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C      PROGRAM MESHLESS(PLASTICITY)
C
C      Remark : This is for Plane Stress
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CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NPMESH=1200)
PARAMETER (NEMESH=1100)
PARAMETER (NP2=2*NPMESH)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NNODE=1200)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NAX=3000)
PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
PARAMETER (N2=2*NNODE)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/KBC/SCALE2(NF),ICF(NF)
COMMON/LBC/SCALE3(NIC),ICI(NIC)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
COMMON/QBC/PHI2(NAX2,NPMESH,2),LMN2(NAX2,NPMESH),NN2(NPMESH)
COMMON/SBC/XBARRIER(2),YBARRIER(2)
COMMON/TBC/P(3,3),Q(3,3),AA,BB,CC,DD,R2
COMMON/UBC/MUPRINT,MSPRINT,IUPRINT(4),ISPRINT(3)
COMMON/VBC/XCRACK,YCRACK
COMMON/WBC/SIDEAS(4,NEMESH)
COMMON/XBC/TU(NAX),PE
COMMON/YBC/RATIO(20),ICRACK(20)
COMMON/ZBC/AS0,CS0,ASI(20),CSI(20),COEFF(20),NDATA,MTERM
C*****
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OPEN(5,FILE='infile',STATUS='UNKNOWN',FORM='FORMATTED')
OPEN(6,FILE='outfile',STATUS='UNKNOWN',FORM='FORMATTED')
OPEN(8,FILE='ideas.unv',STATUS='UNKNOWN',FORM='FORMATTED')
C*****
C*****
C*****
1   FORMAT(10X/10X,'SOMETHING IS WRONG IN SUBROUTINE INPUT.'/)
2   FORMAT(10X/10X,'SOMETHING IS WRONG IN SUBROUTINE START.'/)
3   FORMAT(10X/10X,'SOMETHING IS WRONG IN SUBROUTINE FORM.'/)
4   FORMAT(10X/10X,'SOMETHING IS WRONG IN SUBROUTINE LOAD.'/)
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5      FORMAT ( 10X/10X,'SOMETHING IS WRONG IN SUBROUTINE SOLVE.'/ )
6      FORMAT ( 10X/10X,'SOMETHING IS WRONG IN SUBROUTINE CHECK.'/ )
7      FORMAT ( 10X/10X,'SOMETHING IS WRONG IN SUBROUTINE UPDATE.'/ )
8      FORMAT ( 10X/10X,'SOMETHING IS WRONG IN SUBROUTINE RESIDUAL.'/ )
9      FORMAT ( 10X/10X,'SOMETHING IS WRONG IN SUBROUTINE PRINT.'/ )
C*****
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C*****
100    CONTINUE
      CALL INPUT
      CALL INITIAL
      CALL GROWTH
      IF(IER.EQ.0) GO TO 200
      WRITE(6,1)
      GO TO 3000
2000   CONTINUE
200    CONTINUE
      CALL START
      IF(IER.EQ.0) GO TO 300
      WRITE(6,2)
      GO TO 3000
300    CONTINUE
      CALL FORM
      IF(IER.EQ.0) GO TO 400
      WRITE(6,3)
      GO TO 3000
400    CONTINUE
      CALL LOAD
      IF(IER.EQ.0) GO TO 1000
      WRITE(6,4)
      GO TO 3000
1000   CONTINUE
      CALL SOLVE
      IF(IER.EQ.0) GO TO 500
      GO TO 3000
500    CONTINUE
      CALL CHECK
      IF(IER.EQ.0) GO TO 600
      WRITE(6,6)
      GO TO 3000
600    CONTINUE
      CALL UPDATE
      IF(IER.EQ.0) GO TO 700
      WRITE(6,7)
      GO TO 3000
700    CONTINUE
      CALL RESIDUAL
      IF(IER.EQ.0) GO TO 800
      WRITE(6,8)
      GO TO 3000
800    CONTINUE
      CALL PRINT
      IF(IER.EQ.0) GO TO 900
      WRITE(6,9)
      GO TO 3000
900    CONTINUE
      GO TO (1000,2000,3000),INDEX

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3000  CONTINUE
      CLOSE(5)
      CLOSE(6)
      CLOSE(8)
      STOP
      END

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      SUBROUTINE INPUT
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/DBC/IJK(4,NEMESH)
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
      COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
      COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
      COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
      COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
1      FORMAT(10X,'Something is wrong in CONTROL!'/)
2      FORMAT(10X,'Something is wrong in NODE!'/)
3      FORMAT(10X,'Something is wrong in BMESH!'/)
4      FORMAT(10X,'Something is wrong in MATERIAL!'/)
5      FORMAT(10X,'Something is wrong in BCIC!'/)
6      FORMAT(10X,'Something is wrong in GROWTH!'/)
7      FORMAT(10X,'Something is wrong in BARRI!'/)
8      FORMAT(10X,'Something is wrong in INPLOT!'/)
100    CONTINUE
      CALL CONTROL
      IF(IER.EQ.0) GO TO 200
      WRITE(6,1)
      GO TO 9999
200    CONTINUE
      CALL NODE
      IF(IER.EQ.0) GO TO 300
      WRITE(6,2)
      GO TO 9999
300    CONTINUE
      CALL BMESH
      IF(IER.EQ.0) GO TO 400
      WRITE(6,3)
      GO TO 9999
400    CONTINUE
      CALL MATERIAL
      IF(IER.EQ.0) GO TO 500
      WRITE(6,4)
      GO TO 9999
500    CONTINUE
      CALL BCIC

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        IF( IER.EQ.0 ) GO TO 1000
        WRITE( 6,5 )
1000    CONTINUE
9999    CONTINUE
        RETURN
        END
C=====
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C=====
        SUBROUTINE CONTROL
        IMPLICIT REAL*8 (A-H,O-Z)
        PARAMETER (NPMESH=1200)
        PARAMETER (NEMESH=1100)
        PARAMETER (NSAMP=4*NEMESH)
        PARAMETER (NNODE=1200)
        PARAMETER (NAX1=250)
        PARAMETER (NAX2=NAX1)
        COMMON/ABC/ID(10), IER, INDEX, ISTEP
        COMMON/BBC/XMESH(NPMESH), YMESH(NPMESH), XSAMP(NSAMP), YSAMP(NSAMP)
        COMMON/CBC/MPMESH, MEMESH, MNODE, MSAMP, MAX1, MAX2, MU, MF, MIC
        COMMON/DBC/IJK(4, NEMESH)
        IER=0
        ISTEP=1
        INDEX=1
        READ(5,5) (ID(I), I=1,7)
C*****C
C
C
C      ID(1) = 0 : Static case
C
C      ID(2) = 0 : local theory
C
C      ID(3) = 2 : 2nd order polynomial
C              3 : 3rd order polynomial
C
C      ID(4) =      plane stress
C
C
C
C      ID(5) = 0 : no barrier
C              1 : there is a barrier
C
C
C      ID(6) = number of load steps
C
C
C      ID(7) = 0 : no mirror symmetry
C              1 : mirror symmetry with respect to x-axis
C              2 : mirror symmetry with respect to x-axis and y-axis
C
C
C*****C
5      FORMAT(16I5)
7      FORMAT(2X, 'Before node-adding:      MP, ME, MN, MS = ', 4I5/)
        WRITE(6,5) (ID(I), I=1,7)
        READ(5,5) MPMESH, MEMESH, MNODE, MSAMP
        WRITE(6,7) MPMESH, MEMESH, MNODE, MSAMP
        RETURN
        END
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C=====
C=====
      SUBROUTINE NODE
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      IER=0
1      FORMAT(9X,I8,7X,3G8.5)
7      FORMAT(I5,3(5X,E15.8))
      DO 100 K=1,MNODE
      READ(5,7) J, XT,YT,RT
      XNODE(K)=XT
      YNODE(K)=YT
C      RNODE(K)=RT
      RNODE(K)=RT*1.2
      XMESH(K)=XNODE(K)
      YMESH(K)=YNODE(K)
      WRITE(6,7) K,XNODE(K),YNODE(K),RNODE(K)
100     CONTINUE
      RETURN
      END
C=====
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C=====
      SUBROUTINE MATERIAL
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
      COMMON/TBC/P(3,3),Q(3,3),AA,BB,CC,DD,R2
1      FORMAT(3(5X,E15.8)/)
4      FORMAT(/5X/)
5      FORMAT(E15.8)
2      FORMAT(5X/5X,'Young Modulus'='',E15.8/)
3      FORMAT(5X/5X,'Poisson Ratio'='',E15.8/)
6      FORMAT(5X/5X,'Von Mises Yield Strength'='',E15.8/)
7      FORMAT(5X/5X,'Plastic Modulus'='',E15.8/)
8      FORMAT(5X/5X,'Isotropic/Kinematic Hardening'='',E15.8/)
      IER=0
      WRITE(6,4)
      READ(5,5) YOUNG
      READ(5,5) POISSON
      READ(5,5) VON
      READ(5,5) PSLOPE

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        WRITE(6,2) YOUNG
        WRITE(6,3) POISSON
        WRITE(6,6) VON
        WRITE(6,7) PSLOPE
        ELAME1=YOUNG*POISSON/(1.0+POISSON)/(1.0-2.0*POISSON)
        ELAME2=0.5*YOUNG/(1.0+POISSON)
C=====
C
C      plane strain
C
C=====
        T=YOUNG/(1.0-POISSON**2)
        DK(1,1)=T
        DK(1,2)=POISSON*T
        DK(3,3)=0.5D0*(1.0D0-POISSON)*T
        DK(2,1)=DK(1,2)
        DK(2,2)=DK(1,1)
        DK(1,3)=0.0D0
        DK(2,3)=0.0D0
        DK(3,1)=0.0D0
        DK(3,2)=0.0D0
        T=1.0D0/DSQRT(2.0D0)
        Q(1,1)=T
        Q(2,2)=T
        Q(1,2)=-T
        Q(2,1)=T
        Q(3,3)=1.0D0
        Q(1,3)=0
        Q(3,1)=0
        Q(2,3)=0
        Q(3,2)=0
        P(1,1)=2.0/3.0
        P(2,2)=2.0/3.0
        P(1,2)=-1.0/3.0
        P(2,1)=-1.0/3.0
        P(3,3)=2.0D0
        P(1,3)=0
        P(3,1)=0
        P(2,3)=0
        P(3,2)=0
        R2=P(1,1)*VON*VON
        CC=1.0D0/3.0D0/(1.0D0-POISSON)+2.0D0/3.0D0*PSLOPE/YOUNG
        DD=1.0D0/(1.0D0+POISSON)+2.0D0/3.0D0*PSLOPE/YOUNG
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
C
C      T(K) =  DK(KL) *  E(L)
C
C
CCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCCC
        WRITE(6,4)
        WRITE(6,1) ((DK(III,JJJ),JJJ=1,3),III=1,3)
        WRITE(6,4)
        RETURN
        END
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        SUBROUTINE BCIC

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IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NPMESH=1200)
PARAMETER (NEMESH=1100)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NNODE=1200)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NAX=3000)
PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
PARAMETER (N2=2*NNODE)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/KBC/SCALE2(NF),ICF(NF)
COMMON/LBC/SCALE3(NIC),ICI(NIC)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
3  FORMAT(5X,'-----')
4  FORMAT(20X,I3)
5  FORMAT(16I5)
6  FORMAT(/10X,'No. of disp. specified boundary conditions =',I5/)
7  FORMAT(/10X,'No. of load specified boundary conditions =',I5/)
8  FORMAT(/10X,'Number of non-zero initial conditions =',I5/)
9  FORMAT(5X,I5,5X,F15.8)
10 FORMAT(I5,3(5X,F15.8))
11 FORMAT(1X,I3,' IC=',I5,' at x, y =',2E15.8,' factor =',E15.8)
12 FORMAT(5X/20X,'The essential boudary conditions are:')
IER=0
READ(5,5) MU,MF,MIC
WRITE(6,6) MU
IF(MU.EQ.0.OR.MU.GT.NU) IER=1
IF(MU.EQ.0.OR.MU.GT.NU) GO TO 150
WRITE(6,12)
DO 91 I=1,MU
READ(5,10) ICU(I),XB(I),YB(I),SCALE1(I)
91  WRITE(6,11) I,ICU(I),XB(I),YB(I),SCALE1(I)
150 CONTINUE
WRITE(6,7) MF
IF(MF.GT.NF) IER=1
IF(MF.EQ.0) GO TO 250
DO 200 I=1,MF
READ(5,10) ICF(I),SCALE2(I)
200 WRITE(6,9) ICF(I),SCALE2(I)
250 CONTINUE
WRITE(6,8) MIC
IF(MIC.GT.NIC) IER=1
IF(MIC.EQ.0) GO TO 500
DO 300 I=1,MIC

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      READ(5,10) ICI(I),SCALE3(I)
300  WRITE(6,9) ICI(I),SCALE3(I)
500  CONTINUE
      RETURN
      END

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      SUBROUTINE GROWTH
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      PARAMETER (NAX=3000)
      PARAMETER (NU=100)
      PARAMETER (NF=50)
      PARAMETER (NIC=10)
      PARAMETER (N2=2*NNODE)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/DBC/IJK(4,NEMESH)
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
      COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
      COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
      COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
      COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
      COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
      COMMON/KBC/SCALE2(NF),ICF(NF)
      COMMON/LBC/SCALE3(NIC),ICI(NIC)
      COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
      COMMON/YBC/RATIO(20),ICRACK(20)
      COMMON/ZBC/AS0,CS0,ASI(20),CSI(20),COEFF(20),NDATA,MTERM
      DIMENSION A(20,20),B(20),C(20)
1    FORMAT(16I5)
2    FORMAT(2F15.8)
3    FORMAT(5X,'AS(',I2,') =',F15.8,' CS(',I2,') =',F15.8/)
4    FORMAT(10X,'MTERM = ',I2,' Error =',F15.8/)
5    FORMAT(5X,I3,' data points are in stress-crack size curve:')
6    FORMAT(5X,'I=',I5,' CS-data =',F15.8,' CS =',F15.8/)
7    FORMAT(6F12.5)
      READ(5,1) NDATA,MTERM
      WRITE(6,5) NDATA
      READ(5,2) AS0,CS0
      WRITE(6,3) 0,AS0,0,CS0
      DO 100 I=1,NDATA
      READ(5,2) ASI(I),CSI(I)
      ASI(I)=ASI(I)-AS0
      CSI(I)=CSI(I)-CS0
      WRITE(6,3) I,ASI(I),I,CSI(I)
100  CONTINUE
      DO 200 I=1,MTERM
      B(I)=0.0

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DO 200 J=1,MTERM
200  A(I,J)=0.0
      DO 500 I=1,NDATA
      DO 300 K=1,MTERM
      B(K)=B(K)+ASI(I)*CSI(I)**K
      DO 300 L=1,MTERM
      KL=K+L
      A(K,L)=A(K,L)+CSI(I)**KL
300  CONTINUE
500  CONTINUE
      CALL GAUSS(MTERM,A,B,COEFF,20,IER)
      ERROR=0.0
      DO 400 I=1,NDATA
      C(I)=0.0
      DO 450 J=1,MTERM
450  C(I)=C(I)+COEFF(J)*CSI(I)**J
      WRITE(6,6) I,CSI(I),C(I)
      ERROR=ERROR+(ASI(I)-C(I))**2
400  CONTINUE
      WRITE(6,4) MTERM,ERROR
      RETURN
      END
C=====
C=====
C=====
      SUBROUTINE TBARR
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NU=100)
      PARAMETER (NF=50)
      PARAMETER (NIC=10)
      PARAMETER (NNODE=1200)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
      COMMON/KBC/SCALE2(NF),ICF(NF)
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      COMMON/LBC/SCALE3(NIC),ICI(NIC)
      COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
      COMMON/SBC/XBARRIER(2),YBARRIER(2)
      COMMON/VBC/XCRACK,YCRACK
1  FORMAT(2X/10X,'XBARRIER =',F15.8/)
      WRITE(6,1) XBARRIER(2)
      DO 100 I=1,MNODE
      IF(XNODE(I).GE.XBARRIER(2)) GO TO 100
      IF(YNODE(I).LT.0.1D-7) YNODE(I)=0.1D-7
100 CONTINUE
      RETURN
      END
C=====
C=====
C=====
      SUBROUTINE INITIAL
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)

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PARAMETER (NAX=3000)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (N2=2*NNODE)
PARAMETER (NP2=2*NPMESH)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
COMMON/SBC/XBARRIER(2),YBARRIER(2)
COMMON/XBC/TU(NAX),PE
MAX=2*MNODE+MU
DO 100 I=1,MAX
  F(I)=0
  DISP(I)=0
  TU(I)=0
100  CONTINUE
  DO 200 I=1,MSAMP
    DO 200 J=1,3
      PSTRAIN(J,I)=0
      STRAIN(J,I)=0
      STRESS(J,I)=0
      BETA(J,I)=0
200  CONTINUE
  ISTEP=1
  PE=0.0D0
  XBARRIER(1)=-1000.0
  YBARRIER(1)=0.0
  XBARRIER(2)=XB(MU)-0.0001
  YBARRIER(2)=0.0
  RETURN
END
C=====
C=====
C=====
SUBROUTINE START
IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NPMESH=1200)
PARAMETER (NEMESH=1100)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NNODE=1200)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)

```

```

COMMON/CBC/MPMESH, MEMESH, MNODE, MSAMP, MAX1, MAX2, MU, MF, MIC
COMMON/DBC/IJK(4, NEMESH)
COMMON/EBC/XNODE(NNODE), YNODE(NNODE), RNODE(NNODE)
COMMON/FBC/YOUNG, POISSON, VON, PSLOPE, RIK, ELAME1, ELAME2, DK(3, 3)
COMMON/GBC/LMN1(NAX1, NSAMP), NN1(NSAMP)
COMMON/HBC1/PHI(NAX1, NSAMP), PHIX(NAX1, NSAMP), PHIY(NAX1, NSAMP)
COMMON/HBC2/QHI(NAX1, NSAMP), QHIX(NAX1, NSAMP), QHIY(NAX1, NSAMP)
COMMON/IBC/AREA(NSAMP), H(NSAMP), HMAX, FACTOR(NAX2, NSAMP)
COMMON/QBC/PHI2(NAX2, NPMESH, 2), LMN2(NAX2, NPMESH), NN2(NPMESH)
COMMON/SBC/XBARRIER(2), YBARRIER(2)
DIMENSION NNN(NAX1)
DIMENSION S(NAX1), SX(NAX1), SY(NAX1)
DIMENSION T(NAX1), TX(NAX1), TY(NAX1)
12  FORMAT(2I5, ' X, Y, H, Area=', 4F13.8)
14  FORMAT(5X, 'J=', I5, 4(1X, F15.8))
15  FORMAT(10X, 'ISAMP =', I5, '    area =', F15.8/)
16  FORMAT(16I5)
18  FORMAT(5(1X, F15.8))
17  FORMAT(10X, '-----')
    CALL TBARR
    MAX1=0
    DO 200 IS=1, MSAMP
      XS=XSAMP(IS)
      YS=YSAMP(IS)
      CALL SHAPE3(XS, YS, NUMBER, NNN, S, SX, SY, T, TX, TY)
      IF(IER.NE.0) GO TO 3000
      IF(NUMBER.GT.MAX1) MAX1=NUMBER
      NN1(IS)=NUMBER
      DO 200 I=1, NUMBER
        LMN1(I, IS)=NNN(I)
        PHI(I, IS)=S(I)
        PHIX(I, IS)=SX(I)
        PHIY(I, IS)=SY(I)
        QHI(I, IS)=T(I)
        QHIX(I, IS)=TX(I)
        QHIY(I, IS)=TY(I)
200  CONTINUE
3000 CONTINUE
    WRITE(6, 125) IS, IER
125  FORMAT(5X, 'after START, IS, IER=', 2I5/)
      IF(MAX1.GT.NAX1) IER=1
      IF(MAX1.GT.NAX1) WRITE(6, 126) MAX1, IER
126  FORMAT(5X, 'wrong: MAX1 =', I5, '    ier=', I5/)
      MAX2=0
      DO 201 IS=1, MPMESH
        XS=XMESH(IS)
        YS=YMESH(IS)
        CALL SHAPE3(XS, YS, NUMBER, NNN, S, SX, SY, T, TX, TY)
        IF(IER.NE.0) GO TO 3001
        IF(NUMBER.GT.MAX2) MAX2=NUMBER
        NN2(IS)=NUMBER
        DO 201 I=1, NUMBER
          LMN2(I, IS)=NNN(I)
          PHI2(I, IS, 1)=S(I)
          PHI2(I, IS, 2)=T(I)
C    PHIX(I, IS)=SX(I)
C    PHIY(I, IS)=SY(I)

```

```

201  CONTINUE
3001  CONTINUE
      WRITE(6,125) IS,IER
      IF(MAX2.GT.NAX2) IER=1
      IF(MAX2.GT.NAX2) WRITE(6,127) MAX1,IER
127  FORMAT(5X,'wrong: MAX2 =',I5,'   ier=',I5/)
      RETURN
      END
C=====
C=====
C=====
      SUBROUTINE SHAPE3(X,Y,NUMBER,NNN,S,SX,SY,T,TX,TY)
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      PARAMETER (LAX=2*NAX1)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      COMMON/SBC/XBARRIER(2),YBARRIER(2)
      COMMON/VBC/XCRACK,YCRACK
      DIMENSION P(10),A(10,10),AINV(10,10)
      DIMENSION AX(10,10),AY(10,10),PX(10),PY(10)
      DIMENSION B(10,NAX1),BX(10,NAX1),BY(10,NAX1)
      DIMENSION W(NAX1),WX(NAX1),WY(NAX1)
      DIMENSION NNN(*)
      DIMENSION MMM(LAX),LLL(LAX)
      DIMENSION S(*),SX(*),SY(*)
      DIMENSION T(*),TX(*),TY(*)
      DIMENSION SS(LAX),SSX(LAX),SSY(LAX)
      DIMENSION TEST(10,10)
1  FORMAT(10X,'NUMBER =',I5,5X,'NAX1 =',I5,'   Wrong!'//)
      NPOLY=6
      IF(ID(3).EQ.3) NPOLY=10
      NUMBER=0
      DO 12 I=1,LAX
12  LLL(I)=0
      DO 250 J=1,MNODE
      XJ=XNODE(J)
      YJ=YNODE(J)
      R=RNODE(J)
      DIST=DSQRT((X-XJ)**2+(Y-YJ)**2)
      IF(DIST.GE.R) GO TO 250
      NUMBER=NUMBER+1
      MMM(NUMBER)=J
      LLL(NUMBER)=0
      IF(ID(7).EQ.0) GO TO 250
      IF(DABS(YNODE(J)).LT.0.1D-6) GO TO 260
      YJ=-YNODE(J)
      DIST=DSQRT((X-XJ)**2+(Y-YJ)**2)
      IF(DIST.GE.R) GO TO 260
      CALL BARRIER(XJ,YJ,X,Y,IPASS)
      IF(IPASS.EQ.0) GO TO 260

```

```

NUMBER=NUMBER+1
MMM(NUMBER)=J
LLL(NUMBER)=1
260  CONTINUE
      IF(ID(7).NE.2) GO TO 250
      IF(DABS(XNODE(J)).LT.0.1D-6) GO TO 250
      XJ=-XNODE(J)
      YJ=YNODE(J)
      DIST=DSQRT((X-XJ)**2+(Y-YJ)**2)
      IF(DIST.GE.R) GO TO 250
      NUMBER=NUMBER+1
      MMM(NUMBER)=J
      LLL(NUMBER)=2
250  CONTINUE
1234  FORMAT(5X,'I am in SHAPE3, I=',I5)
      IF(NUMBER.GT.NAX1) WRITE(6,1) NUMBER,NAX1
      IF(NUMBER.GT.NAX1) IER=1
      IF(NUMBER.GT.NAX1) GO TO 9999
C=====
      DO 10 I=1,NPOLY
      DO 10 J=1,NPOLY
      AX(I,J)=0.0D0
      AY(I,J)=0.0D0
10    A(I,J)=0.0D0
C=====
      DO 100 I=1,NUMBER
      IN=MMM(I)
      XI=XNODE(IN)
      YI=YNODE(IN)
      RI=RNODE(IN)
      IF(LLL(I).EQ.1) YI=-YNODE(IN)
      IF(LLL(I).EQ.2) XI=-XNODE(IN)
      D=DSQRT((X-XI)**2+(Y-YI)**2)/RI
      W(I)=1.0-6.0*D*D+8.0*D*D*D-3.0*D*D*D*D
      WS=-12.0*D+24.0*D*D-12.0*D*D*D
      ANG=DATAN2(Y-YI,X-XI)
      CO=DCOS(ANG)
      SI=DSIN(ANG)
      WX(I)=WS*CO/RI
      WY(I)=WS*SI/RI
      P(1)=1.0D0
      P(2)=XI
      P(3)=YI
      P(4)=XI*XI
      P(5)=YI*YI
      P(6)=XI*YI
      P(7)=XI*XI*XI
      P(8)=YI*YI*YI
      P(9)=XI*XI*YI
      P(10)=XI*YI*YI
      DO 100 II=1,NPOLY
      B(II,I)=W(I)*P(II)
      BX(II,I)=WX(I)*P(II)
      BY(II,I)=WY(I)*P(II)
      DO 100 JJ=1,NPOLY
      A(II,JJ)=A(II,JJ)+P(II)*P(JJ)*W(I)
      AX(II,JJ)=AX(II,JJ)+P(II)*P(JJ)*WX(I)

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```

        AY(II,JJ)=AY(II,JJ)+P(II)*P(JJ)*WY(I)
100    CONTINUE
C=====
C=====
C=====
        DO 111 I=1,10
        DO 111 J=1,10
111    AINV(I,J)=A(I,J)
C=====
C=====
C=====
C    CALL INVERSION(NPOLY,A,10,AINV,10)
C    CALL SIMPIN(NPOLY,AINV,10,IER)
C    CALL DLINRG(NPOLY,A,10,AINV,10)
C=====
C=====
C=====
        CALL SIMPIN(NPOLY,AINV,10,IER)
        IF(IER.EQ.0) GO TO 115
        WRITE(6,22) NPOLY,X,Y
        DO 112 I=1,NPOLY
        DO 112 J=1,NPOLY
        TEST(I,J)=0.0D0
        IF(I.EQ.J) TEST(I,I)=-1.0D0
        DO 113 K=1,NPOLY
113    TEST(I,J)=TEST(I,J)+A(I,K)*AINV(K,J)
        WRITE(6,11) I,J,A(I,J),AINV(I,J),TEST(I,J)
112    CONTINUE
11    FORMAT(2I5,' A, A*, test =',3(1X,E15.8))
22    FORMAT(5X,'NPOLY, X, Y =',I5,2(5X,F15.8))
115    CONTINUE
        IF(IER.NE.0) WRITE(6,123) NUMBER
        IF(IER.NE.0) GO TO 9999
123    FORMAT(10X,'SHAPE3: wrong in SIMPIN, number =',I5)
C-----
        P(1)=1.0D0
        P(2)=X
        P(3)=Y
        P(4)=X*X
        P(5)=Y*Y
        P(6)=X*Y
        P(7)=X*X*X
        P(8)=Y*Y*Y
        P(9)=X*X*Y
        P(10)=X*Y*Y
        PX(1)=0
        PX(2)=1
        PX(3)=0
        PX(4)=2*X
        PX(5)=0
        PX(6)=Y
        PX(7)=3*X*X
        PX(8)=0
        PX(9)=2*X*Y
        PX(10)=Y*Y
        PY(1)=0
        PY(2)=0

```

```

    PY(3)=1
    PY(4)=0
    PY(5)=2*Y
    PY(6)=X
    PY(7)=0
    PY(8)=3*Y*Y
    PY(9)=X*X
    PY(10)=2*X*Y
    DO 300 I=1,NUMBER
    SS(I)=0.0D0
    SSX(I)=0.0D0
    SSY(I)=0.0D0
    DO 300 II=1,NPOLY
    DO 300 JJ=1,NPOLY
    SS(I)=SS(I)+P(II)*AINV(II,JJ)*B(JJ,I)
    SSX(I)=SSX(I)+PX(II)*AINV(II,JJ)*B(JJ,I)+
*      P(II)*AINV(II,JJ)*BX(JJ,I)
    SSY(I)=SSY(I)+PY(II)*AINV(II,JJ)*B(JJ,I)+
*      P(II)*AINV(II,JJ)*BY(JJ,I)
    DO 300 MM=1,NPOLY
    DO 300 NN=1,NPOLY
    SSX(I)=SSX(I)-P(II)*AINV(II,JJ)*
*      AX(JJ,MM)*AINV(MM,NN)*B(NN,I)
    SSY(I)=SSY(I)-P(II)*AINV(II,JJ)*
*      AY(JJ,MM)*AINV(MM,NN)*B(NN,I)
300  CONTINUE
    NUM=0
    DO 400 I=1,NUMBER
    J=MMM(I)
    K=LLL(I)
    IF(K.EQ.1) GO TO 401
    IF(K.EQ.2) GO TO 402
    NUM=NUM+1
    NNN(NUM)=J
    S(NUM)=SS(I)
    SX(NUM)=SSX(I)
    SY(NUM)=SSY(I)
    T(NUM)=SS(I)
    TX(NUM)=SSX(I)
    TY(NUM)=SSY(I)
    GO TO 400
401  CONTINUE
    S(NUM)=S(NUM)+SS(I)
    SX(NUM)=SX(NUM)+SSX(I)
    SY(NUM)=SY(NUM)+SSY(I)
    T(NUM)=T(NUM)-SS(I)
    TX(NUM)=TX(NUM)-SSX(I)
    TY(NUM)=TY(NUM)-SSY(I)
    GO TO 400
402  CONTINUE
    S(NUM)=S(NUM)-SS(I)
    SX(NUM)=SX(NUM)-SSX(I)
    SY(NUM)=SY(NUM)-SSY(I)
    T(NUM)=T(NUM)+SS(I)
    TX(NUM)=TX(NUM)+SSX(I)
    TY(NUM)=TY(NUM)+SSY(I)
400  CONTINUE

```

```

      NUMBER=NUM
C=====
9999  CONTINUE
      RETURN
      END
C=====
C=====
C=====
      SUBROUTINE FORM
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX=3000)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      PARAMETER (NU=100)
      PARAMETER (NF=50)
      PARAMETER (N2=2*NNODE)
      PARAMETER (NP2=2*NPMESH)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/DBC/IJK(4,NEMESH)
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
      COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
      COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
      COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
      COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
      COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
      COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
      COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
      COMMON/XBC/TU(NAX),PE
2      FORMAT(10X,'Something is wrong in STIFF!'/)
3      FORMAT(10X,'Something is wrong in COUPLING!'/)
      CALL STIFF
      CALL SYM
      WRITE(6,11)
      IF(IER.EQ.0) GO TO 300
11     FORMAT(10X,'passing STIFF'/)
      WRITE(6,2)
      GO TO 1000
300    CONTINUE
      CALL COUPLING
      WRITE(6,12)
12     FORMAT(10X,'passing COUPLING'/)
      IF(IER.EQ.0) GO TO 1000
      WRITE(6,3)
1000   CONTINUE
      RETURN
      END
C=====
C=====
C=====
      SUBROUTINE STIFF

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```

IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NPMESH=1200)
PARAMETER (NEMESH=1100)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NNODE=1200)
PARAMETER (NAX=3000)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NTWO=2*NAX1)
PARAMETER (N2=2*NNODE)
PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
DIMENSION B(3,NTWO),LL(NTWO)
M2=2*MNODE
MAX=M2+MU
DO 100 I=1,MAX
DO 100 J=1,MAX
100 AK(I,J)=0.0D0
DO 200 IS=1,MSAMP
MM2=2*NN1(IS)
DO 250 J=1,NN1(IS)
JJ=LMN1(J,IS)
J1=2*J-1
J2=J1+1
LL(J1)=2*JJ-1
LL(J2)=2*JJ
B(1,J1)=PHIX(J,IS)
B(1,J2)=0
B(2,J2)=QHIY(J,IS)
B(2,J1)=0
B(3,J1)=PHIY(J,IS)
B(3,J2)=QHIX(J,IS)
250 CONTINUE
DO 230 IA=1,MM2
IALPHA=LL(IA)
DO 230 JB=1,MM2
JBETA=LL(JB)
TAK=0
DO 220 I=1,3
DO 220 J=1,3
TAK=DK(I,J)*B(I,IA)*B(J,JB)*AREA(IS)
AK(IALPHA,JBETA)=AK(IALPHA,JBETA)+TAK
220 CONTINUE
230 CONTINUE
200 CONTINUE
RETURN
END
C=====

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```

C=====
C=====
      SUBROUTINE COUPLING
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX=3000)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      PARAMETER (NTWO=2*NAX1)
      PARAMETER (N2=2*NNODE)
      PARAMETER (NU=100)
      PARAMETER (NF=50)
      PARAMETER (NIC=10)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
C      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
C      COMMON/DBC/IJK(4,NEMESH)
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
C      COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
C      COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
      COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
      COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
      COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
      COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
      COMMON/QBC/PHI2(NAX2,NPMESH,2),LMN2(NAX2,NPMESH),NN2(NPMESH)
      DIMENSION S(NAX1),SX(NAX1),SY(NAX1)
      DIMENSION T(NAX1),TX(NAX1),TY(NAX1)
      DIMENSION NNN(NAX1)
1      FORMAT(2X/2X,2I5,'  x, y =',2F15.8,' number,ier=',2I5/)
2      FORMAT(10X,2I5,'  XN, YN, S =',3F15.8/)
3      FORMAT(10X,2I5,'  XN, YN, T =',3F15.8/)
      M2=2*MNODE
      DO 50 I=1,MU
      DO 50 J=1,M2
50      AG(I,J)=0.0D0
      DO 1000 III=1,MU
      IC=ICU(III)
      X=XB(III)
      Y=YB(III)
      CALL SHAPE3(X,Y,NUMBER,NNN,S,SX,SY,T,TX,TY)
C      IF(IER.NE.0) WRITE(6,1) III,IC,X,Y,NUMBER,IER
      WRITE(6,1) III,IC,X,Y,NUMBER,IER
      DO 2000 I=1,NUMBER
      IN=NNN(I)
      XN=XNODE(IN)
      YN=YNODE(IN)
      II=2*IN+IC-2
      IF(IC.EQ.1) AG(III,II)=S(I)
      IF(IC.EQ.2) AG(III,II)=T(I)
      IF(IC.EQ.1) WRITE(6,2) I,NNN(I),XN,YN,AG(III,II)
      IF(IC.EQ.2) WRITE(6,3) I,NNN(I),XN,YN,AG(III,II)
2000      CONTINUE
1000      CONTINUE
      DO 120 I=1,MU

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        II=I+M2
        DO 120 J=1,M2
        AK(II,J)=AG(I,J)
        AK(J,II)=AG(I,J)
120    CONTINUE
        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE SOLVE
        IMPLICIT REAL*8 (A-H,O-Z)
        PARAMETER (NPMESH=1200)
        PARAMETER (NEMESH=1100)
        PARAMETER (NSAMP=4*NEMESH)
        PARAMETER (NNODE=1200)
        PARAMETER (NAX1=250)
        PARAMETER (NAX2=NAX1)
        PARAMETER (NAX=3000)
        PARAMETER (NTWO=2*NAX1)
        PARAMETER (N2=2*NNODE)
        PARAMETER (NU=100)
        PARAMETER (NF=50)
        PARAMETER (NIC=10)
        COMMON/ABC/ID(10),IER,INDEX,ISTEP
        COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
        COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
        COMMON/DBC/IJK(4,NEMESH)
        COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
        COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
        COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
        COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
        COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
        COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
        COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
        COMMON/XBC/TU(NAX),PE
        COMMON/YBC/RATIO(20),ICRACK(20)
1      FORMAT(2X,I5,' X, Y=',2E12.5,' DUX, DUY =',2E12.5)
2      FORMAT(5X/5X,'The followings are incremental disp at nodes:')
3      FORMAT(5X/5X,'The subroution GAUSS does not do well.')
        M2=2*MNODE
        MAX=M2+MU
        CALL GAUSS(MAX,AK,F,U,NAX,IER)
        DO 100 I=1,MAX
100    TU(I)=TU(I)+U(I)
        IF(IER.NE.0) WRITE(6,3)
        IF(IER.NE.0) GO TO 1000
        C      WRITE(6,2)
        C      DO 200 I=1,MNODE
        C      X=XNODE(I)
        C      Y=YNODE(I)
        C      J=2*I-1
        C      K=J+1
        C      WRITE(6,1) I,XNODE(I),YNODE(I),U(J),U(K)
        C200 CONTINUE
1000   CONTINUE
        RETURN

```

```

      END
C=====
C=====
C=====
      SUBROUTINE SOLVE1
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      PARAMETER (NAX=3000)
      PARAMETER (NTWO=2*NAX1)
      PARAMETER (N2=2*NNODE)
      PARAMETER (NU=100)
      PARAMETER (NF=50)
      PARAMETER (NIC=10)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/DBC/IJK(4,NEMESH)
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
      COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
      COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
      COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
      COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
      COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
      M2=2*MNODE
      MAX=2*MNODE+MU
      DO 120 I=1,MU
      II=I+M2
      DO 120 J=1,M2
      AK(II,J)=AG(I,J)*1.0D+0
      AK(J,II)=AG(I,J)*1.0D+0
120  CONTINUE
12  FORMAT(10X,'The followings are disp. at nodes: '/')
      CALL GAUSS(MAX,AK,F,U,NAX,IER)
      IF(IER.NE.0) GO TO 9000
      WRITE(6,12)
      DO 123 I=1,MNODE
      X=XNODE(I)
      Y=YNODE(I)
      J=2*I-1
      K=J+1
      WRITE(6,16) I,XNODE(I),YNODE(I),U(J),U(K)
123  CONTINUE
16  FORMAT(2X,I5,' X, Y=',2E12.5,' UX, UY =',2E12.5)
9000 CONTINUE
      RETURN
      END
C=====
C=====
C=====
      SUBROUTINE LOAD
      IMPLICIT REAL*8 (A-H,O-Z)

```

```

PARAMETER (NPMESH=1200)
PARAMETER (NEMESH=1100)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NNODE=1200)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NAX=3000)
PARAMETER (NTWO=2*NAX1)
PARAMETER (N2=2*NNODE)
PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/KBC/SCALE2(NF),ICF(NF)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
COMMON/YBC/RATIO(20),ICRACK(20)
CALL APPLY
WRITE(6,1) ISTEP,RATIO(ISTEP)
1  FORMAT(5X,'From LOAD: ISTEP, RATIO =',I5,F15.8/)
M2=2*MNODE
MAX=M2+MU
DO 100 I=1,MAX
F(I)=0
IF(ISTEP.EQ.1) CF(I)=0
100 CONTINUE
IF(MF.EQ.0) GO TO 201
DO 200 I=1,MF
200 F(ICF(I))=RATIO(ISTEP)*SCALE2(I)
201 CONTINUE
DO 300 I=1,MU
300 F(I+M2)=RATIO(ISTEP)*SCALE1(I)
DO 400 I=1,MAX
400 F(I)=F(I)-CF(I)
RETURN
END

C=====
C=====
C=====

SUBROUTINE APPLY
C*****
C*****
C    This is a user-supplied subroutine:
C    For a given crack size, it computes the applied
C    stress.
C*****
C*****
IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NU=100)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/YBC/RATIO(20),ICRACK(20)
COMMON/ZBC/AS0,CS0,ASI(20),CSI(20),COEFF(20),NDATA,MTERM
CS=XB(MU)

```

```

CT=CS-CS0
AS=0.0
DO 450 J=1,MTERM
450 AS=AS+COEFF(J)*CT**J
RATIO(ISTEP)=AS+AS0
RETURN
END

C=====
C=====
C=====

SUBROUTINE RESIDUAL
IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NPMESH=1200)
PARAMETER (NEMESH=1100)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NNODE=1200)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NAX=3000)
PARAMETER (NTWO=2*NAX1)
PARAMETER (N2=2*NNODE)
PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
PARAMETER (NP2=2*NPMESH)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/KBC/SCALE2(NF),ICF(NF)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
COMMON/SBC/XBARRIER(2),YBARRIER(2)
COMMON/XBC/TU(NAX),PE
COMMON/YBC/RATIO(20),ICRACK(20)
DIMENSION S(3),B(3,2),TF(2)
DIMENSION TFORCE(N2)
M2=2*MNODE
MAX=M2+MU
DO 100 I=1,M2
TFORCE(I)=0
100 CF(I)=0
DO 300 IS=1,MSAMP
S(1)=STRESS(1,IS)
S(2)=STRESS(2,IS)
S(3)=STRESS(3,IS)
DV=AREA(IS)
DO 350 K=1,NN1(IS)

```

```

      JP=LMN1(K,IS)
      B(1,1)=0
      B(2,1)=0
      B(3,1)=0
      B(1,2)=0
      B(2,2)=0
      B(3,2)=0
      TF(1)=0
      TF(2)=0
      JX=2*JP-1
      JY=JX+1
      B(1,1)=PHIX(K,IS)
      B(2,2)=QHIY(K,IS)
      B(3,1)=PHIY(K,IS)
      B(3,2)=QHIX(K,IS)
      DO 355 IALPHA=1,2
      DO 355 J=1,3
355   TF(IALPHA)=TF(IALPHA)+S(J)*B(J,IALPHA)*DV
      CF(JX)=CF(JX)+TF(1)
      CF(JY)=CF(JY)+TF(2)
350   CONTINUE
300   CONTINUE
      DO 620 I=1,M2
      DO 610 J=M2+1,MAX
      CF(I)=CF(I)+AK(I,J)*TU(J)
610   CONTINUE
620   CONTINUE
C=====
C=====
C=====
      IF(MF.EQ.0) GO TO 450
      DO 400 I=1,MF
      II=ICF(I)
      TFORCE(II)=RATIO(ISTEP)*SCALE2(I)
400   CONTINUE
450   CONTINUE
      CS=XB(MU)
      AS=RATIO(ISTEP)
      ERROR=0.0D0
      FT=0.
      DO 500 I=1,M2
      F(I)=TFORCE(I)-CF(I)
      FT=FT+TFORCE(I)**2
      ERROR=ERROR+F(I)**2
500   CONTINUE
      FT=DSQRT(FT/M2)
      ERROR=DSQRT(ERROR/M2)
      INDEX=1
      TEST=ERROR/FT*100.0
C   IF(TEST.LT.0.01) GO TO 600
      IF(TEST.LT.0.1) GO TO 600
      GO TO 700
600   CONTINUE
      INDEX=2
      ISTEP=ISTEP+1
      MU=MU-1
      XBARRIER(2)=XB(MU)-0.0001

```

```

        IF(ISTEP.GT.ID(6)) INDEX=3
700    CONTINUE
        WRITE(6,1) INDEX,TEST,CS,AS,PE
1      FORMAT(5X/5X,'from RESIDUAL: INDEX =',I5/
        *10X,' Percentage Error=',E15.8/
        *10X,' Crack Size      =',E15.8/
        *10X,' Applied Stress  =',E15.8/
        *10X,' Plastic Energy  =',E15.8/)
        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE PRINT
        IMPLICIT REAL*8 (A-H,O-Z)
        PARAMETER (NPMESH=1200)
        PARAMETER (NEMESH=1100)
        PARAMETER (NSAMP=4*NEMESH)
        PARAMETER (NNODE=1200)
        PARAMETER (NAX1=250)
        PARAMETER (NAX2=NAX1)
        PARAMETER (NAX=3000)
        PARAMETER (NTWO=2*NAX1)
        PARAMETER (N2=2*NNODE)
        PARAMETER (NP2=2*NPMESH)
        PARAMETER (NU=100)
        PARAMETER (NF=50)
        PARAMETER (NIC=10)
        COMMON/ABC/ID(10),IER,INDEX,ISTEP
        COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
        COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
        COMMON/DBC/IJK(4,NEMESH)
        COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
        COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
        COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
        COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
        COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
        COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
        COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
        COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
        COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
        COMMON/XBC/TU(NAX),PE
1      FORMAT(I4,2F9.4,4E12.4)
2      FORMAT(20X,'----- IS =',I5,' -----')
3      FORMAT(1X,'Stresses:      ',4E15.8)
4      FORMAT(1X,'Strains:      ',4E15.8)
5      FORMAT(1X,'Plastic Strains: ',4E15.8)
6      FORMAT(1X,'Beta:         ',4E15.8)
8      FORMAT(1X,'Alpha:        ',4E15.8)
7      FORMAT(1X,'-----in PRINT-----')
9      FORMAT(1X/2X,'IP',9X,'x',8X,'y',7X,'x-disp',6X,'y-disp',
        *6X,'x-force',5X,'y-force'/)
10     FORMAT(2X/5X,'The followings are x, y, Ux, Uy, Fx, Fy of nodes. '//)
        IF(INDEX.LT.2) GO TO 500
        WRITE(6,7)
        WRITE(6,9)
        DO 100 IP=1,MPMESH

```



```

        IX=2*IP-1
        IY=IX+1
        WRITE(6,1) IP,XNODE(IP),YNODE(IP),
*DISP(IX),DISP(IY),CF(IX),CF(IY)
100    CONTINUE
        DO 200 IS=1,MSAMP
        WRITE(6,2) IS
        WRITE(6,3) STRESS(1,IS),STRESS(2,IS),STRESS(3,IS)
        WRITE(6,4) STRAIN(1,IS),STRAIN(2,IS),STRAIN(3,IS)
        WRITE(6,5) PSTRAIN(1,IS),PSTRAIN(2,IS),PSTRAIN(3,IS)
        WRITE(6,6) BETA(1,IS),BETA(2,IS),BETA(3,IS)
200    CONTINUE
        CALL SFI
        CALL IDEAS2
500    CONTINUE
        RETURN
        END
C=====
C=====
        SUBROUTINE PINV(M,M2,T,NA)
        IMPLICIT REAL*8 (A-H,O-Z)
        COMMON/ABC/ID(10),IER,INDEX,ISTEP
        DIMENSION T(NA,NA)
        DIMENSION B(M,M2)
C        DIMENSION A(M,M)
C=====
C=====
        DO 10 I=1,M
        DO 10 J=1,M2
C        A(I,J)=T(I,J)
        B(I,J)=0
        IF(I.EQ.J) B(I,J)=1
10    CONTINUE
C=====
C=====
        DO 100 K=1,M-1
        KMAX=K
        TMAX=DABS(T(K,K))
        DO 110 KK=K+1,M
        IF(TMAX.GE.DABS(T(KK,K))) GO TO 110
        KMAX=KK
        TMAX=DABS(T(KK,K))
110    CONTINUE
        IF(KMAX.EQ.K) GO TO 111
        DO 120 KK=K,M
        RT=T(K,KK)
        T(K,KK)=T(KMAX,KK)
120    T(KMAX,KK)=RT
        DO 121 KK=1,M2
        RT=B(K,KK)
        B(K,KK)=B(KMAX,KK)
121    B(KMAX,KK)=RT
111    CONTINUE
        DO 100 I=K+1,M
        FACT = -T(I,K)/T(K,K)
        DO 102 J=1,M2
        B(I,J) = B(I,J)+FACT*B(K,J)

```

```

102  CONTINUE
      DO 101 J=K+1,M
      T(I,J) = T(I,J)+FACT*T(K,J)
101  CONTINUE
100  CONTINUE
C=====
C=====
C=====
      DO 300 J=1,M2
300  B(M,J) = B(M,J)/T(M,M)
C=====
C=====
C=====
      DO 400 K=1,M-1
      I = M-K
      DO 500 J=I+1,M
      DO 500 L=1,M2
      B(I,L)=B(I,L)-T(I,J)*B(J,L)
500  CONTINUE
      DO 550 L=1,M2
      B(I,L)=B(I,L)/T(I,I)
550  CONTINUE
400  CONTINUE
      DO 900 I=1,M
      DO 900 J=1,M2
900  T(I,J)=B(I,J)
C=====
C=====
C=====
C      DO 1000 I=1,M
C      DO 1000 J=1,M
C      TEST=0
C      IF(I.EQ.J) TEST=-1
C      DO 1001 K=1,M
C      TEST=TEST+A(I,K)*B(K,J)
C1001 CONTINUE
C1000 IF(DABS(TEST).GT.1.0D-8) WRITE(6,1) I,J,TEST
      WRITE(6,2)
1    FORMAT(5X,'in PINV:',2I8,E17.8/)
2    FORMAT(10X,'passing PINV'/)
      RETURN
      END
C=====
C=====
C=====
      SUBROUTINE SFI
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NP2=2*NPMESH)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      PARAMETER (NAX=3000)
      PARAMETER (NTWO=2*NAX1)
      PARAMETER (N2=2*NNODE)

```

```

PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
COMMON/VBC/XCRACK,YCRACK
COMMON/WBC/SIDEAS(4,NEMESH)
WRITE(6,2)
DO 300 IE=1,MEMESH
SIDEAS(1,IE)=0
SIDEAS(2,IE)=0
SIDEAS(3,IE)=0
XT=0
YT=0
III=(IE-1)*4
DO 400 II=1,4
J=III+II
XT=XT+0.25*XSAMP(J)
YT=YT+0.25*YSAMP(J)
SIDEAS(1,IE)=SIDEAS(1,IE)+0.25*STRESS(1,J)
SIDEAS(2,IE)=SIDEAS(2,IE)+0.25*STRESS(2,J)
SIDEAS(3,IE)=SIDEAS(3,IE)+0.25*STRESS(3,J)
400 CONTINUE
WRITE(6,1) IE,XT,YT,(SIDEAS(K,IE),K=1,3)
300 CONTINUE
1 FORMAT(I5,2F8.4,4F13.5)
2 FORMAT(5X/2X,'IE',4X,'XC',6X,'YC',8X,'Sxx',10X,'Syy',
*10X,'Sxy',10X,'Szz'/)
RETURN
END

C=====
C=====
C=====
SUBROUTINE UPDATE
IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NPMESH=1200)
PARAMETER (NP2=2*NPMESH)
PARAMETER (NEMESH=1100)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NNODE=1200)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NAX=3000)
PARAMETER (NTWO=2*NAX1)
PARAMETER (N2=2*NNODE)

```

```

PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
COMMON/QBC/PHI2(NAX2,NPMESH,2),LMN2(NAX2,NPMESH),NN2(NPMESH)
COMMON/TBC/P(3,3),Q(3,3),AA,BB,CC,DD,R2
COMMON/VBC/XCRACK,YCRACK
COMMON/WBC/SIDEAS(4,NEMESH)
COMMON/XBC/TU(NAX),PE
COMMON/YBC/RATIO(20),ICRACK(20)
DIMENSION DSTRAIN(3),S(3),T(3)
1  FORMAT(1X,'IP=',I5,' X,Y,Ux,Uy=',4(1X,E12.5))
8  FORMAT(1X,'IS=',I5,' F2,R2,DGAMA,DPE=',4E12.5)
9  FORMAT(6E12.5)
2  FORMAT(4(1X,E15.8))
C=====
      M2=2*MNODE
      MAX=M2+MU
      CONST1=2./3.
C      CONST2=DSQRT(CONST1)
      DO 100 IP=1,MPMESH
      X=XMESH(IP)
      Y=YMESH(IP)
      IX=2*IP-1
      IY=IX+1
      DO 200 K=1,NN2(IP)
      JP=LMN2(K,IP)
      JX=2*JP-1
      JY=JX+1
      DISP(IX)=DISP(IX)+PHI2(K,IP,1)*U(JX)
      DISP(IY)=DISP(IY)+PHI2(K,IP,2)*U(JY)
200  CONTINUE
100  CONTINUE
      DO 500 I=M2+1,MAX
      DISP(I)=DISP(I)+U(I)
500  CONTINUE
      IF(IER.EQ.1) GO TO 3000
      DO 300 IE=1,MSAMP
      DV=AREA(IE)
      DSTRAIN(1)=0.0D0
      DSTRAIN(2)=0.0D0
      DSTRAIN(3)=0.0D0
      DO 350 K=1,NN1(IE)

```

```

JP=LMN1(K,IE)
JX=2*JP-1
JY=JX+1
DSTRAIN(1)=DSTRAIN(1)+PHIX(K,IE)*U(JX)
DSTRAIN(2)=DSTRAIN(2)+QHIY(K,IE)*U(JY)
DSTRAIN(3)=DSTRAIN(3)+QHIX(K,IE)*U(JY)+PHIY(K,IE)*U(JX)
350  CONTINUE
      STRAIN(1,IE)=STRAIN(1,IE)+DSTRAIN(1)
      STRAIN(2,IE)=STRAIN(2,IE)+DSTRAIN(2)
      STRAIN(3,IE)=STRAIN(3,IE)+DSTRAIN(3)
      T(1)=STRAIN(1,IE)-PSTRAIN(1,IE)
      T(2)=STRAIN(2,IE)-PSTRAIN(2,IE)
      T(3)=STRAIN(3,IE)-PSTRAIN(3,IE)
      CALL EASY(S,T,DK)
      T(1)=S(1)-BETA(1,IE)
      T(2)=S(2)-BETA(2,IE)
      T(3)=S(3)-BETA(3,IE)
      F2=0.0
      DO 111 II=1,3
      DO 111 JJ=1,3
111   F2=F2+T(II)*T(JJ)*P(II,JJ)
      IF(F2.GT.R2) GO TO 333
      STRESS(1,IE)=S(1)
      STRESS(2,IE)=S(2)
      STRESS(3,IE)=S(3)
      GO TO 300
333  CONTINUE
      TT1=T(1)+T(2)
      TT2=-T(1)+T(2)
      AA=TT1*TT1/6.0D0/R2
      BB=(0.5D0*TT2*TT2+2.0D0*T(3)*T(3))/R2
      CALL ALGEB(AA,BB,CC,DD,DGAMA)
      TAU1=1.0D0/(1.0D0+CC*DGAMA)
      TAU2=1.0D0/(1.0D0+DD*DGAMA)
      DGAMA=DGAMA/YOUNG
      S(1)=TAU1*TT1/DSQRT(2.0D0)
      S(2)=TAU2*TT2/DSQRT(2.0D0)
      S(3)=TAU2*T(3)
      CALL EASY(T,S,Q)
      BETA(1,IE)=BETA(1,IE)+CONST1*PSLOPE*DGAMA*T(1)
      BETA(2,IE)=BETA(2,IE)+CONST1*PSLOPE*DGAMA*T(2)
      BETA(3,IE)=BETA(3,IE)+CONST1*PSLOPE*DGAMA*T(3)
      P1=DGAMA*(P(1,1)*T(1)+P(1,2)*T(2))
      P2=DGAMA*(P(2,1)*T(1)+P(2,2)*T(2))
      P3=DGAMA*P(3,3)*T(3)
      PSTRAIN(1,IE)=PSTRAIN(1,IE)+P1
      PSTRAIN(2,IE)=PSTRAIN(2,IE)+P2
      PSTRAIN(3,IE)=PSTRAIN(3,IE)+P3
      SN1=T(1)+BETA(1,IE)
      SN2=T(2)+BETA(2,IE)
      SN3=T(3)+BETA(3,IE)
      DS1=SN1+STRESS(1,IE)
      DS2=SN2+STRESS(2,IE)
      DS3=SN3+STRESS(3,IE)
      DPE=0.5*DV*(P1*DS1+P2*DS2+P3*DS3)
      PE=PE+DPE
      STRESS(1,IE)=SN1

```

```

        STRESS(2,IE)=SN2
        STRESS(3,IE)=SN3
        IF(DPE.GT.0.0D0) GO TO 300
        WRITE(6,8) IE,F2,R2,DGAMA,DPE
        WRITE(6,9) P1,DS1,P2,DS2,P3,DS3
        PDS1=P1*DS1
        PDS2=P2*DS2
        PDS3=P3*DS3
        TOTAL=PDS1+PDS2+PDS3
        WRITE(6,2) PDS1,PDS2,PDS3,TOTAL
300    CONTINUE
3000   CONTINUE
        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE ALGEB(AA,BB,CC,DD,X)
        IMPLICIT REAL*8 (A-H,O-Z)
        A=2.0D0/CC+2.0D0/DD
        B=4.0D0/CC/DD+(1.0D0-BB)/DD/DD+(1.0D0-AA)/CC/CC
        C=2.0D0*((1.0D0-BB)/CC/DD/DD+(1.0D0-AA)/DD/CC/CC)
        D=(1.0D0-AA-BB)/CC/CC/DD/DD
        P=B*B/9.0D0-(A*C-4.0D0*D)/3.0D0
        Q=B*B*B/27.0D0-B*(A*C-4.0D0*D)/6.0+(A*A*D-4.0*B*D+C*C)*0.5
        TEST=Q*Q-P*P*P
        TESTM=-TEST
        CON=1.0D0/3.0D0
        IF(TEST.LT.0.0D0) GO TO 100
        T1=Q+DSQRT(TEST)
        T2=Q-DSQRT(TEST)
        IF(T1.GE.0.0D0) T1=T1**CON
        IF(T1.LT.0.0D0) T1=-(-T1)**CON
        IF(T2.GE.0.0D0) T2=T2**CON
        IF(T2.LT.0.0D0) T2=-(-T2)**CON
        Y=T1+T2+B/3.0D0
        GO TO 200
100    CONTINUE
        TESTM=DSQRT(TESTM)
        TA=DATAN2(TESTM,Q)/3.0D0
        Y=2.0D0*DSQRT(P)*DCOS(TA)+B/3.0D0
200    CONTINUE
        QQ=DSQRT(0.25*A*A-B+Y)
        SS=0.75*A*A-2.0D0*B-QQ*QQ
        TEST=QQ*QQ
        IF(TEST.GT.1.0D-14) GO TO 300
        TT=2.0D0*DSQRT(Y*Y-4.0D0*D)
        GO TO 400
300    TT=(4.0D0*A*B-8.0D0*C-A*A*A)/QQ*0.25D0
400    CONTINUE
        TEST=TT+SS
        IF(TEST.GT.0.0D0) GO TO 500
        X=-0.25D0*A-0.5D0*QQ+0.5D0*DSQRT(SS-TT)
        GO TO 600
500    X=-0.25D0*A+0.5D0*QQ+0.5D0*DSQRT(SS+TT)
600    CONTINUE
        TW=Q*Q-P*P*P

```

```

C      WRITE(6,1) AA,BB,CC,DD
C      WRITE(6,2) A,B,C,D
C      WRITE(6,3) TW,Y
C      WRITE(6,4) QQ,SS,TT,X
1      FORMAT(2X,'AA,BB,CC,DD =',4(1X,E12.5))
2      FORMAT(2X,'A ,B ,C ,D =',4(1X,E12.5))
3      FORMAT(2X,'TEST, Y      =',4(1X,E12.5))
4      FORMAT(2X,'QQ,SS,TT, X =',4(1X,E12.5))
      RETURN
      END

C=====
C=====
C=====
      SUBROUTINE EASY(A,B,Q)
      IMPLICIT REAL*8 (A-H,O-Z)
      DIMENSION A(3),B(3),Q(3,3)
      DO 100 I=1,3
      A(I)=0.0D0
      DO 100 J=1,3
      A(I)=A(I)+Q(I,J)*B(J)
100    CONTINUE
      RETURN
      END

C=====
C=====
C=====
      SUBROUTINE CHECK
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NP2=2*NPMESH)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NNODE=1200)
      PARAMETER (NAX1=250)
      PARAMETER (NAX2=NAX1)
      PARAMETER (NAX=3000)
      PARAMETER (NTWO=2*NAX1)
      PARAMETER (N2=2*NNODE)
      PARAMETER (NU=100)
      PARAMETER (NF=50)
      PARAMETER (NIC=10)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/DBC/IJK(4,NEMESH)
      COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
      COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
      COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
      COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
      COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
      COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
      COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
      COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
      COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
      COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
      COMMON/VBC/XCRACK,YCRACK
      COMMON/WBC/SIDEAS(4,NEMESH)

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```

COMMON/YBC/RATIO(20),ICRACK(20)
5  FORMAT(5X,I5,'  T,F,DF =',3(1X,F15.8))
8  FORMAT(5X/10X,'The solver did a good job.'/)
M2=2*MNODE
MAX=M2+MU
FMAX=0.0D0
DO 50 I=1,MAX
50 IF(DABS(F(I)).GT.FMAX) FMAX=DABS(F(I))
FMAX=FMAX*1.0D-8
JER=0
DO 60 I=1,MAX
T=0.0D0
DO 70 J=1,MAX
70 T=T+AK(I,J)*U(J)
DF=F(I)-T
IF(DABS(DF).LT.FMAX) GO TO 60
WRITE(6,5) I,T,F(I),DF
JER=JER+1
60 CONTINUE
C  IF(JER.EQ.0) WRITE(6,8)
RETURN
END

C=====
C=====
C=====
SUBROUTINE SYM
IMPLICIT REAL*8 (A-H,O-Z)
PARAMETER (NPMESH=1200)
PARAMETER (NP2=2*NPMESH)
PARAMETER (NEMESH=1100)
PARAMETER (NNODE=1200)
PARAMETER (NSAMP=4*NEMESH)
PARAMETER (NAX1=250)
PARAMETER (NAX2=NAX1)
PARAMETER (NAX=3000)
PARAMETER (NTWO=2*NAX1)
PARAMETER (N2=2*NNODE)
PARAMETER (NU=100)
PARAMETER (NF=50)
PARAMETER (NIC=10)
COMMON/ABC/ID(10),IER,INDEX,ISTEP
COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
C=====
M2=2*MNODE
MAX=2*MNODE+MU

```



```

      ISYM=1
1    FORMAT(10X,'SYMMETRY is checked and ISYM =',I5/)
2    FORMAT(2X,'sym: I,J,DIFF,SUM,TEST =',2I4,3E12.5)
      DO 100 I=1,M2-1
      DO 100 J=I+1,M2
      DIFF=DABS(AK(I,J)-AK(J,I))
      SUM=DABS(AK(I,J)+AK(J,I))
      IF(SUM.LT.1.0D-8) GO TO 100
      TEST=DIFF/SUM*100.0
      IF(TEST.GT.1.0D-3) ISYM=0
      IF(TEST.GT.1.0D-3) WRITE(6,2) I,J,DIFF,SUM,TEST
100  CONTINUE
      WRITE(6,1) ISYM
2000 CONTINUE
      RETURN
      END

C=====
C=====
C=====
      SUBROUTINE IDEAS1
C-----C
C      This is a 2-D case. C
C C
C      Subroutine to print nodal coordinate and element connectivity in C
C      IDEAS format for postprocessing. C
C-----C
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/DBC/IJK(4,NEMESH)
10    FORMAT ('      -1')
11    FORMAT ('      781')
12    FORMAT(4I10)
13    FORMAT(1P3D25.16)
14    FORMAT ('      780')
15    FORMAT(8I10)
C-----C
C      write nodal coordinates C
C-----C
      WRITE(8,10)
      WRITE(8,11)
      Z=0
      DO 100 I=1,MPMESH
      WRITE(8,12) I,0,0,11
      WRITE(8,13) XMESH(I),YMESH(I),Z
100  CONTINUE
      WRITE(8,10)
C-----C
C      write the element no. and connectivity C
C-----C
      WRITE(8,10)
      WRITE(8,14)
      DO 200 I=1,MEMESH
C      WRITE(8,15) I,115,1,2,1,1,7,8

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```

        WRITE(8,15) I,94,1,3,1,1,11,4
C      WRITE(8,15) (IJK(J,I),J=5,8),(IJK(K,I),K=1,4)
        WRITE(8,15) (IJK(K,I),K=1,4)
200    CONTINUE
        WRITE(8,10)
        RETURN
        END

C=====
C=====
C=====
      SUBROUTINE IDEAS2
C-----C
C      This is a 2-D case.                                C
C                                                                C
C      Subroutine to print out stresses and displacements    C
C                                                                C
C-----C
      IMPLICIT REAL*8 (A-H,O-Z)
      PARAMETER (NPMESH=1200)
      PARAMETER (NP2=2*NPMESH)
      PARAMETER (NEMESH=1100)
      PARAMETER (NSAMP=4*NEMESH)
      PARAMETER (NAX=3000)
      COMMON/ABC/ID(10),IER,INDEX,ISTEP
      COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC
      COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
      COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
      COMMON/WBC/SIDEAS(4,NEMESH)

C=====
C=====
C=====
31      FORMAT ('      -1')
32      FORMAT ('      56')
33      FORMAT ('RATIO=',E14.8,' at ITIME=',I3)
35      FORMAT ('Model Solution From POLAR')
36      FORMAT (5X,'ISTEP =',I5)
37      FORMAT (5X,'Time =',F15.8)
38      FORMAT ('  ')
39      FORMAT (6I10)
40      FORMAT (A6)
41      FORMAT (1P6E13.5)
42      FORMAT (14X,I5)
43      FORMAT ('      55')
51      FORMAT ('The Stress Data at :')
52      FORMAT ('The Displacement Data at :')
57      FORMAT (5X)
C-----C
C      writes stresses of each element                        C
C-----C
      TIME=ITIME*DTIME
      WRITE(6,1) ISTEP-1
1      FORMAT(10X,'In ideas2: ISTEP =',I5/)
      WRITE(8,31)
      WRITE(8,32)
      WRITE(8,51)
      WRITE(8,36) ISTEP-1
      WRITE(8,57)

```

```

        WRITE(8,37) TIME
        WRITE(8,38)
        WRITE(8,39) 1,1,4,2,2,6
        WRITE(8,39) 1,1,ITIME
        WRITE(8,41) 0.0E0
        DO 100 IE=1,MEMESH
        WRITE(8,39) IE,6
100      * WRITE(8,41) SIDEAS(1,IE),SIDEAS(3,IE),SIDEAS(2,IE),
          *      0.0,0.0,0.0
        WRITE(8,31)
C-----C
C      write displacements of each node      C
C-----C
        WRITE(8,31)
        WRITE(8,43)
        WRITE(8,52)
        WRITE(8,36) ISTEP-1
        WRITE(8,57)
        WRITE(8,37) TIME
        WRITE(8,38)
        WRITE(8,39) 1,1,3,8,2,6
        WRITE(8,39) 1,1,ITIME
        WRITE(8,41) 0.0E0
        DO 400 I=1,MPMESH
        J1=(I-1)*2+1
        J2=J1+1
        WRITE(8,39) I
        WRITE(8,41) (DISP(K),K=J1,J2)
400      CONTINUE
        WRITE(8,31)
        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE INVERSION(M,A,NA,B,NB)
        IMPLICIT REAL*8 (A-H,O-Z)
        COMMON/ABC/ID(10),IER,INDEX,ISTEP
        DIMENSION A(NA,NA),B(NB,NB),T(M,M)
C*****
        AMAX=0
        IER=0
        DO 10 I=1,M
        DO 10 J=1,M
        B(I,J)=0.0D0
        IF(I.EQ.J) B(I,J)=1.0D0
        IF(DABS(A(I,J)).GT.AMAX) AMAX=DABS(A(I,J))
10      T(I,J)=A(I,J)
        AERROR=AMAX*1.0D-8
C*****
        DO 100 K=1,M-1
        DO 100 I=K+1,M
        FACT = -T(I,K)/T(K,K)
        DO 101 J=K+1,M
        T(I,J) = T(I,J)+FACT*T(K,J)
101      CONTINUE
        DO 102 J=1,M

```

```

        B(I,J)=B(I,J)+FACT*B(K,J)
102  CONTINUE
100  CONTINUE
C*****
C      IF(DABS(T(M,M)).LT.AERROR) IER=1
C      IF(DABS(T(M,M)).LT.AERROR) WRITE(6,2) M,T(M,M)
        DO 200 J=1,M
            B(M,J)=B(M,J)/T(M,M)
200  CONTINUE
C*****
        DO 400 K=1,M-1
            I = M-K
C      IF(DABS(T(I,I)).LT.AERROR) IER=1
C      IF(DABS(T(I,I)).LT.AERROR) WRITE(6,2) I,T(I,I)
        DO 500 J=I+1,M
            DO 500 L=1,M
                B(I,L)=B(I,L)-T(I,J)*B(J,L)
500  CONTINUE
        DO 550 L=1,M
            B(I,L)=B(I,L)/T(I,I)
550  CONTINUE
400  CONTINUE
C*****
        DO 1000 I=1,M
            DO 1000 J=1,M
                T(I,J)=0.0D0
                IF(I.EQ.J) T(I,J)=-1.0D0
                DO 900 K=1,M
500  T(I,J)=T(I,J)+A(I,K)*B(K,J)
                IF(DABS(T(I,J)).GT.1.0D-6) IER=1
                IF(DABS(T(I,J)).GT.1.0D-6) WRITE(6,1) I,J,T(I,J)
1000 CONTINUE
1  FORMAT(2I5,' in INVERSION ',E15.8)
2  FORMAT(5X,' in inversion ',I5,2X,'T=',E15.8/)
C*****
        RETURN
        END

C=====
C=====
C=====
        SUBROUTINE AMP(T,FL,FU)
            IMPLICIT REAL*8 (A-H,O-Z)
            COMMON/ABC/ID(10),IER,INDEX,ISTEP
            COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
C*****
C
C
C
        IF(ID(1).EQ.0) GO TO 100
C=====
C
C      For dynamic case, as an example, FL and FU may be given as:
C
C
C=====
        TF=10.0*DTIME
        PI=4.0D0*ATAN(1.0D0)

```

```

        FU=0
        FL=0
        IF(T.LE.TF) FL=DSIN(T*PI/TF)
        GO TO 1000
100    CONTINUE
        FL=1.0
        FU=1.0
1000   RETURN
        END
C=====
C=====
C=====
        SUBROUTINE BARRIER(X1,Y1,X2,Y2,IPASS)
        IMPLICIT REAL*8 (A-H,O-Z)
        COMMON/ABC/ID(10),IER,INDEX,ISTEP
        COMMON/SBC/XBARRIER(2),YBARRIER(2)
        IPASS=1
        IF(ID(5).NE.1) GO TO 1000
C      XB1=XBARRIER(1)
C      YB1=YBARRIER(1)
        XB2=XBARRIER(2)
C      YB2=YBARRIER(2)
        IF(X1.GE.XB2.AND.X2.GE.XB2) GO TO 1000
        YTEST=Y1*Y2
        IF(YTEST.GE.0.0D0) GO TO 1000
        DX=DABS(X2-X1)
        DY=DABS(Y2-Y1)
        IF(DY.LT.1.0D-9) GO TO 1000
        IF(DX.LT.1.0D-9) IPASS=0
        IF(DX.LT.1.0D-9) GO TO 1000
        S=(Y2-Y1)/(X2-X1)
        B=Y1-S*X1
        XX=-B/S
        IF(XX.GE.XB2) GO TO 1000
        IPASS=0
1000   CONTINUE
C      IF(IPASS.EQ.0) WRITE(6,1) X1,Y1,X2,Y2,IPASS
1      FORMAT(2X,'BARRIER: X1, Y1=',2F15.8/
        *11X,'X2, Y2=',2F15.8,' ipass =',I5)
        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE SIMPIN(M,T,NA,IER)
        IMPLICIT REAL*8 (A-H,O-Z)
        DIMENSION T(NA,NA),B(M,M),A(M,M)
C*****
        DO 10 I=1,M
        DO 10 J=1,M
        B(I,J)=0.0D0
        A(I,J)=T(I,J)
        IF(I.EQ.J) B(I,J)=1.0D0
10     CONTINUE
        IER = 0
        DO 100 K=1,M-1
        KMAX=K

```

```

        TMAX=DABS(T(K,K))
        DO 110 KK=K+1,M
        IF(TMAX.GE.DABS(T(KK,K))) GO TO 110
        KMAX=KK
        TMAX=DABS(T(KK,K))
110    CONTINUE
        IF(KMAX.EQ.K) GO TO 111
        DO 119 J=1,M
        RT=B(K,J)
        B(K,J)=B(KMAX,J)
119    B(KMAX,J)=RT
        DO 120 KK=K,M
        RT=T(K,KK)
        T(K,KK)=T(KMAX,KK)
120    T(KMAX,KK)=RT
111    CONTINUE
        DO 100 I=K+1,M
        FACT = -T(I,K)/T(K,K)
        DO 101 J=K+1,M
        T(I,J) = T(I,J)+FACT*T(K,J)
101    CONTINUE
        DO 102 J=1,M
        B(I,J)=B(I,J)+FACT*B(K,J)
102    CONTINUE
100    CONTINUE
C*****
        DO 200 J=1,M
        B(M,J)=B(M,J)/T(M,M)
200    CONTINUE
C*****
        DO 400 K=1,M-1
        I = M-K
        DO 500 J=I+1,M
        DO 500 L=1,M
        B(I,L)=B(I,L)-T(I,J)*B(J,L)
500    CONTINUE
        DO 550 L=1,M
        B(I,L)=B(I,L)/T(I,I)
550    CONTINUE
400    CONTINUE
C*****
        DO 900 I=1,M
        DO 900 J=1,M
        TEST=0
        IF(I.EQ.J) TEST=-1
        DO 950 K=1,M
950    TEST=TEST+A(I,K)*B(K,J)
        IF(DABS(TEST).LT.1.0D-6) GO TO 900
        IER=1
        WRITE(6,1) I,J,TEST
900    CONTINUE
1    FORMAT(5X,2I5,'    test=',5X,E15.8/)
        DO 1000 I=1,M
        DO 1000 J=1,M
        T(I,J)=B(I,J)
1000    CONTINUE
2000    CONTINUE

```

```

        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE GAUSS(M,A,APF,Y,NA,IER)
        IMPLICIT REAL*8 (A-H,O-Z)
        DIMENSION A(NA,NA)
        DIMENSION T(M,M),F(M)
        DIMENSION Y(*),APF(*)
C=====
C=====
        IER = 0
        FMAX=0.0
        DO 10 I=1,M
        F(I)=APF(I)
        IF(DABS(F(I)).GT.FMAX) FMAX=DABS(F(I))
        DO 10 J=1,M
        IF(DABS(A(I,J)).GT.AMAX) AMAX=DABS(A(I,J))
10      T(I,J)=A(I,J)
C=====
C=====
        DO 100 K=1,M-1
        KMAX=K
        TMAX=DABS(T(K,K))
        DO 110 KK=K+1,M
        IF(TMAX.GE.DABS(T(KK,K))) GO TO 110
        KMAX=KK
        TMAX=DABS(T(KK,K))
110      CONTINUE
        IF(KMAX.EQ.K) GO TO 111
        RF=F(K)
        F(K)=F(KMAX)
        F(KMAX)=RF
        DO 120 KK=K,M
        RT=T(K,KK)
        T(K,KK)=T(KMAX,KK)
120      T(KMAX,KK)=RT
111      CONTINUE
        DO 100 I=K+1,M
        FACT = -T(I,K)/T(K,K)
        F(I) = F(I)+FACT*F(K)
        DO 100 J=K+1,M
        T(I,J) = T(I,J)+FACT*T(K,J)
100      CONTINUE
C=====
C=====
C=====
        Y(M) = F(M)/T(M,M)
C=====
C=====
C=====
        DO 400 K=1,M-1
        I = M-K
        DO 500 J=I+1,M
        F(I) = F(I)-T(I,J)*Y(J)
500      CONTINUE

```

```

        Y(I) = F(I)/T(I,I)
400    CONTINUE
C=====
C=====
C=====
        DO 600 I=1,M
        TEST=APF(I)
        DO 601 J=1,M
601    TEST=TEST-A(I,J)*Y(J)
        TEST=DABS(TEST)/FMAX
        IF(DABS(TEST).GT.1.0D-7) IER=1
        IF(DABS(TEST).GT.1.0D-7) WRITE(6,1) I,FMAX,APF(I),TEST
600    CONTINUE
C    IF(IER.EQ.0) WRITE(6,2)
1    FORMAT(2X,'in GAUSS:',I5,' FMAX, f and test =',E10.3,E12.5,F14.9)
2    FORMAT(10X,'GAUSS did a good job.'/)
3    FORMAT(2X,'from GAUSS: Y(',I5,')=',3E15.8)
        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE FTIME(T,FU)
        IMPLICIT REAL*8 (A-H,O-Z)
        COMMON/OBC/DTIME,TFINAL,ITIME,MTIME
C
C
C    this is a user-specified subroutine
C
C
C    PI2=8.0D0*DATAN(1.0D0)
        FU=0
        IF(T.LE.TFINAL) FU=1
C    IF(T.LE.TFINAL) FU=DSIN(PI2*T/TFINAL)
        RETURN
        END
C=====
C=====
C=====
        SUBROUTINE BMESH
C    Check date: May 22, 2001
        IMPLICIT REAL*8 (A-H,O-Z)
        PARAMETER (NPMESH=1200)
        PARAMETER (NEMESH=1100)
        PARAMETER (NP2=2*NPMESH)
        PARAMETER (NSAMP=4*NEMESH)
        PARAMETER (NNODE=1200)
        PARAMETER (NAX1=250)
        PARAMETER (NAX2=NAX1)
        PARAMETER (NAX=3000)
        PARAMETER (NU=100)
        PARAMETER (NF=50)
        PARAMETER (NIC=10)
        PARAMETER (N2=2*NNODE)
        COMMON/ABC/ID(10),IER,INDEX,ISTEP
        COMMON/BBC/XMESH(NPMESH),YMESH(NPMESH),XSAMP(NSAMP),YSAMP(NSAMP)
        COMMON/CBC/MPMESH,MEMESH,MNODE,MSAMP,MAX1,MAX2,MU,MF,MIC

```



```

COMMON/DBC/IJK(4,NEMESH)
COMMON/EBC/XNODE(NNODE),YNODE(NNODE),RNODE(NNODE)
COMMON/FBC/YOUNG,POISSON,VON,PSLOPE,RIK,ELAME1,ELAME2,DK(3,3)
COMMON/GBC/LMN1(NAX1,NSAMP),NN1(NSAMP)
COMMON/HBC1/PHI(NAX1,NSAMP),PHIX(NAX1,NSAMP),PHIY(NAX1,NSAMP)
COMMON/HBC2/QHI(NAX1,NSAMP),QHIX(NAX1,NSAMP),QHIY(NAX1,NSAMP)
COMMON/IBC/AREA(NSAMP),H(NSAMP),HMAX,FACTOR(NAX2,NSAMP)
COMMON/JBC/XB(NU),YB(NU),SCALE1(NU),ICU(NU)
COMMON/KBC/SCALE2(NF),ICF(NF)
COMMON/LBC/SCALE3(NIC),ICI(NIC)
COMMON/MBC/AK(NAX,NAX),AG(NU,N2),F(NAX),U(NAX)
COMMON/NBC/CF(NAX),PSTRAIN(3,NSAMP),BETA(3,NSAMP)
COMMON/PBC/DISP(NAX),STRAIN(3,NSAMP),STRESS(3,NSAMP)
COMMON/QBC/PHI2(NAX2,NPMESH,2),LMN2(NAX2,NPMESH),NN2(NPMESH)
COMMON/SBC/XBARRIER(2),YBARRIER(2)
COMMON/TBC/P(3,3),Q(3,3),AA,BB,CC,DD,R2
COMMON/UBC/MUPRINT,MSPRINT,IUPRINT(4),ISPRINT(3)
COMMON/VBC/XCRACK,YCRACK
COMMON/WBC/SIDEAS(4,NEMESH)
COMMON/XBC/TU(NAX),PE
COMMON/YBC/RATIO(20),ICRACK(20)
COMMON/ZBC/AS0,CS0,ASI(20),CSI(20),COEFF(20),NDATA,MTERM
1  FORMAT(10X/
15X,'The followings are information about background mesh'/)
2  FORMAT(10X/5X,'=====')
5  FORMAT(16I5)
3  FORMAT(I5,3(5X,E15.8))
4  FORMAT(I5,3(5X,E15.8))
8  FORMAT(9X,I8,8X,4I8)
C7  FORMAT(9X,I8,7X,2G9.3)
7  FORMAT(9X,I8,7X,2G8.5)
9  FORMAT(9X,6I8)
   IER=0
   WRITE(6,1)
   WRITE(6,5) MPMESH, MEMESH
   DO 250 K=1,MEMESH
     READ(5,5) I, (IJK(J,I),J=1,4)
C*****
C
C      IJK(J,I) = CONNECTIVITY OF THE BACKGROUND MESH.
C
C*****
   WRITE(6,5) I, (IJK(J,I),J=1,4)
250  CONTINUE
   PF=45.0D0/DATAN(1.0D0)
   DO 200 J=1,MPMESH
C*****C
C
C
C      MEMESH = NUMBER OF ELEMENTS IN BACKGROUND MESH
C
C
C      XMESH(I), YMESH(I) ARE COORDINATES of the background mesh.
C
C*****C
C      READ(5,7) I,XMESH(I),YMESH(I)
C      WRITE(6,3) I, XMESH(I), YMESH(I)

```

```

200  CONTINUE
      WRITE(6,2)
      CALL IDEAS1
1000  CONTINUE
      WRITE(6,15) MSAMP
15    FORMAT(5X,'There are ',I5,' sampling points:')/
      DO 3000 J=1,MSAMP
        READ(5,3) I,XSAMP(I),YSAMP(I),AREA(I)
        WRITE(6,3) I,XSAMP(I),YSAMP(I),AREA(I)
3000  CONTINUE
17    FORMAT(10X/
15X,'The followings are information about nodes:')/
18    FORMAT(10X/5X,'=====')/
      WRITE(6,17)
      WRITE(6,18)
      WRITE(6,16) MNODE
16    FORMAT(5X,'There are ',I5,' nodes:')/
      DO 6000 I=1,MNODE
6000  WRITE(6,66) I,XNODE(I),YNODE(I),RNODE(I)
66    FORMAT(2X,I5,'  X,Y,R =',3(2X,F15.8))
      RETURN
      END

```

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