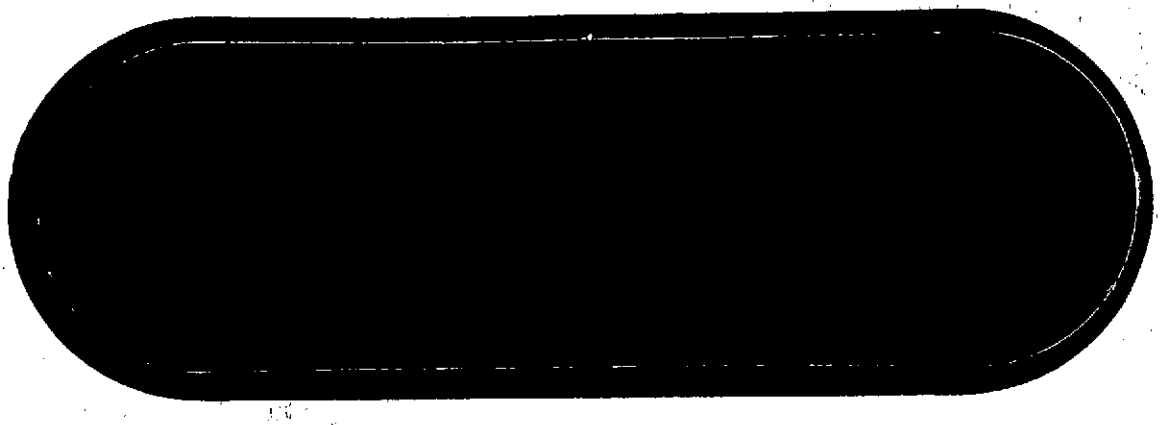
NASA CR- 111869-2

BOEING



(NASA-CR-111869-2) BUCLAP: A COMPUTER PROGRAM FOR UNIAXIAL COMPRESSIVE BUCKLING LOADS OF ORTHOTROPIC LAMINATED PLATES (Boeing Co., Renton, Wash.) 175 p

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PROGRAM DESCRIPTION DOCUMENT

BUCLAP

A Computer Program for Uniaxial Compressive Buckling Loads of Orthotropic Laminated Plates

Prepared for the
National Aeronautics and Space Administration
Langley Research Center
Hampton, Virginia
under
Contract No. NAS1-8858
by
The Boeing Company
Commercial Airplane Group
Renton, Washington

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ABSTRACT

This Program Description document describes the program structure and details of a CDC 6600 Fortran IV digital computer program which applies minimum energy principles to solve for buckling loads of orthotropic laminated plates. Given up to 25 laminas and their material constants, this program calculates uniaxial compressive buckling loads for the plate for a choice of 4 different boundary conditions. A Program Method and Usage document is also available for this program.

This program is developed for NASA, Langley Research Center, under Contract No. NAS1-8858.

KEY WORDS

BUCKLING
UNIAXIAL COMPRESSION
COMPOSITES
PLATES
LAMINATES
ORTHOTROPIC
PLATE BUCKLING
SANDWICH PLATES

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1. SUMMARY

The BUCLAP program has the capability to solve for the critical uniaxial compressive buckling load of an orthotropic laminated flat plate with various boundary conditions. The method used here is the classical approach of minimum energy consideration. A variational principle is applied to derive the equilibrium equations and the consistent boundary conditions. Linearized theory is used.

Four different boundary condition configurations are available.

1.1 Problem Description

This program was originated in connection with NASA Contract No. NAS1-8858. The purpose of the computer program is to implement the analytical work under the same contract.

The objective is to develop a program which computes the axial compressive buckling load for various composite reinforced metal plates.

The following four boundary condition configurations are required:

B.C. I	All sides simply supported.
B.C. II	Loaded edges clamped, two sides simply supported.
B.C. III	Loaded edges simply supported, one side simply supported, one side free.
B.C. IV	Loaded edges simply supported, two sides free.

The program is written in such a manner that it can be used as a building block for further programming efforts (under this contract) on a program for buckling of structural sections built up of flat orthotropic laminated plate elements.

1.2 Program Design

The program is dimensioned so that it can handle rectangular plates with up to 25 laminas. The various laminas can be of either isotropic material, or orthotropic material. Sandwich cores, or glue layers, can be included in the laminate by using their appropriate in-plane properties, and assuming that they have infinite out-of-plane stiffness. For filamentary composites only fiber orientation parallel and normal to the load direction are allowed.

The structure of the program is built as one main overlay for the purpose of generating absolute program tapes. The main program is in essence designed to find the zero crossing of the buckling determinant DB, by a process in which trial loads are increased stepwise until the determinant changes sign. The last step is subdivided by using a smaller load step until the sign change occurs again. This process is repeated until the sign change (critical load) is located to an interval of sufficiently small size. The function subroutine DB returns the value of the buckling determinant. In doing this DB needs to solve the equilibrium equations, which is expressed as a complex determinant expression det(DT) = 0. ZARK, a complex root-finder, is used for this purpose. The function subroutine DT is written for the purpose of generating and evaluating the DT-determinant.

The program is coded in Fortran IV and has been run on the CDC 6600 computers at The Boeing Company in Renton. The only data input required is by cards, and all output is in the form of print. No data tapes or punched output is given. The intent is to write the program in such a way as to facilitate converting and running it at the computer installation of NASA at Langley Research Center.

1.3 Conclusions

The program has been subject to specific testing and checkout, which is shown in Section 5.0 of Program Method and Usage document.

It is concluded that the program is in accordance with the original objectives, as the results obtained are in good agreement with theoretical and test results available in the literature.

1.4 Recommendations

The numerical difficulties, inherent in the type of problem solved here, have established the search strategy for determining the critical load. The progress of this search depends upon the magnitude of the starting load and load interval. In certain cases, two zero crossings of the buckling determinant occur for quite close buckling loads; or the critical load is close to a load which gives double roots when the equilibrium equations are solved. Under conditions like this, some care should be exercised in choosing the starting load and the iteration step size. If any difficulties are encountered, the load increment input data can be decreased and another run made.

The program has been coded with care so as to minimize the probability for any of these problems to occur.

2.0 COMPUTER PROGRAM DESCRIPTION

2.1 Definitions

B.C. — Short form of 'boundary condition configuration'. Often used in this document together with a roman figure from I to IV to identify the four available configurations.

'Coupling' — Coupling between bending and stretching occurs when the coupling stiffness matrix B is nonzero.

Definitions of other terms are also given where they are used, in the comments to the flow charts and in the descriptions of each individual subroutine. The program listing also contains a legend of the variables.

2.2 Program Discussion

The structure of this program is designed as one main overlay for the purpose of generating absolute program tapes. The overall structure of the program and the communication lines to subroutines can best be seen from Section 2.3.1 where a top level flowchart for the entire program is shown. See Section 3.0 for comments on theoretical equations, and differences between theory and program for practical reasons.

First the program reads the data and initializes certain variables, for the first data set. However, a check is made for an End-of-File card at the first data card read in each set, so that the program will read and execute each set one by one until encounter of EOF card. This way it is not necessary to load the program for each data set. After the title card the program proceeds to read the rest of the data, which contains various controls, data describing the geometry of the plate and also material properties. Data for the material properties for one lamina may be given in three ways. For detailed description of data and the different options please see data input specifications (Method and Usage Document, Section 4.7). When they are entered as fiber and matrix properties the subroutine MACON is called to compute the other elastic constants (E11, E22, G12, etc.) and the lamina stiffness matrix [Q]. When the Q-matrix is entered directly the program will compute the properties E11, E22, etc., to print them out for checking purposes.

After the Q-matrix is established the location of the neutral reference plane with respect to the chosen reference plane at one of the plate surfaces is calculated.

Now the plate stiffness matrices A, B, and D are established. A is extensional stiffness, B coupling stiffness, and D is the bending stiffness matrix.

When the B-matrix is zero (for isotropic plates and symmetric laminates) there is no coupling between stretching and bending and the computations in the rest of the program can be simplified and some computer time saved. A flag KXY is used in the rest of the program to choose the appropriate path for a case of "no coupling."

The program looks for a zero B-matrix by checking all of its elements against a specified tolerance (1.0 has been tried and found to be satisfactory during actual use of the program). If they are all smaller than this tolerance the B-matrix is assumed to be zero and the flag KXY is set to 1. If the material constants only are required, the execution of the program will be interrupted here according to a control which is given in input data cards.

Four different boundary condition configurations are available and any selection of these may be chosen for each data set. This is done by looping four times and checking corresponding positions in the control-array NCASE (see input specifications) for which B.C.'s were specified in the input and then bypass the ones not required.

The buckling displacement pattern chosen for a particular B.C. for the plate corresponds to a transverse mode N and/or a longitudinal mode M. In the input is given lower and upper limits for all the modes relevant to the boundary conditions. The program provides in the dimension statements for a maximum of 30 modes in each direction so that the difference between upper and lower limits should not exceed this limitation. For B.C. I both N and M are considered, for B.C. II N alone is used while for B.C. III and B.C. IV the longitudinal mode M is used.

The program is set up with loops on both the modes, and for B.C.'s where the mode for one of the two directions is irrelevant the respective loop limits are set to one making that loop a dummy loop.

The process for finding the critical load falls into two categories. For B.C. I the load can be solved directly from the equilibrium equations as the displacement pattern automatically satisfies boundary conditions. For B.C. II, III, and IV the boundary conditions are satisfied by solving the determinant expression $|DB| = 0$. $|DB|$ is the so called buckling determinant and in the process of establishing the value of this determinant the equilibrium equations also will be solved. Solving the equilibrium equations here, means that we have to find the complex roots of another determinant expression $|DT| = 0$, this being the determinant of the coefficient matrix for the equilibrium equations.

The search for the first zero crossing for the buckling determinant DB is set up as a straight forward iteration procedure where a starting load is given and thereafter the load is increased by a given step until the sign of the determinant changes. After the first change in sign the program now uses as a start load the last load before the sign change and as load step a secondary interval that was read in. At subsequent sign changes this process is repeated each time halving the load step until the zero-crossing (and the critical load for the current mode and B.C.) is located to an interval of size less than a certain per cent of the lower bound of the interval. For loads less than 50 lbs/in 1% is used and for higher loads 0.5%.

Now the load is established by linear interpolation in this small interval, and we can go on to the next mode if any.

However, this search is complicated by the fact that at loads where double roots are encountered in the solution of the equilibrium equations, the sign of the buckling determinant is unpredictable. (See explanation of Subroutine Function DB and DT. The DB-function uses the ZARK-routine to solve the equilibrium equations and solves with respect to p^2 and thus when we talk about the "root" here we mean the root-squared.) Because of this complication, the loads at which double roots occur have to be found. The roots (complex) consist of conjugate pairs and real numbers. At the point where one conjugate pair degenerates into two real numbers of the same size these can be interpreted as double roots, and thus a double root is detected when the number of conjugate pairs or the number of negative real roots changes.

For a real root (squared), if it goes from positive to negative, this means that it is zero for some load in between, and we have a double root (± 0 when we take the square root).

The load(s) which produce the double roots are located more closely by using the same step iteration procedure as used for finding the critical load. The search for the double root is started when a change occurs in the number of conjugate pairs, total number of real roots or number of negative real roots among the roots of the equilibrium equation. If the critical load is sensed on the way to the double root it will be located instead and the search for the "double root" abandoned.

The "double root" load is located to an interval of size less than 0.04% of the lower bound of the interval for loads larger than 50 lbs. and 0.1% otherwise. This small interval is then ignored in the remainder of the search for the critical load.

After the "double root" location is found a new start is made on the search, but with primary and secondary load step equal to 1/10 of the step sizes read in. If nothing happens during the first ten steps after the "double root" the program will return to the primary and secondary load steps that were read in.

In the coding the logic for finding the critical load and that for finding the loads which gives "double roots" is overlapped and intermingled and the logic is best seen from the program flowchart.

The initial load after the "double root" will be the upper limit of the interval to which it is located.

In certain cases of double real roots this start load will also result in real roots which are still practically double. This can also happen for the first trial load (read in) at the start of this mode, even though the chance for this is very remote. When this happens a message is printed and this load is skipped. The new start load is arrived at by perturbing the previous load by 1%, but not less than 0.5 lbs/in and not more than the primary interval. When the double real root has been avoided the program will proceed normally.

The reason for being so careful is that one has found from experience that in some cases the buckling load can be quite close to a load which gives "double root" and thus the critical load could be bypassed otherwise.

In situations where many load steps have to be made in order to find the critical load and the loads which give "double root" it is possible to exceed available array space if precautions are not taken. Consequently a restart with reset indexing is made each time 50 loads have been tried, while still keeping track of possible sign change and occurance of "double root," thus allowing that the array space be reused.

When the total number of loadsteps used exceeds the limit 800 for the mode under consideration, the calculations are interrupted and the program proceeds to the next mode or data set, if any. A message is printed to this effect. The purpose of this check is to conserve computer time in cases where the startload and loadsteps are chosen too low relative to the critical load. A rerun is then required with increased startload and/or loadstep for this particular data set.

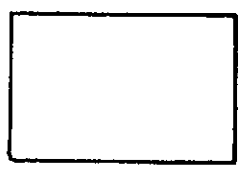
For B.C. II two different buckling displacement patterns (one symmetric and one antisymmetric) are considered simultaneously, and the two buckling determinants are computed at the same time. Double roots occur for the same loads for both cases and thus the logic is completely parallel for both. The program will choose the smallest buckling load of the two displacement patterns as the critical buckling load.

After the loop on all modes are done the program will select and print out the critical loads and modes in a manner relevant with the B.C. in question.

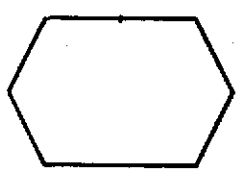
2.3 Program Flowcharts

The following symbols will be used in the flowcharts given for this program:

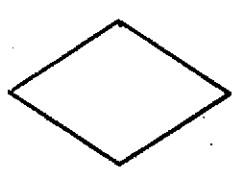
Start or termination of program or subroutine.



Computation, Input, Output, Subroutine Call.



Start of Do-Loop.

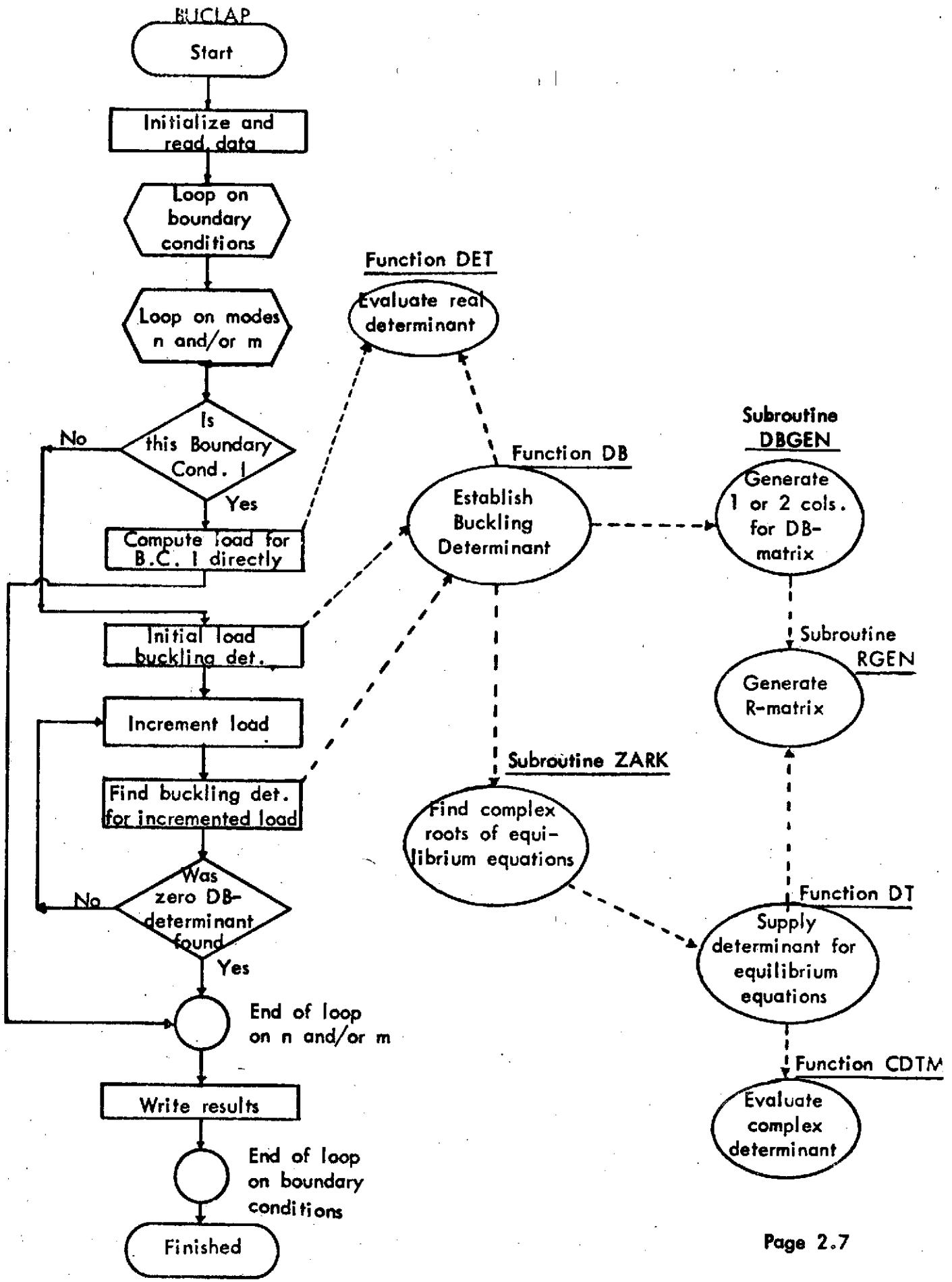


Decisions

Statement numbers, end of loop, connector.

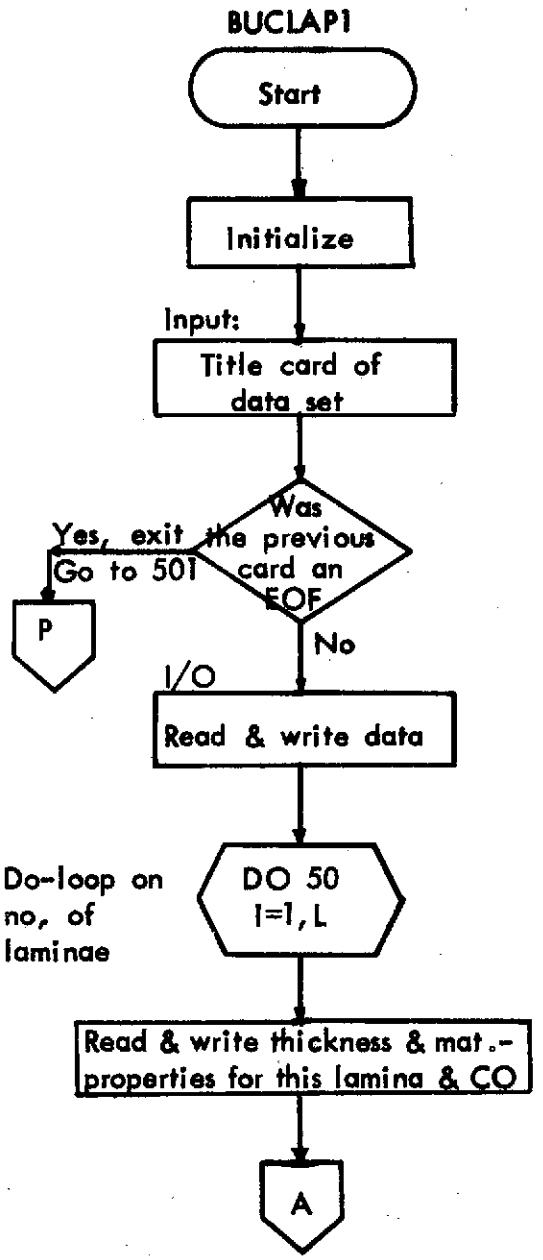
Off-page and On-page connector.

2.3.1 Top Level Flowchart for Entire Program



2.3.2 Intermediate Level Flowchart

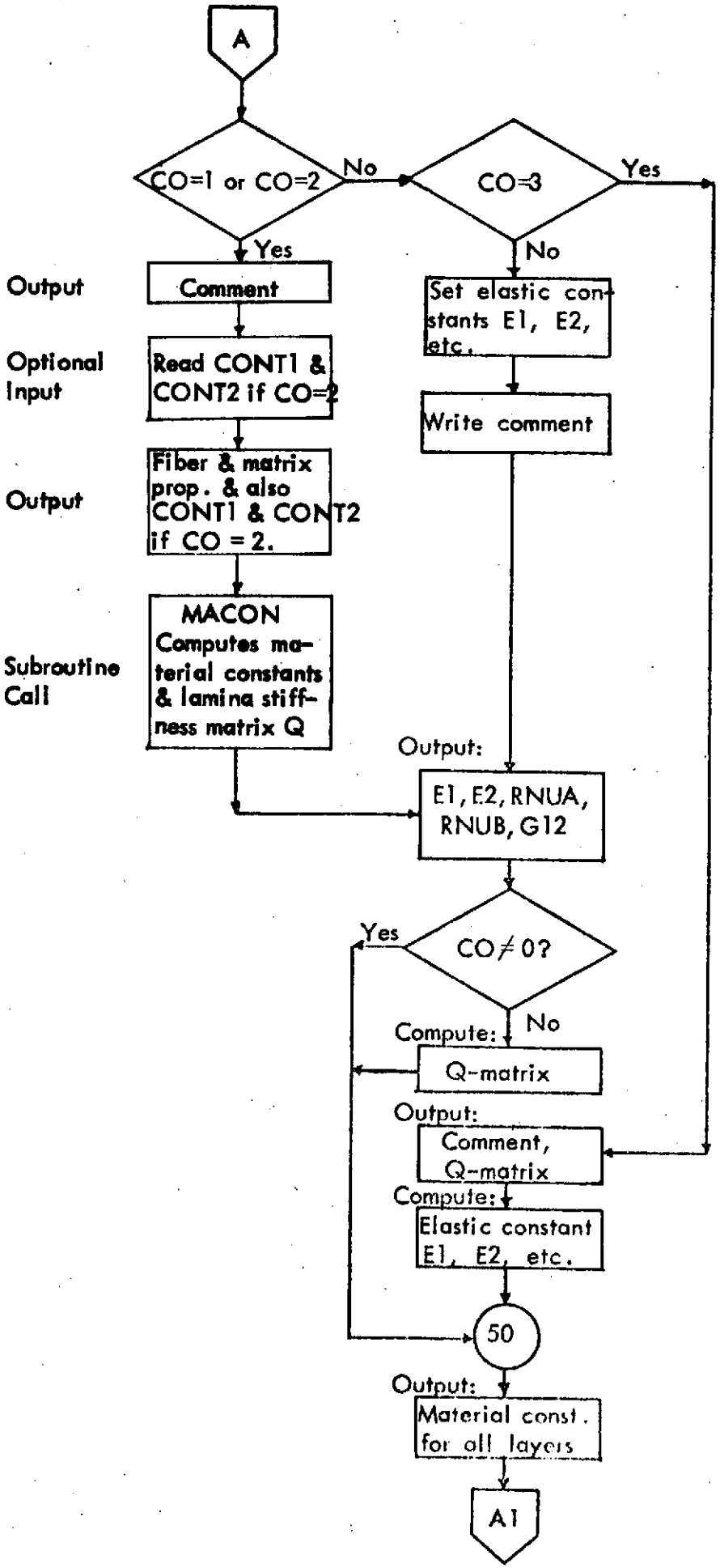
Main Program: BUCLAP1



Please see the input specifications for details on data formats.

I = index for current lamina
L = no. of lamina

CO - control for which input option will be used for the lamina-properties.



The available options are:

CO=0 Enter material properties E1, E2, etc.

CO=1 Enter fiber and matrix properties and compute E1, E2, etc. Contiguity factors have no change for this lamina.

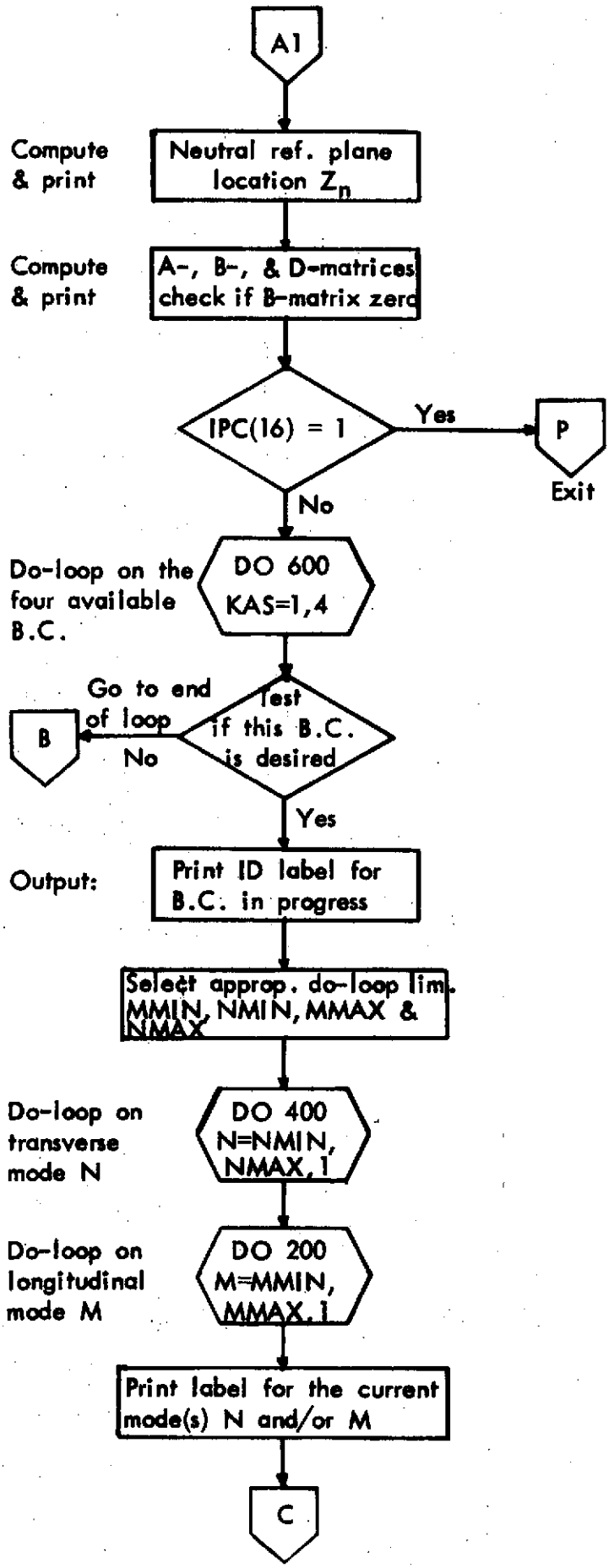
CO=2 Same as for CO=1 but that the contiguity factors are different than previous. These are read once after the first layer, and each time they change.

CO=3 Enter Q-matrix directly.

MACON is a subroutine used to compute the other material constants when fiber and matrix constants are given.

CONT, CONT1, CONT2 are contiguity factors.

If Q-matrix is entered directly, the material-properties are derived and printed for checking purposes.



If B-matrix - coupling stiffness-- is zero there is no coupling between bending and stretching.

IPC(16) controls if only calculation for material properties is required.

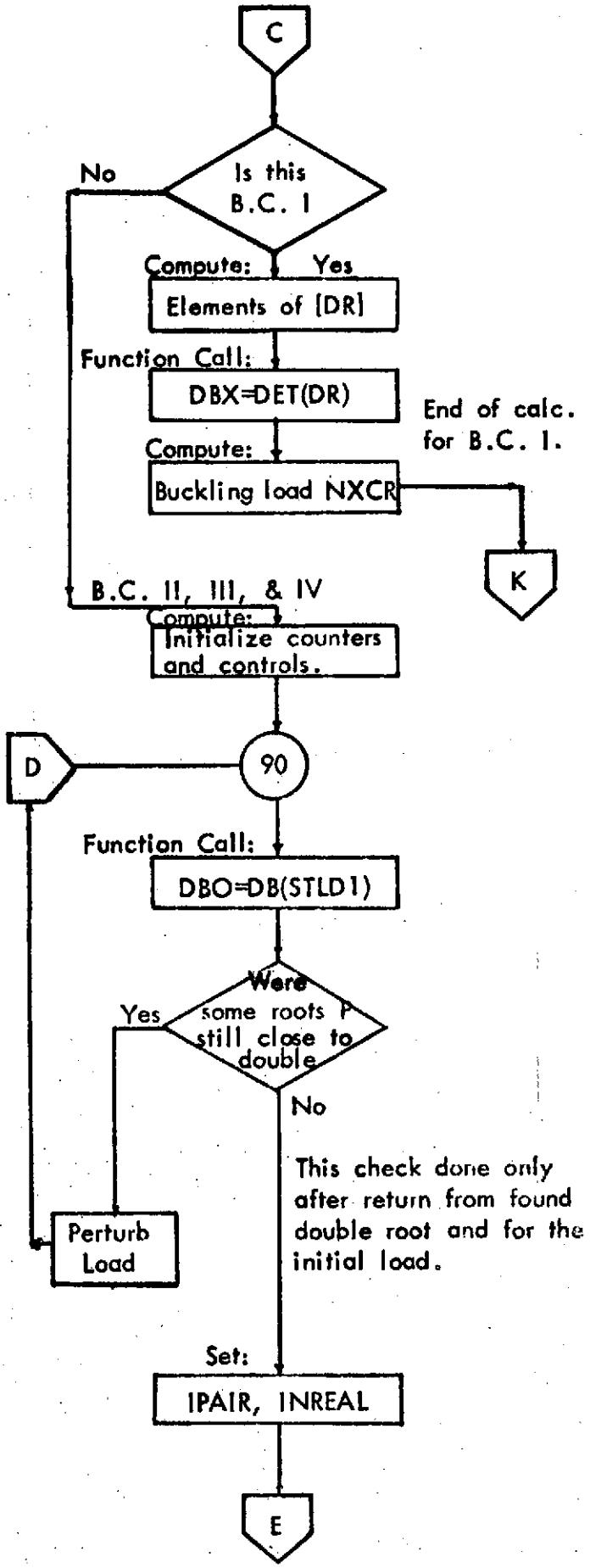
The array NCASE controls which boundary conditions are to be selected.

If NCASE(KAS) $\neq$ 0 then proceed and do the work for this boundary condition.

See program listing of program description for more information on available boundary conditions.

The limits for the loop on transverse mode N and longitudinal mode M are read in with the data and is now picked up for use with the relevant boundary condition.

For B.C.'s where the mode for one of the two directions are irrelevant, the limits for this direction are both set to one. That loop is then a dummy loop.

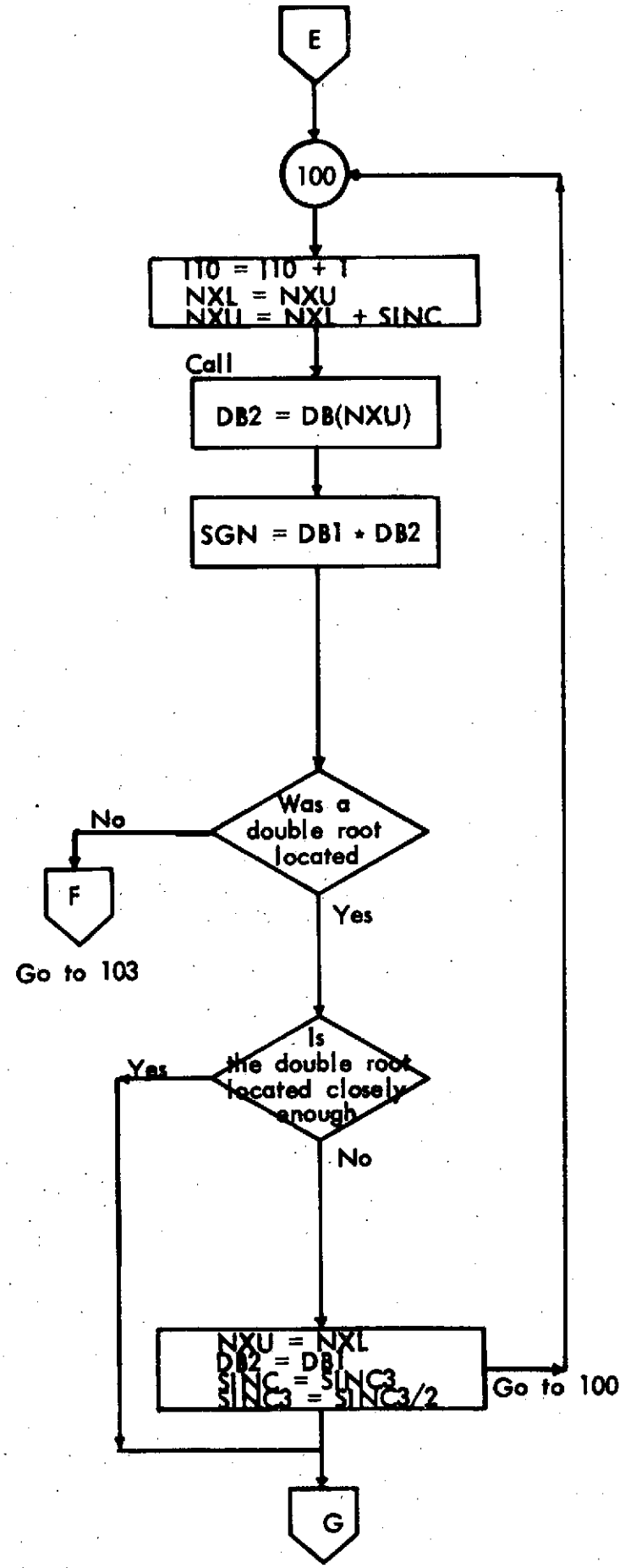


For B.C. I the loaded edges and both sides are simply supported. The boundary conditions are satisfied automatically through the way the displacement function is chosen. Consequently the buckling load can be found directly from the equilibrium equations and without iteration. DR is the same as the R-matrix for B.C. I.

Initial call to the DB-function at the start of the iteration and also after a double root in the equilibrium equations was located.

IPAIR = Number of conjugate pairs among the P-roots.

INREAL = Number of negative real roots among the P-roots.



I10 - Counter for number of DB-calls.
NXL - Lower bound for current load interval.
NXU - Upper bound for current load interval.

Set counter.
Reset lower limit and increment will give upper limit.

Find buckling determinant DB for the incremented load.

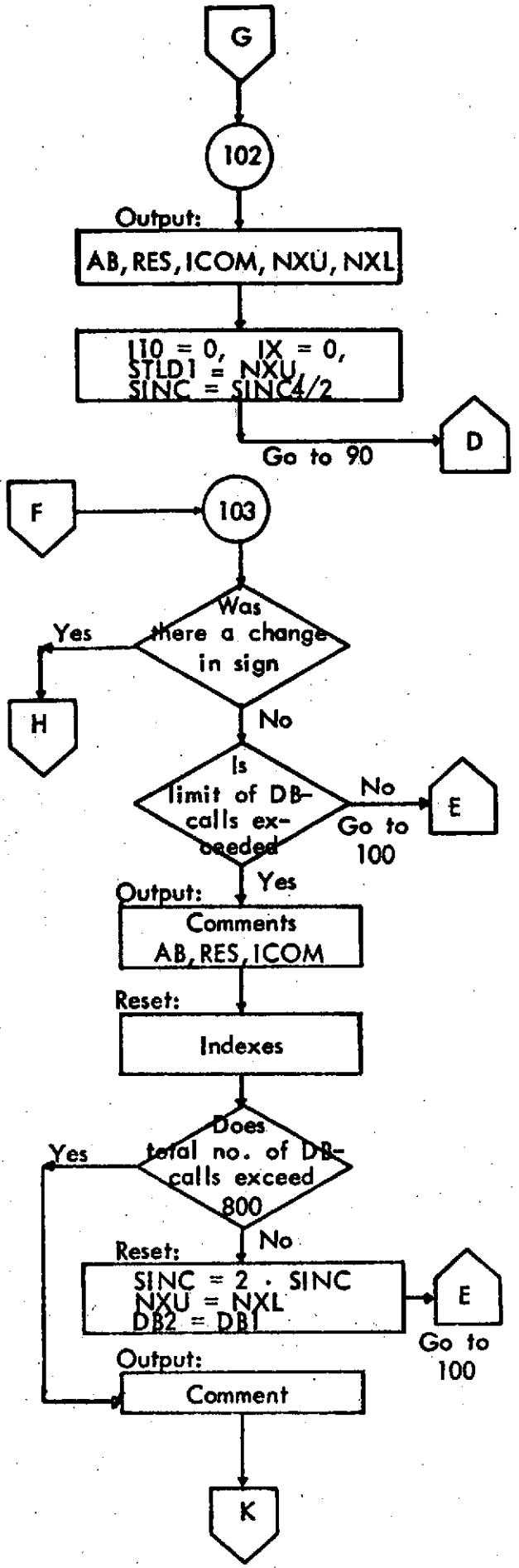
The zero of the DB-determinant is located by finding where its sign changes (if no double root was encountered).

KK - number of conjugate pairs currently.
IPAIR = number of conjugate pairs previously.
KRN = number of negative real roots currently.
INREAL = number of negative real roots previously.

The check is done on the number of conjugate pairs and the number of negative numbers in the roots P from the equilibrium equations.

If the KK or KRN change, a double root occurs in the vicinity of this load. The load which causes this double root will then be located by iteration.

The tolerance for this iteration is set as 0.1% of the current load, for loads less than 50 lbs., otherwise 0.04%.
Reset upper limit and its DB-determinant.
Go back with increment equal to secondary interval (read in) the first time. For subsequent iterations halve interval each time.



AB - Loads tried during iteration.
RES - DB-determinant values.
ICOM - Appropriate comments.

These arrays contain the information for each call to DB.

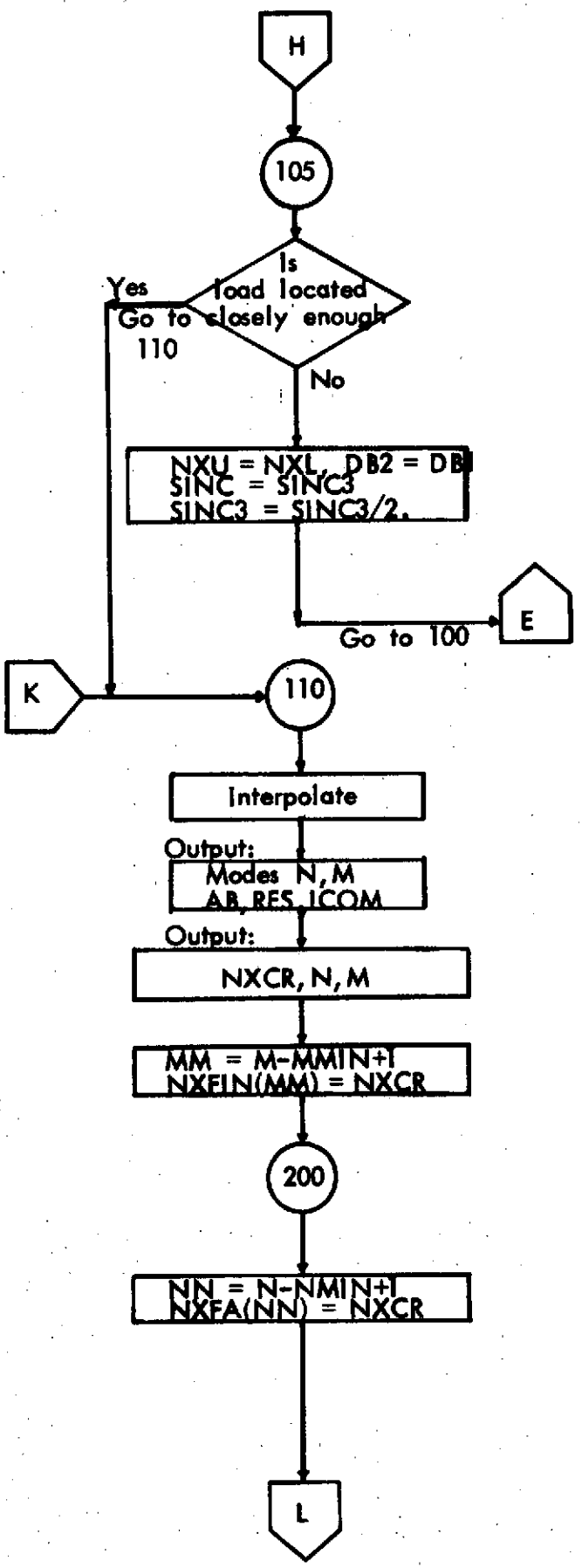
NXU, NXL are in this case the upper and lower limit of the intervals to which the load that gives the double robt is located.

SGN indicates if the sign of the DB-determinant has changed between two subsequent DB-calls.

$I10 \leq 50$. If this limit is exceeded the indexes are reset so that array space is not overfilled and can be used over again.

Write appropriate comments and the results obtained so far.

If the total number of DB-calls exceeds 800, the critical load should have been found if the startload and initial load increments were chosen properly. In such a case one will quit here and the user can re-evaluate his data. A comment is provided to this effect, and the program proceeds to the next mode. Otherwise the loadincrement is doubled and restart is done by going back to 100.



It is assumed that the load is located closely enough for practical purposes if the DB-determinant zero-crossing is narrowed down to an interval of size less than 0.5% of the lower limit of the interval. If the load is less than 50 (lbs/in) this percentage is 1.0.

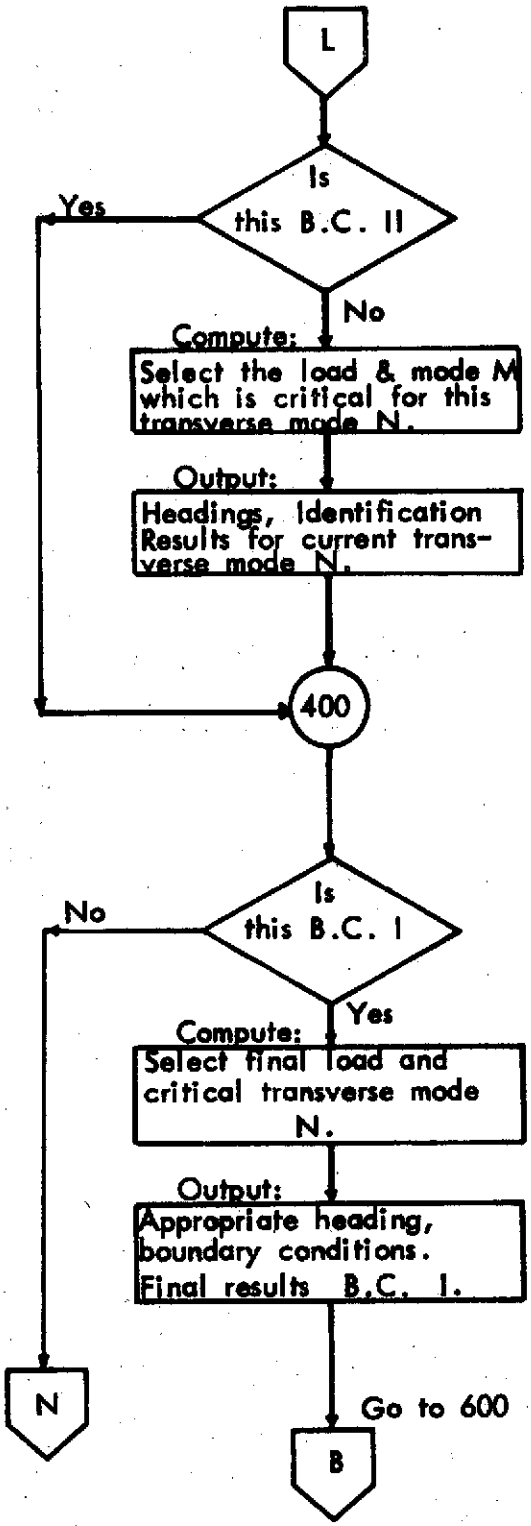
The interval lower limit is reset and the load increment halved before a return is made to statement 100. This process is repeated until the tolerances are satisfied.

The critical load for this mode is located to an interval of size less than a specified tolerance. The load is then obtained through linear interpolation in this interval.

NXCR - critical load (lbs/in)
N - transverse mode
M - longitudinal mode
NXFIN - array containing loads for the long. modes.
Store result for this longitudinal mode.

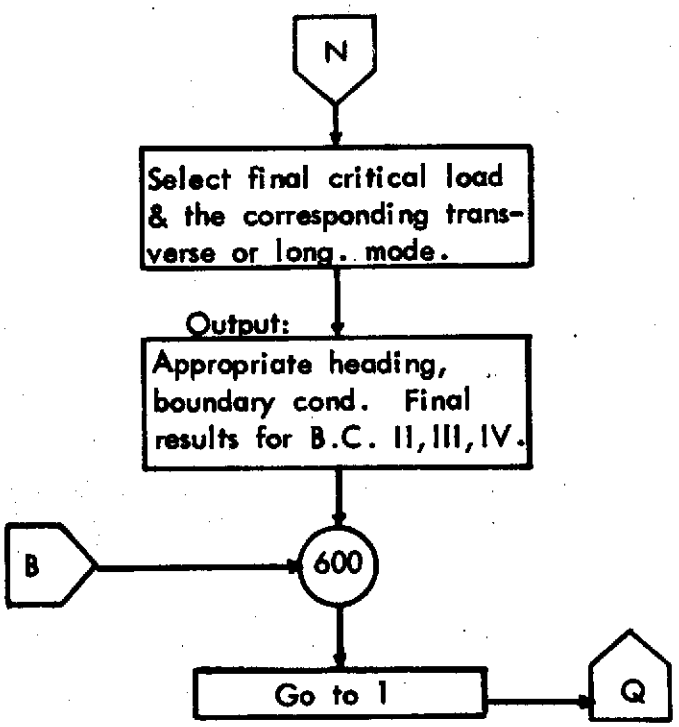
End of loop on longitudinal modes M. For boundary conditions where M is irrelevant (B.C. II) only one pass is made.

NXFA - array for critical load for the transverse modes.



End of loop on the transverse modes N.
For boundary conditions where N is irrelevant (B.C. III and IV) only one pass is made through this loop.

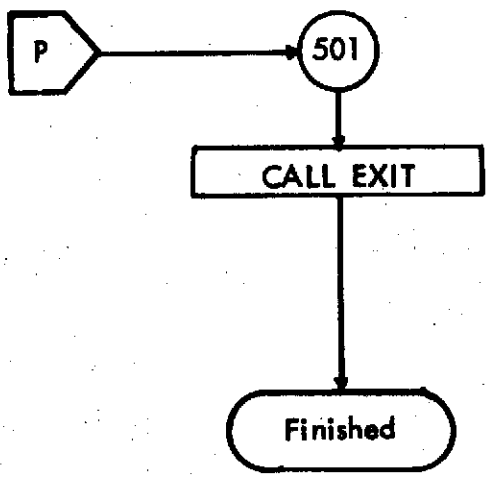
For B.C. I the buckling modes in both directions are considered, and the output is consequently treated differently.



The final output is labeled with respect to which one of either the longitudinal mode M or the transverse mode N is relevant for the current boundary condition.

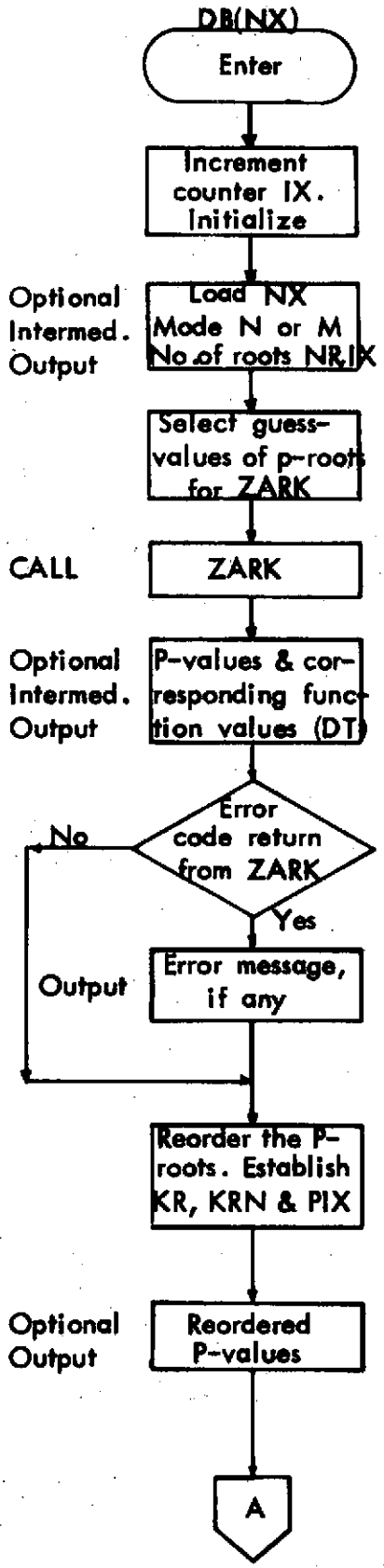
End of loop on the 4 available boundary conditions.

Go back to the beginning of the program for another data set.



If EOF is encountered instead of more data program will jump to 501 and exit.

2.3.3 Intermediate Level Flowchart Function Subprogram: DB



DB is used to form and evaluate the buckling determinant.

NX - uniaxial compressive load.

IX - counter for number of calls to this routine. It is reset after double roots in det(DT) = 0 and for every 50 calls to DB.

P = p^2 (see explanation below)

NR = number of roots.

ZARK is used to solve the complex determinant expression det(DT) = 0. Values of det(DT) is supplied to ZARK by an external function subprogram called DT. Expressed in polynomial form the equilibrium equation would have only terms with even powers of the parameter p. We take advantage of this in that we solve for p^2 and thus solve for half the number of roots.

The ZARK program needs guess-values and there are three possibilities for selecting these:

a. Let ZARK use its own set of guesses. The control IO is set for this for the initial DB-call and at restart.

b. Use the perturbed P-values from the last load tried as guess-values.

c. Use the perturbed P-values (P2) from last DB-call before sign change or double root was encountered.

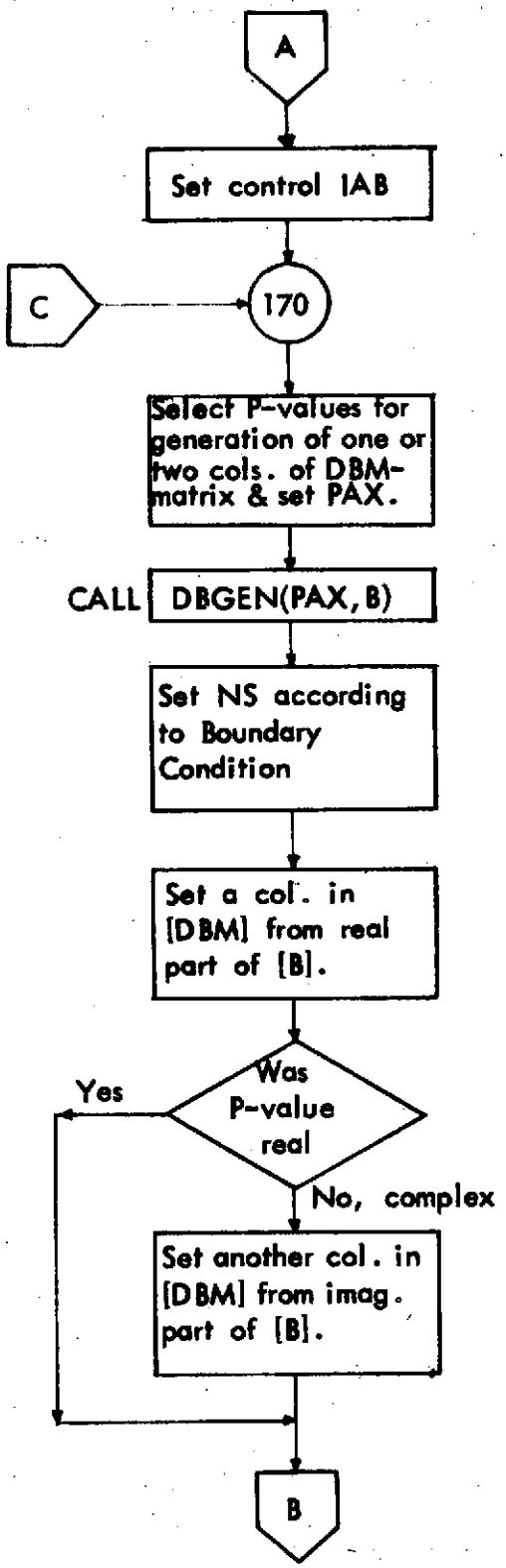
The P-roots are ordered so that conjugate pairs stand together in the array and the one with the negative imaginary part first. Real numbers are not reordered. At the same time KK, KR, KRN and PIX are generated.

KR - number of real roots + total number of roots.

KRN - number of negative real roots.

KK - number of conjugate pairs.

PIX - array containing identification for the respective p-values.



Check if any of the real roots p are double - if so set IAB = 1 otherwise IAB = 0. Two real roots are considered to be double if they are less than 3% different from each other.

PAX = p = $\sqrt{P}$

Set PAX so that it becomes a complex number with both parts positive. This can be done for reasons of symmetry.

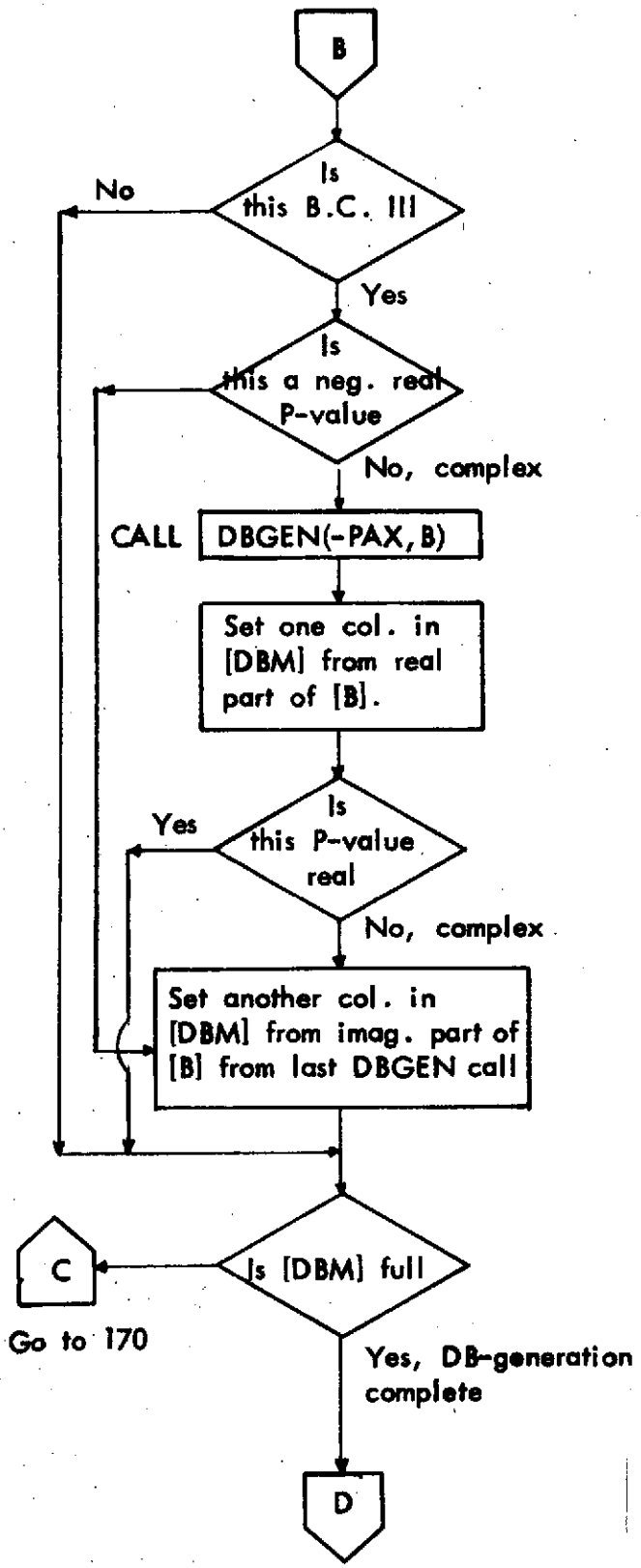
NS = number of rows.

[B] = output from DBGEN. Will contribute one or two columns in DB.

[DBM] = the matrix for the DB-determinant.

The [B] from one cell to DBGEN will contribute one column of [DBM] for a real P-value and two columns for a complex P-value or a negative real P-value.

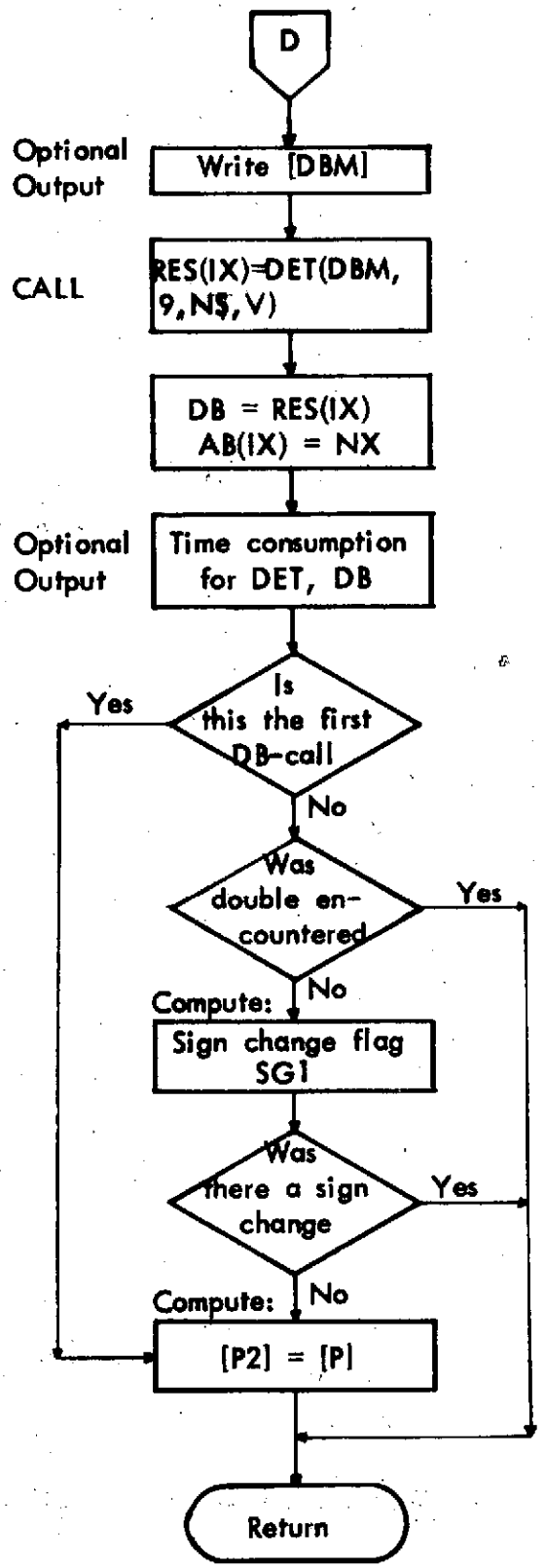
The reason for this process is that we will make the DB-determinant real. For the case of complex P-values occuring in conjugate pairs, the two complex columns can be converted to two real columns by a process of addition and subtraction and by taking the common factor $i = \sqrt{-1}$ outside.



For Boundary Condition III also the negative values of P are used since the enforced boundary conditions are different along the two edges.

This is done by calling DBGEN with -p instead of p(PAX) and add one or two more columns.

When the P-value is negative and real PAX becomes a complex number and thus for B.C. III will contribute two columns.



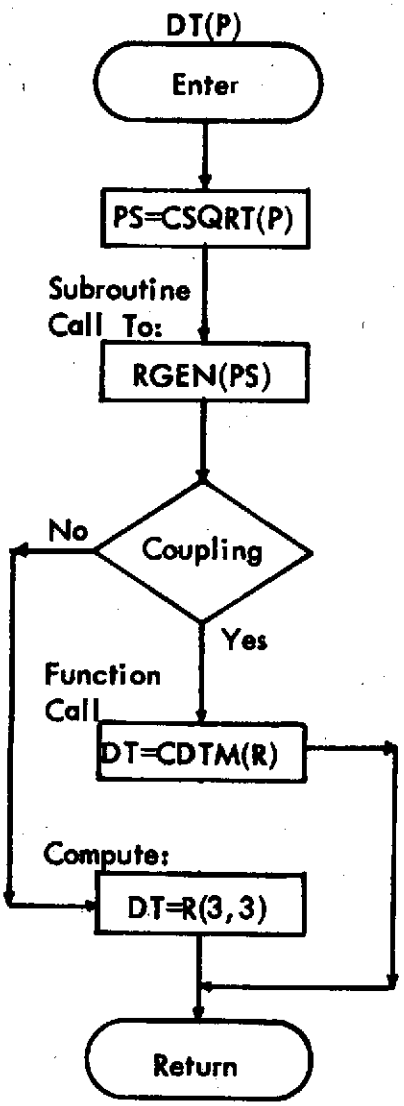
The DET function subprogram is used to evaluate real determinants.

RES(IX) - buckling determinant for DB-call no. IX.

AB(IX) - load for DB-call no. IX.

P2 is a save array for P-values to be perturbed and used as guess values for ZARK in the case that the next DB-call gives a sign change or a double root is encountered. P2 will then be used for the DB-call following the change.

2.3.4 Flowchart of Function Subprogram DT



The DT function receives a parameter P and returns the value of the determinant of the R-matrix which is the matrix for the equilibrium equation.

RGEN is called to generate the elements of the R-matrix while CDTM is used to evaluate its determinant.

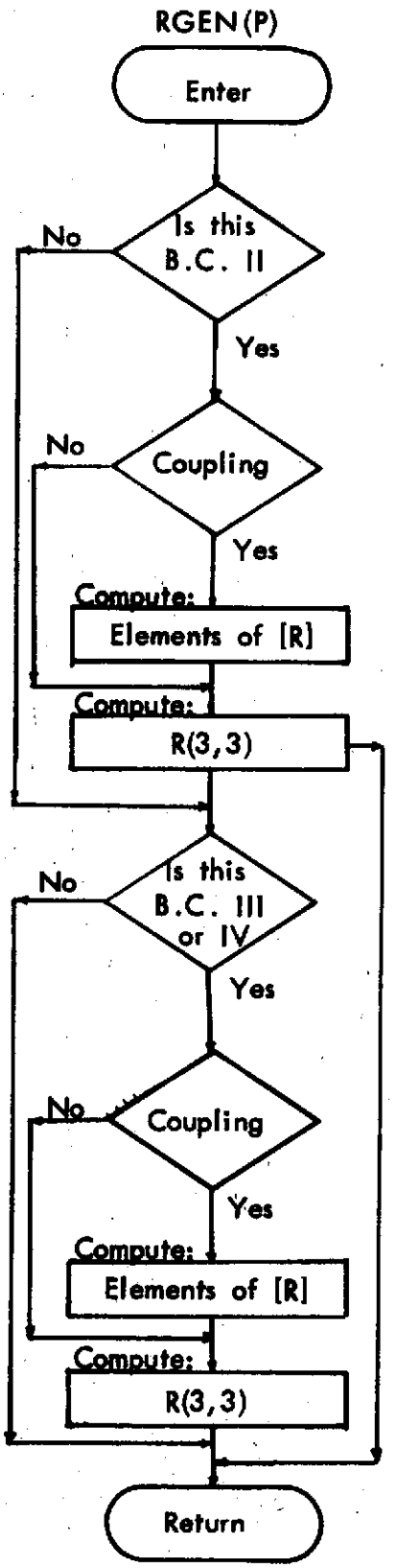
If the determinant of the R-matrix is developed in a polynomial form it will have only even powers of P.

Consequently we can reduce the order of the problem by letting ZARK solve for P^2. This is done by entering the square root of P ($PS = p = \sqrt{P}$) into the RGEN function.

'COUPLING' refers to coupling between stretching and bending. In the case of no coupling the DT-function returns the value of element R(3,3) as function value.

DT is used by the complex rootfinder subroutine ZARK as an external function.

2.3.5 Flowchart of Subroutine RGEN



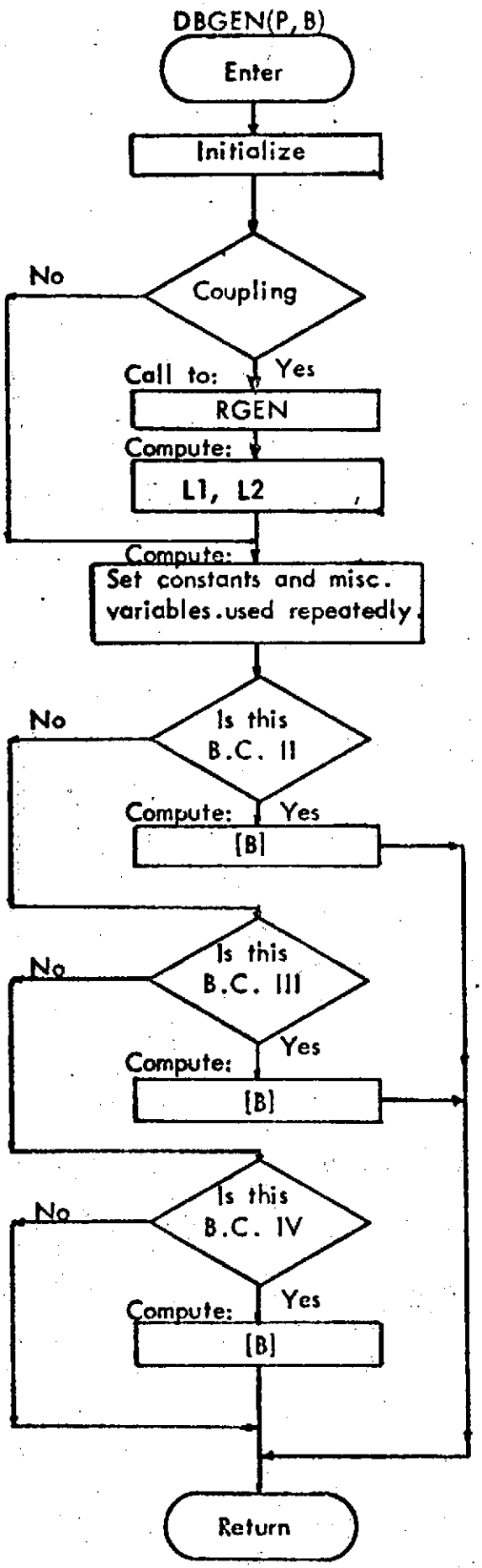
RGEN is used for boundary conditions II, III, and IV and generates elements of coefficient matrix [R] for the equilibrium equations.

'B.C.' - Boundary Condition

'Coupling' - Refers to coupling between uniaxial stretching and bending. In the case of no coupling (symmetric laminates) only the element R(3,3) is calculated.

RGEN is used by the DT-function subprogram and DBGEN subroutine. It uses only complex numbers.

2.3.6 Flowchart of Subroutine DBGEN



This subroutine generates the elements for one or two columns of the boundary conditions matrix DB, (the buckling determinant) returned as the complex array [B].

It is called by the DB-function subprogram. In the case of coupling (between bending and stretching) it becomes necessary to find the relative displacements L1 and L2 which are then used in the expressions for [B].

The existance of coupling is determined by testing the flag KXY and the appropriate formulae chosen accordingly.

3.0 SUBPROGRAM DESCRIPTION

Sections 3.1 to 3.8 describe the various subprograms used. Some special comments are made below regarding the equations used in the subprograms RGEN, DBGEN, and the equations used in that part of the main program where computations are made for B.C. 1.

Equations given in Section 2.0 (Theory) of the Program Method and Usage Document (here-in-after called "Theory Equations," in this section), are written in terms of the length of the plate "a" and the width of the plate "b". When test cases of very wide and very long plates were run on the program, it was found desirable to use a/b (for wide plates) and b/a (for long plates), ratios instead of "a" and "b" separately.

For wide plates, the "Theory Equations" for R_{11}, R_{12}, and R_{22} are multiplied by a^2, those for R_{23} and R_{32} are multiplied by a^3 and that for R_{33} multiplied by a^4. Similarly, for a long plate the multiplying factors become b^2, b^3, and b^4. This results in equations in terms of (a/b) for wide plates and (b/a) for long plates. These changes are effected in the coding in DR(I, J), (I, J=1, 2, 3), in the main program and in the subprogram RGEN through two factors F1 and F2. The use of these factors saves separate coding, each for wide and long plates. The factors take the following values.

Table 3.1 Multiplying Factor for Wide and Long Plates

Factor	$a/b \leq 1$ (wide plate)	$b/a < 1$ (long plate)
F1	1.0	b/a
F2	a/b	1.0

Identical changes are effected in the coding of the subprogram DBGEN also, through use of the same factors, to distinguish between wide and long plates.

It is further pointed out that, in the main program coding for B.C. 1, R_{IJ} and D_R of "Theory Equations" are referred to as DR(I, J) and DBX, respectively.

3.1 Subroutine MACON

Author: Viktor Oeverli

Purpose: This subroutine will compute the material constants and the lamina stiffness matrix when the fiber and matrix properties are given for a composite. Also the volume fraction coefficient for the fibers, the contiguity factors, and the ply angle must be given.

Method: First the engineering constants E11, E22, $\nu 12$, $\nu 21$, and G are established for the directions normal and parallel to the ply direction of the lamina. All the formulae for this part is taken from Tsai, S. W., Structural Behavior of Composite Materials, NASA-CR-71, Section 2.0, (1964). Then the lamina stiffness matrix is computed and transformed to the plate axis, according to Ashton, J. E., Halpin, J. C., Petit, P. E., Primer on Composite Materials: Analysis, Progress in Material Science Series, Vol. III, Chapter 2.3, Technomic Publications, 1969.

This subroutine is general in the sense that any ply-angle may be considered, but however the complete buckling analysis considers only plates which are orthotropic with respect to the plate axes. Consequently the use of this subroutine should be limited to ply angles of 0° and 90° when full buckling analysis is done. If for some reason the material constants and lamina stiffness matrix only is required the user can use also other ply angles and optionally interrupt the program after the material constants are printed out.

Usage: See Section 5.1 for glossary of variables in common.

```
CALL  MACON(K, CONT1, CONT2)
```

Input:

K	Lamina index.
CONT1	Contiguity factor used for G and ZMU12.
CONT2	Contiguity factor used for E22 and ZMU21.

Contiguity factors could be established from the literature (see the above reference) or by tests.

Common Input:

EF, GF, ZMUF, EM, GM, ZMUM, UF, THETA

Common Output:

E11, E22, G, ZMU12, ZMU21, C

Subroutines Called: None

Restrictions: See Method and references above.

Equipment: CDC 6600

Language: Fortran IV

Precision: Single

Storage: 706_8

3.2 Function Subprogram DB

Author: Viktor Oeverli

Purpose: The purpose of this routine is to form and evaluate the buckling determinant DB for a given load and for given modes N and/or M.

Method: The DB-function is called repeatedly by the main program in a search procedure to find the smallest load where the DB function is zero. The value of the DB function depends upon the roots of the equilibrium equations, which are described by the determinant expression det(DT)=0.

The routine ZARK which is a complex root finder, is used to solve this complex determinant expression. The DT function subprogram (external) is used by ZARK for the purpose of supplying function values for trial values of the set of roots, P.

Actually, ZARK solved for the set of roots P which are the square of roots p from the equilibrium equations (see description of DT routine). The complex square roots of P are then used later as p.

The ZARK routine requires three sets of guess-values to be supplied. Optionally, ZARK routine can generate the sets of guess-values that are needed. In this program ZARK uses its own values for only the initial call to DB for the current mode and boundary conditions.

In all later calls to DB, some previous set of roots are used to make three sets of guess values by perturbation. After a double root or sign change is encountered, the set of roots from the last DB-call (stored in P2 array) prior to the double root or sign change, are used for the guess-values. Otherwise the set of roots from the previous DB-call are used. (See description of P2 at end of this section.)

If errors covered by the error code return for ZARK are encountered the relevant error messages are then printed out.

The set of roots P given by ZARK are in a random order and therefore have to be reordered.

These roots are reordered so that conjugate pairs are selected in a manner so that they stand together and the one with the negative imaginary part coming first. Two roots P1 and P2 are considered a conjugate pair when the absolute values of both real and imaginary parts do not differ by more than a selected tolerance. The tolerances are set to a value equal the real or imaginary part divided by 10^6. The real roots are reordered in increasing order when there are two real roots and one conjugate pair, otherwise they are not reordered.

A root is assumed to be real number when its imaginary part is less than 10^{-6}, as this tolerance was found to work satisfactorily during actual use of the program.

Simultaneous to the reordering procedure, an array PIX(9) is set up which contains numbering for each of the roots. Each conjugate pair is given numbers sequentially from one and upwards (both roots of the pair are given the same number). The real roots are numbered sequentially upwards starting at a number which is one larger than the total number of roots. These numbers are stored in PIX. The purpose of this array is to establish once only which roots are real and complex, and later the same information can be obtained from PIX.

Now all the real roots are checked against each other to see if any two of them are equal or so close to each other that they are virtually double roots. If a double real root is found the control IAB is set to one and is used in the main program.

The generation of the elements of the DBM matrix (buckling det.) is done next. A procedure is used which gives the buckling determinant in a real form. As mentioned earlier, ZARK finds the roots to the second power. So, the complex square root of each one is taken to arrive at the roots PAX. A loop is done on the roots in which each conjugate pair contributes two columns and each real root one column of DBM. When two columns of the DB-determinant are formed from the conjugate values, then by a process of addition and subtraction of the two columns, one column of only real numbers and another column of only imaginary numbers can be formed. Then by taking the common factor i $(=\sqrt{-1})$ outside, the determinant is made to contain only real numbers.

The negative roots ($PAX_i = -\sqrt{P_i}$) are ignored for B.C. II and B.C. IV, as the enforced boundary conditions are symmetric, whereas for B.C. III the negative roots also are considered. See "Theory" Section of the Program Method and Usage Document.

The determinant is now evaluated by the DET routine and the load and determinant value is stored in AB and RES.

Parallel to the above procedure for generating the DB-determinant, for B.C. II another matrix DBMA is also set up for the alternate assymetric displacement pattern as well. This determinant is also evaluated and then stored in the RESA array. For B.C. II the main program thus investigates both an assymetric and a symmetric displacement pattern.

At the end of the routine the P2 array, which is used later for the guess values for ZARK, is normally reset. By avoiding the reset of P2 when a double root or a sign change occurs during the current call of this routine, the values from a previous call remain in P2.

Thus in the next DB-call P2 will contain those same values which were obtained just prior to the detection of either a double root or a sign change in the buckling determinant. Guess values for ZARK can then be set up using as a basis P2 which came from a load smaller than the one which gives the double root or sign change.

Usage: See Section 5.1 for glossary of variables in common.

DB1 = DB(NX)

Input:

NX Load (lbs/in)

Common Input:

KXX, KXY, DB1, DB2, DB1A, DB2A, DBA, N, M, PI, AL, BL, INREAL, IPAIR, SGN, SGNA

Common Output:

IX, AB, RES, RESA, KK, KRNA, IAB

Error Returns: None

Subroutines Called: DBGEN, ZARK, DET

Restrictions: Special routine for BUCLAP only.

Equipment: CDC 6600

Language: Fortran IV

Precision: Single

Storage: 2621_8

3.3 Function Subprogram DT

Author: Viktor Oeverli

Purpose: The purpose of this routine is to supply function values of the DT-function. This function is the determinant of the coefficient matrix for the equilibrium equations, and is used by the ZARK routine to solve these equations.

Method: Subroutine RGEN is used to generate the complex elements of DT (R-matrix) while the complex determinant evaluation is done by the CDTM function subprogram.

The equilibrium equations expanded in a polynomial form will contain only even powers of the root p_i. (See Section 2.2.3.2 of Method and Usage Document) The order of the equations can then be halved by solving with respect to p_i^2 and then take the square root afterwards. Since RGEN contains formulae in terms of p_i and DT is entered with the parameter P (p_i-squared) RGEN is called with the complex square root of P.

The program uses the flag KXY to distinguish between symmetrical and unsymmetrical laminates. For a symmetrical laminate (isotropic plate, e.g.) the RGEN routine will compute only element R(3,3) and DT-function is set equal to this element instead of evaluating the determinant.

Usage: See Section 5.1 for glossary of variables in common.

The DT function subprogram is used inside the ZARK routine which is called in the following manner in the DB routine.

```
EXTERNAL DT
CALL  ZARK(N, GUESS, MAX, EP1, EP2, DT, I, ANS, FANS)
```

The other parameters in the calling sequence are defined in Section 3.8.

Input:

The DT function is called with a parameter P which is one trial root in the iteration process.

Common Input:

R, KXY

Error Return: None

Subroutines Called: CDTM - complex determinant evaluation

Restrictions: Special routine for BUCLAP only.

Equipment: CDC 6600

Language: Fortran IV

Precision: Single

Storage: 51_8

3.4 Subroutine RGEN

Author: Viktor Oeverli

Purpose: The purpose of this subroutine is to generate the elements of the coefficient matrix R for the equilibrium equations.

Method: The program takes different paths according to which boundary conditions is being considered. The R-matrix is the same for B.C. III and B.C. IV. See Method and Usage Document Section 2.2.3.2 for equations for B.C. II and Section 2.2.3.3. and 2.2.3.4 for equations for B.C. III and B.C. IV.

F1 and F2 are factors incorporated for the purpose of avoiding separate coding to handle very wide and very long plates as well. F1 and F2 are set in the main program and is described in Section 3.0. The only element that is coded separately for wide and long plates is element R(3,3).

Usage: See Section 5.1 for glossary of variables in common.

CALL RGEN(P)

Input:

P One root of the equilibrium equations.

Common Input:

LC, NC, N2C, MC, M2C, AC, BC, DC, KXX, KXY, F1, F2

Common Output:

R

Error Return: None

Subroutines Called:	None
Restrictions:	Special routine for BUCLAP only.
Equipment:	CDC 6600
Language:	Fortran IV
Precision:	Single
Storage:	611_8

3.5 Subroutine DBGEN

Author: Viktor Oeverli

Purpose: This subroutine generates the elements for the buckling determinant DB.

Method: A complex matrix [B] is generated. It will contain elements of one or two DB columns, depending on whether its imaginary parts are zero or not, as one column is made from the real part of the number and another from the complex part. Please see description and flowchart for Function Subprogram DB for further details.

The RGEN routine is called to generate the R-matrix which is used to compute the relative displacements L1 and L2.

The code is divided into separate blocks for the three relevant boundary conditions II, III, and IV.

Please refer to Section 3.0 for comments on the equations used.

No coupling between bending and stretching is detected by testing the flag KXY and thus calculations can be minimized. See the flowchart for DBGEN routine. See Method and Usage document for equations.

Usage: See Section 5.1 for glossary of variables.

CALL DBGEN(P, B, B2)

Output:

B DB-column(s) output
B2 DB-column(s) output - alternate assymmetric displacement pattern - B.C. II only.

Input:

P One root of the set roots of the equilibrium equations.

Common Input:

AC, BC, DC, R, KXX, KXY, PI, AL, BL, LC, NC, N2C, MC, M2C, F1, F2

Errors:	No error code returns.
Subroutines Called:	RGEN - generates R-matrix.
Restrictions:	Special routine for BUCLAP only.
Equipment:	CDC 6600
Language:	Fortran IV
Precision:	Single
Storage:	1313_8

3.6 Function Subprogram DET

Author: Paul Lu

Purpose: To evaluate the determinant of a real square matrix.

Method: The given square matrix A is decomposed into lower and upper triangular matrices, L and U, by Crout's method with partial pivoting and row equilibration. Therefore,

$$PA = LU$$

where P is a product of permutation matrices, and we have

$$\det(PA) = \det(L)\,\det(U) = \prod_{i=1}^{n} \ell_{ii}$$

and

$$\det(A) = (-1)^k \prod_{i=1}^{n} \ell_{ii}$$

(k is the total number of row permutations performed on A.)

Usage:

```
DIMENSION  A(NR, ≥ N),  V(≥ N)
Y = DET(A, NR, N, V)
```

Input:

A - elements of a given matrix stored in an array.
NR - the maximum row dimension of the array A.
N - the dimension of the square matrix.
V - a scratch array.

Output: Y - the determinant

Error Return: DET=0. indicates that the given matrix appears singular to this routine. The criteria for singularity is testing the magnitude of a pivotal element against a given tolerance. This test is not fool proof, but reduces the chances of continuing when the matrix being operated upon is hopeless for the given machine precision.

Subroutines Called: None

Checkout: The subprogram DET was used to evaluate the determinant of the inverse Hilbert segment of order seven. The result is correct to seven significant figures.

Restrictions: The magnitude of DET must be between the lower and the upper bounds of the floating point numbers on the machine.

Equipment: CDC 6600

Language: Fortran IV

Precision: Single precision except the accumulated inner product is done in double precision.

Storage: 321_8

3.7. Function Subprogram CDTM

Author: Paul Lu

Purpose: To evaluate the determinant of a complex square matrix.

Method: The given square matrix A is decomposed into lower and upper triangular matrices, L and U, by Crout's method with partial pivoting and row equilibration. So we have

$$\det(PA) = \det(L)\,\det(U) = \prod_{i=1}^{n} \ell_{i,i}$$

where PA = LU and P is a product of permutation matrices, and

$$\det(A) = (-1)^k \prod_{i=1}^{n} \ell_{i,i}$$

where k is the total number of row permutations performed on A.

The routine uses the standard FORTRAN convention for storing complex matrices, but it does not use FORTRAN complex arithmetic.

Usage:
```
COMPLEX A, CDTM, Y
DIMENSION A(NC, ≥N), V(≥N)
Y = CDTM(A, NR, N, V)
```

Input:
- A - elements of a given matrix stored in a complex array.
- NR - 2x NC (the maximum row dimension of the complex array A).
- N - the dimension of the square matrix.
- V - a scratch array.

Output:
- Y - the complex determinant.

Error Return: Both the real and the imaginary parts of CDTM equal to zero indicates the given matrix appears singular. The criteria for singularity is a zero pivot. This test is not fool proof, but reduces the chances of continuing when the matrix being operated upon is hopeless for the given machine precision.

Subroutines Called: None

Checkout: The subprogram CDTM was used to evaluate the determinant of the inverse Hilbert segment of order seven premultiplied by a diagonal complex matrix with elements (1+i, 1-i, 1+2i, 1-2i, 1+3i, 1-3i, 1+4i). The result is correct to seven significant figures.

Restrictions: The magnitude of the real or the imaginary part of CDTM must be between the lower and the upper bounds of the floating point numbers on the machine.

Equipment: CDC 6600

Language: Fortran IV

Precision: Single precision except the accumulated inner product is done in double precision.

Storage: 606_8

3.8 Fortran IV Subroutine ZARK

Author: P. F. Nesdore

Purpose: To find N zeros of an arbitrary complex valued function of a complex variable.

Method: Muller's method of successive approximation with quadratic complex polynomials. The Newtonian form of the approximating polynomial is used. Successive zeros are found by factoring out previously found zeros. That is, if F(Z) is the original function, and a zero Z_o is computed, then the next zero will be found for the function $f(Z)/(Z-Z_o)$. In general, if Z_i i=0, . . . , n, are discovered zeros, the next zero will be sought for the function.

$$F(Z)/\prod_{i=0}^{n}(Z-Z_i) \quad .$$

Usage:

```
EXTERNAL FUN
COMPLEX GUESS(3,N), FUN, ANS(N), FANS(N)
CALL ZARK(N,GUESS,MAX,EP1,EP2,FUN,I,ANS,FANS)
```

Inputs:

N - Number of zeros to be found. Replaced by number of zeros actually found if this is $< N$.

GUESS - Complex array of starting guesses if I = -1. (If I = -2, no starting guesses are given but array space must be saved.) Thus, guesses for the m^{th} zero will be in array elements (1,m), (2,m), (3,m). No two points for one guess must be the same.

MAX - Maximum number of iterations to be executed in finding any one zero.

EP1, EP2 - Convergence tolerances. Iteration will be terminated if $|X_i - X_{i-1}| \leq EP1 \cdot (|X_i|)$ or if $|F(X_i)| \leq EP2$.

X_i and X_{i-1} are the last two approximations to the zero.

FUN - Complex function subprogram with complex parameter X which returns FUN = F(X).

Input/
Output:

I = -1 if guesses are supplied for all desired zeros.

-2 if no starting guesses are supplied. In this case N guesses will be generated from points on the unit circle.

Upon execution of the program I will contain:

0 - if the run was successful.

1 - if it failed to converge in maximum number of iterations. In this case N will contain number of zeros found.

2 - if it failed due to a previously discovered zero lying on the iteration path of a subsequent one. That is, if Z_o is a new zero already found, then the function we are dealing with is $F(Z)/(Z-Z_o)$ (see Method). Thus, if in converging to Z_1, we pass through Z_o, $F(Z)/(Z-Z_o)$ is undefined. This condition does not have a high probability of occurring. If it does occur, perturbing the starting guesses will help.

Output: ANS - N dimensional complex array returning N zeros.

FANS - N dimensional complex array returning the function values at N computed zeros.

Subroutines Called: None

Checkout: Successful runs were obtained for the following problems:

a. 3 zeros for $F(Z) = \sin Z - Z$. $EP1 = 10^{-7}$, $EP2 = 10^{-14}$.

b. 5 zeros for $F(Z) = Z \tan Z - (1+i)$, $EP1 = EP2 = 10^{-10}$.

c. 5 zeros for $f(Z) = (Z-(1+i))\cdot(Z-(1-i))\cdot(Z-i)^3$, $EP1 = EP2 = 10^{-7}$.

d. 1 zero for $F(Z) = Z-(1.1+1.1i)$, $EP1 = EP2 = 10^{-10}$.

e. 5 zeros of $F(Z) = (X-2)^5$, $EP1 = 10^{-9}$, $EP2 = 10^{-20}$.

The answers averaged seven places of the true answer.

Restrictions: None

Equipment: CDC 6600

Language: Fortran IV

Precision: Single

Storage: 1140_8

4.0 SAMPLE PROBLEMS

4.1 Input for Sample 1

```
TEST PLATE K
1    1    1    1
4         1    2    2    1
     3         9.00         2.8          1.0         20.0         2.0
.025 34.0E+6    2.5+6        0.25         1.0+6
.050  16.4+6                  0.35        6.2E+6
.025 34.0E+6    2.5+6        0.25         1.0+6
```

(blank cards here)

4.2. Output for Sample 1

```
TES-285                                                    MAR 17  70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING --          UNIFORM  UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I   ALL EDGES SIMPLY SUPPORTED
                    II  LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
                    III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
                    IV  LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE
*****************************************************************************


TEST PLATE K
    0

BOUNDARY CONDITIONS CONSIDERED IN THIS DATASET ARE
                                                              I
                                                             II
                                                            III
                                                             IV
    1    1    1    1

STARTVALUES FOR LONGITUDINAL MODES M
     B.C.I            B.C.III.    B.C.IV

        1                1          1


STARTVALUES FOR TRANSVERSE MODES N
     B.C.I    B.C.II

        1        1


MAXIMUM VALUES FOR LONGITUDINAL MODES M
     B.C.I            B.C.III.    B.C.IV

        4                1          2


MAXIMUM VALUES FOR TRANSVERSE MODES N
     B.C.I    B.C.II

        2        1
```

NUMBER OF LAYERS	L	=	3
LENGTH	AL	=	9.000
WIDTH	BL	=	2.800

STARTING LOAD	STLD	=	1.000
PRIMARY INTERVAL	SINC	=	20.000
SEC. INTERVAL (NOT USED IF ZERO)	SINC2	=	2.000

LAYER NO 1 INPUT OPTION NO 0 WAS USED
MATERIAL PROPERTIES WAS ENTERED AS E11,E22 ETC.

THICKNESS	T1	=	.0250
E-MODULUS	E1	=	34060000.0000
	E2	=	2500000.0000
POISSONS RATIO	RNUA	=	.2500
	RNUB	=	.0183
TORSIONAL MOD.	G12	=	1000000.0000

LAYER NO 2 INPUT OPTION NO 0 WAS USED
MATERIAL PROPERTIES WAS ENTERED AS E11,E22 ETC.

THICKNESS	T1	=	.0500
E-MODULUS	E1	=	16400000.0000
	E2	=	16400000.0000
POISSONS RATIO	RNUA	=	.3000
	RNUB	=	.3000
TORSIONAL MOD.	G12	=	6200000.0000

LAYER NO 3 INPUT OPTION NO 0 WAS USED
MATERIAL PROPERTIES WAS ENTERED AS E11,E22 ETC.

THICKNESS	T1	=	.0250
E-MODULUS	E1	=	34060000.0000
	E2	=	2500000.0000
POISSONS RATIO	RNUA	=	.2500
	RNUB	=	.0183
TORSIONAL MOD.	G12	=	1000000.0000

LAYER	EXX	EYY	MUXY	MUYX	G
1	3.406000E+07	2.500000E+06	2.500000E-01	1.834997E-02	1.000000E+06
2	1.640000E+07	1.640000E+07	3.000000E-01	3.000000E-01	6.200000E+06
3	3.406000E+07	2.500000E+06	2.500000E-01	1.834997E-02	1.000000E+06

Q-MATRIX LAYER NO 1

34216970.099	627880.397	0.000
627880.397	2511521.587	0.000
0.000	0.000	1000000.000

Q-MATRIX LAYER NO 2

18021978.022	5406593.407	0.000
5406593.407	18021978.022	0.000
0.000	0.000	6200000.000

Q-MATRIX LAYER NO 3

34216970.099	627880.397	0.000
627880.397	2511521.587	0.000
0.000	0.000	1000000.000

LOCATION OF NEUTRAL PLANE
RELATIVE TO REFERENCE PLANE .0500

A-MATRIX

2611947.406	301723.690	0.000
301723.690	1026674.980	0.000
0.000	0.000	360000.000

B-MATRIX

.000	.000	0.000
.000	.000	0.000
0.000	0.000	.000

C-MATRIX

2682.716	102.102	0.000
102.102	370.861	0.000
0.000	0.000	137.500

```
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
B                                      B
B BOUNDARY CONDITION          I        B
B                                      B
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
```

TRANSVERSE MODE N = 1

N = 1 M = 1

CRITICAL LOAD = 6099.8434 P.L.I.

N = 1 M = 2

CRITICAL LOAD = 3462.8514 P.L.I.

N = 1 M = 3

CRITICAL LOAD = 4427.3233 P.L.I.

N = 1 M = 4

CRITICAL LOAD = 6481.0130 P.L.I.

TES-285 MAR 17 70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE K

*** BOUNDARY CONDITION I ***

RESULTS FOR ALL MODES OF M FOR N = 1

LOAD	M
6099.843	1
3462.851	2
4427.323	3
6481.013	4

FINAL RESULTS FOR THIS TRANSVERSE MODE

CRITICAL LOAD = 3463 P.L.I.
FOR MODES M = 2
N = 1

TRANSVERSE MODE N = 2

N = 2 M = 1

CRITICAL LOAD = 81300.8916 P.L.I.

N = 2 M = 2

CRITICAL LOAD = 24399.3756 P.L.I.

N = 2 M = 3

CRITICAL LOAD = 15314.8618 P.L.I.

N = 2 M = 4

CRITICAL LOAD = 13851.4065 P.L.I.

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE K

*** BOUNDARY CONDITION I ***

RESULTS FOR ALL MODES OF M FOR N = 2

LOAD	M
81300.892	1
24399.376	2
15314.662	3
13851.406	4

FINAL RESULTS FOR THIS TRANSVERSE MODE

CRITICAL LOAD = 13851 P.L.I.
FOR MODES M = 4
N = 2

TRANSV. MODE	LONG. MODE	LOAD
1	2	3462.851
2	4	13851.406

TES-285 MAR 17 70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE K

*** BOUNDARY CONDITION 1 ***

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 3463 P.L.I.
FOR MODES M = 2
N = 1

BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
B B
B BOUNDARY CONDITION II B
B B
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB

****
* *
* MODE IS N = 1 *
* *
* *
****

LOADS (PLI)	DE-DETERMINANTS SYMMETRIC MODE	DE-DETERMINANTS ANTISYMM.MODE	COMMENTS
1.00	1.07458E+00	1.08579E+00	
21.00	1.08080E+00	1.09296E+00	
41.00	1.08696E+00	1.10009E+00	
61.00	1.09307E+00	1.10717E+00	
81.00	1.09913E+00	1.11421E+00	
101.00	1.10514E+00	1.12121E+00	
121.00	1.11109E+00	1.12816E+00	
141.00	1.11699E+00	1.13507E+00	
161.00	1.12284E+00	1.14195E+00	
181.00	1.12865E+00	1.14878E+00	
201.00	1.13440E+00	1.15557E+00	
221.00	1.14010E+00	1.16232E+00	
241.00	1.14576E+00	1.16904E+00	
261.00	1.15137E+00	1.17571E+00	
281.00	1.15693E+00	1.18235E+00	
301.00	1.16245E+00	1.18894E+00	
321.00	1.16792E+00	1.19550E+00	
341.00	1.17335E+00	1.20203E+00	
361.00	1.17873E+00	1.20851E+00	
381.00	1.18406E+00	1.21496E+00	
401.00	1.18935E+00	1.22137E+00	
421.00	1.19460E+00	1.22774E+00	
441.00	1.19980E+00	1.23408E+00	
461.00	1.20496E+00	1.24039E+00	
481.00	1.21008E+00	1.24665E+00	
501.00	1.21515E+00	1.25288E+00	
521.00	1.22019E+00	1.25906E+00	
541.00	1.22518E+00	1.26524E+00	
561.00	1.23013E+00	1.27136E+00	
581.00	1.23503E+00	1.27745E+00	
601.00	1.23990E+00	1.28350E+00	
621.00	1.24472E+00	1.28952E+00	
641.00	1.24951E+00	1.29550E+00	
661.00	1.25425E+00	1.30145E+00	
681.00	1.25895E+00	1.30736E+00	
701.00	1.26361E+00	1.31323E+00	
721.00	1.26823E+00	1.31907E+00	
741.00	1.27281E+00	1.32488E+00	
761.00	1.27735E+00	1.33065E+00	
781.00	1.28185E+00	1.33638E+00	
801.00	1.28631E+00	1.34208E+00	
821.00	1.29074E+00	1.34774E+00	
841.00	1.29512E+00	1.35337E+00	

861.00	1.29946E+00	1.35896E+00	
881.00	1.30376E+00	1.36451E+00	
901.00	1.30802E+00	1.37002E+00	
921.00	1.31224E+00	1.37550E+00	
941.00	1.31642E+00	1.38095E+00	
961.00	1.32056E+00	1.38635E+00	
981.00	1.32467E+00	1.39172E+00	
1001.00	1.32873E+00	1.39705E+00	
1021.00	1.33275E+00	1.40234E+00	LIMIT 50 CS-CALLS

ABOVE ARE 50 TRIES WITHOUT CHANGE IN SIGN
DOUBLE LOAD-INCREMENT AND START OVER AGAIN

LOADS (FLI)	CS-DETERMINANTS SYMMETRIC MODE	CS-DETERMINANTS ANTISYMM.MODE	COMMENTS
1041.00	1.33673E+00	1.40759E+00	
1081.00	1.34457E+00	1.41797E+00	
1121.00	1.35225E+00	1.42820E+00	
1161.00	1.35976E+00	1.43826E+00	
1201.00	1.36711E+00	1.44815E+00	
1241.00	1.37428E+00	1.45787E+00	
1281.00	1.38129E+00	1.46741E+00	
1321.00	1.38812E+00	1.47677E+00	
1361.00	1.39477E+00	1.48593E+00	
1401.00	1.40125E+00	1.49490E+00	
1441.00	1.40755E+00	1.50367E+00	
1481.00	1.41367E+00	1.51222E+00	
1521.00	1.41952E+00	1.52055E+00	
1561.00	1.42522E+00	1.52866E+00	
1601.00	1.43071E+00	1.53652E+00	
1641.00	1.43598E+00	1.54413E+00	
1681.00	1.44103E+00	1.55147E+00	
1721.00	1.44585E+00	1.55854E+00	
1761.00	1.45042E+00	1.56531E+00	
1801.00	1.45474E+00	1.57178E+00	
1841.00	1.45880E+00	1.57792E+00	
1881.00	1.46258E+00	1.58372E+00	
1921.00	1.46608E+00	1.58915E+00	
1961.00	1.46926E+00	1.59420E+00	
2001.00	1.47212E+00	1.59884E+00	
2041.00	1.47464E+00	1.60305E+00	
2081.00	1.47680E+00	1.60679E+00	
2121.00	1.47857E+00	1.61004E+00	
2161.00	1.47993E+00	1.61276E+00	
2201.00	1.48089E+00	1.61491E+00	
2241.00	1.48130E+00	1.61646E+00	
2281.00	1.48124E+00	1.61735E+00	
2321.00	1.48064E+00	1.61754E+00	
2361.00	1.47945E+00	1.61697E+00	
2401.00	1.47763E+00	1.61558E+00	
2441.00	1.47512E+00	1.61331E+00	
2481.00	1.47185E+00	1.61008E+00	
2521.00	1.46777E+00	1.60580E+00	
2561.00	1.46279E+00	1.60038E+00	
2601.00	1.45682E+00	1.59372E+00	
2641.00	1.44977E+00	1.58569E+00	
2681.00	1.44151E+00	1.57616E+00	
2721.00	1.43192E+00	1.56498E+00	
2761.00	1.42084E+00	1.55198E+00	
2801.00	1.40809E+00	1.53694E+00	
2841.00	1.39347E+00	1.51964E+00	
2881.00	1.37672E+00	1.49982E+00	

2921.00	1.35757E+00	1.47714E+00	
2961.00	1.33566E+00	1.45123E+00	
3001.00	1.31056E+00	1.42165E+00	
3041.00	1.28176E+00	1.38784E+00	LIMIT 50 CB-CALLS

ABOVE ARE 50 TRIES WITHOUT CHANGE IN SIGN
DOUBLE LOAD-INCREMENT AND START OVER AGAIN

LOADS (FLI)	CB-DETERMINANTS SYMMETRIC MODE	CB-DETERMINANTS ANTISYMM.MODE	COMMENTS
3081.00	1.24862E+00	1.34912E+00	
3161.00	1.16579E+00	1.25336E+00	
3241.00	1.05192E+00	1.12392E+00	
3321.00	8.8687QE-01	9.40328E-01	
3401.00	6.15396E-01	6.46385E-01	
3481.00	-7.33524E-01	-7.61674E-01	DBLE ROOT ENCOUNTERD
3403.00	6.05943E-01	6.36291E-01	
3405.00	5.96280E-01	6.25981E-01	
3407.00	5.86396E-01	6.15442E-01	
3409.00	5.76278E-01	6.04664E-01	
3411.00	5.65913E-01	5.93631E-01	
3413.00	5.55289E-01	5.82331E-01	
3415.00	5.44386E-01	5.70746E-01	
3417.00	5.33193E-01	5.58859E-01	
3419.00	5.21685E-01	5.46649E-01	
3421.00	5.09841E-01	5.34094E-01	
3423.00	4.97639E-01	5.21168E-01	
3425.00	4.85049E-01	5.07844E-01	
3427.00	4.72041E-01	4.94086E-01	
3429.00	4.58577E-01	4.79862E-01	
3431.00	4.44617E-01	4.65124E-01	
3433.00	4.30110E-01	4.49822E-01	
3435.00	4.14999E-01	4.33897E-01	
3437.00	3.99215E-01	4.17276E-01	
3439.00	3.82674E-01	3.99873E-01	
3441.00	3.65271E-01	3.81579E-01	
3443.00	3.46877E-01	3.62259E-01	
3445.00	3.27323E-01	3.41739E-01	
3447.00	3.06386E-01	3.19768E-01	
3449.00	2.83759E-01	2.96085E-01	
3451.00	2.58999E-01	2.70175E-01	
3453.00	2.31420E-01	2.41330E-01	
3455.00	1.99857E-01	2.08354E-01	
3457.00	1.61996E-01	1.68834E-01	
3459.00	1.11600E-01	1.16275E-01	
3461.00	7.54141E-02	7.85501E-02	DBLE ROOT ENCOUNTERD
3460.00	7.43434E-02	7.74465E-02	
3461.00	7.54141E-02	7.85501E-02	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE F-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 3461.000
NXL = 3460.000

THE FIRST LOAD EXAMINED AFTER PASSING THE DOUBLE REAL ROOTS

DID NOT PRODUCE SIGNIFICANT DIFFERENCE BETWEEN THE ROOTS

PERTURB LOAD AND TRY AGAIN

LOADS (PLI)	CB-DETERMINANTS SYMMETRIC MODE	CB-DETERMINANTS ANTISYMM.MODE	COMMENTS
3463.00	-2.47082E-01	-2.57279E-01	
3465.00	-3.40489E-01	-3.54434E-01	
3467.00	-4.12723E-01	-4.29495E-01	
3469.00	-4.73575E-01	-4.92669E-01	
3471.00	-5.27005E-01	-5.48085E-01	
3473.00	-5.75089E-01	-5.97907E-01	
3475.00	-6.19075E-01	-6.43438E-01	
3477.00	-6.59784E-01	-6.85536E-01	
3479.00	-6.97794E-01	-7.24801E-01	
3481.00	-7.33524E-01	-7.61674E-01	
3501.00	-1.01229E+00	-1.04774E+00	
3521.00	-1.21165E+00	-1.24982E+00	
3541.00	-1.38763E+00	-1.40567E+00	
3561.00	-1.49462E+00	-1.53043E+00	
3581.00	-1.60020E+00	-1.63206E+00	
3601.00	-1.68900E+00	-1.71551E+00	
3621.00	-1.76411E+00	-1.78403E+00	
3641.00	-1.82774E+00	-1.83986E+00	
3661.00	-1.88153E+00	-1.88491E+00	
3681.00	-1.92676E+00	-1.92045E+00	
3701.00	-1.96445E+00	-1.94759E+00	
3721.00	-1.99543E+00	-1.96721E+00	
3741.00	-2.02040E+00	-1.98006E+00	
3761.00	-2.03992E+00	-1.98677E+00	
3781.00	-2.05452E+00	-1.98786E+00	
3801.00	-2.06461E+00	-1.98382E+00	
3821.00	-2.07058E+00	-1.97506E+00	
3841.00	-2.07276E+00	-1.96192E+00	
3861.00	-2.07146E+00	-1.94475E+00	
3881.00	-2.06694E+00	-1.92384E+00	
3901.00	-2.05944E+00	-1.89944E+00	
3921.00	-2.04918E+00	-1.87180E+00	
3941.00	-2.03636E+00	-1.84113E+00	
3961.00	-2.02117E+00	-1.80764E+00	
3981.00	-2.00378E+00	-1.77152E+00	
4001.00	-1.98433E+00	-1.73294E+00	
4021.00	-1.96298E+00	-1.69205E+00	
4041.00	-1.93985E+00	-1.64900E+00	
4061.00	-1.91506E+00	-1.60394E+00	
4081.00	-1.88877E+00	-1.55700E+00	
4101.00	-1.86104E+00	-1.50829E+00	
4121.00	-1.83199E+00	-1.45793E+00	
4141.00	-1.80171E+00	-1.40603E+00	
4161.00	-1.77030E+00	-1.35269E+00	
4181.00	-1.73784E+00	-1.29801E+00	
4201.00	-1.70441E+00	-1.24209E+00	
4221.00	-1.67009E+00	-1.18500E+00	
4241.00	-1.63494E+00	-1.12683E+00	
4261.00	-1.59905E+00	-1.06766E+00	
4281.00	-1.56246E+00	-1.00756E+00	
4301.00	-1.52525E+00	-9.46608E-01	
4321.00	-1.48748E+00	-8.84871E-01	LIMIT 50 CB-CALLS

ABOVE ARE 50 TRIES WITHOUT CHANGE IN SIGN
DOUBLE LOAD-INCREMENT AND START OVER AGAIN

LOADS (PLI)	DB-DETERMINANTS SYMMETRIC MODE	DD-DETERMINANTS ANTISYMM.MODE	COMMENTS
4341.00	-1.44019E+00	-8.22414E-01	
4381.00	-1.37129E+00	-6.95585E-01	
4421.00	-1.29195E+00	-5.66591E-01	
4461.00	-1.21153E+00	-4.35861E-01	
4501.00	-1.13036E+00	-3.03793E-01	
4541.00	-1.04874E+00	-1.70754E-01	
4581.00	-9.66946E-01	-3.70825E-02	
4621.00	-8.85236E-01	9.69066E-02	SGN CHANG ANTISYMM.
4583.00	-9.62857E-01	-3.03881E-02	
4585.00	-9.58767E-01	-2.36929E-02	
4587.00	-9.54678E-01	-1.69970E-02	
4589.00	-9.50590E-01	-1.03004E-02	
4591.00	-9.46502E-01	-3.60324E-03	
4593.00	-9.42414E-01	3.09457E-03	CRIT. LD ANTISYMM.

N = 1

CRITICAL LOAD = 4592.0759 P.L.I.

ANTISYMMETRIC MODE (B.C. II)

TES-285 MAR 17 70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE K

*** BOUNDARY CONDITION II ***

RESULTS FOR ALL MODES N

LOAD	N
4592.076	1

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 4592 P.L.I.
FOR MODE N = 1

```
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
B                                    B
B BOUNDARY CONDITION        III      B
B                                    B
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
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**********************************
*                                *
*    MODE   IS   N =    1       *
*                                *
*                                *
**********************************
```

LOADS (PLI)	DB-DETERMINANTS	COMMENTS
1.00	-2.13039E+06	
21.00	-1.87401E+06	
41.00	-1.63372E+06	
61.00	-1.40949E+06	
81.00	-1.20130E+06	
101.00	-1.00911E+06	
121.00	-8.32681E+05	
141.00	-6.72582E+05	
161.00	-5.28180E+05	
181.00	-3.99652E+05	
201.00	-2.87002E+05	
221.00	-1.90278E+05	
241.00	-1.09625E+05	
261.00	-4.53874E+04	
281.00	-6.42296E+03	DBLE ROOT ENCOUNTERD
283.00	-3.98913E+04	
285.00	-3.45660E+04	
287.00	-2.94187E+04	
289.00	-2.44449E+04	
291.00	-1.96482E+04	
293.00	-1.50304E+04	
295.00	-1.05935E+04	
297.00	-6.33970E+03	
299.00	-2.27144E+03	
281.00	-6.42296E+03	DBLE ROOT ENCOUNTERD
280.00	-5.07733E+02	
281.00	-6.42296E+03	DBLE ROOT ENCOUNTERD
280.50	-2.62356E+03	DBLE ROOT ENCOUNTERD
280.25	-7.03056E+02	DBLE ROOT ENCOUNTERD
280.12	-6.55969E+01	
280.25	-7.03056E+02	DBLE ROOT ENCOUNTERD
280.19	-2.20758E+02	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE F-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

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NXU =          280.187
NXL =          280.125
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LOADS (PLI)	DB-DETERMINANTS	COMMENTS

280.19	-2.20758E+02	
282.19	-1.52233E+04	
284.19	-2.93306E+04	
286.19	-4.25336E+04	
288.19	-5.48215E+04	
290.19	-6.61817E+04	
292.19	-7.65991E+04	
294.19	-8.60562E+04	
296.19	-9.45319E+04	
298.19	-1.02001E+05	
318.19	-1.09045E+05	
338.19	8.42409E+04	DBLE ROOT ENCOUNTERD
320.19	-9.98426E+04	
322.19	-8.70155E+04	
324.19	-6.84447E+04	
326.19	-3.59810E+04	
328.19	2.54520E+04	DBLE ROOT ENCOUNTERD
327.19	1.21595E+04	DBLE ROOT ENCOUNTERD
326.69	-1.91639E+04	
327.19	1.21595E+04	DBLE ROOT ENCOUNTERD
326.94	5.20769E+03	DBLE ROOT ENCOUNTERD
326.81	-1.14164E+04	
326.94	5.20769E+03	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE P-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 326.937
NXL = 326.812

LOADS (PLI)	DD-DETERMINANTS	COMMENTS
326.94	5.20769E+03	
328.94	3.22579E+04	
330.94	4.64957E+04	
332.94	5.82160E+04	
334.94	6.87023E+04	
336.94	7.84334E+04	
338.94	8.76432E+04	
340.94	9.64626E+04	
342.94	1.04972E+05	
344.94	1.13223E+05	
364.94	1.85648E+05	
384.94	2.42238E+05	
404.94	2.81756E+05	
424.94	3.02138E+05	
444.94	3.01561E+05	
464.94	2.78523E+05	
484.94	2.31791E+05	
504.94	1.60359E+05	
524.94	6.34011E+04	
544.94	-5.97615E+04	SIGN CHANGE IN DB
526.94	5.22742E+04	
528.94	4.08844E+04	
530.94	2.92314E+04	
532.94	1.73144E+04	
534.94	5.13285E+03	
536.94	-7.31372E+03	CRITICAL LOAD FOUND

M = 1

CRITICAL LOAD = 535.7623 P.L.I.

TES-285 MAR 17 70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE K

*** BOUNDARY CONDITION III ***

RESULTS FOR ALL MODES M

LOAD	M
535.762	1

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 536 P.L.I.
FOR MODE M = 1

72

```
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
B                                    B
B BOUNDARY CONDITION          IV   B
B                                    B
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
```

```
*******************************
*                             *
*    MODE   IS   M =    1    *
*                             *
*                             *
*******************************
```

LOADS (PLI)	DD-DETERMINANTS	COMMENTS
1.00	2.81093E+03	
21.00	2.56104E+03	
41.00	2.31700E+03	
61.00	2.07915E+03	
81.00	1.84789E+03	
101.00	1.62368E+03	
121.00	1.40704E+03	
141.00	1.19857E+03	
161.00	9.98956E+02	
181.00	8.09038E+02	
201.00	6.29784E+02	
221.00	4.62320E+02	
241.00	3.07801E+02	
261.00	1.66266E+02	
281.00	-4.84067E+01	DBLE ROOT ENCOUNTERD
263.00	1.52637E+02	
265.00	1.39024E+02	
267.00	1.25377E+02	
269.00	1.11621E+02	
271.00	9.76396E+01	
273.00	8.32316E+01	
275.00	6.80225E+01	
277.00	5.11611E+01	
279.00	2.97319E+01	
281.00	-4.84667E+01	DBLE ROOT ENCOUNTERD
280.00	1.07770E+01	
281.00	-4.84667E+01	DBLE ROOT ENCOUNTERD
280.50	-3.12221E+01	DBLE ROOT ENCOUNTERD
280.25	-1.62261E+01	DBLE ROOT ENCOUNTERD
280.12	4.96601E+00	
280.25	-1.62261E+01	DBLE ROOT ENCOUNTERD
280.19	-9.10126E+00	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE P-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

```
NXU =          280.187
NXL =          280.125
```

LOADS (PLI)	DB-DETERMINANTS	COMMENTS

```
      280.19        -9.10126E+00
      282.19        -7.31941E+01
      284.19        -9.82175E+01
      286.19        -1.14116E+02
      288.19        -1.24725E+02
      290.19        -1.31606E+02
      292.19        -1.35596E+02
      294.19        -1.37212E+02
      296.19        -1.36802E+02
      298.19        -1.34617E+02
      318.19        -4.30062E+01
      338.19         1.34426E+02          DBLE ROOT ENCOUNTERD
      320.19        -2.84282E+01
      322.19        -1.30390E+01
      324.19         3.13265E+00          SIGN CHANGE IN CB
      323.19        -5.04930E+00
      324.19         3.13265E+00          CRITICAL LOAD FOUND

M   =    1

CRITICAL LOAD  =          323.8046     P.L.I.
```

```
**********************************
*                                *
*    MODE   IS   M =    2        *
*                                *
*                                *
**********************************
```

LOADS (PLI)	CB-DETERMINANTS	COMMENTS
1.00	1.20164E+05	
21.00	1.17785E+05	
41.00	1.15411E+05	
61.00	1.13044E+05	
81.00	1.10684E+05	
101.00	1.08331E+05	
121.00	1.05985E+05	
141.00	1.03646E+05	
161.00	1.01313E+05	
181.00	9.89847E+04	
201.00	9.66714E+04	
221.00	9.43616E+04	
241.00	9.20597E+04	
261.00	8.97656E+04	
281.00	8.74796E+04	
301.00	8.52019E+04	
321.00	8.29326E+04	
341.00	8.06719E+04	
361.00	7.84200E+04	
381.00	7.61771E+04	
401.00	7.39435E+04	
421.00	7.17193E+04	
441.00	6.95049E+04	
461.00	6.73004E+04	
481.00	6.51062E+04	
501.00	6.29224E+04	
521.00	6.07494E+04	
541.00	5.85876E+04	
561.00	5.64372E+04	
581.00	5.42985E+04	
601.00	5.21720E+04	
621.00	5.00580E+04	
641.00	4.79569E+04	
661.00	4.58691E+04	
681.00	4.37951E+04	
701.00	4.17354E+04	
721.00	3.96905E+04	
741.00	3.76608E+04	
761.00	3.56469E+04	
781.00	3.36494E+04	
801.00	3.16689E+04	
821.00	2.97060E+04	
841.00	2.77612E+04	
861.00	2.58353E+04	
881.00	2.39288E+04	
901.00	2.20421E+04	
921.00	2.01758E+04	
941.00	1.83299E+04	
961.00	1.65044E+04	

981.00	1.46984E+04	
1001.00	1.29100E+04	
1021.00	1.11350E+04	LIMIT 50 CB-CALLS

ABOVE ARE 50 TRIES WITHOUT CHANGE IN SIGN
DOUBLE LOAD-INCREMENT AND START OVER AGAIN

LOADS (PLI)	CB-DETERMINANTS	COMMENTS
1041.00	9.36532E+03	
1061.00	5.74812E+03	
1121.00	-9.29332E+02	DBLE ROOT ENCOUNTERD
1083.00	5.55837E+03	
1085.00	5.36687E+03	
1087.00	5.17339E+03	
1089.00	4.97766E+03	
1091.00	4.77937E+03	
1093.00	4.57812E+03	
1095.00	4.37347E+03	
1097.00	4.16486E+03	
1099.00	3.95165E+03	
1101.00	3.73295E+03	
1103.00	3.50769E+03	
1105.00	3.27444E+03	
1107.00	3.03130E+03	
1109.00	2.77559E+03	
1111.00	2.50337E+03	
1113.00	2.20845E+03	
1115.00	1.88066E+03	
1117.00	1.49616E+03	
1119.00	9.94205E+02	
1121.00	-9.29332E+02	DBLE ROOT ENCOUNTERD
1120.00	6.16686E+02	
1121.00	-9.29332E+02	DBLE ROOT ENCOUNTERD
1120.50	2.84357E+02	
1121.00	-9.29332E+02	DBLE ROOT ENCOUNTERD
1120.75	-5.21215E+02	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE F-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 1120.750
NXL = 1120.500

LOADS (PLI)	CB-DETERMINANTS	COMMENTS
1120.75	-5.21215E+02	
1122.75	-2.21804E+03	
1124.75	-3.68081E+03	
1126.75	-3.69068E+03	
1128.75	-4.20478E+03	
1130.75	-4.64206E+03	
1132.75	-5.02290E+03	
1134.75	-5.35963E+03	
1136.75	-5.66037E+03	
1138.75	-5.93086E+03	
1156.75	-7.57260E+03	
1178.75	-8.06161E+03	
1198.75	-7.83119E+03	

1218.75	-7.05494E+03	
1238.75	-5.82510E+03	
1258.75	-4.19814E+03	
1278.75	-2.21163E+03	
1298.75	1.08078E+02	SIGN CHANGE IN DS
1280.75	-1.99429E+03	
1282.75	-1.77365E+03	
1284.75	-1.54972E+03	
1286.75	-1.32253E+03	
1288.75	-1.09210E+03	
1290.75	-8.58437E+02	
1292.75	-6.21572E+02	
1294.75	-3.81520E+02	
1296.75	-1.38297E+02	
1298.75	1.08078E+02	CRITICAL LOAD FOUND

M = 2

CRITICAL LOAD = 1297.8727 P.L.I.

TES-285 MAR 17 70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE K

*** BOUNDARY CONDITION IV ***

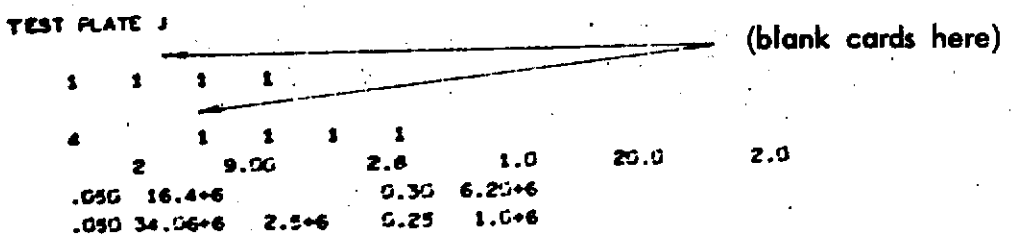
RESULTS FOR ALL MODES M

LOAD	M
323.805	1
1297.873	2

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 324 P.L.I.
FOR MODE M = 1

4.3. Input for Sample 2



4.4 Output for Sample 2

```
IES-285                                                    MAR 17  70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING --          UNIFORM  UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I   ALL EDGES SIMPLY SUPPORTED
                    II  LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
                    III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
                    IV  LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE
*****************************************************************************

TEST PLATE J
    0

BOUNDARY CONDITIONS CONSIDERED IN THIS DATASET ARE
                                                              I
                                                             II
                                                            III
                                                             IV
    1    1    1    1

STARTVALUES FOR LONGITUDINAL MODES M
     B.C.I            B.C.III.    B.C.IV

        1                1          1


STARTVALUES FOR TRANSVERSE MODES N
     B.C.I    B.C.II

        1        1


MAXIMUM VALUES FOR LONGITUDINAL MODES M
     B.C.I            B.C.III.    B.C.IV

        4                1          1


MAXIMUM VALUES FOR TRANSVERSE MODES N
     B.C.I    B.C.II

        1        1
```

NUMBER OF LAYERS	L	=	2
LENGTH	AL	=	9.000
WIDTH	BL	=	2.800

STARTING LOAD	STLO	=	1.000
PRIMARY INTERVAL	SINC	=	20.000
SEC. INTERVAL (NOT USED IF ZERO)	SINC2	=	2.000

LAYER NO 1 INPUT OPTION NO 0 WAS USED
MATERIAL PROPERTIES WAS ENTERED AS E11,E22 ETC.

THICKNESS	T1	=	.0500
E-MODULUS	E1	=	16400000.0000
	E2	=	16400000.0000
POISSONS RATIO	RNUA	=	.3000
	RNUB	=	.3000
TORSIONAL MOD.	G12	=	6200000.0000

LAYER NO 2 INPUT OPTION NO 0 WAS USED
MATERIAL PROPERTIES WAS ENTERED AS E11,E22 ETC.

THICKNESS	T1	=	.0500
E-MODULUS	E1	=	34000000.0000
	E2	=	2500000.0000
POISSONS RATIO	RNUA	=	.2500
	RNUB	=	.0183
TORSIONAL MOD.	G12	=	1000000.0000

LAYER	EXX	EYY	NUXY	NUYX	G
1	1.640000E+07	1.640000E+07	3.000000E-01	3.000000E-01	6.200000E+06
2	3.406000E+07	2.500000E+06	2.500000E-01	1.834997E-02	1.000000E+06

Q-MATRIX LAYER NO 1

18021978.022	5406593.407	0.000
5406593.407	18021978.022	0.000
0.000	0.000	6200000.000

Q-MATRIX LAYER NO 2

34216970.099	627880.397	0.000
627880.397	2511521.587	0.000
0.000	0.000	1000000.000

LOCATION OF NEUTRAL PLANE
RELATIVE TO REFERENCE PLANE .0587

A-MATRIX

2611947.406	301723.690	0.000
301723.690	1026674.980	0.000
0.000	0.000	360000.000

B-MATRIX

-2609.506	-8613.324	0.000
-8613.324	-28370.968	0.000
0.000	0.000	-9649.822

C-MATRIX

2022.332	379.063	0.000
379.063	1273.430	0.000
0.000	0.000	441.303

```
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
B                                       B
B BOUNDARY CONDITION          I   B
B                                       B
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
```

TRANSVERSE MODE N = 1

N = 1 M = 1

CRITICAL LOAD = 7985.6434 P.L.I.

N = 1 M = 2

CRITICAL LOAD = 3976.8139 P.L.I.

N = 1 M = 3

CRITICAL LOAD = 4232.2368 P.L.I.

N = 1 M = 4

CRITICAL LOAD = 5522.5962 P.L.I.

TES-285 MAR 17 70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE J

*** BOUNDARY CONDITION I ***

RESULTS FOR ALL MODES OF M FOR N = 1

LOAD	M
7985.643	1
3976.814	2
4232.237	3
5522.598	4

FINAL RESULTS FOR THIS TRANSVERSE MODE

CRITICAL LOAD = 3977 P.L.I.
FOR MODES M = 2
N = 1

TES-205 MAR 17 70

BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE J

*** BOUNDARY CONDITION I ***

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 3977 P.L.I.
FOR MODES M = 2
N = 1

BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
B   B
B BOUNDARY CONDITION   II   B
B   B
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB

****
*   *
*   MODE IS   N =   1   *
*   *
*   *
****

LOADS (FLI)	DB-DETERMINANTS SYMMETRIC MODE	DB-DETERMINANTS ANTISYMM.MODE	COMMENTS
1.00	1.97939E+03	1.93278E+03	
21.00	2.15122E+03	2.10151E+03	
41.00	2.32751E+03	2.27475E+03	
61.00	2.50823E+03	2.45248E+03	
81.00	2.69337E+03	2.63467E+03	
101.00	2.88290E+03	2.82132E+03	
121.00	3.07680E+03	3.01240E+03	
141.00	3.27503E+03	3.20789E+03	
161.00	3.47758E+03	3.40776E+03	
181.00	3.68441E+03	3.61203E+03	
201.00	3.89551E+03	3.82064E+03	
221.00	4.11086E+03	4.03358E+03	
241.00	4.33043E+03	4.25083E+03	
261.00	4.55419E+03	4.47239E+03	
281.00	4.78214E+03	4.69823E+03	
301.00	5.01425E+03	4.92833E+03	
321.00	5.25050E+03	5.16269E+03	
341.00	5.49088E+03	5.40129E+03	
361.00	5.73537E+03	5.64411E+03	
381.00	5.98395E+03	5.89115E+03	
401.00	6.23660E+03	6.14239E+03	
421.00	6.49333E+03	6.39781E+03	
441.00	6.75410E+03	6.65742E+03	
461.00	7.01891E+03	6.92123E+03	
481.00	7.28775E+03	7.18913E+03	
501.00	7.56060E+03	7.46121E+03	
521.00	7.83745E+03	7.73744E+03	
541.00	8.11830E+03	8.01779E+03	
561.00	8.40313E+03	8.30227E+03	
581.00	8.69193E+03	8.59086E+03	
601.00	8.98470E+03	8.88356E+03	
621.00	9.28142E+03	9.18036E+03	
641.00	9.58210E+03	9.48125E+03	
661.00	9.88671E+03	9.78623E+03	
681.00	1.01953E+04	1.00953E+04	
701.00	1.05077E+04	1.04084E+04	
721.00	1.08241E+04	1.07256E+04	
741.00	1.11444E+04	1.10469E+04	
761.00	1.14686E+04	1.13722E+04	
781.00	1.17968E+04	1.17016E+04	
801.00	1.21288E+04	1.20350E+04	
821.00	1.24647E+04	1.23724E+04	
841.00	1.28045E+04	1.27139E+04	

861.00	1.31481E+04	1.30593E+04	
881.00	1.34957E+04	1.34088E+04	
901.00	1.38471E+04	1.37624E+04	
921.00	1.42024E+04	1.41199E+04	
941.00	1.45616E+04	1.44814E+04	
961.00	1.49246E+04	1.48469E+04	
981.00	1.52915E+04	1.52164E+04	
1001.00	1.56622E+04	1.55899E+04	
1021.00	1.60368E+04	1.59673E+04	LIMIT 50 DB-CALLS

ABOVE ARE 50 TRIES WITHOUT CHANGE IN SIGN
DOUBLE LOAD-INCREMENT AND START OVER AGAIN

LOADS (PLI)	DB-DETERMINANTS SYMMETRIC MODE	DB-DETERMINANTS ANTISYMM.MODE	COMMENTS
1041.00	1.64152E+04	1.63487E+04	
1081.00	1.71836E+04	1.71234E+04	
1121.00	1.79674E+04	1.79136E+04	
1161.00	1.87665E+04	1.87200E+04	
1201.00	1.95810E+04	1.95417E+04	
1241.00	2.04107E+04	2.03790E+04	
1281.00	2.12557E+04	2.12318E+04	
1321.00	2.21160E+04	2.20999E+04	
1361.00	2.29915E+04	2.29833E+04	
1401.00	2.38821E+04	2.38819E+04	
1441.00	2.47880E+04	2.47954E+04	
1481.00	2.57090E+04	2.57239E+04	
1521.00	2.66451E+04	2.66671E+04	
1561.00	2.75963E+04	2.76249E+04	
1601.00	2.85626E+04	2.85971E+04	
1641.00	2.95438E+04	2.95835E+04	
1681.00	3.05399E+04	3.05840E+04	
1721.00	3.15509E+04	3.15981E+04	
1761.00	3.25767E+04	3.26258E+04	
1801.00	3.36173E+04	3.36667E+04	
1841.00	3.46724E+04	3.47206E+04	
1881.00	3.57421E+04	3.57870E+04	
1921.00	3.68261E+04	3.68656E+04	
1961.00	3.79244E+04	3.79560E+04	
2001.00	3.90369E+04	3.90578E+04	
2041.00	4.01632E+04	4.01704E+04	
2081.00	4.13033E+04	4.12933E+04	
2121.00	4.24568E+04	4.24259E+04	
2161.00	4.36236E+04	4.35676E+04	
2201.00	4.48033E+04	4.47176E+04	
2241.00	4.59956E+04	4.58752E+04	
2281.00	4.72000E+04	4.70395E+04	
2321.00	4.84162E+04	4.82095E+04	
2361.00	4.96437E+04	4.93842E+04	
2401.00	5.08817E+04	5.05623E+04	
2441.00	5.21298E+04	5.17427E+04	
2481.00	5.33871E+04	5.29239E+04	
2521.00	5.46528E+04	5.41043E+04	
2561.00	5.59259E+04	5.52822E+04	
2601.00	5.72053E+04	5.64557E+04	
2641.00	5.84896E+04	5.76225E+04	
2681.00	5.97774E+04	5.87802E+04	
2721.00	6.10670E+04	5.99263E+04	
2761.00	6.23564E+04	6.10577E+04	
2801.00	6.36433E+04	6.21711E+04	
2841.00	6.49251E+04	6.32626E+04	
2881.00	6.61984E+04	6.43282E+04	

2921.00	6.74608E+04	6.53629E+04	
2961.00	6.87079E+04	6.63615E+04	
3001.00	6.99325E+04	6.73177E+04	
3041.00	7.11318E+04	6.82247E+04	LIMIT 50 -DB-CALLS

ABOVE ARE 50 TRIES WITHOUT CHANGE IN SIGN
DOUBLE LOAD-INCREMENT AND START OVER AGAIN

LOADS (PLI)	DB-DETERMINANTS SYMETRIC MODE	DB-DETERMINANTS ANTISYMM.MODE	COMMENTS
3081.00	7.22981E+04	6.90745E+04	
3161.00	7.44989E+04	7.05645E+04	
3241.00	7.64522E+04	7.16966E+04	
3321.00	7.80387E+04	7.23472E+04	
3401.00	7.90816E+04	7.23442E+04	
3481.00	7.93059E+04	7.14395E+04	
3561.00	7.82877E+04	6.92576E+04	
3641.00	7.52644E+04	6.51883E+04	
3721.00	6.87949E+04	5.81131E+04	
3801.00	5.54110E+04	4.54330E+04	
3881.00	1.56760E+04	1.24000E+04	
3961.00	-1.06048E+05	-8.18049E+04	DBLE ROOT ENCOUNTERD
3883.00	1.24403E+04	9.83077E+03	
3885.00	7.91265E+03	6.24665E+03	
3887.00	1.10667E+04	8.72787E+03	DBLE ROOT ENCOUNTERD
3886.00	4.01122E+03	3.16509E+03	
3887.00	1.10667E+04	8.72787E+03	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE F-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 3887.000
NXL = 3886.000

LOADS (PLI)	DB-DETERMINANTS SYMETRIC MODE	DB-DETERMINANTS ANTISYMM.MODE	COMMENTS
3887.00	-1.10667E+04	-8.72787E+03	
3889.00	-2.22206E+04	-1.75071E+04	
3891.00	-2.93527E+04	-2.31028E+04	
3893.00	-3.50135E+04	-2.75303E+04	
3895.00	-3.98355E+04	-3.12899E+04	
3897.00	-4.40950E+04	-3.46001E+04	
3899.00	-4.79423E+04	-3.75802E+04	
3901.00	-5.14700E+04	-4.03036E+04	
3903.00	-5.47402E+04	-4.28199E+04	
3905.00	-5.77966E+04	-4.51636E+04	
3925.00	-8.12351E+04	-6.27995E+04	
3945.00	-9.76724E+04	-7.46559E+04	
3965.00	-1.10357E+05	-8.33495E+04	
3985.00	-1.20543E+05	-8.99025E+04	
4005.00	-1.28685E+05	-9.48513E+04	
4025.00	-1.35776E+05	-9.85238E+04	
4045.00	-1.41480E+05	-1.01140E+05	
4065.00	-1.46184E+05	-1.02859E+05	
4085.00	-1.50026E+05	-1.03798E+05	
4105.00	-1.53116E+05	-1.04052E+05	
4125.00	-1.55539E+05	-1.03694E+05	
4145.00	-1.57365E+05	-1.02787E+05	
4165.00	-1.58654E+05	-1.01382E+05	

4185.00	-1.59454E+05	-9.95236E+04
4205.00	-1.59808E+05	-9.72504E+04
4225.00	-1.59755E+05	-9.45960E+04
4245.00	-1.59325E+05	-9.15901E+04
4265.00	-1.58549E+05	-8.82594E+04
4285.00	-1.57452E+05	-8.46282E+04
4305.00	-1.56057E+05	-8.07183E+04
4325.00	-1.54387E+05	-7.65498E+04
4345.00	-1.52459E+05	-7.21411E+04
4365.00	-1.50292E+05	-6.75092E+04
4385.00	-1.47903E+05	-6.26701E+04
4405.00	-1.45306E+05	-5.76384E+04
4425.00	-1.42515E+05	-5.24281E+04
4445.00	-1.39545E+05	-4.70521E+04
4465.00	-1.36406E+05	-4.15228E+04
4485.00	-1.33111E+05	-3.58516E+04
4505.00	-1.29671E+05	-3.00497E+04
4525.00	-1.26095E+05	-2.41275E+04
4545.00	-1.22394E+05	-1.80948E+04
4565.00	-1.18577E+05	-1.19613E+04
4585.00	-1.14652E+05	-5.73598E+03
4605.00	-1.10629E+05	5.72484E+02

CRIT. LC ANTISYMM.

N = 1

CRITICAL LOAD = 4603.1850 P.L.I.

ANTISYMMETRIC MODE (B.C. II)

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BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE J

*** BOUNDARY CONDITION II ***

RESULTS FOR ALL MODES N

LOAD	N
4603.185	1

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 4603 P.L.I.
FOR MODE N = 1

```
EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
E                                    E
E BOUNDARY CONDITION          III    E
E                                    E
EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
```

```
**********************************
*                                *
*    MODE   IS   M =    1        *
*                                *
*                                *
**********************************
```

LOADS (PLI)	CB-DETERMINANTS	COMMENTS
1.00	3.39316E+15	
21.00	7.37777E+14	
41.00	9.58066E+12	
61.00	1.55956E+14	
81.00	4.70917E+14	
101.00	5.88529E+14	
121.00	4.05109E+14	
141.00	2.39611E+12	DBLE ROOT ENCOUNTERD
123.00	3.7181EE+14	
125.00	3.36271E+14	
127.00	2.98625E+14	
129.00	2.59036E+14	
131.00	2.17669E+14	
133.00	1.74697E+14	
135.00	1.30299E+14	
137.00	8.46588E+13	
139.00	3.79664E+13	
141.00	2.39611E+12	DBLE ROOT ENCOUNTERD
140.00	1.42859E+13	
141.00	2.39611E+12	DBLE ROOT ENCOUNTERD
140.50	2.37269E+12	
141.00	2.39611E+12	DBLE ROOT ENCOUNTERD
140.75	9.00174E+11	DBLE ROOT ENCOUNTERD
140.62	1.53168E+11	DBLE ROOT ENCOUNTERD
140.56	8.80354E+11	
140.62	1.53168E+11	DBLE ROOT ENCOUNTERD
140.59	1.33927E+11	
140.62	1.53168E+11	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE P-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

```
NXU =          140.625
NXL =          140.594
```

LOADS (PLI)	CB-DETERMINANTS	COMMENTS
140.62	1.53168E+11	
142.62	1.21759E+13	
144.62	2.43170E+13	

146.62	3.65261E+13	
148.62	4.87526E+13	
150.62	6.09455E+13	
152.62	7.30536E+13	
154.62	8.50260E+13	
156.62	9.68120E+13	
158.62	1.08361E+14	
178.62	2.00300E+14	
198.62	2.21745E+14	
218.62	1.53539E+14	
238.62	2.67355E+13	
258.62	-2.22671E+14	DBLE ROOT ENCOUNTERD
240.62	1.56051E+13	
242.62	6.18158E+12	
244.62	1.44203E+12	DBLE ROOT ENCOUNTERD
243.62	2.42819E+12	
244.62	1.44201E+12	DBLE ROOT ENCOUNTERD
244.12	8.86116E+11	
244.62	1.44203E+12	DBLE ROOT ENCOUNTERD
244.37	2.22667E+11	
244.62	1.44203E+12	DBLE ROOT ENCOUNTERD
244.50	3.19258E+11	DBLE ROOT ENCOUNTERD
244.44	6.66917E+10	
244.50	3.19258E+11	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE P-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 244.500
NXL = 244.437

LOADS (PLI)	DE-DETERMINANTS	COMMENTS
244.50	3.19258E+11	
246.50	-4.96278E+12	DBLE ROOT ENCOUNTERD
244.70	2.07065E+12	
244.90	3.56744E+12	
245.10	4.77190E+12	
245.30	5.63070E+12	
245.50	6.06160E+12	
245.70	5.91871E+12	
245.90	4.86256E+12	
246.10	-3.21285E+11	DBLE ROOT ENCOUNTERD
265.90	-4.60467E+14	DBLE ROOT ENCOUNTERD
247.90	-1.80165E+13	DBLE ROOT ENCOUNTERD
246.90	-8.42280E+12	DBLE ROOT ENCOUNTERD
246.40	-4.08651E+12	DBLE ROOT ENCOUNTERD
246.15	-1.47991E+12	DBLE ROOT ENCOUNTERD
246.02	3.20727E+12	
246.15	-1.47991E+12	DBLE ROOT ENCOUNTERD
246.09	1.23271E+12	
246.15	-1.47991E+12	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE P-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 246.150
NXL = 246.087

LOADS (PLI)	CB-DETERMINANTS	COMMENTS
246.15	-1.47991E+12	
248.15	-2.06859E+13	
250.15	-4.59334E+13	
252.15	-7.77451E+13	
254.15	-1.15776E+14	
256.15	-1.59854E+14	
258.15	-2.09907E+14	
260.15	-2.65922E+14	
262.15	-3.27920E+14	
264.15	-3.95948E+14	
284.15	-1.42400E+15	
304.15	-3.13444E+15	
324.15	-5.58091E+15	
344.15	-8.65873E+15	
364.15	-1.22795E+16	
384.15	-1.61487E+16	
404.15	-1.98451E+16	
424.15	-2.27802E+16	
444.15	-2.41791E+16	
464.15	-2.30620E+16	
484.15	-1.82266E+16	
504.15	-8.23201E+15	
524.15	8.61856E+15	SIGN CHANGE IN CB
506.15	-6.88574E+15	
508.15	-5.46930E+15	
510.15	-3.98081E+15	
512.15	-2.41838E+15	
514.15	-7.80086E+14	
516.15	9.36018E+14	CRITICAL LOAD FOUND

M = 1

CRITICAL LOAD = 515.0591 P.L.I.

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BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE J

*** BOUNDARY CONDITION III ***

RESULTS FOR ALL MODES M

LOAD	M
515.059	1

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 515 P.L.I.
FOR MODE M = 1

```
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
B                                    B
B BOUNDARY CONDITION          IV     B
B                                    B
BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB
```

```
**********************************
*                                *
*    MODE   IS   M =    1        *
*                                *
*                                *
**********************************
```

LOADS (PLI)	DS-DETERMINANTS	COMMENTS
1.00	-2.79847E+10	
21.00	-1.24267E+10	
41.00	1.34034E+09	SIGN CHANGE IN DS
23.00	-1.11364E+10	
25.00	-9.89142E+09	
27.00	-8.69150E+09	
29.00	-7.53412E+09	
31.00	-6.41958E+09	
33.00	-5.34577E+09	
35.00	-4.31023E+09	
37.00	-3.30855E+09	
39.00	-2.33050E+09	
41.00	-1.34034E+09	
43.00	8.44154E+08	DBLE ROOT ENCOUNTERD
42.00	-7.84122E+08	
43.00	8.44154E+08	DBLE ROOT ENCOUNTERD
42.50	-4.13915E+08	
43.00	8.44154E+08	DBLE ROOT ENCOUNTERD
42.75	2.45012E+08	DBLE ROOT ENCOUNTERD
42.62	-2.74313E+08	
42.75	2.45012E+08	DBLE ROOT ENCOUNTERD
42.69	-1.71450E+08	
42.75	2.45012E+08	DBLE ROOT ENCOUNTERD
42.72	-6.37407E+07	
42.75	2.45012E+08	DBLE ROOT ENCOUNTERD
42.73	1.27169E+08	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE F-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 42.734
NXL = 42.719

THE FIRST LOAD EXAMINED AFTER PASSING THE DOUBLE REAL ROOTS

DID NOT PRODUCE SIGNIFICANT DIFFERENCE BETWEEN THE ROOTS

PERTURB LOAD AND TRY AGAIN

LOADS (PLI)	CO-DETERMINANTS	COMMENTS
43.23	-1.11415E+09	
45.23	-1.63644E+09	
47.23	4.53644E+08	DBLE ROOT ENCOUNTERD
45.43	-1.59281E+09	
45.63	-1.53218E+09	
45.83	-1.45271E+09	
46.03	-1.35136E+09	
46.23	-1.22300E+09	
46.43	-1.05822E+09	
46.63	-8.36183E+08	
66.63	6.30027E+09	DBLE ROOT ENCOUNTERD
48.63	1.20331E+09	DBLE ROOT ENCOUNTERD
47.63	7.15325E+08	DBLE ROOT ENCOUNTERD
47.13	3.68423E+08	DBLE ROOT ENCOUNTERD
46.88	-3.34165E+08	
47.13	3.68423E+08	DBLE ROOT ENCOUNTERD
47.01	2.27688E+08	DBLE ROOT ENCOUNTERD
46.95	1.06962E+08	DBLE ROOT ENCOUNTERD
46.92	-1.82979E+08	
46.95	1.06962E+08	DBLE ROOT ENCOUNTERD
46.93	3.87647E+07	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE F-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 46.931
NXL = 46.916

LOADS (PLI)	CO-DETERMINANTS	COMMENTS
46.93	3.87647E+07	
48.93	1.33070E+09	
50.93	2.10334E+09	
52.93	2.79201E+09	
54.93	3.42536E+09	
56.93	4.01249E+09	
58.93	4.55753E+09	
60.93	5.06295E+09	
62.93	5.53045E+09	
64.93	5.96135E+09	
84.93	8.46278E+09	
104.93	8.18929E+09	
124.93	5.63724E+09	
144.93	1.37502E+09	DBLE ROOT ENCOUNTERD
126.93	5.25132E+09	
128.93	4.83392E+09	
130.93	4.37913E+09	
132.93	3.87717E+09	
134.93	3.31039E+09	
136.93	2.64185E+09	
138.93	1.78548E+09	
140.93	3.69768E+08	DBLE ROOT ENCOUNTERD
139.93	1.11181E+09	
140.93	3.69768E+08	DBLE ROOT ENCOUNTERD
140.43	5.56267E+08	
140.93	3.69768E+08	DBLE ROOT ENCOUNTERD
140.68	1.93872E+08	DBLE ROOT ENCOUNTERD

140.56	2.81500E+08	
140.60	1.93872E+08	DBLE ROOT ENCOUNTERD
140.62	9.43771E+07	DBLE ROOT ENCOUNTERD
140.59	1.47608E+08	
140.62	9.43771E+07	DBLE ROOT FOUND

THE DOUBLE ROOT IN THE P-VALUES ARE IN THE FOLLOWING INTERVAL
WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD

NXU = 140.619
NXL = 140.587

LOADS (PLI)	DB-DETERMINANTS	COMMENTS
140.62	9.43771E+07	
142.62	9.52329E+08	
144.62	1.32717E+09	
146.62	1.60255E+09	
148.62	1.82310E+09	
150.62	2.00619E+09	
152.62	2.16073E+09	
154.62	2.29201E+09	
156.62	2.40347E+09	
158.62	2.49750E+09	
178.62	2.73034E+09	
198.62	2.05036E+09	
218.62	8.53743E+08	
238.62	-1.87875E+08	SIGN CHANGE IN DB
220.62	7.25435E+08	
222.62	5.98565E+08	
224.62	4.74235E+08	
226.62	3.53560E+08	
228.62	2.36004E+08	
230.62	1.29159E+08	
232.62	2.90639E+07	
234.62	-5.97115E+07	SIGN CHANGE IN DB
233.62	-1.69285E+07	CRITICAL LOAD FOUND

M = 1

CRITICAL LOAD = 233.2507 P.L.I.

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BUCKLING OF ORTHOTROPIC LAMINATED PLATES

LOADING -- UNIFORM UNIAXIAL COMPRESSION
BOUNDARY CONDITIONS I ALL EDGES SIMPLY SUPPORTED
II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED
III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED, ONE SIDE FREE
IV LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE

****

TEST PLATE J

*** BOUNDARY CONDITION IV ***

RESULTS FOR ALL MODES M

LOAD	M
233.251	1

FINAL RESULTS -- ALL MODES CONSIDERED

CRITICAL LOAD = 233 P.L.I.
FOR MODE M = 1

5. COMPUTER PROGRAM RECORDS

5.1 Glossary of Program Variables

A legend for the variables is given in this section. Variables which are not essential to the understanding of the program and are used only locally will be omitted. All common block variables are explained and it is attempted to use the same name for these variables in all routines.

See data input specifications for explanation of variables which are read in.

Common Block A

LC	Line load on plate - complex
NC	Transverse buckling mode N/width BL - complex
N2C	NC squared
MC	Longitudinal buckling mode M/length AL - complex
M2C	MC squared
AC(3,3)	Extensional stiffness matrix A - complex
BC(3,3)	Coupling stiffness matrix B - complex
DC(3,3)	Bending stiffness matrix D - complex

Common Block AR

N	Transverse buckling mode
M	Longitudinal buckling mode
PI	$\pi = 3.14...$ In the program PI is set by using the closest possible octal representation of the number.
AL	Length of plate (same as a in theory)
BL	Width of plate (same as b in theory)
F1 and F2	Factors used in main program (for B.C. 1) and in the RGEN and DBGEN routines to avoid separate coding for wide and long plates.

Common Block BLK1

DB1	Value of buckling determinant for previous load tried.
DB2	Value of buckling determinant for current load.
KK	Number of conjugate pairs among the complex roots p of the equilibrium equations. (Set in DB-routine)
KRN	Number of negative real roots (p) + total number of roots. (Set in DB-routine)
IPAIR	Same as KK but for previous DB-call.
INREAL	Same as KRN but for previous DB-call.
IAB	Control for the case of double real roots. (Set by DB-routine)
IXT	Count of number of times DB was called more than 50 times.
IXU	Control for whether double root in p-roots was found.
SGN	DB1 * DB2. Reflects sign change in DB-determinant.

Common Block CON

KXX	Control for current boundary condition. Set to 1, 2, 3, or 4.
KXY	Flag set by program to mark whether this plate has coupling between bending and stretching or not. The B-matrix is checked against zero.
NCASE(10)	Array with controls set for the required boundary conditions. See input data specs.
IPC(20)	Array with controls read in.

Common Block ICK

IX	Counter for number of DB-calls (since last reset).
RES(100)	Buckling determinant values for DB-calls.
AB(100)	Loads (lbs/in) at DB-calls.
DBA	Transfer of current value of buckling det. for an alternate displ. pattern (B.C. II only).
DB1A	Same as DB1 but for assym. displ. pattern (B.C. II)
DB2A	Same as DB2 but for assym. displ. pattern (B.C. II)
SGNA	Same as SGN but for assym. displ. pattern (B.C. II)

Common Block RC

R(3,3)	Coefficient matrix for equilibrium equations.

Common Block TRS

ZMUM(25)	Poissons ratio for matrix material.
ZMUF(25)	Poissons ratio for fibers.
GM(25)	Shear modulus for matrix.
GF(25)	Shear modulus for fibers.
VM(25)	Volume fraction coefficient for matrix.
VF(25)	Volume fraction coefficient for fibers.
ZMU12(25)	Poisson ratio ν_{12} for composite layer.
ZMU21(25)	Poisson ratio ν_{21} for composite layer.
ANGLE(25)	Fiber orientation for the layer (degrees).
EM(25)	Modulus of elasticity for matrix.
EF(25)	Modulus of elasticity for fibers.

Common Block STF

E11(25)	Modulus of elasticity - direction 1.
E22(25)	Modulus of elasticity - direction 2.
G(25)	Shear modulus - G12
THETA(25)	Fiber orientation for the layers (radians).
Q(3,3,25)	Lamina stiffness matrices.

Main Program BUCLAP1 - Local Variables

A(3,3)	Extensional stiffness matrix for plate.
B(3,3)	Coupling stiffness matrix.
D(3,3)	Bending stiffness matrix.
TH(25)	Thicknesses of layers.
H(26)	Coordinate of layer surface, measured from reference plane.
S11(25)	The first element of the S-matrix or $[Q]^{-1}$.
ZN	Location of neutral reference plane.
BCON(10)	Alphanumeric label for the different boundary conditions.
NMIN, NMAX	Lower and upper limit for loop on transverse modes. Set from read in arrays.
MMIN, MMAX	Lower and upper limit for loop on longitudinal modes. Set from read in arrays.
DR(3,3)	Real R-matrix. Coefficient matrix for equilibrium equations. Used only for B.C. 1.
ICOM(100,2)	Array containing alphanumeric comments describing progress of search for critical load.
NXCR	Buckling load for current mode N and/or M.
NXFIN(30)	Storage for buckling loads for all modes M for one transverse mode N.
NXFA(30)	Storage for critical buckling loads for all N.
NXF, NXFX	Selected minimal critical buckling load.
MODN, MODM	The modes N and M for which the minimum critical load occurs.

Function Subroutine DB - Local Variables

P(9)	Set of roots from equilibrium equations - squared
P2(9)	Set of roots from equilibrium equations - squared but from a previous DB-call (in the case of double-root or sign change)
PAX	One root from equilibrium equations
NROOTS	Number of roots from equilibrium equations (actual found)
NR	Number of roots from equilibrium equations (expected)
GUESS(3,9)	Three sets of guess-values for ZARK
PIX(9)	Array parallel to P with control set to indicate conjugate pair or real number
DBM(9,9)	Buckling determinant - matrix
DBMA(9,9)	Buckling determinant - matrix assym. displ. pattern (B.C. II only)
B(9)	One or two columns of DBM
BA(9)	One or two columns of DBMA

5.2 Listings

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      OVERLAY(BUCLAP1,0,0)                                                    BU2     00002
      PROGRAM S0285A(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)                   BU2     00003
C                                                                             BU2     00004
C*************************************************************************** BU2     00005
C                                                                             BU2     00006
C  NAME                                                                       BU2     00007
C                                                                             BU2     00008
C     BUCLAP1                                                                 BU2     00009
C     A COMPUTER PROGRAM FOR UNIAXIAL COMPRESSIVE BUCKLING LOADS              BU2     00010
C     OF ORTHOTROPIC LAMINATED PLATES                                         BU2     00011
C                                                                             BU2     00012
C  CLASSIFICATION                                                             BU2     00013
C                                                                             BU2     00014
C     NASA  CONTRACT                                                          BU2     00015
C     DEVELOPMENT                                                             BU2     00016
C                                                                             BU2     00017
C  DOCUMENTS                                                                  BU2     00018
C                                                                             BU2     00019
C                  PROGRAM METHOD AND USAGE DOCUMENT                        BU2     00020
C                  PROGRAM DESCRIPTION DOCUMENT                             BU2     00021
C                  PREPARED UNDER CONTRACT NO. NAS 1-6658   BY              BU2     00022
C                  THE BOEING COMPANY                                       BU2     00023
C                  RENTON, WASHINGTON                                       BU2     00024
C                                                                           BU2     00025
C  DEVELOPERS                                                               BU2     00026
C                                                                           BU2     00027
C                THEORY  A.V.VISWANATHAN  PH. 206-237-2360                  BU2     00028
C                                         ORG.   6-8650                     BU2     00029
C                                         STRESS ANALYSIS RESEARCH          BU2     00030
C                                                                           BU2     00031
C                PROGRAM V.DEVERLI        PH. 206-237-4744                  BU2     00032
C                                         ORG.   6-2560-4                   BU2     00033
C                                         STRESS SYSTEMS                    BU2     00034
C                                                                           BU2     00035
C  PURPOSE                                                                  BU2     00036
C                                                                           BU2     00037
C     THIS PROGRAM HAS THE CAPABILITY TO COMPUTE THE                        BU2     00038
C     CRITICAL UNIAXIAL COMPRESSIVE LOAD ON A RECT. ORTHOTROPIC             BU2     00039
C     LAMINATED PLATE WITH VARIOUS BOUNDARY CONDITIONS.                     BU2     00040
C     THE MAXIMUM NUMBER OF LAYERS IS 25 . ADHESIVE LAYERS AND              BU2     00041
C     SANDWICH CORES MAY BE CONSIDERED.  A MINIMUM ENERGY                   BU2     00042
C     APPROACH IS USED, IN WHICH A VARIATIONAL PRINCIPLE IS                 BU2     00043
C     EMPLOYED TO DERIVE THE EQUILIBRIUM EQUATIONS AND THE                  BU2     00044
C     CONSISTENT BOUNDARY CONDITIONS. LINEAR THEORY IS APPLIED.             BU2     00045
C                                                                           BU2     00046
C     THE BOUNDARY CONDITIONS NOW AVAILABLE ARE                             BU2     00047
C                                                                           BU2     00048
C  B.C.  I ALL EDGES AND SIDES SIMPLY SUPPORTED.                            BU2     00049
C  B.C. II LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED.                BU2     00050
C  B.C.III LOADED EDGES SIMPLY SUPP.,ONE SIDE SIMPLY SUPP.,ONE SIDE FREE    BU2     00051
C  B.C. IV LOADED EDGES SIMPLY SUPP.,TWO SIDES FREE.                        BU2     00052
C                                                                           BU2     00053
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      C  LANGUAGE          FORTRAN IV                                                  BU2     00054
      C                                                                                BU2     00055
      C  MACHINE           CDC 6600      OPERATING SYSTEM  SCOPE 3.1                  BU2     00056
      C                                                                                BU2     00057
      C******************************************************************************* BU2     00058
      C                                                                                BU2     00059
000003        EXTERNAL DB                                                             BU2     00060
000003        COMPLEX LC,NC,N2C,MC,M2C,AC,BC,DC                                       BU2     00061
000003        COMMON/A/LC,NC,N2C,MC,M2C,AC(3,3),BC(3,3),DC(3,3)                       BU2     00062
000003        COMMON/AR/N,M,P1,AL,BL,F1,F2                                            BU2     00063
000003        COMMON/BLK1/DB1,DB2,KK,KRN,IPAIR,INREAL,IAB,IXT,SGN,IXU                 BU2     00064
000003        COMMON/CON/KXX,KXY,NCASE(10),IPC(20)                                    BU2     00065
000003        COMMON/ICK/IX,AB(100),RES(100),RESA(100),DBA,DB1A,DB2A,SGNA             BU2     00066
000003        COMPLEX R(3,3)                                                          BU2     00067
000003        COMMON/RC/R                                                             BU2     00068
000003        DIMENSION S(3,3),DR(3,3),BCON(10),ITITL(10),ICOM(100,2),V(10)           BU2     00069
000003        DIMENSION A(3,3),B(3,3),D(3,3)                                          BU2     00070
000003        COMMON/TRS/ZMUM(25),ZMUF(25),GM(25),GF(25),VM(25),VF(25),ZMU12(25)      BU2     00071
             1 ,ZMU21(25),ANGLE(25),EM(25),EF(25)                                     BU2     00072
000003        COMMON/STF/E11(25),E22(25),G(25),THETA(25),Q(3,3,25)                    BU2     00073
000003        DOUBLE S11,ZN,SM1,SM2,HP,HP1                                            BU2     00074
000003        DIMENSION S11(25),H(26),EK(26),TH(25)                                   BU2     00075
000003        REAL NX,NXU,NXL,NXO,NXF,NXFIN,NXFA,NXFX,NXCR                            BU2     00076
000003        REAL LCMIN                                                              BU2     00077
000003        DIMENSION EST(3,1),NXCR(1),CBNX(1),NXFIN(30),NXFA(30),MODA(30)          BU2     00078
000003        DIMENSION NMI(4),MMI(4),NMA(4),MMA(4)                                   BU2     00079
      C                                                                               BU2     00080
000003    1   CONTINUE                                                                BU2     00081
000003        BCON(1) = 1HI                                                           BU2     00082
000005        BCON(2) = 1HII                                                          BU2     00083
000006        BCON(3) = 1HIII                                                         BU2     00084
000010        BCON(4) = 1HIV                                                          BU2     00085
      C                                                                               BU2     00086
000011        DO 5 J=1,3                                                              BU2     00087
000013        DO 5 K=1,3                                                              BU2     00088
000014        DO 5 I=1,25                                                             BU2     00089
000015    5   Q(J,K,I) =  0.0                                                         BU2     00090
000030        NTEST=1                                                                 BU2     00091
000031        CALL DATE(DAT,YEA)                                                      BU2     00092
000033        PI = 03.14159265358979323846                                            BU2     00093
      C                                                                               BU2     00094
      C******************************************************************************* BU2     00095
      C     LOCATE REFERENCE PLANE AT ONE SURFACE                                     BU2     00096
      C***************************** ***************************************************** BU2     00097
000035        H(1) = 0.0                                                              BU2     00098
      C                                                                               BU2     00099
      C******************************************************************************* BU2     00100
      C                                                                               BU2     00101
      C     LEGEND                                                                    BU2     00102
      C                                                                               BU2     00103
      C     MAIN PROGRAM BUCLAP1 - LOCAL VARIABLES.                                   BU2     00104
      C     ------------                                                              BU2     00105
      C     ITITL    -ARRAY CONTAINING TITLE OF PROBLEM                               BU2     00106
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C     IPC(1)   -CONTROL FOR PRINT OF INTERMEDIATE RESULTS LIKE          BU2    00107
C                                THE P-VALUES  (WHICH ARE THE          BU2    00108
C                                ROOTS OF THE DT-DETERM   = ZERO)      BU2    00109
C                                AND ALSO THE DB-DETERMINANT AND       BU2    00110
C                                ITS VALUES.                           BU2    00111
C     IPC(1) =1 ACTIVATE INT. PRINT                                    BU2    00112
C     IPC(1) =0 SUPPRESS SAME.                                         BU2    00113
C                                                                      BU2    00114
C     NCASE(I) -CONTROL ARRAY FOR DESIRED BOUND.COND.                  BU2    00115
C     NCASE(I) =1 DO COMPUTATIONS FOR B.C. I                           BU2    00116
C     NCASE(I) =0 DON"T ,ETC.                                          BU2    00117
C                                                                      BU2    00118
C     TH(25)        THICKNESSES OF LAYERS.                             BU2    00119
C     H(26)         COORDINATE OF LAYER SURFACE, MEASURED FROM REFERENCE BU2   00120
C                   PLANE                                              BU2    00121
C     S11(25)       THE FIRST ELEMENT OF THE S-MATRIX                  BU2    00122
C     ZN            LOCATION OF NEUTRAL REFERENCE PLANE.               BU2    00123
C     BCON(10)      ALPHANUMERIC LABEL FOR VARIOUS BOUND. CONDITIONS   BU2    00124
C     NMIN,NMAX     LOWER AND UPPER LIMIT FOR LOOP ON TRANSVERSE MODES. BU2    00125
C                   FROM READ IN ARRAYS.                               BU2    00126
C     MMIN,MMAX     LOWER AND UPPER LIMIT FOR LOOP ON LONGITUDINAL MODES. BU2  00127
C                   FROM READ IN ARRAYS.                               BU2    00128
C     MMI(I)    STARTVALUES FOR LOOP ON M-MODES(FOR B.C. I)            BU2    00129
C     MMA(I)    ENDVALUES   FOR LOOP ON M-MODES(FOR B.C. I)            BU2    00130
C     NNI(I)    STARTVALUES FOR LOOP ON N-MODES (FOR B.C.I)            BU2    00131
C     NMA(I)    ENDVALUES   FOR LOOP ON N-MODES (FOR B.C.I)            BU2    00132
C                                                                      BU2    00133
C     L         NUMBER OF LAYERS                                       BU2    00134
C     STLD      STARTING LOAD IN SEARCH FOR CRITICAL LOAD              BU2    00135
C     SINC      PRIMARY INTERVAL IN LOAD SEARCH                        BU2    00136
C     SINC2     SEC.    INTERVAL IN LOAD SEARCH                        BU2    00137
C               IF SINC2  = 0. PROG. THEN SETS SINC2 TO SINC/10.       BU2    00138
C                                                                      BU2    00139
C               EXERCISE CARE IN CHOICE OF START LOAD AND INTERVALS    BU2    00140
C                                                                      BU2    00141
C     T         THICKNESS OF LAYER.                                    BU2    00142
C     E1,E2,RNUA,RNUB ,G12,Q11,Q12,Q21,AND Q66 ARE MATERIAL PROPERTIES. BU2    00143
C                                                                      BU2    00144
C     A(3,3)        EXTENSIONAL STIFFNESS MATRIX FOR PLATE.            BU2    00145
C     B(3,3)        COUPLING STIFFNESS MATRIX.                         BU2    00146
C     D(3,3)        BENDING STIFFNESS MATRIX.                          BU2    00147
C     DR(3,3)       REAL R-MATRIX. COEFFICIENTS FOR EQUILIB. EQUATIONS BU2    00148
C                   USED ONLY FOR B.C.I.                               BU2    00149
C     ICON(100,2)   ARRAY CONTAINING ALPHANUMERIC COMMENTS DESCRIBING  BU2    00150
C                   PROGRESS OF SEARCH FOR CRITICAL LOAD.              BU2    00151
C     NXCR          BUCKLING LOAD FOR CURRENT MODE N AND/OR M.         BU2    00152
C     NXFIN(30)     STORAGE FOR BUCKLING LOADS FOR ALL MODES M         BU2    00153
C                   FOR ONE TRANSVERSE MODE N.                         BU2    00154
C     NXFA(30)      STORAGE FOR CRITICAL BUCKLING LOADS FOR ALL N.     BU2    00155
C     NXF,NXFX      SELECTED MINIMAL CRITICAL BUCKLING LOAD.           BU2    00156
C     MODN,MODM     THE MODES N AND M FOR WHICH THE MINIMUM CRITICAL LOAD BU2  00157
C                   OCCURS.                                            BU2    00158
C                                                                      BU2    00159
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C     COMMON BLOCK A                                                    BU2     00160
C     ------------                                                      BU2     00161
C     LC            LINE LOAD ON PLATE - COMPLEX                        BU2     00162
C     MC            TRANSVERSE BUCKLING MODE N/WIDTH BL - COMPLEX       BU2     00163
C     M2C           MC SQUARED                                          BU2     00164
C     NC            LONGITUDINAL BUCKLING MODE M/LENGTH AL - COMPLEX    BU2     00165
C     N2C           NC SQUARED                                          BU2     00166
C     AC(3,3)       EXTENSIONAL STIFFNESS MATRIX A - COMPLEX            BU2     00167
C     BC(3,3)       COUPLING STIFFNESS MATRIX B - COMPLEX               BU2     00168
C     DC(3,3)       BENDING STIFFNESS MATRIX D - COMPLEX                BU2     00169
C                                                                       BU2     00170
C     COMMON BLOCK AR                                                   BU2     00171
C     ------------                                                      BU2     00172
C     N             TRANSVERSE BUCKLING MODE                            BU2     00173
C     M             LONGITUDINAL BUCKLING MODE                          BU2     00174
C     PI            =3.14...                                            BU2     00175
C                   PI IS SET BY USING THE CLOSEST POSSIBLE OCTAL       BU2     00176
C                   REPRESENTATION OF THE NUMBER.                       BU2     00177
C     AL            LENGTH OF PLATE (SAME AS A IN THEORY)               BU2     00178
C     BL            WIDTH OF PLATE (SAME AS B IN THEORY)                BU2     00179
C     F1 AND F2      FACTORS USED IN  MAINPROGRAM   (FOR B.C. I) AND    BU2     00180
C                   IN RGEN AND DBGEN ROUTINES  TO AVOID SEPARATE       BU2     00181
C                   CODE FOR WIDE AND LONG PLATES                       BU2     00182
C                                                                       BU2     00183
C                                                                       BU2     00184
C     COMMON BLOCK BLK1                                                 BU2     00185
C     ------------                                                      BU2     00186
C     DB1           VALUE OF BUCKLING DETERMINANT FOR PREVIOUS LOAD TRIED BU2     00187
C     DB2           VALUE OF BUCKLING DETERMINANT FOR CURRENT LOAD.     BU2     00188
C     KK            NUMBER OF CONT.FAIRS AMONG THE COMPLEX ROOTS OF     BU2     00189
C                   THE EQUILIBRIUM EQUATIONS (SET IN DB-ROUTINE)       BU2     00190
C     KRN           NUMBER OF NEGATIVE REAL ROOTS (P) + TOT. NO. OF ROOTS BU2     00191
C                   (SET IN DB-ROUTINE)                                 BU2     00192
C     IPAIR         SAME AS KK BUT FOR PREVIOUS DB-CALL.                BU2     00193
C     INREAL        SAME AS KRN BUT FOR PREVIOUS DB-CALL.               BU2     00194
C     IAB           CONTROL FOR CASE OF DOUBLE REAL ROOTS.              BU2     00195
C                   (SET IN DB-ROUTINE)                                 BU2     00196
C     IXT           COUNT OF NUMBER OF TIMES DB WAS CALLED MORE THAN    BU2     00197
C                   50 TIMES.                                           BU2     00198
C     IXU           CONTROL FOR WHETHER DOUBLE ROOT IN P-ROOTS WAS FOUND. BU2     00199
C     SGN           DB1*DB2. REFLECTS SIGN CHANGE IN DB-DETERMINANT.    BU2     00200
C                                                                       BU2     00201
C     COMMON BLOCK CON                                                  BU2     00202
C     ------------                                                      BU2     00203
C     KXX           CONTROL FOR CURRENT BOUNDARY CONDITION.             BU2     00204
C                   SET TO 1,2,3, OR 4.                                 BU2     00205
C     KXY           FLAG SET BY PROGRAM TO MARK WHETHER THIS PLATE HAS  BU2     00206
C                   COUPLING                                            BU2     00207
C                   BETWEEN BENDING AND STRETCHING OR NOT.THE B-MATRIX IS BU2     00208
C                   CHECKED AGAINST ZERO.                               BU2     00209
C     NCASE(10)     ARRAY WITH CONTROLS SET FOR THE REQ. BOUND. COND.   BU2     00210
C                   SEE INPUT DATA SPECS.                               BU2     00211
C     IPC(20)       ARRAY WITH CONTROLS READ IN.                        BU2     00212
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      C                                                                      BU2    00213
      C     COMMON BLOCK ICK                                                 BU2    00214
      C     ------------                                                     BU2    00215
      C     IX            COUNTER FOR NUMBER OF DB-CALLS -SINCE LAST RESET.  BU2    00216
      C     RES(100)      BUCKLING DETERMINANT VALUES FOR DB-CALLS.          BU2    00217
      C     AB(100)       LOADS(LBS/IN) AT DB-CALLS.                         BU2    00218
      C     DBA           TRANSFER OF CURRENT VALUE OF BUCKLING DET.   FOR AN BU2    00219
      C                   ALTERNATE DISPL. PATTERN (B.C. II  ONLY)           BU2    00220
      C     DB1A          SAME AS DB1 BUT FOR ASSYM. DISPL. PATTERN (B.C. II) BU2   00221
      C     DB2A          SAME AS DB2 BUT FOR ASSYM. DISPL. PATTERN (B.C. II) BU2   00222
      C     SGNA          SAME AS SGN BUT FOR ASSYM. DISPL. PATTERN (B.C. II) BU2   00223
      C                                                                      BU2    00224
      C     COMMON BLOCK RC                                                  BU2    00225
      C     ------------                                                     BU2    00226
      C     R(3,3)        COEFFICIENT MATRIX FOR EQUILIBRIUM EQ1ATIONS       BU2    00227
      C                                                                      BU2    00228
      C     COMMON BLOCK TRS                                                 BU2    00229
      C     ------------                                                     BU2    00230
      C     ZMUM(25)      POISSONS RATIO FOR MATRIX MATERIAL.                BU2    00231
      C     ZMUF(25)      POISSONS RATIO FOR FIBERS                          BU2    00232
      C     GM(25)        SHEAR MODULUS FOR MATRIX.                          BU2    00233
      C     GF(25)        SHEAR MODULUS FOR FIBERS.                          BU2    00234
      C     VM(25)        VOLUME FRACTION COEFFICIENT FOR MATRIX.            BU2    00235
      C     VF(25)        VOLUME FRACTION COEFFICIENT FOR FIBERS.            BU2    00236
      C     ZMU12(25)     POISSON RATIO     FOR COMPOSITE LAYER.             BU2    00237
      C     ZMU21(25)     POISSON RATIO    FOR  COMPOSITE LAYER.             BU2    00238
      C     ANGLE(25)     FIBER ORIENTATION FOR THE LAYER (DEGREES).         BU2    00239
      C     EM(25)        MODULUS OF ELASTICITY FOR MATRIX.                  BU2    00240
      C     EF(25)        MODULUS OF ELASTICITY FOR FIBERS.                  BU2    00241
      C                                                                      BU2    00242
      C     COMMON BLOCK STF                                                 BU2    00243
      C     ------------                                                     BU2    00244
      C     E11(25)       MODULUS OF ELASTICITY - DIRECTION 1.               BU2    00245
      C     E22(25)       MODULUS OF ELASTICITY - DIRECTION 2.               BU2    00246
      C     G(25)         SHEAR MODULUS - G12.                               BU2    00247
      C     THETA(25)     FIBER ORIENTATION FOR THE LAYERS (RADIANS).        BU2    00248
      C     Q(3,3,25)     LAMINA STIFFNESS MATRICES.                         BU2    00249
      C                                                                      BU2    00250
      C*********************************************************************** BU2   00251
      C                                                                      BU2    00252
      C     READ DATA                                                        BU2    00253
      C                                                                      BU2    00254
      C*********************************************************************** BU2   00255
      C                                                                      BU2    00256
000036        READ(5,5006) (ITITL(I),I=1,8)                                  BU2    00257
000047        IF(EOF,5) 501,7                                                BU2    00258
      C                                                                      BU2    00259
      C     ********************************************************************** BU2 00260
      C     UNLESS ANOTHER DATASET IS PRESENT THE PROGRAM WILL               BU2    00261
      C     JUMP TO 501 AND EXIT                                             BU2    00262
      C     ********************************************************************** BU2 00263
      C                                                                      BU2    00264
000052    7   CONTINUE                                                       BU2    00265
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000052          WRITE(6,5011)                                                   BU2     00266
000056          WRITE(6,5011)                                                   BU2     00267
000062          WRITE(6,2000) DAT,YEA                                           BU2     00268
000072          WRITE(6,5007)(ITITL(I),I=1,8)                                   BU2     00269
000104          READ(5,5013)  (IPC(I),I=1,16)                                   BU2     00270
000116          DO 8 I=1,16                                                     BU2     00271
000120          IF(IPC(I).LE. 0)  IPC(I) = 0                                    BU2     00272
000124    8     CONTINUE                                                        BU2     00273
000126          WRITE(6,5014) (IPC(I),I=1,1)                                    BU2     00274
000140          READ(5,5013)(NCASE(I),I=1,4)                                    BU2     00275
000152          WRITE(6,2025)                                                   BU2     00276
000156          DO 10 I=1,4                                                     BU2     00277
000160          IF(NCASE(I).LE.0) NCASE(I)= 0                                   BU2     00278
000164          IF(NCASE(I).EQ. 0)  GO TO 10                                    BU2     00279
000166          WRITE(6,2026)  BCON(I)                                          BU2     00280
000173    10    CONTINUE                                                        BU2     00281
000175          WRITE(6,5014) (NCASE(I) ,I=1,4)                                 BU2     00282
000207          READ(5,5013) (( MMI(I),I=1,4),(NMI(J),J=1,2))                   BU2     00283
000227          DO 11 I=1,4                                                     BU2     00284
000231          IF(MMI(I).LT.1)  MMI(I)= 1                                      BU2     00285
000235          IF(MMI(I).LT.1)  MMI(I)= 1                                      BU2     00286
000241    11    CONTINUE                                                        BU2     00287
000243          WRITE(6,5045)                                                   BU2     00288
000247          WRITE(6,5042)                                                   BU2     00289
000253          WRITE(6,5040) MMI(1),MMI(3),MMI(4)                              BU2     00290
000265          WRITE(6,5044)                                                   BU2     00291
000271          WRITE(6,5043)                                                   BU2     00292
000275          WRITE(6,5041) MMI(1),MMI(2)                                     BU2     00293
000305          READ(5,5013) (( MMA(I),I=1,4),(MMA(J),J=1,2))                   BU2     00294
000325          WRITE(6,5047)                                                   BU2     00295
000331          WRITE(6,5042)                                                   BU2     00296
000335          WRITE(6,5040) MMA(1),MMA(3),MMA(4)                              BU2     00297
000347          WRITE(6,5046)                                                   BU2     00298
000353          WRITE(6,5043)                                                   BU2     00299
000357          WRITE(6,5041) NMA(1),NMA(2)                                     BU2     00300
000367          READ(5,5000) L,AL,BL ,STLD,SINC,SINC2                           BU2     00301
000407          WRITE(6,5008) L,AL,BL,STLD,SINC,SINC2                           BU2     00302
000427          SINC4 = SINC                                                    BU2     00303
000431          IF(SINC2.EQ. 0.) SINC2 = SINC/10.                               BU2     00304
000433          CONT1 = 0.0                                                     BU2     00305
000434          CONT2 = 0.0                                                     BU2     00306
000435          DO 50  I=1,L                                                    BU2     00307
000436          READ(5,5021)T,Q11,Q12,Q22,Q66,GS,ZMU,VFC,ANG,CO                 BU2     00308
000465          IF(CO.LE. 0.0)  CO=0.0                                          BU2     00309
000470          TH(I)=T                                                         BU2     00310
000472          H(I+1)=H(I)+T                                                   BU2     00311
          C                                                                     BU2     00312
          C     ************************************************************* BU2     00313
          C     THE CONTROL   CO   DETERMINES THE FORM IN WHICH THE MATERIAL    BU2     00314
          C     PROPERTIES WILL BE ENTERED                                      BU2     00315
          C     ************************************************************* BU2     00316
          C                                                                     BU2     00317
000474          IF(CO.EQ.1.0 .OR. CO.EQ.2.0) GO TO 30                           BU2     00318
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000503          IF(CO.EQ.3.0) GO TO 40                                          BU2     00319
          C                                                                     BU2     00320
          C     ********************************************************************* BU2     00321
          C     THIS INPUT OPTION  (CO = 0.) PROVIDES FOR THE MATERIAL PROPERTIES  BU2     00322
          C     TO BE ENTERED AS  E1,E2,ETC.(FOR ISOTROPIC AND ORTHOTROPIC LAMINA) BU2     00323
          C     ********************************************************************* BU2     00324
          C                                                                     BU2     00325
000504          WRITE(6,5050) I,CO                                              BU2     00326
000514          WRITE(6,5052)                                                   BU2     00327
000520          E1 = Q11                                                        BU2     00328
000522          EK(I) = E1                                                      BU2     00329
000524          E2 = Q12                                                        BU2     00330
000525          IF(Q12.EQ. 0.0)   E2 = E1                                       BU2     00331
000526          RNUA = Q22                                                      BU2     00332
000530          RNUB = 0.0                                                      BU2     00333
000531          IF(RNUA.NE. 0.0)   RNUB = RNUA*E2/E1                            BU2     00334
000534          G12=Q66                                                         BU2     00335
000536          E11(I)=E1                                                       BU2     00336
000540          E22(I)=E2                                                       BU2     00337
000541          ZMU12(I)= RNUA                                                  BU2     00338
000543          ZMU21(I)=RNUB                                                   BU2     00339
000544          G(I) = G12                                                      BU2     00340
000546          GO TO 35                                                        BU2     00341
000546    30    CONTINUE                                                        BU2     00342
          C                                                                     BU2     00343
          C********************************************************************* BU2     00344
          C                                                                     BU2     00345
          C     THIS INPUT OPTION (CO=1.OR 2.) PROVIDES FOR MATR. PROPERTIES TO BE BU2     00346
          C     ENTERED AS                                                      BU2     00347
          C                    FIBER AND MATRIXPROPERTIES   (FOR COMPOSITE LAMINAE) BU2     00348
          C                                                                     BU2     00349
          C     THE REQUIRED ELASTIC CONSTANTS CAN THEN BE COMPUTED             BU2     00350
          C     BY THE PROGRAM.                                                 BU2     00351
          C     SUBROUTINE       MACON IS USED FOR THIS PURPOSE.                BU2     00352
          C                                                                     BU2     00353
          C     EF(I)   MODULUS OF ELASTICITY FOR FIBERS                        BU2     00354
          C     GF(I)   SHEAR MODULUS FOR FIBERS                                BU2     00355
          C     ZMUF(I) POISSONS RATIO FOR THE FIBERS                           BU2     00356
          C     EM(I)   MODULUS OF ELASTICITY FOR THE MATRIX MATERIAL           BU2     00357
          C     GM(I)   SHEAR MODULUS FOR MATRIX                                BU2     00358
          C     ZMUM(I) POISSONS RATIO FOR MATRIX                               BU2     00359
          C     VF(I)   VOLUME FRACTION COEFFICIENT FOR FIBERS                  BU2     00360
          C                                                                     BU2     00361
          C********************************************************************* BU2     00362
          C                                                                     BU2     00363
000546          WRITE(6,5050) I,CO                                              BU2     00364
000556          WRITE(6,5053)                                                   BU2     00365
000562          IF(CO.EQ.2.0 )                READ(5,5001) CONT1,CONT2          BU2     00366
000574          ANGLE(I) = ANG                                                  BU2     00367
000576          THETA(I)=ANGLE(I)*PI/180.                                       BU2     00368
000601          EF(I)=Q11                                                       BU2     00369
000603          GF(I)=Q12                                                       BU2     00370
000604          ZMUF(I)=Q22                                                     BU2     00371
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000606          EM(I)=Q66                                                       BU2     00372
000607          GM(I)= G8                                                       BU2     00373
000611          ZMUM(I)=ZMU                                                     BU2     00374
000612          VF(I) = VFC                                                     BU2     00375
000614          WRITE(6,5054) EF(I),GF(I),ZMUF(I),EM(I),GM(I),ZMUM(I),VF(I),    BU2     00376
               1              ANGLE(I)                                         BU2     00377
000637          IF(CO.EQ.2.0 )              WRITE(6,5055)  CONT1,CONT2          BU2     00378
000651          CALL MACON(I,CONT1,CONT2)                                       BU2     00379
000654          E1 = E11(I)                                                     BU2     00380
000656          G12=G(I)                                                        BU2     00381
000660          RNUA = ZMU12(I)                                                 BU2     00382
000661          E2 = E22(I)                                                     BU2     00383
000663          RNUB = ZMU21(I)                                                 BU2     00384
          C                                                                     BU2     00385
000664     35   CONTINUE                                                        BU2     00386
000664          WRITE(6,5009) T,E1,E2,RNUA,RNUB,G12                             BU2     00387
000704          IF(CO.NE. 0.0) GO TO 45                                         BU2     00388
000705          RNU1  = 1.0 -RNUA*RNUB                                          BU2     00389
000710          Q11 = E1/RNU1                                                   BU2     00390
000712          Q22 = E2/RNU1                                                   BU2     00391
000713          Q12 = RNUA*E2/RNU1                                              BU2     00392
000714          Q66 = G12                                                       BU2     00393
000716          GO TO 41                                                        BU2     00394
000716     40   CONTINUE                                                        BU2     00395
          C                                                                     BU2     00396
          C     ********************************************************************* BU2     00397
          C     THIS INPUT OPTION   (CO=3.) PROVIDES FOR THE MATERIAL PROPERTIES  BU2     00398
          C     TO BE ENTERED DIRECTLY AS THE LAMINA STIFFNESS MATRIX  Q          BU2     00399
          C     WHEN IT IS AVAILABLE                                            BU2     00400
          C     ********************************************************************* BU2     00401
          C                                                                     BU2     00402
000716          WRITE(6,5050) I,CO                                              BU2     00403
000726          WRITE(6,5051)                                                   BU2     00404
000732          WRITE(6,5010) T,Q11,Q12,Q22,Q66                                 BU2     00405
000750          ZMU12(I) = Q12/Q22                                              BU2     00406
000753          ZMU21(I)=Q12/Q11                                                BU2     00407
000754          ZU=1.0-ZMU12(I)*ZMU21(I)                                        BU2     00408
000757          E11(I)=Q11*ZU                                                   BU2     00409
000761          E1 = E11(I)                                                     BU2     00410
000763          E22(I)=Q22*ZU                                                   BU2     00411
000764          G(I) = Q66                                                      BU2     00412
000766     41   CONTINUE                                                        BU2     00413
000766          Q(1,1,I)=Q11                                                    BU2     00414
000771          Q(1,2,I)=Q12                                                    BU2     00415
000774          Q(2,1,I)= Q12                                                   BU2     00416
000776          Q(2,2,I)=Q22                                                    BU2     00417
001000          Q(3,3,I)= Q66                                                   BU2     00418
001003     45   CONTINUE                                                        BU2     00419
001003          SQ = 0.0                                                        BU2     00420
001004          DO 55  J=1,3                                                    BU2     00421
001006          DO 55  K=1,3                                                    BU2     00422
001007     55   SQ = SQ + Q(J,K,I)                                              BU2     00423
001021          IF(ABS(SQ) .LT. 1.E-6)   GO TO 54                               BU2     00424
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001024          S11(I) = 1.0D0/DBLE(E1)                                          BU2     00425
001043          GO TO 50                                                         BU2     00426
001044     54   S11(I) = 0.0D                                                    BU2     00427
001050     50   CONTINUE                                                         BU2     00428
001053          WRITE(6,4003)                                                    BU2     00429
001056          WRITE(6,4006)(I,E11(I),E22(I),ZMU12(I),ZMU21(I),G(I),I=1,L)      BU2     00430
001102     4003 FORMAT(1H0,1X,5HLAYER,9X,3HEXX,13X,3HEYY,12X,4HMUXY,12X,4HMUYX,  BU2     00431
               1 15X,1HG//)                                                     BU2     00432
001102     4006 FORMAT(4X,I2,5(3X,E13.6))                                        BU2     00433
001102          WRITE(6,5011)                                                    BU2     00434
001106          DO 56  I=1,L                                                     BU2     00435
           C                                                                     BU2     00437
           C*************************************************************************** BU2     00438
           C     LOCATE NEUTRAL REFERENCE PLANE                                  BU2     00439
           C*************************************************************************** BU2     00440
           C                                                                     BU2     00441
001110     56   WRITE(6,5012) (I,((Q(J,K,I),J=1,3),K=1,3))                       BU2     00436
001134          SM1 = 0.0D                                                       BU2     00442
001136          SM2 = 0.0D                                                       BU2     00443
001141          DO 60  I=1,L                                                     BU2     00444
001142          IF(S11(I) .EQ. 0.0D)  GO TO 60                                   BU2     00445
001145          SM1 = SM1 + 0.5*TH(I)*(H(I+1)+H(I))/S11(I)                       BU2     00446
001174          SM2 = SM2 + TH(I)/S11(I)                                         BU2     00447
001214     60   CONTINUE                                                         BU2     00448
001217          ZN = SM1/SM2                                                     BU2     00449
001232          ZNX = SNGL(ZN)                                                   BU2     00450
001235          WRITE(6,5002) ZNX                                                BU2     00451
           C                                                                     BU2     00452
           C*************************************************************************** BU2     00453
           C     CALCULATE  A,B, AND  D-MATRICES                                 BU2     00454
           C                                                                     BU2     00455
           C     A IS EXTENSIONAL STIFFNESS                                      BU2     00456
           C     B IS COUPLING STIFFNESS                                         BU2     00457
           C     D  IS BENDING STIFFNESS                                         BU2     00458
           C                                                                     BU2     00459
           C*************************************************************************** BU2     00460
           C                                                                     BU2     00461
001242          DO 70 I=1,3                                                      BU2     00462
001244          DO 70 J=1,3                                                      BU2     00463
001245          A(I,J) = 0.0                                                     BU2     00464
001250          B(I,J) = 0.0                                                     BU2     00465
001252          D(I,J) =  0.0                                                    BU2     00466
001254          DO 70 N=1,L                                                      BU2     00467
001255          HP = H(N) - ZN                                                   BU2     00468
001263          HP1= H(N+1)-ZN                                                   BU2     00469
001272          A(I,J) = A(I,J)+Q(I,J,N)*TH(N)                                   BU2     00470
001302          B(I,J) = B(I,J)+Q(I,J,N)*TH(N)*(HP1+HP)/2.0                      BU2     00471
001337     70   D(I,J) =  D(I,J)+Q(I,J,N)*TH(N)*(HP1*HP1+HP1*HP +HP*HP)/3.0      BU2     00472
001414          WRITE(6,5003) ((A(I,J),I=1,3),J=1,3)                             BU2     00473
001432          WRITE(6,5004) ((B(I,J),I=1,3),J=1,3)                             BU2     00474
001450          WRITE(6,5005) ((D(I,J),I=1,3),J=1,3)                             BU2     00475
001466          IF(IPC(16).EQ.1) GO TO 501                                       BU2     00476
           C                                                                     BU2     00477
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      C*********************************************************************** BU2    00478
      C     FIND OUT IF THE B-MATRIX IS ZERO,THEN THERE IS                    BU2    00479
      C     NO COUPLING BETWEEN STRETCHING AND BENDING                        BU2    00480
      C*********************************************************************** BU2    00481
      C                                                                       BU2    00482
001470        TOL = 1.0                                                       BU2    00483
001472        KXY = 0                                                         BU2    00484
001473        KNT = 0                                                         BU2    00485
001474        DO 72  I=1,3                                                    BU2    00486
001475        DO 72  J=1,3                                                    BU2    00487
001476        IF(ABS( B(I,J)).LT. TOL)  KNT = KNT + 1                         BU2    00488
001504        AC(I,J)  = CMPLX(A(I,J),0.)                                     BU2    00489
001515        BC(I,J)  = CMPLX(B(I,J),0.)                                     BU2    00490
001526   72   DC(I,J)  = CMPLX(D(I,J),0.)                                     BU2    00491
001543        IF(KNT .EQ. 9)   KXY = 1                                        BU2    00492
      C                                                                       BU2    00493
      C*********************************************************************** BU2    00494
      C     LOOP ON THE VARIOUS BOUNDARY CONDITIONS  STARTS HERE              BU2    00495
      C     THE DESIRED B.C. ARE PICKED FROM ARRAY NCASE                      BU2    00496
      C     I.E.    NCASE(1).EQ. 1   DO CALCULATIONS FOR B.C.I                BU2    00497
      C     AND     NCASE(1).NE. 1   OMIT  B.C. I                             BU2    00498
      C*********************************************************************** BU2    00499
      C                                                                       BU2    00500
001546        DO 600 KAS=1,4                                                  BU2    00501
001550        IF(NCASE(KAS)  .EQ. 0)  GO TO 600                               BU2    00502
001551        KXX =KAS                                                        BU2    00503
001552        WRITE(6,2030) BCON(KXX)                                         BU2    00504
      C                                                                       BU2    00505
      C*********************************************************************** BU2    00506
      C     SET THE MAXIMUM NUMBER OF MODES TO BE INVESTIGATED AND            BU2    00507
      C     RELEVANT TO THE B.C. IN QUESTION                                  BU2    00508
      C                                                                       BU2    00509
      C     MMAX IS RELEVANT ONLY FOR B.C. I,III,AND IV                       BU2    00510
      C     NMAX IS RELEVANT ONLY FOR B.C. I AND II                           BU2    00511
      C*********************************************************************** BU2    00512
      C                                                                       BU2    00513
001560        NMIN =NMI(KAS)                                                  BU2    00514
001562        MMIN =MMI(KAS)                                                  BU2    00515
001564        NMAX =NMA(KAS)                                                  BU2    00516
001565        MMAX =MMA(KAS)                                                  BU2    00517
001567        IF(KXX.EQ.2) MMIN = 1                                           BU2    00518
001572        IF(KXX.EQ.2)  MMAX = 1                                          BU2    00519
001575        IF(KXX.EQ. 3  .OR. KXX.EQ. 4)  NMAX = 1                         BU2    00520
001605        IF(KXX.EQ.3  .OR. KXX.EQ. 4)  NMIN = 1                          BU2    00521
001615        IF(NMAX.LT. NMIN)  NMAX = NMIN                                  BU2    00522
001621        IF(MMAX.LT. MMIN)  MMAX = MMIN                                  BU2    00523
      C                                                                       BU2    00524
      C*********************************************************************** BU2    00525
      C     LOOPS ON MAXIMUM NUMBER OF N AND M MODES START HERE               BU2    00526
      C*********************************************************************** BU2    00527
      C                                                                       BU2    00528
001625        DO 400 N=NMIN,NMAX                                              BU2    00529
001627        IF(KXX  .EQ.1   .AND.  N.GT.NMIN)   WRITE(6,5011)               BU2    00530
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001642          IF(KXX  .EQ.2   .AND.  N.GT.NMIN)   WRITE(6,5011)                  BU2     00531
001656          DO 200 M=MMIN,MMAX                                                  BU2     00532
001660          IF(KXX  .EQ.3   .AND.  M.GT.MMIN)   WRITE(6,5011)                  BU2     00533
001673          IF(KXX  .EQ.4   .AND.  M.GT.MMIN)   WRITE(6,5011)                  BU2     00534
001707          IF(KXX.EQ. 1  .AND. IPC(1).EQ. 1) WRITE(6,3005) N,M                BU2     00535
001726          IF(KXX.EQ.1 .AND. IPC(1) .NE. 1 .AND. M.EQ. 1) WRITE(6,2031) N     BU2     00536
001747          IF(KXX.EQ.2)   WRITE(6,3050) N                                     BU2     00537
001757          IF(KXX.EQ.3 .OR.KXX.EQ.4)  WRITE(6,3051) M                         BU2     00538
          C                                                                         BU2     00539
          C*************************************************************************BU2     00540
          C     ALL THE COMPUTATION FOR  B.C. I  IS DONE HERE                       BU2     00541
          C     THE DR-MATRIX  (COEFF. MATRIX FOR EQUILIB. EQUATIONS)               BU2     00542
          C     IS GENERATED  AND ITS DETERMINANT EVALUATED BY THE DET-FUNCTION.    BU2     00543
          C     FROM THIS THE LOAD NX  CAN BE SOLVED DIRECTLY.                      BU2     00544
          C*************************************************************************BU2     00545
          C                                                                         BU2     00546
001774          IF(KXX.NE.1)   GO TO 87                                             BU2     00547
001776          IF(AL/BL.LE.1.0) GO TO 80                                           BU2     00548
002002          F1 = BL/AL                                                          BU2     00549
002003          F2 = 1.0                                                            BU2     00550
002004          RLL = PI*PI/(BL*BL*F1*M*F1*M)                                       BU2     00551
002010          GO TO 81                                                            BU2     00552
002011    80    F1 = 1.0                                                            BU2     00553
002013          F2 = AL/BL                                                          BU2     00554
002015          RLL = PI*PI/(AL*AL*FLOAT(M)*FLOAT(M))                               BU2     00555
002020    81    CONTINUE                                                            BU2     00556
002020          PA = M*F1                                                           BU2     00557
002023          PB = N*F2                                                           BU2     00558
002025          PA2 =  PA*PA                                                        BU2     00559
002027          PB2 =  PB*PB                                                        BU2     00560
002030          DR(1,1) =  -A(1,1)*PA2   -A(3,3)*PB2                                BU2     00561
002034          DR(1,2) = -(A(1,2) + A(3,3))*PA*PB                                  BU2     00562
002040          DR(1,3) =   B(1,1)*PA2*PA  +(B(1,2) + 2.0*B(3,3))*PA*PB2            BU2     00563
002047          DR(2,1) =   DR(1,2)                                                 BU2     00564
002050          DR(2,2) =  -A(2,2)*PB2    -A(3,3)*PA2                               BU2     00565
002053          DR(2,3) =  (B(1,2) +2.*B(3,3))*PA2*PB  + B(2,2)*PB2*PB              BU2     00566
002062          DR(3,1) =  -DR(1,3)                                                 BU2     00567
002064          DR(3,2) =  -DR(2,3)                                                 BU2     00568
002065          DR(3,3) =   C(1,1)*PA2*PA2 +(2.*C(1,2) +4.*C(3,3))*PA2*PB2          BU2     00569
                1          +C(2,2)*PB2*PB2                                        BU2     00570
002076          IF(IPC(1).EQ.1 )  WRITE(6,1000)   ((DR(I,J),I=1,3),J=1,3)          BU2     00571
          C     ------------------------------------------------------------------BU2     00572
          C     THE FUNCTION SUBPROGRAM  DET   IS DEVELOPED FOR THE PURPOSE OF      BU2     00573
          C     EVALUATION OF REAL      DETERMINANTS                                BU2     00574
          C     BY THE MATH. ANALYSIS GROUP   FOR THIS  PROGRAM                     BU2     00575
          C     ------------------------------------------------------------------BU2     00576
002116          DBX =  DET(DR,3,3,V)                                                BU2     00577
002122          NXCR = -DBX*RLL/(DR(1,2)*DR(2,1) -DR(1,1)*DR(2,2))                  BU2     00578
002127          GO TO 180                                                           BU2     00579
          C                                                                         BU2     00580
          C*************************************************************************BU2     00581
          C     END OF B.C. I                                                       BU2     00582
          C************************** ***************************************** BU2     00583
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      C                                                                       BU2   00584
      C*************************************************************************BU2   00585
      C                                                                       BU2   00586
002130  87   CONTINUE                                                        BU2   00587
      C                                                                       BU2   00588
      C*************************************************************************BU2   00589
      C     INITIALIZE COUNTERS AND CONTROLS                                  BU2   00590
      C*************************************************************************BU2   00591
      C                                                                       BU2   00592
002130      IF(AL/BL .LE. 1.0) GO TO 88                                       BU2   00593
002134      F1 = BL/AL                                                        BU2   00594
002135      F2 = 1.0                                                          BU2   00595
002136      GO TO 89                                                          BU2   00596
002136  88  F1 = 1.0                                                         BU2   00597
002140      F2 = AL/BL                                                        BU2   00598
002142  89  CONTINUE                                                         BU2   00599
002142      NC = CMPLX(FLOAT(N),0.)*F2                                        BU2   00600
002152      NC = CMPLX(FLOAT(N),0.)*F1                                        BU2   00601
002162      N2C= NC*NC                                                        BU2   00602
002167      N2C= NC*NC                                                        BU2   00603
      C                                                                       BU2   00604
002174      IX = 0                                                            BU2   00605
002175      I10 = 0                                                           BU2   00606
002176      IXX = 0                                                           BU2   00607
002177      IXT = 0                                                           BU2   00608
002200      IXU=0                                                             BU2   00609
002201      I5=0                                                              BU2   00610
002202      IAB = 0                                                           BU2   00611
002203      DB1 = 0.0                                                         BU2   00612
002204      SGN = 0.0                                                         BU2   00613
002205      SGNA = 0.0                                                        BU2   00614
002206      DB1A = 0.0                                                        BU2   00615
002207      KRN =0                                                            BU2   00616
002210      KK  =0                                                            BU2   00617
002211      IPAIR = 0                                                         BU2   00618
002212      INREAL = 0                                                        BU2   00619
002213      STLD1 = STLD                                                      BU2   00620
002214      SINC = SINC4                                                      BU2   00621
002216      IXV = 0                                                           BU2   00622
002217      IXH  = 10                                                         BU2   00623
      C                                                                       BU2   00624
      C*************************************************************************BU2   00625
      C     RETURN TO STATEMENT ---90--- WHEN  A. A DOUBLE ROOT WAS LOCATED   BU2   00626
      C                                        B. THE FIRST TRY AFTER A DOUBLE BU2   00627
      C                                           ROOT DID NOT PRODUCE ENOUGH  BU2   00628
      C                                           CHANGE SO THAT ROOT IS STILL BU2   00629
      C                                           PRACTICALLY DOUBLE           BU2   00630
      C     IAB    IS THE CONTROL FOR CASE B                                  BU2   00631
      C     IAB=1  INSIGNIFICANT CHANGE IN DOUBLE ROOT                        BU2   00632
      C     IAB=0  O.K.                                                       BU2   00633
      C*************************************************************************BU2   00634
      C                                                                       BU2   00635
002220  90  DB0 = DB(STLD1)                                                   BU2   00636
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002223          IF(KXX.EQ.2) DBOA = DBA                                          BU2     00637
002226          ICOM(1 ,1)=1OH                                                   BU2     00638
002230          ICOM(1 ,2)=1OH                                                   BU2     00639
002231          IF(IAB .EQ. 0) GO TO 91                                          BU2     00640
002232          IF(I5)92,92,93                                                   BU2     00641
002234     92   WRITE(6,5037)                                                    BU2     00642
002240     93   WRITE(6,5036)                                                    BU2     00643
002244          ICOM(IX,1)=1OHSTILL DBLE                                         BU2     00644
002246          ICOM(IX,2)=1OH REAL ROOT                                         BU2     00645
002250          ANCR = STLD1/100.                                                BU2     00646
002252          IF(ANCR.GT. SINC)   ANCR = SINC                                  BU2     00647
002255          IF(ANCR.LT.0.5)ANCR=0.5                                          BU2     00648
002261          STLD1 = STLD1 + ANCR                                             BU2     00649
002263          IX = 0                                                           BU2     00650
002264          GO TO 90                                                         BU2     00651
002264     91   CONTINUE                                                         BU2     00652
002264          IPAIR = KK                                                       BU2     00653
002266          INREAL = KRN                                                     BU2     00654
002267          SINC3 = SINC2                                                    BU2     00655
002271          IF(IXH.EQ. 0) SINC3= SINC/10.                                    BU2     00656
002274          DB2=DBO                                                          BU2     00657
002276          IF(KXX.EQ.2) DB2A = DBOA                                         BU2     00658
002301          NXU = STLD1                                                      BU2     00659
002303          I5=1                                                             BU2     00660
          C                                                                      BU2     00661
          C******* ********************************************************** BU2     00662
          C     RETURN TO STATEMENT ---100--- WHEN C. A SIGN CHANGE OCCURRED IN  BU2     00663
          C                                        THE DB-DETERMINANT AND THE    BU2     00664
          C                                        CRITICAL LOAD IS BEING        BU2     00665
          C                                        CIRCLED IN.                   BU2     00666
          C                                    D. MORE THAN 50 CALLS HAVE BEEN   BU2     00667
          C                                        MADE TO DB-FUNCTION WITHOUT   BU2     00668
          C                                        CHANGE IN SIGN OR ENCOUNTER-  BU2     00669
          C                                        ING DOUBLE ROOT.              BU2     00670
          C                                                                      BU2     00671
          C                                    E. A CHANGE IN NUMBER OF REAL     BU2     00672
          C                                        ROOTS OR NUMBER OF CONJUGATE  BU2     00673
          C                                        PAIRS FOUND FROM THE DT-FUNC  BU2     00674
          C                                        -TION. THIS INDICATES A       BU2     00675
          C                                        DOUBLE ROOT WHICH IS THEN     BU2     00676
          C                                        LOCATED MORE CLOSELY.         BU2     00677
          C********************************************************************* BU2     00678
          C                                                                      BU2     00679
002304    100   I10=I10+1                                                        BU2     00680
002306          IXH = IXH +1                                                     BU2     00681
002307          IF(IXH.EQ. 10 .A. IXV.EQ.1) SINC = SINC4                         BU2     00682
002316          IF(IXH.EQ. 10 .A. IXV.EQ.1) SINC3= SINC2                         BU2     00683
002326          NXL=NXU                                                          BU2     00684
002330          DB1=DB2                                                          BU2     00685
002331          IF(KXX.EQ.2) DB1A = DB2A                                         BU2     00686
002335          NXU = NXL + SINC                                                 BU2     00687
002337          DB2=DB(NXU)                                                      BU2     00688
002342          IF(KXX.EQ.2) DB2A = DBA                                          BU2     00689
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002345          ICOM(IX,1)=1GH                                                  BU2     00690
002347          ICOM(IX,2)=1GH                                                  BU2     00691
002351          SGN = SIGN(1.0,DB1)*SIGN(1.0,DB2)                               BU2     00692
002360          IF(KXX.EQ.2) SGNA = SIGN(1.0,DB1A)*SIGN(1.0,DB2A)               BU2     00693
002367          IXT = 0                                                         BU2     00694
002370          IF(KK.EQ. IFAIR .AND. KRN .EQ. INREAL)   GO TO 103              BU2     00695
002400          ICOM(IX,1)=1GHDBLE ROOT                                         BU2     00696
002402          ICOM(IX,2)=1GHFOUND                                             BU2     00697
002403          TOLD = 0.04/100.                                                BU2     00698
002405          IF(NXL.LT. 50.) TOLD= 0.1/100.                                  BU2     00699
002411          IF(SINC.LT. NXL*TOLD) GO TO 102                                 BU2     00700
002415          IF(IPC(1) .EQ. 1)  WRITE(6,5034)                                BU2     00701
002422          ICOM(IX,1)=1GHDBLE ROOT                                         BU2     00702
002424          ICOM(IX,2)=1GHENCOUNTERD                                        BU2     00703
002426          NXU = NXL                                                       BU2     00704
002427          DB2 = DB1                                                       BU2     00705
002431          IF(KXX.EQ.2) DB2A = DB1A                                        BU2     00706
002434          SINC = SINC3                                                    BU2     00707
002436          SINC3 = SINC3/2.0                                               BU2     00708
002437          GO TO 100                                                       BU2     00709
        C                                                                       BU2     00710
        C*************************************************************************BU2     00711
        C     COME TO  ---102--- WHEN THE DOUBLE ROOT OF THE DT-FUNCTION IS     BU2     00712
        C                        LOCATED TO THE TOLERANCE SPECIFIED             BU2     00713
        C*************************************************************************BU2     00714
        C                                                                       BU2     00715
002437   102  IF(KXX.NE.2)WRITE(6,3010)((AB(I),RES(I),ICOM(I,1),ICOM(I,2)),I=1,  BU2     00716
            1  IX)                                                             BU2     00717
002462          IF(KXX.EQ.2)WRITE(6,3011)((AB(I),RES(I),RESA(I),ICOM(I,1),      BU2     00718
            1  ICOM(I,2)),I=1,IX)                                              BU2     00719
002507          WRITE(6,5035) NXU,NXL                                           BU2     00720
002517          IXU=0                                                           BU2     00721
002520          I10 = 0                                                         BU2     00722
002521          IX = 0                                                          BU2     00723
002522          STLD1 = NXU                                                     BU2     00724
002523          SINC = SINC4/10.                                                BU2     00725
002525          IXH  = 0                                                        BU2     00726
002526          IXV = 1                                                         BU2     00727
002527          ICOM(1 ,1)=1GH                                                  BU2     00728
002530          ICOM(1 ,2)=1GH                                                  BU2     00729
002532          GO TO 90                                                        BU2     00730
        C                                                                       BU2     00731
        C*************************************************************************BU2     00732
        C     COME TO  ---103--- TO CHECK FOR SIGN CHANGE IN DB-DETERMINANT     BU2     00733
        C                        AND IF LIMIT OF 50 DB-CALLS IS EXCEEDED,       BU2     00734
        C*************************************************************************BU2     00735
        C                                                                       BU2     00736
002532   103  CONTINUE                                                         BU2     00737
002532          IF(KXX.EQ.2) GO TO 107                                          BU2     00738
002534          IF(SGN.LE. 0.) GO TO 105                                        BU2     00739
002536          GO TO 109                                                       BU2     00740
002536   107  IF(SGN.LE. 0..OR. SGNA.LE.0.) GO TO 105                         BU2     00741
002546   109  CONTINUE                                                         BU2     00742
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002546          IF(I1G.LE. 50)GO TO 100                                          BU2     00743
002551          ICOM(IX,1)=10H LIMIT 50                                          BU2     00744
002553          ICOM(IX,2)=10H DB-CALLS                                          BU2     00745
002554          IF(KXX.NE.2)WRITE(6,3010)((AB(I),RES(I),ICOM(I,1),ICOM(I,2)),I=1,  BU2     00746
               1  IX)                                                           BU2     00747
002577          IF(KXX.EQ.2)WRITE(6,3011)((AB(I),RES(I),RESA(I),ICOM(I,1),       BU2     00748
               1  ICOM(I,2)),I=1,IX)                                           BU2     00749
002624          WRITE(6,1002)                                                    BU2     00750
002630          I10 = 0                                                          BU2     00751
002631          IX  = 0                                                          BU2     00752
002632          IXU=1                                                            BU2     00753
002633          NDB = 50+IXX                                                     BU2     00754
002635          LIM = 800                                                        BU2     00755
002636          IF(NDB.GE. LIM)  GO TO   104                                     BU2     00756
002640          IXT = IXT + 1                                                    BU2     00757
002642          IXX = IXX + 1                                                    BU2     00758
002642          SINC = SINC*2.0                                                  BU2     00759
002644          NXU = NXL                                                        BU2     00760
002645          DB2 = DB1                                                        BU2     00761
002647          IF(KXX.EQ.2) DB2A = DB1A                                         BU2     00762
002652          GO TO 100                                                        BU2     00763
002653   104    WRITE(6,5019) LIM                                                BU2     00764
002661          GO TO 110                                                        BU2     00765
               C                                                                BU2     00766
               C*****************************************************************BU2     00767
               C     COME TO  ---105--- TO HALVE LD  INTERVAL WHEN SIGN CHANGE OCCURS  BU2     00768
               C                        OR CHECK IF INTERVAL IS LESS THAN SPECIFIED  BU2     00769
               C                        TOLERANCE FOR CRITICAL LOAD             BU2     00770
               C*****************************************************************BU2     00771
               C                                                                BU2     00772
002662   105    CONTINUE                                                         BU2     00773
002662          ICOM(IX,1)=10HCRITICAL L                                         BU2     00774
002664          ICOM(IX,2)=10HOAD FOUND                                          BU2     00775
002666          IF(KXX.NE.2) GO TO 106                                           BU2     00776
002670          IXV = 0                                                          BU2     00777
002671          ICOM(IX,1) = 10HCRIT.  LD                                        BU2     00778
002672          ICOM(IX,2) = 10HSYMMETRIC                                        BU2     00779
002674          IF(SGN.LT. 0. .A. SGNA.LT.0.)  ICOM(IX,2) = 10HBOTH MODES        BU2     00780
002705          IF(SGN.GT. 0. .A. SGNA.LT.0.) ICOM(IX,2) = 10HANTISYMM.          BU2     00781
002717   106    CONTINUE                                                         BU2     00782
002717          IF(SINC.LT.NXL/100..AND.NXL.LT.50.)  GO TO 115                   BU2     00783
002730          IF(SINC.LT. NXL/200.)  GO TO 110                                 BU2     00784
002733          NXU = NXL                                                        BU2     00785
002734          DB2 = DB1                                                        BU2     00786
002735          IF(KXX.EQ.2) DB2A = DB1A                                         BU2     00787
002741          SINC = SINC3                                                     BU2     00788
002742          SINC3 = SINC3/2.0                                                BU2     00789
002743          ICOM(IX,1)=10HSIGN CHANG                                         BU2     00790
002745          ICOM(IX,2)=10HE IN DB                                            BU2     00791
002747          IF(KXX.NE.2)GO TO 100                                            BU2     00792
002750          ICOM(IX,1) = 10HSGN CHANG                                        BU2     00793
002752          ICOM(IX,2) = 10HSYMMETRIC                                        BU2     00794
002753          IF(SGN.LT. 0. .A. SGNA.LT.0.)  ICOM(IX,2) = 10HBOTH MODES        BU2     00795
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002764          IF(SGN.GT. 0. .A. SGNA.LT.0)  ICOM(IX,2) = 1OHANTISYMM.          BU2     00796
002776          GO TO 100                                                        BU2     00797
                C                                                                BU2     00798
                C*****************************************************************BU2     00799
                C     COME TO ---110--- WHEN THE CRITICAL LOAD IS LOCATED IN AN  BU2     00800
                C                       INTERVAL OF SIZE LESS THAN A SPECIFIED TOLERANCE BU2  00801
                C                       THE CRITICAL LOAD IS THEN  ESTABLISHED BY LINEAR BU2  00802
                C                       INTERPOLATION.                           BU2     00803
                C*****************************************************************BU2     00804
                C                                                                BU2     00805
002777     110  CONTINUE                                                         BU2     00806
002777          NXO = DB1*(NXU-NXL)/(DB1-DB2)  +NXL                              BU2     00807
003005          IF(KXX.NE.2) GO TO 112                                           BU2     00808
003007          IF(SGN.LT.0. .A. SGNA.GT. 0.) GO TO 112                          BU2     00809
003016          NXO = DB1A*(NXU-NXL)/(DB1A-DB2A) +NXL                            BU2     00810
003023     112  NXCR = NXO                                                       BU2     00811
003025          IF(KXX.NE.2)WRITE(6,3010)((AB(I),RES(I),ICOM(I,1),ICOM(I,2)),I=1,BU2     00812
                1  IX)                                                           BU2     00813
003047          IF(KXX.EQ.2)WRITE(6,3011)((AB(I),RES(I),RESA(I),ICOM(I,1),       BU2     00814
                1  ICOM(I,2)),I=1,IX)                                           BU2     00815
003074     180  CONTINUE                                                         BU2     00816
003074          IF(KXX.EQ.1) WRITE(6,3004) N,M                                   BU2     00817
003106          IF(KXX.EQ.2) WRITE(6,3006) N                                     BU2     00818
003116          IF(KXX.EQ.3 .OR.KXX.EQ.4)WRITE(6,3007)M                          BU2     00819
003133          WRITE(6,2007)NXCR                                                BU2     00820
003141          IF(KXX.NE.2) GO TO 190                                           BU2     00821
003143          IF(SGN.LT.0..A.  SGNA .GT.0.) GO TO 182                          BU2     00822
003152          IF(SGN.LT.0..A. SGNA .LT.0.) GO TO 183                           BU2     00823
003157          WRITE(6,3009)                                                    BU2     00824
003162          GO TO 190                                                        BU2     00825
003163     182  WRITE(6,3008)                                                    BU2     00826
003167          GO TO 190                                                        BU2     00827
003170     183  WRITE(6,3012)                                                    BU2     00828
003174     190  CONTINUE                                                         BU2     00829
003174          MM = M-MMIN+1                                                    BU2     00830
003177          NXFIN(MM)= NXCR                                                  BU2     00831
003201     200  CONTINUE                                                         BU2     00832
                C                                                                BU2     00833
                C*****************************************************************BU2     00834
                C     END OF LOOP ON LONGITUDINAL MODES M                        BU2     00835
                C*****************************************************************BU2     00836
                C                                                                BU2     00837
003203          NN = N-NMIN+1                                                    BU2     00838
003205          NXFA(NN) = NXCR                                                  BU2     00839
003207          IF(KXX.EQ. 2)  GO TO 400                                         BU2     00840
003211          MODE = MMIN                                                      BU2     00841
003213          NOM = MMAX-MMIN+ 1                                               BU2     00842
003215          NXF = NXFIN(1)                                                   BU2     00843
003216          IF(NOM.LE.1) GO TO 301                                           BU2     00844
003220          DO 300 IJ=2,NOM                                                  BU2     00845
003222          IF(ABS(NXF).LT. ABS(NXFIN(IJ)))  GO TO 300                       BU2     00846
003227          NXF =  NXFIN(IJ)                                                 BU2     00847
003230          MODE=  IJ +MMIN-1                                                BU2     00848
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003232     300  CONTINUE                                                    BU2    00849
003235     301  CONTINUE                                                    BU2    00850
003235          MODM = MODE                                                 BU2    00851
003237          WRITE(6,2000)  DAT,YEA                                      BU2    00852
003246          WRITE(6,5007)(ITITL(I),I=1,8)                               BU2    00853
003260          WRITE(6,5031) BCON(KXX)                                     BU2    00854
003266          IF(KXX.EQ. 3 .OR. KXX.EQ.4)   GO TO 340                     BU2    00855
003276          WRITE (6,2020) N                                            BU2    00856
003303          WRITE(6,2021) ((NXFIN(I-MMIN+1),I),I=MMIN,MMAX)             BU2    00857
003321          IF(NOM.EQ.1) GO TO 350                                      BU2    00858
003323          WRITE(6,2008)                                               BU2    00859
003327          WRITE(6,2009)  NXF,MODE,N                                   BU2    00860
003341          GO TO 350                                                   BU2    00861
003342     340  CONTINUE                                                    BU2    00862
003342          WRITE(6,2019)                                               BU2    00863
003346          WRITE(6,2021) ((NXFIN(I-MMIN+1),I),I=MMIN,MMAX)             BU2    00864
003364     350  CONTINUE                                                    BU2    00865
003364          NXFA(NN) = NXF                                              BU2    00866
003366          MODA(NN) = MODE                                             BU2    00867
                C                                                           BU2    00868
                C*************************************************************** BU2    00869
                C     END OF LOOP ON TRANSVERSE   MODES N                   BU2    00870
                C*************************************************************** BU2    00871
                C                                                           BU2    00872
003370     400  CONTINUE                                                    BU2    00873
003373          IF(KXX.NE. 1) GO TO 470                                     BU2    00874
                C                                                           BU2    00875
                C*************************************************************** BU2    00876
                C     OUTPUT FOR BOUNDARY COND. I                           BU2    00877
                C*************************************************************** BU2    00878
                C                                                           BU2    00879
003375          NON = NMAX-NMIN+1                                           BU2    00880
003376          NXFX = NXFA(1)                                              BU2    00881
003400          MODN = NMIN                                                 BU2    00882
003401          MODM = MODA(1)                                              BU2    00883
003402          IF(NON.EQ.1) GO TO 451                                      BU2    00884
003404          WRITE(6,5015)((I,MODA(I-NMIN+1),NXFA(I-NMIN+1)),I=NMIN,NMAX)BU2    00885
003423          DO 450 IJ=2,NON                                             BU2    00886
003425          IF(ABS(NXFX).LT.ABS(NXFA(IJ))) GO TO 450                    BU2    00887
003432          NXFX = NXFA(IJ)                                             BU2    00888
003433          MODM = MODA(IJ)                                             BU2    00889
003434          MODN = IJ+NMIN-1                                            BU2    00890
003436     450  CONTINUE                                                    BU2    00891
003441     451  CONTINUE                                                    BU2    00892
003441          WRITE(6,2000)DAT,YEA                                        BU2    00893
003451          WRITE(6,5007)(ITITL(I),I=1,8)                               BU2    00894
003463          WRITE(6,5031) BCON(KXX)                                     BU2    00895
003471          WRITE(6,5018)                                               BU2    00896
003475          WRITE (6,2009) NXFX,MODM,MODN                               BU2    00897
                C                                                           BU2    00898
                C*************************************************************** BU2    00899
                C     END OF OUTPUT FOR B.C.I                               BU2    00900
                C*************************************************************** BU2    00901
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      C                                                                      BU2    00902
003507      GO TO 600                                                        BU2    00903
003510  470 CONTINUE                                                         BU2    00904
      C                                                                      BU2    00905
      C*********************************************************************** BU2  00906
      C     OUTPUT FOR BOUNDARY CONDITIONS II,III AND IV IS DONE HERE.       BU2    00907
      C*********************************************************************** BU2  00908
      C                                                                      BU2    00909
003510      NON =NMAX- NMIN+1                                                BU2    00910
003513      MODN= NMIN                                                       BU2    00911
003514      NXFX = NXFA(1)                                                   BU2    00912
003515      IF(KXX.NE.2) GO TO 473                                           BU2    00913
003517      IF(NON.EQ.1) GO TO 472                                           BU2    00914
003521      DO 471 IJ=2,NON                                                  BU2    00915
003522      IF(ABS(NXFX)  .LT. ABS(NXFA(IJ)))  GO TO 471                     BU2    00916
003530      NXFX = NXFA(IJ)                                                  BU2    00917
003531      MODN = IJ+NMIN-1                                                 BU2    00918
003533  471 CONTINUE                                                         BU2    00919
003536  472 CONTINUE                                                         BU2    00920
003536      WRITE(6,2000)   DAT,YEA                                          BU2    00921
003546      WRITE(6,5007)(ITITL(I),I=1,8)                                    BU2    00922
003560      WRITE(6,5031) BCON(KXX)                                          BU2    00923
003566      WRITE(6,2018)                                                    BU2    00924
003572      WRITE(6,2011) ((NXFA(I-NMIN+1),I),I=NMIN,NMAX)                   BU2    00925
003610  473 CONTINUE                                                         BU2    00926
003610      WRITE(6,5018)                                                    BU2    00927
003614      IF(KXX.EQ.2)  WRITE(6,2012) NXFX,MODN                            BU2    00928
003626      IF(KXX.EQ.3 .OR. KXX.EQ.4)  WRITE(6,2013) NXF,MODM               BU2    00929
003645  600 CONTINUE                                                         BU2    00930
003647  500 CONTINUE                                                         BU2    00931
003647      GO TO 1                                                          BU2    00932
003650  501 CALL EXIT                                                        BU2    00933
      C                                                                      BU2    00934
      C*********************************************************************** BU2  00935
      C     FORMAT STATEMENTS                                                BU2    00936
      C*********************************************************************** BU2  00937
      C                                                                      BU2    00938
003651  1000 FORMAT(*0CR-MATRIX*/(3F20.3))                                   BU2    00939
003651  1002 FORMAT(*0ABOVE ARE  50 TRIES WITHOUT CHANGE IN SIGN*/           BU2    00940
         1 * DOUBLE LOAD-INCREMENT AND START OVER AGAIN*/)                   BU2    00941
003651  2000 FORMAT(*1TES-285*55X,A6,2X,A6//                                 BU2    00942
         1 * BUCKLING OF ORTHOTROPIC LAMINATED PLATES*//                     BU2    00943
         2 * LOADING --          UNIFORM  UNIAXIAL COMPRESSION*/             BU2    00944
         3 * BOUNDARY CONDITIONS I   ALL EDGES SIMPLY SUPPORTED*/           BU2    00945
         4 21X,*II  LOADED EDGES CLAMPED, TWO SIDES SIMPLY SUPPORTED*/      BU2    00946
         5 21X,*III LOADED EDGES SIMPLY SUPPORTED, ONE SIDE SIMPLY SUPPORTED BU2    00947
         6, ONE SIDE FREE*/                                                 BU2    00948
         7 21X,*IV  LOADED EDGES SIMPLY SUPPORTED, TWO SIDES FREE*/         BU2    00949
         861H ************************************************************,  BU2  00950
         920H********************//)                                        BU2    00951
003651  2007 FORMAT(* CRITICAL LOAD  = *F20.4*     P.L.I.*//)               BU2    00952
003651  2008 FORMAT(*0*////* FINAL RESULTS FOR THIS TRANSVERSE MODE*/)       BU2    00953
003651  2009 FORMAT(*0CRITICAL LOAD   =*F10.0* P.L.I.*/* FOR MODES     M =*I10/ BU2    00954
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          1 15X,*N =*I10//)                                                    BU2   00955
003651    2011 FORMAT(*0*6X*LOAD*9X*N*/(1X,F10.3,I10))                         BU2   00956
003651    2012 FORMAT(*0CRITICAL LOAD   =*F10.0* P.L.I.*/* FOR MODE      N =*I10) BU2   00957
003651    2013 FORMAT(*0CRITICAL LOAD   =*F10.0* P.L.I.*/* FOR MODE      M =*I10) BU2   00958
003651    2018 FORMAT(*0RESULTS FOR ALL MODES    N*/)                          BU2   00959
003651    2019 FORMAT(*0RESULTS FOR ALL MODES    M*/)                          BU2   00960
003651    2020 FORMAT(*0RESULTS FOR ALL MODES OF M       FOR  N =  * I5/)      BU2   00961
003651    2021 FORMAT(*0*6X*LOAD*9X*N*/(1X,F10.3,I10))                         BU2   00962
003651    2025 FORMAT(*0BOUNDARY CONDITIONS CONSIDERED IN THIS DATASET ARE*)    BU2   00963
003651    2026 FORMAT(50X,A10)                                                 BU2   00964
003651    2030 FORMAT(*1BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB*/* B*34X,*B*/  BU2   00965
          1* B BOUNDARY CONDITION  *A10,*   B*/* B*34X*B*/                    BU2   00966
          2* BBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBBB*//)                       BU2   00967
003651    2031 FORMAT(*0TRANSVERSE   MODE  N  =*I10//)                         BU2   00968
003651    3004 FORMAT(*0N  =*I5*   M  =*I5/)                                   BU2   00969
003651    3005 FORMAT(31H0**********************************/2H *,28X,1H*/2H *,4X, BU2   00970
          1 15HMODES ARE   N =,I5,5H    */2H *,16X,3HM =,I5,5H    */           BU2   00971
          2 2H *,28X,1H*/31H **********************************///)           BU2   00972
003651    3006 FORMAT(*0N   =*I5/)                                             BU2   00973
003651    3007 FORMAT(*0M   =*I5/)                                             BU2   00974
003651    3008 FORMAT(* SYMMERIC MODE  (B.C. II)*/)                            BU2   00975
003651    3009 FORMAT(* ANTISYMMETRIC MODE  (B.C. II)*/)                       BU2   00976
003651    3010 FORMAT(*0*5X*LOADS*5X*DB-DETERMINANTS*10X*COMMENTS*/6X*(PLI)*//  BU2   00977
          1    (1X,F10.2,7X,E13.5,10X,2A10))                                   BU2   00978
003651    3011 FORMAT(*0*5X*LOADS*5X*DB-DETERMINANTS*5X*DB-DETERMINANTS*       BU2   00979
          1 10X*COMMENTS*/6X*(PLI)*6X*SYMMETRIC MODE*7X*ANTISYMM.MODE*//       BU2   00980
          2  (1X,F10.2,2(7X,E13.5),10X,2A10))                                 BU2   00981
003651    3012 FORMAT(* CRITICAL LOADS FOR BOTH MODES ARE NEAR EACH OTHER      BU2   00982
          1 (B.C. II)*/)                                                       BU2   00983
003651    3050 FORMAT(31H0**********************************/2H *,28X,1H*/2H *,4X, BU2   00984
          1 15HMODE  IS    N =,I5,5H    */2H *,26X,            1H*/          BU2   00985
          2 2H *,28X,1H*/31H **********************************///)           BU2   00986
003651    3051 FORMAT(31H0**********************************/2H *,28X,1H*/2H *,4X, BU2   00987
          1 15HMODE  IS   M =,I5,5H    */2H *,26X,            1H*/          BU2   00988
          2 2H *,28X,1H*/31H **********************************///)           BU2   00989
003651    5000 FORMAT(I10,7F10.2)                                              BU2   00990
003651    5001 FORMAT(8F10.2)                                                  BU2   00991
003651    5002 FORMAT(1H0,* LOCATION OF NEUTRAL PLANE*/                        BU2   00992
          1 2X,*RELATIVE TO REFERENCE PLANE  *   F10.4/)                       BU2   00993
003651    5003 FORMAT(9H1A-MATRIX//(1X,3F20.3))                                BU2   00994
003651    5004 FORMAT(9H0B-MATRIX//(1X,3F20.3))                                BU2   00995
003651    5005 FORMAT(9H0D-MATRIX//(1X,3F20.3))                                BU2   00996
003651    5006 FORMAT(8A10)                                                    BU2   00997
003651    5007 FORMAT(1H ,8A10)                                                BU2   00998
003651    5008 FORMAT(*1NUMBER OF LAYERS                  L    =*I20/          BU2   00999
          1       * LENGTH                                AL   =*F20.3/        BU2   01000
          2       * WIDTH                                 BL   =*F20.3/ //     BU2   01001
          3       * STARTING LOAD                         STLD =*F20.3/        BU2   01002
          4       * PRIMARY INTERVAL                      SINC =*F20.3/        BU2   01003
          5       * SEC. INTERVAL (NOT USED IF ZERO)  SINC2=*F20.3/)            BU2   01004
003651    5009 FORMAT(*0*,16X,*THICKNESS      T1  =*F20.4/                     BU2   01005
          1                15X,*  E-MODULUS      E1  =*F20.4/                 BU2   01006
          2                32X,*E2  =*F20.4/                                   BU2   01007
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     3                15X,*  POISSONS RATIO RNUA=*F20.4/                    BU2   01008
     4                32X,*RNUB=*F20.4/                                     BU2   01009
     5                15X,*  TORSIONAL MOD. G12 =*F20.4//)                  BU2   01010
003651  5010 FORMAT(*0*,16X,*THICKNESS      T1  =*F20.4/                     BU2   01011
     1  32X,5HQ11 =, F20.4/32X,5HQ12 =,F20.4/32X,5HQ22 =,F20.4/             BU2   01012
     2  32X,5HQ66 =,F20.4//)                                                BU2   01013
003651  5011 FORMAT(1H1)                                                    BU2   01014
003651  5012 FORMAT(*0Q-MATRIX*,10X,*LAYER NO  *I5//(10X,3F20.3))           BU2   01015
003651  5013 FORMAT(16I5)                                                   BU2   01016
003651  5014 FORMAT(1X,16I5)                                                BU2   01017
003651  5015 FORMAT(*0*///9X,*TRANSV. MODE*10X*LONG. MODE*16X*LOAD*/        BU2   01018
     1  (1X,2I20,F20.3))                                                    BU2   01019
003651  5017 FORMAT(1X,F20.3,2I20,F20.3)                                    BU2   01020
003651  5018 FORMAT(*0*////* FINAL RESULTS  --  ALL MODES CONSIDERED*/)     BU2   01021
003651  5019 FORMAT(* LIMIT FOR NO OF CB-CALLS OF * I5* IS EXCEEDED*/       BU2   01022
     1 * EXTRAPOLATE FOR LOAD*/* NOTE ANSWER IS NOT RELIABLE*///           BU2   01023
     2* IT IS RECOMMENDED THAT YOU REVIEW YOUR DATA FOR A POSSIBLE*/       BU2   01024
     3* CHANGE OF STARTLOAD AND LOADINTERVALS*//)                          BU2   01025
003651  5021 FORMAT(10F8.2)                                                 BU2   01026
003651  5030 FORMAT(*0 NMAX = *I8/*  MMAX = *I8/)                           BU2   01027
003651  5031 FORMAT(4H0***, *  BOUNDARY CONDITION   * A10,5H  ***/)         BU2   01028
003651  5033 FORMAT(* BUCKLING LOAD*F20.3*  POUNDS*/)                       BU2   01029
003651  5034 FORMAT(*0WARNING - A DOUBLE ROOT IN P  - INVESTIGATE THE LOAD REGI BU2   01030
     1ON UP TO THIS DOUBLE ROOT*//)                                        BU2   01031
003651  5035 FORMAT(*0THE DOUBLE ROOT IN THE P-VALUES ARE IN THE FOLLOWING INTE BU2   01032
     1RVAL*/* WHICH WILL BE IGNORED IN THE SEARCH FOR THE CRITICAL LOAD* BU2   01033
     2//* NXU = *F20.3/* NXL = *F20.3//)                                    BU2   01034
003651  5036 FORMAT(*0THE FIRST LOAD EXAMINED AFTER PASSING THE DOUBLE REAL ROO BU2   01035
     1TS*/                                                                 BU2   01036
     2/* DID NOT PRODUCE SIGNIFICANT DIFFERENCE BETWEEN THE ROOTS*/        BU2   01037
     3/* PERTURB LOAD AND TRY AGAIN *///)                                  BU2   01038
003651  5037 FORMAT(*0THE START LOAD WAS TO CLOSE TO  DOUBLE REAL ROOTS*/    BU2   01039
     1/* PERTURB LOAD AND TRY AGAIN*//)                                    BU2   01040
003651  5040 FORMAT(*0*I10,10X,2I10///)                                     BU2   01041
003651  5041 FORMAT(*0*2I10///)                                             BU2   01042
003651  5042 FORMAT(*      B.C.I*13X*B.C.III.*4X*B.C.IV*)                   BU2   01043
003651  5043 FORMAT(*      B.C.I    B.C.II*)                                BU2   01044
003651  5044 FORMAT(*0STARTVALUES FOR TRANSVERSE MODES N*)                   BU2   01045
003651  5045 FORMAT(*0STARTVALUES FOR LONGITUDINAL MODES M*)                 BU2   01046
003651  5046 FORMAT(*0MAXIMUM VALUES FOR TRANSVERSE MODES N*)                BU2   01047
003651  5047 FORMAT(*0MAXIMUM VALUES FOR LONGITUDINAL MODES M*)              BU2   01048
     C                                                                     BU2   01049
003651  5050 FORMAT(*0LAYER NO *I5*  INPUT OPTION NO  *F5.0*  WAS USED*)     BU2   01050
003651  5051 FORMAT(17X,*THE Q-MATRIX WAS ENTERED DIRECTLY*/)               BU2   01051
003651  5052 FORMAT(17X,*MATERIAL PROPERTIES WAS ENTERED AS E11,E22  ETC.*/) BU2   01052
003651  5053 FORMAT(17X,*MATERIAL PROPERTIES FOR FIBER AND MATRIX WAS GIVEN*/) BU2   01053
003651  5054 FORMAT(*0*16X,*FIBER PROPERTIES*/17X,*E-MODULUS      EF  =*F20.4/ BU2   01054
     1 17X,*G-MODULUS      GF  =*F20.4/17X,*POISSON RAT. ZMUF  =*F20.4// BU2   01055
     2 17X,*MATRIX PROPERTIES*        /17X,*E-MODULUS      EM  =*F20.4/ BU2   01056
     3 17X,*G-MODULUS      GM  =*F20.4/17X,*POISSON RAT. ZMUM  =*F20.4// BU2   01057
     4 17X,*VOL.FRACT. CO. VF  =*F20.4/17X,*PLY         ANGLE  =*F20.4/) BU2   01058
003651  5055 FORMAT(*0*16X,*CONTIGUITY  FACTORS*//17X*FOR G-MODULUS AND POISSON BU2   01059
     1S RATIO  ZMU12     CONTI =*F10.4/    17X*FOR E2-MODULUS              BU2   01060
```

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RUN  VERSION FEB 70     19041 22/04/70

              2                    CONT2 =*F10.4//)                              BU2     01061
003651         END                                                               BU2     01062
```

RUN VERSION FEB 70 19041 22/04/70

PROGRAM LENGTH INCLUDING I/O BUFFERS
012533

STATEMENT FUNCTION REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES

STATEMENT NUMBER REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
000003	L00003	1	003647					
000015	L00020	5	NONE					
000052	L00041	7	NONE					
000124	L00072	8	000121					
000173	L00124	10	000165					
000241	L00153	11	000237					
000546	L00315	30	000502					
000664	L00360	35	000545					
000716	L00373	40	000503					
000766	L00413	41	000715					
001003	L00420	45	000704					
001050	L00442	50	001043					
001044	L00441	54	001023					
001007	L00427	55	NONE					
001214	L00505	60	001144					
002011	L00756	80	002000	002001				
002020	L00761	81	002010					
002130	L01013	87	001775					
002136	L01020	88	002132	002133				
002142	L01022	89	002135					
002220	L01051	90	002263	002531				
002264	L01105	91	002231					
002234	L01063	92	002232					
002240	L01066	93	002233					
002304	L01121	100	002436	002547	002550	002652	002747	002776
002437	L01210	102	002414					
002532	L01243	103	002377					
002653	L01321	104	002637					
002662	L01325	105	002534	002535	002545			
002717	L01344	106	002667	002714				
002536	L01250	107	002533					
002546	L01254	109	002535					
002777	L01400	110	002661	002727	002732			
003023	L01410	112	003006	003015				
003074	L01427	180	002127	003050				
003163	L01470	182	003151					
003170	L01474	183	003156					
003174	L01477	190	003142	003162	003167			
003232	L01522	300	003226					
003235	L01524	301	003217					
003342	L01565	340	003275					

003364	L01575	350	003322	003341				
003370	L01577	400	003210					
003436	L01626	450	003431					
003441	L01630	451	003403					
003510	L01652	470	003374					
003533	L01670	471	003527					
003536	L01672	472	003520					
003610	L01715	473	003516					
003647	L01735	500	NONE					
003650	L01736	501	000051	001467				
003645	L01733	600	001550	003507	003635			
004036	C00164	1000	002100					
004042	C00170	1002	002624					
004056	C00204	2000	000062	003236	003441	003536		
004155	C00303	2007	003133					
004163	C00311	2008	003323					
004172	C00320	2009	003327	003475				
004203	C00331	2011	003572					
004210	C00336	2012	003616					
004220	C00346	2013	003635					
004230	C00356	2018	003566					
004235	C00363	2019	003342					
004242	C00370	2020	003275					
004251	C00377	2021	003303	003346				
004256	C00404	2025	000152					
004265	C00413	2026	000165					
004270	C00416	2030	001552					
004312	C00440	2031	001741					
004317	C00445	3004	003076					
004323	C00451	3005	001716					
004346	C00474	3006	003110					
004351	C00477	3007	003125					
004354	C00502	3008	003163					
004361	C00507	3009	003156					
004366	C00514	3010	002441	002556	003026			
004401	C00527	3011	002464	002601	003051			
004423	C00551	3012	003170					
004434	C00562	3050	001751					
004457	C00605	3051	001766					
003707	C00035	4003	001052					
003720	C00046	4006	001056					
004502	C00630	5000	000367					
004505	C00633	5001	000564					
004507	C00635	5002	001234					
004523	C00651	5003	001414					
004527	C00655	5004	001432					
004533	C00661	5005	001450					
004537	C00665	5006	000035					
004541	C00667	5007	000072	003246	003451	003546		
004544	C00672	5008	000407					
004614	C00742	5009	000664					
004663	C01011	5010	000732					
004703	C01031	5011	000052	000056	001102	001636	001652	001667

			001703					
004705	C01033	5012	001107					
004713	C01041	5013	000104	000140	000207	000305		
004715	C01043	5014	000126	000175				
004720	C01046	5015	003403					
004731	C01057	5017	NONE					
004735	C01063	5018	003471	003610				
004744	C01072	5019	002653					
004775	C01123	5021	000435					
004777	C01125	5030	NONE					
005004	C01132	5031	003260	003463	003560			
005012	C01140	5033	NONE					
005017	C01145	5034	002416					
005032	C01160	5035	002507					
005054	C01202	5036	000407	000514	000664	001751	002234	002240
			002653	003163	003260	003463	003560	
005104	C01232	5037	002234					
005117	C01245	5040	000253	000335				
005123	C01251	5041	000275	000357				
005126	C01254	5042	000247	000331				
005133	C01261	5043	000271	000353				
005137	C01265	5044	000265					
005145	C01273	5045	000243					
005153	C01301	5046	000347					
005161	C01307	5047	000325					
005167	C01315	5050	000504	000546	000716			
005176	C01324	5051	000726					
005204	C01332	5052	000514					
005213	C01341	5053	000556					
005223	C01351	5054	000613					
005265	C01413	5055	000641					

EXTERNALS AND TAGS

DB - S00200	DATE - S00300	INPUTC.- S00400	IFENDF.- S00500				
OUTPTC.- S00600	MACON - S00700	DBLE - S01000	SNGL - S01100				
DET - S01200	EXIT - S01300	END. - S01400	QBNTRY.- S00100				

BLOCK NAMES AND LENGTHS

A - 000100	AR - 000007	BLK1 - 000012	CON - 000040				
ICK - 000461	RC - 000022	TRS - 000423	STF - 000505				

VARIABLE REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
005733	A00020	A	002030					
000001C05	A00006	AB	NONE					
000012C01	A00001	AC	NONE					
000003C02	V00131	AL	000374	000414	001776	002012	002130	002137
006452	V00234	ANCR	002251	002254	002255			
006412	V00151	ANG	000460	000575				
000310C07	A00033	ANGLE	NONE					
005744	A00021	B	002042					
000034C01	A00002	BC	NONE					

005365	A00014	BCON	000004						
000004C02	V00132	BL	000376	000416	001776	002013	002130	002140	
006413	V00152	CO	000462	000465	000511	000553	000562	000637	
			000704	000723					
006400	V00137	CONT1	000433	000567	000644	000651			
006401	V00140	CONT2	000434	000571	000646	000652			
005755	A00022	D	002070						
006371	V00125	DAT	000030	000065	003241	003444	003541		
000455C05	V00233	DBA	002224	002343					
006306	A00051	DBNX	NONE						
006441	V00206	DBX	002121	002124					
006450	V00231	DBO	002222	002274					
006451	V00232	DBOA	002225	002277					
000000C03	V00216	DB1	002203	002330	002353	002427	002645	002733	
			002777						
000456C05	V00221	DB1A	002206	002334	002364	002432	002650	002737	
			003015						
000001C03	V00236	DB2	002275	002327	002341	002350	002430	002646	
			002734	002777					
000457C05	V00237	DB2A	002300	002333	002344	002361	002433	002651	
			002740	003016					
000056C01	A00003	DC	NONE						
005354	A00013	DR	002033	002116	002122				
000372C07	A00035	EF	NONE						
006114	A00045	EK	NONE						
000341C07	A00034	EM	NONE						
006303	A00047	EST	NONE						
006414	V00153	E1	000521	000532	000536	000655	000671	000710	
			000762	001023					
000000C10	A00036	E11	NONE						
006415	V00154	E2	000524	000525	000532	000540	000662	000673	
			000711						
000031C10	A00037	E22	NONE						
000005C02	V00177	F1	002002	002003	002012	002021	002134	002137	
			002157						
000006C02	V00200	F2	002003	002014	002023	002135	002141	002147	
000062C10	A00040	G	NONE						
000113C07	A00026	GF	NONE						
000062C07	A00025	GM	NONE						
006407	V00146	GS	000452	000607					
006420	V00157	G12	000535	000544	000657	000701	000714		
006062	A00044	H	000035	000472	001144	001263			
006056	V00071	HP	001262	001303	001343				
006060	V00073	HP1	001270	001301	001336				
006367	V00123	I	000014	000117	000122	000124	000157	000162	
			000164	000170	000173	000230	000235	000241	
			000435	000470	000507	000521	000535	000551	
			000574	000616	000620	000622	000624	000626	
			000630	000632	000634	000651	000654	000721	
			000750	000766	001011	001026	001044	001050	
			001107	001112	001121	001131	001141	001173	
			001214	001243	001245	001271	001310	001474	
			001475	001504					

000006C03	V00215	IAB	002202	002231				
005411	A00016	ICOM	002227	002527				
006463	V00247	IJ	003221	003232	003424	003436	003521	003533
000005C03	V00225	INREAL	002212	002266	002374			
000004C03	V00224	IPAIR	002211	002265	002370			
000014C04	A00005	IPC	001712	001732	002076	002414		
005377	A00015	ITITL	NONE					
000000C05	V00207	IX	002174	002244	002263	002345	002377	002422
			002456	002503	002521	002550	002573	002620
			002631	002662	002743	003043	003070	
006447	V00230	IXH	002217	002270	002305	002525		
000007C03	V00212	IXT	002177	002367	002640			
000011C03	V00213	IXU	002200	002517	002632			
006446	V00227	IXV	002216	002311	002526	002670		
006443	V00211	IXX	002176	002632				
006442	V00210	I10	002175	002304	002520	002546	002630	
006444	V00214	I5	002201	002232	002303			
006365	V00121	J	000012	000015	000025	001005	001007	001016
			001244	001272	001410	001475	001505	
006366	V00122	K	000013	000016	000023	001006		
006427	V00170	KAS	001547	001560	003645			
000002C03	V00223	KK	002210	002264	002370			
006426	V00167	KNT	001473	001502	001542			
000003C03	V00222	KRN	002207	002265	002373			
000000C04	V00171	KXX	001551	001555	001566	001626	001642	001657
			001673	001707	001726	001747	001757	001774
			002222	002275	002331	002341	002357	002430
			002437	002462	002532	002554	002577	002646
			002665	002735	002746	003005	003024	003047
			003074	003106	003116	003141	003207	003263
			003266	003372	003466	003515	003563	003614
			003626					
000001C04	V00166	KXY	001472	001545				
006373	V00130	L	000372	000412	001050	001076	001131	001214
			001406					
000000C01	V00001	LC	NONE					
006302	V00111	LDMIN	NONE					
006456	V00242	LIN	002635	002656				
000001C02	V00176	M	001657	001662	001676	001723	001734	001771
			002004	002014	002020	002152	003103	003130
			003174					
000006C01	V00007	MC	002161	002167				
006457	V00243	MM	003176					
006361	A00060	MMA	000340					
006433	V00175	MMAX	001566	001574	001621	003201	003212	003315
			003360					
006351	A00056	MMI	000256					
006431	V00173	MMIN	001563	001571	001621	001656	001663	001677
			003174	003211	003227	003306	003310	003351
			003353					
006307	A00054	MODA	003400	003412				
006461	V00245	MODE	003212	003231	003235	003334	003366	
006464	V00250	MODM	003236	003401	003433	003502	003642	

006466	V00252	MODN	003400	003435	003504	003513	003532	003623
006370	V00124	MTEST	000030					
000010C01	V00011	M2C	002173					
000000C02	V00164	N	001254	001263	001276	001626	001631	001645
			001721	001744	001754	002022	002142	003101
			003113	003203	003300	003336	003370	
000002C01	V00003	NC	002151	002162				
000002C04	A00004	NCASE	NONE					
006455	V00241	NDB	002634	002636				
006355	A00057	NMA	000362					
006432	V00174	NMAX	001564	001604	001615	003370	003417	003510
			003604					
006345	A00055	NMI	000300					
006430	V00172	NMIN	001561	001614	001615	001632	001646	003203
			003374	003406	003411	003414	003434	003510
			003530	003575	003577			
006460	V00244	NN	003204	003364				
006462	V00246	NON	003214	003216	003232	003321		
006465	V00251	NON	003375	003402	003436	003512	003517	003533
006177	V00100	NX	NONE					
006301	A00050	NXCR	002126	003024	003137	003177	003206	
006203	V00104	NXF	003215	003223	003332	003365	003640	
006242	A00053	NXFA	003376	003415	003513	003600		
006204	A00052	NXFIN	003214	003311	003354			
006300	V00107	NXFX	003377	003426	003500	003514	003524	003621
006201	V00102	NXL	002327	002335	002404	002425	002514	002643
			002717	003001	003017			
006200	V00101	NXU	002302	002326	002336	002337	002426	002512
			002521	002644	002733	003000		
006202	V00103	NXO	003004	003022	003023			
000004C01	V00005	N2C	002166					
006435	V00202	PA	002022	002025	002035	002043		
006437	V00204	PA2	002026	002030	002043	002055	002071	
006436	V00203	PB	002024	002026	002036	002056		
006440	V00205	PB2	002027	002032	002044	002057	002072	
000002C02	V00127	PI	000034	000577	002006	002016		
000144C10	A00042	Q	NONE					
006403	V00142	Q11	000442	000520	000601	000711	000737	000753
			000757	000770				
006404	V00143	Q12	000444	000523	000603	000713	000741	000751
			000772					
006405	V00144	Q22	000446	000526	000604	000712	000743	000751
			000763	000777				
006406	V00145	Q66	000450	000534	000606	000715	000745	000764
			001001					
000000C06	A00011	R	NONE					
000145C05	A00007	RES	NONE					
000311C05	A00010	RESA	NONE					
006434	V00201	RLL	002007	002017	002125			
006416	V00155	RNUA	000527	000530	000660	000675	000705	
006417	V00156	RNUB	000530	000533	000543	000663	000677	000706
006421	V00160	RNU1	000707					
005343	A00012	S	NONE					

000010C03	V00217	SGN	002204	002357	002534	002536	002673	002705
			002753	002764	003007	003143		
000460C05	V00220	SGNA	002205	002366	002541	002676	002755	003011
			003145					
006375	V00134	SINC	000402	000422	000427	002215	002252	002271
			002315	002335	002411	002435	002524	002642
			002717					
006376	V00135	SINC2	000404	000424	000430	002267	002324	
006453	V00235	SINC3	002270	002273	002325	002434	002741	
006377	V00136	SINC4	000430	002214	002314	002523		
006052	V00065	SM1	001135	001150	001172	001216		
006054	V00067	SM2	001137	001175	001212	001220		
006423	V00162	SQ	001003	001013				
006374	V00133	STLD	000400	000420	002212			
006445	V00226	STLD1	002213	002220	002247	002261	002301	002522
005766	A00043	S11	NONE					
006402	V00141	T	000440	000471	000667	000735		
006146	A00046	TH	NONE					
000113C10	A00041	THETA	NONE					
006425	V00165	TOL	001471	001500				
006454	V00240	TOLD	002404	002410	002412			
005721	A00017	V	002117					
000175C07	A00030	VF	NONE					
006411	V00150	VFC	000456	000612				
000144C07	A00027	VM	NONE					
006372	V00126	YEA	000031	000067	003243	003446	003543	
006410	V00147	ZMU	000454	000611				
000031C07	A00024	ZMUF	NONE					
000000C07	A00023	ZMUM	NONE					
000226C07	A00031	ZMU12	NONE					
000257C07	A00032	ZMU21	NONE					
006050	V00063	ZN	001231	001232	001256	001264		
006424	V00163	ZNX	001234	001237				
006422	V00161	ZU	000756					

START OF CONSTANTS
003652

START OF TEMPORARIES
005306

START OF INDIRECTS
005330

SPACE REQUIRED TO COMPILE
056100

```
                SUBROUTINE MACON(K,CONT1,CONT2)                                 MAC     00002
              C                                                                 MAC     00003
              C*********************************************************************** MAC     00004
              C  PURPOSE                                                        MAC     00005
              C     THIS SUBROUTINE WILL COMPUTE MATERIAL CONSTANTS AND THE     MAC     00006
              C     LAMINA STIFFNESS MATRIX WHEN FIBER  AND MATRIX PROPERTIES   MAC     00007
              C     ARE GIVEN FOR A COMPOSITE LAMINA                            MAC     00008
              C  UPDATE                                                         MAC     00009
              C                                                                 MAC     00010
              C     3/15/70 PROGRAMMED BY VIKTOR OEVERLI                        MAC     00011
              C             APPROVED   BY AL HILLSTROM                          MAC     00012
              C  DISCUSSION                                                     MAC     00013
              C     THIS SUBROUTINE IS WRITTEN WITH THE INTENT OF PROVIDING FUTURE MAC     00014
              C     USERS WITH A POSSIBILITY TO USE A DIFFERENT FORMULATION     MAC     00015
              C     BY EXCHANGING THIS ROUTINE WITH THEIR OWN. ALSO AS FURTHER  MAC     00016
              C     PROGRESS IN MATERIAL TECHNOLOGY IS MADE THIS ROUTINE SHOULD  MAC     00017
              C     BE IMPROVED                                                 MAC     00018
              C                                                                 MAC     00019
              C     THE FORMULAE USED HERE ARE THOSE SHOWN IN                   MAC     00020
              C                                                                 MAC     00021
              C     TSAI,S.W. -STRUCTURAL BEHAVIOR OF COMPOSITE MATERIALS- SECTION 2.0 MAC     00022
              C     NASA  CR-71   1964                                          MAC     00023
              C                                                                 MAC     00024
              C     AND                                                         MAC     00025
              C                                                                 MAC     00026
              C     ASHTON,J.E. HALPIN,J.C.  PETIT,P.E, -PRIMER ON COMPOSITE MATERIALS MAC     00027
              C     ,ANALYSIS, PROGRESS IN MATERIAL SCIENCES SERIES,VOL. III,   MAC     00028
              C      CHAPTER 2.3,  TECHNOMIC PUBLICATIONS, 1969.                MAC     00029
              C                                                                 MAC     00030
              C  INPUT  ARGUMENTS                                               MAC     00031
              C     K - LAYER NO                                                MAC     00032
              C     CONT1,CONT2-CONTIGUITY FACTORS                              MAC     00033
              C                                                                 MAC     00034
              C  COMMON INPUT  EF,GF,ZMUF,EM,GM,ZMUM,VF,THETA                   MAC     00035
              C  COMMON OUTPUT   E11,E22,G,ZMU12,ZMU21,C                        MAC     00036
              C                              SEE MAIN PROGRAM FOR LEGEND ON VARIABLES MAC     00037
              C                              IN COMMON                          MAC     00038
              C                                                                 MAC     00039
              C  SUBROUTINE USER  MAINPROGRAM BUCLAP                            MAC     00040
              C                                                                 MAC     00041
              C*********************************************************************** MAC     00042
              C                                                                 MAC     00043
000006              COMMON/STF/E11(25),E22(25),G(25),THETA(25),C(3,3,25)        MAC     00044
000006              COMMON/TRS/ZMUM(25),ZMUF(25),GM(25),GF(25),VM(25),VF(25),ZMU12(25) MAC     00045
                   1 ,ZMU21(25),ANGLE(25),EM(25),EF(25)                         MAC     00046
              C                                                                 MAC     00047
              C     ********************************************************** MAC     00048
              C           COMPUTE E11,VM                                        MAC     00049
              C     ********************************************************** MAC     00050
              C                                                                 MAC     00051
000006              E11(K)=EM(K)+(EF(K)-EM(K))*VF(K)                            MAC     00052
000016              XKF=EF(K)/(1.D-ZMUF(K))*.5                                  MAC     00053
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000022          VM(K)=1.0-VF(K)                                                  MAC     00054
                                                                                 MAC     00055
          C                                                                      MAC     00056
          C     ************************************************************** MAC     00057
          C           COMPUTE G,ZMU12                                          MAC     00058
          C     ************************************************************** MAC     00059
          C                                                                      MAC     00060
000026          CONT = CONT1                                                     MAC     00061
000027          XKM=EM(K)/(1.0-ZMUM(K))*.5                                       MAC     00062
000033          XMMM=XKM*ZMUM(K)                                                 MAC     00063
000035          GFMV=(XKF-XKM)*VM(K)                                             MAC     00064
000040          XFMF=XKF*ZMUF(K)                                                 MAC     00065
000042          XMGM=2.0*XKM+GM(K)                                               MAC     00066
000045          XFGM=2.0*XKF+GM(K)                                               MAC     00067
000050          XMGF=2.0*XKM+GF(K)                                               MAC     00068
000053          XFGF=2.0*XKF+GF(K)                                               MAC     00069
000056          ZMU12(K)=(1.0-CONT)*(XFMF*XMGM*VF(K)+XMMM*XFGM*VM(K))/(XKF*XMGM-GM MAC     00070
               1(K)*GFMV)+CONT*(XMMM*XFGF*VM(K)+XFMF*XMGF*VF(K))/(XKF*XMGF-GF(K)*G MAC     00071
               1FMV)                                                             MAC     00072
000110          IF(ABS(ANGLE(K)).EQ.45.0)CONT=0.0                                MAC     00073
000114          GFM=(GF(K)-GM(K))*VM(K)                                          MAC     00074
000121          GFPM=GF(K)+GM(K)                                                 MAC     00075
000124          GGG=(1.0-CONT)*GM(K)*(2.0*GF(K)-GFM)/(2.0*GM(K)+GFM)+CONT*GF(K)*( MAC     00076
               1GFPM-GFM)/(GFPM+GFM)                                             MAC     00077
000144          G(K)=GGG                                                         MAC     00078
          C                                                                      MAC     00079
          C     ************************************************************** MAC     00080
          C           COMPUTE E22,ZMU21                                        MAC     00081
          C     ************************************************************** MAC     00082
          C                                                                      MAC     00083
000147          CONT = CONT2                                                     MAC     00084
000147          E22(K)=2.0*(1.0-ZMUF(K)+(ZMUF(K)-ZMUM(K))*VM(K))*((1.0-CONT)*(XKF MAC     00085
               1*XMGM-GM(K)*GFMV)/(2.0*XKM+GM(K)+2.0*GFMV)+CONT*(XKF*XMGF-GF(K)* MAC     00086
               2GFMV)/(2.0*XKM+GF(K)+2.0*GFMV))                                  MAC     00087
000207          ZMU21(K)=E22(K)*ZMU12(K)/E11(K)                                  MAC     00088
          C                                                                      MAC     00089
          C     ************************************************************** MAC     00090
          C     ESTABLISH LAMINA STIFFNESS MATRIX FOR LAYER NO. K                MAC     00091
          C     ************************************************************** MAC     00092
          C                                                                      MAC     00093
000214          C11=E11(K)/(1.-ZMU12(K)*ZMU21(K))                                MAC     00094
000222          C22=E22(K)/(1.-ZMU12(K)*ZMU21(K))                                MAC     00095
000227          C12=ZMU12(K)*C22                                                 MAC     00096
000231          C16=0.                                                           MAC     00097
000232          C26=0.                                                           MAC     00098
000233          C66=G(K)                                                         MAC     00099
000235          ZM=COS(THETA(K))                                                 MAC     00100
000242          ZN=-SIN(THETA(K))                                                MAC     00101
000250          A=ZM**4                                                          MAC     00102
000252          B=(2M*ZN)**2                                                     MAC     00103
000253          CC=ZN*ZM**3                                                      MAC     00104
000255          D=ZN**4                                                          MAC     00105
000256          E=ZM*ZN**3                                                       MAC     00106
000257          F=A+D
```

```
000261          GG=CC-E                                                 MAC     00107
000263          HH=A-3.*B                                               MAC     00108
000266          ZI=3.*B-D                                               MAC     00109
000270          C(1,1,K)=A*C11+2.*B*C12+4.*CC*C16+D*C22                 MAC     00110
                1+4.*E*C26+4.*B*C66                                     MAC     00111
000307          C(1,2,K)=B*C11+F*C12-2.*GG*C16+B*C22                    MAC     00112
                1+2.*GG*C26-4.*B*C66                                    MAC     00113
000326          C(3,1,K)=-CC*C11+GG*C12+HH*C16+E*C22+                   MAC     00114
                1ZI*C26+2.*GG*C66                                       MAC     00115
000344          C(2,2,K)=D*C11+2.*B*C12-4.*E*C16+A*C22-4.               MAC     00116
                1*CC*C26+4.*B*C66                                       MAC     00117
000364          C(3,2,K)=-C11*E-C12*GG+C16*ZI+C22*CC+                   MAC     00118
                1C26*HH-2.*C66*GG                                       MAC     00119
000402          C(3,3,K)=B*C11-2.*B*C12-2.*GG*C16+B                     MAC     00120
                1*C22+2.*GG*C26+(F-2.*B)*C66                            MAC     00121
000423          C(2,1,K)=C(1,2,K)                                       MAC     00122
000430          C(1,3,K)=C(3,1,K)                                       MAC     00123
000433          C(2,3,K)=C(3,2,K)                                       MAC     00124
000436          RETURN                                                  MAC     00125
000436          END                                                     MAC     00126
```

SUBPROGRAM LENGTH
000706

STATEMENT FUNCTION REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES

STATEMENT NUMBER REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES

EXTERNALS AND TAGS
COS - S00100 SIN - S00200 END. - S00300

BLOCK NAMES AND LENGTHS
STF - 000505 TRS - 000423

VARIABLE REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
000675	V00051	A	000251	000257	000354			
000310C02	A00016	ANGLE	000110					
000676	V00052	B	000252	000263	000273	000303	000316	000322
			000350	000360	000402	000413		
000144C01	A00005	C	000267	000306	000325	000344	000363	000404
			000422	000425	000427	000430	000432	000433
000677	V00053	CC	000254	000261	000275	000327	000356	000373
000651	V00025	CONT	000026	000101	000136	000166		
000665	V00041	C11	000221	000272	000311	000330	000347	000365
			000407					
000667	V00043	C12	000230	000274	000312	000331	000351	000366
			000410					
000670	V00044	C16	000231	000276	000314	000333	000353	000370
			000412					
000666	V00042	C22	000226	000300	000316	000335	000355	000371
			000414					
000671	V00045	C26	000232	000302	000320	000337	000357	000373
			000416					
000672	V00046	C66	000234	000304	000323	000341	000361	000377
			000420					
000700	V00054	D	000255	000257	000265	000277	000346	
000701	V00055	E	000256	000261	000301	000333	000352	000366
000372C02	A00020	EF	000007	000017				
000341C02	A00017	EM	000006	000030				
000000C01	A00001	E11	000011	000211	000217			
000031C01	A00002	E22	000202	000207	000225			
000702	V00056	F	000260	000311	000402			
000062C01	A00003	G	000144	000232				
000113C02	A00011	GF	000050	000053	000056	000114	000121	000130
			000147					
000662	V00036	GFM	000120	000124				

000654	V00030	GFMV	000037	000060	000073	000151		
000663	V00037	GFPM	000123					
000703	V00057	GG	000262	000314	000330	000341	000367	000377
			000411					
000664	V00040	GGG	000143					
000062C02	A00010	GM	000041	000045	000071	000115	000122	000131
			000157					
000704	V00060	HH	000265	000332	000375			
000113C01	A00004	THETA	000234	000242				
000175C02	A00013	VF	000012	000023	000062			
000144C02	A00012	VM	000022	000035	000063	000117	000177	
000661	V00035	XFGF	000055	000064				
000657	V00033	XFGM	000047	000077				
000655	V00031	XFMF	000041	000065	000075			
000650	V00024	XKF	000021	000034	000046	000054	000072	000154
			000163					
000652	V00026	XKM	000032	000043	000051	000150		
000660	V00034	XMGF	000052	000057	000066	000154		
000656	V00032	XMGM	000044	000072	000164			
000653	V00027	XMMM	000034	000064	000076			
000705	V00061	ZI	000267	000335	000371			
000673	V00047	ZM	000241	000250				
000031C02	A00007	ZMUF	000015	000037	000174			
000000C02	A00006	ZMUM	000026	000032	000175			
000226C02	A00014	ZMU12	000103	000210	000214	000221	000227	
000257C02	A00015	ZMU21	000206	000215	000222			
000674	V00050	ZN	000247	000251				

START OF CONSTANTS
000437

START OF TEMPORARIES
000445

START OF INDIRECTS
000551

SPACE REQUIRED TO COMPILE
037000

```
      FUNCTION CB(NX)                                                    DB      00002
C                                                                        DB      00003
C*************************************************************************DB      00004
C                                                                        DB      00005
C  PURPOSE                                                               DB      00006
C                                                                        DB      00007
C     THIS SUBROUTINE GENERATES AND EVALUATES THE DETERMINANT  CB        DB      00008
C     FOR A GIVEN LOAD NX  AND MODES N AND/OR M.                         DB      00009
C                                                                        DB      00010
C  UPDATE                                                                DB      00011
C                                                                        DB      00012
C     3/15/70 PROGRAMMED BY VIKTOR OEVERLI                               DB      00013
C             APPROVED   BY AL HILLSTROM                                 DB      00014
C                                                                        DB      00015
C  DISCUSSION                                                            DB      00016
C                                                                        DB      00017
C     THE BUCKLING DETERMINANT CB IS FORMED FROM THE BOUNDARY CONDITIONS DB      00018
C     OF THE PROBLEM. ITS VALUE DEPENDS UPON THE ROOTS OF  DET(CT)= 0    DB      00019
C     THE CT-DETERMINANT MUST BE ZERO TO SATISFY EQUILIBRIUM EQUATIONS.  DB      00020
C     DET(CT) = 0  IS SOLVED USING THE COMPLEX ROOT-FINDER ROUTINE       DB      00021
C     ZARK .  ZARK WILL USE THE CT-FUNCTION SUBROUTINE TO                DB      00022
C     SUPPLY THE CT-FUNCTION VALUE.                                      DB      00023
C                                                                        DB      00024
C     THE CBGEN ROUTINE IS CALLED TO GENERATE CB-COLUMNWISE              DB      00025
C     AND THE DET ROUTINE PERFORMS THE REAL DETERMINANT EVALUATION       DB      00026
C                                                                        DB      00027
C     THE ABOVE PROCEDURE HAS AN EXCEPTION FOR B.C. I  WHEN THE          DB      00028
C     BOUNDARY COND. (AND CB) IS AUTOMATICALLY SATISFIED BY THE          DB      00029
C     WAY THE DISPLACEMENT FUNCTIONS WERE CHOSEN.  THE LOAD CAN          DB      00030
C     THEN BE SOLVED DIRECTLY FROM THE EXPRESSION  DET(CT) =0 .          DB      00031
C                                                                        DB      00032
C     FOR THE OTHER B.C. THE CB-FUNCTION IS CALLED REPEATEDLY            DB      00033
C     WITH INCREASING LOAD IN GIVEN STEPS UNTIL A ZERO CROSSING          DB      00034
C     IS FOUND. THE STEPS ARE THEN HALVED UNTIL THE CRITICAL LOAD        DB      00035
C     IS FOUND WITH ADEQUATE ACCURACY. MORE MODES ARE INVESTIGATED       DB      00036
C     IN THE SAME MANNER                                                 DB      00037
C                                                                        DB      00038
C  INPUT ARGUMENTS  - NX     LOAD  LBS/IN                                DB      00039
C                                                                        DB      00040
C  COMMON INPUT     KXX,KXY,CB1,CB2,CB1A,CB2A,CBA,N,M,PI,AL,BL         DB      00041
C                   INREAL,IPAIR,SGN,SGNA,IXU,IXT                      DB      00042
C                                                                        DB      00043
C  COMMON OUTPUT   IX,AB,RES,RESA,KK,KRN,IAB                           DB      00044
C                            SEE MAIN PROGRAM FOR LEGEND ON VARIABLES  DB      00045
C                            IN COMMON                                 DB      00046
C                                                                        DB      00047
C  PROGRAM SUBROUTINES   ZARK,DET,CT,CBGEN                             DB      00048
C                                                                        DB      00049
C  SUBROUTINE  USER      MAIN PROGRAM  BUCLAP1                         DB      00050
C                                                                        DB      00051
C*************************************************************************DB      00052
C                                                                        DB      00053
```

```
000003          EXTERNAL DT                                                          DB      00054
000003          COMPLEX DT                                                           DB      00055
000003          COMPLEX GUESS(3,9),P(9),FF(9),B(9),BA(9),PX(9),P2(9)                 DB      00056
000003          COMPLEX PY                                                           DB      00057
000003          COMPLEX PAX                                                          DB      00058
000003          INTEGER POX,PCHK(9),PIX(9),PIXX(9)                                   DB      00059
000003          DIMENSION DBM(9,9),DBMA(9,9),V(10)                                   DB      00060
000003          REAL NX                                                              DB      00061
000003          COMPLEX LC,NC,N2C,MC,M2C,AC,BC,DC                                    DB      00062
000003          COMMON/A/LC,NC,N2C,MC,M2C,AC(3,3),BC(3,3),DC(3,3)                    DB      00063
000003          COMMON/AR/N,M,PI,AL,BL                                               DB      00064
000003          COMMON/BLK1/DB1,DB2,KK,KRN,IPAIR,INREAL,IAB,IXT,SGN,IXU              DB      00065
000003          COMMON/CON/KXX,KXY,NCASE(10),IPC(20)                                 DB      00066
000003          COMMON/ICK/IX,AB(100),RES(100),RESA(100),DBA,DB1A,DB2A,SGNA          DB      00067
          C     ********************************************************************** DB      00068
          C     LEGEND                                                               DB      00069
          C     ------                                                               DB      00070
          C                                                                          DB      00071
          C     P(9)            SET OF ROOTS FROM EQUILIBRIUM EQUATIONS  - SQUARED   DB      00072
          C     P2(9)           SET OF ROOTS FROM EQUILIBRIUM EQUATIONS  - SQUARED   DB      00073
          C                     BUT FROM A PREVIOUS DB-CALL (IN THE CASE OF          DB      00074
          C                     DOUBLE-ROOT   OR SIGN CHANGE)                        DB      00075
          C     PAX             ONE ROOT FROM EQUILIB.   EQUATIONS                   DB      00076
          C     NROOTS          NUMBER OF ROOTS FROM EQUILIB. EQ. (ACTUAL FOUND)     DB      00077
          C     NR              NUMBER OF ROOTS FROM EQUILIB. EQ. (EXPECTED)         DB      00078
          C     GUESS(3,9)      THREE SETS OF GUESS-VALUES FOR ZARK                  DB      00079
          C     PIX(9)          ARRAY PARALLEL TO P WITH CONTROL SET TO INDICATE     DB      00080
          C                     CONJUGATE PAIR OR REAL NUMBER                        DB      00081
          C     DBM(9,9)        BUCKLING DETERMINANT- MATRIX                         DB      00082
          C     DBMA(9,9)       BUCKLING DETERMINANT- MATRIX  ASSYM. DISPL. PATTERN  DB      00083
          C                     (B.C. II ONLY)                                       DB      00084
          C     B(9)            ONE OR TWO COLS. OF DBM                              DB      00085
          C     BA(9)           ONE OR TWO COLS. OF DBMA                             DB      00086
          C     ********************************************************************** DB      00087
000003          IX = IX + 1                                                          DB      00088
000005          SG1 = 0.                                                             DB      00089
000006          SG1A= 0.                                                             DB      00090
000007          DO 10 I =1,9                                                         DB      00091
000010          B(I) = (0.,0.)                                                       DB      00092
000014          BA(I) = (0.,0.)                                                      DB      00093
000021          DO 10 J=1,9                                                          DB      00094
000022          DBMA(I,J) =0.                                                        DB      00095
000025    10    DBM(I,J) =0.                                                         DB      00096
000034          LC = CMPLX(NX,0.)                                                    DB      00097
000037          NR = 4                                                               DB      00098
000040          IF(KXY .EQ.1)  NR = 2                                                DB      00099
000043          NROOTS = NR                                                          DB      00100
000045          IF(IPC(1).NE.1) GO TO 110                                            DB      00101
000046          IF(KXX.EQ.2)  WRITE(6,2000) NX,N,NR,IX                               DB      00102
000065          IF(KXX.EQ.3 .OR. KXX.EQ.4)  WRITE(6,1999) NX,M,NR,IX                 DB      00103
000111    110   CONTINUE                                                             DB      00104
000111          MAXREP = 300                                                         DB      00105
000112          EP1=1.E-9                                                            DB      00106
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000114          EP2 = 1.E-9                                                     CB      00107
                C                                                               CB      00108
                C*********************************************************************** CB      00109
                C     BEFORE CALLING ZARK  A SET OF GUESS VALUES HAS TO BE PROVIDED     CB      00110
                C     FOR THE P-VALUES, OR THE PROPER CONTROL SET SO THAT ZARK WILL     CB      00111
                C     AUTOMATICALLY SELECT GUESS VALUES                                 CB      00112
                C*********************************************************************** CB      00113
                C                                                               CB      00114
000115          IF(IX.LE.1 .AND. IXT .EQ. 0)  GO TO 130                         CB      00115
000124          IO= -1                                                          CB      00116
000125          IF(IX.LE.2.AND.IXU.EQ.0)GOTO 117                                CB      00117
000134          IF(KK.EQ.IPAIR .AND.KRN.EQ.INREAL.A.SGN.GE.0..A.SGNA.GE.0.)GOTO117 CB   00118
000153          DO 118 I=1,NR                                                   CB      00119
000155          GUESS(1,I) = P2(I) + (0.001,0.)*P2(I)                           CB      00120
000171          GUESS(2,I) = P2(I)                                              CB      00121
000177   118    GUESS(3,I) = P2(I) + (-0.001,0.0)*P2(I)                         CB      00122
000215          GO TO 140                                                       CB      00123
000216   117    CONTINUE                                                        CB      00124
000216          DO 120 I=1,NR                                                   CB      00125
000220          GUESS(1,I) = P(I) + (0.001,0.)*P(I)                             CB      00126
000234          GUESS(2,I) = P(I)                                               CB      00127
000242   120    GUESS(3,I) = P(I) + (-0.001,0.)*P(I)                            CB      00128
000260          GO TO 140                                                       CB      00129
000261   130    IO = -2                                                         CB      00130
000262   140    CONTINUE                                                        CB      00131
000262          CALL SECOND(T1)                                                 CB      00132
                C     ------------------------------------------------------------- CB      00133
                C     THE SUBROUTINE  ZARK           IS DEVELOPED FOR THE PURPOSE OF    CB      00134
                C     FINDING  ROOTS OF A COMPLEX FUNCTION                      CB      00135
                C     BY THE MATH. ANALYSIS GROUP   FOR THIS  PROGRAM           CB      00136
                C     ------------------------------------------------------------- CB      00137
000264          CALL ZARK(NROOTS,GUESS,MAXREP,EP1,EP2,DT,IO,P,FP)               CB      00138
000275          CALL SECOND(T2)                                                 CB      00139
000277          T = T2 - T1                                                     CB      00140
000301          IF(IPC(1) .EQ.1) WRITE(6,2001) ((P(I),FP(I)),I=1,NROOTS)        CB      00141
                C                                                               CB      00142
                C*********************************************************************** CB      00143
                C     WRITE ERROR MESSAGES IF ANY                               CB      00144
                C*********************************************************************** CB      00145
                C                                                               CB      00146
000324          IF (IO-1)  150,151,152                                          CB      00147
000327   150    IF(IPC(1).EQ.1)  WRITE(6,2002) T                                CB      00148
000340          GO TO 153                                                       CB      00149
000341   151    WRITE(6,2003)                                                   CB      00150
000345          GO TO 153                                                       CB      00151
000347   152    WRITE(6,2004)                                                   CB      00152
000353   153    CONTINUE                                                        CB      00153
000353   2002 FORMAT(* ZARK  SUCCESSFUL*10X,*TIMECONSUMPTION* F10.2/)           CB      00154
000353   2003 FORMAT(* ZARK  FAILED TO CONVERGE IN THE MAX. NO OF ITER. SPEC.*/) CB      00155
000353   2004 FORMAT(* ZARK  FAILED - A ZERO IN THE PATH OF A SUBSEQUENT ONE*/) CB      00156
000353   2001 FORMAT(* CB. COMPLEX P-SET*50X*FUNCTION-VALUES*/(1X,2E25.14,10X,  CB      00157
               1  2E25.14))                                                     CB      00158
                C                                                               CB      00159
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      C*********************************************************************** CB      00160
      C                                                                       CB      00161
      C     GENERATE TERMS OF THE CB-MATRIX(FORMED FROM BOUNDARY CONDITIONS)  CB      00162
      C                                                                       CB      00163
      C     FIRST REORDER THE P-VALUES                                        CB      00164
      C*********************************************************************** CB      00165
      C                                                                       CB      00166
000353        DO 519 I=1,NR                                                   CB      00167
000356        PIX(I) = 0                                                      CB      00168
000360   519  PCHK(I) = 0                                                     CB      00169
000363        KK = 0                                                          CB      00170
000364        KR = NR                                                         CB      00171
000365        KRN = 0                                                         CB      00172
000366        I = 0                                                           CB      00173
000367        K = 0                                                           CB      00174
000370   520  I = I + 1                                                       CB      00175
000372        DO 525  J = 1 , NR                                              CB      00176
000373        K = J                                                           CB      00177
000374        IF(PCHK(J) .NE. J)  GO TO 526                                   CB      00178
000376   525  CONTINUE                                                        CB      00179
000400   526  CONTINUE                                                        CB      00180
000400        DO 530 J=K,NR                                                   CB      00181
000402        IF(PCHK(J) .EQ. J)  GO TO 530                                   CB      00182
000404        IF(ABS(AIMAG(P(K))) .LT. 1.E-6)  GO TO  550                     CB      00183
000413        TOLR2 =ABS(AIMAG(P(K)))*1.E-6                                   CB      00184
000421        IF(ABS(REAL(P(K))) .LT. 1.E-6)  GO TO  527                      CB      00185
000430        TOLR1 =ABS (REAL(P(K)))*1.E-6                                   CB      00186
000435        IF(ABS(REAL(P(K)) - REAL(P(J)))  .LT.  TOLR1 .AND.              CB      00187
             1ABS(AIMAG(P(K)) +AIMAG(P(J))) .LT. TOLR2)  GO TO 540            CB      00188
000456        GO TO 530                                                       CB      00189
000456   527  CONTINUE                                                        CB      00190
000456        IF(ABS(AIMAG(P(K)) +AIMAG(P(J))).LT. TOLR2) GO TO  545          CB      00191
000470   530  CONTINUE                                                        CB      00192
000473        WRITE(6,2010)                                                   CB      00193
000476   2010 FORMAT(*0AN ERROR APPEARED IN THE P VALUES*/                    CB      00194
            1 * A COMPLEX ROOT THAT IS NOT ONE OF A CONJUGATE PAIR*/)       CB      00195
000476   540  PX(I) = P(K)                                                    CB      00196
000504        KK = KK + 1                                                     CB      00197
000506        PIX(K) = KK                                                     CB      00198
000510        PIX(J) = KK                                                     CB      00199
000512        PIXX(I) = KK                                                    CB      00200
000514        PCHK(K) = K                                                     CB      00201
000516        I = I + 1                                                       CB      00202
000516        PX(I) = P(J)                                                    CB      00203
000523        PIXX(I) = KK                                                    CB      00204
000525        PCHK(J) = J                                                     CB      00205
000527        GO TO 600                                                       CB      00206
000531   545  PX(I) = CMPLX(0.,AIMAG(P(K)))                                  CB      00207
000544        KK = KK + 1                                                     CB      00208
000545        PIX(K) = KK                                                     CB      00209
000550        PIX(J) = KK                                                     CB      00210
000552        PIXX(I) = KK                                                    CB      00211
000554        P(K) = PX(I)                                                    CB      00212
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```
000561          PCHK(K) = K                                                     DB      00213
000563          I = I + 1                                                       DB      00214
000564          PX(I) = CMPLX(0.,AIMAG(P(J)))                                   DB      00215
000577          P(J) = PX(I)                                                    DB      00216
000605          PIXX(I) = KK                                                    DB      00217
000607          PCHK(J) = J                                                     DB      00218
000611          GO TO 600                                                       DB      00219
000612      550 PX(I) = CMPLX(REAL(P(K)),0.)                                    DB      00220
000625          KR = KR + 1                                                     DB      00221
000626          IF(REAL(P(K)).LT.  0.)   KRN = KRN + 1                          DB      00222
000634          PIX(K) = KR                                                     DB      00223
000637          PIXX(I) = KR                                                    DB      00224
000641          P(K) = PX(I)                                                    DB      00225
000646          PCHK(K) = K                                                     DB      00226
000650          GO TO 602                                                       DB      00227
000650      600 IF(AIMAG(PX(I-1)).LT.0.)  GO TO 602                             DB      00228
000655          PAX = PX(I)                                                     DB      00229
000661          PX(I) = PX(I-1)                                                 DB      00230
000666          PX(I-1) = PAX                                                   DB      00231
000672      602 IF(I.LT.NR)  GO TO 520                                          DB      00232
000675          DO 603 I=1,NR                                                   DB      00233
000676          PIX(I) = PIXX(I)                                                DB      00234
000701      603 P(I) = PX(I)                                                    DB      00235
000710          IF(IPC(1).EQ.1)  WRITE(6,2009) (PX(I), I=1,NR)                  DB      00236
000727      2009 FORMAT(*OREORDERED P-SET*/(1X,2E25.14))                        DB      00237
000727      604 CONTINUE                                                        DB      00238
            C                                                                   DB      00239
            C*******************************************************************DB      00240
            C     CHECK IF ANY OF THE REAL ROOTS ARE DOUBLE (WITHIN 3 PCT)      DB      00241
            C*******************************************************************DB      00242
            C                                                                   DB      00243
000727          IAB = 0                                                         DB      00244
000730          IF(KR.EQ.NR)     GO TO 610                                      DB      00245
000732          NRX = NR- 1                                                     DB      00246
000734          DO 606 I=1,NRX                                                  DB      00247
000735          IF(PIX(I) .LE. NR)   GO TO 606                                  DB      00248
000740          IXA = I +1                                                      DB      00249
000742          DO 605 J=IXA,NR                                                 DB      00250
000743          RAT = REAL(P(I))/REAL(P(J))                                     DB      00251
000752          IF(RAT.GT. 0.97 .AND. RAT.LT.1.03) IAB= 1                       DB      00252
000764      605 CONTINUE                                                        DB      00253
000767      606 CONTINUE                                                        DB      00254
000772      610 CONTINUE                                                        DB      00255
            C   *******************************************************************DB      00256
            C   IN THE CASE OF ONE CONJ. PAIR  AND TWO REAL ROOTS               DB      00257
            C   THEN REORDER ALSO REAL ROOTS IN INCREASING ORDER                DB      00258
            C   *******************************************************************DB      00259
000772          IF(NR.NE.4) GO TO 620                                           DB      00260
000774          IF(KR.NE.2) GO TO 620                                           DB      00261
000776          IR=0                                                            DB      00262
000777          DO 611 I=1,NR                                                   DB      00263
001000          IF(PIX(I) .LT.NR) GO TO 611                                     DB      00264
001003          IR=IR+1                                                         DB      00265
```

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001005          IF(IR.EQ.2.)GO TO 612                                                  DB      00266
001007          IR1 = 1                                                                DB      00267
001011          PY = P(I)                                                              DB      00268
001014          GO TO 611                                                              DB      00269
001015      612 CONTINUE                                                               DB      00270
001015          IF(P(I).GT. PY) GO TO 620                                              DB      00271
001022          P(IR1) =  P(I)                                                         DB      00272
001027          P(I)   =  PY                                                           DB      00273
001033          GO TO 620                                                              DB      00274
001034      611 CONTINUE                                                               DB      00275
001037      620 CONTINUE                                                               DB      00276
            C                                                                          DB      00277
            C*************************************************************************** DB      00278
            C     GENERATE  DB-MATRIX  (BOUNDARY CONDITIONS)                           DB      00279
            C*************************************************************************** DB      00280
            C                                                                          DB      00281
001037          JX = 0                                                                 DB      00282
001040          I = 0                                                                  DB      00283
001041      170 I = I +1                                                               DB      00284
001043      171 JX = JX + 1                                                            DB      00285
001045          IF (PIX(JX) .EQ. 0)  GO TO 171                                         DB      00286
001047          PAX = CSQRT(P(JX))                                                     DB      00287
001052          POX = PIX(JX)                                                          DB      00288
001055          PIX(JX) = 0                                                            DB      00289
001056          IF( POX .GT.NR)   GO TO 175                                            DB      00290
001063          DO 172 JY =1,NR                                                        DB      00291
001064          IF (POX .EQ. PIX(JY))   PIX(JY) = 0                                    DB      00292
001070      172 CONTINUE                                                               DB      00293
001073      175 CONTINUE                                                               DB      00294
001073          IF(REAL(PAX) .LT. 0.) PAX =CMPLX(-REAL(PAX),AIMAG(PAX))                DB      00295
001102          IF(AIMAG(PAX) .LT. 0.) PAX =CMPLX(REAL(PAX),-AIMAG(PAX))               DB      00296
001111          CALL DBGEN(PAX,B,BA)                                                   DB      00297
001114          NS = NR                                                                DB      00298
001116          IF(KXX.EQ. 3)  NS =2*NR                                                DB      00299
001122          DO 200 J=1,NS                                                          DB      00300
001124          IF(KXX.NE.2) GOTO 200                                                  DB      00301
001126          IF(POX.GT.NR  .A. REAL(P(JX)) .LT. 0.0) GO TO 199                      DB      00302
001142          DBMA(J,I) =  REAL(BA(J))                                               DB      00303
001150          GO TO 200                                                              DB      00304
001151      199 DBMA(J,I) =  AIMAG(BA(J))                                              DB      00305
001160      200 DBM(J,I) = REAL(B(J))                                                  DB      00306
001172          IF( POX .GT.NR)   GO TO 251                                            DB      00307
001175          I = I +1                                                               DB      00308
001176          DO 250 J=1,NS                                                          DB      00309
001177          IF(KXX.EQ.2) DBMA(J,I)= AIMAG(BA(J))                                   DB      00310
001207      250 DBM(J,I) = AIMAG(B(J))                                                 DB      00311
001221      251 CONTINUE                                                               DB      00312
001221          IF(KXX.NE.3)  GO TO 300                                                DB      00313
001223          I1 = I + NR                                                            DB      00314
001225          IF(POX.GT.NR .AND. REAL(P(JX)) .LT. 0.0)  GO TO 261                    DB      00315
001242          CALL DBGEN(-PAX,B,BA)                                                  DB      00316
001247          IF(POX .LE. NR)   I1 = I1 -1                                           DB      00317
001255          DO 260 J=1,NS                                                          DB      00318
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001257    260  DBM(J,I1) = REAL(B(J))                                          DB      00319
001267         IF(POX.GT. NR)   GO TO 300                                      DB      00320
001273         I1 = I1 + 1                                                     DB      00321
001274    261  DO 265 J=1,NS                                                   DB      00322
001276    265  DBM(J,I1)  = AIMAG(B(J))                                        DB      00323
001307    300  CONTINUE                                                        DB      00324
001307         IF(I.LT.NR)GO TO 170                                            DB      00325
          C                                                                    DB      00326
          C*******************************************************************DB      00327
          C     EVALUATE THE DETERMINANT OF THE DB-MATRIX                      DB      00328
          C*******************************************************************DB      00329
          C                                                                    DB      00330
001312         IF(IPC(1).NE.1)   GO TO 341                                     DB      00331
001314         WRITE(6,1002)                                                   DB      00332
001317         DO 340 I=1,NS                                                   DB      00333
001322    340  WRITE(6,1003)  (DBM(I,J),J=1,NS)                               DB      00334
001342         IF(KXX.NE.2)GOTO 341                                            DB      00335
001344         WRITE(6,1004)                                                   DB      00336
001347         DO 342 I=1,NS                                                   DB      00337
001352    342  WRITE(6,1003)  (DBMA(I,J),J=1,NS)                              DB      00338
001372    341  CONTINUE                                                        DB      00339
001372         CALL SECOND(T1)                                                 DB      00340
          C     ---------------------------------------------------------------DB      00341
          C     THE FUNCTION SUBPROGRAM  DET   IS DEVELOPED FOR THE PURPOSE OF DB      00342
          C     EVALUATION OF REAL      DETERMINANTS                           DB      00343
          C     BY THE MATH. ANALYSIS GROUP   FOR THIS  PROGRAM                DB      00344
          C     ---------------------------------------------------------------DB      00345
001374         RES(IX) = DET(DBM,9,NS,V)                                       DB      00346
001402         IF(KXX.EQ.2) RESA(IX) = DET(DBMA,9,NS,V)                        DB      00347
001413         CALL SECOND(T2)                                                 DB      00348
001415         T = T2 - T1                                                     DB      00349
001417         IF(IPC(1).EQ.1) WRITE(6,2007) T                                 DB      00350
001431         AB(IX) = NX                                                     DB      00351
001434         DB = RES(IX)                                                    DB      00352
001436         DBA = RESA(IX)                                                  DB      00353
001440         IF(IPC(1).EQ.1)  WRITE(6,2006) DB                               DB      00354
001450         IF(IPC(1).EQ.1 .AND. KXX.EQ.2) WRITE(6,2008) DBA                DB      00355
                                                                               DB      00356
          C                                                                    DB      00357
          C*******************************************************************DB      00358
          C     SAVE P-VALUES IN P2-ARRAY FOR LATER PERTURBATION AND USE AS    DB      00359
          C     GUESS VALUES FOR ZARK  -- IN THE CASE OF ENCOUNTERED           DB      00360
          C     DOUBLE ROOT OR SIGN CHANGE IN THE NEXT DB CALL.                DB      00361
          C*******************************************************************DB      00362
          C                                                                    DB      00363
001466         IF(IX.EQ.1) GO TO 615                                           DB      00364
001470         IF(KK.NE. IPAIR) GO TO 608                                      DB      00365
001472         IF(KRN.NE. INREAL) GO TO 608                                    DB      00366
001474         SG1 = SIGN(1.0,DB1)*SIGN(1.0,RES(IX))                           DB      00367
001503         IF(KXX.EQ.2) SG1A =SIGN(1.0,DB1A)*SIGN(1.0,RESA(IX))            DB      00368
001515         IF (SG1.LT.0..OR.  SG1A .LT. 0.) GO TO 608                      DB      00369
001524    615  CONTINUE                                                        DB      00370
001524         DO 607 I=1,9                                                    DB      00371
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001526    607  P2(I) = P(I)                                                    DB      00372
001535    608  CONTINUE                                                        DB      00373
001535    900  RETURN                                                          DB      00374
                                                                              DB      00375
001537    1999 FORMAT(* LOAD ON PLATE*F10.3* LBS/IN*10X*MODE M*I5,10X*NR=*I5,  DB      00376
              1 10X*IX=*I5)                                                   DB      00377
001537    2000 FORMAT(* LOAD ON PLATE*F10.3* LBS/IN*10X*MODE N*I5,10X*NR=*I5,  DB      00378
              1 10X*IX=*I5)                                                   DB      00379
001537    2006 FORMAT(*  DB-DETERMINANT              *E13.5/)                 DB      00380
001537    2007 FORMAT(*0 DB-DETERMINANT EVALUATION  TIME * F10.3/)            DB      00381
001537    2008 FORMAT(*  DB-DETERMINANT -ANTISYMM.  *E13.5/)                  DB      00382
001537    1002 FORMAT(*0 DBM-MATRIX*/)                                        DB      00383
001537    1003 FORMAT(1X,9E13.5)                                              DB      00384
001537    1004 FORMAT(*0 DBM-MATRIX   ANTISYM. MODE -B.C. II ONLY*/)          DB      00385
001537         END                                                            DB      00386
```

SUBPROGRAM LENGTH
002621

STATEMENT FUNCTION REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES

STATEMENT NUMBER REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES			
000111	L00046	110	000045	000074		
000216	L00100	117	000133	000152		
000261	L00110	130	000123			
000262	L00111	140	000215	000260		
000327	L00130	150	NONE			
000341	L00136	151	000325			
000347	L00142	152	000326			
000353	L00145	153	000340	000346		
001041	L00365	170	001311			
001043	L00366	171	001046			
001070	L00406	172	001066			
001073	L00410	175	001061			
001151	L00437	199	001141			
001160	L00440	200	001125	001150		
001207	L00454	250	001200			
001221	L00456	251	001173			
001257	L00475	260	NONE			
001274	L00504	261	001241			
001276	L00507	265	NONE			
001307	L00512	300	001222	001271		
001372	L00550	341	001313	001343		
000370	L00160	520	000674			
000400	L00170	526	000375			
000456	L00210	527	000427			
000470	L00212	530	000403	000455		
000476	L00217	540	000455			
000531	L00232	545	000467			
000612	L00247	550	000412			
000650	L00261	600	000530	000611		
000672	L00266	602	000647	000654		
000727	L00305	604	000711			
000764	L00327	605	000762			
000767	L00331	606	000737			
001526	L00627	607	NONE			
001535	L00631	608	001471	001473	001523	
000772	L00333	610	000731			
001034	L00361	611	001002	001014		
001015	L00353	612	001006			
001524	L00624	615	001467			
001037	L00363	620	000773	000775	001020	001033
001535	L00631	900	001471	001473	001523	

001717	C00157	1002	001313	
001722	C00162	1003	001321	001351
001725	C00165	1004	001343	
001653	C00113	1999	000074	
001664	C00124	2000	000050	
001607	C00047	2001	000304	
001560	C00020	2002	000331	
001567	C00027	2003	000341	
001577	C00037	2004	000347	
001675	C00135	2006	001441	
001703	C00143	2007	001422	
001711	C00151	2008	001457	
001641	C00101	2009	000712	
001621	C00061	2010	000472	

EXTERNALS AND TAGS

DT	- S00100	OUTPTC.	- S00200	SECOND	- S00300	ZARK	- S00400
CSQRT	- S00500	CBGEN	- S00600	CET	- S00700	END.	- S01000

BLOCK NAMES AND LENGTHS

A	- 000100	AR	- 000005	BLK1	- 000012	CON	- 000040
ICK	- 000461						

VARIABLE REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
000001C05	A00023	AB	001431					
000012C01	A00016	AC	NONE					
002143	A00004	B	000010	001111	001160	001207	001244	001257
			001276					
002165	A00005	BA	000014	001112	001142	001151	001201	001245
000034C01	A00017	BC	NONE					
002010	V00002	CB	000164	000206	000227	000251	001435	001444
			001535					
000455C05	V00131	CBA	001437	001462				
002313	A00013	CBM	000025	001164	001213	001265	001277	001326
			001374					
002434	A00014	CBMA	000022	001145	001155	001204	001356	001404
000000C03	V00132	CB1	001500					
000456C05	V00133	CB1A	001510					
000056C01	A00020	DC	NONE					
002576	V00075	EP1	000113	000265				
002577	V00076	EP2	000114	000266				
002121	A00003	FP	000272	000314				
002011	A00001	GUESS	000156	000170	000200	000221	000233	000243
			000264					
002571	V00064	I	000007	000014	000022	000154	000171	000217
			000234	000355	000366	000370	000476	000512
			000537	000551	000562	000572	000620	000636
			000650	000672	000675	000705	000734	000746
			000767	000777	001007	001015	001034	001040
			001041	001145	001155	001164	001204	001213
			001223	001307	001321	001325	001337	001351

			001355	001367	001525	001533		
000006C03	V00117	IAB	000727	000763				
000005C03	V00105	INREAL	000140	001472				
002600	V00100	IO	000124	000261	000270	000324		
000004C03	V00103	IPAIR	000134	001470				
000014C04	A00022	IFC	000044	000302	000327	000710	001311	001420
			001437	001450				
002613	V00123	IR	000776	001003				
002614	V00124	IR1	001010	001021				
000000C05	V00061	IX	000003	000061	000105	000114	001377	001411
			001431	001466	001474			
002611	V00121	IXA	000741					
000007C03	V00077	IXT	000120					
000011C03	V00101	IXU	000130					
002620	V00130	I1	001224	001253	001261	001272	001300	
002572	V00065	J	000021	000372	000401	000435	000456	000470
			000510	000525	000547	000564	000576	000607
			000742	000764	001123	001141	001151	001154
			001160	001163	001176	001200	001207	001212
			001256	001275				
002615	V00125	JX	001037	001043	001052	001125	001225	
002616	V00126	JY	001063	001070				
002605	V00114	K	000367	000373	000400	000404	000413	000421
			000427	000437	000461	000500	000505	000531
			000545	000612	000626	000634		
000002C03	V00102	KK	000133	000363	000504	000524	000543	000606
			001470					
002604	V00113	KR	000364	000624	000730	000774		
000003C03	V00104	KRN	000137	000365	000632	001472		
000000C04	V00071	KXX	000046	000065	001116	001123	001176	001221
			001341	001402	001453	001503		
000001C04	V00067	KXY	000037					
000000C01	V00034	LC	000035					
000001C02	V00073	M	000101					
002575	V00074	MAXREP	000111	000265				
000006C01	V00042	MC	NONE					
000010C01	V00044	M2C	NONE					
000000C02	V00072	N	000055					
000002C01	V00036	NC	NONE					
000002C04	A00021	NCASE	NONE					
002573	V00066	NR	000037	000042	000043	000057	000103	000213
			000256	000361	000376	000470	000672	000706
			000722	000730	000736	000764	000772	001001
			001034	001057	001070	001114	001132	001172
			001223	001250	001267	001307		
002574	V00070	NROOTS	000044	000264	000317			
002610	V00120	NRX	000733	000767				
002617	V00127	NS	001115	001121	001167	001216	001265	001304
			001332	001337	001362	001367	001375	001405
000004C01	V00040	N2C	NONE					
002077	A00002	P	000220	000236	000242	000271	000311	000404
			000413	000421	000430	000435	000440	000456
			000462	000500	000517	000531	000553	000564

			000577	000612	000626	000640	000700	000743
			000746	001010	001015	001022	001023	001027
			001046	001126	001225	001527		
002255	V00023	PAX	000657	000667	001051	001073	001100	001102
			001111	001241				
002260	A00010	PCHK	000357	000374	000402	000514	000525	000561
			000607	000646				
002271	A00011	PIX	000356	000506	000510	000545	000550	000634
			000676	000735	001000	001045	001052	001054
			001064	001066				
002302	A00012	PIXX	000512	000523	000552	000605	000637	000677
002257	V00025	POX	001054	001057	001065	001131	001171	001230
			001250	001267				
002207	A00006	PX	000476	000516	000537	000555	000572	000601
			000620	000642	000650	000655	000661	000662
			000666	000702	000717			
002253	V00021	PY	001013	001017				
002231	A00007	P2	000155	000173	000177	001526		
002612	V00122	RAT	000751	000752				
000145C05	A00024	RES	001400	001433	001474			
000311C05	A00025	RESA	001411	001435	001505			
000010C03	V00106	SGN	000143					
000460C05	V00107	SGNA	000146					
002567	V00062	SG1	000005	001502	001515			
002570	V00063	SG1A	000006	001514	001517			
002603	V00112	T	000300	000334	001416	001425		
002607	V00116	TOLR1	000434	000446				
002606	V00115	TOLR2	000420	000451	000466			
002601	V00110	T1	000262	000277	001372	001415		
002602	V00111	T2	000275	000277	001413	001415		
002555	A00015	V	001375	001406				

START OF CONSTANTS
001540

START OF TEMPORARIES
001732

START OF INDIRECTS
001772

SPACE REQUIRED TO COMPILE
043000

```
      FUNCTION DT(P)                                                    DT      00002
C                                                                       DT      00003
C*********************************************************************** DT      00004
C                                                                       DT      00005
C  PURPOSE                                                              DT      00006
C                                                                       DT      00007
C     THIS SUBROUTINE GENERATES AND                                     DT      00008
C     EVALUATES THE DT-DETERMINANT.                                     DT      00009
C     THE DT-DETERMINANT EXPRESSION REPRESENTS THE                      DT      00010
C     EQUILIBRIUM EQUATIONS.                                            DT      00011
C                                                                       DT      00012
C  UPDATE                                                               DT      00013
C                                                                       DT      00014
C     3/15/70 PROGRAMMED BY VIKTOR OEVERLI                              DT      00015
C             APPROVED   BY AL HILLSTROM                                DT      00016
C                                                                       DT      00017
C  DISCUSSION                                                           DT      00018
C                                                                       DT      00019
C     SUBROUTINE RGEN GENERATES THE ELEMENTS OF DT WHILE                DT      00020
C     FUNCTION   CDTM EVALUATES THE DETERMINANT                         DT      00021
C                                                                       DT      00022
C     WE ARE SOLVING FOR P**2                                           DT      00023
C     THE DT-DETERMINANT EXPRESSION IN POLYNOMIAL FORM CONTAINS         DT      00024
C     ONLY EVEN POWERS OF P .          THUS WE CAN HALVE THE ORDER      DT      00025
C     OF THE PROBLEM.                                                   DT      00026
C     WE SOLVE ONLY HALF THE NUMBER OF ROOTS BY ENTERING THE            DT      00027
C     SQUARE ROOT OF P  INTO THE DT-FUNCTION                            DT      00028
C                                                                       DT      00029
C  INPUT  ARGUMENTS          P  (TRIAL ROOT IN ITERATION)               DT      00030
C  COMMON INPUT              R,KXY                                      DT      00031
C                                                                       DT      00032
C                            SEE MAIN PROGRAM FOR LEGEND ON VARIABLES   DT      00033
C                            IN COMMON                                  DT      00034
C                                                                       DT      00035
C                            RGEN,CDTM                                  DT      00036
C                            ZARK       (USED IN DB-FUNCTION)           DT      00037
C                                                                       DT      00038
C*********************************************************************** DT      00039
C                                                                       DT      00040
000003      COMMON/CON/KXX,KXY,NCASE(10),IFC(20)                        DT      00041
000003      COMPLEX DT,R(3,3),P,PS                                      DT      00042
000003      COMPLEX CDTM                                                DT      00043
000003      DIMENSION V(3)                                              DT      00044
000003      COMMON/RC/ R                                                DT      00045
000003      PS= CSQRT(P)                                                DT      00046
000006      CALL RGEN(PS)                                               DT      00047
000010      IF(KXY.EQ. 1)  GO TO 50                                     DT      00048
000013      NC=3                                                        DT      00049
000014      NR=2*NC                                                     DT      00050
      C     ------------------------------------------------------------ DT      00051
      C     THE FUNCTION SUBPROGRAM  CDTM  IS DEVELOPED FOR THE PURPOSE OF DT     00052
      C     EVALUATION OF  COMPLEX  DETERMINANTS                        DT      00053
```

```
        C     BY THE MATH. ANALYSIS GROUP   FOR THIS  PROGRAM                    DT      00054
        C     ------------------------------------------------------------------ DT      00055
000015          DT = CDTH(R,NR,3,V)                                              DT      00056
000021          GO TO 100                                                        DT      00057
000023    50    DT = R(3,3)                                                      DT      00058
000026    100   RETURN                                                           DT      00059
000030          END                                                              DT      00060
```

```
RUN  VERSION FEB 70     19041 22/04/70


SUBPROGRAM LENGTH
000051

STATEMENT FUNCTION REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES

STATEMENT NUMBER REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES
        000023    L00017    50        000012
        000026    L00020    100       000022

EXTERNALS AND TAGS
CSQRT  -  S00100    RGEN   -  S00200    CDTM   -  S00300    END.   -  S00400

BLOCK NAMES AND LENGTHS
CON    -  000040    RC     -  000022

VARIABLE REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES
        000042    V00011    CDTM      NONE
        000036    V00002    DT        000020    000024    000026
        000014C01 A00002    IFC       NONE
        000001C01 V00014    KXY       000011
        000047    V00015    NC        000013
        000002C01 A00001    NCASE     NONE
        000050    V00016    NR        000014    000015
        000040    V00007    PS        000005    000006
        000000C02 A00003    R         000015
        000044    A00004    V         000016

START OF CONSTANTS
000031

START OF TEMPORARIES
000032

START OF INDIRECTS
000036

SPACE REQUIRED TO COMPILE
035200
```

```
      SUBROUTINE RGEN(P)                                                RGE    00002
C                                                                       RGE    00003
C*********************************************************************** RGE    00004
C                                                                       RGE    00005
C  PURPOSE                                                              RGE    00006
C                                                                       RGE    00007
C     THIS SUBROUTINE GENERATES THE ELEMENTS OF THE EQUILIBRIUM         RGE    00008
C     EQUATIONS MATRIX  R -- THE DETERMINANT OF R IS CALLED DT          RGE    00009
C                                                                       RGE    00010
C  UPDATE                                                               RGE    00011
C                                                                       RGE    00012
C     3/15/70 PROGRAMMED BY VIKTOR OEVERLI                              RGE    00013
C             APPROVED   BY AL HILLSTROM                                RGE    00014
C                                                                       RGE    00015
C  DISCUSSION                                                           RGE    00016
C                                                                       RGE    00017
C     RGEN IS CALLED BY DT   (FOR EVALUATION THE DT-DETERMINANT)        RGE    00018
C     AND BY DBGEN  (GENERATION OF THE BUCKLING DETERMINANT DB)         RGE    00019
C     FOR THE CASE OF NO COUPLING  (KXY=1) ONLY ELEMENT R(3,3) IS       RGE    00020
C     NEEDED                                                            RGE    00021
C                                                                       RGE    00022
C  INPUT ARGUMENTS            P       TRIAL ROOT OF EQUILIB. EQUATIONS  RGE    00023
C                                      WHEN CALLED BY DT (ZARK-ITERATION) RGE  00024
C                                      ONE ROOT OF EQUILIB. EQ.          RGE    00025
C                                      WHEN CALLED BY DBGEN              RGE    00026
C  COMMON INPUT               LC,NC,NLC,MC,M2C,AC,BC,DC,KXX,KXY         RGE    00027
C                             F1,F2                                     RGE    00028
C  COMMON OUTPUT              R                                         RGE    00029
C                             SEE MAIN PROGRAM FOR LEGEND ON VARIABLES  RGE    00030
C                             IN COMMON                                 RGE    00031
C                                                                       RGE    00032
C  SUBROUTINE USER            DT,DBGEN                                  RGE    00033
C                                                                       RGE    00034
C*********************************************************************** RGE    00035
C                                                                       RGE    00036
000003      COMPLEX P,PSQ,PQU,CX,R(3,3)                                 RGE    00037
000003      COMPLEX PZ,LY                                               RGE    00038
000003      COMPLEX LC,NC,N2C,MC,M2C,AC,BC,DC                           RGE    00039
000003      COMMON/A/LC,NC,N2C,MC,M2C,AC(3,3),BC(3,3),DC(3,3)           RGE    00040
000003      COMMON/AR/N,M,PI,AL,BL,F1,F2                                RGE    00041
000003      COMMON/CON/KXX,KXY,NCASE(10),IFC(20)                        RGE    00042
000003      COMMON/RC/ R                                                RGE    00043
000003      PZ = P                                                      RGE    00044
000005      IF(KXX.NE.2) GO TO  50                                      RGE    00045
C                                                                       RGE    00046
C*********************************************************************** RGE    00047
C     BOUNDARY CONDITION  II                                            RGE    00048
C*********************************************************************** RGE    00049
C                                                                       RGE    00050
000007      P = P*F1                                                    RGE    00051
000013      PSQ = P*P                                                   RGE    00052
000020      PQU = PSQ*PSQ                                               RGE    00053
```

```
000025          IF(KXY .EQ.1)  GO TO 30                                          RGE     00054
000027          CX = (BC(1,2)  +(2.,0.)*BC(3,3))*P*NC                            RGE     00055
000050          R(1,1)  =  AC(1,1)*PSQ  - AC(3,3)*N2C                            RGE     00056
000065          R(1,2)  = -((AC(1,2) +  AC(3,3))*NC*P)                           RGE     00057
000103          R(1,3)  = -(BC(1,1)*PSQ*P  - CX*NC)                              RGE     00058
000124          R(2,1) =-R(1,2)                                                  RGE     00059
000127          R(2,2)  =  AC(3,3)*PSQ  - AC(2,2)*N2C                            RGE     00060
000142          R(2,3)  =  BC(2,2)*N2C*NC  - CX*P                                RGE     00061
000161          R(3,1) = R(1,3)                                                  RGE     00062
000163          R(3,2) =-R(2,3)                                                  RGE     00063
000166     30   R(3,3) =                 +DC(1,1)*PQU  -(2.0*DC(1,2)             RGE     00064
               1      +4.0*DC(3,3))*PSQ*N2C  + DC(2,2)*N2C*N2C                  RGE     00065
000227          IF(AL/BL.LE.1.0)GO TO 31                                         RGE     00066
000232          LY = LC*PSQ*BL*BL/(PI*PI)                                        RGE     00067
000245          GO TO 32                                                         RGE     00068
000246     31   LY=LC*PSQ*AL*AL/(PI*PI)                                          RGE     00069
000261     32   R(3,3)=R(3,3)+LY                                                 RGE     00070
000266          GO TO 100                                                        RGE     00071
000266     50   CONTINUE                                                         RGE     00072
000266          IF(KXX.NE. 3 .AND. KXX.NE. 4)   GO TO 60                         RGE     00073
           C                                                                     RGE     00074
           C*************************************************************************** RGE     00075
           C     BOUNDARY CONDITION  III                                         RGE     00076
           C     BOUNDARY CONDITION  IV                                          RGE     00077
           C*************************************************************************** RGE     00078
           C                                                                     RGE     00079
000276          P = P*F2                                                         RGE     00080
000302          PSQ = P*P                                                        RGE     00081
000307          PQU = PSQ*PSQ                                                    RGE     00082
000314          IF(KXY .EQ. 1)  GO TO 55                                         RGE     00083
000316          CX = (BC(1,2)  +(2.,0.)*BC(3,3))*MC*P                            RGE     00084
000337          R(1,1)  = -AC(1,1)*M2C     +AC(3,3)*PSQ                          RGE     00085
000352          R(1,2)  =  (AC(1,2)+  AC(3,3))*MC*P                              RGE     00086
000370          R(1,3)  =  BC(1,1)*M2C*MC  - CX*P                                RGE     00087
000406          R(2,1) = -R(1,2)                                                 RGE     00088
000411          R(2,2)  =  AC(2,2)*PSQ  - AC(3,3)*M2C                            RGE     00089
000424          R(2,3)  =  CX*MC  -  BC(2,2)*PSQ*P                               RGE     00090
000443          R(3,1) = -R(1,3)                                                 RGE     00091
000445          R(3,2) = R(2,3)                                                  RGE     00092
000450     55   R(3,3) =                  + DC(1,1)*M2C*M2C -(2.0*DC(1,2)        RGE     00093
               1    +4.0*DC(3,3))*PSQ*M2C   + DC(2,2)*PQU                       RGE     00094
000511          IF(AL/BL .LE. 1.0) GO TO 56                                      RGE     00095
000514          LY=-LC*MC*MC*BL*BL/(PI*PI)                                       RGE     00096
000531          GO TO 57                                                         RGE     00097
000531     56   LY =-LC*MC*MC*AL*AL/(PI*PI)                                      RGE     00098
000546     57   R(3,3)=R(3,3)+LY                                                 RGE     00099
000553     60   CONTINUE                                                         RGE     00100
000553     100  CONTINUE                                                         RGE     00101
000553          P = PZ                                                           RGE     00102
000556          RETURN                                                           RGE     00103
000556          END                                                              RGE     00104
```

SUBPROGRAM LENGTH
000611

STATEMENT FUNCTION REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES

STATEMENT NUMBER REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES	
000166	L00025	30	000026	
000246	L00032	31	000231	
000261	L00033	32	000245	
000266	L00035	50	000006	
000450	L00057	55	000315	
000531	L00064	56	000513	
000546	L00065	57	000530	
000553	L00066	60	000265	000275
000553	L00066	100	000265	000275

EXTERNALS AND TAGS
END. - S00100

BLOCK NAMES AND LENGTHS
A - 000100 AR - 000007 CON - 000040 RC - 000022

VARIABLE REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
000012C01	A00002	AC	000047	000336				
000003C02	V00043	AL	000226	000254	000510	000541		
000034C01	A00003	BC	000103	000367				
000004C02	V00044	BL	000227	000240	000511			
000603	V00006	CX	000046	000113	000152	000335	000377	000424
000056C01	A00004	DC	000200	000462				
000005C02	V00041	F1	000010					
000006C02	V00046	F2	000277					
000014C03	A00006	IPC	NONE					
000000C03	V00040	KXX	000005	000266				
000001C03	V00042	KXY	000024	000313				
000000C01	V00016	LC	000233	000247	000515	000532		
000607	V00014	LY	000244	000260	000262	000527	000545	000547
000006C01	V00024	MC	000327	000360	000374	000425	000517	000534
000010C01	V00026	M2C	000340	000371	000417	000464	000476	
000002C01	V00020	NC	000043	000071	000114	000146		
000002C03	A00005	NCASE	NONE					
000004C01	V00022	N2C	000056	000135	000143	000212	000217	
000002C02	V00045	PI	000232	000246	000514	000531		
000601	V00004	PQU	000023	000202	000312	000503		
000577	V00002	PSQ	000016	000017	000032	000051	000104	000105
			000110	000115	000130	000144	000147	000154

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                                    000174    000207    000220    000235    000251    000254
                                    000305    000306    000321    000345    000412    000426
                                    000432    000433    000436    000456    000473    000504
                                    000541
        000605     VGGG12    PZ     000004    000553
        GGGGGGC04  AGGGG1    R      000062    000351

START OF CONSTANTS
000557

START OF TEMPORARIES
000565

START OF INDIRECTS
000577

SPACE REQUIRED TO COMPILE
037600
```

```
      SUBROUTINE DBGEN(P,B,BA)                                          DBG    00002
      C                                                                 DBG    00003
      C*****************************************************************DBG    00004
      C                                                                 DBG    00005
      C  PURPOSE                                                        DBG    00006
      C                                                                 DBG    00007
      C     THIS SUBROUTINE GENERATES THE ELEMENTS FOR ONE OR TWO COLUMNS OF DBG    00008
      C     THE BOUNDARY CONDITIONS MATRIX DB. (THE BUCKLING DETERMINANT) DBG    00009
      C                                                                 DBG    00010
      C  UPDATE                                                         DBG    00011
      C                                                                 DBG    00012
      C     3/15/70 PROGRAMMED BY VIKTOR OEVERLI                        DBG    00013
      C             APPROVED  BY AL HILLSTROM                           DBG    00014
      C                                                                 DBG    00015
      C  DISCUSSION                                                     DBG    00016
      C                                                                 DBG    00017
      C     IT CONTRIBUTES ONE COLUMN TO DB FOR EACH CALL WHEN P IS REAL AND DBG    00018
      C     TWO COLUMNS WHEN P IS COMPLEX                               DBG    00019
      C     P  IS A ROOT  OF THE DETRMINANT EXPRESSION  DET(DT) = 0     DBG    00020
      C                                                                 DBG    00021
      C  INPUT  ARGUMENTS           P  (ROOT)                           DBG    00022
      C  OUTPUT ARGUMENTS           B    CONTAINS ONE OR TWO COLUMNS    DBG    00023
      C                                  FOR  DB-DETERMINANT            DBG    00024
      C                             BA   SAME AS B  BUT FOR ALTERNATE ASSYM. DBG    00025
      C                                  DISP. PATTERN  FOR B.C. II     DBG    00026
      C  COMMON INPUT      AC,BC,DC,R,KXX,KXY,PI,AL,BL,LC,NC,N2C,MC,M2C DBG    00027
      C                    F1,F2                                        DBG    00028
      C                                                                 DBG    00029
      C                           SEE MAIN PROGRAM FOR LEGEND ON VARIABLES DBG    00030
      C                           IN COMMON                             DBG    00031
      C                                                                 DBG    00032
      C  SUBROUTINE USER          DB                                    DBG    00033
      C                                                                 DBG    00034
      C*****************************************************************DBG    00035
      C                                                                 DBG    00036
000006      COMPLEX P,PSQ,B,R(3,3),L1,L2                                DBG    00037
000006      COMPLEX PZ,BA,SX,CX                                         DBG    00038
000006      COMPLEX LC,NC,N2C,MC,M2C,AC,BC,DC                           DBG    00039
000006      COMMON/A/LC,NC,N2C,MC,M2C,AC(3,3),BC(3,3),DC(3,3)           DBG    00040
000006      COMMON/AR/N,M,PI,AL,BL,F1,F2                                DBG    00041
000006      COMMON/CON/KXX,KXY,NCASE(10),IPC(20)                        DBG    00042
000006      COMMON/RC/ R                                                DBG    00043
000006      COMPLEX ALF,CNTAN                                           DBG    00044
000006      COMPLEX CSIN,CCOS,EA,EAN                                    DBG    00045
000006      DIMENSION B(1),BA(1)                                        DBG    00046
000006      L1 = (0.,0.)                                                DBG    00047
000010      L2 = (0.,0.)                                                DBG    00048
000013      IF(KXY .EQ. 1)  GO TO 40                                    DBG    00049
000015      CALL RGEN(P)                                                DBG    00050
000016      L1 = (R(2,3)*R(1,1) -R(1,3)*R(2,1))/(R(1,2)*R(2,1)-R(2,2)*R(1,1)) DBG    00051
000055      L2 = (R(1,3)*R(2,2) -R(2,3)*R(1,2))/(R(1,2)*R(2,1)-R(2,2)*R(1,1)) DBG    00052
000113   40 CONTINUE                                                    DBG    00053
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000113          PZ = P                                                          DBG     00054
000117          ALF=  PI*P/2.                                                   DBG     00055
000127          ALR=REAL(ALF)                                                   DBG     00056
000130          ALI=AIMAG(ALF)                                                  DBG     00057
000132          THCO=TANH(ALR)*COS(ALI)                                         DBG     00058
000137          THSI=TANH(ALR)*SIN(ALI)                                         DBG     00059
000144          CHTAN =CMPLX(THCO,SIN(ALI))/CMPLX(COS(ALI),THSI)                DBG     00060
000165          SX = CMPLX(COS(ALI),THSI)                                       DBG     00061
000171          IF(KXX.NE.2) GO TO 50                                           DBG     00062
                C                                                               DBG     00063
                C*******************************************************************DBG     00064
                C     BOUNDARY CONDITION  II                                    DBG     00065
                C*******************************************************************DBG     00066
                C                                                               DBG     00067
000175          P= P*F1                                                         DBG     00068
000201          PSQ = P*P                                                       DBG     00069
000206          B(1) = (1.0,0.)                                                 DBG     00070
000211          B(2) = CHTAN*PZ                                                 DBG     00071
000217          BA(1) = CHTAN*SX                                                DBG     00072
000225          BA(2) = PZ*SX                                                   DBG     00073
000234          IF(KXY.EQ.1)  GO TO 100                                         DBG     00074
000236          B(3) = AC(1,1)*L2*P -AC(1,2)*L1*MC - BC(1,1)*PSQ + BC(1,2)*M2C  DBG     00075
000273          B(4) = L1                                                       DBG     00076
000276          BA(3) = CHTAN*B(3)*SX                                           DBG     00077
000310          BA(4) = CHTAN*L1*SX                                             DBG     00078
000321          GO TO 100                                                       DBG     00079
000322    50    CONTINUE                                                        DBG     00080
000322          IF(KXX.NE.3) GO TO 60                                           DBG     00081
000324    51    CONTINUE                                                        DBG     00082
                C                                                               DBG     00083
                C*******************************************************************DBG     00084
                C     BOUNDARY CONDITION  III                                   DBG     00085
                C*******************************************************************DBG     00086
                C                                                               DBG     00087
000324          EA=(1.,0.)+CHTAN                                                DBG     00088
000331          EAN= (1.,0.) - CHTAN                                            DBG     00089
000335          P = P*F2                                                        DBG     00090
000341          PSQ = P*P                                                       DBG     00091
000346          B(1) = EA*(-BC(1,2)*MC*L2+BC(2,2)*L1*P+DC(1,2)*M2C -DC(2,2)*PSQ)DBG     00092
000411          CX = L2*P + MC*L1                                               DBG     00093
000424          B(2) = B(1)*P +EA*(-2.*BC(3,3)*CX*MC  + 4.*DC(3,3)*M2C*P)       DBG     00094
000466          B(3) = EAN                                                      DBG     00095
000471          B(4) = EAN*(-BC(1,2)*MC*L2+BC(2,2)*L1*P +DC(1,2)*M2C-DC(2,2)*PSQ)DBG    00096
000534          IF(KXY.EQ.1)  GO TO 100                                         DBG     00097
000536          B(5) = EA*(-AC(1,2)*MC*L2+AC(2,2)*L1*P+BC(1,2)*M2C-BC(2,2)*PSQ) DBG     00098
000601          B(6) = EA*(AC(3,3)*CX -2.*BC(3,3)*MC*P)                         DBG     00099
000631          B(7) = EAN*L2                                                   DBG     00100
000637          B(8) = EAN*(-AC(1,2)*MC*L2+AC(2,2)*L1*P+BC(1,2)*M2C-BC(2,2)*PSQ)DBG     00101
000702          GO TO 100                                                       DBG     00102
000703    60    CONTINUE                                                        DBG     00103
000703          IF(KXX.NE.4) GO TO 70                                           DBG     00104
                C                                                               DBG     00105
                C*******************************************************************DBG     00106
```

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      C     BOUNDARY CONDITION  IV                                                    DBG     00107
      C*************************************************************************** DBG     00108
      C                                                                             DBG     00109
000705        P = P*F2                                                              DBG     00110
000711        PSQ = P*P                                                             DBG     00111
000716        B(1) = -BC(1,2)*HC*L2 +BC(2,2)*L1*P+DC(1,2)*H2C-DC(2,2)*PSQ           DBG     00112
000753        CX = L2*P +HC*L1                                                      DBG     00113
000766        B(2) =  CMTAN*(-BC(1,2)*HC*L2*P+BC(2,2)*L1*PSQ+DC(1,2)*H2C*P          DBG     00114
             1       -DC(2,2)*PSQ*P-2.*BC(3,3)*CX*HC +4.*DC(3,3)*H2C*P)             DBG     00115
001070        IF(KXY.EQ.1)  GO TO 100                                               DBG     00116
001072        B(3) = -AC(1,2)*HC*L2 +AC(2,2)*L1*P +BC(1,2)*H2C -BC(2,2)*PSQ         DBG     00117
001127        B(4) =  CMTAN*(AC(3,3)*CX  -2.*BC(3,3)*HC*P)                          DBG     00118
001157    70  CONTINUE                                                              DBG     00119
001157    100 CONTINUE                                                              DBG     00120
001157        DO 101 I=1,8                                                          DBG     00121
001161    101 B(I) = B(I)*SX                                                        DBG     00122
001172        P = PZ                                                                DBG     00123
001175        RETURN                                                                DBG     00124
001175        END                                                                   DBG     00125
```

SUBPROGRAM LENGTH
001313

STATEMENT FUNCTION REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES

STATEMENT NUMBER REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
000113	L00016	40	000014					
000322	L00054	50	000174					
000324	L00056	51	NONE					
000703	L00076	60	000323					
001157	L00111	70	000235	000321	000535	000702	000704	001071
001157	L00111	100	000235	000321	000535	000702	000704	001071
001161	L00114	101	NONE					

EXTERNALS AND TAGS
RGEN - S00100 TANH - S00200 COS - S00300 SIN - S00400
END. - S00500

BLOCK NAMES AND LENGTHS
A - 000100 AR - 000007 CON - 000040 RC - 000022

VARIABLE REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
000012C01	A00002	AC	000236					
001272	V00044	ALF	000125	000126				
001307	V00063	ALI	000131	000136	000143	000150	000164	
001306	V00062	ALR	000127	000133	000140			
000034C01	A00003	BC	000256					
001300	V00052	CCOS	NONE					
001274	V00046	CMTAN	000163	000211	000217	000276	000310	000325
			000332	001062	001150			
001276	V00050	CSIN	NONE					
001270	V00020	CX	000423	000430	000602	000765	001036	001130
000056C01	A00004	DC	NONE					
001302	V00054	EA	000327	000402	000457	000573	000622	
001304	V00056	EAN	000334	000466	000526	000631	000674	
000005C02	V00067	F1	000176					
000006C02	V00070	F2	000336	000706				
001312	V00071	I	001160	001170				
000014C03	A00006	IPC	NONE					
000000C03	V00066	KXX	000173	000322	000703			
000001C03	V00060	KXY	000012	000233	000534	001070		
000000C01	V00022	LC	NONE					
001260	V00010	L1	000007	000053	000247	000273	000311	000357
			000417	000502	000547	000650	000727	000761
			001002	001104				

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        001262     V00012    L2        000011    000112    000257    000352    000410    000475
                                       000542    000632    000643    000722    000752    000772
                                       001077
        000006C01  V00030    MC        000347    000415    000433    000472    000537    000612
                                       000640    000717    000757    000767    001041    001074
                                       001140
        000010C01  V00032    M2C       000367    000442    000513    000560    000661    000740
                                       001013    001051    001114
        000002C01  V00024    MC        000252
        000002C03  A00005    MCASE     NONE
        000004C01  V00026    M2C       000265
        000002C02  V00061    P1        000117
        001256     V00004    PSQ       000204    000260    000344    000375    000520    000565
                                       000666    000714    000745    001005    001023    001122
        001264     V00014    PZ        000116    000212    000225    001172
        000000C04  A00001    R         000024    000033    000063
        001266     V00016    SX        000170    000220    000227    000303    000314    001163
        001310     V00064    THCO      000136    000153
        001311     V00065    THSI      000143    000145    000166

START OF CONSTANTS
001176

START OF TEMPORARIES
001213

START OF INDIRECTS
001245

SPACE REQUIRED TO COMPILE
041400
```

```
                      FUNCTION DET(A,NR,N,V)                                    DET     00002
                C     TO EVALUATE THE DETERMINANT OF A REAL SQUARE MATRIX       DET     00003
000007                DIMENSION  A(NR,1),V(1)                                   DET     00004
000007                DOUBLE PRECISION  SUM,DX                                  DET     00005
000007                DATA  EPS/O1640777777777777776/                           DET     00006
000007                E8=8.*EPS                                                 DET     00007
000011                DO 5 I=1,N                                                DET     00008
000012                SUM=0.                                                    DET     00009
000014                DO 105 J=1,N                                              DET     00010
000015                DX=A(I,J)                                                 DET     00011
000022            105 SUM=SUM+DX*DX                                             DET     00012
000035                Y=SUM                                                     DET     00013
000037                IF(Y) 40,40,5                                             DET     00014
000040              5 V(I)=1./SQRT(Y)                                           DET     00015
000052                DET=1.                                                    DET     00016
000053                DO 50 K=1,N                                               DET     00017
000054                L=K                                                       DET     00018
000055                X=0.                                                      DET     00019
000056                K1=K-1                                                    DET     00020
000057                DO 25 I=K,N                                               DET     00021
000060                Y=A(I,K)                                                  DET     00022
000064                IF(K1) 22,22,21                                           DET     00023
000066             21 SUM=0.                                                    DET     00024
000070                DO 110 J=1,K1                                             DET     00025
000071                DX=A(I,J)                                                 DET     00026
000076            110 SUM=SUM+DX*A(J,K)                                         DET     00027
000115                Y=Y-SUM                                                   DET     00028
000122             22 A(I,K)=Y                                                  DET     00029
000127                Y=ABS(Y*V(I))                                             DET     00030
000131                IF(Y.LE.X) GO TO 25                                       DET     00031
000134                X=Y                                                       DET     00032
000134                L=I                                                       DET     00033
000135             25 CONTINUE                                                  DET     00034
000140                IF(L.EQ.K) GO TO  35                                      DET     00035
000142                DET=-DET                                                  DET     00036
000143                DO 30 J=1,N                                               DET     00037
000144                Y=A(K,J)                                                  DET     00038
000150                A(K,J)=A(L,J)                                             DET     00039
000156             30 A(L,J)=Y                                                  DET     00040
000163                V(L)=V(K)                                                 DET     00041
000166             35 CONTINUE                                                  DET     00042
000166                IF(X-E8) 40,45,45                                         DET     00043
000171             40 DET=0.                                                    DET     00044
000172                GO TO 55                                                  DET     00045
000173             45 X=1./A(K,K)                                               DET     00046
000200                DET=DET*A(K,K)                                            DET     00047
000204                J=K+1                                                     DET     00048
000205             46 IF(J-N) 47,47,50                                          DET     00049
000207             47 Y=A(K,J)                                                  DET     00050
000214                IF(K1) 49,49,48                                           DET     00051
000215             48 SUM=0.                                                    DET     00052
000217                DO 120 I=1,K1                                             DET     00053
```

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000220          DX=A(K,I)                                          DET     00054
000225      120 SUM=SUM+DX*A(I,J)                                  DET     00055
000244          Y=Y-SUM                                            DET     00056
000251       49 A(K,J)=X*Y                                         DET     00057
000257          J=J+1                                              DET     00058
000260          GO TO 46                                           DET     00059
000260       50 CONTINUE                                           DET     00060
000263       55 RETURN                                             DET     00061
000265          END                                                DET     00062
```

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SUBPROGRAM LENGTH
000321

STATEMENT FUNCTION REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES

STATEMENT NUMBER REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES
        000040    L00024    5         NONE
        000066    L00043    21        NONE
        000122    L00053    22        000064    000065
        000135    L00061    25        000132    000133
        000166    L00076    35        000141
        000171    L00077    40        000037
        000173    L00101    45        000167    000170
        000205    L00104    46        000257
        000207    L00105    47        000206
        000215    L00107    48        NONE
        000251    L00117    49        000214
        000260    L00122    50        000206
        000263    L00124    55        000172

EXTERNALS AND TAGS
SQRT  -  S00100    END.  -  S00200

BLOCK NAMES AND LENGTHS

VARIABLE REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES
        000303    V00005    DET       000052    000141    000171    000202    000263
        000306    V00010    DX        000020    000023    000074    000102    000223    000231
        000310    V00012    EPS       000007
        000311    V00013    E8        000010    000166
        000312    V00014    I         000011    000015    000045    000057    000071    000122
                                      000135    000217    000241
        000313    V00015    J         000014    000032    000070    000112    000143    000204
                                      000205    000210    000225    000252
        000315    V00017    K         000053    000061    000076    000123    000140    000144
                                      000164    000173    000207    000220    000251    000260
        000320    V00022    K1        000056    000064    000112    000213    000241
        000316    V00020    L         000054    000134    000137    000154    000156    000162
        000304    V00006    SUM       000012    000021    000031    000034    000066    000100
                                      000111    000115    000215    000227    000240    000244
        000317    V00021    X         000055    000131    000166    000177    000255
        000314    V00016    Y         000036    000040    000063    000114    000121    000126
                                      000147    000157    000213    000243    000250    000255

START OF CONSTANTS
```

```
RUN  VERSION FEB 70     19041 22/04/70

000266

START OF TEMPORARIES
000271

START OF INDIRECTS
000275

SPACE REQUIRED TO COMPILE
036200
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```
                      FUNCTION CDTM(CA,NR,N,V)                                  CDT     00002
                C     TO EVALUATE THE DETERMINANT OF A COMPLEX MATRIX           CDT     00003
000007                DIMENSION  CA(NR,1),V(1),CDET(2)                          CDT     00004
000007                DOUBLE PRECISION  SUM,DX,DY,SOM                           CDT     00005
000007                COMPLEX  CDTM                                             CDT     00006
000007                N2=N+N                                                    CDT     00007
000010                DO 5 I=1,N2,2                                             CDT     00008
000011                I1=I+1                                                    CDT     00009
000013                SUM=0.                                                    CDT     00010
000014                DO 105 J=1,N                                              CDT     00011
000016                DX=CA(I,J)                                                CDT     00012
000023                DY=CA(I1,J)                                               CDT     00013
000027            105 SUM=SUM+DX*DX+DY*DY                                       CDT     00014
000050                Y=SUM                                                     CDT     00015
000052                IF(Y) 97,97,3                                             CDT     00016
000053              3 J=I1/2                                                    CDT     00017
000055                V(J)=1./Y                                                 CDT     00018
000060              5 CONTINUE                                                  CDT     00019
000062                CDET(1)=1.                                                CDT     00020
000064                CDET(2)=0.                                                CDT     00021
000065                DO 95 K=1,N                                               CDT     00022
000066                KK=K-1                                                    CDT     00023
000070                K2=2*K                                                    CDT     00024
000071                K1=K2-1                                                   CDT     00025
000072                L1=K1                                                     CDT     00026
000073                Z=0.                                                      CDT     00027
000074                DO 25 I=K1,N2,2                                           CDT     00028
000075                I1=I+1                                                    CDT     00029
000077                X=CA(I,K)                                                 CDT     00030
000103                Y=CA(I1,K)                                                CDT     00031
000107                IF(KK) 15,15,10                                           CDT     00032
000110             10 SUM=0.                                                    CDT     00033
000112                SOM=0.                                                    CDT     00034
000113                DO 110 J=1,KK                                             CDT     00035
000115                J2=2*J                                                    CDT     00036
000116                J1=J2-1                                                   CDT     00037
000120                DX=CA(I,J)                                                CDT     00038
000125                DY=CA(I1,J)                                               CDT     00039
000131                SUM=SUM+DX*CA(J1,K)-DY*CA(J2,K)                           CDT     00040
000157            110 SOM=SOM+DX*CA(J2,K)+DY*CA(J1,K)                           CDT     00041
000205                X=X-SUM                                                   CDT     00042
000213                Y=Y-SOM                                                   CDT     00043
000220             15 CA(I,K)=X                                                 CDT     00044
000225                CA(I1,K)=Y                                                CDT     00045
000231                J=I1/2                                                    CDT     00046
000232                X=(X*X+Y*Y)*V(J)                                          CDT     00047
000236                IF(Z-X) 20,25,25                                          CDT     00048
000240             20 Z=X                                                       CDT     00049
000242                L1=I                                                      CDT     00050
000243             25 CONTINUE                                                 CDT     00051
000246                L2=L1+1                                                   CDT     00052
000250                LH=L2/2                                                   CDT     00053
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```
000251          IF(L1-K1) 30,45,30                                                  CDT     00054
000253       30 CDET(1)=-CDET(1)                                                    CDT     00055
000254          CDET(2)=-CDET(2)                                                    CDT     00056
000255          J=N                                                                 CDT     00057
000256       35 X=CA(K1,J)                                                          CDT     00058
000263          Y=CA(K2,J)                                                          CDT     00059
000267          CA(K1,J)=CA(L1,J)                                                   CDT     00060
000274          CA(K2,J)=CA(L2,J)                                                   CDT     00061
000300          CA(L1,J)=X                                                          CDT     00062
000302          CA(L2,J)=Y                                                          CDT     00063
000305          J=J-1                                                               CDT     00064
000306          IF(J) 40,40,35                                                      CDT     00065
000310       40 V(LH)=V(K)                                                          CDT     00066
000314       45 CONTINUE                                                            CDT     00067
000314          X=CA(K1,K)                                                          CDT     00068
000321          Y=CA(K2,K)                                                          CDT     00069
000325          Z=X*X+Y*Y                                                           CDT     00070
000327          W=X*CDET(1)-Y*CDET(2)                                               CDT     00071
000332          CDET(2)=X*CDET(2)+Y*CDET(1)                                         CDT     00072
000334          CDET(1)=W                                                           CDT     00073
000335          IF(CDET(1).EQ.0..AND.CDET(2).EQ.0.) GO TO 100                       CDT     00074
000342          J=K+1                                                               CDT     00075
000344       75 IF(J-N) 80,80,95                                                    CDT     00076
000346       80 CONTINUE                                                            CDT     00077
000346          U=CA(K1,J)                                                          CDT     00078
000353          W=CA(K2,J)                                                          CDT     00079
000357          IF(KK) 90,90,85                                                     CDT     00080
000360       85 SUM=0.                                                              CDT     00081
000362          SOM=0.                                                              CDT     00082
000363          DO 120 I=1,KK                                                       CDT     00083
000365          I2=2*I                                                              CDT     00084
000366          I1=I2-1                                                             CDT     00085
000370          DX=CA(K1,I)                                                         CDT     00086
000375          DY=CA(K2,I)                                                         CDT     00087
000401          SUM=SUM+DX*CA(I1,J)-DY*CA(I2,J)                                     CDT     00088
000427      120 SOM=SOM+DX*CA(I2,J)+DY*CA(I1,J)                                     CDT     00089
000455          U=U-SUM                                                             CDT     00090
000463          W=W-SOM                                                             CDT     00091
000470       90 CA(K1,J)=(U*X+W*Y)/Z                                                CDT     00092
000501          CA(K2,J)=(W*X-U*Y)/Z                                                CDT     00093
000511          J=J+1                                                               CDT     00094
000512          GO TO 75                                                            CDT     00095
000512       95 CONTINUE                                                            CDT     00096
000515          GO TO 100                                                           CDT     00097
000515       97 CDET(1)=0.                                                          CDT     00098
000516          CDET(2)=0.                                                          CDT     00099
000517      100 CDTM=CMPLX(CDET(1),CDET(2))                                         CDT     00100
000523          RETURN                                                              CDT     00101
000525          END                                                                 CDT     00102
```

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SUBPROGRAM LENGTH
000606

STATEMENT FUNCTION REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES

STATEMENT NUMBER REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES
        000053    L00026    5         NONE
        000110    L00052    10        NONE
        000220    L00070    15        000107
        000240    L00075    20        NONE
        000243    L00077    25        000236    000237
        000253    L00104    30        NONE
        000256    L00107    35        000307
        000310    L00117    40        000306
        000314    L00120    45        000252
        000344    L00133    75        000511
        000346    L00134    80        000345
        000360    L00137    85        NONE
        000470    L00155    90        000357
        000512    L00161    95        000345
        000515    L00164    97        000052
        000517    L00166    100       000341    000514

EXTERNALS AND TAGS
END.    - S00100

BLOCK NAMES AND LENGTHS

VARIABLE REFERENCES

        LOCATION  GEN TAG   SYM TAG   REFERENCES
        000550    A00001    CDET      000063    000253    000327    000515    000517
        000546    V00005    CDTM      000521    000522
        000556    V00013    DT        NONE
        000554    V00011    DX        000021    000030    000123    000140    000164    000373
                                      000410    000434
        000566    V00023    DY        000026    000036    000130    000147    000173    000400
                                      000417    000443
        000563    V00020    I         000010    000016    000057    000074    000120    000220
                                      000241    000243    000364    000452
        000564    V00021    I1        000012    000022    000053    000076    000102    000124
                                      000225    000367    000400    000431
        000605    V00042    I2        000365    000366    000405
        000565    V00022    J         000015    000045    000054    000114    000202    000231
                                      000233    000255    000257    000304    000343    000344
                                      000347    000402    000475    000505
        000600    V00035    J1        000117    000130    000161
```

000577	V00034	J2	000115	000116	000135			
000570	V00025	K	000065	000077	000132	000221	000311	000315
			000341	000512				
000571	V00026	KK	000067	000106	000203	000356	000453	
000573	V00030	K1	000071	000251	000256	000314	000346	000370
			000473					
000572	V00027	K2	000070	000262	000274	000320	000352	000374
			000503					
000602	V00037	LH	000250	000310				
000574	V00031	L1	000072	000242	000245	000272	000277	
000601	V00036	L2	000247	000275	000302			
000562	V00017	N2	000007	000060	000243			
000560	V00015	SOH	000112	000162	000201	000213	000362	000432
			000451	000463				
000552	V00007	SUM	000013	000026	000044	000047	000110	000136
			000155	000206	000360	000406	000425	000456
000604	V00041	U	000352	000455	000462	000470	000501	
000603	V00040	W	000331	000333	000356	000462	000467	000471
000576	V00033	X	000102	000205	000212	000224	000232	000240
			000262	000301	000320	000324	000470	000500
000567	V00024	Y	000051	000056	000106	000212	000217	000230
			000266	000303	000324	000472	000502	
000575	V00032	Z	000073	000235	000241	000326	000477	000507

START OF CONSTANTS
000526

START OF TEMPORARIES
000530

START OF INDIRECTS
000536

SPACE REQUIRED TO COMPILE
037100

```
                      SUBROUTINE ZARK(N,GUESS,MAX,EP1,EP2,FUN,I,ANSA,FANSA)                ZAR     00002
000014                COMPLEX FANX                                                         ZAR     00003
000014                COMPLEX GUESS(3,1),FUN,ANSA(1),FANSA(1),FA,FB,FC,SDDBT,SDDAT,DDDT,   ZAR     00004
                     1TEMP1,TEMP2,SDDT,SDDXT,X1,X2,X3,FX1,FX2,FX3,B1,B2,B3                 ZAR     00005
000014                A=0164140000000000000000                                             ZAR     00006
                C               IF GUESSES GIVEN GO TO 11                                  ZAR     00007
000015                IF(I.EQ.-1) GO TO 11                                                 ZAR     00008
000020                DO 100 IX=1,N                                                        ZAR     00009
000021                GUESS(1,IX)=CMPLX(1.+A,A)                                            ZAR     00010
000031                GUESS(2,IX)=(-.5,.866)                                               ZAR     00011
000035              100 GUESS(3,IX)=(-.5,-.4)                                              ZAR     00012
                C               SET UP GUESSES FOR FIRST THREE POINTS                      ZAR     00013
000044               11 X3=GUESS(3,1)                                                      ZAR     00014
000047                X1=GUESS(1,1)                                                        ZAR     00015
000052                X2=GUESS(2,1)                                                        ZAR     00016
                C               INITIALIZE ERROR CODE                                      ZAR     00017
000055                I=0                                                                  ZAR     00018
                C               BEGIN MAIN LOOP FOR N ZEROS                                ZAR     00019
000056                DO 7 NN=1,N                                                          ZAR     00020
                C               IF WORKING ON FIRST ZERO NO NEED TO GO TO FLUB             ZAR     00021
000060                IF(NN.EQ.1) GO TO 2                                                  ZAR     00022
                C               IF SOME ZEROS ALREADY FOUND GO TO FLUB TO DIVIDE THEM OUT  ZAR     00023
000062                K=NN-1                                                               ZAR     00024
000063                FX1=FA                                                               ZAR     00025
000065                FX2=FB                                                               ZAR     00026
000070                FX3=FC                                                               ZAR     00027
                C               INITIALIZE ERROR CODE                                      ZAR     00028
000072                LX=1                                                                 ZAR     00029
                C               INITIALIZE DENOMINATOR MULTIPLIERS                         ZAR     00030
000073                B1=(1.,0.)                                                           ZAR     00031
000076                B2=B1                                                                ZAR     00032
000100                B3=B1                                                                ZAR     00033
                C               BEGIN LOOP TO CALCULATE DENOMINATOR PRODUCT                ZAR     00034
000103                DO 15JJ=1,K                                                          ZAR     00035
000104                B1=B1*(X1-ANSA(JJ))                                                  ZAR     00036
000120                B2=B2*(X2-ANSA(JJ))                                                  ZAR     00037
000135                B3=B3*(X3-ANSA(JJ))                                                  ZAR     00038
000151               15 CONTINUE                                                           ZAR     00039
                C               CHECK DENOMINATOR FOR ZERO                                 ZAR     00040
000154                IF((CABS(B1).EQ.0).OR.(CABS(B2).EQ.0).OR.(CABS(B3).EQ.0)) GO TO 16   ZAR     00041
                C               COMPUTE MODIFIED FUNCTION VALUS                            ZAR     00042
000200                FA =FUN(X1)/B1                                                       ZAR     00043
000220                FB =FUN(X2)/B2                                                       ZAR     00044
000240                FC =FUN(X3)/B3                                                       ZAR     00045
000260                GO TO 17                                                             ZAR     00046
000261               16 LX=0                                                               ZAR     00047
000262               17 IF(LX.EQ.0) GO TO 8                                                ZAR     00048
000263                GO TO 3                                                              ZAR     00049
000264                2 FA=FUN(X1)                                                         ZAR     00050
000275                FB=FUN(X2)                                                           ZAR     00051
000306                FC=FUN(X3)                                                           ZAR     00052
                C               INITIALIZE QUANTITY FOR MULLER ITERATION                   ZAR     00053
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000317       3 SDDBT=(FB-FC)/(X2-X3)                                                ZAR     00054
         C              BEGIN MULLER LOOP                                          ZAR     00055
000340         DO 1 II=1,MAX                                                        ZAR     00056
000341         SDDAT=(FA-FB)/(X1-X2)                                                ZAR     00057
000362         DDDT=(SDDAT-SDDBT)/(X1-X3)                                           ZAR     00058
000402         TEMP1=SDDAT+(X1-X2)*DDDT                                             ZAR     00059
000417         TEMP2=CSQRT(TEMP1*TEMP1-4.*FA*DDDT)                                  ZAR     00060
000436         SDDXT=TEMP1-TEMP2                                                    ZAR     00061
000443         SDDT=TEMP1+TEMP2                                                     ZAR     00062
         C              CHECK FOR DENOMINATOR OF MAXIMUM MAGNITUDE                 ZAR     00063
000447         IF((CABS(SDDXT)).GT.(CABS(SDDT))) GO TO 4                            ZAR     00064
000465         TEMP1=SDDT                                                           ZAR     00065
000467         GO TO 5                                                              ZAR     00066
000470       4 TEMP1=SDDXT                                                          ZAR     00067
         C              CORRECT OLD VALUE                                          ZAR     00068
000473       5 ANSA(NN)=X1-(2.*FA)/TEMP1                                            ZAR     00069
         C              IF FIRST ZERO DONT NEED FLUB                               ZAR     00070
000514         FANSA(NN)=FUN(ANSA(NN))                                              ZAR     00071
000534         IF(NN.NE.1)GO TO 14                                                  ZAR     00072
000536         FANX=FANSA(NN)                                                       ZAR     00073
000542         GO TO 10                                                             ZAR     00074
000542      14 K=NN-1                                                               ZAR     00075
000544         FX1=FANX                                                             ZAR     00076
000547         FX2=FB                                                               ZAR     00077
000551         FX3=FC                                                               ZAR     00078
000554         LX=1                                                                 ZAR     00079
         C              INITIALIZE DENOMINATOR MULTIPLIERS                         ZAR     00080
000555         B1=(1.,0.)                                                           ZAR     00081
000557         B2=B1                                                                ZAR     00082
000562         B3=B1                                                                ZAR     00083
         C              BEGIN LOOP TO CALCULATE DENOMINATOR PRODUCT                ZAR     00084
000564         DO 18JJ=1,K                                                          ZAR     00085
000566         B1=B1*(ANSA(NN)-ANSA(JJ))                                            ZAR     00086
000603      18 CONTINUE                                                             ZAR     00087
         C              CHECK DENOMINATOR FOR ZERO                                 ZAR     00088
000606         IF((CABS(B1).EQ.0).OR.(CABS(B2).EQ.0).OR.(CABS(B3).EQ.0)) GO TO 19   ZAR     00089
         C              COMPUTE MODIFIED FUNCTION VALUS                            ZAR     00090
000632         FANX=FUN(ANSA(NN))/B1                                                ZAR     00091
000655         GO TO 20                                                             ZAR     00092
000656      19 LX=0                                                                 ZAR     00093
000657      20 IF(LX.EQ.0) GO TO 8                                                  ZAR     00094
         C              MAKE CONVERGENCE CHECK                                     ZAR     00095
000660      10 IF((CABS(ANSA(NN)-X1).LE.(EP1*(CABS(ANSA(NN))          ))).OR.      ZAR     00096
           1(CABS(FANSA(NN)).LE.EP2)) GO TO 6                                     ZAR     00097
         C              IF LAST ITERATION SKIP PREPARATION FOR NEXT ONE            ZAR     00098
000727         IF(II.EQ.MAX)GO TO 1                                                 ZAR     00099
         C              PUSH DOWN POINT LIST                                       ZAR     00100
000731         X3=X2                                                              ZAR     00101
000733         X2=X1                                                              ZAR     00102
000736         X1=ANSA(NN)                                                        ZAR     00103
000742         SDDBT=SDDAT                                                        ZAR     00104
         C              PUSH DOWN FUNCTION VALU LIST                               ZAR     00105
000745         FC=FB                                                              ZAR     00106
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000747         FB=FA                                                          ZAR     00107
000752         FA=FANX                                                        ZAR     00108
       C               END MULLER LOOP                                        ZAR     00109
000754       1 CONTINUE                                                       ZAR     00110
       C               IF MAX ITERATIONS ATTAINED SET N EQUAL TO NUMBER OF FOUND ZAR   00111
000757         N=NN-1                                                         ZAR     00112
       C               SET ERROR CODE TO INDICATE MAX ITERATIONS EXCEEDED     ZAR     00113
000760         I=1                                                            ZAR     00114
000762         RETURN                                                         ZAR     00115
       C               IF ALL ZEROS FOUND, QUIT                               ZAR     00116
000762       6 IF(NN.EQ.N) GO TO 7                                            ZAR     00117
       C               IF MORE ZEROS LEFT TO FIND, SET UP NEW STARTING GUESSES ZAR     00118
000764         X1=GUESS(1,NN+1)                                               ZAR     00119
000767         X2=GUESS(2,NN+1)                                               ZAR     00120
000773         X3=GUESS(3,NN+1)                                               ZAR     00121
       C               END LOOP FOR NN ZEROS                                  ZAR     00122
000777       7 CONTINUE                                                       ZAR     00123
001002         RETURN                                                         ZAR     00124
       C               SET FLUB ERROR CODE                                    ZAR     00125
001002       8 I=2                                                            ZAR     00126
001004         N=NN-1                                                         ZAR     00127
001005         RETURN                                                         ZAR     00128
001006         END                                                            ZAR     00129
```

SUBPROGRAM LENGTH
001140

STATEMENT FUNCTION REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES

STATEMENT NUMBER REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES	
000754	L00231	1	000730	
000264	L00106	2	000061	
000317	L00117	3	000263	
000470	L00141	4	000463	
000473	L00142	5	000467	
000762	L00236	6	000726	
000777	L00243	7	000763	
001002	L00246	8	000262	000657
000660	L00210	10	000541	
000044	L00026	11	000017	
000542	L00152	14	000535	
000261	L00102	16	000177	
000262	L00103	17	000260	
000656	L00205	19	000631	
000657	L00206	20	000655	

EXTERNALS AND TAGS
CABS - S00100 CSQRT - S00200 END. - S00300

BLOCK NAMES AND LENGTHS

VARIABLE REFERENCES

LOCATION	GEN TAG	SYM TAG	REFERENCES					
001131	V00062	A	000014	000021				
000001	L00012	ANSA	000104	000120	000500	000566	000631	000675
			000735					
001123	V00054	B1	000074	000075	000112	000117	000165	000212
			000556	000557	000575	000602	000617	000647
001125	V00056	B2	000077	000126	000133	000160	000232	000560
			000612					
001127	V00060	B3	000101	000143	000150	000153	000252	000563
			000605					
001075	V00026	DDDT	000401	000411	000426			
001063	V00014	FA	000062	000217	000273	000345	000423	000474
			000747	000753				
000002	L00013	FANSA	000527	000660				
001061	V00012	FANX	000540	000544	000654	000751		
001065	V00016	FB	000065	000237	000304	000323	000347	000546
			000744	000750				
001067	V00020	FC	000067	000257	000315	000325	000551	000746

001115	V00046	FX1	000064	000545					
001117	V00050	FX2	000066	000550					
001121	V00052	FX3	000071	000552					
000000	L00011	I	000015	000055	000760	001002			
001137	V00070	II	000340	000727	000754				
001132	V00063	IX	000020	000031					
001136	V00067	JJ	000103	000121	000565	000603			
001134	V00065	K	000062	000151	000543	000603			
001135	V00066	LX	000072	000261	000262	000554	000656	000657	
001133	V00064	NN	000057	000501	000530	000542	000567	000632	
			000661	000676	000736	000756	000762	000777	
			001003						
001073	V00024	SCDAT	000360	000366	000406	000742			
001071	V00022	SCDBT	000336	000367	000743				
001103	V00034	SCDT	000446	000452	000464				
001105	V00036	SCDXT	000441	000454	000470				
001077	V00030	TEMP1	000415	000416	000436	000442	000466	000471	
			000505						
001101	V00032	TEMP2	000435	000437	000444				
001107	V00040	X1	000050	000105	000177	000264	000341	000361	
			000402	000502	000711	000733	000741	000766	
001111	V00042	X2	000053	000122	000220	000274	000317	000342	
			000403	000730	000734	000772			
001113	V00044	X3	000046	000136	000240	000305	000320	000363	
			000732	000776					

START OF CONSTANTS
001007

START OF TEMPORARIES
001023

START OF INDIRECTS
001055

SPACE REQUIRED TO COMPILE
040200

5.3 Core Maps

```
CORE MAP  19.28.47.  OVERLAY    00.00    CONTROL                                                    000100    035111    000000    000000
          ---TIME---LOAD MODE --L1--L2-----TYPE---------------USER-----0----CALL-------------FWA LOAD--LWA LOAD--BLNK COMN--LENGTH--
          FWA LOADER  034473  FWA TABLES  032620
          -PROGRAM----ADDRESS-                    --LABELED---COMMON--
          $0285       002115                                  A         000101
                                                              AR        000201
                                                              BLK1      000210
                                                              CON       000222
                                                              ICK       000262
                                                              RC        000743
                                                              TRS       000765
                                                              STF       001410
          MACON       016666                                  STF       001410
                                                              TRS       000765
          DB          017574                                  A         000101
                                                              AR        000201
                                                              BLK1      000210
                                                              CON       000222
                                                              ICK       000262
          DT          022413                                  CON       000222
                                                              RC        000743
          RGEN        022466                                  A         000101
                                                              AR        000201
                                                              CON       000222
                                                              RC        000743
          DBGEN       023277                                  A         000101
                                                              AR        000201
                                                              CON       000222
                                                              RC        000743
          DET         024612
          CDTM        025133
          ZARK        025741
          SYSTEM      027101                                  USERARG   027101
                                                              SCOPE2    027101
          DATE        030234
          INPUTC      030420
          IFENCF      031524
          OUTPTC      031956
          DBLE        033116
          SNGL        033122
          SINCOS      033125
          SECOND      033224
          CSQRT       033242
          TANH        033277
          SQRT        033344
          CABS        033407
          SIOS        033445
          CPC         034551
          GETBA       035015
          EXP         035032
          --ENTRY-----ADDRESS-                                                REFERENCES
          $0285       002116
          MACON       016667          $0285       0 2765
          DB          017575          $0285       0 4351    004430
          DT          022416          DB          0 0062
          RGEN        022467          DT          0 2424
                                      DBGEN       023314
          DBGEN       023500          DB          0 0707    021042
          DET         024613          $0285       0 4230
```

```
                                    CB          021172  021203

CBTN        029134                  BT          022434

ZARK .      029745                  CB          020063  020070

&ENTRY      027102
SYSTEM      027372                  INPUTC      030457  031335
                                    IFENDF      031548
                                    OUTPTC      031572  032727
                                    BINCOB      033170  033173
                                    CSQRT       033266
                                    TANH        033326
                                    SQRT        033371
                                    CABS        033432
                                    EXP         033065

SYSTEMC     027536
SYSTEMP     027565
END         027262
STOP        027311
EXIT        027305                  SO285       003760

ABNORML     027321                  INPUTC      030460  031336
                                    IFENDF      031547
                                    OUTPTC      031573  032730

&ENTRY.     027102                  SO285       002117

END.        027262                  SO285       003761
                                    MACON       004324
                                    CB          001333
                                    BT          002449
                                    CBGEN       004474
                                    GET         005077
                                    ZARK        006747

STOP.       027311
CLOCK       030314
DATE        030255                  SO285       002147

&DATE       030260
DATER       030276
INPUTC      030422
&BAKER      030524
INPUTC.     030422                  SO285       002154  002160  002163  002223  002227  002232  002237
                                                002265  002268  002326  002332  002340  002343  002424
                                                002430  002436  002441  002506  002510  002512  002514
                                                002516  002520  002522  002525  002554  002556  002560
                                                002562  002564  002566  002570  002572  002574  002576
                                                002600  002601  002700  002702  002704  002705

IFENDF      031525
IFENDF.     031525                  SO285       002169

OUTPTC      031560
&OCER       031717
OUTPTC.     031560                  SO285       002171  002172  002175  002176  002201  002203  002205
                                                002206  002211  002215  002220  002245  002251  002254
                                                002271  002272  002304  002305  002307  002314  002320
                                                002325  002362  002363  002366  002367  002372  002374
                                                002376  002400  002401  002404  002405  002410  002411
                                                002414  002416  002420  002421  002444  002445  002450
                                                002451  002454  002456  002460  002462  002463  002466
```

			002487	002478	002473	002476	002500	002502	002503
			002526	002530	002532	002534	002536	002540	002542
			002543	002623	002625	002627	002630	002633	002634
			002662	002664	002666	002667	002672	002675	002727
			002731	002733	002735	002737	002741	002743	002745
			002747	002750	002755	002757	002761	002762	003000
			003002	003004	003006	003010	003012	003014	003019
			003032	003034	003036	003037	003042	003043	003046
			003050	003052	003054	003056	003060	003061	003164
			003163	003170	003173	003175	003177	003201	003203
			003205	003211	003214	003215	003221	003223	003233
			003240	003346	003350	003351	003526	003534	003541
			003544	003552	003557	003562	003570	003575	003664
			003666	003667	003750	003751	003764	003765	004001
			004002	004013	004016	004030	004032	004034	004035
			004053	004055	004056	004063	004065	004066	004100
			004102	004103	004212	004220	004225	004546	004547
			004552	004553	004530	004531	004553	004557	004561
			004563	004565	004571	004576	004602	004604	004606
			004610	004612	004616	004621	004623	004625	004626
			004670	004674	004676	004700	004702	004706	004715
			004717	004721	004723	004725	004727	004733	004736
			004737	004765	004767	004770	005140	005144	005146
			005150	005152	005156	005163	005167	005171	005173
			005175	005177	005203	005210	005212	005214	005215
			005222	005224	005225	005237	005241	005242	005245
			005247	005250	005270	005271	005275	005276	005302
			005303	005350	005352	005354	005355	005360	005364
			005367	005372	005374	005375	005407	005411	005412
			005415	005422	005424	005430	005435	005436	005441
			005443	005445	005447	005450	005454	005455	005460
			005465	005467	005473	005515	005520	005523	005526
			005532	005553	005555	005557	005560	005565	005567
			005572	005575	005577	005600	005603	005604	005607
			005611	005613	005615	005616	005650	005652	005654
			005655	005660	005664	005667	005672	005674	005675
			005700	005701	005704	005711	005713	005717	005722
			005725	005730	005732	005734	005735	005747	005751
			005753	005754					
		OB	017646	017650	017652	017654	017656	017657	017672
			017674	017676	017700	017702	017703	020102	020107
			020112	020116	020127	020131	020132	020137	020140
			020145	020146	020270	020271	020510	020515	020521
			021111	021112	021117	021125	021131	021141	021142
			021147	021153	021161	021220	021222	021223	021237
			021241	021242	021255	021257	021260		

DBLE	033117	SO28S	003134				
SNGL	033123	SO28S	003543				
SIN	033126	MACON	017132				
		OBGEN	023436	023450			
COS	033131	MACON	017124				
		OBGEN	023431	023443	023464		
SECOND	033225	OB	020057	020072	021167	021210	
SQRT	033243	OB	020644				
		OT	022420				
		ZARR	026375				
TANH	033300	OBGEN	023433	023440			

```
SQRT        033549          DET         024693
                            CSQRT       033256

CABS        033418          ZARK        026113  026122  026127  026414  026416  026947  026954
                                        026581  026625  026842  026856
                            CSQRT       033231

BRSPRU.     034015
PIZBAK.     034025
POSFIL.     034067          OUTPTC      031610

RDPRU.      034162
BAT.        034317          INPUTC      030476  030444  030467
                            OUTPTC      031634  031630  031615

CIOS.       033772
OPEN.       033447          SYSTEM      027673
                            INPUTC      030442
                            OUTPTC      031600

BIO.        033646          INPUTC      030472
                            OUTPTC      031647

AGVIN.      034077          SYSTEM      027575

WWDS.       033677
POSFI.      034110
PIZBA.      034125
TYPEIT      034203
CPC         034617          DATE        030241  030263  030301  030321  030324

CPCD2       034676
CPCD3       034551
CPCD4       034570
CPC999      035003
GETBA       035013          INPUTC      030430
                            IFENDF      031930
                            OUTPTC      031566

EXP         035035          TANH        033307

----UNSATISFIED EXTERNALS-----                      REFERENCES
```