岩手大学教育学部研究年報　第42巻第2号（1983.2）　59～73

木材骨組構造の横座屈解析に関するプログラム

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（1982年9月30日受理）

Abstract

A computer program for the analysis of lateral buckling of wooden frame structures is described.

The procedure is the finite element method based upon displacement method, the buckling characteristic equation is obtained by employing the principle of virtual work.

Data computed at each node include the deflections, rotations, axial displacements, moments, shears and axial forces. The method is verified by comparing measured and predicted behavior for wooden gable frames. A listing of program, written in JIS FORTRAN is given. In addition, eigenvalue is calculated with QR method.

1. 緒　　言

木材柱又は木材梁の弾性座屈に関しては，いままでに理論的にも，実験的にも多くの検討がなされ（例えば杉山[1]，Parker[2]，山本[3]ら），研究もほぼ確立されたと考えられる。

ところで，近年，体育館，倉庫，レストハウス等では，集成材を利用したアーチ，山形ラーメンなどの大スパン単層構造形式がみられる[4]。そこで架構の座屈解析も必要と思われ，筆者らの1人はすでにそのような構造系の合理的な解析法を報告した[5]が，ここでは，その際，開発した木材2次元骨組構造の弾性座屈問題を処理する汎用プログラムについて触れる。

2. 座屈特有方程式

木材梁の弾性座屈を支配する仮想仕事方程式は次式で与えられる[5][6]。

$$\begin{aligned}&\delta U_e+\delta W^{(0)}\\&=\int_0^l(E_{xx}u''I_{xx}\delta u''+E_{xy}I_{yy}v''\delta v''+E_{zz}Aw'\delta w'+E_{zz}I_w\theta''\delta\theta''+G_oK_o\theta'\delta\theta')dz\\&+\int_0^l\{P(u'\delta u'+v'\delta v'+r_0^2\theta'\delta\theta')-M_y(\theta'\delta v'+v'\delta\theta')-M_x(\theta'\delta u'+u'\delta\theta')\\&+V_x(\theta\delta v'+v'\delta\theta)-V_y(\theta\delta u'+u'\delta\theta)\}dz=0\end{aligned}\qquad(1)$$

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(1) 式を満足する梁要素の変位関数として，次の式を使用する[7]。

$$\left.\begin{aligned} u &= \boldsymbol{H}\boldsymbol{A}^{-1}\boldsymbol{u} \\ v &= \boldsymbol{H}\boldsymbol{A}^{-1}\boldsymbol{v} \\ w &= \boldsymbol{I}\boldsymbol{B}^{-1}\boldsymbol{w} \\ \theta &= \boldsymbol{H}\boldsymbol{A}^{-1}\boldsymbol{\theta} \end{aligned}\right\} \tag{2}$$

ここに，

$$\boldsymbol{H}=[1\ Z\ Z^2\ Z^3],\quad \boldsymbol{I}=[1\ Z]$$

$$\boldsymbol{A}^{-1}=\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ -3/^2 & -2/l & 3/l^2 & -1/l \\ 2/l^3 & 1/l^2 & -2/l^3 & 1/l^2 \end{pmatrix},\quad \boldsymbol{B}^{-1}=\begin{pmatrix} 1 & 0 \\ -1/l & 1/l \end{pmatrix}$$

$$\boldsymbol{u}=[u_L u_L' u_R u_R']^T,\quad \boldsymbol{v}=[v_L v_L' v_R v_R']^T,\quad w=[w_L w_R]^T,\quad \boldsymbol{\theta}=[\theta_L \theta_L' \theta_R \theta_R']^T$$

さて，(2) 式を (1) 式における歪エネルギーの変分に代入すると

$$\begin{aligned} \delta U_e=\int_0^l (&\delta\boldsymbol{u}^T\boldsymbol{A}^{-1T}\boldsymbol{H}''^T E_{zx}I_{xx}\boldsymbol{H}''\boldsymbol{A}^{-1}\boldsymbol{u}+\delta\boldsymbol{v}^T\boldsymbol{A}^{-1T}\boldsymbol{H}''^T E_{zy}I_{yy}\boldsymbol{H}''\boldsymbol{A}^{-1}\boldsymbol{v} \\ &+\delta\boldsymbol{w}^T\boldsymbol{B}^{-1T}\boldsymbol{I}'^T E_{zz}A\boldsymbol{I}'\boldsymbol{B}^{-1}\boldsymbol{w}+\delta\boldsymbol{\theta}^T\boldsymbol{A}^{-1T}\boldsymbol{H}''^T E_{zz}I_w\boldsymbol{H}''\boldsymbol{A}^{-1}\boldsymbol{\theta} \\ &+\delta\boldsymbol{\theta}^T\boldsymbol{A}^{-1T}\boldsymbol{H}'^T G_o K_o\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{\theta})dz \end{aligned} \tag{3}$$

ここに，

$$\left.\begin{aligned} &\boldsymbol{k}_{EIx}=\boldsymbol{A}^{-1T}\int_0^l \boldsymbol{H}''^T E_{zx}I_{xx}\boldsymbol{H}''dz\boldsymbol{A}^{-1},\quad \boldsymbol{k}_{EIy}=\boldsymbol{A}^{-1T}\int_0^l \boldsymbol{H}''^T E_{zy}I_{yy}\boldsymbol{H}''dz\boldsymbol{A}^{-1} \\ &\boldsymbol{k}_{EA}=\boldsymbol{B}^{-1T}\int_0^l \boldsymbol{I}'^T E_{zz}A\boldsymbol{I}'dz\boldsymbol{B}^{-1},\quad \boldsymbol{k}_{EIw}=\boldsymbol{A}^{-1T}\int_0^l \boldsymbol{H}''^T E_{zz}I_w\boldsymbol{H}''dz\boldsymbol{A}^{-1} \\ &\boldsymbol{k}_{GK}=\boldsymbol{A}^{-1}\int_0^l \boldsymbol{H}'^T G_o K_o\boldsymbol{H}'dz\boldsymbol{A}^{-1} \end{aligned}\right\} \tag{4}$$

とおけば（3）式は次のようになる。

$$\delta U_e=\delta\boldsymbol{u}^T\boldsymbol{k}_{EIx}\boldsymbol{u}+\delta\boldsymbol{v}^T\boldsymbol{k}_{EIy}\boldsymbol{v}+\delta\boldsymbol{w}^T\boldsymbol{k}_{EA}\boldsymbol{w}+\delta\boldsymbol{\theta}^T\boldsymbol{k}_{EIw}\boldsymbol{\theta}+\delta\boldsymbol{\theta}^T\boldsymbol{k}_{GK}\boldsymbol{\theta} \tag{5}$$

したがって（5）式に Castigliano の定理を適用すると，次のような剛性方程式が得られる。

$$\begin{pmatrix} \boldsymbol{f}_u \\ \boldsymbol{f}_v \\ \boldsymbol{f}_\theta \\ \boldsymbol{f}_w \end{pmatrix}=\begin{pmatrix} \boldsymbol{k}_{EIx} & \boldsymbol{0} & \boldsymbol{0} & \boldsymbol{0} \\ & \boldsymbol{k}_{EIy} & \boldsymbol{0} & \boldsymbol{0} \\ & & \boldsymbol{k}_{EIw}+\boldsymbol{k}_{GK} & \boldsymbol{0} \\ \text{sym.} & & & \boldsymbol{k}_{EA} \end{pmatrix}\begin{pmatrix} \boldsymbol{u} \\ \boldsymbol{v} \\ \boldsymbol{\theta} \\ \boldsymbol{w} \end{pmatrix} \tag{6}$$

あるいは

$$\boldsymbol{f}=\boldsymbol{k}\boldsymbol{d} \tag{7}$$

ここに，$\boldsymbol{k}$ は梁要素の剛性マトリックスをあらわす。

次に，(1) 式における初期応力のポテンシャル $\delta W^{(0)}$ をマトリックス表示すると，

$$\begin{aligned} \delta W^{(0)}=\int_0^l \{&\delta\boldsymbol{u}^T\boldsymbol{A}^{-1T}\boldsymbol{H}'^T(P\boldsymbol{u}^T\boldsymbol{A}^{-1}\boldsymbol{u}-M_x\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{\theta}-V_y\boldsymbol{H}\boldsymbol{A}^{-1}\boldsymbol{\theta}) \\ &+\delta\boldsymbol{v}^T\boldsymbol{A}^{-1T}\boldsymbol{H}'^T(P\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{v}-M_y\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{\theta}+V_x\boldsymbol{H}\boldsymbol{A}^{-1}\boldsymbol{\theta}) \end{aligned}$$

$$+\delta\boldsymbol{\theta}^T\boldsymbol{A}^{-1T}\boldsymbol{H}'^T(P r_0^2\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{\theta}-M_y\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{v}-M_x\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{u})$$
$$+\delta\boldsymbol{\theta}^T\boldsymbol{A}^{-1T}\boldsymbol{H}^T(V_x\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{v}-V_y\boldsymbol{H}'\boldsymbol{A}^{-1}\boldsymbol{u})\}\,dz \tag{8}$$

ここに,

$$\left.\begin{aligned}&\boldsymbol{k}_G{}^P=\boldsymbol{A}^{-1T}\int_0^l\boldsymbol{H}'^T P\boldsymbol{H}'dz\boldsymbol{A}^{-1},\quad \boldsymbol{k}_G{}^{Mx}=\boldsymbol{A}^{-1T}\int_0^l\boldsymbol{H}'^T M_x\boldsymbol{H}'dz\boldsymbol{A}^{-1}\\&\boldsymbol{k}_G{}^{My}=\boldsymbol{A}^{-1T}\int_0^l\boldsymbol{H}'^T M_y\boldsymbol{H}'dz\boldsymbol{A}^{-1},\quad \boldsymbol{k}_G{}^{Vx}=\boldsymbol{A}^{-1T}\int_0^l\boldsymbol{H}^T V_x\boldsymbol{H}'dz\boldsymbol{A}^{-1}\\&\boldsymbol{k}_G{}^{Vy}=\boldsymbol{A}^{-1T}\int_0^l\boldsymbol{H}^T V_y\boldsymbol{H}'dz\boldsymbol{A}^{-1}\end{aligned}\right\} \tag{9}$$

とおけば，(8) 式は次のようにあらわすことができる。

$$\delta W^{(0)}=\delta\boldsymbol{u}^T(\boldsymbol{K}_G{}^P\boldsymbol{u}-\boldsymbol{k}_G{}^M{}_x\boldsymbol{\theta}-\boldsymbol{k}_G{}^{VyT}\boldsymbol{\theta})+\delta\boldsymbol{v}^T(\boldsymbol{k}_G{}^P\boldsymbol{v}-\boldsymbol{k}_G{}^{My}\boldsymbol{\theta}+\boldsymbol{k}_G{}^{VxT}\boldsymbol{\theta})$$
$$+\delta\boldsymbol{\theta}^T(-\boldsymbol{k}_G{}^{Mx}\boldsymbol{u}-\boldsymbol{k}_G{}^{Vy}\boldsymbol{u}-\boldsymbol{k}_G{}^{My}\boldsymbol{v}+\boldsymbol{k}_G{}^{Vx}\boldsymbol{v}+r_0^2\boldsymbol{k}_G{}^P\boldsymbol{\theta}) \tag{10}$$

そこで，(10) 式に Castigliano の定理を適用すると，次のような方程式が得られる。

$$\begin{pmatrix}\boldsymbol{f}_u\\\boldsymbol{f}_v\\\boldsymbol{f}_\theta\end{pmatrix}=\begin{pmatrix}\boldsymbol{k}_G{}^P & \boldsymbol{0} & -\boldsymbol{k}_G{}^{Mx}-\boldsymbol{k}_G{}^{VyT}\\\boldsymbol{0} & \boldsymbol{k}_G{}^p & -\boldsymbol{k}_G{}^{My}+\boldsymbol{k}_G{}^{VxT}\\-\boldsymbol{k}_G{}^{Mx}-\boldsymbol{k}_G{}^{Vy} & -\boldsymbol{k}_G{}^{My}+\boldsymbol{k}_G{}^{Vx} & r_0^2\boldsymbol{k}_G{}^P\end{pmatrix}\begin{pmatrix}\boldsymbol{u}\\\boldsymbol{v}\\\boldsymbol{\theta}\end{pmatrix} \tag{11}$$

あるいは

$$\boldsymbol{f}_G=\boldsymbol{k}_G\boldsymbol{d}_G \tag{12}$$

ここに $\boldsymbol{k}_G$ は梁要素の初期応力マトリックスをあらわす。

以上求めたマトリックス $\boldsymbol{k}$ と $\boldsymbol{k}_G$ を加え合わせることにより，次のような座屈特有方程式が得られる。

$$|\boldsymbol{k}+\boldsymbol{k}_G|=0 \tag{13}$$

ただし，1節点の自由度は等しくする必要がある。なお，θ' の項は無視しても実際の挙動と差異はあまりないことが知られている[7]ので，本研究においても省略した。

ところで，2次元骨組構造において，梁要素の局部座標系は必ずしも全体座標系と一致しない。そこで，全体座標系に変換した後，構造全体について合成すると，結局 (14) 式が得られ，この式の最小固有値が座屈荷重を与えることになる。

$$|\boldsymbol{K}+\boldsymbol{K}_G|=0 \tag{14}$$

さて，(14) 式は，マトリックス $\boldsymbol{K}_G$ の中に含まれる未知荷重 P に関する固有値の特有方程式を与えるが，$\boldsymbol{K}_G$ の自由度を形式的に $\boldsymbol{K}$ と等しくしているため，$\boldsymbol{K}_G$ は特異になっており，このままでは解けない。そこで，次のような操作を行う。

(14) 式を次式のような固有値問題に変換する。

$$(\boldsymbol{K}+P\boldsymbol{K}_G)\boldsymbol{d}=0 \tag{15}$$

さらに，(15) 式を

$$-\boldsymbol{K}^{-1}\boldsymbol{K}_G\boldsymbol{d}=\frac{1}{P}\boldsymbol{d} \tag{16}$$

の標準形に直せば，容易に解は得られるわけである。

3. 計　算　例

Fig. 1 はスパン 7m，軒高 2m，屋根勾配 3/7 の木造山形ラーメンであり，両端ピン支持の境界条件のもとで，5等分4点荷重を作用させた場合の横座屈荷重を計算してみた。手順は次のとおりである。

まず，単位荷重で yz 面内の曲げモーメント，せん断力，軸力を求める。次に，これらの応力を初期応力として，このラーメンの xz 面への横安定問題と考え，(16) 式の最小固有値を計算すると座屈荷重 $P_{cr}=134.7$kg を得た。

なお，固有値の解法には QR 法[8] を用いた。

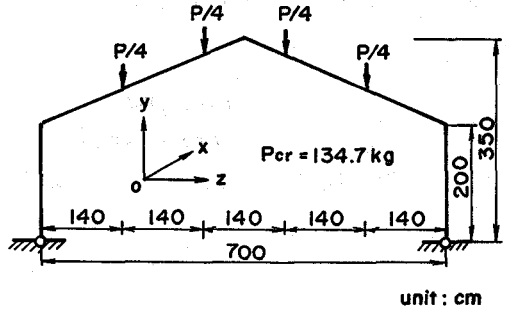

Fig. 1 Wooden gable frame.
Member of the frame: 206 wood
$E_L=120\times10^3$kg/cm^2, $G=7.2\times10^3$kg/cm^2
$G_oK_o=1.56\times10^6$kg/cm^2, $I_w=7.76\times10^2$cm^6
Finite element analysis carried out for a half of the frame and the number of elements and nodes used for calculation are 19 and 20 respectively.

4. プログラムリスト

(16) 式を用いた計算プログラムについて，JIS FORTRAN で記述したものを以下に載せる。

```
C     MAIN PROGRAM    BUCKLING  OF  BEAM-COLUMN
C
C
C     IVEC=0   NO EIGEN VECTOR
C     IVEC=1   YES EIGEN VECTOR
C     NF  =  TOTAL  NODE NUMBER RECIEVED LOAD
C     A(I,J) = EIGEN VALUE MATRIX
C     IPL = 0        ZX  PLANE
C     IPL = 1        ZY  PLANE
C
      COMMON  NODE,NELM,NF,NT,NN, KOX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,FZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),Q(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),RFAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  OSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
C
      CALL INPUT
C
      IJG = 0
C
      DO 505 M=1,NELM
      CALL ESMAT
      CALL MAKOSM
  505 CONTINUE
C
      CALL REARG
C
      CALL SOLV
C
      CALL OUTK
C
C
C                   BUCKLING  OF  BEAM-COLUMN
      IJG = 1
C
      DO 515 M=1,NELM
C
      CALL ESMAT
      CALL EGMAT
      CALL MAKOSM
C
  515 CONTINUE
C
      CALL REARG
C
      CALL MATINV
C
      DO 520 J=1,NN
      DO 520 I=1,NN
      A(I,J) = 0.
      DO 520 K=1,NN
  520 A(I,J) = A(I,J) + OSM(I,K)*B(K,J)
C
C
C
      N=NN
      NA=NN
      NB=NN+3
C
      WRITE(6,100)  N,IVEC
  100 FORMAT(1H1///6X,5HINPUT/9X,3HN =,I3/9X,5HIVEC=,I3/
     2            /9X,6HA(N,N) )
C
      CALL EIGQR
C
      WRITE(6,105)
  105 FORMAT(1H0,5X,6HOUTPUT/6X,11HEIGEN VALUE)
C
      DO 59 I=1,N
   59 EIGR(I) = 1.0/EIGR(I)
      DO 60 I=1,N
   60 WRITE(6,115)  EIGR(I)
  115 FORMAT(3X,      1PE15.7)
      IF(IVEC.EQ.0) GO TO 99
      WRITE(6,120)
  120 FORMAT(1H0,5X,12HEIGEN VECTOR)
      DO 70 J=1,N
   70 WRITE(6,115)  ( UR(I,J),UI(I,J), I=1,N )
C
      DO 150 I=1,NT
      DO 150 J=1,NT
      OSM(I,J) = 0.
  150 B(I,J) = 0.
      DO 155 I=1,N
      DO 155 J=1,N
  155 OSM(I,J) = UR(J,I)
      DO 160 I=1,NN
      IA = INDEX(I)
      DO 160 J=1,NN
      JA = INDEX(J)
  160 B(IA,JA) = OSM(I,J)
C
      DO 180 I=1,3
      IA = INDEX(I)
      WRITE(6,165)  EIGR(I)
  165 FORMAT(1H0,12HEIGEN VALUE=,1PE15.7)
C
      WRITE(6,170)
  170 FORMAT(1H0,1X,4HNODE,10X,5HDIS X,10X,5HDIS Y,10X,5HDIS Z,9X,
     #    6HSITA X,9X,6HSITA Y,9X,6HSITA Z )
      K = 0
      J1 = 1
  172 CONTINUE
      K = K+1
      J6 = J1+5
      WRITE(6,175)  K,(B(IA,J),J=J1,J6)
      J1 = J6+1
      IF(J1.GT.NT)  GO TO 180
      GO TO 172
  175 FORMAT(1H ,I5,1P6E15.4)
  180 CONTINUE
C
   99 STOP
      END
      SUBROUTINE INPUT
C
C
C
      COMMON  NODE,NELM,NF,NT,NN, KOX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
```

```
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),O(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  OSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
   10 FORMAT(16I5)
   15 FORMAT(8F10.0)
   20 FORMAT(I5,7F10.0)
   25 FORMAT(5E10.2)
C
C
      READ(5,10)  NODE,NELM,NF,IPL,IVEC
      NT = NODE*6
      READ(5,10)  KOX, KOY, KOZ, KSX, KSY, KSZ
      READ(5,10)  KGX, KGY, KGZ, KGSX,KGSY,KGSZ
      DO 35 I=1,NT
      DO 35 J=1,NT
      OSM(I,J) = 0.
   35 B(I,J) = 0.
C
C
      MAX = 0
C
      DO 100 I=1,NELM
      READ(5,10)  L,(MCON(L,J),J=1,3)
      MCON(L,3) = MCON(L,3)+1
      IF(MCON(L,3),GT,MAX)  MAX=MCON(L,3)
  100 CONTINUE
C
C
      READ(5,15)  BAIZ,BAIX,BAIY
C
      DO 102 K=1,NODE
      READ(5,20)  I,Z(I),X1(I),Y1(I)
      Z(I) = BAIZ*Z(I)
      X1(I) = BAIX*X1(I)
      Y1(I)= BAIY*Y1(I)
  102 CONTINUE
C
      NT=NODE*6
      DO 105 I=1,NT
  105 F(I)=0.
C
      DO 115 K=1,NF
      READ(5,20) I,FX,FY,FZ,FXS,FYS,FZS
      F(6*I-5) = FX
      F(6*I-4) = FY
      F(6*I-3) = FZ
      F(6*I-2) = FXS
      F(6*I-1) = FYS
      F(6*I) = FZS
  115 CONTINUE
C
      IF(KOX,EQ,0) GO TO 120
      READ(5,10)  (NKOX(I),I=1,KOX)
  120 IF(KOY,EQ,0) GO TO 121
      READ(5,10)  (NKOY(I),I=1,KOY)
  121 IF(KOZ,EQ,0) GO TO 122
      READ(5,10)  (NKOZ(I),I=1,KOZ)
  122 IF(KSX,EQ,0)  GO TO 123
      READ(5,10)  (NKSX(I),I=1,KSX)
  123 IF(KSY,EQ,0) GO TO 124
      READ(5,10)  (NKSY(I),I=1,KSY)
  124 IF(KSZ,EQ,0) GO TO 125
      READ(5,10)  (NKSZ(I),I=1,KSZ)
C
  125 IF(KGX,EQ,0)  GO TO 126
      READ(5,10)  (NKGX(I),I=1,KGX)
  126 IF(KGY,EQ,0)  GO TO 127
      READ(5,10)  (NKGY(I),I=1,KGY)
  127 IF(KGZ,EQ,0)  GO TO 128
      READ(5,10)  (NKGZ(I),I=1,KGZ)
  128 IF(KGSX,EQ,0)  GO TO 129
      READ(5,10)  (NKGSX(I),I=1,KGSX)
  129 IF(KGSY,EQ,0)  GO TO 130
      READ(5,10)  (NKGSY(I),I=1,KGSY)
  130 IF(KGSZ,EQ,0)  GO TO 131
      READ(5,10)  (NKGSZ(I),I=1,KGSZ)
  131 CONTINUE
C
      DO 135 I=1,MAX
      READ(5,15)  BRED(I), HIGH(I), ELX(I),ELY(I),ELZ(I),GK1(I),GIW1(I)
      A1(I)= BRED(I)* HIGH(I)
      IF(IPL,EQ,1)  GO TO 250
      ZIXX1(I)= BRED(I)* HIGH(I)**3/ 12.0
      ZIYY1(I)= HIGH(I)* BRED(I)**3/ 12.0
      GO TO 135
  250 CONTINUE
      ZIYY1(I) = BRED(I)*HIGH(I)**3/12.0
      ZIXX1(I) = HIGH(I)*BRED(I)**3/12.0
  135 CONTINUE
C
C
      DO 140 I=1,NELM
      AR(I)=0.
      ZIXX(I)=0.
      ZIYY(I) = 0.
      EZZ(I) = 0.
      EZX(I) = 0.
      EZY(I) = 0.
      GK(I) = 0.
      GIW(I)=0.
  140 CONTINUE
C
      DO 150 NE=1,NELM
      I = MCON(NE,3)
      AR(NE) = A1(I)
      ZIXX(NE) = ZIXX1(I)
      ZIYY(NE) = ZIYY1(I)
      EZZ(NE) = ELZ(I)
      EZX(NE) = ELX(I)
      EZY(NE) = ELY(I)
      GK(NE) = GK1(I)
      GIW(NE) = GIW1(I)
  150 CONTINUE
C
C
      WRITE(6,50)  NODE,NELM,NF,IPL,IVEC
   50 FORMAT(1H0,5HNODE=,I5,5X,5HNELM=,I5,5X,3HNF=,I5,5X,4HIPL=,I1
     *    ,5X,5HIVEC=,I1 )
      WRITE(6,51)  KOX,KOY,KOZ,KSX,KSY,KSZ
   51 FORMAT(1H0,4HKOX=,I5,5X,4HKOY=,I5,5X,4HKOZ=,I5,5X,4HKSX=,I5,5X
     *   ,5HKSY=,I5,5X,5HKSZ=,I5)
      WRITE(6,52)   KGX,KGY,KGZ,KGSX,KGSY,KGSZ
   52 FORMAT(1H0,4HKGX=,I2,5X,4HKGY=,I2,5X,4HKGZ=,I2,5X,7HSITA X=,I2
```

```
     *          ,5X,7HSITA Y=,I2,5X,7HSITA Z=,I2)
        WRITE(6,55)
    55 FORMAT(1H0,2(7HELEMENT,5X,5HNODES,2X,3HMAT,5X,7HAREA(M),5X
       *      ,7HZIXX(M),5X,7HZIYY(M),5X ))
        WRITE(6,56)  (I,(MCON(I,J),J=1,3),AR(I),ZIXX(I),ZIYY(I),I=1,NELM)
    56 FORMAT(1H ,2(I7,3I5,1P3E12.5,5X ))
        WRITE(6,57)
    57 FORMAT(1H0,3(4HNODE,7X,18HCOORDINATE (Z,X,Y),10X))
        WRITE(6,58)  (I,Z(I),X1(I),Y1(I),I=1,NODE)
    58 FORMAT(1H ,3(I4,1P3E12.2))
        WRITE(6,59)
    59 FORMAT(1H0,2X,3HMAT,3X,7HBRED(M),3X,7HHIGH(M),4X,6HELX(M),4X,
       *         6HELY(M),4X,6HELZ(M),9X,6HGK1(M), 8X,7HGIW1(M) )
        WRITE(6,60)  (I,BRED(I),HIGH(I),ELX(I),ELY(I),ELZ(I),GK1(I)
       *                ,GIW1(I), I=1,MAX )
    60 FORMAT(1H ,I5,1P5E10.2,1P2E15.5 )
C
        WRITE(6,181)
   181 FORMAT(1H0,1X,4HNODE,8X,2HFX,8X,2HFY,8X,2HFZ,7X,3HFXS,7X,3HFYS
       *          ,7X,3HFZS)
        WRITE(6,182) (I,F(6*I-5),F(6*I-4),F(6*I-3),F(6*I-2),F(6*I-1)
       *               ,F(6*I),I=1,NODE)
   182 FORMAT(1H ,I5,6F10.2)
C
        IF(KOX.EQ.0)  GO TO 160
        WRITE(6,61)
     61 FORMAT(1H0, 8HFIXED  X )
        WRITE(6,80)  (NKOX(I),I=1,KOX )
     80 FORMAT(1H,20I5)
    160 IF(KOY.EQ.0)  GO TO 161
        WRITE(6,62)
     62 FORMAT(1H0, 8HFIXED  Y )
        WRITE(6,80)  (NKOY(I),I=1,KOY )
    161 IF(KOZ.EQ.0)  GO TO 162
        WRITE(6,63)
     63 FORMAT(1H0,8HFIXED  Z)
        WRITE(6,80)  (NKOZ(I),I=1,KOZ)
    162 IF(KSX.EQ.0)  GO TO 163
        WRITE(6,64)
     64 FORMAT(1H0,12HFIXED SITA X)
        WRITE(6,80)  (NKSX(I),I=1,KSX)
    163 IF(KSY.EQ.0)  GO TO 164
        WRITE(6,65)
     65 FORMAT(1H0,12HFIXED SITA Y)
        WRITE(6,80)  (NKSY(I),I=1,KSY)
    164 IF(KSZ.EQ.0)  GO TO 165
        WRITE(6,66)
     66 FORMAT(1H0,12HFIXED SITA Z)
        WRITE(6,80)   (NKSZ(I),I=1,KSZ)
    165 CONTINUE
C
        IF(KGX.EQ.0)  GO TO 170
        WRITE(6,61)
        WRITE(6,80)  (NKGX(I),I=1,KGX)
    170 IF(KGY.EQ.0)  GO TO 171
        WRITE(6,62)
        WRITE(6,80)  (NKGY(I),I=1,KGY)
    171 IF(KGZ.EQ.0)  GO TO 172
        WRITE(6,63)
        WRITE(6,80)   (NKGZ(I),I=1,KGZ)
    172 IF(KGSX.EQ.0)   GO TO 173
        WRITE(6,64)
        WRITE(6,80)   (NKGSX(I),I=1,KGSX)
    173 IF(KGSY.EQ.0)   GO TO 174
        WRITE(6,65)
        WRITE(6,80)   (NKGSY(I),I=1,KGSY)
    174 IF(KGSZ.EQ.0)  GO TO 175
        WRITE(6,66)
        WRITE(6,80)   (NKGSZ(I),I=1,KGSZ)
    175 CONTINUE
C
        RETURN
        END
        SUBROUTINE ESMAT
C
C
C
        COMMON  NODE,NELM,NF,NT,NN, KOX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
        COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
        COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
        COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
        COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
        COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
        COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
        COMMON  ESM(12,12),HEN(12,12),B(12,12),WO(12),WS(12), TSM(35,12)
        COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
        COMMON  OSM(180,180),H(180,180),A(100,100),IC(100),EIGR(100)
        COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
        COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
C
        I= MCON(M,1)
        J= MCON(M,2)
C
        IF(IPL.GE.1)  GO TO 2
        AL = SQRT((Z(J)-Z(I))**2 +(X1(J)-X1(I))**2)
        CS = (Z(J)-Z(I))/AL
        SN = (X1(J)-Y1(I))/AL
        GO TO 5
C
     2  CONTINUE
        AL = SQRT((Z(J)-Z(I))**2 + (Y1(J)-Y1(I))**2)
        CS = (Z(J)-Z(I))/AL
        SN = (Y1(J)-Y1(I))/AL
     5  CONTINUE
C
        DO 10 I=1,12
        DO 10 J=1,12
        ESM(I,J) = 0.
        ESG(I,J) = 0.
    10  HEN(I,J) = 0.
C
C
        EIXX = EZX(M) * ZIXX(M)
        EIYY = EZY(M) * ZIYY(M)
        EA = EZZ(M) * AR(M)
        ELIW= EZZ(M) * GIW(M)
C
C
        ESM(1,1) = 12. * EIXX/ AL**3
        ESM(1,5) =  6. * EIXX/ AL**2
        ESM(1,7) = -ESM(1,1)
        ESM(1,11) = ESM(1,5)
        ESM(2,2) = 12. * EIYY/ AL**3
        ESM(2,4) = -6. * EIYY/ AL**2
        ESM(2,8) = -ESM(2,2)
        ESM(2,10) = ESM(2,4)
        ESM(3,3) = EA/AL
        ESM(3,9) =-EA/AL
        ESM(4,4) = 4. * EIYY/ AL
```

```
      ESM(4,8) = 6. *EIYY/AL**2
      ESM(4,10) = 2. *EIYY/AL
      ESM(5,5) = 4. *EIXX/AL
      ESM(5,7) = -6. *EIXX/AL**2
      ESM(5,11) = 2. *EIXX/AL
      ESM(6,6) = 12.*ELIW/AL**3 + 6.*GK(M)/ (5.*AL)
      ESM(6,12) = -ESM(6,6)
      ESM(7,7) =  ESM(1,1)
      ESM(7,11) = -ESM(1,5)
      ESM(8,8) =  ESM(2,2)
      ESM(8,10) =  ESM(4,8)
      ESM(9,9)  =  ESM(3,3)
      ESM(10,10) = ESM(4,4)
      ESM(11,11) = ESM(5,5)
      ESM(12,12) = ESM(6,6)
C
      DO 20 J=1,11
      IJ = J+1
      DO 20 K=IJ,12
      ESM(K,J) = ESM(J,K)
   20 CONTINUE
C
C
      IF(IPL.GE.1)  GO TO 50
      HEN(1,1) = CS
      HEN(1,3) = -SN
      HEN(2,2) = 1.
      HEN(3,1) = SN
      HEN(3,3) = CS
      GO TO 55
C
   50 CONTINUE
      HEN(1,1) = 1.
      HEN(2,2) = CS
      HEN(2,3) = SN
      HEN(3,2) =-SN
      HEN(3,3) = CS
   55 CONTINUE
C
      I=1
      J=1
   25 CONTINUE
      I2 = I+2
      J2 = J+2
      DO 30 I1=I,I2
      DO 30 J1=J,J2
      HEN(I1+3,J1+3) = HEN(I1,J1)
   30 CONTINUE
      I=I+3
      J=J+3
      IF(I.GE.10) GO TO 32
      GO TO 25
   32 CONTINUE
C
C
      DO 40 I=1,12
      DO 40 J=1,12
      O(I,J) = 0.
      DO 40 K=1,12
   40 O(I,J) = O(I,J) + HEN(K,I)*ESM(K,J)
      DO 45 I=1,12
      DO 45 J=1,12
      ESM(I,J) = 0.
      DO 45 K=1,12
   45 ESM(I,J) = ESM(I,J) + O(I,K)*HEN(K,J)
C
C
      RETURN
      END
      SUBROUTINE MAKOSM
C
C
C
      COMMON  NODE,NELM,NF,NT,NN, KOX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),O(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  OSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
      DO 10 I=1,2
      DO 10 J=1,2
      KI = (MCON(M,I)-1)*6
      KJ = (MCON(M,J)-1)*6
      IS = (I-1)*6
      JS = (J-1)*6
      DO 10 K=1,6
      DO 10 L=1,6
      KIK = KI+K
      KJL = KJ+L
      ISK = IS+K
      JSL = JS+L
      IF(IJG.GE.1)  GO TO 11
      OSM(KIK,KJL) = OSM(KIK,KJL) + FSM(ISK,JSL)
      GO TO 12
C
   11 CONTINUE
      OSM(KIK,KJL) = OSM(KIK,KJL) + FSM(ISK,JSL)
      B(KIK,KJL) = B(KIK,KJL) + FSG(ISK,JSL)
C
   12 CONTINUE
   10 CONTINUE
C
      RETURN
      END
      SUBROUTINE REARG
C
C
C
      COMMON  NODE,NELM,NF,NT,NN, KOX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),O(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  OSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
```

```
      IF(IJG.GE.1)  GO TO 200
C
      DO 11 I=1,NT
   11 INDEX(I) = I
      IF(KOX.EQ.0)  GO TO 118
      DO 120 I=1,KOX
      N = 6*NKOX(I)-5
  120 INDEX(N) = 0
  118 IF(KOY.EQ.0)  GO TO 121
      DO 122 I=1,KOY
      N = 6*NKOY(I)-4
  122 INDEX(N) = 0
  121 IF(KOZ.EQ.0)  GO TO 124
      DO 125 I=1,KOZ
      N = 6*NKOZ(I)-3
  125 INDEX(N) = 0
  124 IF(KSX.EQ.0) GO TO 126
      DO 127 I=1,KSX
      N = 6*NKSX(I)-2
  127 INDEX(N) = 0
  126 IF(KSY.EQ.0) GO TO 129
      DO 128 I=1,KSY
      N = 6*NKSY(I)-1
  128 INDEX(N) = 0
  129 IF(KSZ.EQ.0)  GO TO 134
      DO 132 I=1,KSZ
      N = 6*NKSZ(I)
  132 INDEX(N) = 0
C
  134 NN=0
C
      DO 150 I=1,NT
      IF(INDEX(I).EQ.0)  GO TO 150
      NN = NN+1
      INDEX(NN) = I
  150 CONTINUE
C
      DO 155 I=1,NN
      IA = INDEX(I)
      F(I) = F(IA)
      DO 155 J=1,NN
      JA = INDEX(J)
  155 OSM(I,J) = OSM(IA,JA)
C
      GO TO 300
C
C
  200 CONTINUE
      DO 201 I=1,NT
  201 INDEX(I)=I
      IF(KGX.EQ.0)  GO TO 218
      DO 220 I=1,KGX
      N = 6*NKGX(I)-5
  220 INDEX(N) = 0
  218 IF(KGY.EQ.0)  GO TO 221
      DO 222 I=1,KGY
      N = 6*NKGY(I)-4
  222 INDEX(N) = 0
  221 IF(KGZ.EQ.0)  GO TO 224
      DO 225 I=1,KGZ
      N = 6* NKGZ(I)-3
  225 INDEX(N) = 0
  224 IF(KGSX.EQ.0)   GO TO 226
      DO 227 I=1,KGSX
      N = 6*NKGSX(I)-2
  227 INDEX(N) = 0
  226 IF(KGSY.EQ.0)   GO TO 229
      DO 228 I=1,KGSY
      N = 6*NKGSY(I)-1
  228 INDEX(N) = 0
  229 IF(KGSZ.EQ.0)   GO TO 234
      DO 232 I=1,KGSZ
      N = 6*NKGSZ(I)
  232 INDEX(N) = 0
C
  234 NN=0
C
      DO 250 I=1,NT
      IF(INDEX(I).EQ.0)  GO TO 250
      NN = NN+1
      INDEX(NN) = I
  250 CONTINUE
C
      DO 255 I=1,NN
      IA = INDEX(I)
      DO 255 J=1,NN
      JA = INDEX(J)
      OSM(I,J) = OSM(IA,JA)
      B(I,J) = B(IA,JA)
  255 CONTINUE
C
C
C
  300 CONTINUE
C
      RETURN
      END
      SUBROUTINE SOLV
C
C
C
      COMMON  NODE,NELM,NF,NT,NN, KDX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRFD(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),O(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  OSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAM(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
      DO 140 I=1,NT
  140 DIS(I) = 0.
C
      CALL MATINV
C
      DO 141 I=1,NN
      REAC(I) = 0.
      DO 141 K=1,NN
  141 REAC(I) = REAC(I) + OSM(I,K)*F(K)
      DO 143 I=1,NN
      IA = INDEX(I)
  143 DIS(IA) = REAC(I)
C
      DO 150 I=1,NT
  150 REAC(I) = 0.
C
```

```
C
C
      DO 155 M=1,NELM
C
      CALL ESMAT
C
      DO 160 I=1,2
      IA = MCON(M,I)
      WD(6*I-5) = DIS(6*IA-5)
      WD(6*I-4) = DIS(6*IA-4)
      WD(6*I-3) = DIS(6*IA-3)
      WD(6*I-2) = DIS(6*IA-2)
      WD(6*I-1) = DIS(6*IA-1)
  160 WD(6*I) = DIS(6*IA)
C
      DO 165 I=1,12
      WS(I)=0.
      DO 165 K=1,12
  165 WS(I) = WS(I) + ESM(I,K)*WD(K)
C
      DO 170 I=1,2
      IA = MCON(M,I)
      DO 170 J=1,6
      IR = 6*(IA-1)+J
      IW = 6*(I-1)+J
  170 REAC(IR) = REAC(IR)+WS(IW)
C
      DO 155 I=1,12
      TSM(M,I) = 0.
      DO 155 K=1,12
      TSM(M,I) = TSM(M,I) + HEN(I,K)*WS(K)
  155 CONTINUE
C
      RETURN
      END
      SUBROUTINE MATINV
      COMMON  NODE,NELM,NF,NT,NN, KDX,KDY,KDZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKDX(30),NKDY(30),NKDZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),O(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  OSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
      DO 102 K=1,NN
  102 IND(K)=K
      DO 103 K=1,NN
      U=0.
      DO 104 I=K,NN
      IF(ABS(OSM(I,1)).LE.U) GO TO 104
      U=ABS(OSM(I,1))
      IR=I
  104 CONTINUE
      IF(IR.EQ.K) GO TO 106
      DO 107 J=1,NN
      U=OSM(K,J)
      OSM(K,J)=OSM(IR,J)
  107 OSM(IR,J)=U
      MR=IND(K)
      IND(K)=IND(IR)
      IND(IR)=MR
  106 U=OSM(K,1)
      N1=NN-1
      DO 108 J=1,N1
  108 OSM(K,J)=OSM(K,J+1)/U
      OSM(K,NN)=1.0/U
      DO 109 I=1,NN
      IF(I.EQ.K) GO TO 109
      U=OSM(I,1)
      DO 110 J=1,N1
  110 OSM(I,J)=OSM(I,J+1)-U*OSM(K,J)
      OSM(I,NN)=-U*OSM(K,NN)
  109 CONTINUE
  103 CONTINUE
      DO 111 K=1,N1
      IF(K.EQ.IND(K)) GO TO 111
      K1=K+1
      DO 112 I=K1,NN
      IF(K.NE.IND(I)) GO TO 112
      IR=I
      GO TO 114
  112 CONTINUE
  114 DO 115 J=1,NN
      U=OSM(J,K)
      OSM(J,K)=OSM(J,IR)
  115 OSM(J,IR)=U
      IND(IR)=IND(K)
      IND(K)=K
  111 CONTINUE
      RETURN
      END
      SUBROUTINE OUTK
C
C
C
      COMMON  NODE,NELM,NF,NT,NN, KDX,KDY,KDZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKDX(30),NKDY(30),NKDZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),O(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  OSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
      WRITE(6,205)
  205 FORMAT(1H0,1X,4HNODE,10X,5HDIS X,10X,5HDIS Y,10X,5HDIS Z,9X
     *       ,6HSITA X,9X,6HSITA Y,9X,6HSITA Z )
      WRITE(6,210)  (I,DIS(6*I-5),DIS(6*I-4),DIS(6*I-3),DIS(6*I-2)
     *              ,DIS(6*I-1),DIS(6*I),I=1,NODE )
  210 FORMAT(1H ,I5,1P6E15.4)
      WRITE(6,215)
  215 FORMAT(1H0,1X,4HNODE,    11X,4HRE X,11X,4HRE Y,11X,4HRE Z,10X
     *          ,5HRE MX,10X,5HRE MY,10X,5HRE MZ)
      WRITE(6,210)  (I,REAC(6*I-5),REAC(6*I-4),REAC(6*I-3),REAC(6*I-2)
     *              ,REAC(6*I-1),REAC(6*I) ,I=1,NODE )
      WRITE(6,220)
  220 FORMAT(1H0,1X,4HNELM,2X,8HNODE NO,,8X,7HFORCE-X,8X,7HFORCE-Y
     *      ,8X ,7HFORCE-Z,7X,8HMOMENT-X,7X,8HMOMENT-Y,7X,8HMOMENT-Z)
      DO 225 M=1,NELM
```

```
      IA = MCON(M,1)
      WRITE(6,228)  M,IA,(TSM(M,J),J=1,6)
      JA = MCON(M,2)
      WRITE(6,230)    JA,(TSM(M,J),J=7,12)
  228 FORMAT(1H0,I5,I10,1P6E15.4)
  230 FORMAT(1H ,5X,I10,1P6E15.4)
  225 CONTINUE
C
C
      WRITE(6,240)
  240 FORMAT(1H0,1X,4HNELM,11X,3HMXL,11X,3HMXR,11X,3HMYL,11X,3HMYR,10X
     *          ,4HSEFX,10X,4HSEFY,11X,3HAXL )
C
      DO 280 I=1,NT
      DO 280 J=1,NT
      DSM(I,J) = 0.
  280 B(I,J) = 0.
C
      DO 285 M=1,NELM
      TMXL1 =  TSM(M,4)
      TMXR1 = -TSM(M,10)
      TMYL1 =  TSM(M,5)
      TMYR1 = -TSM(M,11)
      SEFX1 =  TSM(M,1)
      SEFY1 =  TSM(M,2)
      AXL1  =  TSM(M,3)
C
      WRITE(6,290)  M,TMXL1, TMXR1,TMYL1,TMYR1, SEFX1,SEFY1, AXL1
  290 FORMAT(1H0,2X,I2,1X,1P7E14.3)
C
  285 CONTINUE
C
      RETURN
      END
      SUBROUTINE EGMAT
C
C
C
      COMMON  NODE,NELM,NF,NT,NN, KOX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),D(12,12),WO(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  DSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
C
      I=MCON(M,1)
      J=MCON(M,2)
C
C
      IF(IPL.GE.1)  GO TO 3
      AL = SQRT((Z(J)-Z(I))**2 +(X1(J)-X1(I))**2)
      CS = (Z(J)-Z(I))/AL
      SN = (X1(J)-X1(I))/AL
      GO TO 8
C
    3 CONTINUE
      AL = SQRT((Z(J)-Z(I))**2 +(Y1(J)-Y1(I))**2)
      SN = (Y1(J)-Y1(I))/AL
      CS = (Z(J)-Z(I))/AL
C
    8 CONTINUE
      DO 11 I=1,12
      DO 11 J=1,12
      HEN(I,J) = 0
   11 ESG(I,J) = 0.
C
C
C
      TMXL =  TSM(M,4)
      TMXR = -TSM(M,10)
      TMYL =  TSM(M,5)
      TMYR = -TSM(M,11)
      SEFX =  TSM(M,1)
      SEFY =  TSM(M,2)
      AXL  =  TSM(M,3)
C
C
      C11 = -3.0*(TMXL+TMXR)/(5.0*AL) + 0.5*SEFY
      C12 =      -TMXR/10. - SEFY*AL/10.
      C13 = -C11
      C14 =      -TMXL/10. + SEFY*AL/10.
      C31 =  3.0*(TMXL+TMXR)/(5.0*AL) + 0.5*SEFY
      C32 =       TMXR/10. + SEFY*AL/10.
      C33 = -3.0*(TMXL+TMXR)/(5.0*AL) - 0.5*SEFY
      C34 =       TMXL/10. - SEFY*AL/10.
C
      D11 = -3.0*(TMYL+TMYR)/(5.0*AL) - 0.5*SEFX
      D12 =      -TMYR/10. + SEFX*AL/10.
      D13 = -D11
      D14 =      -TMYL/10. - SEFX*AL/10.
      D31 =  3.0*(TMYL+TMYR)/(5.0*AL) - 0.5*SEFX
      D32 =       TMYR/10. - SEFX*AL/10.
      D33 = -3.0*(TMYL+TMYR)/(5.0*AL) + 0.5*SEFX
      D34 =       TMYL/10. + SEFX*AL/10.
C
C     R2 = ( ZIXX(M)+ZIYY(M) )/ AR(M)
C
      ESG(1,1) = 6.0*AXL/(5.0*AL)
      ESG(1,5) =     AXL/10.0
      ESG(1,6) = C11
      FSG(1,7) = -ESG(1,1)
      ESG(1,11) =   AXL/10.0
      ESG(1,12) = C31
      ESG(2,2)  =  ESG(1,1)
      ESG(2,4)  =  -AXL/10.0
      ESG(2,6)  =  D11
      ESG(2,8)  =  ESG(1,7)
      ESG(2,10) =  ESG(2,4)
      ESG(2,12) = D31
      ESG(4,4)  = 2.*AL*AXL/15.0
      ESG(4,6)  =  D12
      ESG(4,8)  =  AXL/10.0
      ESG(4,10) = -AL*AXL/30.0
      ESG(4,12) =  D32
      ESG(5,5)  =  ESG(4,4)
      ESG(5,6)  =  C12
      ESG(5,7)  = -AXL/10.0
      ESG(5,11) = -AL*AXL/30.0
      ESG(5,12)  =  C32
      ESG(6,6)   =  6.0*R2*AXL/(5.0*AL)
      ESG(6,7)   =  C13
      ESG(6,8)   =  D13
```

```
      ESG(6,10)  =  D14
      ESG(6,11)  =  C14
      ESG(6,12)  = -ESG(6,6)
      ESG(7,7)   =  ESG(1,1)
      ESG(7,11)  = -AXL/10.
      ESG(7,12)  =  C33
      ESG(8,8)   =  ESG(7,7)
      ESG(8,10)  =  ESG(4,8)
      ESG(8,12)  =  D33
      ESG(10,10) =  ESG(4,4)
      ESG(10,12) =  D34
      ESG(11,11) =  ESG(5,5)
      ESG(11,12) =  C34
      ESG(12,12) =  ESG(6,6)
C
      DO 20 J=1,11
      IJ = J+1
      DO 20 K=IJ,12
      ESG(K,J) = ESG(J,K)
   20 CONTINUE
C
C
C
C
      IF(IPL.GE.1)  GO TO 50
      HEN(1,1) = CS
      HEN(1,3) = -SN
      HEN(2,2) = 1.0
      HEN(3,1) = SN
      HEN(3,3) = CS
      GO TO 55
C
   50 CONTINUE
      HEN(1,1) = 1.
      HEN(2,2) = CS
      HEN(2,3) = SN
      HEN(3,2) =-SN
      HEN(3,3) = CS
   55 CONTINUE
C
      I=1
      J=1
   25 CONTINUE
      I2 = I+2
      J2 = J+2
      DO 30 I1=I,I2
      DO 30 J1=J,J2
      HEN(I1+3,J1+3) = HEN(I1,J1)
   30 CONTINUE
      I=I+3
      J=J+3
      IF(I.GE.10)  GO TO 32
      GO TO 25
   32 CONTINUE
C
C
C
      DO 40 I=1,12
      DO 40 J=1,12
      D(I,J) = 0.
      DO 40 K=1,12
   40 D(I,J) = D(I,J) + HEN(K,I)*ESG(K,J)
      DO 45 I=1,12
      DO 45 J=1,12
      ESG(I,J) = 0.
      DO 45 K=1,12
   45 ESG(I,J) = ESG(I,J) + D(I,K)*HEN(K,J)
C
C
C
      RETURN
      END
      SUBROUTINE EIGGR
C
      COMMON  NODE,NELM,NF,NT,NN, KOX,KOY,KOZ,KSX,KSY,KSZ ,M,IPL
      COMMON  NKOX(30),NKOY(30),NKOZ(30),NKSX(30),NKSY(30),NKSZ(30)
      COMMON  KGX,KGY,KGZ,KGSX,KGSY,KGSZ,NKGX(30),NKGY(30),NKGZ(30)
      COMMON  NKGSX(30),NKGSY(30),NKGSZ(30) ,X1(30),Y1(30),Z(30),F(180)
      COMMON  ELX(35),ELY(35),ELZ(35),GK1(35),GIW1(35),A1(35),BRED(35)
      COMMON  EZX(35) ,EZY(35) ,EZZ(35) ,GK(35) ,GIW(35),AR(35),HIGH(35)
      COMMON  ZIXX1(35),ZIYY1(35),  ZIXX(35) ,ZIYY(35) , MCON(35,3)
      COMMON  ESM(12,12),HEN(12,12),D(12,12),WD(12),WS(12), TSM(35,12)
      COMMON  DIS(180),REAC(180), INDEX(180),IND(180), ESG(12,12)
      COMMON  DSM(180,180),B(180,180),A(100,100),IC(100),EIGR(100)
      COMMON  EIGI(100),UR(100,100),UI(100,100),PRR(2),PRI(2),PAN(2)
      COMMON  IJG,NA,NB,IVEC,IER,N
C
C
C
      INTEGER P,Q
      IER=0
      IF(N) 4500,4500,20
   20 IF( NA-N ) 4500,40,40
   40 IF( NB-N-3 ) 4500,60,60
C
   60 NM2 = N-2
      M=N
      IF( M.NE.1 ) GO TO 70
      EIGR(1) = A(1,1)
      EIGI(1) = 0.0
      GO TO 1700
   70 IF( M.EQ.2 ) GO TO 175
      DO 170 K=1,NM2
      KP1 = K+1
      IC(KP1) = 0
      PIV = ABS( A(KP1,K) )
      J=KP1
      KP2 = K+2
      DO 110 I=KP2,N
      X=ABS( A(I,K) )
      IF( X.LT.PIV ) GO TO 110
      PIV = X
      J=I
  110 CONTINUE
      IF( PIV.LT.1.E-30 ) GO TO 170
      IF( J.EQ.KP1 ) GO TO 140
      IC(KP1)=J
      DO 120 I=K,N
      X=A(KP1,I)
      A(KP1,I) = A(J,I)
  120 A(J,I) = X
      DO 130 I=1,N
      X = A(I,KP1)
      A(I,KP1) = A(I,J)
  130 A(I,J) = X
  140 DO 160 J=KP2,N
      A(J,K) = A(J,K)/A(KP1,K)
      DO 150 I=KP1,N
  150 A(J,I) = A(J,I) - A(J,K)*A(KP1,I)
      DO 160 I=1,N
  160 A(I,KP1) = A(I,KP1) + A(J,K)*A(I,J)
  170 CONTINUE
```

```
 175 CONTINUE
C
C
      DO 180 I=1,N
      DO 180 J=1,N
 180 B(J+3,I) = A(I,J)
      E6 = 1.0E-6
      E7 = 1.0E-7
      E12= 1.0E-12
      H=0.5
      ITMAX = 30
C
C
 200 N1 = N-1
      IF( N1.EQ.0 ) GO TO 1300
      R=0.0
      S=0.0
      DO 220 I=1,2
      PAN(I)= 0.0
      PRR(I)= 0.0
 220 PRI(I)= 0.0
      N2 = N1-1
      DO 1500 IT=1,ITMAX
      IF( ABS( A(N,N1) ).LE.E12*ABS( A(N,N) )) GO TO 1300
C
C
      T=A(N1,N1) - A(N,N)
C
C
      U = T*T
      V = 4.0* A(N1,N)*A(N,N1)
      IF( ABS(V).GE.U*E7 ) GO TO 240
      EIGR(N1) = A(N1,N1)
      EIGR(N) = A(N,N)
      GO TO 280
 240 T = U+V
      IF( ABS(T).LT.E6*AMAX1( U,ABS(V) )) T=0.0
      U = ( A(N1,N1)+A(N,N) )/2.0
      V = SQRT( ABS(T) )/2.0
      IF( T.GE.0.0) GO TO 260
C
      EIGR(N) = U
      EIGR(N1) = U
      EIGI(N) = -V
      EIGI(N1) = V
      GO TO 300
C
 260 EIGR(N) = U+V
      EIGR(N1) = U-V
 280 EIGI(N) = 0.0
      EIGI(N1) = 0.0
      IF( ABS( EIGR(N1) ).GE.ABS( EIGR(N) )) GO TO 300
      T = EIGR(N1)
      EIGR(N1) = EIGR(N)
      EIGR(N) = T
 300 IF( N2.EQ.0 ) GO TO 1280
C
      EPS = E12*( EIGI(N1) + ABS( EIGR(N1) ))
      IF( ABS( A(N1,N2) ).LE.EPS ) GO TO 1280
      IF( ABS( A(N1,N2)-PAN(1) ).LT.ABS( A(N1,N2) )*E6 ) GO TO 1240
      IF( ABS(  A(N,N1)-PAN(2) ).LT.ABS( A(N,N1) )*E6 ) GO TO 1240
      K=0
C
      DO 360 I=1,2
      J=I+N2
      IF( ABS( EIGR(J)-PRR(I) ) + ABS( EIGI(J)-PRI(I) ).LT.H*
     2  ( ABS( EIGR(J) )+ABS( EIGI(J) ))) K=K+I
      PRR(I) = EIGR(J)
      PRI(I) = EIGI(J)
      PAN(I) = A(J,J-1)
 360 CONTINUE
      IF( K.NE.0 ) GO TO 440
      R=0.0
      S=0.0
      GO TO 500
 440 IF(K.NE.3) GO TO 460
      S = A(N,N) + A(N1,N1)
      R = A(N,N)*A(N1,N1)-A(N1,N)  * A(N,N1)
      GO TO 500
 460 R = PRR(K) * PRR(K)
      S = PRR(K) + PRR(K)
C
 500 IF( N.GE.4 ) GO TO 525
      P=1
      Q=1
      GO TO 650
 525 DO 515 IO=2,N2
      Q = N2+2-IO
      IF( ABS( A(Q,Q-1) ).LE.EPS ) GO TO 530
 515 CONTINUE
      Q=1
 530 IF( Q.GE.N2 ) GO TO 680
      IQ1 = Q+1
      DO 660 IO=IQ1,N2
      P = N2+IQ1-IO
      IP1 = P+1
      IF( ( ABS( A(P,P)+A(IP1,IP1)-S )+AHS( A(IP1+1,IP1) ) )
     2    * ABS( A(P,P-1)*A(IP1,P) ).LT.EPS *
     3      ABS( A(P,P)*( A(P,P)-S )+A(P,IP1)*A(IP1,P)+R )) GO TO 650
 660 CONTINUE
 680 P=Q
C
 650 DO 1220 I=P,N1
      IP1=I+1
      IP2=IP1+1
      I1=I-1
      IF( I.NE.P ) GO TO 720
      G1 = A(I,I)*( A(I,I)-S )+A(I,IP1)*A(IP1,I)+R
      G2 = A(IP1,I)*( A(IP1,IP1)+A(I,I)-S )
      G3 = A(IP1,I)* A(IP2,IP1)
      A(IP2,I) = 0.0
      GO TO 780
 720 G1 = A(I,I1)
      G2 = A(IP1,I1)
      IF( I.LE.N2 ) GO TO 760
      G3 = 0.0
      GO TO 780
 760 G3 = A(IP2,I1)
 780 U = SQRT( G1*G1+G2*G2+G3*G3 )
      IF( U ) 800,860,800
 860 PHI = 2.0
      PSI1 = 0.0
      PSI2 = 0.0
      GO TO 880
 800 IF( G1.LT.0.0 ) U=-U
      T=G1+U
      PSI1 = G2/T
      PSI2=G3/T
      PHI = 2.0/(1.0+PSI1*PSI1+PSI2*PSI2)
 880 IF( I-Q ) 900,960,900
 900 IF( I-P ) 920,940,920
 940 A(I,I1) = -A(I,I1)
```

```
      GO TO 960
  920 A(I,I1)=-U
C
  960 DO 1040 J=I,N
      T=PSI1*A(IP1,J)
      IF( I.LT.N1 ) T=T+PSI2*A(IP2,J)
      ETA = PHI*( T+A(I,J) )
      A(I,J) = A(I,J)-ETA
      A(IP1,J) = A(IP1,J)-PSI1*ETA
      IF( I.LT.N1 ) A(IP2,J)=A(IP2,J)-PSI2*ETA
 1040 CONTINUE
C
      IF( I-N1 ) 1080,1060,1060
 1060 K=N
      GO TO 1100
 1080 K=IP2
 1100 DO 1180 J=G,K
      T = PSI1*A(J,IP1)
      IF( I.LT.N1 ) T=T+PSI2*A(J,IP2)
      ETA = PHI*( T+A(J,I) )
      A(J,I) = A(J,I)-ETA
      A(J,IP1) = A(J,IP1)-ETA*PSI1
      IF( I.LT.N1 ) A(J,IP2)=A(J,IP2)-ETA*PSI2
 1180 CONTINUE
      IF( I.GE.N2 ) GO TO 1220
      IP3=IP2+1
      ETA=PHI*PSI2*A(IP3,IP2)
      A(IP3,I)=-ETA
      A(IP3,IP1)=-ETA*PSI1
      A(IP3,IP2)=A(IP3,IP2)-ETA*PSI2
C
 1220 CONTINUE
 1500 CONTINUE
 1240 IF( ABS( A(N,N1) )-ABS( A(N1,N2) ) ) 1300,1300,1280
C
 1280 N=N2
      GO TO 1600
 1300 EIGR(N)=A(N,N)
      EIGI(N)=0.0
      N=N1
 1600 IF( N.GT.0 ) GO TO 200
C
 1700 N=M
      IF( IVEC.EQ.0 ) RETURN
C
      IF( N.NE.1 ) GO TO 1800
      UR(1,1) = 1.0
      UI(1,1) = 0.0
      RETURN
 1800 IF( N.EQ.2 ) GO TO 1920
      DO 1900 I=1,NM2
      IP2 = I+2
      DO 1900 J=IP2,N
 1900 A(J,I) = B(I+3,J)
 1920 CONTINUE
      L=1
      NP1=N+1
      NM1=N-1
      DO 3700 JJ=1,N
      EIR=EIGR(JJ)
      EII=EIGI(JJ)
 1950 IF(JJ.EQ.1) GO TO 2190
      IF(EII.EQ.0.) GO TO 2100
      IF(ABS(EIR-EIGR(JJ-1)).GT.1.E-6*ABS(EIR).OR.ABS(EII+EIGI(JJ-1))
     1   .GT.1.E-6*ABS(EII)) GO TO 2100
      DO 2000 I=1,N
      UR(I,JJ)=UR(I,JJ-1)
 2000 UI(I,JJ)=-UI(I,JJ-1)
      GO TO 3700
 2100 IF(ABS(EIR-EIGR(JJ-1)).GT.1.E-2*ABS(EIR).OR.ABS(FII+EIGI(JJ-1))
     1   .GT.1.E-2*ABS(EII)) GO TO 2190
      DO 2150 I=1,N
      L=L*48828125
      A(I,NP1)=FLOAT(L)/2147483648.
      B(I,NP1)=0.
      IF(EIGI(JJ).EQ.0.) GO TO 2150
      L=L*48828125
      B(I,NP1)=FLOAT(L)/2147483648.
 2150 CONTINUE
      GO TO 2210
 2190 DO 2200 I=1,N
      A(I,NP1)=1.
 2200 B(I,NP1)=0.
 2210 INDD=1
 2300 DO 2500 I=1,N
      IM1=I-1
      IF(I.EQ.1) IM1=1
      DO 2400 J=IM1,N
      A(I,J)=B(J+3,I)
 2400 B(I,J)=0.0
      A(I,I)=A(I,I)-EIR
 2500 B(I,I)=-EII
      DO 3000 K=1,NM1
      KP1=K+1
      IF(A(K,K)*A(K,K)+B(K,K)*B(K,K)-A(KP1,K)*A(KP1,K)-B(KP1,K)*B(KP1,K)
     1   ) 2600,2800,2800
 2600 DO 2700 I=K,NP1
      X=A(K,I)
      A(K,I)=A(KP1,I)
      A(KP1,I)=X
      X=B(K,I)
      B(K,I)=B(KP1,I)
 2700 B(KP1,I)=X
 2800 X=A(K,K)*A(K,K) + B(K,K)*B(K,K)
      IF(X.LT.1.E-30) GO TO 3000
      PIVR=A(K,K)/X
      PIVI=-B(K,K)/X
      X=A(KP1,K)*PIVR-B(KP1,K)*PIVI
      PIVI=A(KP1,K)*PIVI+B(KP1,K)*PIVR
      PIVR=X
      DO 2900 J=KP1,NP1
      A(KP1,J)=A(KP1,J)-A(K,J)*PIVR+B(K,J)*PIVI
 2900 B(KP1,J)=B(KP1,J)-A(K,J)*PIVI-B(K,J)*PIVR
 3000 CONTINUE
      DO 3300 I=1,N
      J=N+1-I
      IF(I.EQ.1) GO TO 3200
      JP1=J+1
      DO 3100 K=JP1,N
      A(J,NP1)=A(J,NP1)-A(J,K)*A(K,NP1)+B(J,K)*B(K,NP1)
 3100 B(J,NP1)=B(J,NP1)-A(J,K)*B(K,NP1)-B(J,K)*A(K,NP1)
 3200 X=A(J,J)*A(J,J)+B(J,J)*B(J,J)
      IF(X.GT.1.E-20) GO TO 3250
      IF(EIR.EQ.0.,AND.EII.EQ.0.) EIR=1.E-5
      EIR=EIR*1.000005
      EII=EII*1.000005
      GO TO 1950
 3250 A(J,J)=A(J,J)/X
      B(J,J)=-B(J,J)/X
      X=A(J,J)*A(J,NP1)-B(J,J)*B(J,NP1)
      B(J,NP1)=A(J,J)*B(J,NP1)+B(J,J)*A(J,NP1)
 3300 A(J,NP1)=X
```

```
      X=0.
      DO 3350 I=1,N
 3350 X=X+ABS( A(I,NP1) ) + ABS( B(I,NP1) )
      DO 3360 I=1,N
      A(I,NP1) = A(I,NP1)/X
 3360 B(I,NP1) = B(I,NP1)/X
      IF(INDD.EQ.2) GO TO 3400
      INDD = INDD+1
      GO TO 2300
 3400 DO 3500 I=1,N
      UR(I,JJ) = A(I,NP1)
 3500 UI(I,JJ) = B(I,NP1)
 3700 CONTINUE
C
      IF( N.EQ.2 ) GO TO 4250
      DO 4200 L=1,NM2
      K=NM2+1-L
      KP1=K+1
      KP2=K+2
      DO 4000 J=KP2,N
      DO 4000 I=1,N
      UR(J,I)=UR(J,I)+A(J,K)*UR(KP1,I)
 4000 UI(J,I)=UI(J,I)+A(J,K)*UI(KP1,I)
      J=IC(KP1)
      IF(J.EQ.0) GO TO 4200
      DO 4100 I=1,N
      X=UR(J,I)
      UR(J,I)=UR(KP1,I)
      UR(KP1,I)=X
      X=UI(J,I)
      UI(J,I) = UI(KP1,I)
 4100 UI(KP1,I) = X
 4200 CONTINUE
 4250 CONTINUE
C
      DO 4400 J=1,N
      X=0.
      DO 4300 I=1,N
      Y = UR(I,J)*UR(I,J) + UI(I,J)*UI(I,J)
      IF(Y.LE.X) GO TO 4300
      X=Y
      K=I
 4300 CONTINUE
      PIV = UR(K,J)*UR(K,J)+UI(K,J)*UI(K,J)
      X = UR(K,J)/PIV
      Y =-UI(K,J)/PIV
      DO 4400 I=1,N
      PIV = UR(I,J)*X -UI(I,J)*Y
      UI(I,J) = UR(I,J)*Y + UI(I,J)*X
 4400 UR(I,J) = PIV
      GO TO 5000
 4500 IER=3
      WRITE(6,1) N,NA,NB
    1 FORMAT(1H0,'(SUBR. EIGOR) INVALID ARGUMENT. N,NA,NB =',I5,
     2         ',',I5,',',I5 )
 5000 RETURN
      END
```

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