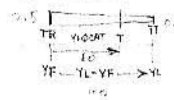
```
0001        REAL MX,MZ
0002        READ(5,100)S,DY
      C
      C  DEFLECTIONS AND TWISTS INITIALIZED TO ZERO AT THE WING ROOT
      C
0003        Z=0.0
0004        X=0.0
0005        TWIST=0.0
0006        ZANG=0.0
0007        XANG=0.0
0008        ANGZ=0.0
0009        ANGX=0.0
      C
      C  STARTING 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,E,G,XIBAR,ZIBAR,PMI,YLOCAT,ICOUNT,DY,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,E,G,XIBAR,ZIBAR,PMI,YLOCAT,ICOUNT,DY,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,F8.4,/,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=23.47
        C DRAG/IN AS A FUNCTION Y
0004          DRAG=121.6
        C TORQUE/IN AS A FUNCTION OF Y
0005          TORQUE=2.0
        C
        C
0006          GO TO (1,2,3),N
0007        1 FCN=LIFT
0008          GO TO 4
0009        2 FCN=DRAG
0010          GO TO 4
0011        3 FCN=TORQUE
0012        4 RETURN
0013          END
```

```
0001          SUBROUTINE SECT(VX,VZ,WX,WZ,E,G,XIBAR,ZIBAR,PMI,YLOCAT,ICOUNT,DY,M
             *X,MZ,S,TPNT,TDISTR)
0002          DIMENSION ITLEG(4),IARRY(4,5),ISENSE(4,5),IARRYW(3),LNO(13),LBEG(1
             *3),LEND(13),IV(13),IU(13),RX(100),RZ(100),TX(100),TZ(100),TF(100),
             *TT(100),YS(10),X(100),Z(100),T(100),AREAC(4),QXF(980),QZF(980),COF
             *T(4,3),IDRXZF(980),IDRXXF(980),QT(4),Q(980),IDRX(980),SIGMA(980),X
             *P(100),ZP(100),XX(980),ZZ(980),TE(980),LBEGN(13),LNON(13)
0003          REAL MOMENZ,MX,MZ,MXA,MZA,MXP,MZP
        C
        C  READ DATA IN, WRITE DATA OUT, IF FIRST TIME THROUGH SUBROUTINE SECT
        C
0004          IF(YLOCAT.NE.0.0)GO TO 175
0005          CALL INOUT(NCELL,NPNTS,NLEG,ITLEG,IARRY,ISENSE,IARRYW,LNO,LBEG,LEN
             *D,IV,IU,RX,RZ,TX,TZ,TR,TT,YF,YL,RXAC,RZAC,TXAC,TZAC,RHOS,RHOC,DC,A
             *TANGD,CHAND,E,G,NN,YS,NWEB)
        C
        C  REDEFINE LEG POINTS AND SIZE FOR EXPANDED COORDINATE SYSTEM
        C
0006          DO 360 ILEG=1,NLEG
0007          IF(IV(ILEG).NE.1)IV(ILEG)=10.0*(IV(ILEG)-1)
0008          IF(IU(ILEG).NE.1)IU(ILEG)=10.0*(IU(ILEG)-1)
0009          J=10*(LBEG(ILEG)-1)
0010          JJ=10*(LBEG(ILEG)+LNO(ILEG)-2)
0011          IF(LBEG(ILEG).EQ.1)J=1
0012          LBEGN(ILEG)=J
0013          LNON(ILEG)=JJ-LBEGN(ILEG)+1
0014      360 CONTINUE
        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 LOCATION
        C
        C
        C     ISKIP IS A SWITCH WHICH CAUSES THE SUBROUTINE TO EVALUATE
        C     THE MIDSPAN FIRST AND THEN THE ROOT FOR SHEAR CENTER LOCATION
        C         INITIALIZE SKIP VARIABLE
        C
0015          ISKIP=0
        C
        C     INITIALIZE SKIN AND CORE VOLUMES
        C
0016          SVOL=0.0
0017          CVOL=0.0
        C
        C     CALCULATE MIDSPAN LOCATION
        C
0018          YM=(YL-YF)/2.
        C
        C     CHANGE ANGLES TO RADIANS
        C
0019          ATTANG=ATANGD*2.*3.14159/360.
0020          CHANG=CHAND*2.*3.14159/360.
        C
        C     DIRECTION COSINES FOR (A.C.LINE, A LINE PERPENDICULAR TO THE A.C.LINE
        C     AND LYING IN THE YZ PLANE, A LINE PERPENDICULAR TO BOTH OF THESE)
        C
```

```
0021            UNIT=SQRT((TXAC-RXAC)**2+(TZAC-RZAC)**2+(YL-YF)**2)
0022            A1=(TXAC-RXAC)/UNIT
0023            B1=(YL-YF)/UNIT
0024            C1=(TZAC-RZAC)/UNIT
0025            A2=SQRT(1./((A1/B1)**2+1.))
0026            B2=-A2*A1/B1
0027            C2=0.
0028            VAR1=-B2/A2
0029            VAR2=-C1*VAR1/(A1*VAR1+B1)
0030            C3=SQRT(1./(1.+VAR1**2+VAR2**2))
0031            B3=-C3*C1/B1
0032            A3=B3*A1/B1
          C
          C     TEST STATE OF SUBROUTINE FOR CALCULATIONG SHEAR CENTER LOCATIONS
          C
0033        175 IF(YLOCAT.EQ.0.0.AND.ISKIP.EQ.0)YLOCAT=YM
          C
          C  THE AIRFOIL SHAPE AT SPAN LOCATION YLOCAT IS CALCULATED BY THE EQUATION OF
          C  A LINE IN THREE DIMENSIONS.
          C
0034            DO 180 I=1,NPNTS
0035            X(I)=((TX(I)-RX(I))*(YLOCAT-YF)/(YL-YF))+RX(I)
0036            Z(I)=((TZ(I)-RZ(I))*(YLOCAT-YF)/(YL-YF))+RZ(I)
0037            T(I)=((TR(I)-TR(I))*(YLOCAT-YF)/(YL-YF))+TR(I)
0038            XAC=((TXAC-RXAC)*(YLOCAT-YF)/(YL-YF))+RXAC
0039            ZAC=((TZAC-RZAC)*(YLOCAT-YF)/(YL-YF))+RZAC
0040            XP(I)=X(I)
0041            ZP(I)=Z(I)
0042            XACP=XAC
0043            ZACP=ZAC
0044        180 CONTINUE
          C
          C  THE CENTROID LOCATION, MOMENTS OF INERTIA, PRINCIPAL CENTROIDAL AXIS
          C  ORIENTATION, AND SKIN AREA AND VOLUME ARE CALCULATED AT EACH SECTION.
          C
0045            CALL CENTRD(NLEG,LBEG,LNO,XP,ZP,T,XBAR,ZBAR,XPBAR,ZPBAR,XIBAR,ZIBA
               *R,XIBARP,ZIBARP,XZIBAR,PMI,TANG,TAND,SVOL,CVOL,ISKIP,ICOUNT,DY,DC)
          C
          C     CELL AREA IS CALCULATED FOR EACH CELL AT EACH SECTION
          C
0046            DO 225 ICELL =1,NCELL
0047            AREA1=0.0
0048            AREA2=0.0
0049            IND=ITLEG(ICELL)
0050            DO 220 IORD=1,IND
0051            ILEG=IARRY(ICELL,IORD)
0052            L=LBEG(ILEG)
0053            K=L+LNO(ILEG)-2
0054            DO 220 I=L,K
0055            J=I+1
0056            DELTAX=(X(J)-X(I))*ISENSE(ICELL,IORD)
0057            AVGZ=(Z(J)+Z(I))/2.
0058            IF(DELTAX)215,215,210
0059        210 AREA1=AREA1+DELTAX*AVGZ
0060            GO TO 220
0061        215 AREA2=AREA2-DELTAX*AVGZ
0062        220 CONTINUE
0063            AREAC(ICELL)=AREA1-AREA2
```



$\frac{T-TT}{TR-TT} \neq \frac{YLOCAT-YF}{YL-YF} = \frac{T-TR}{TT-TR}$

```
  225 CONTINUE
C
C     THE MOMENTS, SHEAR FORCES, AND TORQUE ABOUT THE AERODYNAMIC CENTER
C     ARE CALCULATED AT EACH SECTION
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 230
      VZA=0.0
      MZA=0.0
      VXA=0.0
      MXA=0.0
      TORQUE=0.0
      GO TO 275
  230 F=YL-YLOCAT
      N1=500*F/YL
      N2=N1*4/5
      N=1
  235 CONTINUE
      U=YLOCAT
      H=F/N1
      SUM=FCN(U,N)+FCN(YL,N)
      DO 240 I=2,N1
      U=U+H
  240 SUM=SUM+FCN(U,N)*2.
      FORCE=H/2.*SUM
      IF(N.EQ.3)GO TO 250
      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 245 I=2,N2
      U=U+H
      UL=U-H
      US=US+H
      USL=US-H
  245 SUM=SUM+2.*FCN(USL,N)*UL+FCN(USL,N)*U+FCN(US,N)*UL
      MOMENT=H/4.*SUM
  250 GO TO(255,260,265),N
  255 VZA=FORCE
      MXA=MOMENT
      GO TO 270
  260 VXA=FORCE
      MZA=-MOMENT
      GO TO 270
  265 TORQUE=FORCE
  270 N=N+1
      IF(N.LT.4)GO TO 235
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
0114               275 SUB1=B1*WTA
0115                   SUB2=B1*TORQUE+B2*MXA+B3*MZA
0116                   SUB3=A1*TORQUE+A1*WTA*DY/2.+A2*MXA+A3*MZA
0117                   SUB4=C1*TORQUE+C1*WTA*DY/2.+C2*MXA+C3*MZA
0118                   WTA=SUB1
0119                   TORQUE=SUB2
0120                   MXA=SUB3
0121                   MZA=SUB4
                 C    FORCE VECTORS SUPERPOSED ON X,Y,Z AXIS
0122                   SUB5=A2*WXA+A3*WZA
0123                   SUB6=C2*WXA+C3*WZA
0124                   SUB7=A2*VXA+A3*VZA
0125                   SUB8=C2*VXA+C3*VZA
0126                   WXA=SUB5
0127                   WZA=SUB6
0128                   VXA=SUB7
0129                   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
0130                   TU=ATTANG-CHANG
0131                   VZ=VZA*COS(TU)-VXA*SIN(TU)
0132                   WZ=WZA*COS(TU)-WXA*SIN(TU)
0133                   VX=VZA*SIN(TU)+VXA*COS(TU)
0134                   WX=WZA*SIN(TU)+WXA*COS(TU)
0135                   MZ=MZA*COS(TU)-MXA*SIN(TU)
0136                   MX=MZA*SIN(TU)+MXA*COS(TU)
0137                   THETA=ATTANG-CHANG+TANG
0138                   VZP=VZA*COS(THETA)-VXA*SIN(THETA)
0139                   WZP=WZA*COS(THETA)-WXA*SIN(THETA)
0140                   VXP=VZA*SIN(THETA)+VXA*COS(THETA)
0141                   WXP=WZA*SIN(THETA)+WXA*COS(THETA)
0142                   MZP=MZA*COS(THETA)-MXA*SIN(THETA)
0143                   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
0144                   SM1=S-DY
0145                   IF(YLOCAT.EQ.SM1)WSKIN=RHCS*SVOL
0146                   IF(YLOCAT.EQ.SM1)WCORE=RHOC*CVOL
0147                   IF(YLOCAT.EQ.SM1)WRITE(6,280)WSKIN,WCORE
0148               280 FORMAT(1X,'SKIN WEIGHT= ',E12.5,/,1X,'CORE WEIGHT= ',E12.5)
                 C
                 C  CLEAR COORDINATE ARRAY
                 C
0149                   NPNT=10.0*(NPNTS-1)
0150                   DO 281 I=1,NPNT
0151                   XX(I)=0.0
0152                   ZZ(I)=0.0
0153                   TE(I)=0.0
0154               281 CONTINUE
                 C
                 C        FOR COMPUTING ACCURACY EACH LINE SEGMENT IN THE X,Z CORD. SYSTEM
                 C        IS BROKEN INTO TEN ADDITIONAL SEGMENTS WHICH FORMS A NEW
                 C                   EXPANDED XX,ZZ CORD. SYSTEM
```

```
            C
0155              DO 364 ILEG=1,NLEG
0156              L=LBEG(ILEG)
0157              K=L+LNO(ILEG)
0158              DO 364 I=L,K
0159              J=10.0*(I-1)
0160              IF(I.EQ.1)J=1
0161              XX(J)=XP(I)
0162              ZZ(J)=ZP(I)
0163              TE(J)=T(I)
0164          364 CONTINUE
            C
            C        SINCE THE FIRST SEGMENT OF THE FIRST LEG BEGINS WITH THE
            C        NUMBER ONE THEN THE FIRST SEGMENT IS DIVIDED INTO NINE INTERVALS.
            C
0165              I=1
0166              J=10
0167              DIFTE=TE(J)-TE(I)
0168              DELTAX=XX(J)-XX(I)
0169              DELTAZ=ZZ(J)-ZZ(I)
0170              DTE=DIFTE/9.0
0171              DX=DELTAX/9.0
0172              DZ=DELTAZ/9.0
0173              DO 365 N=1,8
0174              XX(I+N)=XX(I)+N*DX
0175              ZZ(I+N)=ZZ(I)+N*DZ
0176              TE(I+N)=TE(I)+N*DTE
0177          365 CONTINUE
0178              DO 370 ILEG=1,NLEG
0179              L=LBEGN(ILEG)
0180              K=L+LNON(ILEG)-2
0181              IF(ILEG.EQ.1)L=L+9
0182              DO 370 I=L,K,10
0183              J=I+10
0184              DIFTE=TE(J)-TE(I)
0185              DELTAX=XX(J)-XX(I)
0186              DELTAZ=ZZ(J)-ZZ(I)
0187              DTE=DIFTE/10.0
0188              DX=DELTAX/10.0
0189              DZ=DELTAZ/10.0
0190              DO 370 N=1,9
0191              M=I+N
0192              XX(M)=XX(I)+N*DX
0193              ZZ(M)=ZZ(I)+N*DZ
0194              TE(M)=TE(I)+N*DTE
0195          370 CONTINUE
            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
0196              IF(((YLOCAT.EQ.0.0).OR.(YLOCAT.EQ.YM)).AND.ICOUNT.EQ.0)GO TO 355
            C
            C  INFORMATION AT A SECTION SPECIFIED IN THE DATA IS PRINTED OUT.
            C
0197          349 DO 350 I=1,NN
0198              ITEST=YS(I)/DY
```

```
0199              IF(ITEST.EQ.ICOUNT)CALL SHEAR(VXP,VZP,ZIBARP,XIBARP,NLEG,LBEGN,LNO
                 *N,IV,IU,QXF,QZF,XX,ZZ,TE,XPBAR,ZPBAR,NCELL,ITLEG,IARRY,ISENSE,NWEB
                 *,IARRYW,COFT,IDRXZF,IDRXXF,ZACP,XACP,TANG,ZSC,XSC,ISKIP,ICOUNT,YLO
                 *CAT,TORQUE,Q,IDRX,SIGMA,MZP,MXP,ZSCM,ZSCF,XSCM,XSCF,NPNTS,WTA,WXP,
                 *WZP,YM,AREAC,TORQ,G,TPNT,TDISTR,DY,QT)
            C
            C   IF SPECIFIED WRITE OUT CALCULATED RESULTS
            C
0200              IF(ITEST.EQ.ICOUNT)CALL OUT(YLOCAT,NPNTS,X,Z,XP,ZP,TAND,XAC,ZAC,CH
                 *AND,ATANGD,XIBAR,ZIBAR,XZIBAR,PMI,XBAR,ZBAR,VX,VZ,MZ,MX,TORQUE,TOR
                 *Q,XSC,ZSC,IDRXXF,IDRXZF,QXF,QZF,IDRX,Q,SIGMA,YM,TPNT,TDISTR,QT,NCE
                 *LL)
0201          350 CONTINUE
0202              ZSC=((YLOCAT-YF)/(YM-YF))*(ZSCM-ZSCF)+ZSCF
0203              XSC=((YLOCAT-YF)/(YM-YF))*(XSCM-XSCF)+XSCF
0204              ZS=ZSC*COS(TANG)-XSC*SIN(TANG)
0205              XS=ZSC*SIN(TANG)+XSC*COS(TANG)
0206              ZSHEAR=ZS-ZACP
0207              XSHEAR=XS-XACP
            C
            C  WITH A SHEAR CENTER LOCATION THE TORQUE IS TRANSFERED FROM THE AERODYNAMIC
            C  CENTER TO THE SHEAR CENTER
            C
0208              TORQ=TORQUE-VZP*XSHEAR+VXP*ZSHEAR
0209              WT=WTA-WZP*XSHEAR+WXP*ZSHEAR
            C
            C  THE SHEAR FLOW DISTRIBUTION IS CALCULATED FOR TORQUE LOADS
            C
0210              CALL CELLT(NWEB,IARRYW,LBEGN,LNON,XX,ZZ,NCELL,ITLEG,IARRY,COFT,QT,
                 *AREAC,TPNT,TDISTR,WT,TORQ,YLOCAT,YM,ICOUNT,G,TE,DY)
0211              RETURN
            C
            C  THE FOLLOWING CALCULATES THE SHEAR FLOW DUE TO A SHEAR LOAD USING SUCCESSIVE
            C  APPROXIMATIONS, LOCATES SHEAR CENTER, AND ASSIGNS A SIGN BY NUMBER CONVENTION
            C                          TO EACH POINT
            C
0212          355 CALL SHEAR(VXP,VZP,ZIBARP,XIBARP,NLEG,LBEGN,LNON,IV,IU,QXF,QZF,XX,
                 *ZZ,TE,XPBAR,ZPBAR,NCELL,ITLEG,IARRY,ISENSE,NWEB,IARRYW,COFT,IDRXZF
                 *,IDRXXF,ZACP,XACP,TANG,ZSC,XSC,ISKIP,ICOUNT,YLOCAT,TORQUE,Q,IDRX,S
                 *IGMA,MZP,MXP,ZSCM,ZSCF,XSCM,XSCF,NPNTS,WTA,WXP,WZP,YM,AREAC,TORQ,G
                 *,TPNT,TDISTR,DY,QT)
0213              IF(YLOCAT.EQ.0.0.AND.ISKIP.EQ.0)GO TO 349
0214              IF(YLOCAT.EQ.YM.AND.ISKIP.EQ.1)YLOCAT=0.0
0215              IF(YLOCAT.EQ.0.0.AND.ISKIP.EQ.1)GO TO 175
0216              RETURN
0217              END
```

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FORTRAN IV G LEVEL  19              CENTRD              DATE = 74049          02/10/50               PAGE 0001

0001                SUBROUTINE CENTRD(NLEG,LBEG,LNO,XP,ZP,T,XBAR,ZBAR,XPBAR,ZPBAR,XIBA
                   *R,ZIBAR,XIBARP,ZIBARP,XZIBAR,PMI,TANG,TAND,SVOL,CVOL,ISKIP,ICOUNT,
                   *DY,DC)
0002                DIMENSION LBEG(13),LNO(13),XP(100),ZP(100),T(100)
0003                TANG=0.0
0004                ANG=0.0
0005            185 AREAT=0.0
0006                AXT=0
0007                AZT=0
0008                AXZT=0
0009                XIT=0
0010                ZIT=0
0011                CIRCUM=0.0
0012                DO 190 ILEG=1,NLEG
0013                L=LBEG(ILEG)
0014                K=L+LNO(ILEG)-2
0015                DO 190 I=L,K
0016                J=I+1
0017                DELTAX=XP(J)-XP(I)
0018                DELTAZ=ZP(J)-ZP(I)
0019                DIST=SQRT(DELTAX**2+DELTAZ**2)
0020                CIRCUM=DIST+CIRCUM
0021                TAVG=(T(J)+T(I))/2.0
0022                XIS=DIST*(TAVG**3)/12.0
0023                ZIS=TAVG*(DIST**3)/12.0
0024                SINANG=DELTAZ/DIST
0025                COSANG=DELTAX/DIST
0026                XIC=XIS*(COSANG**2)+ZIS*(SINANG**2)
0027                ZIC=XIS*(SINANG**2)+ZIS*(COSANG**2)
0028                AREA=DIST*TAVG
0029                XBARS=(XP(J)+XP(I))/2.0                                        ARNE
0030                ZBARS=(ZP(J)+ZP(I))/2.0                                        ARNE
0031                AX=AREA*XBARS
0032                AZ=AREA*ZBARS
0033                AXZ=AREA*XBARS*ZBARS
0034                AZSQD=AREA*(ZBARS**2)
0035                AXSQD=AREA*(XBARS**2)
0036                XI=XIC+AZSQD
0037                ZI=ZIC+AXSQD
0038                AREAT=AREA+AREAT
0039                AXT=AX+AXT
0040                AZT=AZ+AZT
0041                AXZT=AXZ+AXZT
0042                XIT=XI+XIT
0043                ZIT=ZI+ZIT
0044            190 CONTINUE
0045                XPBAR=AXT/AREAT
0046                ZPBAR=AZT/AREAT
0047                XIBARP=XIT-AREAT*(ZPBAR**2)
0048                ZIBARP=ZIT-AREAT*(XPBAR**2)
0049                XZIBRP=AXZT-AREAT*XPBAR*ZPBAR
0050                PMIP=XIBARP+ZIBARP
0051                IF(ANG.EQ.0.0)XBAR=XPBAR
0052                IF(ANG.EQ.0.0)ZBAR=ZPBAR
0053                IF(ANG.EQ.0.0)XIBAR=XIBARP
0054                IF(ANG.EQ.0.0)ZIBAR=ZIBARP
0055                IF(ANG.EQ.0.0)XZIBAR=XZIBRP
0056                IF(ANG.EQ.0.0)PMI=PMIP
```

```
0057            Y=2.*XZIBPP
0058            W=ZIBARP-XIBARP
0059            IF(Y.LT.0.001) GO TO 205
0060            ANG=ATAN2(Y,W)/2.
0061            TANG=TANG+ANG
0062            DO 200 I=1,NPNTS
0063            XP(I)=XP(I)*COS(ANG)+ZP(I)*SIN(ANG)
0064        200 ZP(I)=-XP(I)*SIN(ANG)+ZP(I)*COS(ANG)
0065            XACP=XACP*COS(ANG)+ZACP*SIN(ANG)
0066            ZACP=-XACP*SIN(ANG)+ZACP*COS(ANG)
0067            GO TO 185
0068        205 TAND=TANG*360./(2.*3.14159)
          C
          C     THIN SKIN WEIGHT CALCULATED FOR EACH SECTION
          C
0069            IF(ISKIP.EQ.1.OR.ICOUNT.GT.0)SVOL=AREAT*DY+SVOL
0070            IF(ISKIP.EQ.1.OR.ICOUNT.GT.0)CVOL=CIRCUM*DC*DY+CVOL
0071            RETURN
0072            END
```

```
0001          SUBROUTINE SHEAR(VXP,VZP,ZIBARP,XIBARP,NLEG,LBEG,LNO,IV,IU,QXF,QZF
             *,XX,ZZ,TE,XPBAR,ZPBAR,NCELL,ITLEG,IARRY,ISENSE,NWEB,IARRYW,COEFT,ID
             *RXZF,IDRXXF,ZACP,XACP,TANG,ZSC,XSC,ISKIP,ICOUNT,YLOCAT,TORQUE,Q,ID
             *RX,SIGMA,MZP,MXP,ZSCM,ZSCF,XSCM,XSCF,NPNTS,WTA,WXP,WZP,YM,AREAC,TO
             *RQ,G,TPNT,TDISTR,DY,QT)
0002          DIMENSION LBEG(13),LNO(13),QXF(980),QZF(980),XX(980),ZZ(980),TE(98
             *0),ITLEG(4),IARRY(4,5),ISENSE(4,5),IARRYW(3),WLDIVT(3),CLDIVT(3),C
             *OFT(4,3),QXR(4),QXL(4),QZR(4),QZL(4),QVX(4),QVZ(4),IDRXZF(980),IDR
             *XXF(980),QT(4),Q(980),IDRX(980),SIGMA(980),IU(13),IV(13),AREAC(4),
             *QVXA(4),QVZA(4)
0003          REAL LDIVT,MAXQZF,MAXQXF,MXFY,MZFY,MZP,MXP
        C
        C  CLEAR ARRAYS
        C
0004          NPNT=10.0*(NPNTS-1)
0005          DO 374 I=1,NPNT
0006          IDRXXF(I)=0.0
0007          IDRXZF(I)=0.0
0008          QXF(I)=0.0
0009          QZF(I)=0.0
0010          IDRX(I)=0.0
0011          Q(I)=0.0
0012          SIGMA(I)=0.0
0013      374 CONTINUE
        C
        C        WITH THE NEW EXPANDED COORDINATE SYSTEM THE PROGRAM PROCEEDS TO
        C        CALCULATE SHEAR FLOWS FOR THE OPEN CELLS DUE TO SHEAR LOADS.
        C
0014          QXF(1)=0.
0015          QZF(1)=0.
0016          CONXF=-VXP/ZIBARP
0017          CONZF=-VZP/XIBARP
0018          DO 375 ILEG=1,NLEG
0019          L=LBEG(ILEG)
0020          K=L+LNO(ILEG)-2
0021          QXF(L)=QXF(IV(ILEG))+QXF(IU(ILEG))
0022          QZF(L)=QZF(IV(ILEG))+QZF(IU(ILEG))
0023          DO 375 I=L,K
0024          J=I+1
0025          DELTAX=XX(J)-XX(I)
0026          DELTAZ=ZZ(J)-ZZ(I)
0027          DIST=SQRT(DELTAX**2+DELTAZ**2)
0028          TAVG=(TE(J)+TE(I))/2.0
0029          XH=(XX(J)+XX(I))/2.0
0030          ZH=(ZZ(J)+ZZ(I))/2.0
0031          AREA=TAVG*DIST
0032          XCENT=XH-XPBAR
0033          ZCENT=ZH-ZPBAR
0034          QXF(J)=QXF(I)+CONXF*XCENT*AREA
0035          QZF(J)=QZF(I)+CONZF*ZCENT*AREA
0036      375 CONTINUE
        C
        C        BEFORE ITERATING ON Q THE PROPER SIGN IS ASSIGNED
        C        BY MULTIPLYING THE Q'S BY THE SENSE VARIABLE.  WITH
        C        CORRECT SIGNS FOR Q, THE FIRST Q APPROXIMATIONS
        C            ARE CALCULATED FOR EACH CELL
        C
0037          DO 385 ICELL=1,NCELL
```

```
      INO=ITLEG(ICELL)
      LDIVT=0.0
      DELXF=0.0
      DELZF=0.0
      DO 380 IORD=1,INO
      ILEG=IARRY(ICELL,IORD)
      L=LBEG(ILEG)
      K=L+LNC(ILEG)-2
      ISENS=ISENSE(ICELL,IORD)
      DO 380 I=L,K
      J=I+1
      DELTAX=XX(J)-XX(I)
      DELTAZ=ZZ(J)-ZZ(I)
      DIST=SQRT(DELTAX**2+DELTAZ**2)
      QXFI=ISENS*QXF(I)
      QZFI=ISENS*QZF(I)
      QXFJ=ISENS*QXF(J)
      QZFJ=ISENS*QZF(J)
      QAVXF=(QXFJ+QXFI)/2.0
      QAVZF=(QZFJ+QZFI)/2.0
      TAVG=(TE(J)+TE(I))/2.0
      DELXF=DELXF+QAVXF*DIST/TAVG
      DELZF=DELZF+QAVZF*DIST/TAVG
      LDIVT=LDIVT+DIST/TAVG
  380 CONTINUE
      QVX(ICELL)=-DELXF/LDIVT
      QVZ(ICELL)=-DELZF/LDIVT
      QVXA(ICELL)=QVX(ICELL)
      QVZA(ICELL)=QVZ(ICELL)
  385 CONTINUE
C
C   CALCULATE CARRY OVER FACTORS, CELL 1-2, CELL 2-1, CELL 2-3, CELL 3-2 ETC.
C
      DO 286 IWEB=1,NWEB
      WLDIVT(IWEB)=0.
      ILEG=IARRYW(IWEB)
      L=LBEG(ILEG)
      K=L+LNC(ILEG)-2
      DO 285 I=L,K
      J=I+1
      DELTAX=XX(J)-XX(I)
      DELTAZ=ZZ(J)-ZZ(I)
      DIST=SQRT(DELTAX**2+DELTAZ**2)
      TAVG=(TE(J)+TE(I))/2.0
      WLDIVT(IWEB)=WLDIVT(IWEB)+DIST/TAVG
  285 CONTINUE
  286 CONTINUE
      DO 295 IWEB=1,NWEB
      ICELW=IWEB+1
      DO 295 ICELL=IWEB,ICELW
      CLDIVT(ICELL)=0.
      INO=ITLEG(ICELL)
      DO 290 IORD=1,INO
      ILEG=IARRY(ICELL,IORD)
      L=LBEG(ILEG)
      K=L+LNC(ILEG)-2
      DO 290 I=L,K
      J=I+1
```

```
0093          DELTAX=XX(J)-XX(I)
0094          DELTAZ=ZZ(J)-ZZ(I)
0095          DIST=SQRT(DELTAX**2+DELTAZ**2)
0096          TAVG=(TE(J)+TE(I))/2.0
0097          CLDIVT(ICELL)=CLDIVT(ICELL)+DIST/TAVG
0098      290 CONTINUE
0099          COFT(ICELL,IWEB)=WLDIVT(IWEB)/CLDIVT(ICELL)
0100      295 CONTINUE
        C
        C        WITH AN INITIAL QUESS FOR Q IN EACH CELL THE ITERATION ON Q STARTS
        C
0101          QXR(1)=0.0
0102          QZR(1)=0.0
0103          QXL(NCELL)=0.0
0104          QZL(NCELL)=0.0
0105          QTOLRX=ABS(QVX(1)/100000.)
0106          QTOLRZ=ABS(QVZ(1)/100000.)
0107          DO 400 I=1,100
0108          DO 390 ICELL=2,NCELL
0109          IWEB=ICELL-1
0110          QXR(ICELL)=COFT(ICELL,IWEB)*QVXA(ICELL-1)
0111          QVX(ICELL)=QVX(ICELL)+QXR(ICELL)
0112          QZR(ICELL)=COFT(ICELL,IWEB)*QVZA(ICELL-1)
0113          QVZ(ICELL)=QVZ(ICELL)+QZR(ICELL)
0114      390 CONTINUE
0115          DO 395 ICELB=2,NCELL
0116          ICELL=NCELL-(ICELB-1)
0117          IWEB=ICELL
0118          QXL(ICELL)=COFT(ICELL,IWEB)*QVXA(ICELL+1)
0119          QVX(ICELL)=QVX(ICELL)+QXL(ICELL)
0120          QZL(ICELL)=COFT(ICELL,IWEB)*QVZA(ICELL+1)
0121          QVZ(ICELL)=QVZ(ICELL)+QZL(ICELL)
0122      395 CONTINUE
0123          DO 396 ICELL=1,NCELL
0124          QVXA(ICELL)=QXR(ICELL)+QXL(ICELL)
0125          QVZA(ICELL)=QZR(ICELL)+QZL(ICELL)
0126      396 CONTINUE
0127          IF(ABS(QXL(1)).LT.QTOLRX.AND.ABS(QZL(1)).LT.QTOLRZ)GO TO 404
0128      400 CONTINUE
0129          WRITE(6,405)QTOLRX,QTOLRZ,ICELL,QVXL,QVZL
0130      405 FORMAT(1H1,'SUCCESSIVE APPROXIMATIONS FOR CALCULATING SHEAR FLOW D
             *UE TO SHEAR LOAD DID NOT CONVERGE',/,' MIN. TOLERANCE OF',E10.3,'F
             *OR X SHEAR LOAD',E10.3,'FOR Z SHEAR LOAD IN 100 ITERATIONS',/,' LA
             *ST SHEAR FLOW INCREMENT FOR CELL',I2,'WAS',E10.3,'  FOR X SHEAR',E
             *10.3,'FOR Z SHEAR')
        C
        C        THE SUMMATION OF THE CARRIED OVER Q'S ARE NOW ADDED TO FORM
        C        THE SHEAR FLOW DISTRIBUTION FOR THE CLOSED CELLS DUE TO SHEAR LOADS
        C
0131      404 IWEB=1
0132          DO 410 ICELL=1,NCELL
0133          INO=ITLEG(ICELL)
0134          DO 410 IORD=1,INO
0135          ILEG=IARRY(ICELL,IORD)
0136          L=LBEG(ILEG)
0137          K=L+LNO(ILEG)-1
0138          ISENS=ISENSE(ICELL,IORD)
0139          IF(ICELL.GT.IWEB.AND.ILEG.EQ.IARRYW(IWEB))ISENS=-ISENS
```

```
0140            IF(ICELL.GT.IWEB.AND.ILEG.EQ.IARRYW(IWEB))IWEB=IWEB+1
0141            DO 410 I=L,K
0142            QXF(I)=ISENS*QXF(I)+QVX(ICELL)
0143            QZF(I)=ISENS*QZF(I)+QVZ(ICELL)
0144        410 CONTINUE
          C
          C  STARTING AT 1 CALCULATE FORCE COMPONENTS
          C  AND ITS MOMENTS ABOUT THE AERODYNAMIC CENTER
          C  FOR LOCATION OF THE SHEAR CENTER
0145            MXFY=0.
0146            MZFY=0.
0147            DO 542 ICELL=1,NCELL
0148            IND=ITLEG(ICELL)
0149            DO 541 IORD=1,IND
0150            ILEG=IARRY(ICELL,IORD)
0151            IF(ILEG.EQ.IARRYW(ICELL))GO TO 541
0152            L=LBEG(ILEG)
0153            K=L+LNC(ILEG)-2
0154            DO 540 I=L,K
0155            J=I+1
0156            QAVXF=(QXF(J)+QXF(I))/2.0
0157            QAVZF=(QZF(J)+QZF(I))/2.0
0158            DELTAX=XX(J)-XX(I)
0159            DELTAZ=ZZ(J)-ZZ(I)
0160            DIST=SQRT(DELTAX**2+DELTAZ**2)
0161            EFXF=QAVXF*DIST
0162            EFZF=QAVZF*DIST
0163            SINANG=DELTAZ/DIST
0164            COSANG=DELTAX/DIST
0165            XEFXF=-EFXF*COSANG*ISENSE(ICELL,IORD)
0166            ZEFXF=-EFXF*SINANG*ISENSE(ICELL,IORD)
0167            XEFZF=-EFZF*COSANG*ISENSE(ICELL,IORD)
0168            ZEFZF=-EFZF*SINANG*ISENSE(ICELL,IORD)
0169            XH=(XX(J)+XX(I))/2.
0170            ZH=(ZZ(J)+ZZ(I))/2.
0171            ZTAC=ZH-ZACP
0172            XTAC=XH-XACP
0173            MZFY=MZFY-(ZEFZF*XTAC)+(XEFZF*ZTAC)
0174            MXFY=MXFY-(ZEFXF*XTAC)+(XEFXF*ZTAC)
          C
          C  DIRECTION OF QZF'S
          C
0175            IF(ZEFZF)430,431,432
0176        430 IF(XEFZF)438,439,440
0177        431 IF(XEFZF)437,441,433
0178        432 IF(XEFZF)436,435,434
0179        433 IDRXZF(I)=1
0180            GO TO 442
0181        434 IDRXZF(I)=2
0182            GO TO 442
0183        435 IDRXZF(I)=3
0184            GO TO 442
0185        436 IDRXZF(I)=4
0186            GO TO 442
0187        437 IDRXZF(I)=5
0188            GO TO 442
0189        438 IDRXZF(I)=6
0190            GO TO 442
```

```
  439 IDRXZF(I)=7
      GO TO 442
  440 IDRXZF(I)=8
      GO TO 442
  441 IDRXZF(I)=9
C
C  DIRECTION OF QXF'S
C
  442 IF(ZEFXF)530,531,532
  530 IF(XEFXF)526,527,528
  531 IF(XEFXF)525,529,521
  532 IF(XEFXF)524,523,522
  521 IDRXXF(I)=1
      GO TO 540
  522 IDRXXF(I)=2
      GO TC 540
  523 IDRXXF(I)=3
      GO TC 540
  524 IDRXXF(I)=4
      GO TC 540
  525 IDRXXF(I)=5
      GO TC 540
  526 IDRXXF(I)=6
      GO TO 540
  527 IDRXXF(I)=7
      GO TC 540
  528 IDRXXF(I)=8
      GO TO 540
  529 IDRXXF(I)=9
  540 CONTINUE
  541 CONTINUE
  542 CONTINUE
C
C  CALCULATE SHEAR CENTER BY BALANCING PREVIOUSLY CALCULATED MOMENTS
C
      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
      WT=WTA-WZP*XSHEAR+WXP*ZSHEAR
C
C  THE SHEAR FLOW DISTRIBUTION IS CALCULATED FOR TORQUE LOADS
C
      CALL CELLT(NWEB,IARRYW,LBEG,LNO,XX,ZZ,NCELL,ITLEG,IARRY,COFT,QT,AR
     *EAC,TPNT,TDISTR,WT,TORQ,YLOCAT,YM,ICOUNT,G,TE,DY)
C
C  BREAK SHEAR FLOW DUE TO TORQUE LOAD INTO FORCES IN THE X,Z DIRECTION
C  AND THEN SUM UP ALL FORCES DUE TO SHEAR LOADS
C
```

```
      DO 835 ICELL=1,NCELL
      INO=ITLEG(ICELL)
      ICELLM=ICELL-1
      DO 834 IORD=1,INO
      ILEG=IARRY(ICELL,IORD)
      IF(ILEG.EQ.IARRYW(ICELL))GO TO 834
      L=LBEG(ILEG)
      K=L+LNO(ILEG)-2
      DO 833 I=L,K
      J=I+1
      DELTAX=XX(J)-XX(I)
      DELTAZ=ZZ(J)-ZZ(I)
      DIST=SQRT(DELTAX**2+DELTAZ**2)
      QAVXF=QXF(I)
      QAVZF=QZF(I)
      QAVT=QT(ICELL)
      IF(ICELLM.EQ.0)GO TO 619
      IF(ILEG.EQ.IARRYW(ICELLM))QAVT=QT(ICELL)-QT(ICELLM)
  619 SINANG=DELTAZ/DIST
      COSANG=DELTAX/DIST
      EFXF=QAVXF*DIST
      EFZF=QAVZF*DIST
      EFT=QAVT*DIST
      XEFT=-EFT*COSANG*ISENSE(ICELL,IORD)
      ZEFT=-EFT*SINANG*ISENSE(ICELL,IORD)
      XEFXF=-EFXF*COSANG*ISENSE(ICELL,IORD)
      ZEFXF=-EFXF*SINANG*ISENSE(ICELL,IORD)
      XEFZF=-EFZF*COSANG*ISENSE(ICELL,IORD)
      ZEFZF=-EFZF*SINANG*ISENSE(ICELL,IORD)
      XEFF=XEFT+XEFZF+XEFXF
      ZEFF=ZEFT+ZEFZF+ZEFXF
      EFF=SQRT(ZEFF**2+XEFF**2)
      Q(I)=EFF/DIST
C
C  DIRECTION OF Q'S
C
      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 833
  822 IDRX(I)=2
  823 IDRX(I)=3
      GO TO 833
  824 IDRX(I)=4
      GO TO 833
  825 IDRX(I)=5
      GO TO 833
  826 IDRX(I)=6
      GO TO 833
  827 IDRX(I)=7
      GO TO 833
  828 IDRX(I)=8
      GO TO 833
  829 IDRX(I)=9
  833 CONTINUE
  834 CONTINUE
```

```
0290          835 CONTINUE
          C
          C  CALCULATES THE NORMAL STRESS DISTRIBUTION IN THE SKIN AT EACH LOCATION.
          C          MINUS(COMPRESSION)      PLUS(TENSION)
          C
0291              DO 840 ILEG=1,NLEG
0292              L=LBEG(ILEG)
0293              K=L+LNO(ILEG)-1
0294              DO 840 I=L,K
0295              D=XX(I)-XPBAR
0296              V=ZZ(I)-ZPBAR
0297              SIGMAX=-MZP*D/ZIBARP
0298              SIGMAZ=-MXP*V/XIBARP
0299          840 SIGMA(I)=SIGMAX+SIGMAZ
0300              RETURN
0301              END
```

```
0001          SUBROUTINE CELLT(NWEB,IARRYW,LBEG,LNO,XX,ZZ,NCELL,ITLEG,IARRY,COFT
             *,QT,AREAC,TPNT,TDISTR,WT,TORQ,YLOCAT,YM,ICOUNT,G,TE,DY)
0002          DIMENSION IARRYW(3),LBEG(13),LNO(13),XX(980),ZZ(980),IARRY(4,5),AR
             *EAC(4),CLDIVT(4),COFT(4,3),QI(4,3),QT(4),THETA(4),WLDIVT(3),TE(980
             *),QTD(4),THETAD(4),ITLEG(4),QTA(4),QTR(4),CTL(4)
        C
        C     TWISTING DEFLECTIONS ARE CALCULATED FOR EACH SECTION AS A FUNCTION OF THE
        C     SHEAR FLOW DISTRIBUTION IN THE SKIN DUE TO TORQUE LOAD.  THE SHEAR FLOW
        C     DISTRIBUTION OF A MULTI-CELL SECTION IS FOUND BY A METHOD OF SUCCESSIVE
        C                              CORRECTIONS
        C
        C
        C    CALCULATE CARRY OVER FACTORS, CELL 1-2, CELL 2-1, CELL 2-3, CELL 3-2 ETC.
        C
0003          ISW=0
0004          IF(TORQ.EQ.0.0)ISW=1
0005          DO 285 IWEB=1,NWEB
0006          WLDIVT(IWEB)=0.
0007          ILEG=IARRYW(IWEB)
0008          L=LBEG(ILEG)
0009          K=L+LNO(ILEG)-2
0010          DO 285 I=L,K
0011          J=I+1
0012          DELTAX=XX(J)-XX(I)
0013          DELTAZ=ZZ(J)-ZZ(I)
0014          DIST=SQRT(DELTAX**2+DELTAZ**2)
0015          TAVG=(TE(J)+TE(I))/2.0
0016          WLDIVT(IWEB)=WLDIVT(IWEB)+DIST/TAVG
0017      285 CONTINUE
0018          DO 295 IWEB=1,NWEB
0019          ICELW=IWEB+1
0020          DO 295 ICELL=IWEB,ICELW
0021          CLDIVT(ICELL)=0.
0022          INO=ITLEG(ICELL)
0023          DO 290 IORD=1,INO
0024          ILEG=IARRY(ICELL,IORD)
0025          L=LBEG(ILEG)
0026          K=L+LNO(ILEG)-2
0027          DO 290 I=L,K
0028          J=I+1
0029          DELTAX=XX(J)-XX(I)
0030          DELTAZ=ZZ(J)-ZZ(I)
0031          DIST=SQRT(DELTAX**2+DELTAZ**2)
0032          TAVG=(TE(J)+TE(I))/2.0
0033          CLDIVT(ICELL)=CLDIVT(ICELL)+DIST/TAVG
0034      290 CONTINUE
0035          COFT(ICELL,IWEB)=WLDIVT(IWEB)/CLDIVT(ICELL)
0036      295 CONTINUE
        C
        C     CALCULATE Q INDIVIDUALLY FOR EACH CELL ASSUMING G*THETA=1
        C
0037          DO 300 ICELL=1,NCELL
0038          QT(ICELL)=2.*AREAC(ICELL)/CLDIVT(ICELL)
0039          QTA(ICELL)=QT(ICELL)
0040      300 CONTINUE
        C
        C     USING CARRY OVER FACTORS SUMATE Q'S CARRIED OVER FROM CELL TO CELL
        C
```

```
0041          QTR(1)=0.0
0042          QTL(NCELL)=0.0
0043          QTOLR=ABS(QT(1)/100000.)
0044          DO 315 I=1,100
0045          DO 305 ICELL=2,NCELL
0046          IWEB=ICELL-1
0047          QTR(ICELL)=COFT(ICELL,IWEB)*QTA(ICELL-1)
0048          QT(ICELL)=QT(ICELL)+QTR(ICELL)
0049      305 CONTINUE
0050          DO 310 ICELB=2,NCELL
0051          ICELL=NCELL-(ICELB-1)
0052          IWEB=ICELL
0053          QTL(ICELL)=COFT(ICELL,IWEB)*QTA(ICELL+1)
0054          QT(ICELL)=QT(ICELL)+QTL(ICELL)
0055      310 CONTINUE
0056          DO 311 ICELL=1,NCELL
0057          QTA(ICELL)=QTR(ICELL)+QTL(ICELL)
0058      311 CONTINUE
0059          IF(ABS(QTL(1)).LT.QTOLR)GO TO 320
0060      315 CONTINUE
        C
        C  CALCULATE TORQUE IN EACH CELL WHERE TWIST*G WAS ASSUMED UNITY.  THEN
        C  CALCULATE CORRECTED SHEAR FLOW IN EACH CELL AND TWIST
        C
0061      320 T2AQ=0.0
0062          DO 335 ICELL=1,NCELL
0063          T2AQ=T2AQ+2.*AREAC(ICELL)*QT(ICELL)
0064      335 CONTINUE
0065          DO 340 ICELL=1,NCELL
0066          IF(ISW.EQ.0)QT(ICELL)=TORQ*QT(ICELL)/T2AQ
0067          IF(ISW.EQ.1)QT(ICELL)=1.0*QT(ICELL)/T2AQ
0068      340 CONTINUE
0069          DO 341 ICELL=1,NCELL
0070          ICELLP=ICELL+1
0071          ICELLM=ICELL-1
0072          IF(ICELL.EQ.NCELL)THETA(ICELL)=((QT(ICELL)-QT(ICELLM))*WLDIVT(ICEL
             *LM)+QT(ICELL)*(CLDIVT(ICELL)-WLDIVT(ICELLM)))*DY/(2.*AREAC(ICELL)*
             *G)
0073          IF(ICELL.EQ.1)THETA(ICELL)=((QT(ICELL)-QT(ICELLP))*WLDIVT(ICELL)+Q
             *T(ICELL)*(CLDIVT(ICELL)-WLDIVT(ICELL)))*DY/(2.*AREAC(ICELL)*G)
0074          IF(ICELL.GT.1.AND.ICELL.LT.NCELL)THETA(ICELL)=((QT(ICELL)-QT(ICELL
             *P))*WLDIVT(ICELL)+(QT(ICELL)-QT(ICELLM))*WLDIVT(ICELLM)+QT(ICELL)*
             *(CLDIVT(ICELL)-WLDIVT(ICELLM)-WLDIVT(ICELL)))*DY/(2.*AREAC(ICELL)*
             *G)
0075      341 CONTINUE
0076          TPNT=THETA(1)
0077          IF(ISW.EQ.1)TPNT=0.0
0078          IF(ISW.EQ.0)TDISTR=THETA(1)*WT*DY/(2.0*TORQ)
0079          IF(ISW.EQ.1)TDISTR=THETA(1)*WT*DY/2.0
0080          DIFFT=THETA(1)-THETA(2)
0081          TOLRT=THETA(1)/1000.
0082          IF(ABS(TOLRT).LT.ABS(DIFFT))WRITE(6,345)THETA(1),THETA(2)
0083      345 FORMAT(' THE TWIST FOR THE FIRST TWO CELLS ARE NOT EQUAL',/,' CELL
             *1 TWIST=',E10.3,' CELL2 TWIST=',E10.3)
0084          RETURN
0085          END
```

```
0001             SUBROUTINE OUT(YLOCAT,NPNTS,X,Z,XP,ZP,TAND,XAC,ZAC,CHAND,ATANGD,XI
                *BAR,ZIBAR,XZIBAR,PMI,XBAR,ZBAR,VX,VZ,MZ,MX,TORQUE,TORQ,XSC,ZSC,IDR
                *XXF,IDRXZF,QXF,QZF,IDRX,Q,SIGMA,YM,TPNT,TDISTR,QT,NCELL)
0002             DIMENSION X(100),Z(100),XP(100),ZP(100),IDRXXF(980),IDRXZF(980),QX
                *F(980),QZF(980),IDRX(980),Q(980),SIGMA(980),QT(4)
0003             REAL MZ,MX
           C
           C  WRITE OUT VALUES CALCULATED
           C
0004             NPNT=10.0*(NPNTS-1)
0005         845 WRITE(6,965)
0006             WRITE(6,850)YLOCAT
0007         850 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')
0008             DO 855 I=1,NPNTS
0009         855 WRITE(6,860)I,X(I),I,Z(I),I,XP(I),I,ZP(I)
0010         860 FORMAT(1X,'X(',I3,')=',F7.3,5X,'Z(',I3,')=',F7.3,18X,'XP(',I3,')='
                *,F7.3,5X,'ZP(',I3,')=',F7.3)
0011             WRITE(6,865)TAND,XAC,ZAC,CHAND,ATANGD,XIBAR,ZIBAR,XZIBAR,PMI
0012         865 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
                *,/,' MOMENT OF INERTIA ABOUT THE X  AXIS',E12.5,/,' MOMENT OF INER
                *TIA ABOUT THE Z  AXIS',E12.5,/,' PRODUCT OF INERTIA ABOUT THE  X,Z
                *  AXIS ',E12.5,/,' POLAR MOMENT OF INERTIA ABOUT THE  X,Z  AXIS',E
                *12.5)
0013             WRITE(6,870)XBAR,ZBAR,VX,VZ,MZ,MX,TORQUE,TORQ,XSC,ZSC
0014         870 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)
0015             WRITE(6,871)TPNT,TDISTR
0016         871 FORMAT(1X,'TWIST POINT LOAD=',E12.5,/,' TWIST DISTRIBUTED LOAD',E1
                *2.5)
0017             WRITE(6,965)
0018             WRITE(6,875)
0019         875 FORMAT(1X,'SIGN CONVENTION  1=LEFT, 2=UP LEFT, 3=UP, 4=UP RIGHT, 5
                *=RIGHT, 6=DOWN RIGHT, 7=DOWN, 8=DOWN LEFT')
0020             WRITE(6,880)
0021         880 FORMAT(/,30X,'SHEAR FLOWS DUE TO FORCES ACTING ALONG THE XP AXIS')
0022             DO 885 I=1,NPNT,5
0023             J=I+1
0024             K=I+2
0025             L=I+3
0026             M=I+4
0027         885 WRITE(6,890)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)
0028         890 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)
0029             WRITE(6,965)
0030             WRITE(6,895)
0031         895 FORMAT(/,30X,'SHEAR FLOWS DUE TO FORCES ACTING ALONG THE ZP AXIS')
0032             DO 900 I=1,NPNT,5
0033             J=I+1
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0034              K=I+2
0035              L=I+3
0036              M=I+4
0037          900 WRITE(6,905)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)
0038          905 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)
0039              WRITE(6,965)
0040              WRITE(6,910)(ICELL,QT(ICELL),ICELL=1,NCELL)
0041          910 FORMAT(1X,'SHEAR FLOWS DUE TO TORQUE ABOUT AERODYNAMIC CENTER',4('
                 * QT(',I1,')=',F12.5))
0042              WRITE(6,930)
0043          930 FORMAT(/,30X,'SHEAR FLOWS DUE TO TORQUE AND SHEAR LOADS APPLIED AT
                 * THE AERODYNAMIC CENTER')
0044              DO 935 I=1,NPNT,5
0045              J=I+1
0046              K=I+2
0047              L=I+3
0048              M=I+4
0049          935 WRITE(6,940)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)
0050          940 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)
0051              WRITE(6,965)
0052              WRITE(6,945)
0053          945 FORMAT(1X'NORMAL SKIN STRESSES  -(COMPRESSION)  +(TENSION)',/)
0054              DO 950 I=1,NPNT,5
0055              J=I+1
0056              K=I+2
0057              L=I+3
0058              M=I+4
0059          950 WRITE(6,955)I,SIGMA(I),J,SIGMA(J),K,SIGMA(K),L,SIGMA(L),M,SIGMA(M)
0060          955 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)
0061              WRITE(6,965)
0062              WRITE(6,970)
0063          965 FORMAT(1H1)
0064          970 FORMAT(11X,'YLOCAT',12X,'Z',17X,'X',17X,'TWIST',7X,'ABOUT THE X,Z
                 *AXIS')
0065              RETURN
0066              END
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0001           SUBROUTINE INOUT(NCELL,NPNTS,NLEG,ITLEG,IARRY,ISENSE,IARRYW,LNO,LB
              *EG,LEND,IV,IU,RX,RZ,TX,TZ,TR,TT,YF,YL,RXAC,RZAC,TXAC,TZAC,RHOS,RHO
              *C,DC,ATANGD,CHAND,E,G,NN,YS,NWEB)
0002           DIMENSION ITLEG(4),IARRY(4,5),ISENSE(4,5),IARRYW(3),LNO(13),LBEG(1
              *3),LEND(13),IV(13),IU(13),RX(100),RZ(100),TX(100),TZ(100),TR(100),
              *TT(100),YS(10)
         C
         C            NUMBER OF CELLS
         C
0003         5 READ(5,6)NCELL
0004         6 FORMAT(16X,I1)
         C
         C            NUMBER OF POINTS DEFINING SHAPE OF CROSSECTION
         C
0005           READ(5,10)NPNTS
0006        10 FORMAT(47X,I2)
         C
         C        POINTS IN EACH LEG DEFINED
         C
         C          NUMBER OF LEGS
         C
0007           READ(5,15)NLEG
0008        15 FORMAT(15X,I2)
         C
         C          TOTAL NUMBER OF LEGS FOLLOWED BY THE ORDER OF
         C           LEGS ASSOCIATED WITH EACH CELL
         C
0009           DO 30 ICELL =1,NCELL
0010           READ(5,21)ITLEG(ICELL)
0011        21 FORMAT(22X,I1)
0012           INO=ITLEG(ICELL)
0013           READ(5,25)(IARRY(ICELL,IORD),IORD=1,INO)
0014        25 FORMAT(5I1)
0015        30 CONTINUE
         C
         C          THE SENSE OF EACH LEG AND EACH CELL
         C          PLUS COUNTER CLOCKWISE, MINUS CLOCKWISE
         C
0016           DO 33 ICELL=1,NCELL
0017           INO=ITLEG(ICELL)
0018           READ(5,32)(ISENSE(ICELL,ICRD),ICRD=1,INO)
0019        32 FORMAT(5I2)
0020        33 CONTINUE
         C
         C          LEGS COMMON TO ADJACENT CELLS (SHEAR WEBS DEFINED)
         C
         C             READ IN NUMBER OF SHEAR WEBS
         C
0021           READ(5,35)NWEB
0022        35 FORMAT(30X,I1)
0023           READ(5,40)(IARRYW(IWEB),IWEB=1,NWEP)
0024        40 FORMAT(4X,I2)
         C
         C          NUMBER OF POINTS IN EACH LEG
         C          NUMBER BEGINING EACH LEG
         C          NUMBER ENDING EACH LEG
         C
0025           DO 55 ILEG=1,NLEG
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0026            READ(5,50)LNO(ILEG),LBEG(ILEG),LEND(ILEG)
0027         50 FORMAT(20X,I2,32X,I2,17X,I2)
0028         55 CONTINUE
           C
           C         SHEAR FLOW CALCULATED AT THE BEGINNING OF EACH LEG
           C
0029            DO 57 ILEG=1,NLEG
0030            READ(5,56)IV(ILEG),IU(ILEG)
0031         56 FORMAT(19X,I2,4X,I2)
0032         57 CONTINUE
           C
           C        POINTS LOCATIONS IN THE XZ PLANE
           C        AT THE WING ROOT AND TIP
           C
0033            DO 65 I=1,NPNTS
0034            READ(5,60)RX(I),RZ(I),TX(I),TZ(I),TR(I),TT(I)
0035         60 FORMAT(5X,F6.3,5X,F6.3,5X,F6.3,5X,F6.3,5X,F6.3,5X,F6.3)
0036         65 CONTINUE
           C
           C        SEMI-SPAN LENGTH
           C
0037            READ(5,70)YF,YL
0038         70 FORMAT(5X,F10.5,5X,F10.5)
           C
           C        ROOT AND TIP AERODYNAMIC CENTERS
           C
0039            READ(5,75)RXAC,RZAC,TXAC,TZAC
0040         75 FORMAT(5X,F10.5,5X,F10.5,5X,F10.5,5X,F10.5)
           C
           C        SKIN AND CORE MATERIAL DENSITIES
           C
0041            READ(5,80)RHOS,RHOC,DC
0042         80 FORMAT(24X,F10.3,/,24X,F10.3,/,19X,F10.3)
           C
           C        INITIAL ANGLE OF ATTACK, CHORD ANGLE, BENDING AND SHEAR MODULUS
           C                    NUMBER OF WRITEOUTS
           C
0043            READ(5,85)ATANGD,CHAND,E,G,NN
0044         85 FORMAT(16X,F8.5,/,12X,F8.5,/,23X,F10.3,/,14X,F10.3,/,49X,I2)
           C
           C        SPAN LOCATION WHERE WRITEOUT OCCURS (UP TO 10 MAX)
           C
0045            DO 95 I=1,NN
0046            READ(5,90)YS(I)
0047         90 FORMAT(36X,F8.4)
0048         95 CONTINUE
           C
           C        THIS SECTION WRITES OUT ALL DATA READ IN
           C
0049            WRITE(6,100)
0050        100 FORMAT(1H1'THE INPUT DATA WAS READ AS FOLLOWS')
0051            WRITE(6,105)NCELL,NPNTS,NLEG
0052        105 FORMAT(1X,'TOTAL NUMBER OF CELLS=',I2,/,' TOTAL NUMBER OF POINTS D
               *EFINING CROSSECTION SHAPE=',I2,/,' NUMBER OF LEGS',I2,/,' THE TOTA
               *L NUMBER OF LEGS FOLLOWED BY A LIST OF LEGS ASSOCIATED WITH EACH C
               *ELL')
0053            DO 120 ICELL=1,NCELL
0054            WRITE(6,110)ICELL,ITLEG(ICELL)
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0055        110 FORMAT(1X,'CELL ',I1,' HAS A TOTAL OF ',I1,'LEGS.  THE LIST OF LEG
               *S')
0056            IND=ITLEG(ICELL)
0057            WRITE(6,115)(IARRY(ICELL,IORD),IORD=1,IND)
0058        115 FORMAT(1X,5I2)
0059        120 CONTINUE
0060            WRITE(6,121)
0061        121 FORMAT(1X,'THE SENSE OF EACH LEG (PLUS COUNTER CLOCKWISE, MINUS CL
               *OCKWISE)')
0062            DO 123 ICELL=1,NCELL
0063            IND=ITLEG(ICELL)
0064            WRITE(6,122)(ISENSE(ICELL,IORD),IORD=1,IND),ICELL
0065        122 FORMAT(1X,5I2,' SENSE FOR CELL ',I1)
0066        123 CONTINUE
0067            WRITE(6,125)NWEB
0068        125 FORMAT(1X,'NUMBER OF SHEAR WEBS=',I1)
0069            DO 135 IWEB=1,NWEB
0070            WRITE(6,130)IARRYW(IWEB),IWEB
0071        130 FORMAT(1X,'LEG ',I2,' FORMS SHEAR WEB ',I1)
0072        135 CONTINUE
0073            DO 145 ILEG=1,NLEG
0074            WRITE(6,140)ILEG,LNO(ILEG),LBEG(ILEG),LEND(ILEG)
0075        140 FORMAT(1X,'IN LEG ',I2,' THERE ARE ',I2,' POINTS STARTING WITH POI
               *NT NO. ',I2,' AND ENDING WITH ',I2)
0076        145 CONTINUE
0077            DO 147 ILEG=1,NLEG
0078            WRITE(6,146)ILEG,LBEG(ILEG),IV(ILEG),IU(ILEG)
0079        146 FORMAT(1X,'IN LEG ',I2,'  Q(',I2,')=Q(',I2,')+Q(',I2,')')
0080        147 CONTINUE
0081            DO 155 I=1,NPNTS
0082            WRITE(6,150)I,RX(I),I,RZ(I),I,TX(I),I,TZ(I),I,TR(I),I,TT(I)
0083        150 FORMAT(1X,'RX(',I2,')=',F7.3,$X,'RZ(',I2,')=',F7.3,$X,'TX(',I2,')=
               *',F7.3,5X,'TZ(',I2,')=',F7.3,5X,'TR(',I2,')=',E10.3,$X,'TT(',I2,')
               *=',E10.3)
0084        155 CONTINUE
0085            WRITE(6,160)YF,YL,RXAC,RZAC,TXAC,TZAC,RHOS,RHOC,DC,ATANGD,CHAND,ES
               *G,NN
0086        160 FORMAT(1X,'THE Y LOCATION OF ROOT AIRFOIL IS ',F9.5,/,' THE Y LOCA
               *TION OF THE TIP AIRFOIL IS ',F9.5,/,' THE LOCATION OF THE ROOT AER
               *ODYNAMIC CENTER IS',7X,'RXAC=',F9.5,5X,'RZAC=',F9.5,/,' THE LOCATI
               *ON OF THE TIP AERODYNAMIC CENTER IS',7X,'TXAC=',F9.5,5X,'TZAC=',F9
               *.5,/,' SKIN DENSITY LBS./IN.**3 =',E10.3,/,' CORE DENSITY LBS./IN.
               ***3 =',E10.3,/,' CORE THICKNESS IN. =',E10.3,/,' ANGLE OF ATTACK='
               *,F7.5,/,' CHORD ANGLE=',F7.5,/,' MODULUS OF ELASTICITY=',E10.3,/,'
               * SHEAR MODULUS=',E10.3,/,/' NUMBER OF WRITEOUTS=',I2)
0087            DO 170 I=1,NN
0088            WRITE(6,165)YS(I)
0089        165 FORMAT(1X,' INFO. ETC. PRINT OUT AT SECTION Y=',F9.3)
0090        170 CONTINUE
0091            RETURN
0092            END
```