Repeat the operation for w and Φ. If a station number appears more than once for a certain operator, assign a new index number to the sum of the coefficients referring to that station. Enter the new index number as an element of $\lfloor A \rfloor$ which is also included in Table 2.



f. Repeat procedures (d) and (e) until the matrix is filled with the index numbers. In the input format to the computer program, only non-zero elements are included where the index numbers are identified with proper row and column numbers.

INDEX NUMBERS	MATRIX ELEMENTS	INDEX NUMBERS	MATRIX ELEMENTS	INDEX NUMBERS	MATRIX ELEMENTS	INDEX NUMBERS	MATRIX ELEMENTS
(1)	1	(19)	$\nu\lambda^2 D_\varphi' / D_\varphi$	(36)	-(12)	(57)	2x(22)
(2)	$-4\lambda^2\left(D_x\lambda^2 + H\right)/D$	(20)	$-2\left[1 + \left(\nu\lambda^2 D_\varphi'/D_\varphi\right)\right]$	(37)	-(17)	(58)	2x(24)
(3)	$D_x\lambda^4/D$	(21)	$-2\lambda^2(a\Delta\varphi)^2 R$	(38)	-(29)	(59)	2x(25)
(4)	$-4\left(H\lambda^2 + D_\varphi\right)/D$	(22)	$\lambda^2(a\Delta\varphi)^2 R$	(39)	2x(2)	(60)	2x(26)
(5)	$2H\lambda^2/D$	(23)	$\left(6K_x\lambda^4/K\right) + 8P\lambda^2 + (6K_\varphi/K)$	(40)	2x(3)	(61)	2x(27)
(6)	D_φ/D	(24)	$-4\lambda^2\left[\left(K_x\lambda^2/K\right) + P\right]$	(41)	2x(4)	(62)	2x(28)
(7)	$2\lambda^2(a\Delta\varphi)^2/aD$	(25)	$K_x\lambda^4/K$	(42)	2x(5)	(63)	2x(1)
(8)	$\left(6D_x\lambda^4 + 8H\lambda^2 + 6D_\varphi\right)/D$	(26)	$-4\left[(K_\varphi/K) + P\lambda^2\right]$	(43)	2x(6)	(64)	-(30)
(9)	$-\lambda^2(a\Delta\varphi)^2/aD$	(27)	$2P\lambda^2$	(44)	(3)+(8)	(65)	2x(9)
(10)	$-2\bar{K}_x(a\Delta\varphi)^2/D_x\lambda^3$	(28)	K_φ/K	(45)	(6)+(8)	(66)	-(1)
(11)	$\alpha/\lambda^2 D_x$	(29)	-2	(46)	(3)+(6)+(8)	(67)	-(11)
(12)	$-2\left[1 + \left(\alpha/\lambda^2 D_x\right)\right]$	(30)	$D(1-\nu)/a$	(47)	2x(11)	(68)	$2\bar{K}_1(a\Delta\varphi)^2/D\lambda(1-\nu)$
(14)	$\nu D_x'/\lambda^2 D_x$	(31)	$K(a\Delta\varphi)^2 R/K_x\lambda^2$	(48)	-2x(11)	(69)	-(18)
(15)	$-2\left[1 + \left(\nu D_x'/\lambda^2 D_x\right)\right]$	(32)	-4	(49)	4x(5)	(70)	2x(19)
(16)	$-2\lambda\bar{K}_\varphi(a\Delta\varphi)^2/D_\varphi$	(33)	$-\nu K/\lambda^2 K_x$	(50)	4x(27)	(71)	-2x(29)
(17)	$\beta\lambda^2/D_\varphi$	(34)	$-4 + \left(\nu K/\lambda^2 K_x\right)$	(51)	2x(14)		
(18)	$-2\left[1 + \left(\beta\lambda^2/D_\varphi\right)\right]$	(35)	$2K(a\Delta\varphi)^2 R/K_x\lambda^2$	(52)	(25)+(23)		
				(53)	(23)+(28)		
				(54)	2x(17)		
				(55)	-2x(17)		
				(56)	(23)+(25)+(28)		

TABLE 2. TYPICAL INDEX TABLE OF THE FINITE DIFFERENCE PROGRAM

The interior mass matrix $\left[M_1\right]$ is a square matrix of order mn. The diagonal terms are generated as follows:

$$(M_1)_{ii} = 1 + \frac{W_i + \rho g \left[A_{s\varphi_i} a \Delta\varphi + A_{sx_i} \Delta x\right]}{\overline{m} g \Delta x a \Delta\varphi} \text{ for interior points} \tag{50}$$

$$(M_1)_{ii} = 1 \qquad \text{for points on the boundaries} \tag{51}$$

where the subscript i indicates the station number and W_i is the concentrated weight attached to that station.

The off diagonal terms of M_1 matrix appear only for a component connected to the quarter panel through more than one attachment point. All values of $(M_1)_{i,j,\ i \neq j}$ must be precalculated as input to the computer program. Considering the loaded I. U. segment (Figure 14) as an example, the inertia forces acting on the attachment points A and B due to

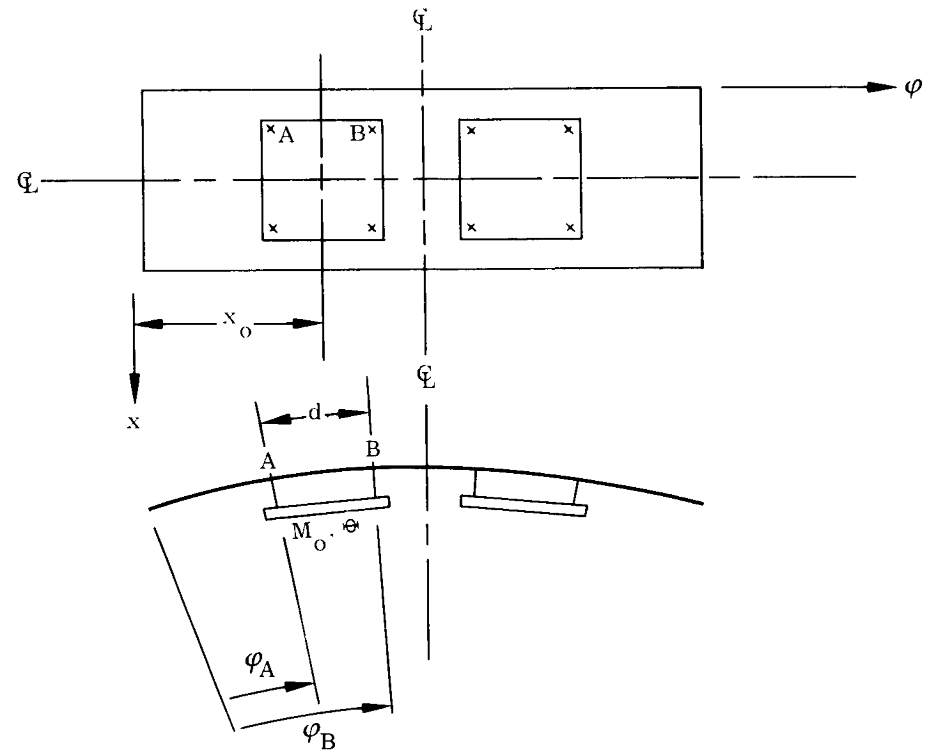


FIGURE 14. LOADED INSTRUMENT UNIT SEGMENT

a component with mass M_o and moment of inertia Θ with respect to the axis through centroid in x-direction may be expressed in the following forms.

$$F_A = \frac{M_o}{4} \omega^2 \left(\frac{w_A + w_B}{2}\right) - \frac{\Theta}{2d} \omega^2 \frac{w_B - w_A}{d}$$

$$= \frac{\omega^2}{8} \left[\left(M_o + \frac{4\Theta}{d^2}\right) w_A + \left(M_o - \frac{4\Theta}{d^2}\right) w_B\right] \tag{52}$$

$$F_B = \frac{\omega^2}{8} \left[\left(M_o - \frac{4\Theta}{d^2}\right) w_A + \left(M_o + \frac{4\Theta}{d^2}\right) w_B\right] \tag{53}$$

where d is the distance between A and B in circumferential direction. If each attachment point coincides with a grid point, it follows that

$$\Delta(M_1)_{A,A} = \Delta(M_1)_{B,B} = \frac{1}{8\bar{m}\Delta x a\Delta\varphi}\left(M_o + \frac{4\Theta}{d^2}\right) \tag{54}$$

$$(M_1)_{A,B} = (M_1)_{B,A} = \frac{1}{8\bar{m}\Delta x a\Delta\varphi}\left(M_o - \frac{4\Theta}{d^2}\right) \tag{55}$$

The values computed from Equation (54) represent the concentrated weights attached to stations A and B. The values are to be added to the corresponding elements of Equation (50).

If the attachment points are off the grid points, similar approach can be used to evaluate the corresponding elements of M_1. Numerical example is given later in Appendix II.

The boundary mass matrix $\left[M_2\right]$ is a rectangular matrix of size (2m + 2n + 1) x (mn). It is composed of the inertia terms for the masses attached to the edge of the panel which is reflected in the transverse shear equations. Referring to the grid pattern and number systems of Figure 13, the elements of M_2 are defined as follows:

$$(M_2)_{i,j} = 0 \text{ except} \tag{56}$$

$$(M_2)_{i,i} = -\frac{2D\left|(1/2)\rho g\left(A_{s\varphi_i}\, a\Delta\varphi + A_{sx_i}\,\Delta x\right) + W_{x_i}\right|}{D_{x_i}\lambda^3\,(a\Delta\varphi)^2\,\bar{m}g} \qquad i = 2, 3, \ldots .n \tag{57}$$

$$(M_2)_{n+1,1} = \frac{2\left|\frac{\rho g}{4}\left[A_{s\varphi_1}\, a\Delta\varphi + A_{sx_1}\,\Delta x\right] + W_{x_1}\right|}{\lambda\,(1-\upsilon)\,(a\Delta\varphi)^2\,\bar{m}g} \tag{58}$$

$$(M_2)_{2n+1+i,j} = -\frac{2D\lambda\left|(1/2)\rho g\,(A_{sx_j}\,\Delta x + A_{s\varphi_j}\, a\Delta\varphi) + W_{\varphi_j}\right|}{D_{\varphi_j}\,(a\Delta\varphi)^2\,\bar{m}g} \qquad \begin{matrix} i = 2, \ldots .m \\ j = (i-1)n + 1 \end{matrix} \tag{59}$$

C. THE EIGENVALUE-EIGENVECTOR PROBLEM

In the previous section, a procedure is described to generate the index numbers representing the elements of [A], $\left[M_1\right]$ and $\left[M_2\right]$. The index number pattern is used as the input to the subject computer program. Based on the input, the computer program generates the matrices according to the local shell and stiffener data which is also part of the input information. The final matrix equation generated by the computer is of the following form:

$$\begin{bmatrix} A_{11} & A_{12} & A_{13} \\ A_{21} & A_{22} & 0 \\ A_{31} & A_{32} & A_{33} \end{bmatrix} \begin{Bmatrix} w_a \\ w_b \\ \Phi \end{Bmatrix} - \Omega \begin{Bmatrix} M_1 \; w_a \\ M_2 \; w_a \\ 0 \end{Bmatrix} = 0 \tag{60}$$

or

$$A_{11}\ w_a + A_{12}\ w_b + A_{13}\ \Phi - \Omega M_1\ w_a = 0 \tag{61}$$

$$A_{21}\ w_a + A_{22}\ w_b \qquad - \Omega M_2\ w_a = 0 \tag{62}$$

$$A_{31}\ w_a + A_{32}\ w_b + A_{33}\ \Phi \qquad = 0 \tag{63}$$

where

A_{11} = square matrix (mn) x (mn)

A_{12} = rectangular matrix (mn) x (2m + 2n + 1)

A_{13} = rectangular matrix (mn) x (mn + m + n)

A_{21} = rectangular matrix (2m + 2n + 1) x (mn)

A_{22} = square matrix (2m + 2n + 1) x (2m + 2n + 1)

A_{31} = rectangular matrix (mn + m + n) x (mn)

A_{32} = rectangular matrix (mn + m + n) x (2m + 2n + 1)

A_{33} = square matrix (mn + m + n) x (mn + m + n)

Equation (60) represents an eigenvalue-eigenvector problem. Ω is the eigenvalue and w_a the corresponding eigenvectors. Specifically, matrix Equation (61) represents the dynamic equations of equilibrium for the interior and boundary points of the system. Equation (62) represents the boundary conditions involving bending moments and transverse shears. Equation (63) represents the compatibility equations and the boundary conditions involving the in-plane forces. The column of w_b pertains to the deflections at the exterior points of the system. Φ represents the stress function at all stations concerned.

Equations (62) and (63) are used to eliminate w_b and Φ from Equation (61). The end result is a matrix equation suitable for eigenvalue-eigenvector determination by the "MITERS" routine which forms part of the computer program.

From Equation (62),

$$w_b = A_{22}^{-1}\left(\Omega M_2 - A_{21}\right) w_a \tag{64}$$

From Equation (63),

$$\Phi = -A_{33}^{-1}\left(A_{31}\ w_a + A_{32}\ w_b\right) \tag{65}$$

Substituting equation (64) into (65) yields:

$$\Phi = -A_{33}^{-1}\left[A_{31} + A_{32}\ A_{22}^{-1}\left(\Omega M_2 - A_{21}\right)\right] w_a \tag{66}$$

Substituting equations (64) and (66) into (61), the standard format suitable for the "MITERS" routine is obtained:

$$[\bar{A}]\left\{w_a\right\} - \frac{1}{\Omega}\left\{w_a\right\} = 0 \qquad (67)$$

where

$$[\bar{A}] = \left[A_{11} - A_{12} A_{22}^{-1} A_{21} - A_{13} A_{33}^{-1} \left(A_{31} - A_{32} A_{22}^{-1} A_{21}\right)\right]^{-1}$$
$$\left[M_1 - \left(A_{12} - A_{13} A_{33}^{-1} A_{32}\right) A_{22}^{-1} M_2\right] \qquad (68)$$

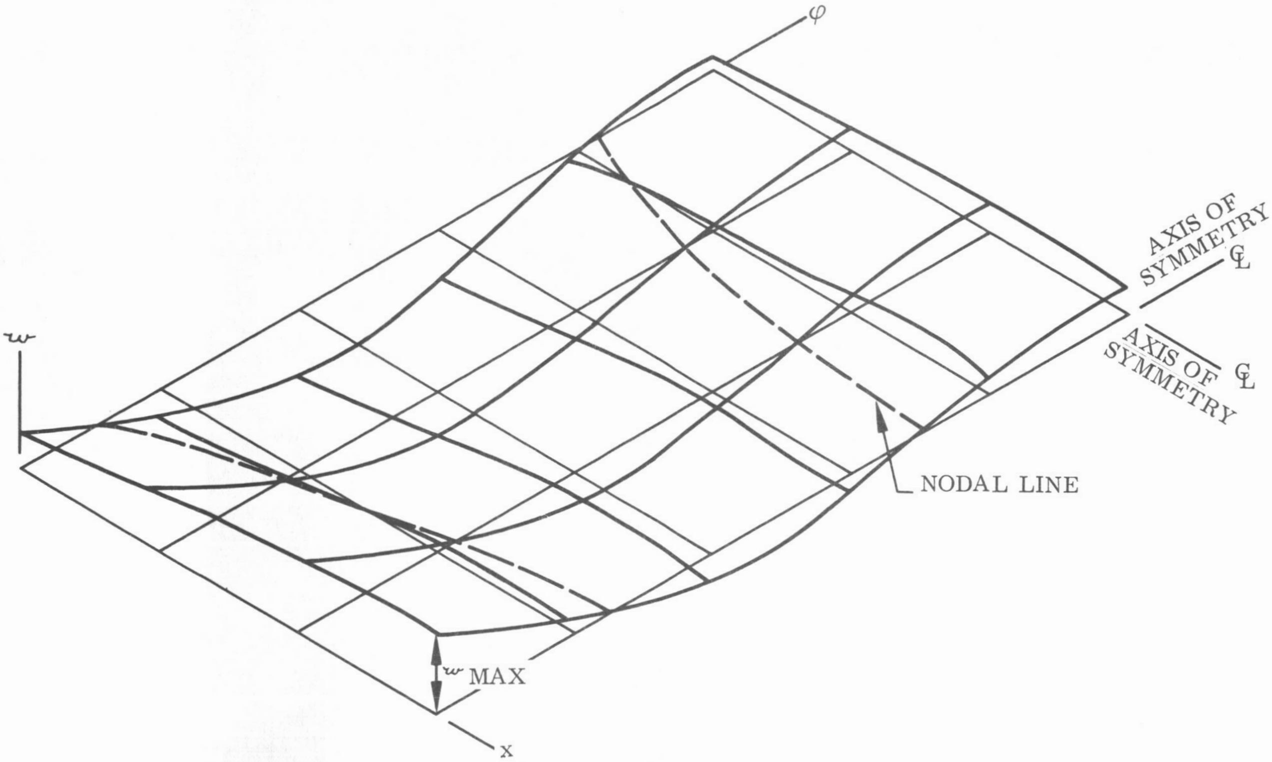
The computer program yields the eigenvalues and the eigenvectors starting with the largest value of $\frac{1}{\Omega}$. In other words, the lowest frequency and the corresponding modal data are generated first, to be followed by modal data corresponding to gradually increasing frequencies. After one eigenvalue and the corresponding mode shape are obtained, Equation (66) is used to compute the corresponding ϕ values as partial output of the computer program.

The above writeup describes the general scheme used in mechanizing the computer program. Results obtained so far have been promising as compared to the test data. The complete program, the work instructions and the sample data are given in Appendix II.

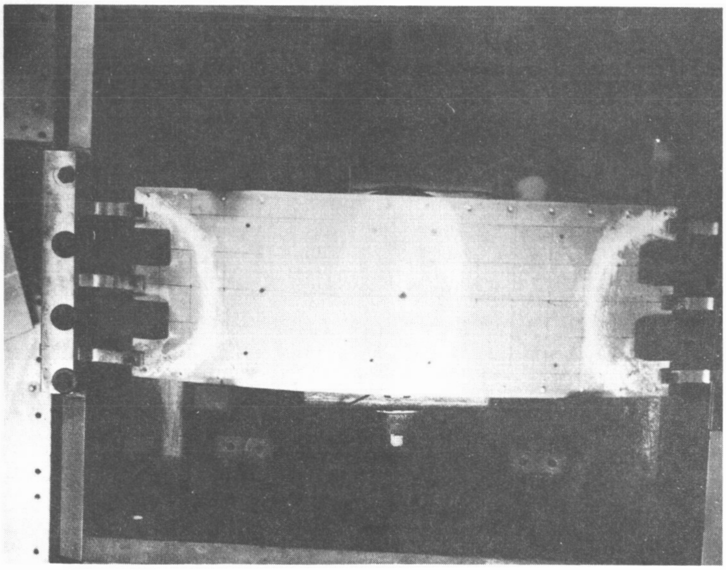
D. SEGMENTED INSTRUMENT UNIT DATA

Four (4) sets of analytical data were acquired from the finite difference computer program for the unloaded and loaded Instrument Unit segments. The computed natural frequencies and corresponding mode shapes of the first five modes of the unloaded Instrument Unit scale model segment supported by stiff springs (supporting configuration II) are plotted in Figure 4 and Figures 15 through 18. Figures 19 through 23 give the analytical data of the unloaded I. U. scale model supported by soft springs (supporting configuration I). Modal data of loaded scale model supported by stiff springs, and loaded full scale Instrument Unit segment supported by soft springs are shown in Figures 24-28 and Figures 29-33 respectively. Figures 34 and 35 are the plots of in-plane stress distribution and magnitude and direction of the top surface principal stresses corresponding to the mode given in Figure 4. The in-plane stress distribution corresponding to the first mode of loaded full scale I. U. segment is shown in Figure 36.

Testing was undertaken on the segmented I. U. scale model supported by stiff springs. Test data compared favorably with the analytical data for the first two modes in both unloaded and loaded configurations. The experimental frequencies and corresponding nodal lines are shown in the bottom portion of figures 4, 15, and 24. The comparison between the theoretical predicted frequencies and the test frequencies corresponding to the minimum impedance points for the loaded I. U. segment is given in Figure 7.



(a) ANALYTICAL DATA f = 289.7 CPS



(b) EXPERIMENTAL DATA f = 264 CPS

FIGURE 15. SECOND MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (II)

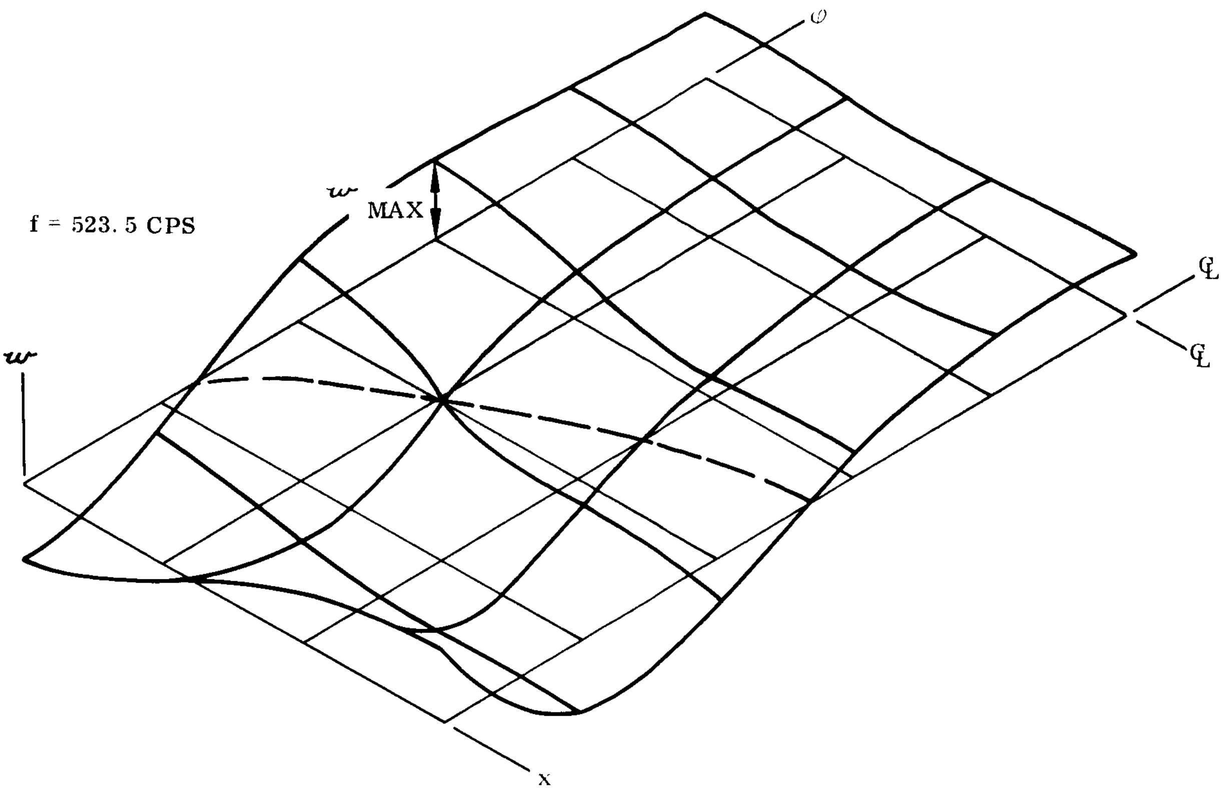


FIGURE 16. THIRD MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (II)

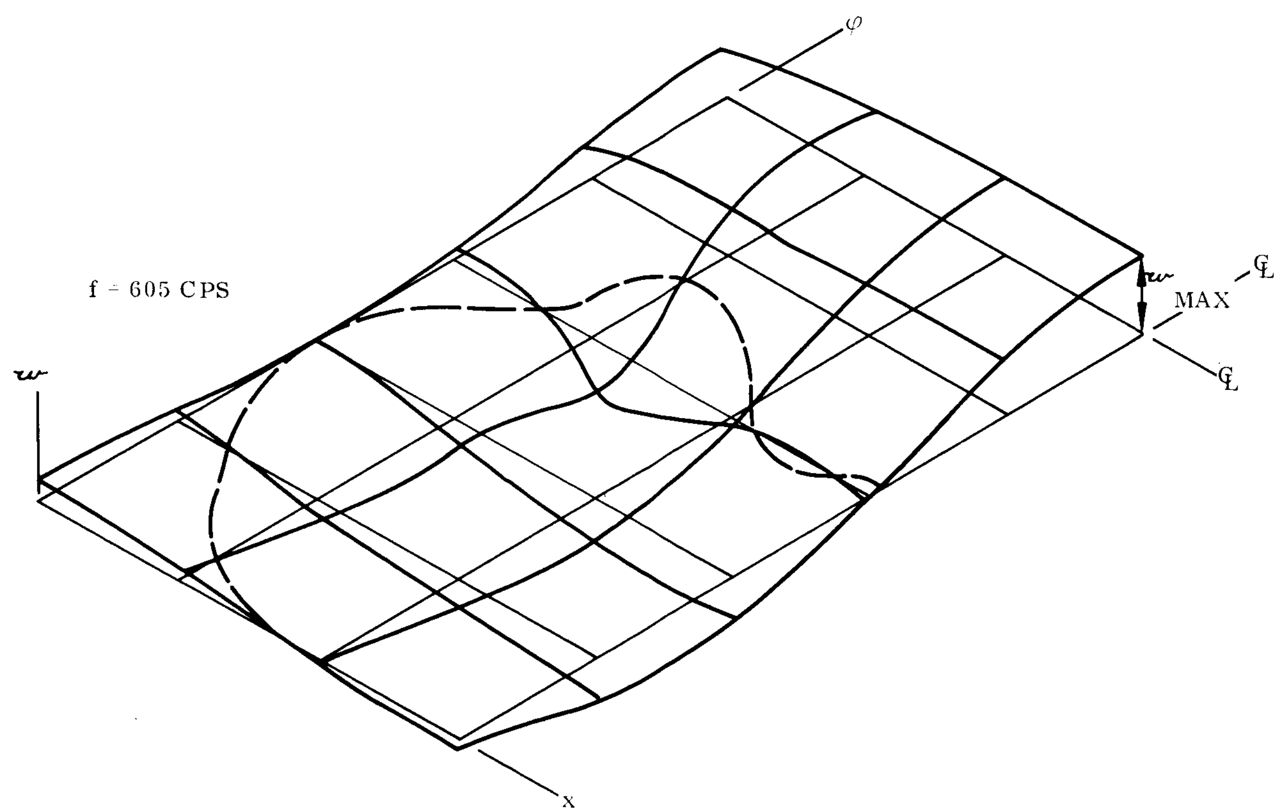


FIGURE 17. FOURTH MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (II)

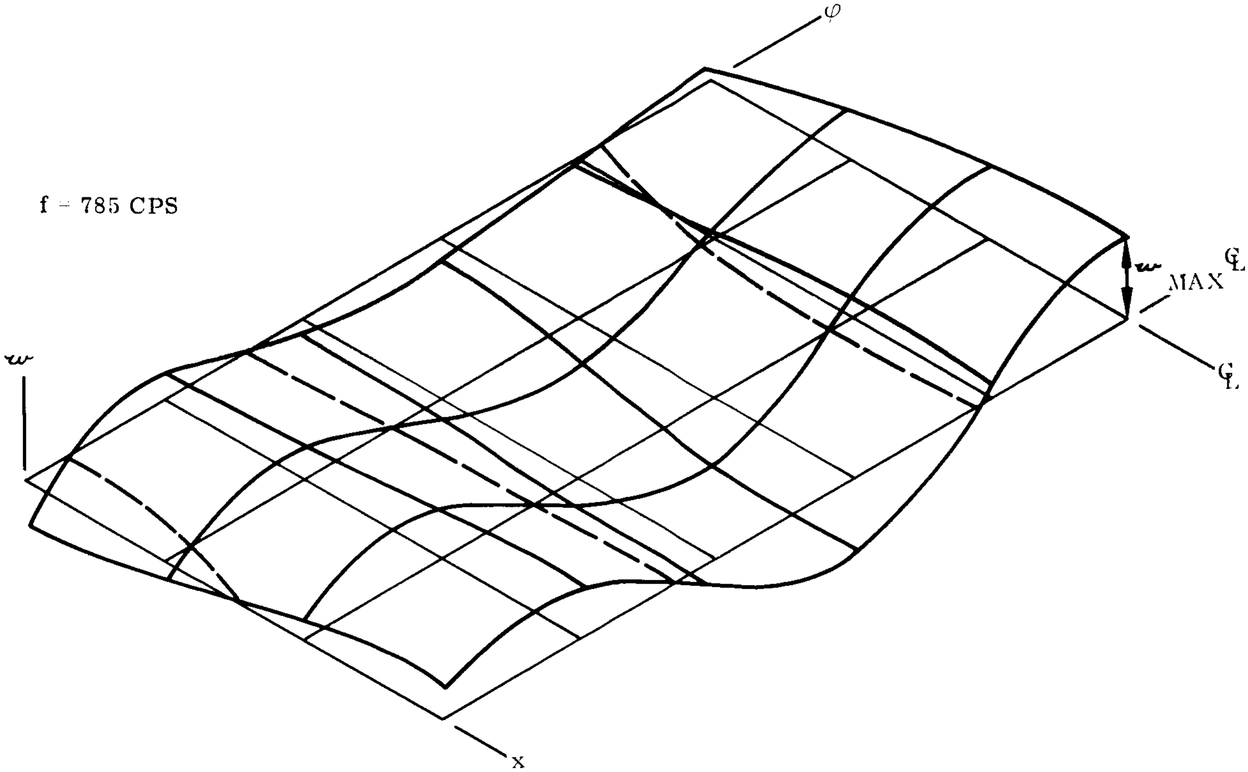


FIGURE 18. FIFTH MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (II)

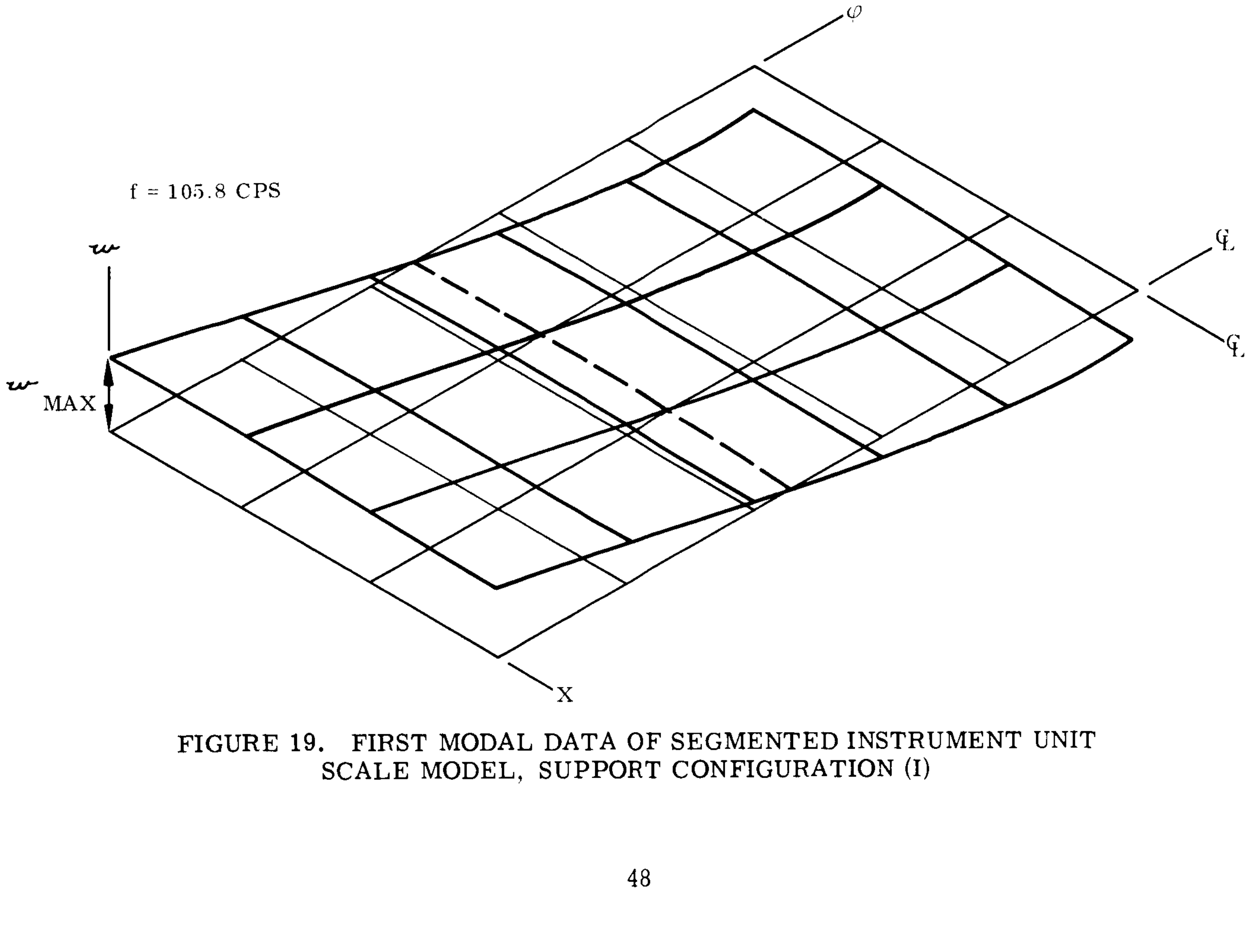


FIGURE 19. FIRST MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (I)

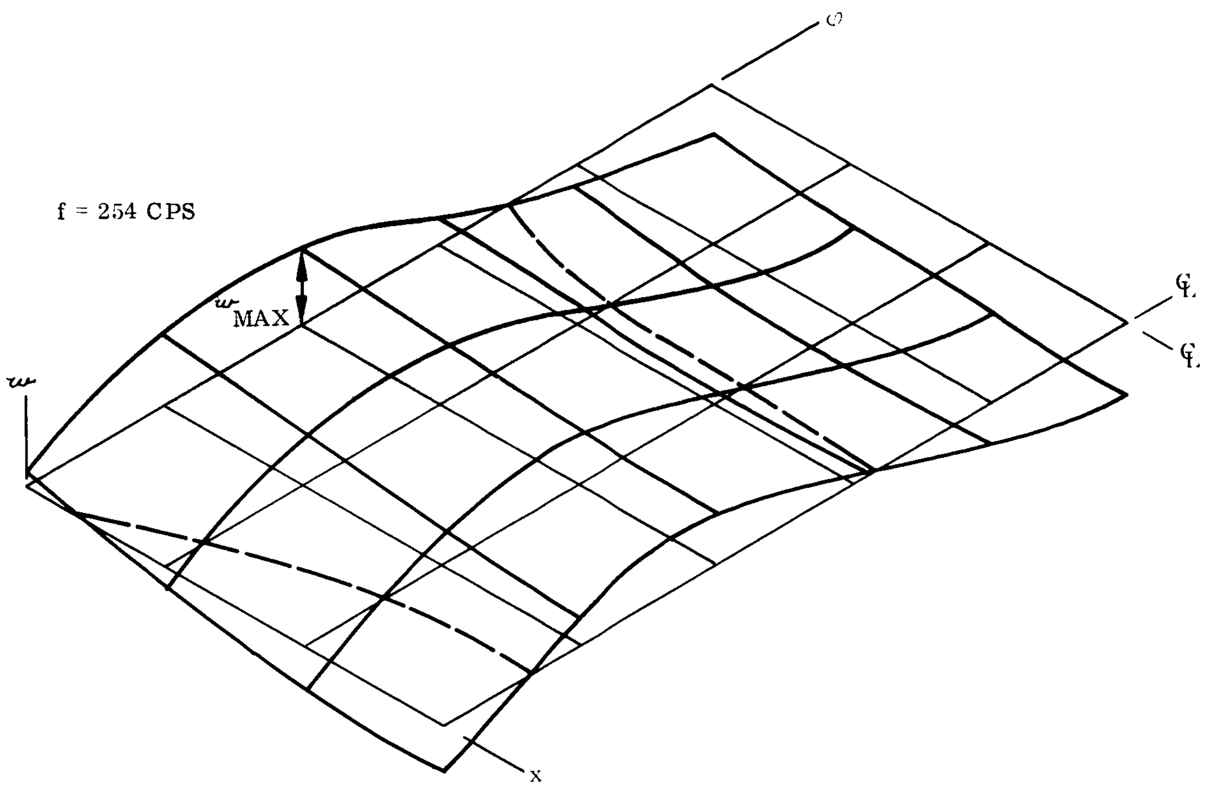


FIGURE 20. SECOND MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (I)

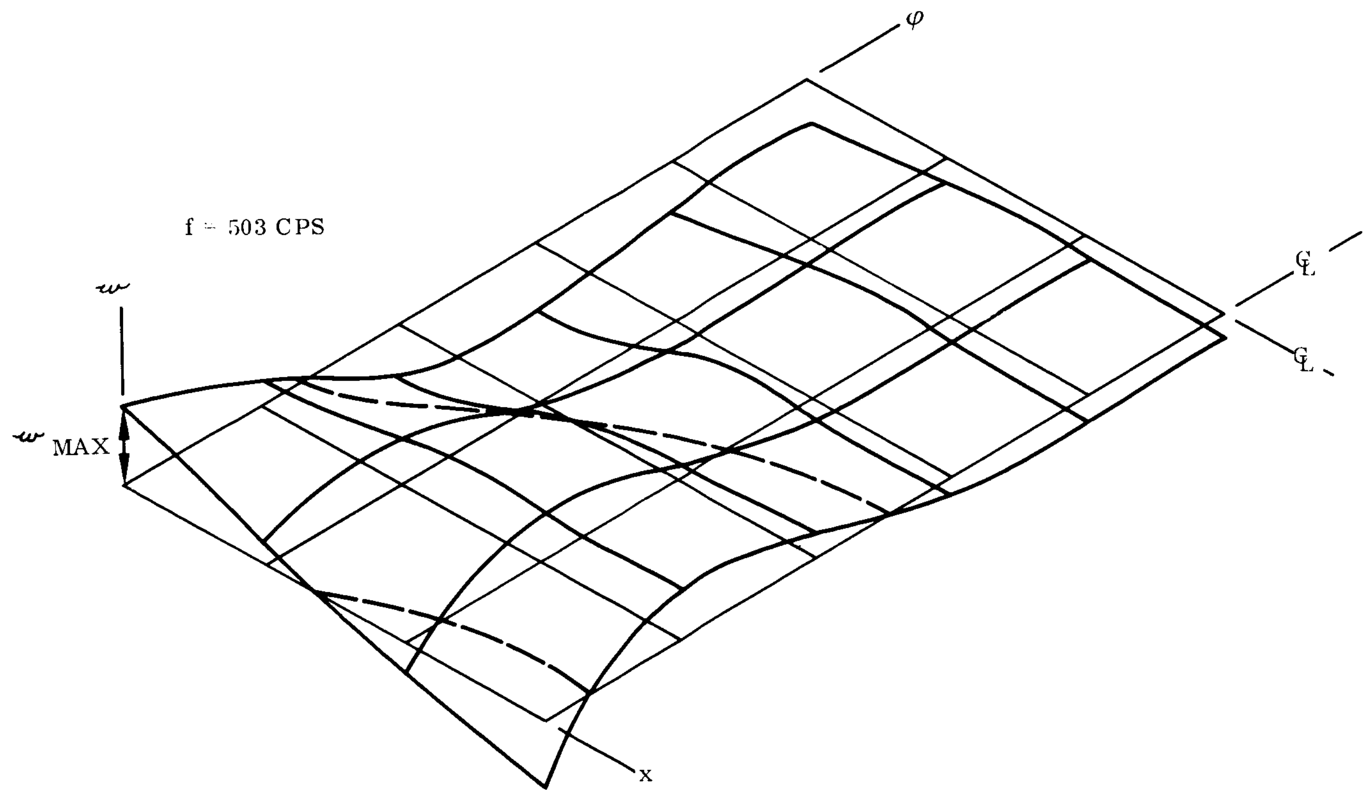


FIGURE 21. THIRD MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (I)

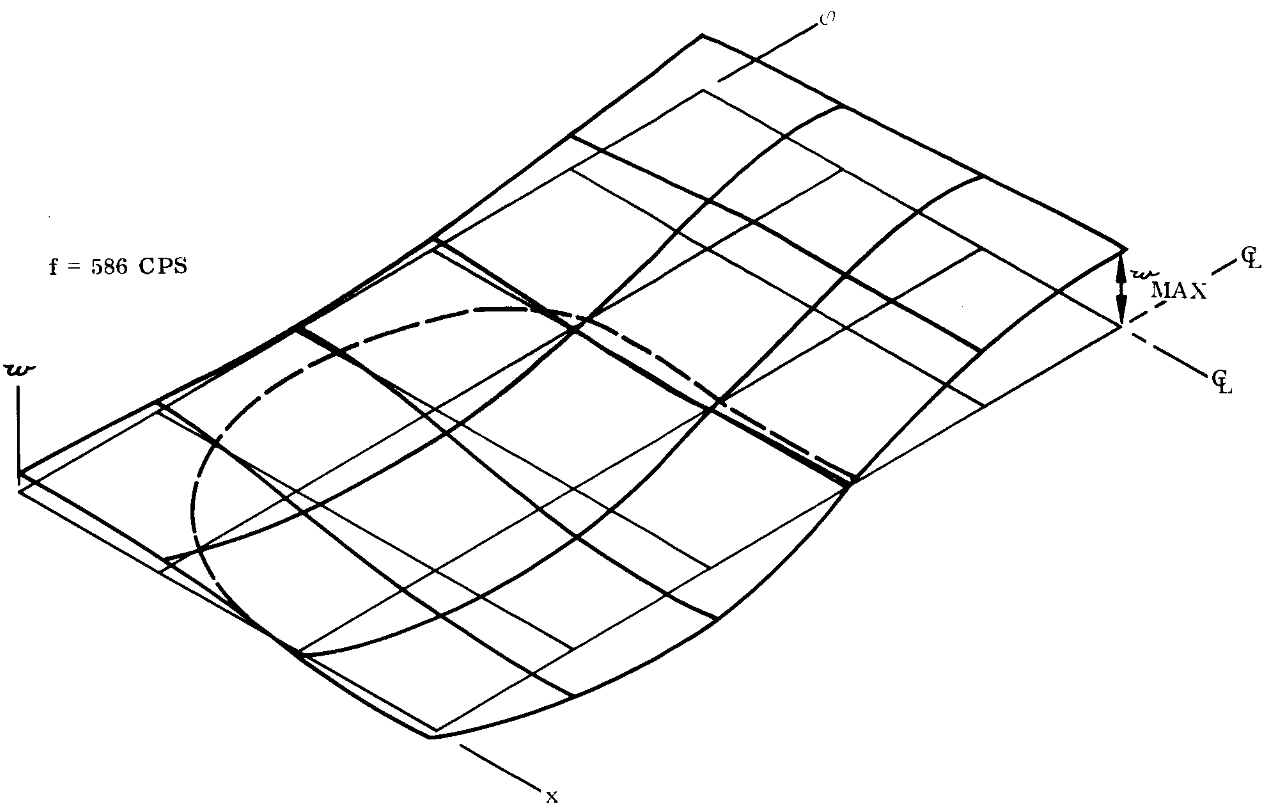


FIGURE 22. FOURTH MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (I)

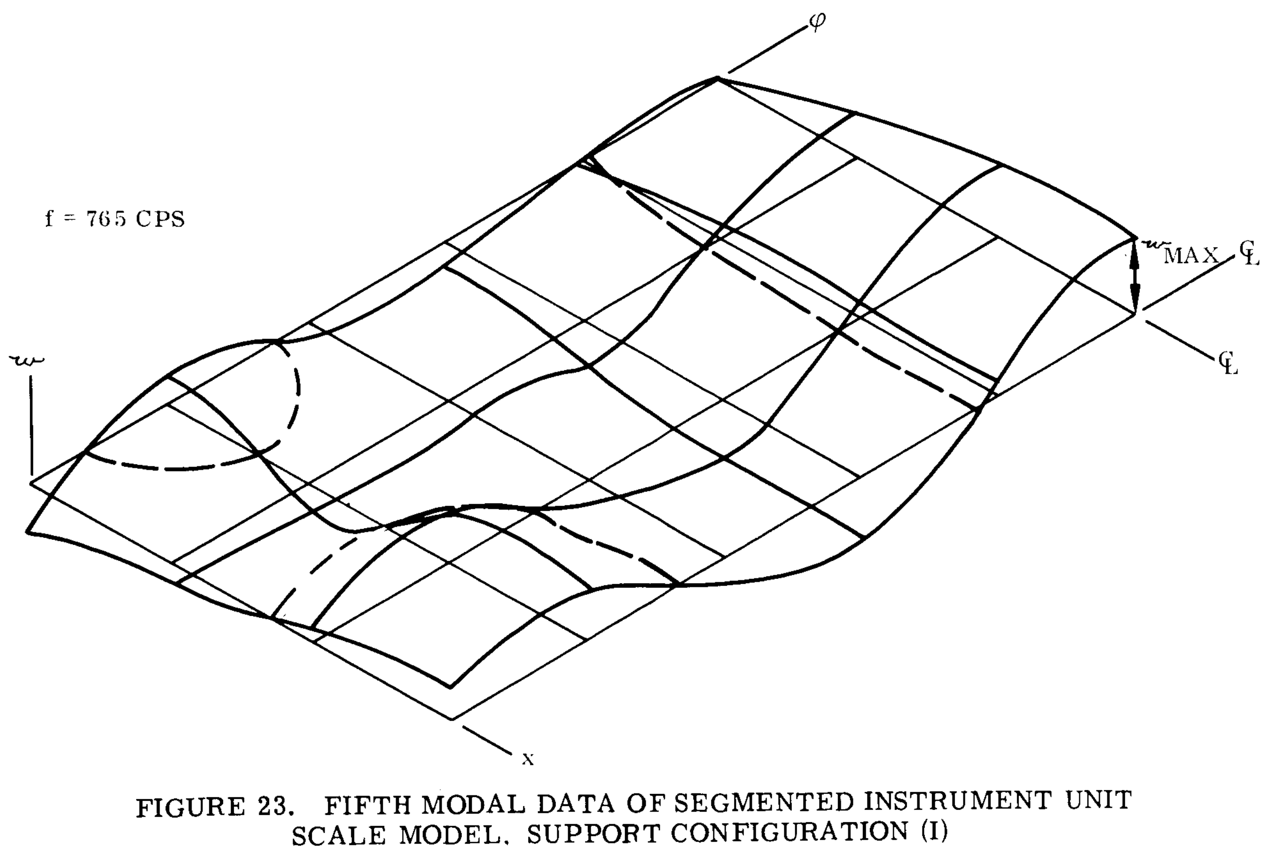
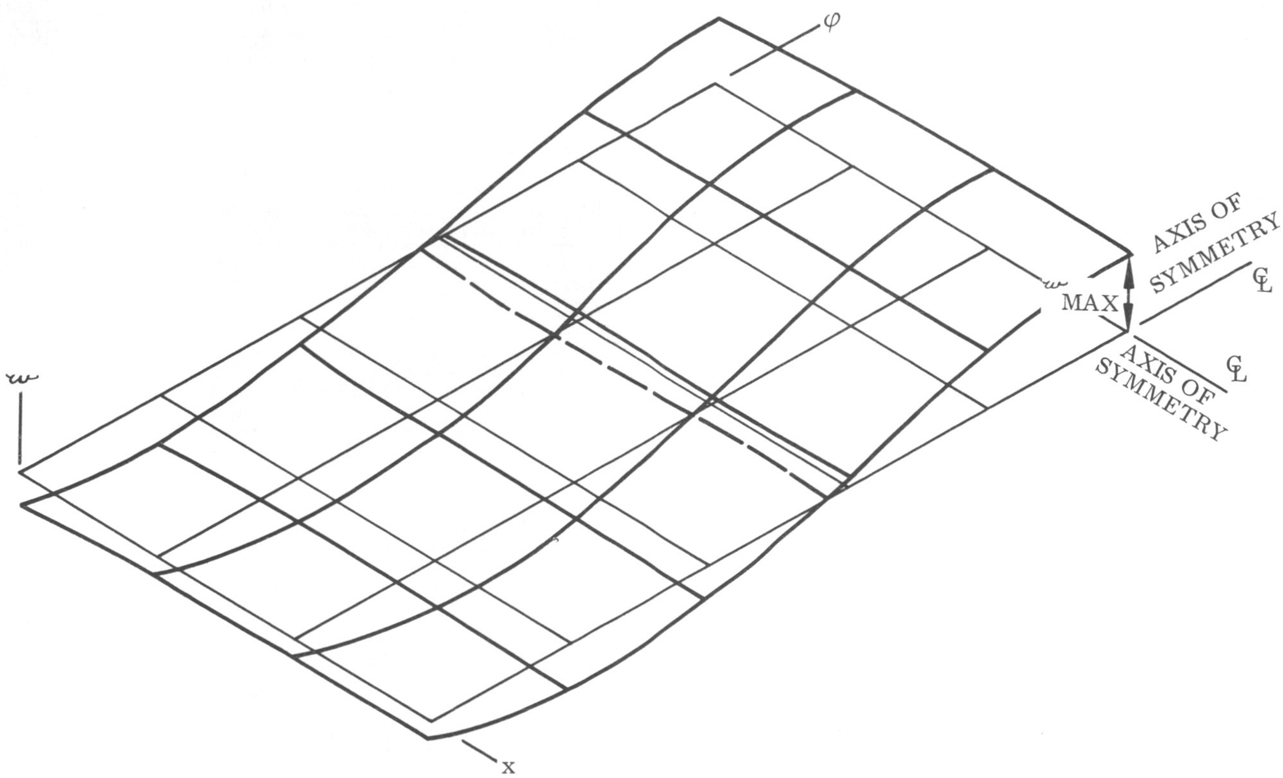
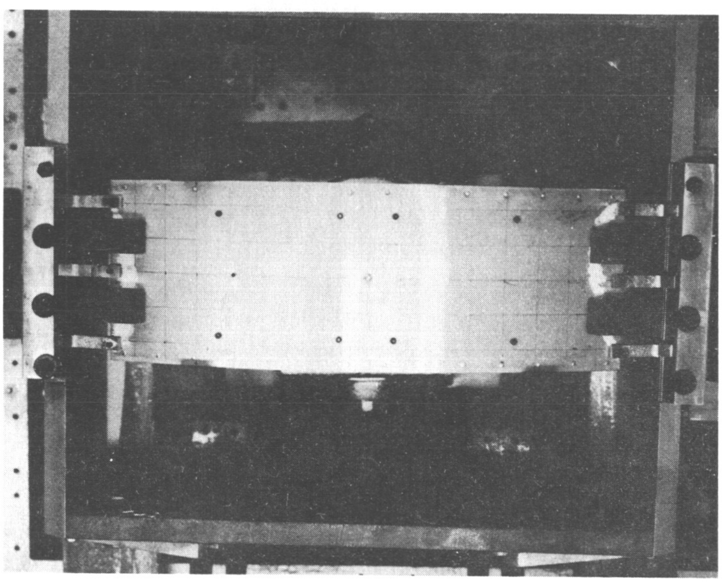


FIGURE 23. FIFTH MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (I)



(a) ANALYTICAL DATA f = 172.8 CPS



(b) EXPERIMENTAL DATA f = 172 CPS

FIGURE 24. FIRST MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL WITH SIMULATED COMPONENTS ATTACHED, SUPPORT CONFIGURATION (II)

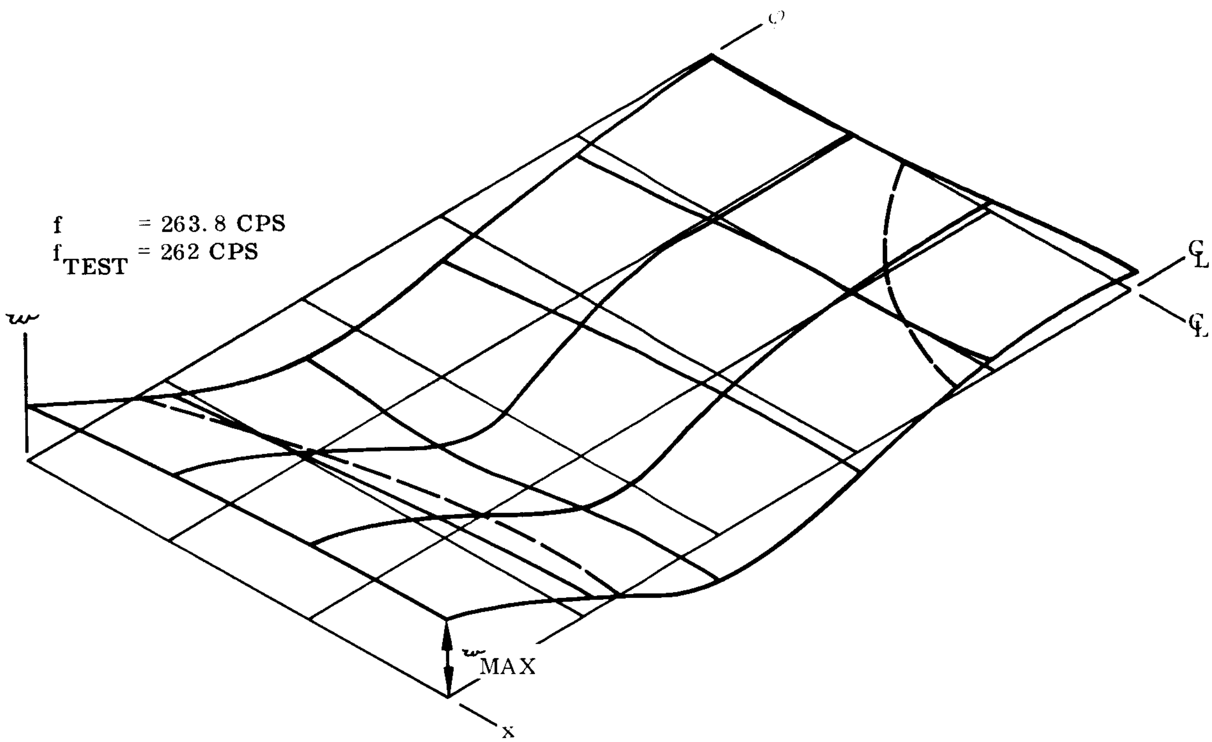


FIGURE 25. SECOND MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL WITH SIMULATED COMPONENTS ATTACHED, SUPPORT CONFIGURATION (II)

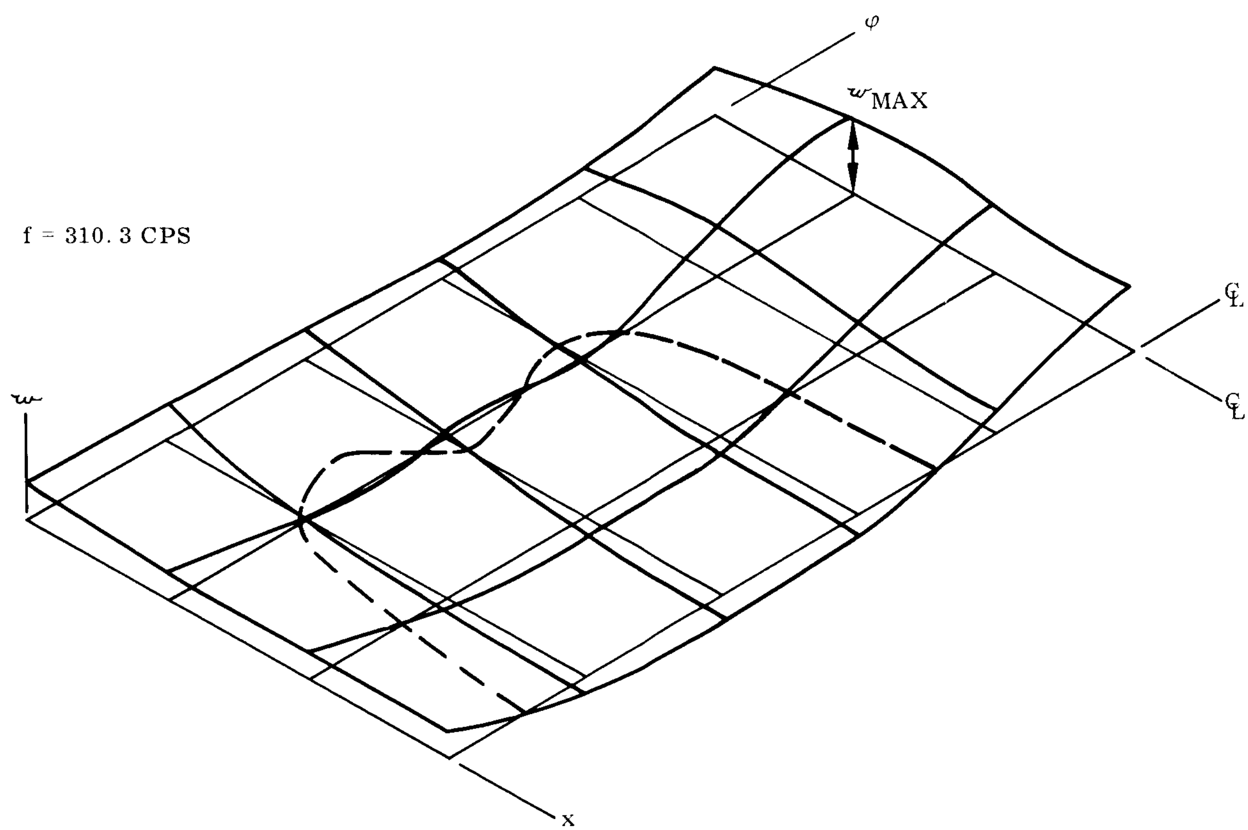


FIGURE 26. THIRD MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL WITH SIMULATED COMPONENTS ATTACHED, SUPPORT CONFIGURATION (II)

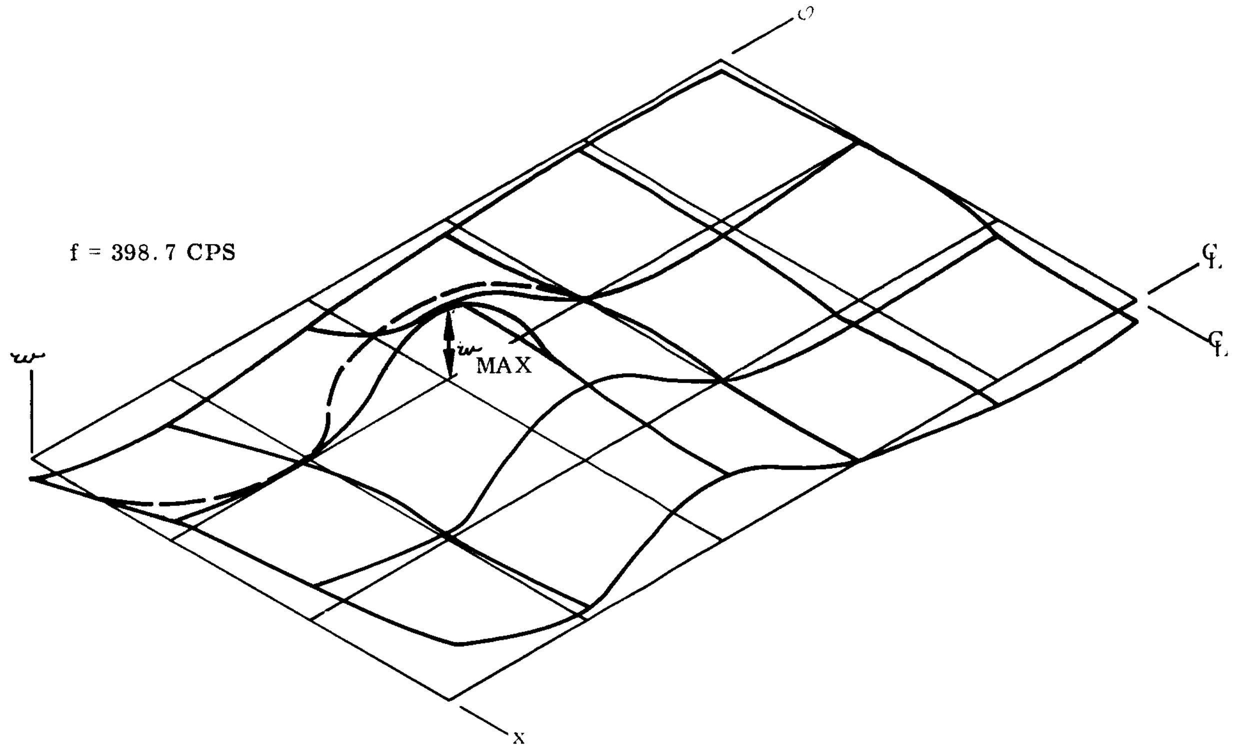


FIGURE 27. FOURTH MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL WITH SIMULATED COMPONENTS ATTACHED, SUPPORT CONFIGURATION (II)

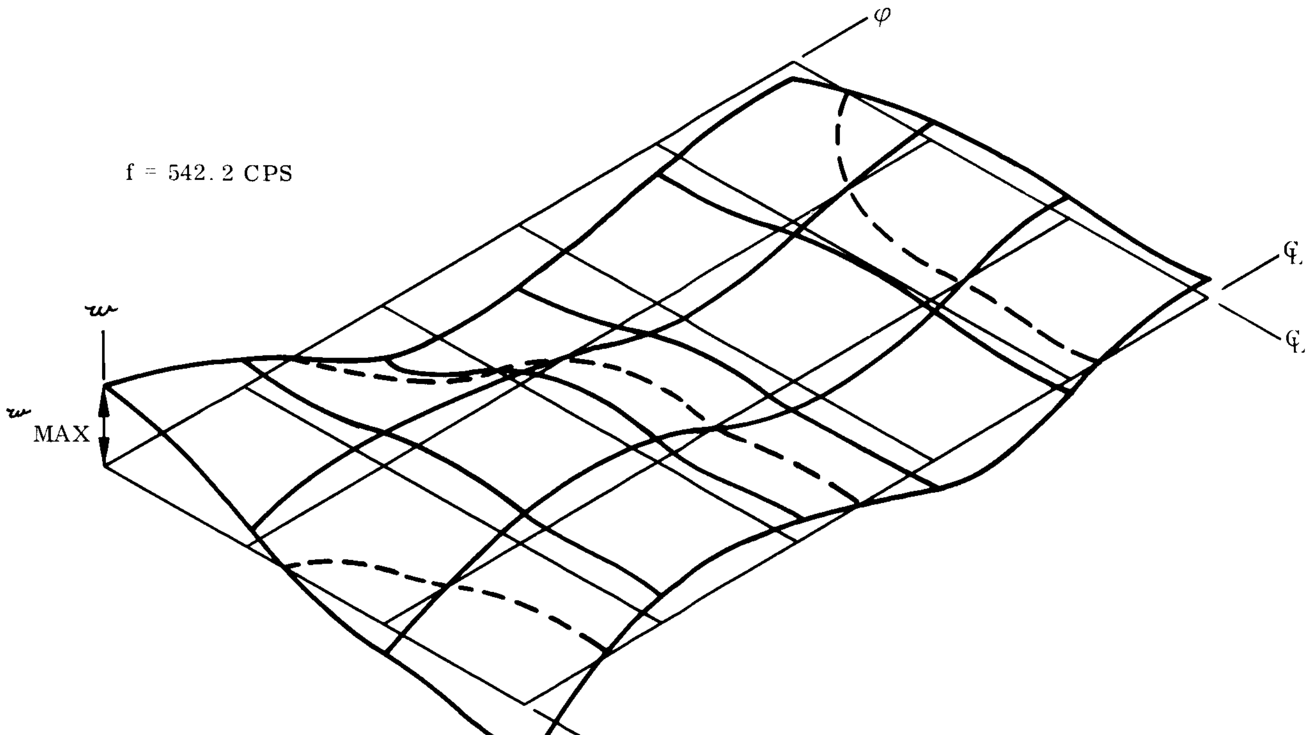


FIGURE 28. FIFTH MODAL DATA OF SEGMENTED INSTRUMENT UNIT SCALE MODEL WITH SIMULATED COMPONENTS ATTACHED, SUPPORT CONFIGURATION (II)

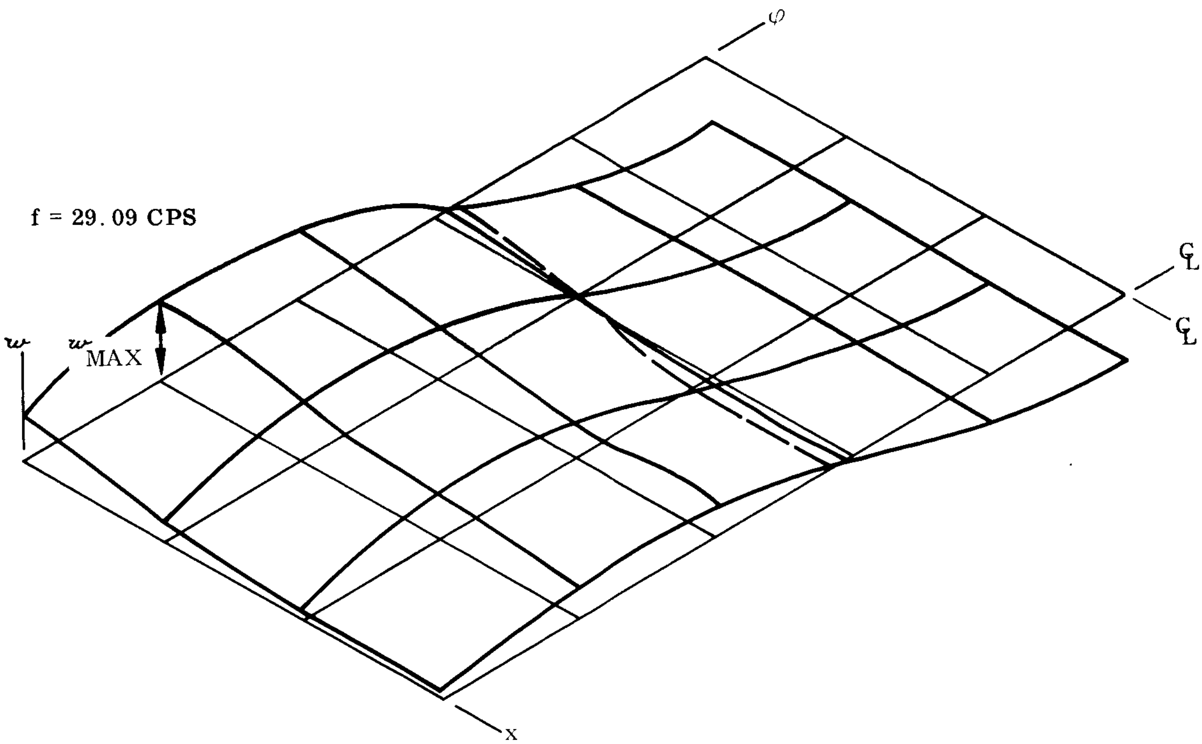


FIGURE 29. FIRST MODAL DATA OF INSTRUMENT UNIT SEGMENT WITH COMPONENTS ATTACHED, SUPPORT CONFIGURATION (I)

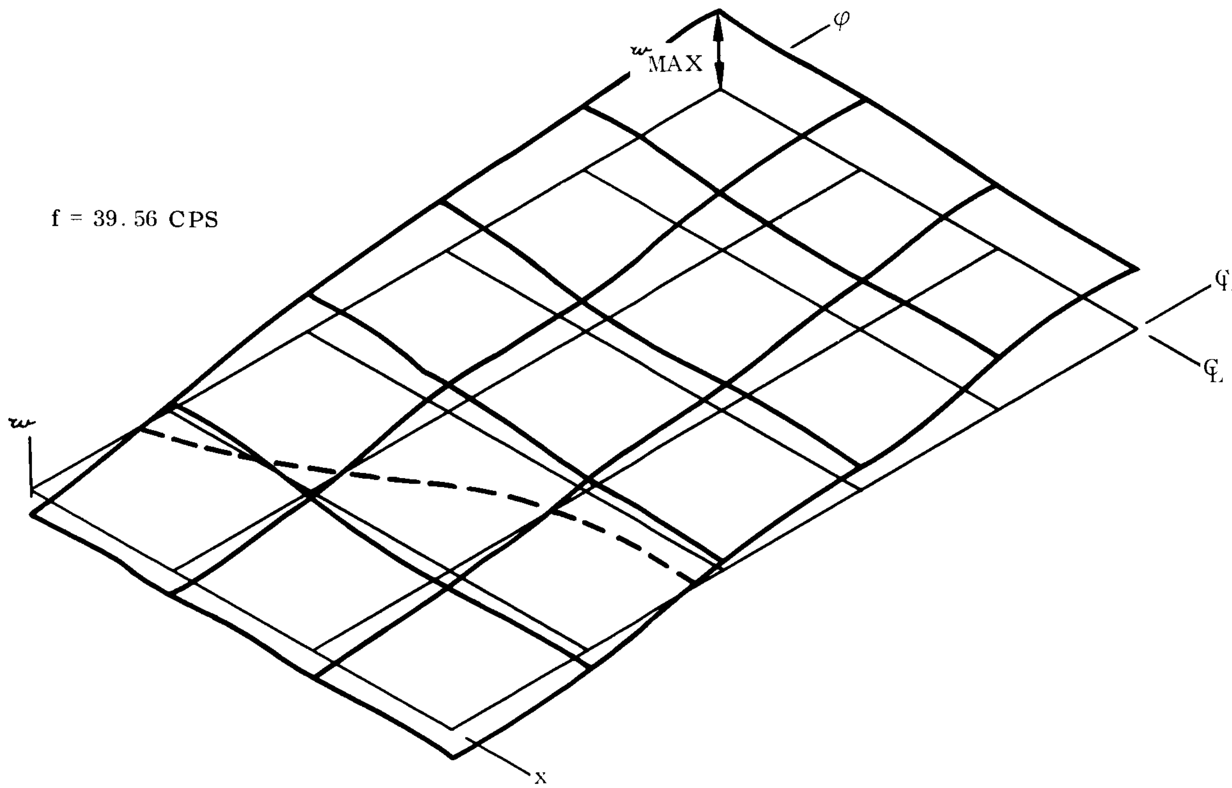


FIGURE 30. SECOND MODAL DATA OF INSTRUMENT UNIT SEGMENT WITH COMPONENTS ATTACHED, SUPPORT CONFIGURATION (I)

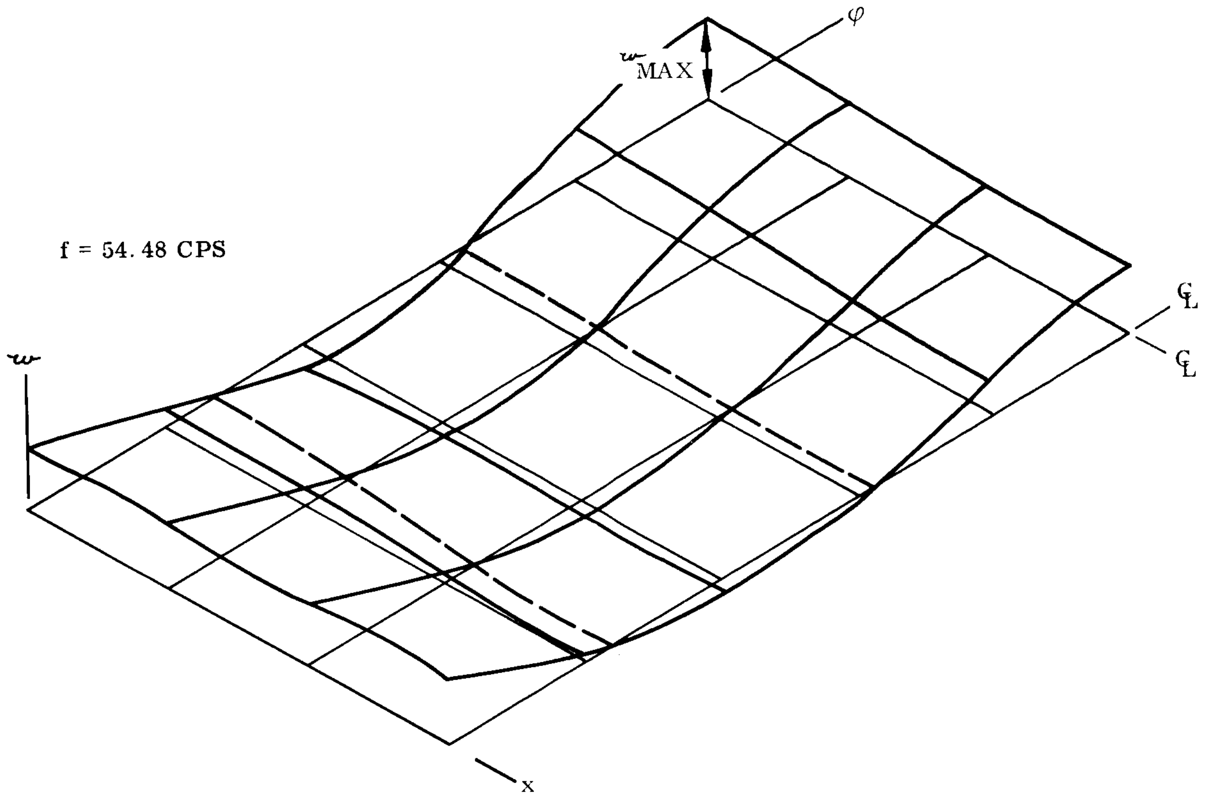


FIGURE 31. THIRD MODAL DATA OF INSTRUMENT UNIT SEGMENT WITH COMPONENTS ATTACHED. SUPPORT CONFIGURATION (I)

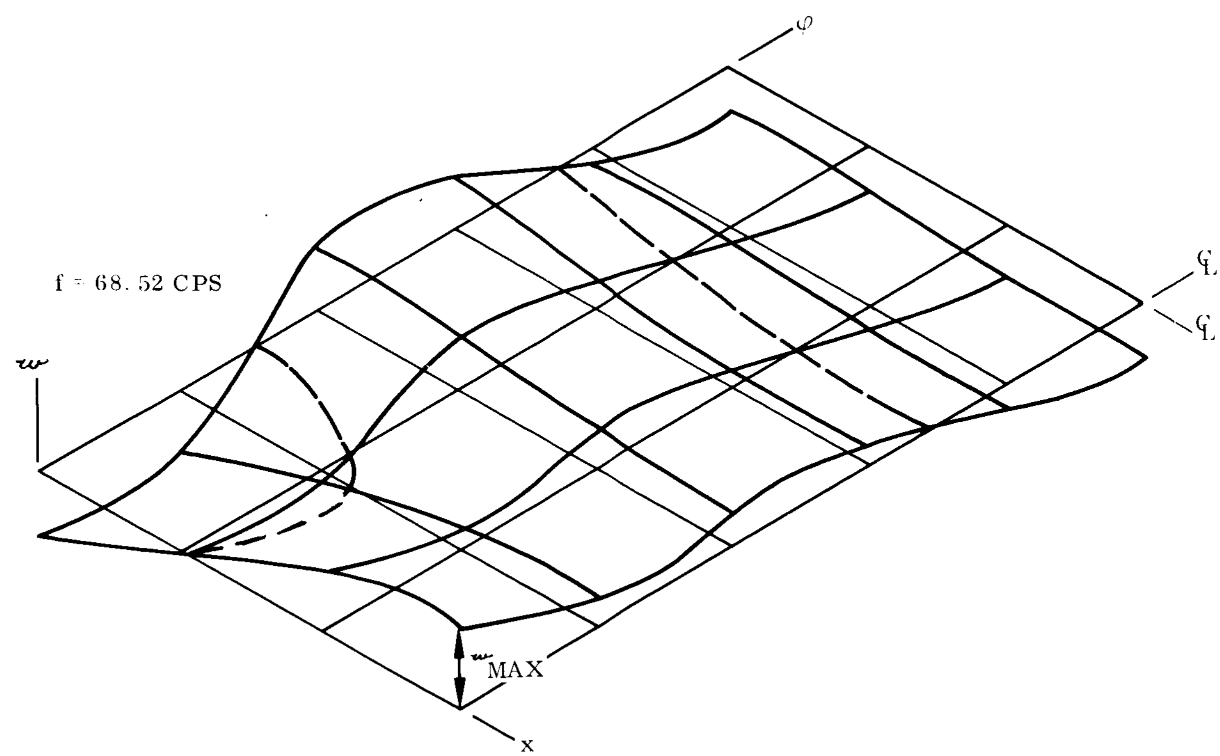


FIGURE 32. FOURTH MODAL DATA OF INSTRUMENT UNIT SEGMENT WITH COMPONENTS ATTACHED, SUPPORT CONFIGURATION (I)

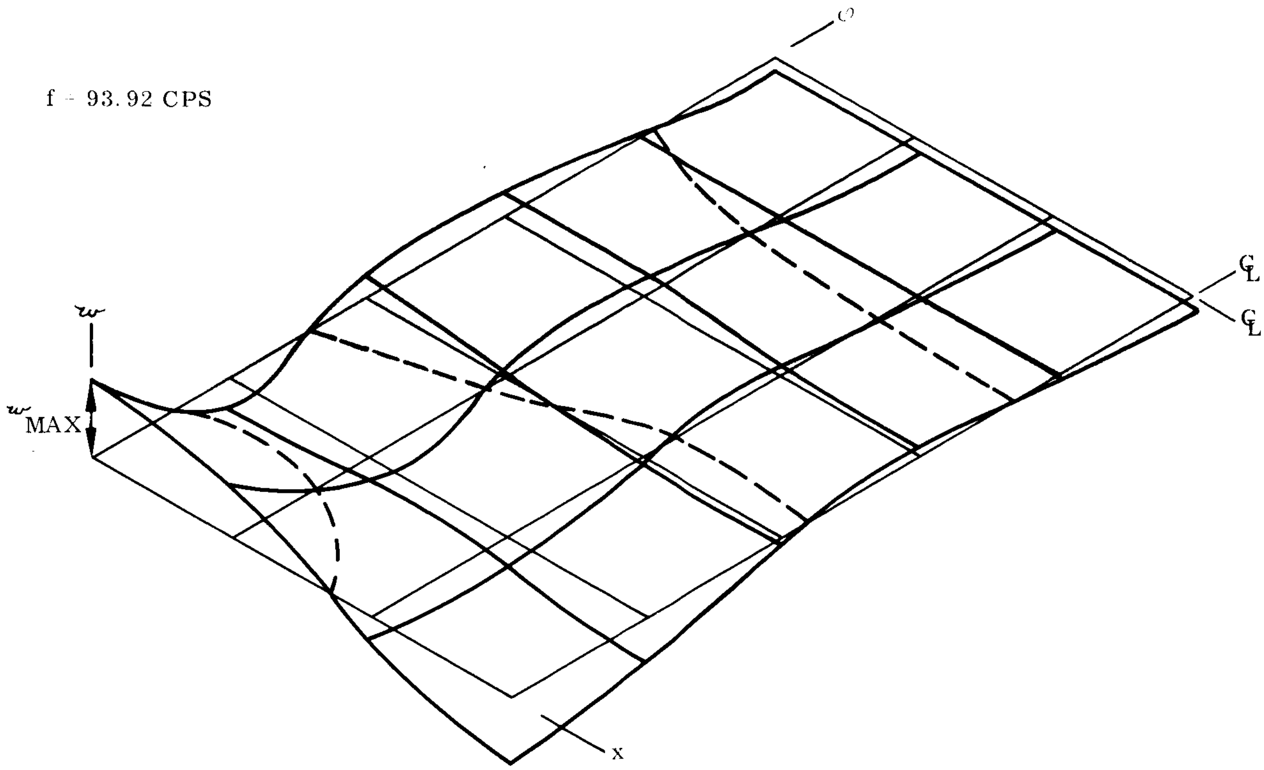


FIGURE 33. FIFTH MODAL DATA OF INSTRUMENT UNIT SEGMENT WITH COMPONENTS ATTACHED, SUPPORT CONFIGURATION (I)

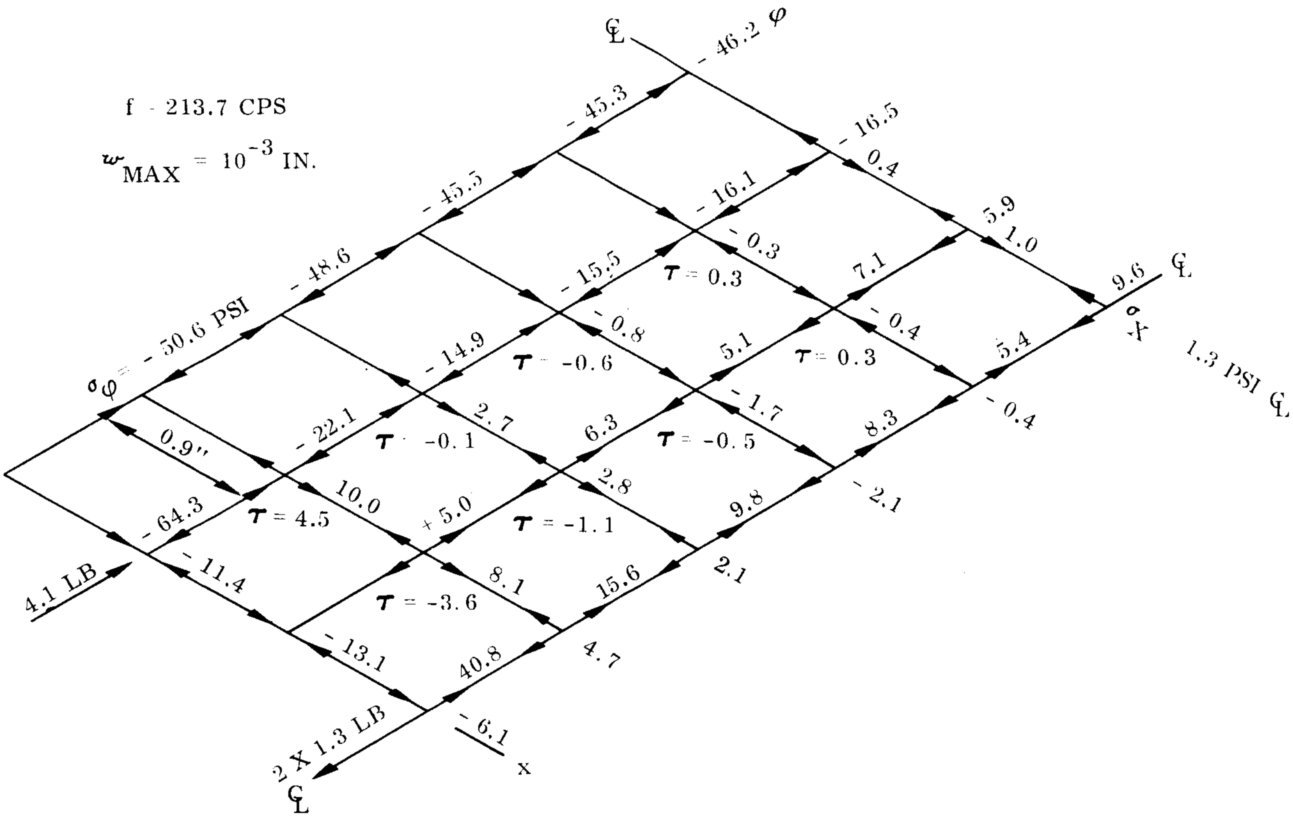


FIGURE 34. IN-PLANE STRESS DISTRIBUTION CORRESPONDING TO THE FIRST MODE OF SEGMENTED INSTRUMENT UNIT SCALE MODEL, SUPPORT CONFIGURATION (II)

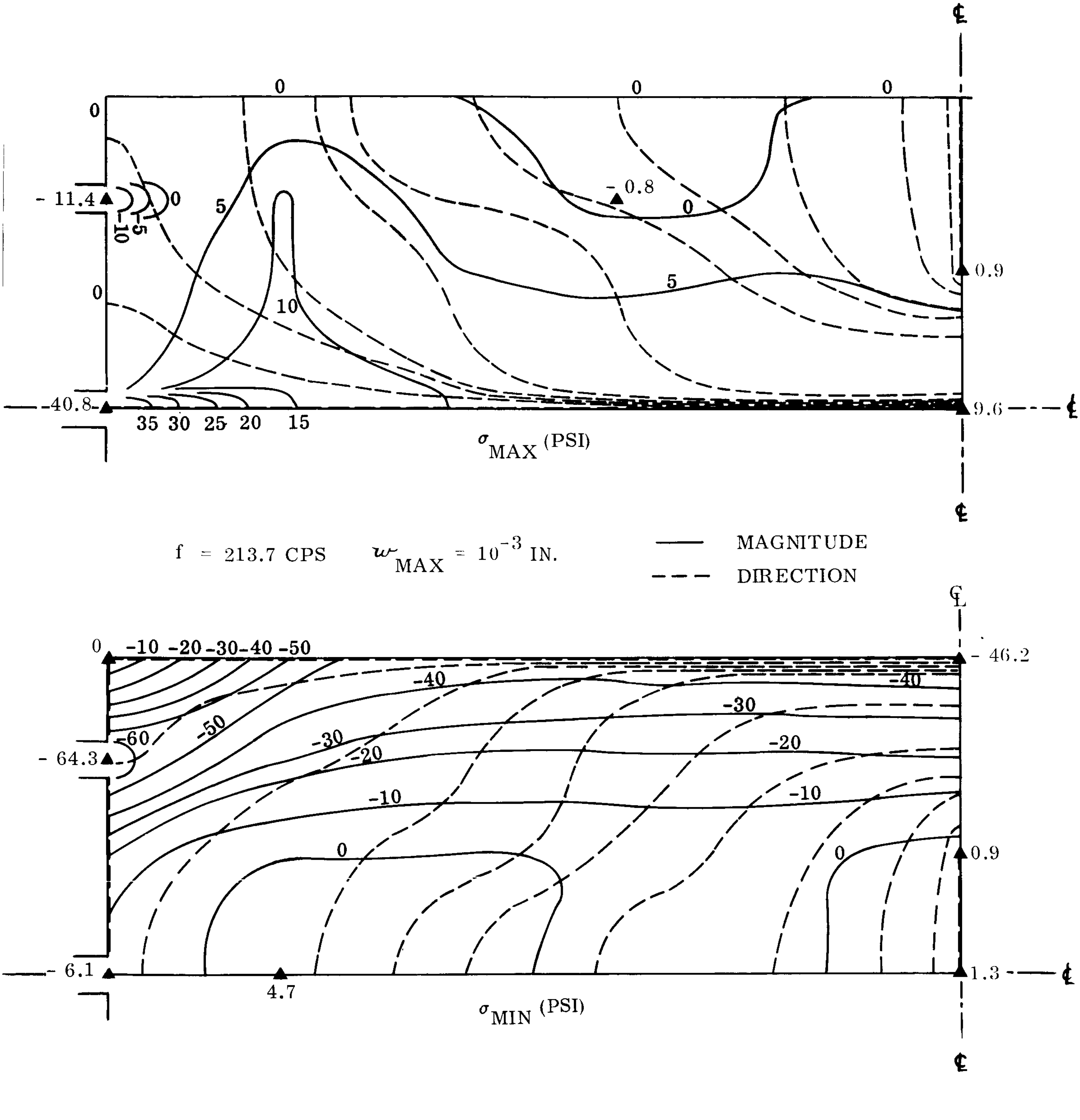


FIGURE 35. MAGNITUDE AND DIRECTION OF TOP SURFACE PRINCIPAL STRESSES CORRESPONDING TO THE FIRST MODE OF SEGMENTED INSTRUMENT UNIT SCALE MODEL. SUPPORT CONFIGURATION (II)

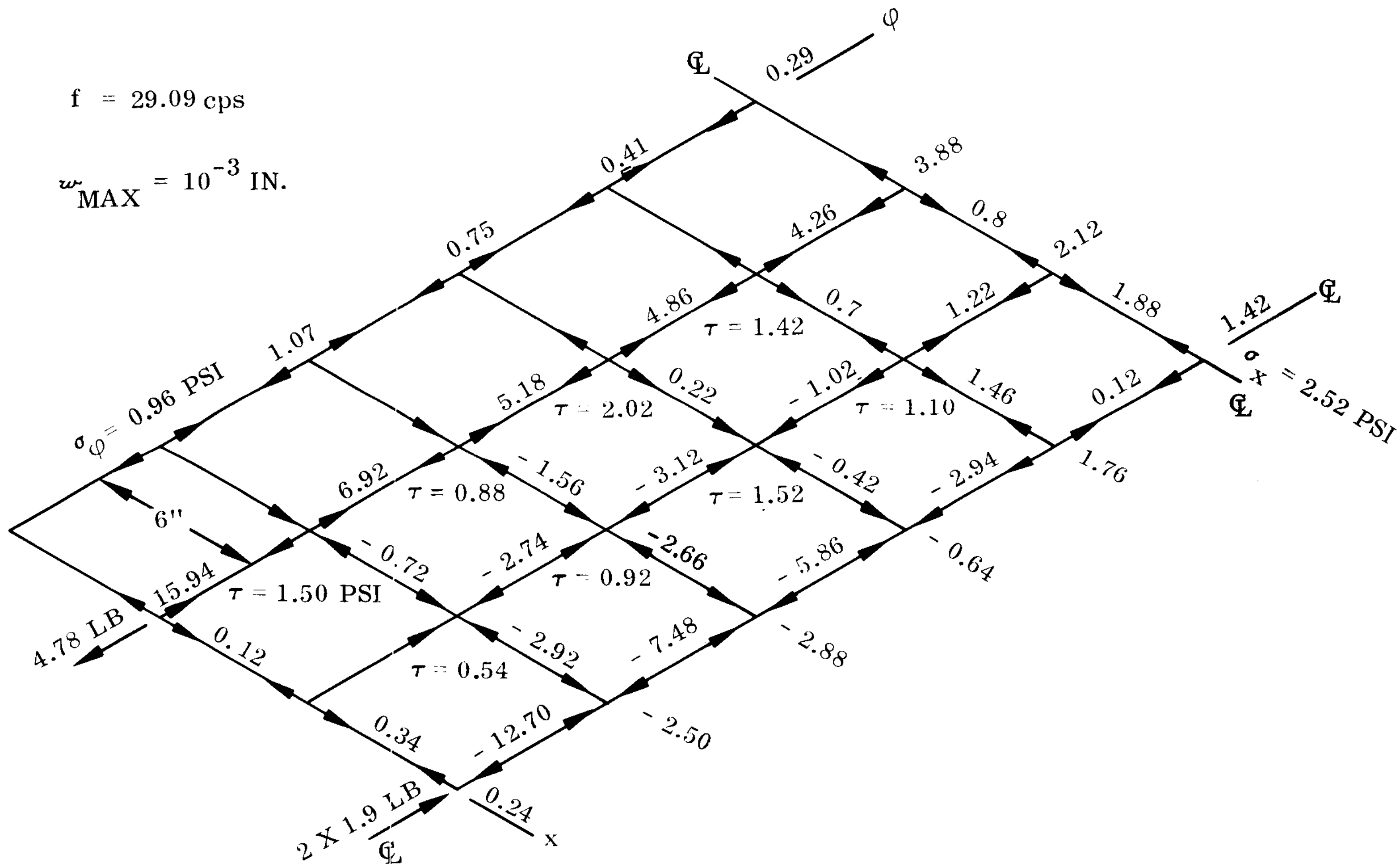


FIGURE 36. IN-PLANE STRESS DISTRIBUTION CORRESPONDING TO THE FIRST MODE OF INSTRUMENT UNIT SEGMENT WITH COMPONENTS ATTACHED. SUPPORT CONFIGURATION (I)

APPENDIX II

USER INFORMATION OF THE FINITE DIFFERENCE COMPUTER PROGRAM

The program gives the analytical predictions of natural vibration modes and frequencies of a curved panel or a curved sandwiched panel with arbitrary boundary and supporting conditions. Coefficient matrix derived from the finite difference expression for equilibrium equations, compatibility equations, and boundary conditions is organized and read into the program as input data.

The complete program consists of three CHAIN's. The first chain is used to compute all necessary data and set up a table called "E table" - that has all the elements needed in the coefficient matrix A. The second chain is mechanized to transfer these elements to proper locations in the matrix and to reduce the matrix into an eigenmatrix. The third chain is used to compute the eigenvalues and eigenvectors, and the associated stress function.

INPUT DATA

The program is set up for the grid pattern shown in Figure 13.

1. Solid Shell

Symbols used in Analysis	Fortran Coding	Definitions
a	A	Radius of curvature (in)
b	B	Length of a panel in x-direction (in)
φ_o	PHIO	Circumferential angle in φ-direction (rad)
ν	PNU	Poisson's ratio
E	E	Young's modulus of elasticity (lb/in^2)
ρ	RHO	Mass density per unit volume (lb-sec^2/in^4)
h	H	Shell thickness (in)
n	N	Number of grid points in φ-direction = 6
m	M	Number of grid points in x-direction = 4
	NMODE	Number of modes sought
	IOPT	= 1 for solid shell

Symbols used in Analysis	Fortran Coding	Definitions
$z_{sx}, z_{s\varphi}$	SZX, SZP	Distances from c.g. of the stiffeners to the middle surface of the panel in x-direction and φ-direction, (in.) numbers of values to be read in are controlled by an index, NEXT; their locations in the array by J1, J2 and K2.
$A_{sx}, A_{s\varphi}$	SAX, SAP	Cross sectional area of stiffener* in x-direction and φ-direction (in^2). Controlling indices are J1, J2, K2 and NEXT.
$I_{sx}, I_{s\varphi}$	SIX, SIP	Moment of inertial of stiffener,* in x-direction and φ-direction respectively, about its own centroidal axis (in^4). Controlling indices are J1, J2, K2 and NEXT.
$\bar{K}_x$	BARKX	Spring constant of a point-support along the axis x = 0, (lbs/in) Controlling indices are I1, I2, and NXT1.
$\bar{K}_\varphi$	BARKP	Same as above along the axis $\varphi = 0$, (lbs/in) Controlling indices are I3, I4, and NXT2.
W_x	WX	Weights along the boundary x = 0, (lbs) Controlling indices are I5, I6, and NXT3.
W_φ	WP	Weights along the boundary $\varphi = 0$, (lbs) Controlling indices are I5, I6, and NXT4.
W	WT	Weights at interior points of the panel (lbs) Controlling index is JWT
i, j	IM1, IM2	Row and column number, respectively, of off-diagonal term of mass (internal) matrix.
(M_1) i, j, i≠j	AM3	Actual element that corresponds to IM1 and IM2 in the (internal) mass matrix. Number of this off-diagonal terms is limited to six.
	IETBL, NEC	Row number and column number, respectively of the matrix element (E) table. The E table is generated according to the definition of Table 2 for all grid points. A particular element of the table is to be transferred to a particular location in the coefficient matrix A.
	NZRO	Number of non-zero elements in a row of coefficient matrix.
	NAC	Column number of the non-zero element in the coefficient matrix.

NOTE: For a stiffener which is placed along one boundary of the panel, double the values of the corresponding cross-sectional area and the moment of inertia as input.

2. Sandwiched Shell

The definitions made for the solid shell apply to the sandwiched shell with the following exceptions and additional definitions.

Symbols used in Analysis	Fortran Coding	Definition
h	H	Total thickness of outer and inner facings.
c	CORE	Thickness of core.
$\bar{m}$	BARM	Mass per unit area of the panel.
	IOPT	= 2. For sandwiched panel.

KEY PUNCH FORM - GENERAL PURPOSE

FORM 20-73e (R.7-63)

JOB TITLE		ENGINEER	PAGE OF
DPWA SERIAL NO.	PRE. / DPC JOB NO. / DASH / FOR ORGN. NO.	ANALYST	DATE

INPUT DATA FORMAT

Columns 1–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80
A	B	PHIO	PNU	E	RHO		
H	CORE	BARM	N / M / * / **	*NMODE **IOPT			
J1 / K2 / JWT							
SZX (1)	SZX (2)	- - - - -	SZX (J1)	SZP (1)	SZP (2)		
- - - -	SZP (K2)	- - - - -					
- - - -							
SIX (1)	SIX (2)	- - -	SIX (J1)	SIP (1)	SIP (2)		
- - -	SIP (K2)	- - -					
- - -							
SAX (1)	SAX (2)	- - -	SAX (J1)	SAP (1)	SAP (2)		
- - -	SAP (K2)	- - -					
- - -							
J2 / NEXT	FOR NEXT 0. REPEAT THIS AND THE FOLLOWING CARDS FOR NEXT 1. THE FOLLOWING IS THE LAST READING FOR SAX, SAP, SIX, SIP, SZX. SZP						
SAX (J2)	SAP (J2)	SIX (J2)	SIP (J2)	SZX (J2)	SZP (J2)		
I1 / I2 / NXT1	FOR NXT1 0. REPEAT THIS AND THE FOLLOWING CARDS FOR NXT1 1. THE FOLLOWING IS THE LAST READING FOR BARKX						

KEY PUNCH FORM - GENERAL PURPOSE

FORM 20-708 (R.7-63)

JOB TITLE	ENGINEER	PAGE OF
DPWA SERIAL NO. / PRE. / OFD JOB NO. / DASH / FOR ORGN. NO.	ANALYST	DATE

Columns 1–80:

BARKX (I1) | BARKX (I2)

I3 | I4 | NXT2 | FOR NXT2 = 0, REPEAT THIS AND THE FOLLOWING CARDS

FOR NXT2 = 1, THE FOLLOWING IS THE LAST READING FOR BARKP

BARKP (I3) | BARKP (I4)

I5 | I6 | NXT3 | FOR NXT3 = 0, REPEAT THIS AND THE FOLLOWING CARDS

FOR NXT3 = 1, THE FOLLOWING IS THE LAST READING FOR WX

WX (I5) | WX (I6)

I7 | I8 | NXT4 | FOR NXT4 = 0, REPEAT THIS AND THE FOLLOWING CARDS

FOR NXT4 = 1, THE FOLLOWING IS THE LAST READING FOR WP

WP (I7) | WP (I8)

WT (1) | WT (2) | - - - | WT (JWT)

(IM1 (I), IM2 (I), I = 1, 6)

AM3 (1) | AM3 (2) | AM3 (3) | AM3 (4) | AM3 (5) | AM3 (6)

(IETBL (I), I = 1, NR) 1

NZRO | (NAC (I), NEC (I), I = 1, NZRO)

KEY PUNCH FORM - GENERAL PURPOSE
FORM 20-708 (R.7-63)

JOB TITLE	ENGINEER	PAGE OF
DPWA SERIAL NO. / PRE. / DPD JOB NO. / DASH / FOR ORGN. NO.	ANALYST	DATE

```
(IETBL (J), J = 1, NR)*2
NZRO (NAC (I), NEC (I), I = 1, NZRO)
(IETBL (J), J = 1, NR)*3
NZRO (NAC (I), NEC (I), I = 1, NZRO)
```

*1 THIS IS TO READ THE ROW NUMBER OF "E TABLE", THE CORRESPONDING ELEMENTS OF WHICH ARE TO BE TRANSFERRED TO A_{21} AND A_{22} MATRIX. HERE, A_{21} AND A_{22} ARE TREATED AS ONE BIG MATRIX (21 x 45). FOR PRESENT PROGRAM NR = 21

*2 SAME AS ABOVE EXCEPT ELEMENTS ARE TO BE TRANSFERRED TO A_{31}, A_{32} AND A_{33}. NR = 34

*3 SAME AS ABOVE EXCEPT ELEMENTS ARE TO BE TRANSFERRED TO A_{11}, A_{12} AND A_{13}. NR = 24

LISTINGS

The following listing contains the complete main program and its subroutines with the exception of a subroutine named "MITER"*. The MITER subroutine is a standard eigenvalue, eigenvector routine. Its physical package of the subroutine follows CHAIN 3. DATA are also included here, and the technique for their arrangements is stated in the next section of the appendix.

*The writeup and subroutine deck of "MITER" are available at IBM SHARE general program library.

```
$EXECUTE         FIB
*        XEQ
*        CHAIN (1,8)                                                        MAIN
C     CHAIN 1 - SETUP FOR E TABLE                                           CHN10001
         DIMENSION SAX(24),SIX(24),SZX(24),SAP(24),SIP(24),SZP(24),WT(24),  CHN10002
       1   BARKX(24), BARKP(24), WP(24),  CZX(24),FX(24),DBXP(24),DBX(24),CHN10003
       2   CZP(24),FP(24),DPPR(24),DP(24),SKP(24),BIGP(24),BIGR(24),        CHN10004
       3   ALFA(24),BETA(24),AM1(24,24),AM2(21,24),EL(24,80),WX(24),        CHN10005
       4   SKX(24),BIGH(24),XEL(24,80),XAM1(24,24),XAM2(21,24),IM1(6),      CHN10006
       5   IM2(6),AM3(6)                                                    CHN10007
         EQUIVALENCE (XEL,EL),(NMODE,NMODX),(E,XEX),(RHO,XRHO),(H,XH),      CHN10008
       1   (D,XD),(ADP2,XADP2),(AM1,XAM1),(AM2,XAM2)                        CHN10009
         COMMON EL,NMODE,E,RHO,H,D,ADP2,AM1,AM2,BARM,IOPT                   CHN10010
C                                                                           CHN10011
C    FOR SINGLE SHELL IOPT =1                                               CHN10012
C    FOR SANDWICHED SHELL WITH HONEYCOMB CORE IOPT =2                       CHN10013
C                                                                           CHN10014
   10 FORMAT (6E12.8/3E12.8,4I3)                                            CHN10015
   30 FORMAT(3I3)                                                           CHN10016
   31 FORMAT(2I3)                                                           CHN10017
   32 FORMAT(6E12.8)                                                        CHN10018
   50 FORMAT(I12,E12.8,I12,E12.8,I12)                                       CHN10019
   62 FORMAT(2E12.8)                                                        CHN10020
    1 STARTS=1000.                                                          CHN10021
      READ INPUT TAPE 5,10,A,B,PHIO,PNU,E,RHO,H,CORE,BARM,N,M,NMODE,IOPTCHN10022
      M =M-1                                                                CHN10023
      N =N-1                                                                CHN10024
      NM=(N+1)*(M+1)                                                        CHN10025
      DO 15 I=1,NM                                                          CHN10026
      SAX(I)=0.                                                             CHN10027
      SIX(I)=0.                                                             CHN10028
      SZX(I)=0.                                                             CHN10029
      SAP(I)=0.                                                             CHN10030
      SIP(I)=0.                                                             CHN10031
      SZP(I)=0.                                                             CHN10032
      WT(I)=0.                                                              CHN10033
      BARKP(I)=0.                                                           CHN10034
   25 WP(I)=0.                                                              CHN10035
   15 CONTINUE                                                              CHN10036
      CN=N                                                                  CHN10037
```

```
      CM=M                                                              CHN10038
      N1=N+1                                                            CHN10039
      M1=M+1                                                            CHN10040
      NEXT =0                                                           CHN10041
      DO 20 I=1,N1                                                      CHN10042
      BARKX(I)=0.                                                       CHN10043
   20 WX(I)=0.                                                          CHN10044
      IF(IOPT-2) 336,337,338                                            CHN10045
  338 CALL EXIT                                                         CHN10046
  336 WRITE OUTPUT TAPE 6,7                                             CHN10047
    7 FORMAT (1H1 //20X,62H ** FINITE DIFFERENCE METHOD FOR LOCALIZED SHCHN10048
     1ELL VIBRATION ** ///)                                             CHN10049
      GO TO 328                                                         CHN10050
  337 WRITE OUTPUT TAPE 6,339,CORE,BARM                                 CHN10051
  339 FORMAT (1H1 //75H FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL   CHN10052
     1WITH      CORE THICKNESS =E14.5,22H AND RIGIDITY FACTOR =E14.5,//)CHN10053
  328 WRITE OUTPUT TAPE 6,300                                           CHN10054
  300 FORMAT (1H 35X,18H ** INPUT DATA ** //)                           CHN10055
      WRITE OUTPUT TAPE 6,310                                           CHN10056
  310 FORMAT(9X,1HA 13X,1HB 11X,4HPHIO 13X,2HNU 15X,1HE 11X,3HRHO 13X,  CHN10057
     1        1HH 13X,5HNMODE)                                          CHN10058
      WRITE OUTPUT TAPE 6,320,A,B,PHIO,PNU,E,RHO,H,NMODE                CHN10059
  320 FORMAT(7E15.5,8X,I2 //)                                           CHN10060
      READ INPUT TAPE 5,30,J1,K2,JWT                                    CHN10061
      READ INPUT TAPE 5,32,(SZX(I),I=1,J1),(SZP(I),I=1,K2)              CHN10062
      READ INPUT TAPE 5,32,(SIX(I),I=1,J1),(SIP(I),I=1,K2)              CHN10063
      READ INPUT TAPE 5,32,(SAX(I),I=1,J1),(SAP(I),I=1,K2)              CHN10064
   26 READ INPUT TAPE 5,31,J2,NEXT                                      CHN10065
      READ INPUT TAPE 5,32,SAX(J2),SAP(J2),SIX(J2),SIP(J2),SZX(J2),     CHN10066
     1      SZP(J2)                                                     CHN10067
      IF(NEXT-1) 26,52,26                                               CHN10068
   52 READ INPUT TAPE 5,30,I1,I2,NXT1                                   CHN10069
      READ INPUT TAPE 5,62,BARKX(I1),BARKX(I2)                          CHN10070
      IF(NXT1-1) 52,51,52                                               CHN10071
   51 READ INPUT TAPE 5,30,I3,I4,NXT2                                   CHN10072
      READ INPUT TAPE 5,62,BARKP(I3),BARKP(I4)                          CHN10073
      IF(NXT2-1) 51,53,51                                               CHN10074
   53 READ INPUT TAPE 5,30,I5,I6,NXT3                                   CHN10075
      READ INPUT TAPE 5,62,WX(I5),WX(I6)                                CHN10076
      IF(NXT3-1) 53,54,53                                               CHN10077
```

```
   54 READ INPUT TAPE 5,30,I7,I8,NXT4                               CHN10078
      READ INPUT TAPE 5,62,WP(I7),WP(I8)                            CHN10079
      IF(NXT4-1) 54,55,54                                           CHN10080
   55 READ INPUT TAPE 5,32,(WT(I),I=1,JWT)                          CHN10081
      WRITE OUTPUT TAPE 6,330                                       CHN10082
  330 FORMAT( 8H **AX** )                                           CHN10083
      WRITE OUTPUT TAPE 6,340,(SAX(I),I=1,NM)                       CHN10084
      WRITE OUTPUT TAPE 6,350                                       CHN10085
  350 FORMAT(// 9H **APHI** )                                       CHN10086
      WRITE OUTPUT TAPE 6,340,(SAP(I),I=1,NM)                       CHN10087
      WRITE OUTPUT TAPE 6,360                                       CHN10088
  360 FORMAT(// 9H ** ZX **)                                        CHN10089
      WRITE OUTPUT TAPE 6,340,(SZX(I),I=1,NM)                       CHN10090
      WRITE OUTPUT TAPE 6,370                                       CHN10091
  370 FORMAT(// 9H ** ZP **)                                        CHN10092
      WRITE OUTPUT TAPE 6,340,(SZP(I),I=1,NM)                       CHN10093
      WRITE OUTPUT TAPE 6,380                                       CHN10094
  380 FORMAT(// 9H ** IX **)                                        CHN10095
      WRITE OUTPUT TAPE 6,340,(SIX(I),I=1,NM)                       CHN10096
      WRITE OUTPUT TAPE 6,390                                       CHN10097
  390 FORMAT(// 9H ** IP **)                                        CHN10098
      WRITE OUTPUT TAPE 6,340,(SIP(I),I=1,NM)                       CHN10099
      WRITE OUTPUT TAPE 6,400                                       CHN10100
  400 FORMAT(// 9H ** WX **)                                        CHN10101
      WRITE OUTPUT TAPE 6,340,(WX(I),I=1,N1)                        CHN10102
      WRITE OUTPUT TAPE 6,410                                       CHN10103
  410 FORMAT(// 9H ** WP **)                                        CHN10104
      WRITE OUTPUT TAPE 6,340,(WP(I),I=1,NM)                        CHN10105
      WRITE OUTPUT TAPE 6,420                                       CHN10106
  420 FORMAT(// 9H ** WT **)                                        CHN10107
      WRITE OUTPUT TAPE 6,340,(WT(I),I=1,NM)                        CHN10108
      WRITE OUTPUT TAPE 6,430                                       CHN10109
  430 FORMAT(// 9H ** KX **)                                        CHN10110
      WRITE OUTPUT TAPE 6,340,(BARKX(I),I=1,N1)                     CHN10111
      WRITE OUTPUT TAPE 6,440                                       CHN10112
  440 FORMAT(// 9H ** KP **)                                        CHN10113
      WRITE OUTPUT TAPE 6,340,(BARKP(I),I=1,NM)                     CHN10114
  340 FORMAT(6E18.5)                                                CHN10115
   60 H2 =H*H                                                       CHN10116
      H3 =H2*H                                                      CHN10117
```

```
      PNU2 =PNU*PNU                                                     CHN10118
      IF(IOPT-2) 101,102,103                                            CHN10119
  103 CALL EXIT                                                         CHN10120
  101 D =E*H3/(12.*(1.-PNU2))                                           CHN10121
      GO TO 104                                                         CHN10122
  102 D =(E*H*(H+2.*CORE)**2)/(16.*(1.-PNU2))                           CHN10123
  104 DELX =0.5*B/CM                                                    CHN10124
      DELP =0.5*PHIO/CN                                                 CHN10125
      BLAM =A*DELP/DELX                                                 CHN10126
      SK =E*H/(1.-PNU2)                                                 CHN10127
      ADP =A*DELP                                                       CHN10128
      HADP =H*ADP                                                       CHN10129
      HDELX =H*DELX                                                     CHN10130
      EAP =E/ADP                                                        CHN10131
      EDX =E/DELX                                                       CHN10132
      DO 100 I=1,NM                                                     CHN10133
      SKX(I) =SK+E*SAX(I)/ADP                                           CHN10134
      CZX(I) =SAX(I)*SZX(I)/(SAX(I)+HADP)                               CHN10135
      FX(I) =EAP*(SIX(I)+SAX(I)*(SZX(I)-CZX(I))**2)                     CHN10136
      DBXP(I) =D+SK*CZX(I)*CZX(I)                                       CHN10137
      DBX(I) =FX(I)+DBXP(I)                                             CHN10138
      CZP(I) =SAP(I)*SZP(I)/(SAP(I)+HDELX)                              CHN10139
      FP(I) =EDX*(SIP(I)+SAP(I)*(SZP(I)-CZP(I))**2)                     CHN10140
      DPPR(I) =D+SK*CZP(I)*CZP(I)                                       CHN10141
      DP(I) =FP(I)+DPPR(I)                                              CHN10142
      SKP(I) =SK+EDX*SAP(I)                                             CHN10143
  100 CONTINUE                                                          CHN10144
      PNU5 =0.5*PNU                                                     CHN10145
      DNU =D*(1.-PNU)                                                   CHN10146
      PNUK =PNU2*SK*SK                                                  CHN10147
      AK =A*SK                                                          CHN10148
      PKN1 =(1.-PNU)*SK*SK                                              CHN10149
      PNUK1 =PNU*SK*SK                                                  CHN10150
      DO 110 J=1,NM                                                     CHN10151
      BIGH(J) =PNU5*(DBXP(J)+DPPR(J))+DNU                               CHN10152
      SKXP =SKX(J)*SKP(J)                                               CHN10153
      BIGP(J) =(SKXP-PNUK1)/PKN1                                        CHN10154
      BIGR(J) =(SKXP-PNUK)/AK                                           CHN10155
      ALFA(J) =PNU*DBXP(J)+2.*DNU                                       CHN10156
      BETA(J) =PNU*DPPR(J)+2.*DNU                                       CHN10157
```

```
  110 CONTINUE                                                          CHN10158
      RG =RHO*386.064                                                   CHN10159
      IF (IOPT-2) 112,113,114                                           CHN10160
  114 CALL EXIT                                                         CHN10161
  112 RGH =RG*H                                                         CHN10162
      GO TO 116                                                         CHN10163
  113 RGH =BARM*386.064                                                 CHN10164
  116 DXAP =RGH*DELX*ADP                                                CHN10165
C                                                                       CHN10166
C  FORMATION OF M1 AND M2 MATRIX                                        CHN10167
      DO 119 I =1,NM                                                    CHN10168
      DO 119 J =1,NM                                                    CHN10169
  119 AM1(I,J) =0.                                                      CHN10170
C                                                                       CHN10171
      DO 120 I=1,NM                                                     CHN10172
      IF(I-N1) 130,130,125                                              CHN10173
  125 AM1(I,I) =1.+(WT(I)+RG*(SAP(I)*ADP+SAX(I)*DELX))/DXAP             CHN10174
      GO TO 120                                                         CHN10175
  130 AM1(I,I) =1.                                                      CHN10176
  120 CONTINUE                                                          CHN10177
      K =1                                                              CHN10178
      DO 140 I=1,M1                                                     CHN10179
      AM1(K,K) =1.                                                      CHN10180
      K=K+N1                                                            CHN10181
  140 CONTINUE                                                          CHN10182
      READ INPUT TAPE 5,403,(IM1(IJ),IM2(IJ),IJ=1,6)                    CHN10183
      READ INPUT TAPE 5, 32,(AM3(K),K=1,6)                              CHN10184
  403 FORMAT (12I3)                                                     CHN10185
      DO 414 K =1,6                                                     CHN10186
      I=IM1(K)                                                          CHN10187
      J=IM2(K)                                                          CHN10188
  414 AM1(I,J) =AM3(K)                                                  CHN10189
C                                                                       CHN10190
C                                                                       CHN10191
      M2=2*(N+M+2)+1                                                    CHN10192
C                                                                       CHN10193
      DO 142 I=1,M2                                                     CHN10194
      DO 142 J=1,NM                                                     CHN10195
  142 AM2(I,J) =0.                                                      CHN10196
C                                                                       CHN10197
```

```
      BL3 =BLAM**3                                                    CHN10198
      ADP2 =ADP*ADP                                                   CHN10199
      APRG =ADP2*RGH                                                  CHN10200
      APRL =BLAM*(1.-PNU)*APRG                                        CHN10201
      RG5 =0.5*RG                                                     CHN10202
      RG4 =0.5*RG5                                                    CHN10203
C                                                                     CHN10204
      DO 150 I=2,N1                                                   CHN10205
  150 AM2(I,I)=-2.*(D/DBX(I))*((RG5*(SAP(I)*ADP+SAX(I)*DELX)+WX(I))/(BL3CHN10206
     1*APRG))                                                         CHN10207
      AM2(N+2,1) =2.*(RG4*(SAP(1)*ADP+SAX(1)*DELX)+WX(1))/APRL        CHN10208
      DO 146 K=2,M1                                                   CHN10209
      I =N1*(K-1)+1                                                   CHN10210
      L =2*N+3+K                                                      CHN10211
      AM2(L,I) =-2.*(D/DP(I))*(BLAM*(RG5*(SAX(I)*DELX+SAP(I)*ADP)+WP(I))CHN10212
     1  )/(ADP2*RGH)                                                  CHN10213
  146 CONTINUE                                                        CHN10214
      WRITE OUTPUT TAPE 6,122                                         CHN10215
  122 FORMAT (1H125HMASS 1 MATRIX - INTERNAL )                        CHN10216
      DO 121 I=1,NM                                                   CHN10217
      WRITE OUTPUT TAPE 6,470,I                                       CHN10218
  121 WRITE OUTPUT TAPE 6,340,(AM1(I,J),J=1,NM)                       CHN10219
      WRITE OUTPUT TAPE 6,126                                         CHN10220
  126 FORMAT(//26H MASS 2 MATRIX - BOUNDARY )                         CHN10221
      DO 152 I=1,M2                                                   CHN10222
      WRITE OUTPUT TAPE 6,470,I                                       CHN10223
  152 WRITE OUTPUT TAPE 6,340, (AM2(I,J),J=1,NM)                      CHN10224
C                                                                     CHN10225
C  TO MAKE A STORAGE TABLE FOR ELEMENTS USED IN MATRICES              CHN10226
C                                                                     CHN10227
      BL2 =BLAM*BLAM                                                  CHN10228
      BL4 =BL2*BL2                                                    CHN10229
      BLD4 =BL4/D                                                     CHN10230
      BLD2 =BL2/D                                                     CHN10231
      FAC14 =PNU/BL2                                                  CHN10232
      FAC19 =PNU*BL2                                                  CHN10233
      FAC21 =ADP2*BL2                                                 CHN10234
      ADBL2 =ADP2/BL2                                                 CHN10235
C                                                                     CHN10236
      JK=80                                                           CHN10237
```

```
C                                                                       CHN10238
      DO 165 I=1,NM                                                     CHN10239
      DO 165 J=1,JK                                                     CHN10240
  165 EL(I,J) =0.                                                       CHN10241
      ADBL2 =ADP2/BL2                                                   CHN10242
      DO 170 J=1,NM                                                     CHN10243
      EL(J,1) =1.                                                       CHN10244
      EL(J,2) =-4.*(BLD4*DBX(J)+BLD2*BIGH(J))                           CHN10245
      EL(J,3) =BLD4*DBX(J)                                              CHN10246
      EL(J,4) =-4.*(BLD2*BIGH(J)+DP(J)/D)                               CHN10247
      EL(J,5) =2.*BLD2*BIGH(J)                                          CHN10248
      EL(J,6) =DP(J)/D                                                  CHN10249
      EL(J,7) =2.*FAC21/(A*D)                                           CHN10250
      EL(J,8) =6.*BLD4*DBX(J)+8.*BLD2*BIGH(J)+6.*DP(J)/D                CHN10251
      EL(J,9) =-0.5*EL(1,7)                                             CHN10252
      EL(J,11) =ALFA(J)/(BL2*DBX(J))                                    CHN10253
      EL(J,12) =-2.*(1.+EL(J,11))                                       CHN10254
      EL(J,14) =FAC14*DBXP(J)/DBX(J)                                    CHN10255
      EL(J,15) =-2.*(1.+EL(J,14))                                       CHN10256
      EL(J,17) =BL2*BETA(J)/DP(J)                                       CHN10257
      EL(J,18) =-2.*(1.+EL(J,17))                                       CHN10258
      EL(J,19) =FAC19*DPPR(J)/DP(J)                                     CHN10259
      EL(J,20) =-2.*(1.+EL(J,19))                                       CHN10260
      EL(J,21) =-2.*FAC21*BIGR(J)                                       CHN10261
      EL(J,22) =-0.5*EL(J,21)                                           CHN10262
      EL(J,23) =6.*SKX(J)*BL4/SK+8.*BIGP(J)*BL2+6.*SKP(J)/SK            CHN10263
      EL(J,24) =-4.*BL2*(SKX(J)*BL2/SK+BIGP(J))                         CHN10264
      EL(J,25) =SKX(J)*BL4/SK                                           CHN10265
      EL(J,26) =-4.*(SKP(J)/SK+BIGP(J)*BL2)                             CHN10266
      EL(J,27) =2.*BIGP(J)*BL2                                          CHN10267
      EL(J,28) =SKP(J)/SK                                               CHN10268
      EL(J,29) =-2.                                                     CHN10269
      EL(J,30) =D*(1.-PNU)/A                                            CHN10270
      EL(J,31) =SK*ADBL2*BIGR(J)/SKX(J)                                 CHN10271
      EL(J,32) =-4.                                                     CHN10272
      EL(J,33) =-FAC14*SK/SKX(J)                                        CHN10273
      EL(J,34) =-(4.+EL(J,33))                                          CHN10274
      EL(J,35) =2.*EL(J,31)                                             CHN10275
      EL(J,36) =-EL(J,12)                                               CHN10276
      EL(J,37) =-EL(J,17)                                               CHN10277
```

```
      EL(J,38) =2.                                                      CHN10278
      EL(J,39) =2.*EL(J,2)                                              CHN10279
      EL(J,40) =2.*EL(J,3)                                              CHN10280
      EL(J,41) =2.*EL(J,4)                                              CHN10281
      EL(J,42) =2.*EL(J,5)                                              CHN10282
      EL(J,43) =2.*EL(J,6)                                              CHN10283
      EL(J,44) =EL(J,3)+EL(J,8)                                         CHN10284
      EL(J,45) =EL(J,6)+EL(J,8)                                         CHN10285
      EL(J,46) =EL(J,3)+EL(J,6)+EL(J,8)                                 CHN10286
      EL(J,47) =2.*EL(J,11)                                             CHN10287
      EL(J,48) =-EL(J,47)                                               CHN10288
      EL(J,49) =4.*EL(J,5)                                              CHN10289
      EL(J,50) =4.*EL(J,27)                                             CHN10290
      EL(J,51) =2.*EL(J,14)                                             CHN10291
      EL(J,52) =EL(J,25)+EL(J,23)                                       CHN10292
      EL(J,53) =EL(J,23)+EL(J,28)                                       CHN10293
      EL(J,54) =EL(J,17)*2.                                             CHN10294
      EL(J,55) =-EL(J,54)                                               CHN10295
      EL(J,56) =EL(J,23)+EL(J,25)+EL(J,28)                              CHN10296
      EL(J,57) =2.*EL(J,22)                                             CHN10297
      EL(J,58) =2.*EL(J,24)                                             CHN10298
      EL(J,59) =2.*EL(J,25)                                             CHN10299
      EL(J,60) =2.*EL(J,26)                                             CHN10300
      EL(J,61) =2.*EL(J,27)                                             CHN10301
      EL(J,62) =2.*EL(J,28)                                             CHN10302
      EL(J,63) =2.                                                      CHN10303
      EL(J,64) =-EL(1,30)                                               CHN10304
      EL(J,65) =2.*EL(1,9)                                              CHN10305
      EL(J,66) =-1.                                                     CHN10306
      EL(J,67) =-EL(J,11)                                               CHN10307
      EL(J,69) =-EL(J,18)                                               CHN10308
      EL(J,70) =2.*EL(J,19)                                             CHN10309
      EL(J,71) =4.                                                      CHN10310
  170 CONTINUE                                                          CHN10311
      EL(1,68) =+(BARKX(1)*ADP2)/(D*BLAM*(1.-PNU)*0.5)                  CHN10312
C                                                                       CHN10313
      DO 180 K=2,M1                                                     CHN10314
      I=(K-1)*(N+1)+1                                                   CHN10315
  180 EL(I,16) =-2.*BLAM*BARKP(I)*ADP2/DP(I)                            CHN10316
      DO 185 I=2,N1                                                     CHN10317
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  185 EL(I,10) =-2.*BARKX(I)*ADP2/(DBX(I)*BL3)                        CHN10318
      WRITE OUTPUT TAPE 6,450                                          CHN10319
  450 FORMAT(1H114H ** E TABLE **)                                     CHN10320
      DO 460 I=1,NM                                                    CHN10321
      WRITE OUTPUT TAPE 6,470,I                                        CHN10322
      WRITE OUTPUT TAPE 6,480,(EL(I,J),J=1,71)                         CHN10323
  460 CONTINUE                                                         CHN10324
  470 FORMAT(/9H ROW NO. I2)                                           CHN10325
  480 FORMAT(8E15.4)                                                   CHN10326
      CALL CHAIN (2,8)                                                 CHN10327
      END                                                              CHN10328
*     CHAIN (2,8)                                                      CHN2
C     CHAIN 2 - TRANSFER OF E TABLE TO PROPER LOCATION IN A MATRIX AND CHN20001
C     REDUCTION PERFORMED                                              CHN20002
C                                                                      CHN20003
      DIMENSION EL(24,80),TEMP1(34,24),EXTRA(34,24),A11(24,24),        CHN20004
     1   A12(24,21),A13(24,34),A22(21,21),A31(34,24),A32(34,21),       CHN20005
     2   A33(34,34),AA1(24,79),AA2(21,45),AA3(34,79),B1(34,1),NAC(60), CHN20006
     3   NEC(60),AM1(24,24),AM2(21,24),A21(21,24),IETBL(34),XEL(24,80), CHN20007
     4   XAM1(24,24),XAM2(21,24)                                       CHN20008
      EQUIVALENCE (AA1(1),A11(1)),(AA1(577),A12(1)),(AA1(1081),A13(1)), CHN20009
     1   (AA2(1),A21(1)),(AA2(505),A22(1)),(AA3(1),A31(1)),            CHN20010
     2   (AA3(817),A32(1)),(AA3(1531),A33(1))                          CHN20011
      EQUIVALENCE (XEL,EL),(NMODE,NMODX),(E,XEX),(RHO,XRHO),(H,XH),    CHN20012
     1   (D,XD),(ADP2,XADP2),(AM1,XAM1),(AM2,XAM2)                     CHN20013
      COMMON EL,NMODE,E,RHO,H,D,ADP2,AM1,AM2,BARM,IOPT,EXTRA,TEMP1     CHN20014
C                                                                      CHN20015
C     GENERATING A21(21*24) AND A22(21*21) MATRICES                    CHN20016
C                                                                      CHN20017
      NR=21                                                            CHN20018
      NC=45                                                            CHN20019
      DO 501 I=1,NR                                                    CHN20020
      DO 501 J=1,NC                                                    CHN20021
  501 A22(I,J) =0.                                                     CHN20022
  575 FORMAT(36I2)                                                     CHN20023
      READ INPUT TAPE 5,575,(IETBL(J),J=1,NR)                          CHN20024
      DO 511 J=1,NR                                                    CHN20025
      L3 =IETBL(J)                                                     CHN20026
  552 READ INPUT TAPE 5,535,NZRO,(NAC(I),NEC(I),I=1,NZRO)              CHN20027
      DO 510 K=1,NZRO                                                  CHN20028
```

```
      L1=NAC(K)                                                         CHN20029
      L2=NEC(K)                                                         CHN20030
      AA2(J,L1) =EL(L3,L2)                                              CHN20031
  510 CONTINUE                                                          CHN20032
  511 CONTINUE                                                          CHN20033
  509 WRITE OUTPUT TAPE 6,550                                           CHN20034
  550 FORMAT(1H1 16H** A21 MATRIX **//)                                 CHN20035
      DO 520 I=1,NR                                                     CHN20036
      WRITE OUTPUT TAPE 6,560,I                                         CHN20037
  520 WRITE OUTPUT TAPE 6,565,(A21(I,J),J=1,24)                         CHN20038
      WRITE OUTPUT TAPE 6,570                                           CHN20039
  560 FORMAT( 8H ** ROW I2,2H**)                                        CHN20040
  565 FORMAT(8E15.4)                                                    CHN20041
  570 FORMAT(1H1 16H** A22 MATRIX **//)                                 CHN20042
      DO 521 I=1,NR                                                     CHN20043
      WRITE OUTPUT TAPE 6,560,I                                         CHN20044
  521 WRITE OUTPUT TAPE 6,565,(A22(I,J),J=1,21)                         CHN20045
C                                                                       CHN20046
C  GENERATING A31(34*24),A32(34*21) AND A33(34*34) MATRICES             CHN20047
C                                                                       CHN20048
      WRITE OUTPUT TAPE 6,48                                            CHN20049
   48 FORMAT (1H116HCHECK M1 MATRIX //)                                 CHN20050
      DO 45 I=1,24                                                      CHN20051
      WRITE OUTPUT TAPE 6,46,I                                          CHN20052
   45 WRITE OUTPUT TAPE 6,47,(AM1(I,J),J=1,24)                          CHN20053
   46 FORMAT ( 8H ROW NO.I2)                                            CHN20054
   47 FORMAT (8E15.4)                                                   CHN20055
      WRITE OUTPUT TAPE 6,49                                            CHN20056
   49 FORMAT (1H116HCHECK M2 MATRIX //)                                 CHN20057
      DO 52 I=1,21                                                      CHN20058
      WRITE OUTPUT TAPE 6,46,I                                          CHN20059
   52 WRITE OUTPUT TAPE 6,47,(AM2(I,J),J=1,24)                          CHN20060
      NR=34                                                             CHN20061
      NC=79                                                             CHN20062
      DO 600 I=1,NR                                                     CHN20063
      DO 600 J=1,NC                                                     CHN20064
  600 AA3(I,J) =0.                                                      CHN20065
C                                                                       CHN20066
      READ INPUT TAPE 5,575,(IETBL(J),J=1,NR)                           CHN20067
C                                                                       CHN20068
```

```
      DO 610 J=1,NR                                                     CHN20069
      L3 =IETBL(J)                                                      CHN20070
      READ INPUT TAPE 5,535,NZRO,(NAC(I),NEC(I),I=1,NZRO)               CHN20071
      DO 610 K=1,NZRO                                                   CHN20072
      L1=NAC(K)                                                         CHN20073
      L2=NEC(K)                                                         CHN20074
      AA3(J,L1) =EL(L3,L2)                                              CHN20075
  610 CONTINUE                                                          CHN20076
C                                                                       CHN20077
  615 WRITE OUTPUT TAPE 6,630                                           CHN20078
  630 FORMAT(1H1 16H** A31 MATRIX **//)                                 CHN20079
      DO 640 I=1,34                                                     CHN20080
      WRITE OUTPUT TAPE 6,560,I                                         CHN20081
  640 WRITE OUTPUT TAPE 6,565,(A31(I,J),J=1,24)                         CHN20082
      WRITE OUTPUT TAPE 6,650                                           CHN20083
  650 FORMAT(1H1 16H** A32 MATRIX **//)                                 CHN20084
      DO 660 I=1,34                                                     CHN20085
      WRITE OUTPUT TAPE 6,560,I                                         CHN20086
  660 WRITE OUTPUT TAPE 6,565,(A32(I,J),J=1,21)                         CHN20087
      WRITE OUTPUT TAPE 6,670                                           CHN20088
  670 FORMAT(1H1 16H** A33 MATRIX **//)                                 CHN20089
      DO 680 I=1,34                                                     CHN20090
      WRITE OUTPUT TAPE 6,560,I                                         CHN20091
  680 WRITE OUTPUT TAPE 6,565,(A33(I,J),J=1,34)                         CHN20092
      DO 522 I=1,21                                                     CHN20093
  522 B1(I,1) =1.                                                       CHN20094
      CALL MXIV1 (A22,21,B1,1,DETER)                                    CHN20095
      WRITE OUTPUT TAPE 6,576,DETER                                     CHN20096
  576 FORMAT(///10X,14H DETERMINANT =E15.6)                             CHN20097
      CALL MLTMX4 (34,21,A32,21,21,A22,EXTRA,A32)                       CHN20098
  535 FORMAT(24I3)                                                      CHN20099
      CALL MLTMX1 (34,21,A32,21,24,A21,EXTRA,TEMP1)                     CHN20100
      DO 690 I=1,34                                                     CHN20101
  690 B1(I,1) =1.                                                       CHN20102
      CALL MXIV2 (A33,34,B1,1,DETR)                                     CHN20103
      WRITE OUTPUT TAPE 6,576,DETR                                      CHN20104
      DO 700 I=1,34                                                     CHN20105
      DO 700 J=1,24                                                     CHN20106
  700 TEMP1(I,J) =A31(I,J)-TEMP1(I,J)                                   CHN20107
      CALL MLTMX2 (34,34,A33,34,24,TEMP1,EXTRA,TEMP1)                   CHN20108
```

```
      CALL MLTMX3 (34,34,A33,34,21,A32,EXTRA,A32)                       CHN20109
      CALL MLTX11 (34,21,A32,21,24,AM2,EXTRA,A33)                       CHN20110
C                                                                       CHN20111
C                                                                       CHN20112
C                                                                       CHN20113
C  GENERATING A11(24*24),A12(24*21), AND A13(24*24) MATRIX              CHN20114
C                                                                       CHN20115
C                                                                       CHN20116
      NR=24                                                             CHN20117
      NC=79                                                             CHN20118
      DO 720 I=1,NR                                                     CHN20119
      DO 720 J=1,NC                                                     CHN20120
  720 AA1(I,J) =0.                                                      CHN20121
      READ INPUT TAPE 5,575,(IETBL(J),J=1,NR)                           CHN20122
      DO 730 J=1,NR                                                     CHN20123
      L3 =IETBL(J)                                                      CHN20124
C                                                                       CHN20125
      READ INPUT TAPE 5,535,NZRO,(NAC(I),NEC(I),I=1,NZRO)               CHN20126
      DO 730 K=1,NZRO                                                   CHN20127
      L1=NAC(K)                                                         CHN20128
      L2=NEC(K)                                                         CHN20129
      AA1(J,L1) =EL(L3,L2)                                              CHN20130
  730 CONTINUE                                                          CHN20131
      WRITE OUTPUT TAPE 6,740                                           CHN20132
  740 FORMAT(1H1 16H** A11 MATRIX **//)                                 CHN20133
      DO 741 I=1,NR                                                     CHN20134
      WRITE OUTPUT TAPE 6,745,I                                         CHN20135
  741 WRITE OUTPUT TAPE 6,750,(A11(I,J),J=1,24)                         CHN20136
  745 FORMAT(8H ** ROW I2,2H**)                                         CHN20137
  750 FORMAT(8E15.4)                                                    CHN20138
      WRITE OUTPUT TAPE 6,755                                           CHN20139
  755 FORMAT(1H1 16H** A12 MATRIX **//)                                 CHN20140
      DO 751 I=1,NR                                                     CHN20141
      WRITE OUTPUT TAPE 6,745,I                                         CHN20142
  751 WRITE OUTPUT TAPE 6,750,(A12(I,J),J=1,21)                         CHN20143
      WRITE OUTPUT TAPE 6,765                                           CHN20144
  765 FORMAT(1H1 16H** A13 MATRIX **//)                                 CHN20145
      DO 761 I=1,NR                                                     CHN20146
      WRITE OUTPUT TAPE 6,745,I                                         CHN20147
  761 WRITE OUTPUT TAPE 6,750,(A13(I,J),J=1,34)                         CHN20148
```

```
      CALL MLTMX5 (24,21,A12,21,21,A22,EXTRA,A12)                    CHN20149
      CALL MLTX12 (24,21,A12,21,24,A21,EXTRA,A31)                    CHN20150
      CALL MLTMX6 (24,34,A13,34,24,TEMP1,EXTRA,EL)                   CHN20151
      DO 772 I=1,24                                                  CHN20152
      DO 772 J=1,24                                                  CHN20153
  772 A11(I,J) =A11(I,J)-A31(I,J)-EL(I,J)                            CHN20154
C                                                                    CHN20155
      CALL MLTMX8 (24,21,A12,21,24,AM2,EXTRA,EL)                     CHN20156
      CALL MLTX10 (24,34,A13,34,24,A33,EXTRA,A13)                    CHN20157
      DO 773 I=1,24                                                  CHN20158
      DO 773 J=1,24                                                  CHN20159
      A31(I,J) =EL(I,J)-A13(I,J)                                     CHN20160
  775 A13(I,J) =AM1(I,J)-A31(I,J)                                    CHN20161
  773 CONTINUE                                                       CHN20162
      WRITE OUTPUT TAPE 6,54                                         CHN20163
   54 FORMAT (1H1 20HINTERMEDIATE PRINTS )                           CHN20164
      DO 56 I =1,24                                                  CHN20165
      WRITE OUTPUT TAPE 6,46,I                                       CHN20166
   56 WRITE OUTPUT TAPE 6,47,(A13(I,J),J=1,24)                       CHN20167
      DO 780 I=1,24                                                  CHN20168
  780 B1(I,1)=1.                                                     CHN20169
      CALL MXIV3 (A11,24,B1,1,DETR)                                  CHN20170
      WRITE OUTPUT TAPE 6,576,DETR                                   CHN20171
      WRITE OUTPUT TAPE 6,54                                         CHN20172
      DO 62 I=1,24                                                   CHN20173
      WRITE OUTPUT TAPE 6,46,I                                       CHN20174
   62 WRITE OUTPUT TAPE 6,47,(A11(I,J),J=1,24)                       CHN20175
      CALL MLTMX7 (24,24,A11,24,24,A13,EXTRA,EL)                     CHN20176
      WRITE OUTPUT TAPE 6,782                                        CHN20177
  782 FORMAT(1H1 13HFINAL MATRIX /)                                  CHN20178
      DO 785 I=1,24                                                  CHN20179
      WRITE OUTPUT TAPE 6,745,I                                      CHN20180
  785 WRITE OUTPUT TAPE 6,750,(EL(I,J),J=1,24)                       CHN20181
      DO 796 I=1,34                                                  CHN20182
      DO 796 J=1,24                                                  CHN20183
  796 EXTRA(I,J) =A33(I,J)                                           CHN20184
      CALL CHAIN (3,8)                                               CHN20185
      END                                                            CHN20186
      SUBROUTINE MLTX12 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                    MLTM
```

```
C      **FOR MULTIPLICATION OF REAL MATRICES                        MLTM
C        AB = A * B                                                 MLTM
       DIMENSION A(24,21),B(21,24),AB(34,24),ABF(34,24)             MAIN
C                                                                   MLTM
 10    DO 1 I=1,N1                                                  MLTM
       DO 1 J=1,M2                                                  MLTM
       AB(I,J)=0.                                                   MLTM
       DO 1 K=1,M1                                                  MLTM
       PRODCT=A(I,K)*B(K,J)                                         MLTM
  1    AB(I,J)=AB(I,J)+PRODCT                                       MLTM
       DO 2 I=1,N1                                                  MLTX
       DO 2 J=1,M2                                                  MLTX
  2    ABF(I,J)=AB(I,J)                                             MLTX
       RETURN                                                       MLTM
       END
       SUBROUTINE MLTX11 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                   MLTM
C      **FOR MULTIPLICATION OF REAL MATRICES                        MLTM
C        AB = A * B                                                 MLTM
       DIMENSION A(34,21),B(21,24),AB(34,24),ABF(34,34)             MAIN
C                                                                   MLTM
 10    DO 1 I=1,N1                                                  MLTM
       DO 1 J=1,M2                                                  MLTM
       AB(I,J)=0.                                                   MLTM
       DO 1 K=1,M1                                                  MLTM
       PRODCT=A(I,K)*B(K,J)                                         MLTM
  1    AB(I,J)=AB(I,J)+PRODCT                                       MLTM
       DO 2 I=1,N1                                                  MLTX
       DO 2 J=1,M2                                                  MLTX
  2    ABF(I,J)=AB(I,J)                                             MLTX
       RETURN                                                       MLTM
       END
       SUBROUTINE MLTX10 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                   MLTM
C      **FOR MULTIPLICATION OF REAL MATRICES                        MLTM
C        AB = A * B                                                 MLTM
       DIMENSION A(24,34),B(34,34),AB(34,24),ABF(24,34)
C                                                                   MLTM
 10    DO 1 I=1,N1                                                  MLTM
       DO 1 J=1,M2                                                  MLTM
```

```
      AB(I,J)=0.                                                        MLTM
      DO 1 K=1,M1                                                       MLTM
      PRODCT=A(I,K)*B(K,J)                                              MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                            MLTM
      DO 2 I=1,N1                                                       MLTX
      DO 2 J=1,M2                                                       MLTX
 2    ABF(I,J)=AB(I,J)                                                  MLTX
      RETURN                                                            MLTM
      END
      SUBROUTINE MLTMX8 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                       MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                             MLTM
C       AB = A * B                                                      MLTM
      DIMENSION A(24,21),B(21,24),AB(34,24),ABF(24,80)
C                                                                       MLTM
 10   DO 1 I=1,N1                                                       MLTM
      DO 1 J=1,M2                                                       MLTM
      AB(I,J)=0.                                                        MLTM
      DO 1 K=1,M1                                                       MLTM
      PRODCT=A(I,K)*B(K,J)                                              MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                            MLTM
      DO 2 I=1,N1                                                       MLTX
      DO 2 J=1,M2                                                       MLTX
 2    ABF(I,J)=AB(I,J)                                                  MLTX
      RETURN                                                            MLTM
      END
      SUBROUTINE MLTMX7 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                       MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                             MLTM
      DIMENSION A(24,24),B(24,34),AB(34,24),ABF(24,80)
C       AB = A * B                                                      MLTM
C                                                                       MLTM
 10   DO 1 I=1,N1                                                       MLTM
      DO 1 J=1,M2                                                       MLTM
      AB(I,J)=0.                                                        MLTM
      DO 1 K=1,M1                                                       MLTM
      PRODCT=A(I,K)*B(K,J)                                              MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                            MLTM
      DO 2 I=1,N1                                                       MLTX
      DO 2 J=1,M2                                                       MLTX
```

```
 2    ABF(I,J)=AB(I,J)                                          MLTX
      RETURN                                                    MLTM
      END
      SUBROUTINE MLTMX6 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                               MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                     MLTM
C       AB = A * B                                              MLTM
C                                                               MLTM
      DIMENSION A(24,34),B(34,24),AB(34,24),ABF(24,80)
 10   DO 1 I=1,N1                                               MLTM
      DO 1 J=1,M2                                               MLTM
      AB(I,J)=0.                                                MLTM
      DO 1 K=1,M1                                               MLTM
      PRODCT=A(I,K)*B(K,J)                                      MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                    MLTM
      DO 2 I=1,N1                                               MLTX
      DO 2 J=1,M2                                               MLTX
 2    ABF(I,J)=AB(I,J)                                          MLTX
      RETURN                                                    MLTM
      END
      SUBROUTINE MLTMX5 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                               MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                     MLTM
C       AB = A * B                                              MLTM
C                                                               MLTM
      DIMENSION A(24,21),B(21,21),AB(34,24),ABF(24,21)
 10   DO 1 I=1,N1                                               MLTM
      DO 1 J=1,M2                                               MLTM
      AB(I,J)=0.                                                MLTM
      DO 1 K=1,M1                                               MLTM
      PRODCT=A(I,K)*B(K,J)                                      MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                    MLTM
      DO 2 I=1,N1                                               MLTX
      DO 2 J=1,M2                                               MLTX
 2    ABF(I,J)=AB(I,J)                                          MLTX
      RETURN                                                    MLTM
      END
      SUBROUTINE MLTMX4 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                               MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                     MLTM
```

```
C        AB = A * B                                                   MLTM
C                                                                     MLTM
      DIMENSION A(34,21),B(21,21),AB(34,24),ABF(34,21)
 10   DO 1 I=1,N1                                                     MLTM
      DO 1 J=1,M2                                                     MLTM
      AB(I,J)=0.                                                      MLTM
      DO 1 K=1,M1                                                     MLTM
      PRODCT=A(I,K)*B(K,J)                                            MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                          MLTM
      DO 2 I=1,N1                                                     MLTX
      DO 2 J=1,M2                                                     MLTX
 2    ABF(I,J)=AB(I,J)                                                MLTX
      RETURN                                                          MLTM
      END
      SUBROUTINE MLTMX3 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                     MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                           MLTM
C        AB = A * B                                                   MLTM
C                                                                     MLTM
      DIMENSION A(34,34),B(34,21),AB(34,24),ABF(34,21)                MAIN
 10   DO 1 I=1,N1                                                     MLTM
      DO 1 J=1,M2                                                     MLTM
      AB(I,J)=0.                                                      MLTM
      DO 1 K=1,M1                                                     MLTM
      PRODCT=A(I,K)*B(K,J)                                            MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                          MLTM
      DO 2 I=1,N1                                                     MLTX
      DO 2 J=1,M2                                                     MLTX
 2    ABF(I,J)=AB(I,J)                                                MLTX
      RETURN                                                          MLTM
      END
      SUBROUTINE MLTMX2 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                     MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                           MLTM
C        AB = A * B                                                   MLTM
C                                                                     MLTM
      DIMENSION A(34,34),B(34,24),AB(34,24),ABF(34,24)
 10   DO 1 I=1,N1                                                     MLTM
      DO 1 J=1,M2                                                     MLTM
      AB(I,J)=0.                                                      MLTM
```

```
      DO 1 K=1,M1                                                       MLTM
      PRODCT=A(I,K)*B(K,J)                                              MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                            MLTM
      DO 2 I=1,N1                                                       MLTX
      DO 2 J=1,M2                                                       MLTX
 2    ABF(I,J)=AB(I,J)                                                  MLTX
      RETURN                                                            MLTM
      END
      SUBROUTINE MLTMX1 (N1,M1,A,N2,M2,B,AB,ABF)
C                                                                       MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                             MLTM
C       AB = A * B                                                      MLTM
      DIMENSION A(34,21),B(21,24),AB(34,24),ABF(34,24)
C                                                                       MLTM
 10   DO 1 I=1,N1                                                       MLTM
      DO 1 J=1,M2                                                       MLTM
      AB(I,J)=0.                                                        MLTM
      DO 1 K=1,M1                                                       MLTM
      PRODCT=A(I,K)*B(K,J)                                              MLTM
 1    AB(I,J)=AB(I,J)+PRODCT                                            MLTM
      DO 2 I=1,N1                                                       MLTX
      DO 2 J=1,M2                                                       MLTX
 2    ABF(I,J)=AB(I,J)                                                  MLTX
      RETURN                                                            MLTM
      END
```

```
      SUBROUTINE MXIV1 (A,N,B,M,DETERM)
C     MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS   ANF40201
      DIMENSION IPIVOT(21),A(21,21),B(21,1),INDEX(21,2),PIVOT(21)
      EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)         F4020007
C                                                                       F4020008
C     INITIALIZATION                                                    F4020009
C                                                                       F4020010
   10 DETERM=1.0                                                        F4020011
   15 DO 20 J=1,N                                                       F4020012
   20 IPIVOT(J)=0                                                       F4020013
   30 DO 550 I=1,N                                                      F4020014
C                                                                       F4020015
C     SEARCH FOR PIVOT ELEMENT                                          F4020016
C                                                                       F4020017
   40 AMAX=0.0                                                          F4020018
   45 DO 105 J=1,N                                                      F4020019
   50 IF (IPIVOT(J)-1) 60, 105, 60                                      F4020020
   60 DO 100 K=1,N                                                      F4020021
   70 IF (IPIVOT(K)-1) 80, 100, 740                                     F4020022
   80 IF (ABSF(AMAX)-ABSF(A(J,K))) 85, 100, 100                         F4020023
   85 IROW=J                                                            F4020024
   90 ICOLUM=K                                                          F4020025
   95 AMAX=A(J,K)                                                       F4020026
  100 CONTINUE                                                          F4020027
  105 CONTINUE                                                          F4020028
  110 IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1                                   F4020029
C                                                                       F4020030
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL                 F4020031
C                                                                       F4020032
  130 IF (IROW-ICOLUM) 140, 260, 140                                    F4020033
  140 DETERM=-DETERM                                                    F4020034
  150 DO 200 L=1,N                                                      F4020035
  160 SWAP=A(IROW,L)                                                    F4020036
  170 A(IROW,L)=A(ICOLUM,L)                                             F4020037
  200 A(ICOLUM,L)=SWAP                                                  F4020038
  205 IF(M) 260, 260, 210                                               F4020039
  210 DO 250 L=1, M                                                     F4020040
  220 SWAP=B(IROW,L)                                                    F4020041
  230 B(IROW,L)=B(ICOLUM,L)                                             F4020042
  250 B(ICOLUM,L)=SWAP                                                  F4020043
```

```
  260 INDEX(I,1)=IROW                                          F4020044
  270 INDEX(I,2)=ICOLUM                                        F4020045
  310 PIVOT(I)=A(ICOLUM,ICOLUM)                                F4020046
  320 DETERM=DETERM*PIVOT(I)                                   F4020047
C                                                              F4020048
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT                        F4020049
C                                                              F4020050
  330 A(ICOLUM,ICOLUM)=1.0                                     F4020051
  340 DO 350 L=1,N                                             F4020052
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)                         F4020053
  355 IF(M) 380, 380, 360                                      F4020054
  360 DO 370 L=1,M                                             F4020055
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT(I)                         F4020056
C                                                              F4020057
C     REDUCE NON-PIVOT ROWS                                    F4020058
C                                                              F4020059
  380 DO 550 L1=1,N                                            F4020060
  390 IF(L1-ICOLUM) 400, 550, 400                              F4020061
  400 T=A(L1,ICOLUM)                                           F4020062
  420 A(L1,ICOLUM)=0.0                                         F4020063
  430 DO 450 L=1,N                                             F4020064
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T                            F4020065
  455 IF(M) 550, 550, 460                                      F4020066
  460 DO 500 L=1,M                                             F4020067
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T                            F4020068
  550 CONTINUE                                                 F4020069
C                                                              F4020070
C     INTERCHANGE COLUMNS                                      F4020071
C                                                              F4020072
  600 DO 710 I=1,N                                             F4020073
  610 L=N+1-I                                                  F4020074
  620 IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630                 F4020075
  630 JROW=INDEX(L,1)                                          F4020076
  640 JCOLUM=INDEX(L,2)                                        F4020077
  650 DO 705 K=1,N                                             F4020078
  660 SWAP=A(K,JROW)                                           F4020079
  670 A(K,JROW)=A(K,JCOLUM)                                    F4020080
  700 A(K,JCOLUM)=SWAP                                         F4020081
  705 CONTINUE                                                 F4020082
  710 CONTINUE                                                 F4020083
```

```
  740 RETURN                                                            F4020084
  750 END (2,2,2,2,0)                                                   F4020085
      SUBROUTINE MXIV2 (A,N,B,M,DETERM)
      DIMENSION IPIVOT(34),A(34,34),B(34,1),INDEX(34,2),PIVOT(34)
C     MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS  ANF40201
      EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)        F4020007
C                                                                       F4020008
C     INITIALIZATION                                                    F4020009
C                                                                       F4020010
   10 DETERM=1.0                                                        F4020011
   15 DO 20 J=1,N                                                       F4020012
   20 IPIVOT(J)=0                                                       F4020013
   30 DO 550 I=1,N                                                      F4020014
C                                                                       F4020015
C     SEARCH FOR PIVOT ELEMENT                                          F4020016
C                                                                       F4020017
   40 AMAX=0.0                                                          F4020018
   45 DO 105 J=1,N                                                      F4020019
   50 IF (IPIVOT(J)-1) 60, 105, 60                                      F4020020
   60 DO 100 K=1,N                                                      F4020021
   70 IF (IPIVOT(K)-1) 80, 100, 740                                     F4020022
   80 IF (ABSF(AMAX)-ABSF(A(J,K))) 85, 100, 100                         F4020023
   85 IROW=J                                                            F4020024
   90 ICOLUM=K                                                          F4020025
   95 AMAX=A(J,K)                                                       F4020026
  100 CONTINUE                                                          F4020027
  105 CONTINUE                                                          F4020028
  110 IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1                                   F4020029
C                                                                       F4020030
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL                 F4020031
C                                                                       F4020032
  130 IF (IROW-ICOLUM) 140, 260, 140                                    F4020033
  140 DETERM=-DETERM                                                    F4020034
  150 DO 200 L=1,N                                                      F4020035
  160 SWAP=A(IROW,L)                                                    F4020036
  170 A(IROW,L)=A(ICOLUM,L)                                             F4020037
  200 A(ICOLUM,L)=SWAP                                                  F4020038
  205 IF(M) 260, 260, 210                                               F4020039
  210 DO 250 L=1, M                                                     F4020040
  220 SWAP=B(IROW,L)                                                    F4020041
```

```
  230 B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
  260 INDEX(I,1)=IROW
  270 INDEX(I,2)=ICOLUM
  310 PIVOT(I)=A(ICOLUM,ICOLUM)
  320 DETERM=DETERM*PIVOT(I)
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  330 A(ICOLUM,ICOLUM)=1.0
  340 DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
  355 IF(M) 380, 380, 360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT(I)
C
C     REDUCE NON-PIVOT ROWS
C
  380 DO 550 L1=1,N
  390 IF(L1-ICOLUM) 400, 550, 400
  400 T=A(L1,ICOLUM)
  420 A(L1,ICOLUM)=0.0
  430 DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
  455 IF(M) 550, 550, 460
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C
C     INTERCHANGE COLUMNS
C
  600 DO 710 I=1,N
  610 L=N+1-I
  620 IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630
  630 JROW=INDEX(L,1)
  640 JCOLUM=INDEX(L,2)
  650 DO 705 K=1,N
  660 SWAP=A(K,JROW)
  670 A(K,JROW)=A(K,JCOLUM)
  700 A(K,JCOLUM)=SWAP
```

```
  705 CONTINUE                                                          F4020082
  710 CONTINUE                                                          F4020083
  740 RETURN                                                            F4020084
  750 END (2,2,2,2,0)                                                   F4020085
      SUBROUTINE MXIV3 (A,N,B,M,DETERM)
C     MATRIX INVERSION WITH ACCOMPANYING SOLUTION OF LINEAR EQUATIONS   ANF40201
      DIMENSION IPIVOT(24),A(24,24),B(24,1),INDEX(24,2),PIVOT(24)
      EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)         F4020007
C                                                                       F4020008
C     INITIALIZATION                                                    F4020009
C                                                                       F4020010
   10 DETERM=1.0                                                        F4020011
   15 DO 20 J=1,N                                                       F4020012
   20 IPIVOT(J)=0                                                       F4020013
   30 DO 550 I=1,N                                                      F4020014
C                                                                       F4020015
C     SEARCH FOR PIVOT ELEMENT                                          F4020016
C                                                                       F4020017
   40 AMAX=0.0                                                          F4020018
   45 DO 105 J=1,N                                                      F4020019
   50 IF (IPIVOT(J)-1) 60, 105, 60                                      F4020020
   60 DO 100 K=1,N                                                      F4020021
   70 IF (IPIVOT(K)-1) 80, 100, 740                                     F4020022
   80 IF (ABSF(AMAX)-ABSF(A(J,K))) 85, 100, 100                         F4020023
   85 IROW=J                                                            F4020024
   90 ICOLUM=K                                                          F4020025
   95 AMAX=A(J,K)                                                       F4020026
  100 CONTINUE                                                          F4020027
  105 CONTINUE                                                          F4020028
  110 IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1                                   F4020029
C                                                                       F4020030
C     INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL                 F4020031
C                                                                       F4020032
  130 IF (IROW-ICOLUM) 140, 260, 140                                    F4020033
  140 DETERM=-DETERM                                                    F4020034
  150 DO 200 L=1,N                                                      F4020035
  160 SWAP=A(IROW,L)                                                    F4020036
  170 A(IROW,L)=A(ICOLUM,L)                                             F4020037
  200 A(ICOLUM,L)=SWAP                                                  F4020038
  205 IF(M) 260, 260, 210                                               F4020039
```

```
  210 DO 250 L=1, M
  220 SWAP=B(IROW,L)
  230 B(IROW,L)=B(ICOLUM,L)
  250 B(ICOLUM,L)=SWAP
  260 INDEX(I,1)=IROW
  270 INDEX(I,2)=ICOLUM
  310 PIVOT(I)=A(ICOLUM,ICOLUM)
  320 DETERM=DETERM*PIVOT(I)
C
C     DIVIDE PIVOT ROW BY PIVOT ELEMENT
C
  330 A(ICOLUM,ICOLUM)=1.0
  340 DO 350 L=1,N
  350 A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
  355 IF(M) 380, 380, 360
  360 DO 370 L=1,M
  370 B(ICOLUM,L)=B(ICOLUM,L)/PIVOT(I)
C
C     REDUCE NON-PIVOT ROWS
C
  380 DO 550 L1=1,N
  390 IF(L1-ICOLUM) 400, 550, 400
  400 T=A(L1,ICOLUM)
  420 A(L1,ICOLUM)=0.0
  430 DO 450 L=1,N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
  455 IF(M) 550, 550, 460
  460 DO 500 L=1,M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C
C     INTERCHANGE COLUMNS
C
  600 DO 710 I=1,N
  610 L=N+1-I
  620 IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630
  630 JROW=INDEX(L,1)
  640 JCOLUM=INDEX(L,2)
  650 DO 705 K=1,N
  660 SWAP=A(K,JROW)
```

```
  670 A(K,JROW)=A(K,JCOLUM)                                              F4020080
  700 A(K,JCOLUM)=SWAP                                                   F4020081
  705 CONTINUE                                                           F4020082
  710 CONTINUE                                                           F4020083
  740 RETURN                                                             F4020084
  750 END (2,2,2,2,0)                                                    F4020085
*     CHAIN (3,8)                                                        CHN3
C                                                                        CHN30001
      DIMENSION GUESS(24,2),VECTOR(24,20),EIGVAL(20),NITER(10),          CHN30002
     1   US(24,28),HH(24,50),NAKSR(10),NAKDR(10),FREQ(10),EL(24,80),     CHN30003
     2   AM1(24,24),AM2(21,24),TEMP1(34,24),A33(34,24),STRESS(34),       CHN30004
     3   XEL(24,80),XAM2(21,24),XAM1(24,24),AMT(24,96),TEMP2(34,24)      CHN30005
      COMMON EL,NMODE,E,RHO,H,D,ADP2,AM1,AM2,BARM,IOPT,A33,TEMP1         CHN30006
      EQUIVALENCE (EL(1),XEL(1)),(NMODE,NMODX),(E,XEX),(RHO,XRHO),       CHN30007
     1   (H,XH),(D,XD),(ADP2,XADP2),(AM1,XAM1),(AM2,XAM2),(BARM,XBAM),   CHN30008
     2   (IOPT,IXPT)                                                     CHN30009
C                                                                        CHN30010
      DO 12 I=1,24                                                       CHN30011
      DO 12 J=2,48,2                                                     CHN30012
   12 AMT(I,J) =0.                                                       CHN30013
      DO 14 I=1,24                                                       CHN30014
      K=1                                                                CHN30015
      DO 14 J=1,47,2                                                     CHN30016
      AMT(I,J) =EL(I,K)                                                  CHN30017
   14 K=K+1                                                              CHN30018
      NM=24                                                              CHN30019
      NC=2                                                               CHN30020
      AITKEN=0.0                                                         CHN30021
      NITRDP=350                                                         CHN30022
      NITRSP=50                                                          CHN30023
      EPSP=0.                                                            CHN30024
      EPDP=0.                                                            CHN30025
      MAXR=24                                                            CHN30026
      NTAPE=4                                                            CHN30027
      WRITE OUTPUT TAPE 6,57                                             CHN30028
   57 FORMAT (1H1)                                                       CHN30029
      CALL MITERS (AMT,NTAPE,NM,GUESS,0,NMODE,VECTOR,EIGVAL,NITER,       CHN30030
     1      NITRSP,NITRDP,EPSP,EPDP,IR,US,HH,MAXR,NC,AITKEN,NAKSR,       CHN30031
     2      NAKDR,6)                                                     CHN30032
C                                                                        CHN30033
```

```
      PI=3.1415927                                          CHN30034
      SMAS=RHO*H                                            CHN30035
      IF(IOPT-2) 32,33,34                                   CHN30036
   34 CALL EXIT                                             CHN30037
   32 CONV=D/(ADP2*ADP2*SMAS)                               CHN30038
      GO TO 35                                              CHN30039
   33 CONV=D/(ADP2*ADP2*BARM)                               CHN30040
   35 IF(NC-2) 1261,1265,1261                               CHN30041
 1265 NMODE =NMODE*2                                        CHN30042
 1261 DO 1234 I=1,NMODE                                     CHN30043
      EIGVAL(I) =1./EIGVAL(I)                               CHN30044
      FREQ(I)=SQRTF(ABSF(EIGVAL(I))*CONV)/(2.*PI)           CHN30045
 1234 CONTINUE                                              CHN30046
      WRITE OUTPUT TAPE 6,1235                              CHN30047
 1235 FORMAT(1H0,21H**FREQUENCY IN CPS** /)                 CHN30048
      WRITE OUTPUT TAPE 6,1236,(FREQ(I),I=1,NMODE)          CHN30049
 1236 FORMAT(5X,5E18.6)                                     CHN30050
C                                                           CHN30051
      WRITE OUTPUT TAPE 6,1246                              CHN30052
 1246 FORMAT (////32H VALUES OF STRESS FUNCTIONS ARE //)    CHN30053
      DO 1242 K=1,NMODE                                     CHN30054
      IF(EIGVAL(K)-0.1E-20) 1242,1242,1240                  CHN30055
 1240 WRITE OUTPUT TAPE 6,1245,K,EIGVAL(K)                  CHN30056
      DO 1241 I=1,34                                        CHN30057
      DO 1241 J=1,24                                        CHN30058
 1241 TEMP2(I,J) =-(TEMP1(I,J)+EIGVAL(K)*A33(I,J))          CHN30059
      CALL MLTX15 (34,24,TEMP2,24,1,VECTOR,K,STRESS)        CHN30060
      WRITE OUTPUT TAPE 6,1243,(STRESS(IS),IS=1,34)         CHN30061
 1242 CONTINUE                                              CHN30062
 1245 FORMAT (9H FOR NO. I2,1H,3X,14HEIGENVALUE OF E15.6)   CHN30063
 1243 FORMAT(6E18.6)                                        CHN30064
      CALL EXIT                                             CHN30065
      END                                                   CHN30066
      SUBROUTINE MLTX15 (N1,M1,A, N2,M2,B,KL,ABF)           MX15
C                                                           MLTM
C     **FOR MULTIPLICATION OF REAL MATRICES                 MLTM
C       AB = A * B                                          MLTM
      DIMENSION A(34,24),B(24,20),AB(34,2),ABF(34)          MX15
C                                                           MLTM
      J=KL                                                  MX15
```

```
10    DO 1 I=1,N1                                                            MLTM
      AB(I,1)=0.                                                             MX15
      DO 1 K=1,M1                                                            MLTM
      PRODCT=A(I,K)*B(K,J)                                                   MLTM
    1 AB(I,1)=AB(I,1)+PRODCT                                                 MX15
      DO 2 I=1,N1                                                            MLTX
    2 ABF(I)=AB(I,1)                                                         MX15
      RETURN                                                                 MLTM
      END
*      DATA
+13       +03+36     +02+7854   -00+3      -00+103    +08+2588   -03      0001
+5        -01+9      -00+1712   -04  6   4   5  2                         0002
  1  6 12                                                                 0003
+0        +00+0      +00+0      +00+0      +00+0      +00+0      +00      0004
+0        +00                                                             0005
+1286     +00+1286   +00+1286   +00+1286   +00+1286   +00+1286   +00      0006
+1286     +00                                                             0007
+906      +00+906    +00+906    +00+906    +00+906    +00+906    +00      0008
+906      +00                                                             0009
  7  0                                                                    0010
+906      +00+0      +00+1286   +00+0      +00+0      +00+0      +00      0011
 13  0                                                                    0012
+906      +00+0      +00+1286   +00+0      +00+0      +00+0      +00      0013
 19  1                                                                    0014
+906      +00+0      +00+1286   +00+0      +00+0      +00+0      +00      0015
  1  1  1                                                                  18A
+00       -00+00     -00                                                   18B
  7 19  1                                                                  19A
+627      +04+627    +04                                                   19B
  2  3  1                                                                  20A
+176      +02+176    +02                                                   20B
  7 19  1                                                                  21A
+235      +02+235    +02                                                   21B
+0        +00+0      +00+0      +00+0      +00+0      +00+0      +00WT    0001
+0        +00+0      +00+106    +02+0      +00+156    +01+125    +02WT000002
  9 11  9 12 11  9 11 12 12  9 12 11                                 MASS0001
+84       +01+168    +02+84     +01+77     +01+336    +02+154    +02MASS0001
 1 2 3 4 5 6 1 1 2 3 4 5 6 1 71319 1 71319                           AA30002A
  8  7 36  8 67 13 66 25  1 31 11 32 12 33 11 41 67                   A2001A
  9  2 10  7 67  8 36  9 67 14 66 26  1 32 11 33 12 34 11             A2002A
```

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 9  3 10  8 67  9 36 10 67 15 66 27  1 33 11 34 12 35 11          A2003A
 9  4 10  9 67 10 36 11 67 16 66 28  1 34 11 35 12 36 11          A2004A
 9  5 10 10 67 11 36 12 67 17 66 29  1 35 11 36 12 37 11          A2005A
 7  6 10 11 48 12 36 18 66 30  1 36 47 37 12                      A2006A
 5  1 13  8  1 31  1 33 66 41 66                                  A2007A
 5  1 15  2 14  7  1 32  1 39 14                                  A2008A
 5  1 14  2 15  3 14  8  1 33  1                                  A2009A
 5  2 14  3 15  4 14  9  1 34  1                                  A2010A
 5  3 14  4 15  5 14 10  1 35  1                                  A2011A
 5  4 14  5 15  6 14 11  1 36  1                                  A2012A
 4  5 51  6 15 12  1 37  1                                        A2013A
 8  2 69  3 66  8 37 31 17 33 37 38  1 39 18 41 17                A2014A
 9  2 37  7 16  8 69  9 66 14 37 39 17 40  1 41 18 43 17          A2016A
 9  8 37 13 16 14 69 15 66 20 37 41 17 42  1 43 18 45 17          A2018A
 7 14 55 19 16 20 69 21 66 43 54 44  1 45 18                      A2020A
 [illegible] [illegible] 20 [illegible] 1 [illegible] 19 32 19 39  1   A2015A
 5  1 19  7 20  8  1 13 19 41  1                                  A2017A
 5  7 19 13 20 14  1 19 19 43  1                                  A2019A
 4 13 70 19 20 20  1 45  1                                        A2021A
8 910111214151617182021222324 2 3 4 5 624 1 2 3 4 5 6 71319 1 71319   AA30001A
16  2 22  8 21 14 22 46 27 47 24 48 27 52 26 53 23 54 26 55 28 58 27 59  A3001A
24 60 27 65 25 71 25 77 28                                        A3001B
16  3 22  9 21 15 22 47 27 48 24 49 27 52 28 53 26 54 23 55 26 56 28 59  A3002A
27 60 24 61 27 66 25 72 25                                        A3002B
16  4 22 10 21 16 22 48 27 49 24 50 27 53 28 54 26 55 23 56 26 57 28 60  A3003A
27 61 24 62 27 67 25 73 25                                        A3003B
15  5 22 11 21 17 22 49 27 50 24 51 27 54 28 55 26 56 53 57 26 61 27 62  A3004A
24 63 27 68 25 74 25                                              A3004B
12  6 22 12 21 18 22 50 61 51 24 55 62 56 60 57 23 62 61 63 24 69 25 75  A3005A
25                                                                A3005B
15  8 22 14 21 20 22 47 25 52 27 53 24 54 27 58 26 59 52 60 26 61 28 64  A3006A
27 65 24 66 27 78 28                                              A3006B
15  9 22 15 21 21 22 48 25 53 27 54 24 55 27 58 28 59 26 60 52 61 26 62  A3007A
28 65 27 66 24 67 27                                              A3007B
15 10 22 16 21 22 22 49 25 54 27 55 24 56 27 59 28 60 26 61 52 62 26 63  A3008A
28 66 27 67 24 68 27                                              A3008B
14 11 22 17 21 23 22 50 25 55 27 56 24 57 27 60 28 61 26 62 56 63 26 67  A3009A
27 68 24 69 27                                                    A3009B
11 12 22 18 21 24 22 51 25 56 61 57 24 61 62 62 60 63 52 68 61 69 24     A3010A
11 14 57 20 21 53 59 58 61 59 58 60 61 64 26 65 23 66 26 67 28 79 28     A3011A
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11 15 57 21 21 54 59 59 61 60 58 61 61 64 28 65 26 66 23 67 26 68 28        A3012A
11 16 57 22 21 55 59 60 61 61 58 62 61 65 28 66 26 67 23 68 26 69 28        A3013A
10 17 57 23 21 56 59 61 61 62 58 63 61 66 28 67 26 68 53 69 26              A3014A
 8 18 57 24 21 57 59 62 50 63 58 67 62 68 60 69 23                          A3015A
 8  7 64  9 30 32 30 34 64 52 66 54  1 70  1 72 66                          A3023A
 8  8 64 10 30 33 30 35 64 53 66 55  1 71  1 73 66                          A3024A
 8  9 64 11 30 34 30 36 64 54 66 56  1 72  1 74 66                          A3025A
 8 10 64 12 30 35 30 37 64 55 66 57  1 73  1 75 66                          A3026A
 8 11 64 12 30 36 30 37 64 56 66 57  1 74  1 75 66                          A3027A
 1 69  1                                                                    A3034A
 3 46 29 47  1 76  1                                                        A3028A
 3 46  1 47 29 48  1                                                        A3029A
 3 47  1 48 29 49  1                                                        A3030A
 3 48  1 49 29 50  1                                                        A3031A
 3 49  1 50 29 51  1                                                        A3032A
 2 50 38 51 29                                                              A3033A
 4 47 66 59  1 76  1 78 66                                                  A3016A
 4 53 66 65  1 77  1 79 66                                                  A3017A
 4 59 66 65  1 78  1 79 66                                                  A3018A
 3 46 29 52  1 70  1                                                        A3019A
25  7 31  8 35  9 35 10 35 11 35 12 31 46  1 47 63 48 63 49 63 50 63 51     A3021A
 1 52 29 53 34 54 32 55 32 56 32 57 29 58  1 59 63 60 63 61 63 62 63 63     A3021B
 1 77 33                                                                    A3021C
 3 52  1 58 29 64  1                                                        A3020A
19 19 31 20 35 21 35 22 35 23 35 24 31 58 38 59 71 60 71 61 71 62 71 63     A3022A
38 64 29 65 34 66 32 67 32 68 32 69 29 79 33                                A3022B
1 2 3 4 5 6 7 8 9101112131415161718192021222324                           AA10003A
16  1  8  2  4  3  6  7  2  8  5 13  3 25  3 31  5 32  2 33  5 38  6 39     A1001A
 4 41  5 46  7 52  9 70  9                                                  A1001B
16  1  4  2  8  3  4  4  6  7  5  8  2  9  5 14  3 26  3 32  5 33  2 34     A1002A
 5 39  6 47  7 53  9 71  9                                                  A1002B
16  1  6  2  4  3  8  4  4  5  6  8  5  9  2 10  5 15  3 27  3 33  5 34     A1003A
 2 35  5 48  7 54  9 72  9                                                  A1003B
16  2  6  3  4  4  8  5  4  6  6  9  5 10  2 11  5 16  3 28  3 34  5 35     A1004A
 2 36  5 49  7 55  9 73  9                                                  A1004B
15  3  6  4  4  5 45  6  4 10  5 11  2 12  5 17  3 29  3 35  5 36  2 37     A1005A
 5 50  7 56  9 74  9                                                        A1005B
12  4 43  5 41  6  8 11 42 12  2 18  3 30  3 36 42 37  2 51  7 57  9 75     A1006A
 9                                                                          A1006B
16  1  2  2  5  7  8  8  4  9  6 13  2 14  5 19  3 32  3 39  5 40  6 41     A1007A
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 4 43  5 46  9 52  7 58  9                                                   A1007B
16  1  5  2  2  3  5  7  4  8  8  9  4 10  6 13  5 14  2 15  5 20  3 33      A1008A
 3 41  6 47  9 53  7 59  9                                                   A1008B
16  2  5  3  2  4  5  7  6  8  4  9  8 10  4 11  6 14  5 15  2 16  5 21      A1009A
 3 34  3 48  9 54  7 60  9                                                   A1009B
16  3  5  4  2  5  5  8  6  9  4 10  8 11  4 12  6 15  5 16  2 17  5 22      A1010A
 3 35  3 49  9 55  7 61  9                                                   A1010B
15  4  5  5  2  6  5  9  6 10  4 11 45 12  4 16  5 17  2 18  5 23  3 36      A1011A
 3 50  9 56  7 62  9                                                         A1011B
12  5 42  6  2 10 43 11 41 12  8 17 42 18  2 24  3 37  3 51  9 57  7 63      A1012A
 9                                                                           A1012B
15  1  3  7  2  8  5 13 44 14  4 15  6 19  2 20  5 41  5 42  6 43  4 45      A1013A
 5 52  9 58  7 64  9                                                         A1013B
15  2  3  7  5  8  2  9  5 13  4 14 44 15  4 16  6 19  5 20  2 21  5 43      A1014A
 6 53  9 59  7 65  9                                                         A1014B
15  3  3  8  5  9  2 10  5 13  6 14  4 15 44 16  4 17  6 20  5 21  2 22      A1015A
 5 54  9 60  7 66  9                                                         A1015B
15  4  3  9  5 10  2 11  5 14  6 15  4 16 44 17  4 18  6 21  5 22  2 23      A1016A
 5 55  9 61  7 67  9                                                         A1016B
14  5  3 10  5 11  2 12  5 15  6 16  4 17 46 18  4 22  5 23  2 24  5 56      A1017A
 9 62  7 68  9                                                               A1017B
11  6  3 11 42 12  2 16 43 17 41 18 44 23 42 24  2 57  9 63  7 69  9         A1018A
11  7 40 13 39 14 42 19  8 20  4 21  6 43 42 44  6 45  4 58 65 64  7         A1019A
11  8 40 13 42 14 39 15 42 19  4 20  8 21  4 22  6 45  6 59 65 65  7         A1020A
11  9 40 14 42 15 39 16 42 19  6 20  4 21  8 22  4 23  6 60 65 66  7         A1021A
11 10 40 15 42 16 39 17 42 20  6 21  4 22  8 23  4 24  6 61 65 67  7         A1022A
10 11 40 16 42 17 39 18 42 21  6 22  4 23 45 24  4 62 65 68  7               A1023A
 8 12 40 17 49 18 39 22 43 23 41 24  8 63 65 69  7                           A1024A
```

SAMPLE RUN

Some of the preliminary computations for the arrangement of input data are shown here, together with the definitions illustrated in figures. Appendix I supplements further information needed for the use of the programs.

The sample run provided here is the segment of the full scale Instrument Unit with sandwiched panel. Its idealized configuration is shown in Figure 37. The unit mass of the panel is

$$\mathrm{BARM} = 0.2588 \times 10^{-3} \times (0.02 + 0.03) + \frac{3.1}{12 \times 144} \times 0.9 \times \frac{1}{386}$$

$$= 0.1712 \times 10^{-4} \ (\mathrm{lb\text{-}sec^2/in^2})$$

A, B, PHIO, PNU, E, RHO, N, M, NMODE, CORE, and IOPT are defined in the list of definitions and also in Figure 37. Referring to Figure 38, the distance from c.g.'s of the stiffener to the center line of the panel is assumed to be small.

$$z_{s\varphi} = \mathrm{SZP} \approx 0$$

Along the edge parallel to the x-direction, similar stiffening effect is assumed due to the filler material used at the boundary to replace the honeycomb material.

The cross-sectional area and moment of inertia of the stiffener are calculated as follows:

$$A_{s\varphi} = (2)(1.0)(0.125) + (1.25)(0.1625) = 0.453 \text{ in.}^2$$

$$I_{s\varphi} = 2\left[\left(\frac{1}{12}\right)(1)(0.125)^3 + (0.125)(1)(0.3875^2)\right] + \left(\frac{1}{12}\right)(0.1625)(1.25)^3 = 0.0643 \text{ in.}^4$$

Here, symmetry about the center line of panel is assumed. Since the stiffeners are placed along the boundaries, the values calculated above (A_s and I_s) are doubled for use in the computer program:

$$A_{sx} = A_{s\varphi} = 0.906 \text{ in.}^2$$

$$I_{sx} = I_{s\varphi} = 0.1286 \text{ in.}^4$$

$$z_{sx} \approx 0$$

The Instrument Unit segment is supported by six cantilever beam type springs as shown in Figure 5. For a quarter panel, two springs are assumed acting on stations 7 and 19 (see

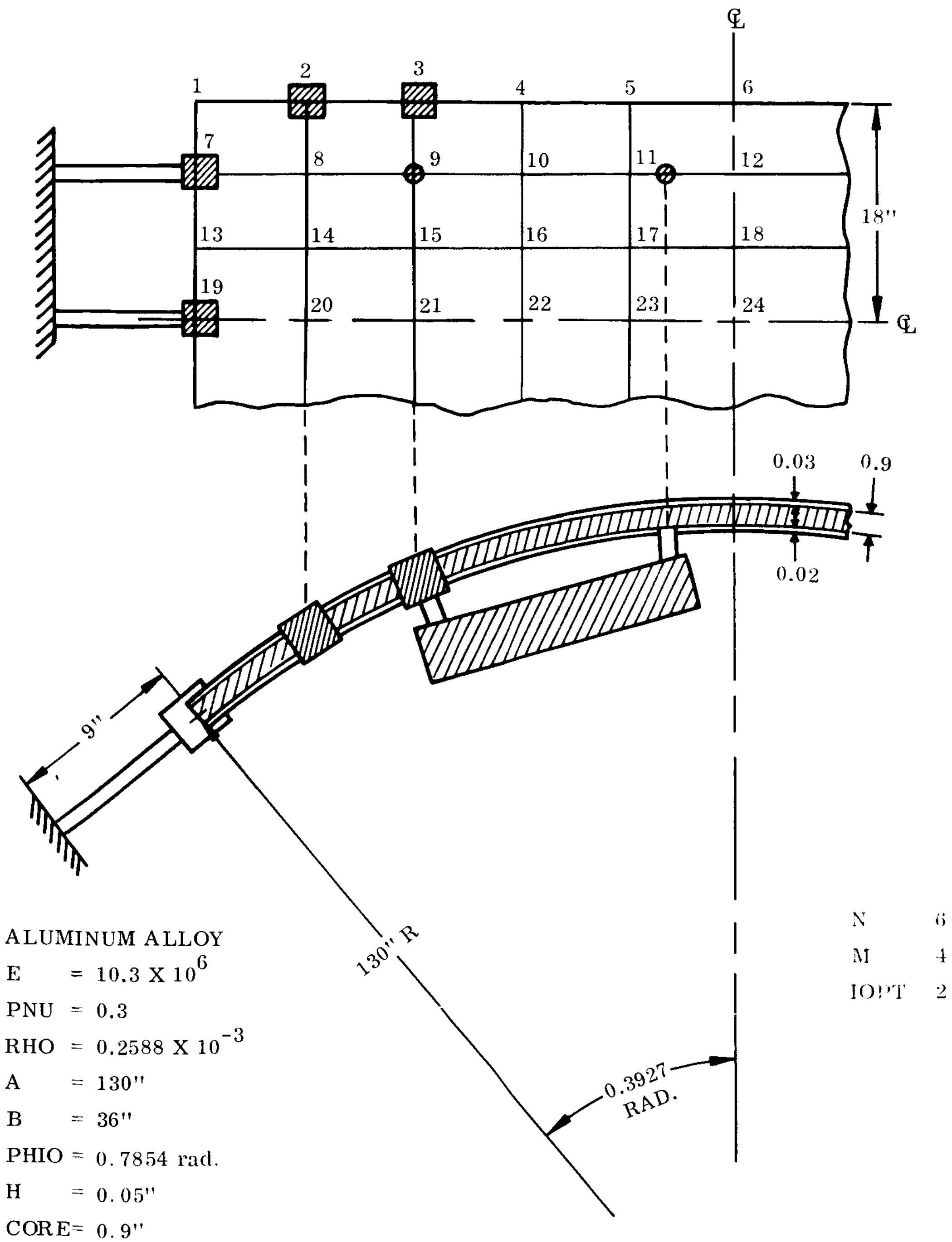

FIGURE 37. FULL SCALE INSTRUMENT UNIT LOCALIZED SHELL

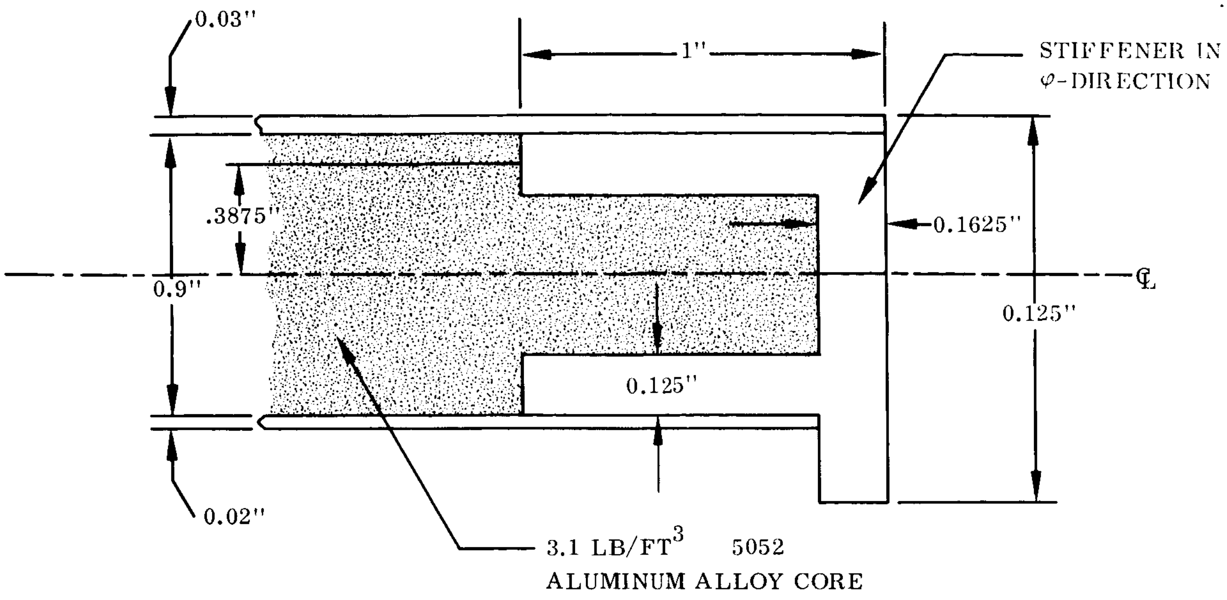

FIGURE 38. EDGE STIFFENER CONFIGURATION

Figure 37). The length of the cantilever supports is 9 inches. The corresponding spring constant, $\overline{K}_{\varphi}$, is

$$\overline{K}_{\varphi}(7) = \overline{K}_{\varphi}(19) = \frac{3EI}{\ell^3} = \frac{3 \times 30 \times 10^6 \times 2.5 \times 0.625^3}{12 \times 9^3} = 6,270 \text{ lb./in.}$$

$$\overline{K}_x = 0.$$

For convenience in computation, the weights attached near the cantilever supports (see Figure 5) are assumed evenly distributed over the springs (Figure 37).

$$W_{\varphi}(7) = W_{\varphi}(19) = \frac{1}{3} \times 70.5 = 23.5 \text{ lb.}$$

Along the circumferential edges, boundary weights are attached at stations 2 and 3:

$$W_x(2) = W_x(3) = \frac{1}{2} \times 35.2 = 17.6 \text{ lb.}$$

The component-weight is assumed to be symmetrical with respect to both center lines of the I. U. segment, as shown in Figure 39. Considering the mass and mass moment of inertia of the component, if the attachment points A, B are both coinciding with the grid points, Eqs. (54) (55) may be used to compute its mass matrix elements. In the present case, point A falls on grid point 9. Point B is located between grid points 11, 12. The off-diagonal terms of M_1 matrix, and the equivalent concentrated weights used at the points of attachment, are calculated as follows (see Figure 39).

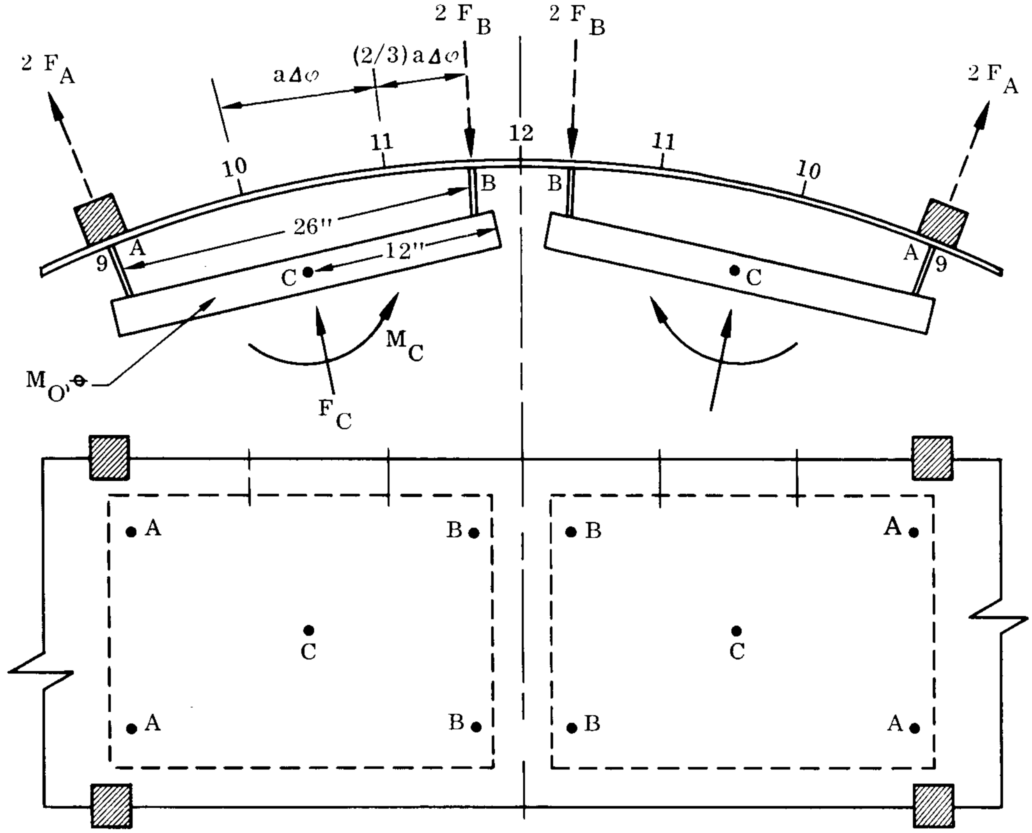

FIGURE 39. INERTIA FORCE DISTRIBUTION DUE TO A RIGID COMPONENT

M_o = mass of the component = $\frac{90}{g}$ (lb.-sec.^{2}/in.)

θ = moment of inertia of the component about the axis through centroid in x-direction

$\approx$ 3.5 (in.-lb.-sec.^{2})

w_A = deflection at station 9 = w_9

w_B = $\frac{1}{3}(w_{11} + 2w_{12})$ by assuming that w_B is linearly proportional with w_{11} and w_{12}

w_C = normal deflection at the centroid of the component

$= \frac{1}{26}(12w_A + 14w_B)$

$= \frac{1}{26}\left(12\,w_9 + \frac{14}{3}\,w_{11} + \frac{28}{3}\,w_{12}\right)$

$$F_A = \frac{1}{2}\left(\frac{12}{26}\,M_o\,\omega^2\,w_c - \frac{1}{26}\,\theta\,\omega^2\,\frac{dw_C}{a\,d\varphi}\right)$$

= inertia force acting at A due to M_o and θ

$$F_B = \frac{1}{2}\left(\frac{14}{26} M_o \omega^2 w_c + \frac{1}{26} \Theta \omega^2 \frac{dw_c}{ad\varphi}\right)$$

= inertia force acting at B due to M_o and Θ

$$F_C = M_o \omega^2 w_c$$

$$M_C = \Theta \omega^2 \frac{dw_c}{ad\varphi}$$

The inertia forces applied on the panel at points 9, 11 and 12 are

$$F_9 = F_A = \omega^2 (27.5\, w_9 + 8.8\, w_{11} + 17.6\, w_{12}) \times 10^{-3} \text{ lb.}$$

$$F_{11} = \frac{1}{3} F_B = \omega^2 (8.8\, w_9 + 4.05\, w_{11} + 8.1\, w_{12}) \times 10^{-3} \text{ lb.}$$

$$F_{12} = (2)\left(\frac{2}{3}\right) F_B = \omega^2 (35.2\, w_9 + 16.2\, w_{11} + 32.4\, w_{12}) \text{ lb.}$$

Since the inertia force of the panel, as shown in the diagonal of M_1 matrix, is unity per unit area, the above inertia forces must be normalized accordingly:

$$(M_1)_{9,11} = \frac{\omega^2 \times 10^{-3}}{\overline{m}\ (\Delta x)\ (a\Delta\varphi)\omega^2} \times 8.8 = 8.4$$

$$(M_1)_{9,12} = \frac{\omega^2 \times 10^{-3}}{\overline{m}\ (\Delta x)(a\Delta\varphi)\omega^2} \times 17.6 = 16.8$$

The equivalent concentrated weight attached at station 9 is

$$WT(9) = 10^{-3} \times 27.5 \times g = 10.6 \text{ lb.}$$

$$(M_1)_{11,9} = \frac{\omega^2 \times 10^{-3}}{\overline{m}\ (\Delta x)(a\Delta\varphi)\omega^2} \times 8.8 = 8.4$$

$$(M_1)_{11,12} = \frac{\omega^2 \times 10^{-3}}{\overline{m}\ (\Delta x)(a\Delta\varphi)\omega^2} \times 8.1 = 7.7$$

$$WT(11) = 10^{-3} \times 4.05\, g = 1.56 \text{ lb}$$

$$(M_1)_{12,9} = \frac{\omega^2 \times 10^{-3}}{\overline{m}\ (\Delta x)(a\Delta\varphi)\omega^2} \times 35.2 = 33.6$$

$$(M_1)_{12,11} = \frac{\omega^2 \times 10^{-3}}{\overline{m}\ (\Delta x)(a\Delta\varphi)\omega^2} \times 16.2 = 15.4$$

$$WT(12) = 10^{-3} \times 32.4 \times g = 12.5 \text{ lb}$$

The non-zero elements of the M_1 matrix are computed as follows:

	1	2	…	…	…	9	10	11	12	13	…	…
	1					⋮						
		1				⋮						
			⋱			⋮						
				⋱		⋮						
					1							
9	…	…	…	…	…	27.2		8.4	16.8			
10							1					
11						8.4		4.85	7.7			
12						33.6		15.4	31.9			
13										1		
											⋱	
												1

1 The computer printout of the sample run is given in the following pages.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** INPUT DATA **

A	B	PHIO	NU	E	RHO	H	NMODE
0.13000E 03	0.36000E 02	0.78540E 00	0.30000E-00	0.10300E 08	0.25880E-03	0.50000E-01	5

AX

0.90600E 00	0.	0.	0.	0.	0.
0.90600E 00	0.	0.	0.	0.	0.
0.90600E 00	0.	0.	0.	0.	0.
0.90600E 00	0.	0.	0.	0.	0.

APHI

0.90600E 00	0.90600E 00	0.90600E 00	0.90600E 00	0.90600E 00	0.90600E 00
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

** ZX **

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

** ZP **

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

** IX **

0.12860E-00	0.	0.	0.	0.	0.
0.12860E-00	0.	0.	0.	0.	0.
0.12860E-00	0.	0.	0.	0.	0.
0.12860E-00	0.	0.	0.	0.	0.

** IP **

0.12860E-00	0.12860E-00	0.12860E-00	0.12860E-00	0.12860E-00	0.12860E-00
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** WX **
      0.              0.17600E 02     0.17600E 02     0.              0.              0.

** WP **
      0.              0.              0.              0.              0.              0.
      0.23500E 02     0.              0.              0.              0.              0.
      0.              0.              0.              0.              0.              0.
      0.23500E 02     0.              0.              0.              0.              0.

** WT **
      0.              0.              0.              0.              0.              0.
      0.              0.              0.10600E 02     0.              0.15600E 01     0.12500E 02
      0.              0.              0.              0.              0.              0.
      0.              0.              0.              0.              0.              0.

** KX **
      0.              0.              0.              0.              0.              0.

** KP **
      0.              0.              0.              0.              0.              0.
      0.62700E 04     0.              0.              0.              0.              0.
      0.              0.              0.              0.              0.              0.
      0.62700E 04     0.              0.              0.              0.              0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

MASS 1 MATRIX - INTERNAL

** INPUT DATA **

ROW NO. 1

0.10000E 01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 2

0.	0.10000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 3

0.	0.	0.10000E 01	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 4

0.	0.	0.	0.10000E 01	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 5

0.	0.	0.	0.	0.10000E 01	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 6

0.	0.	0.	0.	0.	0.10000E 01
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 7

0.	0.	0.	0.	0.	0.
0.10000E 01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 8

0.	0.	0.	0.	0.	0.
0.	0.10000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

ROW NO. 9					
0.	0.	0.	0.	0.	0.
0.	0.	0.27179E 02	0.	0.84000E 01	0.16800E 02
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 10					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.10000E 01	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 11					
0.	0.	0.	0.	0.	0.
0.	0.	0.84000E 01	0.	0.48528E 01	0.77000E 01
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 12					
0.	0.	0.	0.	0.	0.
0.	0.	0.33600E 02	0.	0.15400E 02	0.31872E 02
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 13					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.10000E 01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 14					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.10000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 15					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.10000E 01	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 16					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.10000E 01	0.	0.
0.	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
ROW NO. 17
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.10000E 01   0.
    0.            0.            0.            0.            0.            0.

ROW NO. 18
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.10000E 01
    0.            0.            0.            0.            0.            0.

ROW NO. 19
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.10000E 01   0.            0.            0.            0.            0.

ROW NO. 20
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.10000E 01   0.            0.            0.            0.

ROW NO. 21
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.10000E 01   0.            0.            0.

ROW NO. 22
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.10000E 01   0.            0.

ROW NO. 23
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.10000E 01   0.

ROW NO. 24
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.10000E 01
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

MASS 2 MATRIX - BOUNDARY

ROW NO. 1					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 2					
0.	-0.10639E 02	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 3					
0.	0.	-0.10639E 02	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 4					
0.	0.	0.	-0.27221E-00	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 5					
0.	0.	0.	0.	-0.27221E-00	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 6					
0.	0.	0.	0.	0.	-0.27221E-00
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 7					
0.89392E 00	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 8					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 9					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

ROW NO. 10					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 11					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 12					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 13					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 14					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 15					
0.	0.	0.	0.	0.	0.
-0.11742E 03	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 16					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
-0.13414E 01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
ROW NO. 17					
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
-0.11742E 03	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

ROW NO. 18

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 19

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 20

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

ROW NO. 21

0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** E TABLE **

ROW NO. 1							
0.1000E 01	-0.8107E 02	0.1737E 02	-0.2288E 02	0.5792E 01	0.2824E 01	0.3836E-04	0.1443E 03
-0.1918E-04	0.	0.2834E-00	-0.2567E 01	0.	0.5001E-01	-0.2100E 01	0.
0.1743E 01	-0.5487E 01	0.3077E-00	-0.2615E 01	-0.2553E 08	0.1276E 08	0.4685E 03	-0.2449E 03
0.2193E 02	-0.1722E 03	0.7861E 02	0.3748E 01	-0.2000E 01	0.6518E 03	0.5820E 06	-0.4000E 01
-0.3962E-01	-0.3960E 01	0.1164E 07	0.2567E 01	-0.1743E 01	0.2000E 01	-0.1621E 03	0.3474E 02
-0.4576E 02	0.1158E 02	0.5647E 01	0.1617E 03	0.1472E 03	0.1645E 03	0.5668E 00	-0.5668E 00
0.2317E 02	0.3144E 03	0.1000E-00	0.4904E 03	0.4723E 03	0.3487E 01	-0.3487E 01	0.4942E 03
0.2553E 08	-0.4899E 03	0.4386E 02	-0.3444E 03	0.1572E 03	0.7496E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.2834E-00	0.	0.5487E 01	0.6153E 00	0.4000E 01	
ROW NO. 2							
0.1000E 01	-0.4513E 02	0.8386E 01	-0.2288E 02	0.5792E 01	0.2824E 01	0.3836E-04	0.9042E 02
-0.1918E-04	-0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.1743E 01	-0.5487E 01	0.3077E-00	-0.2615E 01	-0.9615E 07	0.4808E 07	0.1869E 03	-0.9060E 02
0.8386E 01	-0.7205E 02	0.2853E 02	0.3748E 01	-0.2000E 01	0.6518E 03	0.5733E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.1147E 07	0.3174E 01	-0.1743E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.4576E 02	0.1158E 02	0.5647E 01	0.9881E 02	0.9325E 02	0.1016E 03	0.1174E 01	-0.1174E 01
0.2317E 02	0.1141E 03	0.2072E-00	0.1953E 03	0.1907E 03	0.3487E 01	-0.3487E 01	0.1991E 03
0.9615E 07	-0.1812E 03	0.1677E 02	-0.1441E 03	0.5706E 02	0.7496E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.5487E 01	0.6153E 00	0.4000E 01	
ROW NO. 3							
0.1000E 01	-0.4513E 02	0.8386E 01	-0.2288E 02	0.5792E 01	0.2824E 01	0.3836E-04	0.9042E 02
-0.1918E-04	-0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.1743E 01	-0.5487E 01	0.3077E-00	-0.2615E 01	-0.9615E 07	0.4808E 07	0.1869E 03	-0.9060E 02
0.8386E 01	-0.7205E 02	0.2853E 02	0.3748E 01	-0.2000E 01	0.6518E 03	0.5733E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.1147E 07	0.3174E 01	-0.1743E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.4576E 02	0.1158E 02	0.5647E 01	0.9881E 02	0.9325E 02	0.1016E 03	0.1174E 01	-0.1174E 01
0.2317E 02	0.1141E 03	0.2072E-00	0.1953E 03	0.1907E 03	0.3487E 01	-0.3487E 01	0.1991E 03
0.9615E 07	-0.1812E 03	0.1677E 02	-0.1441E 03	0.5706E 02	0.7496E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.5487E 01	0.6153E 00	0.4000E 01	
ROW NO. 4							
0.1000E 01	-0.4513E 02	0.8386E 01	-0.2288E 02	0.5792E 01	0.2824E 01	0.3836E-04	0.9042E 02
-0.1918E-04	-0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.1743E 01	-0.5487E 01	0.3077E-00	-0.2615E 01	-0.9615E 07	0.4808E 07	0.1869E 03	-0.9060E 02
0.8386E 01	-0.7205E 02	0.2853E 02	0.3748E 01	-0.2000E 01	0.6518E 03	0.5733E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.1147E 07	0.3174E 01	-0.1743E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.4576E 02	0.1158E 02	0.5647E 01	0.9881E 02	0.9325E 02	0.1016E 03	0.1174E 01	-0.1174E 01
0.2317E 02	0.1141E 03	0.2072E-00	0.1953E 03	0.1907E 03	0.3487E 01	-0.3487E 01	0.1991E 03
0.9615E 07	-0.1812E 03	0.1677E 02	-0.1441E 03	0.5706E 02	0.7496E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.5487E 01	0.6153E 00	0.4000E 01	

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

-0.1918E-04	-0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.1743E 01	-0.5487E 01	0.3077E-00	-0.2615E 01	-0.9615E 07	0.4808E 07	0.1869E 03	-0.9060E 02
0.8386E 01	-0.7205E 02	0.2853E 02	0.3748E 01	-0.2000E 01	0.6518E 03	0.5733E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.1147E 07	0.3174E 01	-0.1743E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.4576E 02	0.1158E 02	0.5647E 01	0.9881E 02	0.9325E 02	0.1016E 03	0.1174E 01	-0.1174E 01
0.2317E 02	0.1141E 03	0.2072E-00	0.1953E 03	0.1907E 03	0.3487E 01	-0.3487E 01	0.1991E 03
0.9615E 07	-0.1812E 03	0.1677E 02	-0.1441E 03	0.5706E 02	0.7496E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.5487E 01	0.6153E 00	0.4000E 01	
NO. 6							
0.1000E 01	-0.4513E 02	0.8386E 01	-0.2288E 02	0.5792E 01	0.2824E 01	0.3836E-04	0.9042E 02
-0.1918E-04	-0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.1743E 01	-0.5487E 01	0.3077E-00	-0.2615E 01	-0.9615E 07	0.4808E 07	0.1869E 03	-0.9060E 02
0.8386E 01	-0.7205E 02	0.2853E 02	0.3748E 01	-0.2000E 01	0.6518E 03	0.5733E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.1147E 07	0.3174E 01	-0.1743E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.4576E 02	0.1158E 02	0.5647E 01	0.9881E 02	0.9325E 02	0.1016E 03	0.1174E 01	-0.1174E 01
0.2317E 02	0.1141E 03	0.2072E-00	0.1953E 03	0.1907E 03	0.3487E 01	-0.3487E 01	0.1991E 03
0.9615E 07	-0.1812E 03	0.1677E 02	-0.1441E 03	0.5706E 02	0.7496E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.5487E 01	0.6153E 00	0.4000E 01	
NO. 7							
0.1000E 01	-0.8107E 02	0.1737E 02	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.1334E 03
-0.1918E-04	0.	0.2834E-00	-0.2567E 01	0.	0.5001E-01	-0.2100E 01	-0.1838E 02
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.6637E 07	0.3318E 07	0.2142E 03	-0.1260E 03
0.2193E 02	-0.4231E 02	0.1915E 02	0.1000E 01	-0.2000E 01	0.6518E 03	0.1513E 06	-0.4000E 01
-0.3962E-01	-0.3960E 01	0.3027E 06	0.2567E 01	-0.4923E 01	0.2000E 01	-0.1621E 03	0.3474E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.1508E 03	0.1344E 03	0.1518E 03	0.5668E 00	-0.5668E 00
0.2317E 02	0.7661E 02	0.1000E-00	0.2361E 03	0.2152E 03	0.9846E 01	-0.9846E 01	0.2371E 03
0.6637E 07	-0.2520E 03	0.4386E 02	-0.8461E 02	0.3831E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.2834E-00	0.	0.1185E 02	0.1737E 01	0.4000E 01	
NO. 8							
0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	
NO. 9							
0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

ROW NO. 10

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 11

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 12

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 13

0.1000E 01	-0.8107E 02	0.1737E 02	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.1334E 03
-0.1918E-04	0.	0.2834E-00	-0.2567E 01	0.	0.5001E-01	-0.2100E 01	-0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.6637E 07	0.3318E 07	0.2142E 03	-0.1260E 03
0.2193E 02	-0.4231E 02	0.1915E 02	0.1000E 01	-0.2000E 01	0.6518E 03	0.1513E 06	-0.4000E 01
-0.3962E-01	-0.3960E 01	0.3027E 06	0.2567E 01	-0.4923E 01	0.2000E 01	-0.1621E 03	0.3474E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.1508E 03	0.1344E 03	0.1518E 03	0.5668E 00	-0.5668E 00
0.2317E 02	0.7661E 02	0.1000E-00	0.2361E 03	0.2152E 03	0.9846E 01	-0.9846E 01	0.2371E 03
0.6637E 07	-0.2520E 03	0.4386E 02	-0.8461E 02	0.3831E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.2834E-00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 14

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

ROW NO. 15

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 16

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 17

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 18

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

ROW NO. 19

0.1000E 01	-0.8107E 02	0.1737E 02	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.1334E 03
-0.1918E-04	0.	0.2834E-00	-0.2567E 01	0.	0.5001E-01	-0.2100E 01	-0.1838E 02
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.6637E 07	0.3318E 07	0.2142E 03	-0.1260E 03
0.2193E 02	-0.4231E 02	0.1915E 02	0.1000E 01	-0.2000E 01	0.6518E 03	0.1513E 06	-0.4000E 01
-0.3962E-01	-0.3960E 01	0.3027E 06	0.2567E 01	-0.4923E 01	0.2000E 01	-0.1621E 03	0.3474E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.1508E 03	0.1344E 03	0.1518E 03	0.5668E 00	-0.5668E 00
0.2317E 02	0.7661E 02	0.1000E-00	0.2361E 03	0.2152E 03	0.9846E 01	-0.9846E 01	0.2371E 03
0.6637E 07	-0.2520E 03	0.4386E 02	-0.8461E 02	0.3831E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.2834E-00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 20

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 21

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 22

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

ROW NO. 23

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

ROW NO. 24

0.1000E 01	-0.4513E 02	0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	0.3836E-04	0.7948E 02
-0.1918E-04	0.	0.5871E 00	-0.3174E 01	0.	0.1036E-00	-0.2207E 01	0.
0.4923E 01	-0.1185E 02	0.8687E 00	-0.3737E 01	-0.2392E 07	0.1196E 07	0.7948E 02	-0.4513E 02
0.8386E 01	-0.1558E 02	0.5792E 01	0.1000E 01	-0.2000E 01	0.6518E 03	0.1426E 06	-0.4000E 01
-0.1036E-00	-0.3896E 01	0.2852E 06	0.3174E 01	-0.4923E 01	0.2000E 01	-0.9025E 02	0.1677E 02
-0.3117E 02	0.1158E 02	0.2000E 01	0.8787E 02	0.8048E 02	0.8887E 02	0.1174E 01	-0.1174E 01
0.2317E 02	0.2317E 02	0.2072E-00	0.8787E 02	0.8048E 02	0.9846E 01	-0.9846E 01	0.8887E 02
0.2392E 07	-0.9025E 02	0.1677E 02	-0.3117E 02	0.1158E 02	0.2000E 01	0.2000E 01	-0.6518E 03
-0.3836E-04	-0.1000E 01	-0.5871E 00	0.	0.1185E 02	0.1737E 01	0.4000E 01	

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** A21 MATRIX **

** ROW  1**
   0.             0.             0.             0.             0.             0.             0.2567E 01     -0.2834E-00
   0.             0.             0.             0.            -0.1000E 01     0.             0.              0.
   0.             0.             0.             0.             0.             0.             0.              0.
** ROW  2**
   0.            -0.             0.             0.             0.             0.            -0.5871E 00      0.3174E 01
  -0.5871E 00     0.             0.             0.             0.            -0.1000E 01     0.              0.
   0.             0.             0.             0.             0.             0.             0.              0.
** ROW  3**
   0.             0.            -0.             0.             0.             0.             0.             -0.5871E 00
   0.3174E 01    -0.5871E 00     0.             0.             0.             0.            -0.1000E 01      0.
   0.             0.             0.             0.             0.             0.             0.              0.
** ROW  4**
   0.             0.             0.            -0.             0.             0.             0.              0.
  -0.5871E 00     0.3174E 01    -0.5871E 00     0.             0.             0.             0.             -0.1000E 01
   0.             0.             0.             0.             0.             0.             0.              0.
** ROW  5**
   0.             0.             0.             0.            -0.             0.             0.              0.
   0.            -0.5871E 00     0.3174E 01    -0.5871E 00     0.             0.             0.              0.
  -0.1000E 01     0.             0.             0.             0.             0.             0.              0.
** ROW  6**
   0.             0.             0.             0.             0.            -0.             0.              0.
   0.             0.            -0.1174E 01     0.3174E 01     0.             0.             0.              0.
   0.            -0.1000E 01     0.             0.             0.             0.             0.              0.
** ROW  7**
   0.             0.             0.             0.             0.             0.             0.              0.1000E 01
   0.             0.             0.             0.             0.             0.             0.              0.
   0.             0.             0.             0.             0.             0.             0.              0.
** ROW  8**
  -0.2100E 01     0.5001E-01     0.             0.             0.             0.             0.1000E 01      0.
   0.             0.             0.             0.             0.             0.             0.              0.
   0.             0.             0.             0.             0.             0.             0.              0.
** ROW  9**
   0.1036E-00    -0.2207E 01     0.1036E-00     0.             0.             0.             0.              0.1000E 01
   0.             0.             0.             0.             0.             0.             0.              0.
   0.             0.             0.             0.             0.             0.             0.              0.
** ROW 10**
   0.             0.1036E-00    -0.2207E 01     0.1036E-00     0.             0.             0.              0.
   0.1000E 01     0.             0.             0.             0.             0.             0.              0.
   0.             0.             0.             0.             0.             0.             0.              0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 11**							
0.	0.	0.1036E-00	-0.2207E 01	0.1036E-00	0.	0.	0.
0.	0.1000E 01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 12**							
0.	0.	0.	0.1036E-00	-0.2207E 01	0.1036E-00	0.	0.
0.	0.	0.1000E 01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 13**							
0.	0.	0.	0.	0.2072E-00	-0.2207E 01	0.	0.
0.	0.	0.	0.1000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 14**							
0.	0.5487E 01	-0.1000E 01	0.	0.	0.	0.	-0.1743E 01
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 15**							
0.	-0.4923E 01	0.	0.	0.	0.	-0.1838E 02	0.1185E 02
-0.1000E 01	0.	0.	0.	0.	-0.4923E 01	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 16**							
0.	0.	0.	0.	0.	0.	0.	-0.4923E 01
0.	0.	0.	0.	-0.	0.1185E 02	-0.1000E 01	0.
0.	0.	0.	-0.4923E 01	0.	0.	0.	0.
** ROW 17**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	-0.9846E 01	0.	0.
0.	0.	-0.1838E 02	0.1185E 02	-0.1000E 01	0.	0.	0.
** ROW 18**							
-0.2615E 01	0.1000E 01	0.	0.	0.	0.	0.3077E-00	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 19**							
0.8687E 00	0.	0.	0.	0.	0.	-0.3737E 01	0.1000E 01
0.	0.	0.	0.	0.8687E 00	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 20**							
0.	0.	0.	0.	0.	0.	0.8687E 00	0.
0.	0.	0.	0.	-0.3737E 01	0.1000E 01	0.	0.
0.	0.	0.8687E 00	0.	0.	0.	0.	0.
** ROW 21**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.1737E 01	0.	0.	0.
0.	0.	-0.3737E 01	0.1000E 01	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** A22 MATRIX **

** ROW  1**
    0.1000E 01   0.           0.           0.           0.           0.           0.2834E-00   -0.2567E 01
    0.2834E-00   0.           0.           0.           0.           0.           0.           0.
   -0.2834E-00   0.           0.           0.           0.
** ROW  2**
    0.           0.1000E 01   0.           0.           0.           0.           0.           0.5871E 00
   -0.3174E 01   0.5871E 00   0.           0.           0.           0.           0.           0.
    0.           0.           0.           0.           0.
** ROW  3**
    0.           0.           0.1000E 01   0.           0.           0.           0.           0.
    0.5871E 00  -0.3174E 01   0.5871E 00   0.           0.           0.           0.           0.
    0.           0.           0.           0.           0.
** ROW  4**
    0.           0.           0.           0.1000E 01   0.           0.           0.           0.
    0.           0.5871E 00  -0.3174E 01   0.5871E 00   0.           0.           0.           0.
    0.           0.           0.           0.           0.
** ROW  5**
    0.           0.           0.           0.           0.1000E 01   0.           0.           0.
    0.           0.           0.5871E 00  -0.3174E 01   0.5871E 00   0.           0.           0.
    0.           0.           0.           0.           0.
** ROW  6**
    0.           0.           0.           0.           0.           0.1000E 01   0.           0.
    0.           0.           0.           0.1174E 01  -0.3174E 01   0.           0.           0.
    0.           0.           0.           0.           0.
** ROW  7**
    0.           0.           0.           0.           0.           0.           0.1000E 01   0.
   -0.1000E 01   0.           0.           0.           0.           0.           0.           0.
   -0.1000E 01   0.           0.           0.           0.
** ROW  8**
    0.           0.           0.           0.           0.           0.           0.           0.1000E 01
    0.           0.           0.           0.           0.           0.           0.5001E-01   0.
    0.           0.           0.           0.           0.
** ROW  9**
    0.           0.           0.           0.           0.           0.           0.           0.
    0.1000E 01   0.           0.           0.           0.           0.           0.           0.
    0.           0.           0.           0.           0.
** ROW 10**
    0.           0.           0.           0.           0.           0.           0.           0.
    0.           0.1000E 01   0.           0.           0.           0.           0.           0.
    0.           0.           0.           0.           0.
** ROW 11**
    0.           0.           0.           0.           0.           0.           0.           0.
    0.           0.           0.1000E 01   0.           0.           0.           0.           0.
    0.           0.           0.           0.           0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 12**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.1000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 13**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.1000E 01	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 14**							
0.	0.	0.	0.	0.	0.	0.1743E 01	0.
-0.1743E 01	0.	0.	0.	0.	0.1000E 01	-0.5487E 01	0.
0.1743E 01	0.	0.	0.	0.			
** ROW 15**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.4923E 01	0.1000E 01
-0.1185E 02	0.	0.4923E 01	0.	0.			
** ROW 16**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.4923E 01	0.1000E 01	-0.1185E 02	0.	0.4923E 01			
** ROW 17**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.9846E 01	0.1000E 01	-0.1185E 02			
** ROW 18**							
0.	0.	0.	0.	0.	0.	0.	0.3077E-00
0.	0.	0.	0.	0.	0.	0.1000E 01	0.
0.	0.	0.	0.	0.			
** ROW 19**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.1000E 01	0.	0.	0.	0.			
** ROW 20**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.1000E 01	0.	0.			
** ROW 21**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.1000E 01			

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** A31 MATRIX **

** ROW  1**
   0.            0.1196E 07    0.            0.            0.            0.            0.            -0.2392E 07
   0.            0.            0.            0.            0.            0.1196E 07    0.            0.
   0.            0.            0.            0.            0.            0.            0.            0.
** ROW  2**
   0.            0.            0.1196E 07    0.            0.            0.            0.            0.
  -0.2392E 07    0.            0.            0.            0.            0.            0.1196E 07    0.
   0.            0.            0.            0.            0.            0.            0.            0.
** ROW  3**
   0.            0.            0.            0.1196E 07    0.            0.            0.            0.
   0.           -0.2392E 07    0.            0.            0.            0.            0.            0.1196E 07
   0.            0.            0.            0.            0.            0.            0.            0.
** ROW  4**
   0.            0.            0.            0.            0.1196E 07    0.            0.            0.
   0.            0.           -0.2392E 07    0.            0.            0.            0.            0.
   0.1196E 07    0.            0.            0.            0.            0.            0.            0.
** ROW  5**
   0.            0.            0.            0.            0.            0.1196E 07    0.            0.
   0.            0.            0.           -0.2392E 07    0.            0.            0.            0.
   0.            0.1196E 07    0.            0.            0.            0.            0.            0.
** ROW  6**
   0.            0.            0.            0.            0.            0.            0.            0.1196E 07
   0.            0.            0.            0.            0.           -0.2392E 07    0.            0.
   0.            0.            0.            0.1196E 07    0.            0.            0.            0.
** ROW  7**
   0.            0.            0.            0.            0.            0.            0.            0.
   0.1196E 07    0.            0.            0.            0.            0.           -0.2392E 07    0.
   0.            0.            0.            0.            0.1196E 07    0.            0.            0.
** ROW  8**
   0.            0.            0.            0.            0.            0.            0.            0.
   0.            0.1196E 07    0.            0.            0.            0.            0.           -0.2392E 07
   0.            0.            0.            0.            0.            0.1196E 07    0.            0.
** ROW  9**
   0.            0.            0.            0.            0.            0.            0.            0.
   0.            0.            0.1196E 07    0.            0.            0.            0.            0.
  -0.2392E 07    0.            0.            0.            0.            0.            0.1196E 07    0.
** ROW 10**
   0.            0.            0.            0.            0.            0.            0.            0.
   0.            0.            0.            0.1196E 07    0.            0.            0.            0.
   0.           -0.2392E 07    0.            0.            0.            0.            0.            0.1196E 07
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 11**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.2392E 07	0.	0.
0.	0.	0.	-0.2392E 07	0.	0.	0.	0.
** ROW 12**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.2392E 07	0.
0.	0.	0.	0.	-0.2392E 07	0.	0.	0.
** ROW 13**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.2392E 07
0.	0.	0.	0.	0.	-0.2392E 07	0.	0.
** ROW 14**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.2392E 07	0.	0.	0.	0.	0.	-0.2392E 07	0.
** ROW 15**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.2392E 07	0.	0.	0.	0.	0.	-0.2392E 07
** ROW 16**							
0.	0.	0.	0.	0.	0.	-0.6518E 03	0.
0.6518E 03	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 17**							
0.	0.	0.	0.	0.	0.	0.	-0.6518E 03
0.	0.6518E 03	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 18**							
0.	0.	0.	0.	0.	0.	0.	0.
-0.6518E 03	0.	0.6518E 03	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 19**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	-0.6518E 03	0.	0.6518E 03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 20**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	-0.6518E 03	0.6518E 03	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 21**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 22**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 23**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 24**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 25**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 26**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 27**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 28**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 29**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 30**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 31**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
** ROW 32**							
0.	0.	0.	0.	0.	0.	0.1513E 06	0.3027E 06
0.3027E 06	0.3027E 06	0.3027E 06	0.1513E 06	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** ROW 33**
    0.            0.            0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.            0.            0.
** ROW 34**
    0.            0.            0.            0.            0.            0.            0.            0.
    0.            0.            0.            0.            0.            0.            0.            0.
    0.            0.            0.1513E 06    0.3027E 06    0.3027E 06    0.3027E 06    0.3027E 06    0.1513E 06
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** A32 MATRIX **

** ROW 1**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 2**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 3**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 4**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 5**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 6**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 7**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 8**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 9**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 10**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** ROW 11**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 12**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 13**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 14**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 15**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 16**
   0.             0.             0.             0.             0.             0.             0.             0.6518E 03
   0.            -0.6518E 03     0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 17**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.6518E 03     0.            -0.6518E 03     0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 18**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.6518E 03     0.            -0.6518E 03     0.             0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 19**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.6518E 03     0.            -0.6518E 03     0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 20**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.6518E 03    -0.6518E 03     0.             0.             0.
   0.             0.             0.             0.             0.
** ROW 21**
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.             0.             0.             0.
   0.             0.             0.             0.             0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** ROW 33**
   0.       0.       0.       0.       0.       0.       0.       0.
   0.       0.       0.       0.       0.       0.       0.       0.
   0.       0.       0.       0.       0.
** ROW 34**
   0.       0.       0.       0.       0.       0.       0.       0.
   0.       0.       0.       0.       0.       0.       0.       0.
   0.       0.       0.       0.       0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** ROW 22**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 23**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 24**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 25**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 26**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 27**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 28**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 29**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 30**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 31**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
** ROW 32**
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.      0.      0.      0.
   0.      0.      0.      0.      0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** A33 MATRIX **

** ROW  1**
   0.5792E 01   -0.4513E 02    0.5792E 01    0.            0.            0.           -0.1558E 02    0.7948E 02
  -0.1558E 02    0.1000E 01    0.            0.            0.5792E 01   -0.4513E 02    0.5792E 01    0.
   0.            0.            0.            0.8386E 01    0.            0.            0.            0.
   0.            0.8386E 01    0.            0.            0.            0.            0.            0.1000E 01
   0.            0.
** RCW  2**
   0.            0.5792E 01   -0.4513E 02    0.5792E 01    0.            0.            0.1000E 01   -0.1558E 02
   0.7948E 02   -0.1558E 02    0.1000E 01    0.            0.            0.5792E 01   -0.4513E 02    0.5792E 01
   0.            0.            0.            0.            0.8386E 01    0.            0.            0.
   0.            0.            0.8386E 01    0.            0.            0.            0.            0.
   0.            0.
** RCW  3**
   0.            0.            0.5792E 01   -0.4513E 02    0.5792E 01    0.            0.            0.1000E 01
  -0.1558E 02    0.7948E 02   -0.1558E 02    0.1000E 01    0.            0.            0.5792E 01   -0.4513E 02
   0.5792E 01    0.            0.            0.            0.            0.8386E 01    0.            0.
   0.            0.            0.            0.8386E 01    0.            0.            0.            0.
   0.            0.
** RCW  4**
   0.            0.            0.            0.5792E 01   -0.4513E 02    0.5792E 01    0.            0.
   0.1000E 01   -0.1558E 02    0.8048E 02   -0.1558E 02    0.            0.            0.            0.5792E 01
  -0.4513E 02    0.5792E 01    0.            0.            0.            0.            0.8386E 01    0.
   0.            0.            0.            0.            0.8386E 01    0.            0.            0.
   0.            0.
** ROW  5**
   0.            0.            0.            0.            0.1158E 02   -0.4513E 02    0.            0.
   0.            0.2000E 01   -0.3117E 02    0.7948E 02    0.            0.            0.            0.
   0.1158E 02   -0.4513E 02    0.            0.            0.            0.            0.            0.8386E 01
   0.            0.            0.            0.            0.            0.8386E 01    0.            0.
   0.            0.
** RCW  6**
   0.            0.8386E 01    0.            0.            0.            0.            0.5792E 01   -0.4513E 02
   0.5792E 01    0.            0.            0.           -0.1558E 02    0.8787E 02   -0.1558E 02    0.1000E 01
   0.            0.            0.5792E 01   -0.4513E 02    0.5792E 01    0.            0.            0.
   0.            0.            0.            0.            0.            0.            0.            0.
   C.1000E 01    0.
** RCW  7**
   0.            0.            0.8386E 01    0.            0.            0.            0.            0.5792E 01
  -0.4513E 02    0.5792E 01    0.            0.            0.1000E 01   -0.1558E 02    0.8787E 02   -0.1558E 02
   0.1000E 01    0.            0.            0.5792E 01   -0.4513E 02    0.5792E 01    0.            0.
   0.            0.            0.            0.            0.            0.            0.            0.
   0.            0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 8**							
0.	0.	0.	0.8386E 01	0.	0.	0.	0.
0.5792E 01	-0.4513E 02	0.5792E 01	0.	0.	0.1000E 01	-0.1558E 02	0.8787E 02
-0.1558E 02	0.1000E 01	0.	0.	0.5792E 01	-0.4513E 02	0.5792E 01	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 9**							
0.	0.	0.	0.	0.8386E 01	0.	0.	0.
0.	0.5792E 01	-0.4513E 02	0.5792E 01	0.	0.	0.1000E 01	-0.1558E 02
0.8887E 02	-0.1558E 02	0.	0.	0.	0.5792E 01	-0.4513E 02	0.5792E 01
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 10**							
0.	0.	0.	0.	0.	0.8386E 01	0.	0.
0.	0.	0.1158E 02	-0.4513E 02	0.	0.	0.	0.2000E 01
-0.3117E 02	0.8787E 02	0.	0.	0.	0.	0.1158E 02	-0.4513E 02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 11**							
0.	0.	0.	0.	0.	0.	0.	0.1677E 02
0.	0.	0.	0.	0.1158E 02	-0.9025E 02	0.1158E 02	0.
0.	0.	-0.1558E 02	0.7948E 02	-0.1558E 02	0.1000E 01	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.1000E 01						
** ROW 12**							
0.	0.	0.	0.	0.	0.	0.	0.
0.1677E 02	0.	0.	0.	0.	0.1158E 02	-0.9025E 02	0.1158E 02
0.	0.	0.1000E 01	-0.1558E 02	0.7948E 02	-0.1558E 02	0.1000E 01	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 13**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.1677E 02	0.	0.	0.	0.	0.1158E 02	-0.9025E 02
0.1158E 02	0.	0.	0.1000E 01	-0.1558E 02	0.7948E 02	-0.1558E 02	0.1000E 01
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 14**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.1677E 02	0.	0.	0.	0.	0.1158E 02
-0.9025E 02	0.1158E 02	0.	0.	0.1000E 01	-0.1558E 02	0.8048E 02	-0.1558E 02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 15**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.1677E 02	0.	0.	0.	0.
0.2317E 02	-0.9025E 02	0.	0.	0.	0.2000E 01	-0.3117E 02	0.7948E 02
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 16**							
0.	0.	0.	0.	0.	0.	-0.1000E 01	0.
0.1000E 01	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.1000E 01	0.	-0.1000E 01	0.	0.	0.	0.	0.
0.	0.						
** ROW 17**							
0.	0.	0.	0.	0.	0.	0.	-0.1000E 01
0.	0.1000E 01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.1000E 01	0.	-0.1000E 01	0.	0.	0.	0.
0.	0.						
** ROW 18**							
0.	0.	0.	0.	0.	0.	0.	0.
-C.1000E 01	0.	0.1000E 01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.1000E 01	0.	-0.1000E 01	0.	0.	0.
0.	0.						
** ROW 19**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	-0.1000E 01	0.	0.1000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.1000E 01	0.	-0.1000E 01	0.	0.
0.	0.						
** ROW 20**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	-0.1000E 01	0.1000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.1000E 01	-0.1000E 01	0.	0.
0.	0.						
** ROW 21**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
C.	0.	0.	0.	0.	0.	0.	0.1000E 01
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 22**

-0.2000E 01	0.1000E 01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.1000E 01	0.
0.	0.						

** ROW 23**

0.1000E 01	-0.2000E 01	0.1000E 01	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

** ROW 24**

0.	0.1000E 01	-0.2000E 01	0.1000E 01	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

** ROW 25**

0.	0.	0.1000E 01	-0.2000E 01	0.1000E 01	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

** ROW 26**

0.	0.	0.	0.1000E 01	-0.2000E 01	0.1000E 01	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

** ROW 27**

0.	0.	0.	0.	0.2000E 01	-0.2000E 01	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

** ROW 28**

0.	-0.1000E 01	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.1000E 01	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.1000E 01	0.
-0.1000E 01	0.						

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** ROW 29**
   0.            0.            0.            0.            0.            0.            0.            -0.1000E 01
   0.            0.            0.            0.            0.            0.            0.             0.
   0.            0.            0.            0.1000E 01    0.            0.            0.             0.
   0.            0.            0.            0.            0.            0.            0.             0.1000E 01
   0.           -0.1000E 01
** ROW 30**
   0.            0.            0.            0.            0.            0.            0.             0.
   0.            0.            0.            0.            0.           -0.1000E 01    0.             0.
   0.            0.            0.            0.1000E 01    0.            0.            0.             0.
   0.            0.            0.            0.            0.            0.            0.             0.
   0.1000E 01   -0.1000E 01
** ROW 31**
  -0.2000E 01    0.            0.            0.            0.            0.            0.1000E 01     0.
   0.            0.            0.            0.            0.            0.            0.             0.
   0.            0.            0.            0.            0.            0.            0.             0.
   0.1000E 01    0.            0.            0.            0.            0.            0.             0.
   0.            0.
** ROW 32**
   0.1000E 01    0.2000E 01    0.2000E 01    0.2000E 01    0.2000E 01    0.1000E 01   -0.2000E 01   -0.3960E 01
  -0.4000E 01   -0.4000E 01   -0.4000E 01   -0.2000E 01    0.1000E 01    0.2000E 01    0.2000E 01    0.2000E 01
   0.2000E 01    0.1000E 01    0.            0.            0.            0.            0.             0.
   0.            0.            0.            0.            0.            0.            0.            -0.3962E-01
   0.            0.
** ROW 33**
   0.            0.            0.            0.            0.            0.            0.1000E 01     0.
   0.            0.            0.            0.           -0.2000E 01    0.            0.             0.
   0.            0.            0.1000E 01    0.            0.            0.            0.             0.
   0.            0.            0.            0.            0.            0.            0.             0.
   0.            0.
** ROW 34**
   0.            0.            0.            0.            0.            0.            0.             0.
   0.            0.            0.            0.            0.2000E 01    0.4000E 01    0.4000E 01    0.4000E 01
   0.4000E 01    0.2000E 01   -0.2000E 01   -0.3960E 01   -0.4000E 01   -0.4000E 01   -0.4000E 01   -0.2000E 01
   0.            0.            0.            0.            0.            0.            0.             0.
   0.           -0.3962E-01
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** A11 MATRIX **

** ROW  1**
  0.1443E 03  -0.2288E 02   0.2824E 01   0.           0.           0.          -0.8107E 02   0.5792E 01
  0.           0.           0.           0.           0.1737E 02   0.           0.           0.
  0.           0.           0.           0.           0.           0.           0.           0.
** ROW  2**
 -0.2288E 02   0.9042E 02  -0.2288E 02   0.2824E 01   0.           0.           0.5792E 01  -0.4513E 02
  0.5792E 01   0.           0.           0.           0.           0.8386E 01   0.           0.
  0.           0.           0.           0.           0.           0.           0.           0.
** ROW  3**
  0.2824E 01  -0.2288E 02   0.9042E 02  -0.2288E 02   0.2824E 01   0.           0.           0.5792E 01
 -0.4513E 02   0.5792E 01   0.           0.           0.           0.           0.8386E 01   0.
  0.           0.           0.           0.           0.           0.           0.           0.
** ROW  4**
  0.           0.2824E 01  -0.2288E 02   0.9042E 02  -0.2288E 02   0.2824E 01   0.           0.
  0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.           0.           0.           0.8386E 01
  0.           0.           0.           0.           0.           0.           0.           0.
** ROW  5**
  0.           0.           0.2824E 01  -0.2288E 02   0.9325E 02  -0.2288E 02   0.           0.
  0.           0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.           0.           0.
  0.8386E 01   0.           0.           0.           0.           0.           0.           0.
** ROW  6**
  0.           0.           0.           0.5647E 01  -0.4576E 02   0.9042E 02   0.           0.
  0.           0.           0.1158E 02  -0.4513E 02   0.           0.           0.           0.
  0.           0.8386E 01   0.           0.           0.           0.           0.           0.
** ROW  7**
 -0.8107E 02   0.5792E 01   0.           0.           0.           0.           0.1334E 03  -0.1558E 02
  0.1000E 01   0.           0.           0.          -0.8107E 02   0.5792E 01   0.           0.
  0.           0.           0.1737E 02   0.           0.           0.           0.           0.
** ROW  8**
  0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.           0.          -0.1558E 02   0.7948E 02
 -0.1558E 02   0.1000E 01   0.           0.           0.5792E 01  -0.4513E 02   0.5792E 01   0.
  0.           0.           0.           0.8386E 01   0.           0.           0.           0.
** ROW  9**
  0.           0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.           0.1000E 01  -0.1558E 02
  0.7948E 02  -0.1558E 02   0.1000E 01   0.           0.           0.5792E 01  -0.4513E 02   0.5792E 01
  0.           0.           0.           0.           0.8386E 01   0.           0.           0.
** ROW 10**
  0.           0.           0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.           0.1000E 01
 -0.1558E 02   0.7948E 02  -0.1558E 02   0.1000E 01   0.           0.           0.5792E 01  -0.4513E 02
  0.5792E 01   0.           0.           0.           0.           0.8386E 01   0.           0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 11**							
0.	0.	0.	0.5792E 01	-0.4513E 02	0.5792E 01	0.	0.
0.1000E 01	-0.1558E 02	0.8048E 02	-0.1558E 02	0.	0.	0.	0.5792E 01
-0.4513E 02	0.5792E 01	0.	0.	0.	0.	0.8386E 01	0.
** ROW 12**							
0.	0.	0.	0.	0.1158E 02	-0.4513E 02	0.	0.
0.	0.2000E 01	-0.3117E 02	0.7948E 02	0.	0.	0.	0.
0.1158E 02	-0.4513E 02	0.	0.	0.	0.	0.	0.8386E 01
** ROW 13**							
0.1737E 02	0.	0.	0.	0.	0.	-0.8107E 02	0.5792E 01
0.	0.	0.	0.	0.1508E 03	-0.1558E 02	0.1000E 01	0.
0.	0.	-0.8107E 02	0.5792E 01	0.	0.	0.	0.
** ROW 14**							
0.	0.8386E 01	0.	0.	0.	0.	0.5792E 01	-0.4513E 02
0.5792E 01	0.	0.	0.	-0.1558E 02	0.8787E 02	-0.1558E 02	0.1000E 01
0.	0.	0.5792E 01	-0.4513E 02	0.5792E 01	0.	0.	0.
** ROW 15**							
0.	0.	0.8386E 01	0.	0.	0.	0.	0.5792E 01
-0.4513E 02	0.5792E 01	0.	0.	0.1000E 01	-0.1558E 02	0.8787E 02	-0.1558E 02
0.1000E 01	0.	0.	0.5792E 01	-0.4513E 02	0.5792E 01	0.	0.
** ROW 16**							
0.	0.	0.	0.8386E 01	0.	0.	0.	0.
0.5792E 01	-0.4513E 02	0.5792E 01	0.	0.	0.1000E 01	-0.1558E 02	0.8787E 02
-0.1558E 02	0.1000E 01	0.	0.	0.5792E 01	-0.4513E 02	0.5792E 01	0.
** ROW 17**							
0.	0.	0.	0.	0.8386E 01	0.	0.	0.
0.	0.5792E 01	-0.4513E 02	0.5792E 01	0.	0.	0.1000E 01	-0.1558E 02
0.8887E 02	-0.1558E 02	0.	0.	0.	0.5792E 01	-0.4513E 02	0.5792E 01
** ROW 18**							
0.	0.	0.	0.	0.	0.8386E 01	0.	0.
0.	0.	0.1158E 02	-0.4513E 02	0.	0.	0.	0.2000E 01
-0.3117E 02	0.8787E 02	0.	0.	0.	0.	0.1158E 02	-0.4513E 02
** ROW 19**							
0.	0.	0.	0.	0.	0.	0.3474E 02	0.
0.	0.	0.	0.	-0.1621E 03	0.1158E 02	0.	0.
0.	0.	0.1334E 03	-0.1558E 02	0.1000E 01	0.	0.	0.
** ROW 20**							
0.	0.	0.	0.	0.	0.	0.	0.1677E 02
0.	0.	0.	0.	0.1158E 02	-0.9025E 02	0.1158E 02	0.
0.	0.	-0.1558E 02	0.7948E 02	-0.1558E 02	0.1000E 01	0.	0.
** ROW 21**							
0.	0.	0.	0.	0.	0.	0.	0.
0.1677E 02	0.	0.	0.	0.	0.1158E 02	-0.9025E 02	0.1158E 02
0.	0.	0.1000E 01	-0.1558E 02	0.7948E 02	-0.1558E 02	0.1000E 01	0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 22**								
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.1677E 02	0.	0.	0.	0.	0.1158E 02	-0.9025E 02
	0.1158E 02	0.	0.	0.1000E 01	-0.1558E 02	0.7948E 02	-0.1558E 02	0.1000E 01
** ROW 23**								
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.1677E 02	0.	0.	0.	0.	0.1158E 02
	-0.9025E 02	0.1158E 02	0.	0.	0.1000E 01	-0.1558E 02	0.8048E 02	-0.1558E 02
** ROW 24**								
	0.	0.	0.	0.	0.	0.	0.	0.
	0.	0.	0.	0.1677E 02	0.	0.	0.	0.
	0.2317E 02	-0.9025E 02	0.	0.	0.	0.2000E 01	-0.3117E 02	0.7948E 02

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
** A12 MATRIX **

** ROW  1**
   0.1737E 02   0.           0.           0.           0.           0.           0.5792E 01   -0.8107E 02
   0.5792E 01   0.           0.           0.           0.           0.2824E 01  -0.2288E 02    0.
   0.5792E 01   0.           0.           0.           0.
** ROW  2**
   0.           0.8386E 01   0.           0.           0.           0.           0.            0.5792E 01
  -0.4513E 02   0.5792E 01   0.           0.           0.           0.           0.2824E 01    0.
   0.           0.           0.           0.           0.
** ROW  3**
   0.           0.           0.8386E 01   0.           0.           0.           0.            0.
   0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.           0.           0.            0.
   0.           0.           0.           0.           0.
** ROW  4**
   0.           0.           0.           0.8386E 01   0.           0.           0.            0.
   0.           0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.           0.            0.
   0.           0.           0.           0.           0.
** ROW  5**
   0.           0.           0.           0.           0.8386E 01   0.           0.            0.
   0.           0.           0.5792E 01  -0.4513E 02   0.5792E 01   0.           0.            0.
   0.           0.           0.           0.           0.
** ROW  6**
   0.           0.           0.           0.           0.           0.8386E 01   0.            0.
   0.           0.           0.           0.1158E 02  -0.4513E 02   0.           0.            0.
   0.           0.           0.           0.           0.
** ROW  7**
   0.           0.           0.           0.           0.           0.           0.            0.1737E 02
   0.           0.           0.           0.           0.           0.           0.5792E 01    0.1000E 01
  -0.1558E 02   0.           0.5792E 01   0.           0.
** ROW  8**
   0.           0.           0.           0.           0.           0.           0.            0.
   0.8386E 01   0.           0.           0.           0.           0.           0.            0.
   0.1000E 01   0.           0.           0.           0.
** ROW  9**
   0.           0.           0.           0.           0.           0.           0.            0.
   0.           0.8386E 01   0.           0.           0.           0.           0.            0.
   0.           0.           0.           0.           0.
** ROW 10**
   0.           0.           0.           0.           0.           0.           0.            0.
   0.           0.           0.8386E 01   0.           0.           0.           0.            0.
   0.           0.           0.           0.           0.
** ROW 11**
   0.           0.           0.           0.           0.           0.           0.            0.
   0.           0.           0.           0.8386E 01   0.           0.           0.            0.
   0.           0.           0.           0.           0.
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 13**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.5792E 01	0.1000E 01	-0.1558E 02	0.	0.5792E 01			
** ROW 14**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.1000E 01	0.	0.			
** ROW 15**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 16**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 17**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 18**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 19**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.1158E 02	0.1000E 01	-0.1558E 02			
** ROW 20**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.1000E 01			
** ROW 21**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			
** ROW 22**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 23**

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			

** ROW 24**

0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.			

** A13 MATRIX **

** ROW 1**

0.3836E-04	0.	0.	0.	0.	0.	-0.1918E-04	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
-0.1918E-04	0.	0.	0.	0.	0.	0.	0.
0.	0.						

** ROW 2**

0.	0.3836E-04	0.	0.	0.	0.	0.	-0.1918E-04
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	-0.1918E-04	0.	0.	0.	0.	0.	0.
0.	0.						

** ROW 3**

0.	0.	0.3836E-04	0.	0.	0.	0.	0.
-0.1918E-04	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	-0.1918E-04	0.	0.	0.	0.	0.
0.	0.						

** ROW 4**

0.	0.	0.	0.3836E-04	0.	0.	0.	0.
0.	-0.1918E-04	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	-0.1918E-04	0.	0.	0.	0.
0.	0.						

** ROW 5**

0.	0.	0.	0.	0.3836E-04	0.	0.	0.
0.	0.	-0.1918E-04	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-0.1918E-04	0.	0.	0.
0.	0.						

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 6**							
0.	0.	0.	0.	0.	0.3836E-04	0.	0.
0.	0.	0.	-0.1918E-04	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	-0.1918E-04	0.	0.
0.	0.						
** ROW 7**							
-0.1918E-04	0.	0.	0.	0.	0.	0.3836E-04	0.
0.	0.	0.	0.	-0.1918E-04	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 8**							
0.	-0.1918E-04	0.	0.	0.	0.	0.	0.3836E-04
0.	0.	0.	0.	0.	-0.1918E-04	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 9**							
0.	0.	-0.1918E-04	0.	0.	0.	0.	0.
0.3836E-04	0.	0.	0.	0.	0.	-0.1918E-04	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 10**							
0.	0.	0.	-0.1918E-04	0.	0.	0.	0.
0.	0.3836E-04	0.	0.	0.	0.	0.	-0.1918E-04
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 11**							
0.	0.	0.	0.	-0.1918E-04	0.	0.	0.
0.	0.	0.3836E-04	0.	0.	0.	0.	0.
-0.1918E-04	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 12**							
0.	0.	0.	0.	0.	-0.1918E-04	0.	0.
0.	0.	0.	0.3836E-04	0.	0.	0.	0.
0.	-0.1918E-04	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 13**							
0.	0.	0.	0.	0.	0.	-0.1918E-04	0.
0.	0.	0.	0.	0.3836E-04	0.	0.	0.
0.	0.	-0.1918E-04	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 14**							
0.	0.	0.	0.	0.	0.	0.	-0.1918E-04
0.	0.	0.	0.	0.	0.3836E-04	0.	0.
0.	0.	0.	-0.1918E-04	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 15**							
0.	0.	0.	0.	0.	0.	0.	0.
-0.1918E-04	0.	0.	0.	0.	0.	0.3836E-04	0.
0.	0.	0.	0.	-0.1918E-04	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 16**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	-0.1918E-04	0.	0.	0.	0.	0.	0.3836E-04
0.	0.	0.	0.	0.	-0.1918E-04	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 17**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	-0.1918E-04	0.	0.	0.	0.	0.
0.3836E-04	0.	0.	0.	0.	0.	-0.1918E-04	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 18**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	-0.1918E-04	0.	0.	0.	0.
0.	0.3836E-04	0.	0.	0.	0.	0.	-0.1918E-04
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 19**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	-0.3836E-04	0.	0.	0.
0.	0.	0.3836E-04	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 20**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	-0.3836E-04	0.	0.
0.	0.	0.	0.3836E-04	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 21**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	-0.3836E-04	0.
0.	0.	0.	0.	0.3836E-04	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 22**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	-0.3836E-04
0.	0.	0.	0.	0.	0.3836E-04	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 23**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
-0.3836E-04	0.	0.	0.	0.	0.	0.3836E-04	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						
** ROW 24**							
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.
0.	-0.3836E-04	0.	0.	0.	0.	0.	0.3836E-04
0.	0.	0.	0.	0.	0.	0.	0.
0.	0.						

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
FINAL MATRIX
** ROW  1**
  0.2885E-00   0.5906E 01   0.1873E 01  -0.3089E-01  -0.8800E-01  -0.5335E-01   0.6062E 01   0.7048E-01
 -0.9111E 00  -0.2300E-01  -0.5554E 00  -0.1040E 01   0.3324E-01   0.3335E-01   0.7738E-02  -0.2573E-01
 -0.5118E-01  -0.3024E-01   0.1842E-00   0.1082E-01   0.1739E-02  -0.1323E-01  -0.2535E-01  -0.1493E-01
** ROW  2**
  0.1517E-00   0.1105E 02   0.6762E 01   0.1512E-01  -0.1659E-00  -0.1165E-00   0.3091E 01   0.1553E-00
 -0.3981E-00  -0.7413E-02  -0.7061E 00  -0.1280E 01   0.1510E-01   0.1040E-00   0.7469E-01  -0.1845E-01
 -0.1053E-00  -0.6972E-01   0.4061E-01   0.4396E-01   0.3262E-01  -0.1104E-01  -0.5300E-01  -0.3484E-01
** ROW  3**
  0.4865E-01   0.6778E 01   0.9703E 01   0.1338E-00  -0.9031E-01  -0.8952E-01   0.6211E 00   0.1011E-00
  0.1267E 01   0.4222E-01  -0.5206E-01  -0.2740E-01  -0.6223E-02   0.7106E-01   0.9446E-01   0.1686E-01
 -0.7925E-01  -0.6011E-01  -0.2754E-00   0.3064E-01   0.4009E-01   0.4174E-02  -0.4143E-01  -0.3054E-01
** ROW  4**
 -0.2083E-01   0.4452E-00   0.3693E 01   0.2740E-00   0.1722E-00   0.5688E-01  -0.1194E 01  -0.6859E-02
  0.2347E 01   0.9531E-01   0.9660E 00   0.1828E 01  -0.2619E-01  -0.1818E-01   0.1680E-01   0.5275E-01
  0.3476E-01   0.9555E-02  -0.6452E 00  -0.1104E-01   0.4003E-02   0.1944E-01   0.1264E-01   0.3009E-02
** ROW  5**
 -0.6087E-01  -0.4520E 01  -0.2458E 01   0.1725E-00   0.5057E 00   0.2811E-00  -0.2304E 01  -0.9914E-01
  0.4447E 01   0.6312E-01   0.2534E 01   0.4766E 01  -0.4007E-01  -0.1003E-00  -0.7817E-01   0.3503E-01
  0.1684E-00   0.1068E-00  -0.9244E 00  -0.5048E-01  -0.4107E-01   0.1268E-01   0.7561E-01   0.4921E-01
** ROW  6**
 -0.7397E-01  -0.6361E 01  -0.4893E 01   0.1142E-00   0.5623E 00   0.4544E-00  -0.2678E 01  -0.1345E-00
  0.6010E 01   0.4036E-01   0.3477E 01   0.6644E 01  -0.4500E-01  -0.1325E-00  -0.1185E-00   0.1957E-01
  0.2137E-00   0.1623E-00  -0.1026E 01  -0.6611E-01  -0.6043E-01   0.6111E-02   0.9843E-01   0.7436E-01
** ROW  7**
  0.1182E-00   0.2348E 01   0.4650E-00  -0.3342E-01  -0.6418E-01  -0.3727E-01   0.4975E 01   0.4297E-01
 -0.8435E 00  -0.2003E-01  -0.4556E-00  -0.8590E 00   0.7006E-01   0.3436E-01   0.5410E-02  -0.1999E-01
 -0.3695E-01  -0.2144E-01   0.1351E 01   0.1519E-01   0.2255E-02  -0.9985E-02  -0.1834E-01  -0.1064E-01
** ROW  8**
  0.8154E-01   0.7000E 01   0.4557E 01  -0.1136E-01  -0.1627E-00  -0.1103E-00   0.2547E 01   0.1469E-00
 -0.5436E 00  -0.1071E-01  -0.7190E 00  -0.1312E 01   0.3391E-01   0.1255E-00   0.8265E-01  -0.1394E-01
 -0.9843E-01  -0.6552E-01   0.6531E 00   0.5812E-01   0.3946E-01  -0.7605E-02  -0.4936E-01  -0.3276E-01
** ROW  9**
  0.2467E-01   0.4680E 01   0.6268E 01   0.6998E-01  -0.1106E-00  -0.9254E-01   0.4591E-00   0.9164E-01
  0.1244E 01   0.3659E-01  -0.5341E-01  -0.2821E-01   0.1506E-02   0.8133E-01   0.1177E-00   0.2886E-01
 -0.7223E-01  -0.5696E-01  -0.3227E-01   0.3852E-01   0.5469E-01   0.1269E-01  -0.3682E-01  -0.2870E-01
** ROW 10**
 -0.2607E-01  -0.3128E-00   0.1921E 01   0.1568E-00   0.1039E-00   0.3325E-01  -0.1180E 01  -0.1061E-01
  0.2041E 01   0.9642E-01   0.8436E 00   0.1591E 01  -0.2310E-01  -0.1405E-01   0.2862E-01   0.7857E-01
  0.4815E-01   0.1368E-01  -0.5603E 00  -0.7794E-02   0.1246E-01   0.3520E-01   0.2211E-01   0.6163E-02
** ROW 11**
 -0.5959E-01  -0.4617E 01  -0.3081E 01   0.1033E-00   0.3625E-00   0.2165E-00  -0.2226E 01  -0.9789E-01
  0.4142E 01   0.5682E-01   0.2396E 01   0.4492E 01  -0.3848E-01  -0.9695E-01  -0.7223E-01   0.4801E-01
  0.1957E-00   0.1173E-00  -0.8899E 00  -0.4853E-01  -0.3694E-01   0.2197E-01   0.9315E-01   0.5691E-01
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 12**							
-0.7121E-01	-0.6266E 01	-0.5147E 01	0.6565E-01	0.4328E-00	0.3352E-00	-0.2585E 01	-0.1314E-00
0.5882E 01	0.3385E-01	0.3402E 01	0.6520E 01	-0.4371E-01	-0.1289E-00	-0.1138E-00	0.2720E-01
0.2345E-00	0.1855E-00	-0.1002E 01	-0.6427E-01	-0.5744E-01	0.1214E-01	0.1138E-00	0.8879E-01
** ROW 13**							
0.3268E-01	0.5807E 00	-0.2335E-00	-0.3623E-01	-0.5550E-01	-0.3118E-01	0.3541E 01	0.2896E-01
-0.8615E 00	-0.1960E-01	-0.4331E-00	-0.8205E 00	0.1162E-00	0.4241E-01	0.5823E-02	-0.1828E-01
-0.3230E-01	-0.1847E-01	0.2817E 01	0.2244E-01	0.3532E-02	-0.8975E-02	-0.1615E-01	-0.9249E-02
** ROW 14**							
0.3831E-01	0.4681E 01	0.3205E 01	-0.2938E-01	-0.1637E-00	-0.1082E-00	0.2031E 01	0.1254E-00
-0.7662E 00	-0.1398E-01	-0.7781E 00	-0.1431E 01	0.4971E-01	0.1523E-00	0.9193E-01	-0.1112E-01
-0.9611E-01	-0.6416E-01	0.1202E 01	0.7684E-01	0.4735E-01	-0.5155E-02	-0.4807E-01	-0.3212E-01
** ROW 15**							
0.8736E-02	0.3361E 01	0.4259E 01	0.2792E-01	-0.1275E-00	-0.9681E-01	0.3164E-00	0.8256E-01
0.6820E 00	0.2864E-01	-0.2371E-00	-0.3904E-00	0.6901E-02	0.9198E-01	0.1450E-00	0.3921E-01
-0.6933E-01	-0.5634E-01	0.1471E-00	0.4706E-01	0.7348E-01	0.2094E-01	-0.3435E-01	-0.2819E-01
** ROW 16**							
-0.2981E-01	-0.8304E 00	0.7662E 00	0.8688E-01	0.5790E-01	0.1629E-01	-0.1187E 01	-0.1398E-01
0.1645E 01	0.7856E-01	0.6849E 00	0.1288E 01	-0.2133E-01	-0.1105E-01	0.3924E-01	0.1063E-00
0.5889E-01	0.1616E-01	-0.5098E 00	-0.5205E-02	0.2088E-01	0.5415E-01	0.3078E-01	0.8432E-02
** ROW 17**							
-0.5910E-01	-0.4737E 01	-0.3559E 01	0.5742E-01	0.2764E-00	0.1753E-00	-0.2191E 01	-0.9841E-01
0.3619E 01	0.4815E-01	0.2148E 01	0.4028E 01	-0.3778E-01	-0.9602E-01	-0.6927E-01	0.5891E-01
0.2257E-00	0.1276E-00	-0.8761E 00	-0.4785E-01	-0.3439E-01	0.3073E-01	0.1143E-00	0.6514E-01
** ROW 18**							
-0.6978E-01	-0.6274E 01	-0.5402E 01	0.3179E-01	0.3505E-00	0.2661E-00	-0.2541E 01	-0.1310E-00
0.5107E 01	0.2738E-01	0.3038E 01	0.5804E 01	-0.4323E-01	-0.1282E-00	-0.1126E-00	0.3234E-01
0.2551E-00	0.2131E-00	-0.9949E 00	-0.6392E-01	-0.5640E-01	0.1680E-01	0.1303E-00	0.1076E-00
** ROW 19**							
0.7069E-02	0.6478E-01	-0.4060E-00	-0.3491E-01	-0.5014E-01	-0.2786E-01	0.2699E 01	0.2209E-01
-0.8386E 00	-0.1869E-01	-0.4103E-00	-0.7789E 00	0.1114E-00	0.4051E-01	0.4835E-02	-0.1735E-01
-0.2969E-01	-0.1684E-01	0.3671E 01	0.2440E-01	0.3483E-02	-0.8513E-02	-0.1492E-01	-0.8480E-02
** ROW 20**							
0.2458E-01	0.3954E 01	0.2767E 01	-0.3543E-01	-0.1644E-00	-0.1077E-00	0.1792E 01	0.1161E-00
-0.8713E 00	-0.1539E-01	-0.8090E 00	-0.1493E 01	0.5267E-01	0.1537E-00	0.9408E-01	-0.1048E-01
-0.9575E-01	-0.6394E-01	0.1450E 01	0.9217E-01	0.5181E-01	-0.4190E-02	-0.4783E-01	-0.3204E-01
** ROW 21**							
0.3494E-02	0.2926E 01	0.3613E 01	0.1368E-01	-0.1337E-00	-0.9853E-01	0.2578E-00	0.7879E-01
0.4281E-00	0.2504E-01	-0.3212E-00	-0.5562E 00	0.8461E-02	0.9483E-01	0.1470E-00	0.4178E-01
-0.6876E-01	-0.5638E-01	0.2155E-00	0.5190E-01	0.8918E-01	0.2559E-01	-0.3342E-01	-0.2811E-01
** ROW 22**							
-0.3104E-01	-0.1006E 01	0.3775E-00	0.6418E-01	0.4224E-01	0.1040E-01	-0.1192E 01	-0.1531E-01
0.1470E 01	0.7047E-01	0.6152E 00	0.1155E 01	-0.2081E-01	-0.1011E-01	0.4202E-01	0.1084E-00
0.6155E-01	0.1684E-01	-0.4937E-00	-0.4055E-02	0.2565E-01	0.6984E-01	0.3559E-01	0.9440E-02

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

** ROW 23**							
-0.5892E-01	-0.4782E 01	-0.3727E 01	0.4189E-01	0.2484E-00	0.1616E-00	-0.2180E 01	-0.9876E-01
0.3388E 01	0.4430E-01	0.2038E 01	0.3825E 01	-0.3762E-01	-0.9590E-01	-0.6852E-01	0.6170E-01
0.2286E-00	0.1303E-00	-0.8734E 00	-0.4768E-01	-0.3334E-01	0.3562E-01	0.1310E-00	0.6990E-01
** ROW 24**							
-0.6930E-01	-0.6282E 01	-0.5497E 01	0.2017E-01	0.3231E-00	0.2440E-00	-0.2528E 01	-0.1311E-00
0.4761E 01	0.2473E-01	0.2876E 01	0.5485E 01	-0.4313E-01	-0.1282E-00	-0.1125E-00	0.3387E-01
0.2607E-00	0.2153E-00	-0.9944E 00	-0.6392E-01	-0.5614E-01	0.1891E-01	0.1398E-00	0.1234E-00

MODE	EIGENVALUE		ITERATIONS S.P.	D.P.	AITKENS S.P.	D.P.
1	0.19479618E 02	-0.	33	0	0	0
2	0.10531033E 02	0.	50	7	0	0
3	0.55531769E 01	0.	50	11	0	0
4	0.35102478E 01	-0.	33	0	0	0
5	0.18684153E 01	0.	24	0	0	0

EIGENVECTORS

	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
1	0.51858669E 00	0.	-0.26256932E-00	0.	0.82955208E 00	0.
2	0.09999999E 01	0.	0.58430018E-01	-0.	0.19711509E-00	0.
3	0.83876604E 00	0.	0.49089732E-00	-0.	-0.26645629E-00	-0.
4	0.11453288E-00	0.	0.57833327E 00	-0.	-0.53559955E-01	-0.
5	-0.57907083E 00	-0.	0.80327094E 00	-0.	0.58473975E 00	0.
6	-0.86853939E 00	-0.	0.09999999E 01	-0.	0.09999999E 01	0.
7	0.24821915E-00	0.	-0.32229170E-00	0.	0.80293347E 00	0.
8	0.68749375E 00	0.	-0.78744838E-01	0.	0.15819733E-00	0.
9	0.58132744E 00	0.	0.31116541E-00	-0.	-0.16970488E-00	-0.

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

10	0.63967638E-02	0.	0.43887148E-00	-0.	-0.35012328E-01	-0.
11	-0.59767152E 00	-0.	0.71052743E 00	-0.	0.55494273E 00	0.
12	-0.86276652E 00	-0.	0.94592635E 00	-0.	0.98118098E 00	0.
13	0.10783558E-00	0.	-0.36602819E-00	0.	0.77532082E 00	0.
14	0.50513947E 00	0.	-0.18002120E-00	0.	0.11831706E-00	0.
15	0.43169130E-00	0.	0.14372659E-00	-0.	-0.18593792E-00	-0.
16	-0.62290946E-01	-0.	0.32419031E-00	-0.	-0.55626855E-01	-0.
17	-0.60960596E 00	-0.	0.60354750E 00	-0.	0.48073553E-00	0.
18	-0.85156702E 00	-0.	0.81131788E 00	-0.	0.85065921E 00	0.
19	0.62582181E-01	0.	-0.37343035E-00	0.	0.76783439E 00	0.
20	0.44704827E-00	0.	-0.21693903E-00	0.	0.10090122E-00	0.
21	0.38371947E-00	0.	0.81322035E-01	-0.	-0.20127231E-00	-0.
22	-0.84884894E-01	-0.	0.28060313E-00	-0.	-0.68956271E-01	-0.
23	-0.61312911E 00	-0.	0.55999829E 00	-0.	0.44659440E-00	0.
24	-0.84668494E 00	-0.	0.75397815E 00	-0.	0.79207366E 00	0.
	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN	
1	-0.87628299E 00	0.	0.09999999E 01	0.		
2	-0.79207735E 00	0.	-0.46350756E-00	-0.		
3	0.74732616E 00	-0.	0.30384699E-00	0.		
4	0.50810593E 00	-0.	0.32387317E-00	0.		
5	-0.20617031E-00	0.	0.36590583E-01	0.		
6	-0.56951397E 00	0.	-0.15891776E-00	-0.		
7	-0.20692931E-01	0.	0.62807617E 00	0.		
8	-0.16672950E-00	0.	-0.34258884E-00	-0.		
9	0.56158400E 00	-0.	0.66472695E-01	0.		
10	0.32397218E-00	-0.	0.18065070E-00	0.		
11	-0.29312421E-00	0.	-0.23559903E-01	-0.		
12	-0.62014367E 00	0.	-0.20037647E-00	-0.		
13	0.67312041E 00	-0.	-0.27697901E-00	-0.		
14	0.23614569E-00	-0.	-0.45026598E-00	-0.		
15	0.48143043E-00	-0.	-0.65837588E-01	-0.		
16	0.21075475E-00	-0.	0.99834444E-01	0.		
17	-0.34754954E-00	0.	-0.41262345E-01	-0.		
18	-0.63931520E 00	0.	-0.18150035E-00	-0.		
19	0.09999999E 01	-0.	-0.87648887E 00	-0.		
20	0.38168788E-00	-0.	-0.54694762E 00	-0.		
21	0.46102938E-00	-0.	-0.11268654E-00	-0.		
22	0.17300409E-00	-0.	0.74506169E-01	0.		
23	-0.36566363E-00	0.	-0.43532053E-01	-0.		
24	-0.64436060E 00	0.	-0.16918479E-00	-0.		

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

CHECK EIGENVALUES AND EIGENVECTORS

```
0.19479618E 02 -0.            0.10531032E 02  0.            0.55531759E 01  0.
0.35102473E 01 -0.            0.18684155E 01 -0.
```

	COLUMN 1	COLUMN 2	COLUMN 3	COLUMN 4	COLUMN 5	COLUMN 6
1	0.51858669E 00	0.	-0.26256931E-00	0.	0.82955215E 00	-0.
2	0.09999999E 01	0.	0.58430031E-01	-0.	0.19711513E-00	-0.
3	0.83876604E 00	0.	0.49089731E-00	-0.	-0.26645630E-00	0.
4	0.11453288E-00	0.	0.57833328E 00	-0.	-0.53559976E-01	0.
5	-0.57907083E 00	-0.	0.80327093E 00	-0.	0.58473977E 00	-0.
6	-0.86853939E 00	-0.	0.09999999E 01	-0.	0.09999999E 01	-0.
7	0.24821915E-00	0.	-0.32229170E-00	0.	0.80293357E 00	-0.
8	0.68749375E 00	0.	-0.78744834E-01	0.	0.15819736E-00	-0.
9	0.58132744E 00	0.	0.31116542E-00	-0.	-0.16970489E-00	0.
10	0.63967638E-02	0.	0.43887147E-00	-0.	-0.35012351E-01	0.
11	-0.59767152E 00	-0.	0.71052744E 00	-0.	0.55494275E 00	-0.
12	-0.86276652E 00	-0.	0.94592633E 00	-0.	0.98118101E 00	-0.
13	0.10783558E-00	0.	-0.36602820E-00	0.	0.77532091E 00	-0.
14	0.50513947E 00	0.	-0.18002119E-00	0.	0.11831710E-00	-0.
15	0.43169130E-00	0.	0.14372659E-00	-0.	-0.18593793E-00	0.
16	-0.62290946E-01	-0.	0.32419031E-00	-0.	-0.55626871E-01	0.
17	-0.60960596E 00	-0.	0.60354751E 00	-0.	0.48073554E-00	-0.
18	-0.85156702E 00	-0.	0.81131787E 00	-0.	0.85065920E 00	-0.
19	0.62562181E-01	0.	-0.37343036E-00	0.	0.76783450E 00	-0.
20	0.44704827E-00	0.	-0.21693902E-00	0.	0.10090126E-00	-0.
21	0.38371947E-00	0.	0.81322035E-01	-0.	-0.20127232E-00	0.
22	-0.84884894E-01	-0.	0.28060315E-00	-0.	-0.68956291E-01	0.
23	-0.61312911E 00	-0.	0.55999829E 00	-0.	0.44659439E-00	-0.
24	-0.84668494E 00	-0.	0.75397816E 00	-0.	0.79207366E 00	-0.

	COLUMN 7	COLUMN 8	COLUMN 9	COLUMN 10	COLUMN
1	-0.87628337E 00	-0.	0.09999999E 01	0.	
2	-0.79207761E 00	-0.	-0.46390782E-00	-0.	
3	0.74732621E 00	0.	0.30384646E-00	0.	
4	0.50810624E 00	0.	0.32387303E-00	0.	
5	-0.20617008E-00	-0.	0.36590731E-01	0.	
6	-0.56951362E 00	-0.	-0.15891732E-00	-0.	
7	-0.20693158E-01	-0.	0.62807622E 00	0.	
8	-0.16672964E-00	-0.	-0.34298901E-00	-0.	
9	0.56158413E 00	0.	0.66472408E-01	0.	
10	0.32397238E-00	0.	0.18065064E-00	0.	
11	-0.29312397E-00	-0.	-0.23559695E-01	-0.	
12	-0.62014322E 00	-0.	-0.20037591E-00	-0.	

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

```
 14    0.23614561E-00   0.           -0.45026610E-00  -0.
 15    0.48143050E-00   0.           -0.65837806E-01  -0.
 16    0.21075489E-00   0.            0.99834414E-01   0.
 17   -0.34754938E-00  -0.           -0.41262152E-01  -0.
 18   -0.63931482E 00  -0.           -0.18149985E-00  -0.
 19    0.09999999E 01   0.           -0.87648871E 00  -0.
 20    0.38168780E-00   0.           -0.54694775E 00  -0.
 21    0.46102948E-00   0.           -0.11268668E-00  -0.
 22    0.17300419E-00   0.            0.74506135E-01   0.
 23   -0.36566336E-00  -0.           -0.43531751E-01  -0.
 24   -0.64436039E 00  -0.           -0.16918444E-00  -0.

**FREQUENCY IN CPS**
       0.290874E 02     0.               0.395602E 02     0.               0.544783E 02
       0.               0.685213E 02     0.               0.939199E 02     0.


VALUES OF STRESS FUNCTIONS ARE

FOR NO.  1,   EIGENVALUE OF    0.513357E-01
    -0.184208E 05   -0.184208E 05   -0.184208E 05   -0.184208E 05   -0.184208E 05   -0.184208E 05
    -0.115071E 04   -0.176170E 05   -0.199603E 05   -0.141514E 05   -0.844934E 04   -0.636473E 04
    -0.125596E 05   -0.292725E 05   -0.308387E 05   -0.186144E 05   -0.615749E 04   -0.127328E 04
    -0.239685E 05   -0.360064E 05   -0.361200E 05   -0.212548E 05   -0.605339E 04    0.238612E-03
    -0.356909E 05   -0.522556E 05   -0.545216E 05   -0.484780E 05   -0.426340E 05   -0.405058E 05
    -0.184208E 05   -0.176171E 05   -0.292726E 05   -0.360064E 05
FOR NO.  3,   EIGENVALUE OF   0.949574E-01
    -0.138423E 06   -0.138423E 06   -0.138423E 06   -0.138423E 06   -0.138423E 06   -0.138423E 06
    -0.217546E 05   -0.455286E 05   -0.533679E 05   -0.538811E 05   -0.520430E 05   -0.506917E 05
     0.580042E 04   -0.333661E 04   -0.142275E 05   -0.144442E 05   -0.117691E 05   -0.107757E 05
     0.333554E 05    0.117916E 05   -0.294874E 04   -0.340719E 04   -0.640279E 03    0.186152E-02
    -0.255091E 06   -0.278959E 06   -0.286884E 06   -0.287312E 06   -0.285425E 06   -0.284048E 06
    -0.138423E 06   -0.455286E 05   -0.333662E 04    0.117916E 05
FOR NO.  5,   EIGENVALUE OF   0.180077E-00
    -0.130294E 06   -0.130294E 06   -0.130294E 06   -0.130294E 06   -0.130294E 06   -0.130294E 06
    -0.292528E 05   -0.433851E 05   -0.442211E 05   -0.469772E 05   -0.496250E 05   -0.501455E 05
     0.499362E 03    0.234851E 04    0.331543E 04   -0.932216E 03   -0.770595E 04   -0.110985E 05
     0.302515E 05    0.198840E 05    0.185151E 05    0.134107E 05    0.478330E 04    0.173821E-02
    -0.231335E 06   -0.245472E 06   -0.246097E 06   -0.248972E 06   -0.251727E 06   -0.252274E 06
    -0.130294E 06   -0.433851E 05    0.234850E 04    0.198840E 05
```

FINITE DIFFERENCE METHOD FOR SANDWICHED SHELL, CORE THICKNESS = 0.90000E 00 MBAR = 0.17120E-04

** INPUT DATA **

FOR NO. 7, EIGENVALUE OF 0.284880E-00

-0.230840E 05	-0.230840E 05	-0.230840E 05	-0.230840E 05	-0.230840E 05	-0.230840E 05
0.460472E 04	0.208058E 05	0.217604E 04	-0.710264E 04	-0.735287E 04	-0.647665E 04
0.566376E 05	0.664671E 05	0.233954E 05	-0.218628E 03	-0.276151E 04	-0.106500E 04
0.108670E 06	0.903362E 05	0.325952E 05	0.198122E 04	-0.193952E 04	0.337982E-03
-0.507727E 05	-0.347735E 05	-0.546791E 05	-0.638676E 05	-0.639354E 05	-0.629865E 05
-0.230840E 05	0.208058E 05	0.664671E 05	0.903362E 05		

FOR NO. 9, EIGENVALUE OF 0.535213E 00

0.456284E 05	0.456284E 05	0.456284E 05	0.456284E 05	0.456284E 05	0.456284E 05
0.227783E 05	0.178277E 05	0.121483E 05	0.153824E 05	0.199725E 05	0.216728E 05
-0.330511E 05	-0.239622E 05	-0.202686E 05	-0.102075E 05	0.861574E 03	0.556888E 04
-0.888804E 05	-0.494148E 05	-0.344417E 05	-0.200893E 05	-0.605763E 04	-0.570264E-03
0.684784E 05	0.643211E 05	0.579733E 05	0.613600E 05	0.660853E 05	0.678302E 05
0.456284E 05	0.178277E 05	-0.239622E 05	-0.494148E 05		