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Volume III

Engineer's Program Manual for "STARS-II" — Shell Theory Automated for Rotational Structures-II, Digital Computer Program

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16. ABSTRACT

This manual contains engineering programming information for the STARS II - Shell Theory Automated for Rotational Structures II - digital computer program. The report is written for the engineer who will need to make small alterations to the program, such as incorporating a new geometry, or altering a table size, to fit his specific needs. The sections of the manual each cover one major subroutine. These sections are further subdivided in the following manner where applicable:

A. Subroutine description

B. A list of pertinent engineering symbols and their FORTRAN coded counterparts

C. Subroutine flow chart

D. Subroutine FORTRAN listing.

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INTRODUCTION

This manual presents a general description of the STARS II digital computer program. With the exception of HASTEN, a small assembly language routine, FORTRAN IV is the only language used in writing the various subroutines. The execution of this program requires the use of fourteen temporary storage units.

The program was initially written and debugged on the IBM 360-75 computer and then scaled down to fit the IBM 7094 computer, where it utilizes approximately 28,000 words of core. Since a large number of temporary storage units is needed, care must be used in keeping track of them, and in the manual's flow charts, all tape operations are distinguished by using a rectangular box with a curved bottom, for representation. Only basic IBM FORTRAN Library routines are required by the program, these being: sine, cosine, absolute value, and square root.

For ease and speed in usage, the Table of Contents on the following page has also been laid out to present the call sequence of the program.

CONTENTS

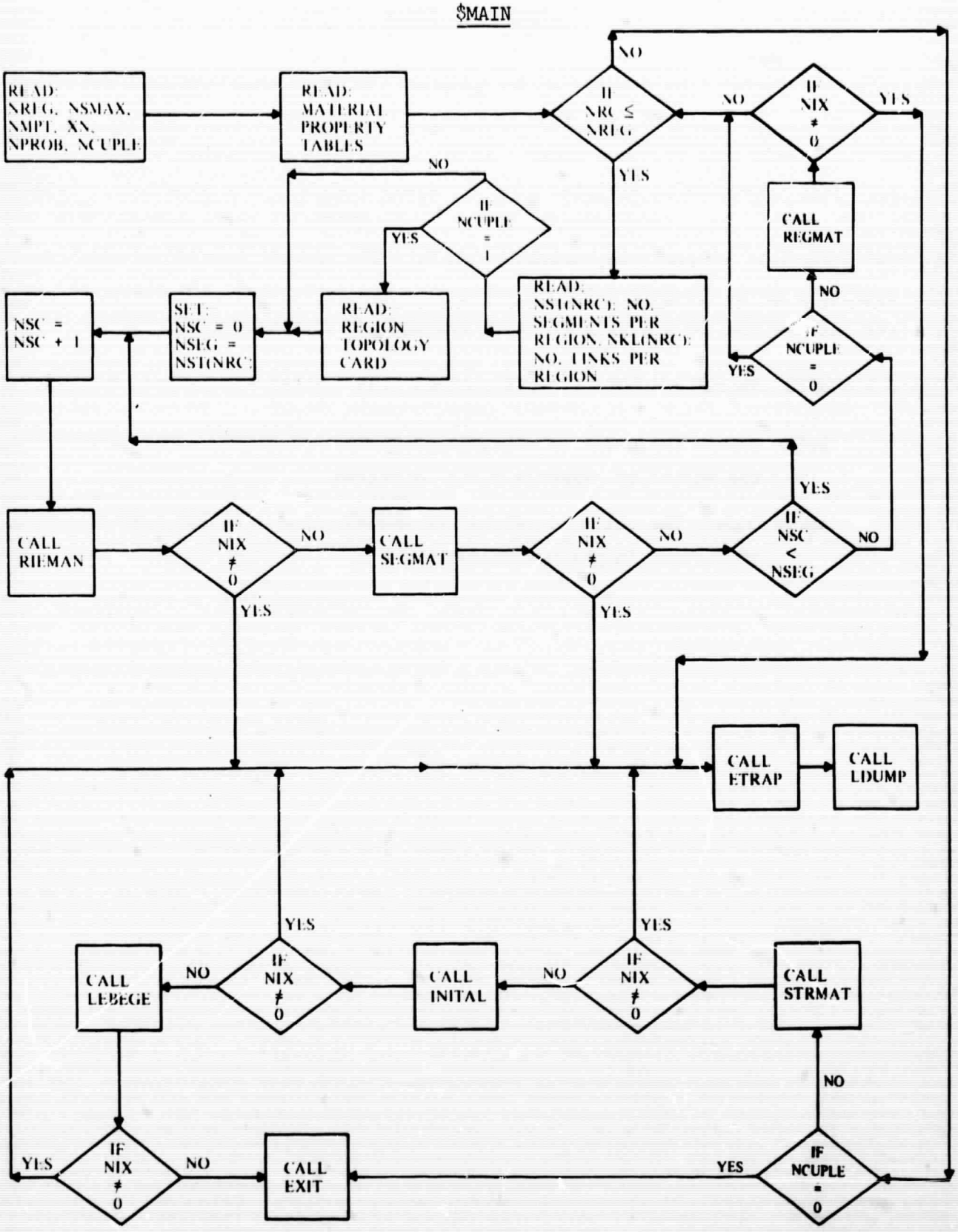
SUBROUTINE $MAIN

$MAIN is the control link for the entire program. Sizing values are read into the program and so are the material property tables. Calls are made to subroutines RIEMAN and SEGMAT once for each segment in a region; then subroutine REGMAT is called. This procedure is executed once for every region in the structure. Finally, calls are made to subroutines STRMAT, INITAL, and LEBEGE. A logic control, NIX, is used after most subroutines called by $MAIN. This control determines whether the operation of the program within a subroutine was successful, and either allows further calculation, or presents an error message, as appropriate.

There are also several counters in this control link. These are defined as follows:

NSC - Counts the calls to subroutines RIEMAN and SEGMAT, from 1 to the number of segments within a region.

NRC - Counts the calls to subroutine REGMAT, from 1 to the number of regions in the structure.


$MAIN
READ: NREG, NSMAX, NMPT, XN, NPROB, NCUPLE
READ: MATERIAL PROPERTY TABLES
IF NRC ≤ NREG
NO
YES
IF NIX ≠ 0
NO
YES
CALL REGMAT
NO
IF NCUPLE = 0
YES
IF NCUPLE = 1
NO
YES
READ: REGION TOPOLOGY CARD
READ: NST(NRC), NO. SEGMENTS PER REGION, NKL(NRC), NO. LINKS PER REGION
SET: NSC = 0 NSEG = NST(NRC)
NSC = NSC + 1
IF NSC < NSEG
YES
NO
CALL RIEMAN
IF NIX ≠ 0
NO
YES
CALL SEGMAT
IF NIX ≠ 0
NO
YES
CALL ETRAP
CALL LDUMP
IF NIX ≠ 0
YES
NO
CALL LEBEGE
IF NIX ≠ 0
YES
NO
CALL INITAL
IF NIX ≠ 0
YES
NO
CALL STRMAT
IF NCUPLE = 0
NO
YES
IF NIX ≠ 0
YES
NO
CALL EXIT

```
      COMMON STORY(16),TALE(16)                                          200010
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                 200030
      COMMON SADUS(60),RADUS(60)                                         200040
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP       200050
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOJT        200060
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                200070
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,    Q    ,NSMAX              200080
      COMMON/NAM1/STRGO(6),THERM(4),MATER(3),SEGTAB(3),FACE(4),EQUATE(3) 200090
     1       ,STRESS(4)
      COMMON /LYCORR/ YCORR(144)                                         200100
      INTEGER SAVJTC,SAVSTP                                              200110
      INTEGER THICK,TYPE                                                 200120
      INTEGER SEGTAB                                                     200130
      INTEGER Q                                                          200140

    1 WRITE(6,1726)                                                      200160    3
 1726 FORMAT(1H1)                                                        200170
      REWIND 1                                                           200180    4
      REWIND 2                                                           200190    5
      REWIND 3                                                           200200    6
      REWIND 4                                                           200210    7
      REWIND 8                                                           200220    8
      REWIND 9                                                           200230    9
      REWIND 10                                                          200240   10
      REWIND 11                                                          200250   11
      REWIND 12                                                          200260   12
      NIX = 0                                                            200270
      Q=5                                                                200280
      NHARM = 1                                                          200290
      READ (5,1001) (STORY(I),I=1,16)                                           15
 1001 FORMAT  (16A4)                                                     200310
      READ(5,1002) NREG,NSMAX,NMPT,XN,NPROB,NCUPLE                       200320   22
 1002 FORMAT(I2,I3,I2,F9.6,I2,I1)                                        200330
      WRITE(6,602) NSMAX,NREG,NMPT,NPROB,XN                              200340   28
  602 FORMAT(////19X,93HUNSYMMETRIC, ORTHOTROPIC, REINFORCED SHELL ANALY 200350
     1SIS WITH COUPLING OF AT MOST 19 SHELL REGIONS,//64X,5HUSING//52X,
     229HLOVE-RELISSNER ACCURACY THEORY////57X,17HDECK NUMBER 45218//57X, 200370
     317HAS OF MAY 5, 1968////8X,21HNUMBER OF SEGMENTS = ,I3,21H NUMBER  200380
     40F REGIONS = ,I2,43H NUMBER OF MATERIAL PROPERTY TABLES USED = ,I2  200390
     5,22H NUMBER OF PROBLEMS = ,I2//52X,15HHARMONIC (N) = ,E14.7/////)  200400
      IF(NCUPLE.EQ.0) WRITE(6,603)                                       200410   29
  603 FORMAT(28X,76HTHE GIVEN INPUT DATA INDICATES THAT THE SHELL SEGMEN 200420
     1TS ARE NOT TO BE COUPLED//)                                        200430
      IF(NCUPLE.EQ.1) WRITE(6,604)                                       200440   31
  604 FORMAT(30X,72HTHE GIVEN INPUT DATA INDICATES THAT THE SHELL SEGMEN 200450
     1TS ARE TO BE COUPLED//)                                            200460
      WRITE(6,605)  (STORY(I),I=1,16)                                    200470   32
  605 FORMAT(////////////////////8X,16A4)                                 200480
      NROW=0                                                             200490
      KK=-1                                                              200500
      NSAVE=0                                                            200510
      DO 13 I=1,NMPT                                                     200520
      KK=KK+2                                                            200530
      NXMAT(KK)=NROW+1                                                   200540
```

```
      II=NROW+1                                                      200550
      READ(5,1004) STD(I),TYPE                                       200560    47
 1004 FORMAT (A4,6X,A4,6X)                                           200570
      NROW = 11
      DO 11 L=1,3                                                    200590
   11 IF(TYPE.EQ.MATER(L)) GOTO 12                                   200600
   12 CONTINUE                                                       200610
      IF(L.EQ.1) NROW=4                                              200620
      IF(L.EQ.2) NROW=7                                              200630
      N=0                                                            200640
      IF(NROW.EQ.4) N=1                                              200650
      IF(NROW.EQ.11) N=1
      IF(NROW.EQ.7) N=1                                              200670
      IF(N.NE.1) GOTO 8000                                           200680
       LLL=NSAVE+NROW                                                200690
      READ (5,1005) ((XMAT(M,J),J=1,10),M=II,LLL )                   200700    73
 1005 FORMAT (8E14.7)                                                200710
      NROW=NSAVE+NROW                                                200720
      NXMAT(KK+1)=LLL                                                200730
   13 NSAVE=NROW                                                     200740
      DO 99 NRC = 1,NREG                                             200750
      WRITE(6,1726)                                                  200760    89
      READ (5,1003) NST(NRC),NKL(NRC),(STORY(I),I=1,16)              200770    90
 1003 FORMAT(212,16A4)                                               200780
      WRITE(6,606)NRC,NST(NRC),NKL(NRC)                              200790    97
  606 FORMAT(////////////////////////////58X,13HREGION NUMBER,I3//35X,10HTH
     1ERE ARE ,I2,14H SEGMENTS AND ,I2,35H KINEMATIC LINKS WITHIN THIS R  200810
     2EGION)                                                         200820
      IF(NCUPLE.EQ.1) READ(5,1006) IR,JRTIC(NRC),JRSTOP(NRC),STORY   200830   100
 1006 FORMAT (3I5,16A4)                                              200840
      NSEG = NST(NRC)                                                200850
  201 NSC=0                                                          200860
      IF(Q.EQ.1)    WRITE(6,602) NSMAX,NREG,NMPT,NPROB,XN            200870   109
  101 NSC=NSC+1                                                      200880
      WRITE(6,1726)                                                  200890   112
      CALL RIEMAN                                                    200900   113
      IF (NIX.NE.0) GOTO 8888                                        200910
      CALL SEGMAT                                                    200920   118
      IF (NIX.NE.0) GOTO 8888                                        200930
      IF(NSC.LT.NSEG) GO TO 101                                      200940
      NSC= 0                                                         200950
      IF(NCUPLE.EQ.0) GO TO 996                                      200960
  102 CALL REGMAT                                                    200970   131
      IF(NIX.LT.0) GO TO 8888
       REWIND 2                                                      200990   135
       REWIND 3                                                      201000   136
   99 CONTINUE                                                       201010
      IF(NCUPLE.EQ.1) GO TO 103                                      201020
  996 READ (5,67)  XN                                                       143
   67 FORMAT(7X,F9.6,3X)                                             201040
      Q=1                                                            201050
      WRITE(6,1726)                                                  201060   144
      GO TO 201                                                      201070
  103 CALL STRMAT                                                    201080   147
      IF (NIX.NE.0) GOTO 8888                                        201090
      CALL INITAL                                                    201100   152
```

STARS2 - EFN SOURCE STATEMENT - IFN(S) -

```
      IF (NIX.NE.0) GOTO 8888                                    201110
      CALL LEBEGE                                                201120    157
      GO TO 1                                                    201130
  555 CALL EXIT                                                  201140    160
 8000 IERROR=8000                                                201150
      NERROR= 1                                                  201160
 8888 CALL PDUMP                                                          164
      CALL ETRAP                                                 201170    166
      STOP                                                       201190
       END
```

07/01/68

```
      BLK        - EFN   SOURCE STATEMENT  -  IFN(S)  -
      BLOCK DATA                                                          100010
      COMMON/NAM1/STRGO(6),THERM(4),MATER(3),SEGTAB(3),FACE(4),EQUATE(3)  100020
     1        ,STRESS(4)                                                 00100021
      DATA STRGO /11.0,13.0,21.0,31.0,12.0,14.0/                         100030
      DATA THERM /4HTHST,4HNOTH,4HTHCN,4HTHIN/                           100040
      DATA MATER /4HISOT,4HORTH,4HSTIF/                                  100050
      DATA SEGTAB /4HST10,4HTHIC,4HRWAF/                                 100060
      DATA FACE /4HSING,4HEQUA,4HUNEQ,4HBLAN/                            100070
      DATA EQUATE/4HLINE,4HOMTH,4HNPHI/                                  100080
      DATA STRESS/4HRING,4HSTRI,4HSHEL,4HWAFF/                           00100081
       END
```

SUBROUTINE RIEMAN

This subroutine link assembles the data tables for use in the integration procedure. The program has the capability of handling at most 10 problems, each with 5 non-temperature load conditions. If, however, temperature loads are included, the capacity of the program is restricted to 1 problem.

RIEMAN is capable of distinguishing among 6 geometries: ellipse, ogive, modified ellipse, parabola, cone, and cylinder. Three general sets of equations for each possible geometry are available; they are the THIC equations, the ST10 equations, and the RWAF equations. The THIC case also has the options for the analysis of homogeneous single sheet, as well as equal or unequal rigid-core sandwich, constructions.

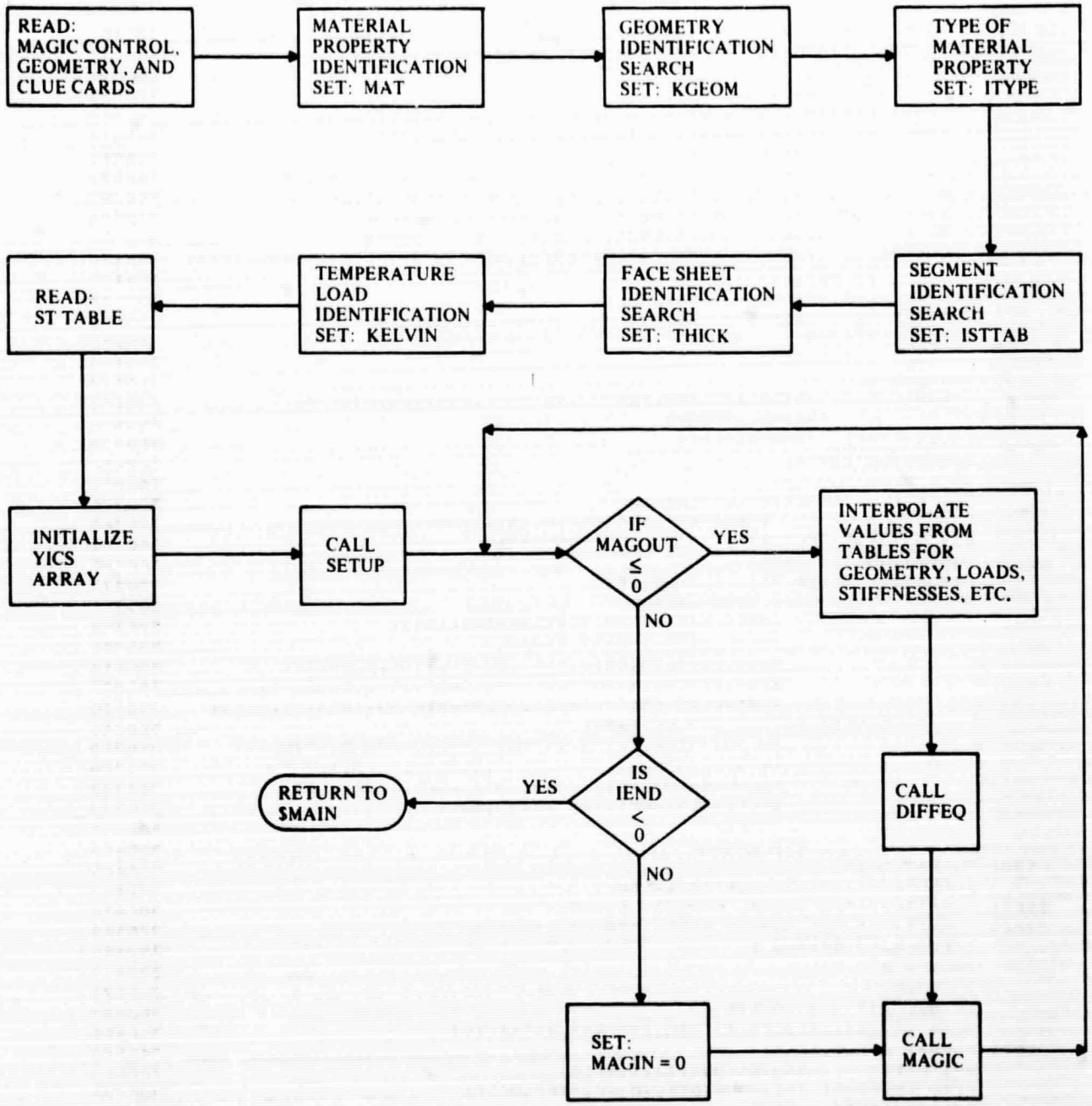
The subprogram link, RIEMAN, utilizes the subroutine SETUP to integrate the differential equations of each segment independently, under arbitrary load conditions. The results of the integrations of each segment are stored in the YCORR array in RIEMAN, and represent the stiffness and deflection coefficients of each segment.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 3)
XFTHLD	f_{θ}
XFPHLD	f_{ϕ}
XFZELD	f_{ζ}
XMTHLD	m_{θ}
XMPHLD	m_{ϕ}
ETHET	E_{θ}
EPHI	E_{ϕ}
XGPT	$G_{\phi\theta}$
XNUTP	$\nu_{\theta\phi}$
XNUPT	$\nu_{\phi\theta}$
ALPHTH	α_{θ}
ALPHPH	α_{ϕ}
XNTTH	$N_{T\theta}$
XNTPH	$N_{T\phi}$
XMTTH	$M_{T\theta}$
XMTPH	$M_{T\phi}$
XK11	K_{11}
XK22	K_{22}
XD11	D_{11}
XD22	D_{22}
XK33	K_{33}
XD33	D_{33}
R2	r_2
BETA	β

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 3)
RO	r_0
R1	r_1
R1DOT	$r_{1,\phi}$
CS	$\cos \phi$
SN	$\sin \phi$
A	a
C	c
XN	n
F2	f_2
F3	f_3
TAN; TN	$\tan \phi$
SEC	$\sec \phi$
TII	T_{ii}
TIK	T_{ic}
TOK	T_{oc}
TOO	T_{oo}
TEFREE	$\overline{T}$
HI	h_i
HO	h_o
T	t
TI	t_i
TO	t_o
SNSQ	$\sin^2\phi$
CSSQ	$\cos^2\phi$
CN	$\cos \phi \sin \phi$
X1CS	$1/\cos \phi$
X1SN	$1/\sin \phi$

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 3)
X1ROSN	$1/r_0 \sin \phi$
X1ROCS	$1/r_0 \cos \phi$
CSX1RO	$\cos \phi/r_0$
CSX1R1	$\cos \phi/r_1$
CSX1R2	$\cos \phi/r_2$
SNX1RO	$\sin \phi/r_0$
SNX1R1	$\sin \phi/r_1$
X1R1	$1/r_1$
X1R2	$1/r_2$
X1R1SQ	$1/r_1^2$
X1ROSQ	$1/r_0^2$

RIEMAN


READ:
MAGIC CONTROL,
GEOMETRY, AND
CLUE CARDS
MATERIAL
PROPERTY
IDENTIFICATION
SET: MAT
GEOMETRY
IDENTIFICATION
SEARCH
SET: KGEOM
TYPE OF
MATERIAL
PROPERTY
SET: ITYPE
SEGMENT
IDENTIFICATION
SEARCH
SET: ISTTAB
FACE SHEET
IDENTIFICATION
SEARCH
SET: THICK
TEMPERATURE
LOAD
IDENTIFICATION
SET: KELVIN
READ:
ST TABLE
INITIALIZE
YICS
ARRAY
CALL
SETUP
IF
MAGOUT
≤
0
YES
NO
INTERPOLATE
VALUES FROM
TABLES FOR
GEOMETRY, LOADS,
STIFFNESSES, ETC.
CALL
DIFFEQ
IS
IEND
<
0
YES
RETURN TO
$MAIN
NO
SET:
MAGIN = 0
CALL
MAGIC

```
C ***** ROUTINE **RIEM    ** ABACUS UPDATED 08/09/69 *****                    300000
C ***** ROUTINE **RIEMAN  ** ABACUS UPDATED 12/03/68 *****                    300010
      SUBROUTINE RIEMAN                                                       300020
      COMMON STORY(16),TALE(16)                                               300030
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)       300040
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                      300050
      COMMON SADUS(60),RADUS(60)                                              300060
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP            300070
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERSOR,RESTOP,RTICK,IOUT             300080
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                     300090
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,   0   ,NSMAX                     300100
      COMMON/NAM1/STRGO(6),THERM(4),MATER(3),SEGTAB(3),FACE(4),EQUATE(3)      300110
     1          ,STRESS(4)                                                   300120
      COMMON /LYCORR/ YCORR(144)                                              300130
      INTEGER SAVJTC,SAVSTP                                                   300140
      INTEGER SEGTAB                                                          300150
      INTEGER THICK,TYPE                                                      300160
      INTEGER Q                                                               300170
      EQUIVALENCE (XMTTH,XMTETH),(XMTPH,XMTEPH),(XNTTH,XNTETH),               300180
     1            (XNTPH,XNTEPH)                                            300190
      EQUIVALENCE  (XNPHI,XAPI)                                               300200
      DIMENSION VAR(4)                                                        300210
      DIMENSION KLUE(4)                                                       300220
      DIMENSION IPROB(10),LST(61)                                             300230
      DIMENSION         YDEV(144),YICS(144),YNEW(144)                         300240
      DIMENSION TBDEL(144),           FWDEL(144)                            300250
      DIMENSION ILAYR(10)                                                     300260
      DIMENSION ST(70,31), XLAYER(10)                                         300270
      DCUBLE  PRECISION  YNEW,YPRED                                           300280
      COMMON /EQUAZN/ YPRED(144),YDOT(144),YASAVE(144),                       300290
     1                YANTH,YAMTH,YAMPT,YAJPH,                               300300
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,             300310
     3                X1RQ,X1RQSQ,X1SNRQ,X1CSRQ,CN1RQ,SN1RQ,CS1RQ,           300320
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RQ,BESQ,       300330
     5    RQSQ,XNSQ,BETA,R1,R2,S1,R1DOT,                                     300340
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,          300350
     7                XMTHLD,XMPHLD,ETHET,EPHI,XGPT,ALPHTH,ALPHPH,           300360
     8                XNUTP,XNUPT,XC11,XC22,XD33,XD22,XD21,XD12,             300370
     9                XK11,XK12,XK21,XK22,XK33,XD11,                         300380
     A                   M,I                                                 300390
     B               ,XNL,XNPHI                                              300400
 1726 FORMAT(1H1)                                                             300410
      INTEGER QTIME,UTIME,FTIME,WTIME                                         300420
32001 FORMAT(/' THE OVERAL TIME IS ',I6/)                                     300430
32002 FORMAT(/ ' THE SUM OF MAGIC TIME IS ',I6/)                              300440
      IF(Q.EQ.1) REWIND 1                                                     300450
      IOUT = 0                                                                300460
      XNL=0.0                                                                 300470
      IF(Q.EQ.1)  GO TO 191                                                   300480
      READ (5,1001,END=9998) RGO,(STORY(I),I=1,16)                            300490
 1001 FORMAT (F2.0,16A4)                                                      300500
      WRITE(1)       RGO,(STORY(I),I=1,16)                                    300510
      READ (5,1002) TIC,STOP,DTAU,DIFF,STEP,DELTA                             300520
 1002 FORMAT (5E14.1,F2.0)                                                    300530
      WRITE(1)       TIC,STOP,DTAU,DIFF,STEP,DELTA                            300540
      READ (5,1002) G1,G2,G3                                                  300550
      WRITE(1)       G1,G2,G3                                                 300560
      READ (5,1003) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,ANALYS,NP           300570
      IF(NP.LT.2.OR.NP.GT.30) GO TO 8787                                      300580
```

```
 1003 FORMAT (8(A4,6X),E10.1,A4,6X,I2                                    300590
      WRITE(1)      TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,ANALYS,NP     300600
      GO TO 192                                                         300610
  191 READ (1    ) RGO,(STORY(I),I=1,16)                                300620
      READ (1    ) TIC,STOP,DTAU,DIFF,STEP,DELTA                       300630
      READ (1    ) G1,G2,G3                                            300640
      READ (1    ) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,ANALYS,NP     300650
  192 EPSIL =1.0E-05                                                    300660
      DIFF  =1.0E-04                                                    300670
      ERR = 1.0 E-07                                                    300680
      I = RGO                                                           300690
      WRITE(6,651) RSC,I,(STORY(I),I=1,16),TIC,STOP,DTAU,DIFF,STEP,     300700
     1             DELTA                                              300710
  651 FORMAT(//13X,15HSEGMENT NUMBER ,I2,5X,13HSEGMENT CODE ,I2,5X,     300720
     1   16A4//22X,3HTIC,15X,4HSTOP,15X,4HDTAU,15X,4HDIFF               300730
     2,15X,4HSTEP,10X,5HDELTA//16X,5(E14.7,5X),2X,F2.0)                 300740
      WRITE(6,652)  G1,G2,G3                                            300750
  652 FORMAT(//54X,24HGEOMETRY INPUT VARIABLES,//30X,3(E14.7,5X))       300760
      WRITE(6,653) TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,ANALYS,NP      300770
  653 FORMAT(//12X5(A4,6X),9HT FREE = ,E10.3,2XA4,6X26HNUMBER OF TABLE C 300780
     1OLUMNS = ,I2)                                                     300790
C     MATERIAL PROPERTY IDENTIFICATION                                  300800
      DO 501 I=1,NMAT                                                   300810
      IF (HLAYR-STD(I)) 501,502,501                                     300820
  502 MAT=I                                                             300830
      GOTO 503                                                          300840
  501 CONTINUE                                                          300850
      GOTO 8076                                                         300860
C     GEOMETRY IDENTIFICATION SEARCH                                    300870
  503 DO 504 I=1,6                                                      300880
      IF(RGO-STRGO(I)) 504,505,504                                      300890
  504 CONTINUE                                                          300900
      GOTO 8086                                                         300910
  505 KGEOM=I                                                           300920
      DO 506 I=1,3                                                      300930
      IF(TYPE-MATER(I))506,507,506                                      300940
  506 CONTINUE                                                          300950
      GOTO 8087                                                         300960
  507 ITYPE=I                                                           300970
      DO 510 I=1,3                                                      300980
      IF(INTERF-SEGTAB(I))510,511,510                                   300990
  510 CONTINUE                                                          301000
      GO TO 8088                                                        301010
  511 ISTTAB=I                                                          301020
      DO 508 I=1,4                                                      301030
      IF (SHEET.EQ.FACE(I)) GOTO 509                                    301040
  508 CONTINUE                                                          301050
      GOTO 8089                                                         301060
  509 THICK=I                                                           301070
C     TEMPERATURE LOAD IDENTIFICATION                                   301080
      DO 401 I=1,4                                                      301090
      IF(RANKIN.EQ.THERM(I))GOTO 402                                    301100
  401 CONTINUE                                                          301110
      GOTO 8090                                                         301120
  402 KELVIN=I                                                          301130
C     LINEAR OR NONLINEAR ANALYSIS IDENTIFICATION                       301140
      DO 403 I=1,3                                                      301150
      IF(ECLATE(I).EQ.ANALYS) GOTO 404                                  301160
  403 CONTINUE                                                          301170
      GOTO 8013                                                         301180
```

```
  404 IANLYZ=I                                                          301190
      IF (IANLYZ.NE.1.AND.NPROB.GT.1) GOTO 8009                         301200
      IF(IANLYZ.NE.1) XNL =1.0                                          301210
      IF(XNL.NE.0.0.AND.XN.NE.0.0) GO TO 8501                           301220
      NROW = 0                                                          301230
      NROW = THICK + 1                                                  301240
      IF (ISTTAB.EQ.1) NROW = 11                                        301250
      IF(ISTTAB.EQ.3)NROW=10                                            301260
      L= 2*(MAT-1)+1                                                    301270
      II=NXMAT(L)                                                       301280
      III=NXMAT(L+1)                                                    301290
      WRITE(6,654)  ((XMAT(I,J),J=1,10),I=II,III)                       301300
  654 FORMAT(//51X,28HMATERIAL PROPERTY TABLE USED,//(10(1H ,E12.5)))   301310
      WRITE(6,655)                                                      301320
  655 FORMAT(//42X, 47HTABLE ORDER PHI OR S VS. CROSSECTION PROPERTIES,) 301330
       DO 901  I=1,NROW                                                 301340
      IF(Q.EQ.1)  GO TO 193                                             301350
      READ (5,1005) (ST(I,J),J=1,NP)                                    301360
 1005 FORMAT (5E14.7)                                                   301370
      WRITE(1)       (ST(I,J),J=1,NP)                                   301380
      GO TO 194                                                         301390
  193 READ (1      ) (ST(I,J),J=1,NP)                                   301400
  194 WRITE (6,600 )  (ST(I,J),J=1,NP)                                  301410
  600 FORMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))                          301420
  901 CONTINUE                                                          301430
      IF(NPROB.EQ.0) GO TO 590                                          301440
      K=NROW+1                                                          301450
      JJ=1                                                              301460
      JJJ=6                                                             301470
      MM=1                                                              301480
      DO 17 NLC=1,NPROB                                                 301490
      JT = JJ                                                           301500
      JTT= JJJ                                                          301510
      L=0                                                               301520
      IF(Q.EQ.1)  GO TO 195                                             301530
      READ (5,1004) (LST(J),J=JJ,JJJ),(TALE(I),I=1,16)                 301540
 1004 FORMAT(6I11,16A4)                                                 301550
      WRITE(1)       (LST(J),J=JJ,JJJ),(TALE(I),I=1,16)                 301560
      GO TO 196                                                         301570
  195 READ (1      ) (LST(J),J=JJ,JJJ),(TALE(I),I=1,16)                 301580
  196 CONTINUE                                                          301590
      IF(LST(JJ))8021,19,20                                             301600
   20 L = LST(JJ)                                                       301610
      IF(NLC.GT.1.AND.LST(JT).NE.0) GO TO 8008                          301620
   19 JJ=JJ+1                                                           301630
   23 IF(LST(JJ))8021,22,21                                             301640
   21 L=L+1                                                             301650
   22 IF(JJ.EQ.JJJ) GOTO 24                                             301660
      JJ=JJ+1                                                           301670
      GOTO 23                                                           301680
   24 IF(L.EQ.0) GO TO 71                                               301690
      KK = K + L - 1                                                    301700
      DO 72 M=K,KK                                                      301710
      IF(Q.EQ.1)  GO TO 197                                             301720
      READ (5,1005) (ST(M,J),J=1,NP)                                    301730
      WRITE(1)       (ST(M,J),J=1,NP)                                   301740
      GO TO 72                                                          301750
  197 READ (1      ) (ST(M,J),J=1,NP)                                   301760
   72 CONTINUE                                                          301770
      IF(NLC.GT.1.OR.LST(1).EQ.0) GO TO 560                             301780
```

```
      WRITE(6,656)                                                      301790
  656 FORMAT(//45X,42HTABLE ORDER PHI OR S VS. TEMPERATURE LOADS.)      301800
      KY = K                                                            301810
      KZ = K & LST(1) -1                                                301820
      DO 657 N=KY,KZ                                                    301830
      WRITE(6,600) (ST(N,J),J=1,NP)                                     301840
  657 CONTINUE                                                          301850
      K = KZ & 1                                                        301860
  660 IF((L-LST(JT)).EQ.0) GO TO 665                                    301870
      WRITE(6,661) NLC                                                  301880
  661 FORMAT(//16X,8HPROBLEM ,I2,5X,84HTABLE ORDER  PHI OR S VS. DISTRIB 301890
     1UTED LOADS (F THETA, F PHI, F ZETA, M THETA, M PHI).)             301900
      WRITE(6,1968) (LST(J),J=JT,JTT)                                   301910
 1968 FORMAT(27H LOAD IDENTIFICATION CLUES ,611/)                       301920
      DO 662 N = K, KK                                                  301930
      WRITE(6,600) (ST(N,J),J=1,NP)                                     301940
  662 CONTINUE                                                          301950
  665 CONTINUE                                                          301960
   71 K = K & L - LST(JT)                                               301970
      JJ=JJJ&1                                                          301980
      JJJ=JJ&5                                                          301990
   17 MM=MM&1                                                           302000
      IF(IANLYZ.EQ.1) GO TO 590                                         302010
      KK = KK & 1                                                       302020
      IF (L.EQ.0) KK = NROW + 1                                         302030
      IF(Q.EQ.1) GO TO 181                                              302040
      READ(5,1005)  (ST(KK,J),J=1,NP)                                   302050
      WRITE(1)      (ST(KK,J),J=1,NP)                                   302060
      GO TO 667                                                         302070
  181 READ(1)       (ST(KK,J),J=1,NP)                                   302080
  667 WRITE(6,666)  (ST(KK,J),J=1,NP)                                   302090
  666 FORMAT(//47X,38HASSUMED NON-LINEAR VALUES VS. PHI OR S//(1H ,     302100
     18(E14.7,2X)))                                                     302110
  590 IF(NCUPLE.EQ.0) GO TO 7                                           302120
      IF(ISTTAB-2)593,597,593                                           302130
  593 READ(5,1006)  (VAR(I),I=1,4)                                      302140
 1006 FORMAT(4(A4,6X))                                                  302150
      WRITE(6,644)(VAR(I),I=1,4)                                        302160
  644 FORMAT(//34X,23HTHE STRESS CLUES ARE    ,4(A4,6X))               302170
C     STRESS CLUES IDENTIFICATION                                       302180
      I = 0                                                             302190
  406 I = I & 1                                                         302200
      DO 405 J=1,4                                                      302210
      IF(VAR(I).EQ.STRESS(J)) GO TO 407                                 302220
  405 CONTINUE                                                          302230
      GO TO 8111                                                        302240
  407 KLUE(I) = J                                                       302250
      IF(I.LT.4) GO TO 406                                              302260
      WRITE(1) (KLUE(I),I=1,4)                                          302270
      K = KK&1                                                          302280
      KK= K&2                                                           302290
      IF(ISTTAB.EQ.1) KK = K&7                                          302300
      WRITE(6,594)                                                      302310
  594 FORMAT(//44X,43HTABLE ORDER  PHI OR S VS. STRESS PROPERTIES/)     302320
      DO 596 I=K,KK                                                     302330
      READ(5,1005)  (ST(I,J),J=1,NP)                                    302340
      WRITE(6,600)  (ST(I,J),J=1,NP)                                    302350
  596 WRITE(1)      (ST(I,J),J=1,NP)                                    302360
  597 CONTINUE                                                          302370
      READ (5,591) IS,SAVJTC(IS),SAVSTP(IS),(STORY(I),I=1,16)           302380
```

```
591 FORMAT (2I5,16A4)                                                   302390
    ITIC = SAVJTC(IS)                                                   302400
    ISTOP = SAVSTP(IS)                                                  302410
    JTIC = JRTIC(NRC)                                                   302420
    JSTOP = JRSTOP(NRC)                                                 302430
  7 CONTINUE                                                            302440
    NEQNS=6408*NPROB                                                    302450
    DO 73 I=1,NEQNS                                                     302460
 73 YICS(I)=0.0                                                         302470
    YICS(5) =1.0                                                        302480
    YICS(14)=1.0                                                        302490
    YICS(23)=1.0                                                        302500
    YICS(32)=1.0                                                        302510
    YICS(33)=1.0                                                        302520
    YICS(42)=1.0                                                        302530
    YICS(51)=1.0                                                        302540
    YICS(60)=1.0                                                        302550
    NCYC=0                                                              302560
    NSAVE=NROW                                                          302570
    IEND=0                                                              302580
    PRINT=TIC                                                           302590
    DTA=DTAU                                                            302600
    DTAU=0.0                                                            302610
    HUNSEC = ICHRON (3)                                                 302620
    WTIME = 0.0                                                         302630
    ETIME = ICHRON(0)                                                   302640
 59 CALL SETUP (MAGIN,MAGOUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,  302650
   1DTIME,YICS,YPRED,YCORR,YDOT,YNEW,YDEV,EWDEL,TDDEL)                  302660
    GOTO  61                                                            302670
 60 CALL MAGIC                                                          302680
    VTIME = ICHRON(0)                                                   302690
    WTIME = WTIME + VTIME-UTIME                                         302700
 61 IF(MAGOUT.LE.0) GOTO 25                                             302710
    IF(TIME.GT.STOP) GOTO 62                                            302720
    IF(TIME.LT.STOP) GOTO 63                                            302730
 64 IEND=-1                                                             302740
    GOTO 67                                                             302750
 62 IF(TIME.LE.(STOP&DIFF)) GOTO 64                                     302760
    GOTO 8001                                                           302770
 63 IF((STOP-DIFF).LE.TIME) GOTO 64                                     302780
    IF((TIME&DTIME).GT.STOP) GOTO 65                                    302790
    IF(PRINT.GT.TIME) GOTO 66                                           302800
    PRINT=TIME&DTA                                                      302810
 67 IF(IOUT.NE.0) GOTO 110                                              302820
    IF(IEND.GT.0) GOTO 8002                                             302830
    IF(IEND.LT.0) GOTO  150                                             302840
 66 MAGIN=0                                                             302850
    GOTO 60                                                             302860
 65 DTIME=STOP-TIME                                                     302870
    DELTA=0.0                                                           302880
    GOTO 67                                                             302890
 75 NCYC=NCYC&1                                                         302900
    MAGIN=-1                                                            302910
    UTIME = ICHRON(0)                                                   302920
    GOTO 60                                                             302930
 25 LT=0                                                                302940
    JJ=NPROB*6                                                          302950
    DO 15  J=1,JJ                                                       302960
 15 LT=LT&LST(J)                                                        302970
    NTOTAL=LT&NSAVE                                                     302980
```

```
      IF(XNL.EQ.1.0) NTOTAL = NTOTAL (                                  302990
      IF(ISTTAB.EQ.1) NTOTAL=NTOTAL & A                                 303000
      IF(ISTTAB.EQ.3) NTOTAL=NTOTAL & A                                 303010
      PHI=TIME                                                          303020
      ARG=PHI                                                           303030
      LL=NP&1                                                           303040
      DO 51 I=1,NP                                                      303050
      IF(ARG-ST(1,I)) 52,55,51                                          303060
   52 IF(I-1) 8003,8003,54                                              303070
   51 CONTINUE                                                          303080
      GOTO 8006                                                         303090
   54 DO 57 IK=2,NTOTAL                                                 303100
   57 ST(IK,LL)=ST(IK,I-1)&(ST(IK,I)-ST(IK,I-1))*(ARG-ST(1,I-1))/(ST(1,I303110
     1)-ST(1,I-1))                                                      303120
      GOTO 80                                                           303130
   55 DO 58 IK=2,NTOTAL                                                 303140
   58 ST(IK,LL)=ST(IK,I)                                                303150
   80 CONTINUE                                                          303160
C     THE UPDATED INTERPOLATED VALUES OF THE MATERIAL PROPERTY COEFFIC  303170
C     IENTS ARE FOUND IN THE XMAT TABLE AND STORED IN THE XLAYER ARRAY  303180
      L=(MAT-1)*2&1                                                     303190
      II=NXMAT(L)                                                       303200
       III=NXMAT(L&1)                                                   303210
      M=1                                                               303220
      LL=NP&1                                                           303230
      GOTO (91,92,93,93),KELVIN                                         303240
   91 L = NROW + 1                                                      303250
      TEMPAV=(ST(L,LL)&ST(L&1,LL) &ST(L&2,LL)&ST(L&3,LL)) / 4.0         303260
      ARG=TEMPAV                                                        303270
      GOTO 94                                                           303280
   93 ARG = ST(NROW + 1,LL)                                             303290
   94 DO 104 I = 2,10                                                   303300
      IF (ARG-XMAT(II,I)) 121,123,104                                   303310
  121 IF (I-2) 8007,8007,124                                            303320
  104 CONTINUE                                                          303330
      GOTO 8067                                                         303340
  123 L=II&1                                                            303350
      DO 122 J=L,III                                                    303360
      XLAYER(M)=XMAT(J,I)                                               303370
  122 M=M&1                                                             303380
      GOTO 111                                                          303390
  124 L=II&1                                                            303400
      DO 125 J=L,III                                                    303410
      XLAYER(M)=XMAT(J,I-1)+(XMAT(J,I)-XMAT(J,I-1))*(ARG-XMAT(II,I-1))/ 303420
     1          (XMAT(II,I)-XMAT(II,I-1))                              303430
  125 M=M&1                                                             303440
      GOTO 111                                                          303450
   92 L = II + 1                                                        303460
      DO 922  J=L,III                                                   303470
      XLAYER(M)= XMAT(J,1)                                              303480
  922 M=M&1                                                             303490
  111 GOTO (101,102,103),ITYPE                                          303500
  101 ETHET    =XLAYER(1)                                               303510
      XNUTP    =XLAYER(2)                                               303520
      ALPHTH   =XLAYER(3)                                               303530
      EPHI     =ETHET                                                   303540
      XNUPT    =XNUTP                                                   303550
      ALPHPH   =ALPHTH                                                  303560
      XGPT     = ETHET/(2.0*(1.0&XNUPT))                                303570
      GOTO 105                                                          303580
```

```
  102 ETHET     =XLAYER(1)                                                  303590
      EPHI      =XLAYER(2)                                                  303600
      XNUTP     =XLAYER(3)                                                  303610
      ALPHTH    =XLAYER(4)                                                  303620
      ALPHPH    =XLAYER(5)                                                  303630
      XGPT      =XLAYER(6)                                                  303640
      XNUPT     =ETHET*XNUTP/EPHI                                           303650
      GOTO 105                                                              303660
  103 ETHET     = XLAYER(1)                                                 303670
      EPHI      = XLAYER(2)                                                 303680
      XNUTP     = XLAYER(3)                                                 303690
      ALPHTH    = XLAYER(4)                                                 303700
      ALPHPH    = XLAYER(5)                                                 303710
      XGPT      = XLAYER(6)                                                 303720
      ER        = XLAYER(7)                                                 303730
      ES        = XLAYER(8)                                                 303740
      ALPHR     = XLAYER(9)                                                 303750
      ALPHS     = XLAYER(10)                                                303760
      XNUPT     = ETHET * XNUTP/EPHI                                        303770
  105 CONTINUE                                                              303780
      GOTO (771,772,773,774,775,776),KGEOM                                  303790
C     GEOMETRY FOR ELLIPSE                                                  303800
  771 A=G1                                                                  303810
      BE=G2                                                                 303820
      BETA = BE                                                             303830
       BESQ=BE**2                                                           303840
      ASQ=A**2                                                              303850
      SN=SIN(PHI)                                                           303860
      CS=COS(PHI)                                                           303870
      SNSQ = SN**2                                                          303880
      CSSQ = CS**2                                                          303890
      R2 = A*SQRT(1.0/(SNSQ&BESQ*CSSQ))                                     303900
      R2SQ = R2**2                                                          303910
      RO=R2*SN                                                              303920
      R1=R2*R2SQ*BESQ/ASQ                                                   303930
      BESQ=BE**2                                                            303940
      R1DOT=0.C                                                             303950
      IF(KGEOM.EQ.1.AND.BETA.NE.1.0) R1DOT=3.0*(R2*BETA/A)**2*(CS/SNSQ)*    303960
     1                                (R1*SN-RO)                           303970
      GOTO 7775                                                             303980
C     GEOMETRY FOR OGIVE                                                    303990
  772 R1=G1                                                                 304000
      C=G2                                                                  304010
      SN=SIN(PHI)                                                           304020
      CS=COS(PHI)                                                           304030
      IF (SN.EQ.0.0) GOTO 777                                               304040
      R2=R1-C/SN                                                            304050
      GOTO 778                                                              304060
  777 R2 = 1.0                                                              304070
  778 RC = R1*SN-C                                                          304080
      R1DOT=0.0                                                             304090
      GOTO 7775                                                             304100
C     GEOMETRY FOR CONE                                                     304110
  773 CS = COS(G1)                                                          304120
      SN=SIN(G1)                                                            304130
      S=PHI                                                                 304140
      S1=1.0/S                                                              304150
      R2=CS*SN*PHI                                                          304160
      RO=PHI*CS                                                             304170
      R1DOT=0.C                                                             304180
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```
      GOTO 7775                                                          004190
C     GEOMETRY FOR CYLINDER                                              004200
  774 RO = G1                                                            004210
      R1DOT=0.0                                                          004220
      SN = 1.0                                                           004230
      CS = 1.0                                                           004240
      GOTO 7775                                                          004250
C   MODIFIED  ELLIPSE                                                    004260
  775 XNEXP = G1                                                         004270
      A   =G2                                                            004280
      XN1 = 1.0 + XNEXP                                                  004290
      XN2 = 1.0/XN1                                                      004300
      XN3 = XN1 + 1.0                                                    004310
      XN4 = XN2 + 1.0                                                    004320
      XN5 = XN4/XN1                                                      004330
      SN = SIN(PHI)                                                      004340
      CS = COS(PHI)                                                      004350
      R2  = A*(2.0/(1.0+SN**XN1))**XN2                                   004360
      R1  = (A/2.0)*(R2/A)**XN3                                          004370
      RO=R2*SN                                                           004380
      R1DOT = -XN3*A*(SN**XNEXP*CS/4.0)*(2.0/(1.0+SN**XN1))**XN5         004390
      GOTO 7775                                                          004400
C     PARABOLIC GEOMETRY                                                 004410
  776 SN=SIN(PHI)                                                        004420
      CS=COS(PHI)                                                        004430
      TAN= SN/CS                                                         004440
      SEC= 1.0/CS                                                        004450
      F1=G1                                                              004460
      F2=G2                                                              004470
      F3=G3                                                              004480
      RO = (F2-TAN)/(2.0*F3)                                             004490
      R1 = -SEC**3/(2.0*F3)                                              004500
      R2 = RO/SN                                                         004510
      R1DOT = -3.0*SEC**4*SN/(2.0*F3)                                    004520
 7775 TAN=SN/CS                                                          004530
      IF(TIME.EQ.TIC) RTICK=RO                                           004540
      IF(NCYC.GT.1.OR.NCUPLE.EQ.0) GO TO 491                             004550
      IF (TIME.EQ.TIC.AND.NSC.EQ.1) SADUS(JTIC) = RO                     004560
      IF (TIME.EQ.TIC) RADUS(ITIC) = RO                                  004570
  491 CONTINUE                                                           004580
      ROSQ = RO**2                                                       004590
      XNSQ=XN**2                                                         004600
      CN=CS*SN                                                           004610
      X1CS=1.0/CS                                                        004620
      TN=SN/CS                                                           004630
      X1RO=1.0/RO                                                        004640
      X1ROSQ=1.0/RO**2                                                   004650
      X1CSRO=1.0/(CS*RO)                                                 004660
      CN1RO=CN/RO                                                        004670
      SN1RO=SN/RO                                                        004680
      CS1RO=CS/RO                                                        004690
      SNSQ=SN**2                                                         004700
      CSSQ=CS**2                                                         004710
      IF(KGEOM.EQ.4.OR.KGEOM.EQ.1) GOTO 79                               004720
      R1SQ = R1**2                                                       004730
      R2SQ = R2**2                                                       004740
      X1SN=1.0/SN                                                        004750
      X1SNRO=1.0/(SN*RO)                                                 004760
      X1R1=1.0/R1                                                        004770
      X1R2=1.0/R2                                                        004780
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      CS1R1=CS/R1                                                    304100
      CS1R2=CS/R2                                                    304110
      SN1R1=SN/R1                                                    304120
      X1R1SQ=1.0/R1**2                                               304130
   79 XNTTH=0.0                                                      304140
      XNTPH=0.0                                                      304150
      XMTTH=0.0                                                      304160
      XMTPH=0.0                                                      304170
      IF (ITYPE.EQ.3) GOTO 711                                       304180
C     COMPUTATION OF K AND D FOR MATERIAL PROPETY INPUT              304190
      GOTO  (701,702,703),THICK                                      304200
C  SINGLE SHEET                                                      304210
  701 HI=ST(2,LL)                                                    304220
      TEMP1=ETHET*HI                                                 304230
      TEMP2=TEMP1*HI**2                                              304240
      TEMP3=(1.0-XNUPT*XNUTP)                                        304250
      XK11=TEMP1/TEMP3                                               304260
      XD11=TEMP2/(12.0*TEMP3)                                        304270
      IF(ITYPE.EQ.1)GOTO 704                                         304280
      XK22=XK11                                                      304290
      XD22=XD11                                                      304300
      GOTO 705                                                       305000
  704 TEMP1=EPHI*HI                                                  305010
      TEMP2=TEMP1*HI**2                                              305020
      XK22=TEMP1/TEMP3                                               305030
      XD22=TEMP2/(12.0*TEMP3)                                        305040
  705 XK33=XGPT*HI                                                   305050
      XD33=XK33*HI**2/12.0                                           305060
      GOTO 710                                                       305070
C  EQUAL  SHEETS                                                     305080
  702 HI=ST(2,LL)                                                    305090
      T= ST(3,LL)                                                    305100
      TEMP1=2.0*ETHET*HI                                             305110
      TEMP2=HI*(4.0*HI**2+6.0*HI*T+3.0*T**2)                         305120
      TEMP3=(1.0-XNUPT*XNUTP)                                        305130
      XK11=TEMP1/TEMP3                                               305140
      XD11=ETHET*TEMP2/(6.0*TEMP3)                                   305150
      IF(ITYPE.EQ.2)GOTO 706                                         305160
      XK22=XK11                                                      305170
      XD22=XD11                                                      305180
      GOTO 707                                                       305190
  706 TEMP1=2.0*EPHI*HI                                              305200
      XK22=TEMP1/TEMP3                                               305210
      XD22=EPHI*TEMP2/(6.0*TEMP3)                                    305220
  707 XK33=2.0*XGPT*HI                                               305230
      XD33=XK33*TEMP2/(12.0*HI)                                      305240
      GOTO 710                                                       305250
C  UNEQUAL SHEETS                                                    305260
  703 HI=ST(2,LL)                                                    305270
      T= ST(3,LL)                                                    305280
      HO=ST(4,LL)                                                    305290
      TEMP1=HI+HO                                                    305300
      TEMP2=TEMP1**4+12.0*HI*HO*T*(TEMP1+T)                          305310
      TEMP3=(1.0-XNUPT*XNUTP)                                        305320
      XK11=ETHET*TEMP1/TEMP3                                         305330
      XD11=ETHET*TEMP2/(12.0*TEMP1*TEMP3)                            305340
      IF(ITYPE.EQ.2) GOTO 708                                        305350
      XK22=XK11                                                      305360
      XD22=XD11                                                      305370
      GOTO 709                                                       305380
```

```
  708 XK22=EPHI*TEMP1/TEMP3                                              305790
      XD22=EPHI*TEMP2/(12.0*TEMP1*TEMP3)                                 305800
  709 XK33=XGPT*TEMP1                                                    305810
      XD33=XGPT*(TEMP2/(12.0*TEMP1))                                     305820
      GOTO 710                                                           305830
C     RANKIN=THSTND MEANS INTERPOLATE,COMPUTE NTEMP,MTEMP                305840
C     RANKIN=NOTHRM MEANS DO NOT INTERPOLATE,DO NOT COMPUTE NTEMP,NTEMP  305850
C     RANKIN=THCNST MEANS DO NOT INTERPOLATE,COMPUTE NTEMP,MTEMP         305860
C     RANKIN=THINPO MEANS INTERPOLATE,BUT DO NOT COMPUTE NTEMP,MTEMP     305870
  711 CONTINUE                                                           305880
      XK11=ST(2,LL)                                                      305890
      XK12=ST(3,LL)                                                      305900
      XK22 = ST(4,LL)                                                    305910
      XK33 = ST(5,LL)                                                    305920
      XD11 = ST(6,LL)                                                    305930
      XD12 = ST(7,LL)                                                    305940
      XD22 = ST(8,LL)                                                    305950
      XD33 = ST(9,LL)                                                    305960
      XC11 = ST(10,LL)                                                   305970
      XC22 = ST(11,LL)                                                   305980
      XK21 = XK12                                                        305990
      XD21 = XD12                                                        306000
  710 GOTO (716,714,715,714),KELVIN                                      306010
  716 TII = ST(NROW+1,LL)                                                306020
      TIK = ST(NROW+2,LL)                                                306030
      TOK = ST(NROW+3,LL)                                                306040
      TOO = ST(NROW+4,LL)                                                306050
      GOTO 717                                                           306060
  715 TII = ST(NROW+1,LL)                                                306070
      TIK = TII                                                          306080
      TOK = TII                                                          306090
      TOO = TII                                                          306100
  717 CONTINUE                                                           306110
      TEMP1=ALPHTH&XNUTP*ALPHPH                                          306120
      TEMP2=ALPHPH&XNUPT*ALPHTH                                          306130
      TEMP3=1.0-XNUPT*XNUTP                                              306140
      TEMP4=HI/4.0                                                       306150
      TEMP5=HI**2/24.0                                                   306160
      TEMP6=TII&TIK&TOK&TOO-4.0*TEFREE                                   306170
      TEMP7=2.0*TII&TIK-TOK-2.0*TOO                                      306180
      GO TO (811,812,813,814),THICK                                      306190
  811 XNTTH = ETHET * TEMP1 * TEMP4 * TEMP6/TEMP3                        306200
      XNTPH=EPHI*TEMP2*TEMP4*TEMP6/TEMP3                                 306210
      XMTTH=ETHET*TEMP1*TEMP5*TEMP7/TEMP3                                306220
      XMTPH=EPHI*TEMP2*TEMP5*TEMP7/TEMP3                                 306230
      GOTO 714                                                           306240
  812 TI=T/2.0                                                           306250
  802 TEMP8=HI/2.0                                                       306260
      TEMP9=TII&TIK-TOK-TOO                                              306270
      XNTTH=ETHET*TEMP1*TEMP8*TEMP6/TEMP3                                306280
      XNTPH=EPHI*TEMP2*TEMP8*TEMP6/TEMP3                                 306290
      XMTTH=ETHET*TEMP1*TEMP8*(HI*TEMP7/3.0&TI*TEMP9)/TEMP3              306300
      XMTPH=EPHI*TEMP2*TEMP8*(HI*TEMP7/3.0&TI*TEMP9)/TEMP3               306310
      GOTO 714                                                           306320
  813 TI = (HC**2-HI**2&2.0*H0*T)/(2.0*(HI&H0))                          306330
      TO = (HI**2-H0**2&2.0*HI*T)/(2.0*(HI&H0))                          306340
      TEMP6=2.0*TII&TIK-3.0*TEFREE                                       306350
      TEMP7=2.0*TCO&TOK-3.0*TEFREE                                       306360
  803 TEMP8=TII&TIK-2.0*TEFREE                                           306370
      TEMP9=TCK&TOO-2.0*TEFREE                                           306380
```

```
      XNTTH=ETHET*TEMP1*0.5*(HI*TEMP8-HO*TEMP9)/TEMP3                    306080
      XNTPH=EPHI*TEMP2*0.5*(HI*TEMP8-HO*TEMP9)/TEMP3                    306090
      XMTTH=ETHET*TEMP1*0.5*(HI**2*TEMP6/3.0-HO**2*TEMP7/3.0-TI*HI*     306100
     1      TEMP8-TO*HO*TEMP9)/TEMP3                                    306110
      XMTPH=EPHI*TEMP2*0.5*(HI**2*TEMP6/3.0-HO**2*TEMP7/3.0-TI*HI*      306120
     1      TEMP8-TO*HO*TEMP9)/TEMP3                                    306130
      GOTO 714                                                          306140
  814 TEMP10=SQRT(-XK11*XD11)/SQRT(48.0)                                306150
      TEMP11=SQRT(-XK22*XD22)/SQRT(48.0)                                306160
      XNTTH=(XK11/4.0)*TEMP1*TEMP6                                      306170
      XNTPH=(XK22/4.0)*TEMP2*TEMP6                                      306180
      XMTTH=TEMP10*TEMP1*TEMP7                                          306190
      XMTPH=TEMP11*TEMP2*TEMP7                                          306200
C     COMPUTATION OF K AND D FOR K AND D INPUT                          306210
  714 LL=NP&1                                                           306220
      IF(XK11.EQ.0.0) GOTO 8101                                         306230
      IF(ITYPE.EQ.3.AND.XK12.EQ.0.) GO TO 8102                          306240
      IF(ITYPE.EQ.3.AND.XK21.EQ.0.) GO TO 8103                          306250
      IF(XK22.EQ.0.0) GOTO 8104                                         306260
      IF(XK33.EQ.0.0) GOTO 8105                                         306270
      IF(XD11.EQ.0.0) GOTO 8106                                         306280
      IF(ITYPE.EQ.3.AND.XD12.EQ.0.) GO TO 8107                          306290
      IF(ITYPE.EQ.3.AND.XD21.EQ.0.) GO TO 8108                          306300
      IF(XD22.EQ.0.0) GOTO 8109                                         306310
      IF(XD33.EQ.0.0) GOTO 8110                                         306320
      NL=0                                                              306330
      XSAVE1 = XNTTH                                                    306340
      XSAVE2 = XNTPH                                                    306350
      XSAVE3 = XMTTH                                                    306360
      XSAVE4 = XMTPH                                                    306370
      XNTTH = 0.0                                                       306380
      XNTPH = 0.0                                                       306390
      XMTTH = 0.0                                                       306400
      XMTPH = 0.0                                                       306410
      XFTHLD=0.0                                                        306420
      XFPHLD=0.0                                                        306430
      XFZELD=0.0                                                        306440
      XMTHLD=0.0                                                        306450
      XMPHLD=0.0                                                        306460
      JF=8&NPROB                                                        306470
C     ANALYS=LINE                                                       306480
C     ANALYS=CMTH                                                       306490
C     ANALYS=NPH                                                        306500
      XNPHI= 0.0                                                        306510
      IJKLMN=NROW+LST(1)+LST(2)+LST(3)+LST(4)+LST(5)+LST(6)+1           306520
      IF(XNL.NE.0.0)XNPHI=ST(IJKLMN,LL)                                 306530
      DO 77 M=1, JF                                                     306540
      I = (M-1)*8 & 1                                                   306550
      IF (M.LT.9) GOTO   49                                             306560
      XNTTH = XSAVE1                                                    306570
      XNTPH = XSAVE2                                                    306580
      XMTTH = XSAVE3                                                    306590
      XMTPH = XSAVE4                                                    306600
      NL=NL&1                                                           306610
      XFTHLD=0.0                                                        306620
      XFPHLD=0.0                                                        306630
      XFZELD=0.0                                                        306640
      XMTHLD=0.0                                                        306650
      XMPHLD=0.0                                                        306660
      K=NROW                                                            306670
```

```
      IR=NL*6-5                                                          306550
      IF(LST(IR).NE.0) K=K&LST(IR)                                       306600
      IF (LST(IR&1).EQ.0) GOTO 44                                        306610
      K=K&1                                                              306620
      XFTHLD=ST(K,LL)                                                    306630
   44 IF(LST(IR&2).EQ.0) GOTO 45                                         306640
      K=K&1                                                              306650
      XFPHLD=ST(K,LL)                                                    306660
   45 IF(LST(IR&3).EQ.0) GOTO 46                                         306670
      K=K&1                                                              306680
      XFZELD=ST(K,LL)                                                    306690
   46 IF(LST(IR&4).EQ.0) GOTO 47                                         306700
      K=K&1                                                              306710
      XMTHLD=ST(K,LL)                                                    306720
   47 IF(LST(IR&5).EQ.0) GOTO 48                                         306730
      K=K&1                                                              306740
      XMPHLD=ST(K,LL)                                                    306750
   48 CONTINUE                                                           306760
   49 CALL DIFFEQ                                                        306770
   77 CONTINUE                                                           306780
      GOTO 75                                                            306790
 8001 IERROR=8001                                                        306800
      NERROR=11                                                          306810
      GOTO 9888                                                          306820
 8002 IERROR=8002                                                        306830
      NERROR=12                                                          306840
      GOTO 9888                                                          306850
 8003 IERROR=8003                                                        306860
      NERROR=13                                                          306870
      GOTO 9888                                                          306880
 8006 IERROR=8006                                                        306890
      NERROR=14                                                          306900
      GOTO 9888                                                          306910
 8007 IERROR=8007                                                        306920
      NERROR=15                                                          306930
      GOTO 9888                                                          306940
 8008 IERROR = 8008                                                      306950
      NERROR=10                                                          306960
      GO TO 9888                                                         306970
 8009 IERROR = 8009                                                      306980
      NERROR= 8                                                          306990
      GO TO 9888                                                         307000
 8031 IERROR=8031                                                        307010
      NERROR= 9                                                          307020
      GOTO 9888                                                          307030
 8036 IERROR=8036                                                        307040
      NERROR= 2                                                          307050
      GOTO 9888                                                          307060
 8086 IERROR=8086                                                        307070
      NERROR= 3                                                          307080
      GOTO 9888                                                          307090
 8087 IERROR=8087                                                        307100
      NERROR= 4                                                          307110
      GOTO 9888                                                          307120
 8088 IERROR=8088                                                        307130
      NERROR=27                                                          307140
      GOTO 9888                                                          307150
 8089 IERROR=8089                                                        307160
      NERROR= 5                                                          307170
      GOTO 9888                                                          307180
```

```
 8090 IERROR=8090                                                    307190
      NERROR= 6                                                      307200
      GOTO 8888                                                      307210
 8067 IERROR= 8067                                                   307220
      NERROR=16                                                      307230
      GOTO 8888                                                      307240
 8101 IERROR = 8101                                                  307250
      NERROR=17                                                      307260
      GOTO 8888                                                      307270
 8102 IERROR = 8102                                                  307280
      NERROR=18                                                      307290
      GOTO 8888                                                      307300
 8103 IERROR = 8103                                                  307310
      NERROR=19                                                      307320
      GOTO 8888                                                      307330
 8104 IERROR = 8104                                                  307340
      NERROR=20                                                      307350
      GOTO 8888                                                      307360
 8105 IERROR = 8105                                                  307370
      NERROR=21                                                      307380
      GOTO 8888                                                      307390
 8106 IERROR = 8106                                                  307400
      NERROR=22                                                      307410
      GOTO 8888                                                      307420
 8107 IERROR = 8107                                                  307430
      NERROR=23                                                      307440
      GOTO 8888                                                      307450
 8108 IERROR = 8108                                                  307460
      NERROR=24                                                      307470
      GOTO 8888                                                      307480
 8109 IERROR = 8109                                                  307490
      NERROR=25                                                      307500
      GOTO 8888                                                      307510
 8110 IERROR = 8110                                                  307520
      NERROR=26                                                      307530
      GOTO 8888                                                      307540
  110 IERROR=110                                                     307550
      NERROR=28                                                      307560
      GOTO 8888                                                      307570
 8013 IERROR=8013                                                    307580
      NERROR= 7                                                      307590
      GOTO 8888                                                      307600
 8787 IERROR = 8787                                                  307610
      NERROR=34                                                      307620
      GO TO 8888                                                     307630
 8501 IERROR=8501                                                    307640
      NERROR=35                                                      307650
      GO TO 8888                                                     307660
 8111 IERROR = 8111                                                  307670
      NERROR = 36                                                    307680
 8888 NIX=1                                                          307690
      RETURN                                                         307700
  150 CONTINUE                                                       307710
      QTIME = ICHRON(0)                                              307720
      QTIME = QTIME - FTIME                                          307730
      WRITE (6,32001) QTIME                                          307740
      WRITE (6,32002) WTIME                                          307750
      WRITE(6,670)                                                   307760
  670 FORMAT(//46X,41HMATRIX X AND Y (TRANSPOSED)  MAGIC OUTPUT)     307770
      WRITE(6,672) (YCORR(I),I=1,NEONS)                              307780
```

```
  672 FORMAT(8(2X,E14.7))                                                  307790
      RESTOP=RO                                                            307800
      IF(NCUPLE.EQ.0) GO TO 9999                                           307810
      RADUS(ISTOP) = RO                                                    307820
      IF(NSC.LT.NSEG) GO TO 9999                                           307830
      SADUS(JSTOP) = RO                                                    307840
      IF(ITIC.GT.ISTOP) SADUS(JSTOP) = RADUS(ITIC)                         307850
 9999 RETURN                                                               307860
 9998 WRITE(6,9997)                                                        307870
 9997 FORMAT('THE PROGRAM HAS PROCESSED ALL THE DATA FOR A CHAIN OF UNCO   307880
     1UPLED SEGMENTS')                                                     307890
      CALL EXIT                                                            307900
       END                                                                 307910
```

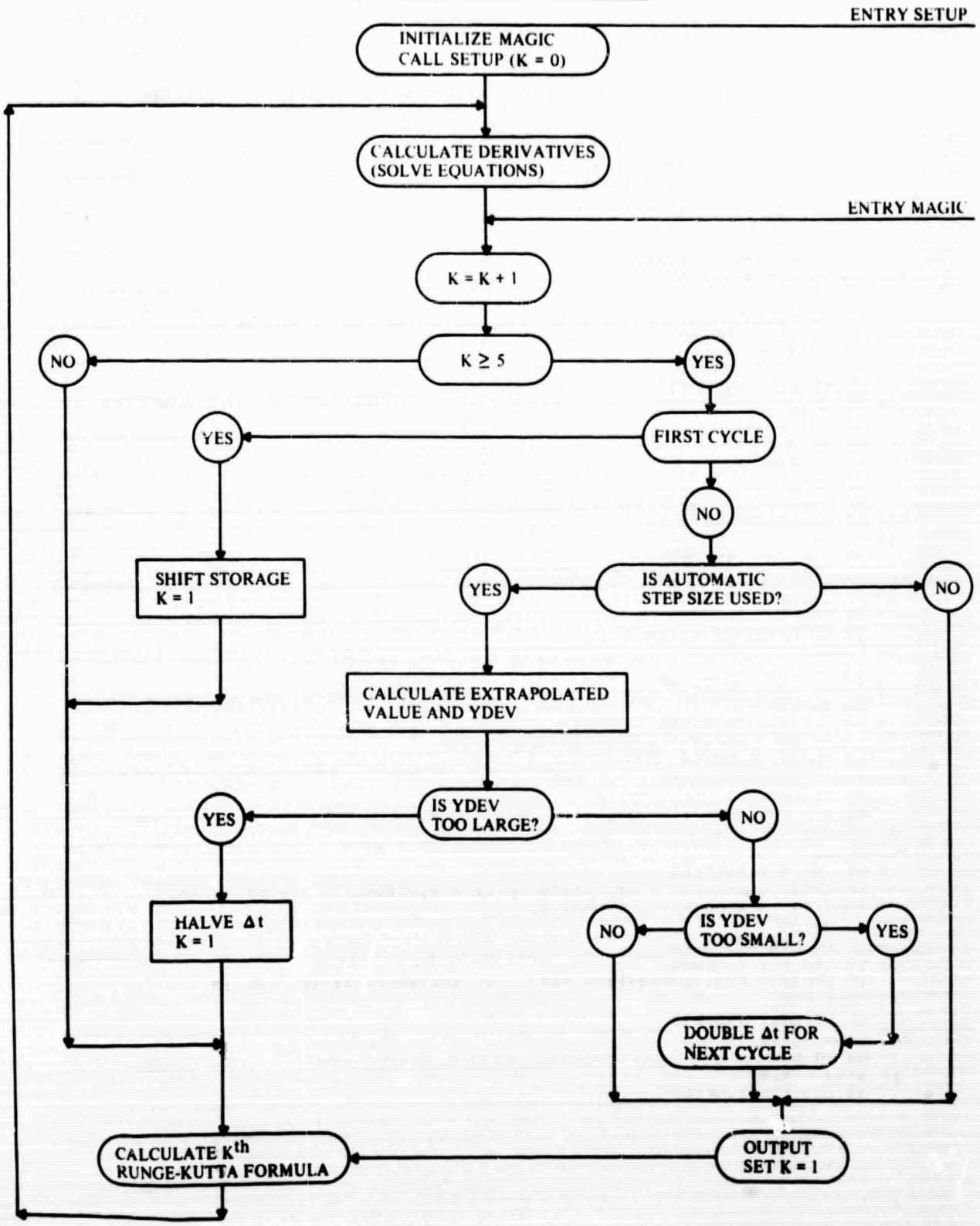
SUBROUTINE SETUP

SETUP is a double entry subroutine called from RIEMAN. It is a mixed precision, numerical integration routine, with automatic selection of a variable integration step size, which utilizes fifth order Runge-Kutta equations to obtain the solution for first order differential equations.

SUBROUTINE MAGIC

MAGIC is an alternate entry point to subroutine SETUP.

RUNGE-KUTTA GENERAL FLOW CHART



SET - EFN SOURCE STATEMENT - IFN(S) -

```
      SUBROUTINE SETUP (MAGIN,MAGOUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR
     1,TIME,DTIME,YICS,YPRED,YCORR,YDOT,YNEW,YDEV,FWDEL,TBDEL)
      DIMENSION YICS( 1),YPRED( 1),YCORR( 1), YDOT( 1), YNEW( 1),
     1                    YDEV( 1),FWDEL( 1),BKDEL( 1),TBDEL( 1)
      DIMENSION C(3),D(3)
      DOUBLE PRECISION YNEW,YPRED,YDERV
      DATA C,D / .5,.5,1.0,.5,.0,.5/
      TIME = TIC
      TAU  = TIC
      IF (DELTA)200,201,200
  200 DTIME = 0.0078125
      GO TO 225
  201 DTIME = STEP
  225 DO 102 I = 1,NEQNS
      YDEV(I)  = 0.0
      YPRED(I) = YICS(I)
      YCORR(I) = YICS(I)
  102 YNEW(I)  = YICS(I)
      MAGOUT   =-2
      GO TO 264
      ENTRY MAGIC
      CONTINUE
      IF (MAGOUT) 205,101,101
  101 IF(MAGIN) 21, 27, 14
   27 K = 0
      DO 202 I = 1,NEQNS
  202 YNEW(I)  = YPRED(I)
   21 K = K +1
  210 DO  2  I = 1,NEQNS
      GO TO (9,6,7,4,11),K
    9 FWDEL(I) = YDOT(I)
      GO TO 105
    6 TBDEL(I) = YDOT(I)
      GO TO 105
    7 TBDEL(I) = TBDEL(I) + YDOT(I)
  105 YPRED(I) = YNEW(I) + C(K)*DTIME*YDOT(I)
      GO TO (2,2,400),K
  400 YCORR(I) = YPRED(I)
    2 CONTINUE
      TIME     = TIME + D(K)*DTIME
   99 MAGOUT   = 0.0
  264 RETURN
    4 DO  8  I = 1,NEQNS
      YPRED(I) = YNEW(I) + DTIME*(FWDEL(I) + 2.*TBDEL(I) + YDOT(I))/6.
    8 YDEV(I)  = YCORR(I) - YPRED(I)
      GO TO 99
   11 IF (DELTA)80, 5,80
   80 DO  13 I = 1,NEQNS
      IF (EPSIL* ABS(YCORR(I)) + ERR    -  ABS(YDEV(I)))14, 13, 13
   13 CONTINUE
      IF (SIGB)15,15,205
  205 SIGB = 0.0
      GO TO 5
   15 SIGB = 0.0
      DO 207 I = 1,NEQNS
```

SET - EFN SOURCE STATEMENT - IFN(S) -

```
      IF (ERR    /100.+ DELTA* ABS(YCORR(I)) -  ABS(YDEV(I))) 5,207,207
  207 CONTINUE
      DTIME     = 2.*DTIME
    5 DO 208 I  = 1,NEQNS
  208 YCORR(I)  = YPRED(I)
  305 IF (DTAU) 19,30,19
   19 IF (TAU - TIME)20,20,27
   20 TAU = TAU + DTAU
   30 MAGOUT = 2
      GO TO 264
   14 DTIME = DTIME/2.0
   25 IF (K-3)48,26,26
   26 TIME  = TIME - DTIME - DTIME
      GO TO 47
   48 TIME  = TIME - DTIME
   47 SIGB     = +2.
      DO 209 I = 1,NEQNS
  209 YDOT(I) = FWDEL(I)
  212 K        = 0
      GO TO 21
       END
```

SUBROUTINE DIFFEQ

This subroutine is called in RIEMAN. Certain geometry clues, trigonometric values, and predicted values of the differential equations are passed via label common area, EQUAZN, to subroutine DIFFEQ.

The specific derivative equations and auxiliary equations are contained in this subroutine link. The value of each derivative equation, YDO^{m}, and each auxiliary equation, YA ---, are returned to RIEMAN via label common EQUAZN.

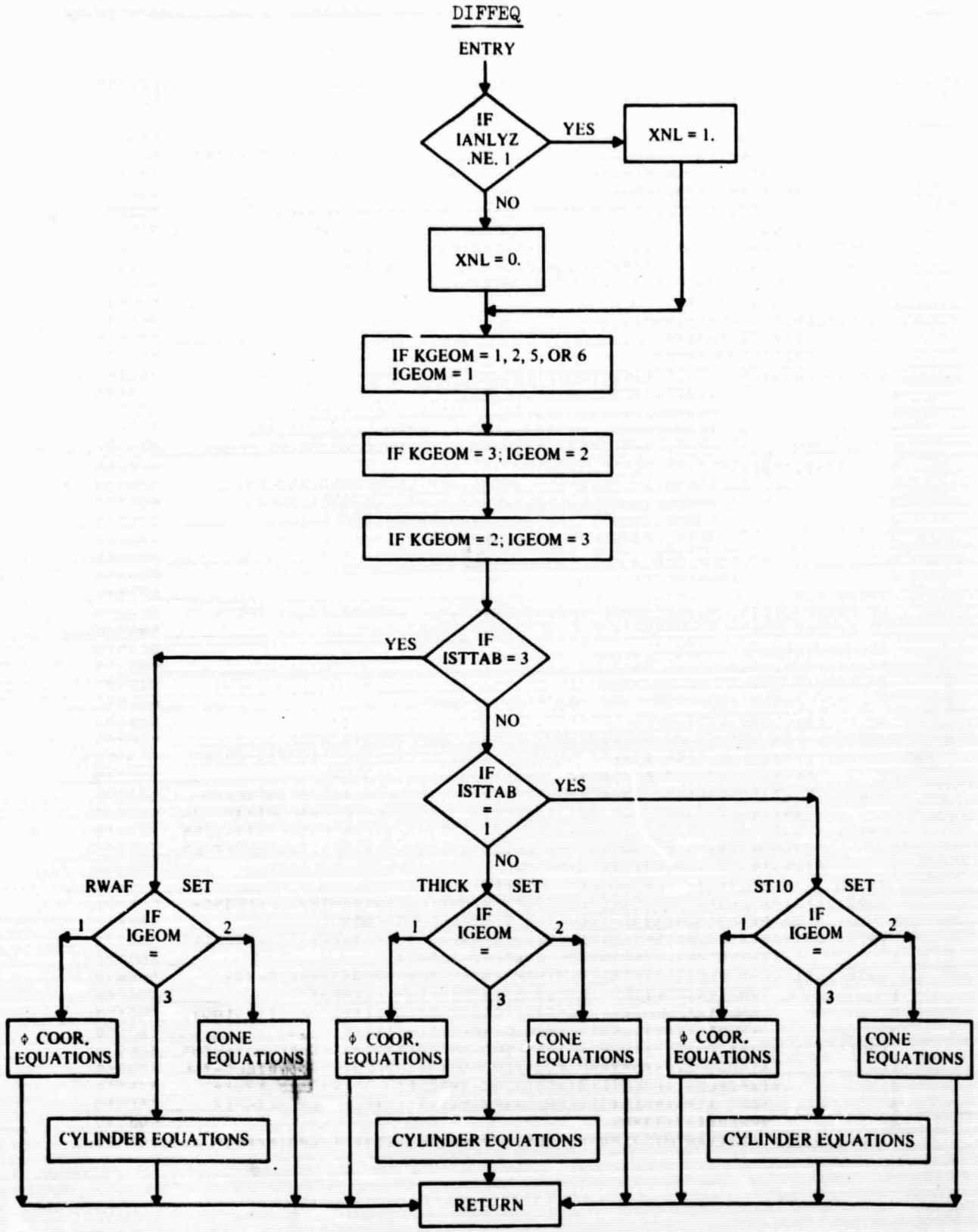
A special equation counter, I, is used in this subroutine, which counts in increments of eight. The first eight values of I, 1 through 57 (in increments of eight), correspond to the eight sets of initial conditions required to compute the segment stiffness matrices in subroutine SEGMAT. The subsequent values of I, 65 through 137 maximum (again in increments of eight) correspond to the computation of each set of eight equations for each loading problem (10 problems maximum).

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTIONS 3 & 4)	
XN	n	
YDOT (I)	$T_{\phi\theta,\phi}$	$\frac{dT_{\phi\theta}}{ds}$
YDOT (I + 1)	$N_{\phi,\phi}$	$\frac{dN_{\phi}}{ds}$
YDOT (I + 2)	$J_{\phi,\phi}$	$\frac{dJ_{\phi}}{ds}$
YDOT (I + 3)	$M_{\phi,\phi}$	$\frac{dM_{\phi}}{ds}$
YDOT (I + 4)	$U_{,\phi}$	$\frac{dU}{ds}$
YDOT (I + 5)	$V_{,\phi}$	$\frac{dV}{ds}$
YDOT (I + 6)	$W_{,\phi}$	$\frac{dW}{ds}$
YDOT (I + 7)	$\Omega_{\theta,\phi}$	$\frac{d\Omega_{\theta}}{ds}$
YPRED (I)	$T_{\varphi\theta}$	
YPRED (I + 1)	N_{ϕ}	
YPRED (I + 2)	J_{ϕ}	
YPRED (I + 3)	M_{ϕ}	
YPRED (I + 4)	U	
YPRED (I + 5)	V	
YPRED (I + 6)	W	
YPRED (I + 7)	Ω_{θ}	
YAMPT	$M_{\phi\theta}$	
YANTH	N_{θ}	
YAMTH	M_{θ}	

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTIONS 3 & 4)
R2SQ	r_2^2
ROSQ	r_0^2
X1RO	$1/r_0$
S	s
XK12	K_{12}
XK21	K_{21}
XD12	D_{12}
XD21	D_{21}
XC11	C_{11}
XC22	C_{22}
XNSQ	n^2

Non-Linear Redefinitions (Ref. 1 Section 7)

YDOT (I+2)	$^*J_{\phi,\phi}$	$\frac{d^*J_\phi}{ds}$
YPRED (I+2)	$^*J_\phi$	
YAJPH	J_ϕ	
XNL	a	
XNPHI	$\overline{N}_\phi$	


DIFFEQ
ENTRY
IF IANLYZ .NE. 1
YES
XNL = 1.
NO
XNL = 0.
IF KGEOM = 1, 2, 5, OR 6 IGEOM = 1
IF KGEOM = 3; IGEOM = 2
IF KGEOM = 2; IGEOM = 3
YES
IF ISTTAB = 3
NO
IF ISTTAB = 1
YES
NO
RWAF SET
IF IGEOM =
1
2
3
φ COOR. EQUATIONS
CONE EQUATIONS
CYLINDER EQUATIONS
THICK SET
IF IGEOM =
1
2
3
φ COOR. EQUATIONS
CONE EQUATIONS
CYLINDER EQUATIONS
ST10 SET
IF IGEOM =
1
2
3
φ COOR. EQUATIONS
CONE EQUATIONS
CYLINDER EQUATIONS
RETURN

```
C ***** ROUTINE **DIFF    ** ABACUS UPDATED 08/09/69 *****                    500000
C ***** ROUTINE **DIFFEQ  ** ABACUS UPDATED 06/20/68 *****                    500010
      SUBROUTINE DIFFEQ                                                      500020
      COMMON STORY(16),TALE(16)                                              500030
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)      500040
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                     500050
      COMMON SADUS(60),RADUS(60)                                             500060
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP           500070
      COMMON NREGEND,NSYM,NRG,NRC,NSC,NIX,IERRCR,RESTOP,RTICK,IOUT           500080
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                    500090
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,   0   ,NSMAX                    500100
      EQUIVALENCE (XMTTH,XMTETH),(XMTPH,XMTEPH),(XNTTH,XNTETH),              500110
     1           (XNTPH,XNTEPH)                                              500120
      EQUIVALENCE  (XNPHI,XNPI)                                              500170
      INTEGER SAVJTC,SAVSTP                                                  500180
      DOUBLE PRECISION YPRED                                                 500190
      COMMON /EQUAZN/ YPRED(144),YDOT(144),YASAVE(144),                      500200
     1                YANTH,YAMTH,YAMPT,YAJPH,                              500210
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,IN,            500220
     3                X1RO,X1ROSQ,X1SNRO,X1CSRO,CN1RO,SN1RO,CS1RO,          500230
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RO,RESQ,      500240
     5    ROSQ,XNSQ,BETA,R1,R2,S1,R1DOT,                                    500250
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,         500260
     7                XMTHLD,XMPHLD,ETHET,EPHI,XGPT,ALPHTH,ALPHPH,          500270
     8                XNUTP,XNUPT,XC11,XC22,XD33,XD22,XD21,XD12,            500280
     9                XK11,XK12,XK21,XK22,XK33,XD11,                        500290
     A                   M,I                                                500300
     B                ,XNL,XNPHI                                            500310
      IGEOM = 0                                                              500320
      IF (KGEOM.EQ.1.OR.KGEOM.EQ.2.OR.KGEOM.EC.5.OR.KGEOM.EQ.6) IGEOM =1     500330
      IF (KGEOM.EQ.3) IGEOM=2                                                500340
      IF(KGEOM.EQ.4) IGECM=3                                                 500350
      IF (ISTTAB.EQ.3)GO TO 7447                                             500360
      IF(ISTTAB.EQ.1)  GO TO 7786                                            500370
C     THE FOLLCWING EQUATIONS ARE THE 'THICK' SET                            500380
      GO TO (151,152,153),IGECM                                              500390
C   EQUATICNS FOR SHELLS OF REVOLUTICN ( PHI  COORDINATE )                   500400
  151 YANTH=XNUPT*YPRED(I&1)&(XK11-XNUPT**2*XK22)*(XN*YPRED(I&4)&YPRED(      500410
     1       I&5)*CS-YPRED(I&6)*SN)*X1RO-XNTETH&XNUPT*XNTEPH                 500420
      YAMTH=XNUPT*YPRED(I&3)-(XD11-XNUPT**2*XD22)*X1RO*(X1RO*(XN*YPRED       500430
     1       (I&4)*SN-XNSQ*YPRED(I&6))&YPRED(I&7)*CS)-XMTETH&XNUPT*XMTEPH    500440
      YAMPT=(-1.0/((RO/XD33)&(SNSQ*X1RO/XK33)))*(-2.0*XN*YPRED(I&7)&YPRE     500450
     1       D(I&4)*(CS1R1-CN1RO)&XN*YPRED(I&5)*(SN1RO&X1R1)&2.0*XN*YPRED    500460
     2       (I&6)*CS1RO&YPRED(I)*SN/XK33)                                   500470
      YAJPH = YPRED(I+2)-XNL*(XNPI*YPRED(I+7))                               500480
      YDOT(I)=R1*(-2.0*YPRED(I)*CS1RO&XN*YANTH*X1RO-XN*YAMTH*SN*X1ROSQ-      500490
     1       YAMPT*CS1RO*(X1R1-SN1RO)-XFTHLD-XMPHLD*SN1RO)                   500500
      YDOT(I&5)=R1*(YPRED(I&6)*X1R1&(1.0/(XK22-XNUTP**2*XK11))*(YPRED(I&     500510
     1          1)-XNUTP*YANTH&XNTEPH-XNUTP*XNTETH))                         500520
      YDOT(I+1) =(-YPRED(I+1)*CS1RO+YANTH*CS1RO-XN*YPRED(I)*X1RO-XN*         500530
     1           YAMPT*X1RO*(SN*X1RO+X1R1)+YPRED(I+2)*X1R1-XFPHLD-           500540
     2            XNL*(XFPHLD*(YPRED(I+5)*CS1RO-YPRED(I+6)*(X1R1+SN1RO)      500550
     3            +YDOT (I+5)*X1R1)-XFZELD*YPRED(I+7)))*R1                   500560
      YDOT(I+2) =(-YAJPH*CS*X1RO-YANTH*SN1RO-YPRED(I+1)*X1R1+XNSQ*YAMTH*     500570
     1           X1ROSQ-2.0*XN*YAMPT*CS*X1ROSQ+XN*XMPHLD*X1RO-XFZELD-XNL     500580
     2          *(XFZELD*(YPRED(I+5)*CS*X1RO-YPRED(I+6)*(X1R1+SN1RO)+       500590
     3           YDOT (I+5)*X1R1)+XFPHLD*YPRED(I+7))-XNL*CS1RO*(XNPI*        500600
     4           YPRED(I+7)))*R1                                             500610
      YDOT(I+3) = R1*(YAMTH*CS1RO-YPRED(I+2)*CS1RO-2.0*XN*YAMPT*X1RO+        500620
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     1              YAJPH+XMTHLD)                                          500590
      YDOT(I&4)=R1*(YPRED(I&4)*CS1RC&XN .PRED(I&5)*X1RO&YPRED(I)/XK33&      500600
     1            YAMPT*SN*X1RO/XK33)                                      500610
      YDOT(I&6)=R1*(YPRED(I&7)-YPRED(I&5)*X1R1)                           500620
      YDOT(I&7)=R1*(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I&3)&XNUTP*YAMTH-   500630
     1            XMTEPH&XNUTP*XMTETH)                                     500640
      GOTO 9005                                                           500650
C     EQUATIONS FOR CONE                                                  500660
  152 YANTH=XNUPT*YPRED(I&1)&(XK11-XNUPT**2*XK22)*(X1CS/S)*(XN*YPRED(I&4  500670
     1      )&YPRED(I&5)*CS-YPRED(I&6)*SN)-XNTETH&XNUPT*XNTEPH            500680
      YAMTH=XNUPT*YPRED(I&3)-(1.0/S)*X1CS*(XD11-XNUPT**2*XD22)*((1.0/S)*  500690
     1      X1CS*(XN*YPRED(I&4)*SN-XNSO*YPRED(I&6))&YPRED(I&7)*CS)-       500700
     2      XMTETH&XNUPT*XMTEPH                                           500710
      YAMPT=(-1.0/((S*CS/XD33)&(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I&7)-    500720
     1      YPRED(I&4)*SN/S&XN*YPRED(I&5)*TN/S&2.0*XN*YPRED(I&6)/S&YPRED  500730
     2      (I)*SN/XK33)                                                  500740
      YAJPH = YPRED(I+2)-XNL*(XNPHI*YPRED(I+7))                           500750
      YDOT(I)  =-2.0*YPRED(I)/S&XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2  500760
     1      &YAMPT*TN/S**2-XFTHLD-XMPHLD*TN/S                             500770
      YDOT(I&5)=(1.0/(XK22-XNUTP**2*XK11))*(YPRED(I&1)-XNUTP*YANTH&XNTEP  500780
     1      H-XNUTP*XNTETH)                                               500790
      YDOT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/    500800
     1      (S**2*CS**2)-XFPHLD-XNL*(XFPHLD*(YPRED(I+5)/S-YPRED           500810
     2      (I+6)*TAN/S+YDOT(I+5))-XFZELD*YPRED(I+7))                     500820
      YDOT(I+2)= -YAJPH/S-YANTH*TAN/S+XNSO*YANTH/(S**2*CS**2)-2.0*XN*     500830
     1      YAMPT/(S**2*CS)+XN*XMPHLD/(S*CS)-XFZELD-XNL*(XFZELD*(         500840
     2      YPRED(I+5)/S-YPRED(I+6)*TAN/S+YDOT(I+5))+XFPHLD*YPRED         500850
     3      (I+7))-XNL*XNPHI*YPRED(I+7)/S                                 500860
      YDOT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD    500870
      YDOT(I&4)=(1.0/S)*(YPRED(I&4)&XN*YPRED(I&5)*X1CS&YAMPT*TN/XK33)     500880
     1      &YPRED(I)/XK33                                                500890
      YDOT(I&6)=YPRED(I&7)                                                500900
      YDOT(I&7)=(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I&3)&XNUTP*YAMTH-      500910
     1      XMTEPH&XNUTP*XMTETH)                                          500920
      GO TO 9005                                                          500930
C     EQUATIONS FOR CYLINDER                                              500940
  153 YANTH=XNUPT*YPRED(I&1)&(XK11-XNUPT**2*XK22)*(X1RO*(XN*YPRED(I&4)-   500950
     1      YPRED(I&6)))-XNTETH&XNUPT*XNTEPH                              500960
      YAMTH=XNUPT*YPRED(I&3)-(X1RO*(XD11-XNUPT**2*XD22))*(X1RO*(XN*YPRED  500970
     1      (I&4)-XN**2*YPRED(I&6)))-XMTETH&XNUPT*XMTEPH                  500980
      YAMPT=(-1.0/((RO/XD33)&(X1RO/XK33)))*(-2.0*XN*YPRED(I&7)&XN*X1RO*   500990
     2      YPRED(I&5)&YPRED(I)/XK33)                                     501000
      YAJPH = YPRED(I+2)-XNPHI*YPRED(I+7)                                 501010
      YDOT(I)  =XN*YANTH*X1RO-XN*YAMTH*X1ROSQ-XFTHLD-XMPHLD*X1RO          501020
      YDOT(I&5)=(1.0/(XK22-XNUTP**2*XK11))*(YPRED(I&1)-XNUTP*YANTH&XNTEP  501030
     1      H-XNUTP*XNTETH)                                               501040
      YDOT(I+1) = -XN*X1RO*YPRED(I)-XN*YAMPT*X1ROSQ-XFPHLD-XNL*(XFPHLD*   501050
     1      (YDOT(I+5)-YPRED(I+6)*X1RO)-XFZELD*YPRED(I+7))                501060
      YDOT(I+2) = -YANTH*X1RO+XNSO*YAMTH*X1ROSQ+XN*XMPHLD*X1RO-XFZELD-    501070
     1      XNL*(XFZELD*(YDOT(I+5)-YPRED(I+6)*X1RO)+XFPHLD*YPRED(         501080
     2      I+7))                                                         501090
      YDOT(I+3) = -2*XN*YAMPT*X1RO+YAJPH+XMTHLD                           501100
      YDOT(I&4)=XN*YPRED(I&5)*X1RO&YPRED(I)/XK33&YAMPT*X1RO/XK33          501110
      YDOT(I&6)=YPRED(I&7)                                                501120
      YDOT(I&7)=(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I&3)&XNUTP*YAMTH-XMTE  501130
     1      PH&XNUTP*XMTETH)                                              501140
      GO TO 9005                                                          501150
 7786 GO TO (4771,4772,4773),IGECM                                        501160
C     THE FOLLOWING EQUATIONS ARE THE 'ST10' SET                          501170
C   EQUATIONS FOR SHELLS OF REVOLUTION  ( PHI  COORDINATE )               501180
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4771  YAMTH= XK12*(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22
     1    )*(YPRED(I&3)&XMTPH))-XNTTH&(X1RO*XK11-XK12*XK21*X1RO*(1.0/
     2    (XK22&XC22**2/XD22)))*(XN*YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&
     3    6)*SN)-(XC11&XK12*XC22*XD21/XD22*(1.0/(XK22&XC22**2/XD22)))*
     4    (X1RO**2*(XN*YPRED(I&4)*SN-XN**2*YPRED(I&6))&YPRED(I&7)*CS*
     5    X1RO)
      YAMTH =-XD12*(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH)-XMTTH
     1    &XD12*(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)&(XC11*
     2    X1RO&XD12*XK21*X1RO*(XC22/(XC22**2&XK22*XD22)))*(XN*YPRED(
     3    I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)&(XD11-XD12*XK22*XD21/(
     4    XC22**2&XK22*XD22))*(X1RO&SO*(XN*YPRED(I&4)*SN-XNSO*YPRED
     5    (I&6))&YPRED(I&7)*CS*X1RO)
      YAMPT=(-1.0/((RO/XD33)&(SNSC*X1RO/XK33)))*(-2.0*XN*YPRED(I&7)&YPRE
     1    D(I&4)*(CS1R1-CN1RO)&XN*YPRED(I&5)*(SN1RO&X1R1)&2.0*XN*YPRED
     2    (I&6)*CS1RO&YPRED(I)*SN/XK33)
      YAJPH = YPRED(I+2)-XNL*(XNPI*YPRED(I+7))
      YDOT(I)=R1*(-2.0*YPRED(I)*CS1RO&XN*YANTH*X1RO-XN*YAMTH*SN*X1ROSO-
     1    YAMPT*CS1RO*(X1R1-SN1RO)-XFTHLD-XMPHLD*SN1RO)
      YDOT (I&5)=R1*(YPRED(I&6)*X1R1&(1.0/(XK22&XC22**2/XD22))*(YPRED(I&
     1    1)&XNTPH&(XC22/XD22)*(YPRED(I&3)&XMTPH)-XK21*X1RO*(XN*
     2    YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)-(XC22*XD21/XD22
     3    )*(X1RO&O*(XN*YPRED(I&4)*SN-XNSO*YPRED(I&6))&YPRED(I&7)
     4    *CS*X1RO)))
      YDOT(I+1) =(-YPRED(I+1)*CS1RO+YANTH*CS1RO-XN*YPRED(I)*X1RO-XN*
     1    YAMPT*X1RO*(SN*X1RO+X1R1)+YPRED(I+2)*X1R1-XFPHLD-
     2    XNL*(XFPHLD*(YPRED(I+5)*CS1RO-YPRED(I+6)*(X1R1+SN1RO)
     3    +YDOT (I+5)*X1R1)-XFZELD*YPRED(I+7)))*R1
      YDOT(I+2) =(-YAJPH*CS*X1RO-YANTH*SN1RO-YPRED(I+1)*X1R1+XNSO*YAMTH*
     1    X1ROSO-2.0*XN*YAMPT*CS*X1ROSO+XN*XMPHLD*X1RO-XFZELD-XNL
     2    *(XFZELD*(YPRED(I+5)*CS*X1RO-YPRED(I+6)*(X1R1+SN1RO)+
     3    YDOT (I+5)*X1R1)+XFPHLD*YPRED(I+7))-XNL*CS1RO*(XNPI*
     4    YPRED(I+7)))*R1
      YDOT(I+3) = R1*(YANTH*CS1RO-YPRED(I+3)*CS1RO-2.0*XN*YAMPT*X1RO+
     1    YAJPH+XMTHLD)
      YDOT(I&4)=R1*(YPRED(I&4)*CS1RO&XN*YPRED(I&5)*X1RO&YPRED(I)/XK33&
     1    YAMPT*SN*X1RO/XK33)
      YDOT(I&6)=R1*(YPRED(I&7)-YPRED(I&5)*X1R1)
      YDOT(I&7)=R1*((-XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH-(XK21/
     1    RO)*(XN*YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&5)*SN))
     2    &(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)-(XK22*
     3    XD21/(XC22**2&XK22*XD22))*(X1RCSO*(XN*YPRED(I&4)*SN-XNSO
     4    *YPRED(I&6))&YPRED(I&7)*CS*X1RO))
      GO TO 9005
C     EQUATIONS FOR CONE
4772  YANTH= XK12*(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22
     1    )*(YPRED(I&3)&XMTPH))-XNTTH&(1.0/(CS*S))*(XK11-XK12*XK21*(
     2    1.0/(XK22&XC22**2/XD22)))*(XN*YPRED(I&4)&YPRED(I&5)*CS-
     3    YPRED(I&6)*SN)-(XC11&(XK12*XD21*XC22/XD22)*(1.0/(XK22&XC22*
     4    *2/XD22)))*((1.0/(S**2*CS**2))*(XN*YPRED(I&4)*SN-XNSO*YPRED
     5    (I&6))&YPRED(I&7)/S)
      YAMTH =-XD12*(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH)-XMTTH&
     1    XD12*(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)&(XC11/
     2    (S*CS)&XD12*XK21/(S*CS))*(XC22/(XC22**2&XK22*XD22))*(XN*
     3    YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)&(XD11-XD12*XK22*
     4    XD21/(XC22**2&XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I&4)*
     5    SN-XNSO*YPRED(I&6))&YPRED(I&7)/S)
      YAMPT=(-1.0/((S*CS/XD33)&(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I&7)-
     1    YPRED(I&4)*SN/S&XN*YPRED(I&5)*TN/S&2.0*XN*YPRED(I&6)/S&YPRED
     2    (I)*SN/XK33)
      YAJPH = YPRED(I+2)-XNL*(XNPI*YPRED(I+7))
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      YDOT(I)  =-2.0*YPRED(I)/S&XN*YAN    (1CS/S-XN*YAMTH*SN*X1CS**2/S**2 501790
     1          &YAMPT*TN/S**2-XFTHLD-XMPHLD*TN/S                          501800
      YDOT(I&5)=(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22)* 501810
     1          (YPRED(I&3)&XMTPH)-(XK21/(S*CS))*(XN*YPRED(I&4)&YPRED( 501820
     2          I&5)*CS-YPRED(I&6)*SN)-(XC22*XD21/XD22)*((1.0/(S**2*CS** 501830
     3          2))*(XN*YPRED(I&4)*SN-XNSQ*YPRED(I&6))&YPRED(I&7)/S)) 501840
      YDOT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/ 501850
     1            (S**2*CS**2)-XFPHLD-XNL*(XFPHLD*(YPRED(I+5)/S-YPRED 501860
     2            (I+6)*TAN/S+YDOT(I+5))-XFZELD*YPRED(I+7))           501870
      YDOT(I+2)= -YAJPH/S-YANTH*TAN/S+XNSQ*YANTH/(S**2*CS**2)-2.0*XN* 501880
     1          YAMPT/(S**2*CS)+XN*XMPHLD/(S*CS)-XFZELD-XNL*(XFZELD*( 501890
     2            YPRED(I+5)/S-YPRED(I+6)*TAN/S+YDOT(I+5))+XFPHLD*YPRED 501900
     3           (I+7))-XNL*XNPHI*YPRED(I+7)/S                         501910
      YDOT(I+3)= YANTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD 501920
      YDOT(I&4)=(1.0/S)*(YPRED(I&4)&XN*YPRED(I&5)*X1CS&YAMPT*TN/XK33)  501930
     1          &YPRED(I)/XK33                                         501940
      YDOT(I&6)=YPRED(I&7)                                            501950
      YDOT(I&7)=-(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH-XK21*(XN* 501960
     1          YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)/(S*CS))&      501970
     2          (XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)-(XK22*XD21 501980
     3          /(XC22**2&XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I&4)*SN 501990
     4          -XN**2*YPRED(I&6))&YPRED(I&7)/S)                       502000
      GO TO 9005                                                      502010
C     EQUATIONS FOR CYLINDER                                          502020
 4773 YANTH= XK12*(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22 502030
     1       )*(YPRED(I&3)&XMTPH))-XNTTH&(X1RO*(XK11-XK12*XK21*(1.0/( 502040
     2       XK22&XC22**2/XD22))))*(XN*YPRED(I&4)-YPRED(I&6))-(XC11&( 502050
     3       XK12*XC22*XD21/XD22)*(1.0/(XK22&XC22**2/XD22)))*(X1RO**2*( 502060
     4       XN*YPRED(I&4)-XNSQ*YPRED(I&6)))                          502070
      YAMTH =-XD12*(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH)-XMTTH& 502080
     1        XD12*(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)&(XC11* 502090
     2        X1RO&XD12*XK21*X1RO*(XC22/(XC22**2&XK22*XD22)))*(XN*YPRED 502100
     3        (I&4)-YPRED(I&6))&(XD11-XD12*XK22*XD21/(XC22**2&XK22*XD22) 502110
     4        )*(X1RCSQ*(XN*YPRED(I&4)-XNSQ*YPRED(I&6)))               502120
      YAMPT=(-1.0/((RO/XD33)+(X1RC/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RO* 502130
     1      YPRED(I+5)+YPRED(I)/XK33)                                  502140
      YAJPH = YPRED(I+2)-XNPHI*YPRED(I+7)                             502150
      YDOT(I)  =XN*YANTH*X1RO-XN*YAMTH*X1ROSQ-XFTHLD-XMPHLD*X1RO      502160
      YDOT (I&5) =(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22 502170
     1          )*(YPRED(I&3)&XMTPH)-(XK21*X1RO)*(XN*YPRED(I&4)-YPRED 502180
     2      (I&6))-(XC22*XD21/XD22)*(X1ROSQ*(XN*(YPRED(I&4)-XN*YPRE    502190
     3          D(I&5))))                                              502200
      YDOT(I+1) = -XN*X1RC*YPRED(I)-XN*YAMPT*X1ROSQ-XFPHLD-XNL*(XFPHLD* 502210
     1            (YDOT(I+5)-YPRED(I+6)*X1RO)-XFZELD*YPRED(I+7))       502220
      YDOT(I+2) = -YANTH*X1RC+XNSQ*YAMTH*X1ROSQ+XN*XMPHLD*X1RO-XFZELD- 502230
     1            XNL*(XFZELD*(YDOT(I+5)-YPRED(I+6)*X1RO)+XFPHLD*YPRED( 502240
     2            I+7))                                                502250
      YDOT(I+3) = -2*XN*YAMPT*X1RO+YAJPH+XMTHLD                       502260
      YDOT(I&4)=XN*YPRED(I&5)*X1RO&YPRED(I)/XK33&YAMPT*X1RO/XK33      502270
      YDOT(I&6)=YPRED(I&7)                                            502280
      YDOT(I&7)=-(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH-XK21*X1RO* 502290
     9          (                                                     502300
     1          XN*YPRED(I&4)-YPRED(I&6)))&(XK22/(XC22**2&XK22*XD22))*( 502310
     2          YPRED(I&3)&XMTPH)-(XK22*XD21/(XC22**2&XK22*XD22))*(    502320
     3          X1RCSQ*(XN*YPRED(I&4)-XNSQ*YPRED(I&6)))                502330
      GO TO 9005                                                      502340
 7447 GO TO (7341,7342,7343),IGECM                                    502350
C     THE FOLLOWING EQUATIONS ARE THE 'RWAF' SET                      502360
C     EQUATIONS FOR SHELLS OF REVOLUTION ( PHI COORDINATE )           502370
 7341 YANTH = (YPRED(I+1)+XNTPH)*(1.0+(XK12-XK22)*(XK22+XC11**2/XD22)** 502380
```

```
     1          (-1))-XNTTH+(XK12-XK22)*    11/(XK22*XD22+XC11**2))*(YPRED    502390
     2          (I+3)+XMTPH)-(XK12-XK22)*((XD12*XC11-XC11*XD22)/(XK22*XD22    502400
     3     +XC11**2))*X1ROSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6)+RO*YPRED      502410
     4          (I+7)*CS)+X1RO*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+5)*SN)   502420
     5          *(XK11-XK12-(XK12-XK22)*((XK12*XD22+XC11**2)/(XK22*XD22+     502430
     6          XC11**2)))                                                   502440
          YAMTH = (YPRED(I+3)+XMTPH)*(1.0+(XD12-XD22)*(XK22/(XC11**2+XD22*    502450
     1          XK22)))-XMTTH-(YPRED(I+1)+XNTPH)*(XD12-XD22)*(XC11/(XC11     502460
     2          **2+XD22*XK22))+(XD12-XD22)*(XK12-XK22)*(XC11/(XC11**2+      502470
     3          XD22*XK22))*X1RO*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*    502480
     4          SN)+X1ROSQ*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6)+RO*YPRED(I+7)   502490
     5          *CS)*(XD11-XD12-(XC12-XD22)*((XC11**2+XD12*XK22)/(XC11**2+   502500
     6          XD22*XK22)))                                                 502510
          YAMPT = (1.0/(XC11*SN*X1RO-XK33-SN*X1RO*(XD33*SN/(    RO)-XC11)))  502520
     1          *((XK33*XD33-XC11**2)*X1RO*(-2.0*XN*YPRED(I+7)+YPRED(I+4)*   502530
     2          (CS*X1R1-CN1RO)+XN*YPRED(I+5)*(X1R1+SN1RO)+2.0*XN*YPRED      502540
     3          (I+6)*CS*X1RO)+YPRED(I)*(XD33*SN*X1RO-XC11))                 502550
          YAJPH = YPRED(I+2)-XNL*(XNPI*YPRED(I+7))                           502560
          YDOT(I)=R1*(-2.0*YPRED(I)*CS1RO&XN*YANTH*X1RO-XN*YAMTH*SN*X1ROSQ-  502570
     1          YAMPT*CS1RO*(X1R1-SN1RO)-XFTHLD-XMPHLD*SN1RO)                502580
          YDOT(I+5)=YPRED(I+6)+R1*(1.0/(XK22+XC11**2/XD22))*(YPRED(I+1)+     502590
     1          XNTPH  +(XC11/XD22)*(YPRED(I+3)+XMTPH )-(XK12+XC11**2/       502600
     2          XD22)*X1RO*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)       502610
     3          -(XD12*XC11/XD22-XC11)*X1ROSQ*(XN*YPRED(I+4)*SN-XNSQ*        502620
     4          YPRED(I+5)+RO*YPRED(I+7)*CS))                                502630
          YDOT(I+1) =(-YPRED(I+1)*CS1RO+YANTH*CS1RO-XN*YPRED(I)*X1RO-XN*     502640
     1          YAMPT*X1RO*(SN*X1RO+X1R1)+YPRED(I+2)*X1R1-XFPHLD-            502650
     2          XNL*(XFPHLD*(YPRED(I+5)*CS1RO-YPRED(I+6)*(X1R1+SN1RO)        502660
     3          +YDOT (I+5)*X1R1)-XFZELD*YPRED(I+7)))*R1                     502670
          YDOT(I+2) =(-YAJPH*CS*X1RO-YANTH*SN1RO-YPRED(I+1)*X1R1+XNSQ*YAMTH*  502680
     1          X1ROSQ-2.0*XN*YAMPT*CS*X1ROSQ+XN*XMPHLD*X1RO-XFZELD-XNL      502690
     2          *(XFZELD*(YPRED(I+5)*CS*X1RO-YPRED(I+6)*(X1R1+SN1RO)+        502700
     3          YDOT (I+5)*X1R1)+XFPHLD*YPRED(I+7))-XNL*CS1RO*(XNPI*         502710
     4          YPRED(I+7)))*R1                                              502720
          YDOT(I+3) = R1*(YAMTH*CS1RO-YPRED(I+3)*CS1RO-2.0*XN*YAMPT*X1RO+    502730
     1          YAJPH+XMTHLD)                                                502740
          YDOT(I+4) =R1*(YPRED(I+4)*CS*X1RO+XN*YPRED(I+5)*X1RO+(1.0/(XK33-   502750
     1          XC11**2/XD33))*(YPRED(I)+YAMPT*(SN*X1RO-XC11/XD33)))         502760
          YDOT(I+6)=R1*(YPRED(I+7)-YPRED(I+5)*X1R1)                          502770
          YDOT(I+7)=R1*((XK22/(XC11**2+XD22*XK22))*(YPRED(I+3)+XMTPH)+ (XC11 502780
     1          /(XC11**2+XD22*XK22))*(-YPRED(I+1)-XNTPH+(XK12-XK22)*        502790
     2     X1RO*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN))-((XC11**2+      502800
     3          XD12*XK22)/(XD22*XK22+XC11**2))*X1ROSQ*(XN*YPRED(I+4)*SN     502810
     4     -XNSQ*YPRED(I+6)+RO*YPRED(I+7)*CS))                               502820
          GO TO 9005                                                         502830
     C    EQUATIONS FOR CONE                                                 502840
       7342 YANTH = (YPRED(I+1)+XNTPH)*(1.0+(XK12-XK22)*(1.0/(XK22+XC11**2/  502850
     1          XD22)))-XNTTH+(XK12-XK22)*(XC11/(XK22*XD22+XC11**2))*(       502860
     2          YPRED(I+3)+XMTPH)-(XK12-XK22)*(XD12*XC11-XC11*XD22)*((1.0/   502870
     3          (S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7   502880
     4          )/S)/(XK22*XD22+XC11**2)+(1.0/(S*CS))*(XN*YPRED(I+4)+YPRED   502890
     5          (I+5)*CS-YPRED(I+6)*SN)*(XK11-XK12-(XK12-XK22)*(XK12*XD22+   502900
     6          XC11**2)/(XK22*XD22+XC11**2))                                502910
          YAMTH=(YPRED(I+3)+XMTPH)*(1.0+(XD12-XD22)*(XK22/(XC11**2+XD22*XK22   502920
     1        )))-XMTTH-(YPRED(I+1)+XNTPH)*(XD12-XD22)*(XC11/(XD22*XK22+     502930
     2        XC11**2))+(XD12-XD22)*(XK12-XK22)*(XC11/(XD22*XK22+XC11**2))   502940
     3*(1.0/(S*CS))*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)+((1.0/       502950
     4  (S*CS)**2)*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7)*S1)*(       502960
     5  XD11-XD12-(XD12-XD22)*(XC11**2+XD12*XK22)/(XC11**2+XD22*XK22))       502970
          YAMPT =((XC11*TAN/S-XK33-(TAN/S)*(XD33*TAN/S-XC11))**(-1))*((XK33*  502980
```

```
     1        XD33-XC11**2)*(1.0/(S*CS))   2.0*XN*YPRED(I+7)-YPRED(I+4)*    503990
     2         SN/S+XN*YPRED(I+5)*TAN/S+2.0*XN*YPRED(I+6)/S)+YPRED(I)*(    504000
     3        XD33*TAN/S-XC11))                                            504010
      YAJPH = YPRED(I+2)-XNL*(XNPHI*YPRED(I+7))                           504020
      YDOT(I)  =-2.0*YPRED(I)/S&XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2  504030
     1          &YAMPT*TN/S**2-XFTHLD-XMPHLD*TN/S                        504040
      YDOT(I+5) = (1.0/(XK22+XC11**2/XD22))*(YPRED(I+1)+XNTPH+(XC11/XD22  504050
     1           )*(YPRED(I+3)+XMTPH)-(XK12+XC11**2/XD22)*(1.0/(S*CS))*   504060
     2           (XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)-(XD12*XC11   504070
     3           /XD22-XC11)*((1.0/(S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ   504080
     4           *YPRED(I+6))+YPRED(I+7)/S))                              504090
      YDOT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/    504100
     1           (S**2*CS**2)-XFPHLD-XNL*(XFPHLD*(YPRED(I+5)/S-YPRED      504110
     2           (I+6)*TAN/S+YDOT(I+5))-XFZELD*YPRED(I+7))                504120
      YDOT(I+2)= -YAJPH/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)-2.0*XN*     504130
     1          YAMPT/(S**2*CS)+XN*XMPHLD/(S*CS)-XFZELD-XNL*(XFZELD*(     504140
     2           YPRED(I+5)/S-YPRED(I+6)*TAN/S+YDOT(I+5))+XFPHLD*YPRED    504150
     3          (I+7))-XNL*XNPHI*YPRED(I+7)/S                             504160
      YDOT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD    504170
      YDOT (I+4) = YPRED(I+4)/S+XN*YPRED(I+5)/(S*CS)+(1.0/(XK33-XC11**2/  504180
     1            XD33))*(YPRED(I)+YAMPT*(TAN/S-XC11/XD33))                504190
      YDOT(I&6)=YPRED(I&7)                                                504200
      YDOT (I+7) =(XK22/(XC11**2+XD22*XK22))*(YPRED(I+3)+XMTPH)+(XC11/(   504210
     1           XC11**2+XD22*XK22))*(-YPRED(I+1)-XNTPH+(XK12-XK22)*      504220
     2           (1.0/(S*CS))*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*    504230
     3    SN))-((XC11**2+XD12*XK22)/(XD22*XK22+XC11**2))*((1.0/(          504240
     4           S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED    504250
     5           (I+7)/S)                                                 504260
      GO TO 900                                                           504270
C     EQLATIONS FOR CYLINDER                                              504280
 7343 YANTH=(YPRED(I+1)+XNTPH)*(1+(XK12-XK22)*(1/(XK22+XC11**2/XD22)))-   504290
     1       XNTTH+(XK12-XK22)*(XC11/(XK22*XD22+XC11**2))*(YPRED(I+3)+    504300
     2       XMTPH)-(XK12-XK22)*((XD12*XC11-XC11*XD22)/(XK22*XD22+XC11**2 504310
     3       ))*X1ROSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))+X1RO*(XN*YPRED(I+4 504320
     4       )-YPRED(I+6))*(XK11-XK12-(XK12-XK22)*((XK12*XD22+XC11**2)/   504330
     5       (XK22*XD22+XC11**2)))                                        504340
      YAMTH=(YPRED(I+3)+XMTPH)*(1+(XD12-XD22)*(XK22/(XC11**2-XD22*XK22))  504350
     1     )-XMTTH-(YPRED(I+1)+XNTPH)*(XD12-XD22)*(XC11/(XD22*XK22+XC11*  504360
     2    *2))+(XC12-XD22)*(XK12-XK22)*(XC11/(XD22*XK22+XC11**2))*X1RO*   504370
     3       (XN*YPRED(I+4)-YPRED(I+6))+X1ROSQ*(XN*YPRED(I+4)-XNSQ*YPRED  504380
     4       (I+6))*(XD11-XD12-(XD12-XD22)*((XC11**2+XD12*XK22)/(XC11**2  504390
     5       +XD22*XK22)))                                                504400
      YAMPT=(1/(XC11*X1RO-XK33-X1RO*(XD33*X1RO-XC11)))*((XK33*XD33-XC11   504410
     1     **2)*X1RO*(-2*XN*YPRED(I+7)+XN*X1RO*YPRED(I+5))+YPRED(I)*(     504420
     2       XD33*X1RO-XC11))                                             504430
      YAJPH = YPRED(I+2)-XNPHI*YPRED(I+7)                                 504440
      YDOT(I)  =XN*YANTH*X1RO-XN*YAMTH*X1ROSQ-XFTHLD-XMPHLD*X1RO          504450
      YDOT(I+5)=(1/(XK22+XC11**2/XD22))*(YPRED(I+1)+XNTPH+(XC11/XD22)*    504460
     1          (YPRED(I+3)+XMTPH)-(XK12+XC11**2/XD22)*X1RO*(XN*YPRED(I+  504470
     2          4)-YPRED(I+6))-(XD12*XC11/XD22-XC11)*X1ROSQ*(XN*YPRED(I+  504480
     3          4)-XNSQ*YPRED(I+6)))                                       504490
      YDOT(I+1) = -XN*X1RO*YPRED(I)-XN*YAMPT*X1ROSQ-XFPHLD-XNL*(XFPHLD*   504500
     1            (YDOT(I+5)-YPRED(I+6)*X1RO)-XFZELD*YPRED(I+7))           504510
      YDOT(I+2) = -YANTH*X1RO+XNSQ*YAMTH*X1ROSQ+XN*XMPHLD*X1RO-XFZELD-    504520
     1            XNL*(XFZELD*(YDOT(I+5)-YPRED(I+6)*X1RO)+XFPHLD*YPRED(    504530
     2            I+7))                                                    504540
      YDOT(I+3) = -2*XN*YAMPT*X1RO+YAJPH+XMTHLD                           504550
      YDOT(I+4)=(XN*YPRED(I+5)/RO)+(1/(XK33-XC11**2/XD33))*(YPRED(I)+     504560
     1          YAMPT*(X1RO-XC11/XD33))                                    504570
      YDOT(I&6)=YPRED(I&7)                                                504580
```

```
      YDOT(I+7)=(XK22/(XC11**2+XD22*XK    )*(YPRED(I+3)+XMTPH)+(XC11/      503590
     1           XC11**2+XK22*XD22))*(-YPRED(I+1)-XNTPH+(XK12-XK22)*)/ D*  503600
     2           (XN*YPRED(I+4)-YPRED(I+6)))-((XC11**2+XD12*XK22)/(X 22*   503610
     3    XK22+XC11**2))*X1RQ**2*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))           503620
      GO TO 9005                                                          503630
 9005 IY =8*(M-1)&1                                                       503640
      YASAVE(IY) = YANTH                                                  503650
      YASAVE(IY&1)=YAMTH                                                  503660
      YASAVE(IY&2)=YAMPT                                                  503670
      YASAVE(IY&3)=YANPT                                                  503680
      YASAVE(IY&4)=YAQPH                                                  503690
      YASAVE(IY&5)=YAQPH                                                  503700
      YASAVE(IY&6)=YAQTH                                                  503710
      YASAVE(IY+7) = YAJPH                                                503720
      RETURN                                                              503730
      END                                                                 503740
```

SUBROUTINE SEGMAT

The results of subroutine link, RIEMAN, are passed through the label common area, LYCORR, to this subroutine. SEGMAT places the elements of the YCORR array into several double-subscripted arrays, forms some coordinate transformation arrays, and calls subroutine SREVNI for matrix inversion.

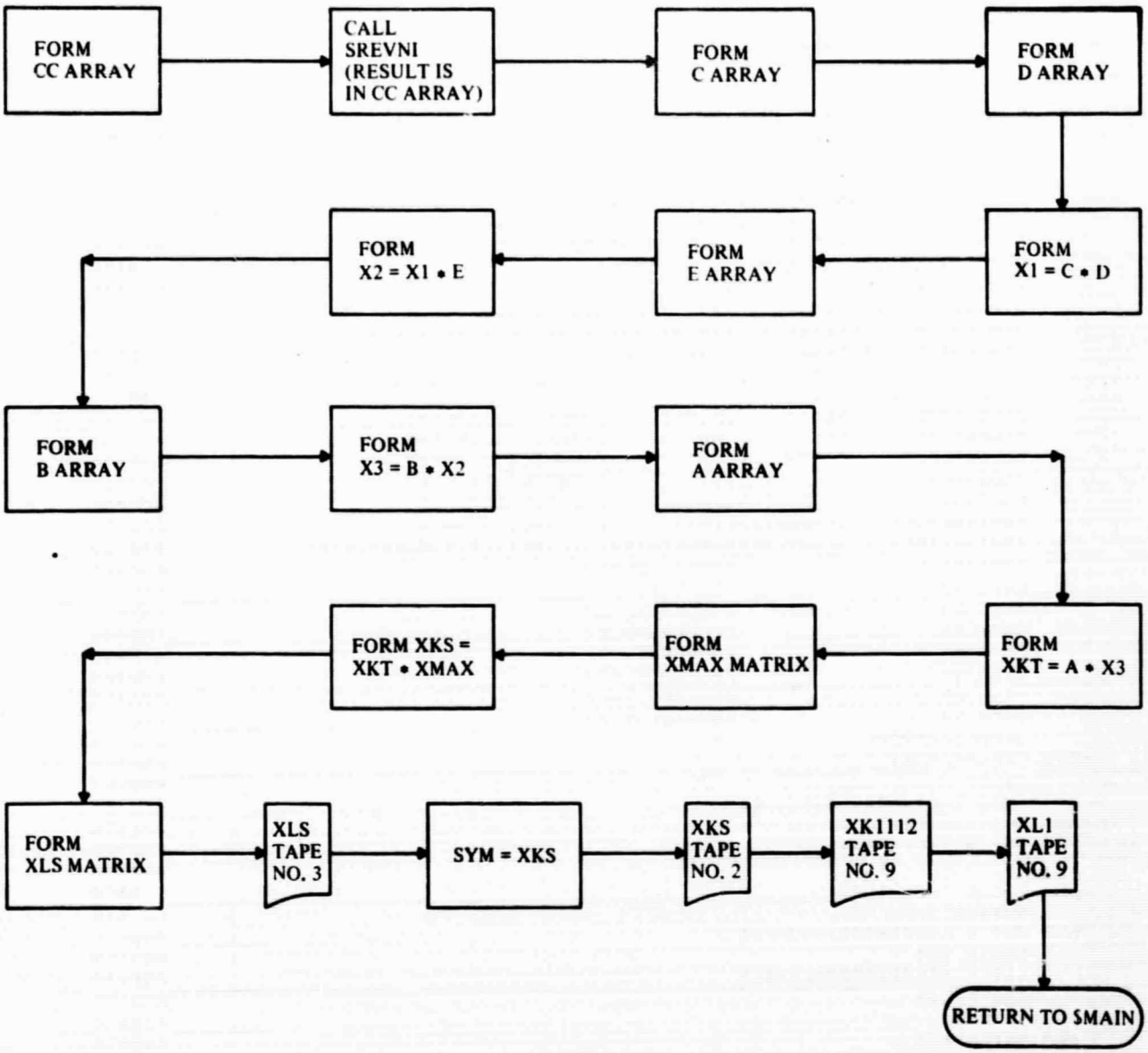
As a result of appropriate matrix operations this subroutine produces a segment stiffness matrix, the XKS array, and a segment load matrix, the XLS array, for each segment. SEGMAT also orients each segment into the global coordinate system of the structure as a result of the matrix operations.

Subroutine SREVNI

SREVNI is a subroutine called by SEGMAT to invert a real, single-precision, in-core matrix utilizing Gauss-Jordan elimination with partial pivoting.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 5)
SNI	si
SNJ	sj
CSI	ci
CSJ	cj
A MATRIX	$\left[\begin{array}{c\|c} IFT & 0 \\ \hline 0 & JFT \end{array}\right]$
B MATRIX	$\left[\begin{array}{c\|c\|c} 0 & I_4 & 0 \\ \hline X_1 & X_2 & X_3 \end{array}\right]$
C MATRIX	$\left[\begin{array}{c\|c\|c} I_4 & 0 & 0 \\ \hline 0 & Y_2^{-1} & 0 \\ \hline 0 & 0 & I_p \end{array}\right]$
D MATRIX	$\left[\begin{array}{c\|c\|c} I_4 & 0 & 0 \\ \hline -Y_1 & JDT^T & -Y_3 \\ \hline 0 & 0 & I_p \end{array}\right]$
E MATRIX	$\left[\begin{array}{c\|c\|c} IDT^T & 0 & 0 \\ \hline 0 & I_4 & 0 \\ \hline 0 & 0 & I_p \end{array}\right]$
XKT MATRIX	$\left[k \mid \ell\right]$
XMAX MATRIX	$\left[\begin{array}{c\|c} 2\pi r_0(i) & \\ \hline & 2\pi r_0(j) \end{array}\right]$
XKS MATRIX	$s\left[\hat{k}\right]^{(n)}$
XLS MATRIX	$s\left[\hat{\ell}\right]^{(n)}$

SEGMAT


FORM CC ARRAY
CALL SREVNI (RESULT IS IN CC ARRAY)
FORM C ARRAY
FORM D ARRAY
FORM X1 = C * D
FORM E ARRAY
FORM X2 = X1 * E
FORM B ARRAY
FORM X3 = B * X2
FORM A ARRAY
FORM XKT = A * X3
FORM XMAX MATRIX
FORM XKS = XKT * XMAX
FORM XLS MATRIX
XLS TAPE NO. 3
SYM = XKS
XKS TAPE NO. 2
XK1112 TAPE NO. 9
XL1 TAPE NO. 9
RETURN TO $MAIN

```
C ***** ROUTINE **SEGM     ** ABACUS UPDATED 07/23/69 *****                    600000
C ***** ROUTINE **SEGMAT   ** ABACUS UPDATED 06/20/68 *****                    600010
      SUBROUTINE SEGMAT                                                       600020
      COMMON STORY(16),TALE(16)                                               600030
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)       600040
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                      600050
      COMMON SADLS(60),RADUS(60)                                              600060
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP            600070
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOUT             600080
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                     600090
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,   0   ,NSMAX                     600100
      INTEGER SAVJTC,SAVSTP                                                   600110
      COMMON /LYCORR/ YCORR(144)                                              600120
      DIMENSION C(18,18),CC(4,4),D(18,18),E(18,18),B(8,18),A(8,8)             600130
      DIMENSION X1(18,18),X2(18,18),X3(8,18),XKT(8,18),XMAX(8,18)             600140
      DIMENSION XKS(8,18),XLS(8,10),SYM(8,8)                                  600150
      DIMENSION  DEAD(4)                                                      600160
      DIMENSION LABEL(16)                                                     600170
      DIMENSION     N1(2)     ,N2(2)     ,N3(2)     ,N4(2)                   600180
      DIMENSION     N5(2)     ,N6(2)     ,N7(2)     ,N8(2)                   600190
      EQUIVALENCE   (LABEL( 1),N1)      ,(LABEL( 3),N2)                       600200
      EQUIVALENCE   (LABEL( 5),N3)      ,(LABEL( 7),N4)                       600210
      EQUIVALENCE   (LABEL( 9),N5)      ,(LABEL(11),N6)                       600220
      EQUIVALENCE   (LABEL(13),N7)      ,(LABEL(15),N8)                       600230
      EQUIVALENCE (C,E,X3,XMAX,XLS),(X2,D,A,XKS),(X1,B,XKT,SYM)               600240
      DATA N1                  /8HFORCE T1/                                   600250
      DATA N2                  /8HFORCE Z1/                                   600260
      DATA N3                  /8HFORCE R1/                                   600270
      DATA N4                  /8HMOMENT 1/                                   600280
      DATA N5                  /8HFORCE T2/                                   600290
      DATA N6                  /8HFORCE Z2/                                   600300
      DATA N7                  /8HFORCE R2/                                   600310
      DATA N8                  /8HMOMENT 2/                                   600320
      WRITE(6,1726)                                                           600330
 1726 FORMAT(1H1)                                                             600340
      A1=G1                                                                   600350
      GOTO (601,602,603),IGEOM                                                600360
  601 SNI = SIN(TIC)                                                          600370
      SNJ = SIN(STOP)                                                         600380
      CSI = COS(TIC)                                                          600390
      CSJ = COS(STOP)                                                         600400
      GOTO 1                                                                  600410
  602 SNI = COS(1.5707963-A1)                                                 600420
      SNJ = SNI                                                               600430
      CSI = SIN(1.5707963-A1)                                                 600440
      CSJ = CSI                                                               600450
      GOTO 1                                                                  600460
  603 SNI = 1.0                                                               600470
      SNJ = 1.0                                                               600480
      CSI = 0.0                                                               600490
      CSJ = 0.0                                                               600500
    1 JJ = 8*NPROB                                                            600510
      DO 111 J=1,18                                                           600520
      DO 111 I=1,18                                                           600530
  111 C(I,J)=0.0                                                              600540
      K=28                                                                    600550
      DO 112 J=1,4                                                            600560
      K=K+8                                                                   600570
      L=K                                                                     600580
```

```
      DO 112 I=1,4                                                    600590
      L=L&1                                                           600600
  112 CC(I,J)=YCORR(L)                                                600610
      CALL SREVNI (CC,4,DEAD,4,NIX)                                   600620
      IF (NIX.NE.0) GOTO 8120                                         600630
      J1=0                                                            600640
      DO 113 J=5,8                                                    600650
      J1=J1&1                                                         600660
      II=0                                                            600670
      DO 113 I=5,8                                                    600680
      II=II&1                                                         600690
  113 C(I,J)=CC(II,J1)                                                600700
      DO 114 IJ=1,4                                                   600710
  114 C(IJ,IJ)=1.0                                                    600720
      DO 115 IJ=9,JJ                                                  600730
  115 C(IJ,IJ)=1.0                                                    600740
      DO 116 J=1,18                                                   600750
      DO 116 I=1,18                                                   600760
  116 D(I,J)=0.0                                                      600770
      DO 117 IJ=1,4                                                   600780
  117 D(IJ,IJ)=1.0                                                    600790
      I=5                                                             600800
      D(I,I)=1.0                                                      600810
      D(I&1,I&1)=-SNJ                                                 600820
      D(I&2,I&2)=-SNJ                                                 600830
      D(I&3,I&3)=1.0                                                  600840
      D(I&1,I&2)= CSJ                                                 600850
      D(I&2,I&1)=-CSJ                                                 600860
      DO 218 IJ=9,JJ                                                  600870
  218 D(IJ,IJ)=1.0                                                    600880
      K=-4                                                            600890
      DO 118 J=1,4                                                    600900
      K=K&8                                                           600910
      L=K                                                             600920
      DO 118 I=5,8                                                    600930
      L=L&1                                                           600940
  118 D(I,J)= -YCORR(L)                                               600950
      K=60                                                            600960
      DO 119 J=9,JJ                                                   600970
      K=K&8                                                           600980
      L=K                                                             600990
      DO 119 I=5,8                                                    601000
      L=L&1                                                           601010
  119 D(I,J)=-YCORR(L)                                                601020
      DO 120 J=1,JJ                                                   601030
      DO 120 I=1,JJ                                                   601040
      X1(I,J)=0.0                                                     601050
      DO 120 M=1,JJ                                                   601060
  120 X1(I,J)=X1(I,J)&C(I,M)*D(M,J)                                   601070
      DO 121 J=1,18                                                   601080
      DO 121 I=1,18                                                   601090
  121 E(I,J)=0.0                                                      601100
      I=1                                                             601110
      E(I,I)=1.0                                                      601120
      E(I&1,I&1)=-SNI                                                 601130
      E(I&2,I&2)=-SNI                                                 601140
      E(I&3,I&3)=1.0                                                  601150
      E(I&1,I&2)=CSI                                                  601160
      E(I&2,I&1)=-CSI                                                 601170
      DO 122 J=5,JJ                                                   601180
```

```
122 E(J,J)=1.0                                                  601190
    DO 123 J=1,JJ                                               601200
    DO 123 I=1,JJ                                               601210
    X2(I,J)=0.0                                                 601220
    DO 123 M=1,JJ                                               601230
123 X2(I,J)=X2(I,J)&X1(I,M)*E(M,J)                              601240
    DO 124 J=1,JJ                                               601250
    DO 124 I=1,8                                                601260
124 B(I,J)=0.0                                                  601270
    J=4                                                         601280
    DO 125  I=1,4                                               601290
    J=J&1                                                       601300
125 B(I,J)=1.0                                                  601310
    K=-8                                                        601320
    DO 126 J=1,4                                                601330
    K=K&8                                                       601340
    L=K                                                         601350
    DO 126 I=5,8                                                601360
    L=L&1                                                       601370
126 B(I,J)=YCORR(L)                                             601380
    K = 24                                                      601390
    DO 127 J=5,8                                                601400
    K=K&8                                                       601410
    L=K                                                         601420
    DO 127 I=5,8                                                601430
    L=L&1                                                       601440
127 B(I,J)=YCORR(L)                                             601450
    K=56                                                        601460
    DO 128 J=9,JJ                                               601470
    K=K&8                                                       601480
    L=K                                                         601490
    DO 128 I=5,8                                                601500
    L=L&1                                                       601510
128 B(I,J)=YCORR(L)                                             601520
    DO 129 J=1,JJ                                               601530
    DO 129 I=1,8                                                601540
    X3(I,J)=0.0                                                 601550
    DO 129 M=1,JJ                                               601560
129 X3(I,J)=X3(I,J)&B(I,M)*X2(M,J)                              601570
    DO 130 J=1,8                                                601580
    DO 130 I=1,8                                                601590
130 A(I,J)=0.0                                                  601600
    I=1                                                         601610
    A(I,I)=-1.0                                                 601620
    A(I&1,I&1)=SNI                                              601630
    A(I&2,I&2)=SNI                                              601640
    A(I&1,I&2)=CSI                                              601650
    A(I&2,I&1)=-CSI                                             601660
    A(I&3,I&3)=1.0                                              601670
    I=5                                                         601680
    A(I,I)=1.0                                                  601690
    A(I&1,I&1)=-SNJ                                             601700
    A(I&2,I&2)=-SNJ                                             601710
    A(I&3,I&3)=-1.0                                             601720
    A(I&1,I&2)=-CSJ                                             601730
    A(I&2,I&1)=CSJ                                              601740
    DO 131 J=1,JJ                                               601750
    DO 131 I=1,8                                                601760
    XKT(I,J)=0.0                                                601770
    DO 131 M=1,8                                                601780
```

```
  131 XKT(I,J)=XKT(I,J)&A(I,M)*X3(M,J)                                  601790
      PI=3.1415927                                                      601800
      RI=RTICK                                                          601810
      X2PIRI=2.0*PI*RI                                                  601820
      RJ=RESTOP                                                         601830
      X2PIRJ=2.0*PI*RJ                                                  601840
      DO 132 J=1,8                                                      601850
      DO 132 I=1,8                                                      601860
  132 XMAX(I,J)=0.0                                                     601870
      DO 133 I=1,4                                                      601880
  133 XMAX(I,I)=X2PIRI                                                  601890
      DO 134 J=5,8                                                      601900
  134 XMAX(J,J)=X2PIRJ                                                  601910
      WRITE (9) ((XKT(I,J),J=1,  8),I=1,4),IGEOM,G1                     601920
      WRITE(9) ((XKT(I,J),J=9,JJ),I=1,4)                                601930
      DO 135 J=1,JJ                                                     601940
      DO 135 I=1,8                                                      601950
      XKS(I,J)=0.0                                                      601960
      DO 135 M=1,8                                                      601970
  135 XKS(I,J)=XKS(I,J)&XMAX(I,M)*XKT(M,J)                              601980
      WRITE (6,781)                                                     601990
  781 FORMAT(///55X,22HSTIFFENESS COEFFICIENTS,//14X,8HDELTA T1,7X,8HDELTA  602000
     1 Z1,7X,8HDELTA R1,7X,7HTHETA 1,8X,8HDELTA T2,7X,8HDELTA Z2,7X,8HDE    602010
     2LTA R2,7X,7HTHETA 2)                                              602020
      III=0                                                             602030
      DO 20 M=1,8                                                       602040
      II =III+1                                                         602050
      III=II+1                                                          602060
      WRITE(6,23) (LABEL(I),I=II,III), (XKS(M,J),J=1,8)                 602070
   23 FORMAT(/1X,2A4,1X,8(E14.7,1X))                                    602080
   20 CONTINUE                                                          602090
 9968 FORMAT(1H ,8(E14.7,2X)/(9X,8(E14.7,2X)))                          602100
      J1=8                                                              602110
      NSYM=0                                                            602120
      ISEG=0                                                            602130
      NRC1=NRC-1                                                        602140
      IF(NRC1.EQ.0)GOTO 143                                             602150
      DO 244 I=1,NRC1                                                   602160
  244 ISEG=ISEG&NST(I)                                                  602170
  143 ISEG=ISEG&NSC                                                     602180
      SAVTIC(ISEG)=TIC                                                  602190
      WRITE(2) ((XKS(I,J),J= 1,  8),I= 1,  8)                           602200
      DO 137 J=1,8                                                      602210
      DO 137 I=1,8                                                      602220
  137 SYM(I,J)=0.0                                                      602230
      DO 139 I=1,8                                                      602240
      DO 139 J=1,8                                                      602250
  138 SYM(I,J)=XKS(I,J)                                                 602260
      JJ = 2                                                            602270
      N  = 8                                                            602280
      J  = 1                                                            602290
      DO 42  II=1,7                                                     602300
      M  = JJ                                                           602310
      DO 43  I=M,N                                                      602320
      ALPH = ABS(SYM(I,J)) - ABS(SYM(J,I))                              602330
      IF(ALPH) 47,71,48                                                 602340
   47 IF(SYM(I,J).EQ.0.0) GOTO 71                                       602350
      SYM(I,J) = SYM(J,I) / SYM(I,J)                                    602360
      GOTO 43                                                           602370
   48 IF(SYM(J,I).EQ.0.0) GOTO 71                                       602380
```

```
      SYM(I,J) = SYM(I,J) / SYM(J,I)                                    602390
      GOTO 43                                                           602400
   71 SYM(I,J) = 1.0                                                    602410
   43 SYM(J,I) = 0.0                                                    602420
      JJ = JJ +1                                                        602430
      J = J+1                                                           602440
   42 CONTINUE                                                          602450
      WRITE(6,785)                                                      602460
  785 FORMAT(//55X,22HSEGMENT SYMMETRY CHECK.)                          602470
      DO 144 I=1,8                                                      602480
  144 WRITE(6,9968)  (SYM(I,J),J=1,8)                                   602490
      DO 136 J=1,NPROB                                                  602500
      J1=J1&1                                                           602510
      DO 136 I=1,8                                                      602520
  136 XLS(I,J)=XKS( I,J1)                                               602530
      WRITE(3)((XLS(I,J),J=1,NPROB),I=1,8)                              602540
      WRITE (6,782)                                                     602550
  782 FORMAT(//55X,22HSEGMENT LOAD MATRICES .)                          602560
      DO 840 I=1,8                                                      602570
  840 WRITE(6,9968)(XLS(I,J),J=1,NPROB)                                 602580
      GOTO 9999                                                         602590
 8120 IERROR=8120                                                       602600
      NERROR=29                                                         602610
 8888 NIx=1                                                             602620
 9999 RETURN                                                            602630
      END                                                               602640
```

SUBROUTINE REGMAT

The segment stiffness matrices, XKS, and the segment load matrices, XLS, are passed from SEGMAT to REGMAT via Tapes #2 and #3, and are placed in the XKRTOT array and the XLRTOT array, respectively. If kinematic links occur between segments in the region, the XKRTOT array and the XLRTOT array are modified to represent the situation.

A horizontal and vertical partitioning of the XKRTOT array occurs while the XLRTOT array is subjected to a horizontal partitioning only. Appropriate matrix operations are performed upon the partitions of each array, thus reducing the size of the region stiffness and load matrices and resulting in increased program capacity. The results of these manipulations are the region stiffness matrix, XKR, and the region load matrix, XLR.

Subroutines Called from REGMAT

Subroutine SWITCH: Is a routine used to arrange a matrix in a form convenient for use by another routine employing a positive definite method for solving linear algebraic equations.

Subroutine CHASE: Is a routine used to obtain the solution X of the linear system AX = Y, given at least one right side of Y and the positive, definite, symmetric, real coefficient matrix A.

Subroutine FUTILE: Is a routine called from CHASE and used to obtain the factorization of the positive definite, real, symmetric matrix A into the product of a lower triangular matrix and its transpose by utilizing a Cholesky decomposition.

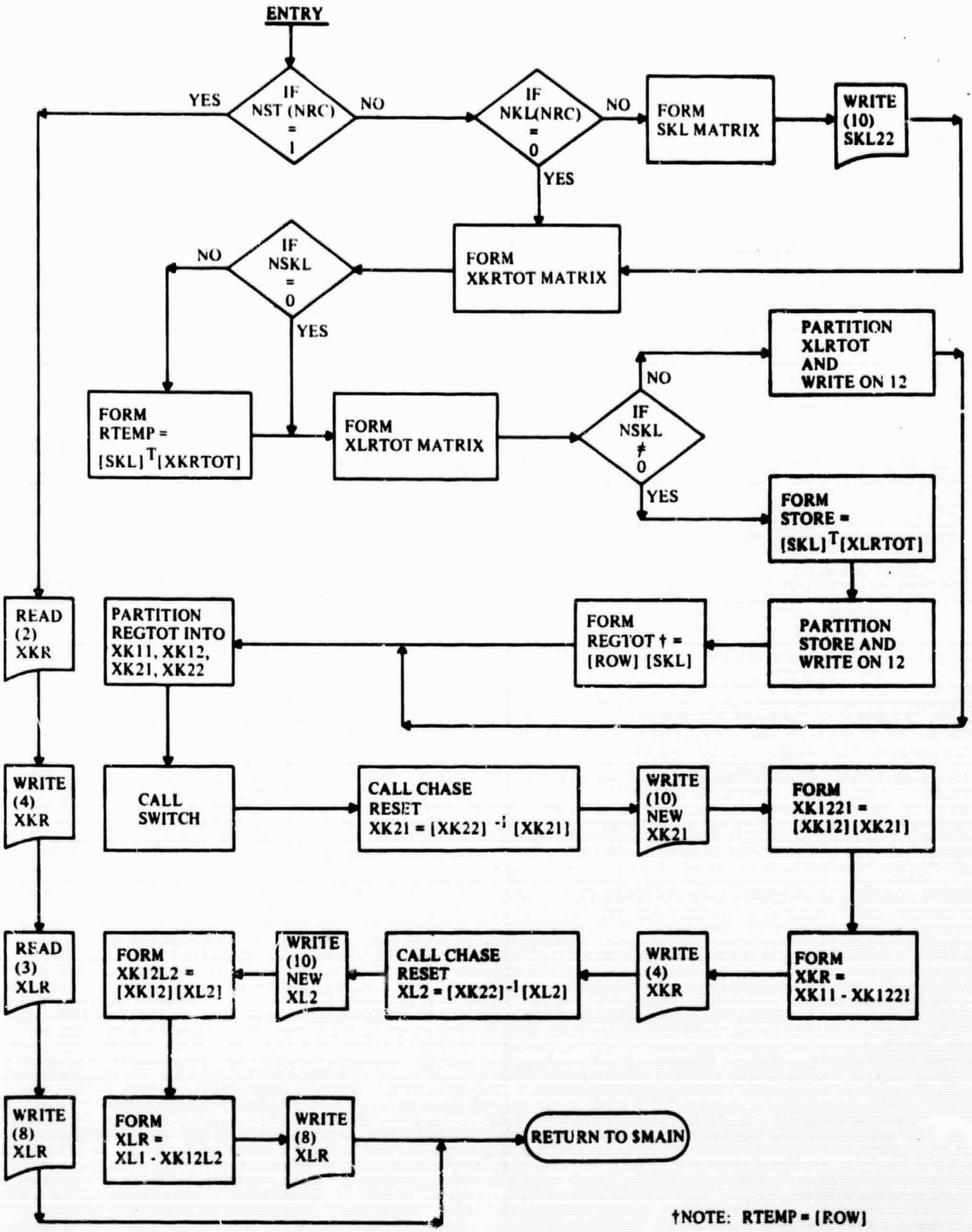
Subroutine HASTEN: Is an assembly language routine used to improve the accuracy of the matrix operation via a double precision summation of inner products - the exact inner products are added in double precision. This routine is called from subroutine FUTILE.

Subroutine TRIEQ: Is a routine called by CHASE to solve a triangular system of algebraic equations.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 6)
SKL MATRIX	$[SKL]$
SKLTR MATRIX	$[SKL]^T$
XKRTOT MATRIX	$\begin{bmatrix} K'_{11} & K'_{12} \\ K'_{21} & K'_{22} \end{bmatrix}$
XLRTOT MATRIX	$\begin{bmatrix} L'_{iR1} \\ L'_{jR1} \\ L' \end{bmatrix}$
SKL22 MATRIX	$[SKL_{22}]$
REGTOT MATRIX	$\begin{bmatrix} K_{11} & K_{12} \\ K_{21} & K_{22} \end{bmatrix}$
STORE MATRIX	$\begin{bmatrix} L_{iR1} \\ L_{jR1} \\ L \end{bmatrix}$
XK11 PARTITION	$[\hat{K}_{11}]$
XK12 PARTITION	$[\hat{K}_{12}]$
XK22 PARTITION	$[\hat{K}_{22}]$
XK21 PARTITION	$[\hat{K}_{21}]$

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 6)
XL1 PARTITION	$\left[\hat{L}_{R1}\right]$
XL2 PARTITION	$\left[\hat{L}\right]$
XKR MATRIX	$\left[\hat{K}_{R}\right]$
XLR MATRIX	$\left[\hat{L}_{R}\right]$

REGMAT



†NOTE: RTEMP = [ROW]

```
      SUBROUTINE REGMAT                                                 700010
      COMMON STORY(16),TALE(16)                                         700020
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                700040
      COMMON SADUS(60),RADUS(60)                                        700050
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP      700060
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOUT       700070
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1               700080
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,   0   ,NSMAX               700090
      COMMON /OPT2/ PRINT                                               700100
      INTEGER SAVJTC,SAVSTP                                             700110
      DIMENSION OPEN(4,4)                                               700120
      DIMENSION XTEMP(8,8),SKL(100,100),SKLTR(100)
      DIMENSION TEMP(4,4)                                               700140
      DIMENSION SYM(8,8)                                                700150
      EQUIVALENCE (SYM,XK12L2)                                          700160
      DIMENSION XKRTOT(100,100),RTEMP(100),XLRTOT(100,10),XKEEP(8,10)
      DIMENSION STORE(100,10),RCW(100),REGTOT(100),HOLD(4,100)
      DIMENSION XK22(100,100),XK11(8,8),XK12(8,100),XK21(100,8)
      DIMENSION XKIV(5050),XK1221(8,8),XKR(8,8)
      DIMENSION XL1(8,10),XL2(100,10),XK12L2(8,10),XLR(8,10)
      DIMENSION JDEP(15),JIND(15),ANGLE(15)                             700220
      DIMENSION LABEL(16)                                               700230
      DIMENSION     N1(2)     ,N2(2)     ,N3(2)     ,N4(2)             700240
      DIMENSION     N5(2)     ,N6(2)     ,N7(2)     ,N8(2)             700250
      EQUIVALENCE   (LABEL( 1),N1)      ,(LABEL( 3),N2)                 700260
      EQUIVALENCE   (LABEL( 5),N3)      ,(LABEL( 7),N4)                 700270
      EQUIVALENCE   (LABEL( 9),N5)      ,(LABEL(11),N6)                 700280
      EQUIVALENCE   (LABEL(13),N7)      ,(LABEL(15),N8)                 700290
      EQUIVALENCE (SKL,XKRTOT,XK22,XKIV,XLRTOT)                         700300
      EQUIVALENCE (XKR,XK11,XTEMP,XLR,XL1,XKEEP,TEMP)                   700310
      EQUIVALENCE (RTEMP,RCW),(SKLTR,REGTOT),(XK1221,XK12L2),(STORE,XL2) 700320
      DATA N1                 /8HFORCE T1/                              700330
      DATA N2                 /8HFORCE Z1/                              700340
      DATA N3                 /8HFORCE R1/                              700350
      DATA N4                 /8HMOMENT 1/                              700360
      DATA N5                 /8HFORCE T2/                              700370
      DATA N6                 /8HFORCE Z2/                              700380
      DATA N7                 /8HFORCE R2/                              700390
      DATA N8                 /8HMOMENT 2/                              700400
      REWIND 2                                                          700410    1
      REWIND 3                                                          700420    2
       REWIND 11                                                        700430    3
      REWIND 12                                                         700440    4
      PRINT = 0.0                                                       700450
      NOJ = NST(NRC) + NKL(NRC) +1                                      700460
      NOJ4 = NOJ*4                                                      700470
      NSKL = NKL(NRC)                                                   700480
      NH4=4                                                             700490
      NJTNH4=NH4*NOJ                                                    700500
      NJINK4 = (NOJ-NSKL)*4                                             700510
      M8=NJINK4-8                                                       700520
      NKIV = NJINK4 - 8                                                 700530
      IF (NS1(NRC).EQ.1) GOTO 1                                         700540
      WRITE(6,1726)                                                     700550   19
```

```
      REG .      - EFN   SOURCE STATEMENT  - IFN(S) -
 1726 FORMAT(1H1)                                                        700560
      WRITE(6,681) NRC,NOJ,NSKL                                          700570     20
  681 FORMAT(////51X31HINPUT DATA FOR SEGMENT COUPLING///25X14HREGION NJ  700580
     1MBER ,I2,5X25HNUMBER OF SEGMENT JOINTS ,I3,5X,26HNUMBER OF KINEMAT 700590
     2IC LINKS ,I3//)                                                    700600
      WRITE(6,682)                                                       700610     21
  682 FORMAT(22X,7HSEGMENT,11X,8HJOINT(I),11X,8HJOINT(J),11X,8HRZERO(I), 700620
     111X,8HRZERO(J)//)                                                  700630
      DO 683 I=1,NSEG                                                    700640
      KTIC = SAVJTC(I)                                                   700650
      KSTOP= SAVSTP(I)                                                   700660
      WRITE(6,684) I,KTIC,KSTOP,RADUS(KTIC),RADUS(KSTOP)                 700670     28
  684 FORMAT(24X,I3,16X,I3,16X,I3,10X,E14.7, 5X,E14.7)                   700680
  683 CONTINUE                                                           700690
      IF (NKL(NRC).EQ.0) GOTO 2                                          700700
      DO 7011 I=1,4                                                      700710
      DO 7011 J=1,4                                                      700720
 7011 TEMP(I,J)=0.C                                                      700730
      DO 501 J=1,NJTNH4                                                  700740
      DO 501 I=1,NJTNH4                                                  700750
  501 SKL(I,J)=0.0                                                       700760
      WRITE(6,685)                                                       700770     57
  685 FORMAT(//60X13HSEGMENT LINKS//43X8HJOINT(J)5X8HJOINT(I)5X20HANGLE  700780
     1OF ORIENTATION//)                                                  700790
      DO 103  NRIG = 1,NSKL                                              700800
      READ (5,503) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG),(TALE(I),I=1,15)    700810     60
  503 FORMAT (2I2,E14.7,15A4)                                            700820
      WRITE(6,686) JDEP(NRIG),JIND(NRIG),ANGLE(NRIG)                     700830     68
  686 FORMAT(45X,I3,10X,I3,11X,E14.7)                                    700840
      IF(JIND(NRIG).GE.JDEP(NRIG)) GO TO 8797                            700850
  103 CONTINUE                                                           700860
      J = -3                                                             700870
      N = 1                                                              700880
      DO 100  IJ = 1,NOJ                                                 700890
      I = 4*IJ-3                                                         700900
      IF(IJ.EQ.JDEP(N)) GOTO 11                                          700910
      J = J + 4                                                          700920
      GOTO 12                                                            700930
   11 JD = JDEP(N)                                                       700940
      JI = JIND(N)                                                       700950
      COTAN = COS(ANGLE(N))/SIN(ANGLE(N))                                700960     96     98
      IF(N.LT.NRIG) N=N+1                                                700970
      SKL(  I,  J) = RADUS(JD)/RADUS(JI)                                 700980
      SKL(I+1,J+3) =-(RADUS(JD)-RADUS(JI))                               700990
      SKL(I+2,J+3) =-SKL(I+1,J+3)*COTAN                                  701000
      GOTO 13                                                            701010
   12 SKL(  I,  J) = 1.0                                                 701020
   13 SKL(I+1,J+1) = 1.0                                                 701030
      SKL(I+2,J+2) = 1.0                                                 701040
      SKL(I+3,J+3) = 1.0                                                 701050
    1 CONTINUE                                                           701060
   50 FORMAT(1H ,8(E14.7,2X)/(5X,8(E14.7,2X)))                           701070
      II = NOJ4 - 4                                                      701080
      JJ = NJINK4 - 4                                                    701090
      DO 768 I=5,II                                                      701100
  768 WRITE(10) (SKL(I,J),J=5,JJ)                                        701110     125
```


2

```
      DO 702 J=1,NJINK4                                                 701120
  702 WRITE(11)  (SKL(I,J),I=1,NOJ4)                                    701130    135
      WRITE(11) ((SKL(I,J),J=1,NJINK4),I=1,NOJ4)                        701140    141
      REWIND  11                                                        701150    151
    2 NNT = NST(NRC)                                                    701160
      DO 350 I=1,100                                                    701170
      DO 350 J=1,100                                                    701180
  350 XKRTOT(I,J)=0.0                                                   701190
  591 FORMAT (3I5,16A4)                                                 701200
      DO 701 NS=1,NNT                                                   701210
      READ(2) ((XTEMP(I,J),J=1,8),I=1,8)                                701220    167
      J1 = SAVJTC(NS)                                                   701230
      J2 = SAVSTP(NS)                                                   701240
      II = 4*(J1-1)                                                     701250
       L = II                                                           701260
      IF (J1.GT.J2) GOTO 950                                            701270
      DO 910  I = 1,8                                                   701280
       JJ = L                                                           701290
      II = II + 1                                                       701300
      DO 910  J = 1,8                                                   701310
      JJ = JJ + 1                                                       701320
  910 XKRTOT(II,JJ)=XKRTOT(II,JJ)+XTEMP(I,J)                            701330
      GOTO 701                                                          701340
  950 JJ = 4*(J2-1)+1                                                   701350
      II = II + 1                                                       701360
      DO 960  JK = 1,4                                                  701370
      GOTO (951,952,953,954) , JK                                       701380
  951 IX = II                                                           701390
      IND = II                                                          701400
      DO 961 I=1,4                                                      701410
      DO 961 J=1,4                                                      701420
  961 OPEN(I,J) = XTEMP(I,J)                                            701430
      GOTO 955                                                          701440
  952 IX = II                                                           701450
      IND = JJ                                                          701460
      DO 962 I=1,4                                                      701470
      DO 962 J=1,4                                                      701480
  962 OPEN(I,J) = XTEMP(I,J+4)                                          701490
      GOTO 955                                                          701500
  953 IX = JJ                                                           701510
      IND = II                                                          701520
      DO 963 I=1,4                                                      701530
      DO 963 J=1,4                                                      701540
  963 OPEN(I,J) = XTEMP(I+4,J)                                          701550
      GOTO 955                                                          701560
  954 IX = JJ                                                           701570
      IND = JJ                                                          701580
      DO 964 I=1,4                                                      701590
      DO 964 J=1,4                                                      701600
  964 OPEN(I,J) = XTEMP(I+4,J+4)                                        701610
  955 DO 956 I=1,4                                                      701620
      JX = IND                                                          701630
      DO 957 J=1,4                                                      701640
      XKRTOT(IX,JX) = XKRTOT(IX,JX) + OPEN(I,J)                         701650
  957 JX = JX + 1                                                       701660
  956 IX = IX + 1                                                       701670
```

```
      REG       -  EFN   SOURCE STATEMENT  -  IFN(S)  -
  960 CONTINUE                                                          701680
  701 CONTINUE                                                          701690
      REWIND   2                                                        701700    273
      IF(NSKL.NE.0) GO TO 931                                           701710
      DO 5504 I=1,NOJ4                                                  701720
      WRITE(2) (XKRTOT(I,J),J=1,NOJ4)                                   701730    279
 5504 CONTINUE                                                          701740
      GO TO 101                                                         701750
  931 DO 740 I=1,NJINK4                                                 701760
      READ(11)(SKLTR(J),J=1,NOJ4)                                       701770    291
      DO 741 J=1,NOJ4                                                   701780
      RTEMP  (J)=0.0                                                    701790
      DO 741 K=1,NOJ4                                                   701800
  741 RTEMP  (J)=RTEMP  (J)+SKLTR(K)*XKRTOT(K,J)                        701810
      WRITE(12) (RTEMP  (J),J=1,NOJ4)                                   701820    307
  740 CONTINUE                                                          701830
      REWIND     11                                                     701840    314
      REWIND 12                                                         701850    315
  101 DO 436 I = 1,NOJ4                                                 701860
      DO 436 J=1,NPROB                                                  701870
  436 XLRTOT(I,J)=0.0                                                   701880
      DO  971 NS = 1,NNT                                                701890
      JTIC = SAVJTC(NS)                                                 701900
      JSTOP= SAVSTP(NS)                                                 701910
      READ (3) ((XKEEP(I,J),J=1,NPROB),I=1,8)                           701920    333
      DO  971 N =1,2                                                    701930
      GOTO (981,982),N                                                  701940
  981 II = (JTIC-1)*4 + 1                                               701950
      III= II + 3                                                       701960
      GOTO 983                                                          701970
  982 II = (JSTOP-1)*4 +1                                               701980
      III= II + 3                                                       701990
  983 DO  971 J=1,NPROB                                                 702000
      I =0                                                              702010
      IF (N.EQ.2) I=4                                                   702020
      DO  971 IL = II,III                                               702030
      I = I + 1                                                         702040
  971 XLRTOT(IL,J)= XLRTOT(IL,J)+ XKEEP(I,J)                            702050
      REWIND 3                                                          702060    365
      IF (NSKL.NE.0) GOTO 147                                           702070
      DO 119 I=1,4                                                      702080
  119 WRITE(3) (XLRTOT(I,J),J=1,NPROB)                                  702090    372
      M3=NJINK4-3                                                       702100
      DO 118 I=M3,NJINK4                                                702110
  118 WRITE(3) (XLRTOT(I,J),J=1,NPROB)                                  702120    383
      M4=NJINK4-4                                                       702130
      DO 117 I=5,M4                                                     702140
  117 WRITE(3) (XLRTOT(I,J),J=1,NPROB)                                  702150    394
      REWIND 3                                                          702160    400
      GOTO 102                                                          702170
  147 DO 747  I=1,NJINK4                                                702180
      READ  (11)  (SKLTR(J),J=1,NOJ4)                                   702190    405
      DO 748  J=1,NPROB                                                 702200
      STORE(I,J)=0.0                                                    702210
      DO 748   K=1,NOJ4                                                 702220
  748 STORE(I,J)=STORE(I,J)+SKLTR(K)*XLRTOT(K,J)                        702230
```

REG - EFN SOURCE STATEMENT - IFN(S) -

```
    747 CONTINUE                                                          702240
        DO 919 I=1,4                                                      702250
    919 WRITE(3) (STORE(I,J),J=1,NPROB)                                   702260    428
        M3=NJINK4-3                                                       702270
        DO 918 I=M3,NJINK4                                                702280
    918 WRITE(3) (STORE(I,J),J=1,NPROB)                                   702290    439
        M4=NJINK4-4                                                       702300
        DO 917 I=5,M4                                                     702310
    917 WRITE(3) (STORE(I,J),J=1,NPROB)                                   702320    450
        REWIND 3                                                          702330    456
        READ(11) ((SKL(I,J),J=1,NJINK4),I=1,NOJ4)                         702340    457
        REWIND 11                                                         702350    467
        DO 750 I=1,NJINK4                                                 702360
        READ(12) (ROW(J),J=1,NOJ4)                                        702370    470
        DO 751 J=1,NJINK4                                                 702380
        REGTOT (J)=0.0                                                    702390
        DO 751 K=1,NOJ4                                                   702400
    751 REGTOT (J)=REGTOT (J) + ROW(K)*SKL(K,J)                           702410
    750 WRITE(2) (REGTOT(J),J=1,NJINK4)                                   702420
C       THE 780 LOOP REARRANGES AND PARTITIONS THE REGION STIFFNESS MATRIX 702430    487
    102 NJINK = NJINK4/4                                                  702440
        REWIND 2                                                          702450    495
        DO 625 INK=1,8                                                    702460
        DO 626 JAK=1,8                                                    702470
    626 XK11(INK,JAK)=0.0                                                 702480
        DO 625 KIX=1,M8                                                   702490
        XK12(INK,KIX)=0.0                                                 702500
        XK21(KIX,INK)=0.0                                                 702510
    625 CONTINUE                                                          702520
        DO 627 KIX=1,M8                                                   702530
        DO 627 LAX=1,M8                                                   702540
    627 XK22(KIX,LAX)=0.0                                                 702550
        NREAD=0                                                           702560
        KOUNT=-8                                                          702570
        NJINK3=NJINK-1                                                    702580
        DO 780 N=1,NJINK                                                  702590
        NREAD=NREAD+1                                                     702600
        KOUNT=KOUNT+4                                                     702610
        DO 781 I=1,4                                                      702620
    781 READ(2) (HOLD(I,J),J=1,NJINK4)                                    702630    532
        IF(NREAD.LE.2.OR.NREAD.GE.NJINK3)GO TO 790                        702640
        KK=KOUNT+1                                                        702650
        KKK=KOUNT+12                                                      702660
        DO 785 L=KK,KKK                                                   702670
        IROW=4*(NREAD-2)                                                  702680
        J=L-4                                                             702690
        DO 785 K=1,4                                                      702700
        IROW=IROW+1                                                       702710
    785 XK22(IROW,J)=HOLD(K,L)                                            702720
        GO TO 780                                                         702730
    790 IF(NREAD.EQ.1)GO TO 791                                           702740
        IF(NREAD.EQ.2)GO TO 792                                           702750
        IF(NREAD.EQ.NJINK3)GO TO 793                                      702760
        IF(NREAD.EQ.NJINK)GO TO 794                                       702770
    791 DO 796 I=1,4                                                      702780
        DO 796 J=1,4                                                      702790
```

```
      REG       - EFN   SOURCE STATEMENT  - IFN(S) -
      XK11(I,J)=HOLD(I,J)                                              702800
      JJ=J+4                                                           702810
  796 XK12(I,J)=HOLD(I,JJ)                                             702820
      GO TO 780                                                        702830
  792 DO 797 I=1,4                                                     702840
      DO 797 J=1,4                                                     702850
      XK21(I,J)=HOLD(I,J)                                              702860
      JJ=J+4                                                           702870
      XK22(I,J)=HOLD(I,JJ)                                             702880
      JJJ=J+8                                                          702890
      IF(NNT.EQ.2)  GO TO 795                                          702900
      XK22(I,JJ)=HOLD(I,JJJ)                                           702910
       GO TO 797                                                       702920
  795 XK21(I,JJ)=HOLD(I,JJJ)                                          702930
  797 CONTINUE                                                         702940
      GO TO 780                                                        702950
  793 M11=NJINK4-11                                                    702960
      M4=NJINK4-4                                                      702970
      M8=NJINK4-8                                                      702980
      KROW=M8-4                                                        702990
      DO 798 I=1,4                                                     703000
      KROW=KROW+1                                                      703010
      KCOL=4                                                           703020
      K8=M8-8                                                          703030
      DO 795 J=M11,M8                                                  703040
      K8=K8+1                                                          703050
      XK22(KROW,K8)=HOLD(I,J)                                          703060
      JJ=J+4                                                           703070
      KK=K8+4                                                          703080
      XK22(KROW,KK)   =HOLD(I,JJ)                                      703090
      JJJ=J+8                                                          703100
      KCOL=KCOL+1                                                      703110
  798 XK21(KROW,KCOL)=HOLD(I,JJJ)                                      703120
      GO TO 780                                                        703130
  794 KEND=NJINK4-8                                                    703140
      KROW=4                                                           703150
      M4=NJINK4-4                                                      703160
      M7=NJINK4-7                                                      703170
      DO 799 I=1,4                                                     703180
      KROW=KROW+1                                                      703190
      K4=KEND-4                                                        703200
      KCOL=4                                                           703210
      DO 799 J=M7,M4                                                   703220
      K4=K4+1                                                          703230
      XK12(KROW,K4)=HOLD(I,J)                                          703240
      KCOL=KCOL+1                                                      703250
      JJ=J+4                                                           703260
  799 XK11(KROW,KCOL)=HOLD(I,JJ)                                       703270
  780 CONTINUE                                                         703280
 7703 NSING=NKIV*(NKIV+1)/2                                            703290
      N=NKIV                                                           703300
      IK=1                                                             703310
      DO 10 K=1,N                                                      703320
      DO 10 I=K,N                                                      703330
      XKIV(IK)=XK22(I,K)                                               703340
   10 IK=IK+1                                                          703350
```

```
      REG       - EFN   SOURCE STATEMENT  - IFN(S)  -
      CALL SWITCH (XKIV,-NKIV)                                          703360    670
      CALL CHASE (XKIV,NKIV,XK21,8,100,NIX)                             703370    672
      IF (NIX.LT.0) GOTO 8841                                           703380
      WRITE (10) ((XK21(I,J),J=1,8),I=1,M8    )                         703390    676
      WRITE (10)(( SAVJTC(I), SAVSTP(I)),I=1,NNT)                       703400    686

      DO 81 J=1,8                                                       703410
      DO 81 I=1,8                                                       703420
      XK1221(I,J)=0.0                                                   703430
      DO 81 K=1,NKIV                                                    703440
   81 XK1221(I,J)=XK1221(I,J)+XK12(I,K)*XK21(K,J)                       703450
      DO 82 J=1,8                                                       703460
      DO 82 I=1,8                                                       703470
   82 XKR(I,J)=XK11(I,J)-XK1221(I,J)                                    703480
      WRITE (4) ((XKR(I,J),J=1,8),I=1,8)                                703490    722
 7840 CONTINUE                                                          703500
      WRITE(6,5011)                                                     703510    732
 5011 FORMAT(////55X23HREGION STIFFNESS MATRIX//14X8HDELTA T17X8HDELTA Z 703520
     11,7X,8HDELTA R1,7X,7HTHETA 1,8X,8HDELTA T2,7X,8HDELTA Z2,7X,8HDELT 703530
     2A R2,7X,7HTHETA 2)                                                703540
      III=0                                                             703550
      DO 687 M=1,8                                                      703560
      II=III+1                                                          703570
      III=II+1                                                          703580
      WRITE(6,688)  (LABEL(I),I=II,III),(XKR(M,J),J=1,8)                703590    738
  688 FORMAT(/1X,2A4,1X,8(E14.7,1X))                                    703600
  687 CONTINUE                                                          703610
      DO 137 J=1,8                                                      703620
      DO 137 I=1,8                                                      703630
  137 SYM(I,J)=0.0                                                      703640
      DO 138 I=1,8                                                      703650
      DO 138 J=1,8                                                      703660
  138 SYM(I,J)=XKR(I,J)                                                 703670
      JJ = 2                                                            703680
      N  = 8                                                            703690
      J  = 1                                                            703700
      DO 42  II=1,7                                                     703710
      M  = JJ                                                           703720
      DO 43  I=M,N                                                      703730
      ALPH = ABS(SYM(I,J)) - ABS(SYM(J,I))                              703740
      IF(ALPH) 47,71,48                                                 703750
   47 IF(SYM(I,J).EQ.0.0) GOTO 71                                       703760
      SYM(I,J) = SYM(J,I) / SYM(I,J)                                    703770
      GOTO 43                                                           703780
   48 IF(SYM(J,I).EQ.0.0) GOTO 71                                       703790
      SYM(I,J) = SYM(I,J) / SYM(J,I)                                    703800
      GOTO 43                                                           703810
   71 SYM(I,J) = 1.0                                                    703820
   43 SYM(J,I) = 0.0                                                    703830
      JJ = JJ +1                                                        703840
      J = J+1                                                           703850
   42 CONTINUE                                                          703860
      WRITE(6,157)                                                      703870    807
  157 FORMAT(//56X,21HREGION SYMMETRY CHECK/)                           703880
      DO 1730 I=1,8                                                     703890
```

```
      REG        - EFN   SOURCE STATEMENT  - IFN(S)  -
      WRITE(6,5000) (SYM(I,J),J=1,8)                                  703900    810
 1730 CONTINUE                                                        703910
      DO 819 I=1,4                                                    703920
  819 READ(3)  (XL1(I,J),J=1,NPROB)                                   703930    821
      DO 818 I=5,8                                                    703940
  818 READ(3)  (XL1(I,J),J=1,NPROB)                                   703950    831
      M8 = NJINK4-8                                                   703960
      DO 817 I=1,M8                                                   703970
  817 READ(3)  (XL2(I,J),J=1,NPROB)                                   703980    843
      CALL CHASE (XKIV,NKIV,XL2,-NPROB,100,NIX)                       703990    850
      IF (NIX.LT.0) GOTO 8842                                         704000
      WRITE (10) ((XL2(I,J),J=1,NPROB),I=1,M8    )                    704010    854
      NL2=NPROB                                                       704020
      DO 205  J=1,NPROB                                               704030
      DO 205  I=1,8                                                   704040
      XK12L2(I,J)=0.0                                                 704050
      DO 205  K=1,NKIV                                                704060
  205 XK12L2(I,J)=XK12L2(I,J)+XK12(I,K)*XL2(K,J)                      704070
      DO 206  J=1,NPROB                                               704080
      DO 206  I=1,8                                                   704090
  206 XLR(I,J)=XL1(I,J)-XK12L2(I,J)                                   704100
      WRITE(8) ((XLR(I,J),J=1,NPROB),I=1,8)                           704110    893
      WRITE(6,5012)                                                   704120    903
 5012 FORMAT(//57X,18HREGION LOAD MATRIX/)                            704130
      DO 5512 I=1,8                                                   704140
 5512 WRITE(6,5000)  (XLR(I,J),J=1,NPROB)                             704150    907
      GOTO 150                                                        704160
 8841 IERROR=8841                                                     704170
      NERROR=30                                                       704180
      GOTO 150                                                        704190
 8797 IERROR = 8797                                                   704200
      NERROR=33                                                       704210
      GO TO 150                                                       704220
 8842 IERROR=8842                                                     704230
      NERROR=31                                                       704240
      GOTO 150                                                        704250
    1 READ (2) ((XKR(I,J),J=1,8),I=1,8)                               704260    924
      WRITE(4) ((XKR(I,J),J=1,8),I=1,8)                               704270    934
      READ(3)  ((XLR(I,J),J=1,NPROB),I=1,8)                           704280    944
      WRITE(8) ((XLR(I,J),J=1,NPROB),I=1,8)                           704290    954
  150 RETURN                                                          704300
      END
```

```
      SUBROUTINE SWITCH(A,M)                                          1100010
      DIMENSION A(1)                                                  1100020
      N = IABS(M)                                                     1100030
      IF (N - 2) 190,190,90                                           1100040
   90 L = (N*(N+1)) / 2                                               1100050
      KEY = 1                                                         1100060
      LOCK = N/2 + 1                                                  1100070
      IF (M) 100,190,160                                              1100080
  100 IF (N - 3) 110,140,110                                          1100090
  110 KKT = 3                                                         1100100
      NKF = N - 1                                                     1100110
      IMAGE = L                                                       1100120
      INTO = L - 3                                                    1100130
      I = 3                                                           1100140
      DO 130  K = 2,LOCK                                              1100150
      DO 120  IK = KKT,NKF                                            1100160
      X = A(IK)                                                       1100170
      A(IK) = A(INTO)                                                 1100180
      A(INTO) = X                                                     1100190
      INTO = INTO - I                                                 1100200
  120 I = I + 1                                                       1100210
      KKT = NKF + K                                                   1100220
      NKF = NKF + N - K                                               1100230
      IMAGE = IMAGE - K                                               1100240
      INTO = IMAGE                                                    1100250
  130 I = K                                                           1100260
  140 IF (KEY) 150,190,150                                            1100270
  150 KEY = 0                                                         1100280
  160 LOV2 = L / 2                                                    1100290
      K = L - 2                                                       1100300
      DO 170  I = 3,LOV2                                              1100310
      X = A(I)                                                        1100320
      A(I) = A(K)                                                     1100330
      A(K) = X                                                        1100340
  170 K = K - 1                                                       1100350
      IF (KEY) 180,190,180                                            1100360
  180 KEY = 0                                                         1100370
      GO TO 100                                                       1100380
  190 RETURN                                                          1100390
      END
```

CHA - EFN SOURCE STATEMENT - IFN(S) -

```
      SUBROUTINE CHASE(A,MO,Y,NO,MID,NIX)
      REAL A(1),Y(1)
      COMMON /WINTER/ INDIC8
      COMMON /BOND/ M,L
      COMMON /OPT2/ PRINT
    9 FORMAT(12H1SOLUTION(S)/1H0)
   10 FORMAT (I5,1P8E15.7/(5X,8E15.7))
      M = MO
      INDIC8 = 0
      N = IABS(NO)
      IF (NO) 110,100,100
  100 CALL FUTILE(A,M,NIX)                                          7
      IF (NIX) 170,110,110
  110 PRINT = 0.0
      IF (PRINT .GT. 0.0)  WRITE(6,9)                               11
      MK1 = 1
      L = 1
      I1 = M
      DO 160  K = 1,N
      CALL TRIEQ(A,Y(MK1))                                          19
      IF (PRINT .GT. 0.) WRITE (6,10) K,(Y(K1), K1 = MK1,I1)        22
      I1 = I1 + MID
      MK1 = MK1 + MID
  160 CONTINUE
  170 RETURN
      END
```

STEXT HASTEN HAST0001

```
                                        ENTRY   PRELIM
                                        ENTRY   DOT
                                        ENTRY   PROLOG
                                        ENTRY   ADJ

BINARY CARD (NOT PUNCHED)
00000  0500 00 4 00003  10000  PRELIM  CLA     3,4
00001  0402 00 0 00077  10001          SUB     =1
00002  0621 00 0 00022  10001          STA     LOAD
00003  0500 60 4 00004  10000          CLA*    4,4
00004  0767 00 0 00022  10000          ALS     18
00005  0760 00 0 00006  10000          COM
00006  0622 00 0 00021  10001          STD     LOOP
00007  0500 00 4 00005  10000          CLA     5,4
00010  0402 00 0 00077  10001          SUB     =1
00011  0621 00 0 00023  10001          STA     MULT
00012  0500 60 4 00006  10000          CLA*    6,4
00013  0402 00 0 00100  10001          SUB     =1820
00014  0767 00 0 00022  10000          ALS     18
00015  0622 00 0 00027  10001          STD     INC
00016  0020 00 4 00001  10000          TRA     1,4
00017  0634 00 1 00036  10001  DOT     SXA     XR1,1
00020  4774 00 1 00001  10000          AXC     1,1
00021  7 00000 1 00027  10001  LOOP    TXL     INC,1,**
00022  0560 00 1 00000  10000  LOAD    LDQ     **,1

BINARY CARD (NOT PUNCHED)
00023  0260 00 1 00000  10000  MULT    FMP     **,1
00024  0301 00 0 06000  10011          DFAD    SUM
00025  4603 00 0 06000  10011          DST     SUM
00026  1 77777 1 00021  10001          TXI     LOOP,1,-1
00027  1 00000 1 01001  10011  INC     TXI     **+1,1,**
00030  4634 00 1 00021  10001          SXD     LOOP,1
00031  0500 60 4 00003  10000          CLA*    3,4
00032  0400 00 0 00023  10001          ADD     MULT
00033  0621 00 0 00023  10001          STA     MULT
00034  0500 00 0 06000  10011          CLA     SUM
00035  0760 00 0 00011  10000          FRN
00036  0774 00 1 00000  10000  XR1     AXT     0,1
00037  0020 00 4 00001  10000          TRA     1,4
00040  0500 00 4 00003  10000  PROLOG  CLA     3,4
00041  0402 00 0 00077  10001          SUB     =1
00042  0621 00 0 00073  10001          STA     ADD
00043  0621 00 0 00075  10001          STA     GET
00044  0500 60 4 00004  10000          CLA*    4,4
00045  0767 00 0 00022  10000          ALS     18

BINARY CARD (NOT PUNCHED)
00046  0760 00 0 00006  10000          COM
00047  0622 00 0 00070  10001          STD     LOOR
00050  0500 00 4 00005  10000          CLA     5,4
00051  0402 00 0 00077  10001          SUB     =1
00052  0621 00 0 00072  10001          STA     MPY
00053  0500 60 4 00006  10000          CLA*    6,4
```

ASSEMBLED TEXT.

```
00054  0400 00 0 00100  10001          ADD     =1820
00055  0767 00 0 00022  10000          ALS     18
00056  0622 00 0 00065  10001          STD     INF
00057  0020 00 4 00001  10000          TRA     1,4
00060  0634 00 1 00036  10001  ADJ     SXA     XR1,1
00061  0500 00 0 00072  10001          CLA     MPY
00062  0402 60 4 00003  10000          SUB*    3,4
00063  0621 00 0 00072  10001          STA     MPY
00064  4534 00 1 00070  10001          LXD     LOOR,1
00065  1 00000 1 00001  10011  INF     TXI     *+1,1,**
00066  4634 00 1 00070  10001          SXD     LOOR,1
00067  4774 00 1 00001  10000          AXC     1,1
00070  7 00000 1 00036  10001  LOOR    TXL     XR1,1,**

BINARY CARD (NOT PUNCHED)
00071  0560 00 0 06000  10011          LDQ     SJM
00072  0260 00 1 00000  10000  MPY     FMP     **,1
00073  0300 00 1 00000  10000  ADD     FAD     **,1
00074  0760 00 0 00011  10000          FRN
00075  0601 00 1 00000  10000  GET     STO     **,1
00076  1 77777 1 00070  10001          TXI     LOOR,1,-1
                                SUMMER  CONTRL  SJMMER
00101  100CCC000101      00001          USE     SUMMER
00101  200CCC000002      00001  SUM     BSS     2
00077  100CC0000077      00001          USE
00077  CCCCC0000001      10000          *LORG
00100  CCJCC0100000      10000
                  00000  01111          END
```

SCDICT HASTEN HAST0002

```
BINARY CARD (NOT PUNCHED)
                0001C3000000            PREFACE   START=0,LENGTH=67,TYPE=7094,CMPLX=5
                0000C4000005
                302162632545  HASTEN DECK       LOC=0,LENGTH=67
                0001C3000000
                47512543314A  PRELIM REAL       LOC=0,LENGTH=0
                000000000000
                2446636060    DOT    REAL       LOC=17,LENGTH=0
                000000000017
                47514643462?  PROLOG REAL       LOC=40,LENGTH=0
                000000000040
                212441606060  ADJ    REAL       LOC=60,LENGTH=0
                000000000060
                626444442551  SUMMER REAL       LOC=101,LENGTH=2
                000002000101
```

SDKEND HASTEN HAST0003

NO MESSAGES FOR THIS ASSEMBLY

07/01/68

FUT - EFN SOURCE STATEMENT - IFN(S) -

```
      SUBROUTINE FUTILE(A,N,SCORE)
      DIMENSION A(1)
      COMMON /OPT1/ DETERM
      COMMON /OVFLOW/ OVFLOW
      DOUBLE PRECISION SUM
      COMMON /SUMMER/ SUM
      DATA CATCH/0100000/
      EQUIVALENCE (SUM,SUM)
      INTEGER SCORE
      SCORE = 0
      K1 = 1
      KK = 0
      DO 210 K = 1,N
      KK = KK + K
      CALL PRELIM(A(K1),K-1,A(K1),0)                                    9
      IK = KK
      DO 140 I = K,N
      SUM = -A(IK)
      IF (I - K) 120,100,120
  100 DENOM = -DOT(I)                                                   19
      DETERM = DENOM * DETERM
      IF (DENOM) 980,980,110
  110 DENOM = -SQRT(DENOM)                                              22
      A(IK) = -DENOM
      GO TO 130
  120 CALL DOT(I)

      A(IK) = SUM / DENOM
  130 IK = IK + I
  140 CONTINUE
      K1 = K1 + K
  210 CONTINUE
      IF (AND(OVFLOW,CATCH)) 220,230,220
  220 SCORE = 1
      OVFLOW = 0.
  230 RETURN
  980 SCORE = -1
      RETURN
       END
```

```
      SUBROUTINE TRIEQ(A,Y)
      REAL A(1),Y(1)
      DOUBLE PRECISION SUM
      COMMON /SUMMER/ SUM
      COMMON /WINTER/INDIC8
      COMMON /BOND/ M,L
      EQUIVALENCE (SUN,SUM)
      IF (INDIC8) 130,100,100
  100 II = 0
      CALL PRELIM(Y(L),0,A(L),1)                                        7
      DO 110  I = L,M
      II = II + I
      SUM = -Y(I)
      Y(I) = -DOT(I) / A(II)                                           14
  110 CONTINUE
      IF (INDIC8) 150,140,160
  130 II = (M*(M+1)) / 2
  140 I = M
      IIL1 = II + L
      CALL PROLOG(Y(L),M+1-L,A(IIL1),1)                                27
      DO 150  MII = L,M
      SUN = -Y(I) / A(II)
      Y(I) = -SUN
      CALL ADJ(I)                                                      35
      II = II - I
      I = I - 1
  150 CONTINUE
  160 RETURN
      END
```

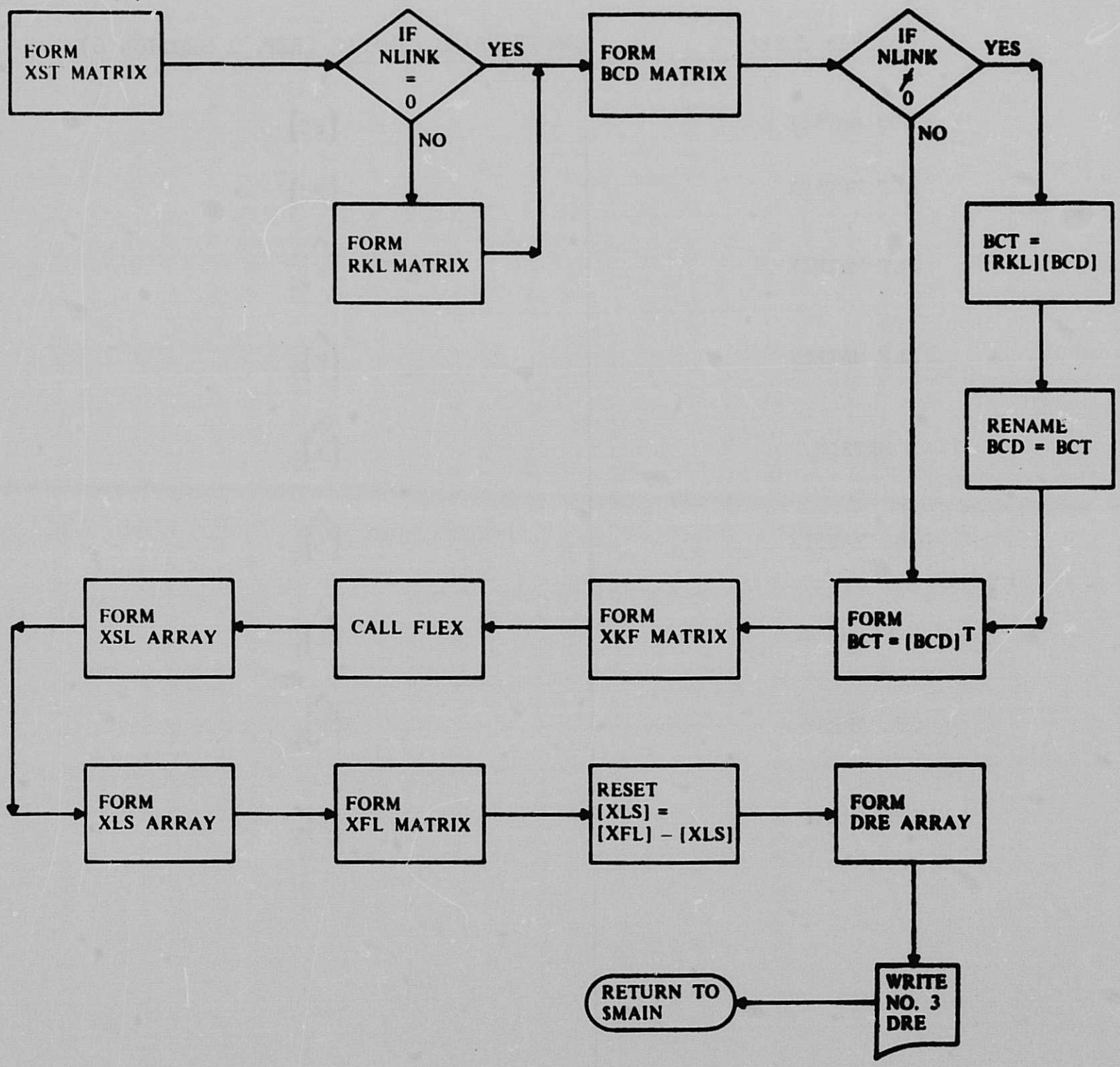
SUBROUTINE STRMAT

The region stiffness matrices, XKR, and the region load matrices, XLR, are passed from REGMAT to STRMAT via Tape #4 and Tape #8, and are placed in the XKSTOT array and the XLSTOT array, respectively. A matrix, BCD, is formed to represent the boundary conditions, and, if kinematic links occur between regions, the RKL matrix is developed to represent this situation.

As a result of appropriate matrix operations, a reduced structure stiffness matrix is formed. Subroutine FLEX, a routine identical to SREVNI with the name changed due to the structure of the OVERLAY option, is called to invert this matrix thus producing A, the flexibility matrix for the structure. The region end deflection array, DRE, is produced as the result of another set of matrix operations.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 6)
BCD MATRIX	$[BC]$
BCT MATRIX	$[BC]^T$
XST MATRIX	$[\hat{K}]_T$
XKF MATRIX	$[\hat{K}]_F$
A MATRIX	$[\hat{A}]_F$
XSL MATRIX	$[\hat{L}]_T$
XLS ARRAY	$\{\hat{L}\}_F$
XFL ARRAY	$\{\hat{F}\}_F$
DRE ARRAY	$\{\Delta\}_T$

STRMAT


FORM XST MATRIX
IF NLINK = 0
YES
NO
FORM RKL MATRIX
FORM BCD MATRIX
IF NLINK ≠ 0
YES
NO
BCT = [RKL][BCD]
RENAME BCD = BCT
FORM BCT = [BCD]T
FORM XKF MATRIX
CALL FLEX
FORM XSL ARRAY
FORM XLS ARRAY
FORM XFL MATRIX
RESET [XLS] = [XFL] – [XLS]
FORM DRE ARRAY
WRITE NO. 3 DRE
RETURN TO SMAIN

STR - EFN SOURCE STATEMENT - IFN(S) -

```
      SUBROUTINE STRMAT                                                  800010
      COMMON STORY(16),TALE(16)                                          800020
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                 800040
       COMMON SADUS(60), RADUS(60)                                       800050
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP       800060
      COMMON NRGEND,NSYM,NRG,NRC,NSC,N X,IERROR,RESTOP,RTICK,IOUT        800070
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                800080
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,    0    ,NSMAX              800090
      INTEGER SAVJTC,SAVSTP                                              800100
      DIMENSION ICOL(10)                                                 800110
      DIMENSION RKL(80,80),OPEN(4,4)
      DIMENSION IREG(30)                                                 800130
      DIMENSION DLP(4),BCD(80,80),TEMP(80),BCT(80),XKF(80),BC(80)
      DIMENSION A(80,80),XSL(80,10),XFL(80,10),DRE(80,10),BCA(80)
      DIMENSION XKR(8,8),XSTR(80),XLS(80,10),XLR(8,10)
      DIMENSION XST(80,80),XSTBC(80,80)
      DIMENSION COLTTL(2)                                                800180
      EQUIVALENCE (XST,BCD,A,XSTBC)                                      800190
      EQUIVALENCE (XSTR,XKF)                                             800200
      EQUIVALENCE (XFL,XSL,DRE)                                          800210
      EQUIVALENCE (XKR,XLR)                                              800220
      EQUIVALENCE (BC,BCT,BCA)                                           800230
      REWIND  1                                                          800240    1
      REWIND  2                                                          800250    2
      REWIND  3                                                          800260    3
      REWIND  4                                                          800270    4
      REWIND  8                                                          800280    5
      REWIND  9                                                          800290    6
    1 FORMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))                           800300
  101 FORMAT (3I5,16A4)                                                  800310
      DATA  COLTTL /8H  COLUMN/                                          800320
      WRITE(6,1726)                                                      800330    7
 1726 FORMAT(1H1)                                                        800340
      READ (5,101) NOJ,NLINK                                             800350    8
      NH4=4                                                              800360
      NH8=8                                                              800370
      NJTNH4=NOJ*NH4                                                     800380
      DO 102  J=1,NJTNH4                                                 800390
      DO 102  I=1,NJTNH4                                                 800400
  102 XST(I,J)=0.0                                                       800410
      DO 100 NR=1,NREG                                                   800420
      READ(4) ((XKR(I,J),J=1,8),I=1,8)                                   800430   26
      J1=JRTIC(NR)                                                       800440
      J2=JRSTOP(NR)                                                      800450
      II=4*(J1-1)                                                        800460
  450 JJ=4*(J2-1)+1                                                      800470
      II=II+1                                                            800480
      DO 460 JK=1,4                                                      800490
      GO TO (451,452,453,454),JK                                         800500
  451 IX=II                                                              800510
      IND=II                                                             800520
      DO 461 I=1,4                                                       800530
      DO 461 J=1,4                                                       800540
  461 OPEN(I,J)=XKR(I,J)                                                 800550
```

```
      GO TO 455                                                          800560
  452 IX=II                                                              800570
      IND=JJ                                                             800580
      DO 462 I=1,4                                                       800590
      DO 462 J=1,4                                                       800600
  462 OPEN(I,J)=XKR(I,J+4)                                               800610
      GO TO 455                                                          800620
  453 IX=JJ                                                              800630
      IND=II                                                             800640
      DO 463 I=1,4                                                       800650
      DO 463 J=1,4                                                       800660
  463 OPEN(I,J)=XKR(I+4,J)                                               800670
      GO TO 455                                                          800680
  454 IX=JJ                                                              800690
      IND=JJ                                                             800700
      DO 464 I=1,4                                                       800710
      DO 464 J=1,4                                                       800720
  464 OPEN(I,J)=XKR(I+4,J+4)                                             800730
  455 DO 456 I=1,4                                                       800740
      JX=IND                                                             800750
      DO 457 J=1,4                                                       800760
      XST(IX,JX)=XST(IX,JX)+OPEN(I,J)                                    800770
  457 JX=JX+1                                                            800780
  456 IX=IX+1                                                            800790
  460 CONTINUE                                                           800800
  100 CONTINUE                                                           800810
      DO 107 I=1,NJTNH4                                                  800820
  107 WRITE (2)  (XST(I,J),J=1,NJTNH4)                                   800830    119
      REWIND 2                                                           800840    126
      REWIND 4                                                           800850
C  GENERATION OF BC BOUNDARY CONDITION SCRAMBLING MATRIX                 800860    127
      WRITE(6,347) NOJ,NLINK                                             800870    128
  347 FORMAT(////51X30HINPUT DATA FOR REGION COUPLING///31X24HNUMBER OF   800880
     1REGION JOINTS ,I3,14X26HNUMBER OF KINEMATIC LINKS ,I3///25X6HREGI)  800890
     2N11X8HJOINT(I)11X8HJOINT(J)11X8HRZERO(I)11X8HRZERO(J)///)          800900
      DO 348 I=1,NREG                                                    800910
      KTIC=JRTIC(I)                                                      800920
      KSTOP=JRSTOP(I)                                                    800930
      WRITE(6,349) I,KTIC,KSTOP,SADUS(KTIC),SADUS(KSTOP)                 800940    135
  349 FORMAT(27X,I2,16X,I3,16X,I3,10X,E14.7,5X,E14.7)                    800950
  348 CONTINUE                                                           800960
      IF(NLINK.EQ.0) GO TO 3108                                          800970
      DO 756 I=1,NJTNH4                                                  800980
      DO 756 J=1,NJTNH4                                                  800990
  756 RKL(I,J)=0.0                                                       801000
      DO 757 I = 1,NJTNH4                                                801010
  757 RKL(I,I) = 1.0                                                     801020
      DO 789 I=1,4                                                       801030
      DO 789 J=1,4                                                       801040
  789 OPEN(I,J)=0.0                                                      801050
      OPEN(2,2) = 1.0                                                    801060
      OPEN(3,3) = 1.0                                                    801070
      OPEN(4,4) = 1.0                                                    801080
      WRITE(6,1824)                                                      801090    171
 1824 FORMAT(//60X,12HREGION LINKS//43X,8HJOINT(J),5X,8HJOINT(I),        801100
     15X,20HANGLE OF ORIENTATION)                                        801110
```

```
      STR        -  EFN   SOURCE STATEMENT  -  IFN(S)  -
      DO 502 NRIG=1,NLINK                                                801120
      READ(5,503) JD,JI,COTAN,(TALE(I),I=1,13)                           801130    174
  503 FORMAT (2I2,E14.7,13A4)                                            801140
      WRITE(6,1828) JD,JI,COTAN                                          801150    181
 1828 FORMAT(46X,I2,11X,I2,11X,E14.7)                                    801160
      COTAN = COS(COTAN)/SIN(COTAN)                                      801170    182  183
      OPEN(1,1) = SADUS(JD) / SADUS(JI)                                  801180
      OPEN(2,4) = - (SADUS(JD)-SADUS(JI))                                801190
      OPEN(3,4) = - OPEN(2,4)* COTAN                                     801200
      IXX= JD*4-3                                                        801210
      DO 504 I=1,4                                                       801220
      JXX= JI*4-3                                                        801230
      DO 505 J=1,4                                                       801240
      RKL(IXX,JXX)=OPEN(I,J)                                             801250
  505 JXX=JXX+1                                                          801260
  504 IXX=IXX+1                                                          801270
  502 CONTINUE                                                           801280
      DO 781 I=1,NJTNH4                                                  801290
  781 WRITE (3) (RKL(I,J),J=1,NJTNH4)                                    801300    208
      REWIND 3                                                           801310    214
 3108 CONTINUE                                                           801320
      DO 108 J=1,NJTNH4                                                  801330
      DO 108 I=1,NJTNH4                                                  801340
  108 BCD(I,J)=0.0                                                       801350
      ICR =1                                                             801360
      WRITE(6,2372)                                                      801370    226
 2372 FORMAT(///////57X19HBOUNDARY CONDITIONS//30X5HJOINT5X7HDELTA T,5X,7 801380
     1HDELTA Z,5X,7HDELTA R,5X,7H THETA ,7X,11HANGLE ALPHA)              801390
      DO 109 J=1,NOJ                                                     801400
      READ (5,110) JN,DLP(1),DLP(2),DLP(3),DLP(4),ANGLE                  801410    229
  110 FORMAT  (I2,4F2.0,E14.1)                                           801420
      I1 = DLP(1)                                                        801430
      I2 = DLP(2)                                                        801440
      I3 = DLP(3)                                                        801450
      I4 = DLP(4)                                                        801460
      WRITE(6,2373) JN,I1,I2,I3,I4,ANGLE                                 801470    234
 2373 FORMAT(/31X,I3,9X,I2,10X,I2,10X,I2,10X,I2, 7X,E14.7)               801480
      II  = (4*JN)-3                                                     801490
      DO 121 I=1,4                                                       801500
      IF(DLP(I)-1.0) 113,114,115                                         801510
  115 IF(DLP(I)-2.0) 116,116,117                                         801520
  114 BCD(II,ICR)=1.0                                                    801530
      GOTO 118                                                           801540
  116 BCD(II,ICR)=SIN(ANGLE)                                             801550    247
      BCD(II+1,ICR)= -COS(ANGLE)                                         801560    249
      GOTO 118                                                           801570
  117 BCD(II-1,ICR)=COS(ANGLE)                                           801580    253
      BCD(II,ICR)=SIN(ANGLE)                                             801590    255
  118 ICR=ICR+1                                                          801600
  113 II=II+1                                                            801610
  121 CONTINUE                                                           801620
  109 CONTINUE                                                           801630
      ICR=ICR-1                                                          801640
      NZ=ICR                                                             801650
      IF(NLINK.EQ.0) GO TO 3124                                          801660
      DO 783 N=1,NJTNH4                                                  801670
```

```
      READ (3) (TEMP(M),M=1,NJTNH4)                                  801680    271
      DO 782 J=1,NZ                                                  801690
      BCT(J)=0.0                                                     801700
      DO 782 I=1,NJTNH4                                              801710
  782 BCT(J)=BCT(J)+TEMP(I)*BCD(I,J)                                 801720
  783 WRITE (4)  (BCT(L),L=1, NZ)                                    801730    288
      REWIND 3                                                       801740    294
      REWIND 4                                                       801750    295
      DO 126 M=1,NJTNH4                                              801760
      READ(4)  (BCT(J),J=1,NZ)                                       801770    298
      DO 126 N=1,NZ                                                  801780
      BCD(M,N) = 0.0                                                 801790
  126 BCD(M,N) = BCT(N)                                              801800
C     AT THIS POINT THE BCD ARRAY IS THE PRODUCT OF RKL AND BCD ARRAYS 801810
 3124 CONTINUE                                                       801820
      DO 124 J=1,NZ                                                  801830
  124 WRITE (3)  (BCD(I,J),I=1,NJTNH4)                               801840    316
      DO 125 I=1,NJTNH4                                              801850
  125 WRITE (3)  (BCD(I,J),J=1,NZ)                                   801860    326
      REWIND 3                                                       801870    332
      REWIND 4                                                       801880    333
      DO 180  L=1,NJTNH4                                             801890
      READ (2) (XSTR(J),J=1,NJTNH4)                                  801900    336
      DO 184  M=1,NZ                                                 801910
      TEMP(M)=0.0                                                    801920
      DO 181  N=1,NJTNH4                                             801930
  181 TEMP(M)=TEMP(M)+XSTR(N)*BCD(N,M)                               801940
  184 CONTINUE                                                       801950
      WRITE (4) (TEMP(I),I=1,NZ)                                     801960    353
  180 CONTINUE                                                       801970
      REWIND 4                                                       801980    360
      DO 183  II=1,NJTNH4                                            801990
  183 READ (4) (XSTBC(II,JJ),JJ=1,NZ)                                802000    364
      REWIND 4                                                       802010    370
      DO 182  N=1,NZ                                                 802020
      READ (3) (BCT(J),J=1,NJTNH4)                                   802030    373
      DO 185  M=1,NZ                                                 802040
      XKF(M)=0.0                                                     802050
      DO 186  K=1,NJTNH4                                             802060
  186 XKF(M)=XKF(M)+BCT(K)*XSTBC(K,M)                                802070
  185 CONTINUE                                                       802080
      WRITE (4) (XKF(I),I=1,NZ)                                      802090    390
  182 CONTINUE                                                       802100
      REWIND 2                                                       802110    397
      REWIND 4                                                       802120    398
      DO 187 I=1,NZ                                                  802130
  187 READ(4) (A(I,J),J=1,NZ)                                        802140    402
      CALL FLEX (A,NZ,XSTR,80,NIX)                                   802150    409
      IF(NIX.NE.0) GOTO 8777                                         802160
      WRITE(6,1726)                                                  802170    413
      WRITE(6,2365)                                                  802180    414
 2365 FORMAT(50X,31H THE REDUCED FLEXIBILITY MATRIX/)                802190
      NUMBER = 2                                                     802200
      JJ = 0                                                         802210
      JJJ = 0                                                        802220
 1725 JJ = JJJ + 1                                                   802230
```

```
      JJJ = JJJ + 2                                                    802240
      MM = 8                                                           802250
      IF (JJJ.GT.NZ) MM=8-(JJJ-NZ)                                     802260
      MMM = JJ                                                         802270
      IF(JJJ.GT.NZ) JJJ=NZ                                             802280
      DO 1721 M=1,MM                                                   802290
      ICOL(M)=MMM                                                      802300
 1721 MMM = MMM + 1                                                    802310
      NUMBER = NUMBER + 3                                              802320
      WRITE(6,1729) ((COLTTL,ICOL(M)),M=1,MM)                          802330    434

 1729 FORMAT(/10H   ROW     ,8(2A4,1X,I3,3X)/)                         802340
      DO 1722 I=1,NZ                                                   802350
      NUMBER = NUMBER + 1                                              802360
      WRITE(6,1728)I,(A(I,J),J=JJ,JJJ)                                 802370    445
 1728 FORMAT(3X,I3,4X,8(E14.7,1X))                                     802380
      IF(NUMBER.LT.55) GO TO 1722                                      802390
      NUMBER = 3                                                       802400
      WRITE(6,1726)                                                    802410    453
      WRITE(6,1729) ((COLTTL,ICOL(M)),M=1,MM)                          802420    454

 1722 CONTINUE                                                         802430
      IF(JJJ.NE.NZ) GO TO 1725                                         802440
      DO 804 L=1,NJTNH4                                                802450
      READ(3) (BC(I),I=1,NZ)                                           802460    468
      DO 716 M=1,NZ                                                    802470
      TEMP(M) = 0.0                                                    802480
      DO 805 N=1,NZ                                                    802490
  805 TEMP(M) = TEMP(M) + BC(N)*A(N,M)                                 802500
  716 CONTINUE                                                         802510
      WRITE (2) (TEMP(I),I=1,NZ)                                       802520    485
  804 CONTINUE                                                         802530
      REWIND 2                                                         802540    492
      REWIND 3                                                         802550    493
      DO 991 J=1,NPROB                                                 802560
      DO 991 I=1,NJTNH4                                                802570
  991 XSL(I,J) = 0.0                                                   802580
 1001 DO 777 NR=1,NREG                                                 802590
      J1 = JRTIC(NR)                                                   802600
      J2 = JRSTOP(NR)                                                  802610
      READ(3) ((XLR(I,J),J=1,NPROB),I=1,NH8)                           802620    511
      DO 777 N2 = 1,2                                                  802630
      GOTO (11,12),N2                                                  802640
   11 II = (J1-1)*NH4+1                                                802650
      III= II+NH4-1                                                    802660
      GOTO 3                                                           802670
   12 II = (J2-1)*4+1                                                  802680
      III= II+NH4-1                                                    802690
    3 DO 777 J=1,NPROB                                                 802700
      I=0                                                              802710
      IF(N2.EQ.2) I=NH4                                                802720
      DO 777 IL=II,III                                                 802730
      I=I+1                                                            802740
  777 XSL(IL,J) = XSL(IL,J)+XLR(I,J)                                   802750
```

```
      STR        -  EFN   SOURCE STATEMENT  -  IFN(S)  -
      DO 876 N=1,NZ                                                    802760
      READ(3) (BCT(J),J=1,NJTNH4)                                      802770    546
      DO 717 M=1,NPROB                                                 802780
      XLS(N,M) = 0.0                                                   802790
      DO 806 K=1,NJTNH4                                                802800
  806 XLS(N,M) = XLS(N,M) + BCT(K)*XSL(K,M)                            802810
  717 CONTINUE                                                         802820
  876 CONTINUE                                                         802830
      REWIND 3                                                         802840    566
      DO 301 J=1,NPROB                                                 802850
      DO 301 I=1,NZ                                                    802860
  301 XFL(I,J) = 0.0                                                   802870
      READ(5,302)  LINLOD,(STORY(I),I=1,16)                            802880    576
  302 FORMAT(I4,16A4)                                                  802890
      IF(LINLOD.EQ.0)  GO TO 303                                       802900
      WRITE(6,341)                                                     802910    586
  341 FORMAT(1H1///57X,19HEXTERNAL LINE LOADS///36X,14HPROBLEM NUMBER,7X 802920
     12HPOINT OF APPLICATION,7X,12HAPPLIED LOAD//)                     802930
      DO 304 N=1,LINLOD                                                802940
      READ(5,305) JEXT2,JEXT1,XFL(JEXT1,JEXT2)                         802950    589
  305 FORMAT(2I5,E14.7)                                                802960
      WRITE(6,342) JEXT2,JEXT1,XFL(JEXT1,JEXT2)                        802970    593
  342 FORMAT(41X,I3,22X,I3,15X,E14.7)                                  802980
  304 CONTINUE                                                         802990
  303 DO 811 J=1,NPROB                                                 803000
      DO 811 I=1,NZ                                                    803010
  811 XLS(I,J)=XFL(I,J)-XLS(I,J)                                       803020
      REWIND 3                                                         803030    611
      DO 812 J=1,NJTNH4                                                803040
      READ (2) (BCA(K),K=1,NZ)                                         803050    614
      DO 813 M=1,NPROB                                                 803060
      DRE(J,M)=0.0                                                     803070
      DO 813 N=1,NZ                                                    803080
  813 DRE(J,M)=DRE(J,M)+BCA(N)*XLS(N,M)                                803090
  812 CONTINUE                                                         803100
      WRITE(6,1726)                                                    803110    633
      WRITE(6,2368)                                                    803120    634
 2368 FORMAT(31X,70HTHE EXPANDED REGION JOINT DISPLACEMENT MATRIX (REGI) 803130
     1N END DEFLECTIONS))                                              803140
      WRITE(6,1770)                                                    803150    635
 1770 FORMAT(//14X,5HJOINT,14X,7HPROBLEM,13X,7HDELTA T,13X,7HDELTA Z,13X 803160
     1,7HDELTA R,11X,11HOMEGA-THETA)                                   803170
      NUMBER = 4                                                       803180
      KK=-3                                                            803190
      DO 1735 J=1,NOJ                                                  803200
      NUMBER = NUMBER + NPROB + 1                                      803210
      IF(NUMBER.LT.56) GO TO 1745                                      803220
      WRITE(6,1726)                                                    803230    644
      WRITE(6,1770)                                                    803240    645
      NUMBER=2+NPROB+3                                                 803250
 1745 KK=KK+4                                                          803260
      KKK=KK+3                                                         803270
      WRITE(6,1739)                                                    803280    648
 1739 FORMAT(1H )                                                      803290
      DO 1764 L=1,NPROB                                                803300
      WRITE(6,1765) J,L,(DRE(K,L),K=KK,KKK)                            803310    650
```

```
1765 FORMAT(15X,I2,18X,I2,9X,4(3X,E14.7,3X))                    803320
1764 CONTINUE                                                   803330
1735 CONTINUE                                                   803340
     DO 71  NR=1,NREG                                           803350
     DO 71  K=1,2                                               803360
     II =(JRTIC(NR) - 1) *4 +1                                  803370
     IF(K.EQ.2) II= JRSTOP(NR)*4-3                              803380
     III= II + 3                                                803390
     DO 71 I = II,III                                           803400
  71 WRITE(3) (DRE(I,J),J=1,NPROB)                              803410    673
     REWIND 2                                                   803420    681
     REWIND 3                                                   803430    682
     REWIND 4                                                   803440    683
     GUTO 7                                                     803450
8777 IERROR =8777                                               803460
     NERROR=32                                                  803470
     NIX=1                                                      803480
   7 RETURN                                                     803490
     END
```

FLE - EFN SOURCE STATEMENT - IFN(S) -

```
      SUBROUTINE FLEX  (A,M,LOC,MID,NIX)                                1200010
      REAL A(MID,1)                                                     1200020
      INTEGER LOC(1)                                                    1200030
  100 N = M                                                             1200040
      DO 190  K = 1,N                                                   1200050
      PIVOT = 0.                                                        1200060
      DO 120  I = K,N                                                   1200070
      IF (PIVOT - ABS(A(I,K))) 110,110,120                              1200080
  110 PIVOT = ABS(A(I,K))                                               1200090
      L = I                                                             1200100
  120 CONTINUE                                                          1200110
      IF (PIVOT) 140,130,140                                            1200120
  130 NIX = -1                                                          1200130
      GO TO 210                                                         1200140
  140 LOC(K) = L                                                        1200150
      DO 150  J = 1,N                                                   1200160
      TEMP1 = A(K,J)                                                    1200170
      A(K,J) = A(L,J)                                                   1200180
  150 A(L,J) = TEMP1                                                    1200190
      TEMP1 = A(K,K)                                                    1200200
      A(K,K) = 1.                                                       1200210
      DO 160  J = 1,N                                                   1200220
  160 A(K,J) = A(K,J)/TEMP1                                             1200230
      DO 190  I = 1,N                                                   1200240
      IF (I - K) 170,190,170                                            1200250
  170 TEMP1 = -A(I,K)                                                   1200260
      A(I,K) = 0.                                                       1200270
      DO 180    J = 1,N                                                 1200280
  180 A(I,J) = A(I,J) + TEMP1*A(K,J)                                    1200290
  190 CONTINUE                                                          1200300
      DO 200  K = 1,N                                                   1200310
      NK = N - K                                                        1200320
      L = LOC(NK+1)                                                     1200330
      DO 200  I = 1,N                                                   1200340
      TEMP1 = A(I,NK+1)                                                 1200350
      A(I,NK+1) = A(I,L)                                                1200360
  200 A(I,L) = TEMP1                                                    1200370
      NIX = 0                                                           1200380
  210 RETURN                                                            1200390
       END
```

SUBROUTINE INITAL

As a result of the matrix operations performed in REGMAT, the SKL22, the XK2221, and the XK22L2 arrays for each region are passed to INITAL. The XK1112 and XL1 arrays for each segment, resulting from the matrix procedures in SEGMAT, are also passed to INITAL. The region end deflection matrices, DRE, were formed in STRMAT and are transmitted to INITAL.

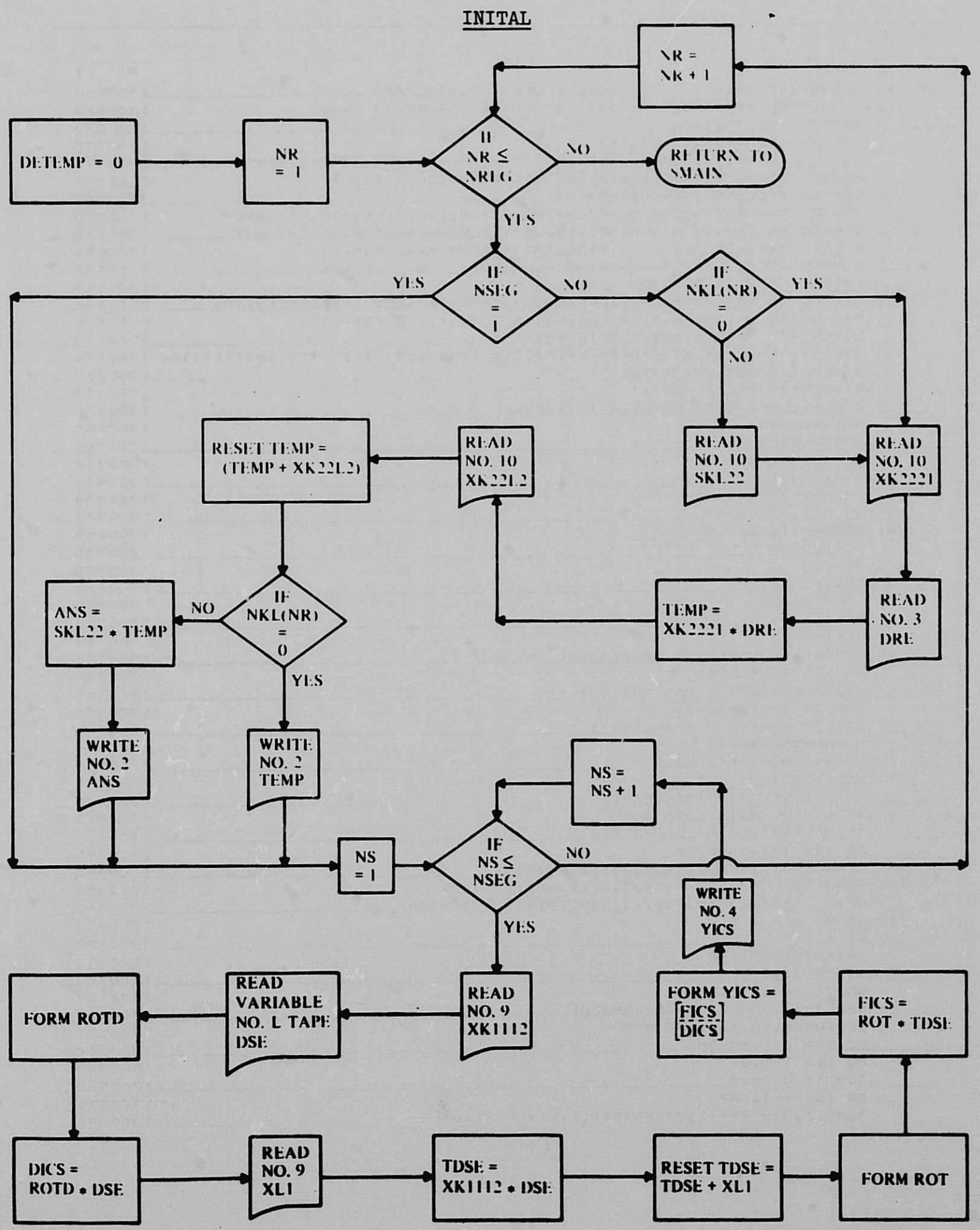
Following appropriate matrix operations upon these arrays, the force initial conditions, the FICS array, and the deflections initial conditions, the DICS array, are produced. These arrays combine to form the YICS matrix, which contains the true initial conditions for the structure to be analyzed.

The pertinent counters in the subroutine are:

NS = segment counter

NR = region counter

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 6)
XK2221 MATRIX	$\left[\hat{K}_{22}\right]^{-1} \left[\hat{K}_{21}\right]$
XK22L2 MATRIX	$\left[\hat{K}_{22}\right]^{-1} \left[\hat{L}\right]$
DSE ARRAY	$\{\Delta\}$
XK1112 MATRIX	$\left[k_{ii} \mid k_{ij}\right]$
ROTD MATRIX	$\left[IDT\right]^{T}$
DICS ARRAY	$\{\delta(i)\}$
XL1 ARRAY	$\{\ell(i)\}$
ROT MATRIX	$\left[IFT\right]^{T}$
FICS ARRAY	$\{f(i)\}$


INITAL
NR = NR + 1
DETEMP = 0
NR = 1
IF NR ≤ NREG
NO
RETURN TO SMAIN
YES
IF NSEG = 1
YES
NO
IF NKL(NR) = 0
YES
NO
RESET TEMP = (TEMP + XK22L2)
READ NO. 10 XK22L2
READ NO. 10 SKL22
READ NO. 10 XK2221
ANS = SKL22 * TEMP
NO
IF NKL(NR) = 0
TEMP = XK2221 * DRE
READ NO. 3 DRE
YES
WRITE NO. 2 ANS
WRITE NO. 2 TEMP
NS = NS + 1
NS = 1
IF NS ≤ NSEG
NO
YES
WRITE NO. 4 YICS
FORM ROTD
READ VARIABLE NO. L TAPE DSE
READ NO. 9 XK1112
FORM YICS = [FICS] [DICS]
FICS = ROT * TDSE
DICS = ROTD * DSE
READ NO. 9 XL1
TDSE = XK1112 * DSE
RESET TDSE = TDSE + XL1
FORM ROT

```
C ..... ROUTINE **INIT    ** ABACUS UPD. ED 07/22/69 .....                1300000
C ..... ROUTINE **INITAL  ** ABACUS UPDATED 06/20/68 .....                1300010
      SUBROUTINE INITAL                                                   1300020
      COMMON STORY(16),TALE(16)                                           1300030
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)   1300040
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                  1300050
      COMMON SACS(60),RADUS(60)                                           1300060
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP        1300070
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOUT         1300080
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                 1300090
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,    Q    ,NSMAX               1300100
      INTEGER SAVJTC,SAVSTP                                               1300110
      DIMENSION XK2221(112,8),DRE(8,10),TEMP(112,10),XK22L2(112,10)       1300120
      DIMENSION XK1112(4,8),DSE(8,10),ROTD(4,4), DICS(4,10)               1300130
      DIMENSION TDSE(8,10),TDRE(8,10)                                     1300140
      DIMENSION XL1(4,10),ROT(4,4),FICS(4,10),SKL22(112,112),ANS(112,10)  1300150
      DIMENSION DETEMP( 4,10)                                             1300160
      DIMENSION YICS( 8,10)                                               1300170
      EQUIVALENCE (ROT,ROTD),(TIC,TICK)                                   1300180
      NH4=4*NHARM                                                         1300190
      NH41=NH4&1                                                          1300200
      NH8=8*NHARM                                                         1300210
      NH81=NH8&1                                                          1300220
      DO 991 J=1,NPROB                                                    1300230
      DO 991 I=1,NH4                                                      1300240
  991 DETEMP(I,J)=0.0                                                     1300250
      REWIND  2                                                           1300260
      REWIND  3                                                           1300270
      REWIND  4                                                           1300280
       REWIND  8                                                          1300290
      REWIND  9                                                           1300300
      REWIND 10                                                           1300310
    1 FORMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))                            1300320
      DO 100 NR=1,NREG                                                    1300330
      NOJ = NST(NR) & NKL(NR) & 1                                         1300340
      ISKL22 = 4*(NOJ-2)                                                  1300350
      JSKL22 = 4*(NOJ-2-NKL(NR))                                          1300360
      NJTNH4=NOJ*NH4                                                      1300370
      MB=4*(NOJ-NKL(NR))-8                                                1300380
      NSEG=NST(NR)                                                        1300390
      NH4NS1=(NHARM*4)*(NSEG-1)                                           1300400
      IF (NSEG.EQ.1) GOTO 703                                             1300410
      IF(NKL(NR).EQ.0) GO TO 415                                          1300420
      DO 425 I=1,ISKL22                                                   1300430
  425 READ (10) (SKL22(I,J),J=1,JSKL22)                                   1300440
  415 READ(10)  ((XK2221(I,J),J=1,NH8),I=1,MB)                            1300450
      READ  (10)(( SAVJTC(I), SAVSTP(I)),I=1,NSEG)                        1300460
  703 DO 91 K = 1,2                                                       1300470
      II = 1                                                              1300480
      IF(K.EQ.2) II=5                                                     1300490
      III = II+3                                                          1300500
      DO 91 I=II,III                                                      1300510
   91 READ(3) (DRE(I,J),J=1,NPROB)                                        1300520
      IF (NSEG.EQ.1) GOTO 999                                             1300530
      DO 101 J=1,NPROB                                                    1300540
      DO 101 I=1,MB                                                       1300550
      TEMP(I,J)=0.0                                                       1300560
      DO 101 K=1,NH8                                                      1300570
      TEMP(I,J)=TEMP(I,J)&XK2221(I,K)*DRE(K,J)                            1300580
```

```
101 CONTINUE                                                          1300590
    READ(10)((XK22L2(I,J),J=1,NPROB),I=1,MB)                          1300600
    DO 102 J=1,NPROB                                                  1300610
    DO 102 I=1,MB                                                     1300620
102 TEMP(I,J)= -(TEMP(I,J)*XK22L2(I,J))                               1300630
    IF(NKL(NR).EQ.0) GO TO 435                                        1300640
    DO 445 I = 1,ISKL22                                               1300650
    DO 445 J=1,NPROB                                                  1300660
    ANS(I,J)=0.0                                                      1300670
    DO 445 K = 1,JSKL22                                               1300680
445 ANS(I,J)=ANS(I,J)+SKL22(I,K)*TEMP(K,J)                            1300690
435 DO 391 N=1,NSEG                                                   1300700
    IF((N.EQ.1.OR.N.EQ.NSEG).AND.SAVJTC(N).GT.SAVSTP(N)) GO TO 370    1300710
    DO 398 K=1,2                                                      1300720
    IF (N.NE.1.OR.K.NE.1) GOTO 393                                    1300730
    DO 394 I= 1,4                                                     1300740
394 WRITE (2) (DRE(I,J),J=1,NPRCB)                                    1300750
    GO TO 398                                                         1300760
393 IF(N.EQ.NSEG.AND.K.EQ.2) GOTO 395                                 1300770
    IF (K.EQ.1) II =SAVJTC(N)*4-7                                     1300780
    IF (K.EQ.2) II = SAVSTP(N)*4-7                                    1300790
    III= II + 3                                                       1300800
    DO 397 I=II,III                                                   1300810
    IF (NKL(NR).EQ.0) GOTO 392                                        1300820
    WRITE (2) (ANS(I,J),J=1,NPRCB)                                    1300830
    GOTO 397                                                          1300840
392 WRITE (2) (TEMP(I,J),J=1,NPROB)                                   1300850
397 CONTINUE                                                          1300860
    GO TO 398                                                         1300870
395 DO 396 I=5,8                                                      1300880
396 WRITE (2)  (DRE(I,J),J=1,NPROB)                                   1300890
398 CONTINUE                                                          1300900
    GO TO 391                                                         1300910
370 IF(N.EQ.NSEG) GO TO 380                                           1300920
    IF(NKL(NR).EQ.0) GO TO 375                                        1300930
    DO 371 I=1,4                                                      1300940
371 WRITE(2) (ANS(I,J),J=1,NPRCB)                                     1300950
    GO TO 376                                                         1300960
375 DO 372 I=1,4                                                      1300970
372 WRITE(2) (TEMP(I,J),J=1,NPRCB)                                    1300980
376 DO 373 I=1,4                                                      1300990
373 WRITE(2) (DRE(I,J),J=1,NPRCB)                                     1301000
    GO TO 391                                                         1301010
380 II =MB - 3                                                        1301020
    III = MB                                                          1301030
    DO 381 I=5,8                                                      1301040
381 WRITE(2) (DRE(I,J),J=1,NPRCB)                                     1301050
    IF(NKL(NR).EQ.0) GO TO 385                                        1301060
    DO 382 I=II,III                                                   1301070
382 WRITE(2) (ANS(I,J),J=1,NPRCB)                                     1301080
    GO TO 391                                                         1301090
385 DO 383 I=II,III                                                   1301100
383 WRITE(2) (TEMP(I,J),J=1,NPRCB)                                    1301110
391 CONTINUE                                                          1301120
    REWIND 2                                                          1301130
999 DO 201 NS=1,NSEG                                                  1301140
    READ  (9) ((XK1112(I,J),J=1,NHB),I=1,NHA),IGEOM,G1                1301150
    ISEG=0                                                            1301160
    NR1=NR-1                                                          1301170
    IF(NR1.EQ.0)GOTO9                                                 1301180
```

```
      DO 7 I=1,NR1                                                    1301190
    7 ISEG=ISEG&NST(I)                                                1301200
    8 ISEG=ISEG&NS                                                    1301210
      TIC= SAVTIC(ISEG)                                               1301220
      GO TO (21,22,23),IGEOM                                          1301230
   21 SN = SIN(TIC)                                                   1301240
      CS=COS(TIC)                                                     1301250
      GO TO 25                                                        1301260
   22 SN = COS(1.5707963-G1)                                          1301270
      CS = SIN(1.5707963-G1)                                          1301280
      GO TO 25                                                        1301290
   23 SN = 1.0                                                        1301300
      CS = 0.0                                                        1301310
   25 CONTINUE                                                        1301320
      IF (NSEG.EQ.1) GOTO 76                                          1301330
      DO 78 I = 1,8                                                   1301340
   78 READ (2) (DSE(I,J),J=1,NPROB)                                   1301350
      GOTO 80                                                         1301360
   76 DO 79 J = 1,NPROB                                               1301370
      DO 79 I = 1,8                                                   1301380
   79 DSE(I,J) = DRE(I,J)                                             1301390
   80 CONTINUE                                                        1301400
      DO 302 J=1,NH4                                                  1301410
      DO 302 I=1,NH4                                                  1301420
  302 ROTD(I,J)=0.0                                                   1301430
      DO 305 J=1,NH4,4                                                1301440
      ROTD(J,J)=1.0                                                   1301450
      ROTD(J&1,J&2)=CS                                                1301460
      ROTD(J&2,J&1)=-CS                                               1301470
      ROTD(J&1,J&1)=-SN                                               1301480
      ROTD(J&2,J&2)=-SN                                               1301490
  305 ROTD(J&3,J&3)=1.0                                               1301500
      DO 306 J=1,NPROB                                                1301510
      DO 306 I=1,NH4                                                  1301520
      DICS(I,J)=0.0                                                   1301530
      DO 306 K=1,NH4                                                  1301540
  306 DICS(I,J)=DICS(I,J)&ROTD(I,K)*DSE(K,J)                          1301550
      READ (9) ((XL1(I,J),J=1,NPRCB),I=1,NH4)                        1301560
      DO 202 J=1,NPRCB                                                1301570
      DO 202 I=1,NH4                                                  1301580
      TDSE(I,J)=0.0                                                   1301590
      DO 202 K=1,NH8                                                  1301600
  202 TDSE(I,J)=TDSE(I,J)&XK1112(I,K)*DSE(K,J)                        1301610
      DO 203 J=1,NPROB                                                1301620
      DO 203 I=1,NH4                                                  1301630
  203 TDSE(I,J)=TDSE(I,J)&XL1(I,J)                                    1301640
      DO 301 J=1,NH4                                                  1301650
      DO 301 I=1,NH4                                                  1301660
  301 ROTD(I,J)=0.0                                                   1301670
      DO 204 J=1,NH4,4                                                1301680
      ROT(J,J)=-1.0                                                   1301690
      ROT(J&1,J&2)=-CS                                                1301700
      ROT(J&2,J&1)= CS                                                1301710
      ROT(J&1,J&1)=SN                                                 1301720
      ROT(J&2,J&2)=SN                                                 1301730
  204 ROT(J&3,J&3)=1.0                                                1301740
      DO 205 J=1,NPROB                                                1301750
      DO 205 I=1,NH4                                                  1301760
      FICS(I,J)=0.0                                                   1301770
      DO 205 K=1,NH4                                                  1301780
```

```
  205 FICS(I,J)=FCT(I,K)*TDSE(K,J)&FIC    ,J)                          1301790
      DO 402 J=1,NPROB                                                  1301800
      DO 402 I=1,NH4                                                    1301810
      II=I&NH4                                                          1301820
      YICS(I,J)=FICS(I,J)                                               1301830
  402 YICS(II,J)=DICS(I,J)                                              1301840
      WRITE(4)    ((YICS(I,J),I=1,8),J=1,NPROB)                         1301850
  201 CONTINUE                                                          1301860
      REWIND 2                                                          1301870
  100 CONTINUE                                                          1301880
      REWIND  1                                                         1301890
      REWIND  4                                                         1301900
       REWIND  8                                                        1301910
      GOTO 501                                                          1301920
 8999 IERROR=8999                                                       1301930
      NIX=1                                                             1301940
  501 RETURN                                                            1301950
       END                                                              1301960
```

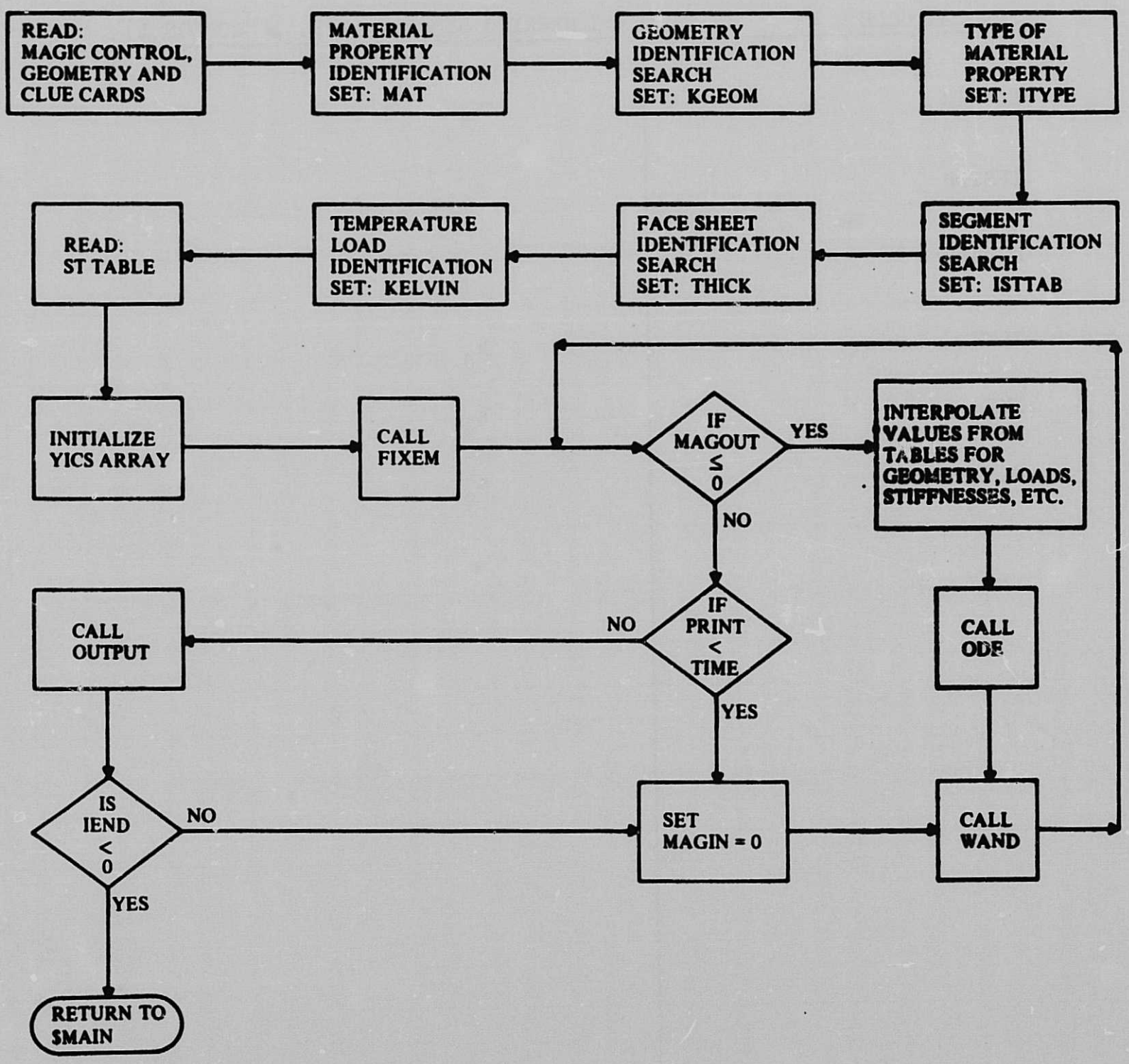
SUBROUTINE LEBEGE

The subroutine link LEBEGE receives the YICS array for each segment from INITAL via Tape #4. The subroutine FIXEM is called to integrate the differential equations of each segment, under true load conditions. FIXEM is identical to subroutine SETUP, while WAND corresponds to subroutine MAGIC and only consideration of the OVERLAY structure dictates the change in names.

The results of the final integration sequence are the forces and deflections at the beginning, intermediate, and end points of each segment.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 1)
EPSITH	ε_{θ_o}
EPSIPH	ε_{ϕ_o}
GAPHTH	$\gamma_{\phi\theta_o}$
XKTH	k_θ
XKPH	k_ϕ
XKPT	$k_{,\theta}$

LEBEGE


READ: MAGIC CONTROL, GEOMETRY AND CLUE CARDS
MATERIAL PROPERTY IDENTIFICATION SET: MAT
GEOMETRY IDENTIFICATION SEARCH SET: KGEOM
TYPE OF MATERIAL PROPERTY SET: ITYPE
SEGMENT IDENTIFICATION SEARCH SET: ISTTAB
FACE SHEET IDENTIFICATION SEARCH SET: THICK
TEMPERATURE LOAD IDENTIFICATION SET: KELVIN
READ: ST TABLE
INITIALIZE YICS ARRAY
CALL FIXEM
IF MAGOUT ≤ 0
YES
INTERPOLATE VALUES FROM TABLES FOR GEOMETRY, LOADS, STIFFNESSES, ETC.
NO
CALL ODE
IF PRINT < TIME
NO
YES
CALL OUTPUT
SET MAGIN = 0
CALL WAND
IS IEND < 0
NO
YES
RETURN TO $MAIN

```
C ***** ROUTINE **LEBE    ** ABACUS UPDATED 08/09/69 *****                    1400000
C ***** ROUTINE **LEBEGE  ** ABACUS UPDATED 08/02/68 *****                    1400010
      SUBROUTINE LEBEGE                                                      1400020
      COMMON STORY(16),TALE(16)                                              1400030
      COMMON XMAT(110,10),STD(10),NST(20),NKL(20),NXMAT(20),SAVTIC(900)      1400040
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                     1400050
      COMMON SACUS(60),RADUS(60)                                             1400060
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP           1400070
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOUT            1400080
      COMMON MAT,KGECM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                    1400090
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,   0   ,NSMAX                    1400100
      COMMON/NAM1/STRGO(6),THERM(4),MATER(3),SEGTAB(3),FACE(4),EQUATE(3)     1400110
      INTEGER SAVJTC, SAVSTP                                                 1400120
      INTEGER SEGTAB                                                         1400130
      INTEGER THICK,TYPE                                                     1400140
      INTEGER G                                                              1400150
      EQUIVALENCE (XMTTH,XMTETH),(XMTPH,XMTEPH),(XNTTH,XNTETH),              1400160
     1           (XNTPH,XNTEPH)                                              1400170
      EQUIVALENCE  (XNPHI,XNPI)                                              1400180
      DIMENSION IPROB(10),LST(61)                                            1400190
      DIMENSION       YDEV( 80),YICS( 80),YNEW( 80)                          1400200
      DIMENSION TBDEL( 80),          FWDEL( 80)                              1400210
      DIMENSION YCCBR(80)                                                    1400220
      DIMENSION ILAYR(10)                                                    1400230
      DIMENSION KLUE(4)                                                      1400240
      DIMENSION ST(70,31), XLAYER(10)                                        1400250
      DOUBLE  PRECISION  YNEW,YPRED                                          1400260
      COMMON /LASTEG/ YPRED( 80),YDOT( 80),YASAVE( 80),                      1400270
     1                YANTH,YAMTH,YAMPT,YANPT,YAQPH,YAQPH,YAUTH,YAJPH,       1400280
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,             1400290
     3                X1RQ,X1RQSQ,X1SNRQ,X1CSRQ,CN1RQ,SN1RQ,CS1RQ,           1400300
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RQ,RESQ,       1400310
     5     RQSQ,XNSQ,BETA,R1,R2,S1,R1DCT,R1SQ,                               1400320
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,          1400330
     7                XMTHLD,XMPHLD,ETHET,EPHI,XGPT,ALPHTH,ALPHPH,           1400340
     8                XNUTP,XNUPT,XC11,XC22,XD33,XD22,XD21,XC12,             1400350
     9                XK11,XK12,XK21,XK22,XK33,XD11,                         1400360
     A                   M,I,SITIN,SITOUT,SIFIN,SIPOUT,TPTIN,TPTOUT,         1400370
     B               ZBRIN,ZBROUT,SCRIPA,SCRIPI,SIFIN,SIFOUT,TZEPH,TZETH    1400380
     C                ,XNL,XNPHI                                            1400390
      INTEGER QTIME,UTIME,FTIME,WTIME                                        1400400
32001 FORMAT(/' THE OVERAL TIME IS ',I6/)                                    1400410
32002 FORMAT(/ ' THE SUM OF MAGIC TIME IS ',I6/)                             1400420
      HUNSEC = ICHRON (3)                                                    1400430
      WTIME = 0                                                              1400440
      FTIME = 0                                                              1400450
      REWIND  1                                                              1400460
  600 FORMAT(1H ,8(E14.7,2X)/(3X,8(E14.7,2X)))                               1400470
      KSC = 0                                                                1400480
      JAM =1                                                                 1400490
      JNSC =0                                                                1400500
      DO 451 I=1,NREG                                                        1400510
  451 KSC = KSC + NST(I)                                                     1400520
      LSC = 0                                                                1400530
  902 LSC = LSC & 1                                                          1400540
      QTIME = 0                                                              1400550
      QTIME = ICHRON(0)                                                      1400560
      QTIME = QTIME - FTIME                                                  1400570
      WRITE (6,32001)  QTIME                                                 1400580
```

```
      WRITE (6,32002) WTIME                                                    1400590
      XNTTH = 0.0                                                              1400600
      XNTPH = 0.0                                                              1400610
      XMTTH = 0.0                                                              1400620
      XMTPH = 0.0                                                              1400630
      XNL = 0.0                                                                1400640
      NSC=LSC                                                                  1400650
      JNSC=JNSC&1                                                              1400660
      IF(JNSC.LE.NST(JAM)) GO TO 1727                                          1400670
      JAM=JAM&1                                                                1400680
      JNSC=1                                                                   1400690
 1727 CONTINUE                                                                 1400700
      IOUT = 1                                                                 1400710
      READ(1)        RGO,(STORY(I),I=1,16)                                     1400720
      READ(1)        TIC,STOP,DTAU,DIFF,STEP,DELTA                             1400730
      READ(1)        G1,G2,G3                                                  1400740
      READ(1)        TYPE,HLAYR,SHEET,INTERP,RANKIN,TEFREE,ANALYS,NP           1400750
      DIFF  =1.0E-04                                                           1400760
      EPSIL =1.0E-05                                                           1400770
      ERR = 1.0 E-07                                                           1400780
      I = RGO                                                                  1400790
      WRITE(6,1726)                                                            1400800
 1726 FORMAT(1H1)                                                              1400810
      IF(JNSC.EQ.1) WRITE(6,606) JAM,NST(JAM),NKL(JAM)                         1400820
  606 FORMAT(//58X,13HREGION NUMBER,I3//35X,10HTHERE ARE ,I2,14H SEGMENT      1400830
     1S AND ,I2,35H KINEMATIC LINKS WITHIN THIS REGION)                        1400840
      WRITE(6,651)  JNSC,I  ,(STORY(I),I=1,16)                                 1400850
  651 FORMAT(//13X,15HSEGMENT NUMBER ,I2,5X,13HSEGMENT CODE ,I2,5X,            1400860
     116A4)                                                                    1400870
C     MATERIAL PROPERTY IDENTIFICATION                                         1400880
      DO 501 I=1,NMAT                                                          1400890
      IF (HLAYR-STO(I)) 501,502,501                                            1400900
  502 MAT=I                                                                    1400910
      GOTO 503                                                                 1400920
  501 CONTINUE                                                                 1400930
      GOTO 8086                                                                1400940
C     GEOMETRY IDENTIFICATION SEARCH                                           1400950
  503 DO 504 I=1,6                                                             1400960
      IF(RGO-STRGO(I)) 504,505,504                                             1400970
  504 CONTINUE                                                                 1400980
      GOTO 8086                                                                1400990
  505 KGEOM=I                                                                  1401000
      IGEOM = 0                                                                1401010
      IF (KGEOM.EQ.1.OR.KGEOM.EQ.2.OR.KGEOM.EQ.5.OR.KGEOM.EQ.6) IGEOM =1       1401020
      IF (KGEOM.EQ.3) IGEOM=2                                                  1401030
      IF(KGEOM.EQ.4) IGEOM=3                                                   1401040
      DO 506 I=1,3                                                             1401050
      IF(TYPE-MATER(I))506,507,506                                             1401060
  506 CONTINUE                                                                 1401070
      GOTO 8087                                                                1401080
  507 ITYPE=I                                                                  1401090
      DO 510 I=1,3                                                             1401100
      IF(INTERP-SEGTAB(I))510,511,510                                          1401110
  510 CONTINUE                                                                 1401120
      GO TO 8088                                                               1401130
  511 ISTTAB=I                                                                 1401140
      DO 508 I=1,4                                                             1401150
      IF (SHEET.EQ.FACE(I)) GOTO 509                                           1401160
  508 CONTINUE                                                                 1401170
      GOTO 8089                                                                1401180
```

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  509 THICK=I                                                          1401190
C     TEMPERATURE LCAD IDENTIFICATION                                  1401200
      DO 401 I=1,4                                                     1401210
      IF(RANKIN.EQ.THERM(I))GOTO 402                                   1401220
  401 CONTINUE                                                         1401230
      GOTO 8090                                                        1401240
  402 KELVIN=I                                                         1401250
C     LINEAR OR NONLINEAR ANALYSIS IDENTIFICATION                      1401260
      DO 403 I=1,3                                                     1401270
      IF(EQUATE(I).EQ.ANALYS) GOTO 404                                 1401280
  403 CONTINUE                                                         1401290
      GOTO 8013                                                        1401300
  404 IANLYZ=I                                                         1401310
      IF (IANLYZ.NE.1.AND.NPROB.GT.1) GOTO 8009                        1401320
      IF(IANLYZ.NE.1) XNL = 1.0                                        1401330
      IF(XNL.NE.0.0.AND.XN.NE.0.0) GO TO 8501                          1401340
      NROW = 0                                                         1401350
      NROW = THICK + 1                                                 1401360
      IF (ISTTAB.EQ.1) NROW = 11                                       1401370
      IF(ISTTAB.EQ.3)NROW=10                                           1401380
      WRITE(6,655)                                                     1401390
  655 FORMAT(//42X,47HTABLE ORDER PHI OR S VS. CROSSECTION PROPERTIES)  1401400
       DO 901   I=1,NROW                                               1401410
      READ(1)          (ST(I,J),J=1,NP)                                1401420
      WRITE(6,600)   (ST(I,J),J=1,NP)                                  1401430
  901 CONTINUE                                                         1401440
      K=NROW+1                                                         1401450
      JJ=1                                                             1401460
      JJJ=6                                                            1401470
      MM=1                                                             1401480
      DO 17 NLC=1,NPROB                                                1401490
      JT = JJ                                                          1401500
      JTT= JJJ                                                         1401510
      L=0                                                              1401520
      READ(1)          (LST(J),J=JJ,JJJ),(TALE(I),I=1,16)              1401530
      IF(LST(JJ))8031,19,20                                            1401540
   20 L = LST(JJ)                                                      1401550
      IF(NLC.GT.1.AND.LST(JT).NE.0) GO TO 8008                         1401560
   19 JJ=JJ+1                                                          1401570
   23 IF(LST(JJ))8031,22,21                                            1401580
   21 L=L+1                                                            1401590
   22 IF(JJ.EQ.JJJ) GOTO 24                                            1401600
      JJ=JJ+1                                                          1401610
      GOTO 23                                                          1401620
   24 IF(L.EQ.0) GO TO 71                                              1401630
      KK = K + L - 1                                                   1401640
      DO 72 M=K,KK                                                     1401650
      READ(1)          (ST(M,J),J=1,NP)                                1401660
   72 CONTINUE                                                         1401670
      IF(NLC.GT.1.OR.LST(1).EQ.0) GO TO 660                            1401680
      WRITE(6,656)                                                     1401690
  656 FORMAT(//45X,42HTABLE ORDER PHI OR S VS. TEMPERATURE LCADS.)     1401700
      KY = K                                                           1401710
      KZ = K + LST(1) -1                                               1401720
      DO 657 N=KY,KZ                                                   1401730
      WRITE(6,600) (ST(N,J),J=1,NP)                                    1401740
  657 CONTINUE                                                         1401750
      K = KZ + 1                                                       1401760
  660 IF((L-LST(JT)).EQ.0) GO TO 665                                   1401770
      WRITE(6,661) NLC                                                 1401780
```

```
  661 FORMAT(//16X,8HPROBLEM ,I2,5X,84   BLE CRDER  PHI OR S VS. DISTRIB 1401790
     1UTED LOADS (F THETA, F PHI, F ZETA, M THETA, M PHI),)              1401800
      WRITE(6,1968) (LST(J),J=JT,JTT)                                   1401810
 1968 FORMAT(27H LCAD IDENTIFICATION CLUES ,6I1/)                       1401820
      DO 662 N = K, KK                                                  1401830
      WRITE(6,600) (ST(N,J),J=1,NP)                                     1401840
  662 CONTINUE                                                          1401850
  665 CONTINUE                                                          1401860
   71 K = K & L - LST(JT)                                               1401870
      JJ=JJJ&1                                                          1401880
      JJJ=JJ&5                                                          1401890
   17 MM=MM&1                                                           1401900
      IF(IANLYZ.EQ.1) GO TO 590                                         1401910
      IF (L.EQ.0) KK = NROW + 1                                         1401920
      KK = KK & 1                                                       1401930
      READ(1)   (ST(KK,J),J=1,NP)                                       1401940
      WRITE(6,666) (ST(KK,J),J=1,NP)                                    1401950
  666 FORMAT(//47X,38HASSUMED NCN-LINEAR VALUES VS. PHI OR S//(1H ,     1401960
     18(E14.7,2X)))                                                     1401970
  590 CONTINUE                                                          1401980
      NSAVE = NROW                                                      1401990
      JJ=NPRCB*6                                                        1402000
      LT=0                                                              1402010
      DO 15   J=1,JJ                                                    1402020
   15 LT=LT&LST(J)                                                      1402030
      NTOTAL=LT&NSAVE                                                   1402040
      IF(XNL.EQ.1.0) NTOTAL = NTOTAL + 1                                1402050
      IF(ISTTAB-2)593,592,594                                           1402060
  593 K   = KK & 1                                                      1402070
      KK = KK & 8                                                       1402080
      NTOTAL = NTOTAL & 8                                               1402090
      GO TO 595                                                         1402100
  594 K   = KK & 1                                                      1402110
      KK = KK & 4                                                       1402120
      NTOTAL = NTOTAL & 4                                               1402130
  595 READ(1)   (KLUE(I),I=1,4)                                         1402140
      DO 596  I=K,KK                                                    1402150
  596 READ(1)   (ST(I,J),J=1,NP)                                        1402160
  592 CONTINUE                                                          1402170
      NEQNS=8*NPRCB                                                     1402180
      DO 73  I=1,NEQNS                                                  1402190
   73 YICS(I)=0.0                                                       1402200
      READ(4)     (YICS(I),I=1,NEQNS)                                   1402210
      NCYC=0                                                            1402220
      NSAVE=NROW                                                        1402230
      IEND=0                                                            1402240
      PRINT=TIC                                                         1402250
      DTA=DTAU                                                          1402260
      DTAU=0.0                                                          1402270
      WTIME = 0.0                                                       1402280
      FTIME = ICHRON(0)                                                 1402290
   59 CALL FIXEM (MAGIN,MAGOUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,1402300
     1            DTIME,YICS,YPRED,YCORR,YDOT,YNEW,YDEV,FWDEL,TBDEL)    1402310
      GOTO  61                                                          1402320
   60 CALL WAND(MAGIN,MAGOUT,TIC,STEP,NEQNS,DTAU,EPSIL,DELTA,ERR,TIME,  1402330
     1          DTIME,YICS,YPRED,YCORR,YDOT,YNEW,YDEV,FWDEL,TBDEL)      1402340
      VTIME = ICHRON(0)                                                 1402350
      WTIME = WTIME + VTIME-UTIME                                       1402360
   61 IF(MAGOUT.LE.0) GOTO 25                                           1402370
      IF(TIME.GT.STOP) GOTO 62                                          1402380
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      IF(TIME.LT.STOP) GOTO 63                                          1402390
   64 IEND=-1                                                           1402400
      GOTO 67                                                           1402410
   62 IF(TIME.LE.(STOP&DIFF)) GOTO 64                                   1402420
      GOTO 8001                                                         1402430
   63 IF((STOP-DIFF).LE.TIME) GOTO 64                                   1402440
      IF((TIME&DTIME).GT.STOP) GOTO 65                                  1402450
      IF(PRINT.GT.TIME) GOTO 66                                         1402460
      PRINT=TIME&DTA                                                    1402470
   67 IF(ICLT.NE.0) GOTO 110                                            1402480
 6450 IF(IEND.GT.0) GO TO 8002                                          1402490
      IF(IEND.LT.0) GOTO  150                                           1402500
   66 MAGIN=0                                                           1402510
      GOTO 60                                                           1402520
   65 DTIME=STOP-TIME                                                   1402530
      DELTA=0.0                                                         1402540
      GOTO 67                                                           1402550
   75 NCYC=NCYC&1                                                       1402560
      MAGIN=-1                                                          1402570
      UTIME = ICHECK(0)                                                 1402580
      GOTO 60                                                           1402590
   25 PHI=TIME                                                          1402600
      ARG=PHI                                                           1402610
      LL=NP&1                                                           1402620
      DO 51 I=1,NP                                                      1402630
      IF(ARG-ST(1,I)) 52,55,51                                          1402640
   52 IF(I-1) 8003,8003,54                                              1402650
   51 CONTINUE                                                          1402660
      GOTO 8006                                                         1402670
   54 DO 57 IK=2,NTOTAL                                                 1402680
   57 ST(IK,LL)=ST(IK,I-1)&(ST(IK,I)-ST(IK,I-1))*(ARG-ST(1,I-1))/(ST(1,I 1402690
     1)-ST(1,I-1))                                                      1402700
      GOTO 80                                                           1402710
   55 DO 58 IK=2,NTOTAL                                                 1402720
   58 ST(IK,LL)=ST(IK,I)                                                1402730
   80 CONTINUE                                                          1402740
C     THE UPDATED INTERPOLATED VALUES OF THE MATERIAL PROPERTY COEFFIC   1402750
C     IENTS ARE FOUND IN THE XMAT TABLE AND STORED IN THE XLAYER ARRAY   1402760
      L=(MAT-1)*2&1                                                     1402770
      II=NXMAT(L)                                                       1402780
       III=NXMAT(L&1)                                                   1402790
      M=1                                                               1402800
      LL=NP&1                                                           1402810
      GOTO (91,92,93,93),KELVIN                                         1402820
   91 L = NROW + 1                                                      1402830
      TEMPAV=(ST(L,LL)&ST(L&1,LL)&ST(L&2,LL)&ST(L&3,LL)) / 4.0          1402840
      ARG=TEMPAV                                                        1402850
      GOTO 94                                                           1402860
   93 ARG = ST(NROW + 1,LL)                                             1402870
   94 DO 104 I = 2,10                                                   1402880
      IF (ARG-XMAT(II,I)) 121,123,104                                   1402890
  121 IF (I-2) 8007,8007,124                                            1402900
  104 CONTINUE                                                          1402910
      GOTO 8067                                                         1402920
  123 L=II&1                                                            1402930
      DO 122 J=L,III                                                    1402940
      XLAYER(M)=XMAT(J,I)                                               1402950
  122 M=M&1                                                             1402960
      GOTO 111                                                          1402970
  124 L=II&1                                                            1402980
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      DO 125 J=L,III                                                    1402990
      XLAYER(M)=XMAT(J,I-1)+(XMAT(J,I)-XMAT(J,I-1))*(ARG-XMAT(II,I-1))/  1403000
     1          (XMAT(II,I)-XMAT(II,I-1))                              1403010
  125 M=M&1                                                             1403020
      GOTO 111                                                          1403030
   92 L = II + 1                                                        1403040
      DO 922  J=L,III                                                   1403050
      XLAYER(M)= XMAT(J,1)                                              1403060
  922 M=M&1                                                             1403070
  111 GOTO (101,102,103),ITYPE                                          1403080
  101 ETHET     =XLAYER(1)                                              1403090
      XNUTP     =XLAYER(2)                                              1403100
      ALPHTH    =XLAYER(3)                                              1403110
      EPHI      =ETHET                                                  1403120
      XNUPT     =XNUTP                                                  1403130
      ALPHPH    =ALPHTH                                                 1403140
      XGPT      = ETHET/(2.0*(1.0&XNUPT))                               1403150
      GOTO 105                                                          1403160
  102 ETHET     =XLAYER(1)                                              1403170
      EPHI      =XLAYER(2)                                              1403180
      XNUTP     =XLAYER(3)                                              1403190
      ALPHTH    =XLAYER(4)                                              1403200
      ALPHPH    =XLAYER(5)                                              1403210
      XGPT      =XLAYER(6)                                              1403220
      XNUPT     =ETHET*XNUTP/EPHI                                       1403230
      GOTO 105                                                          1403240
  103 ETHET    = XLAYER(1)                                              1403250
      EPHI     = XLAYER(2)                                              1403260
      XNUTP    = XLAYER(3)                                              1403270
      ALPHTH   = XLAYER(4)                                              1403280
      ALPHPH   = XLAYER(5)                                              1403290
      XGPT     = XLAYER(6)                                              1403300
      ER       = XLAYER(7)                                              1403310
      ES       = XLAYER(8)                                              1403320
      ALPHR    = XLAYER(9)                                              1403330
      ALPHS    = XLAYER(10)                                             1403340
      XNUPT    = ETHET * XNUTP/EPHI                                     1403350
  105 CONTINUE                                                          1403360
      GOTO (771,772,773,774,775,776),KGEOM                              1403370
C     GEOMETRY FOR ELLIPSE                                              1403380
  771 A=G1                                                              1403390
      BE=G2                                                             1403400
      BETA = BE                                                         1403410
       BESQ=BE**2                                                       1403420
      ASQ=A**2                                                          1403430
      SN=SIN(PHI)                                                       1403440
      CS=COS(PHI)                                                       1403450
      SNSQ = SN**2                                                      1403460
      CSSQ = CS**2                                                      1403470
      R2 = A*SQRT(1.0/(SNSQ&BESQ*CSSQ))                                 1403480
      R2SQ = R2**2                                                      1403490
      R0=R2*SN                                                          1403500
      R1=R2*R2SQ*BESQ/ASQ                                               1403510
      BESQ=BE**2                                                        1403520
      R1DOT=0.0                                                         1403530
      IF(KGEOM.EQ.1.AND.BETA.NE.1.0) R1DOT=3.0*(R2*BETA/A)**2*(CS/SNSQ)* 1403540
     1                                          (R1*SN-R0)             1403550
      GOTO 7775                                                         1403560
C     GEOMETRY FOR CGIVE                                                1403570
  772 R1=G1                                                             1403580
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      C=G2                                                              1403590
      SN=SIN(PHI)                                                       1403600
      CS=COS(PHI)                                                       1403610
      IF (SN.EQ.0.0) GOTO 777                                           1403620
      R2=R1-C/SN                                                        1403630
      GOTO 778                                                          1403640
  777 R2 = 1.0                                                          1403650
  778 RO = R1*SN-C                                                      1403660
      R1DOT=0.0                                                         1403670
      GOTO 7775                                                         1403680
C     GEOMETRY FOR CONE                                                 1403690
  773 CS = COS(G1)                                                      1403700
      SN=SIN(G1)                                                        1403710
      S=PHI                                                             1403720
      S1=1.0/S                                                          1403730
      R2=CS*SN*PHI                                                      1403740
      RO=PHI*CS                                                         1403750
      R1DOT=0.0                                                         1403760
      GOTO 7775                                                         1403770
C     GEOMETRY FOR CYLINDER                                             1403780
  774 RO = G1                                                           1403790
      SN=1.0                                                            1403800
      CS=1.0                                                            1403810
      R1DOT=0.0                                                         1403820
      GOTO 7775                                                         1403830
C     MODIFIED ELLIPSE                                                  1403840
  775 XNEXP=G1                                                          1403850
      A   =G2                                                           1403860
      XN1=1.0&XNEXP                                                     1403870
      XN2=1.0/XN1                                                       1403880
      XN3=XN1&1.0                                                       1403890
      XN4=XN3&1.0                                                       1403900
      XN5=XN4/XN1                                                       1403910
      SN = SIN(PHI)                                                     1403920
      CS = COS(PHI)                                                     1403930
      R2= A*(2.0/(1.0&SN**XN1))**XN2                                    1403940
      R1=(A/2.0)*(R2/A)**XN3                                            1403950
      RO=R2*SN                                                          1403960
      R1DOT=-XN3*A*(SN**XNEXP*CS/4.0)*(2.0/(1.0&SN**XN1))**XN5          1403970
      GOTO 7775                                                         1403980
C     PARABOLIC GEOMETRY                                                1403990
  776 SN=SIN(PHI)                                                       1404000
      CS=COS(PHI)                                                       1404010
      TAN= SN/CS                                                        1404020
      SEC= 1.0/CS                                                       1404030
      F1=G1                                                             1404040
      F2=G2                                                             1404050
      F3=G3                                                             1404060
      RO = (F2-TAN)/(2.0*F3)                                            1404070
      R1 = -SEC**3/(2.0*F3)                                             1404080
      R2 = RO/SN                                                        1404090
      R1DOT = -3.0*SEC**4*SN/(2.0*F3)                                   1404100
 7775 TAN=SN/CS                                                         1404110
      DEGRES = 0.0                                                      1404120
      IF(IGEOM.EQ.1) DEGRES = PHI * 57.29578                            1404130
      RQSQ = RO**2                                                      1404140
      XNSQ=XN**2                                                        1404150
      CN=CS*SN                                                          1404160
      X1CS=1.0/CS                                                       1404170
      TN=SN/CS                                                          1404180
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      X1RO=1.0/RO                                                    1404190
      X1ROSQ=1.0/RO**2                                               1404200
      X1CSRO=1.0/(CS*RO)                                             1404210
      CN1RO=CN/RO                                                    1404220
      SN1RO=SN/RO                                                    1404230
      CS1RO=CS/RO                                                    1404240
      SNSQ=SN**2                                                     1404250
      CSSQ=CS**2                                                     1404260
      IF(KGEOM.EQ.4.OR.KGEOM.EQ.3) GOTO 79                           1404270
      R1SQ = R1**2                                                   1404280
      R2SQ = R2**2                                                   1404290
      X1SN=1.0/SN                                                    1404300
      X1SNRO=1.0/(SN*RO)                                             1404310
      X1R1=1.0/R1                                                    1404320
      X1R2=1.0/R2                                                    1404330
      CS1R1=CS/R1                                                    1404340
      CS1R2=CS/R2                                                    1404350
      SN1R1=SN/R1                                                    1404360
      X1R1SQ=1.0/R1**2                                               1404370
   79 XNTTH=0.0                                                      1404380
      XNTPH=0.0                                                      1404390
      XMTTH=0.0                                                      1404400
      XMTPH=0.0                                                      1404410
      IF (ITYPE.EQ.3) GOTO 711                                       1404420
C     COMPUTATION OF K AND D FOR MATERIAL PROPETY INPUT               1404430
      GOTO  (701,702,703),THICK                                      1404440
C  SINGLE SHEET                                                      1404450
  701 HI=ST(2,LL)                                                    1404460
      TEMP1=ETHET*HI                                                 1404470
      TEMP2=TEMP1*HI**2                                              1404480
      TEMP3=(1.0-XNUPT*XNUTP)                                        1404490
      XK11=TEMP1/TEMP3                                               1404500
      XD11=TEMP2/(12.0*TEMP3)                                        1404510
      IF(ITYPE.EQ.2)GOTO 704                                         1404520
      XK22=XK11                                                      1404530
      XD22=XD11                                                      1404540
      GOTO 705                                                       1404550
  704 TEMP1=EPHI*HI                                                  1404560
      TEMP2=TEMP1*HI**2                                              1404570
      XK22=TEMP1/TEMP3                                               1404580
      XD22=TEMP2/(12.0*TEMP3)                                        1404590
  705 XK33=XGPT*HI                                                   1404600
      XD33=XK33*HI**2/12.0                                           1404610
      GOTO 710                                                       1404620
C  EQUAL  SHEETS                                                     1404630
  702 HI=ST(2,LL)                                                    1404640
      T= ST(3,LL)                                                    1404650
      TEMP1=2.0*ETHET*HI                                             1404660
      TEMP2=HI*(4.0*HI**2+6.0*HI*T+3.0*T**2)                         1404670
      TEMP3=(1.0-XNUPT*XNUTP)                                        1404680
      XK11=TEMP1/TEMP3                                               1404690
      XD11=ETHET*TEMP2/(6.0*TEMP3)                                   1404700
      IF(ITYPE.EQ.2)GOTO 706                                         1404710
      XK22=XK11                                                      1404720
      XD22=XD11                                                      1404730
      GOTO 707                                                       1404740
  706 TEMP1=2.0*EPHI*HI                                              1404750
      XK22=TEMP1/TEMP3                                               1404760
      XD22=EPHI*TEMP2/(6.0*TEMP3)                                    1404770
  707 XK33=2.0*XGPT*HI                                               1404780
```

```
      XD33=XK33*TEMP2/(12.0*HI)                                          1404790
      GOTO 710                                                           1404800
C  UNEQUAL SHEETS                                                        1404810
  703 HI=ST(2,LL)                                                        1404820
      T= ST(3,LL)                                                        1404830
      HC=ST(4,LL)                                                        1404840
      TEMP1=HI&HO                                                        1404850
      TEMP2=TEMP1**4&12.0*HI*HO*T*(TEMP1&T)                              1404860
      TEMP3=(1.0-XNUPT*XNUTP)                                            1404870
      XK11=ETHET*TEMP1/TEMP3                                             1404880
      XD11=ETHET*TEMP2/(12.0*TEMP1*TEMP3)                                1404890
      IF(ITYPE.EQ.2) GOTO 708                                            1404900
      XK22=XK11                                                          1404910
      XD22=XD11                                                          1404920
      GOTO 709                                                           1404930
  708 XK22=EPHI*TEMP1/TEMP3                                              1404940
      XD22=EPHI*TEMP2/(12.0*TEMP1*TEMP3)                                 1404950
  709 XK33=XGPT*TEMP1                                                    1404960
      XD33=XGPT*(TEMP2/(12.0*TEMP1))                                     1404970
      GOTO 710                                                           1404980
C     RANKIN=THSTND MEANS INTERPOLATE,COMPUTE NTEMP,MTEMP                1404990
C     RANKIN=NOTHRM MEANS DO NOT INTERPOLATE,DO NOT COMPUTE NTEMP,NTEMP  1405000
C     RANKIN=THCNST MEANS DO NOT INTERPOLATE,COMPUTE NTEMP,MTEMP         1405010
C     RANKIN=THINHD MEANS INTERPOLATE,BUT DO NOT COMPUTE NTEMP,MTEMP     1405020
  711 CONTINUE                                                           1405030
      XK11=ST(2,LL)                                                      1405040
      XK12=ST(3,LL)                                                      1405050
      XK22 = ST(4,LL)                                                    1405060
      XK33 = ST(5,LL)                                                    1405070
      XD11 = ST(6,LL)                                                    1405080
      XD12 = ST(7,LL)                                                    1405090
      XD22 = ST(8,LL)                                                    1405100
      XD33 = ST(9,LL)                                                    1405110
      XC11 = ST(10,LL)                                                   1405120
      XK21 = XK12                                                        1405130
      XD21 = XD12                                                        1405140
      IF(ISTTAE-2)737,710,738                                            1405150
  737 K = NTOTAL - 7                                                     1405160
      XC22 = ST(11,LL)                                                   1405170
      ZINTH = ST(K,LL)                                                   1405180
      ZOUTTH= ST(K&1,LL)                                                 1405190
      ZINPH = ST(K&2,LL)                                                 1405200
      ZOUTPH= ST(K&3,LL)                                                 1405210
      SR    = ST(K&4,LL)                                                 1405220
      SS    = ST(K&5,LL)                                                 1405230
      TR    = ST(K&6,LL)                                                 1405240
      TS    = ST(K&7,LL)                                                 1405250
      GO TO 710                                                          1405260
  738 K = NTOTAL - 3                                                     1405270
      ZINTH  = ST(K,LL)                                                  1405280
      ZOUTTH = ST(K&1,LL)                                                1405290
      SR     = ST(K&2,LL)                                                1405300
      TR     = ST(K&3,LL)                                                1405310
      ZINPH  = ZINTH                                                     1405320
      ZOUTPH = ZOUTTH                                                    1405330
  710 GOTO (716,714,715,714),KELVIN                                      1405340
  716 TII = ST(NROW+1,LL)                                                1405350
      TIK = ST(NROW+2,LL)                                                1405360
      TOK = ST(NROW+3,LL)                                                1405370
      TOO = ST(NROW+4,LL)                                                1405380
```

```
      GOTO 717                                                          1405390
  715 TII = ST(NRCW+1,LL)                                               1405400
      TIK = TII                                                         1405410
      TOK = TII                                                         1405420
      TOO = TII                                                         1405430
  717 CONTINUE                                                          1405440
      TEMP1=ALPHTH&XNUTP*ALPHPH                                         1405450
      TEMP2=ALPHPH&XNUPT*ALPHTH                                         1405460
      TEMP3=1.0-XNUPT*XNUTP                                             1405470
      TEMP4=HI/4.0                                                      1405480
      TEMP5=HI**2/24.0                                                  1405490
      TEMP6=TII&TIK&TOK&TOO-4.0*TEFREE                                  1405500
      TEMP7=2.0*TII&TIK-TOK-2.0*TCC                                     1405510
      GO TO (811,812 813,814),THICK                                     1405520
  811 CONTINUE                                                          1405530
      IF(ITYPE.EQ.3) GO TO 814                                          1405540
      IF (THICK.EQ.2) GOTO 812                                          1405550
      IF (THICK.EQ.3) GOTO 813                                          1405560
  801 XNTTH=ETHET*TEMP1*TEMP4*TEMP6/TEMP3                               1405570
      XNTPH=EPHI*TEMP2*TEMP4*TEMP6/TEMP3                                1405580
      XMTTH=ETHET*TEMP1*TEMP5*TEMP7/TEMP3                               1405590
      XMTPH=EPHI*TEMP2*TEMP5*TEMP7/TEMP3                                1405600
      GOTO 714                                                          1405610
  812 TI=T/2.0                                                          1405620
  802 TEMP8=HI/2.0                                                      1405630
      TEMP9=TII&TIK-TOK-TOO                                             1405640
      XNTTH=ETHET*TEMP1*TEMP8*TEMP6/TEMP3                               1405650
      XNTPH=EPHI*TEMP2*TEMP8*TEMP6/TEMP3                                1405660
      XMTTH=ETHET*TEMP1*TEMP8*(HI*TEMP7/3.0&TI*TEMP9)/TEMP3             1405670
      XMTPH=EPHI*TEMP2*TEMP8*(HI*TEMP7/3.0&TI*TEMP9)/TEMP3              1405680
      GOTO 714                                                          1405690
  813 TI = (HC**2-HI**2&2.0*HO*T)/(2.0*(HI&HC))                         1405700
      TO = (HI**2-HO**2&2.0*HI*T)/(2.0*(HI&HC))                         1405710
      TEMP6=2.0*TII&TIK-3.0*TEFREE                                      1405720
      TEMP7=2.0*TCO&TOK-3.0*TEFREE                                      1405730
  803 TEMP8=TII&TIK-2.0*TEFREE                                          1405740
      TEMP9=TCK&TCO-2.0*TEFREE                                          1405750
      XNTTH=ETHET*TEMP1*0.5*(HI*TEMP8&HO*TEMP9)/TEMP3                   1405760
      XNTPH=EPHI*TEMP2*0.5*(HI*TEMP8&HO*TEMP9)/TEMP3                    1405770
      XMTTH=ETHET*TEMP1*0.5*(HI**2*TEMP6/3.0-HO**2*TEMP7/3.0&TI*HI*     1405780
     1       TEMP8-TO*HO*TEMP9)/TEMP3                                   1405790
      XMTPH=EPHI*TEMP2*0.5*(HI**2*TEMP6/3.0-HO**2*TEMP7/3.0&TI*HI*      1405800
     1       TEMP8-TO*HO*TEMP9)/TEMP3                                   1405810
      GOTO 714                                                          1405820
  814 TEMP10=SQRT(-XK11*XD11)/SQRT(48.0)                                1405830
      TEMP11=SQRT(-XK22*XD22)/SQRT(48.0)                                1405840
      XNTTH=(XK11/4.0)*TEMP1*TEMP6                                      1405850
      XNTPH=(XK22/4.0)*TEMP2*TEMP6                                      1405860
      XMTTH=TEMP10*TEMP1*TEMP7                                          1405870
      XMTPH=TEMP11*TEMP2*TEMP7                                          1405880
C     COMPUTATION OF K AND D FUR K AND D INPUT                          1405890
  714 LL=NP&1                                                           1405900
      IF(XK11.EQ.0.0.C) GOTO 8101                                       1405910
      IF(ITYPE.EQ.3.AND.XK12.EQ.0.0) GO TO 8102                         1405920
      IF(ITYPE.EQ.3.AND.XK21.EQ.0.0) GO TO 8103                         1405930
      IF(XK22.EQ.0.0.0) GOTO 8104                                       1405940
      IF(XK33.EQ.0.0) GOTO 8105                                         1405950
      IF(XD11.EQ.0.0) GOTO 8106                                         1405960
      IF(ITYPE.EQ.3.AND.XD12.EQ.0.0) GO TO 8107                         1405970
      IF(ITYPE.EQ.3.AND.XD21.EQ.0.0) GO TO 8108                         1405980
```

```
      IF(XD22.EC.C.0) GOTO 8109                                          1405900
      IF(XD33.EC.C.0) GOTO 8110                                          1406000
      NL=0                                                               1406010
      XNPHI = 0.0                                                        1406020
      IJKLMN=NRCW+LST(1)+LST(2)+LST(3)+LST(4)+LST(5)+LST(6)+1            1406030
      IF(XNL.NE.0.0) XNPHI = ST(IJKLMN,LL)                               1406040
      JF = NPROB                                                         1406050
      DO 77 M=1, JF                                                      1406060
      I = (M-1)*8 & 1                                                    1406070
      NL=NL&1                                                            1406080
      XFTHLD=0.0                                                         1406090
      XFPHLD=0.0                                                         1406100
      XFZELD=0.0                                                         1406110
      XMTHLD=0.0                                                         1406120
      XMPHLD=0.0                                                         1406130
      K=NPOW                                                             1406140
      IR=NL*6-5                                                          1406150
      IF(LST(IR).NE.0) K=K&LST(IR)                                       1406160
      IF (LST(IR&1).EQ.0) GOTO 44                                        1406170
      K=K&1                                                              1406180
      XFTHLD=ST(K,LL)                                                    1406190
   44 IF(LST(IR&2).EQ.0) GOTO 45                                         1406200
      K=K&1                                                              1406210
      XFPHLD=ST(K,LL)                                                    1406220
   45 IF(LST(IR&3).EC.0) GOTO 46                                         1406230
      K=K&1                                                              1406240
      XFZELD=ST(K,LL)                                                    1406250
   46 IF(LST(IR&4).EQ.0) GOTO 47                                         1406260
      K=K&1                                                              1406270
      XMTHLD=ST(K,LL)                                                    1406280
   47 IF(LST(IR&5).EQ.0) GOTO 48                                         1406290
      K=K&1                                                              1406300
      XMPHLD=ST(K,LL)                                                    1406310
   48 CONTINUE                                                           1406320
   49 CALL ODE                                                           1406330
   77 CONTINUE                                                           1406340
      GOTO 75                                                            1406350
 8001 IERROR=8001                                                        1406360
      NERROR = 11                                                        1406370
      GOTO 8888                                                          1406380
 8002 IERROR=8002                                                        1406390
      NERROR = 12                                                        1406400
      GOTO 8888                                                          1406410
 8003 IERROR=8003                                                        1406420
      NERROR = 13                                                        1406430
      GOTO 8888                                                          1406440
 8006 IERROR=8006                                                        1406450
      NERROR = 14                                                        1406460
      GOTO 8888                                                          1406470
 8007 IERROR=8007                                                        1406480
      NERROR = 15                                                        1406490
      GOTO 8888                                                          1406500
 8008 IERROR = 8008                                                      1406510
      NERROR = 10                                                        1406520
      GO TO 8888                                                         1406530
 8009 IERROR = 8009                                                      1406540
      NERROR = 6                                                         1406550
      GO TO 8888                                                         1406560
 8031 IERROR=8031                                                        1406570
      NERROR = 6                                                         1406580
```

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      GOTO 8888                                                    1406590
 8036 IERROR=8036                                                  1406600
      NERROR = 2                                                   1406610
      GOTO 8888                                                    1406620
 8086 IERROR=8086                                                  1406630
      NERROR = 3                                                   1406640
      GOTO 8888                                                    1406650
 8087 IERROR=8087                                                  1406660
      NERROR = 4                                                   1406670
      GOTO 8888                                                    1406680
 8088 IERROR=8088                                                  1406690
      NERROR = 27                                                  1406700
      GOTO 8888                                                    1406710
 8089 IERROR=8089                                                  1406720
      NERROR = 5                                                   1406730
      GOTO 8888                                                    1406740
 8090 IERROR=8090                                                  1406750
      NERROR = 6                                                   1406760
      GOTO 8888                                                    1406770
 8067 IERROR= 8067                                                 1406780
      NERROR = 16                                                  1406790
      GOTO 8888                                                    1406800
 8101 IERROR = 8101                                                1406810
      NERROR = 17                                                  1406820
      GOTO 8888                                                    1406830
 8102 IERROR = 8102                                                1406840
      NERROR = 18                                                  1406850
      GOTO 8888                                                    1406860
 8103 IERROR = 8103                                                1406870
      NERROR = 19                                                  1406880
      GOTO 8888                                                    1406890
 8104 IERROR = 8104                                                1406900
      NERROR = 20                                                  1406910
      GOTO 8888                                                    1406920
 8105 IERROR = 8105                                                1406930
      NERROR = 21                                                  1406940
      GOTO 8888                                                    1406950
 8106 IERROR = 8106                                                1406960
      NERROR = 22                                                  1406970
      GOTO 8888                                                    1406980
 8107 IERROR = 8107                                                1406990
      NERROR = 23                                                  1407000
      GOTO 8888                                                    1407010
 8108 IERROR = 8108                                                1407020
      NERROR = 24                                                  1407030
      GOTO 8888                                                    1407040
 8109 IERROR = 8109                                                1407050
      NERROR = 25                                                  1407060
      GOTO 8888                                                    1407070
 8110 IERROR = 8110                                                1407080
      NERROR = 26                                                  1407090
      GOTO 8888                                                    1407100
 8013 IERROR=8013                                                  1407110
      NERROR = 7                                                   1407120
      GOTO 8888                                                    1407130
 8787 IERROR = 8787                                                1407140
      NERROR = 34                                                  1407150
      GO TO 8888                                                   1407160
 8501 IERROR = 8501                                                1407170
      NERROR = 35                                                  1407180
```

```
      GO TO 8888                                                        1407190
C     THE HUBER VON MISSES STRESS EQLATIONS                             1407200
  110 CALL OUTPUT         (KLUE,YCORR,ER,ES,ALPHR,ALPHS,ZINTH,          1407210
     1        ZOUTTH,ZINPH,ZOUTPH,SR,SS,TR,TS,NCYC,TIME,DEGRES,DIA,STEP, 1407220
     2        HI,HC,T,TII,TOO)      (                                   1407230
      IF(NIX.EQ.1) GO TO 9999                                           1407240
      GO TO 6050                                                        1407250
 8888 NIX=1                                                             1407260
      GO TO 9999                                                        1407270
  150 IF(LSC.LT.KSC) GO TO 502                                          1407280
 9999 RETURN                                                            1407290
      END                                                               1407300
```

SUBROUTINE ODE†

Subroutine LEBEGE calls ODE, and various geometric and trigonometric clues, as well as the predicted values of the differential equations, are passed to this subprogram via label common area LASTEQ.

The equations in ODE are identical to those in subroutine DIFFEQ, with the addition of the four auxiliary equations for YANPT, YAQPH, YAQTH, and YAOPH. Subroutine ODE performs the final integration for each segment in the structure utilizing the initial conditions previously obtained, and returns these values to LEBEGE via label common area LASTEQ.

- - - - -

†The ODE flow chart is identical to the DIFFEQ flow chart.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 3)
YANPT	$N_{\phi\theta}$
YAQPH	Q_{ϕ}
YAQTH	Q_{ϑ}
YAOPH	Ω_{ϕ}

```
C ..... ROUTINE **ODE      ** ABACUS UPD .ED 08/09/69 .....                1600000
C ..... ROUTINE **ODE      ** ABACUS UPDATED 06/20/68 .....                1600010
      SUBROUTINE ODE                                                       1600020
      COMMON STORY(16),TALE(16)                                            1600030
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)    1600040
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                   1600050
      COMMON SADLS(60),RADUS(60)                                           1600060
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP         1600070
      COMMON NREGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOUT         1600080
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                  1600090
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,   0   ,NSMAX                  1600100
      INTEGER C                                                            1600110
      EQUIVALENCE (XMTTH,XMTETH),(XMTPH,XMTEPH),(XNTTH,XNTETH),            1600120
     1           (XNTPH,XNTEPH)                                            1600130
      COMMON /LASTEC/ YPRED( 80),YDOT( 80),YASAVE( 80),                    1600140
     1                YANTH,YAMTH,YAMPT,YANPT,YAOPH,YAOPH,YAOTH,YAJPH,     1600150
     2                S,SN,CS,SNSC,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,           1600160
     3                X1RO,X1ROSQ,X1SNRO,X1CSRO,CN1RO,SN1RO,CS1RO,         1600170
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RO,BESQ,     1600180
     5    ROSQ,XNSQ,BETA,R1,R2,S1,R1DOT,R1SQ,                             1600190
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,        1600200
     7                XMTHLD,XMPHLD,ETHET,EPHI,XGPT,ALPHTH,ALPHPH,         1600210
     8                XNUTP,XNUPT,XC11,XC22,XD33,XD22,XD21,XC12,           1600220
     9                XK11,XK12,XK21,XK22,XK33,XD11,                       1600230
     A                   M,I,SITIN,SITOUT,SIPIN,SIPOUT,TPTIN,TPTOUT,       1600240
     B               ZBRIN,ZBROUT,SCRIPA,SCRIPI,SIFIN,SIFOUT,TZEPH,TZETH   1600250
     C                ,XNL,XNPHI                                          1600260
      EQUIVALENCE  (XNPHI,XNPI)                                            1600270
      DOUBLE PRECISION YPRED                                               1600280
      IF (ISTTAB.EQ.3)GO TO 7447                                           1600290
      IF(ISTTAB.EQ.1)  GO TO 7786                                          1600300
C     THE FOLLOWING EQUATIONS ARE THE 'THICK' SET                          1600310
      GO TO (151,152,153),IGEOM                                            1600320
C   EQUATIONS FOR SHELLS OF REVOLUTION  ( PHI  COORDINATE )                1600330
  151 YANTH=XNUPT*YPRED(I&1)&(XK11-XNUPT**2*XK22)*(XN*YPRED(I&4)&YPRED(    1600340
     1       I&5)*CS-YPRED(I&6)*SN)*X1RO-XNTETH&XNUPT*XNTEPH               1600350
      YAMTH=XNUPT*YPRED(I&3)-(XD11-XNUPT**2*XD22)*X1RO*(X1RO*(XN*YPRED     1600360
     1       (I&4)*SN-XNSQ*YPRED(I&5))&YPRED(I&7)*CS)-XMTETH&XNUPT*XMTEPH  1600370
      YAMPT=(-1.0/((RO/XD33)&(SNSQ*X1RO/XK33)))*(-2.0*XN*YPRED(I&7)&YPRE   1600380
     1       D(I&4)*(CS1R1-CN1RO)&XN*YPRED(I&5)*(SN1RC&X1R1)&2.0*XN*YPRED  1600390
     2       (I&6)*CS1RC&YPRED(I)*SN/XK33)                                 1600400
      YAJPH = YPRED(I+2)-XNL*(XNPI*YPRED(I+7))                             1600410
      YANPT=YPRED(I)&YAMPT*SN1RC                                           1600420
      YAOPH=XN*YPRED(I&6)*X1RO-YPRED(I&4)*SN1RO                            1600430
      YAOPH=YPRED(I&2)-XN*YAMPT*X1RO                                       1600440
      YAOTH=(2.0*CS1RO-(2.0*CS*(RO*XK33&XD33*SN1R1))/(ROSQ*XK33&XD33*SNS   1600450
     1       Q))*YAMPT&(-X1R1/(RO/XD33&SNSQ*X1RC/XK33))*(-2.*XN*YDOT(I&7   1600460
     2       )&YDOT (I&4)*(CS1R1-CN1RO)&YPRED(I&4)*(SN*SN1RC-CS*CS1RO-SN1  1600470
     3       R1-R1DOT*CS1R1*X1R1&R1*CS1RO**2*SN)&XN*YDOT(I&5)*(SN1RO       1600480
     4       &X1R1)&XN*YPRED(I&5)*(CS1RO-R1*CN*X1ROSQ-R1DOT*X1R1**2)&2.0*  1600490
     5       XN*YDOT(I&6)*CS1RO-2.C*XN*YPRED(I&6)*(SN1RO&R1*CS1RO**2)&      1600500
     6       YDOT(I)*SN/XK33&YPRED(I)*CS/XK33)-XN*YAMTH*X1RO-XMPHLD         1600510
      IF(XN.EQ.0.0.AND.XFTHLD.EQ.0.0.AND.XMPHLD.EQ.0.0)  YAOTH=0.0         1600520
      YDOT(I)=R1*(-2.0*YPRED(I)*CS1RO&XN*YANTH*X1RC-XN*YAMTH*SN*X1ROSQ-    1600530
     1         YAMPT*CS1RC*(X1R1-SN1RC)-XFTHLD-XMPHLD*SN1RO)               1600540
      YDOT(I&5)=R1*(YPRED(I&6)*X1R1&(1.0/(XK22-XNUTP**2*XK11))*(YPRED(I&   1600550
     1          1)-XNUTP*YANTH&XNTEPH-XNUTP*XNTETH))                       1600560
      YDOT(I+1) =(-YPRED(I+1)*CS1RO+YANTH*CS1RC-XN*YPRED(I)*X1RO-XN*       1600570
     1           YAMPT*X1RO*(SN*X1RO+X1R1)+YPRED(I+2)*X1R1-XFPHLD-          1600580
```

```
     2              XNL*(XFPHLD*(YPRED(I    *CS1RO-YPRED(I+6)*(X1R1+SN1RO)  1600590
    3-              +YDOT (I+5)*X1R1)-XFZELD*YPRED(I+7)))*R1                1600600
      YDOT(I+2) =(-YAJPH*CS*X1RO-YANTH*SN1RO-YPRED(I+1)*X1R1+XNSQ*YAMTH*    1600610
     1             X1ROSQ-2.0*XN*YAMPT*CS*X1ROSQ+XN*XMPHLD*X1RO-XFZELD-XNL  1600620
     2             *(XFZELD*(YPRED(I+5)*CS*X1RO-YPRED(I+6)*(X1R1+SN1RO)+     1600630
     3             YDOT(I+5)*X1R1)+XFPHLD*YPRED(I+7))-XNL*CS1RO*(XNPI*       1600640
     4             YPRED(I+7)))*R1                                           1600650
      YDOT(I+3) = R1*(YAMTH*CS1RO-YPRED(I+3)*CS1RO-2.0*XN*YAMPT*X1RO+        1600660
     1             YAJPH+XMTHLD)                                             1600670
      YDOT(I&4)=R1*(YPRED(I&4)*CS1RO&XN*YPRED(I&5)*X1RO&YPRED(I)/XK33&       1600680
     1             YAMPT*SN*X1RO/XK33)                                       1600690
      YDOT(I&6)=R1*(YPRED(I&7)-YPRED(I&5)*X1R1)                              1600700
      YDOT(I&7)=R1*(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I&3)&XNUTP*YAMTH-      1600710
     1             XMTEPH&XNUTP*XMTETH)                                      1600720
      GOTO 9005                                                              1600730
C     EQUATIONS FOR CONE                                                     1600740
    152 YANTH=XNUPT*YPRED(I&1)&(XK11-XNUPT**2*XK22)*(X1CS/S)*(XN*YPRED(I&4   1600750
     1       )&YPRED(I&5)*CS-YPRED(I&6)*SN)-XNTETH&XNUPT*XNTEPH              1600760
      YAMTH=XNUPT*YPRED(I&3)-(1.0/S)*X1CS*(XD11-XNUPT**2*XD22)*((1.0/S)*     1600770
     1       X1CS*(XN*YPRED(I&4)*SN-XNSQ*YPRED(I&6))&YPRED(I&7)*CS)-         1600780
     2       XMTETH&XNUPT*XMTEPH                                             1600790
      YAMPT=(-1.0/((S*CS/XD33)&(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I&7)-       1600800
     1       YPRED(I&4)*SN/S&XN*YPRED(I&5)*TN/S&2.0*XN*YPRED(I&5)/S&YPRED    1600810
     2       (I)*SN/XK33)                                                    1600820
      YAJPH = YPRED(I+2)-XNL*(XNPHI*YPRED(I+7))                              1600830
      YAMPT=YPRED(I)&YAMPT*TN/S                                              1600840
      YACPH=XN*YPRED(I&6)*X1CS/S-YPRED(I&4)*TN/S                             1600850
      YAQTH=(3.0/S-2.0*XK33*S*CS**2/(XK33*S**2*CS**2&XD33*SN**2))*YAMPT&     1600860
     1       (-1.0/((S*CS/XD33)&(SN**2*X1CS/(XK33*S))))*(-2.0*XN*YDOT(I&7   1600870
     2       )-YDOT(I&4)*SN/S&YPRED(I&4)*SN/S**2&XN*YDOT(I&5)*TN/S-XN*       1600880
     3       YPRED(I&5)*TN/S**2&2.0*YDOT(I&6)*XN/S-2.0*XN*YPRED(I&6)/S**2    1600890
     4       &YDOT(I)*SN/XK33)-XN*YAMTH*X1CS/S-XMPHLD                        1600900
      IF(XN.EQ.0.0.AND.XPTHLD.EQ.0.0.AND.XMPHLD.EQ.0.0)  YAQTH=0.0           1600910
      YDOT(I)  =-2.0*YPRED(I)/S&XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2     1600920
     1       &YAMPT*TN/S**2-XPTHLD-XMPHLD*TN/S                               1600930
      YDOT(I&5)=(1.0/(XK22-XNUTP**2*XK11))*(YPRED(I&1)-XNUTP*YANTH&XNTEP     1600940
     1       H-XNUTP*XNTETH)                                                 1600950
      YDOT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/       1600960
     1       (S**2*CS**2)-XFPHLD-XNL*(XFPHLD*(YPRED(I+5)/S-YPRED             1600970
     2       (I+6)*TAN/S+YDOT(I+5))-XFZELD*YPRED(I+7))                       1600980
      YDOT(I+2)= -YAJPH/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)-2.0*XN*        1600990
     1       YAMPT/(S**2*CS)+XN*XMPHLD/(S*CS)-XFZELD-XNL*(XFZELD*(           1601000
     2       YPRED(I+5)/S-YPRED(I+6)*TAN/S+YDOT(I+5))+XFPHLD*YPRED           1601010
     3       (I+7))-XNL*XNPHI*YPRED(I+7)/S                                   1601020
      YDOT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD       1601030
      YDOT(I&4)=(1.0/S)*(YPRED(I&4)&XN*YPRED(I&5)*X1CS&YAMPT*TN/XK33)        1601040
     1       &YPRED(I)/XK33                                                  1601050
      YDOT(I&6)=YPRED(I&7)                                                   1601060
      YDOT(I&7)=(1.0/(XD22-XNUTP**2*XD11))*(-YPRED(I&3)&XNUTP*YAMTH-         1601070
     1       XMTEPH&XNUTP*XMTETH)                                            1601080
      GO TO 9005                                                             1601090
C     EQUATIONS FOR CYLINDER                                                 1601100
    153 YANTH=XNUPT*YPRED(I&1)&(XK11-XNUPT**2*XK22)*(X1RO*(XN*YPRED(I&4)-    1601110
     1       YPRED(I&6)))-XNTETH&XNUPT*XNTEPH                                1601120
      YAMTH=XNUPT*YPRED(I&3)-(X1RO*(XD11-XNUPT**2*XD22))*(X1RO*(XN*YPRED     1601130
     1       (I&4)-XN**2*YPRED(I&6)))-XMTETH&XNUPT*XMTEPH                    1601140
      YAMPT=(-1.0/((RO/XD33)&(X1RO/XK33)))*(-2.0*XN*YPRED(I&7)&XN*X1RO*      1601150
     2       YPRED(I&5)&YPRED(I)/XK33)                                       1601160
      YAJPH = YPRED(I+2)-XNPHI*YPRED(I+7)                                    1601170
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      YANPT=YPRED(I)&YAMPT*X1RO                                          1601190
      YACPH=X1RC*(XN*YPRED(I&5)-YPRED(I&4                                1601200
      YAQPH=YPRED(I&?)-XN*YAMPT*X1RO                                     1601210
      YACTH=(-1.0/((RO/XD33)&(X1RC/XK33)))*(-?.0*XN*YDOT(I&7)&XN*YDOT(I& 1601220
     1       5)*X1RO&YDOT(I)/XK33)-XN*YAMTH*X1RO-XMPHLD                  1601230
      IF(XN.EC.0.0.AND.XFTHLD.EQ.0.0.0.AND.XMPHLC.EQ.0.0)  YAQTH=0.0     1601240
      YDOT(I)  =XN*YANTH*X1RO-XN*YAMTH*X1ROSO-XFTHLD-XMPHLD*X1RO         1601250
      YDOT(I&5)=(1.0/(XK22-XNUTP**?*XK11))*(YPRED(I&1)-XNUTP*YANTH&XNTEP 1601260
     1          H-XNUTP*XNTETH)                                          1601270
      YDOT(I+1) = -XN*X1RC*YPRED(I)-XN*YAMPT*X1ROSC-XFPHLD-XNL*(XFPHLC*  1601280
     1             (YDOT(I+5)-YPRED(I+6)*X1RO)-XFZELD*YPRED(I+7))       1601290
      YDOT(I+?) = -YANTH*X1RO+XNSO*YAMTH*X1ROSC+XN*XMPHLD*X1RO-XFZELC-   1601300
     1            XNL*(XFZELD*(YDOT(I+5)-YPRED(I+6)*X1RO)+XFPHLD*YPRED(  1601310
     ?            I+7))                                                  1601320
      YDCT(I+3) = -2*XN*YAMFT*X1RO+YAJPH+XMTPLD                          1601330
      YDOT(I&4)=XN*YPRED(I&5)*X1RC&YPRED(I)/XK33&YAMPT*X1RO/XK33         1601340
      YDOT(I&6)=YPRED(I&7)                                               1601350
      YDOT(I&7)=(1.0/(XD22-XNUTP**?*XD11))*(-YPRED(I&3)&XNUTP*YAMTH-XMTE 1601360
     1          PH&XNUTP*XMTETH)                                         1601370
      GO TC 9005                                                         1601380
 7786 GO TO (4771,4772,4773),IGECM                                       1601390
C     THE FOLLCWING EQUATIONS ARE THE 'ST10' SET                         1601400
C   EQUATIONS FOR SHELLS CF REVOLUTICN  ( PHI  COORDINATE )              1601410
 4771 YANTH= XK12*(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22 1601420
     1       )*(YPRED(I&3)&XMTPH))-XNTTH&(X1RO*XK11-XK12*XK21*X1RO*(1.0/ 1601430
     2       (XK22&XC22**2/XD22)))*(XN*YPRED(I&4)&YPRED(I&5)*CS-YPRED(I& 1601440
     3      6)*SN)-(XC11&XK12*XC22*XC21/XD22*(1.0/(XK22&XC22**2/XD22)))* 1601450
     4       (X1RO**2*(XN*YPRED(I&4)*SN-XN**2*YPRED(I&6))&YPRED(I&7)*CS* 1601460
     5       X1RO)                                                       1601470
      YAMTH =-XC12*(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH)-XMTTH   1601480
     1        &XD12*(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)&(XC11* 1601490
     2        X1RO&XD12*XK21*X1RC*(XC22/(XC22**2&XK22*XD22)))*(XN*YPRED( 1601500
     3        I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)&(XD11-XD12*XK22*XD21/(   1601510
     4        XC22**2&XK22*XD22))*(X1ROSO*(XN*YPRED(I&4)*SN-XNSO*YPRED   1601520
     5        (I&6))&YPRED(I&7)*CS*X1RO)                                 1601530
      YAMPT=(-1.0/((RO/XD33)&(SNSC*X1RO/XK33)))*(-2.0*XN*YPRED(I&7)&YPRE 1601540
     1      D(I&4)*(CS1R1-CN1RO)&XN*YPRED(I&5)*(SN1RO&X1R1)&2.0*XN*YPRED 1601550
     2      (I&6)*CS1RO&YPRED(I)*SN/XK33)                                1601560
      YAJPH = YPRED(I+?)-XNL*(XNPI*YPRED(I+7))                           1601570
      YANPT=YPRED(I)&YAMPT*SN1RO                                         1601580
      YAQPH=XN*YPRED(I&6)*X1RC-YPRED(I&4)*SN1RC                          1601590
      YAQPH=YPRED(I&?)-XN*YAMPT*X1RC                                     1601600
      YAQTH=(3.0*CS1RO-(2.0*CS*(RC*XK33&XD??*SN1R1))/(ROSQ*XK33&XD33*SNS 1601610
     1      Q))*YAMPT&(-X1R1/(RO/XD33&SNSO*X1RO/XK33))*(-2.*XN*YDOT(I&7  1601620
     2      )&YDOT (I&4)*(CS1R1-CN1RC)&YPRED(I&4)*(SN*SN1RC-CS*CS1RO-SN1 1601630
     3      R1-R1DOT*CS1R1*X1R1&R1*CS1PO**?*SN)&XN*YDOT(I&5)*(SN1RO       1601640
     4      &X1R1)&XN*YPRED(I&5)*(CS1RO-R1*CN*X1ROSO-R1DOT*X1R1**2)&2.0*  1601650
     5      XN*YDCT(I&6)*CS1RO-?.0*XN*YPRED(I&6)*(SN1RO&R1*CS1RO**?)&     1601660
     6      YDOT(I)*SN/XK33&YPRED(I)*CS/XK33)-XN*YAMTH*X1RO-XMPHLD         1601670
      IF(XN.EQ.0.0.AND.XFTHLD.EQ.0.0.0.AND.XMPHLD.EQ.0.0)  YAQTH=0.0     1601680
      YDCT(I)=R1*(-2.0*YPRED(I)*CS1RO&XN*YANTH*X1RO-XN*YAMTH*SN*X1ROSO-   1601690
     1        YAMPT*CS1RO*(X1R1-SN1RO)-XFTHLD-XMPHLD*SN1RO)              1601700
      YDOT (I&5)=R1*(YPRED(I&6)*X1R1&(1.0/(XK22&XC22**?/XD22))*(YPRED(I& 1601710
     1           1)&XNTPH&(XC22/XD22)*(YPRED(I&3)&XMTPH)-XK21*X1RO*(XN*   1601720
     2           YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)-(XC22*XD21/XD22  1601730
     3           )*(X1ROSO*(XN*YPRED(I&4)*SN-XNSO*YPRED(I&6))&YPRED(I&7)  1601740
     4           *CS*X1RO)))                                              1601750
      YDCT(I+1) =(-YPRED(I+1)*CS1RO+YANTH*CS1RC-XN*YPRED(I)*X1RO-XN*      1601760
     1           YAMPT*X1RO*(SN*X1RO+X1R1)+YPRED(I+2)*X1R1-XFPHLD-         1601770
     ?            XNL*(XFPHLD*(YPRED(I+5)*CS1RC-YPRED(I+6)*(X1R1+SN1RO)   1601780
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     3              +YDOT (I+5)*X1R1)-XF    D*YPRED(I+7)))*R1                    1601790
      YDOT(I+2) =(-YAJPH*CS*X1RO-YANTH*SN1RO-YPRED(I+1)*X1R1+XNSO*YAMTH*  1601800
     1            X1ROSO-2.0*XN*YAMPT*CS*X1ROSO+XN*XMPHLD*X1RO-XFZELD-XNL 1601810
     2           *(XFZELO*(YPRED(I+5)*CS*X1RO-YPRED(I+6)*(X1R1+SN1RO)+    1601820
     3            YDCT (I+5)*X1R1)+XFPHLD*YPRED(I+7))-XNL*CS1RO*(XNPI*     1601830
     4            YPRED(I+7)))*R1                                          1601840
      YDOT(I+3) = R1*(YAMTH*CS1RO-YPRED(I+3)*CS1RO-2.0*XN*YAMPT*X1RO+     1601850
     1            YAJPH+XMTHLD)                                            1601860
      YDOT(I&4)=R1*(YPRED(I&4)*CS1RO&XN*YPRED(I&5)*X1RO&YPRED(I)/XK33&     1601870
     1           YAMPT*SN*X1RO/XK33)                                       1601880
      YDOT(I&6)=R1*(YPRED(I&7)-YPRED(I&5)*X1R1)                            1601890
      YDOT(I&7)=R1*((-XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH-(XK21/   1601900
     1           RO)*(XN*YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN))          1601910
     2           &(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)-(XK22*     1601920
     3           XD21/(XC22**2&XK22*XD22))*(X1ROSO*(XN*YPRED(I&4)*SN-XNSO  1601930
     4           *YPRED(I&6))&YPRED(I&7)*CS*X1RO))                         1601940
      GO TO 9005                                                           1601950
C     EQLATIONS FOR CONE                                                   1601960
 4772 YANTH= XK12*(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22  1601970
     1      )*(YPRED(I&3)&XMTPH))-XNTTH&(1.0/(CS*S))*(XK11-XK12*XK21*(    1601980
     2      1.0/(XK22&XC22**2/XD22)))*(XN*YPRED(I&4)&YPRED(I&5)*CS-        1601990
     3      YPRED(I&6)*SN)-(XC11&(XK12*XD21*XC22/XD22)*(1.0/(XK22&XC22*    1602000
     4      *2/XD22)))*((1.0/(S**2*CS**2))*(XN*YPRED(I&4)*SN-XNSO*YPRED    1602010
     5      (I&6))&YPRED(I&7)/S)                                           1602020
      YAMTH =-XD12*(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH)-XMTTH&    1602030
     1        XD12*(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)&(XC11/    1602040
     2        (S*CS)&XD12*XK21/(S*CS))*(XC22/(XC22**2&XK22*XD22))*(XN*     1602050
     3        YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)&(XD11-XD12*XK22*     1602060
     4        XD21/(XC22**2&XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I&4)*   1602070
     5        SN-XNSO*YPRED(I&5))&YPRED(I&7)/S)                            1602080
      YAMPT=(-1.0/((S*CS/XD33)&(SN*TN/(XK33*S))))*(-2.0*XN*YPRED(I&7)-     1602090
     1      YPRED(I&4)*SN/S&XN*YPRED(I&5)*TN/S&2.0*XN*YPRED(I&6)/S&YPRED   1602100
     2      (I)*SN/XK33)                                                   1602110
      YAJPH = YPRED(I+2)-XNL*(XNPHI*YPRED(I+7))                            1602120
      YANPT=YPRED(I)&YAMPT*TN/S                                            1602130
      YAOPH=XN*YPRED(I&6)*X1CS/S-YPRED(I&0)*TN/S                           1602140
      YAQPH=YPRED(I&2)-XN*YAMPT*X1CS/S                                     1602150
      YACTH=(3.0/S-2.0*XK33*S*CS**2/(XK33*S**2*CS**2&XD33*SN**2))*YAMPT&   1602160
     1      (-1.0/((S*CS/XD33)&(SN**2*X1CS/(XK33*S))))*(-2.0*XN*YDOT(I&7   1602170
     2      )-YDOT(I&4)*SN/S&YPRED(I&4)*SN/S**2&XN*YDOT(I&5)*TN/S-XN*      1602180
     3      YPRED(I&5)*TN/S**2&2.0*YDOT(I&6)*XN/S-2.0*XN*YPRED(I&6)/S**2   1602190
     4      &YDOT(I)*SN/XK33)-XN*YAMTH*X1CS/S-XMPHLD                       1602200
      IF(XN.EC.0.0.AND.XFTHLD.EC.0.0.AND.XMPHLD.EQ.0.0)  YAQTH=0.0         1602210
      YDOT(I)  =-2.0*YPRED(I)/S&XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2   1602220
     1          &YAMPT*TN/S**2-XFTHLD-XMPHLD*TN/S                          1602230
      YDOT(I&5)=(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22)*   1602240
     1          (YPRED(I&3)&XMTPH)-(XK21/(S*CS))*(XN*YPRED(I&4)&YPRED(     1602250
     2          I&5)*CS-YPRED(I&6)*SN)-(XC22*XC21/XD22)*((1.0/(S**2*CS**   1602260
     3          2))*(XN*YPRED(I&4)*SN-XNSO*YPRED(I&6))&YPRED(I&7)/S))      1602270
      YDOT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/     1602280
     1            (S**2*CS**2)-XFPHLD-XNL*(XFPHLD*(YPRED(I+5)/S-YPRED     1602290
     2            (I+6)*TAN/S+YDOT(I+5))-XFZELD*YPRED(I+7))               1602300
      YDOT(I+2)= -YAJPH/S-YANTH*TAN/S+XNSO*YAMTH/(S**2*CS**2)-2.0*XN*      1602310
     1           YAMPT/(S**2*CS)+XN*XMPHLD/(S*CS)-XFZELD-XNL*(XFZELD*(     1602320
     2            YPRED(I+5)/S-YPRED(I+6)*TAN/S+YDOT(I+5))+XFPHLD*YPRED   1602330
     3           (I+7))-XNL*XNPHI*YPRED(I+7)/S                            1602340
      YDOT(I+3)= YAMTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD     1602350
      YDOT(I&4)=(1.0/S)*(YPRED(I&4)&XN*YPRED(I&5)*X1CS&YAMPT*TN/XK33)      1602360
     1          &YPRED(I)/XK33                                             1602370
      YDOT(I&6)=YPRED(I&7)                                                 1602380
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      YDOT(I&7)=-(XC22/(XC22**2&XK22*XL   )*(YPRED(I&1)&XNTPH-XK21*(XN*  1602390
     1          YPRED(I&4)&YPRED(I&5)*CS-YPRED(I&6)*SN)/(S*CS))&          1602400
     2          (XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)-(XK22*XD21  1602410
     3          /(XC22**2&XK22*XD22))*((1.0/(S*CS)**2)*(XN*YPRED(I&4)*SN  1602420
     4          -XN**2*YPRED(I&5)&YPRED(I&7)/S)                           1602430
      GO TO 9005                                                          1602440
C     EQUATIONS FOR CYLINDER                                              1602450
 4773 YANTH= XK12*(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22  1602460
     1    )*(YPRED(I&3)&XMTPH))-XNTTH&(X1RO*(XK11-XK12*XK21*(1.0/(       1602470
     2    XK22&XC22**2/XD22))))*(XN*YPRED(I&4)-YPRED(I&6))-(XC11&(       1602480
     3    XK12*XC22*XD21/XD22)*(1.0/(XK22&XC22**2/XD22)))*(X1RO**2*(     1602490
     4    XN*YPRED(I&4)-XNSO*YPRED(I&6)))                               1602500
      YAMTH =-XD12*(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH)-XMTTH&  1602510
     1       XD12*(XK22/(XC22**2&XK22*XD22))*(YPRED(I&3)&XMTPH)&(XC11*   1602520
     2       X1RO&XD12*XK21*X1RO*(XC22/(XC22**2&XK22*XD22)))*(XN*YPRED  1602530
     3       (I&4)-YPRED(I&6))&(XD11-XD12*XK22*XD21/(XC22**2&XK22*XD22) 1602540
     4       )*(X1ROSO*(XN*YPRED(I&4)-XNSO*YPRED(I&6)))                 1602550
      YAMPT=(-1.0/((RO/XD33)+(X1RO/XK33)))*(-2.0*XN*YPRED(I+7)+XN*X1RO*  1602560
     1    YPRED(I+5)+YPRED(I)/XK33)                                     1602570
      YAJPH = YPRED(I+2)-XNPHI*YPRED(I+7)                               1602580
      YANPT=YPRED(I)&YAMPT*X1RO                                         1602590
      YACPH=X1RO*(XN*YPRED(I&6)-YPRED(I&4))                             1602600
      YAGPH=YPRED(I&2)-XN*YAMPT*X1RO                                    1602610
      YAGTH=(-1.0/((RO/XD33)&(X1RO/XK33)))*(-2.0*XN*YDOT(I&7)&XN*YDOT(I& 1602620
     1    5)*X1RO&YDOT(I)/XK33)-XN*YAMTH*X1RO-XMPHLD                    1602630
      IF(XN.EQ.0.0.AND.XFTHLD.EQ.0.0.AND.XMPHLD.EQ.0.0)  YAGTH=0.0      1602640
      YDOT(I)  =XN*YANTH*X1RO-XN*YAMTH*X1ROSO-XFTHLD-XMPHLD*X1RO        1602650
      YDOT (I&5) =(1.0/(XK22&XC22**2/XD22))*(YPRED(I&1)&XNTPH&(XC22/XD22 1602660
     1          )*(YPRED(I&3)&XMTPH)-(XK21*X1RO)*(XN*YPRED(I&4)-YPRED  1602670
     2    (I&6))-(XC22*XD21/XD22)*(X1ROSO*(XN*(YPRED(I&4)-XN*YPRE       1602680
     3          D(I&6))))                                               1602690
      YDOT(I+1) = -XN*X1RO*YPRED(I)-XN*YAMPT*X1ROSO-XFPHLD-XNL*(XFPHLD*  1602700
     1          (YDOT(I+5)-YPRED(I+6)*X1RO)-XFZELD*YPRED(I+7))          1602710
      YDOT(I+2) = -YANTH*X1RO+XNSO*YAMTH*X1ROSO+XN*XMPHLD*X1RO-XFZELD-   1602720
     1          XNL*(XFZELD*(YDOT(I+5)-YPRED(I+6)*X1RO)+XFPHLD*YPRED(   1602730
     2          I+7))                                                   1602740
      YDOT(I+3) = -2*XN*YAMPT*X1RO+YAJPH+XMTHLD                         1602750
      YDOT(I&4)=XN*YPRED(I&5)*X1RO&YPRED(I)/XK33&YAMPT*X1RO/XK33        1602760
      YDOT(I&6)=YPRED(I&7)                                              1602770
      YDOT(I&7)=-(XC22/(XC22**2&XK22*XD22))*(YPRED(I&1)&XNTPH-XK21*X1RO*  1602780
     9          (                                                       1602790
     1          XN*YPRED(I&4)-YPRED(I&6)))&(XK22/(XC22**2&XK22*XD22))*(  1602800
     2          YPRED(I&3)&XMTPH)-(XK22*XD21/(XC22**2&XK22*XD22))*(      1602810
     3          X1ROSO*(XN*YPRED(I&4)-XNSO*YPRED(I&6)))                 1602820
      GO TO 9005                                                        1602830
 7447 GO TO (7341,7342,7343),IGECM                                      1602840
C     THE FOLLOWING EQUATIONS ARE THE 'RWAF' SET                        1602850
C     EQUATIONS FOR SHELLS OF REVOLUTION ( PHI COORDINATE )             1602860
 7341 YANTH = (YPRED(I+1)+XNTPH)*(1.0+(XK12-XK22)*(XK22+XC11**2/XD22)**  1602870
     1    (-1))-XNTTH+(XK12-XK22)*(XC11/(XK22*XD22+XC11**2))*(YPRED     1602880
     2    (I+3)+XMTPH)-(XK12-XK22)*((XD12*XC11-XC11*XD22)/(XK22*XD22    1602890
     3  +XC11**2))*X1ROSO*(XN*YPRED(I+4)*SN-XNSO*YPRED(I+6)+RO*YPRED    1602900
     4    (I+7)*CS)+X1RO*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)    1602910
     5    *(XK11-XK12-(XK12-XK22)*((XK12*XD22+XC11**2)/(XK22*XD22+      1602920
     6    XC11**2)))                                                    1602930
      YAMTH = (YPRED(I+3)+XMTPH)*(1.0+(XD12-XD22)*(XK22/(XC11**2+XD22*  1602940
     1     XK22)))-XMTTH-(YPRED(I+1)+XNTPH)*(XD12-XD22)*(XC11/(XC11     1602950
     2    **2+XD22*XK22))+(XD12-XD22)*(XK12-XK22)*(XC11/(XC11**2+       1602960
     3    XD22*XK22))*X1RO*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*     1602970
     4    SN)+X1ROSO*(XN*YPRED(I+4)*SN-XNSO*YPRED(I+6)+RO*YPRED(I+7)    1602980
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     5         *CS)*(XD11)-XD12-(XD12-XD    *((XC11**2+XD12*XK22)/(XC11**2+ 1602990
     6        XD22*XK22)))                                                  1603000
      YAMPT = (1.0/(XC11*SN*X1RO-XK33-SN*X1RO*(XD33*SN/(      RO)-XC11))) 1603010
     1        *((XK33*XD33-XC11**2)*X1RO*(-2.0*XN*YPRED(I+7)+YPRED(I+4)* 1603020
     2        (CS*X1R1-CN1RO)+XN*YPRED(I+5)*(X1R1+SN1RO)+2.0*XN*YPRED     1603030
     3        (I+6)*CS*X1RO)+YPRED(I)*(XD33*SN*X12O-XC11))                1603040
      YAJPH = YPRED(I+2)-XNL*(XNPI*YPRED(I+7))                            1603050
      YANPT=YPRED(I)&YAMPT*SN1RO                                          1603060
      YAQPH=XN*YPRED(I&6)*X1RO-YPRED(I&4)*SN1RO                           1603070
      YAQPH=YPRED(I&2)-XN*YAMPT*X1RO                                      1603080
      YAQTH=(4.*CS1RO-((2.*CS*(XC11*RO*X1R1&XC11*SN-RO*XK33-SN1R1*XD33)) 1603090
     1     /(2.*RO*XC11*SN-ROSQ*XK33-XD33*SNSQ)))*YAMPT&(X1R1/(2.*XC11*  1603100
     2     SN1RO-XK33-XD33*SNSQ*X1ROSQ))*((XK33*XD33-XC11**2)*(-2.*XN*    1603110
     3     YDOT(I&7)*X1RO&2.*XN*YPRED(I&7)*R1*CS*X1ROSQ&YDOT(I&4)*(       1603120
     4     CS1R1*X1RO-CN1RO*X1RO)&YPRED(I&4)*(-SN1R1*X1RO-(CS*(RO*R1DOT   1603130
     5     &R1SQ*CS))/(R1SQ*ROSQ)-(CSSQ-SNSQ)*X1ROSQ&2.*R1*CSSQ*SN*X1RO  1603140
     6     *X1ROSQ)&XN*YDOT(I&5)*(X1RO*X1R1&SN1RO*X1RO)&XN*YPRED(I&5)     1603150
     7    *(-2.*R1*CN1RO*X1ROSQ-R1DOT*X1R1SQ*X1RO)+2.*XN*YDOT(I+6)*       1603160
     8     CS*X1ROSQ-2.*XN*YPRED(I&6)*(SN1RO*X1RO&2.*R1*CSSQ*X1RO*X1ROSQ) 1603170
     9     )&YDOT(I)*(XD33*SN1RO-XC11)&YPRED(I)*(XD33*CS1RO-XC33*R1*       1603180
     A     CN1RO*X1RO))-XN*YAMTH*X1RO-XMPHLD                               1603190
      IF(XN.EQ.0.0.AND.XFTHLD.EQ.0.0.AND.XMPHLD.EQ.0.0)  YAQTH=0.0        1603200
      YDOT(I)=R1*(-2.0*YPRED(I)*CS1RO&XN*YANTH*X1RO-XN*YAMTH*SN*X1ROSQ-   1603210
     1        YAMPT*CS1RO*(X1R1-SN1RO)-XFTHLD-XMPHLD*SN1RO)               1603220
      YDOT(I+5)=YPRED(I+6)+R1*(1.0/(XK22+XC11**2/XD22))*(YPRED(I+1)+      1603230
     1          XNTPH  +(XC11/XD22)*(YPRED(I+3)+XMTPH )-(XK12+XC11**2/    1603240
     2          XD22)*X1RO*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN)    1603250
     3       -(XD12*XC11/XD22-XC11)*X1ROSQ*(XN*YPRED(I+4)*SN-XNSQ*        1603260
     4          YPRED(I+6)+RC*YPRED(I+7)*CS))                             1603270
      YDOT(I+1) =(-YPRED(I+1)*CS1RO+YANTH*CS1RO-XN*YPRED(I)*X1RO-XN*      1603280
     1          YAMPT*X1RO*(SN*X1RO+X1R1)+YPRED(I+2)*X1R1-XFPHLD-          1603290
     2          XNL*(XFPHLD*(YPRED(I+5)*CS1RO-YPRED(I+6)*(X1R1+SN1RO)     1603300
     3          +YDOT (I+5)*X1R1)-XFZELD*YPRED(I+7)))*R1                  1603310
      YDOT(I+2) =(-YAJPH*CS*X1RO-YANTH*SN1RO-YPRED(I+1)*X1R1+XNSQ*YAMTH*  1603320
     1          X1ROSQ-2.0*XN*YAMPT*CS*X1ROSQ+XN*XMPHLD*X1RO-XFZELD-XNL   1603330
     2         *(XFZELD*(YPRED(I+5)*CS*X1RO-YPRED(I+6)*(X1R1+SN1RO)+      1603340
     3          YDOT (I+5)*X1R1)+XFPHLD*YPRED(I+7))-XNL*CS1RO*(XNPI*      1603350
     4          YPRED(I+7)))*R1                                           1603360
      YDOT(I+3) = R1*(YAMTH*CS1RO-YPRED(I+3)*CS1RO-2.0*XN*YAMPT*X1RO+     1603370
     1           YAJPH+XMTHLD)                                            1603380
      YDOT(I+4) =R1*(YPRED(I+4)*CS*X1RO+XN*YPRED(I+5)*X1RO+(1.0/(XK33-    1603390
     1          XC11**2/XD33))*(YPRED(I)+YAMPT*(SN*X1RO-XC11/XD33)))      1603400
      YDOT(I&6)=R1*(YPRED(I&7)-YPRED(I&5)*X1R1)                           1603410
      YDOT(I+7)=R1*((XK22/(XC11**2+XD22*XK22))*(YPRED(I+3)+XMTPH)+(XC11   1603420
     1         /(XC11**2+XD22*XK22))*(-YPRED(I+1)-XNTPH+(XK12-XK22)*      1603430
     2    X1RC*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*SN))-((XC11**2+     1603440
     3         XD12*XK22)/(XD22*XK22+XC11**2))*X1ROSQ*(XN*YPRED(I+4)*SN   1603450
     4   -XNSQ*YPRED(I+6)+RC*YPRED(I+7)*CS))                               1603460
      GO TO 9005                                                          1603470
C     EQUATIONS FOR CONE                                                  1603480
 7342 YANTH = (YPRED(I+1)+XNTPH)*(1.0+(XK12-XK22)*(1.0/(XK22+XC11**2/     1603490
     1       XD22)))-XNTTH+(XK12-XK22)*(XC11/(XK22*XD22+XC11**2))*(       1603500
     2       YPRED(I+3)+XMTPH)-(XK12-XK22)*(XD12*XC11-XC11*XD22)*((1.0/   1603510
     3       (S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED(I+7   1603520
     4       )/S)/(XK22*XD22+XC11**2)+(1.0/(S*CS))*(XN*YPRED(I+4)+YPRED   1603530
     5       (I+5)*CS-YPRED(I+6)*SN)*(XK11-XK12-(XK12-XK22)*(XK12*XC22+   1603540
     6       XC11**2)/(XK22*XD22+XC11**2))                                1603550
      YAMTH=(YPRED(I+3)+XMTPH)*(1.0+(XD12-XD22)*(XK22/(XC11**2+XD22*XK22   1603560
     1    )))-XMTTH-(YPRED(I+1)+XNTPH)*(XD12-XD22)*(XC11/(XD22*XK22+      1603570
     2    XC11**2))+(XD12-XD22)*(XK12-XK22)*(XC11/(XD22*XK22+XC11**2))    1603580
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     3*(1.0/(S*CS))*(XN*YPRED(I+4)+YPR    I+5)*CS-YPRED(I+6)*SN)+((1.0/    1603590
     4 (S*CS)**2)*(XN*YPRED(I+4)*SN-XNS  YPRED(I+6))+YPRED(I+7)*S1)*(     1603600
     5 XD11-XD12-(XD12-XD22)*(XC11**2+XD12*XK22)/(XC11**2+XD22*XK22))     1603610
      YAMPT =((XC11*TAN/S-XK33-(TAN/S)*(XD33*TAN/S-XC11))**(-1))*((XK33*  1603620
     1        XD33-XC11**2)*(1.0/(S*CS))*(-2.0*XN*YPRED(I+7)-YPRED(I+4)*   1603630
     2         SN/S+XN*YPRED(I+5)*TAN/S+2.0*XN*YPRED(I+6)/S)+YPRED(I)*(    1603640
     3        XD33*TAN/S-XC11))                                            1603650
      YAJPH =  YPRED(I+2)-XNL*(XNPHI*YPRED(I+7))                          1603660
      YAMPT=YPRED(I)&YAMPT*TN/S                                           1603670
      YAOPH=XN*YPRED(I&6)*X1CS/S-YPRED(I&4)*TN/S                          1603680
      YAOPH=YPRED(I&2)-XN*YAMPT*X1CS/S                                    1603690
      YAOTH=(4./S-(2.*CS*(XC11*SN-S*XK33*CS))/(2.*S*XC11*CS*SN-S*S*XK33*  1603700
     1CSSQ-XD33*SNSQ))*YAMPT&(1./(2.*XC11*TAN*S1-XK33-XD33*TAN**2        1603710
     2*S1**2))*((XK33*XD33-XC)**2)*(((-2.*XN)/(S*CS))*YDOT(I&7)          1603720
     3&(2.*XN*YPRED(I&7))/(S**2*CS)-YDOT(I&4)*(TAN*S1**2)&YPRED(I&4      1603730
     4 )*(2.*TAN/S**3)&XN*YDOT(I&5)*(TAN/(S**2*CS))-XN*YPRED(I&5)*((2.   1603740
     5*TAN)/(S**3*CS))&YDOT(I&6)*((2.*XN)/(S**2*CS))-2.*XN*YPRED(I&6)    1603750
     6*(2./(S**3*CS)))&YDOT(I)*(XD33*TAN*S1-XC11)-YPRED(I)*((XD33        1603760
     7       *TAN)/(S**2)))   -(XN*YAMTH)/(S*CS)-XMPHLD                  1603770
      IF(XN.EQ.0.0.AND.XFTHLD.EQ.0.0.0.AND.XMPHLD.EQ.0.0)  YAOTH=0.0     1603780
      YDOT(I)   =-2.0*YPRED(I)/S&XN*YANTH*X1CS/S-XN*YAMTH*SN*X1CS**2/S**2 1603790
     1          &YAMPT*TN/S**2-XFTHLD-XMPHLD*TN/S                         1603800
      YDOT(I+5) = (1.0/(XK22+XC11**2/XD22))*(YPRED(I+1)+XNTPH+(XC11/XD22  1603810
     1           )*(YPRED(I+3)+XMTPH)-(XK12+XC11**2/XD22)*(1.0/(S*CS))*   1603820
     2           (XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+5)*SN)-(XD12*XC11   1603830
     3           /XD22-XC11)*((1.0/(S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ   1603840
     4           *YPRED(I+6))+YPRED(I+7)/S))                              1603850
      YDOT(I+1)= -YPRED(I+1)/S+YANTH/S-XN*YPRED(I)/(S*CS)-XN*YAMPT*SN/    1603860
     1           (S**2*CS**2)-XFPHLD-XNL*(XFPHLD*(YPRED(I+5)/S-YPRED      1603870
     2           (I+6)*TAN/S+YDOT(I+5))-XFZELD*YPRED(I+7))                1603880
      YDOT(I+2)= -YAJPH/S-YANTH*TAN/S+XNSQ*YAMTH/(S**2*CS**2)-2.0*XN*     1603890
     1         YAMPT/(S**2*CS)+XN*XMPHLD/(S*CS)-XFZELD-XNL*(XFZELD*(      1603900
     2           YPRED(I+5)/S-YPRED(I+6)*TAN/S+YDOT(I+5))+XFPHLD*YPRED    1603910
     3          (I+7))-XNL*XNPHI*YPRED(I+7)/S                             1603920
      YDOT(I+3)= YANTH/S-YPRED(I+3)/S-2.0*XN*YAMPT/(S*CS)+YAJPH+XMTHLD    1603930
      YDOT (I+4) = YPRED(I+4)/S+XN*YPRED(I+5)/(S*CS)+(1.0/(XK33-XC11**2/  1603940
     1            XD33))*(YPRED(I)+YAMPT*(TAN/S-XC11/XD33))                1603950
      YDOT(I&6)=YPRED(I&7)                                                1603960
      YDOT (I+7) =(XK22/(XC11**2+XD22*XK22))*(YPRED(I+3)+XMTPH)+(XC11/(   1603970
     1           XC11**2+XD22*XK22))*(-YPRED(I+1)-XNTPH+(XK12-XK22)*      1603980
     2           (1.0/(S*CS))*(XN*YPRED(I+4)+YPRED(I+5)*CS-YPRED(I+6)*    1603990
     3    SN))-((XC11**2+XD12*XK22)/(XD22*XK22+XC11**2))*((1.0/(          1604000
     4           S**2*CS**2))*(XN*YPRED(I+4)*SN-XNSQ*YPRED(I+6))+YPRED    1604010
     5           (I+7)/S)                                                 1604020
      GO TO 9005                                                          1604030
C     EQUATIONS FOR CYLINDER                                              1604040
 7343 YANTH=(YPRED(I+1)+XNTPH)*(1+(XK12-XK22)*(1/(XK22+XC11**2/XD22)))-   1604050
     1      XNTTH+(XK12-XK22)*(XC11/(XK22*XD22+XC11**2))*(YPRED(I+3)+     1604060
     2      XMTPH)-(XK12-XK22)*((XD12*XC11-XC11*XD22)/(XK22*XD22+XC11**2  1604070
     3      ))*X1RQSQ*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))+X1RQ*(XN*YPRED(I+4  1604080
     4      )-YPRED(I+6))*(XK11-XK12-(XK12-XK22)*((XK12*XD22+XC11**2)/    1604090
     5      (XK22*XD22+XC11**2)))                                         1604100
      YAMTH=(YPRED(I+3)+XMTPH)*(1+(XD12-XD22)*(XK22/(XC11**2-XD22*XK22)))  1604110
     1    )-XMTTH-(YPRED(I+1)+XNTPH)*(XD12-XD22)*(XC11/(XD22*XK22+XC11*   1604120
     2   *2))+(XD12-XD22)*(XK12-XK22)*(XC11/(XD22*XK22+XC11**2))*X1RQ*    1604130
     3    (XN*YPRED(I+4)-YPRED(I+6))+X1RQSQ*(XN*YPRED(I+4)-XNSQ*YPRED     1604140
     4    (I+6))*(XD11-XD12-(XD12-XD22)*((XC11**2+XD12*XK22)/(XC11**2     1604150
     5    +XD22*XK22)))                                                   1604160
      YAMPT=(1/(XC11*X1RQ-XK33-X1RQ*(XD33*X1RQ-XC11)))*((XK33*XD33-XC11   1604170
     1      **2)*X1RQ*(-2*XN*YPRED(I+7)+XN*X1RQ*YPRED(I+5))+YPRED(I)*(    1604180
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     2       XC33*X1RO-XC11))                                                  1604190
      YAJPH = YPRED(I+2)-XNPHI*YPRED(I+7)                                      1604200
      YANPT=YPRED(I)&YAMPT*X1RO                                                1604210
      YACPH=X1RO*(XN*YPRED(I&5)-YPRED(I&4))                                    1604220
      YAQPH=YPRED(I&2)-XN*YAMPT*X1RO                                           1604230
      YAQTH=(1./(2.*XC11*X1RO-XK33-XD33*X1ROSQ))*((XK33*XD33-XC11**2)*         1604240
     9  X1RO                                                                  1604250
     1  *(-2.*XN*YDOT(I&7)&XN*X1RO*YDOT(I&5))&YDOT(I)*(XD33*X1RO-              1604260
     2       XC11))-XN*X1RO*YAMTH-XMPHLD                                      1604270
      IF(XN.EQ.0.0.AND.XFTHLD.EQ.0.0.AND.XMPHLD.EQ.0.0)  YAQTH=0.0             1604280
      YDOT(I)  =XN*YANTH*X1RO-XN*YAMTH*X1ROSQ-XFTHLD-XMPHLD*X1RO               1604290
      YDOT(I+5)=(1/(XK22+XC11**2/XD22))*(YPRED(I+1)+XNTPH+(XC11/XD22)*         1604300
     1           (YPRED(I+3)+XMTPH)-(XK12+XC11**2/XD22)*X1RO*(XN*YPRED(I+      1604310
     2           4)-YPRED(I+6))-(XD12*XC11/XD22-XC11)*X1ROSQ*(XN*YPRED(I+      1604320
     3           4)-XNSQ*YPRED(I+6)))                                          1604330
      YDOT(I+1) = -XN*X1RO*YPRED(I)-XN*YAMPT*X1ROSQ-XFPHLD-XNL*(XFPHLD*        1604340
     1             (YDOT(I+5)-YPRED(I+6)*X1RO)-XFZELD*YPRED(I+7))             1604350
      YDOT(I+2) = -YANTH*X1RO+XNSQ*YAMTH*X1ROSQ+XN*XMPHLD*X1RO-XFZELD-         1604360
     1           XNL*(XFZELD*(YDOT(I+5)-YPRED(I+6)*X1RO)+XFPHLD*YPRED(         1604370
     2           I+7))                                                         1604380
      YDOT(I+3) = -2*XN*YAMPT*X1RO+YAJPH+XMTHLD                                1604390
      YDOT(I+4)=(XN*YPRED(I+5)/RC)+(1/(XK33-XC11**2/XD33))*(YPRED(I)+          1604400
     1           YAMPT*(X1RO-XC11/XD33))                                       1604410
      YDOT(I&6)=YPRED(I&7)                                                     1604420
      YDOT(I+7)=(XK22/(XC11**2+XD22*XK22))*(YPRED(I+3)+XMTPH)+(XC11/(          1604430
     1           XC11**2+XK22*XD22))*(-YPRED(I+1)-XNTPH+(XK12-XK22)*X1RO*      1604440
     2           (XN*YPRED(I+4)-YPRED(I+6)))-((XC11**2+XD12*XK22)/(XD22*       1604450
     3      XK22+XC11**2))*X1RO**2*(XN*YPRED(I+4)-XNSQ*YPRED(I+6))             1604460
      GO TO 9005                                                               1604470
 9005 IY =8*(M-1)&I                                                            1604480
      YASAVE(IY) = YANTH                                                       1604490
      YASAVE(IY&1)=YAMTH                                                       1604500
      YASAVE(IY&2)=YAMPT                                                       1604510
      YASAVE(IY&3)=YANPT                                                       1604520
      YASAVE(IY&4)=YAQPH                                                       1604530
      YASAVE(IY&5)=YACPH                                                       1604540
      YASAVE(IY&6)=YAQTH                                                       1604550
      YASAVE(IY+7)=YAJPH                                                       1604560
      RETURN                                                                   1604570
      END                                                                      1604580
```

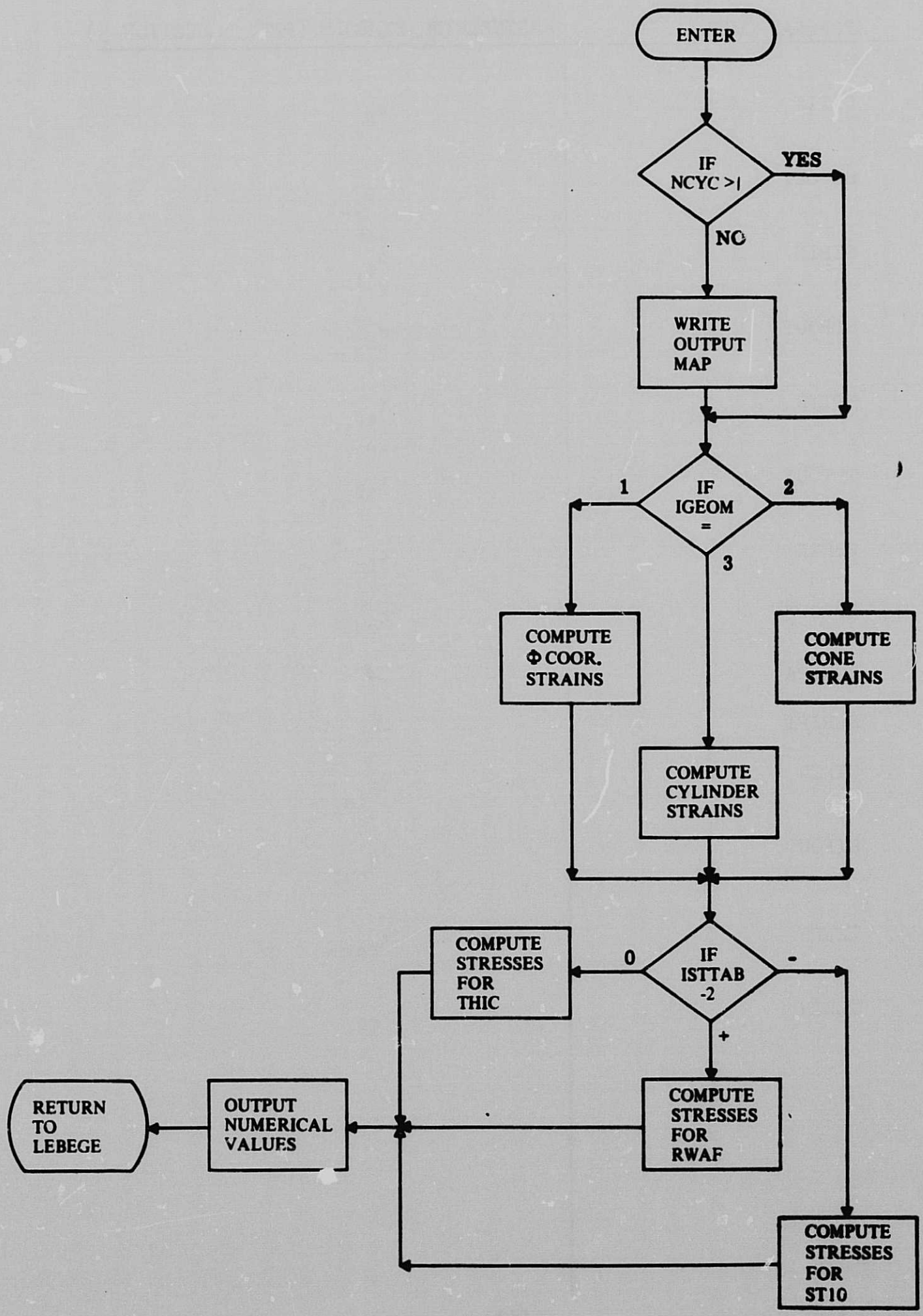
SUBROUTINE OUTPUT

Subroutine LEBEGE calls OUTPUT, and various geometric clues, as well as the values of strain and curvature are passed to this subprogram.

Subroutine OUTPUT uses the common information to calculate stresses throughout the structure.

FORTRAN CODE	ENGINEERING SYMBOLS (REF. 1 SECTION 3)
SITIN	$\sigma_{\theta_{in}}$
SITOUT	$\sigma_{\theta_{out}}$
SIPIN	$\sigma_{\phi_{in}}$
SIPOUT	$\sigma_{\phi_{out}}$
TPTIN	$\tau_{\phi\theta_{in}}$
TPTOUT	$\tau_{\phi\theta_{out}}$
ZBRIN	$\bar{\zeta}_{in}$
ZBROUT	$\bar{\zeta}_{out}$
SCRIPA	$\mathcal{A}$
SCRIPI	$\mathcal{I}$
SIFIN	$\sigma_{F_{in}}$
SIFOUT	$\sigma_{F_{out}}$
TZEPH	$\tau_{\zeta\phi}$
TZETH	$\tau_{\zeta\theta}$

SUBROUTINE OUTPUT



```
      SUBROUTINE OUTPUT  (KLUE,YCORR,ER,ES,ALPHR,ALPHS,ZINTH,
     1        ZOUTTH,ZINPH,ZOUTPH,SR,SS,TR,TS,NCYC,TIME,DEGRES,DTA,STEP,
     2        HI,HO,T,TII,TOO)
      COMMON STORY(16),TALE(16)                                          1300020
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)
      COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                 1300040
      COMMON SADUS(60),RADUS(60)                                         1300050
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP       1300060
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOUT        1300070
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                1300080
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,   0   ,NSMAX                1300090
      COMMON/NAM1/STRGD(6),THERM(4),MATER(3),SEGTAB(3),FACE(4),EQUATE(3) 1300100
      INTEGER SAVJTC, SAVSTP                                             1300110
      INTEGER SEGTAB                                                     1300120
      INTEGER THICK,TYPE                                                 1300130
      INTEGER Q                                                          1300140
      EQUIVALENCE (XMTTH,XMTETH),(XMTPH,XMTEPH),(XNTTH,XNTETH),          1300150
     1           (XNTPH,XNTEPH)                                          1300160
      EQUIVALENCE  (XNPHI,XNPI)                                          1300170
      DIMENSION KLUE(4)
      DIMENSION IPROB(10),LST(61)                                        1300180
      DIMENSION         YDEV( 80),YICS( 80),YNEW( 80)                    1300190
      DIMENSION TBDEL( 80),          FWDEL( 80)                          1300200
      DIMENSION YCORR(80)                                                1300210
      DIMENSION ILAYR(10)                                                1300220
      DIMENSION  ST(62,31) , XLAYER(6)                                   1300230
      DOUBLE  PRECISION  YNEW,YPRED                                      1300240
      COMMON /LASTEQ/ YPRED( 80),YDOT( 80),YASAVE( 80),                  1300250
     1                YANTH,YAMTH,YAMPT,YANPT,YAOPH,YAOPH,YAOTH,YAJPH,   1300260
     2                S,SN,CS,SNSQ,CSSQ,TAN,SEC,CN,X1CS,X1SN,TN,         1300270
     3                X1RO,X1ROSQ,X1SNRO,X1CSRO,CN1RO,SN1RO,CS1RO,       1300280
     4                X1R1,X1R2,CS1R1,CS1R2,SN1R1,X1R1SQ,R2SQ,RO,BESO,   1300290
     5    ROSQ,XNSQ,BETA,R1,R2,S1,R1DOT,R1SQ,                           1300300
     6                XNTTH,XNTPH,XMTTH,XMTPH,XFTHLD,XFPHLD,XFZELD,      1300310
     7                XMTHLD,XMPHLD,ETHET,EPHI,XGPT,ALPHTH,ALPHPH,       1300320
     8                XNUTP,XNUPT,XC11,XC22,XD33,XD22,XD21,XD12,         1300330
     9                XK11,XK12,XK21,XK22,XK33,XD11,                     1300340
     A                   M,I,SITIN,SITOUT,SIPIN,SIPOUT,TPTIN,TPTOUT,     1300350
     B               ZBRIN,ZBROUT,SCRIPA,SCRIPI,SIFIN,SIFOUT,TZEPH,TZETH 1300360
     C                ,XNL,XNPHI                                        1300370
 1726 FORMAT(1H1)
      IF(KELVIN.NE.2) GO TO 338
      TII = 0.0
      TOO = 0.0
  338 IF(NCYC.GT.1) GO TO 339
      TZEPH   = 0.0                                                      1306660
      TZETH   = 0.0                                                      1306670
      SITIN   = 0.0                                                      1306680
      SITOUT  = 0.0                                                      1306690
      SIPIN   = 0.0                                                      1306700
      SIPOUT  = 0.0                                                      1306710
      TPTIN   = 0.0                                                      1306720
      TPTOUT  = 0.0                                                      1306730
      SIFIN   = 0.0                                                      1306740
      SIFOUT  = 0.0                                                      1306750
```

```
      EPSITH = 0.0                                                                  1306760
      EPSIPH = 0.0                                                                  1306770
      GAPHTH = 0.0                                                                  1306780
      XKPH   = 0.0                                                                  1306790
      XKTH   = 0.0                                                                  1306800
      XKPT   = 0.0                                                                  1306810
      WRITE(6,1726)                                                                 1306820    8
      WRITE(6,7000)                                                                 1306830    9
 7000 FORMAT(3X,17HPHI (RAD. OR IN.),4X,7HDEGREES,14X,14HPRINT INTERVAL,            1306840
     17X,4HSTEP,17X,5HR ZERO,15X,16HNUMBER OF CYCLES/                               1306950
     2        3X,21HEPSILON THETA          21HEPSILON PHI                         1306860
     3           21HGAMMA PHI THETA        21HK PHI                               1306870
     4           21HK THETA                21HN TEMPERATURE THETA  /              1306880
     5        3X,21HU                      21HQ PHI                               1306890
     6           21HK PHI THETA            21HJ PHI STAR                          1306900
     7           21HT PHI THETA            21HN TEMPERATURE PHI    /              1306910
     8        3X,21HV                      21HJ PHI                               1306920
     9           21HN THETA                21HN PHI                               1306930
     A           21HN PHI THETA            21HM TEMPERATURE THETA  /              1306940
     B        3X,21HW                      21HQ THETA                             1306950
     C           21HM THETA                21HM PHI                               1306960
     D           21HM PHI THETA            21HM TEMPERATURE PHI    /              1306970
     E        3X,21HOMEGA THETA            21HTAU ZETA PHI = Q/T                  1306980
     F           21HSIGMA THETA IN         21HSIGMA PHI IN                        1306990
     G           21HTAU PHI THETA IN       21HSIGMA F IN           /              1307000
     H        3X,21HOMEGA PHI              21HTAU ZETA THETA = Q/T                1307010
     I           21HSIGMA THETA OUT        21HSIGMA PHI OUT                       1307020
     J           21HTAU PHI THETA OUT      21HSIGMA F OUT          //)            1307030
  339 CONTINUE                                                                     1307040
      DO  244 LI = 1,NPROB                                                         1307050
      IL =(LI-1)*8+1                                                               1307060
      IA = IL                                                                      1307070
      GO TO (1781,1782,1783),IGEOM                                                 1307310
C     PHI COORDINATE                                                               1307320
 1781 EPSITH=X1RO*(XN*YCORR(IL+4) + YCORR(IL+5)*CS - YCORR(IL+6)*SN)               1307330
      EPSIPH=X1R1*(YDOT(IL+5) - YCORR(IL+6))                                       1307340
      GAPHTH=YDOT(IL+4)*X1R1 - (XN*YCORR(IL+5) + YCORR(IL+4)*CS)*X1RO              1307350
      XKPH = YDOT(IL+7)*X1R1                                                       1307360
      XKTH = X1RO*(YCORR(IL+7)*CS +(XN*YCORR(IL+4)*SN-XNSQ*YCORR(IL+6))*           1307370
     1       X1RO)                                                                 1307380
      XKPT = X1RO*0.5*(2.0*YASAVE(IA+4)*CS - XN*YCORR(IL+7) + X1R1*(               1307390
     1YDOT(IL+4)*SN + YCORR(IL+4)*CS - XN*YDOT (IL+6)))                            1307400
      GO TO 1785                                                                   1307410
C     CONE                                                                         1307420
 1782 EPSITH=(1.0/(S*CS))*(XN*YCORR(IL+4)+CS*YCORR(IL+5)-SN*YCORR(IL+6))          1307430
      EPSIPH= YDOT(IL+5)                                                           1307440
      GAPHTH= YDOT(IL+4)-1.0/(S*CS)*(XN*YCORR(IL+5)+CS*YCORR(IL+4))                1307450
      XKPH  = YDOT(IL+7)                                                           1307460
      XKTH  = 1.0/(S*CS)*(YCORR(IL+7)*CS + 1.0/(S*CS)*(XN*SN*YCORR(IL+4)           1307470
     1        - XNSQ*YCORR(IL+5)))                                                 1307480
      XKPT  = 1.0/(2.0*S*CS)*(2.0*YASAVE(IA+4)*CS - XN*YCORR(IL+7) +               1307490
     1    YDOT(IL+4)*SN - XN*YDOT(IL+6))                                           1307500
      GO TO 1785                                                                   1307510
C     CYLINDER                                                                     1307520
 1783 EPSITH=X1RO * (XN*YCORR(IL+4) - YCORR(IL+5))                                 1307530
      EPSIPH= YDOT(IL+5)                                                           1307540
```

```
      GAPHTH= YDOT(IL+4) - XN*X1RO*YCORR(IL+5)                          1307550
      XKPH  = YDOT(IL+7)                                                1307560
      XKTH  = X1ROSQ * (XN*YCORR(IL+4) - XNSQ*YCORR(IL+6))              1307570
      XKPT  = 0.5 * X1RO *(-XN*YCORR(IL+7)+YDOT(IL+4)-XN*YDOT(IL+6))    1307580
 1785 CONTINUE                                                          1307590
      IF (ISTTAB.NE.2) GO TO 640                                        1307080
      GO TO (610,620,630,640),THICK                                     1307090
  610 ZBRIN =  HI/2.0                                                   1307100
      ZBROUT = HI/2.0                                                   1307110
      GO TO 670                                                         1307120
  620 ZBRIN  = T/2.0 + HI                                               1307130
      ZBROUT = T/2.0 + HI                                               1307140
      GO TO 650                                                         1307150
  630 ZBRIN =(HI**2+HO**2+2.0*HI*HO+2.0*HO*T)/(2.0*(HI+HO))             1307160
      ZBROUT=(HI**2+HO**2+2.0*HI*HO+2.0*HI*T)/(2.0*(HI+HO))             1307170
  650 TZEPH = YASAVE(IA+5)/T                                            1307180
      TZETH = YASAVE(IA+6)/T                                            1307190
  670 SCRIPA =((1.0-XNUPT * XNUTP) * XK11)/ETHET                        1307200
      SCRIPI=((1.0-XNUPT*XNUTP)*XD11)/ETHET                             1307210
      TPTIN = YASAVE(IA+3)/SCRIPA+YASAVE(IA+2)*ZBRIN/SCRIPI             1307220
      TPTOUT= YASAVE(IA+3)/SCRIPA-YASAVE(IA+2)*ZBROUT/SCRIPI            1307230
      SIPIN = YPRED(IL+1)/SCRIPA+YPRED(IL+3)*ZBRIN/SCRIPI               1307240
      SIPOUT= YPRED(IL+1)/SCRIPA-YPRED(IL+3)*ZBROUT/SCRIPI              1307250
      SITIN = YASAVE(IA)/SCRIPA+YASAVE(IA+1)*ZBRIN/SCRIPI               1307260
      SITOUT= YASAVE(IA)/SCRIPA-YASAVE(IA+1)*ZBROUT/SCRIPI              1307270
      SIPIN = SQRT(SITIN**2-SITIN*SIPIN+SIPIN**2+3.0*TPTIN**2)          1307280    90
      SIPOUT= SQRT(SITOUT**2-SITOUT*SIPOUT+SIPOUT**2+3.0*TPTOUT**2)     1307290    91
      GO TO 50
  640 CONTINUE                                                          1307300
      NCLUE = KLUE(1)
      GO TO (11,12,13,14),NCLUE
   11 IERROR=11
      NERROR=37
      GO TO 8888
C     PHI STRINGER INNER
   12 SIPIN =  (TS*ES/SS)*(EPSIPH-ZINPH*XKPH-ALPHS*TII)
      TPTIN =  0.0
      GO TO 20
C     PHI SHELL INNER
   13 SIPIN =  (EPHI/(1.0-XNUPT*XNUTP))*(EPSIPH+XNUPT*EPSITH-ZINPH*(XKPH
     1        +XNUPT*XKTH)-(ALPHPH+XNUPT*ALPHTH)*TII)
      TPTIN =  XGPT*(GAPHTH-2.0*ZINPH*XKPT)
      GO TO 20
C     PHI WAFF INNER
   14 SIPIN =  (0.5*TR*ER/SR)*((EPSITH+EPSIPH+GAPHTH)-ZINPH*(XKPH+XKTH+
     1        2.0*XKPT)-2.0*ALPHR*TII)
      TPTIN =  0.0
   20 NCLUE = KLUE(2)
      GO TO (21,22,23,24),NCLUE
   21 IERROR = 21
      NERROR = 38
      GO TO 8888
C     PHI STRINGER OUTER
   22 SIPOUT = (TS*ES/SS)*(EPSIPH-ZOUTPH*XKPH-ALPHS*TOO)
      TPTOUT = 0.0
      GO TO 30
```

```
          OUT        -  EFN   SOURCE STATEMENT  -  IFN(S)  -
C     PHI SHELL OUTER
   23 SIPOUT = (EPHI/(1.0-XNUPT*XNUTP))*(EPSIPH+XNUPT*EPSITH-ZOUTPH*
     1          (XKPH+XNUPT*XKTH)-(ALPHPH+XNUPT*ALPHTH)*TOO)
      TPTOUT= XGPT*(GAPHTH-2.0*ZOUTPH*XKPT)
      GO TO 30
C     PHI WAFF OUTER
   24 SIPOUT = (0.5*TR*ER/SR)*((EPSITH+EPSIPH+GAPHTH)-ZOUTPH*(XKPH+XKTH
     1          +2.0*XKPT)-2.0*ALPHR*TOO)
      TPTOUT = 0.0
   30 NCLUE  = KLUE(3)
      GO TO (31,32,33,34),NCLUE
C     THETA RING INNER
   31 SITIN =  (TR*ER/SR)*(EPSITH-ZINTH*XKTH-ALPHR*TII)
      GO TO 40
   32 IERROR = 32
      NERROR = 39
      GO TO 8888
C     THETA SHEL INNER
   33 SITIN =  (ETHET/(1.0-XNUPT*XNUTP))*(EPSITH+XNUTP*EPSIPH-ZINTH*(
     1          XKTH+XNUTP*XKPH)-(ALPHTH+XNUTP*ALPHPH)*TII)
      GO TO 40
C     THETA WAFF INNER
   34 SITIN =  SIPIN
   40 NCLUE  = KLUE(4)
      GO TO (41,42,43,44),NCLUE
C     THETA RING OUTER
   41 SITOUT = (TR*ER/SR)*(EPSITH-ZOUTTH*XKTH-ALPHR*TOO)
      GO TO 50
   42 IERROR = 42
      NERROR = 40
      GO TO 8888
C     THETA SHEL OUTER
   43 SITOUT = (ETHET/(1.0-XNUPT*XNUTP))*(EPSITH+XNUTP*EPSIPH-ZOUTTH*(
     1          XKTH+XNUTP*XKPH)-(ALPHTH+XNUTP*ALPHPH)*TOO)
      GO TO 50
C     THETA WAFF OUTER
   44 SITOUT = SIPOUT
   50 CONTINUE
      WRITE(6,7002) LI                                          1307600    133
 7002 FORMAT(//58X,15HPROBLEM NUMBER ,I2//)                     1307610
      WRITE(6,7001)TIME,DEGRES,DTA,STEP,RC,NCYC,EPSITH,EPSIPH,GAPHTH,  1307620
     1XKPH,XKTH,XNTTH,YCORR(IL+4),YASAVE(IA+5),XKPT,YCORR(IL+2),       1307630
     2YCORR(IL),XNTPH,YCORR(IL+5),YASAVE(IA+7),YASAVE(IA),YCORR(IL+1),  1307640
     3YASAVE(IA+3),XMTTH,YCORR(IL+6),YASAVE(IA+6),YASAVE(IA+1),         1307650
     4YCORR(IL+3),YASAVE(IA+2),XMTPH,YCORR(IL+7),TZEPH,SITIN,SIPIN,     1307660
     5SITIN,SIPIN,YASAVE(IA+4),TZETH,SITOUT,SIPOUT,TPTOJT,SIPOUT        1307670    134
 7001 FORMAT(3X,5(E14.7,7X),I4/(3X,6(E14.7,7X)))                    1307680
  244 CONTINUE                                                      1307690
      GO TO 9999
 8888 NIX = 1
 9999 RETURN
      END
```

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      SUBROUTINE ETRAP                                                      500010
      COMMON STORY(16),TALE(16)                                             500020
      COMMON XMAT(110,10),STD(10),NST(30),NKL(30),NXMAT(20),SAVTIC(900)
     COMMON  SAVJTC(30),SAVSTP(30),JRTIC(30),JRSTOP(30)                     500040
      COMMON SADUS(60),RADUS(60)                                            500050
      COMMON XN,NREG,NSEGTL,NMPT,MATPRP,TEFREE,NCUPLE,TIC,PHI,STOP          500060
      COMMON NRGEND,NSYM,NRG,NRC,NSC,NIX,IERROR,RESTOP,RTICK,IOUT           500070
      COMMON MAT,KGEOM,IGEOM,ITYPE,ISTTAB,THICK,KELVIN,G1                   500080
      COMMON IBEGIN,NPROB,NHARM,NSEG,NERROR,    0    ,NSMAX               500090
      DIMENSION NOGOOD( 713)
      DIMENSION     A1(20)   ,A2(23)   ,A3(22)   ,A4(24)   ,A5(29)         500110
      DIMENSION     A6(24)   ,A7(20)   ,A8(17)   ,A9(16)   ,A10(17)        500120
      DIMENSION     A11(29)  ,A12 (25) ,A13(15)  ,A14(15)  ,A15(29)        500130
      DIMENSION     A16(30)  ,A17 (9)  ,A18(9)   ,A19(9)   ,A20(9)         500140
      DIMENSION     A21(9)   ,A22 (9)  ,A23(9)   ,A24(9)   ,A25(9)         500150
      DIMENSION     A26(9)   ,A27 (20) ,A28(13)  ,A29(15)  ,A30(22)        500160
      DIMENSION     A31(21)  ,A32 (27) ,A33(29)  ,A34(29)  ,A35(13)        500170
      DIMENSION A36(19)
      DIMENSION     A37(15)  ,A38(15)  ,A39(15)  ,A40(15)
      EQUIVALENCE   (NOGOOD(  1),A1 )  ,(NOGOOD( 21),A2 )                  500180
      EQUIVALENCE   (NOGOOD( 44),A3 )  ,(NOGOOD( 66),A4 )                  500190
      EQUIVALENCE   (NOGOOD( 90),A5 )  ,(NOGOOD(119),A6)                   500200
      EQUIVALENCE   (NOGOOD(143),A7 )  ,(NOGOOD(163),A8)                   500210
      EQUIVALENCE   (NOGOOD(180),A9 )  ,(NOGOOD(196),A10)                  500220
      EQUIVALENCE   (NOGOOD(213),A11)  ,(NOGOOD(242),A12)                  500230
      EQUIVALENCE   (NOGOOD(267),A13)  ,(NOGOOD(282),A14)                  500240
      EQUIVALENCE   (NOGOOD(297),A15)  ,(NOGOOD(326),A16)                  500250
      EQUIVALENCE   (NOGOOD(356),A17)  ,(NOGOOD(365),A18)                  500260
      EQUIVALENCE   (NOGOOD(374),A19)  ,(NOGOOD(383),A20)                  500270
      EQUIVALENCE   (NOGOOD(392),A21)  ,(NOGOOD(401),A22)                  500280
      EQUIVALENCE   (NOGOOD(410),A23)  ,(NOGOOD(419),A24)                  500290
      EQUIVALENCE   (NOGOOD(428),A25)  ,(NOGOOD(437),A26)                  500300
      EQUIVALENCE   (NOGOOD(446),A27)  ,(NOGOOD(466),A28)                  500310
      EQUIVALENCE   (NOGOOD(479),A29)  ,(NOGOOD(494),A30)                  500320
      EQUIVALENCE   (NOGOOD(516),A31)  ,(NOGOOD(537),A32)                  500330
      EQUIVALENCE   (NOGOOD(564),A33)  ,(NOGOOD(593),A34)                  500340
      EQUIVALENCE   (NOGOOD(622),A35)  ,(NOGOOD(635),A36)                00500350
      EQUIVALENCE   (NOGOOD(654),A37)  ,(NOGOOD(669),A38)
      EQUIVALENCE   (NOGOOD(684),A39)  ,(NOGOOD(699),A40)
      INTEGER  A1,A2,A3,A4,A5,A6,A7,A8,A9,A10,A11,A12,A13,A14,A15,A16       500360
      INTEGER  A17,A18,A19,A20,A21,A22,A23,A24,A25,A26,A27,A28,A29,A30      500370
      INTEGER  A31,A32,A33,A34,A35                                          500380
      INTEGER A36
      INTEGER A37,A38,A39,A40
      INTEGER SAVJTC,SAVSTP                                                 500390
      WRITE(6,17)                                                           500400
   17 FORMAT(1H1)                                                           500410
      DATA A1 /                                                             500420
     A                          80HONE OF THE MATERIAL PROPERTY TABLES CAN  500430
     1NOT BE IDENTIFIED AS ISOT, ORTH, OR STIF./                            500440
      DATA A2 /                                                             500450
     A                          92HA MATERIAL PROPERTY TABLE NAME FOR A SE  500460
     1GMENT CANNOT BE FOUND IN THE TABLE LIST.          /                  500470
      DATA A3 /                                                             500480
     A                          88HTHE TYPE OF GEOMETRY OF A SEGMENT CANNO  500490
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     1T BE IDENTIFIED AS ONE HANDLED BY THE PROGRAM.   /                        500500
      DATA A4 /                                                                 500510
     A                          96HTHE TYPE OF MATERIAL PROPERTY TABLE FOR     500520
     1 A SEGMENT CANNOT BE IDENTIFIED AS ISOT. ORTH. OR STIF.  /                500530
      DATA A5 /                                                                 500540
     A                         116HTHE WALL CONSTRUCTION OF A SEGMENT CANN     500550
     1OT BE IDENTIFIED AS SING. EQUA. UNEQ. OR BLAN.                            500560
     2       /                                                                  500570
      DATA A6 /                                                                 500580
     A                          96HTHE TYPE OF TEMPERATURE INPUT FOR A SEG     500590
     1MENT CANNOT BE IDENTIFIED AS THST. NOTH. THCN. OR THIN.  /                500600
      DATA A7 /                                                                 500610
     A                          80HTHE PROGRAM CANNOT DETERMINE WHETHER TH     500620
     1E PROBLEM INPUT IS LINEAR OR NON-LINEAR. /                                500630
      DATA A8 /                                                                 500640
     A                          68HTHE PROGRAM CAN EXECUTE ONLY ONE NON-LI     500650
     1NEAR PROBLEM PER DATA DECK.  /                                            500660
      DATA A9 /                                                                 500670
     A                          64HTHE LOAD INDICATOR CLUES CAN ONLY BE ZE     500680
     1RO. BLANK. ONE. OR FOUR. /                                                500690
      DATA A10/                                                                 500700
     A                          68HTHE PROGRAM CAN EXECUTE ONLY ONE THERMA     500710
     1L LOAD PROBLEM PER DATA DECK./                                            500720
      DATA A11/                                                                 500730
     A                         116HTHE MAGIC CYCLE HAS GONE PAST STOP BY M     500740
     1ORE THAN THE PERMITTED VALUE. CHECK TO  SEE IF FIXED STEP SIZE IS         500750
     2TOO LARGE. /                                                              500760
      DATA A12/                                                                 500770
     A                         100HTHE RIEMAN VARIABLE, IEND, WHICH SIGNA_     500780
     1S THE END OF A SEGMENT SHOULD ONLY BE ZERO OR NEGATIVE ONE.  /            500790
      DATA A13/                                                                 500800
     A                          60HTHE FIRST ST TABLE VALUE (PHI OR S) SHO     500810
     1LD BE OVERLAPPED.    /                                                    500820
      DATA A14/                                                                 500830
     A                          60HTHE LAST ST TABLE VALUE (PHI OR S) SHOU     500840
     1LD BE OVERLAPPED.    /                                                    500850
      DATA A15/                                                                 500860
     A                         116HTHE INTERPOLATED VALUE OF TEMPERATURE       500870
     1FOR THE MATERIAL PROPERTY TABLE IS LESS THAN THE SECOND TEMPERATUR        500880
     2E VALUE.    /                                                            500890
      DATA A16/                                                                 500900
     A                         120HTHE INTERPOLATED VALUE OF TEMPERATURE       500910
     1FOR THE MATERIAL PROPERTY TABLE IS GREATER THAN THE LAST VALUE OF         500920
     2TEMPERATURE.    /                                                         500930
      DATA A17/                                                                 500940
     A                          36HTHE K11 STIFFNESS PARAMETER IS ZERO./       500950
      DATA A18/                                                                 500960
     A                          36HTHE K12 STIFFNESS PARAMETER IS ZERO./       500970
      DATA A19/                                                                 500980
     A                          36HTHE K21 STIFFNESS PARAMETER IS ZERO./       500990
      DATA A20/                                                                 501000
     A                          36HTHE K22 STIFFNESS PARAMETER IS ZERO./       501010
      DATA A21/                                                                 501020
     A                          36HTHE K33 STIFFNESS PARAMETER IS ZERO./       501030
      DATA A22/                                                                 501040
     A                          36HTHE D11 STIFFNESS PARAMETER IS ZERO./       501050
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      ETR       - EFN   SOURCE STATEMENT  -  IFN(S)  -
      DATA A23/                                                          501060
     A                          36HTHE D12 STIFFNESS PARAMETER IS ZERO./  501070
      DATA A24/                                                          501080
     A                          36HTHE D21 STIFFNESS PARAMETER IS ZERO./  501090
      DATA A25/                                                          501100
     A                          36HTHE D22 STIFFNESS PARAMETER IS ZERO./  501110
      DATA A26/                                                          501120
     A                          36HTHE D33 STIFFNESS PARAMETER IS ZERO./  501130
      DATA A27/                                                          501140
     A                          80HTHE PROGRAM CANNOT DETERMINE WHETHER TH 501150
     1E PROBLEM INPUT IS THIC. MAF. OR STIO. /                           501160
      DATA A28/                                                          501170
     A                          52HTHE OUTPUT FLAG FOR THE STRESSES. IOUT. 501180
     1IS NOT ZERO. /                                                     501190
      DATA A29/                                                          501200
     A                          60HTHE Y2 BLOCK IN THE SEGMENT MAGIC OUTPJ 501210
     1T IS SINGULAR.       /                                            501220
      DATA A30/                                                          501230
     A                          88HIN THE COMPUTATION OF THE REGION STIFN 501240
     1ESSES. THE K22 MATRIX WAS NOT POSITIVE DEFINITE. /                 501250
      DATA A31/                                                          501260
     A                          84HIN THE COMPUTATION OF THE REGION LOADS. 501270
     1 THE K22 MATRIX WAS NOT POSITIVE DEFINITE.   /                     501280
      DATA A32/                                                          501290
     A                         108HIN THE COMPUTATION OF THE REDUCED FLEXI 501300
     1BILITY MATRIX. THE REDUCED STIFFNESS MATRIX IS NOT POSITIVE DEFINI 501310
     2TE./                                                               501320
      DATA A33/                                                          501330
     A                         116HFOR KINEMATIC LINKS BETWEEN SEGMENTS. T 501340
     1HE DEPENDENT JOINT NUMBER MUST BE GREATER THAN THE INDEPENDENT JOI 501350
     2NT NUMBER. /                                                       501360
      DATA A34/                                                          501370
     A                         116HTHE NUMBER OF POINTS IN THE ST TABLE MU 501380
     1ST BE BETWEEN 2 AND 30.                                            501390
     2      /                                                            501400
      DATA A35/                                                          501410
     A                          52HFOR NON-LINEAR ANALYSIS. THE HARMONIC M 501420
     1UST BE ZERO. /                                                     501430
      DATA A36  /.76HA STRESS PROPERTY CLUE CANNOT BE IDENTIFIED AS RING00501431
     1. STRI. SHEL. OR WAFF.    /                                        00501432
      DATA A37 /60HTHE STRESS CLUE FOR PHI INNER IS NOT STRI. SHEL. OR W
     1AFF.    /
      DATA A38 /60HTHE STRESS CLUE FOR PHI OUTER IS NOT STRI. SHEL. OR W
     1AFF.    /
      DATA A39 /60HTHE STRESS CLUE FOR THETA INNER IS NOT RING. SHEL. OR
     1 WAFF. /
      DATA A40 /60HTHE STRESS CLUE FOR THETA OUTER IS NOT RING. SHEL. OR
     1 WAFF. /
      GO TO (8000.8036.8086.8087.8089.8090.3013.8009.8031.8008.8001.8002 501440
     1.8003.8006.8007.8067.8101.8102.8103.8104.8105.8106.8107.8108.8109. 501450
     28110.8088.110.8120.8841.8842.8777.8797.8787.8501.8111.11.21.32.42
     3),NERROR
 8000 II=1                                                               501470
      III=20                                                             501480
      GO TO 505                                                          501490
 8036 II=21                                                              501500
```

```
      ETR       - EFN   SOURCE STATEMENT  - IFN(S) -
           III=43                                                  501510
           GO TO 505                                               501520
 8086      II=44                                                   501530
           III=65                                                  501540
           GO TO 505                                               501550
 8087      II=66                                                   501560
           III=89                                                  501570
           GO TO 505                                               501580
 8089      II=90                                                   501590
           III=118                                                 501600
           GO TO 505                                               501610
 8090      II=119                                                  501620
           III=142                                                 501630
           GO TO 505                                               501640
 8013      II=143                                                  501650
           III=152                                                 501660
           GO TO 505                                               501670
 8009      II=153                                                  501680
           III=179                                                 501690
           GO TO 505                                               501700
 8031      II=180                                                  501710
           III=195                                                 501720
           GO TO 505                                               501730
 8008      II=196                                                  501740
           III=212                                                 501750
           GO TO 505                                               501760
 8001      II=213                                                  501770
           III=241                                                 501780
           GO TO 505                                               501790
 8002      II=242                                                  501800
           III=265                                                 501810
           GO TO 505                                               501820
 8003      II=267                                                  501830
           III=281                                                 501840
           GO TO 505                                               501850
 8006      II=282                                                  501860
           III=296                                                 501870
           GO TO 505                                               501880
 8007      II=297                                                  501890
           III=325                                                 501900
           GO TO 505                                               501910
 8067      II=326                                                  501920
           III=355                                                 501930
           GO TO 505                                               501940
 8101      II=356                                                  501950
           III=364                                                 501960
           GO TO 505                                               501970
 8102      II=365                                                  501980
           III=373                                                 501990
           GO TO 505                                               502000
 8103      II=374                                                  502010
           III=382                                                 502020
           GO TO 505                                               502030
 8104      II=383                                                  502040
           III=391                                                 502050
           GO TO 505                                               502060
```

```
      ETR       - EFN  SOURCE STATEMENT  -  IFN(S)  -
 8105 II=392                                                    502070
      III=400                                                   502080
      GO TO 505                                                 502090
 8106 II=401                                                    502100
      III=409                                                   502110
      GO TO 505                                                 502120
 8107 II=410                                                    502130
      III=418                                                   502140
      GO TO 505                                                 502150
 8108 II=419                                                    502160
      III=427                                                   502170
      GO TO 505                                                 502180
 8109 II=428                                                    502190
      III=436                                                   502200
      GO TO 505                                                 502210
 8110 II=437                                                    502220
      III=445                                                   502230
      GO TO 505                                                 502240
 8068 II=446                                                    502250
      III=465                                                   502260
      GO TO 505                                                 502270
  110 II=466                                                    502280
      III=478                                                   502290
      GO TO 505                                                 502300
 8120 II=479                                                    502310
      III=493                                                   502320
      GO TO 505                                                 502330
 8841 II=494                                                    502340
      III=515                                                   502350
      GO TO 505                                                 502360
 8842 II=516                                                    502370
      III=536                                                   502380
      GO TO 505                                                 502390
 8777 II=537                                                    502400
      III=563                                                   502410
      GO TO 505                                                 502420
 8797 II=564                                                    502430
      III=592                                                   502440
      GO TO 505                                                 502450
 8787 II=593                                                    502460
      III=621                                                   502470
      GO TO 505                                                 502480
 8501 II=622                                                    502490
      III=634                                                   502500
      GO TO 505                                                 502510
 8111 II=635                                                 00502511
      III=653                                                00502512
      GO TO 505
   11 II =654
      III=668
      GO TO 505
   21 II =669
      III=683
      GO TO 505
   32 II =684
      III=698
```

```
ETR        -  EFN   SOURCE STATEMENT  -  IFN(S)  -
      GO TO 505
   42 II =669
      III=713
  505 WRITE(6,510)IERROR,(NOGOOD(I),I=II,III)                    502520    122
  510 FORMAT(////59X,10H IERROR = ,I4///4X,32A4//20X,28A4)       502530
      RETURN                                                     502540
       END
```

REFERENCES

1. Svalbonas, V., Numerical Analysis of Shells Vol. I: Unsymmetric Analysis of Orthotropic Reinforced Shells of Revolution, NASA CR- 61299