

https://dspace.org/

The effect of liquids on the stress distribution in a glass fibre reinforced plastic road tanker

Armbruster, Michael Herman

2016
http://hdl.handle.net/10539/21352

Downloaded from a DSpace repository. https://dspace.org/

```
1960 KEY 8 , ""
1970 KEY 10 , "TRANSL"
1980 A$=INKEY$
1990 IF A$="" THEN 1980
2000 IF VAL(A$)<1 OR VAL(A$)>6 THEN RETURN
2010 ON VAL(A$) GOSUB 2030,2050,2100,2150,2270,2210,2030,2030,2030
2020 GOTO 1980
2030 RETURN
2040 ' ***  level 6 subroutine to input X translation
2050 KEY OFF:LOCATE 25,1:PRINT "X Translation <";H;"> ";:INPUT A$
2060 IF A$<>"" THEN GOSUB 4710:H=VAL(A$):T(4,1)=H:GOSUB 2380
2070 KEY ON
2080 RETURN
2090 ' ***  level 6 subroutine to input Y translation
2100 KEY OFF:LOCATE 25,1:PRINT "Y Translation <";K;"> ";:INPUT A$
2110 IF A$<>"" THEN GOSUB 4710:K=VAL(A$):T(4,2)=K:GOSUB 2380
2120 KEY ON
2130 RETURN
2140 ' ***  level 6 subroutine to input Z translation
2150 KEY OFF:LOCATE 25,1:PRINT "Z Translation <";L;"> ";:INPUT A$
2160 IF A$<>"" THEN GOSUB 4710:L=VAL(A$):T(4,3)=L:GOSUB 2380
2170 KEY ON
2180 RETURN
2190 KEY ON
2200 ' ***  level 6 subroutine to change  Y axis origin
2210 KEY OFF:LOCATE 25,1:PRINT "Y axis centre<";CY;"> ";:INPUT A$
2220 IF A$<>"" THEN LET CY=VAL(A$)
2230 KEY ON
2240 RETURN
2250 RETURN
2260 ' ***  level 6 subroutine to change axis origin
2270 KEY OFF:LOCATE 25,1:PRINT "X axis centre<";CX;"> ";:INPUT A$
2280 IF A$<>"" THEN LET CX=VAL(A$)
2290 KEY ON
2300 RETURN
2310'************************************   ******************
2320 ' *** assign a,b,c scaling values too transformation matrix
T(i,j)
2330  T(1,1)=A:T(2,2)=B:T(3,3)=C:T(4,4)=1
2340  T(1,1)=A:T(2,2)=B:T(3,3)=C:T(4,4)=1
2350  RETURN
2360'************************************************************
2370 ' *** multiply old points by transformation  for new points
2380   CLS:LOCATE 10,40:PRINT "BUSY"
2390     X=PLOTXMIN*T(1,1)+PLOTYMIN*T(2,1)+PLOTZMIN*T(3,1)+T(4,1)
2400     Y=PLOTXMIN*T(1,2)+PLOTYMIN*T(2,2)+PLOTZMIN*T(3,2)+T(4,1)
2410     Z=PLOTXMIN*T(1,3)+PLOTYMIN*T(2,3)+PLOTZMIN*T(3,3)+T(4,1)
2420  IF ABS(X)<.000001 THEN LET   X=0
2430  IF ABS(Y)<.000001 THEN LET   Y=0
2440  IF ABS(Z)<.000001 THEN LET   Z=0
```

```
2450  PLOTXMIN=X:PLOTYMIN=Y:PLOTZMIN=Z
2460     X=PLOTXMAX*T(1,1)+PLOTYMAX*T(2,1)+PLOTZMAX*T(3,1)+T(4,1)
2470     Y=PLOTXMAX*T(1,2)+PLOTYMAX*T(2,2)+PLOTZMAX*T(3,2)+T(4,1)
2480     Z=PLOTXMAX*T(1,3)+PLOTYMAX*T(2,3)+PLOTZMAX*T(3,3)+T(4,1)
2490  IF ABS(X)<.000001 THEN LET   X=0
2500  IF ABS(Y)<.000001 THEN LET   Y=0
2510  IF ABS(Z)<.000001 THEN LET   Z=0
2520  PLOTXMAX=X:PLOTYMAX=Y:PLOTZMAX=Z
2530     X=DISPXMIN*T(1,1)+DISPYMIN*T(2,1)+DISPZMIN*T(3,1)+T(4,1)
2540     Y=DISPXMIN*T(1,2)+DISPYMIN*T(2,2)+DISPZMIN*T(3,2)+T(4,1)
2550     Z=DISPXMIN*T(1,3)+DISPYMIN*T(2,3)+DISPZMIN*T(3,3)+T(4,1)
2560  DISPXMIN=X:DISPYMIN=Y:DISPZMIN=Z
2570  IF ABS(X)<.000001 THEN LET   X=0
2580  IF ABS(Y)<.000001 THEN LET   Y=0
2590  IF ABS(Z)<.000001 THEN LET   Z=0
2600     X=DISPXMAX*T(1,1)+DISPYMAX*T(2,1)+DISPZMAX*T(3,1)+T(4,1)
2610     Y=DISPXMAX*T(1,2)+DISPYMAX*T(2,2)+DISPZMAX*T(3,2)+T(4,1)
2620     Z=DISPXMAX*T(1,3)+DISPYMAX*T(2,3)+DISPZMAX*T(3,3)+T(4,1)
2630  IF ABS(X)<.000001 THEN LET   X=0
2640  IF ABS(Y)<.000001 THEN LET   Y=0
2650  IF ABS(Z)<.000001 THEN LET   Z=0
2660 DISPXMAX=X:DISPYMAX=Y:DISPZMAX=Z
2670 IF DISPXMAX<DISPXMIN THEN LET
D77=DISPXMIN:DISPXMIN=DISPXMAX:DISPXMAX=D77
2680 IF DISPYMAX<DISPYMIN THEN LET
D77=DISPYMIN:DISPYMIN=DISPYMAX:DISPYMAX=D77
2690 IF DISPZMAX<DISPZMIN THEN LET
D77=DISPZMIN:DISPZMIN=DISPZMAX:DISPZMAX=D77
2700 IF PLOTXMAX<PLOTXMIN THEN LET
D77=PLOTXMIN:PLOTXMIN=PLOTXMAX:PLOTXMAX=D77
2710 IF PLOTYMAX<PLOTYMIN THEN LET
D77=PLOTYMIN:PLOTYMIN=PLOTYMAX:PLOTYMAX=D77
2720 IF PLOTZMAX<PLOTZMIN THEN LET
D77=PLOTZMIN:PLOTZMIN=PLOTZMAX:PLOTZMAX=D77
2730    FOR I=1 TO NONODE
2740       X=X(I)*T(1,1)+Y(I)*T(2,1)+Z(I)*T(3,1)+T(4,1)
2750       Y=X(I)*T(1,2)+Y(I)*T(2,2)+Z(I)*T(3,2)+T(4,2)
2760       Z=X(I)*T(1,3)+Y(I)*T(2,3)+Z(I)*T(3,3)+T(4,3)
2770      X(I)=X:Y(I)=Y:Z(I)=Z
2780    NEXT I
2790    CLS
2800  RETURN
2810'*************************************************************
2820 '*** LEVEL 2 SUBROUTINE FOR rotation around an axis
2830 RETDUM=0:SUBDUM=2
2840 KEY 1, ""
2850 KEY 2, "-X"
2860 KEY 3, "-Y"
2870 KEY 4, "-Z"
2880 KEY  9, "EXIT"
```

```
2890 KEY 5 , ""
2900 KEY 6 , ""
2910 KEY 7 , ""
2920 KEY 8 , ""
2930 KEY 10, "ROTATE"
2940 A$=INKEY$
2950 IF A$="" THEN 2940
2960 ON VAL(A$) GOSUB 3010,3040,3130,3220,3010,3010,3010,3010,3480
2970 IF RETDUM=1 THEN LET RETDUM=0:RETURN
2980 IF VAL(A$)>=5 AND VAL(A$)<=8 THEN 2940
2990 GOSUB 2380:'*** update the points data file
3000 GOTO 2940
3010 RETURN
3020'*************************************************************
3030 ' ***  level 6 subroutine to input x rotation
3040 KEY OFF:LOCATE 25,1:PRINT "Angle around X axis <";THETAX;">
";:INPUT A$
3050 IF A$<>"" THEN LET THETAX=VAL(A$)
3060  GOSUB 4710
3070  RTHETA=THETAX/180*PI
3080 T(2,2)=COS(RTHETA):T(2,3)=SIN(RTHETA):T(3,2)=-
SIN(RTHETA):T(3,3)=T(2,2)
3090 KEY ON
3100 RETURN
3110'*************************************************************
3120 ' ***  level 6 subroutine to input y rotation
3130 KEY OFF:LOCATE 25,1:PRINT "Angle around Y axis (";THETAY;")
";:INPUT A$
3140 IF A$<>"" THEN LET THETAY=V'".(A$)
3150  GOSUB 4710
3160 RTHETA=THETAY/180*PI
3170 T(1,1)=COS(RTHETA):T(3,1)=-
SIN(RTHETA):T(1,3)=SIN(RTHETA):T(3,3)=T(1,1)
3180 KEY ON
3190 RETURN
3200'*************************************************************
3210 ' ***  level 6 subroutine to input Z rotating
3220 KEY OFF:LOCATE 25,1:PRINT "Angle around Z axis (";THETAZ;")
";:INPUT A$
3230 IF A$<>"" THEN LET THETAZ=VAL(A$)
3240  GOSUB 4710
3250 RTHETA=THETAZ/180*PI
3260 T(1,1)=COS(RTHETA):T(1,2)=SIN(RTHETA):T(2,1)=-
SIN(RTHETA):T(2,2)=T(1,1)
3270 KEY ON
3280 RETURN
3290'*************************************************************
3300'*************************************************************
3310 ' ***Level 3 - Zoom onto object by changing distance from eye to
the origin  - RHO
```

```
3320 SUBDUM=3:KEY OFF
3330 LOCATE 25,1:PRINT "Distance from eye to origin (";RHO;") "
;:INPUT DUM$
3340 IF DUM$<>"" THEN LET RHO   =VAL(DUM$)
3350 KEY ON :GOSUB 4710:RETURN
3360'************************************************************
3370 '*** Level 3 - change perspective by changing distance from eye
to screen - D
3380 SUBDUM=3:KEY OFF
3390 LOCATE 25,1:PRINT "Distance from eye to screen (";D  ;"\ "
;:INPUT DUM$
3400 IF DUM$<>"" THEN LET    D  =VAL(DUM$)
3410 KEY ON :GOSUB 4710:RETURN
3420'************************************************************
3430 ' *** Level 2 subroutine to rotate object around specified axis
3440 '*** Reflect the object about an axis
3450 KEY 9 , ""
3460 '*** Rotate an object about an axis
3470 '*** ON KEY RETURN  ROUTINE
3480 RETDUM=1:RETURN
3490'************************************************************
3500 '*** LEVEL 3 SUBROUTINE to change angle of eye to object
3510 SUBDUM=3:KEY OFF
3520 LOCATE 25,1:PRINT "Angle on XY plane (";THETAD;" degrees) "
;:INPUT DUM$
3530 IF DUM$<>"" THEN LET THETAD=VAL(DUM$)
3540 THETA= THETAD/180*PI
3550 KEY ON :GOSUB 4710:RETURN
3560'************************************************************
3570 '*** LEVEL 3 SUBROUTINE to change angle of eye to object
3580 SUBDUM=3:KEY OFF
3590 LOCATE 25,1:PRINT "Angle to Z axis (";PHID;" degrees) " ;:INPUT
DUM$
3600 IF DUM$<>"" THEN LET PHID=VAL(DUM$)
3610 PHI=PHID/180*PI
3620 KEY ON :GOSUB 4710:RETURN
3630'************************************************************
3640 'level 3 subroutine  to calculate and plot screen co-ordinates
3650 SUBDUM=3
3660  CLS:INPUT "TYPE E TO EDIT PICTURE LIMITS";A$
3670  IF A$<> "E"  THEN GOTO 3800
3675 INPUT "SCREEN TYPE (2/9)";SCRN
3676 IF SCRN<>2 AND SCRN<>9 THEN 3675
3677 IF SCRN=9 THEN LET SC=1.5
3678 IF SCRN=2 THEN LET SC=2.4
3680  CLS: LOCATE 1,1:PRINT "X min  <";DISPXMIN;"> ";:INPUT A$
3690  IF A$<>"" THEN LET DISPXMIN=VAL(A$)
3700  LOCATE 1,40:PRINT "X max  <";DISPXMAX;"> ";:INPUT A$
3710  IF A$<>"" THEN LET DISPXMAX=VAL(A$)
3720  LOCATE 3,1:PRINT "Y min  <";DISPYMIN;"> ";:INPUT A$
```

```
3730  IF A$<>"" THEN LET DISPYMIN=VAL(A$)
3740  LOCATE 3,40:PRINT "Y max  <";DISPYMAX;"> ";:INPUT A$
3750  IF A$<>"" THEN LET DISPYMAX=VAL(A$)
3760  LOCATE 5,3:PRINT "Z min  <";DISPZMIN;"> ";:INPUT A$
3770  IF A$<>"" THEN LET DISPZMIN=VAL(A$)
3780  LOCATE 5,40:PRINT "Z max  <";DISPZMAX;"> ";:INPUT A$
3790  IF A$<>"" THEN LET DISPZMAX=VAL(A$)
3800 GOSUB 4140: ' assign sin and cos to variables for speed
3810 CLS:SCREEN SCRN:'9:'2:' 9
3820 LOCATE 1,40:PRINT "Busy"
3830 GOSUB 9070 :' *** draw axis and labels
3840 FOR I= 1 TO NOLIN
3850 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 4090
3860    I1=STPOINT(I):'*** IF PLOPT=2 OR PLOPT=3 THEN GOSUB 3295:' ***
find node
3870    X1=X(I1):Y1=Y(I1):Z1=Z(I1)
3880 ' *** clip picture
3890    IF X1<DISPXMIN OR X1>DISPXMAX THEN 4090
3900    IF Y1<DISPYMIN OR Y1>DISPYMAX THEN 4090
3910    IF Z1<DISPZMIN OR Z1>DISPZMAX THEN 4090
3920   I2=ENDPOINT(I):'*** IF PLOPT=2  OR PLOPT=3 THEN GOSUB 3325:'
*** find node
3930    X2=X(I2):Y2=Y(I2):Z2=Z(I2)
3940 ' *** clip picture
3950    IF X2<DISPXMIN OR X2>DISPXMAX THEN 4090
3960    IF Y2<DISPYMIN OR Y2>DISPYMAX THEN 4090
3970    IF Z2<DISPZMIN OR Z2>DISPZMAX THEN 4090
3980     XE1=-X1*S1+Y1*C1
3990     YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
4000     ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
4010       SX1=D*XE1/ZE1+CX
4020       SY1=(CY-D*YE1/ZE1)/SC
4030     XE2=-X2*S1+Y2*C1
4040     YE2=-X2*C1*C2-Y2*S1*C2+Z2*S2
4050     ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
4060       SX2=D*XE2/ZE2+CX
4070       SY2=(CY-D*YE2/ZE2)/SC
4080   LINE (SX1,SY1)-(SX2,SY2) : ' draw from start point to end point
4090 NEXT I
4100 LOCATE 1,40:PRINT "    "
4110 RETURN
4120'*************************************************************
4130 ' *** routine to calculate sin and cos of angle
4140 S1=SIN (THETA)
4150 C1=COS (THETA)
4160 S2=SIN (PHI)
4170 C2=COS (PHI)
4180 RETURN
4190'*************************************************************
4270 ' setup of default values
```

```
4280 PI=3.141592654#
4290 DECPLACE=4
4300 MULT=.001 :' *** MULTIPLYER FOR INPUT OF CONTOUR
4310 G=9.810001:'                          *** gravitational
acceleration
4320 SUBDUM=0:'                          *** dummy to indicate level of
subroutine
4330 RETDUM=0:'                          *** dummy flag to indicate exit
routine
4340 RHO=100:'                            ***   distance from eye to
object
4350 D= 20000:'5000:'                            ***   distance from eye
to screen
4360 THETAD=45:THETA=THETAD*PI/180:'     *** angle to  x axis o n XY
plane
4370 PHID=45:PHI =PHID*PI/180:  '        *** angle to z axis
4380 CX=320                     '        *** centre of screen x axis
4390 CY=150                     '        *** centre of screen y axis
4400' SC=2.4:'150/110                       '      *** scaling factor for
screen
4405 SC=150/100
4410 FOR I=1 TO 4:T(I,I)=1:NEXT I
4420 A=1:B=1:C=1:'                       *** scaling default values
4430 H=0:K=0:L=0:'                       *** tranlsation Default values
4440 PLFX= 5:' *** plot x multiplyer
4450 PLFY= 5:' *** plot y multiplyer
4460 PLOX=2500:' *** plot x offset
4470 PLOY=1000:' *** plot y offset
4480'************************************************************
4490 DISPXMIN=-1:' *** picture x limit
4500 DISPXMAX=13:' *** picture x limit
4510 DISPYMIN=-1:' *** picture y limit
4520 DISPYMAX=1 :' *** picture y limit
4530 DISPZMIN=-1:' *** picture z limit
4540 DISPZMAX= 1:' *** picture z limit
4550 PLOTXMIN=0:' *** picture x limit
4560 PLOTXMAX=13:' *** picture x limit
4570 PLOTYMIN=-1 :' *** picture y limit
4580 PLOTYMAX=1 :' *** picture y limit
4590 PLOTZMIN=-1  ' *** picture z limit
4600 PLOTZMAX=1 :' *** picture z limit
4680 RETURN
4690'************************************************************
4700 ' *** assign 1 and 0 values too transformation matrix T(i,j)
4710  FOR I1=1 TO 4:FOR J1=1 TO 4:T(I1,J1)=0:NEXT J1:NEXT I1
4720  T(1,1)=1:T(2,2)=1:T(3,3)=1:T(4,4)=1
4730  RETURN
4740'************************************************************
6390 '*** LEVEL 1 SUBROUTINE to save co-ordinate and line data
6400 CLS:LOCATE  1,1:INPUT "Name of file ";NAMEFILE$
```

```
6410 OPEN  NAMEFILE$ FOR OUTPUT AS #1
6420 PRINT#1,NONODE
6430 FOR I=1 TO NONODE
6450   PRINT#1,NODENO(I);
6455    PRINT#1,USING"###.####";X(I),Y(I),Z(I)
6460 NEXT I
6462 NOACTLIN=NOLIN
6464 FOR I= 1 TO NOLIN
6466 IF STPOINT(I)=0 AND ENDPOINT(I)=0 THEN LET NOACTLIN=NOACTLIN-1
6468 NEXT  I
6470 PRINT#1,NOACTLIN
6480 FOR I=1 TO NOLIN
6490 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 6510
6500  PRINT#1,STPOINT(I),ENDPOINT(I)
6510 NEXT I
6520 CLOSE#1
6530 RETURN
6540'************************************************************
6550 '*** LEVEL 1 SUBROUTINE to load co-ordinate and line data
6560 CLS:LOCATE  1,1:INPUT "Name of file ";NAMEFILE$
6570  OPEN  NAMEFILE$ FOR INPUT AS #1
6580   INPUT#1,NONODE
6590    FOR I=1 TO NONODE
6600     INPUT#1,NODENO(I),X(I),Y(I),Z(I)
6610    NEXT I
6620   INPUT#1,NOACTLIN
6630    FOR I=1 TO NOACTLIN
6640     INPUT#1,STPOINT(I),ENDPOINT(I)
6650    NEXT I
6660  NOLIN=NOACTLIN
6670  CLOSE#1
6680 RETURN
6690'************************************************************
6700 '*** LEVEL 1 SUBROUTINE to load ABAQUS file and plot data points
6710 CLS:LOCATE  1,1:INPUT "Name of file ";NAMEFILE$
6720 OPEN  NAMEFILE$ FOR INPUT AS #1
6730 INPUT#1,NONODE
6740 FOR I=1 TO NONODE
6750    INPUT#1,NODENO(I),X(I),Y(I),Z(I)
6760  ' PRINT   NODENO(I);X(I);Y(I);Z(I)
6770 NEXT I
6780 '    INPUT "Press return to continue";A$
6790 INPUT#1,NOLIN
6800 FOR I=1 TO NOLIN
6820   INPUT#1,STPOINT,   ENDPOINT
6821     FOR J= 1 TO NONODE
6822       IF STPOINT=NODENO(J) THEN LET STPOINT(I)=J:GOTO 6825
6823     NEXT J
6825     FOR J= 1 TO NONODE
6826       IF ENDPOINT=NODENO(J) THEN LET ENDPOINT(I)=J:GOTO 6840
```

```
6828      NEXT J
6840 NEXT I
6850 CLOSE#1
6860 RETURN
6870'************************************************************
6880 'level ? subroutine  to find nodenum from abaout
6890 FOR I1=1 TO NONODE
6900 IF STPOINT(I)= NODENO(I1) THEN RETURN
6910 NEXT I1
6920 RETURN
6930'************************************************************
6940 'level ? subroutine  to find nodenum from abaout
6950 FOR I2=1 TO NONODE
6960 IF ENDPOINT(I)= NODENO(I2) THEN RETURN
6970 NEXT I2
6980 RETURN
6990'************************************************************
7000 'level 1 subroutine  to calculate and plot  co-ordinates
7010'************************************************************
7020 SUBDUM=1:CLS
7030 KEY OFF:CLOSE#3
7040 OPEN "o",#3,"lpt1:":'*** open output file to plotter
7050 PAPSIZE=4:INPUT "Size A4 or A3 (4/3)";A$
7060 IF A$<>"" THEN LET PAPSIZE =VAL(A$)
7070 IF PAPSIZE=3 THEN LET PXMAX=4000:PYMAX=2900
7080 IF PAPSIZE=4 THEN LET PXMAX=2900:PYMAX=2000
7090 '*** scale plotter
7100          PRINT "X factor  <";PLFX;"> ";:INPUT A$
7110           IF A$<>"" THEN LET PLFX=VAL(A$)
7120          PRINT "Y factor  <";PLFY;"> ";:INPUT A$
7130           IF A$<>"" THEN LET PLFY=VAL(A$)
7140          PRINT "X offset (mm) <";PLOX/10;"> ";:INPUT A$
7150           IF A$<>"" THEN LET PLOX=VAL(A$)*10
7160          PRINT "Y offset (mm) <";PLOY/10;"> ";:INPUT A$
7170           IF A$<>"" THEN LET PLOY=VAL(A$)*10
7180  CLS:INPUT "TYPE E TO EDIT PLOT LIMITS ";A$
7190  IF A$<> "E"  THEN GOTO 7340
7200  CLS:INPUT "Same as display (Y/N) ";A$
7210  IF A$ = "Y"  THEN LET
PLOTXMIN=DISPXMIN:PLOTXMAX=DISPXMAX:PLOTYMIN=DISPYMIN
:PLOTYMAX=DISPYMAX:PLOTZMIN=DISPZMIN:PLOTZMAX=DISPZMAX:GOTO
7340
7220 CLS: LOCATE 1,1:PRINT "X min  <";PLOTXMIN;"> ";:INPUT A$
7230  IF A$<>"" THEN LET PLOTXMIN=VAL(A$)
7240  LOCATE 1,40:PRINT "X max  <";PLOTXMAX;"> ";:INPUT A$
7250  IF A$<>"" THEN LET PLOTXMAX=VAL(A$)
7260  LOCATE 3,1:PRINT "Y min  <";PLOTYMIN;"> ";:INPUT A$
7270  IF A$<>"" THEN LET PLOTYMIN=VAL(A$)
7280  LOCATE 3,40:PRINT "Y max  <";PLOTYMAX;"> ";:INPUT A$
7290  IF A$<>"" THEN LET PLOTYMAX=VAL(A$)
```

```
7300  LOCATE 5,1:PRINT "Z min  <";PLOTZMIN;"> ";:INPUT A$
7310  IF A$<>"" THEN LET PLOTZMIN=VAL(A$)
7320  LOCATE 5,40:PRINT "Z max  <";PLOTZMAX;"> ";:INPUT A$
7330  IF A$<>"" THEN LET PLOTZMAX=VAL(A$)
7340 GOSUB 4140: '***  asssign sin and cos to variables for speed
7350 PRINT : INPUT "Choose drawing pen color ";PENCOLORD$
7360 PRINT : INPUT "Choose axis pen color ";PENCOLORA$
7370 IF VAL(PENCOLORD$)>6 THEN GOTO 7390
7380 '*** plot nodes option
7390 INPUT "Plot node numbers (Y/N)";PLNDDUM$
7400 IF PLNDDUM$="Y" THEN PRINT : INPUT "Choose node pen color
";PENCOLORN$
7410 INPUT "Plot element numbers (Y/N)";PLELDUM$
7420 IF PLELDUM$="Y" THEN PRINT : INPUT "Choose element pen color
";PENCOLORE$
7430 CLS:LOCATE  1,1:INPUT "Name of ABAQUS file ";NAMEFILE$
7440 CLS:LOCATE 12,40:PRINT "Busy"
7450 IF PENCOLORA$<>"0" THEN GOSUB 8650 :' *** plot axis and limits
7460 PRINT#3,"M0,1200":PRINT#3,"J0"
7470 PRINT#3,"J"+PENCOLORD$
7480 FOR I= 1 TO NOLIN
7490 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 7790
7500   I1=STPOINT(I):IF PLOPT=2 OR PLOPT=3 THEN GOSUB 6890:' *** find
node
7510    X1=X(I1):Y1=Y(I1):Z1=Z(I1)
7520 ' *** clip picture
7530    IF X1<PLOTXMIN OR X1>PLOTXMAX THEN 7790
7540    IF Y1<PLOTYMIN OR Y1>PLOTYMAX THEN 7790
7550    IF Z1<PLOTZMIN OR Z1>PLOTZMAX THEN 7790
7560   I2=ENDPOINT(I):IF PLOPT=2  OR PLOPT=3 THEN GOSUB 6950:' ***
find node
7570    X2=X(I2):Y2=Y(I2):Z2=Z(I2)
7580 ' *** clip picture
7590    IF X2<PLOTXMIN OR X2>PLOTXMAX THEN 7790
7600    IF Y2<PLOTYMIN OR Y2>PLOTYMAX THEN 7790
7610    IF Z2<PLOTZMIN OR Z2>PLOTZMAX THEN 7790
7620     XE1=-X1*S1+Y1*C1
7630     YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
7640     ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
7650       PX1= INT((D*XE1/ZE1)*PLFX+PLOX)
7660       PY1=INT(((D*YE1/ZE1))*PLFY+PLOY)
7670     XE2=-X2*S1+Y2*C1
7680     YE2=-X2*C1*C2-Y2*S1*C2+Z2*S2
7690     ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
7700       PX2=INT((D*XE2/ZE2)*PLFX+PLOX )
7710       PY2=INT(((D*YE2/ZE2))*PLFY+PLOY)
7720 IF PX1<0 OR PX1>PXMAX GOTO 7850
7730 IF PX2<0 OR PX2>PXMAX GOTO 7850
7740 IF PY1<0 OR PY1>PYMAX GOTO 7850
7750 IF PY2<0 OR PY2>PYMAX GOTO 7850
```

```
7760 '*** plot line
7770  PRINT#3,"M"+STR$(PX1)+" "+STR$(PY1)
7780  PRINT#3,"D"+STR$(PX2)+" "+STR$(PY2)
7790 NEXT I
7800 LOCATE 1,40:PRINT "    "
7810 IF PLNDDUM$= "Y" THEN GOSUB 7880:'*** plot node numbers
7820 IF PLELDUM$= "Y" THEN GOSUB 9520:'*** plot element numbers
7830 RETURN
7840'************************************************************
7850 CLS:INPUT "Picture outside of window";A$:GOTO 7100
7860'************************************************************
7870 '*** routine to plot node numbers ************************
7880 IF VAL(PENCOLORN$)>6 THEN GOTO 7910
7890 PRINT#3,"M0,1000":PRINT#3,"J0"
7900 PRINT#3,"J"+PENCOLORN$
7910 PRINT#3,"S8,8"
7920 FOR I= 1 TO NONODE
7930 IF I<> NODENO(I) THEN 8070
7940    X1=X(I):Y1=Y(I):Z1=Z(I)
7950 ' *** clip picture
7960    IF X(I)<PLOTXMIN OR X(I)>PLOTXMAX THEN 8070
7970    IF Y(I)<PLOTYMIN OR Y(I)>PLOTYMAX THEN 8070
7980    IF Z(I)<PLOTZMIN OR Z(I)>PLOTZMAX THEN 8070
7990     XE1=-X1*S1+Y1*C1
8000     YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
8010     ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
8020       PX1= INT((D*XE1/ZE1)*PLFX+PLOX)
8030       PY1=INT((D*YE1/ZE1))*PLFY+PLOY)
8040 D1=-20:D2=-20 :' *** duumy offset for node numbers
8050     PRINT#3,"M"+STR$(PX1+D1)+" "+STR$(PY1+D2)
8060     PRINT#3,"P"+STR$(NODENO(I))
8070  NEXT I
8080  RETURN
8090'************************************************************
8100'************************************************************
8110 '*** LEVEL 2 SUBROUTINE to input contours of 3d object or surface
8120'************************************************************
8130 CLS:X =0:Y1=0:Z1=0:STARTDUM$="Y":KEYDUM$="1":LINDUM$=""
8140 NODENUM=0:LINNO=0:      Y2=0:Z2=0
8150 KEY 1, "X-plane"
8160 KEY 2, "V-veiw "
8170 KEY 3, "D-del"
8180 KEY 4, "L-lines"
8190 KEY 5, "     "
8200 KEY 6, "      "
8210 KEY 7,"       "
8220 KEY 8, "       "
8230 KEY 9, "E-exit"
8240 KEY 10, "     "
8250 IF KEYDUM$="2" THEN LET KEYDUM$="1":GOTO 8380
```

```
8260 PRINT:INPUT "Y =";Y$
8270         IF Y$="E" THEN LET NOLIN=LINNO:GOSUB
10770:NONODE=NODENUM:RETURN
8280         IF Y$="X" THEN LET STARTDUM$="Y": LINDUM$="":GOSUB
8550:GOTO 8260
8290         IF Y$="V" THEN LET NOLIN=LINNO:NONODE=NODENUM:GOSUB
1200:GOTO 8150
8300         IF Y$="D" THEN LET LINNO=LINNO-1:NODENUM=NODENUM-1:GOTO
8260
8310         IF Y$="L" THEN GOSUB 8550:LINDUM$="L":GOTO 8260
8320 X1=X
8330 Y1=VAL(Y$)
8340 INPUT "Z =";Z1
8350 '***********************************
8360 X2=X:' ** same x2 for contours
8370         IF LINDUM$="L" THEN GOSUB 8550:X2=X
8380 PRINT :INPUT "Y =";Y$
8390         IF Y$="V" THEN LET NOLIN=LINNO:NONODE=NODENUM:GOSUB
1200:KEYDUM$="2":GOTO 8150
8400         IF Y$="E" THEN LET NOLIN=LINNO:NONODE=NODENUM:RETURN
8410         IF Y$="X" THEN LET STARTDUM$="Y":LINDUM$="":GOSUB
8550:GOTO 8260
8420         IF Y$="D" THEN LET LINNO=LINNO-1:NODENUM=NODENUM-1:GOTO
8380
8430         IF Y$="L" THEN GOSUB 8550:LINDUM$="L":GOTO 8380
8440 Y2=VAL(Y$)
8450 INPUT "Z =";Z2
8460  IF STARTDUM$<>"Y" THEN GOTO 8500
8470
NODENUM=NODENUM+1:NODENO(NODENUM)=NODENUM:X(NODENUM)=X1*MULT
:Y(NODENUM)=Y1*MULT:Z(NODENUM)=Z1*MULT
8480
NODENUM=NODENUM+1:NODENO(NODENUM)=NODENUM:X(NODENUM)=X2*MULT
:Y(NODENUM)=Y2*MULT:Z(NODENUM)=Z2*MULT
8490           STARTDUM$="N":GOSUB 8520:GOTO 8360
8500
NODENUM=NODENUM+1:NODENO(NODENUM)=NODENUM:X(NODENUM)=X2*MULT
:Y(NODENUM)=Y2*MULT:Z(NODENUM)=Z2*MULT:GOSUB
8520:GOTO 8360
8510'*******************************************************
8520         LINNO=LINNO+1:STPOINT(LINNO)=NODENUM:
1:ENDPOINT(LINNO)=NODENUM:RETURN
8530'*******************************************************
8540 '*****   ROUTINE TO CHANGE X PLANE
8550  PRINT:PRINT "X = <";X;">";:INPUT X$
8560  IF X$<>"" THEN LET X=VAL(X$)
8570  RETURN
8580'*******************************************************
8590 '*** error trap
8600   CLS:INPUT "ERROR";A$:GOTO 70
```

```
8610 IF X(I1)<XPLOTMIN THEN 7790
8620'*************************************************************
8630 ' *** routine to plot axis
8640'*************************************************************
8650 IF VAL(PENCOLORA$)>6 THEN GOTO 8680
8660 PRINT#3,"M0,1200":PRINT#3,"J0"
8670 PRINT#3,"J"+PENCOLORA$
8680
X1=PLOTXMIN:X2=PLOTXMAX:A1=X1:A2=X2:Y1=0:Y2=0:Z1=0:Z2=0:AXISNAME$="X"
8690 '*** allow for 0 axis and avoid overprinting
8700 'IF PLOTXMAX=0 THEN LET A1=X2:A2=X1
8710 GOSUB 8830
8720
Y1=PLOTYMIN:Y2=PLOTYMAX:A1=Y1:A2=Y2:X1=0:X2=0:Z1=0:Z2=0:AXISNAME$="Y"
8730 '*** allow for 0 axis and avoid overprinting
8740 'IF PLOTYMAX=0 THEN LET A1=Y2:A2=Y1
8750 GOSUB 8830
8760
Z1=PLOTZMIN:Z2=PLOTZMAX:A1=Z1:A2=Z2:Y1=0:Y2=0:X1=0:X2=0:AXISNAME$="Z"
8770 '*** allow for 0 axis and avoid overprinting
8780 'IF PLOTZMAX=0 THEN LET A1=Z2:A2=Z1
8790 GOSUB 8830
8800  RETURN
8810'*************************************************************
8820 ' *** routine to plot axis  lines and names
8830     XE1=-X1*S1+Y1*C1
8840     YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
8850     ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
8860       PX1= INT((D*XE1/ZE1)*PLFX+PLOX)
8870       PY1=INT(((D*YE1/ZE1))*PLFY+PLOY)
8880     XE2=-X2*S1+Y2*C1
8890     YE2=-X2*C1*C2-Y2*S1*C2+Z2*S2
8900     ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
8910       PX2=INT((D*XE2/ZE2)*PLFX+PLOX )
8920       PY2=INT(((D*YE2/ZE2))*PLFY+PLOY)
8930  PRINT#3,"M"+STR$(PX1)+" "+STR$(PY1)
8940  PRINT#3,"D"+STR$(PX2)+" "+STR$(PY2)
8950 D1=0:D2=-40:
8960     PRINT#3,"M"+STR$(PX1+D1)+" "+STR$(PY1+D2)
8970     PRINT#3,"P"+STR$(A1)
8980     PRINT#3,"M"+STR$(PX2+D1)+" "+STR$(PY2+D2)
8990     PRINT#3,"P"+STR$(A2)
9000     PRINT#3,"M"+STR$(PX2+D1)+" "+STR$(PY2-D2)
9010     PRINT#3,"P"+AXISNAME$
9020   RETURN
9030'*************************************************************
9040 ' *** routine to disp axis
9050'*************************************************************
9060 DUM=DUM
9070 X1=0
```

```
:X2=DISPXMAX:A1=X1:A2=X2:Y1=0:Y2=0:Z1=0:Z2=0:AXISNAME$="X"
9080 '*** allow for 0 axis and avoid overprinting
9090 GOSUB 9190
9100 Y1=0
:Y2=DISPYMAX:A1=Y1:A2=Y2:X1=0:X2=0:Z1=0:Z2=0:AXISNAME$="Y"
9110 '*** allow for 0 axis and avoid overprinting
9120 GOSUB 9190
9130 Z1=0
:Z2=DISPZMAX:A1=Z1:A2=Z2:Y1=0:Y2=0:X1=0:X2=0:AXISNAME$="Z"
9140 '*** allow for 0 axis and avoid overprinting
9150 GOSUB 9190
9160  RETURN
9170'************************************************************
9180 ' *** routine to plot axis  lines and names
9190     XE1=-X1*S1+Y1*C1
9200     YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
9210     ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
9220       SX1=       D*XE1/ZE1 +CX
9230       SY1=(CY-D*YE1/ZE1)/SC
9240     XE2=-X2*S1+Y2*C1
9250     YE2=-X2*C1*C2-Y2*S1*C2+Z2*S2
9260     ZE2=-X2*S2*C1-Y2*S2*S1-Z2*C2+RHO
9270       SX2=       D*XE2/ZE2 +CX
9280       SY2=(CY-D*YE2/ZE2)/SC
9290     LINE (SX1,SY1)-(SX2,SY2)
9300 AXISX=INT(SX2/640*80+1):AXISY=INT(SY2/200*25+1):'*** screen co-
ords for text
9310 IF AXISX<0 OR AXISX>80 THEN GOTO 9340
9320 IF AXISY<0 OR AXISY>25 THEN GOTO 9340
9330 'LOCATE AXISY,AXISX:PRINT AXISNAME$
9340   RETURN
9350 '**** routine to merge two line files
9360 CLS:LOCATE  1,1:INPUT "Name of file ";NAMEFILE$
9370  OPEN  NAMEFILE$ FOR INPUT AS #1
9375   NOFFSET=0
9380   INPUT#1,NONODE2
9390   NEWNODE=NONODE+1:NONODE =NONODE+NONODE2
9400    FOR I=NEWNODE  TO NONODE
9410     INPUT#1,NODENO(I),X(I),Y(I),Z(I)
9515      NODENO(I)=NODENO(I)+NEWNODE-1
9420    NEXT I
9430   INPUT#1,NOLIN1
9440   NEWELEM =NOLIN+1:NOLIN  =NOLIN+NOLIN1:NOACTLIN=NOLIN
9450    FOR I=NEWELEM  TO NOLIN
9460     INPUT#1,STPOINT(I),ENDPOINT(I)
9470        STPOINT(I)=STPOINT(I)+NEWNODE-
1:ENDPOINT(I)=ENDPOINT(I)+NEWNODE-1
9480    NEXT I
9490  CLOSE#1
9500 RETURN
```

```
9510 ' *** ROUTINE TO LOAD ABAIN FOR PLOTTING ELEMENT NUMBERS
9520 OPEN  NAMEFILE$ FOR INPUT AS #1
9530 LINE INPUT#1,A$
9540 IF LEFT$(A$,5)<>"*NODE" THEN GOTO 9530
9560 NONODE=0:NOELEM=0
9570 '*** LOAD ABAQUS FILE X,Y,Z INTO MATRICES
9580 INPUT#1,A$
9590 IF LEFT$(A$,8)="*ELEMENT" THEN GOTO 9670
9600 NODENUM=VAL(A$) :NONODE=NONODE+1
9610 NODENO(NODENUM)=NODENUM
9620 INPUT#1,A$:X(NODENUM)=VAL(A$)
9630 INPUT#1,A$:Y(NODENUM)=VAL(A$)
9640 INPUT#1,A$:Z(NODENUM)=VAL(A$)
9650 GOTO 9580
9660 '*** routine to element  numbers ****************************
9670 INPUT#1,DUM1$,DUM2$:IF VAL(PENCOLORE$)>6 THEN GOTO 9700
9680 PRINT#3,"M0,1000":PRINT#3,"J0"
9690 PRINT#3,"J"+PENCOLORE$
9700 PRINT#3,"S8,8"
9710 INPUT#1,ELNO$
9720 IF LEFT$(ELNO$,1)="*" THEN CLOSE:RETURN
9730 INPUT#1,N1$,N2$,N3$,N4$,N5$,N6$,N7$,N8$
9740      X1    =(X(NODENO(VAL(N2$)))+X(NODENO(VAL(N3$))))/2
9750      Y1    =(Y(NODENO(VAL(N1$)))+Y(NODENO(VAL(N2$))))/2
9760      Z1    =(Z(NODENO(VAL(N1$)))+Z(NODENO(VAL(N2$))))/2
9770 ' *** clip picture
9780     IF X1  <PLOTXMIN OR X1  >PLOTXMAX THEN 9710
9790     IF Y1  <PLOTYMIN OR Y1  >PLOTYMAX THEN 9710
9800     IF Z1  <PLOTZMIN OR Z1  >PLOTZMAX THEN 9710
9810      XE1=-X1*S1+Y1*C1
9820      YE1=-X1*C1*C2-Y1*S1*C2+Z1*S2
9830      ZE1=-X1*S2*C1-Y1*S2*S1-Z1*C2+RHO
9840        PX1= INT((D*XE1/ZE1)*PLFX+PLOX)
9850        PY1=INT(((D*YE1/ZE1))*PLFY+PLOY)
9860 D1=-0:D2=-0 :' *** dummy offset for element
9870      PRINT#3,"M"+STR$(PX1+D1)+" "+STR$(PY1+D2)
9880      PRINT#3,"P"+ELNO$
9890   GOTO 9710
9900'*************************************************************
9910 '*** LEVEL 1  routine to load abaqus input file and generate lin
file
9920 CLS:LOCATE  1,1:INPUT "Name of file ";NAMEFILE$
9945 CLOSE
9950 OPEN  NAMEFILE$ FOR INPUT AS #1
9955 '*** load in all node numbers
9960 I=0
9970 LINE INPUT#1,A$
9975 IF EOF(1) THEN PRINT "Data not found":INPUT AAA:RETURN
9980 IF LEFT$(A$,5)<>"*NODE" THEN 9970
9990    INPUT#1, A$
```

```
9992          IF LEFT$(A$,8)="*ELEMENT" THEN PRINT "FOUND ELEMENT":GOTO
10040
9995          IF LEFT$(A$,5)="*NODE" THEN PRINT:INPUT#1,B$,A$
10000       I=VAL(A$):  NODENO(I)=I
10010      INPUT#1,X(I),Y(I),Z(I)
10020 NONODE=I:GOTO 9990
10030 '*** load in all the elements
10040 INPUT#1,B$,C$:    POINTNO=0:PRINT A$,B$
10042         IF B$="TYPE=S8R" THEN  NOPEEL=8:SIGNODE=4:GOTO 10700
10044         IF B$="TYPE=STRI3" THEN NOPEEL=3:SIGNODE=3:GOTO 10700
10046         IF B$="TYPE=R32" THEN NOPEEL=3:SIGNODE=3:GOTO 10700
10050 INPUT#1,A$:PRINT A$
10052 IF LEFT$(A$,6) = "*ELSET" THEN CLOSE#1:GOTO 10172:'** REMOCE
DUPLICATE NUMBERS
10055 IF LEFT$(A$,8) = "*ELEMENT" THEN GOTO 10040
10070       FOR I=1 TO NOPEEL
10080        INPUT#1,NODE(I)
10090       NEXT I
10100        FOR I=1 TO SIGNODE-1
10110
POINTNO=POINTNO+1:STPOINT(POINTNO)=NODE(I):ENDPOINT(POINTNO)=NODE(I+1)
10120         NEXT I
10130  IF NOPEEL=8 AND SIGNODE=4 THEN
POINTNO=POINTNO+1:STPOINT(POINTNO)=NODE(4):ENDPOINT(POINTNO)=NODE(1)
10140  NOLIN=POINTNO
10150 NOACTLIN=NOLIN
10160 GOTO 10050
10172 INPUT "Do you want to eliminate duplicate lines (Y/N) ";DUP$
10174 IF DUP$<>"Y" THEN NOCASTLIN=NOLIN:RETURN
10176 GOSUB 10770:RETURN
10180'************************************************************
10190 'level ? subroutine  to find nodenum from abaout
10200 FOR I1=1 TO NONODE
10210 IF STPOINT(I)= NODENO(I1) THEN RETURN
10220 NEXT I1
10230 RETURN
10240'************************************************************
10250 'level ? subroutine  to find nodenum from abaout
10260 FOR I2=1 TO NONODE
10270 IF ENDPOINT(I)= NODENO(I2) THEN RETURN
10280 NEXT I2
10290 RETURN
10300'************************************************************
10310  '****   routine to truncate numbers
10320   TRUNC=TRUNC*10^DECPLACE
10330   TRUNC=INT(TRUNC)
10340   TRUNC=TRUNC/10^DECPLACE
10350   RETURN
10355'************************************************************
10360 '*** ROUTINE TO SAVE DATA AS NISA.NEU FILE ************
```

```
10370 CLS:LOCATE  1,1:INPUT "Name of file ";NAMEFILE$
10380 OPEN  NAMEFILE$ FOR OUTPUT AS #1
10390  PRINT#1,NAMEFILE$
10400 FOR I=1 TO NONODE
10410 IF NODENO(I)=0 THEN GOTO 10500
10420 IF NODENO(I)<>I THEN GOTO 10500
10430  COUNTG=NODENO(I)
10440   SPAG$=CHR$(32)+CHR$(32)+CHR$(32)
10450     IF COUNTG>9 THEN SPAG$=CHR$(32)+CHR$(32)
10460     IF COUNTG>99 THEN SPAG$=CHR$(32)
10470     IF COUNTG>999 THEN SPAG$=""
10480    PRINT #1,1;SPAG$;COUNTG
10490   PRINT #1,USING "#.#########^^^^ ";X(I),Y(I),Z(I)
10500 NEXT I
10510 '*** print lines to disc
10520 FOR I = 1 TO NOACTLIN
10530 IF STPOINT(I)=0 OR ENDPOINT(I)=0 THEN 10710
10540  COUNTL=I
10550   SPAL$=CHR$(32)+CHR$(32)+CHR$(32)
10560    IF COUNTL>9 THEN SPAL$=CHR$(32)+CHR$(32)
10570    IF COUNTL>99 THEN SPAL$=CHR$(32)
10580    IF COUNTL>999 THEN SPAL$=""
10590 PRINT #1,2;SPAL$;COUNTL
10600      X1=X(STPOINT(I)):Y1=Y(STPOINT(I)):Z1=Z(STPOINT(I))
10610      X4=X(ENDPOINT(I)):Y4=Y(ENDPOINT(I)):Z4=Z(ENDPOINT(I))
10620      DIVX=(X4-X1)/3
10630      DIVY=(Y4-Y1)/3
10640      DIVZ=(Z4-Z1)/3
10650     X2=X1+DIVX:Y2=Y1+DIVY:Z2=Z1+DIVZ
10660     X3=X1+2*DIVX:Y3=Y1+2*DIVY:Z3=Z1+2*DIVZ
10670     PRINT #1,USING "#.#########^^^^";X1,Y1,Z1
10680     PRINT #1,USING "#.#########^^^^";X2,Y2,Z2
10690     PRINT #1,USING "#.#########^^^^";X3,Y3,Z3
10700     PRINT #1,USING "#.#########^^^^ ";X4,Y4,Z4
10710 NEXT I
10720 CLOSE #1
10730 RETURN
10740'************************************************************
10750 '** routine to eliminate similar lines
10760'************************************************************
10770 NOACTLIN= NOLIN
10780 '*** NOACTLIN - number of actual active lines
10790 FOR I= 1 TO NOLIN
10795 IF STPOINT(I)=0 AND ENDPOINT(I)=0 THEN 10850
10800  FOR J=1 TO NOLIN
10805 IF STPOINT(I)=0 AND ENDPOINT(I)=0 THEN 10840
10810   IF J=I THEN 10840
10820   IF STPOINT(I)=STPOINT(J) AND ENDPOINT(I)=ENDPOINT(J) THEN LET
STPOINT (I)=0:ENDPOINT(I)=0:NOACTLIN=NOACTLIN-1:GOTO 10840
10830   IF STPOINT(I)=ENDPOINT(J) AND ENDPOINT(I)=STPOINT(J) THEN LET
```

```
STPOINT (I)=0:ENDPOINT(I)=0:NOACTLIN=NOACTLIN-1
10840  NEXT J
10850 NEXT I
10860 RETURN
10870
```

APPENDIX O

LISTING OF DATA TRANSFER PROGRAMS FOR FEM POST PROCESSING

01 : ABASAS.WBA - WBASIC program to extract geometric, stress and stress resultant data from ABAQUS output file

```
00020 print 'abasas- extract stress resultants from abaqus output
file'
00030
00040 dim el(3000),p(3000)
00050 dim x(4000),y(4000),z(4000),r(4000),a(4000),b(4000)
00060 dim c(4000),d(4000),e(4000)
00070 dim f(4000),g(4000),h(4000)
00080 print
00090 print 'input abaqus filename'
00100 input abafile$
00110 abafile$=abafile$+' dat a1'
00120 print 'min element number'
00130 input elmin
00140 print 'maximum element number'
00150 input elmax
00160 open #6,abafile$,input
00170 print 'sas filename'
00180 input sasfile$
00190 sasfile1$=sasfile$+' data a1'
00200 ! **** routine to fetch sigma1,sigma2,tau12
00210 gosub 770
00220 gosub 870
00230
00240 gosub 1240
00250 gosub 1390
00260 close #6
00270 gosub 650
00280 gosub 360
00310 print 'total of ';total;' sas entries'
00320
00330 stop
00340
00350!*************************************
00360 print '*** write sas data file'
00370 open #6, sasfile1$,output
00380 !print #6,total
00390 for i=1 to total
00400 if el(i)<elmin or el(i)>elmax then 450
00410 f1$='#####,###.####,##.####,##.####,##.####,'
00420 print #6,using f1$,el(i);x(i);y(i);z(i);r(i);
00423 f2$='###########,###########'
00425 print#6,using f2$,a(i);b(i)
00427q$='###########,###########,###########,#######,###########,##
00430 print #6,using q$,c(i);d(i);e(i);f(i);g(i);h(i)
00440
00450 next i
00460 close #6
```

```
00470 return
00480!*****************************
00640!*************************************************************************
00650 print '***calculate arclength'
00660 for i= 1 to total
00670    r=sqr(z(i)*z(i)+y(i)*y(i))
00680 theta=atn(z(i)/y(i))
00690 if z(i)<=0 and y(i)<=0 then theta=theta-pi
00700 if z(i)>=0 and y(i)<=0 then theta=theta+pi
00710
00720
00730        r(i)=r*theta
00740   next  i
00750 return
00760 !*********************************************
00770 print'***searching for geometric data'
00780 loop
00790 linput#6,a$
00800  l=len(a$)
00810     if str$(a$,1,21)=' ELEMENT  PT SEC FOOT' then 850
00820  endloop
00830 print 'not found'
00840 print '*** found geometric data '
00850 return
00860 ! ***************************************
00870 print '***loading goemetric data'
00880 i=1
00890 ! ***i= counter for matrix
00900 linput#6,a$
00910   if a$="" then goto 900
00920    l=len(a$)
00930 if str$(a$,1,8)=' MAXIMUM' then return
00940
00950 !*** input element  point and section
00960 b$=str$(a$,8,1)
00970 if b$='1' then 1080
00980 if b$='2' then 1080
00990 if b$='3' then 1080
01000 if b$='4' then 1080
01010 if b$='5' then 1080
01020 if b$='6' then 1080
01030 if b$='7'then 1080
01040 if b$='8' then 1080
01050 if b$='9' then 1080
01060 if b$='0' then 1080
01070 goto 900
01080 el(i)=value(str$(a$,1,9))
01090 !print a$
01100 p(i)=value(str$(a$,9,5))
01110
```

```
01120 se=value(str$(a$,13,5))
01130 if se<>1 then goto 900
01140 !*** input x,y,z co-ordinates
01150 x(i)=value(str$(a$,21,11))
01155 x(i)=x(i)-.054
01160 y(i)=value(str$(a$,33,11))
01165 y(i)=y(i)-.0631
01170 z(i)=value(str$(a$,45,11))
01180 total=i
01190 !print el(i);p(i);se(i);x(i);y(i);z(i)
01200 i=i+1
01210
01220 goto 900
01230!*************************************************************
01240 print '***searching for stress resultants '
01250 loop
01260 linput#6,a$
01270
01280  l=len(a$)
01290
01300
01310     if str$(a$,1,17)=' ELEMENT  PT FOOT' then goto 1340
01320  endloop
01330 print 'not found'
01340 print '*** found stress resultants
01350
01360 return
01370
01380 ! ***************************************
01390 print '*** loading stress resultant data"
01400 i=1
01410 ! ***i= counter for matrix
01420 linput#6,a$
01430
01440   if a$="" then goto 1420
01450    l=len(a$)
01460 if str$(a$,1,8)=' MAXIMUM' then return
01470 !*** input element  point and stress resultants
01480 b$=str$(a$,8,1)
01490 if b$='1' then 1600
01500 if b$='2' then 1600
01510 if b$='3' then 1600
01520 if b$='4' then 1600
01530 if b$='5' then 1600
01540 if b$='6' then 1600
01550 if b$='7'then 1600
01560 if b$='8' then 1600
01570 if b$='9' then 1600
01580 if b$='0' then 1600
01590 goto 1420
```

```
01600 el=value(str$(a$,1,8))
01610 !print a$
01620 !print
'12345678911234567892123456789312345678941234567895123456789'
01630
01640 p=value(str$(a$,9,5))
01650 if p<>p(i) or el<>el(i) then return
01660 !*** ' put x,y,z co-ordinates
01670 a(i)=value(str$(a$,17,12))
01680 b(i)=value(str$(a$,29,12))
01690 c(i)=value(str$(a$,41,12))
01700 d(i)=value(str$(a$,53,12))
01710 e(i)=value(str$(a$,65,12))
01720 f(i)=value(str$(a$,77,12))
01730 g(i)=value(str$(a$,89,12))
01740 h(i)=value(str$(a$,101,12))
01750 !print a(i);b(i);c(i);d(i);e(i);f(i);g(i);h(i)
01760 i=i+1
01770
01780 goto 1420
01790 !************************************
01800 print 'sas smaller files'
01810 for j=1 to 8
01820 small1$=sasfile$+value$(j)+' data a1'
01830 open #6,small1$,output
01840 for i=1 to total
01850 if el(i)<elmin or el(i)>elmax then 1940
01860 if j=1 then print #6,x(i);r(i);a(i)
01870 if j=2 then print #6,x(i);r(i);b(i)
01880 if j=3 then print #6,x(i);r(i);c(i)
01890 if j=4 then print #6,x(i);r(i);d(i)
01900 if j=5 then print #6,x(i);r(i);e(i)
01910 if j=6 then print #6,x(i);r(i);f(i)
01920 if j=7 then print #6,x(i);r(i);g(i)
01930 if j=8 then print #6,x(i);r(i);h(i)
01940 next i
01950 close #6
01960 next j
01970
01980 return
01990 theta=theta+3.1425
```

```
02 : SOLIDVAL.WBA - WBASIC  program for estimation of validation
                          stresses using beam theory

00010 print '*** solidval : validation model stress estimation '
00020 print '                using strength of materials'
00040 fx=5000
00050 ! axial force in n
00060 ym=0.0631
00070 ! distance from cylinder centre-line to pipe
00080
00190 t=1.89e-3
00200 ! thickness of shell
00250 l=.224
00260 ! total length of model
00270
00280 ar=.020
00290 ! width of rib
00320 nr=2
00330 ! number of ribs
00340 ! print "pi;phi;ax;ay;az;p;gxy;t;xc;xd;l"
00350 ! print  pi;phi;ax;ay;az;p;gxy;t;xc;xd;l
00360 !*************************************************
00370 print 'abaqus basic input filename '
00380 input in$
00390 in$=in$+' data a1'
00400 open #4,in$,input
00410 print 'solids sas output filename '
00420 input out$
00430 out$=out$+' data a1'
00440 open #2,out$,output
00441 print 'abaqus sas output filename '
00442 input aba$
00443 aba$=aba$+' data a1'
00444 open #5,aba$,output
00450 print 'differences sas output filename '
00460 input dif$
00470 dif$=dif$+' data a1'
00480 open #3,dif$,output
00490 on eof goto 2480
00500  input#4,el,x,y,z,arc,sf1,sf2
00510  input#4,sf3,sf4,sf5,sm1,sm2,sm3
00511  print#5,el;x;y;z;arc;sf1;sf2
00512  print#5,sf3;sf4;sf5;sm1;sm2;sm3
00520 !*** calculate section properties
00530 !rs=(y**2+z**2)**.5
00540 ! shell radius
00550 ri=.050
00560 ! internal radius
00570 ro=.05189
00580 ! external radius
```

```
00630 dou=ro*2
00640 ! outer diameter
00650 di=ri*2
00660 ! inside diameter
00740 !**** sectional geometric properties
00750 q=2/3*(ro**3-ri**3)
00760 ! first moment of area
00770 a=pi*(ro**2-ri**2)
00780 ! cross sectional area
00790 i=pi/4*(ro**4-ri**4)
00800 ! bending moment of area
00810 j=i*2
00840 !print "rs;ri;ro;dbo;dbi;dou;di;l"
00850 !print rs;ri;ro;dbo;dbi;dou;di;l
00860 !print "rhoc;rhos;cz;cy;q;a;i;j;ap"
00870 !print rhoc;rhos;cz;cy;q;a;i;j;ap
00880 ! torsional moment of area
00890 b=2*(ro-ri)
00900 ! shear width
01160
01500 !*** loads due to offset force
01530       mz=fx*ym
01540          !bending moment due to offset load
01550       nxb=mz*-y/i*t
01560            ! nxx due to bending
01570       nxa=fx/a*t
01575   !print  fx;ym;mz;y;i;t;a;nxb;nxa
01580! nxx due to axial force
02150 !*** find totals of sectional fo[illegible]s
02160     nx=nxb+nxa
02165 if x<.090 then nx=0
02190     qx=0
02200     qt=0
02210     mx=0
02220     mt=0
02230     mxt=0
02240 !*** write theoretical calculations to file
02250   print#2,el;x;y;z;arc;nx;nt
02255   !print,el;x;y;z;arc;nx;nt
02260   print#2,n[illegible];qx;qt;mx;mt;mxt
02270 !*** calculate differences
02280    da=0
02290     if nx<>0 then da=(sf1-nx)/nx*100
02300    db=0
02310     if nt<>0 then db=(sf2-nt)/nt*100
02320    dc=0
02330     if nxt<>0 then dc=(sf3-nxt)/nxt*100
02340    dd=0
02350     if qx<>0 then dd=(sf4-qx)/qx*100
02360    de=0
```

```
02370     if qt<>0 then de=(sf5-qt)/qt*100
02380    df=0
02390     if mx<>0 then df=(sm1-mx)/mx*100
02400    dg=0
02410     if mt<>0 then dg=(sm2-mt)/mt*100
02420    dh=0
02430     if mxt<>0 then dh=(sm3-mxt)/mxt*100
02440   !*** write differences to file
02450   print#3,el;x;y;z;arc;da;db
02460   print#3,dc;dd;de;df;dg;dh
02470 goto 490
02480 close #2
02490 close #4
02500 close #3
02505 close #5
02510 stop
02520 end
```

```
03 : PLOT.SAS - SAS program for plotting of contour maps

OPTIONS LEAVE=20K;
CMS FILEDEF EXAMPLE DISK ABVALIDI DATA A (LRECL 80;
DATA DATAI;
INFILE EXAMPLE;
INPUT E X Y Z ARC SF1 SF2/SF3 SF4 SF5 SM1 SM2 SM3;
*GOPTIONS DEVICE=TEK4010;
*GOPTIONS DEVICE=IBM3279;
*GOPTIONS DEVICE=IBM3179;
**** FOR PLOTTER C:FIBRE TIP A4 MATT;
  GOPTIONS HANDSHAKE=NONE AUTOFEED NOPROMPT;
  GOPTIONS GACCESS=GSASFILA;
  CMS FILEDEF GSASFILE DISK STATA4AB HPGL 0;
  GOPTIONS DEVICE=HP7550A PENMOUNTS=8;
  GOPTIONS COLORS=(BLACK,RED,GREEN,BLUE,ORANGE,BROWN,VIOLET,YELLOW);


*TITLE1 'TANKER STRESS RESULTANTS (N/M WIDTH)';
*TITLE2 'NXT VS X VS ARC FOR AX,AY,AZ=2G';
*TITLE2 'NXX VS X VS ARC FOR P=84000 KPA';
*TITLE2 'NXT VS X VS ARC FOR AZ=2G,THETA=3';
 TITLE1 'VALIDATION STRESS RESULTANTS (N/M WIDTH)';
 TITLE2 'NXT VS X VS ARC FOR FX=5KN';

*  PROC G3GRID DATA=DATAI OUT=DATAG;
* GRID ARC * X = SF3/ ;
*                        AXIS1=.2113 TO 7.789 BY .03789
*                         AXIS2=0     TO 4.3982 BY .2199;


 PROC GCONTOUR DATA = DATAI;
    PLOT ARC * X = SF3 / CTEXT=BLACK
                         CAXIS=BLACK
                            VM=0
                            HM=0
                          HREF=1 TO 11 BY 1
                          VREF=0
LEVELS=-1E4 -8E3 -6E3 -4E3 -2E3 0 2E3 4E3 6E3 8E3 1E4
CLEVELS=BLUE BLACK BROWN BLACK BROWN BLUE VIOLET GREEN YELLOW ORANGE
RED
LLEVELS=2 2 2 1 1 1 1 1 1 1 1;
RUN;

**** FOR PLOTTER A:ROLLERBALL  A4 MATT;
 GOPTIONS HANDSHAKE=NONE AUTOFEED NOPROMPT;
 GOPTIONS GACCESS=GSASFILA;
 CMS FILEDEF GSASFILE DISK STATA4AA HPGL 0;
 GOPTIONS DEVICE=HP7550A PENMOUNTS=4;
 GOPTIONS COLORS=(BLACK,RED,GREEN,BLUE);
```

```
    PROC G3D DATA  = DATAI;
    PLOT ARC* X = SF3 / SIDE
                              TILT = 45
                              ROTATE =45
                                CTEXT=BLACK
                                CAXIS=BLACK
                                 CTOP=BLACK
                              CBOTTOM=BLACK
                               XYTYPE=2
                             XTICKNUM=8
                             YTICKNUM=8
                             ZTICKNUM=10;

    PROC G3D DATA  = DATAI;
    PLOT ARC* X = SF3 / SIDE
                              TILT = 45
                              ROTATE =45
                                CTEXT=BLACK
                                CAXIS=BLACK
                                 CTOP=BLACK
                              CBOTTOM=BLACK
                               XYTYPE=1
                             XTICKNUM=8
                             YTICKNUM=8
                             ZTICKNUM=10;
RUN;

**    PROC G3D DATA  = DATAI;
**   PLOT ARC * X = SF1 / SIDE
                              TILT = 90
                              ROTATE =0;

**    PROC G3D DATA  = DATAI;
**    PLOT ARC * X = SM3 / SIDE
                              TILT = 90
                              ROTATE =90;

**    PROC G3D DATA  = DATAI;
**   SCATTER ARC * X = SF1 /
                             TILT=90
                             ROTATE=0;

**   PROC G3D DATA  = DATAI;
** SCATTER ARC * X = SF1 /
                              TILT = 90
                              ROTATE =90;

*RT27AA
SF1
LEVELS=-1E6 -8E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6
```

```
SF2
LEVELS=-1E6 -8E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6
SF3
LEVELS=-3E5 -2.4E5 -1.8E5 -1.2E5 -6E5 0 6E4 1.2E5 1.8E5 2.5E5 3E5
RT27P
SF1
LEVELS=2.7E5 2.72E5 2.74E5 2.76E5 2.78E5 2.80E5 2.82E5 2.84E5 2.86E5
2.88E5 2.90E5
SF2
LEVELS=1E5 1.6E5 2.2E5 2.8E5 3.4E5 4E5 4.6E5 5.2E5 5.8E5 6.4E5 7.0E5
SF3
LEVELS=-3E3 -2.3E3 -1.6E3 -9E2 -2E2 5E2 1.2E3 1.9E3 2.6E3 3.3E3 4.0E3
P    ?T
{
..      -1E6 -8E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6
SF2
LEVELS=-3E6 -2.4E6 -1.8E6 -1.2E6 -6E5 0 6E5 1.2E6 1.8E6 2.4E6 3E6
SF3
LEVELS=-1E6 -8E5 -6E5 -4E5 -2E5 0 2E5 4E5 6E5 8E5 1E6
VALIDAT.ON
SF1
LEVELS=-2E4 -1.2E4 -3.99E3 4E3 1.2E4 2E4 2.8E4 3.6E4 4.4E4 5.2E4 6E4
SF2
LEVELS=-1E4 -7E3 -4E3 -1E3 2E3 5E3 8E3 1.1E4 1.4E4 1.7E4 2.0E4
SF3
LEVELS=-1E4 -8E3 -6E3 -4E3 -2E3 0 2E3 4E3 6E3 8E3 1E4
END OF FILE
```

APPENDIX P

LISTING OT THE MATHEORY PROGRAM

```
3 '*** matheor7.bas 28/11/1991
   on error goto 25010
4 CLS
5  PRINT"*** MATHEOR7.BAS: road tanker stress estimation "
7 'print "using strength of materials for overhanging ends"
10 '*********************************
20 DEF FNHS(X)=(EXP(X)-EXP(-X))/2
25 DEF FNHC(X)=(EXP(X)+EXP(-X))/2
27 ' *** functions for localized stresses
30 GOSUB 1010
50 ' *** define loading conditions
70 GOSUB 1950
90 ' *** define geomertical properties
110 GOSUB 3950
130 ' *** define shell proporties and densities
140 GOSUB 4490
150 ' *** calculate sectional properties
190 GOSUB 4870
210 ' *** calculate volumes
230 GOSUB 5210
250 ' *** calculate masses
 PRINT:INPUT "ABAQUS OUTPUT, CO-ORDINATES OR RANGE (A/C/R)";DTA$
 IF DTA$="C" THEN RESTORE 312:GOTO 341
 IF DTA$="R" THEN  GOSUB 26000:END
    ' *** for range of x values
270 GOSUB 2780
290 ' *** specify files
295 DUM$="L":INPUT "Input tanker model size - (Large/Small)";DUM1$
    IF DUM1$<>"" THEN DUM$=DUM1$
300 IF DUM$="L" or DUM$="l"  THEN GOSUB 3470
310 IF DUM$="S" or DUM$="s"  THEN GOSUB 23470
    NON$="R"
INPUT "Resultant, Non-Dimensional Data or Max Principal Stresses
(R/N/M)";NON1$
    IF NON1$<>"" THEN NON$=NON1$
311 ' *** define range defaults
312     DATA 781,  -.025, -.528, .389
313     DATA 2  ,   .053, -.529, .390
314     DATA 38 ,   .947, -.529, .390
315     DATA 50 , 1.053, -.529, .390
316     DATA 314,  6.553, -.529, .390
317     DATA 518, 10.95 , -.529, .390
318     DATA 530, 11.05 , -.529, .390
337     DATA 556, 11.95 , -.529, .390
338     DATA 865, 12.02 , -.528, .389
339     DATA 9999,     9 ,     9,    9

340      IF DTA$<>"C" THEN  350
341 'FOR DTA=1 TO 9: READ EL(DTA),X(DTA),Y(DTA),Z(DTA):NEXT DTA
342 ' FOR DTA=1 TO 9: EL=EL(DTA):X=X(DTA):Y=Y(DTA):Z=Z(DTA)
```

```
343 ' INPUT A$:CLS
344 ' PRINT EL;X;Y;Z:
346 '  GOTO 510
350   WHILE NOT EOF(1)
360 '  INPUT#1,EL,X,Y,Z,ARC,SF1,SF2,SF3
370  INPUT#1,EL,X,Y,Z,ARC,SF1,SF2
390  INPUT#1,SF3,SF4,SF5,SM1,SM2,SM3
410    IF X<XMIN OR X>XMAX THEN 870
430    IF Y<YMIN OR Y>YMAX THEN 870
450    IF Z<ZMIN OR Z>ZMAX THEN 870
500  GOSUB 13840
510   ' *** define local variables for dome
550 IF AX<>0 THEN GOSUB 5710
570    ' *** loads due to ax acceleration
590 IF AZ<>0 THEN GOSUB 7110
610    ' *** loads due to az acceleration
630 IF AY<>0 THEN GOSUB 8110
650    ' *** loads due to ay acceleration
670 IF TWIST<>0 THEN  GOSUB 9470
690    ' *** loads due to twisting
710 IF PP<>0 OR AX<>0 THEN  GOSUB 9630
730    ' *** membrane loads due to internal pressure
750 IF AX<>0 OR PP<>0 THEN GOSUB 13858
770     '  ** localized stresses due to domes/cylinder connection
790 IF AX<>0 OR PP<>0 THEN GOSUB 10990
810     '  ** localized stresses due to ribs
      GOSUB 3810
    ' *** write abaqus data file
830 IF DTA$<>"C" THEN GOSUB 10090
850    ' *** find totals and errors and write to file
855 'NEXT DTA
865 'STOP
870 WEND
890 CLOSE #1
910 CLOSE #2
930 CLOSE #3
950 ' CLOSE #4
970 STOP
990 ' ************************************
1010 'print "*** loading conditions ***"
1030 PI=3.141592654#
1050 TWIST=0:'6
1070 PHI=TWIST*PI/180
1090 ' *** angle of twist
1110 AZ=-2*9.810001
1130   ' *** accel in z direction (must be -ve)
1150 AY=-2*9.810001
1170 ' *** accel in y direction (must be -ve)
1190 AX=2*9.810001
1210 ' *** accel in x dirn
```

```
1230 PP=0:'**8.4E5
1250 ' *** internal pressure
      RHOC=1850
      ' *** density of sulphuric acid
1260 '************************************************
1265 ' print "*** material properties ***"
1270 NUS=.1287
1290 ' *** equivalent poissions ratio for the shell
1310 GXTS=4.91E+09
1330 ' *** equivalent shear modulus of the shell
1350 EXS=2.262E+10
1370 ' *** equivalent axial modulus of the shell
1390 ETS=2.262E+10
1410 ' *** equivalent transverse modulus of the shell
1430 ES=(EXS+ETS)/2
1450 ' *** equivalent average modulus of the shell
1470 NUD=.2695
1490 ' *** equivalent poissions ratio for the dome
1510 GXTD=7.469E+09
1530 ' *** equivalent shear modulus of the dome
1550 EXD=1.896E+10
1570 ' *** equivalent axial modulus of the dome
1590 ETD=1.896E+10
1610 ' *** equivalent transverse modulus of the dome
1630 ED=(EXD+ETD)/2
1650 ' *** equivalent average modulus of the dome
1670 NUR=.26
1690 ' *** equivalent poissions ratio for the rib
1710 GXTR=4.14E+09
1730 ' *** equivalent shear modulus of the rib
1750 EXR=3.86E+10
1770 ' *** equivalent axial modulus of the rib
1790 ETR=8.27E+09
1810 ' *** equivalent transverse modulus of the rib
1830 ER=(EXR+ETR)/2
1850 ' *** equivalent average modulus of the rib
1870 'PRINT "pi;phi;az;ay;ax;p;;nus;gxts;exs;ets;es"
1890 'PRINT PI;PHI;AZ;AY;AX;P;NUS;GXTS;EXS;ETS;ES"
1892 'PRINT "nud;gxtd;exd;etd;ed"
1894 'PRINT NUD;GXTD;EXD;ETD;ED"
1896 'PRINT "nur;gxtr;exr;etr;er"
1898 'PRINT NUR;GXTR;EXR;ETR;ER"
1910  RETURN:STOP
1930 ' ****************************************
1950 'print "*** geometrical dimensions ***"
1970 T=.015
1990 ' *** thickness of shell
2010 RI=.65
2030 ' *** shell inside radius
2050 RS=RI+T/2
```

```
2070 ' *** shell centreline radius
2090 RO=RI+T
2110 ' *** shell outside radius
2130 ADOME=RS
2150 ' *** dome major axis
2170 BDOME=RS/2
2190 XC=1
2210 ' *** overhang at back or lhs
2230 XD=1
2250 ' *** overhang at front or rhs
2270 XCYL=12:XT=XCYL
2290 ' *** cylinder length of tanker
     L=1
     ' *** spacing between ribs
2310 ARS=.05
2330 ' *** width of small rib
2350 BRS=.05
2370 ' *** height of small rib
2390 ARL=.05
2410 ' *** width of large rib
2430 BRL=.1
2450 ' *** height of large rib
2455 COFFSET=RO+BRL/2
2460 ' *** distance from tank centreline to back axial restraint
     ROFFSET=0
2465 ' *** offset of reaction for equivalient moment
2470 NRS=5
2490 ' *** number of small ribs
2510 NRL=8
2530 ' *** number of large ribs
2550 NRIBS=NRS+NRL
2570 ' *** total number of ribs
2590 DATA 0,1,2,3,4,5,6,7,8,9,10,11,12
2610 ' *** define rib x position
2630 DATA .05,.05,.05,.05,.05,.05,.05,.05,.05,.05,.05,.05,.05
2650 ' *** define rib widths
2670 DATA .10,.10,.10,.10,.05,.05,.05,.05,.05,.10,.10,.10,.10
2690 ' *** define rib heights
2710 'PRINT "T;RI;RS;RO;ADOME;BDOME;XC;XD;XCYL"
2715 'PRINT T;RI;RS;RO;ADOME;BDOME;XC;XD;XCYL
2720 'PRINT "ARS;BRS;ARL;BRL;COFFSET;NRS;NRL;NRIBS"
2725 'PRINT ARS;BRS;ARL;BRL;COFFSET;NRS;NRL;NRIBS
2750 RETURN
2770 ' ************************************************
2780 PRINT "ABAQUS output filename (excl.ext)"
2810   INPUT IN$
2830   IN$="F:\MIKE\MATHESIS\RT27\"+IN$+".ABA"
       PRINT "Opening file ";IN$
2870   OPEN IN$ FOR INPUT AS #1
2910 PRINT:PRINT "New ABAQUS reduced filename. "
```

```
2930    INPUT ABA$
2970    ABA$="F:\MIKE\MATHESIS\RT27\"+ABA$+".DAT"
        PRINT "Opening file ";ABA$
3010    OPEN ABA$ FOR OUTPUT AS #2
3030 PRINT:PRINT "New THEORY reduced filename. "
3050    INPUT SOL$
3090    SOL$="F:\MIKE\MATHESIS\RT27\"+SOL$+".DAT"
        PRINT "Opening file ";SOL$
3110    OPEN SOL$ FOR OUTPUT AS #3
3150 'PRINT :PRINT "Differences sas filename "
3170 'INPUT DIF$
3210 'DIF$="F:\BIRGIT\MATHESIS\RT27DAT\"+DIF$+".DAT"
     'PRINT "Opening file ;DIF$
3250 'OPEN DIF$ FOR OUTPUT AS #4
3270 RETURN
3290 '************************************
3310 'print "specify range extraction values RT27"
3321 XMIN=0
3322 XMAX=12
3323 YMIN=.070
3324 YMAX=.075
3325 ZMIN=.650
3326 ZMAX=.655
3327 RETURN
3328 ' *** extract positions for top

3331 XMIN=0
3332 XMAX=12
3333 YMIN=.07
3334 YMAX=.075
3335 ZMIN=-.655
3336 ZMAX=-.65
3337 RETURN
3338 ' *** extract positions for bottom

3341 XMIN=0
3342 XMAX=12
3343 YMIN=.65
3344 YMAX=.655
3345 ZMIN=.070
3346 ZMAX=.0755
3347 RETURN
3348 ' *** extract positions for left (+Y)

3351 XMIN=0
3352 XMAX=12
3353 YMIN=-.655
3354 YMAX=-.65
3355 ZMIN=.070
3356 ZMAX=.0755
```

```
3357 RETURN
7358 ' *** extract positions for right (-Y)

3361 XMIN=-1
3362 XMAX=0
3363 YMIN=.024
3364 YMAX=.075
3365 ZMIN=.0
3366 ZMAX=.655
3367 RETURN
3368 ' *** extract positions for back dome

3450 '************************************
3470  PRINT "Specify position (Top/Bottom/Left/Right/Dome/New) "
3490  INPUT RANGE$
3500  IF RANGE$="T" THEN GOSUB 3321:RETURN
3510  IF RANGE$="B" THEN GOSUB 3331:RETURN
3520  IF RANGE$="L" THEN GOSUB 3341:RETURN
3530  IF RANGE$="R" THEN GOSUB 3351:RETURN
3525  IF RANGE$="D" THEN GOSUB 3361:RETURN
3540  IF RANGE$<>"N" THEN RETURN
3545  PRINT "xmin"
3550  INPUT XMIN
3570  PRINT "xmax"
3590  INPUT XMAX
3610  PRINT "ymin"
3630  INPUT YMIN
3650  PRINT "ymax"
3670  INPUT YMAX
3690  PRINT "zmin"
3710  INPUT ZMIN
3730  PRINT "zmax"
3750  INPUT ZMAX
3770 RETURN
3790 ' ***********************************
3810 'print "writing ab file"
3830 PRINT#2,USING " ##.### ";X;
3850 IF NON$="R" THEN
      PRINT#2,USING " ###.##^^^^^ ";SF1;SF2;SF3;SF4;SF5;SM1;SM2;SM3
     END IF

      IF NON$="N" THEN
       PE=PP+P2:DN=PE*RI:DM=PE*RI*T
       '** DUMMIES FOR NON DIMENSIONAL
       PRINT#2,USING " ###.##^^^^^
";SF1/DN;SF2/DN;SF3/DN;SF4/DN;SF5/DN;SM1/DM;SM2/DM;SM3/DM
      END IF
3870 '  PRINT#2,EL;X;Y;Z;ARC;SF1;SF2;SF3
3890 '  print#2,sf3;sf4;sf5;sm1;sm2;sm3
3910 RETURN
```

```
3930 ' ********************************
3950 'input "** shell properties **",a$
3970 XBI=RI/2
3990 ' *** depth of elliptical dome  inside
4010 XBO=RO/2
4030 ' *** depth of elliptical dome outside
4050 XB=RS/2
4070 XF=XB
4090 ' *** depth of elliptical dome middle
4110 DOU=RO*2
4130 ' *** outer diameter
4150 DI=RI*2
4170 ' *** inside diameter
4190 XL=XCYL-XC-XD
4210 ' *** unsupported span of the tanker
4230 'PRINT "XBI;XBO;XB;XF;DOU;DI;XL"
4250 'PRINT XBI;XBO;XB;XF;DOU;DI;XL
4270 ' ********************************************
4290 'input "*** densities of shell and contents ***",a$

4350 RHOR=1900
4370 ' *** density of the ribs
4390 RHOS=1900
4410 ' *** density of the shell
4430 'PRINT "RHOC;RHOR;RHOS"
4450 'PRINT RHOC;RHOR;RHOS
4470 ' ********************************************

4490 'input "** sectional geometric properties **",a$

4550 A=PI*(RO^2-RI^2):ACROSS=A
4570 ' *** cross sectional area
4590 II=PI/4*(RO^4-RI^4)
4610 ' *** bending moment of area
4630 JJ=II*2
4650 ' *** torsional moment of area
4670 AP=PI*RI^2
4690 ' *** internal projected area
4750 ' ** DS=ES*T^3/(12*(1-NUS^2))
     DS=7.473E3:'D11 FROM STIFFNESS MATRIX
4770 ' *** average flexural rigidity of shell
4775 '** DDOME=ED*T^3/(12*(1-NUD^2))
     DDOME=6.428E3:'D11 FROM STIFFNESS MATRIX
4780 ' *** average flexural rigidity of shell
4790 'PRINT "Q;A;I;J;AP;B;DS;DDOME"
4800 'PRINT Q;A;I;J;AP;B;DS;DDOME
4830 RETURN
4850 ' ************************************

4870 'input "*** calculate volumes ***",a$
```

```
4890     VCC=PI/4*DI^2*XCYL
4910       ' *** volume of cyl contents
4930     VCS=PI/4*(DOU^2-DI^2)*XCYL
4950       ' *** volume of cyl shell
4970     VDS=PI*4/6*(RO^2*XBO-RI^2*XBI)
4990       ' *** volume of dome shell
5010     VDC=PI*4/6*(RI^2*XBI)
5030       ' *** volume of dome contents
5050     VRS= PI*((RO+BRS)^2-(RO^2))*ARS
5070       ' *** volume of small rib
5090     VRL= PI*((RO+BRL)^2-(RO^2))*ARL
5110       ' *** volume of large rib
5130 'print "vcc;vcs;vds;vdc;vrs;vrl"
5150 'print vcc;vcs;vds;vdc;vrs;vrl
5170 RETURN
5190 ' ***********************************

5210 'input "*** calculate masses ***",a$

5230      MRG=6000
5250       ' *** mass of running gear,fifth wheel and landing legs
5270      MCC=VCC*RHOC
5290       ' *** mass cylidrical contents
5310      MCS=VCS*RHOS
5330       ' *** mass cylidrical shell
5350      MDC=VDC*RHOC
5370       ' *** mass dome contents
5390      MDS=VDS*RHOS
5410       ' *** mass dome shell
5430      MRS=VRS*RHOR
5450       ' *** mass per small rib
5470      MRL=VRL*RHOR
5490       ' *** mass per large rib
5510      MRT=MRL*NRL+MRS*NRS
5530      ' *** total mass of rings
5540      MSHELL=MCS+2*MDS+MRT
5550      ' *** total mass of shell only
          MT=MCC+MCS+2*(MDC+MDS)+MRT
5570       ' *** total mass of shell and contents
5590      MTRG=MT+MRG
5610       ' *** total mass of tanker
5630 'PRINT "mrg;mcc;mcs;mdc;mds;mrs;mrl;mrt;mt;mtrg"
5650 'PRINT MRG;MCC;MCS;MDC;MDS;MRS;MRL;MRT;MT;MTRG
5670 RETURN
5690 ' ************************************************************

5710 'input "*** loads due to ax acceleration ***",a$

5730 'print "** forces due to content's average pressure in front head
```

```
(1) **"
5750 HAVE=RI/2+XC+XL+XD+3/8*RI/2
5770 ' *** average head in front dome
5790 P1=RHOC*HAVE*AX
5810 ' *** average pressure in front dome
5830 FX=P1*AP
5850 ' ***axial force in shell from pressure of contents
5855 RX1=-FX
5856 ' ***axial reaction at back support
5857  MYB=RX1*(ROFFSET)
5858 ' *** moment due to offset of force from support using offset
assumption
5870 RZF1=-MYB/XL
5890 ' *** vertical reaction as back support (+ve upwards)
5910 RZB1=MYB/XL
5930 ' *** vertical reaction as front support (+ve upwards)

5990 IF X>=XC THEN FX1=-RX1
6010 IF X<XC THEN FX1=0
6030 ' *** Fx1 axial force in x direction

6050 IF X >= XC AND X <= (XC+XL) THEN VZ1=RZB1
6070 IF X < XC OR X > (XC+XL) THEN VZ1=0
6090 ' *** vz1 shearing force in z direction

6110 IF X >= XC AND X <= (XC+XL) THEN MY1=RZB1*(X-XC)-MYB
6130 IF X>(XC+XL) AND X<=XCYL THEN MY1=0
6150 IF X>XCYL OR X<XC THEN MY1=0
     ' *** MY1 bending moment

6170 'print "x;have;p1;fx;rzb1;rzf1;myb;fx1;vz1;my1"
6190 'print x;have;p1;fx;rzb1;rzf1;myb;fx1;vz1;my1

6195 ' ************************************************
6210 'print "** forces due to ax :pressure along length (2) **"
6220 P2=RHOC*AX*(X+RI/2)
6225 ' *** pressure as a function of x
6227 'PRINT "p2"
6229 'PRINT P2

6391 '  ****************************************
6392 'print "** forces due to ribs and shells (3)**"
6394 ' *** routine to establish number of ribs after x
6396  MRAX=0:MAX3=0
6398  ' *** MRAX = total mass of ribs after x
6402  ' *** find ribs after x
6404  RESTORE 2590
6406  FOR I=1 TO NRIBS
6408   READ XRIB
6410   ' *** x rib back and x rib front
```

```
6411   IF XRIB>X THEN 6413
6412  NEXT I
6413 RESTORE 2670
6414 FOR J=1 TO I-1:READ HB:NEXT J
6415 ' read rib thickness values which are not needed
6418 FOR J = I TO NRIBS
6420  READ HB
6422  IF HB=BRS THEN MRAX=MRAX+MRS
6424  IF HB=BRL THEN MRAX=MRAX+MRL
6426 NEXT J
     WTOTAL=AX*MSHELL
     ' *** equivalent weight for 2G acceleration
     WFRONT=RHOS*(XCYL-X)*ACROSS+MRAX+MDS)*AX
     ' *** weight of shell and ribs to front of x
     WBACK=WTOTAL-WFRONT
     ' *** weight of shell and ribs behind  x
6429 RX3=-WTOTAL
     ' ***support reaction axial force due to wax
     MYB=RX3*ROFFSET
     ' *** moment due to offset of force from support uses smaller
offset
6340 RZF3 = -MYB/XL
6342 ' *** vertical reaction as back support (+ve upwards)
6344 RZB3 = MYB/XL
6346 ' *** vertical reaction as front support (+ve upwards)

6334 IF X>=0 AND X<XC THEN FX3=-(MRL+RHOS*ACROSS*X+MDS)*AX
6435 IF X>=XC AND X<=XCYL THEN FX3=WFRONT
6337 ' *** fx3 axial reaction force due to shell deceleration

6360 IF X>=XC AND X<=XC+XL THEN VZ3=RZB3
6362 IF X<0 OR X>XC+XL THEN VZ3=0
6364 ' *** vz3 shearing force in z direction

6366 IF X>=XC AND X<=(XC+XL) THEN MY3=RZB3*(X-XC)-MYB
6370 IF X>(XC+XL) OR X<XC THEN MY3=0
     ' *** MY3 bending moment

6372 'print "X;max3;fx;fx3t;rx3;rzb3;rzf3;my;fx3;vz3;my3"
6374 'print X;max3;fx;fx3t;rx3;rzb3;rzf3;my;fx3;vz3;my3

6377 '
*****************************************************************

6381 ' *** sectional properties for shear
6382 Q=2/3*(RO^2-Z^2)^(3/2)-2/3*(RI^2-Z^2)^(3/2)
6383 ' *** first moment of area
6384 B=2*(RO^2-Z^2)^.5 - 2*(RI^2-Z^2)^.5
6385 ' *** shear width
```

```
6464 'input "** stress resultants for ax **",a$
6465 NXXAX=(FX1+FX3)/A*T-(MY1+MY3)*Z/II*T
6466 ' *** from beam theory definition z is positive downwards
6467 NTTAX=P2*RI
6470 NXTAX=(VZ1+VZ3)*Q/II/B*T
6490 'print "nxxax;nttax;nxtax"
6510 'print nxxax;nttax;nxtax
6530 RETURN

7090 ' ****************************************

7110 'input "*** loads due az accelaration ***",a$

7130 'print " ** uniformily ditributed load (4) **"
7150 WZ=(MT*ABS(AZ))/(XCYL+4*XB/3)
7170 ' *** ud load per unit lenght on the beam (+ve down)
7190 RBZ=(MT*ABS(AZ))/2
7210 ' *** reaction at back support for xc=xd (+ve up)
7230 RFZ=(MT*ABS(AZ),/2
7250 ' *** reaction at fron  support for xc=xd (+ve up)
7270 FPZ=WZ*RS
7290 '*** hydrostatic force due to presssure of the ends
7300 MTZ=1/4*WZ*(RS^2-XB^2)
7310 ' *** moment due to mass of domes and offset of Fp
7330 FDZ=2*XB/3*WZ
7350 ' *** vertical force due to mass of domes and contents
7355 'print "X,wz;rbz;rfz;fpz;mtz;fdz"
7357 'print X,wz;rbz;rfz;fpz;mtz;fdz
7370 IF X<0 OR X>12 THEN RETURN
7380  IF X>=1 THEN 7450
7390  ' *** axial force, shearing force and bending moment as f(x)
7400   FX=FPZ
7410   VZ=-FDZ-WZ*X
7420   MZ=-WZ/2*X^2+MTZ-FDZ*X
7430  GOTO 7560
7450 IF X>=11 THEN 7510
7470   FX=FPZ
7480   VZ=RBZ-FDZ-WZ*X
7490   MZ=-WZ/2*X^2+RBZ*(X-XC)-FDZ*X+MTZ
7500  GOTO 7560
7510   FX=FPZ
7520   VZ=WZ*(XCYL-X)+FDZ
7530   MZ=-WZ/2*(XCYL^2-2*XCYL*X+X^2)-FDZ*(XCYL-X)+MTZ
7560 PZ=RHOC*ABS(AZ)*ABS(Z-RI)
7570 ' *** pressure due to z accel
7580 'print " *** axial force, shearing force and bending moment as
f(x)"
7590 'print "x;fx;vz;mz;pz"
7600 'print x;fx;vz;mz;pz
```

```
7601 'print "  *** sectional properties for shear"
7602 Q=2/3*(RO^2-Z^2)^(3/2)-2/3*(RI^2-Z^2)^(3/2)
7603 'print " *** first moment of area"
7604 B=2*((RO^2-Z^2)^.5 - (RI^2-Z^2)^.5)
7605 ' *** shear width

7610 'print "** stress resultants for az **"
7660 NXXAZ=FX/A*T-MZ*Z/II*T
7670 NTTAZ=PZ*RI
7680 NXTAZ=VZ*Q/II/B*T
7690 'print "nxxaz;nttaz;nxtaz"
7700 'print nxxaz;nttaz;nxtaz
7710 RETURN
7720 ' ****************************************

8110 'input "*** loads due ay accelaration ***",a$
8130 'print " ** uniformily ditributed load (5) **"
    IF X<0 OR X>12 THEN RETURN
8150 WY=(MT*ABS(AY))/(XCYL+4*XB/3)
8170 ' *** ud load per unit lenght on the beam (+ve down)
8190 RBY=(MT*ABS(AY))/2
8210 ' *** reaction at back support for xc=xd (+ve up)
8230 RFY=(MT*ABS(AY))/2
8250 ' *** reaction at front support for xc=xd (+ve up)
8270 FPY=WY*RS
8290 '*** hydrostatic force due to presssure of the ends
8300 MTY=1/4*WY*(RS^2-XB^2)
8310 ' *** moment due to mass of domes and offset of fp
8330 FDY=2*XB/3*WY
8350 ' *** vertical force due to mass of domes and contents
8355 'print "wy;rby;rfy;fpy;mty;fdy"
8357 'print wy;rby;rfy;fpy;mty;fdy

8380  IF X>=1 THEN 8450
8390  ' *** axial force, shearing force and bending moment as f(x)
8400   FX=FPY
8410   VY=-FDY-WY*X
8420   MY=-WY/2*X^2+MTY-FDY*X
8430  GOTO 8560
8450 IF X>=11 THEN 8510
8470   FX=FPY
8480   VY=RBY-FDY-WY*X
       ' *** possible problems with this equation for rhoc=0
8490   MY=-WY/2*X^2+RBY*(X-XC)-FDY*X+MTY
8500  GOTO 8560
8510   FX=FPY
8520   VY=WY*(XCYL-X)+FDY
8530   MY=-WY/2*(XCYL^2-2*XCYL*X+X^2)-FDY*(XCYL-X)+MTY
8560 PY=RHOC*ABS(AY)*ABS(Y-RI)
8570 ' *** pressure due to y accel
```

```
8580 'print " *** axial force, shearing force and bending moment as
f(x)"
8590 'print "x;fx;vy;my;py"
8600 'print x;fx;vy;my;py

8601 ' *** sectional properties for shear
8602 Q=2/3*(RO^2-Y^2)^(3/2)-2/3*(RI^2-Y^2)^(3/2)
8603 ' *** first moment of area
8604 B=2*((RO^2-Y^2)^.5 - (RI^2-Y^2)^.5)
8605 ' *** shear width

8610 'print "** stress resultants for ay **"
8660 NXXAY=FX/A*T-MY*Y/II*T
8670 NTTAY=PY*RI
8680 NXTAY=-VY*Q/II/B*T
8690 'print "nxxay;nttay;nxtay"
8700 'print nxxay;nttay;nxtay
8710 RETURN
9450 ' ***********************************************"

9470 'input "****** loads due to twisting ******",a$

9490 NXTT=PHI*GXTS*RS/XL/2*T
9510 IF X<XC OR X>(XC+XL) THEN NXTT=0
9530          ' ****** shear sectional force due to twisting
9550 'print "x;phi;gxts;rs;xl;t;nxtt"
9570 'print x;phi;gxts;rs;xl;t;nxtt
9590 RETURN
9610 ' ************************************************
9630 'input "*** loads due to internal pressure ***" a$
9650 IF X >= 0 AND X <= XCYL THEN 9930
9670   ' *** consider membrane stresses in domes only
9690    R2DOME=((ADOME^4*YDOME^2+BDOME^4*XDOME^2)^.5)/BDOME^2
9710    ' *** tangential or circumferential radius of curvature
9730    R1DOME=(R2DOME^3*BDOME^2/ADOME^4)
9750    ' *** axial or meridional radius of curvature
9770    NXXP=(PP+P2)*R2DOME/2
9790    ' *** meridional stress resultant
9810    NTTP=(PP+P2)*R2DOME*(1-R2DOME/2/R1DOME)
9830    ' *** circumferential stress resultant
9850 '  print "x;y;z;adome;bdome;xdome;ydome;r2dome;r1dome;nxxp;nttp"
9870 '   print x;y;z;adome;bdome;xdome;ydome;r2dome;r1dome;nxxp;nttp
9890 RETURN
9905 ' ************************************************************

9910  ' *** stresses considering membrane stresses on cylinder only

9930  NXXP=PP*RI/2
9950  ' *** longitudinal or axial stress resultant
9970  NTTP=(PP)*RI
```

```
9990  ' *** hoop or tangential stress resultant
10010 'print "nxxp;nttp"
10030 'print nxxp;nttp
10050 RETURN
10070 ' ************************************************

10090 'input "find totals of sectional forces",a$

10110     NXX=NXXAX+NXXAZ+NXXAY+NXXP
10130     NTT=NTTAX+NTTAZ+NTTAY+NTTP+NTD+NTR
10150     NXT=NXTAX+NXTAZ+NXTAY+NXTT
10170     QXX=QXD+QXR
10190     QTT=QTD+QTR
10210     MXX=MXD+MXR
10230     MTT=MTD+MTR
10250     MXT=0
10270 'print "nxx;ntt;nxt;qxx;qtt;mxx;mtt;mxt"
10290 'print "solids-";nxx;ntt;nxt;qxx;qtt;mxx;mtt;mxt
10310 'print "abaqus-";sf1;sf2;sf3;sf4;sf5;sm1;sm2;sm3
10330 'input " ***** write theoretical calculations to file",a$
      IF DTA$="C" THEN
        PRINT USING " ####.### ";EL;X;Y;Z
        PRINT NXX;NTT;NXT;QXX;QTT;MXX;MTT;MXT
        RETURN
      END IF

10370 IF NON$="R" THEN
        PRINT#3,USING "  ##.### ";X;
        PRINT#3,USING " ###.##^^^^^ ";NXX;NTT;NXT;QXX;QTT;MXX;MTT;MXT
        RETURN
      END IF

       IF NON$="N" THEN
        PE=PP+P2:DN=PE*RI:DM=PE*RI*T
        '** DUMMIES FOR NON DIMENSIONAL
        PRINT#3,USING "  ##.### ";X;
        PRINT#3,USING " ###.##^^^^^
";NXX/DN;NTT/DN;NXT/DN;QXX/DN;QTT/DN;MXX/DM;MTT/DM;MXT/DM
       RETURN
      END IF

       '*** CALCULATE MAX PRINCIPAL STRESSES
       IF NON$="M" then
         '** stresses as a sum of membrane and bending
         SXXT= NXX/T+6*MXX/T^2
         SXXC= NXX/T-6*MXX/T^2
         STTT= NTT/T+6*MTT/T^2
         STTC= NTT/T-6*MTT/T^2
         ' find maximums for axial or circumferential
         IF ABS(SXXT)>=ABS(SXXC) THEN SX=SXXT
```

```
          IF ABS(SXXC)>=ABS(SXXT) THEN SX=SXXC
          IF ABS(STTT)>=ABS(STTC) THEN ST=STTT
          IF ABS(STTC)>=ABS(STTT) THEN ST=STTC
          ' determine maximums for Mohrs circle
          IF SX>=ST THEN MAX=SX:MIN=ST
          IF ST>=SX THEN MAX=ST:MIN=SX
          ' determine principals
          IF MIN<=0 THEN S1=MAX:S2=MIN:SHEAR=(MAX-MIN)/2
          IF MIN>0 THEN S1=MAX:S2=MIN:SHEAR=MAX/2
        PRINT#3,USING "  ##.### ";X;
        PRINT#3,USING " ###.##^^^^ ";S1;S2;0;SHEAR
        RETURN
       END IF

10390 ' PRINT#3,EL;X;Y;Z;ARC;NXX;NTT;NXT
10410 ' print#3,nxt;qxx;qtt;mxx;mtt;mxt
10430 ' ****** calculate differences
10450    DA=0
10470     IF NXX<>0 THEN DA=(SF1-NXX)/NXX*100
10490    DB=0
10510     IF NTT<>0 THEN DB=(SF2-NTT)/NTT*100
10530    DC=0
10550     IF NXT<>0 THEN DC=(SF3-NXT)/NXT*100
10570    DD=0
10590     IF QXX<>0 THEN DD=(SF4-QXX)/QXX*100
10610    DE=0
10630     IF QTT<>0 THEN DE=(SF5-QTT)/QTT*100
10650    DF=0
10670     IF MXX<>0 THEN DF=(SM1-MXX)/MXX*100
10690    DG=0
10710     IF MTT<>0 THEN DG=(SM2-MTT)/MTT*100
10730    DH=0
10750    IF MXT<>0 THEN DH=(SM3-MXT)/MXT*100
10770 ' *** write differences to file
10790 'PRINT#4,EL;X;Y;Z;ARC;DA;DB;DC;DD;DE;DF;DG;DH
10810 'PRINT#4,USING "  ##.# ";X;
10830 'PRINT#4,DA;DB;DC;DD;DE;DF;DG;DH
10850 'print "el;x;y;z;arc;da;db"
10870 'print el;x;y;z;arc;da;db
10890 'print "dc%;dd%;de%;df%;dg%;dh%"
10910 'print dc%;dd%;de%;df%;dg%;dh%
10930 RETURN
10950 '***
10970 ' ******************************************************

10990 'input " ** stresses from rib contraints";a$
10991 IF X<0 OR X>XCYL THEN RETURN
10992 ' *** rib approximation not accurate beyond cylinderical shell
10995 IF X<0 THEN
      XR=ABS(X):ARIB=ARL*BRL:L=1:RR=(Z^2+Y^2)^.5
```

```
      AB=ARIB:AF=ARIB:GOTO 11480
      END IF
10997 IF X>XCYL THEN
      XR=X-XCYL:ARIB=ARL*BRL:L=1:RR=(Z^2+Y^2)^.5
      AB=ARIB:AF=ARIB:GOTO 11480
      END IF

11000 ' *** routine to establish x co-ordinate relative to existing
rib
11150    RESTORE 2590:READ XRB
11170     FOR I=1 TO NRIBS-1
11190      READ XRF
11210       ' *** x rib back and x rib front
11230      IF X>=XRB AND X<=XRF THEN 11290
11250      XRB=XRF
11270     NEXT I
11290    XR=X-XRB
11310     ' *** local co-ordinate for distance to back rib
11320    RR=RS
11330    ' *** local radius for rib calcs
11340   L=(XRF-XRB)
11345 ' *** distance between rings
11350 'PRINT "X;XRB;XRF;XR;NRIBS;L"
11370 'PRINT X;XRB;XRF;XR;NRIBS;L
11420 ' ************ define plate rigidity paramaters
*****************
11480  BETAD=(ED*T/4/RR^2/DDOME)^.25
11490  BETAS=(ES*T/4/RR^2/DS)^.25
11540 IF X<0 OR X>XCYL THEN BETA=BETAD:D=DDOME:E=ED:NU=NUD
11545 ' *** consider dome properties
11546 IF X>=0 OR X<=XCYL THEN BETA=BETAS:D=DS:E=ES:NU=NUS
11547 ' *** consider shell properties
11550   ALPHA=BETA*L/2
11610
CHI1=(FNHC(2*ALPHA)+COS(2*ALPHA))/(FNHS(2*ALPHA)+SIN(2*ALPHA))
11630     CHI2=(FNHS(2*ALPHA)-
SIN(2*ALPHA))/(FNHS(2*ALPHA)+SIN(2*ALPHA))
11650     CHI3=(FNHC(2*ALPHA)-
COS(2*ALPHA))/(FNHS(2*ALPHA)+SIN(2*ALPHA))
11670      ' *** numerical functions of alpha
11690   ' print "x;pe;l;beta;alpha;chi1;chi2;chi3"
11710   ' print x;pe;l;beta;alpha;chi1;chi2;chi3
11720   '********** find rib cross-sectional areas for back and front
********
11725  IF X<0 OR X>XCYL THEN 12070
11730  RESTORE 2630
11750   FOR J = 1 TO I
11770    READ WB
11790   NEXT J
11810  READ WF
```

```
11830 ' *** find current front and back rib widths
11850  RESTORE 2670
11870   FOR J = 1 TO I
11890    READ HB
11910   NEXT J
11930  READ HF
11950 ' *** find current front and back rib heights
11970 AB=WB*HB
11990 ' *** back rib cross sectional area
12010 AF=WF*HF
12030 ' *** front rib cross sectional area
12035  IF (XRF-X)>(X-XRB) THEN XR=X-XRB:ELSE XR=XRF-X
12037   ' *** local x for rib calcs
12040  IF (XRF-X)>(X-XRB) THEN ARIB=AB:ELSE ARIB=AF
12050   ' ** select rib x-area ARIB depending on which is closer
12065 ' *********** determine constants and equivalent pressures
*********
12070  PE=(PP+P2)*(1-1/2*NU)
12075   ' ** equivalent pressure due to poissions effect of axial force
on dome
12080    PCIRCUMB=PE/(BETA*(CHI1-1/2*CHI2^2/CHI3)+T/ARIB)
12420    ' *** force per unit length of circumference for back rib
12422    ' *** use shell or dome beta
12425     PEB=PE-PCIRCUMB*T/ARIB
12430     ' *** equivalent pressure for back ring incl pe and ring
extension
12432     M0=PEB/(2*BETA^2)*CHI2
12434     ' ** local moment at edge of shell section under ring
12437     ' ** use shell beta as analysis first assumes infinite stiff
ring
12439     Q0=-1/2*PCIRCUMB
12583 '***  METHOD INCORPORATING EQN 281 AND 282 FROM TIMO FOR ALPHA
LARGE

12590  PHI=EXP(-BETA*XR)*(COS(BETA*XR)+SIN(BETA*XR))
12600  PSI=EXP(-BETA*XR)*(COS(BETA*XR)-SIN(BETA*XR))
12610  THETA=EXP(-BETA*XR)*COS(BETA*XR)
12620  ZETA=EXP(-BETA*XR)*SIN(BETA*XR)
       ' *** EQN 281 OF PG 470
12630   W=-1/(2*BETA^3*D)*(BETA*M0*PSI+Q0*THETA)
12640   DWDX=1/(2*BETA^2*D)*(2*BETA*M0*THETA+Q0*PHI)
12650   D2WDX2=-1/(2*BETA*D)*(2*BETA*M0*PHI+2*Q0*ZETA)
12655   D3WDX3=1/D*(2*BETA*M0*ZETA-Q0*PSI)
12660    ' *** differentials of displacement w for local variable xr

12670  NTR=-E*T*W/RR
       ' *** tangential force resultant
12710  MXR=-1*(-D*D2WDX2)
      ' *** axial moment resultant, -1 to account for w inwards for
theory
```

```
12810  MTR=NU*MXR
       ' *** tangential moment resultant
12850  QXR=-1*(-D*D.WDX3)
       ' *** axial transverse shear, -1 to account for w inwards for
theory
12890  QTR=0
       ' *** tangential transverse shear force resultant (=0 due to
symmetry)

13750 ' PRINT "x;ntr;mxr;mtr;qxr;qtr"
13770 ' PRINT x;ntr;mxr;mtr;qxr;qtr
13790 RETURN
13838 '
*****************************************************************

13840 'input " *** definition of local variables **",a$
13842 IF X<0 OR X>XCYL THEN  XDOME=(Y^2+Z^2)^.5
13843 IF X<0 THEN YDOME=ABS(X)
13845 ' *** define local dome co-ordinates for back dome
13846 IF X>XCYL THEN YDOME=X-XCYL
13849 ' *** define local dome co-ordinates for front dome
13850  IF X=>0 AND X<=XCYL/2 THEN YDOME=X
13851  IF X>XCYL/2 AND X<=XCYL THEN YDOME=XCYL-X
13852  IF X=>0 AND X<=XCYL THEN XDOME=RS
13853  ' *** define local co-ordinates for cylinder
13854'print "x;y;z;ydome;xdome"
13855 'print  x;y;z;ydome;xdome

13856 RETURN
13857 ' ***************************************************

13858 ' input "** localized stresses due to domes/cylinder
connection";a$
13859  PE=PP+P2
13860 ' *** instantaneous pressure due to pp and ax
13990  BETAD=(ED*T/4/XDOME^2/DDOME)^.25
14010  BETAS=(ES*T/4/XDOME^2/DS)^.25
14020  ' *** use nu and beta for dome or shell respectivly
14030 IF X<0 OR X>XCYL THEN NU=NUD:BETA=BETAD:E=ED:D=DDOME
14050 IF X>=0 AND X<=XCYL THEN NU=NUS:BETA=BETAS:E=ES:D=DS
14110  Q0=PE/8/BETA*ADOME^2/BDOME^2
14130  ' *** axial transverse shearing force
       ON ERROR GOTO 15000
14150   PHI=EX  (-BETA*YDOME)*(COS(BETA*YDOME)+SIN(BETA*YDOME))
14170   PSI=EXI (-BETA*YDOME)*(COS(BETA*YDOME)-SIN(BETA*YDOME))
14190 THETA=EXP(-BETA*YDOME)*COS(BETA*YDOME)
14210  ZETA=EXP(-BETA*YDOME)*SIN(BETA*YDOME)
14230 ' *** functions of bx
14250  W=-1/(2*BETA^3*D)*(Q0*THETA)
14270  DWDX=1/(2*BETA^2*D)*(Q0*PHI)
```

```
14290  D2WDX2=-1/(2*BETA*D)*(2*Q0*ZETA)
14310  D3WDX3=1/D*(-Q0*PSI)
14330  ' *** differentials of displacement w

       NTD=-E*T*W/XDOME
       ' *** tangential force resultant
       MXD=-1*(-D*D2WDX2)
       ' *** axial moment resultant, -1 to account for w inwards for
theory
       MTD=NU*MXD
       ' *** tangential moment resultant
       QXD=-D*D3WDX3
       ' *** axial transverse shear
       QTD=0
       ' *** tangential transverse shear force resultant (=0 due to
symmetry)

14550 'PRINT "X;YDOME;BETA;Q0;PHI;PSI;THETA;ZETA"
14570 'PRINT X;YDOME;BETA;Q0;PHI;PSI;THETA;ZETA
14590 'PRINT "W;DWDX;D2WDX2;D3WDX3;MXD;MTD;QXD;QTD;NTD"
14610 'PRINT W;DWDX;D2WDX2;D3WDX3;MXD;MTD;QXD;QTD;NTD
14630 'INPUT AAA$
14650 RETURN


15000 ' ERROR TRAP FOR DOMES/CYLINDER
        PHI=0:PSI=0:THETA=0:ZETA=0
        PRINT "ERROR FOR X=";X
        PRINT "X;YDOME;XDOME;BETA;Q0;PHI;PSI;THETA;ZETA"
        PRINT X;YDOME;XDOME;BETA;Q0;PHI;PSI;THETA;ZETA
        INPUT A$
        on error goto 25010
        GOTO 14250

23320 'print "specify range extraction values RT23"
23321 XMIN=0
23322 XMAX=12
23323 YMIN=.1
23324 YMAX=.12
23325 ZMIN=.640
23326 ZMAX=.65
23327 RETURN
23328 ' *** extract positions for top

23331 XMIN=0
23332 XMAX=12
23333 YMIN=.1
23334 YMAX=.12
23335 ZMIN=-.65
23336 ZMAX=-.64
```

```
23337 RETURN
23338 ' *** extract positions for bottom

23341 XMIN=0
23342 XMAX=12
23343 YMIN=.64
23344 YMAX=.65
23345 ZMIN=.1
23346 ZMAX=.12
23347 RETURN
23348 ' *** extract positions for left (+Y)

23351 XMIN=0
23352 XMAX=12
23353 YMIN=-.67
23354 YMAX=-.63
23355 ZMIN=.1
23356 ZMAX=.12
23357 RETURN
23358 ' *** extract positions for right (-Y)

23361 XMIN=-1
23362 XMAX=0
23363 YMIN=.024
23364 YMAX=.1005
23365 ZMIN=.0
23366 ZMAX=.65
23367 RETURN
23368 ' *** extract positions for back dome

23450 '************************************
23470  PRINT "Specify position (Top/Bottom/Left/Right/Dome/New) "
23490  INPUT RANGE$
23500  IF RANGE$="T" THEN GOSUB 23321:RETURN
23510  IF RANGE$="B" THEN GOSUB 23331:RETURN
23520  IF RANGE$="L" THEN GOSUB 23341:RETURN
23530  IF RANGE$="R" THEN GOSUB 23351:RETURN
23525  IF RANGE$="D" THEN GOSUB 23361:RETURN
23540  IF RANGE$<>"N" THEN RETURN
23545  PRINT "xmin"
23550  INPUT XMIN
23570  PRINT "xmax"
23590  INPUT XMAX
23610  PRINT "ymin"
23630  INPUT YMIN
23650  PRINT "ymax"
23670  INPUT YMAX
23690  PRINT "zmin"
23710  INPUT ZMIN
23730  PRINT "zmax"
```

```
23750  INPUT ZMAX
23770 RETURN


25000' *** ERROR TRAP

25010 PRINT "NON RECOVERABLE ERROR ";ERN;" AT LINE ";ERL
      STOP

'*************************************************************************
26000 PRINT "*** DETERMINE FORCE AND MOMENT RESULTANTS FOR RANGE ***"
   PRINT:PRINT "New THEORY reduced filename. "
    INPUT SOL$
    SOL$="F:\MIKE\MATHESIS\RT27\"+SOL$+".DAT"
       PRINT "Opening file ";SOL$
       OPEN SOL$ FOR OUTPUT AS #3
      INPUT "Resultant, Non-Dimensional Data or Max Principal Stresses
(F/N/M)";NON1$
      IF NON1$<>"" THEN NON$=NON1$
      PRINT "Specify position (Top/Bottom/Left/Right/Dome/New) "
      INPUT RANGE$
      XMIN=0:PRINT "XMIN= <";XMIN;"> ";:INPUT A$
      IF A$<>"" THEN XMIN=VAL(A$)
      XMAX=12:PRINT "XMAX= <";XMAX;"> ";:INPUT A$
      IF A$<>"" THEN XMAX=VAL(A$)
      XINC=.01:PRINT "XINCREMENT= <";XINC;"> ";:INPUT A$
      IF A$<>"" THEN XINC=VAL(A$)
EL=0
FOR X = XMIN TO XMAX STEP XINC
   IF X<0 OR X>XCYL THEN
     IF X<0 THEN XDOME=ABS(X)
     IF X>XCYL THEN XDOME=ABS(X-XCYL)
       IF RANGE$="T" THEN Y=0:Z=SQR((1-(XDOME/(RS/2))^2)*RS^2)
       IF RANGE$="B" THEN Y=0:Z=-SQR((1-(XDOME/(RS/2))^2)*RS^2)
       IF RANGE$="L" THEN Z=0:Y=SQR((1-(XDOME/(RS/2))^2)*RS^2)
       IF RANGE$="R" THEN Z=0:Y=-SQR((1-(XDOME/(RS/2))^2)*RS^2)
     END IF
    IF X>=0 AND X<=XCYL THEN
       IF RANGE$="T" THEN Y=.07:Z=.650
       IF RANGE$="B" THEN Y=.07:Z=-.650
       IF RANGE$="L" THEN Y=.650:Z=.070
       IF RANGE$="R" THEN Y=-.650:Z=.070
     END IF

  GOSUB 13840
  ' *** define local variables for dome
  IF AX<>0 THEN GOSUB 5710
    ' *** loads due to ax acceleration
  IF AZ<>0 THEN GOSUB 7110
    ' *** loads due to az acceleration
```

```
  IF AY<>0 THEN GOSUB 8110
   ' *** loads due to ay acceleration
  IF TWIST<>0 THEN  GOSUB 9470
   ' *** loads due to twisting
  IF PP<>0 OR AX<>0 THEN  GOSUB 9630
   ' *** membrane loads due to internal pressure
  IF AX<>0 OR PP<>0 THEN GOSUB 13858
    '  ** localized stresses due to domes/cylinder connection
  IF AX<>0 OR PP<>0 THEN GOSUB 10990
    '  ** localized stresses due to ribs
  EL=EL+1
  GOSUB 10090
   ' *** find totals and errors and write to file
NEXT X
CLOSE #3
RETURN
```

APPENDIX Q

SUMMARISED FEM OUTPUT FOR INTERNAL PRESSURE

ABAQUS FEM OUTPUT

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
-0.33	1.05	0.99	2.71E-3	6.85E-4	8.26E-4	2.44E-4	0.00	0.00
-0.32	1.05	0.99	-1.58E-3	2.75E-5	3.66E-4	-6.11E-4	0.00	0.00
-0.30	0.94	0.80	-1.55E-3	2.06E-3	-5.26E-3	1.73E-2	1.58E-2	1.22E-4
-0.28	0.90	0.67	-1.47E-3	-7.82E-4	7.92E-3	2.05E-2	1.70E-2	6.11E-4
-0.26	0.86	0.51	-2.48E-3	6.01E-4	-1.50E-3	2.08E-2	1.75E-2	2.44E-4
-0.22	0.78	0.21	-2.44E-3	-2.13E-3	-1.34E-2	1.62E-2	1.61E-2	-4.88E-4
-0.19	0.70	-0.08	-4.55E-3	-6.92E-3	1.60E-2	-1.83E-3	9.89E-3	6.11E-4
-0.14	0.61	-0.40	-6.57E-3	-1.68E-2	-2.87E-2	-5.91E-2	-1.09E-2	3.17E-3
-0.09	0.56	-0.46	9.77E-3	-8.27E-3	-6.92E-3	-0.12	-3.36E-2	2.81E-3
-0.03	0.52	-0.11	5.84E-3	4.50E-2	8.75E-2	-3.59E-2	-1.12E-2	6.11E-4
0.05	0.50	0.52	1.64E-3	0.37	-4.03E-2	3.06E-2	4.88E-3	3.66E-4
0.20	0.50	1.13	2.12E-3	0.18	-4.37E-2	3.97E-2	6.72E-3	4.88E-4
0.30	0 50	1.04	-1.02E-3	-0.29	5.07E-2	-1.68E-2	-1.59E-3	-1.22E-4
0.45	0.50	1.00	-9.36E-4	4.90E-2	-7.35E-3	5.62E-3	1.95E-3	1.22E-4
0.55	0.50	0.98	1.96E-3	5.88E-2	-1.02E-2	-2.08E-3	7.33E-4	-1.22E-4
0.70	0.50	1.06	2.79E-3	-0.11	1.49E-2	-1.68E-2	-1.71E-3	-1.22E-4
0.80	0.50	1.04	2.58E-3	7.21E-2	2.83E-3	5.80E-2	9.52E-3	3.66E-4
0.95	0.50	0.53	1.35E-3	8.18E-2	-4.65E-2	-4.11E-2	-6.11E-3	-7.33E-4
1.05	0.50	0.53	-1.11E-3	8.74E-2	1.81E-2	-4.07E-2	-6.11E-3	-1.22E-4
1.20	0.50	1.04	-2.44E-3	7.32E-2	-2.48E-2	5.76E-2	9.40E-3	8.55E-4
1.30	0.50	1.07	-2.79E-3	-0.10	1.66E-2	-1.75E-2	-1.83E-3	-2.44E-4
1.45	0.50	0.98	-1.75E-3	2.84E-2	-1.71E-3	7.33E-4	1.10E-3	0.00
1.55	0.50	0.98	8.57E-4	2.95E-2	-6.80E-3	8.55E-4	9.77E-4	0.00
1.70	0.50	1.07	1.40E-3	-0.11	1.51E-2	-1.76E-2	-1.95E-3	-2.44E-4
1.80	0.50	1.04	1.19E-3	7.93E-2	9.93E-4	5.76E-2	9.28E-3	3.66E-4
1.95	0.50	0.53	6 9.E-4	8.00E-2	-4.52E-2	-4.07E-2	-6.11E-3	-7.33E-4
2.05	0.50	0.53	-1.26E-3	8.59E-2	1.87E-2	-4.07E-2	-6.23E-3	-1.22E-4
2.20	0.50	1.04	-2.16E-3	32E-2	-2.44E-2	5.76E-2	9.16E-3	8.55E-4
2.30	0.50	1.07	-2.48E-3	'	1.63E-2	-1.76E-2	-2.08E-3	-2.44E-4
2.45	0.51	0.98	-1.67E-3	2..eE-2	-1.05E-3	8.55E-4	8.55E-4	0.00
2.55	0.51	0.98	9.18E-4	3.00E-2	-7.47E-3	8.55E-4	8.55E-4	0.00
2.70	0.51	1.07	1.70E-3	-0.11	1.54E-2	-1.75E-2	-1.95E-3	-1.22E-4
2.80	0.51	1.04	1.40E-3	7.97E-2	1.29E-3	5.76E-2	9.28E-3	3.66E-4
2.95	0.50	0.53	7.60E-4	8.14E-2	-4.66E-2	-4.07E-2	-6.11E-3	-7.33E-4
3.05	0.50	0.53	-1.23E-3	8.63E-2	1.71E-2	-4.09E-2	-6.11E-3	-1.22E-4
3.20	0.51	1.04	-1.86E-3	7.69E-2	-2.45E-2	5.79E-2	9.52E-3	8.55E-4
3.30	0.51	1.07	-2.04E-3	-0.10	1.65E-2	-1.75E-2	-1.83E-3	-2.44E-4
3.45	0.51	0.98	-1.35E-3	1.56E-2	1.58E-4	7.33E-4	1.10E-3	0.00
3.55	0.51	0.99	1.00E-3	3.77E-2	-7.73E-3	8.55E-4	1.22E-3	0.00
3.70	0.51	1.06	1.68E-3	-8.90E-2	1.23E-2	-1.45E-2	-1.10E-3	-1.22E-4
3.80	0.51	1.03	1.56E-3	6.29E-2	1.91E-3	4.80E-2	8.30E-3	2.44E-4
3.95	0.51	0.61	3.01E-4	6.87E-2	-3.88E-2	-3.38E-2	-4.64E-3	-6.11E-4
4.05	0.51	0.61	-1.03E-3	7.37E-2	1.42E-2	-3.39E-2	-4.76E-3	-1.22E-4
4.20	0.51	1.03	-1.60E-3	6.07E-2	-2.05E-2	4.81E-2	8.30E-3	7.33E-4
4.30	0.51	1.06	-1.65E-3	-8.50E-2	1.42E-2	-1.44E-2	-3.77E-4	-2.44E-4
4.45	0.51	0.99	-1.02E-3	2.33E-2	-1.88E-3	7.33E-4	1.34E-3	0.00
4.55	0.51	0.99	1.06E-3	2.52E-2	-5.29E-3	7.33E-4	1.34E-3	0.00

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
4.70	0.51	1.06	1.69E-3	-8.85E-2	1.21E-2	-1.43E-2	-9.77E-4	-1.22E-4
4.80	0.51	1.03	1.66E-3	6.57E-2	1.29E-3	4.81E-2	8.42E-3	2.44E-4
4.95	0.50	0.61	1.03E-3	6.89E-2	-3.83E-2	-3.39E-2	-4.64E-3	-6.11E-4
5.05	0.50	0.61	-1.00E-3	7.39E-2	1.37E-2	-3.39E-2	-4.64E-3	-1.22E-4
5.20	0.51	1.03	-1.64E-3	6.10E-2	-2.02E-2	4.81E-2	8.42E-3	7.33E-4
5.30	0.51	1.06	-1.67E-3	-8.54E-2	1.40E-2	-1.44E-2	-8.55E-4	-2.44E-4
5.45	0.51	0.99	-1.03E-3	2.35E-2	-1.75E-3	7.33E-4	1.47E-3	0.00
5.55	0.51	0.99	1.06E-3	2.51E-2	-5.40E-3	7.33E-4	1.47E-3	0.00
5.70	0.51	1.06	1.66E-3	-8.85E-2	1.22E-2	-1.44E-2	-8.55E-4	-1.22E-4
5.80	0.51	1.03	1.65E-3	6.59E-2	1.20E-3	4.81E-2	8.42E-3	2.44E-4
5.95	0.50	0.61	1.03E-3	6.86E-2	-3.81E-2	-3.41E-2	-4.64E-3	-7.33E-4

MATHEORY THEORETICAL OUTPUT

x	N_x	N_ϕ	$N_{x\phi}$	Q_x	Q_ϕ	M_x	M_ϕ	$M_{x\phi}$
-0.329	1.01	1.01	0	0	0	0	-6.45E-26	0
-0.319	0.99	0.94	0	-1.09E-5	0	-2.18E-5	-5.87E-6	0
-0.309	0.97	0.87	0	2.75E-5	0	-5.21E-5	-1.40E-5	0
-0.299	0.94	0.80	0	1.51E-4	0	1.63E-4	4.39E-5	0
-0.289	0.92	0.73	0	2.95E-4	0	6.57E-4	1.77E-4	0
-0.279	0.90	0.66	0	3.92E-4	0	1.33E-3	3.59E-4	0
-0.269	0.88	0.58	0	3.88E-4	0	2.04E-3	5.50E-4	0
-0.259	0.86	0.51	0	2.48E-4	0	2.62E-3	7.06E-4	0
-0.249	0.83	0.43	0	-5.18E-5	0	2.92E-3	7.86E-4	0
-0.239	0.81	0.35	0	-5.26E-4	0	2.77E-3	7.46E-4	0
-0.229	0.79	0.27	0	-1.18E-3	0	2.04E-3	5.49E-4	0
-0.219	0.77	0.19	0	-2.01E-3	0	5.87E-4	1.58E-4	0
-0.209	0.75	0.10	0	-2.99E-3	0	-1.69E-3	-4.55E-4	0
-0.199	0.73	2.17E-2	0	-4.12E-3	0	-4.88E-3	-1.32E-3	0
-0.189	0.71	-5.99E-2	0	-5.35E-3	0	-9.06E-3	-2.44E-3	0
-0.179	0.69	-0.14	0	-6.64E-3	0	-1.42E-2	-3.84E-3	0
-0.169	0.68	-0.22	0	-7.95E-3	0	-2.04E-2	-5.51E-3	0
-0.159	0.66	-0.29	0	-9.21E-3	0	-2.76E-2	-7.43E-3	0
-0.149	0.64	-0.36	0	-1.04E-2	0	-3.56E-2	-9.59E-3	0
-0.139	0.63	-0.42	0	-1.13E-2	0	-4.43E-2	-1.19E-2	0
-0.129	0.61	-0.47	0	-1.19E-2	0	-5.36E-2	-1.44E-2	0
-0.119	0.60	-0.52	0	-1.22E-2	0	-6.31E-2	-1.70E-2	0
-0.109	0.58	-0.55	0	-1.20E-2	0	-7.26E-2	-1.96E-2	0
-0.099	0.57	-0.58	0	-1.11E-2	0	-8.15E-2	-2.20E-2	0
-0.089	0.56	-0.59	0	-9.43E-3	0	-8.95E-2	-2.41E-2	0
-0.079	0.55	-0.58	0	-6.89E-3	0	-9.60E-2	-2.59E-2	0
-0.069	0.54	-0.56	0	-3.31E-3	0	-0.10	-2.70E-2	0
-0.059	0.53	-0.53	0	1.47E-3	0	-0.10	-2.74E-2	0
-0.049	0.52	-0.48	0	7.58E-3	0	-9.91E-2	-2.67E-2	0
-0.039	0.52	-0.41	0	1.52E-2	0	-9.19E-2	-2.48E-2	0
-0.029	0.51	-0.32	0	2.44E-2	0	-7.90E-2	-2.13E-2	0
-0.019	0.51	-0.22	0	3.53E-2	0	-5.93E-2	-1.60E-2	0
-0.009	0.51	-0.11	0	4.81E-2	0	-3.17E-2	-8.53E-3	0
0.001	0.50	1.35	0	0.13	0	-0.20	-2.57E-2	0
0.011	0.50	1.24	0	0.11	0	-0.19	-2.40E-2	0
0.021	0.50	1.14	0	8.86E-2	0	-0.17	-2.21E-2	0
0.031	0.50	1.06	0	6.93E-2	0	-0.15	-1.99E-2	0
0.041	0.50	1.00	0	5.23E-2	0	-0.14	-1.77E-2	0
0.051	0.50	0.95	0	3.77E-2	0	-0.12	-1.54E-2	0
0.061	0.50	0.91	0	2.53E-2	0	-0.10	-1.32E-2	0
0.071	0.50	0.89	0	1.49E-2	0	-8.67E-2	-1.12E-2	0
0.081	0.50	0.87	0	6.48E-3	0	-7.18E-2	-9.24E-3	0
0.091	0.50	0.86	0	-2.60E-4	0	-5.81E-2	-7.48E-3	0
0.101	0.50	0.86	0	-5.47E-3	0	-4.59E-2	-5.91E-3	0
0.111	0.50	0.86	0	-9.36E-3	0	-3.51E-2	-4.52E-3	0
0.121	0.50	0.86	0	-1.21E-2	0	-2.58E-2	-3.32E-3	0
0.131	0.50	0.87	0	-1.39E-2	0	-1.78E-2	-2.29E-3	0

x	N_x'	N_ϕ'	$N_{x\phi}$'	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}$'
0.141	0.50	0.88	0	-1.49E-2	0	-1.11E-2	-1.43E-3	0
0.151	0.50	0.89	0	-1.52E-2	0	-5.57E-3	-7.16E-4	0
0.161	0.50	0.90	0	-1.50E-2	0	-1.13E-3	-1.46E-4	0
0.171	0.50	0.92	0	-1.45E-2	0	2.34E-3	3.01E-4	0
0.181	0.50	0.93	0	-1.36E-2	0	4.96E-3	6.38E-4	0
0.191	0.50	0.94	0	-1.26E-2	0	6.85E-3	8.82E-4	0
0.201	0.50	0.95	0	-1.14E-2	0	8.12E-3	1.05E-3	0
0.211	0.50	0.96	0	-1.02E-2	0	8.88E-3	1.14E-3	0
0.221	0.50	0.97	0	-8.94E-3	0	9.21E-3	1.18E-3	0
0.231	0.50	0.97	0	-7.71E-3	0	9.20E-3	1.18E-3	0
0.241	0.50	0.98	0	-6.55E-3	0	8.93E-3	1.15E-3	0
0.251	0.50	0.99	0	-5.46E-3	0	8.47E-3	1.09E-3	0
0.261	0.50	0.99	0	-4.45E-3	0	7.87E-3	1.01E-3	0
0.271	0.50	1.00	0	-3.55E-3	0	7.18E-3	9.24E-4	0
0.281	0.50	1.00	0	-2.75E-3	0	6.44E-3	8.29E-4	0
0.291	0.50	1.00	0	-2.05E-3	0	5.68E-3	7.32E-4	0
0.301	0.50	1.00	0	-1.45E-3	0	4.94E-3	6.35E-4	0
0.311	0.50	1.00	0	-9.40E-4	0	4.21E-3	5.42E-4	0
0.321	0.50	1.01	0	-5.19E-4	0	3.53E-3	4.55E-4	0
0.331	0.50	1.01	0	-1.79E-4	0	2.91E-3	3.74E-4	0
0.341	0.50	1.01	0	9.02E-5	0	2.34E-3	3.01E-4	0
0.351	0.50	1.01	0	2.96E-4	0	1.83E-3	2.35E-4	0
0.361	0.50	1.01	0	4.47E-4	0	1.38E-3	1.78E-4	0
0.371	0.50	1.01	0	5.52E-4	0	9.97E-4	1.28E-4	0
0.381	0.50	1.01	0	6.17E-4	0	6.70E-4	8.62E-5	0
0.391	0.50	1.00	0	6.50E-4	0	3.97E-4	5.11E-5	0
0.401	0.50	1.00	0	6.57E-4	0	1.74E-4	2.24E-5	0
0.411	0.50	1.00	0	6.44E-4	0	-3.37E-6	-4.34E-7	0
0.421	0.50	1.00	0	6.15E-4	0	-1.41E-4	-1.81E-5	0
0.431	0.50	1.00	0	5.75E-4	0	-2.44E-4	-3.14E-5	0
0.441	0.50	1.00	0	5.28E-4	0	-3.16E-4	-4.07E-5	0
0.451	0.50	1.00	0	4.76E-4	0	-3.64E-4	-4.68E-5	0
0.461	0.50	1.00	0	4.23E-4	0	-3.90E-4	-5.02E-5	0
0.471	0.50	1.00	0	3.69E-4	0	-3.99E-4	-5.14E-5	0
0.481	0.50	1.00	0	3.17E-4	0	-3.95E-4	-5.08E-5	0
0.491	0.50	1.00	0	2.67E-4	0	-3.80E-4	-4.90E-5	0
0.501	0.50	1.00	0	2.26E-4	0	-3.80E-4	-4.90E-5	0
0.511	0.50	1.00	0	2.20E-4	0	-5.29E-4	-6.81E-5	0
0.521	0.50	1.00	0	2.17E-4	0	-6.75E-4	-8.68E-5	0
0.531	0.50	1.00	0	.17E-4	0	-8.19E-4	-1.05E-4	0
0.541	0.50	1.00	0	.17E-4	0	-9.64E-4	-1.24E-4	0
0.551	0.50	1.00	0	2.18E-4	0	-1.11E-3	-1.43E-4	0
0.561	0.50	1.00	0	2.16E-4	0	-1.25E-3	-1.61E-4	0
0.571	0.50	1.00	0	2.10E-4	0	-1.40E-3	-1.80E-4	0
0.581	0.50	1.00	0	1.99E-4	0	-1.53E-3	-1.97E-4	0
0.591	0.50	1.00	0	1.79E-4	0	-1.66E-3	-2.14E-4	0
0.601	0.50	1.00	0	1.48E-4	0	-1.77E-3	-2.28E-4	0
0.611	0.50	1.00	0	1.04E-4	0	-1.85E-3	-2.39E-4	0

x	N_x'	N_ϕ'	$N_{x\phi}$'	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}$'
0.621	0.50	1.00	0	4.38E-5	0	-1.90E-3	-2.45E-4	0
0.631	0.50	1.01	0	-3.58E-5	0	-1.91E-3	-2.46E-4	0
0.641	0.50	1.01	0	-1.38E-4	0	-1.85E-3	-2.38E-4	0
0.651	0.50	1.01	0	-2.65E-4	0	-1.72E-3	-2.21E-4	0
0.661	0.50	1.01	0	-4.20E-4	0	-1.49E-3	-1.92E-4	0
0.671	0.50	1.01	0	-6.06E-4	0	-1.15E-3	-1.48E-4	0
0.681	0.50	1.02	0	-8.24E-4	0	-6.77E-4	-8.7'E-5	0
0.691	0.50	1.02	0	-1.08E-3	0	-4.53E-5	-5 .4E-6	0
0.701	0.50	1.02	0	-1.36E-3	0	7.66E-4	9.86E-5	0
0.711	0.50	1.02	0	-1.69E-3	0	1.78E-3	2.29E-4	0
0.721	0.50	1.02	0	-2.04E-3	0	3.02E-3	3.89E-4	0
0.731	0.50	1.03	0	-2.42E-3	0	4.51E-3	5.80E-4	0
0.741	0.50	1.03	0	-2.82E-3	0	6.25E-3	8.05E-4	0
0.751	0.50	1.03	0	-3.24E-3	0	8.28E-3	1.07E-3	0
0.761	0.50	1.03	0	-3.66E-3	0	1.06E-2	1.36E-3	0
0.771	0.50	1.03	0	-4.07E-3	0	1.32E-2	1.69E-3	0
0.781	0.50	1.02	0	-4.45E-3	0	1.60E-2	2.06E-3	0
0.791	0.50	1.02	0	-4.77E-3	0	1.91E-2	2.46E-3	0
0.801	0.50	1.01	0	-5.01E-3	0	2.23E-2	2.88E-3	0
0.811	0.50	1.00	0	-5.14E-3	0	2.57E-2	3.31E-3	0
0.821	0.50	0.99	0	-5.11E-3	0	2.92E-2	3.75E-3	0
0.831	0.50	0.98	0	-4.89E-3	0	3.25E-2	4.18E-3	0
0.841	0.50	0.96	0	-4.43E-3	0	3.56E-2	4.59E-3	0
0.851	0.50	0.94	0	-3.67E-3	0	3.84E-2	4.94E-3	0
0.861	0.50	0.91	0	-2.55E-3	0	4.04E-2	5.21E-3	0
0.871	0.50	0.88	0	-1.01E-3	0	4.17E-2	5.36E-3	0
0.881	0.50	0.85	0	1.01E-3	0	4.17E-2	5.37E-3	0
0.891	0.50	0.81	0	3.57E-3	0	4.02E-2	5.17E-3	0
0.901	0.50	0.77	0	6.75E-3	0	3.68E-2	4.73E-3	0
0.911	0.50	0.72	0	1.06E-2	0	3.10E-2	3.99E-3	0
0.921	0.50	0.67	0	1.52E-2	0	2.25E-2	2.89E-3	0
0.931	0.50	0.62	0	2.05E-2	0	1.06E-2	1.37E-3	0
0.941	0.50	0.57	0	2.67E-2	0	-5.07E-3	-6.53E-4	0
0.951	0.50	0.52	0	3.36E-2	0	-2.51E-2	-3.23E-3	0
0.961	0.50	0.47	0	4.13E-2	0	-5.01E-2	-6.45E-3	0
0.971	0.50	0.42	0	4.98E-2	0	-8.04E-2	-1.03E-2	0
0.981	0.50	0.39	0	5.88E-2	0	-0.12	-1.50E-2	0
0.991	0.50	0.36	0	6.83E-2	0	-0.16	-2.05E-2	0
1.001	0.50	0.36	0	7.56E-2	0	-0.19	-2.51E-2	0
1.011	0.50	0.37	0	6.59E-2	0	-0.15	-1.90E-2	0
1.021	0.50	0.40	0	5.65E-2	0	-0.11	-1.38E-2	0
1.031	0.50	0.43	0	4.76E-2	0	-7.22E-2	-9.30E-3	0
1.041	0.50	0.48	0	3.93E-2	0	-4.33E-2	-5.57E-3	0
1.051	0.50	0.53	0	3.18E-2	0	-1.96E-2	-2.53E-3	0
1.061	0.50	0.58	0	2.51E-2	0	-7.32E-4	-9.42E-5	0
1.071	0.50	0.64	0	1.91E-2	0	1.39E-2	1.79E-3	0
1.081	0.50	0.69	0	1.40E-2	0	2.49E-2	3.21E-3	0
1.091	0.50	0.74	0	9.57E-3	0	3.27E-2	4.21E-3	0

x	N_x'	N_ϕ'	$N_{x\phi}$'	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}$'
1.101	0.50	0.78	0	5.89E-3	0	3.78E-2	4.87E-3	0
1.111	0.50	0.82	0	2.87E-3	0	4.07E-2	5.24E-3	0
1.121	0.50	0.86	0	4.47E-4	0	4.18E-2	5.38E-3	0
1.131	0.50	0.89	0	-1.44E-3	0	4.14E-2	5.33E-3	0
1.141	0.50	0.92	0	-2.87E-3	0	4.00E-2	5.15E-3	0
1.151	0.50	0.94	0	-3.89E-3	0	3.77E-2	4.85E-3	0
1.161	0.50	0.97	0	-4.57E-3	0	3.49E-2	4.49E-3	0
1.171	0.50	0.98	0	-4.97E-3	0	3.17E-2	4.08E-3	0
1.181	0.50	1.00	0	-5.14E-3	0	2.83E-2	3.64E-3	0
1.191	0.50	1.01	0	-5.12E-3	0	2.49E-2	3.20E-3	0
1.201	0.50	1.01	0	-4.96E-3	0	2.15E-2	2.77E-3	0
1.211	0.50	1.02	0	-4.70E-3	0	1.83E-2	2.35E-3	0
1.221	0.50	1.02	0	-4.36E-3	0	1.53E-2	1.96E-3	0
1.231	0.50	1.03	0	-3.97E-3	0	1.25E-2	1.61E-3	0
1.241	0.50	1.03	0	-3.55E-3	0	9.97E-3	1.28E-3	0
1.251	0.50	1.03	0	-3.13E-3	0	7.74E-3	9.96E-4	0
1.261	0.50	1.03	0	-2.72E-3	0	5.79E-3	7.45E-4	0
1.271	0.50	1.03	0	-2.32E-3	0	4.11E-3	5.29E-4	0
1.281	0.50	1.02	0	-1.94E-3	0	2.70E-3	3.47E-4	0
1.291	0.50	1.02	0	-1.59E-3	0	1.52E-3	1.96E-4	0
1.301	0.50	1.02	0	-1.28E-3	0	5.66E-4	7.28E-5	0
1.311	0.50	1.02	0	-9.97E-4	0	-1.90E-4	-2.45E-5	0
1.321	0.50	1.02	0	-7.51E-4	0	-7.71E-4	-9.92E-5	0
1.331	0.50	1.01	0	-5.39E-4	0	-1.20E-3	-1.54E-4	0
1.341	0.50	1.01	0	-3.59E-4	0	-1.50E-3	-1.93E-4	0
1.351	0.50	1.01	0	-2.10E-4	0	-1.68E-3	-2.17E-4	0
1.361	0.50	1.01	0	-8.78E-5	0	-1.78E-3	-2.29E-4	0
1.371	0.50	1.01	0	9.21E-6	0	-1.81E-3	-2.33E-4	0
1.381	0.50	1.00	0	8.42E-5	0	-1.78E-3	-2.28E-4	0
1.391	0.50	1.00	0	1.40E-4	0	-1.70E-3	-2.19E-4	0
1.401	0.50	1.00	0	1.79E-4	0	-1.59E-3	-2.05E-4	0
1.411	0.50	1.00	0	2.04E-4	0	-1.46E-3	-1.88E-4	0
1.421	0.50	1.00	0	2.18E-4	0	-1.32E-3	-1.70E-4	0
1.431	0.50	1.00	0	2.23E-4	0	-1.18E-3	-1.51E-4	0
1.441	0.50	1.00	0	2.20E-4	0	-1.03E-3	-1.32E-4	0
1.451	0.50	1.00	0	2.11E-4	0	-8.84E-4	-1.14E-4	0
1.461	0.50	1.00	0	1.99E-4	0	-7.47E-4	-9.61E-5	0
1.471	0.50	1.00	0	1.83E-4	0	-6.19E-4	-7.97E-5	0
1.481	0.50	1.00	0	1.66E-4	0	-5.03E-4	-6.47E-5	0
1.491	0.50	1.00	0	1.48E-4	0	-3.99E-4	-5.13E-5	0
1.501	0.50	1.00	0	1.34E-4	0	-3.28E-4	-4.22E-5	0
1.511	0.50	1.00	0	1.52E-4	0	-4.24E-4	-5.45E-5	0
1.521	0.50	1.00	0	1.70E-4	0	-5.31E-4	-6.84E-5	0
1.531	0.50	1.00	0	1.87E-4	0	-6.51E-4	-8.37E-5	0
1.541	0.50	1.00	0	2.02E-4	0	-7.80E-4	-1.00E-4	0
1.551	0.50	1.00	0	2.14E-4	0	-9.19E-4	-1.18E-4	0
1.561	0.50	1.00	0	2.21E-4	0	-1.06E-3	-1.37E-4	0
1.571	0.50	1.00	0	2.22E-4	0	-1.21E-3	-1.56E-4	0

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
1.581	0.50	1.00	0	2.16E-4	0	-1.36E-3	-1.75E-4	0
1.591	0.50	1.00	0	1.99E-4	0	-1.50E-3	-1.93E-4	0
1.601	0.50	1.00	0	1.71E-4	0	-1.62E-3	-2.09E-4	0
1.611	0.50	1.00	0	1.28E-4	0	-1.72E-3	-2.22E-4	0
1.621	0.50	1.00	0	6.72E-5	0	-1.79E-3	-2.30E-4	0
1.631	0.50	1.01	0	-1.30E-5	0	-1.81E-3	-2.33E-4	0
1.641	0.50	1.01	0	-1.16E-4	0	-1.77E-3	-2.27E-4	0
1.651	0.50	1.01	0	-2.45E-4	0	-1.65E-3	-2.12E-4	0
1.661	0.50	1.01	0	-4.02E-4	0	-1.43E-3	-1.84E-4	0
1.671	0.50	1.01	0	-5.89E-4	0	-1.10E-3	-1.42E-4	0
1.681	0.50	1.02	0	-8.10E-4	0	-6.40E-4	-8.24E-5	0
1.691	0.50	1.02	0	-1.06E-3	0	-1.74E-5	-2.24E-6	0
1.701	0.50	1.02	0	-1.35E-3	0	7.86E-4	1.01E-4	0
1.711	0.50	1.02	0	-1.68E-3	0	1.79E-3	2.31E-4	0
1.721	0.50	1.02	0	-2.03E-3	0	3.03E-3	3.90E-4	0
1.731	0.50	1.03	0	-2.41E-3	0	4.51E-3	5.80E-4	0
1.741	0.50	1.03	0	-2.82E-3	0	6.25E-3	8.05E-4	0
1.751	0.50	1.03	0	-3.24E-3	0	8.27E-3	1.06E-3	0
1.761	0.50	1.03	0	-3.66E-3	0	1.06E-2	1.36E-3	0
1.771	0.50	1.03	0	-4.07E-3	0	1.31E-2	1.69E-3	0
1.781	0.50	1.02	0	-4.45E-3	0	1.60E-2	2.06E-3	0
1.791	0.50	1.02	0	-4.77E-3	0	1.91E-2	2.45E-3	0
1.801	0.50	1.01	0	-5.01E-3	0	2.23E-2	2.87E-3	0
1.811	0.50	1.00	0	-5.14E-3	0	2.57E-2	3.31E-3	0
1.821	0.50	0.99	0	-5.12E-3	0	2.92E-2	3.75E-3	0
1.831	0.50	0.98	0	-4.89E-3	0	3.25E-2	4.18E-3	0
1.841	0.50	0.96	0	-4.43E-3	0	3.56E-2	4.59E-3	0
1.851	0.50	0.94	0	-3.67E-3	0	3.83E-2	4.93E-3	0
1.861	0.50	0.91	0	-2.55E-3	0	4.04E-2	5.20E-3	0
1.871	0.50	0.88	0	-1.01E-3	0	4.17E-2	5.36E-3	0
1.881	0.50	0.85	0	1.00E-3	0	4.17E-2	5.36E-3	0
1.891	0.50	0.81	0	3.57E-3	0	4.02E-2	5.17E-3	0
1.901	0.50	0.77	0	6.75E-3	0	3.68E-2	4.73E-3	0
1.911	0.50	0.72	0	1.06E-2	0	3.10E-2	3.99E-3	0
1.921	0.50	0.67	0	1.52E-2	0	2.25E-2	2.89E-3	0
1.931	0.50	0.62	0	2.05E-2	0	1.06E-2	1.37E-3	0
1.941	0.50	0.57	0	2.67E-2	0	-5.07E-3	-6.53E-4	0
1.951	0.50	0.52	0	3.36E-2	0	-2.51E-2	-3.23E-3	0
1.961	0.50	0.47	0	4.13E-2	0	-5.01E-2	-6.44E-3	0
1.971	0.50	0.42	0	4.98E-2	0	-8.04E-2	-1.03E-2	0
1.981	0.50	0.39	0	5.88E-2	0	-0.12	-1.50E-2	0
1.991	0.50	0.36	0	6.83E-2	0	-0.16	-2.05E-2	0
2.001	0.50	0.36	0	7.56E-2	0	-0.19	-2.51E-2	0
2.011	0.50	0.37	0	6.59E-2	0	-0.15	-1.90E-2	0
2.021	0.50	0.40	0	5.65E-2	0	-0.11	-1.38E-2	0
2.031	0.50	0.43	0	4.76E-2	0	-7.22E-2	-9.30E-3	0
2.041	0.50	0.48	0	3.93E-2	0	-4.33E-2	-5.57E-3	0
2.051	0.50	0.53	0	3.18E-2	0	-1.96E-2	-2.53E-3	0

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
2.061	0.50	0.58	0	2.51E-2	0	-7.33E-4	-9.44E-5	0
2.071	0.50	0.64	0	1.91E-2	0	1.39E-2	1.79E-3	0
2.081	0.50	0.69	0	1.40E-2	0	2.49E-2	3.21E-3	0
2.091	0.50	0.74	0	9.57E-3	0	3.27E-2	4.21E-3	0
2.101	0.50	0.78	0	5.89E-3	0	3.78E-2	4.87E-3	0
2.111	0.50	0.82	0	2.87E-3	0	4.07E-2	5.24E-3	0
2.121	0.50	0.86	0	4.47E-4	0	4.18E-2	5.38E-3	0
2.131	0.50	0.89	0	-1.44E-3	0	4.14E-2	5.33E-3	0
2.141	0.50	0.92	0	-2.87E-3	0	4.00E-2	5.15E-3	0
2.151	0.50	0.94	0	-3.89E-3	0	3.77E-2	4.85E-3	0
2.161	0.50	0.97	0	-4.57E-3	0	3.49E-2	4.49E-3	0
2.171	0.50	0.98	0	-4.97E-3	0	3.17E-2	4.08E-3	0
2.181	0.50	1.00	0	-5.14E-3	0	2.83E-2	3.64E-3	0
2.191	0.50	1.01	0	-5.12E-3	0	2.49E-2	3.20E-3	0
2.201	0.50	1.01	0	-4.96E-3	0	2.15E-2	2.77E-3	0
2.211	0.50	1.02	0	-4.70E-3	0	1.83E-2	2.35E-3	0
2.221	0.50	1.02	0	-4.36E-3	0	1.53E-2	1.96E-3	0
2.231	0.50	1.03	0	-3.97E-3	0	1.25E-2	1.61E-3	0
2.241	0.50	1.03	0	-3.55E-3	0	9.97E-3	1.28E-3	0
2.251	0.50	1.03	0	-3.13E-3	0	7.74E-3	9.96E-4	0
2.261	0.50	1.03	0	-2.72E-3	0	5.79E-3	7.45E-4	0
2.271	0.50	1.03	0	-2.32E-3	0	4.11E-3	5.29E-4	0
2.281	0.50	1.02	0	-1.94E-3	0	2.70E-3	3.47E-4	0
2.291	0.50	1.02	0	-1.59E-3	0	1.52E-3	1.96E-4	0
2.301	0.50	1.02	0	-1.28E-3	0	5.66E-4	7.28E-5	0
2.311	0.50	1.02	0	-9.97E-4	0	-1.90E-4	-2.45E-5	0
2.321	0.50	1.02	0	-7.51E-4	0	-7.71E-4	-9.92E-5	0
2.331	0.50	1.01	0	-5.39E-4	0	-1.20E-3	-1.54E-4	0
2.341	0.50	1.01	0	-3.59E-4	0	-1.50E-3	-1.93E-4	0
2.351	0.50	1.01	0	-2.10E-4	0	-1.68E-3	-2.17E-4	0
2.361	0.50	1.01	0	-8.78E-5	0	-1.78E-3	-2.29E-4	0
2.371	0.50	1.01	0	9.20E-6	0	-1.81E-3	-2.33E-4	0
2.381	0.50	1.00	0	8.42E-5	0	-1.78E-3	-2.28E-4	0
2.391	0.50	1.00	0	1.40E-4	0	-1.70E-3	-2.19E-4	0
2.401	0.50	1.00	0	1.79E-4	0	-1.59E-3	-2.05E-4	0
2.411	0.50	1.00	0	2.04E-4	0	-1.46E-3	-1.88E-4	0
2.421	0.50	1.00	0	2.18E-4	0	-1.32E-3	-1.70E-4	0
2.431	0.50	1.00	0	2.23E-4	0	-1.18E-3	-1.51E-4	0
2.441	0.50	1.00	0	2.20E-4	0	-1.03E-3	-1.32E-4	0
2.451	0.50	1.00	0	2.11E-4	0	-8.84E-4	-1.14E-4	0
2.461	0.50	1.00	0	1.99E-4	0	-7.47E-4	-9.61E-5	0
2.471	0.50	1.00	0	1.83E-4	0	-6.19E-4	-7.97E-5	0
2.481	0.50	1.00	0	1.66E-4	0	-5.03E-4	-6.47E-5	0
2.491	0.50	1.00	0	1.48E-4	0	-3.99E-4	-5.13E-5	0
2.501	0.50	1.00	0	1.34E-4	0	-3.28E-4	-4.22E-5	0
2.511	0.50	1.00	0	1.52E-4	0	-4.24E-4	-5.45E-5	0
2.521	0.50	1.00	0	1.70E-4	0	-5.31E-4	-6.84E-5	0
2.531	0.50	1.00	0	1.87E-4	0	-6.51E-4	-8.37E-5	0

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
2.541	0.50	1.00	0	2.02E-4	0	-7.80E-4	-1.00E-4	0
2.551	0.50	1.00	0	2.14E-4	0	-9.19E-4	-1.18E-4	0
2.561	0.50	1.00	0	2.21E-4	0	-1.06E-3	-1.37E-4	0
2.571	0.50	1.00	0	2.22E-4	0	-1.21E-3	-1.56E-4	0
2.581	0.50	1.00	0	2.16E-4	0	-1.36E-3	-1.75E-4	0
2.591	0.50	1.00	0	1.99E-4	0	-1.50E-3	-1.93E-4	0
2.601	0.50	1.00	0	1.71E-4	0	-1.62E-3	-2.09E-4	0
2.611	0.50	1.00	0	1.28E-4	0	-1.72E-3	-2.22E-4	0
2.621	0.50	1.00	0	6.72E-5	0	-1.79E-3	-2.30E-4	0
2.631	0.50	1.01	0	-1.30E-5	0	-1.81E-3	-2.33E-4	0
2.641	0.50	1.01	0	-1.16E-4	0	-1.77E-3	-2.27E-4	0
2.651	0.50	1.01	0	-2.45E-4	0	-1.65E-3	-2.12E-4	0
2.661	0.50	1.01	0	-4.02E-4	0	-1.43E-3	-1.84E-4	0
2.671	0.50	1.01	0	-5.89E-4	0	-1.10E-3	-1.42E-4	0
2.681	0.50	1.02	0	-8.10E-4	0	-6.40E-4	-8.24E-5	0
2.691	0.50	1.02	0	-1.06E-3	0	-1.74E-5	-2.25E-6	0
2.701	0.50	1.02	0	-1.35E-3	0	7.86E-4	1.01E-4	0
2.711	0.50	1.02	0	-1.68E-3	0	1.79E-3	2.31E-4	0
2.721	0.50	1.02	0	-2.03E-3	0	3.03E-3	3.90E-4	0
2.731	0.50	1.03	0	-2.41E-3	0	4.51E-3	5.80E-4	0
2.741	0.50	1.03	0	-2.82E-3	0	6.25E-3	8.05E-4	0
2.751	0.50	1.03	0	-3.24E-3	0	8.27E-3	1.06E-3	0
2.761	0.50	1.03	0	-3.66E-3	0	1.06E-2	1.36E-3	0
2.771	0.50	1.03	0	-4.07E-3	0	1.31E-2	1.69E-3	0
2.781	0.50	1.02	0	-4.45E-3	0	1.60E-2	2.06E-3	0
2.791	0.50	1.02	0	-4.77E-3	0	1.91E-2	2.45E-3	0
2.801	0.50	1.01	0	-5.01E-3	0	2.23E-2	2.87E-3	0
2.811	0.50	1.00	0	-5.14E-3	0	2.57E-2	3.31E-3	0
2.821	0.50	0.99	0	-5.12E-3	0	2.92E-2	3.75E-3	0
2.831	0.50	0.98	0	-4.89E-3	0	3.25E-2	4.18E-3	0
2.841	0.50	0.96	0	-4.43E-3	0	3.56E-2	4.59E-3	0
2.851	0.50	0.94	0	-3.67E-3	0	3.83E-2	4.93E-3	0
2.861	0.50	0.91	0	-2.55E-3	0	4.04E-2	5.20E-3	0
2.871	0.50	0.88	0	-1.01E-3	0	4.17E-2	5.36E-3	0
2.881	0.50	0.85	0	1.00E-3	0	4.17E-2	5.36E-3	0
2.891	0.50	0.81	0	3.57E-3	0	4.02E-2	5.17E-3	0
2.901	0.50	0.77	0	6.75E-3	0	3.68E-2	4.73E-3	0
2.911	0.50	0.72	0	1.06E-2	0	3.10E-2	3.99E-3	0
2.921	0.50	0.67	0	1.52E-2	0	2.25E-2	2.89E-3	0
2.931	0.50	0.62	0	2.05E-2	0	1.06E-2	1.37E-3	0
2.941	0.50	0.57	0	2.67E-2	0	-5.07E-3	-6.53E-4	0
2.951	0.50	0.52	0	3.36E-2	0	-2.51E-2	-3.23E-3	0
2.961	0.50	0.47	0	4.13E-2	0	-5.01E-2	-6.44E-3	0
2.971	0.50	0.42	0	4.98E-2	0	-8.04E-2	-1.03E-2	0
2.981	0.50	0.39	0	5.88E-2	0	-0.12	-1.50E-2	0
2.991	0.50	0.36	0	6.83E-2	0	-0.16	-2.05E-2	0
3.001	0.50	0.36	0	7.56E-2	0	-0.19	-2.51E-2	0
3.011	0.50	0.37	0	6.59E-2	0	-0.15	-1.90E-2	0

x	N_x'	N_ϕ,	$N_{x\phi}'$	Q_x,	Q_ϕ,	M_x,	M_ϕ,	$M_{x\phi}'$
3.021	0.50	0.40	0	5.65E-2	0	-0.11	-1.38E-2	0
3.031	0.50	0.43	0	4.76E-2	0	-7.22E-2	-9.30E-3	0
3.041	0.50	0.48	0	3.93E-2	0	-4.33E-2	-5.57E-3	0
3.051	0.50	0.53	0	3.18E-2	0	-1.96E-2	-2.53E-3	0
3.061	0.50	0.58	0	2.51E-2	0	-7.35E-4	-9.46E-5	0
3.071	0.50	0.64	0	1.91E-2	0	1.39E-2	1.79E-3	0
3.081	0.50	0.69	0	1.40E-2	0	2.49E-2	3.21E-3	0
3.091	0.50	0.74	0	9.57E-3	0	3.27E-2	4.21E-3	0
3.101	0.50	0.78	0	5.89E-3	0	3.78E-2	4.87E-3	0
3.111	0.50	0.82	0	2.87E-3	0	4.07E-2	5.24E-3	0
3.121	0.50	0.86	0	4.48E-4	0	4.18E-2	5.38E-3	0
3.131	0.50	0.89	0	-1.44E-3	0	4.14E-2	5.33E-3	0
3.141	0.50	0.92	0	-2.87E-3	0	4.00E-2	5.15E-3	0
3.151	0.50	0.94	0	-3.89E-3	0	3.77E-2	4.85E-3	0
3.161	0.50	0.97	0	-4.57E-3	0	3.49E-2	4.49E-3	0
3.171	0.50	0.98	0	-4.97E-3	0	3.17E-2	4.08E-3	0
3.181	0.50	1.00	0	-5.14E-3	0	2.83E-2	3.64E-3	0
3.191	0.50	1.01	0	-5.12E-3	0	2.49E-2	3.20E-3	0
3.201	0.50	1.01	0	-4.96E-3	0	2.15E-2	2.77E-3	0
3.211	0.50	1.02	0	-4.70E-3	0	1.83E-2	2.35E-3	0
3.221	0.50	1.02	0	-4.36E-3	0	1.53E-2	1.96E-3	0
3.231	0.50	1.03	0	-3.97E-3	0	1.25E-2	1.61E-3	0
3.241	0.50	1.03	0	-3.56E-3	0	9.97E-3	1.28E-3	0
3.251	0.50	1.03	0	-3.13E-3	0	7.74E-3	9.96E-4	0
3.261	0.50	1.03	0	-2.72E-3	0	5.79E-3	7.45E-4	0
3.271	0.50	1.03	0	-2.32E-3	0	4.11E-3	5.29E-4	0
3.281	0.50	1.02	0	-1.94E-3	0	2.70E-3	3.47E-4	0
3.291	0.50	1.02	0	-1.59E-3	0	1.52E-3	1.96E-4	0
3.301	0.50	1.02	0	-1.28E-3	0	5.66E-4	7.28E-5	0
3.311	0.50	1.02	0	-9.97E-4	0	-1.90E-4	-2.45E-5	0
3.321	0.50	1.02	0	-7.51E-4	0	-7.71E-4	-9.92E-5	0
3.331	0.50	1.01	0	-5.39E-4	0	-1.20E-3	-1.54E-4	0
3.341	0.50	1.01	0	-3.59E-4	0	-1.50E-3	-1.93E-4	0
3.351	0.50	1.01	0	-2.10E-4	0	-1.68E-3	-2.17E-4	0
3.361	0.50	1.01	0	-8.78E-5	0	-1.78E-3	-2.29E-4	0
3.371	0.50	1.01	0	9.20E-6	0	-1.81E-3	-2.33E-4	0
3.381	0.50	1.00	0	8.42E-5	0	-1.78E-3	-2.28E-4	0
3.391	0.50	1.00	0	1.40E-4	0	-1.70E-3	-2.19E-4	0
3.401	0.50	1.00	0	1.79E-4	0	-1.59E-3	-2.05E-4	0
3.411	0.50	1.00	0	2.04E-4	0	-1.46E-3	-1.88E-4	0
3.421	0.50	1.00	0	2.18E-4	0	-1.32E-3	-1.70E-4	0
3.431	0.50	1.00	0	2.23E-4	0	-1.18E-3	-1.51E-4	0
3.441	0.50	1.00	0	2.20E-4	0	-1.03E-3	-1.32E-4	0
3.451	0.50	1.00	0	2.11E-4	0	-8.84E-4	-1.14E-4	0
3.461	0.50	1.00	0	1.99E-4	0	-7.47E-4	-9.61E-5	0
3.471	0.50	1.00	0	1.83E-4	0	-6.19E-4	-7.97E-5	0
3.481	0.50	1.00	0	1.66E-4	0	-5.03E-4	-6.48E-5	0
3.491	0.50	1.00	0	1.48E-4	0	-3.99E-4	-5.13E-5	0

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
3.501	0.50	1.00	0	1.02E-4	0	-2.49E-4	-3.20E-5	0
3.511	0.50	1.00	0	1.15E-4	0	-3.21E-4	-4.13E-5	0
3.521	0.50	1.00	0	1.29E-4	0	-4.02E-4	-5.18E-5	0
3.531	0.50	1.00	0	1.42E-4	0	-4.93E-4	-6.34E-5	0
3.541	0.50	1.00	0	1.53E-4	0	-5.91E-4	-7.61E-5	0
3.551	0.50	1.00	0	1.62E-4	0	-6.96E-4	-8.96E-5	0
3.561	0.50	1.00	0	1.67E-4	0	-8.06E-4	-1.04E-4	0
3.571	0.50	1.00	0	1.68E-4	0	-9.18E-4	-1.18E-4	0
3.581	0.50	1.00	0	1.63E-4	0	-1.03E-3	-1.32E-4	0
3.591	0.50	1.00	0	1.51E-4	0	-1.13E-3	-1.46E-4	0
3.601	0.50	1.00	0	1.29E-4	0	-1.23E-3	-1.58E-4	0
3.611	0.50	1.00	0	9.66E-5	0	-1.30E-3	-1.68E-4	0
3.621	0.50	1.00	0	5.09E-5	0	-1.35E-3	-1.74E-4	0
3.631	0.50	1.00	0	-9.85E-6	0	-1.37E-3	-1.76E-4	0
3.641	0.50	1.01	0	-8.79E-5	0	-1.34E-3	-1.72E-4	0
3.651	0.50	1.01	0	-1.85E-4	0	-1.25E-3	-1.61E-4	0
3.661	0.50	1.01	0	-3.04E-4	0	-1.09E-3	-1.40E-4	0
3.671	0.50	1.01	0	-4.46E-4	0	-8.37E-4	-1.08E-4	0
3.681	0.50	1.01	0	-6.13E-4	0	-4.85E-4	-6.24E-5	0
3.691	0.50	1.01	0	-8.06E-4	0	-1.33E-5	-1.71E-6	0
3.701	0.50	1.02	0	-1.02E-3	0	5.96E-4	7.66E-5	0
3.711	0.50	1.02	0	-1.27E-3	0	1.36E-3	1.75E-4	0
3.721	0.50	1.02	0	-1.54E-3	0	2.29E-3	2.95E-4	0
3.731	0.50	1.02	0	-1.83E-3	0	3.41E-3	4.39E-4	0
3.741	0.50	1.02	0	-2.14E-3	0	4.74E-3	6.09E-4	0
3.751	0.50	1.02	0	-2.45E-3	0	6.26E-3	8.06E-4	0
3.761	0.50	1.02	0	-2.77E-3	0	8.01E-3	1.03E-3	0
3.771	0.50	1.02	0	-3.08E-3	0	9.96E-3	1.28E-3	0
3.781	0.50	1.02	0	-3.37E-3	0	1.21E-2	1.56E-3	0
3.791	0.50	1.01	0	-3.61E-3	0	1.44E-2	1.86E-3	0
3.801	0.50	1.01	0	-3.80E-3	0	1.69E-2	2.18E-3	0
3.811	0.50	1.00	0	-3.89E-3	0	1.95E-2	2.51E-3	0
3.821	0.50	0.99	0	-3.87E-3	0	2.21E-2	2.84E-3	0
3.831	0.50	0.98	0	-3.71E-3	0	2.46E-2	3.17E-3	0
3.841	0.50	0.97	0	-3.36E-3	0	2.70E-2	3.47E-3	0
3.851	0.50	0.95	0	-2.78E-3	0	2.90E-2	3.74E-3	0
3.861	0.50	0.93	0	-1.93E-3	0	3.06E-2	3.94E-3	0
3.871	0.50	0.91	0	-7.68E-4	0	3.15E-2	4.06E-3	0
3.881	0.50	0.89	0	7.60E-4	0	3.16E-2	4.06E-3	0
3.891	0.50	0.86	0	2.70E-3	0	3.04E-2	3.92E-3	0
3.901	0.50	0.83	0	5.11E-3	0	2.79E-2	3.59E-3	0
3.911	0.50	0.79	0	8.03E-3	0	2.35E-2	3.03E-3	0
3.921	0.50	0.75	0	1.15E-2	0	1.70E-2	2.19E-3	0
3.931	0.50	0.71	0	1.56E-2	0	8.05E-3	1.04E-3	0
3.941	0.50	0.67	0	2.02E-2	0	-3.84E-3	-4.94E-4	0
3.951	0.50	0.63	0	2.55E-2	0	-1.90E-2	-2.45E-3	0
3.961	0.50	0.60	0	3.13E-2	0	-3.79E-2	-4.88E-3	0
3.971	0.50	0.56	0	3.77E-2	0	-6.09E-2	-7.84E-3	0

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
3.981	0.50	0.54	0	4.46E-2	0	-8.83E-2	-1.14E-2	0
3.991	0.50	0.52	0	5.18E-2	0	-0.12	-1.55E-2	0
4.001	0.50	0.51	0	5.73E-2	0	-0.15	-1.90E-2	0
4.011	0.50	0.52	0	4.99E-2	0	-0.11	-1.44E-2	0
4.021	0.50	0.54	0	4.28E-2	0	-8.10E-2	-1.04E-2	0
4.031	0.50	0.57	0	3.60E-2	0	-5.47E-2	-7.04E-3	0
4.041	0.50	0.61	0	2.98E-2	0	-3.28E-2	-4.22E-3	0
4.051	0.50	0.64	0	2.41E-2	0	-1.49E-2	-1.91E-3	0
4.061	0.50	0.68	0	1.90E-2	0	-5.56E-4	-7.16E-5	0
4.071	0.50	0.72	0	1.45E-2	0	1.06E-2	1.36E-3	0
4.081	0.50	0.76	0	1.06E-2	0	1.89E-2	2.43E-3	0
4.091	0.50	0.80	0	7.25E-3	0	2.48E-2	3.19E-3	0
4.101	0.50	0.83	0	4.46E-3	0	2.87E-2	3.69E-3	0
4.111	0.50	0.87	0	2.17E-3	0	3.08E-2	3.97E-3	0
4.121	0.50	0.89	0	3.39E-4	0	3.17E-2	4.07E-3	0
4.131	0.50	0.92	0	-1.09E-3	0	3.14E-2	4.04E-3	0
4.141	0.50	0.94	0	-2.17E-3	0	3.03E-2	3.90E-3	0
4.151	0.50	0.96	0	-2.95E-3	0	2.86E-2	3.68E-3	0
4.161	0.50	0.97	0	-3.46E-3	0	2.64E-2	3.40E-3	0
4.171	0.50	0.99	0	-3.77E-3	0	2.40E-2	3.09E-3	0
4.181	0.50	1.00	0	-3.89E-3	0	2.14E-2	2.76E-3	0
4.191	0.50	1.00	0	-3.88E-3	0	1.88E-2	2.42E-3	0
4.201	0.50	1.01	0	-3.76E-3	0	1.63E-2	2.10E-3	0
4.211	0.50	1.02	0	-3.56E-3	0	1.38E-2	1.78E-3	0
4.221	0.50	1.02	0	-3.30E-3	0	1.16E-2	1.49E-3	0
4.231	0.50	1.02	0	-3.01E-3	0	9.45E-3	1.22E-3	0
4.241	0.50	1.02	0	-2.69E-3	0	7.55E-3	9.71E-4	0
4.251	0.50	1.02	0	-2.37E-3	0	5.86E-3	7.54E-4	0
4.261	0.50	1.02	0	-2.06E-3	0	4.38E-3	5.64E-4	0
4.271	0.50	1.02	0	-1.75E-3	0	3.11E-3	4.01E-4	0
4.281	0.50	1.02	0	-1.47E-3	0	2.04E-3	2.63E-4	0
4.291	0.50	1.02	0	-1.21E-3	0	1.15E-3	1.48E-4	0
4.301	0.50	1.01	0	-9.67E-4	0	4.28E-4	5.51E-5	0
4.311	0.50	1.01	0	-7.55E-4	0	-1.44E-4	-1.86E-5	0
4.321	0.50	1.01	0	-5.69E-4	0	-5.84E-4	-7.52E-5	0
4.331	0.50	1.01	0	-4.08E-4	0	-9.08E-4	-1.17E-4	0
4.341	0.50	1.01	0	-2.72E-4	0	-1.13E-3	-1.46E-4	0
4.351	0.50	1.01	0	-1.59E-4	0	-1.28E-3	-1.64E-4	0
4.361	0.50	1.01	0	-6.65E-5	0	-1.35E-3	-1.74E-4	0
4.371	0.50	1.00	0	7.02E-6	0	-1.37E-3	-1.76E-4	0
4.381	0.50	1.00	0	6.38E-5	0	-1.34E-3	-1.73E-4	0
4.391	0.50	1.00	0	1.06E-4	0	-1.29E-3	-1.66E-4	0
4.401	0.50	1.00	0	1.36E-4	0	-1.21E-3	-1.55E-4	0
4.411	0.50	1.00	0	1.55E-4	0	-1.11E-3	-1.43E-4	0
4.421	0.50	1.00	0	1.65E-4	0	-1.00E-3	-1.29E-4	0
4.431	0.50	1.00	0	1.69E-4	0	-8.90E-4	-1.15E-4	0
4.441	0.50	1.00	0	1.66E-4	0	-7.78E-4	-1.00E-4	0
4.451	0.50	1.00	0	1.60E-4	0	-6.69E-4	-8.61E-5	0

x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
4.461	0.50	1 00	0	1.50E-4	0	-5.66E-4	-7.28E-5	0
4.471	0.50	1.00	0	1.39E-4	0	-4.69E-4	-6.04E-5	0
4.481	0.50	1.00	0	1.26E-4	0	-3.81E-4	-4.90E-5	0
4.491	0.50	1.00	0	1.12E-4	0	-3.02E-4	-3.88E-5	0
4.501	0.50	1.00	0	1.02E-4	0	-2.49E-4	-3.20E-5	0
4.511	0.50	1.00	0	1.15E-4	0	-3.21E-4	-4.13E-5	0
4.521	0.50	1.00	0	1.29E-4	0	-4.02E-4	-5.18E-5	0
4.531	0.50	1.00	0	1.42E-4	0	-4.93E-4	-6.34E-5	0
4.541	0.50	1.00	0	1.53E-4	0	-5.91E-4	-7.61E-5	0
4.551	0.50	1.00	0	1.62E-4	0	-6.96E-4	-8.96E-5	0
4.561	0.50	1.00	0	1.67E-4	0	-8.06E-4	-1.04E-4	0
4.571	0.50	1.00	0	1.68E-4	0	-9.18E-4	-1.18E-4	0
4.581	0.50	1.00	0	1.63E-4	0	-1.03E-3	-1.32E-4	0
4.591	0.50	1.00	0	1.51E-4	0	-1.13E-3	-1.46E-4	0
4.601	0.50	1.00	0	1 29E-4	0	-1.23E-3	-1.58E-4	0
4.611	0.50	1.00	0	9.65E-5	0	1.30E-3	-1.68E-4	0
4.621	0.50	1.00	0	5.09E-5	0	-1.35E-3	-1.74E-4	0
4.631	0.50	1.00	0	-9.95E-6	0	-1.37E-3	-1.76E-4	0
4.641	0.50	1.01	0	-8.80E-5	0	-1.34E-3	-1.72E-4	0
4.651	0.50	1.01	0	-1.85E-4	0	-1.25E-3	-1.61E-4	0
4.661	0.50	1.01	0	-3.04E-4	0	-1.09E-3	-1.40E-4	0
4.671	0.50	1.01	0	-4.47E-4	0	-8.36E-4	-1.08E-4	0
4.681	0.50	1.01	0	-6.13E-4	0	-4.84E-4	-6.23E-5	0
4.691	0.50	1.01	0	-8.06E-4	0	-1.24E-5	-1.60E-6	0
4.701	0.50	1.02	0	-1.03E-3	0	5.97E-4	7.68E-5	0
4.711	0.50	1.02	0	-1.27E-3	0	1.36E-3	1.75E-4	0
4.721	0.50	1.02	0	-1.54E-3	0	2.30E-3	2.95E-4	0
4.731	0.50	1.02	0	-1.83E-3	0	3.42E-3	4.40E-4	0
4.741	0.50	1.02	0	-2.14E-3	0	4.74E-3	6.10E-4	0
4.751	0.50	1.02	0	-2.45E-3	0	6.27E-3	8.07E-4	0
4.761	0.50	1.02	0	-2.77E-3	0	8.01E-3	1.03E-3	0
4.771	0.50	1.02	0	-3.08E-3	0	9.96E-3	1.28E-3	0
4.781	0.50	1.02	0	-3.37E-3	0	1.21E-2	1.56E-3	0
4.791	0.50	1.01	0	-3.61E-3	0	1.44E-2	1.86E-3	0
4.801	0.50	1.01	0	-3.80E-3	0	1.69E-2	2.18E-3	0
4.811	0.50	1.00	0	-3.89E-3	0	1.95E-2	2.51E-3	0
4.821	0.50	0.99	0	-3.87E-3	0	2.21E-2	2.84E-3	0
4.831	0.50	0.98	0	-3.71E-3	0	2.46E-2	3.17E-3	0
4.841	0.50	0.97	0	-3.35E-3	0	2.70E-2	3.47E-3	0
4.851	0.50	0.95	0	-2.78E-3	0	2.90E-2	3.74E-3	0
4.861	0.50	0.93	0	-1.93E-3	0	3.06E-2	3.94E-3	0
4.871	0.50	0.91	0	-7.66E-4	0	3.15E-2	4.06E-3	0
4.881	0.50	0.89	0	7.64E-4	0	3.16E-2	4.06E-3	0
4.891	0.50	0.86	0	2.71E-3	0	3.04E-2	3.92E-3	0
4.901	0.50	0.83	0	5.12E-3	0	2.79E-2	3.58E-3	0
4.911	0.50	0.79	0	8.04E-3	0	2.35E-2	3.02E-3	0
4.921	0.50	0.75	0	1.15E-2	0	1.70E-2	2.19E-3	0
4.931	0.50	0.71	0	1.56E-2	0	8.02E-3	1.03E-3	0

x	N_x'	N_ϕ'	$N_{x\phi}$'	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}$'
4.941	0.50	0.67	0	2.02E-2	0	-3.87E-3	-4.98E-4	0
4.951	0.50	0.63	0	2.55E-2	0	-1.91E-2	-2.45E-3	0
4.961	0.50	0.60	0	3.13E-2	0	-3.80E-2	-4.89E-3	0
4.971	0.50	0.56	0	3.77E-2	0	-6.10E-2	-7.84E-3	0
4.981	0.50	0.54	0	4.46E-2	0	-8.84E-2	-1.14E-2	0
4.991	0.50	0.52	0	5.18E-2	0	-0.12	-1.55E-2	0
5.001	0.50	0.51	0	5.73E-2	0	-0.15	-1.90E-2	0
5.011	0.50	0.52	0	4.99E-2	0	-0.11	-1.44E-2	0
5.021	0.50	0.54	0	4.28E-2	0	-8.09E-2	-1.04E-2	0
5.031	0.50	0.57	0	3.60E-2	0	-5.47E-2	-7.04E-3	0
5.041	0.50	0.61	0	2.98E-2	0	-3.28E-2	-4.22E-3	0
5.051	0.50	0.64	0	2.41E-2	0	-1.48E-2	-1.91E-3	0
5.061	0.50	0.68	0	1.90E-2	0	-5.27E-4	-6.78E-5	0
5.071	0.50	0.72	0	1.45E-2	0	1.06E-2	1.36E-3	0
5.081	0.50	0.76	0	1.06E-2	0	1.89E-2	2.43E-3	0
5.091	0.50	0.80	0	7.24E-3	0	2.48E-2	3.19E-3	0
5.101	0.50	0.83	0	4.46E-3	0	2.87E-2	3.69E-3	0
5.111	0.50	0.87	0	2.17E-3	0	3.09E-2	3.97E-3	0
5.121	0.50	0.89	0	3.35E-4	0	3.17E-2	4.07E-3	0
5.131	0.50	0.92	0	-1.10E-3	0	3.14E-2	4.04E-3	0
5.141	0.50	0.94	0	-2.17E-3	0	3.03E-2	3.90E-3	0
5.151	0.50	0.96	0	-2.95E-3	0	2.86E-2	3.68E-3	0
5.161	0.50	0.97	0	-3.46E-3	0	2.64E-2	3.40E-3	0
5.171	0.50	0.99	0	-3.77E-3	0	2.40E-2	3.09E-3	0
5.181	0.50	1.00	0	-3.89E-3	0	2.14E-2	2.76E-3	0
5.191	0.50	1.00	0	-3.88E-3	0	1.88E-2	2.42E-3	0
5.201	0.50	1.01	0	-3.76E-3	0	1.63E-2	2.09E-3	0
5.211	0.50	1.02	0	-3.56E-3	0	1.38E-2	1.78E-3	0
5.221	0.50	1.02	0	-3.30E-3	0	1.15E-2	1.49E-3	0
5.231	0.50	1.02	0	-3.00E-3	0	9.44E-3	1.22E-3	0
5.241	0.50	1.02	0	-2.69E-3	0	7.54E-3	9.71E-4	0
5.251	0.50	1.02	0	-2.37E-3	0	5.86E-3	7.54E-4	0
5.261	0.50	1.02	0	-2.06E-3	0	4.38E-3	5.64E-4	0
5.271	0.50	1.02	0	-1.75E-3	0	3.11E-3	4.00E-4	0
5.281	0.50	1.02	0	-1.47E-3	0	2.04E-3	2.62E-4	0
5.291	0.50	1.02	0	-1.20E-3	0	1.15E-3	1.48E-4	0
5.301	0.50	1.01	0	-9.67E-4	0	4.27E-4	5.49E-5	0
5.311	0.50	1.01	0	-7.54E-4	0	-1.46E-4	-1.87E-5	0
5.321	0.50	1.01	0	-5.68E-4	0	-5.85E-4	-7.53E-5	0
5.331	0.50	1.01	0	-4.08E-4	0	-9.09E-4	-1.17E-4	0
5.341	0.50	1.01	0	-2.72E-4	0	-1.13E-3	-1.46E-4	0
5.351	0.50	1.01	0	-1.59E-4	0	-1.28E-3	-1.64E-4	0
5.361	0.50	1.01	0	-6.63E-5	0	-1.35E-3	-1.74E-4	0
5.371	0.50	1.00	0	7.16E-6	0	-1.37E-3	-1.76E-4	0
5.381	0.50	1.00	0	6.39E-5	0	-1.34E-3	-1.73E-4	0
5.391	0.50	1.00	0	1.06E-4	0	-1.29E-3	-1.66E-4	0
5.401	0.50	1.00	0	1.36E-4	0	-1.21E-3	-1.55E-4	0
5.411	0.50	1.00	0	1.55E-4	0	-1.11E-3	-1.43E-4	0

x	N_x'	N_ϕ'	$N_{x\phi}$'	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}$'
5.421	0.50	1.00	0	1.65E-4	0	-1.00E-3	-1.29E-4	0
5.431	0.50	1.00	0	1.69E-4	0	-8.90E-4	-1.15E-4	0
5.441	0.50	1.00	0	1.66E-4	0	-7.78E-4	-1.00E-4	0
5.451	0.50	1.00	0	1.60E-4	0	-6.69E-4	-8.61E-5	0
5.461	0.50	1.00	0	1.50E-4	0	-5.65E-4	-7.28E-5	0
5.471	0.50	1.00	0	1.39E-4	0	-4.69E-4	-6.03E-5	0
5.481	0.50	1.00	0	1.26E-4	0	-3.81E-4	-4.90E-5	0
5.491	0.50	1.00	0	1.12E-4	0	-3.02E-4	-3.86E-5	0
5.501	0.50	1.00	0	1.02E-4	0	-2.49E-4	-3.20E-5	0
5.511	0.50	1.00	0	1.15E-4	0	-3.21E-4	-4.13E-5	0
5.521	0.50	1.00	0	1.29E-4	0	-4.03E-4	-5.18E-5	0
5.531	0.50	1.00	0	1.42E-4	0	-4.93E-4	-6.35E-5	0
5.541	0.50	1.00	0	1.53E-4	0	-5.91E-4	-7.61E-5	0
5.551	0.50	1.00	0	1.62E-4	0	-6.97E-4	-8.96E-5	0
5.561	0.50	1.00	0	1.67E-4	0	-8.07E-4	-1.04E-4	0
5.571	0.50	1.00	0	1.68E-4	0	-9.19E-4	-1.18E-4	0
5.581	0.50	1.00	0	1.63E-4	0	-1.03E-3	-1.33E-4	0
5.591	0.50	1.00	0	1.51E-4	0	-1.13E-3	-1.46E-4	0
5.601	0.50	1.00	0	1.29E-4	0	-1.23E-3	-1.58E-4	0
5.611	0.50	1.00	0	9.64E-5	0	-1.30E-3	-1.68E-4	0
5.621	0.50	1.00	0	5.07E-5	0	-1.35E-3	-1.74E-4	0
5.631	0.50	1.00	0	-1.01E-5	0	-1.37E-3	-1.76E-4	0
5.641	0.50	1.01	0	-8.82E-5	0	-1.34E-3	-1.72E-4	0
5.651	0.50	1.01	0	-1.86E-4	0	-1.25E-3	-1.60E-4	0
5.661	0.50	1.01	0	-3.05E-4	0	-1.08E-3	-1.40E-4	0
5.671	0.50	1.01	0	-4.47E-4	0	-8.35E-4	-1.08E-4	0
5.681	0.50	1.01	0	-6.14E-4	0	-4.83E-4	-6.22E-5	0
5.691	0.50	1.01	0	-8.07E-4	0	-1.12E-5	-1.44E-6	0
5.701	0.50	1.02	0	-1.03E-3	0	5.98E-4	7.70E-5	0
5.711	0.50	1.02	0	-1.27E-3	0	1.36E-3	1.75E-4	0
5.721	0.50	1.02	0	-1.54E-3	0	2.30E-3	2.96E-4	0
5.731	0.50	1.02	0	-1.83E-3	0	3.42E-3	4.40E-4	0
5.741	0.50	1.02	0	-2.14E-3	0	4.74E-3	6.10E-4	0
5.751	0.50	1.02	0	-2.45E-3	0	6.27E-3	8.07E-4	0
5.761	0.50	1.02	0	-2.77E-3	0	8.01E-3	1.03E-3	0
5.771	0.50	1.02	0	-3.08E-3	0	9.97E-3	1.28E-3	0
5.781	0.50	1.02	0	-3.37E-3	0	1.21E-2	1.56E-3	0
5.791	0.50	1.01	0	-3.61E-3	0	1.45E-2	1.86E-3	0
5.801	0.50	1.01	0	-3.80E-3	0	1.69E-2	2.18E-3	0
5.811	0.50	1.00	0	-3.89E-3	0	1.95E-2	2.51E-3	0
5.821	0.50	0.99	0	-3.87E-3	0	2.21E-2	2.84E-3	0
5.831	0.50	0.98	0	-3.71E-3	0	2.46E-2	3.17E-3	0
5.841	0.50	0.97	0	-3.35E-3	0	2.70E-2	3.47E-3	0
5.851	0.50	0.95	0	-2.78E-3	0	2.90E-2	3.74E-3	0
5.861	0.50	0.93	0	-1.93E-3	0	3.06E-2	3.94E-3	0
5.871	0.50	0.91	0	-7.63E-4	0	3.15E-2	4.06E-3	0
5.881	0.50	0.89	0	7.68E-4	0	3.16E-2	4.06E-3	0
5.891	0.50	0.86	0	2.71E-3	0	3.04E-2	3.92E-3	0

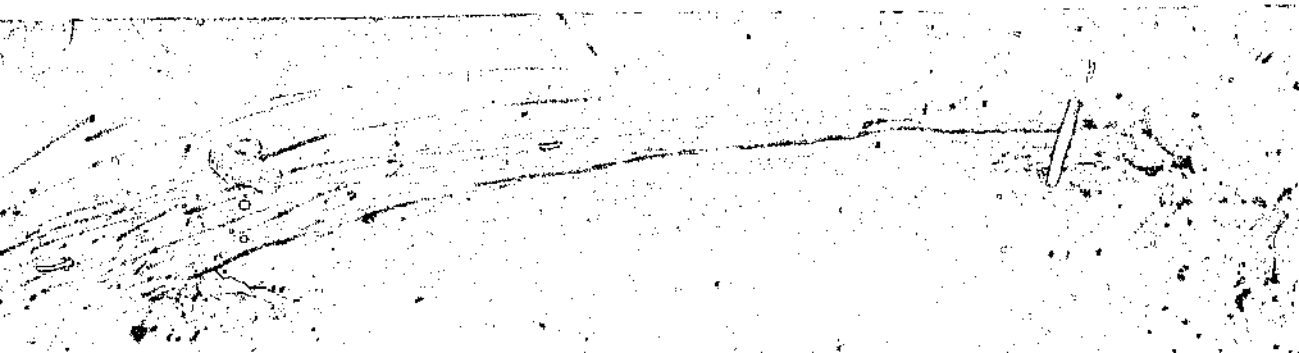
x	N_x'	N_ϕ'	$N_{x\phi}'$	Q_x'	Q_ϕ'	M_x'	M_ϕ'	$M_{x\phi}'$
5.901	0.50	0.83	0	5.12E-3	0	2.78E-2	3.58E-3	0
5.911	0.50	0.79	0	8.05E-3	0	2.35E-2	3.02E-3	0
5.921	0.50	0.75	0	1.15E-2	0	1.70E-2	2.19E-3	0
5.931	0.50	0.71	0	1.58E-2	0	8.00E-3	1.03E-3	0
5.941	0.50	0.67	0	2.02E-2	0	-3.90E-3	-5.02E-4	0
5.951	0.50	0.63	0	2.55E-2	0	-1.91E-2	-2.46E-3	0
5.961	0.50	0.60	0	3.13E-2	0	-3.80E-2	-4.89E-3	0
5.971	0.50	0.56	0	3.77E-2	0	-6.10E-2	-7.85E-3	0
5.981	0.50	0.54	0	4.46E-2	0	-8.84E-2	-1.14E-2	0
5.991	0.50	0.52	0	5.18E-2	0	-0.12	-1.55E-2	0

APPENDIX R

SUMMARISED FEM AND THEORY OUTPUT FOR 2g COMBINED ACCELERATION LOAD CASE

Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
7261	96610	-22630	91690	-114500	315	14	25	
-4439	44091	-24156	7424	26210	-256	-65	26	
-26756	35959	-22550	-43146	6560	53	-19	23	
-34540	56600	-27476	-346	929	31	-133	24	
-55156	14921	-26190	-75470	14375	-127	-17	40	
-57090	88652	-34330	269454	-60950	-113	-116	33	
-42970	-21990	-26636	-154300	95648	353	-50	8	
-60630	110250	61741	-458900	-145700	-1161	-331	-26	
-62870	465850	54115	42859	-484860	1555	111	32	
-81530	144370	-37936	39482	57870	-455	-127	1	
-61250	-75360	-53134	-57450	102920	17	17	8	
-60420	47217	-27334	-32078	-193190	125	-40	12	
-74960	72715	-6860	44195	162420	-43	-102	-19	
-32450	20791	-4863	-13540	-139700	-10	28	-20	
-84710	72141	-458	-36599	-12640	-216	-9	-44	
-82944	247869	-9185	72502	262910	229	-54	-34	
-87450	227450	-51828	-92479	7856	41	-109	15	
-96440	75776	-65059	-51650	-9069	-114	-43	1	
-102040	52217	-72840	71494	-17420	-51	-9	-21	
-111400	40086	-54996	-52540	-42390	2	-27	-19	
-114960	96477	-51634	5043	45449	11	-4	-21	
-122140	77355	-59690	-25146	-49166	-4	61	-19	
-124400	103760	-59550	-21650	-49934	-166	38	-31	
-127200	174350	-42690	49186	221610	149	-17	-17	
-140360	141710	-56370	-40620	115450	-64	-99	3	
-152240	92112	-76310	-72990	-47254	13	-45	-5	
-162860	94299	-52320	44075	-25920	-67	-91	-11	
-177160	190540	-61450	-13020	-15250	-12	-62	-11	
-183360	112330	-42150	2009	-6562	2	-34	-10	
-197580	113360	-71050	-35800	-23310	-25	0	-9	
-205790	127950	-42640	2491	-40180	17	11	-11	
-213780	96363	-36640	73726	96120	12	-25	-4	
-227840	61314	-35145	-12270	94621	-139	-68	-5	
-235900	113250	-56150	-10100	-57200	116	-33	-5	
-243180	127260	-60134	11523	-29250	-66	-75	-6	
-252690	125760	-46650	-3460	-4054	-14	-31	-6	
-258360	130620	-45980	2167	-29420	-7	-9	-5	
-266500	142640	-44710	-32940	-13140	-24	4	-5	
-271700	146710	-42610	9254	-34940	44	30	-3	
-276700	76905	-25510	31459	47643	-60	-4	-1	
-284480	92695	-25450	8143	69314	-143	-36	-2	
-288400	142540	-33560	1914	-33490	134	-15	-2	
-291660	136190	-34130	-4683	-26210	-65	-45	-3	
-295500	147460	-27910	1135	-6333	-12	-5	-2	
-297500	151260	-24750	1314	-23710	-14	4	-1	
-300000	164530	-23710	-26248	-10750	-32	7	-1	
-301100	164460	-19150	12241	-26190	142	34	2	
-301900	71781	-12250	27942	6900	-114	-7	-1	

THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
0.05	13044	22123	6455.5	548.72	0	-1.618	-2.04	0	
0.2	15691	25424	10115	-145.3	0	1.44	0.19	0	
0.3	14972	24467	12528	-22.38	0	1.31	0.14	0	
0.45	23548	32907	16144	8.83	0	-0.0914	-0.0127	0	
0.55	23441	34328	18561	4.49	0	-0.5	-0.0435	0	
0.7	24625	34344	22181	-32.87	0	0.24	0.0305	0	
0.8	32570	46582	24584	-152.4	0	4.78	1.12	0	
0.95	39262	29445	24214	983.13	0	-10.68	-1.3	0	
1.05	143540	36682	-119580	1661	0	-10.87	-1.6	0	
1.2	153230	58147	-115440	-179.5	0	11.43	1.52	0	
1.3	135690	52784	-113460	-50.41	0	0.39	0.0499	0	
1.45	106860	55533	-109260	6.9	0	-0.57	-0.0729	0	
1.55	44243	57491	-107460	9.4	0	-0.6	-0.077	0	
1.7	61065	62468	-103480	-52.42	0	0.41	0.0422	0	
1.8	43463	64493	-101460	-2561	0	16.41	2.12	0	
1.95	17834	41867	-97720	1755.6	0	-17.89	-2.32	0	
2.05	1061.1	43043	-95320	1832.6	0	-18.71	-2.42	0	
2.2	-23020	74058	-91700	-2971	0	19.58	2.52	0	
2.3	-34560	76645	-89290	-31.43	0	0.63	0.0406	0	
2.45	-61098	79110	-85670	13.81	0	-0.87	-0.11	0	
2.55	-75600	81468	-83250	14.41	0	-0.92	-0.12	0	
2.7	-94260	84478	-79640	-93.84	0	0.72	0.0929	0	
2.8	-110100	86484	-77220	-547.7	0	24.24	3.12	0	
2.95	-129500	54162	-73600	2531.1	0	-25.2	-3.33	0	
3.05	-142100	55405	-71190	2604.2	0	-26.69	-3.44	0	
3.2	-164000	97968	-67570	-41.48	0	27.34	3.52	0	
3.3	-171400	100910	-65160	-112.5	0	0.87	0.11	0	
3.45	-187800	102650	-61540	18.92	0	-1.2	-0.15	0	
3.55	-193100	105060	-59120	14.71	0	-0.91	-0.12	0	
3.7	-212900	110070	-55500	-94.57	0	0.73	0.0937	0	
3.8	-222300	112009	-53090	-367.6	0	24.25	3.12	0	
3.95	-233580	78180	-49470	2498.5	0	-25.61	-3.3	0	
4.05	-241900	79619	-47060	2556.8	0	-26.2	-3.37	0	
4.2	-255600	121550	-43440	-405.3	0	26.58	3.42	0	
4.3	-262900	124440	-41020	-108.7	0	6.84	0.11	0	
4.45	-273100	126240	-37400	18.13	0	-1.15	-0.15	0	
4.55	-279500	128640	-34990	18.51	0	-1.18	-0.15	0	
4.7	-287900	134020	-31370	-114.1	0	0.91	0.12	0	
4.8	-293140	135450	-28960	-456.8	0	30.1	3.87	0	
4.95	-300200	93267	-25340	3462.7	0	-31.6	-4.07	0	
5.05	-304500	94776	-22930	3541.2	0	-32.39	-4.14	0	
5.2	-314000	145360	-19310	-492.4	0	32.45	4.18	0	
5.3	-318100	148299	-16896	-192.2	0	1.82	0.23	0	
5.45	-317100	149860	-13270	21.95	0	-1.4	-0.18	0	
5.55	-319200	152220	-10860	22.51	0	-1.42	-0.18	0	
5.7	-322600	157978	-7240	-141.6	0	1.01	0.14	0	
5.8	-322700	159660	-4826	-545.9	0	35.91	4.63	0	
5.95	-323500	144350	-1207	3667.1	0	-37.51	-4.84	0	



TOP OF TANKER (+Z)

FEM x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
6.05	-303000	71347	-9524	23134	32416	-134	-16		-2
6.2	-301600	172344	-10416	11356	-26424	150	13		2
6.3	-300100	163446	-4466	-25200	-22780	-69	-18		1
6.45	-297600	171700	-4622	4239	-6644	-8	9		1
6.55	-295500	172466	-2359	301	-24640	-12	13		3
6.7	-291700	192890	2234	-17016	-10520	-64	-2		3
6.8	-284100	183010	3842	12282	-17410	182	34		5
6.95	-284000	79241	1476	3978	-26700	-162	-15		0
7.05	-277700	92403	1944	34147	-10410	-113	-7		0
7.2	-271300	282516	13427	18131	-18720	148	29		6
7.3	-265100	269270	16440	-31050	-14370	-56	-1		4
7.45	-256000	196430	17684	5785	-9768	-3	12		5
7.55	-249700	192149	19576	-12778	-22920	-13	7		7
7.7	-239300	215720	22423	-4360	-12220	-75	19		7
7.8	-231900	201820	26956	9025	-10520	204	28		9
7.95	-222400	99221	14275	-22160	-51740	-195	-55		6
8.05	-206100	126810	15477	42369	-60060	-78	-10		4
8.2	-197400	225030	33969	20702	-11460	131	54		11
8.3	-186700	233200	39540	-47070	-9949	-52	6		9
8.45	-171400	223030	36119	9330	-20150	4	2		11
8.55	-161600	216750	35550	-3504	-12740	-4	-9		12
8.7	-145100	235350	31228	4310	-21500	-96	-35		12
8.8	-132000	226050	48545	7494	998	226	16		9
8.95	-117400	140710	28426	-43970	-71950	-203	-62		-4
9.05	-100200	175370	23593	34477	-161200	-28	-17		13
9.2	-83440	260520	37150	16298	3442	114	57		22
9.3	-70940	254830	42001	-45470	19430	-44	35		19
9.45	-63460	252420	37142	1376	-53970	10	-3		17
9.55	-54510	241790	42138	-9456	21758	7	-18		14
9.7	-37570	247580	53140	35684	-42900	-111	-26		17
9.8	-25340	255340	54243	-15180	-3159	160	6		6
9.95	-11340	251250	25636	-74400	-18120	-157	-96		-5
10.05	-3626	285500	12948	23510	-190100	97	-49		24
10.2	-3113	283430	15765	-1676	-13500	-4	6		31
10.3	-1720	267580	18005	-24430	41919	-53	-9		18
10.45	2450	240610	18021	-15960	-94960	11	-94		20
10.55	6454	264970	28413	-1699	64941	-10	-112		12
10.7	13576	257430	35780	47994	-79160	-190	-73		12
10.8	16746	297540	33402	-42250	-3335	-4	-42		-3
10.95	25259	335610	36424	-64590	63968	7	-116		-16
11.05	31283	336900	26666	-105000	-44310	-16	-111		8
11.2	43289	310348	33422	-42490	-6100	18	-19		-2
11.3	56146	271630	32283	64361	47226	-108	-29		-14
11.45	70745	280540	34854	-24270	-59040	-12	-45		-14
11.55	82402	310500	44091	-41282	-59296	10	-49		-21
11.7	99551	303450	47366	-121700	-9027	-42	-54		-20
11.8	114520	344760	50560	54179	-8940	6	-28		-29
11.95	134200	218260	46816	205490	30410	567	53		-19

THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
6.05	-323700	169469	12946	3725.6	0	-74.18	-4.91		0
6.2	-325600	165200	4826.4	-581.5	0	34.53	4.83		0
6.3	-322000	172340	7239.6	-1357	0	1.2	0.15		0
6.45	-319400	173450	10859	23.72	0	-1.64	-0.21		0
6.55	-317400	175800	13273	26.1	0	-1.66	-0.21		0
6.7	-314000	181920	16492	-165.1	0	1.27	0.16		0
6.8	-311000	183500	19305	-435	0	41.45	5.39		0
6.95	-305600	123440	22925	4251.6	0	-43.57	-5.61		0
7.05	-301600	124950	25934	4310	0	-44.17	-5.69		0
7.2	-294400	193030	28954	-670.7	0	44.2	5.69		0
7.3	-289700	156290	31371	-179.2	0	1.34	0.18		0
7.45	-281200	157036	34991	29.52	0	-1.84	-0.24		0
7.55	-275100	199360	37404	29.9	0	-1.9	-0.24		0
7.7	-265100	205870	41024	-148.5	0	1.45	0.19		0
7.8	-257900	207330	43437	724.1	0	47.72	6.14		0
7.95	-246100	134550	47057	4836	0	-49.56	-6.54		0
8.05	-238300	140040	49476	4834.4	0	-50.16	-6.46		0
8.2	-225200	216360	53090	-729.6	0	50.07	6.44		0
8.3	-216400	220230	55503	-202.6	0	1.56	0.2		0
8.45	-201400	220610	59123	33.52	0	-2.12	-0.27		0
8.55	-191100	222930	61536	44.69	0	-2.83	-0.36		0
8.7	-174900	230840	65156	-210	0	2.15	0.28		0
8.8	-163600	231870	67569	-1074	0	76.77	9.11		0
8.95	-145900	128340	71149	7156.6	0	-77.35	-9.44		0
9.05	-135800	129540	73602	7233.9	0	-74.14	-9.54		0
9.2	-114500	241450	77222	-1121	0	78.47	9.51		0
9.3	-101200	245240	79635	-294.6	0	2.2	0.3		0
9.45	-84050	244150	83255	49	0	-3.12	-4.4		0
9.55	-65960	246310	15668	49.5	0	-3.15	-0.41		0
9.7	-43520	254900	19288	-311	0	2.39	0.31		0
9.8	-28160	255760	91701	-1181	0	74.52	10.11		0
9.95	-4251	140700	95321	7928.4	0	-81.26	-10.46		0
10.05	12065	141940	97734	8043.6	0	-82.95	-10.56		0
10.2	37466	265040	101358	-1239	0	81.63	10.51		0
10.3	54957	269340	103770	-329.6	0	2.54	0.33		0
10.45	81966	267730	107390	54.01	0	-3.44	-0.44		0
10.55	100490	270090	109800	54.52	0	-3.47	-0.45		0
10.7	129050	274960	113420	-342	0	2.63	0.34		0
10.8	144600	279690	115830	-1362	0	86.28	11.1		0
10.95	174710	153060	119450	4700	0	-89.17	-11.48		0
11.05	184250	154500	-24210	8777.3	0	-88.95	-11.51		0
11.2	179390	282040	-24590	-1356	0	89.42	11.51		0
11.3	175340	293370	-22160	-563.7	0	2.69	0.35		0
11.45	170420	291500	-18560	60.48	0	-4.55	-0.59		0
11.55	167054	294450	-16150	135.15	0	-1.51	-0.19		0
11.7	163240	298110	-12550	-434.5	0	21.4	2.75		0
11.8	161240	264820	-10120	-5309	0	34.29	4.41		0
11.95	159034	290090	-6495	12415	0	-529.5	-68.14		0

BOTTOM OF TANKER (-Z)

FEM x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
0.05	92501	-11846	-44570	31719	117130	-136	-6	30
0.2	147720	45658	-58750	-12490	-30856	177	44	41
0.3	192570	73434	-65620	-24709	12725	-41	40	17
0.45	245480	95672	-79720	60761	93370	184	166	27
0.55	297120	1429	-79110	-27490	-130500	-166	95	17
0.7	377216	263460	-79870	-150400	159990	-95	-24	15
0.8	355846	-5240	-65800	73028	-75610	1230	135	8
0.95	310230	-368860	-57110	166290	-179486	-1985	-304	-32
1.05	-113600	-8009	59513	415580	486860	1443	253	5
1.2	-53250	90967	267440	-224500	-196400	-671	-100	-45
1.3	-79650	-18640	271400	508840	106420	201	-19	37
1.45	-18460	157460	219440	-74310	5226	-55	-164	37
1.55	45007	194220	237350	-11860	-30778	-185	-202	-7
1.7	112420	45731	263516	-9244	144940	-85	-176	-2
1.8	173260	108540	247840	-23470	-174460	-94	-161	-56
1.95	219860	205170	169960	155260	316140	66	-94	-29
2.05	241470	225160	146600	360420	-15360	158	-161	35
2.2	318390	118550	166430	22659	-15130	-219	-471	21
2.3	336870	44016	176490	-25170	-76450	-76	-465	-33
2.45	371290	122550	163130	45094	122130	13	-249	-32
2.55	391590	122740	161540	-21040	-75940	-17	-170	-21
2.7	421940	111000	162490	-5103	57360	-10	-141	-16
2.8	442950	125490	156250	15315	-11140	-64	-119	-12
2.95	466560	161250	114930	14401	66746	79	-48	-37
3.05	480220	171870	96184	252260	-14150	40	-45	4
3.2	495670	140270	102140	7396	-72510	-48	-222	5
3.3	504940	122746	104050	-4446	-2722	-41	-223	-19
3.45	517730	135100	98050	17592	41514	14	-102	-14
3.55	526560	137750	95774	-4405	-4409	6	-46	-13
3.7	538450	143930	95430	-3410	15262	-4	-14	-11
3.8	547410	148450	94264	5976	547	5	4	-14
3.95	555720	151180	90698	18226	90444	-15	-21	-13
4.05	561870	136760	85796	135530	2910	-9	-42	-1
4.2	568150	134930	73629	-9274	-6236	35	-29	-5
4.3	574120	132644	76410	8446	6960	-21	-45	-9
4.45	581230	137720	66650	6332	22678	18	-29	-9
4.55	585619	140320	63419	-2605	15019	10	-5	-7
4.7	591160	140390	62901	5518	16703	-4	13	-6
4.8	595050	172420	57947	147	14702	29	27	-5
4.95	594650	134200	54095	6723	-65815	-56	-7	-5
5.05	600150	139540	55368	56610	2942	-37	-22	-1
5.2	602460	177390	47794	-3561	2474	77	-24	-2
5.3	604430	140920	49043	9197	12570	-19	-35	-1
5.45	606320	140190	46648	1243	16546	17	-1	-3
5.55	607129	143210	37228	-643	16134	15	13	-2
5.7	607410	194940	36021	14579	11272	-12	17	-1
5.8	607260	197460	31796	-4.75	16397	22	33	1
5.95	606020	148190	18555	-7020	17945	-40	-2	-1

THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
0.05	14176	52799	6495.5	544.7	0	-1611	-2.64	0
0.2	16375	56095	10115	-243.3	0	1.48	0.19	0
0.3	14759	59134	12528	-12.34	0	1.31	0.14	0
0.45	11711	62674	16144	3.83	0	-0.0944	-0.0127	0
0.55	9263.3	64999	18562	4.49	0	-0.54	-0.0435	0
0.7	4943.2	69013	22183	-5....	0	0.24	0.0365	0
0.8	146.	71253	24594	-132.4	0	8.79	1.12	0
0.95	-3453	68116	28214	942.43	0	-10.06	-1.3	0
1.05	156529	61352	-112500	1061	0	-10.87	-1.4	0
1.2	169750	58814	-113400	-179.5	0	11.83	1.52	0
1.3	196599	53455	-113400	-54.41	0	0.39	0.0499	0
1.45	219480	46294	-109400	8.9	0	-0.57	-0.0725	0
1.55	234599	41562	-107400	9.4	0	-0.6	-0.077	0
1.7	256140	35079	-103400	-62.82	0	4.46	0.0622	0
1.8	270210	29164	-101400	-236.1	0	16.48	2.12	0
1.95	290710	22478	-97334	17554	0	-17.99	-2.32	0
2.05	303750	17714	-95329	1632.6	0	-18.71	-2.42	0
2.2	323000	10474	-91700	-297.1	0	19.58	2.52	0
2.3	333420	10152	-89250	-81.43	0	0.63	0.0806	0
2.45	351420	10979	-85678	13.91	0	-0.89	-0.11	0
2.55	365000	11244	-83250	14.41	0	-0.92	-0.12	0
2.7	381750	11714	-79640	-91.84	0	0.72	0.0929	0
2.8	392510	11907	-77220	-247.7	0	24.24	3.12	0
2.95	408010	14840	-73600	2527.1	0	-25.9	-3.33	0
3.05	417720	16076	-71190	2604.2	0	-26.69	-3.44	0
3.2	431990	12464...	-67570	-414.3	0	27.34	3.52	0
3.3	441040	13158...	-65160	-112.3	0	8.87	0.11	0
3.45	454090	13736...	-61540	11.92	0	-1.2	-0.15	0
3.55	462350	13572...	-59120	14.71	0	-4.9	-0.12	0
3.7	474110	14074...	-55500	-94.57	0	0.73	0.0957	0
3.8	481540	14267...	-53090	-347.6	0	24.23	3.12	0
3.95	492060	16485...	-49470	2494.3	0	-25.61	-3.3	0
4.05	498550	11936...	-47060	2556.4	0	-26.2	-3.37	0
4.2	507820	15220...	-43440	-401.3	0	28.54	3.42	0
4.3	513590	15311...	-41020	-104.7	0	9.84	0.11	0
4.45	521610	15695...	-37400	14.13	0	-1.15	-0.15	0
4.55	526540	15931...	-34990	14.51	0	-1.14	-0.15	0
4.7	533320	16469...	-31370	-114.1	0	0.91	0.12	0
4.8	537420	16650...	-28960	-456.8	0	36.1	3.87	0
4.95	542950	12594...	-25340	3482.7	0	-31.6	-4.07	0
5.05	546120	12545...	-22930	3141.2	0	-32.19	-4.14	0
5.2	550400	17605...	-19310	-402.4	0	32.45	4.18	0
5.3	552849	17906...	-16900	-132.2	0	1.02	0.13	0
5.45	555870	14054...	-13270	21.95	0	-1.4	-0.18	0
5.55	557440	14285...	-10860	22.31	0	-1.42	-0.18	0
5.7	559230	14464...	-7240	-141.5	0	1.89	0.14	0
5.8	560040	15033...	-4826	-545.5	0	35.91	4.63	0
5.95	560580	13902...	-1207	3447.1	0	-37.56	-4.84	0

Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
92501	-11860	-41570	51710	117130	-130	-6	30	
147750	65658	-56750	-12890	-36180	177	44	41	
192570	73434	-55620	-28730	12725	-41	40	17	
245440	33672	-79720	69761	93370	184	160	27	
297120	1429	-79110	-27450	-136500	-166	95	17	
377210	203460	-79870	-139400	159990	-39	-28	15	
335840	-5240	-45400	73420	-75610	1250	135	6	
310230	-348340	-37110	168250	-179400	-1985	-584	-32	
-113600	-4009	59513	415560	486860	1443	253	5	
-53350	90947	267480	-228500	-196400	-671	-174	-15	
-79650	-11840	271400	3684.3	164070	201	-19	37	
-71460	157460	219440	-74310	5256	-33	-164	37	
45667	166220	237330	-11060	-14770	-165	-202	-7	
112420	65751	263510	-9244	144950	-35	-176	-2	
173260	181540	247840	-23470	-174400	-94	-161	-36	
219840	285170	169960	155280	310140	66	-94	-29	
241070	225160	140490	368420	-15360	153	-161	25	
316390	116550	169830	21630	-15130	-219	-472	21	
336470	44016	176490	-23170	-70450	-76	-465	-35	
371290	122550	163130	45094	121150	13	-249	-32	
391390	122740	161440	-21640	-75940	-17	-174	-21	
421940	111090	162690	-5105	57360	-19	-141	-16	
442950	125490	156590	15315	-11140	-64	-119	-12	
466560	141250	116936	14491	66756	73	-44	-37	
466720	171470	96134	252280	-14150	48	-45	8	
495670	140270	102140	7386	-32510	-48	-222	5	
504940	122740	104080	-4446	-2722	-41	-223	-19	
517734	135100	94830	17592	41514	14	-102	-14	
526500	137750	95774	-4403	-4409	6	-44	-13	
534450	143930	95424	-3410	19962	-4	-14	-11	
547410	148436	88264	5976	547	31	4	-14	
555720	151140	84084	11286	90444	-15	-21	-13	
561270	156760	85794	113530	2930	-9	-42	-4	
568150	154930	73629	-4274	-6236	35	-78	-5	
574120	152680	76440	1446	6960	-21	-45	-9	
581230	157720	69450	6372	21674	14	-29	-9	
585610	160320	63419	-2605	15919	10	-5	-7	
591160	169500	63901	5318	10793	-4	15	-6	
595050	172420	57947	147	10702	79	27	-5	
594650	184200	54095	6723	65685	-14	-7	-3	
600150	159540	55365	46610	2964	-97	-22	-4	
602460	177390	47734	-3261	2474	77	-24	-2	
604430	180420	49943	9197	12570	-13	-15	-3	
606320	180190	49434	1240	14546	17	-1	-3	
607130	185210	47226	-144	14134	15	13	-2	
607410	184940	46321	14529	11272	-12	17	-1	
607260	187460	45794	-4273	16397	59	33	1	
606620	188190	44555	-7434	27365	-40	-2	-1	

THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
0.85	18176	52799	6495.5	344.72	0	-1618	-2.04	0	
*	16375	54995	1611.5	-143.3	0	1.48	0.19	0	
0.9	14729	55136	12528	-22.34	0	1.11	0.14	0	
0.45	11711	62678	16148	3.83	0	-0.0944	-0.0127	0	
0.55	9263.3	64999	14561	4.49	0	-0.34	-0.0435	0	
0.7	4964.2	69015	22161	-32.07	0	0.24	0.0305	0	
0.8	1619	71253	2457	-132.4	0	5.73	1.12	0	
0.95	-3853	66116	28254	983.85	0	-16.04	-1.5	0	
1.05	156529	61352	-119590	1061	0	-10.47	-1.4	0	
1.2	149750	46818	-115000	-179.5	0	11.53	1.52	0	
1.3	196500	42455	-113400	-50.41	0	9.39	0.6492	0	
1.45	219440	46294	-109400	1.9	0	-0.57	-0.0729	0	
1.55	234590	44562	-107400	9.4	0	-0.6	-0.077	0	
1.7	256140	53479	-103400	-62.42	0	0.46	0.0622	0	
1.8	274210	55164	-101400	-250.1	0	16.48	2.12	0	
1.95	299710	72473	-97350	1755.4	0	-17.99	-2.52	0	
2.05	303750	73714	-95320	1832.6	0	-14.71	-2.42	0	
2.2	323500	104726	-91746	-297.1	0	19.58	2.52	0	
2.3	335420	107529	-89290	-31.43	0	9.63	0.6806	0	
2.45	353420	109780	-85670	13.91	0	-0.69	-0.11	0	
2.55	365060	112140	-83250	14.41	0	-0.92	-0.12	0	
2.7	381750	117130	-79640	-95.44	0	6.72	0.9729	0	
2.8	392510	119070	-77220	-367.7	0	24.24	3.12	0	
2.95	404010	44440	-73600	2527.1	0	-25.9	-5.33	0	
3.05	41.7730	86076	-71190	2604.2	0	-26.69	-3.44	0	
3.2	431999	128640	-67570	-414.8	0	27.34	3.52	0	
3.3	441940	131.540	-65160	-112.5	0	0.87	0.11	0	
3.45	454690	133360	-61540	18.92	0	-1.2	-0.15	0	
3.55	462350	135730	-59120	14.71	0	-0.94	-0.12	0	
3.7	474110	140740	-55500	-94.57	0	9.73	1.0937	0	
3.8	481340	142670	-53090	-367.6	0	24.23	3.12	0	
3.95	492060	106850	-49470	2498.3	0	-25.61	-3.3	0	
4.05	494350	110300	-47060	25564	0	-262	-3.37	0	
4.2	507820	152200	-43440	-403.3	0	26.58	3.42	0	
4.3	513590	155110	-41020	-104.7	0	6.84	0.11	0	
4.45	521610	156950	-37400	18.13	0	-1.15	-0.15	0	
4.55	526540	159310	-34990	18.51	0	-1.18	-0.15	0	
4.7	533220	164690	-31370	-114.1	0	9.91	0.12	0	
4.8	537420	166560	-28960	-456.3	0	30.1	3.87	0	
4.95	542950	171940	-25340	3042.7	0	-31.5	-4.87	0	
5.05	546120	175450	-22930	3141.2	0	-32.59	-4.14	0	
5.2	550400	176030	-19310	-492.4	0	32.45	4.14	0	
5.3	552846	179060	-16890	-132.2	0	1.92	0.13	0	
5.45	555178	104540	-13270	21.93	0	-1.4	-0.14	0	
5.55	557498	182490	-10860	22.31	0	-1.42	-0.18	0	
5.7	559276	184940	-7240	-141.6	0	1.09	0.14	0	
5.8	560949	190830	-4826	-545.9	0	35.94	4.63	0	
5.95	564540	139020	-1207	3667.1	0	-37.51	-4.84	0	

Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
-5373	22582	5617	-275600	-25300	-43	-4	-25
-21610	24838	-35220	36453	191020	65	2	-30
-19270	3495	-52520	-137100	9161	-94	-61	-25
-26291	51394	-17410	-16100	54309	71	-134	-35
6842	59195	-51460	60376	-1314	-59	-171	-19
-72499	20455	-141500	-190500	-77739	-266	-141	-21
70174	-323640	-142000	61165	124816	747	69	-32
119640	-355560	69198	242656	-145000	-1784	-253	-54
413510	425270	72844	-240300	358140	1644	504	-121
514960	491790	-140490	-116500	-96060	-353	740	-117
514720	122540	-222500	263100	255200	368	921	71
546290	2338	-97340	-140000	-243600	48	527	66
545730	19049	-72550	113330	305750	-15	430	22
459920	112249	-93160	19250	-200600	91	546	22
438140	84631	-97150	-42120	77424	243	493	99
367470	-72570	-58980	23404	307840	-119	144	47
355100	-58910	-5812	-180400	6772	-187	102	-34
313469	51756	57212	-102	121470	254	358	-13
253810	95342	42953	160	-25950	26	355	39
256810	70384	27210	-24030	-14030	11	281	38
253220	78140	22123	12537	66397	35	244	29
177160	140620	31154	46528	-30220	-1	272	21
173660	95325	24184	-33960	1525	174	258	46
146029	2329	17973	11145	196000	-102	74	33
121660	24340	13125	42256	9330	-155	29	-12
59461	44826	62160	-17740	-2784	140	115	4
15455	113440	47816	12427	25872	-16	68	22
62036	97752	56947	-13450	1211	-41	71	21
47181	103760	47644	4594	33517	8	73	16
26503	120930	55735	37811	995	-21	80	12
12413	127260	47154	-21960	8190	34	69	18
-3607	61343	22933	-14840	44572	-52	30	9
-19740	56705	22570	73557	-4376	-125	1	1
-34740	110210	42156	-3027	8122	131	27	11
-45740	130450	45941	-1341	9623	-34	4	12
-60340	123260	54534	-6496	24050	-15	24	11
-70470	128640	52148	4164	3406	3	32	9
-45520	144340	54020	33194	14872	-37	22	4
-32750	147210	20060	-14150	10453	104	39	9
-102200	73976	15362	-14620	34256	-75	3	2
-113560	60750	10004	33420	648	-122	-13	2
-121700	140020	20543	-5429	11066	129	16	8
-128200	135425	21031	6262	4463	-46	-16	6
-134400	147490	13577	-7771	26459	-43	8	5
-141700	131490	11459	999	5551	-4	4	4
-144400	167820	9672	26578	23325	-51	-17	4
-139500	167170	4093	-13784	19428	121	4	3
-134600	85766	918	-21960	-7970	-160	-16	-2

THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
0.05	13044	22128	-6495	344.72	0	-16.14	-2.06	0
0.2	15691	25424	-10120	-143.3	0	1.48	0.19	0
0.3	16972	26467	-12530	-22.34	0	1.11	0.14	0
0.45	20564	32007	-16150	1.13	0	-0.0984	-0.0127	0
0.55	23481	34328	-16560	4.49	0	-0.34	-0.0435	0
0.7	24425	34344	-22148	-32.07	0	0.24	0.0305	0
0.8	25276	40542	-24590	-132.6	0	4.73	1.42	0
0.95	29282	29445	-28210	343.13	0	-10.04	-1.3	0
1.05	145346	34432	119450	1061	0	-10.67	-1.4	0
1.3	135279	50147	113436	-179.5	0	11.43	1.52	0
1.5	135046	52224	113429	-50.41	0	0.39	0.0499	0
1.45	106284	55313	109866	8.9	0	-0.57	-0.0729	0
1.55	84245	57491	107396	9.4	0	-0.6	-0.077	0
1.7	61845	62468	103770	-62.82	0	0.48	0.0622	0
1.8	45463	64405	101358	-250.1	0	16.41	2.12	0
1.95	17834	41347	97734	1735.4	0	-17.99	-2.32	0
2.05	1061.1	43943	95321	1632.6	0	-16.78	-2.42	0
2.2	-23029	74958	91741	-297.1	0	19.58	2.52	0
2.3	-34569	78345	89214	-81.43	0	0.83	0.1006	0
2.45	-61009	79110	85668	13.91	0	-0.89	-0.11	0
2.55	-75009	81468	83255	14.41	0	-0.92	-0.12	0
2.7	-96549	86470	79658	-93.84	0	0.72	0.0929	0
2.8	-110149	88404	77222	-347.7	0	24.24	3.12	0
2.95	-129509	94169	73698	2527.1	0	-25.9	-3.33	0
3.05	-142169	95465	71149	2594.2	0	-26.69	-3.44	0
3.2	-160009	97968	67569	-414.4	0	27.34	3.52	0
3.3	-171469	100919	65156	-112.5	0	0.67	0.11	0
3.45	-187849	102699	61596	14.92	0	-1.2	-0.15	0
3.55	-198169	103648	59122	14.71	0	-0.94	-0.12	0
3.7	-212949	110479	55503	-94.57	0	0.73	0.0937	0
3.8	-222369	112904	53090	-567.6	0	24.23	3.12	0
3.92	-233589	78169	49479	2491.3	0	-25.61	-3.3	0
4.05	-243909	79685	47057	2556.8	0	-26.2	-3.37	0
4.2	-255609	121536	43457	-403.5	0	26.56	3.42	0
4.3	-262909	124449	41024	-184.7	0	8.84	0.11	0
4.45	-273189	126289	37464	14.13	0	-1.35	-0.15	0
4.55	-279549	128449	34951	14.51	0	-1.34	-0.15	0
4.7	-287909	134929	31371	-116.1	0	9.91	0.12	0
4.8	-293169	135139	28951	-458.8	0	50.1	3.47	0
4.95	-300289	97287	25328	3042.7	0	-91.6	-4.07	0
5.05	-304589	94776	22925	3141.2	0	-32.13	-4.14	0
5.2	-310909	145349	19305	-492.4	0	32.43	4.14	0
5.3	-311749	144599	16892	-1322	0	1.62	0.13	0
5.45	-317209	149469	13275	21.89	0	-1.4	-0.14	0
5.55	-319709	152220	10459	22.31	0	-1.42	-0.14	0
5.7	-321609	157979	7239.5	-141.6	0	1.07	0.14	0
5.8	-322749	159649	4826.4	-345.9	0	33.95	4.63	0
5.95	-323509	164359	1204.6	3647.1	0	-37.56	-4.14	0

LEFT OF TANKER (+Y)

PEM x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
6.05	-152600	43911	-2209	19583	4525	-120	14		1
6.2	-165600	170230	-1428	-7451	21265	133	19		5
6.3	-168100	180610	-5269	14584	8434	-53	-14		1
6.45	-170360	172220	-4552	-1627	24720	-19	2		1
6.55	-171500	174120	-16460	-1701	6765	-3	-3		0
6.7	-172600	191760	-16469	23596	25779	-60	-37		0
6.8	-173200	186700	-16428	-10254	27213	145	-7		-1
6.95	-173200	95926	-12540	-23599	-44710	-126	-27		-3
7.05	-171200	103340	-15640	-22650	17163	-119	-15		-1
7.2	-169300	200050	-24350	-16640	34934	146	34		4
7.3	-167700	296170	-31030	23451	9526	-36	5		-3
7.45	-164000	196450	-30440	-774	23217	-5	11		-1
7.55	-161200	196460	-32700	-4017	6896	-13	-2		-3
7.7	-156500	216130	-42550	18971	26900	-65	-39		-5
7.8	-153100	205460	-39760	-5709	32444	170	-5		-3
7.95	-148000	104060	-25160	-24400	-71310	-132	-31		-1
8.05	-132900	123030	-26920	-72200	25497	-113	-3		-6
8.2	-113200	129220	-46350	-14220	37667	162	69		-3
8.3	-127560	232450	-54190	35963	18344	-37	40		-1
8.45	-117900	219190	-49870	-7564	9593	0	22		-3
8.55	-114800	217130	-52120	-2649	22905	-14	14		-13
8.7	-92240	246570	-64920	24144	11597	-75	-9		-13
8.8	-92844	229420	-61160	-12556	53711	213	56		-1
8.95	-40470	46551	-42250	-42568	-104100	-199	-25		3
9.05	-63990	166540	-35450	-171300	25568	-172	19		-21
9.2	-26040	2[illegible]	-45320	-21160	54576	248	141		-3
9.3	-14340	239700	-55130	56972	30006	-41	159		-16
9.45	-24500	241530	-46140	-10006	-12950	9	112		-19
9.55	-14240	240520	-51690	-7967	35591	-5	101		-24
9.7	2992	276940	-66440	21654	91494	-65	116		-26
9.8	14142	245360	-60490	-29243	-1603	388	156		3
9.95	35315	77766	-54030	-22420	15250	-234	7		11
10.05	59607	104510	-8245	-314000	21972	-19	44		-50
10.2	84220	273160	-61360	-30160	89479	323	244		34
10.3	103970	249210	-57910	63457	54581	-60	239		-25
10.45	132030	255180	-65140	-15610	-98920	24	131		-27
10.55	133540	255010	-62510	661	160550	-11	139		-39
10.7	153120	317140	-72150	12852	-146204	-42	284		-45
10.8	217250	312570	-72700	-1695	144230	468	348		52
10.95	222610	143440	-57450	-44740	-4458	-220	60		47
11.05	229710	156520	-55050	-46040	75315	-159	83		-37
11.2	246180	327010	-58160	-59920	-119200	366	368		-17
11.3	230470	329510	-58310	102530	161960	-14	369		42
11.45	204990	277550	-59770	-75010	-125700	-17	112		45
11.55	201310	245110	-65140	23233	91068	44	92		37
11.7	190400	308140	-57730	42641	-34230	-94	72		29
11.8	146150	349010	-62160	-29060	-21488	249	116		56
11.95	173510	160270	-47710	-47190	153030	77	33		47

THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
6.05	-323700	169360	-1207	37225.6	0	-34.14	-4.91		0
6.2	-323000	169200	-4426	-581.5	0	34.33	4.93		0
6.3	-322000	172340	-7240	-1555.7	0	1.2	4.15		0
6.45	-318150	173450	-14460	25.72	0	-1.64	-0.21		0
6.55	-317800	175400	-17270	262	0	-1.66	-0.21		0
6.7	-314000	181920	-14870	-1653.1	0	1.27	0.16		0
6.8	-311000	183500	-19510	-635	0	41.85	5.39		0
6.95	-305800	123440	-22930	4251.6	0	-43.57	-5.61		0
7.05	-301600	124050	-23140	4316	0	-34.17	-5.69		0
7.2	-294400	193930	-23960	-670.7	0	44.2	5.69		0
7.3	-289700	196290	-21370	-179.2	0	1.38	0.18		0
7.45	-281200	197030	-24990	29.32	0	-1.88	-0.24		0
7.55	-275100	199240	-27400	29.9	0	-1.9	-0.24		0
7.7	-265100	205470	-31020	-1185.2	0	1.45	0.19		0
7.8	-257900	207130	-33440	-1241	0	41.72	6.14		0
7.95	-246400	134534	-47960	4836	0	-49.56	-6.38		0
8.05	-233500	140840	-49470	4894.4	0	-50.16	-6.46		0
8.2	-225200	214660	-53090	-759.4	0	50.07	6.44		0
8.3	-214000	229230	-55580	-202.6	0	1.56	0.2		0
8.45	-201400	226610	-59120	33.22	0	-2.12	-0.27		0
8.55	-191160	222930	-61540	44.49	0	-2.13	-0.36		0
8.7	-174990	234040	-65190	-240	0	2.15	0.28		0
8.8	-163600	231470	-67570	-1074	0	76.77	9.11		0
8.95	-145900	128340	-71150	7156.1	0	-75.35	-9.45		0
9.05	-133400	129580	-73400	7253.9	0	-74.14	-9.54		0
9.2	-114500	241430	-77220	-1121	0	73.47	9.51		0
9.3	-101200	245240	-79640	-294.6	0	2.3	0.3		0
9.45	-84350	244150	-83250	49	0	-3.32	-0.4		0
9.55	-65060	244510	-85670	49.5	0	-3.15	-0.41		0
9.7	-43560	254500	-89250	-211	0	2.39	0.31		0
9.8	-28168	255744	-91700	-1191	0	71.52	10.11		0
9.95	-4251	1 94700	-95120	7928.4	0	-81.26	-10.46		0
10.05	12045	141340	-97730	4005.6	0	-42.45	-10.56		0
10.2	37468	263340	-101400	-1239	0	11.43	10.51		0
10.3	54957	263340	-103400	-329.6	0	3.51	0.53		0
10.45	81568	267730	-107000	54.01	0	-3.44	-0.44		0
10.55	100400	276490	-109400	54.32	0	-3.47	-0.45		0
10.7	129050	271896	-113400	-342	0	2.63	0.34		0
10.8	144600	279280	-115800	-1309	0	84.28	11.1		0
10.95	176720	153668	-119500	8700	0	-49.17	-11.44		0
11.05	164254	154300	28214	87713	0	-49.93	-11.54		0
11.2	179399	269280	24594	-1356	0	10.42	11.51		0
11.3	175340	272370	22141	-363.7	0	2.69	0.35		0
11.45	179029	281369	18561	90.44	0	-4.53	-0.59		0
11.55	167098	284458	16141	135.55	0	-1.51	-0.19		0
11.7	163240	291136	12528	-430.5	0	21.4	2.75		0
11.8	161240	284520	10115	-3349	0	14.28	4.41		0
11.95	159930	290090	64955	11415	0	-526.5	-68.14		0

R 7

RIGHT OF TANKER (-Y)

FEM x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
0.05	-7714	-73480	84925	-91939	169420	-346	-10	-45	
0.2	13345	29497	89759	9719	-27640	340	169	-14	
0.3	16637	76345	143960	44699	-39356	-125	69	-45	
0.45	28223	222355	120560	-45599	84995	91	174	-45	
0.55	41881	28846	115160	-49227	-54499	-322	146	-13	
0.7	72510	194230	145040	-13919	81934	206	961	3	
0.8	91457	-99899	140060	1999	-64959	1919	589	-33	
0.95	127510	-723690	107	37725	29042	-1711	44	-44	
1.05	140720	-402640	-106700	412920	197976	693	363	7	
1.2	96729	111019	-183200	191340	-54599	138	115	13	
1.3	165479	196934	-146900	-306400	-39496	179	92	9	
1.45	142770	84223	-172900	97224	169490	-59	160	6	
1.55	98666	63990	-142200	-1794	-134599	-4	193	27	
1.7	15793	128340	-141600	-39410	36259	-53	170	27	
1.8	42861	41246	-176500	49911	-37440	455	235	48	
1.95	70643	-1936 0	-135600	-34259	-17820	-413	84	30	
2.05	17444	-123000	-115300	171100	295180	-161	64	-1	
2.2	54271	116350	-149500	48292	-92640	242	-28	11	
2.3	144200	145390	-146200	-110200	-57310	-15	-81	21	
2.45	114430	101560	-144300	37165	32175	-2	49	19	
2.55	119650	94965	-146200	-4055	-61644	-4	55	14	
2.7	126269	137150	-103700	-12600	-2842	-42	94	17	
2.8	111699	110040	-95770	28155	-54420	515	144	25	
2.95	115940	-66750	-75634	-20000	26046	-290	36	12	
3.05	146570	-54370	-45850	114030	149670	-93	36	1	
3.2	149470	137090	-42440	73467	-56470	154	-1	10	
3.3	173510	157190	-42640	-44440	-81710	-1	-29	14	
3.45	149520	131890	-51634	1 48	5816	3	46	12	
3.55	134914	125770	-57290	-2643	-32290	-6	73	12	
3.7	213340	150160	-54750	614.	-14290	-29	77	11	
3.8	224759	137910	-48410	2645	-25650	190	104	12	
3.95	254250	56973	-36550	-27560	36045	-165	24	3	
4.05	246914	81913	-35210	71543	67551	-6	27	4	
4.2	212470	161440	-36100	16037	-56149	62	2	1	
4.3	201368	163490	-37110	-50010	-20040	-7	-19	10	
4.45	211390	157694	-36430	9875	-11660	9	25	3	
4.55	219100	135910	-21060	-3271	-17599	2	35	4	
4.7	249250	'	-24400	1767	-21284	-33	29	7	
4.8	264460	h.	-26630	2119	-19450	156	31	7	
4.95	316540	161960	-15170	-20010	11911	-122	-5	1	
5.05	325950	115950	-13240	42046	24744	-21	9	2	
5.2	313130	145320	-11214	10451	-26750	71	-1	6	
5.3	340330	145750	-9955	-34240	-17660	-16	-13	4	
5.45	348790	141230	-5859	5273	-15390	19	9	5	
5.55	315440	146670	-2174	-1211	-15699	5	11	4	
5.7	340270	193530	2694	-6247	-17466	-23	-4	3	
5.8	345190	190100	4812	4220	-14910	124	16	3	
5.95	349630	135040	2963	-8964	-29520	-92	-20	-4	

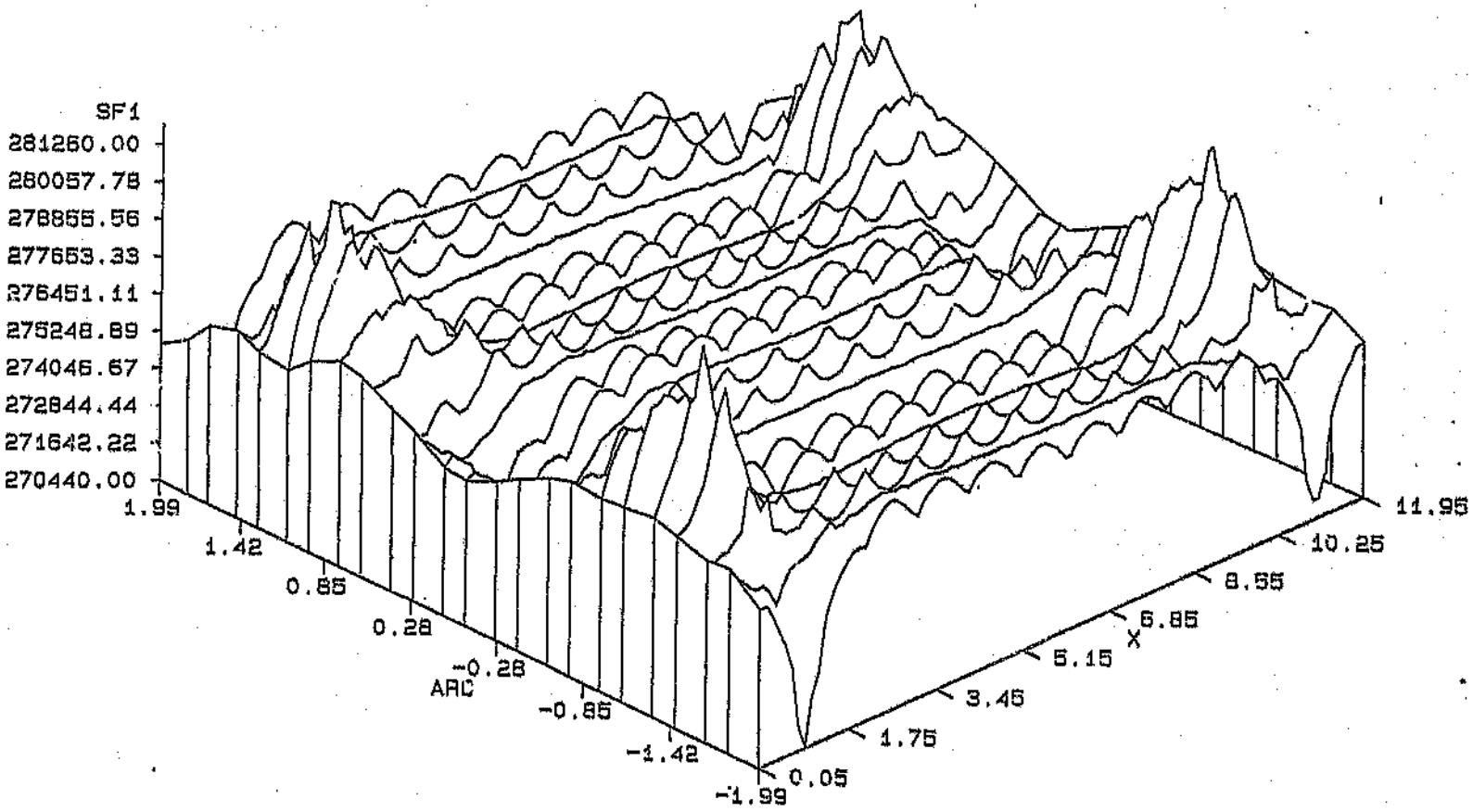
TNE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo	
0.05	18176	52299	-6495	348 72	e	-1618	-2.68	0	
0.2	16375	54095	-10120	-3 3.3	0	1.48	0.59	0	
0.3	14759	59134	-12590	-2.2.8	0	1.11	0.14	0	
0.45	11711	62674	-16150	8.19	0	-0.0984	-0.0127	0	
0.55	9269.3	64999	-18564	4.49	0	-0.54	-0.0435	0	
0.7	4963.2	69015	-22130	-32.07	0	0.24	0.0345	0	
0.8	1649	71253	-24590	-132.4	0	1.73	1.12	0	
0.95	3453	69116	-28210	984.81	0	-10.08	-1.3	0	
1.05	151520	61352	119450	1061	0	-10.87	-1.4	0	
1.2	104749	80814	115430	-179.5	0	11.13	1.52	0	
1.3	196500	65455	113420	-30.41	0	0.39	0.0499	0	
1.45	218480	86284	109400	4.9	0	-0.57	-0.0729	0	
1.55	224990	84562	107390	9.4	0	-0.6	-0.077	0	
1.7	256140	93079	103370	-42.42	0	0.48	0.0622	0	
1.8	270210	95164	101350	-250.1	0	16.48	2.12	0	
1.95	290710	72478	97334	17554	0	-17.99	-2.32	0	
2.05	303750	73714	95321	1832.6	0	-14.78	-2.42	0	
2.2	323600	104736	91301	-2971	0	19.58	2.52	0	
2.3	335420	107520	89284	-41.45	0	0.63	0.0806	0	
2.45	353420	109744	85268	13.91	0	-0.89	-0.11	0	
2.55	365000	112140	83253	14.41	0	-0.92	-0.12	0	
2.7	381750	117140	79235	-93.34	0	6.72	0.8929	0	
2.8	392510	119070	77222	-367.7	0	24.24	3.12	0	
2.95	408410	84440	73602	2577.1	0	-23.5	-3.33	0	
3.05	417750	86476	71189	2694.2	0	-25.69	-3.44	0	
3.2	431990	126440	67569	-414.8	0	27.34	3.52	0	
3.3	441440	121340	65156	-1125	0	6.87	0.11	0	
3.45	454090	133160	61536	13.92	0	-1.2	-0.15	0	
3.55	462250	135790	59123	14.71	0	-4.94	-0.12	0	
3.7	474110	144740	55503	-94.57	0	6.73	0.8937	0	
3.8	481540	142670	53090	-367.6	0	24.23	3.12	0	
3.95	492060	104450	49470	2498.3	0	-25.61	-3.3	0	
4.05	491550	116360	47057	2556.1	0	-26.2	-3.37	0	
4.2	507420	152200	43437	-403.3	0	26.54	3.42	0	
4.3	513590	155110	41024	-104.7	0	6.84	0.51	0	
4.45	521610	156950	37404	14.15	0	-1.15	-0.15	0	
4.55	526540	158910	34991	14.51	0	-1.14	-0.15	0	
4.7	535320	164690	31371	-114.1	0	9.91	0.12	0	
4.8	537420	166560	28958	-456.4	0	30.1	3.87	0	
4.95	542950	123940	25338	3442.7	0	-31.6	-4.07	0	
5.05	546120	125450	22925	3441.2	0	-32.19	-4.14	0	
5.2	550400	176030	19305	-492.4	0	32.45	4.18	0	
5.3	552840	179060	16892	-132.2	0	1.02	0.13	0	
5.45	555870	180540	13273	21.93	0	-1.4	-0.18	0	
5.55	557480	142690	10859	22.51	0	-1.42	-0.18	0	
5.7	559270	144440	7239.5	-141.6	0	1.09	0.14	0	
5.8	560040	190050	4826.4	-545.9	0	3594	4.63	0	
5.95	560364	139029	1206.8	54671	0	-37.36	4.34	0	

Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
374430	140870	5254	17905	-10290	-44	-13	0
377790	204290	13254	7344	-20610	96	10	5
340660	209710	16353	-22440	-15220	-26	-6	2
343320	204320	14434	2747	-16740	19	6	1
343310	205140	22137	845	-14920	7	0	0
346390	217440	29279	-16810	-11630	-35	-27	-1
347950	217140	29254	9126	-16350	121	-6	1
347710	132840	21343	641	-57420	-75	-24	-3
347660	155460	21741	-2793	-40650	-46	-15	-1
347090	230770	34650	6468	-14714	135	33	0
345550	225360	43137	-14000	-13160	-55	19	-3
343530	226750	43729	1665	-16160	9	13	-3
341280	228840	46925	3461	-20120	7	-1	-1
337250	242540	53947	-30740	-4989	-36	-41	-5
333270	243260	54156	17349	-1986	127	-17	-2
349360	159120	40575	12621	-102960	-20	-16	-1
345070	155140	43611	-20420	-64990	-137	-6	-7
341220	253420	64584	7875	-16880	119	78	-5
335570	262470	71622	-4934	-13370	-44	39	-4
344210	244260	71424	5821	-4246	5	33	-4
345240	250350	73722	4722	-32910	6	4	-9
334270	279340	69741	-35126	11570	-49	-49	-10
336740	272760	79452	35742	5929	206	-29	-1
314660	184930	73641	29649	-161200	-126	-12	-3
310170	94646	31475	-28140	-58190	-260	-2	-14
346290	273576	107340	25917	-13650	317	102	-16
340920	234490	115350	-29820	-21670	-77	41	-15
334210	262469	116450	16720	20642	0	39	-16
330020	270250	116710	15535	-67070	-4	-4	-17
328490	316760	121740	-18670	35965	-59	-129	-17
289170	341390	122510	65590	23429	293	-62	1
264050	219065	119460	43420	-314760	-197	12	-3
250330	-7253	140150	-31050	-54730	-471	36	-37
266510	294290	136610	50411	6947	541	219	-32
272170	336570	201610	-39370	-57920	-121	134	-27
285440	268090	194610	9757	90128	43	186	-26
215910	279140	192830	41146	-119600	-162	152	-2
213550	343630	223130	-144900	69494	102	146	5
316750	244840	211830	104290	-26270	453	322	-14
334420	-337100	90782	145750	-255700	-607	167	-23
353720	-344000	-13770	199730	-64140	-569	134	11
344110	266660	-101900	113440	54595	443	402	37
351170	384470	-101400	-174900	-40210	129	263	-5
264534	345720	-46220	104090	59615	-140	153	1
211840	295390	-43910	-12370	-52500	79	144	31
217650	348940	-76140	-62710	27650	-157	56	26
344410	358650	-75270	79410	22013	431	119	42
175530	91646	-66050	-7592	-122300	-117	16	24
135510	149270	-67110	-47139	153050	77	33	42

THE x	Nx	No	Nxo	Qx	Qo	Mx	Mo	Mxo
6.05	560430	146510	-1207	3725.6	0	-54.14	-4.91	0
6.2	559720	159170	-4826	-581.5	0	34.53	4.93	0
6.3	538440	269410	-7240	-155.7	0	1.2	6.15	0
6.45	554480	264120	-10460	25.72	0	-1.64	-0.21	0
6.55	555160	264470	-13720	261	0	-1.66	-0.21	0
6.7	551960	212590	-16690	-1651	0	1.27	0.16	0
6.8	549410	214170	-19710	-435	0	41.85	5.39	0
6.95	544560	154114	-22930	4251.6	0	-43.57	-5.61	0
7.05	541440	155420	-25340	4210	0	-44.17	-5.69	0
7.2	535790	222790	-28960	-670.7	0	44.2	5.69	0
7.3	531570	224964	-31370	-179.2	0	1.34	0.13	0
7.45	524630	227760	-34990	29.52	0	-1.64	-0.24	0
7.55	519540	230060	-37400	29.9	0	-1.9	-0.24	0
7.7	511390	234540	-41020	-168.5	0	1.45	0.19	0
7.8	505520	236060	-43440	-724.1	0	47.72	6.14	0
7.95	496060	169200	-47060	4436	0	-49.56	-6.51	0
8.05	489270	170719	-49470	4654.4	0	-50.16	-6.46	0
8.2	478590	247530	-53090	-759.4	0	50.07	6.44	0
8.3	471050	250090	-55500	-262.6	0	2.56	0.2	0
8.45	459120	251240	-59120	33.52	0	-2.12	-0.27	0
8.55	450750	252690	-61530	44.49	0	-2.83	-0.36	0
8.7	437574	261510	-65149	-219	0	2.15	0.28	0
8.8	428570	262540	-67570	-1074	0	70.77	9.11	0
8.95	413940	139010	-71190	7156.8	0	-75.35	-9.44	0
9.05	403710	140250	-73600	7219.9	0	-74.14	-9.54	0
9.2	388030	272160	-77220	-1121	0	73.47	9.51	0
9.3	377170	273950	-79640	-294.6	0	2.5	0.3	0
9.45	360250	274820	-83250	49	0	-3.12	-4.4	0
9.55	348550	277140	-85670	49.5	0	-3.15	-0.41	0
9.7	330840	245570	-89280	-311	0	2.39	0.31	0
9.8	317660	286450	-91700	-1191	0	76.52	10.11	0
9.95	298440	171370	-95320	7924.4	0	-81.26	-10.46	0
10.05	284440	172610	-97730	8005.6	0	-82.85	-10.56	0
10.2	264220	294010	-101400	-1235	0	81.63	10.51	0
10.3	250024	300010	-103800	-329.6	0	2.54	0.33	0
10.45	226120	294490	-107400	34.01	0	-3.44	-0.44	0
10.55	213100	300760	-109800	58.52	0	-3.47	-0.45	0
10.7	193940	302630	-113400	-342	0	2.61	0.34	0
10.8	174090	314340	-115800	-1309	0	86.24	11.1	0
10.95	149640	143740	-119500	4700	0	-93.17	-11.48	0
11.05	143140	154970	24214	47773	0	-89.93	-11.54	0
11.2	141510	319910	24524	-1356	0	89.42	11.51	0
11.3	151440	324044	22141	-343.7	0	2.69	0.35	0
11.45	155810	322178	18561	60.44	0	-4.55	-0.59	0
11.55	154140	323126	16148	135.35	0	-4.51	-0.59	0
11.7	161920	321784	12526	-456.5	0	27.4	2.73	0
11.8	162534	315490	10115	-9369	0	34.29	4.41	0
11.95	164160	320760	6495.5	11413	0	-529.5	-68.14	0
11.95	159050	290090	6495.5	11413	0	-529.5	-68.14	0

APPENDIX S

FEM MAPS OF INTERNAL PRESSURE FORCE RESULTANTS



S 2

Figure S1 FEM axial force resultants N_x superimposed on the "unrolled" tube.

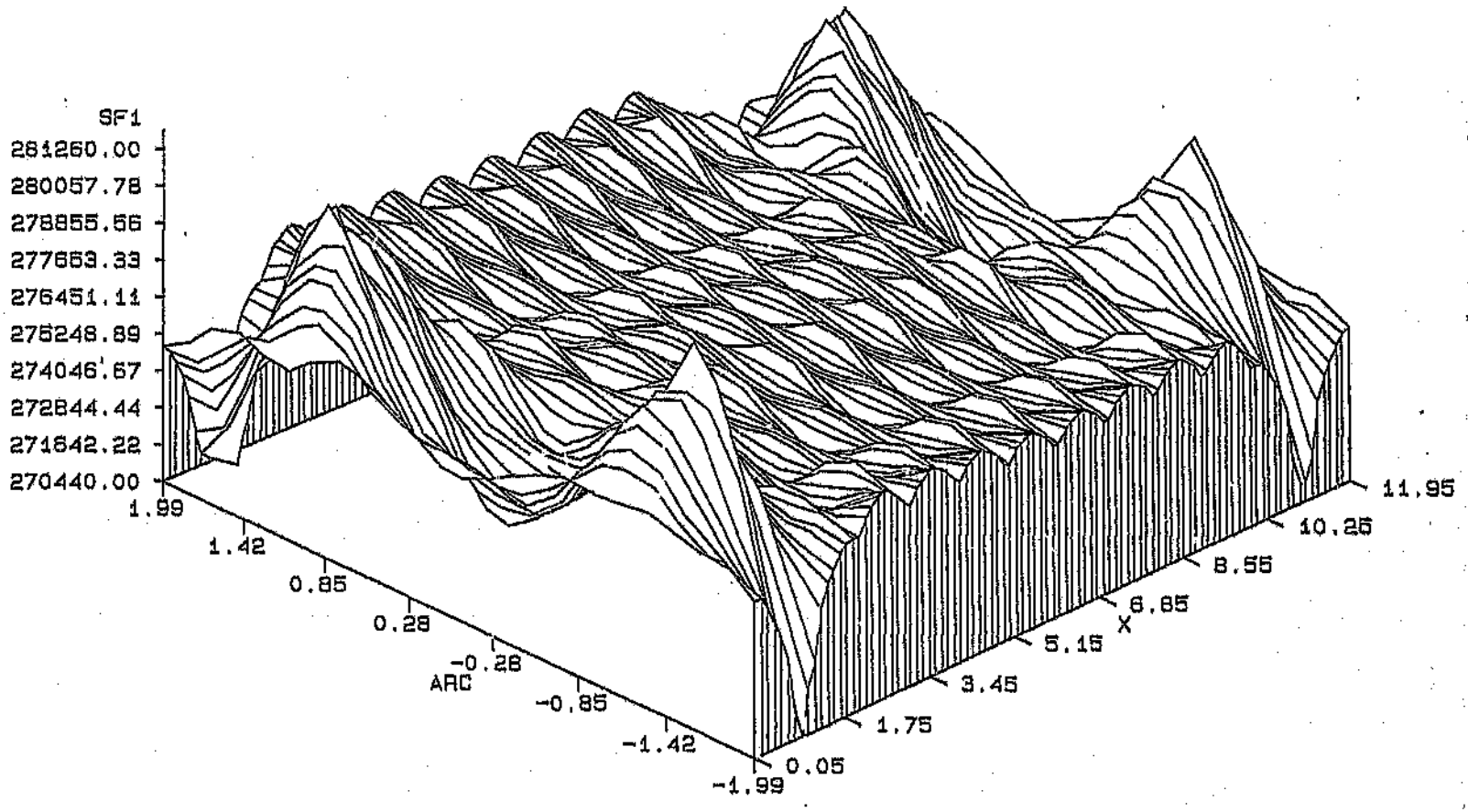
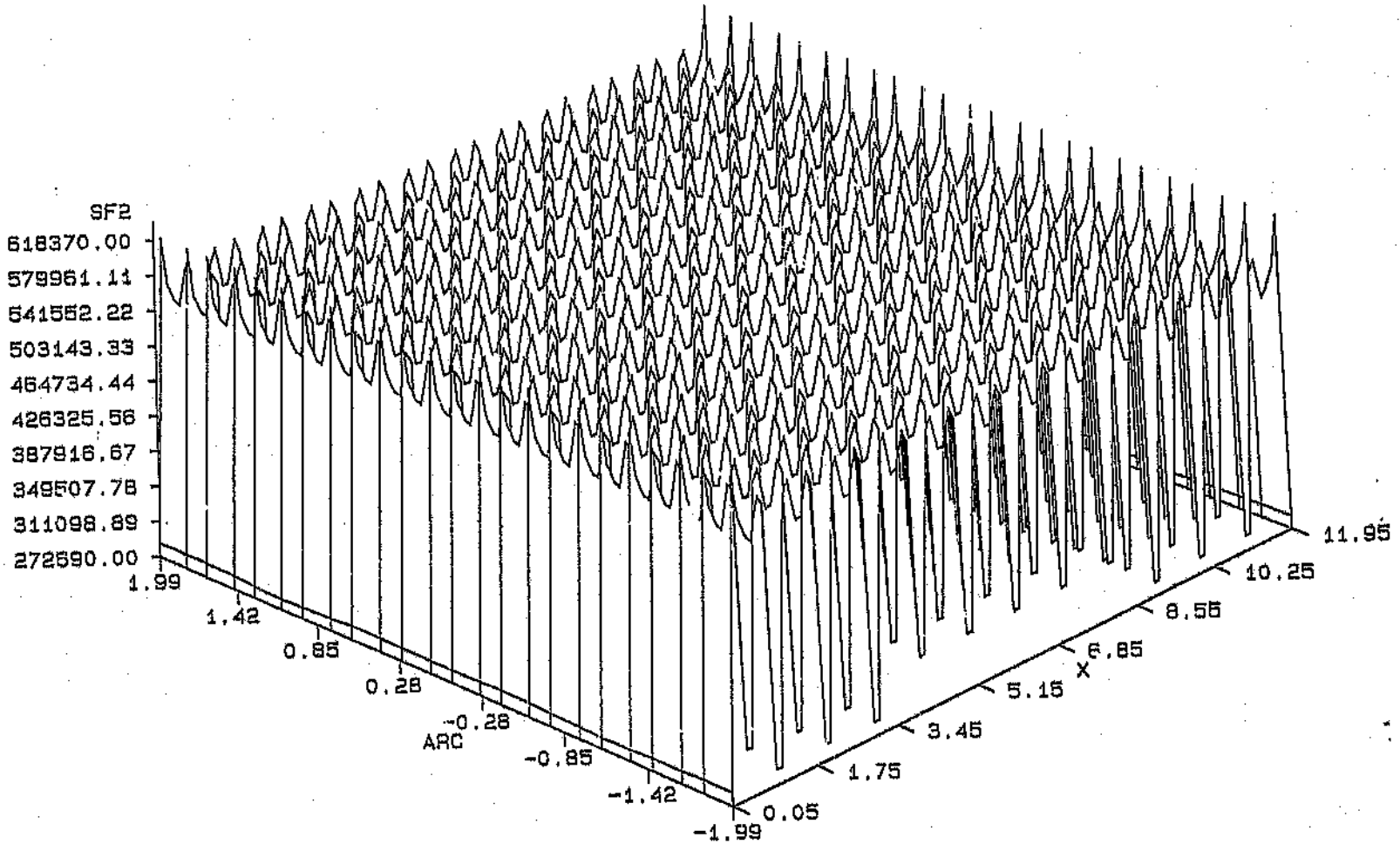


Figure 52 FEM axial force resultants N_x superimposed on the "unrolled" tube.



S 4

Figure S3 FEM circumferential force resultants N_ϕ superimposed on the "unrolled" tube.

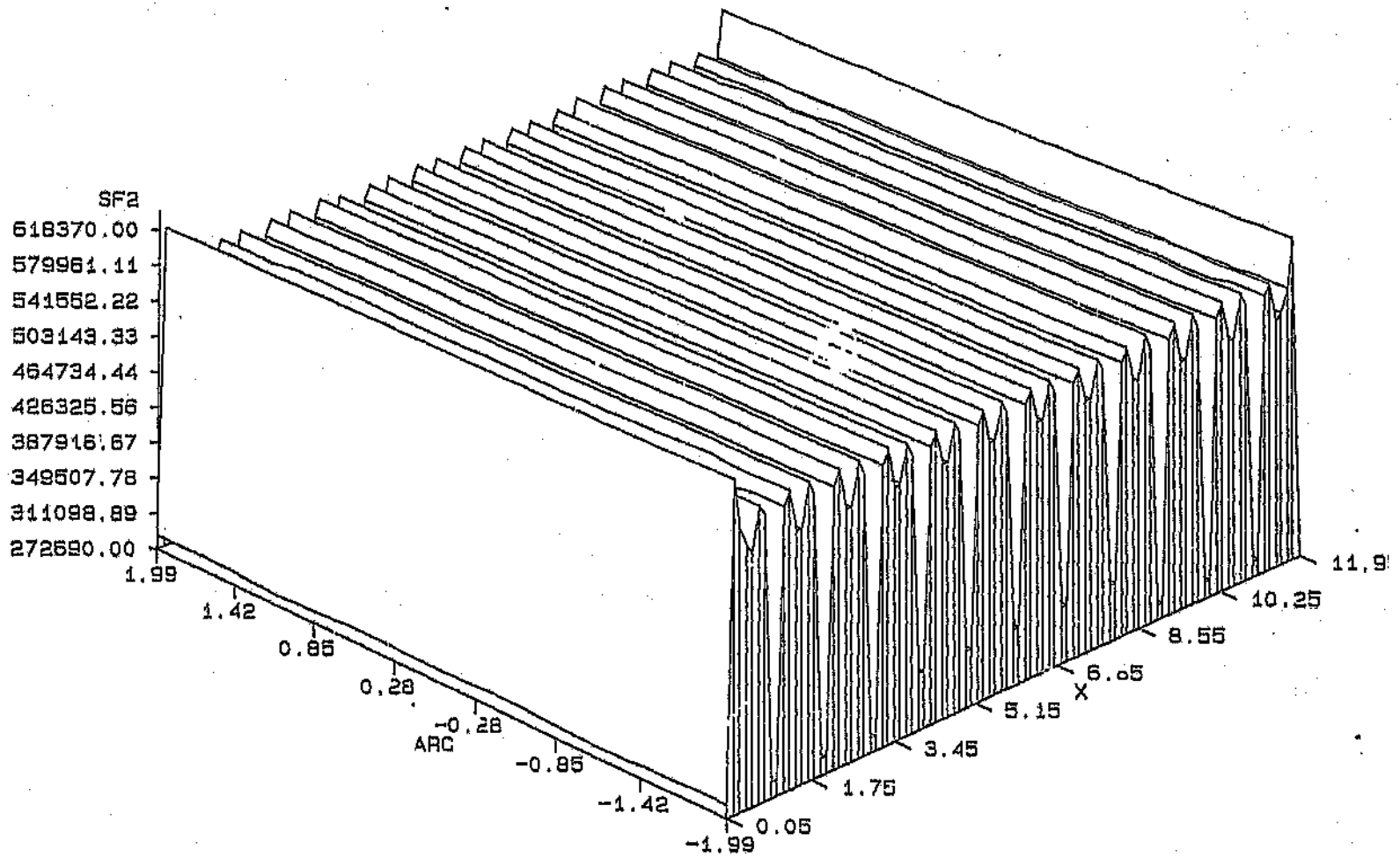


Figure S4 FEM circumferential force resultants N_ϕ superimposed on the "unrolled" tube.

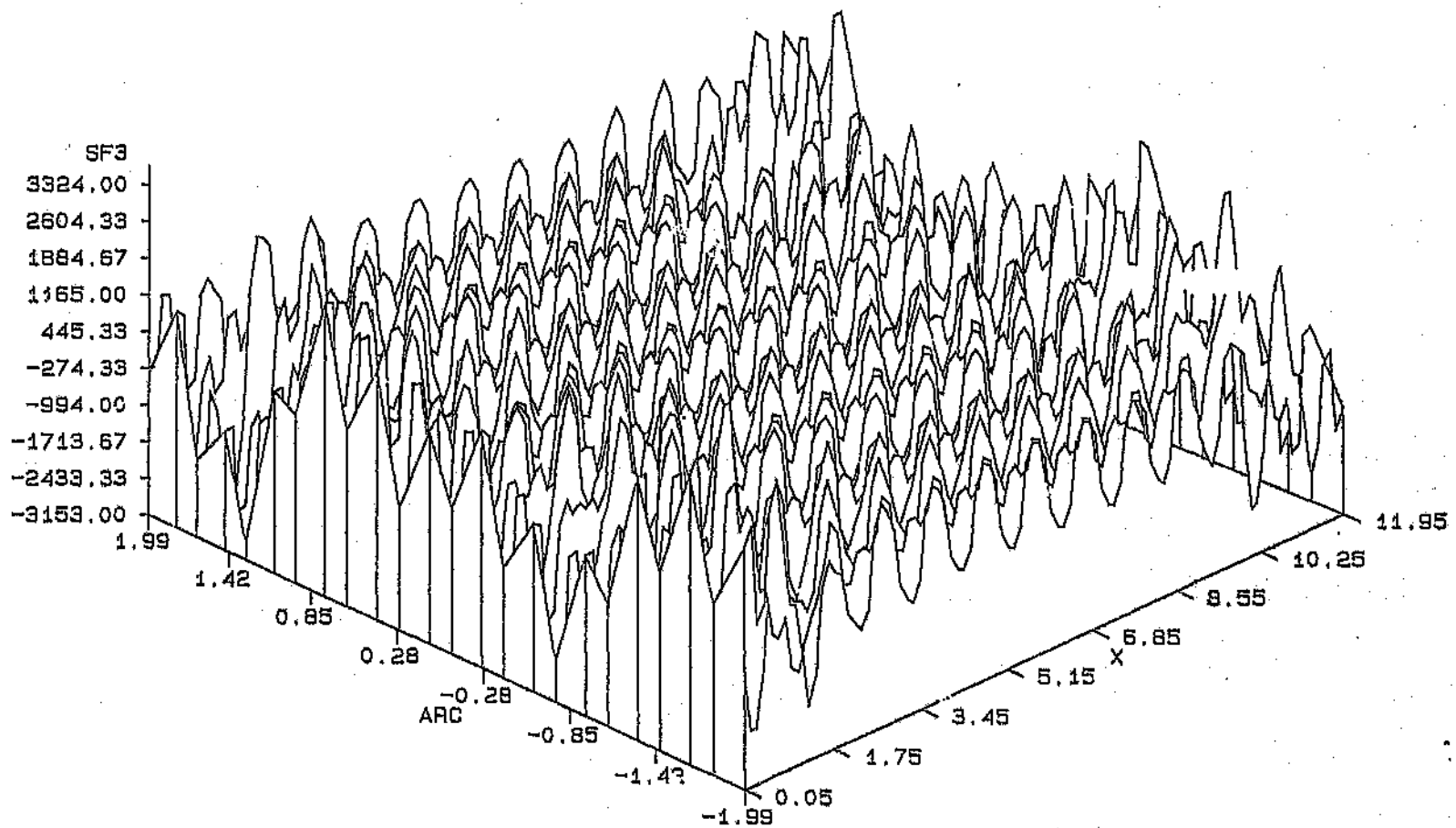


Figure 85 FEM inplane shear force resultants Nx_{ϕ} superimposed on the "unrolled" tube.

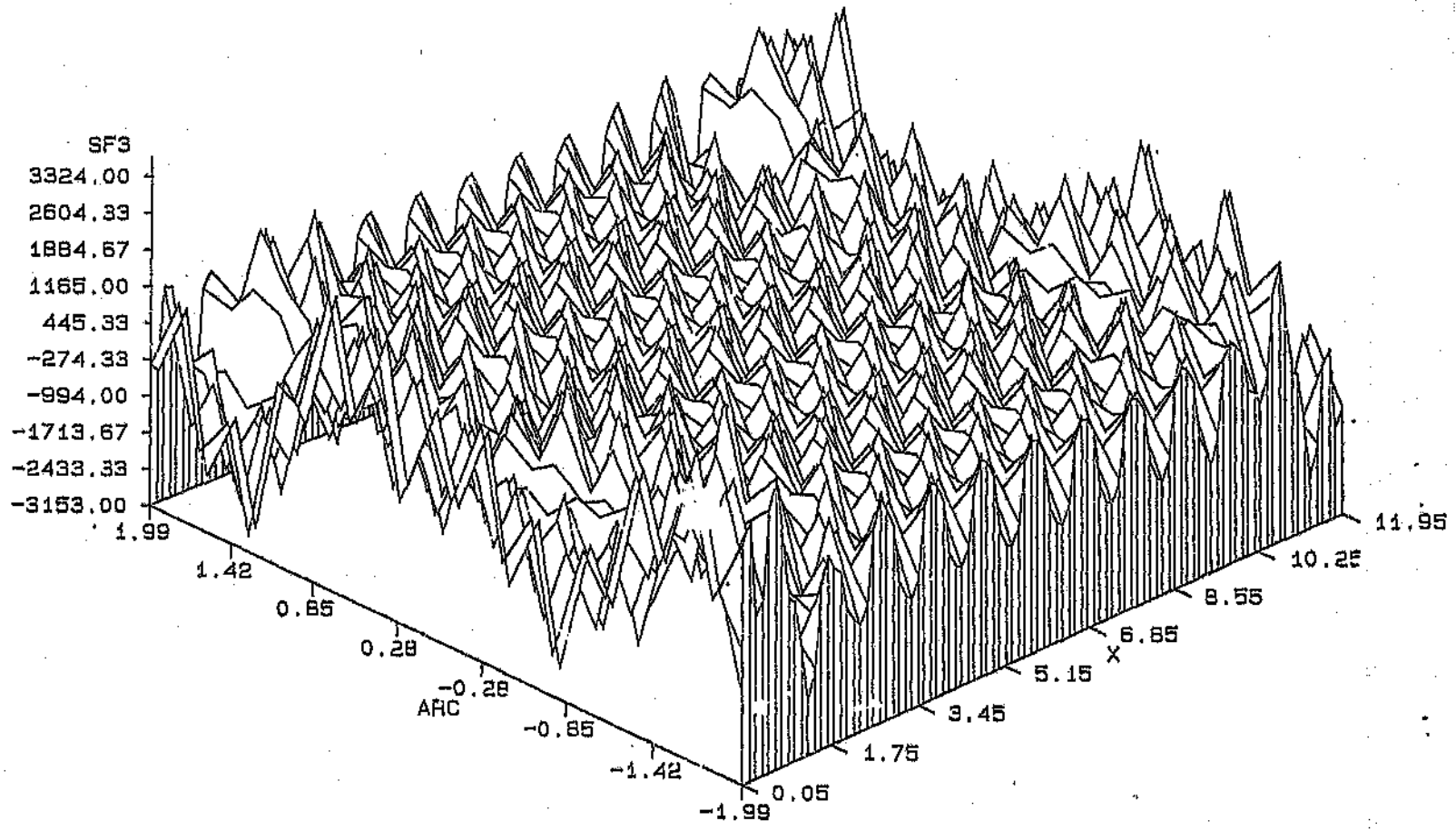


Figure 56 FEM inplane shear force resultants Nx_{ϕ} superimposed on the "unrolled" tube.

APPENDIX T

FEM MAPS OF COMBINED ACCELERATIONS FORCE RESULTANTS

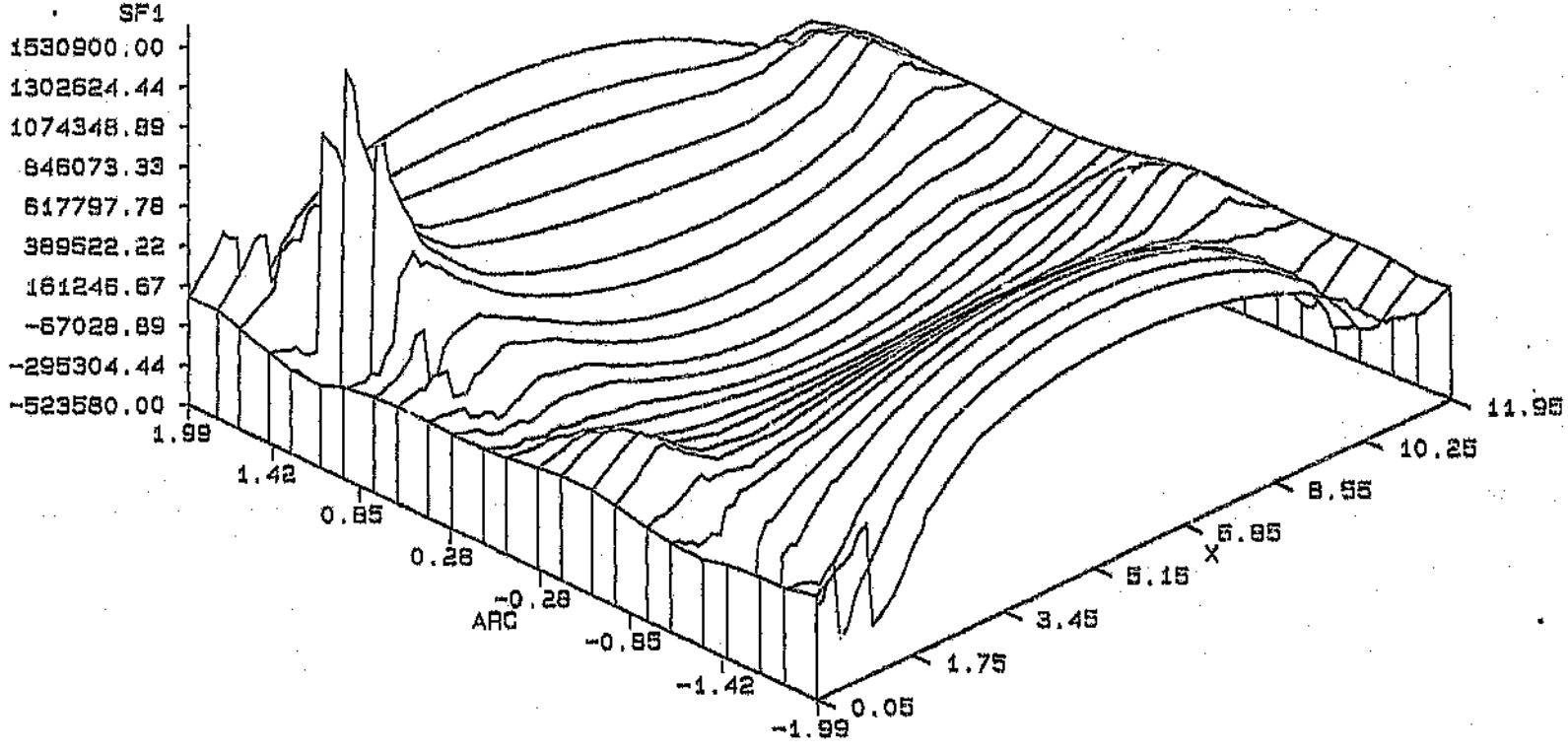


Figure T1 FEM axial force resultants N_x superimposed on the "unrolled" tube.

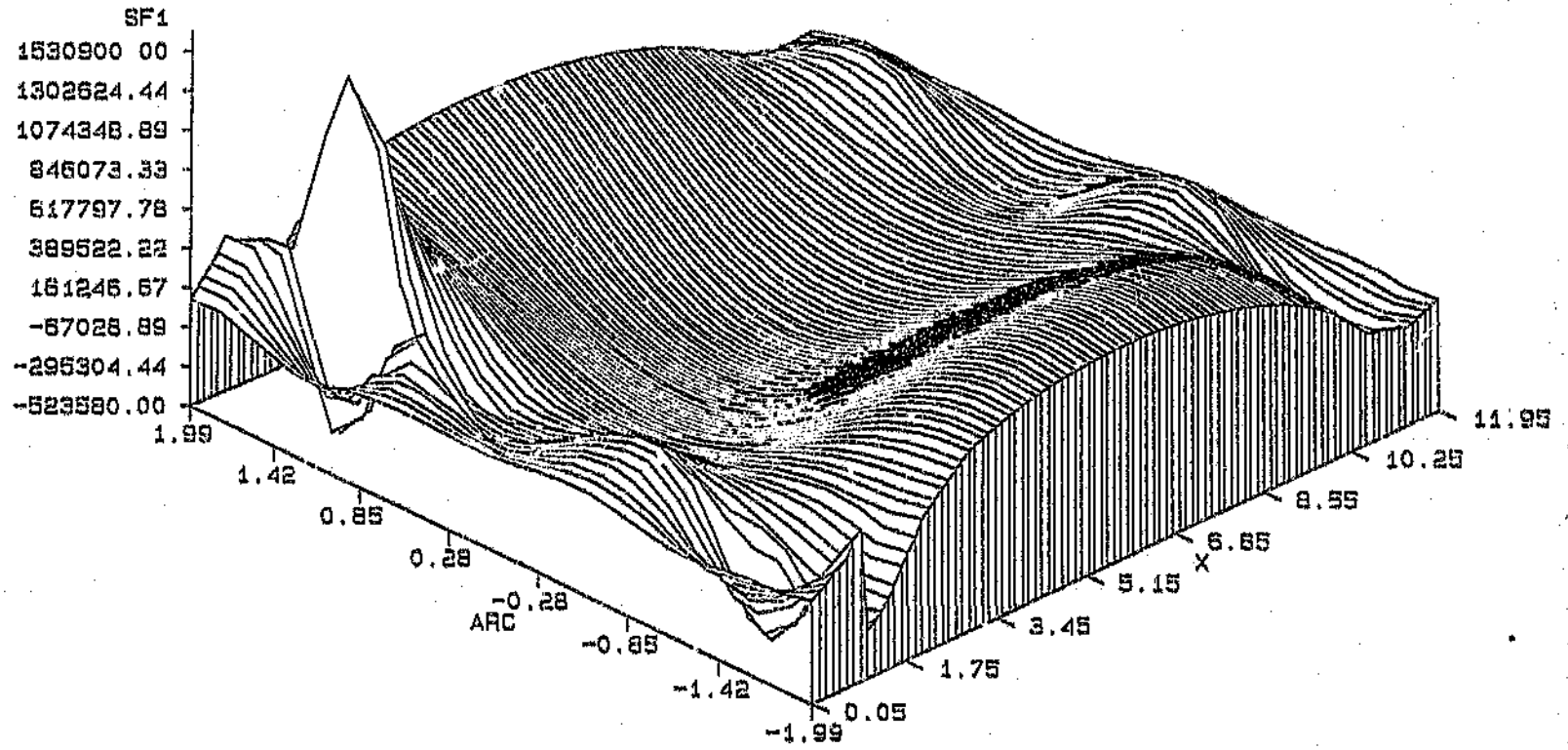


Figure T2 FEM axial force resultants N_x superimposed on the "unrolled" tube.

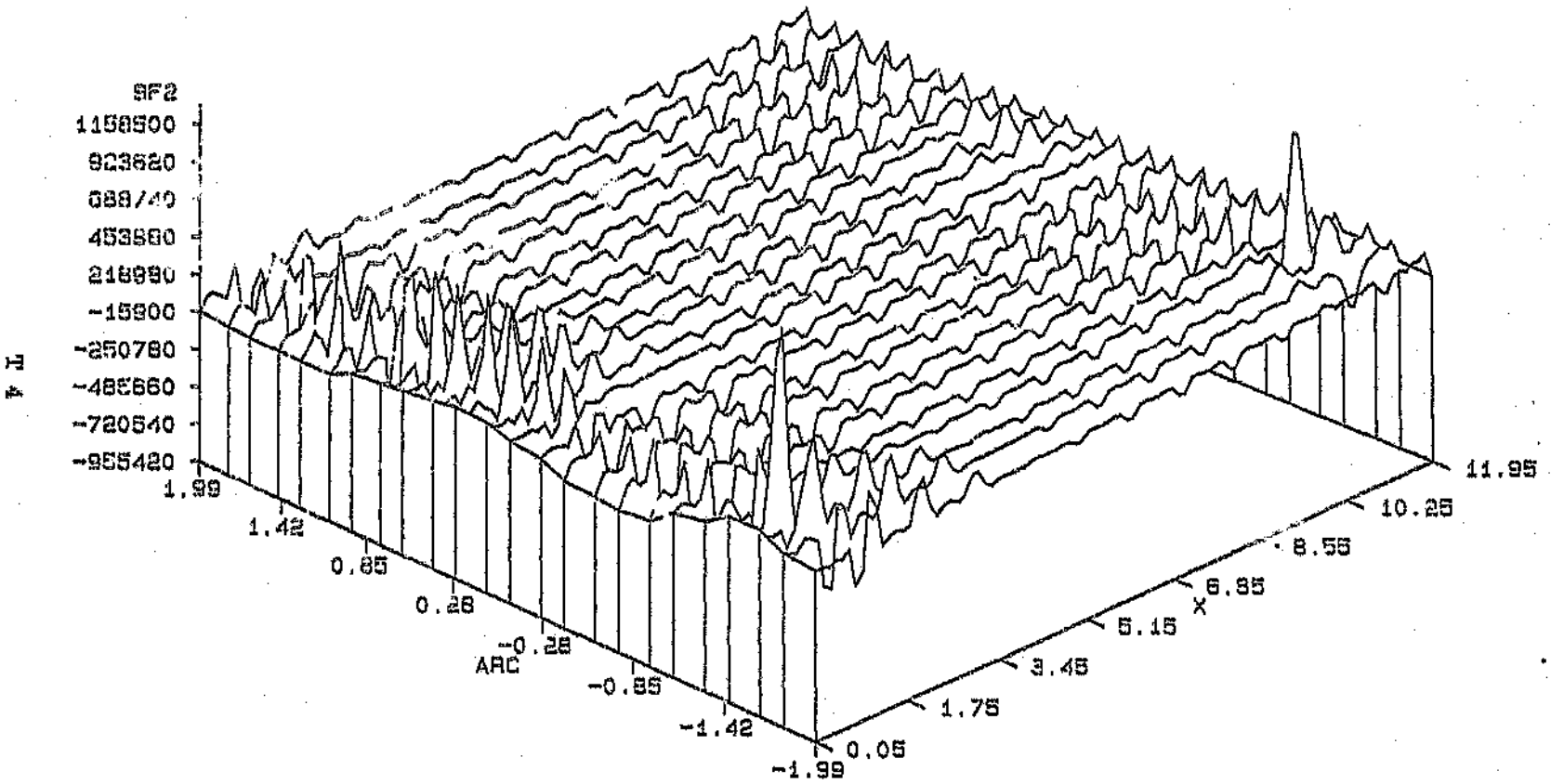


Figure T3 FEM circumferential force resultants N_ϕ superimposed on the "unrolled" tube.

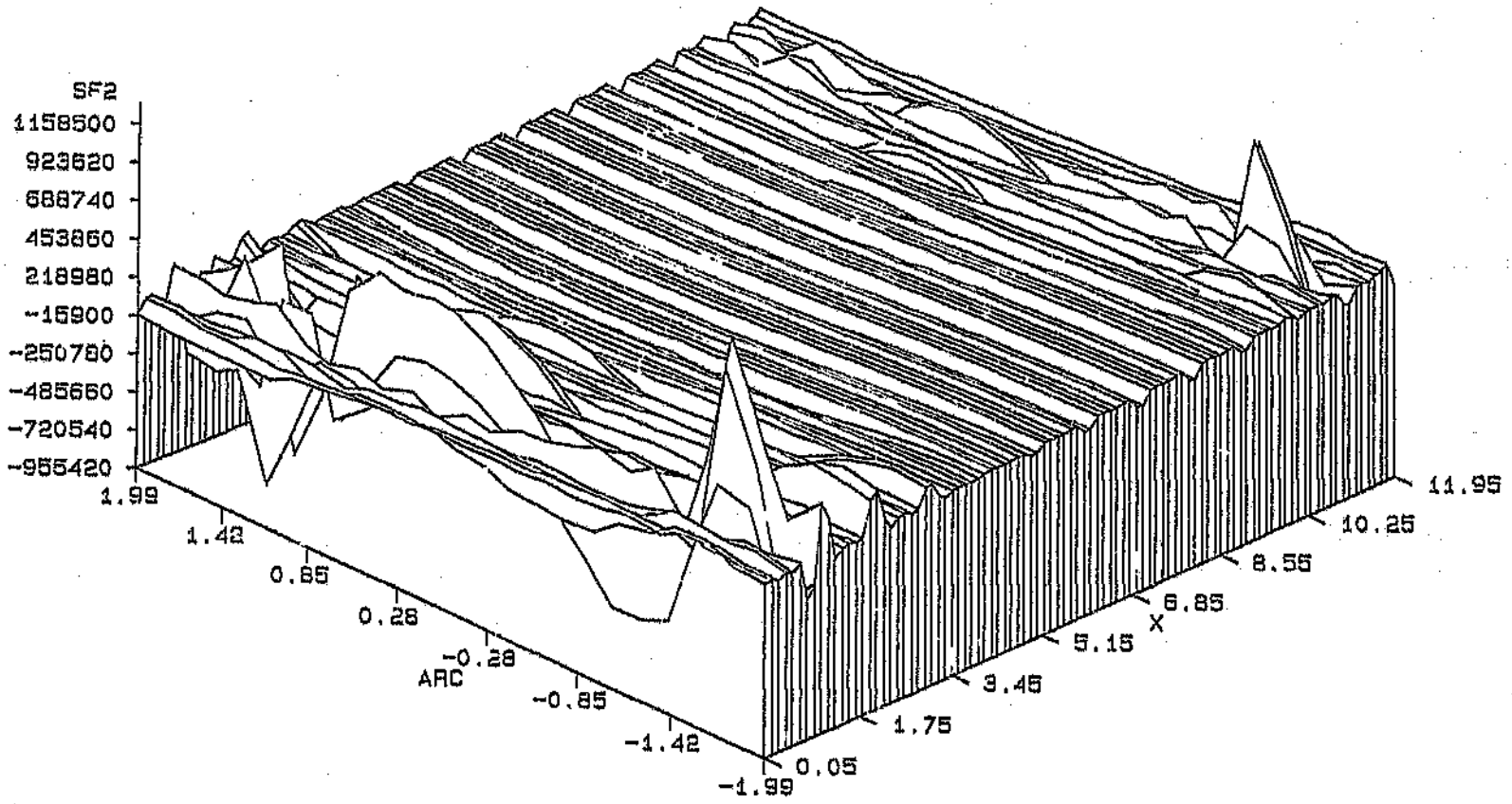


Figure T4 FEM circumferential force resultant's N_ϕ superimposed on the "unrolled" tube.

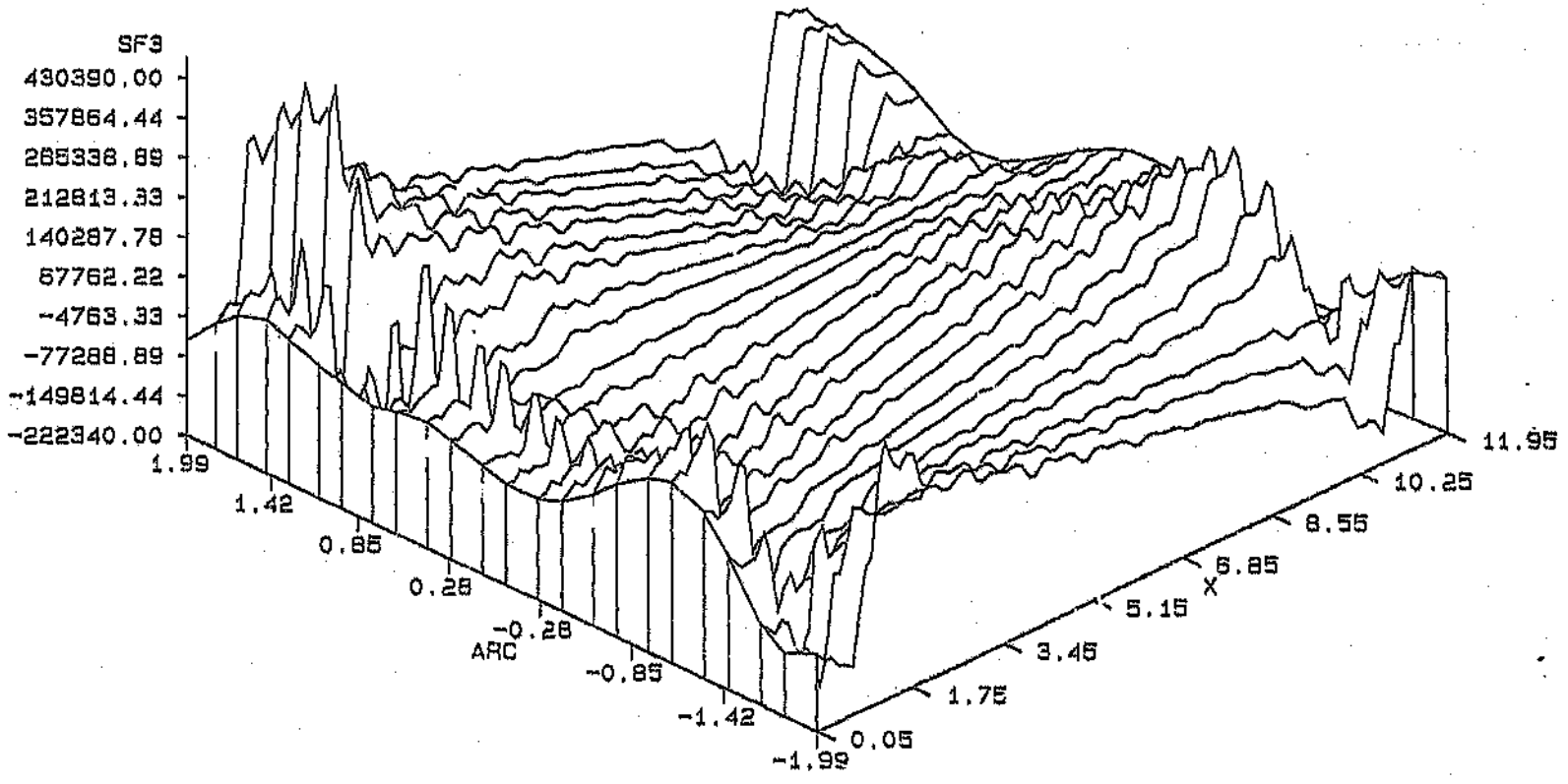


Figure T5 FEM inplane shear force resultants $N_{x\phi}$ superimposed on the "unrolled" tube.

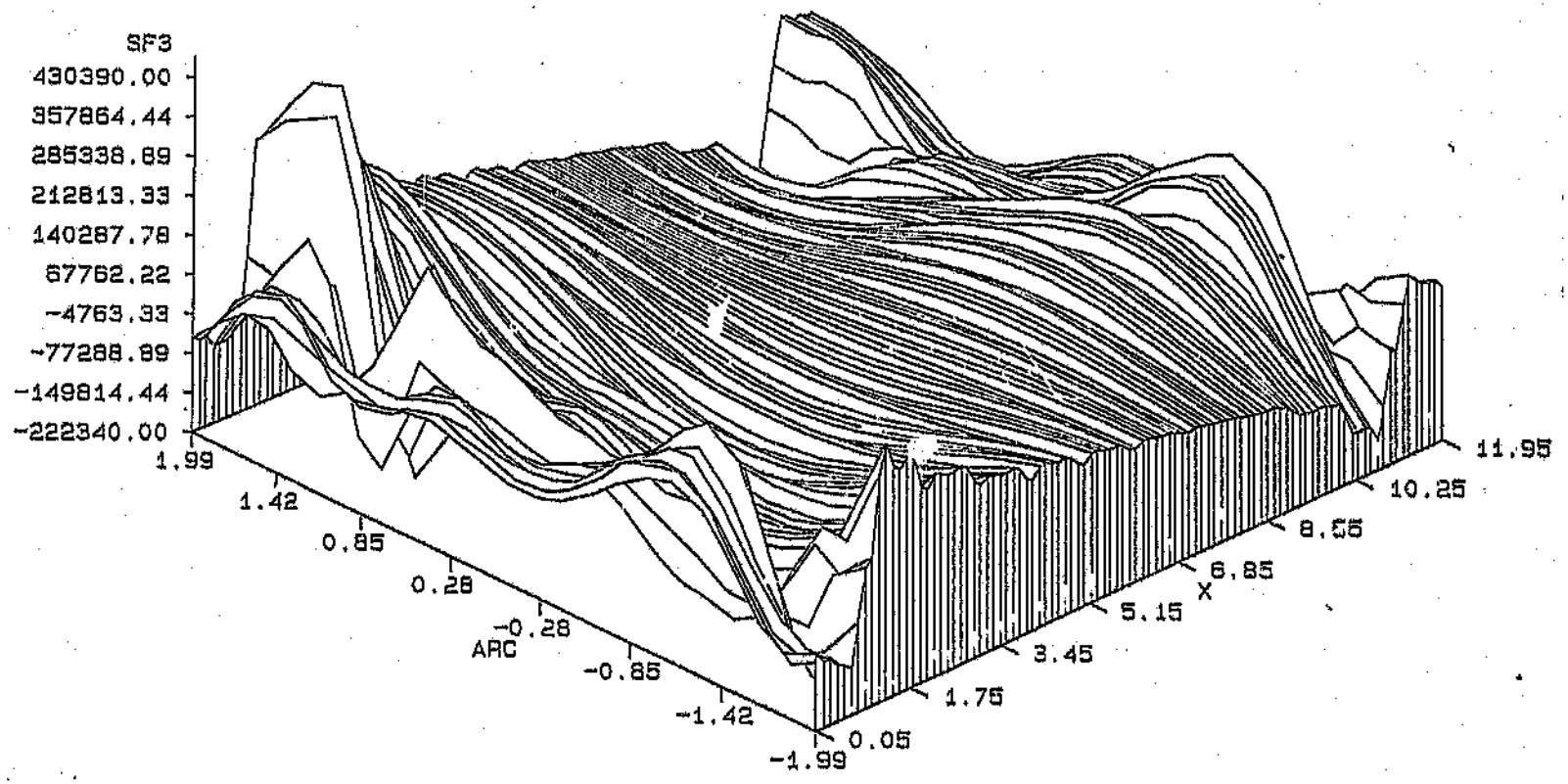


Figure T6 FEM inplane shear force resultants Nx_{ϕ} superimposed on the "unrolled" tube.

APPENDIX U

FEM MAPS OF VALIDATION MODEL FORCE RESULTANTS

APPENDIX U

FEM MAPS OF VALIDATION MODEL FORCE RESULTANTS

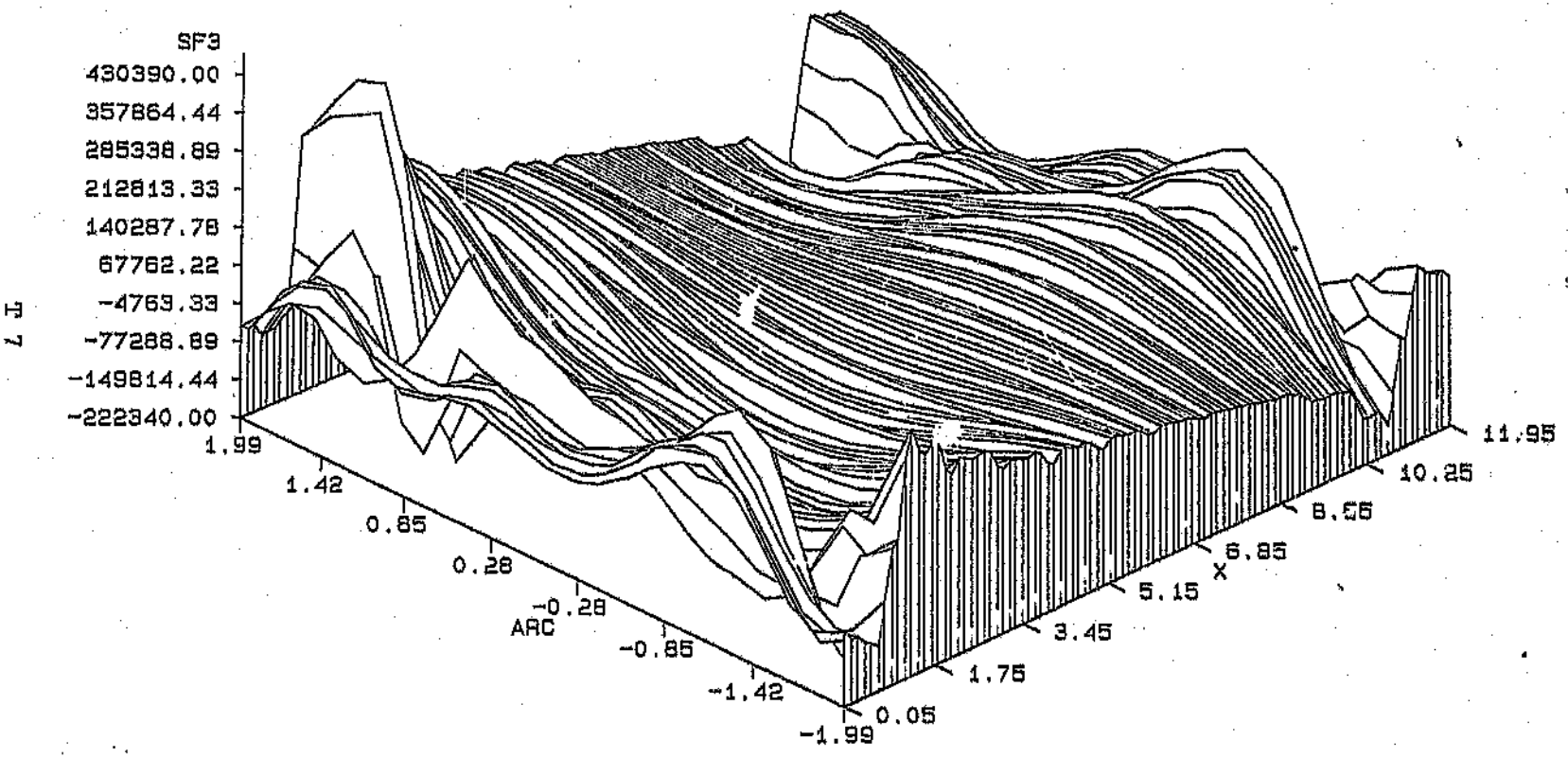


Figure T6 FEM inplane shear force resultants Nx_{ϕ} superimposed on the "unrolled" tube.

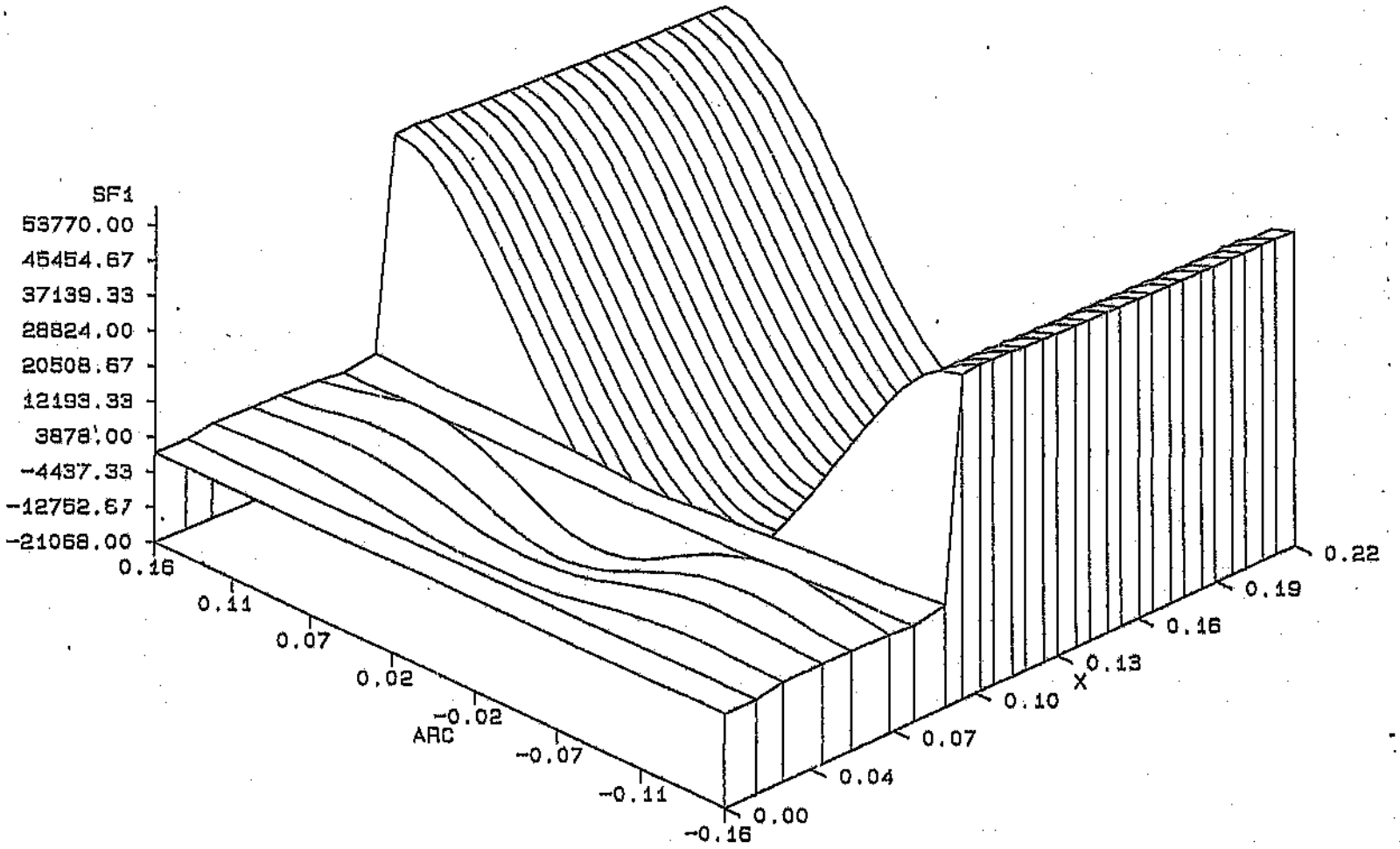


Figure U2 FEM axial force resultants N_x, superimposed on the "unrolled" tube.

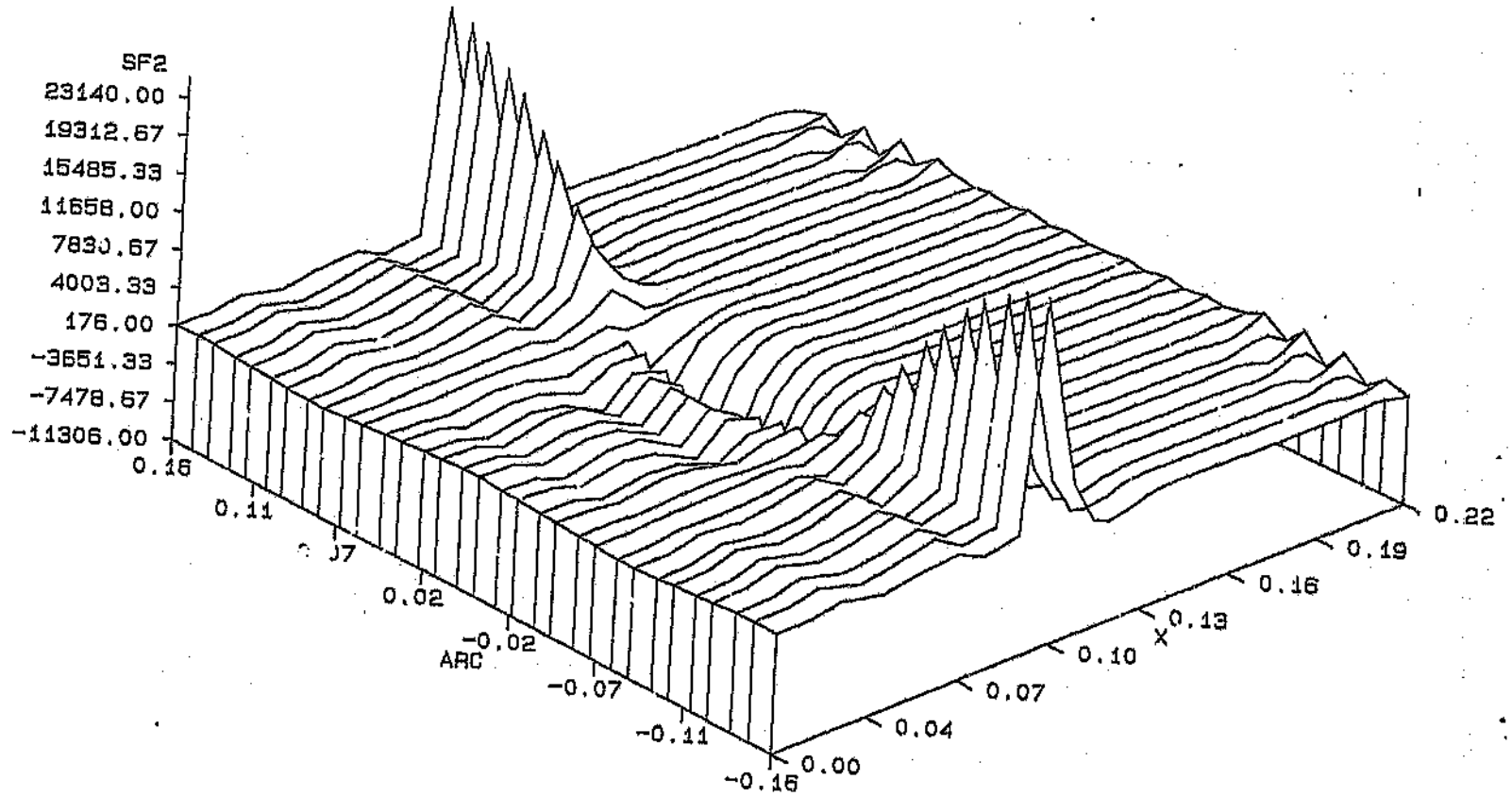


Figure U3 FEM circumferential force resultants, N_ϕ superimposed on the "unrolled" tube.

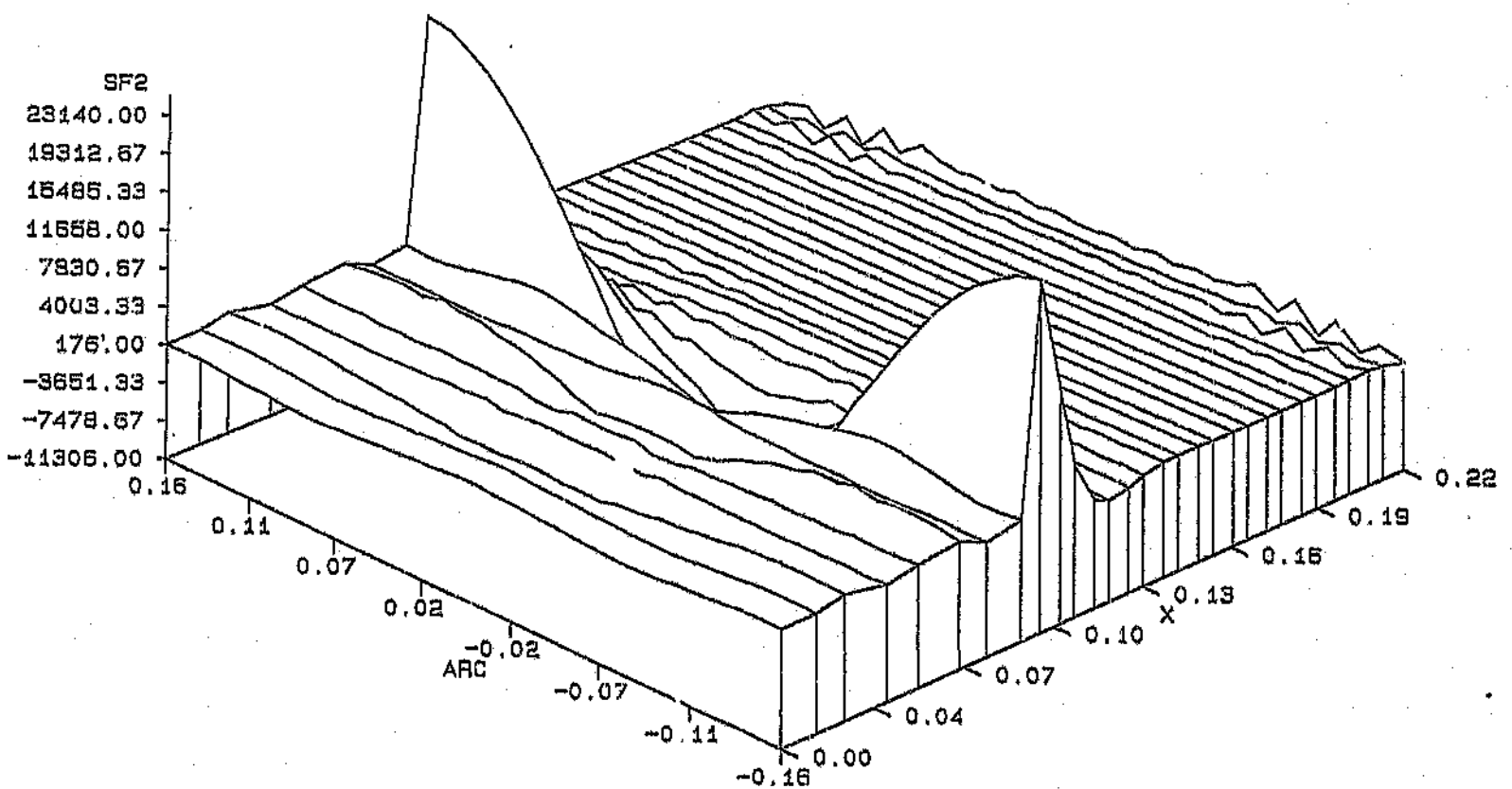


Figure U4 FEM circumferential force resultants N_ϕ superimposed on the "unrolled" tube.

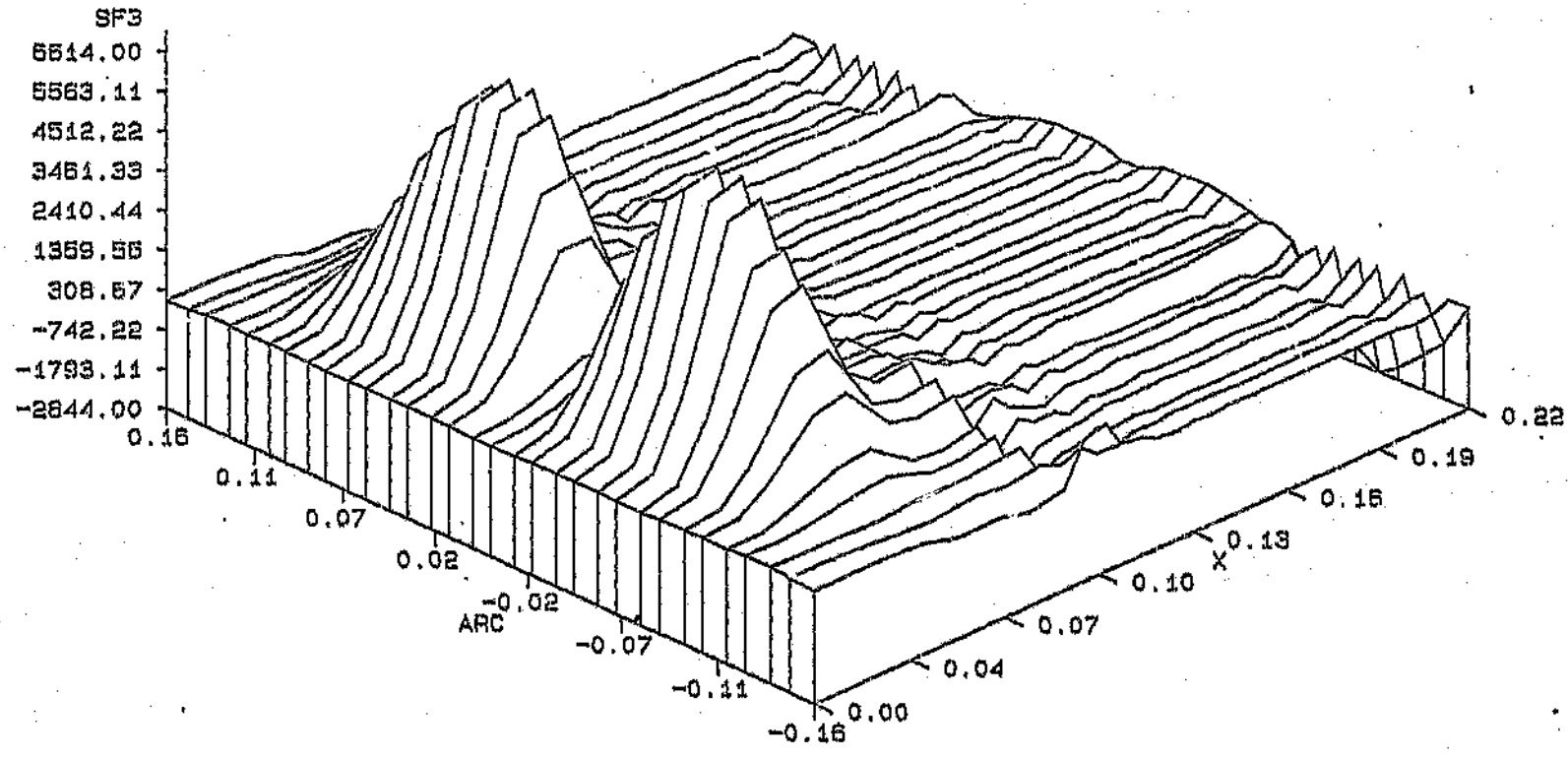


Figure U5 FEM inplane shear force resultants Nx_ϕ superimposed on the "unrolled" tube.

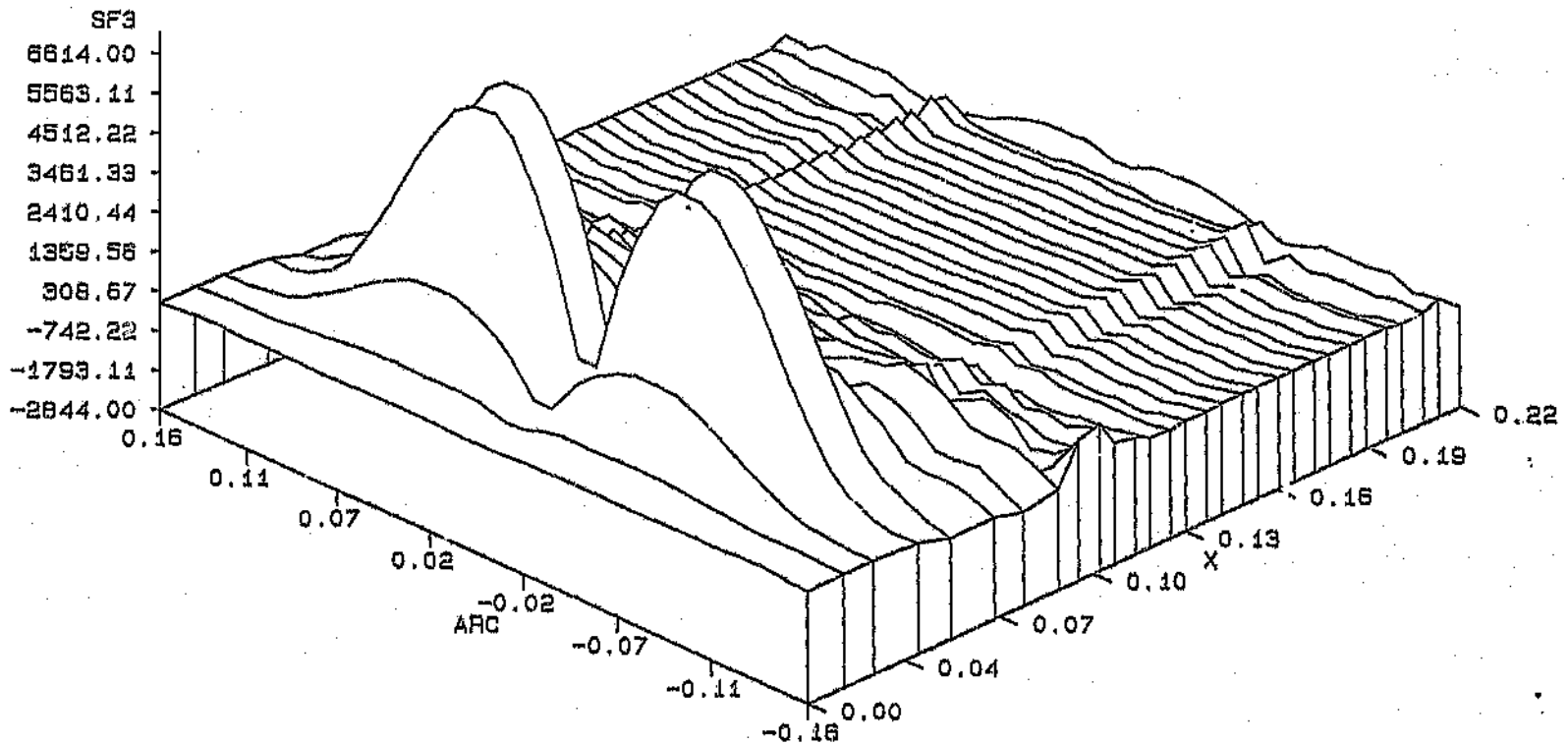


Figure U6 FEM inplane shear force resultants Nx_{ϕ} superimposed on the "unrolled" tube.

APPENDIX V

SELECTED BIBLIOGRAPHY

Booth, D. (1974), A Safty Tanker of the Future, Commercial Motor, 10 May 1974.,pp.38-47.

Brown, R.T. (1987), Computer Programs for Structural Analysis, Engineered Materials Handbook - Composites, ASM International, vol.1, Nov.1987, pp.268-274.

Chassisless RP Tanker Hauls Larger Payloads, R.P. Report, Fibreglass Canada Inc. vol.26, no.3, Autumn 1987.

Chawla, I. (1983), Orthotropic Cylindrical Shells Under Line Load Along A Generator, Computers and Structures, vol.17, no.2, pp.211-216.

Chu, S.C. and Yeung, K.S. (1985), Collapse of Long, Non-Circular, Cylindrical Shells Under Pure Loading, Computers and Structures, vol.21, no.6, pp.1345-1353.

Cunningham, M. A., Safer Way to Carry Eggs at 60 mph, Article from a British Trucking magazine.

Desai, R.R. (1972), Design and Application of Balsa cored Reinforced Plastic Tanks for Storage and Transportation of Chemicals, Proc. 27 SPI Conf., sect.7A, pp.1-8.

Didak Tankers and Underground Storage Tanks, Reinforced Plastics, Dec.1971.

Dow Chemical, Tank Truck Linings from Derakane Vinyl Ester Resins - Best for the Long Haul., Dow Chemical Technical Brochure.

Dropek, R.K. (1987), Numerical Design and Analysis of Structures, Engineered Materials Handbook - Composites, ASM International, vol.1, Nov.1987, pp.461-470.

Dyle C.E. and Brown, G. (1977), The Design, Fabrication and Strain Gauge Testing of a Twelve Foot Diameter Furan Tank for Elected Pressure Service, Proc. 32 SPI Conf., sect.10C, pp.1-7.

Fibre Glass Tanker, Engineering, June 1970, pp.533.

Flanagan, G. and Palozotto, A. (1986), Composite Laminate Optimization Program Suitable fo Micro Computers, Computers and Structures, vol.22, no.6, pp.995-1009.

FRP tanker trucks offer major advantages over steel, FRP Tank Trucks, Fibreglass in Action, case studies.

Galicia, J.L. (1984), Bending vs Membrane Theory in the Design of Fluid Filled, Circular, Cylindrical Shells, Computers and Structures, vol.18, no.6, pp.1005-1008.

Giacofci, T.A. (1981), Modelling Techniques for Adina Analaysis of Stiffened Shell Structures, Computers and Structures, vol.13, pp.601-605.

Gloster Saro Ltd, Filament Wound Tankers from Gloster Saro, Compass Magazine Press Release, pp.12-15.

Government Report says GRP Tanks for Lorries are Safe, Plastics and Rubber Weekly, Nov.28, 1975.

Gradala, M.E., El Madany, M.M. and Galala, M.S. (1986), Finite Element and Analytical Modelling of a Tractor-Semi Trailer Vehicle, Computers and Structures, vol.23, no.6, pp.831-836.

Greenzweig, J. and Moulson, and T. Grasshopper (1982), A Filament-Wound Railroad Hopper Car Resin Development, Proc. 37 SPI Conf.,

sect.4P, pp.1-4, and section 4E, pp.1-5.

GRP Tanker for Scott Bader, Reinforced Plastics, Apr.1966.

J Coudenhove Gmbh, Saving Energy-with GRP Road Tankers, Press Release, J Coudenhove GmbH.

Jun, S.M. and Hong, C.S. (1988), Buckling Behaviour of Laminated Composite Cylindrical Panels Under Axial Compression, Computers and Structures, vol.29, no.3, pp.479-490.

Karihaloo, B.L. and Kanagasundaram, S. (1988), Optimum Structures under Strength and Stiffness Constraints, Computers and Structures, vol.28, no.5, pp.641-661.

Kilber, J.J. (1987), Software for Composite Materials Analysis, Engineered Materials Handbook - Composites, ASM International, vol.1, Nov.1987, pp.273-281.

Leavesley, P.J. and Knight, C.E. (1987), An Analytical Model of Strength Loss in Filament Wound Spherical Vessels, ASME-Journal of Pressure Vessel Technology, vol.109, Aug.1987.

Mattram, J.T. and Selby, A.R. (1987), Bending of Thin Laminated Plates, Computers and Structures, vol.25, no.2, pp.271-280.

M & G Tankers, (1978), Tanker of the '80s - in GRP, Plastics and Rubber Weekly, 20 Oct.1978.

Morley, L.S.D. and Mould, M.P. (1987), The Role of Bending in the Finite Element Analysis of Thin Shells, Finite Elements in Analysis and Design, no.3, pp.213-240.

Noor, A.R. and Peters, J.M. (1988), Error Indicators and Accuracy Improvement of Finite Element Solutions, Engineering Computer Structures, Mar.1988, vol.5.

Petrol Tanker of the Future, Chemical Age, 24 May 1974, pp.15.

Quigley, J.J. (1982), Computer Aided Design of Composite Systems, Proc. 37 SPI Conf., sect 14-b, pp.1-13.

Reddy, J.N. and Pandey, A.K. (1987), A First Ply Failure Analysis of Composite Laminates, Computers and Structures, vol.25, no.3, pp.371-393.

Reducing the Risk of Transporting Petrol, Commercial Transport, Jan.1979, pp.10.

Regers, C.A. and Knight, C.E. (1988), An Axisymetric Linear / High Order Finite Element for Filament-Wound Composites - II - Evaluation of Filament Wound Cylinders, Computers and Structures, vol.29, no.2, pp.273-1988.

Rogers, C.A. and Knight, C.E. (1988), An Axisymetric Linear / High Order Finite Element for Filament-Wound Composites - I - Formulation and Algorithm, Computers and Structures, vol.29, no.2, pp.265-271.

RP Tankers Approved for Gasoline Deliveries, New developments in Fibreglass Reinforced Plastics (FRP), Autumn 1986, vol.25, no.3.

RP Tankers Approved for Gasoline Deliveries, R.P. Report, Fibreglass Canada Inc., vol.25, no.3, Autumn 1986.

Saidla, W. (1972), The Whitney Process for the Manufacture of Filament Wound Cargo Containers and Truck Trailers, Proc. 27 SPI

Conf., sect.6C, pp.1-10

Scott Bader, One for The Road, Scott Bader Press Release.

Scott Bader, New RP Tanker for Scott Bader, Press release Scott Bader.

Scott Bader, Road Tanker Moulded in Reinforced Polyester, Scott Bader Press Release, Oct.1968.

Sheiman, I. Shaw D. and Simites, G.J. (1983), Non-Linear Analysis of Axially-Loaded Laminated Cylindrical Shells, Computer and Structures, vol.16, no.1, pp.131-137.

Silenka Information 1972 no.11, Transportation of Hazardous Substances in Plastic Tanks Reduces Fire Risks, pp.24.

Silenka Information 1972 no.12, Clean Transportation in GRP Tanks, pp.25.

Sussman, T. and Bathe, K.J. (1985), Studies of Finite Element Procedures - on Mesh Selection, Computers and Structures, vol.21, no.1, pp.257-264.

Steps Nearer to the GRP Road Tanker, Reinforced Plastics, Oct.1978, pp.338-340.

Tanker of the '80s - in GRP, Plastics and Rubber Weekly, Oct.20, 1978, pp.66.

Thevendian, I. (1988), A Numerical Approach to the Analysis of Circular Cylindrical Water Tanks, Computers and Structures, vol.23, no.3, pp.379-386.

Tou, S.K. and Wong, K.K. (1987), High Precision Finite Element Analysis of Cylindrical Shells, Computers and Structures, vol.26, no.5, pp.847-854.

Ventatesh, A. and Rao K.P. (1982), Analysis of Laminated Shells of Reduction with Laminated Stiffeners Using a Doubly Curved Quadrilateral Finite Element, Computers and Structures, vol.20, no.4, pp.669-682.

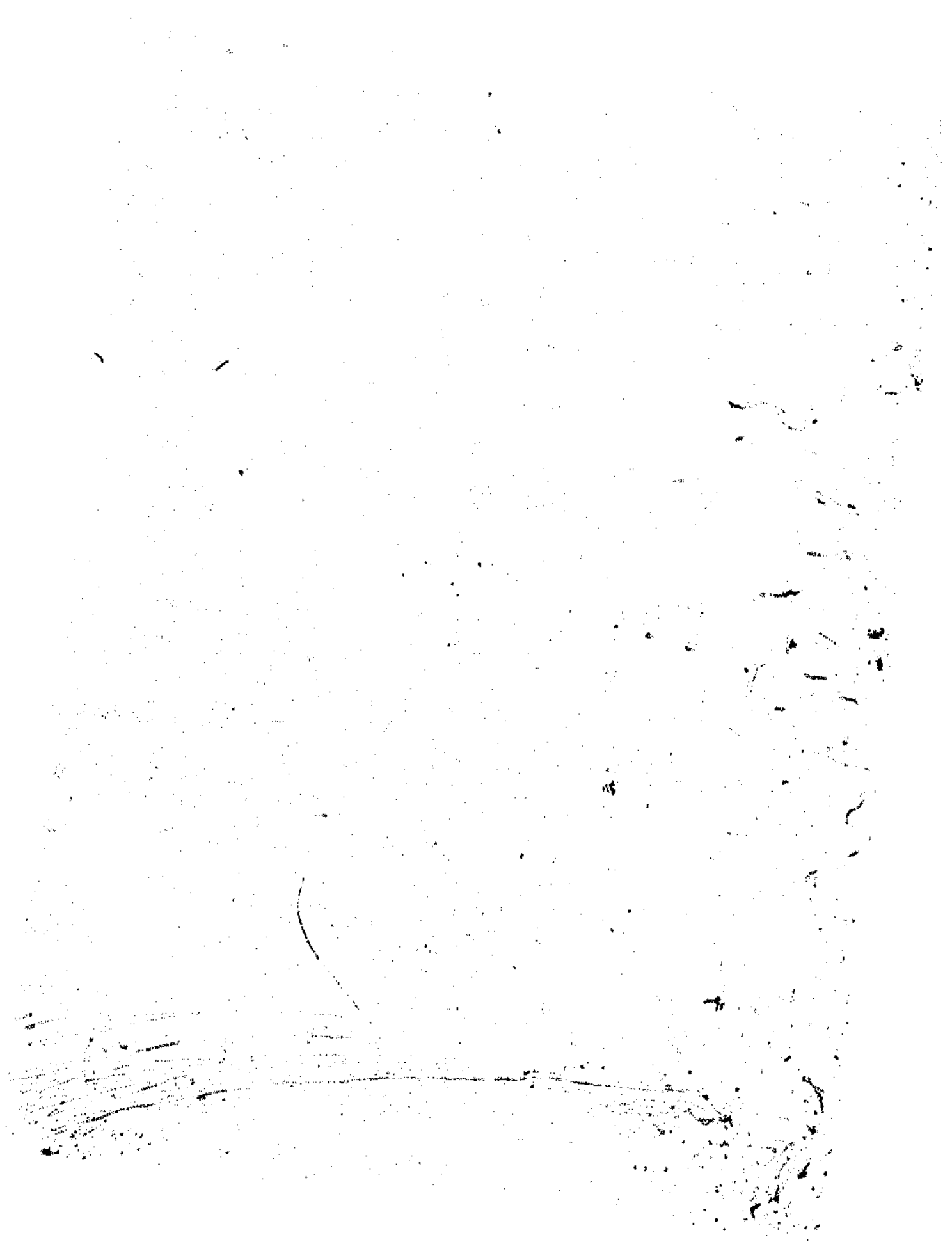
Venkatesh, A. Ramana, P.V. and Rao, K.P. (1986), Finite Element Analysis of Bimodulus Composite Stiffened Thin Shells of Revolution, Computers and Structures, vol.22, no.1, pp.13-24.

Villard, V., Bang, L. and Palazotto, A.N. (1983), Instability of Short Stiffened Composite Cylindrical Shells Under Bending with Pre-Buckling Displacements, Computers and Stuctures, vol.16, no.6, pp.773-775.

Whitney, J.M. (1973), Shear Correction Factors for Orthotropic Laminates Under Static Load, Journal of Applied Mechanics, Transaction of the ASME, Mar.1973, pp.302-304.

Whitney, J.M. and Pagano, N.J. (1970), Shear Deformation in Heterogeneous Anisotropic Plates, Journal of Applied Mechanics, Trans ASME Dec.1970, pp.1031-1036.

W.P. Butterfield (Engineers) Ltd GRP, Tanker for BP Oil, Press Release



Author: Armbruster Michael Hermann.
Name of thesis: The Effect Of Liquids On The Stress Distribution In A Glass Fibre Reinforced Plastic Road Tanker.

PUBLISHER:
University of the Witwatersrand, Johannesburg
©2015

LEGALNOTICES:

Copyright Notice: All materials on the University of the Witwatersrand, Johannesburg Library website are protected by South African copyright law and may not be distributed, transmitted, displayed or otherwise published in any format, without the prior written permission of the copyright owner.

Disclaimer and Terms of Use: Provided that you maintain all copyright and other notices contained therein, you may download material (one machine readable copy and one print copy per page)for your personal and/or educational non-commercial use only.

The University of the Witwatersrand, Johannesburg, is not responsible for any errors or omissions and excludes any and all liability for any errors in or omissions from the information on the Library website.