```
0001          REAL MX,MZ
0002          READ(5,100)S,DY
        C
        C  DEFLECTIONS AND TWISTS INITIALIZED TO ZERO AT THE WING ROOT
        C
0003          Z=0.0
0004          X=0.0
0005          TWIST=0.0
0006          ZANG=0.0
0007          XANG=0.0
0008          ANGZ=0.0
0009          ANGX=0.0
        C
        C  STARTING AT THE WING ROOT THE WING IS DIVIDED INTO AS MANY SECTIONS AS
        C  DESIRED FOR ACCURACY.  EACH SECTION IS TREATED AS A FREEBODY OF CONSTANT
        C  CROSSECTION.  THE DEFLECTIONS FOR EACH SECTION DUE TO MOMENT AND SHEAR LOADS
        C  WERE ACCUMULATED USING SUPERPOSITION AS THE PROGRAM PROGRESSED FROM THE
        C  ROOT TO THE TIP.  TWISTING DEFLECTIONS WERE CALCULATED FOR EACH SECTION AS A
        C  FUNCTION OF THE SHEAR FLOW DISTRIBUTION IN THE SKIN DUE TO THE TORQUE LOAD.
        C
0010          ICOUNT=0
0011          YLOCAT=0.0
0012          CALL SECT(VX,VZ,WX,WZ,TORQ,E,G,XIBAR,ZIBAR,PMI,YLOCAT,ICOUNT,DY,WT
             *,MX,MZ,S,TPNT,TDISTR)
0013          WRITE(6,200)YLOCAT,Z,X,TWIST
0014        1 ICOUNT=ICOUNT+1
0015          YLOCAT=YLOCAT+DY
0016          CALL SECT(VX,VZ,WX,WZ,TORQ,E,G,XIBAR,ZIBAR,PMI,YLOCAT,ICOUNT,DY,WT
             *,MX,MZ,S,TPNT,TDISTR)
0017          ZDISTR=(WZ*DY**4)/(8.*E*XIBAR)
0018          ZPNT=(VZ*DY**3)/(3.*E*XIBAR)
0019          ZMX=(MX*DY**2)/(2.*E*XIBAR)
0020          Z=ZDISTR+ZPNT+ZANG+ZMX+Z
0021          ANGZP=(VZ*DY**2)/(2.*E*XIBAR)
0022          ANGZD=(WZ*DY**3)/(6.*E*XIBAR)
0023          ANGMX=(MX*DY)/(E*XIBAR)
0024          ANGZ=ANGZP+ANGZD+ANGMX+ANGZ
0025          ZANG=DY*SIN(ANGZ)
0026          XDISTR=(WX*DY**4)/(8.*E*ZIBAR)
0027          XPNT=(VX*DY**3)/(3.*E*ZIBAR)
0028          XMZ=(-MZ*DY**2)/(2.*E*ZIBAR)
0029          X=XDISTR+XPNT+XANG+XMZ+X
0030          ANGXP=(VX*DY**2)/(2.*E*ZIBAR)
0031          ANGXD=(WX*DY**3)/(6.*E*ZIBAR)
0032          ANGMZ=(-MZ*DY)/(E*ZIBAR)
0033          ANGX=ANGXP+ANGXD+ANGMZ+ANGX
0034          XANG=DY*SIN(ANGX)
0035          TWIST=TDISTR+TPNT+TWIST
0036          WRITE(6,200)YLOCAT,Z,X,TWIST
0037          IF(YLOCAT.LT.S)GO TO 1
0038          CALL EXIT
0039      100 FORMAT(/,41X,F8.5,/,30X,F7.4)
0040      200 FORMAT(1X,4(5X,E13.5))
0041          END
```

```
0001            FUNCTION FCN(Y,N)
0002            REAL LIFT
          C
          C
          C LIFT/IN AS A FUNCTION OF Y
0003            LIFT=2.0
          C DRAG/IN AS A FUNCTION OF Y
0004            DRAG=-2.0
0005            TORQUE=0.0
0006            TORQUE=-2.0
          C
          C
0007            GO TO (1,2,3),N
0008          1 FCN=LIFT
0009            GO TO 4
0010          2 FCN=DRAG
0011            GO TO 4
0012          3 FCN=TORQUE
0013          4 RETURN
0014            END
```

```
0001          SUBROUTINE SECT(VX,VZ,WX,WZ,TORQ,E,G,XIBAR,ZIBAR,PMI,YLOCAT,ICOUNT
             *,DY,WT,MX,MZ,S,TPNT,TDISTR)
0002          REAL MOMENT,MX,MZ,MXA,MZA,MXP,MZP,MXFY,MZFY,LDIVT,MAXQZF,MAXQXF
0003          DIMENSION X(32),Z(32),RX(32),RZ(32),TX(32),TZ(32),QXF(319),QZF(319
             *),SIGMAX(319),SIGMAZ(319),XX(319),ZZ(319),QCON(319),Q(319),SIGMA(3
             *19),YS(10),XP(32),ZP(32),QX(319),QZ(319),XEFXF(319),ZEFXF(319),XEF
             *ZF(319),ZEFZF(319),IDRXZF(319),IDRXXF(319),IDRX(319)
        C
        C  READ DATA IN.   WRITE DATA OUT
        C
0004          IF(YLOCAT.EQ.0.0) GO TO 1
0005          GO TO 16
0006        1 DO 2 I=1,32
0007        2 READ(5,3)RX(I),RZ(I),TX(I),TZ(I)
0008        3 FORMAT(5X,F6.3,9X,F6.3,9X,F6.3,9X,F6.3)
0009          WRITE(6,4)
0010        4 FORMAT(1H1,'THE INPUT DATA WAS READ AS FOLLOWS')
0011          DO 5 I=1,32
0012        5 WRITE(6,6)I,RX(I),I,RZ(I),I,TX(I),I,TZ(I)
0013        6 FORMAT(1X,'RX(',I3,')=',F7.3,5X,'RZ(',I3,')=',F7.3,5X,'TX(',I3
             *,')=',F7.3,5X,'TZ(',I3,')=',F7.3)
0014          READ(5,7)YF,YL
        C
        C  CALCULATE MIDSPAN LOCATION
0015          YM=(YL-YF)/2.
0016        7 FORMAT(5X,F10.5,5X,F10.5)
0017          READ(5,8)RXAC,RZAC,TXAC,TZAC
0018        8 FORMAT(5X,F10.5,5X,F10.5,5X,F10.5,5X,F10.5)
0019          WRITE(6,9)YF,YL,RXAC,RZAC,TXAC,TZAC
0020        9 FORMAT(1X,'THE Y LOCATION OF ROOT AIRFOIL IS ',F9.5
             1/,' THE Y LOCATION OF THE TIP AIRFOIL IS ',F9.5,/,
             2' THE LOCATION OF THE ROOT AERODYNAMIC CENTER IS',
             37X,'RXAC=',F9.5,5X,'RZAC=',F9.5,/,
             4' THE LOCATION OF THE TIP AERODYNAMIC CENTER IS',
             57X,'TXAC=',F9.5,5X,'TZAC=',F9.5)
0021          READ(5,982)RHOS,RHOC
0022      982 FORMAT(24X,E10.3,/,24X,E10.3)
0023          WRITE(6,983)RHOS,RHOC
0024      983 FORMAT(1X,'SKIN DENSITY LBS./IN.3 =',E10.3,/,1X,'CORE DENSITY LBS.
             */IN.3 =',E10.3)
0025          READ(5,10)T,ATANGD,CHAND,E,G,NN
0026       10 FORMAT(15X,F6.5,/,16X,F8.5,/,12X,F8.5,/,22X,E10.3,/,14X,E10.3,/,49
             *X,I2)
        C
        C  CHANGE ANGLES TO RADIANS.  INITIALIZE SKIP VARIABLE
0027          ATTANG=ATANGD*2.*3.14159/360.
0028          CHANG=CHAND*2.*3.14159/360.
0029          ISKIP=0
0030          DO 11 I=1,NN
0031       11 READ(5,12)YS(I)
0032       12 FORMAT(36X,F8.5)
0033          WRITE(6,13)T,ATTANG,CHANG,E,G,NN
0034       13 FORMAT(1X,'SKIN THICKNESS=',F6.5,/,' ANGLE OF ATTACK=',F7.5,/,' CH
             *ORD ANGLE=',F7.5,/,' MODULUS OF ELASTICITY=',E10.3,/,' SHEAR MODUL
             *US',E10.3,/,' NUMBER OF WRITEOUTS=',I2)
0035          DO 14 I=1,NN
0036       14 WRITE(6,15)YS(I)
0037       15 FORMAT(1X,'  INFO.  ETC. PRINTOUT AT SECTION Y=',F9.3)
```

```
             C
             C  INITIALIZE SKIN AND CORE VOLUMES
0038                SVOL=0.0
0039                CVOL=0.0
0040           16 IF(YLOCAT.EQ.0.0.AND.ISKIP.EQ.0)YLOCAT=YM
             C
             C  THIS SUBROUTINE, TO SAVE TIME, DOES NOT CALCULATE SHEAR CENTER LOCATIONS EACH
             C  TIME A SECTION OF THE WING IS EVALUATED.  INSTEAD THE WING IS FIRST
             C  EVALUATED AT MIDSPAN AND ROOT SECTIONS FOR A SHEAR CENTER LOCATION.  ALL
             C  OTHER SECTION SHEAR CENTER LOCATIONS ARE ASSUMED TO LAY ALONG A LINE DRAWN
             C  BETWEEN THE ROOT SHEAR CENTER AND MIDSPAN SHEAR CENTER
             C          YLOCAT GIVES SPAN LOCATION
             C          ISKIP IS A SWITCH WHICH CAUSES THE SUBROUTINE TO EVALUATE
             C        THE MIDSPAN FIRST AND THEN THE ROOT FOR SHEAR CENTER LOCATIONS
             C
             C
             C  DIRECTION COSINES FOR(A.C. LINE,A LINE L TO THE A.C. LINE AND LYING IN THE
             C   YZ PLANE,A LINE L TO BOTH OF THESE)
             C
0041                UNIT=SQRT((TXAC-RXAC)**2+(TZAC-RZAC)**2+(YL-YF)**2)
0042                A1=(TXAC-RXAC)/UNIT
0043                B1=(YL-YF)/UNIT
0044                C1=(TZAC-RZAC)/UNIT
0045                A2=SQRT(1./((A1/B1)**2+1.))
0046                B2=-A2*A1/B1
0047                C2=0.
0048                VAR1=-B2/A2
0049                VAR2=-C1*VAR1/(A1*VAR1+B1)
0050                C3=SQRT(1./(1.+VAR1**2+VAR2**2))
0051                B3=-C3*C1/B1
0052                A3=B3*A1/B1
             C
             C  THE AIRFOIL SHAPE AT SPAN LOCATION YLOCAT IS CALCULATED BY THE EQUATION FOR
             C  A LINE IN THREE DIMENSIONS.
             C
0053                DO 20 I=1,32
0054                X(I)=((TX(I)-RX(I))*(YLOCAT-YF)/(YL-YF))+RX(I)
0055                Z(I)=((TZ(I)-RZ(I))*(YLOCAT-YF)/(YL-YF))+RZ(I)
0056                XAC=((TXAC-RXAC)*(YLOCAT-YF)/(YL-YF))+RXAC
0057                ZAC=((TZAC-RZAC)*(YLOCAT-YF)/(YL-YF))+RZAC
0058                XP(I)=X(I)
0059                ZP(I)=Z(I)
0060                XACP=XAC
0061                ZACP=ZAC
0062           20 CONTINUE
             C
             C  THE CORE AREA AND VOLUME IS CALCULATED FOR EACH SECTION
             C
0063                AREA1=0.
0064                AREA2=0.
0065                DO 55 I=1,32
0066                J=I+1
0067                IF(I.EQ.32) J=1
0068                DELTAX=X(J)-X(I)
0069                AVGZ=(Z(J)+Z(I))/2.
0070                IF(DELTAX)54,54,53
0071           53 AREA1=AREA1+DELTAX*AVGZ
0072                GO TO 55
```

```
0073        54 AREA2=AREA2-DELTAX*AVGZ
0074        55 CONTINUE
0075           CAREA=AREA2-AREA1
0076           IF(ISKIP.EQ.1.OR.ICOUNT.GT.0)CVOL=CAREA*DY+CVOL
         C
         C  THE CENTROID LOCATION, MOMENTS OF INERTIA, PRINCIPAL CENTROIDAL AXIS
         C  ORIENTATION, AND SKIN AREA AND VOLUME ARE CALCULATED AT EACH SECTION.
         C
0077           TANG=0.0
0078           ANG=0.0
0079        24 AREAT=0.0
0080           AXT=0
0081           AZT=0
0082           AXZT=0
0083           XIT=0
0084           ZIT=0
0085           DO 25 I=1,32
0086           J=I+1
0087           IF(I.EQ.32) J=1
0088           DELTAX=XP(J)-XP(I)
0089           DELTAZ=ZP(J)-ZP(I)
0090           DIST=SQRT(DELTAX**2+DELTAZ**2)
0091           XIS=DIST*(T**3)/12.0
0092           ZIS=T*(DIST**3)/12.0
0093           SINANG=DELTAZ/DIST
0094           COSANG=DELTAX/DIST
0095           XIC=XIS*(COSANG**2)+ZIS*(SINANG**2)
0096           ZIC=XIS*(SINANG**2)+ZIS*(COSANG**2)
0097           AREA=DIST*T
0098           XBARS=(XP(J)+XP(I))/2.0
0099           ZBARS=(ZP(J)+ZP(I))/2.0
0100           AX=AREA*XBARS
0101           AZ=AREA*ZBARS
0102           AXZ=AREA*XBARS*ZBARS
0103           AZSQD=AREA*(ZBARS**2)
0104           AXSQD=AREA*(XBARS**2)
0105           XI=XIC+AZSQD
0106           ZI=ZIC+AXSQD
0107           AREAT=AREA+AREAT
0108           AXT=AX+AXT
0109           AZT=AZ+AZT
0110           AXZT=AXZ+AXZT
0111           XIT=XI+XIT
0112           ZIT=ZI+ZIT
0113        25 CONTINUE
0114           XPBAR=AXT/AREAT
0115           ZPBAR=AZT/AREAT
0116           XIBARP=XIT-AREAT*(ZPBAR**2)
0117           ZIBARP=ZIT-AREAT*(XPBAR**2)
0118           XZIBRP=AXZT-AREAT*XPBAR*ZPBAR
0119           PMIP=XIBARP+ZIBARP
0120           IF(ANG.EQ.0.0)XBAR=XPBAR
0121           IF(ANG.EQ.0.0)ZBAR=ZPBAR
0122           IF(ANG.EQ.0.0)XIBAR=XIBARP
0123           IF(ANG.EQ.0.0)ZIBAR=ZIBARP
0124           IF(ANG.EQ.0.0)XZIBAR=XZIBRP
0125           IF(ANG.EQ.0.0)PMI=PMIP
0126           Y=2.*XZIBRP
```

```
      W=ZIBARP-XIBARP
      IF(Y.LT.0.001) GO TO 28
      ANG=ATAN2(Y,W)/2.
      TANG=TANG+ANG
      DO 26 I=1,32
      XP(I)=XP(I)*COS(ANG)+ZP(I)*SIN(ANG)
   26 ZP(I)=-XP(I)*SIN(ANG)+ZP(I)*COS(ANG)
      XACP=XACP*COS(ANG)+ZACP*SIN(ANG)
      ZACP=-XACP*SIN(ANG)+ZACP*COS(ANG)
      GO TO 24
   28 TAND=TANG*360./(2.*3.14159)
      IF(ISKIP.EQ.1.OR.ICOUNT.GT.0)SVOL=AREAT*DY+SVOL
C
C  THE MOMENTS, SHEAR FORCES, AND TORQUE ABOUT THE AERODYNAMIC CENTER LOCATION
C  AT EACH SECTION IS CALCULATED.
C
      ONE=YLOCAT-DY
      TWO=YLOCAT
      WZA=(FCN(ONE,1)+FCN(TWO,1))/2.
      WXA=(FCN(ONE,2)+FCN(TWO,2))/2.
      WTA=(FCN(ONE,3)+FCN(TWO,3))/2.
      IF(YLOCAT.LT.YL)GO TO 600
      VZA=0.0
      MZA=0.0
      VXA=0.0
      MXA=0.0
      TORQUE=0.0
      GO TO 700
  600 F=YL-YLOCAT
      N1=500*F/YL
      N2=N1*4/5
      N=1
   29 CONTINUE
      U=YLOCAT
      H=F/N1
      SUM=FCN(U,N)+FCN(YL,N)
      DO 30 I=2,N1
      U=U+H
   30 SUM=SUM+FCN(U,N)*2.
      FORCE=H/2.*SUM
      IF(N.EQ.3) GO TO 32
      H=F/N2
      U=H
      UN=H*N2
      US=YLOCAT
      USN=YLOCAT+UN
      SUM=FCN(US,N)*U+FCN(USN,N)*UN
      US=US+H
      DO 31 I=2,N2
      U=U+H
      UL=U-H
      US=US+H
      USL=US-H
   31 SUM=SUM+2.*FCN(USL,N)*UL+FCN(USL,N)*U+FCN(US,N)*UL
      MOMENT=H/4.*SUM
   32 GO TO (33,34,35),N
   33 VZA=FORCE
      MXA=MOMENT
```

```
0181              GO TO 36
0182           34 VXA=FORCE
0183              MZA=-MOMENT
0184              GO TO 36
0185           35 TORQUE=FORCE
0186           36 N=N+1
0187              IF(N.LT.4) GO TO 29
            C
            C  DIRECTION COSINES ORIENT THE MOMENTS AND FORCES PARALLEL TO THE FREE STREAM
            C  VELOCITY FROM THE SKEWED AERODYNAMIC CENTER LINE
            C
            C   MOMENT VECTORS SUPERPOSED ON X,Z,Y AXIS
0188          700 SUB1=B1*WTA
0189              SUB2=B1*TORQUE+B2*MXA+B3*MZA
0190              SUB3=A1*TORQUE+A1*WTA*DY/2.+A2*MXA+A3*MZA
0191              SUB4=C1*TORQUE+C1*WTA*DY/2.+C2*MXA+C3*MZA
0192              WTA=SUB1
0193              TORQUE=SUB2
0194              MXA=SUB3
0195              MZA=SUB4
            C   FORCE VECTORS SUPERPOSED ON X,Z,Y AXIS
0196              SUB5=A2*WXA+A3*WZA
0197              SUB6=C2*WXA+C3*WZA
0198              SUB7=A2*VXA+A3*VZA
0199              SUB8=C2*VXA+C3*VZA
0200              WXA=SUB5
0201              WZA=SUB6
0202              VXA=SUB7
0203              VZA=SUB8
            C
            C  THE MOMENTS AND FORCES ARE ORIENTED WITH RESPECT TO THE X,Y,Z AXIS AND THE
            C  XP,Y,ZP PRINCIPAL CENTROIDAL AXIS
            C
0204              TU=ATTANG-CHANG
0205              VZ=VZA*COS(TU)-VXA*SIN(TU)
0206              WZ=WZA*COS(TU)-WXA*SIN(TU)
0207              VX=VZA*SIN(TU)+VXA*COS(TU)
0208              WX=WZA*SIN(TU)+WXA*COS(TU)
0209              MZ=MZA*COS(TU)-MXA*SIN(TU)
0210              MX=MZA*SIN(TU)+MXA*COS(TU)
0211              THETA=ATTANG-CHANG+TANG
0212              VZP=VZA*COS(THETA)-VXA*SIN(THETA)
0213              WZP=WZA*COS(THETA)-WXA*SIN(THETA)
0214              VXP=VZA*SIN(THETA)+VXA*COS(THETA)
0215              WXP=WZA*SIN(THETA)+WXA*COS(THETA)
0216              MZP=MZA*COS(THETA)-MXA*SIN(THETA)
0217              MXP=MZA*SIN(THETA)+MXA*COS(THETA)
            C
            C  IF THIS WAS THE NEXT TO LAST SECTION TO BE EVALUATED CALCULATE AND WRITE
            C  OUT SKIN AND CORE WEIGHT.
            C
0218              SM1=S-DY
0219              IF(YLOCAT.EQ.SM1)WSKIN=RHOS*SVOL
0220              IF(YLOCAT.EQ.SM1)WCORE=RHOC*CVOL
0221              IF(YLOCAT.EQ.SM1)WRITE(6,981)WSKIN,WCORE
0222          981 FORMAT(1X,'SKIN WEIGHT= ',E12.5,/,1X,'CORE WEIGHT= ',E12.5)
            C
            C  IF THIS IS THE FIRST SECTION TO BE EVALUATED THE PROGRAM CALCULATES THE
```

```
C  SHEAR CENTER AT THE ROOT AND MIDSPAN.  TO SAVE COMPUTING TIME ALL OTHER
C  SHEAR CENTER LOCATIONS ARE CALCULATED BY THE EQUATION FOR A LINE DRAWN
C  BETWEEN THE ROOT AND MIDSPAN SHEAR CENTERS.
C
      IF(((YLOCAT.EQ.0.0).OR.(YLOCAT.EQ.YM)).AND.ICOUNT.EQ.0)GO TO 100
      ZSC=((YLOCAT-YF)/(YM-YF))*(ZSCM-ZSCF)+ZSCF
      XSC=((YLOCAT-YF)/(YM-YF))*(XSCM-XSCF)+XSCF
      ZS=ZSC*COS(TANG)-XSC*SIN(TANG)
      XS=ZSC*SIN(TANG)+XSC*COS(TANG)
      ZSHEAR=ZS-ZACP
      XSHEAR=XS-XACP
C
C  WITH A SHEAR CENTER LOCATION THE TORQUE IS TRANSFERED FROM THE AERODYNAMIC
C  CENTER TO THE SHEAR CENTER
C
      TORQ=TORQUE+VZP*XSHEAR-VXP*ZSHEAR
      WT=WTA+WZP*XSHEAR-WXP*ZSHEAR
C
C
C  TWISTING DEFLECTIONS WERE CALCULATED FOR EACH SECTION AS A FUNCTION OF THE
C  SHEAR FLOW DISTRIBUTION IN THE SKIN DUE TO THE TORQUE LOAD.
C
      LDIVT=0
      DO 573 I=1,319
      J=I+1
      IF(I.EQ.319)J=1
      DELTAX=XX(J)-XX(I)
      DELTAZ=ZZ(J)-ZZ(I)
      DIST=SQRT(DELTAX**2+DELTAZ**2)
      LDIVT=LDIVT+DIST/T
  573 CONTINUE
      TPNT=TORQ*LDIVT*DY/(4.*CAREA**2*G)
      TDISTR=WT*LDIVT*DY**2/(8.*CAREA**2*G)
C
C  INFORMATION AT A SECTION SPECIFIED IN THE DATA IS PRINTED OUT.
C
      DO 400 I=1,NN
      ITEST=YS(I)/DY
      IF(ITEST.EQ.ICOUNT)GO TO 62
  400 CONTINUE
      RETURN
C
C  THE FOLLOWING CALCULATES THE SHEAR FLOW DISTRIBUTION , SHEAR CENTER
C  LOCATION , AND ASSIGNS A SIGN BY NUMBER CONVENTION TO EACH LOCATION
C
  100 DO 37 I=1,32
      J=10.0*(I-1)
      IF(I.EQ.1) J=1
      XX(J)=XP(I)
   37 ZZ(J)=ZP(I)
      I=1
      J=10
      DELTAX=XX(J)-XX(I)
      DELTAZ=ZZ(J)-ZZ(I)
      DX=DELTAX/9.0
      DZ=DELTAZ/9.0
      DO 38 N=1,8
      XX(I+N)=XX(I)+N*DX
```

```
0261         38 ZZ(I+N)=ZZ(I)+N*DZ
0262            DO 39 I=10,310,10
0263            J=I+10
0264            IF(I.EQ.310) J=1
0265            DELTAX=XX(J)-XX(I)
0266            DELTAZ=ZZ(J)-ZZ(I)
0267            DX=DELTAX/10.0
0268            DZ=DELTAZ/10.0
0269            DO 39 N=1,9
0270            XX(I+N)=XX(I)+N*DX
0271         39 ZZ(I+N)=ZZ(I)+N*DZ
0272            LDIVT=0
0273            DELXF=0
0274            DELZF=0
0275            CONXF=-VXP/ZIBARP
0276            CONZF=-VZP/XIBARP
0277            QXF(1)=0
0278            QZF(1)=0
0279            DO 40 I=1,319
0280            J=I+1
0281            IF(I.EQ.319) J=1
0282            DELTAX=XX(J)-XX(I)
0283            DELTAZ=ZZ(J)-ZZ(I)
0284            DIST=SQRT(DELTAX**2+DELTAZ**2)
0285            XH=(XX(J)+XX(I))/2.0
0286            ZH=(ZZ(J)+ZZ(I))/2.0
0287            AREA=T*DIST
0288            XCENT=XH-XPBAR
0289            ZCENT=ZH-ZPBAR
0290            QXF(J)=QXF(I)+CONXF*XCENT*AREA
0291            QZF(J)=QZF(I)+CONZF*ZCENT*AREA
0292            QAVXF=(QXF(J)+QXF(I))/2.0
0293            QAVZF=(QZF(J)+QZF(I))/2.0
0294            DELXF=DELXF+QAVXF*DIST/T
0295            DELZF=DELZF+QAVZF*DIST/T
0296         40 LDIVT=LDIVT+DIST/T
0297            QCONXF=-DELXF/LDIVT
0298            QCONZF=-DELZF/LDIVT
0299            DO 41 I=1,319
0300            QXF(I)=QXF(I)+QCONXF
0301         41 QZF(I)=QZF(I)+QCONZF
           C
           C  LOCATING MAXIMUM SHEAR FLOWS DUE TO FORCES IN THE X DIRECTION, Z DIRECTION
0302            MAXQZF=QZF(1)
0303            MAXQXF=QXF(1)
0304            DO 42 I=1,319
0305            IF(QZF(I).GT.MAXQZF)IMXQZF=I
0306            IF(QZF(I).GT.MAXQZF)MAXQZF=QZF(I)
0307            IF(QXF(I).GT.MAXQXF)IMXQXF=I
0308            IF(QXF(I).GT.MAXQXF)MAXQXF=QXF(I)
0309         42 CONTINUE
           C
           C   ASSIGN APPROPRIATE SIGNS TO SHEAR FLOWS
0310            IZ=IMXQZF
0311            IX=IMXQXF
0312            JZ=IZ+1
0313            JX=IX+1
0314            IF(IZ.EQ.319)JZ=1
```

```
          IF(IX.EQ.319)JX=1
          DELTZZ=ZZ(JZ)-ZZ(IZ)
          DELTXX=XX(JX)-XX(IX)
          IF(VZP)43,44,45
       44 WRITE(6,46)
       46 FORMAT(1X,'METHOD OF LOCATING SHEAR CENTER IN ERROR')
          RETURN
       43 IF(QZF(IZ))61,44,47
       45 IF(QZF(IZ))47,44,61
       61 DO 48 I=1,319
          QZF(I)=-QZF(I)
       48 CONTINUE
       47 IF(VXP)143,44,145
      143 IF(QXF(IX))146,44,147
      145 IF(QXF(IX))147,44,146
      146 DO 148 I=1,319
          QXF(I)=-QXF(I)
      148 CONTINUE
C
C      ASSIGN VALUE TO ZTYPE FOR ONE OF FOUR POSSIBILITIES
C                                 Z EFFECTIVE FORCE
C                              DIRECTION       SIGN
C         ZTYPE=+1.           I TO J / J TO I   + / -
C         ZTYPE=-1.           I TO J / J TO I   - / +
      147 IF(DELTZZ)49,44,50
       49 IF(QZF(IZ))51,44,51
       50 IF(QZF(IZ))210,44,210
      210 ZTYPE=+1.
          GO TO 211
       51 ZTYPE=-1.
C
C      ASSIGN VALUE TO XTYPE FOR ONE OF FOUR POSSIBILITIES
C                                 X EFFECTIVE FORCE
C                              DIRECTION       SIGN
C         XTYPE=+1.         I TO J / J TO I     + / -
C         XTYPE=-1.         I TO J / J TO I     - / +
      211 IF(DELTXX)149,44,150
      149 IF(QXF(IX))151,44,151
      150 IF(QXF(IX))310,44,310
      310 XTYPE=+1.
          GO TO 311
      151 XTYPE=-1.
C
C      STARTING AT 1 CALCULATE FORCE COMPONENTS
C      AND ITS MOMENTS ABOUT THE AERODYNAMIC CENTER
C      FOR LOCATION OF THE SHEAR CENTER
      311 MXFY=0.
          MZFY=0.
          DO 320 I=1,319
          J=I+1
          IF(I.EQ.319)J=1
          QAVXF=(QXF(J)+QXF(I))/2.0
          QAVZF=(QZF(J)+QZF(I))/2.0
          DELTAX=XX(J)-XX(I)
          DELTAZ=ZZ(J)-ZZ(I)
          DIST=SQRT(DELTAX**2+DELTAZ**2)
          EFXF=QAVXF*DIST
          EFZF=QAVZF*DIST
```

```
      SINANG=DELTAZ/DIST
      COSANG=DELTAX/DIST
      XEFXF(I)=EFXF*COSANG*XTYPE
      ZEFXF(I)=EFXF*SINANG*XTYPE
      XEFZF(I)=EFZF*COSANG*ZTYPE
      ZEFZF(I)=EFZF*SINANG*ZTYPE
      XH=(XX(J)+XX(I))/2.
      ZH=(ZZ(J)+ZZ(I))/2.
      ZTAC=ZH-ZACP
      XTAC=XH-XACP
      MZFY=MZFY-(ZEFZF(I)*XTAC)+(XEFZF(I)*ZTAC)
      MXFY=MXFY-(ZEFXF(I)*XTAC)+(XEFXF(I)*ZTAC)
C
C   DIRECTION OF QZF'S
      IF(ZEFZF(I))430,431,432
  430 IF(XEFZF(I))426,427,428
  431 IF(XEFZF(I))425,429,421
  432 IF(XEFZF(I))424,423,422
  421 IDRXZF(I)=1
      GO TO 433
  422 IDRXZF(I)=2
      GO TO 433
  423 IDRXZF(I)=3
      GO TO 433
  424 IDRXZF(I)=4
      GO TO 433
  425 IDRXZF(I)=5
      GO TO 433
  426 IDRXZF(I)=6
      GO TO 433
  427 IDRXZF(I)=7
      GO TO 433
  428 IDRXZF(I)=8
      GO TO 433
  429 IDRXZF(I)=9
C
C   DIRECTION OF QXF'S
  433 IF(ZEFXF(I))530,531,532
  530 IF(XEFXF(I))526,527,528
  531 IF(XEFXF(I))525,529,521
  532 IF(XEFXF(I))524,523,522
  521 IDRXXF(I)=1
      GO TO 320
  522 IDRXXF(I)=2
      GO TO 320
  523 IDRXXF(I)=3
      GO TO 320
  524 IDRXXF(I)=4
      GO TO 320
  525 IDRXXF(I)=5
      GO TO 320
  526 IDRXXF(I)=6
      GO TO 320
  527 IDRXXF(I)=7
      GO TO 320
  528 IDRXXF(I)=8
      GO TO 320
  529 IDRXXF(I)=9
```

```
  320 CONTINUE
C
C   CALCULATE SHEAR CENTER BY BALANCING PREVIOUSLY CALCULATED MOMENTS
      ZSHEAR=-MXFY/VXP
      XSHEAR=MZFY/VZP
      ZS=ZACP+ZSHEAR
      XS=XACP+XSHEAR
      ZSC=ZS*COS(-TANG)-XS*SIN(-TANG)
      XSC=ZS*SIN(-TANG)+XS*COS(-TANG)
      IF(YLOCAT.EQ.0.0)ZSCF=ZSC
      IF(YLOCAT.EQ.0.0)XSCF=XSC
      IF(YLOCAT.EQ.0.0)ISKIP=0
      IF(YLOCAT.EQ.YM.AND.ICOUNT.EQ.0)ZSCM=ZSC
      IF(YLOCAT.EQ.YM.AND.ICOUNT.EQ.0)XSCM=XSC
      IF(YLOCAT.EQ.YM.AND.ICOUNT.EQ.0)ISKIP=1
      TORQ=TORQUE+VZP*XSHEAR-VXP*ZSHEAR
      QCONST=-TORQ/(2.*CAREA)
      DO 59 I=1,319
      J=I+1
      IF(I.EQ.319) J=1
      DELTAX=XX(J)-XX(I)
      DELTAZ=ZZ(J)-ZZ(I)
      DIST=SQRT(DELTAX**2+DELTAZ**2)
      EFC=QCONST*DIST
      SINANG=DELTAZ/DIST
      COSANG=DELTAX/DIST
      XEFC=EFC*COSANG
      ZEFC=EFC*SINANG
      ZEFF=ZEFC+ZEFZF(I)+ZEFXF(I)
      XEFF=XEFC+XEFZF(I)+XEFXF(I)
      EFF=SQRT(ZEFF**2+XEFF**2)
      Q(I)=EFF/DIST
C
C    DIRECTION OF Q'S
      IF(ZEFF)830,831,832
  830 IF(XEFF)826,827,828
  831 IF(XEFF)825,829,821
  832 IF(XEFF)824,823,822
  821 IDRX(I)=1
      GO TO 59
  822 IDRX(I)=2
      GO TO 59
  823 IDRX(I)=3
      GO TO 59
  824 IDRX(I)=4
      GO TO 59
  825 IDRX(I)=5
      GO TO 59
  826 IDRX(I)=6
      GO TO 59
  827 IDRX(I)=7
      GO TO 59
  828 IDRX(I)=8
      GO TO 59
  829 IDRX(I)=9
   59 CONTINUE
C
C  CALCULATES THE NORNAL STRESS DISTRIBUTION IN THE SKIN AT EACH LOCATION.
```

```
              C             MINUS(COMPRESSION)       PLUS(TENSION)
              C
 0463               DO 52 I=1,319
 0464               D=XX(I)-XPBAR
 0465               V=ZZ(I)-ZPBAR
 0466               SIGMAX(I)=-MZP*D/ZIBARP
 0467               SIGMAZ(I)=-MXP*V/XIBARP
 0468            52 SIGMA(I)=SIGMAX(I)+SIGMAZ(I)
              C
              C  WRITE OUT VALUES CALCULATED
              C
 0469            62 WRITE(6,994)
 0470               WRITE(6,63)YLOCAT
 0471            63 FORMAT(1X,'THE AIRFOIL SHAPE AT SECTION ',F9.3,'  IS DEFINED',/,'
                   *BY THE REFERENCE X,Z COORDINATES',20X,'BY THE ROTATED REFERENCE XP
                   *,ZP AXIS')
 0472               DO 64 I=1,32
 0473            64 WRITE(6,65)I,X(I),I,Z(I),I,XP(I),I,ZP(I)
 0474            65 FORMAT(1X,'X(',I3,')=',F7.3,5X,'Z(',I3,')=',F7.3,18X,'XP(',I3,')='
                   *,F7.3,5X,'ZP(',I3,')=',F7.3)
 0475               WRITE(6,661)TAND,XAC,ZAC,CHAND,ATANGD,T,XIBAR,ZIBAR,XZIBAR,PMI
 0476           661 FORMAT(1X,'THE ANGLE IN DEGREES BETWEEN X AND XP AXIS ',F9.3,/,' T
                   *HE LOCATION OF THE AERODYNAMIC CENTER  X=',F9.3,3X,'Z=',F9.3,/,' C
                   *HORD ANGLE IN DEGREES ',F9.3,5X,'ANGLE OF ATTACK IN DEGREES ',F9.3
                   *,/,' SKIN THICKNESS ',F9.3,/,' MOMENT OF INERTIA ABOUT THE X  AXIS
                   *',E12.5,/,' MOMENT OF INERTIA ABOUT THE Z  AXIS',E12.5,/,' PRODUCT
                   * OF INERTIA ABOUT THE  X,Z  AXIS ',E12.5,/,' POLAR MOMENT OF INERT
                   *IA ABOUT THE  X,Z  AXIS',E12.5)
 0477               WRITE(6,662)XBAR,ZBAR,VX,VZ,MZ,MX,TORQUE,TORQ,XSC,ZSC
 0478           662 FORMAT(/,' CENTROID LOCATION X=',F9.3,5X,'Z=',F9.3,/,' SHEAR IN TH
                   *E X  DIRECTION',E12.5,/,' SHEAR IN THE Z  DIRECTION',E12.5,/,' MOM
                   *ENT ABOUT THE Z  AXIS',E12.5,/,' MOMENT ABOUT THE X  AXIS',E12.5,/
                   *,' TORQUE ABOUT THE AERODYNAMIC CENTER ',E12.5,/,' TORQUE ABOUT TH
                   *E SHEAR CENTER ',E12.5,/,' SHEAR CENTER LOCATION X=',F9.3,5X,'Z=',
                   *F9.3)
 0479               IF(ICOUNT.GT.0)GO TO 500
 0480               WRITE(6,994)
 0481               WRITE(6,626)
 0482           626 FORMAT(1X,32X,'SIGN CONVENTION',/,28X,'NUMBER',5X,'DIRECTION',/,30
                   *X,'1',8X,'LEFT',/,30X,'2',8X,'UP LEFT',/,30X,'3',8X,'UP',/,30X,'4'
                   *,8X,'UP RIGHT',/,30X,'5',8X,'RIGHT',/,30X,'6',8X,'DOWN RIGHT',/,30
                   *X,'7',8X,'DOWN',/,30X,'8',8X,'DOWN LEFT')
 0483               WRITE(6,627)
 0484           627 FORMAT(//,30X,'SHEAR FLOWS DUE TO FORCES ACTING ALONG THE XP AXIS'
                   *,/)
 0485               DO 73 I=1,319,5
 0486               J=I+1
 0487               K=I+2
 0488               L=I+3
 0489               M=I+4
 0490            73 WRITE(6,74)I,IDRXXF(I),QXF(I),J,IDRXXF(J),QXF(J),K,IDRXXF(K),QXF(K
                   *),L,IDRXXF(L),QXF(L),M,IDRXXF(M),QXF(M)
 0491            74 FORMAT(1X,'QXF(',I3,')=',I2,E11.4,3X,'QXF(',I3,')=',I2,E11.4,3X,'Q
                   *XF(',I3,')=',I2,E11.4,3X,'QXF(',I3,')=',I2,E11.4,3X,'QXF(',I3,')='
                   *,I2,E11.4)
 0492               WRITE(6,994)
 0493               WRITE(6,628)
 0494           628 FORMAT(//,30X,'SHEAR FLOWS DUE TO FORCES ACTING ALONG THE ZP AXIS'
```

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                *,/)
0495             DO 75 I=1,319,5
0496             J=I+1
0497             K=I+2
0498             L=I+3
0499             M=I+4
0500          75 WRITE(6,76)I,IDRXZF(I),QZF(I),J,IDRXZF(J),QZF(J),K,IDRXZF(K),QZF(K
                *),L,IDRXZF(L),QZF(L),M,IDRXZF(M),QZF(M)
0501          76 FORMAT(1X,'QZF(',I3,')=',I2,E11.4,3X,'QZF(',I3,')=',I2,E11.4,3X,'Q
                *ZF(',I3,')=',I2,E11.4,3X,'QZF(',I3,')=',I2,E11.4,3X,'QZF(',I3,')='
                *,I2,E11.4)
0502             WRITE(6,994)
0503             WRITE(6,663)CAREA,OCONST
0504         663 FORMAT(/,' AREA OF CROSSECTION ',F9.3,/,' SHEAR FLOW IN SKIN DUE T
                *O TORQUE ABOUT SHEAR CENTER ',E12.5)
0505             WRITE(6,632)
0506         632 FORMAT(//,30X,'SHEAR FLOWS DUE TO TORQUE AND SHEAR LOADS APPLIED A
                *T THE AERODYNAMIC CENTER',/)
0507             DO 67 I=1,319,5
0508             J=I+1
0509             K=I+2
0510             L=I+3
0511             M=I+4
0512          67 WRITE(6,68)I,IDRX(I),Q(I),J,IDRX(J),Q(J),K,IDRX(K),Q(K),L,IDRX(L),
                *Q(L),M,IDRX(M),Q(M)
0513          68 FORMAT(1X,'Q(',I3,')=',I2,E11.4,3X,'Q(',I3,')=',I2,E11.4,3X,'Q(',I
                *3,')=',I2,E11.4,3X,'Q(',I3,')=',I2,E11.4,3X,'Q(',I3,')=',I2,E11.4)
0514             WRITE(6,994)
0515             WRITE(6,647)
0516         647 FORMAT(//,' NORMAL SKIN STRESSES  -(COMPRESSION)  +(TENSION)',//)
0517             DO 69 I=1,319,5
0518             J=I+1
0519             K=I+2
0520             L=I+3
0521             M=I+4
0522          69 WRITE(6,70)I,SIGMA(I),J,SIGMA(J),K,SIGMA(K),L,SIGMA(L),M,SIGMA(M)
0523          70 FORMAT(1X,'SIGMA(',I3,')=',E11.4,3X,'SIGMA(',I3,')=',E11.4,3X,'SIG
                *MA(',I3,')=',E11.4,3X,'SIGMA(',I3,')=',E11.4,3X,'SIGMA(',I3,')=',E
                *11.4)
0524             IF(YLOCAT.EQ.YM)GO TO 72
0525         500 WRITE(6,994)
0526             WRITE(6,71)
0527         994 FORMAT(1H1)
0528          71 FORMAT(11X,'YLOCAT',11X,'Z',16X,'X',13X,'TWIST',7X,'ABOUT THE X,Z
                *AXIS')
0529          72 IF(ISKIP.EQ.0)RETURN
0530             IF(YLOCAT.EQ.YM.AND.ICOUNT.EQ.0.AND.ISKIP.EQ.1)YLOCAT=0.0
0531             IF(YLOCAT.EQ.0.0.AND.ICOUNT.EQ.0.AND.ISKIP.EQ.1)GO TO 16
0532             RETURN
0533             END
```